Shrewsbury Town Council

SHREWSBURY BIG TOWN PLAN

ZERO CARBON SHROPSHIRE

Zero Carbon Shropshire
A Strategy to Develop an Energy Network Shrewsbury Town Centre

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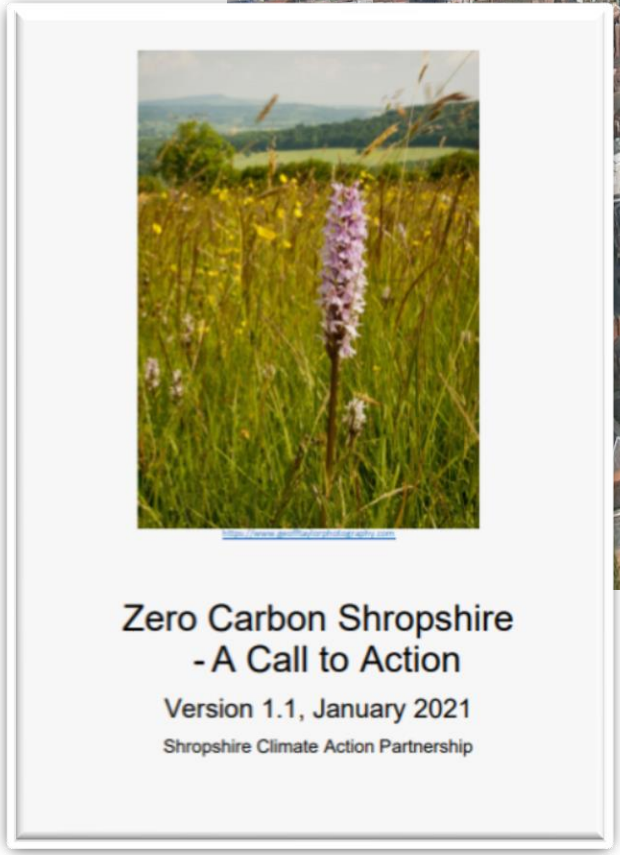
ZCS

15 July 2021

Zero Carbon Strategy – Context

- Big Town Plan
- Regional planning policies
- Local synergy Big Town Plan
- Town Centre Regeneration
- Declared Climate Emergency
- **ZCS "Call to Action"**
- Energy security
- Decarbonising the grid
- Fuel poverty
- Corporate Carbon reduction targets



History of Heat networks

1950s – 60s

Many large public sector housing developments had district heating from central boilers

1970's- 80s

Combined heat and power (CHP) becomes common central plant using gas fired CHP palnt. Housing developments and most hospital sites took this approach

1990's - present

Seen by Government as a route to decarbonising heat networks have moved away from CHP and gas to low carbon sources, energy from waste and heat pumps

Increasingly **Energy Networks** providing heat, cool and power

Heat networks go back to the Roman times

What is a Low Carbon Heat network ?

A network comprises three elements:

Low carbon heat source

Heat pump, waste heat, sea water are examples

A piped distribution network linking all the users

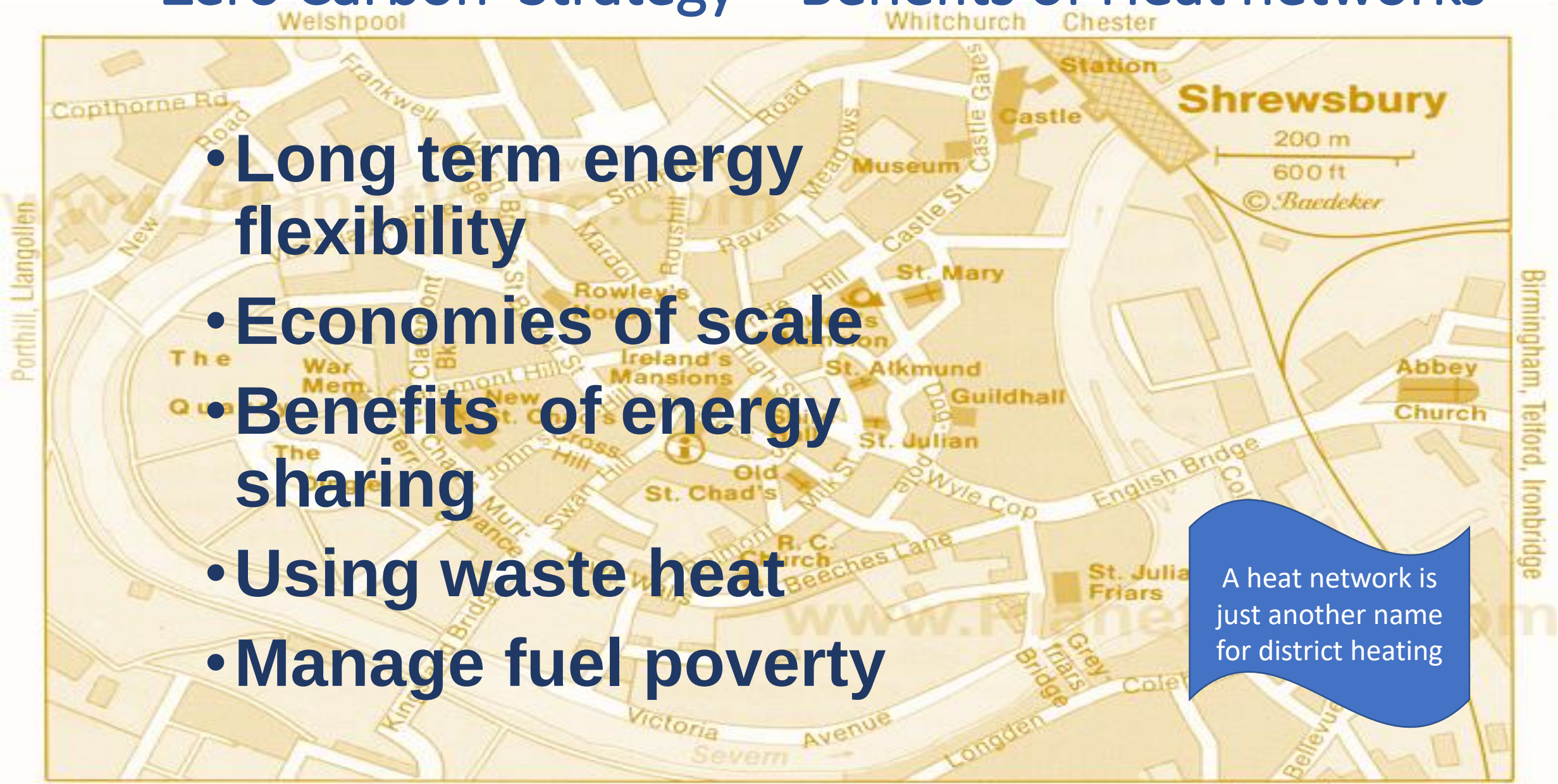
Normally pipes are buried just like gas mains

