Cambridge City Centre Heat Network

Connection Note

November 2023

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Quality information

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1 Purpose of This Document

This document is intended to provide guidance for all those considering connection to the heat network currently under development in Cambridge City Centre.

This document has been issued as an initial reference for developers, existing buildings owners and the Cambridge Council Planning Department. However, as the project evolves, this document is expected to be updated with additional detail on the technical requirements for new connections.

The central purpose of this guide is to ensure that buildings interested in connecting to the Cambridge Heat Network are compatible with the heat network both in their design and operation.

2 Cambridge City Centre Heat Network Overview

In line with its Net Zero Carbon targets, Cambridge City Council has identified the development of a District Heating Network (DHN) as one of the measures to address the causes and consequences of climate change.

AECOM has completed a feasibility study of a Heat Network that would serve the City Centre. It is expected that, once the network is built and operational, it will expand organically with new connections and additional energy centres.

Currently, the scheme is being designed with up to four energy centres across the City Centre with c.70 buildings connected. It will provide a cost-effective form of heat decarbonisation that is compatible with existing and planned wet heating systems.

Some of the benefits of the network are:

- Low carbon source of heat: The network will be fully electrified with no fossil fuel sources in the generation matrix. It will further decarbonise over time in line with the decarbonisation of the National Grid or could fully decarbonise if 100% renewable electricity were used.
- Easy access to the latest low-carbon heating technologies: Enables connected buildings to take advantage of the benefits of the latest low-carbon technologies that may not be available at a building level scale.
- Lower operational and maintenance costs compared to onsite low carbon heating solutions.

An indicative map of the proposed heat network can be found below:

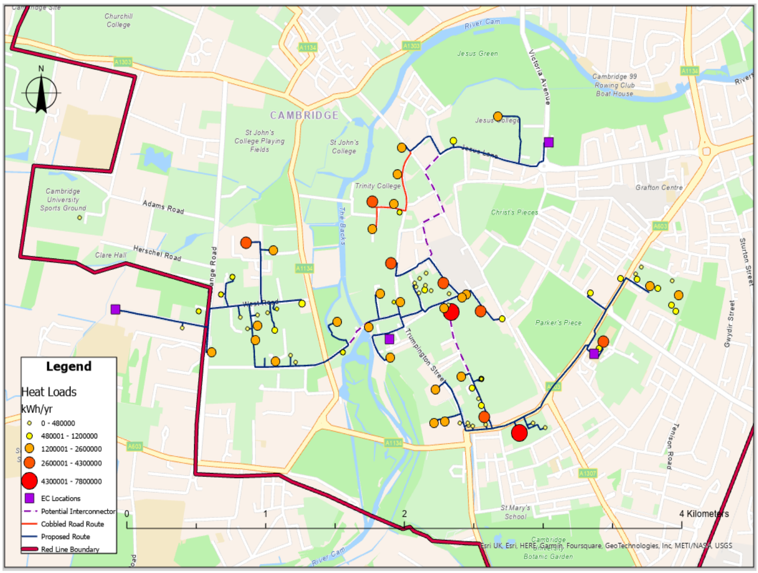


Figure 1: Indicative map of the Heat Network

3 Works to Connect to a District Heating System

3.1 General considerations

Connecting an existing or future building into a heat network would require a bespoke design to ensure the connection is sized correctly and the heat transfer between the network and the site can be maximised. However, to ensure the compatibility of a building with the yet-to-be-built network it is important to achieve the lowest possible return temperature from the connection. This is to maximise the temperature difference (Delta T) between the flow and the return in the connection and therefore, achieve the maximum possible heat transfer.

Additionally, there are several actions that the developer or building owner should take into consideration ahead of exploring a connection to an existing or future heat network. These include but are not limited to:

For new buildings:

- The building must have a “wet heating” system.
- Determine peak demands and generate year-round heat load profiles.
- Define design operating temperatures for the building services and losses in the secondary distribution system that are aligned with the design temperature regime of the heat network (see section 3.2).
- Define minimum flow and minimum load conditions.
- Establish a phasing plan to determine the steps required for conversion from the current system to the DH network, taking a gradual building block approach.
- Include the installation of heat meters in accordance with the Heat Metering and Billing Regulations.
- The heating system should be designed, commissioned, maintained, and operated in compliance with the CIBSE/ADE CP1 Heat Networks Code of Practice.

