COTSWOLD DISTRICT COUNCIL

Sustainable construction policies

District heating information paper

December 2023 I Rev D

Levitt Bernstein People.Design

Etude

Operational energy and carbon

Technical evidence base / New buildings only

Recommends specific policies to reduce new buildings' operational energy use, require low carbon heating systems, increase renewable energy generation and ensure that targeted performance is delivered. Demonstrates that they are technically feasible and comments on their viability.

Embodied carbon

Topic paper / New buildings and retrofit

Explains the concepts of upfront embodied carbon and life cycle carbon. Recommends and assesses specific policies.

This document

District heating

Information paper for officers / New buildings and retrofit

Explains the different types of district heating systems, how they compare with an individual heating system and which systems would help to deliver Net Zero.

Retrofit

Topic paper / Retrofit

Articulates the crucial role of retrofit to achieve Cotswold's carbon targets and how the Local Plan (and wider planning system) can better support and incentivise decarbonisation.

This work was led by

COTSWOLD DISTRICT COUNCIL

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The consultant team includes two organisations who have previously collaborated on a range of new construction and retrofit projects, net zero guidance and policy work. It includes architects, engineers, conservation and energy specialists. It brings together a diverse set of skills with a shared ethos of collaboration, practicality, and commitment to accelerate the reduction of carbon emissions from buildings.

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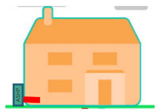
Introduction to the different scales of heating system

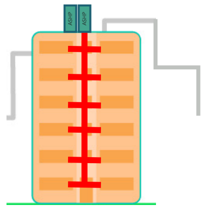
Individual, communal and district heating systems

Heating can be provided from a large number of energy sources in many different system arrangements. These are often categorised into three groups of systems, based on the scale of the heating systems:

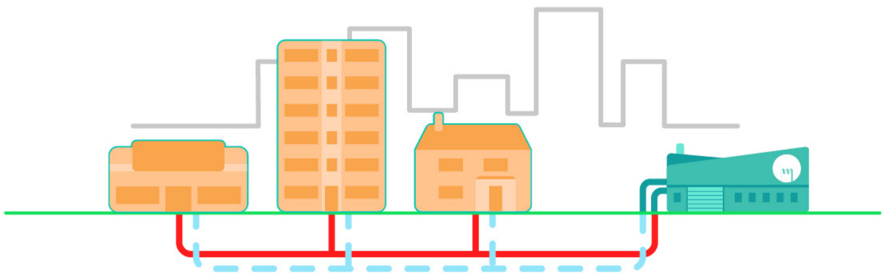
1. **Individual systems** have a single source of heat such as a heat pump, electric radiators or similar, which serves one dwelling.



2. **Communal systems** generally have a single source of heat such as a heat pump, which serves a building with multiple units, most commonly a block of flats.



3. **District systems** have one or more central heat sources such as heat pumps or waste heat sources such as an incinerator or sewer, which serve multiple buildings.



Scale	Advantages	Disadvantages
Individual	• Low distribution losses • Weather compensation • Load compensation • Can use on-site solar • Can easily switch energy suppliers • Eligible for energy price cap	• Maintenance • Space required
Communal	• Fewer larger heat sources may cost less to install and operate than an equivalent number of individual systems • Maintenance may be simpler for landlord • Diversity of load means peak heat demand may be lower than the sum of an equivalent number of individual systems	• Cannot switch suppliers • No energy price cap • Distribution losses • Overheating risk in communal spaces (consequence of distribution losses)
District	• Can use waste heat sources located away from building • Can share multiple heat sources between buildings • Fewer larger heat sources may cost less to install and operate than an equivalent number of individual systems • Maintenance may be simpler for landlord • Diversity of load means peak heat demand may be lower than the sum of an equivalent number of individual systems	• Cannot switch suppliers • No energy price cap • Distribution losses • Overheating risk in communal spaces (consequence of distribution losses)

There are typical advantages and disadvantages of providing heat at different scales, which should be considered when developing policy. In practice, system performance depends on design, installation, commissioning, and operation, so it may vary from what is indicated in the table.

1.0

District heating: the importance of heat sources and distribution systems

Heat sources for district heating

Which heat source is supplying the heat network?

It is important that policy recognises that heat networks are not a heat source, they are just a means of distributing heat at scale around a group of buildings. Policy should clearly differentiate between heat networks which use heat sources that are compatible with net zero and those which are not.

