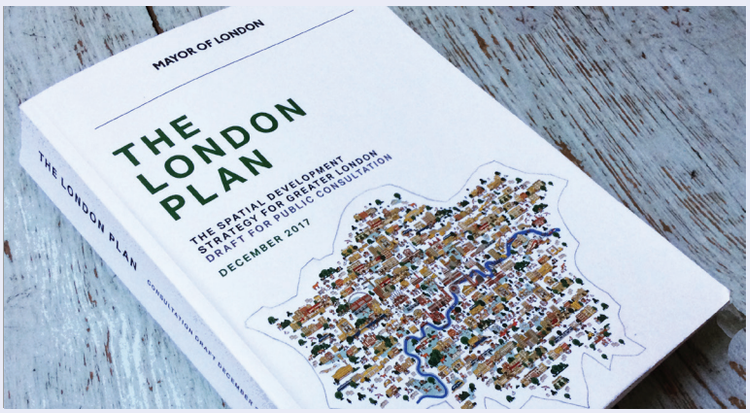
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The London Plan outlines the city's approach to sustainable development, including implementation of heat networks

Heat Networks

By Jamie Goth, Goth Energy Management Limited

Heat networks are systems that distribute heat generated from a central source to multiple buildings through a network of insulated pipes.

These networks can use various heat sources, including fossil fuel powered boilers; combined heat and power plants; energy from waste heat from incineration or industrial processes; and renewable energy sources.

The primary goal of heat networks is to achieve efficiencies in the cost of installation or operation in the provision of heat to multiple users. Economies of scale provide opportunities to reduce maintenance costs and connect to heat sources that would not otherwise be viable.

Drivers for heat networks

There is a considerable range of drivers for the installation of or connection to heat networks, as set out below.

- **Low efficiency of domestic boilers**

Historically, small scale commercial and domestic boilers operated at significantly lower efficiency levels than large industrial or utility scale boilers. Heat networks offered a more efficient alternative to small boilers by centralising heat production and distributing it to multiple buildings, connecting them up to larger, more efficient boilers and heat sources.

One key reason for the greater efficiency of industrial scale boilers over domestic was their ability to extract more heat from the combustion gases. This is achieved by having sufficient capacity and quality of heat exchanges to reduce the temperature of combustion gases below their dew point, causing them to condense. This releases the latent heat of vaporisation from the gases to the heating medium. This technology was not available for small capacity / domestic boilers until the Dutch started to develop domestic scale condensing boilers in the late 1970s. By the end of the 20th century, the technology had not had widespread adoption outside of the Netherlands. Grant incentives were introduced in the UK in the 1990s, generating year on year increases in the number of installed condensing boilers, but it was not until high efficiency boilers were made mandatory from April 2005 that the technology really took off in the UK. By 2006 almost every new domestic gas boiler installation in the UK was condensing.

Gas fired boilers in the energy centres of a heat network still maintain an advantage in operating efficiency compared to domestic boilers. This is caused in part by the diversity in heat demand which reduces boiler cycling and associated standing losses of district and communal heat sources. However, distribution system losses of heat networks reduce some of this efficiency advantage and combustion efficiency is rarely a sole driver of new heat networks.

- **Cost of landlords' obligations for maintenance of tenants' gas-fired domestic boilers**

Landlords are required to conduct periodic inspections and maintenance of gas-fired domestic boilers in their properties. These obligations can be costly and time-consuming. Heat networks eliminate the need for boiler maintenance visits to each home in an estate, as the heat sources are located centrally and in satellite plant rooms, outwith residents' properties. This reduces the financial burden on landlords and ensures consistent and reliable heating for residents. These cost savings are important drivers for the move away from small scale domestic boilers to heat networks.

- **Subsidisation of Residents' Heating costs**

Social landlords often seek ways to reduce the heating costs for their tenants, particularly those in low-income households. Heat networks can provide a more affordable heating solution by leveraging economies of scale and using waste heat from industrial processes. This helps to reduce heating costs and improve the quality of life for tenants and other residents.