For existing buildings:

- Measure or model peak demands and year-round heat profiles.
- Identify opportunities for lowering the return temperatures and ensure the operation of the plant room to be connected is aligned with the regime of the planned heat network.
- Ensure the existing BMS is compatible with the inclusion of an additional heat source in the plant room (see section 3.4).
- Implement a 2-port control strategy, replacing 3-port valves and by-passes where possible.
- Prioritise the use of variable speed pumps in conjunction with differential pressure control valves for balancing the system.
- Install heat meters

3.2 Plantroom Works

3.2.1 Existing Equipment Removal and space allocation

In order to facilitate the connection to the district heating network, space will be required to accommodate a thermal substation. For existing buildings this would typically be found in existing heating plantrooms by removing existing heating plant to make space for the substation. For new buildings space can be found in a suitably located plantroom at ground or basement level.

A substation typically includes plate heat exchanger(s), valves, pumps, heat meter and controls. This space should ideally be made available as close to the existing heat generation plant as possible to reduce complexity in connecting to the secondary side distribution system. Please refer to Appendix A for typical plant dimensions based on the size of the proposed building connection.

If there is sufficient space, by agreement with the heat network operator, the existing heating plant can be retained if desired. However, the network will have resilience with multiple heat sources and strategic disaster prevention connection points for temporary plant to be plugged in. Therefore, it is unlikely on-site plant needs to be retained once the heat network connection is operational.

3.2.2 Hydraulic Connection to DHN

It is proposed that a hydraulic break is installed between the network and the building or site level distribution circuits. This is a typical approach with heat network connections into existing buildings as it provides protection to the district heating pipework from any water quality issues arising in the buildings heating system and reduces the risks to the network should a leak occur in the building heating system. Additionally, it protects the secondary system from the typically higher operating pressure of the heat network. The hydraulic connection provides a clear demarcation in terms of operational responsibilities for system operation and maintenance (O&M).

This hydraulic break is typically comprised of 2 heat exchangers arranged in a duty and assist arrangement, with each sized at 66% of the buildings' peak heat demand to provide a level of resilience. This heat exchanger then connects into the site level distribution circuit. A typical arrangement for this system is shown in Appendix B.

Additionally, it is a requirement that there is space on site for heat network pipework to enter the plant room and connect to the heat exchangers.

3.3 Low Temperature Hot Water (LTHW) Heating System

The proposed heat network is expected initially to be a high temperature regime with an 85ºC flow and 65ºC return on the network side of the heat exchanger. This will allow for a 5ºC drop across the heat exchanger to deliver 80ºC flow on the building side. In order for the network to have a 65ºC return therefore, the building heating system must operate with a 60ºC or lower return.

These temperatures have been chosen to facilitate the connection of existing buildings. Where a new building or development wish to connect to the heat network, that building should be designed for lower operating temperatures as this will improve the operating efficiency of the heat network and also ensures the building will be able to continue using the heat network should the operating temperatures of the network be able to reduce in the future. New buildings should be designed for a flow temperature of 65ºC or less, with a return of 40ºC or less.

If this regime is different to the flow and return temperatures of the existing central heating systems on site (secondary distribution), adaptation works (to either the central heating systems, heating emitters, fabric, or a combination thereof) will be required to bring the temperatures in line with primary network.

The connected buildings dictate the required network operating temperatures. Measures taken at a building level can help improve the network efficiency by enabling lower flow and return temperatures and an increased temperature difference between flow and return. This in turn should enable heat tariffs to be kept lower compared with existing on-site heat costs or even to reduce further over time, benefiting building owners. Please refer to Appendix C for some indicative guidance on lowering return temperatures.

3.4 BMS Requirements

The Building Monitoring System will need to be able to recognise the district heating substation as the main heat source. To facilitate the control required to call for heat from the network, the BMS will need to be compatible with the heat network operator BMS. This will ensure connectivity and consistency across the monitoring systems. This will need to be negotiated with the heat network designer and the heat network operator going forward.