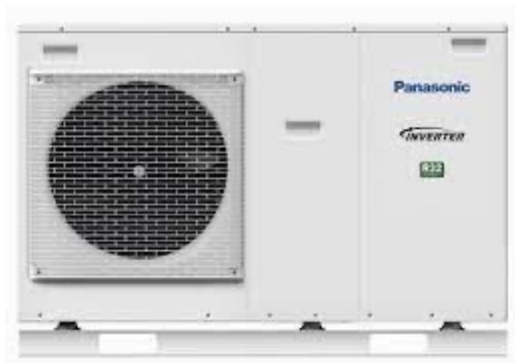
Heat sources compatible with net zero

1. **Heat pumps,** due to decarbonisation of the electricity grid. These can use air, ground, or water as a heat source.
2. **Geothermal energy**, which can be used directly or as a heat source for heat pumps in some locations.
3. **Industrial processes that do not rely on combustion** such as refrigeration, data centres, electricity substations, and subways.
4. **Wastewater**, which can be relatively warm due to discharge of hot water into drains that can provide a heat source for heat pumps.
5. **Minewater**, which can provide a heat source for heat pumps in some locations.

Heat sources not compatible with net zero

1. **Gas boilers,** although it is less common, some networks may use standalone gas boilers.
2. **Gas fired combined heat and power** (and other fossil fuel based thermal power generation). These systems usually also have gas boilers to provide a significant part of the heat demand in winter.
3. **Unabated waste to energy** - these municipal waste incineration plant generate electricity with hot water as waste. through incineration.
4. **Industrial processes that release large amounts of greenhouse gases** such as cement, lime, and iron and steel production.
5. **Unabated combustion of biomass.**

Many heat networks use heat sources such as waste to energy, which are not compatible with delivering net zero emissions. These networks are at high risk of becoming stranded assets. © Renewable Energy World



Heat pumps are compatible with net zero, however they are often more efficient at smaller scales where the flow temperature can be automatically adjusted based on the external temperature. © Panasonic

The evolution of district heating

Heat network ‘generations’

Heat networks have developed through several ‘generations’ over the past century. These are generally defined by their typical energy source and by the temperatures at which the network normally operates. Over time, these operating temperatures have reduced to minimise losses from the networks:

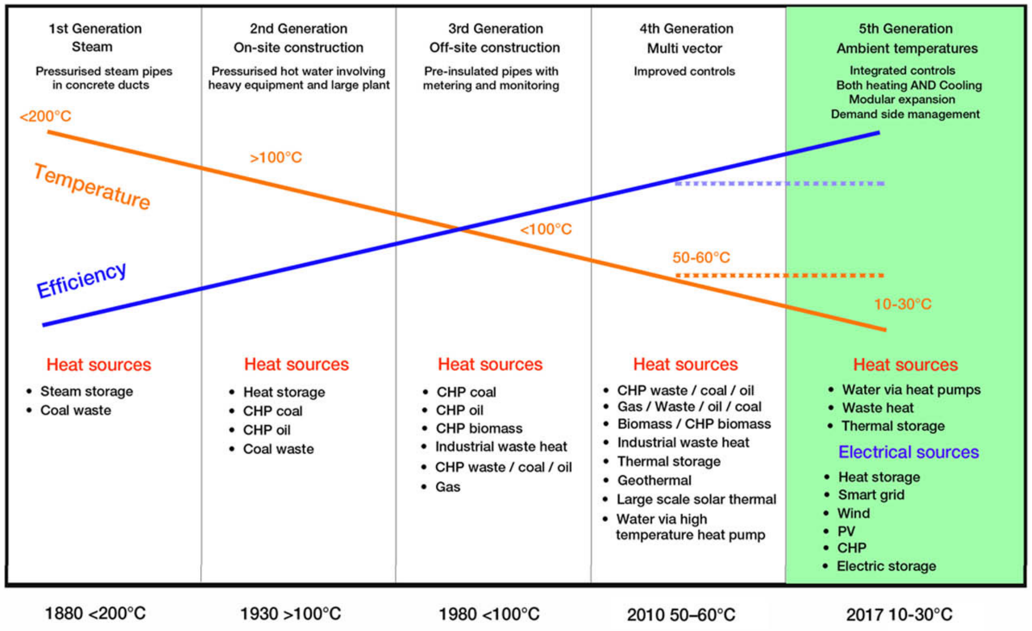
1st **generation** systems were typically coal fired and distributed steam in pipework at temperatures up to 200˚C.

2nd **generation** systems were typically gas fired and distributed hot water at around 100–130˚C.

3rd **generation** systems generally operate at around 90 to 100˚C flow temperatures. Most heat networks now in operation in the UK are of this type.