Metered Heat exchangers in each property

Heat use is measured and billed

Government want 16% of all our buildings on heat networks

Zero Carbon Strategy – Benefits of Heat networks



- Long term energy flexibility
- Economies of scale
- Benefits of energy sharing
- Using waste heat
- Manage fuel poverty

A heat network is just another name for district heating

Zero Carbon Strategy – Benefits of Heat networks

- **Long term energy flexibility**

Over time new low carbon heat sources can be "plugged in" to the network as new technologies evolve

- **Economies of scale**

By combining load profiles peak loads are balanced-out with a much lower combined peak

- **Benefits of energy sharing**

Where heating and cooling exist simultaneously that energy can be shared across the network.

- **Using waste heat**

Heat mapping identifies waste heat sources from industry and commerceas well as energy from waste Once a network is established it is economic to "plug in" even small recovered heat loads

- **Manage Fuel Poverty**

Providing heat from a managed system can ensure no household suffers

Heat networks go back to the Roman times

Zero Carbon Strategy – Benefits of Heat networks

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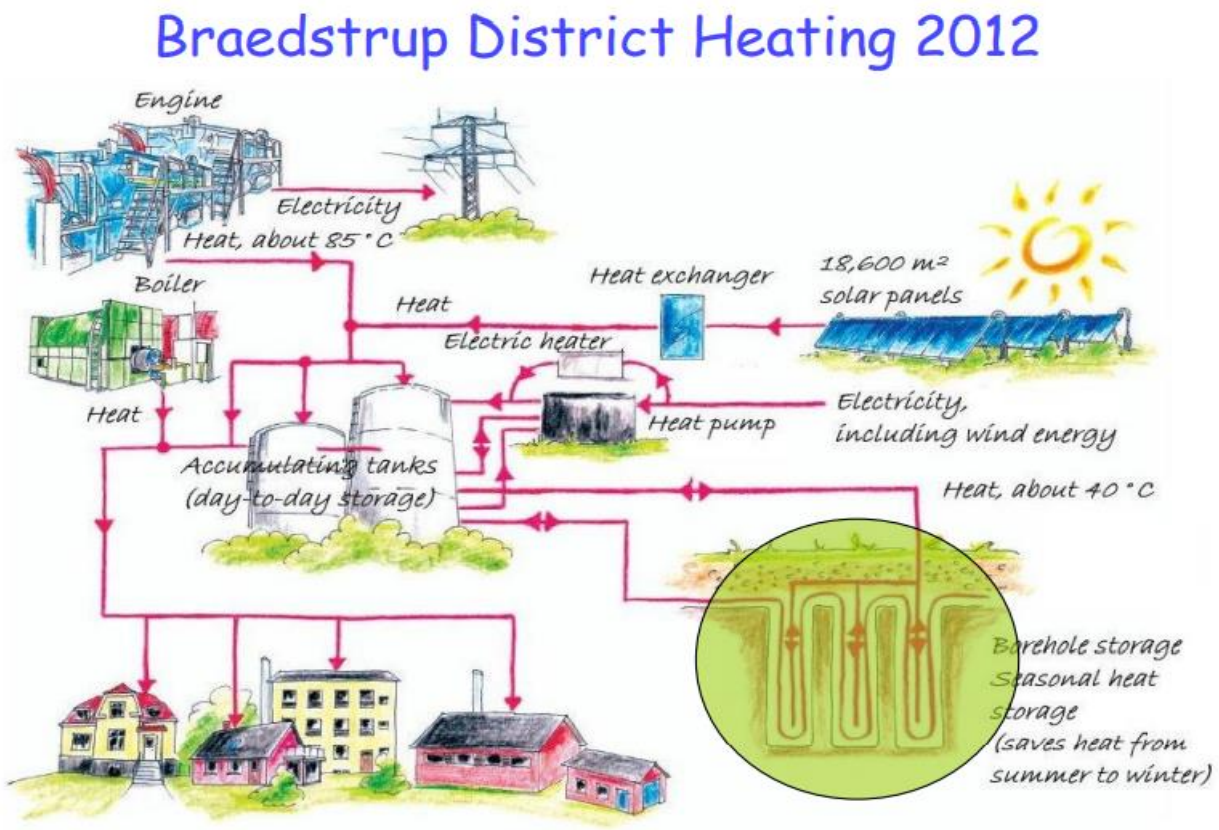

Zero Carbon Strategy – Benefits of Heat networks

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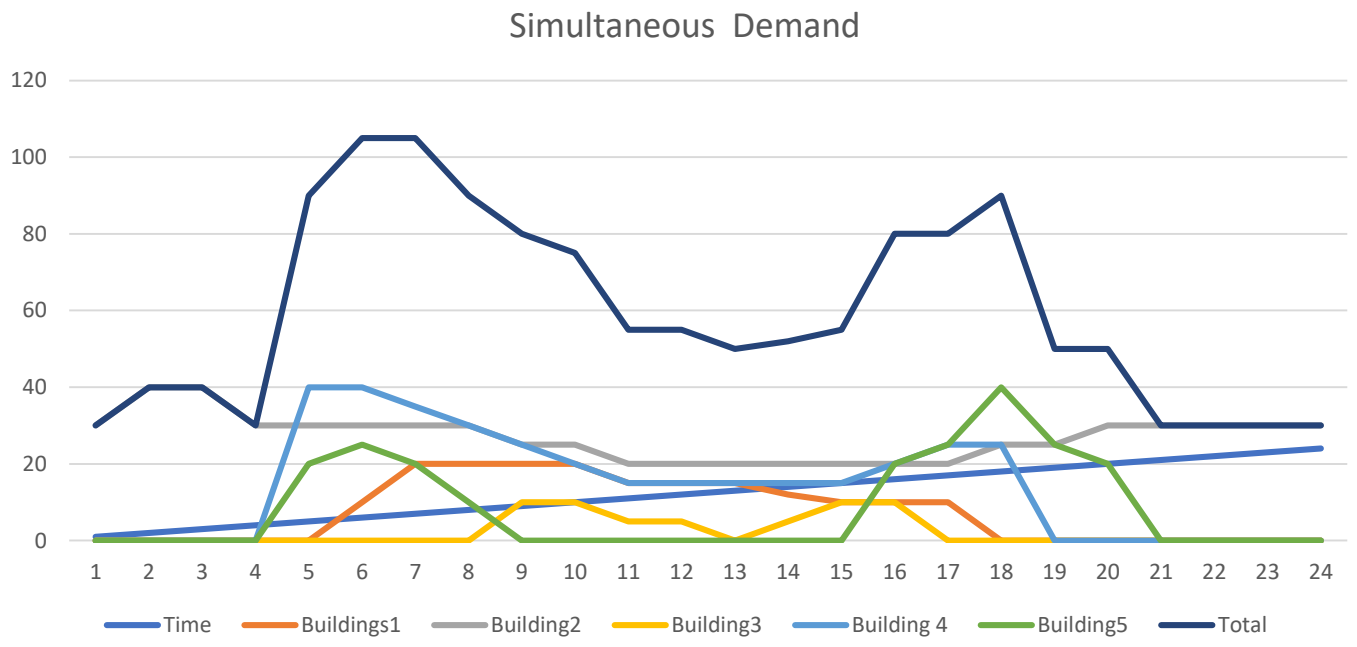