However, even where heat networks are not cost competitive compared to localised solutions, it is not uncommon for social landlords, such as housing associations, to subsidise the cost of heat to tenants. This may be a temporary cap to price rises when national and international events cause sudden utility cost rises. Alternatively, heat cost subsidy may be a permanent feature of a social landlord's strategy, with heat costs being subsidised from other forms of income or activities.

- **Conditions of environmental permits for energy from waste plants**

Energy from waste plants must comply with strict environmental regulations to minimise their impact on the environment. Heat networks can help these plants meet their permit conditions by accepting waste heat generated during energy conversion processes, such as power generation from the incineration of energy from waste.

- **Business opportunities in the sale of waste heat**

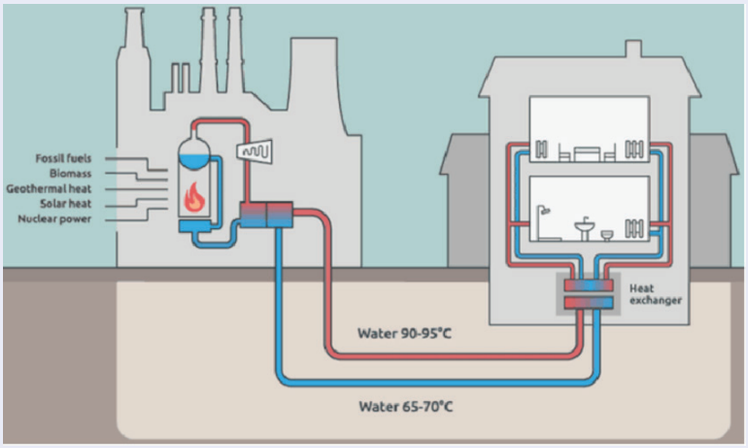
Combined heat and power units and industrial processes often produce excess heat that can be harnessed and sold through heat networks. This presents a business opportunity for companies looking to monetise their waste heat. By integrating waste heat

into heat networks, businesses can generate additional revenue.

- **Insufficient capacity in alternative infrastructure for the provision of space heating**

In some areas, the existing infrastructure for space heating, such as natural gas or electricity grids, may be insufficient or absent to serve a new development or new heating loads in the existing built environment. Heat networks can fill this gap by providing a heating solution that is not reliant upon either the gas or electricity distribution grids. This is particularly important in developments that are off the gas grid and where there is sufficient population density to warrant the installation of a heat network.

Heat from industrial processes is transferred to local homes and buildings



© Uwe Radtke, Hungarian University of Agriculture and Life Sciences

- **Heat decarbonisation**

Heating of homes and other buildings represents a significant proportion of the UK's carbon emissions. The UK is committed to achieving net zero emissions by 2050 and the heat will need to be decarbonised over a similar timescale if this commitment is to be met. Heat networks offer the opportunity to centralise heat sources, providing economies of scale for the investment in low and zero carbon technologies for decarbonised heat. This is becoming a key driver of heat networks in the UK.

Steam for heat and power generation

Thermal power stations operate by burning fuel at high temperatures, which produces hot combustion gases. In the case of a steam turbine power station, these high temperature gases are then used to generate steam in a boiler. The steam produced in the boiler is directed to a turbine, where it drives the turbine blades to generate electricity. This electricity can be supplied to the grid, providing a valuable source of power for homes and businesses.

After passing through the turbine to generate electricity, the steam is still hot and contains significant thermal energy. In conventional thermal power stations, this residual steam is cooled in a condenser or cooling tower and returned as condensate to be heated back up to steam temperature and pressure to generate power. The heat from the condenser and cooling tower is rejected, with no further use.

However, in the case of a combined heat and power plant, the residual steam is directed to a heat exchanger, rather than rejected at a cooling tower. At the heat exchange, it transfers its heat to a secondary water circuit. The heated water is then distributed through a network of insulated pipes to provide space heating for homes; other buildings connected to the heat network and process heating applications.