4th **generation** systems operate at slightly lower temperatures of around 70˚C. These are slowly becoming more common as a way to reduce losses, but they are not well suited to heat pumps or many low emission heat sources.

5th **generation** networks operate at ‘ambient’ temperatures of around 10 to 30˚C, significantly reducing network losses. They are currently being piloted around the UK. These networks rely on small heat pumps in each connected building which take heat from the network and raise the temperature to serve local heating and hot water systems and/or cooling.



First to fourth generation heat networks are generally better suited to higher carbon heat sources that are not net zero compatible. Fifth generation heat networks have much lower losses and are suited to most genuinely low or zero carbon heat sources. © Mitsubishi

Distribution losses in district heating systems

High distribution temperature > high distribution losses

The high temperatures at which most current heat networks operate result in significant amounts of heat loss between the energy centre and the building they serve. The longer the network, the greater the heat losses in proportion to the heat delivered. As the heat needed by buildings is reduced by improved fabric efficiency, the heat lost from the network becomes an increasing proportion of the total heat generated and can also contribute toward the risk of summertime overheating in buildings. Most metered data on heat networks indicate high levels of distribution losses in heat networks which distribute heat at a medium or high temperature.

High distribution temperature > Low heat pump efficiency

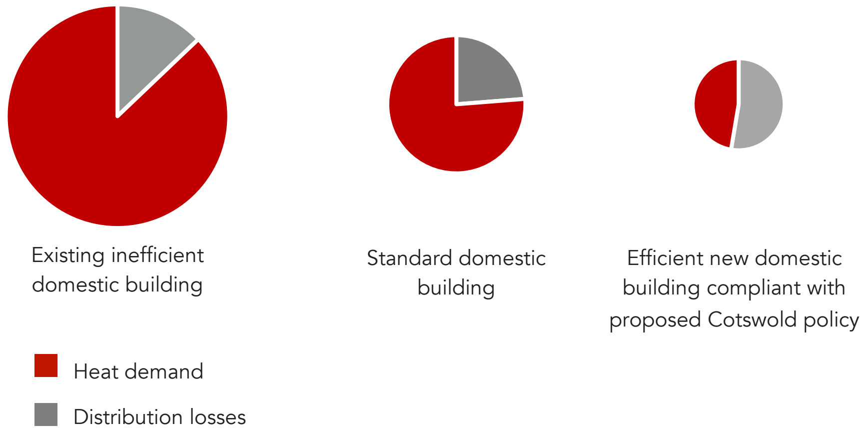
The main strategy to improve heat pump efficiency is to reduce the flow temperature produced by the heat pump. For space heating, this means the use of load and weather compensation, which enables the heat pump to use the lowest possible flow temperature for each hour of the heating season. For water heating, this means lower storage temperatures combined with regular sterilisation cycles.

Neither of these strategies can be used with third or fourth generation heat networks, where flow temperatures are. As a result, heat pump efficiencies are likely to suffer in communal and district heating systems. Only low/ambient distribution temperatures will allow heat pumps to operate at the highest efficiency they can.

Implications of distribution losses for policy

High losses and reduced heat pump will increase operational costs and carbon emissions, relative to systems with lower losses. Distribution losses are therefore an important consideration for policy.

Heat networks relies on distribution pipes. Medium/high distribution temperatures and long pipes will have high distribution losses (Image source: Vital Energi)



As the heat demand of a building reduces, heat losses from distribution and standing losses can become disproportionately high. For new buildings that are compliant with the proposed policy for Cotswold District Council, the losses from third and fourth generation heat networks could be higher than the heat demand of the building.

2.0

Considerations for district heating policy for Cotswold District Council

What is the potential for heat networks in the District?

The potential for heat networks in the UK

A BEIS report from 2021 '*Opportunity Areas for District Heating*' suggests that the maximum economic potential for heat networks in England is up to 19% of heat demand[1].

The Climate Change Committee's Sixth Carbon Budget suggests 18% of homes could be heated by heat networks by 2050.

The National Infrastructure Assessment suggests heat networks will be appropriate for *"a small proportion of buildings"*.

The potential for heat networks in the Cotswolds

Cotswold District Council does not include large cities or high-density developments of multistorey blocks of flats. As heat densities is generally considered to be a key factor in whether a heat network is likely to be beneficial or not, this means that the role of heat networks in the district is likely to be even more reduced than at the national scale.

There may be situations where fifth generation heat networks could provide a good low carbon heating option where individual systems are less suitable:

- Historic buildings where there is a desire to avoid external air source heat pumps.
- Blocks of flats where there may not be space for individual air source heat pumps.
- Compact town centres where heat pumps cannot be physically accommodated at the property.