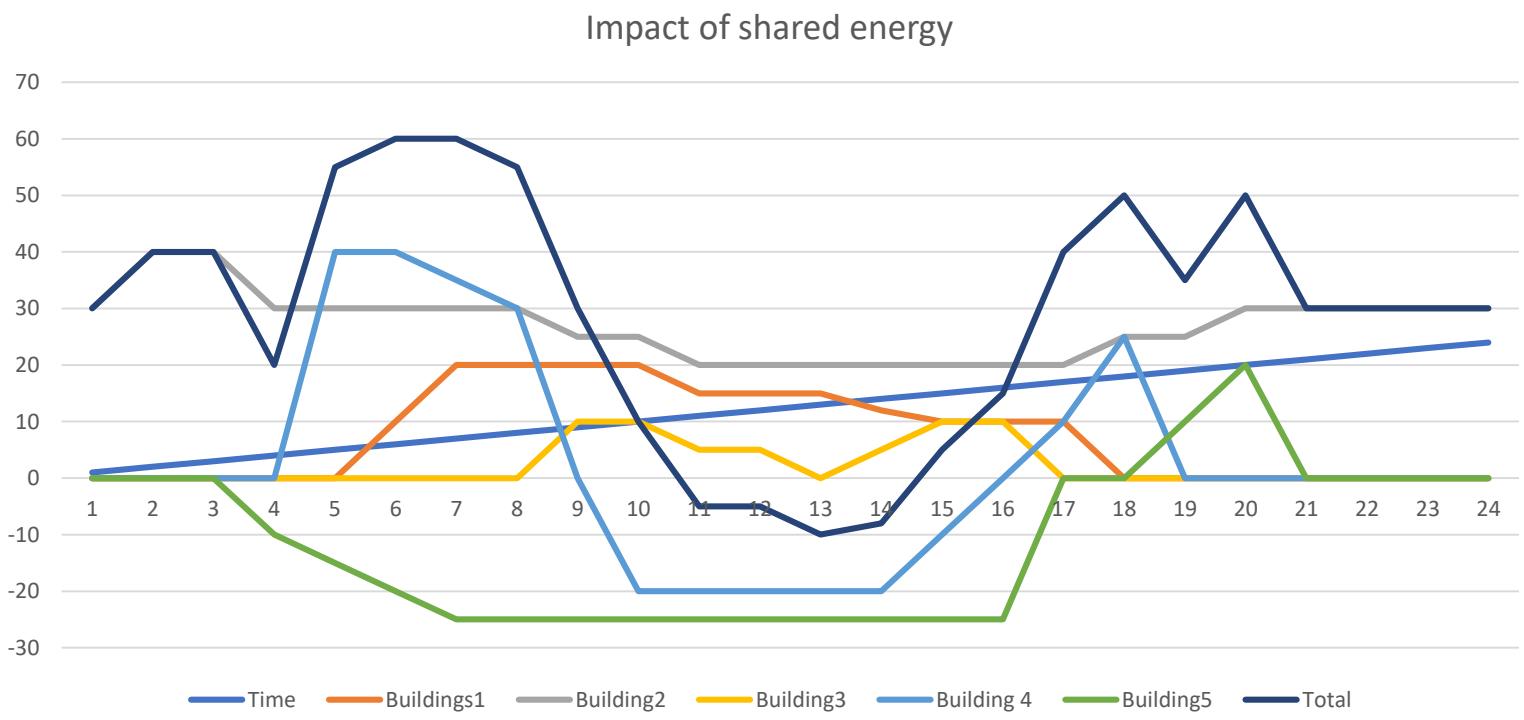
Sum of individual peaks
150 kW

Simultaneous peak
105 kW

Zero Carbon Strategy – Benefits of Heat networks

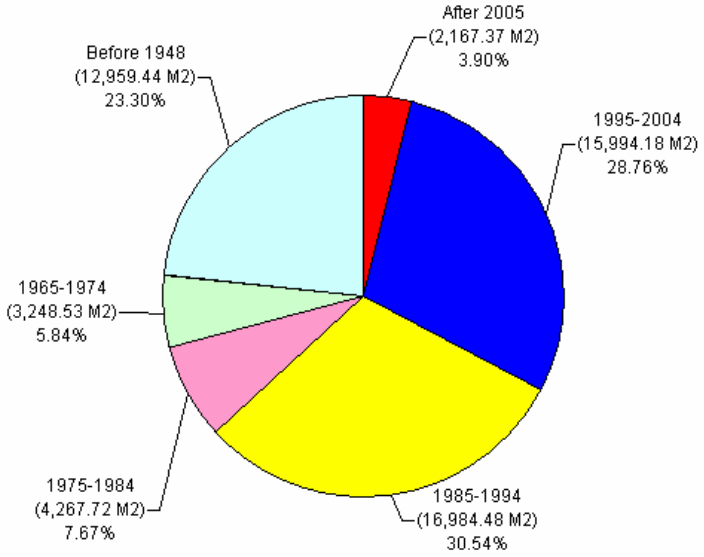
- **Benefits of energy sharing**

Where heating and cooling exist simultaneously that energy can be shared across the network.