By integrating both electricity generation and space heating, the plant maximises the use of the thermal energy produced during the combustion process. This dual-purpose approach enhances the overall efficiency of the plant and contributes to sustainable energy solutions by reducing reliance on fossil fuels and minimising waste.

In an energy-from-waste plant, the process of generating electricity and providing space heating involves these same key steps with the following changes in phase, temperature and pressure of the heat medium:

- **Steam generation:** The plant burns non-recyclable waste materials to produce heat, which is used to generate high-pressure steam in a boiler – typically at temperatures and pressures of the order of 500°C and 100 bar respectively.
- **Turbine for power generation:** The high-pressure steam is directed to a turbine, where it expands and drives the turbine blades to generate electricity. As the steam passes through the turbine, its pressure and temperature drop significantly to the order of approximately 150°C and 1-2 bar respectively.
- **Heat interchange unit for space heating:** The lower-pressure steam exiting the turbine still contains significant thermal energy and is directed to a heat exchanger to transfer its heat to a secondary water circuit. The steam condenses into water on the primary side of the heat exchanger as it releases its heat, further reducing its temperature and pressure. The heated water is then distributed through a network of insulated pipes to provide space heating for homes and other buildings. The heating flow water temperature and pressure will vary considerably depending upon a number of factors. 90°C and 1-2 bar would be common values for the flow temperature and pressure respectively for current space heating applications, although the direction of travel is for further, significantly lower heat network temperatures to accommodate lower temperature heat sources.

Supporting legislative frameworks

- **Denmark**

Denmark's first energy from waste plant to provide both heat and power was installed in 1903 to generate electricity and provide heat to a nearby hospital. Further developments in the 1920s and 1930s led to collective district heating systems, based primarily on using waste heat from electricity generation. Expansion in the larger cities led to around 30% of homes being connected to district heating schemes by 1970. The Danish response to the global energy crisis of 1973/74 was to further expand heat networks across the country.

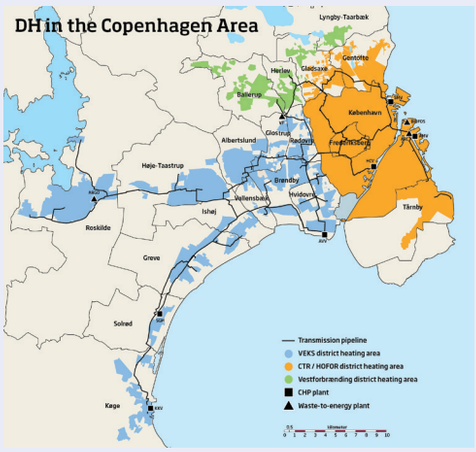
However, it was not until 1979 that Denmark passed its first heating supply law. This set out the steps to be taken by public sector bodies in assessing heating demands and cost effective means of meeting them. The approach includes information gathering; the provision of calculation tools and methods to analyse the results, leading to the establishment of regional plans that include zones that define which areas are to be supplied by heat networks. Over 60% of Danish homes are now connected to heat networks and this proportion is expected to rise to over 70% in the near future. This successful uptake of heat networks in Denmark has led to other countries, such as the United Kingdom taking an interest in how it has been achieved and applying aspects of the approach in UK jurisdictions.

- **England and Wales**

The Department for Energy Security and Net Zero (DESNZ) plays a pivotal role in advancing the development of heat network infrastructure across England and Wales. The department enables this progress through a combination of targeted funding, policy initiatives, and legislative support designed to de-risk projects and attract investment. By offering financial incentives and grants, the UK government helps to mitigate the initial costs and uncertainties associated with heat network projects, making them more appealing to investors and developers. Additionally, UK policy framework promotes the integration of renewable energy sources and waste heat into heat networks, further enhancing their sustainability and efficiency.