The practical disruption from trenching, pipe laying, and making below ground connections to buildings (to prevent freezing) should not be underestimated when considering if such a network is viable.

[1] This assumed a minimum heat demand of 73,000 kWh/year for connection to a building to be viable (this would be a building with a floor area of >2,400 m², based on the proposed new build policies). The 19% figure is also based only on whether heat networks were deemed to be 'economically viable', it does not account for reduced technical potential, competition from other technologies that could offer lower cost heat, or reductions in available 'waste' heat due to reduction in combustion-based processes that is required to deliver net zero.

A fifth generation district heating system that uses a 'shared ground loop' is being trialled in Stithians, a small village in Cornwall. This type of system could be useful in the Cotswolds where external air source heat pumps cannot be installed.

A common argument used in support of heat networks is their flexibility to use heat from different sources. While this may be true for the network operator, individual heating systems such as the air source heat pump pictured above can offer residents higher efficiencies and much greater flexibility as they are not locked into one heat supplier. These systems can use a combination of on-site solar electricity and grid electricity, which can be accessed through a variety of tariffs and providers, resulting in very low costs of heat. © Cotswold Energy Group

Should district heating be covered by the Cotswold Local Plan?

Currently there is no explicit policy

Given the debate around heat networks the absence of clear direction may leave questions unanswered. It would be better to be explicit about when heat networks might be considered.

Policy should be objective

There is no universally applicable inherent advantage to heat networks relative to other scales of heating system, while there are clear disadvantages to indirectly promoting heat sources which are not compatible with Net Zero and to using third and fourth generation high temperature networks. Issues with carbon emissions, heat losses, overheating, reliability, cost, and consumer protection are a significant concern with this type of system. There are none now in the district and there is no objective argument to actively encourage their introduction.

Policy should create a level playing field

The suitability of heat networks for a given location should be assessed objectively using the same criteria as for any other type of system. For example, whether a network uses a net zero compatible low carbon heat source to provide affordable heat. In general, policy should focus on transitioning to use of electricity as the primary energy source for heating, rather than hot water.

Part L contains a set of emission factors for heat networks, which are provided in Appendix 1. For some heat sources, the emission factors were calculated using a considerably simplified approach and should not be used to determine if a heat source is genuinely low emission or net zero compatible.

Fifth generation heat networks could be permitted

If a case can be made that individual heat pumps are physically unfeasible or technically unsuitable, then fifth generation heat networks could be considered. These networks can provide energy efficient cooling as well as heating, which is increasingly a consideration as climate change raises summer temperatures.

Put efficiency first in the production, distribution and consumption of heat; this vastly reduces the size of the decarbonisation challenge while lowering costs at the same time.

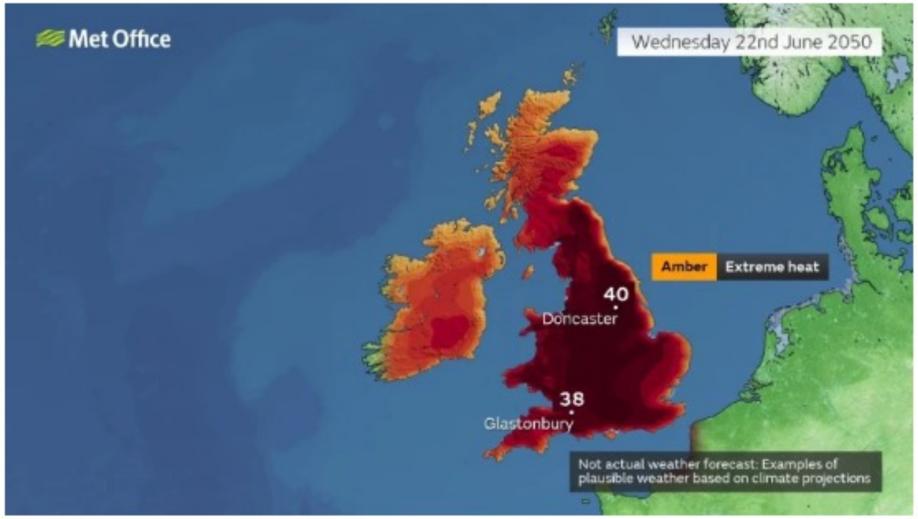
Use local heat planning to enhance alignment between developments in heat supply, distribution and demand, including, where relevant, the phase-out of gas grids.