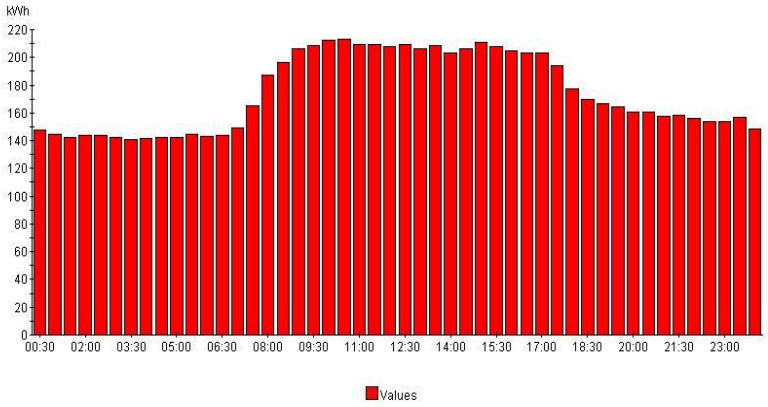


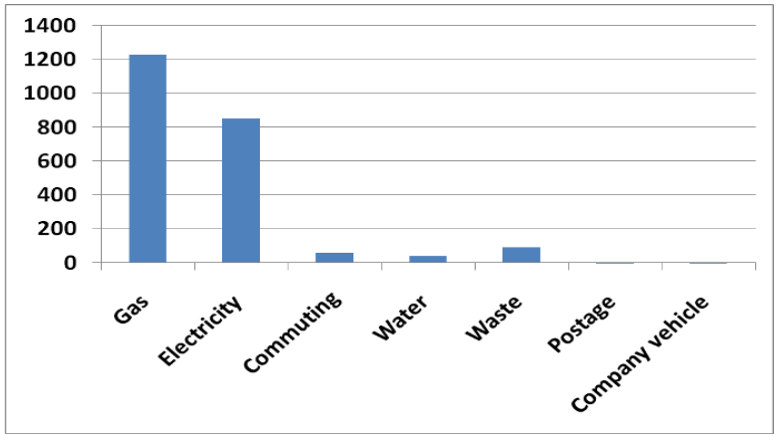
First Step : Evaluate the energy demand

- Evaluate impact of energy efficiency measures
- Energy benchmarking
- Carbon Footprinting
- Gather available data, energy records, EPC and DEC certificates, ESOS data
- Planned new build, statistical data and modelling



EXISTING BUILDINGS HEAT DEMAND SHOULD BE REDUCED AS MUCH AS POSSIBLE





Second Step : Carry people with you

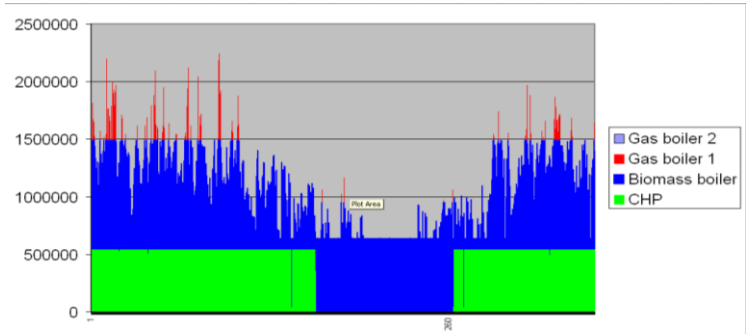
- Explain
- Teach
- Enthuse
- Regular workshops

Third step : Energy Mapping

From load profiles – allowing for predicted energy reductions - develop a “live” energy map using mapping tools.

Although providing a clear visual presentation the map must also carry energy analysis- **with a time line** – to inform system capacity and performance evaluation as it evolves over time .

Most link with existing GIS formats



Third step : Energy Mapping

Example of Thermos modelling software

THERMOS heat network assessment

Fourth Step : Evaluate Network Technologies

Type 1 Medium Temperature 80 – 150 ^{O}C

Commonly the basis of earlier district heating systems

Sources	Industrial Waste heat	None available
	Heat from incinerators	Poss Battlefield
	Combined heat and power	No carbon benefit unless biofuel
	Biomass boilers	Carbon and transport issues

Type 2 Lower temperature 55- 65°C

Larger pipes and pumps,less standing heat losses needs good insulation

Sources	Biomass boilers	Carbon and transport issues
	Centralised Heat pumps	Poor CoP above 60 ^{O}C