The Energy Act 2023 is a cornerstone of this legislative support, as it establishes a comprehensive regulatory framework for heat networks. This Act provides the UK government with the authority to introduce heat network zoning through secondary legislation. A heat network zone is defined as a formally designated geographical area where heat networks are expected to offer the lowest-cost solution for decarbonising heating. By delineating these zones, the Energy Act 2023 ensures that heat networks are strategically implemented in areas where they can deliver the most significant environmental and economic benefits. This targeted approach not only accelerates the transition to low-carbon heating solutions but also fosters a more resilient and sustainable energy infrastructure for the future.

Over 60% of Danish homes are connected to heat networks



© Danish Board of District Heating, 2025

Queens Quay Energy Centre



©Star Refrigeration

- **Scotland**

The Scottish government plays a crucial role in advancing heat networks and has taken significant steps to promote heat networks in Scotland.

The Heat Networks (Scotland) Act 2021 is a key legislative measure that supports the development of heat networks. It sets out the regulatory framework for heat networks in Scotland, aiming to increase their deployment and ensure they contribute to the country's decarbonisation goals. Additionally, the Scottish government has provided councils in Scotland with the powers and duties to develop Local Heat and Energy Efficiency Strategies (LHEES) to provide a strategic approach to improving energy efficiency and promoting heat networks at the local level.

The Scottish and UK governments share a common goal of advancing heat networks to achieve sustainable and efficient heating solutions, but they operate within different legislative frameworks and strategic approaches tailored to their respective jurisdictions.

Developments in local authorities' approaches to heat networks

- **The London Plan**

The London Plan is a strategic framework that outlines the city's approach to sustainable development, including the implementation of heat networks. The plan emphasises the importance of reducing carbon emissions and improving energy efficiency. It encourages the development of heat networks as a key component of London's energy strategy, promoting the use of renewable energy sources and waste heat, aiming to make London a net zero carbon city by 2050.

- **Local Heat and Energy Efficiency Strategies in Scotland**

Local Authorities in Scotland have developed local heat and energy efficiency strategies to identify heating and energy efficiency solutions relevant to their council areas, including support for the implementation of heat networks. These strategies focus on improving energy efficiency, reducing carbon emissions, and promoting the use of renewable energy sources. Local authorities in Scotland are encouraged to develop heat networks as part of their broader energy plans, leveraging waste heat and renewable energy to provide sustainable heating solutions.

Case study examples

- **London Borough of Southwark heat networks for council housing estates**

The London Borough of Southwark has over 100 heat networks providing heat and hot water to approximately 17,000 homes.

The council originally installed heat networks last century to provide heating for its council housing estates. Heat sources for these heat networks ranged from gas fired boilers, combined heat and power plants and waste heat recovery.

One example is the heat network supplying the Newington Estate, which is one of Southwark's largest estates served by a heat network. The estate's heat network was first installed in 1980s, comprising an energy centre and satellite plant rooms. Approximately half of the heat network distribution pipework was replaced after approximately 35 years. The remaining pipework is in the process of a phased replacement.

At its inception, the network primarily relied on natural gas as its fuel source. The decision to use natural gas was driven by its availability and relatively lower cost compared to other fuels at the time. The network was designed to provide consistent and reliable heating to the estate's residents, reducing their dependence on individual gas-fired boilers and improving overall energy efficiency.

Southwark partnered with South East London Combined Heat and Power (SELCHP) to bring heat from its energy from waste centre to Southwark's heat networks. The pipe network was largely completed in 2014, with 2,650 of Southwark's council homes in Bermondsey now served by SELCHP. The SELCHP heat source is classed as 60% renewable and the London Borough of Southwark is exploring options to extend is use to serve properties in the Old Kent Road and Peckham areas.

Three of Southwark's estates are now connected to water source heat pumps drawing their heat from open loop aquifer extraction – the first examples in London.

The approach taken in the London Borough of Southwark is a good example of how Council heat network strategies can evolve over time to incorporate new technologies and energy sources. From its initial reliance on natural gas to its current integration of waste heat and renewable energy, the Council has continually adapted to meet the changing needs of the community and the environment.