Give value to unavoidable waste heat. Harness the huge potential of available and unavoidable waste heat through local heat planning and incentive setting, to replace fossil fuels and save consumers money.

Ensure end-user protection and enable viable business models. End-users should be shielded from potential monopolistic behaviour by district heating operators. A balance needs to be struck between ensuring the economic viability of business models, affordability of heat, and quality of service.

Reward energy system integration. Through coupling with the electricity sector, district heating can provide much needed flexibility and storage. This potential needs to be recognised and incentivised.

Five key policy principles, provided as a result of research by the Regulatory Assistance Project for the development of good practice district heating policy. © RAP



The Met Office have published 'weather forecasts' for 2050 which show the Cotswolds at high risk of extreme heat. Fifth generation heat networks can be capable of providing heating and cooling, as are some types of individual heat pump, so may be an appropriate solution for some buildings. © Met Office

District heating | Summary of potential policies

Initial recommendations

The adjacent table is a ‘long list’ of initial policy recommendations aimed at guiding appropriate development of district heating, for discussion with Cotswold District Council.

Ref	Type of policy	Proposed policy wording	Evidence
DH.01	Net zero compliant heat source	New developments proposing to use heat networks should demonstrate that the proposed heat source(s) are genuinely low carbon, and net zero compatible (Part L emission factors are not acceptable).	Application
DH.02	Net zero compliant heat source	New developments proposing to use heat networks are not allowed to use the following heat sources: oil boilers, gas boilers, gas-fired CHP, unabated biomass, unabated energy from waste.	Application
DH.03	Heat distribution	New developments proposing to use heat networks should demonstrate that their heat distribution flow will be below 30°C.	Application
DH.04	System design	New developments proposing to use heat networks should comply with CIBSE / Association for Decentralised Energy CP1 Heat Network Code of Practice.	Condition
DH.05	Consumer protection	New developments proposing to use heat networks should commit to registering with the Heat Trust’s voluntary consumer protection scheme.	Condition

3.0

Appendices

Appendix 1 – Part L Emission Factors for Heat Networks

Emission factors for heat networks

Several types of emission factor are calculated in Part L for different energy sources. These generally follow the GHG Protocol's methodology, using emission factors from the BEIS/DEFRA GHG Conversion Factors for Company Reporting, however some adjustments/exclusions apply.

Emissions factors for heat networks are treated differently depending on the heat source. Where combustion of fuels occurs to generate heat only, a simple emissions factor is used. Where generation of heat and electricity takes place, the GHG Protocol requires that Scope 1 emissions are allocated to electricity generation rather than heat, in order to prevent double counting of emissions.

The result of this is that the emission factors for heat from combined heat and power plant, thermal power plant, and waste to energy plant, are often very low as they only account for a small amount of additional emissions that are directly associated with making the 'waste' heat available for use. **This should not be misinterpreted as the heat being from a low carbon heat source or being net zero compatible.**

Often, this 'waste' heat is from high carbon heat sources where substantial reductions in the volume of fuel being combusted must occur in the next few years in order to reduce the Scope 1 emissions that are not included in the emission factor for 'waste' heat. Planning policy should not encourage use of this type of waste heat.

Fuel	Standing charge, £ [a]	Unit price p/kWh	Emissions kg CO_{2e} per kWh [b]
Heat networks: [k]	92 [l]		
heat from boilers – mains gas		4.44	0.210
heat from boilers – LPG		4.44	0.241
heat from boilers – oil (assumes 'gas oil')		4.44	0.335
heat from boilers that can use mineral oil or biodiesel		4.44	0.335
heat from boilers using HVO from used cooking oil		4.44	0.036
heat from boilers FAME from animal/vegetable oils [e]		4.44	0.018
heat from boilers – B30D [f]		4.44	0.269
heat from boilers – coal		4.44	0.375
heat from electric heat pump		4.44	0.136 [s]
heat recovered from waste combustion		4.44	0.015 [p]
heat from boilers – biomass		4.44	0.029
heat from boilers – biogas (landfill or sewage gas)		4.44	0.024
heat recovered from power station		3.77	0.015 [p]
high grade heat recovered from process (Appendix C4.3)		3.77	0.011
low grade heat recovered from process (Appendix C4.4)		3.77	0.136 [s][v]
heat recovered from geothermal or other natural processes		3.77	0.011
heat from CHP		3.77	as above[q]
electricity generated by CHP		N/A	See
electricity for pumping in distribution network		N/A	0.136 [s]

Table 12 in SAP 10.2 contains a list of emission factors to be used for calculating the greenhouse gas emissions from residential buildings