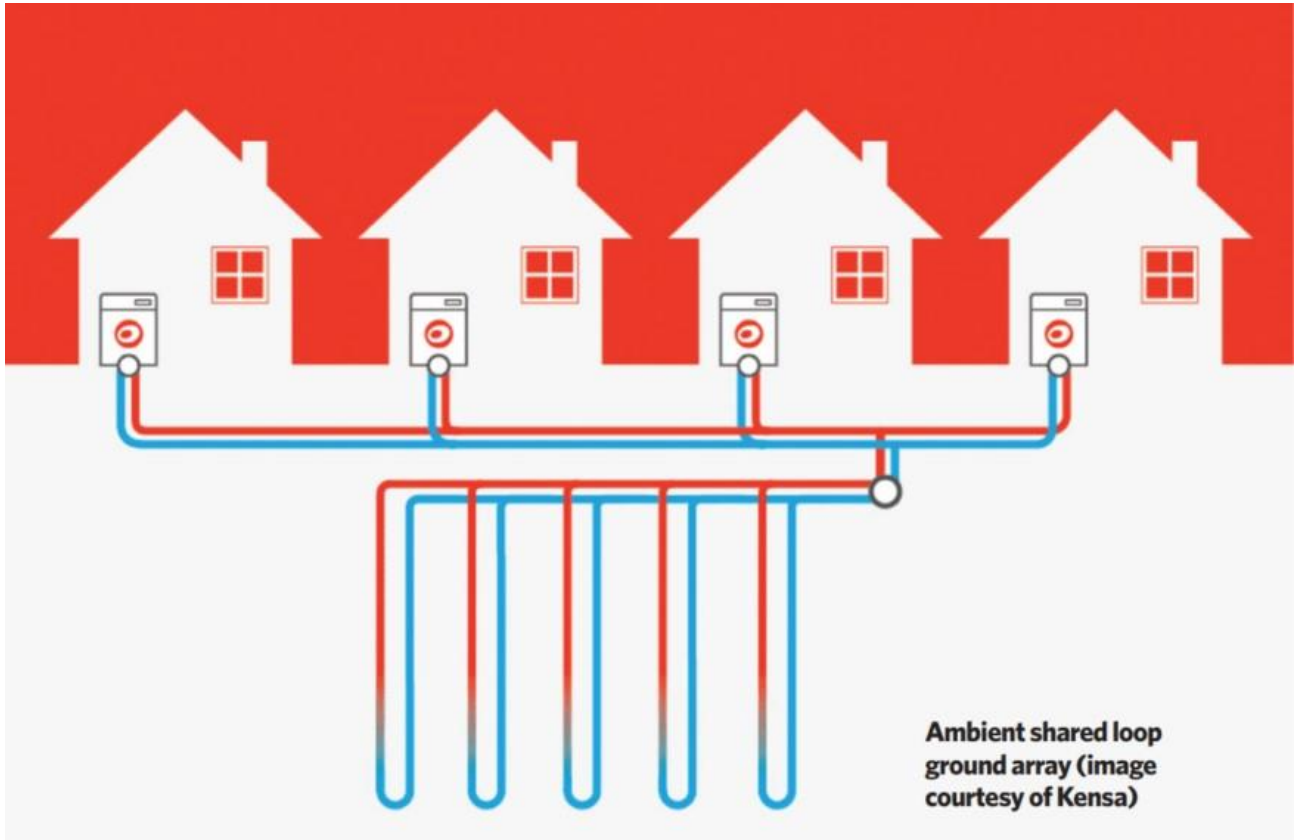
Type 3 Ambient temperature 20 OC

Larger pipes but no insulation Can be higher pump energy

Sources	Decentalised heat pumps	Higher CoP than individual systems

Evaluate a Shrewsbury Network

Ambient loop network options



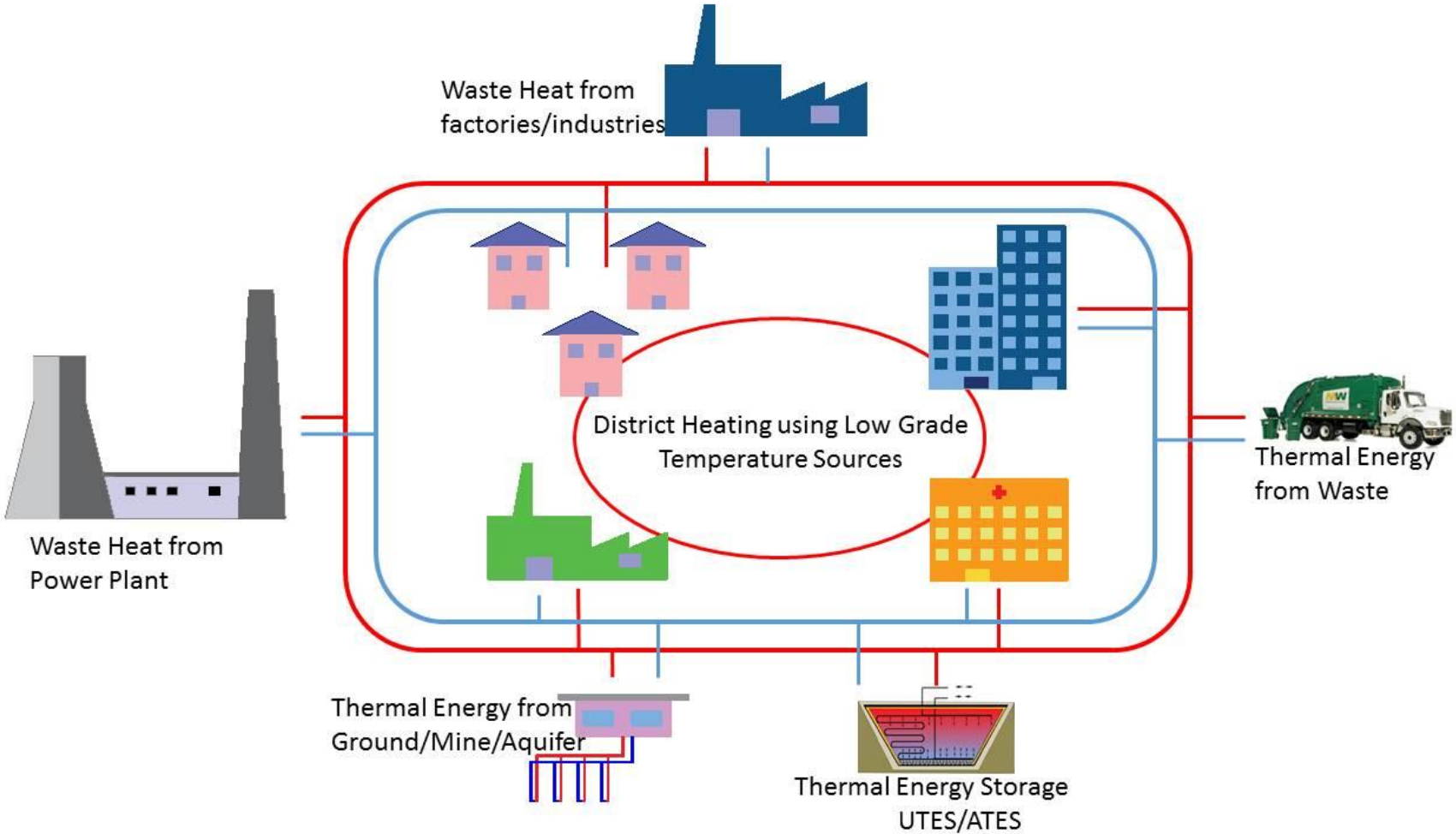
Ambient shared loop ground array (image courtesy of Kensa)

A key benefit of any shared-loop network is reduced capital expenditure (capex) of the network.

The operating temperatures mean the pipework can be installed in plastic pipe and retain an extended working life. This pipework can be uninsulated in most situations, and have external insulation added easily for required sections.