Usually, a read-only link is installed between the district heating network control panel and the boiler room control panel. This may include the facility to request a temperature set-point from the district heating network control panel by the boiler panel. The heat network operator may wish to be able to monitor all heating and hot water circuits connected to the district heating to assist with ongoing fault analysis. This is also useful to monitor efficiency and return temperatures back to the network.

It is important to note that at this point, the BMS for the heat network has not been selected.

3.5 Retain Wet System

To maintain compatibility with the Cambridge City Centre Heat Network it is vital that a “wet heating system” is operational in the connected building. A wet system refers to a heating and distribution system that comprises of a central heat source that produces hot water which is distributed across the building. A district heating connection will not be compatible with a system that distributes heat around the building through circulation of hot air or one that uses electrical room heaters.

4 Energy Efficiency/Optimisation Measures

The measures outlined in section 3 should be considered “must haves” for connecting to the Cambridge City Centre Heat Network, the following measures proposed in this section are recommended for improving the efficiency and comfort levels when connecting to a district heating network.

4.1 Sub Metering

The installation of sub-meters within a connected building will allow for full monitoring of energy consumption in all major heating zones. Understanding the energy consumption across building areas will provide clarity on areas that consume the most energy, and in turn aid in prioritising areas that may require energy efficiency and optimisation measures.

4.2 Dynamic Radiator Control Valves

In order to maintain consistent return temperatures, it is recommended that all TRVs are replaced with Dynamic Radiator Valves (D-TRVs). This will have the benefit of allowing the system to become self-balancing, omitting the need to undertake the steps to manually rebalance the system.

These valves have additional differential pressure controllers which facilitates better control in partial load situations. When the pressure upstream of the valve increases due to other valves closing, the valve self-regulates to ensure the flow remains constant. Installing these valves on all radiators will automatically balance the system, with the pumps controlling the flowrate, facilitating better control of return temperatures.

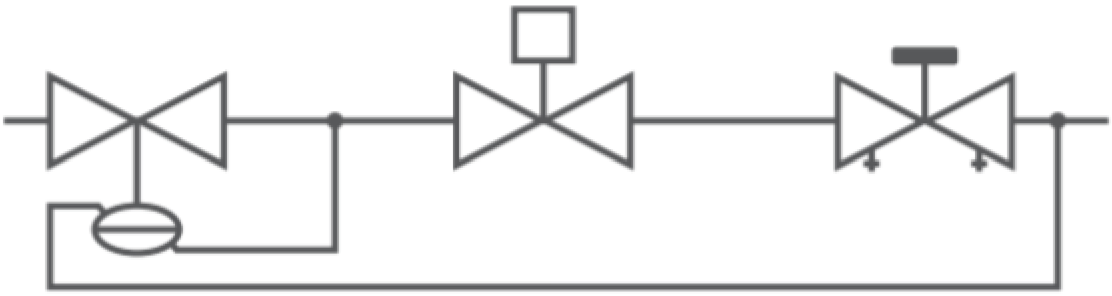


Figure 4-1: Process and instrumentation diagram for a Dynamic Radiator Valve (DRV), courtesy of Danfoss

The benefit of installing the valves will therefore be general improvement of the heating system performance and lower maintenance costs.

4.3 Energy Demand Reduction Measures

It is recommended to priorities the implementation of energy efficiency measure as much as possible in the connected buildings. This will have a beneficial impact in the overall performance of the network and will also improve the thermal comfort. It is noted that many of these buildings have heritage constraints and therefore the scope of these interventions is limited.

After these measures have been installed, the following adjustments are recommended:

- **Occupied areas:** temperature set points are in line with CIBSE Guide A design temperatures for the specific building type (e.g. for offices 22°C or below) and occupier comfort levels are surveyed.
- **Unoccupied areas (i.e. stairwells):** Emitter temperatures are turned down so the level of heating matches fabric protection levels only (i.e. 18°C).