- **Aston University's heat network**

Aston University has developed a heat network for its academic campus, which is connected to the larger Birmingham City heat network. This integration highlights the advantages of connecting smaller heat networks to larger city-wide systems.

- **Queens Quay water source heat pump**

The Queens Quay project in West Dunbartonshire uses a water source heat pump to supply heat to a local network. This innovative approach harnesses the thermal energy from the River Clyde, providing a renewable and sustainable heat source for the network. The primary heating plant is a large scale ammonia heat pump, providing approximately 80% of the projected annual heat demand, with gas-fired boilers providing top up and back up. The plant room has been future-proofed by allowing space for two further heat pumps to be installed as the network expansion proceeds.

The network supplies heat via a 1.5 km heat network, serving a 23 hectare development and plans to serve 1,200 homes. The temperature of the heating medium has a significant impact upon the efficiency of heat generation by the heat pump. Existing buildings on the heat network are designed for conventional low temperature hot water flow and return temperatures of 82°C and 71°C respectively. The network also serves new buildings whose heat demand can be met with lower heating medium temperatures. Heat interface units capable of operating effectively at the low temperatures have been selected. Whilst the ammonia heat pump is capable of delivering temperatures above 80°C, its efficiency will be improved by the opportunity to reduce flow temperatures to as low as 60°C when weather compensation and seasonal demands allow.

The benefits of using ammonia include energy efficiency and low global warming potential. However, its hazards of high toxicity and flammability must be carefully managed.

The project demonstrates the potential of water source heat pumps in urban heat networks.

CPD SERIES 23 / Module 01
Heat Networks

CPD Entry Form

Please mark your answers below by placing a cross in the box. Don't forget that some questions might have more than one correct answer. You may find it helpful to mark the answers in pencil first before filling in the final answers in ink. Once you have completed the answer sheet, return it to the address below. Photocopies are acceptable.

Questions

Question 1. What does SELCHP stand for?

- ☐ South East London Combined Heat and Power
- ☐ South East London Combined Heating Project
- ☐ South East London Community Heating Programme
- ☐ South East London City Heat Plant

Question 2. How many council homes in Bermondsey are served by SELCHP?

- ☐ 2,500
- ☐ 2,650
- ☐ 2,750
- ☐ 2,850

Question 3. What percentage of the SELCHP heat source is classed as renewable?

- ☐ 50%
- ☐ 55%
- ☐ 60%
- ☐ 65%

Question 4. Where is Southwark exploring options to extend the SELCHP heat source to serve properties?

- ☐ Brixton and Clapham
- ☐ Vauxhall and Elephant & Castle
- ☐ Old Kent Road and Peckham
- ☐ Camberwell and Lewisham

Question 5. What is unique about Southwark's water source heat pumps?

A) They draw heat from open loop aquifer extraction
B) They use solar energy
C) They are powered by wind energy
D) They use geothermal energy

Question 6. What does Aston University's heat network connect to?

- ☐ Birmingham City heat network
- ☐ London City heat network
- ☐ Manchester City heat network
- ☐ Leeds City heat network

Question 7. Which river's thermal energy is harnessed by the Queens Quay water source heat pump?

- ☐ River Thames
- ☐ River Clyde
- ☐ River Mersey
- ☐ River Avon

Question 8. Approximately what percentage of the projected annual heat demand is provided by the ammonia heat pump at Queens Quay?

- ☐ 70%
- ☐ 75%
- ☐ 80%
- ☐ 85%

Question 9. What are the flow and return temperatures for existing buildings on the Queens Quay heat network?

- ☐ 82°C and 71°C
- ☐ 80°C and 70°C
- ☐ 78°C and 68°C
- ☐ 76°C and 66°C

Question 10. What is a benefit of using ammonia in heat pumps?

- ☐ High energy efficiency
- ☐ Low global warming potential
- ☐ Both A and B
- ☐ Neither A nor B

Please complete your details below in block capitals.

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Business.....

Business Address .....

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