As such, network infrastructure costs are lower than the installation of high-temperature DHN systems

Evaluate a Shrewsbury Network
Incorporating Storage



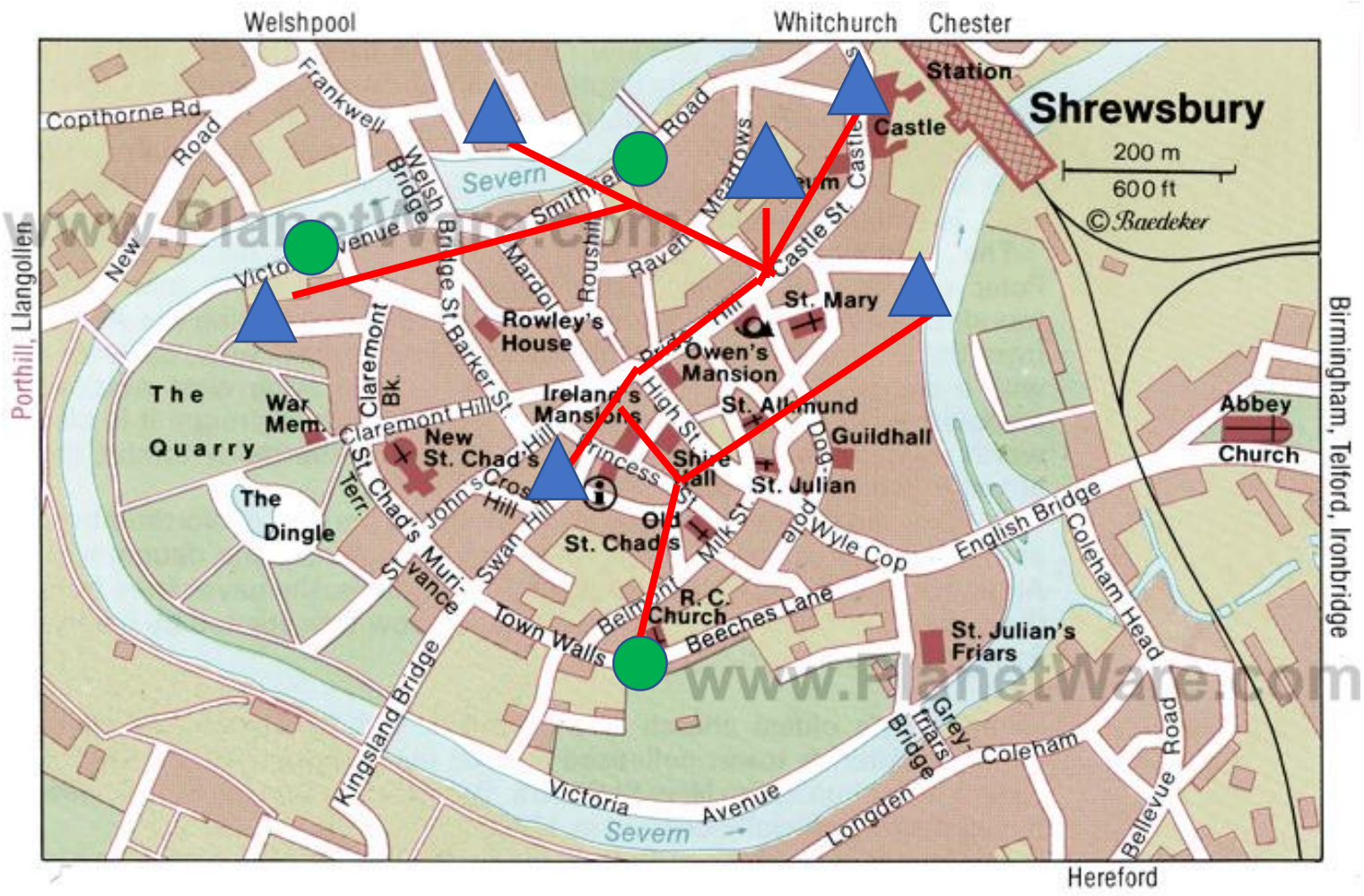
Water vessels generally used to store heat. Problems of heat loss

New phase change materials store more heat in a controllable way

A heat store can be the interface between primary and secondary circuits or to link two primary circuits

The ground can be used as a 12 month cycle heat store.

Fifth Step : Plan a Network Route

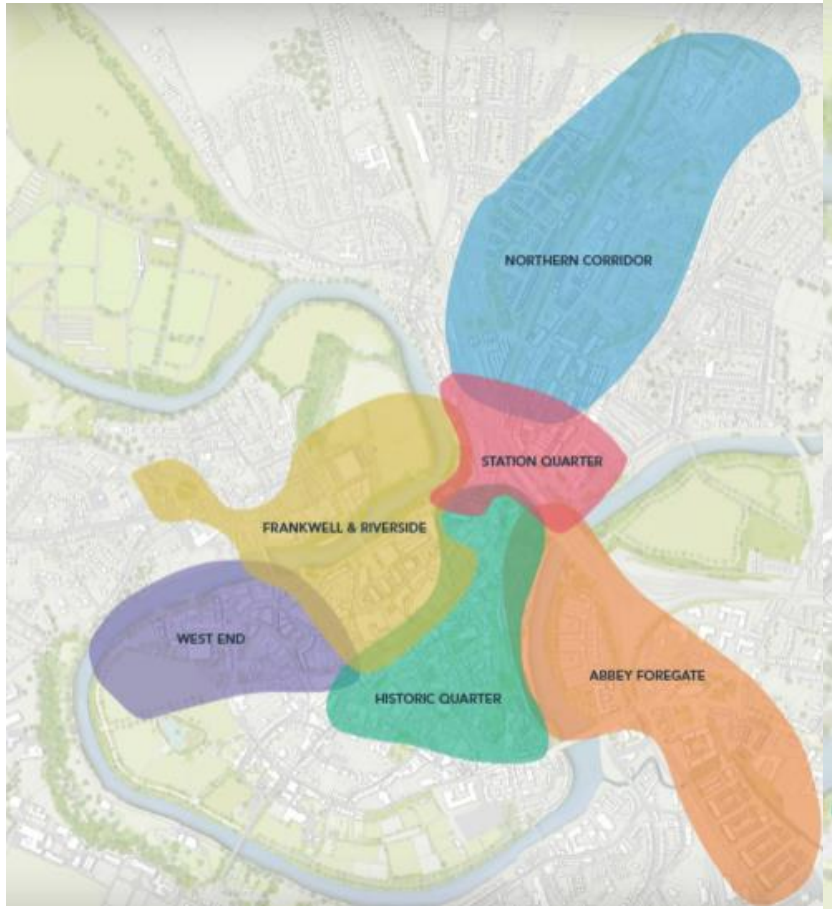


Anchor loads

New build designed for network

A Battlefield network could "daisychain" with a Town Centre nrework

Working with Big Town Plan



Sixth Step : Building Energy Efficiencies

Basic rule for the network

- It is essential every connected property has reduced energy demand as far as possible
- A programme of advice and implementation of efficiency measures must be undertaken before network loads are finalised
- This may be an integrated element of a total network delivery contract