5 Testing

5.1 System Temperatures for existing buildings

To test whether the building can function with the reduced flow and return temperatures, the central heating circuit temperatures should be lowered using the existing building management system (BMS). Ideally this test should be undertaken during the winter months when outside air temperature is at its lowest. Measurements should then be recorded of:

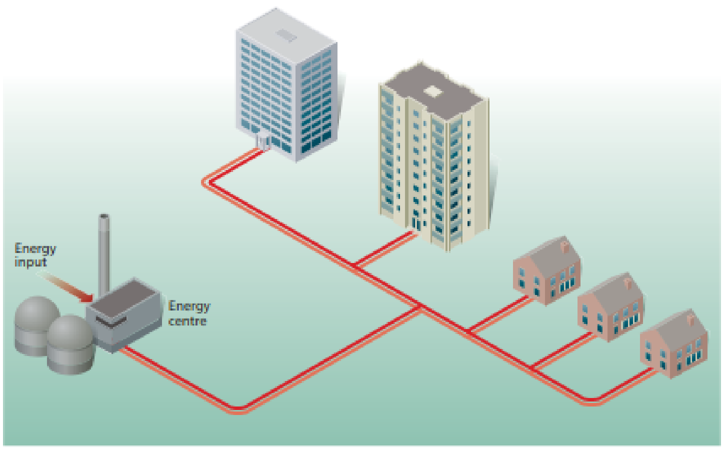
- Whether the internal air temperatures within each zone reaches the existing set points and the time taken to do so; and
- The boiler firing regime to check whether the boilers are shut off once the heating circuit return temperatures approach the flow temperature.
- Return temperatures in the heating system so that the mean temperature can be calculated
- The external air temperature at the time of testing. It is unlikely that the day of the testing will be the coldest of the year, recording the external air temperature at the time of testing will allow for correction calculations to be made.

Should it be found that set point temperatures are not reached at all or within a reasonable time period, and the boilers are continuously operating, the cold spots within the building should be located and additional measures undertaken to enable the building to operate at reduced temperatures (see Appendix C).

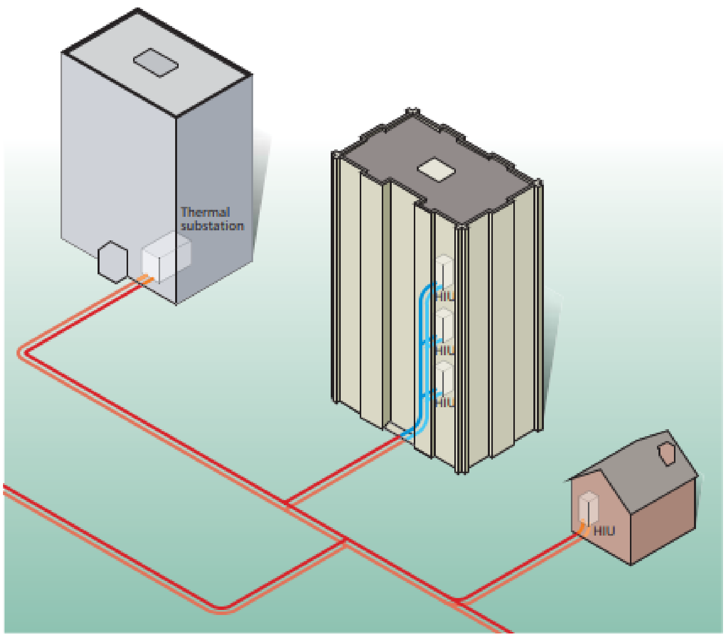
Appendix A –Heat Exchanger Substation Dimensional Information

Item	Heat exchanger substation details					
Output (kW)	250	500	1000	1500	2000	3000
Number of heat exchangers	1	1	2	2	2	2
Length (mm)	1500	2250	2750	2750	3000	3000
Width (mm)	500	750	1500	1500	1500	1500
Height (mm)	2000	2500	2500	2500	2500	2500
Approximate dry weight (kg)	750	1050	1725	1800	1925	2000

Source: London Heat Network Manual[1]