Seventh Step : Delivery and Operation

- Local Authority through conventional contracts
- Special Purpose Vehicle
- Specialist Provider
- Government support HNDU HNIP

Funding

Government support

HNDU and **HNIP**

The list is for Oct- Dec 2020

Projects at implementation stage

Location	Value /scale	Heat source
HNIP funding application stage		
Shoreham	£8.0 m	Seawater source heatpumps plus gas CHP
Bridgend	£4.2 m	Gas fired CHP
Bristol Market	£18.2 m	Water source heat pumps plus gas CHP
Bristol Temple plus 3 others	£20.5 m	Water source heat pumps plus gas CHP
Swaffham	£7.3 m	Ground source heat pump
Cardiff	£15.6 m	CHP plus energy from waste
Bloomsbury	£22.7 m	Water source from sewers plus chiller waste heat
Exeter	Not available	CHP plus Energy from Waste
Seaham Durham	£9.5 m	Water source heat pumps from mine water
Cranbrook Devon	£20.8 m	CHP plus energy from waste
Beverley Yorks	£11.9 m	Ground source heat pump
Goole	£27.0 m	Ground source heat pump
Gateshead plus 1 other	£15.6 m	Water source heat pumps from mine water
Hull	£18 m	CHP plus energy from waste
Isle of White	£8.0	CHP plus energy from waste
Knowsley	Not provided	Gas CHP
Rowenham	£5.3 m	Gas CHP
Leeds phase2	£6.0 m	CHP plus energy from waste
Liverpool plus 2 other	£39.9 m	Water source heat pump
Alder Hey	Not provided	Ground source heat pump
Dagenham	Not provided	Gas CHP
Bexley	£35.4 m	CHP plus energy from waste
Enfield plus 1 other	£48.0 m	CHP plus energy from waste
Tottenham	£29.5 m	CHP plus energy from waste
Wood Green	£30.0 m	CHP plus energy from waste
Newcastle Uni	£6.0 m	CHP bio-gas
Rotherham	£16.0 m	Bio – mass boilers
Sheffield expansion	Not provided	CHP plus energy from waste
Porton Down	£12.0 m	Gas CHP
Worthing	£8.0 m	Ground source heat pump
Commercial stage		
Westminster	£15.0 m	Gas CHP
Alderley Park	Not provided	Ground source heat pump
Crawley	£6.5 m	Gas CHP
Huddersfield	£16.5	CHP plus energy from waste
Tottenham	£10.6 m	Gas CHP
Sandwell	£11.1 m	Water source (canal) plus gas boilers
Middlesbrough	£30.0 m	Gas CHP
Feasibility stage	27 projects	
Master plan mapping stage	7 projects	

Final Step : Delivery and Operation

But remember this

<u>Nothing</u> happens till someone turns up with a bag of tools

Thank you for listening

ZERO CARBON SHROPSHIRE

https://www.cibsejournal.com/technical/designing-community-heat-pumps-for-heat-networks/