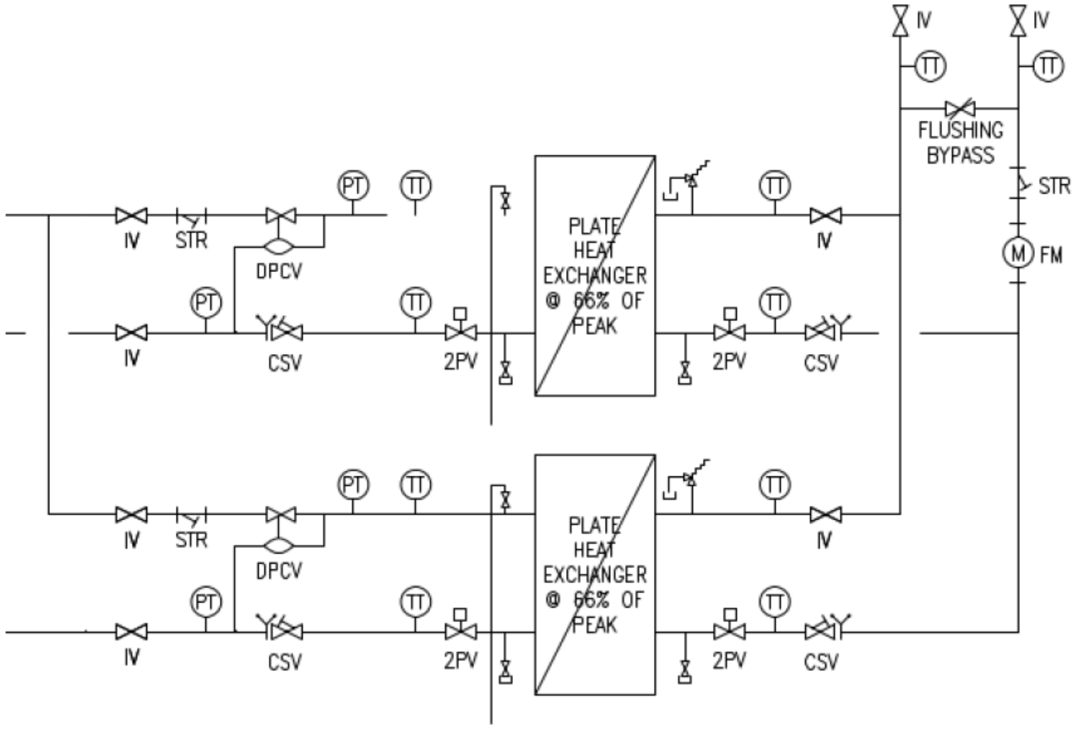
(a) A typical district-wide heat network



(b) Typical locations of thermal substations and heat interface units (HIUs)

[1] https://www.london.gov.uk/sites/default/files/london_heat_map_manual_2014.pdf

Appendix B - Typical Thermal Substation Schematic



Appendix C – Lowering Return Temperatures

In order to achieve a return temperature as low as is practical, the following steps can be undertaken:

- **Select lower mean heating circuit temperatures** - To compensate for reduced flow temperature, additional emitter capacity may be required, either through supplementing or replacing the existing emitters. The extent of these works will be site specific and dependant on whether desired heating set points can be reached at lower flow and return temperatures.

- **Reduce the flow rates to the emitters** – A lower circulation flowrate will create a wider temperature difference and hence a lower return temperature. There are several ways to achieve this that are dependent on the emitter type:

  - ***Branches at a floor level:*** Flow rate could be regulated at a floor level in an office building for example, The branches will be regulated by dynamic regulating valves (DRVs), differential pressure control valves (DPCVs) or pressure independent control valves (PICVS)

  - ***Radiators and trench heaters:*** Flow rate is adjusted through regulating valves (manually if TRVs are installed or automatically if DRVs are installed)

  - ***Air handling unit (AHU) coils and fan coil units (FCUs):*** In this instance flowrates will also be regulated through DRVs

- ***Adjustment of the total flow rate:*** The total flowrate generate by the distribution pumps will need to be adjusted to accommodate the above. This is achieved through control/adjustment of the pumps speed drivers. There are two common ways of controlling pump speed that are appropriate for district heating networks:

  - ***Remote sensing:*** Pump speed is controlled such that the pressure differential across the pump reduces towards the design pressure differential across the most remote differential pressure controlled sub-branch (i.e. containing (DPCV) or PICV). Differential pressure sensors, wired back to the central control system, are required across the selected sub-branches.

  - ***Proportional method:*** Pump speed is controlled such that the pressure differential across the pump reduces in proportion to flow rate (or flow rate squared) towards a preselected differential pressure value.

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