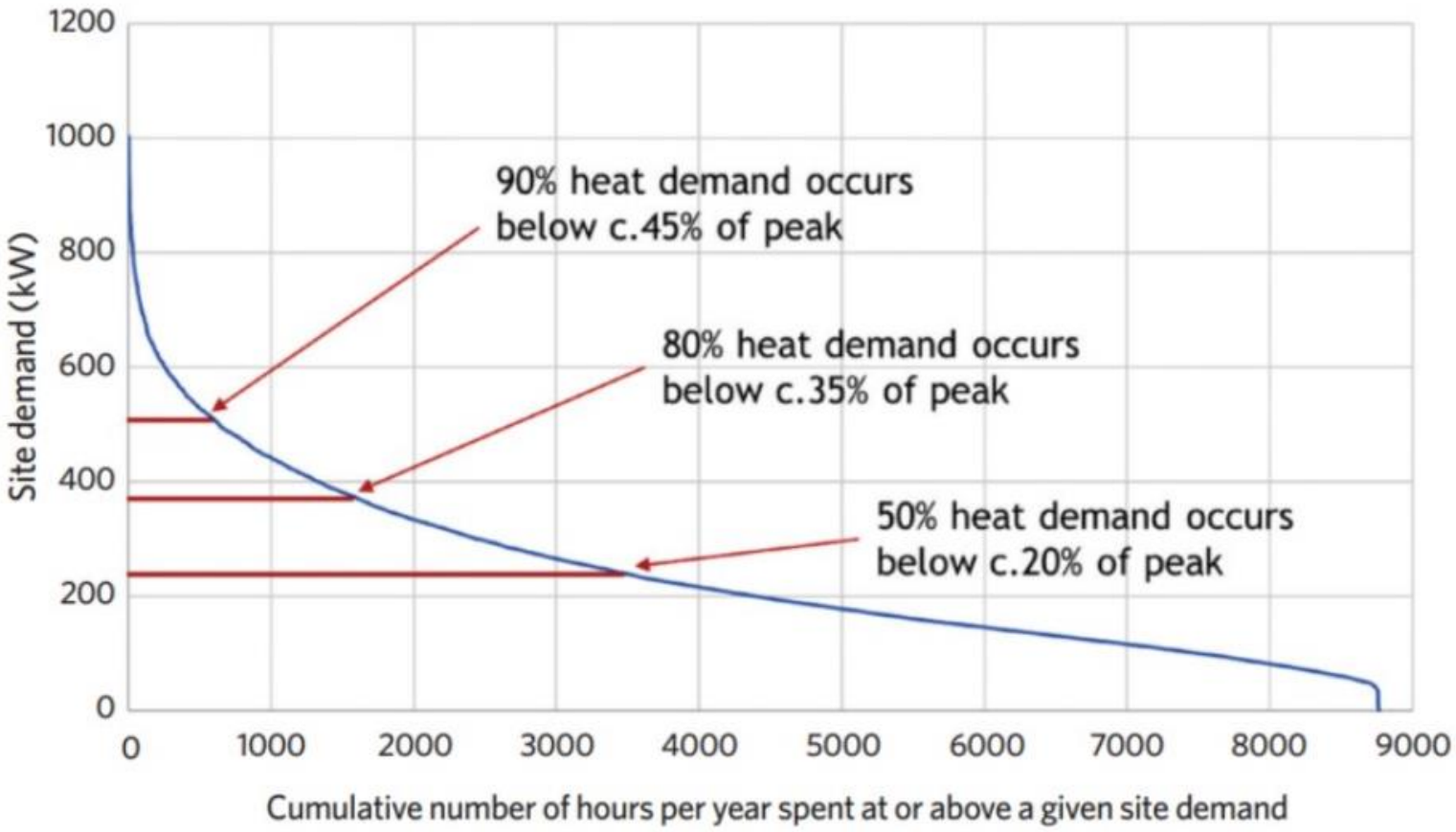


Figure 2: Hourly demand profile for a c.500-unit scheme

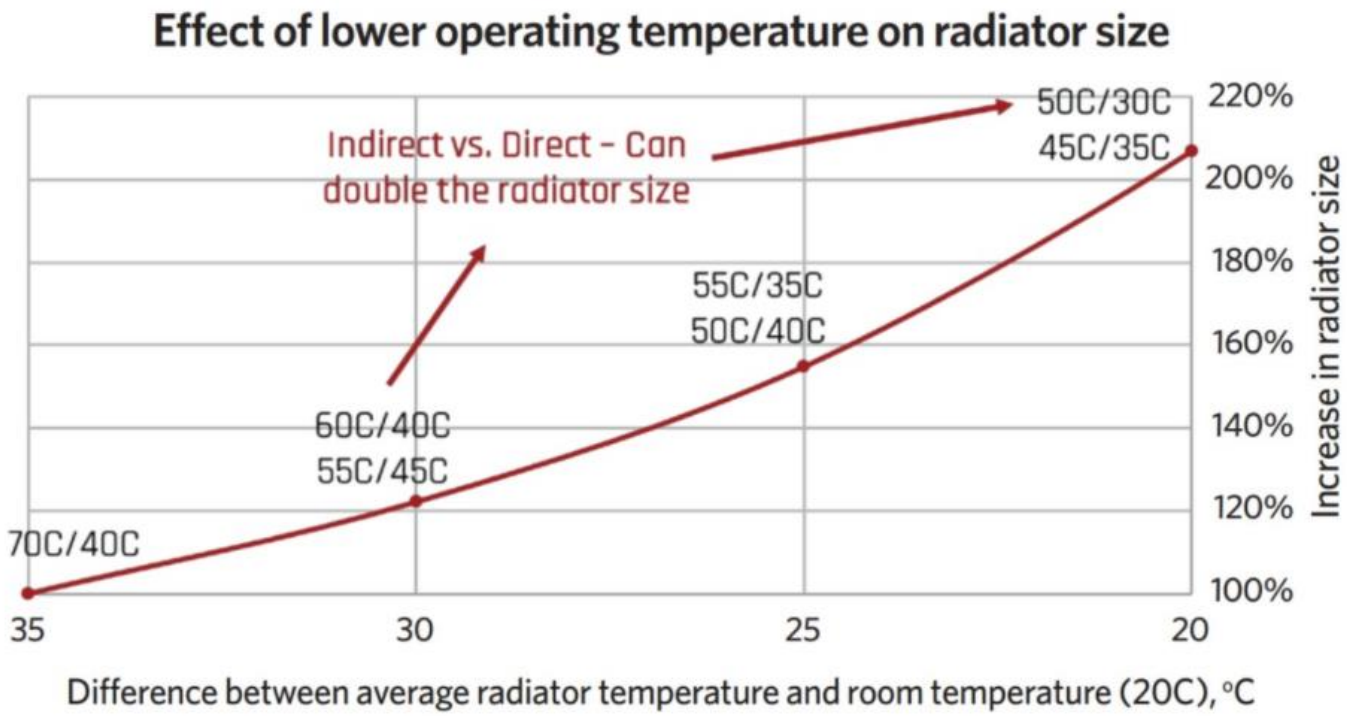


Figure 1: Impact of radiator operating temperatures on unit size

- **Optioneering requires an open mind**
- Optioneering is a critical part of the energy strategy process, particularly with the introduction of new technologies in an uncertain policy and regulatory environment. During the optioneering stage of an energy strategy, there are two fundamental questions developers are faced with for LTHNs with heat pumps:

1. What type of heat pumps should be selected?
2. Where will the heat pumps be located?

- On the first, it is easy to discount ground source heat pumps (GSHP) based on cost, complexity and risk. There is no doubt that due to the infrastructure requirements of the closed- or open-loop bore holes, GSHP systems will cost more £/kW than an ASHP system. However, if rooftop space either holds particularly high value that could be used for alternative means, or the scheme is large and multi-phased, locating all the heat pump on the roof may not be desirable.
- Despite common misconception, closed-loop borehole GSHP systems do not require any permits from the Environmental Agency, this is specific to open-loop systems. It is also possible to drill and install as far as 240 m deep, meaning even highly dense urban developments will often provide sufficient footprint for a baseload heat pump. The key is undertaking the technical due diligence and not discounting the technology prematurely or based on mis-information.
- When it comes to location, hastily disregarding alternative options can lead to ripping up designs 12-months later and starting again with a strategy that was discounted in week one. For ASHP systems, with plant already on the roof, it may be optimal to locate the entire plant on the roof. This can free up ground level space and simplify overall coordination. Weatherproofing will be required but this is not insurmountable.

Approx Energy balance												co2 Factors			
					kg CO2							Grid electricity	0.233	kg CO2e/kWh	
CHP		Heat generated	100	kWh								Nat Gas	0.184		
		Electricity generated	123	kWh								Fuel oil	0.268		
		Gas in	385	kWh	70.7	kg						Bio mass?			
												Coal- domestic	0.345		
		if power to heat pump	492	kW	at EEF 4							LPG	0.214		
		Total heat available	592	kW	direct and via heat pump										
Alternatives to meet that total heat available			592	kWh											
Supply		Gas boiler at 90%	658	kWh	120.9	kg									
		Direct elec at 100%	592	kWh	138.0	kg									
		Grid elec heat pump at EE	148	kWh	34.5	kg									

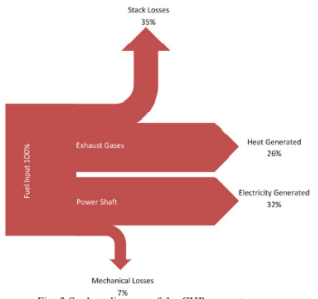


Fig. 3 Sankey diagram of the CHP generator