Cambridge City Centre Heat Network

Future Proofing Guidance Note

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1 Introduction

1.1 Purpose

This document is intended to provide guidance for potential customers considering connection to the Cambridge City Centre Heat Network (CCCHN). It is an update on the Connection Note issued by AECOM in November 2023 and includes adapted wording from this document throughout.

The primary purpose of this guide is to ensure that customers interested in connecting to the CCCHN are compatible with the heat network in terms of both their buildings' design and operation. The document sets out initial technical requirements, regulatory compliance and demarcation boundaries.

Note this document is specifically targeted at connecting existing buildings to the CCCHN. New buildings seeking to connect should ensure their heating system design is fully compatible with heat network connection.

The heat network project is currently at Outline Business Case stage and will be subject to future stages of detailed design. Information presented herein is therefore subject to change. As the heat network project progresses through the Commercialisation stage customers will be engaged further as a full connection specification is developed.

1.2 Cambridge City Centre Heat Network Overview

The CCCHN proposed network has been developed by Cambridge City Council (lead partner) in collaboration with 20 Strategic Partners to deliver a reliable, cost-effective and low-carbon heating system to Cambridge City Centre. Currently, the scheme has been designed with 48 connections serving 43MW of heat demand, with an annual consumption of 73GWh/year. The scheme has been designed at 85/65ºC flow/return temperatures for compatibility with existing wet heating systems, many of which are within listed buildings.

The benefits of the heat network will include:

- Cost competitive low carbon heating to difficult-to-decarbonise buildings
- Strong reliability and resilience
- Deliverability in a space constrained and historic city centre
- Possible access to decarbonisation grant funding that might otherwise not be available
- Future expansion opportunities

Initial Heat Network Zoning study outputs indicate that the City Centre will become a designated Heat Network Zone, and also that additional significant heat loads are suitable for zoning adjacent to this area. It is expected that once the network is built and operation it will expand organically with new connections and additional energy centres.

An indicative map of the proposed network is shown in Figure 1—1.

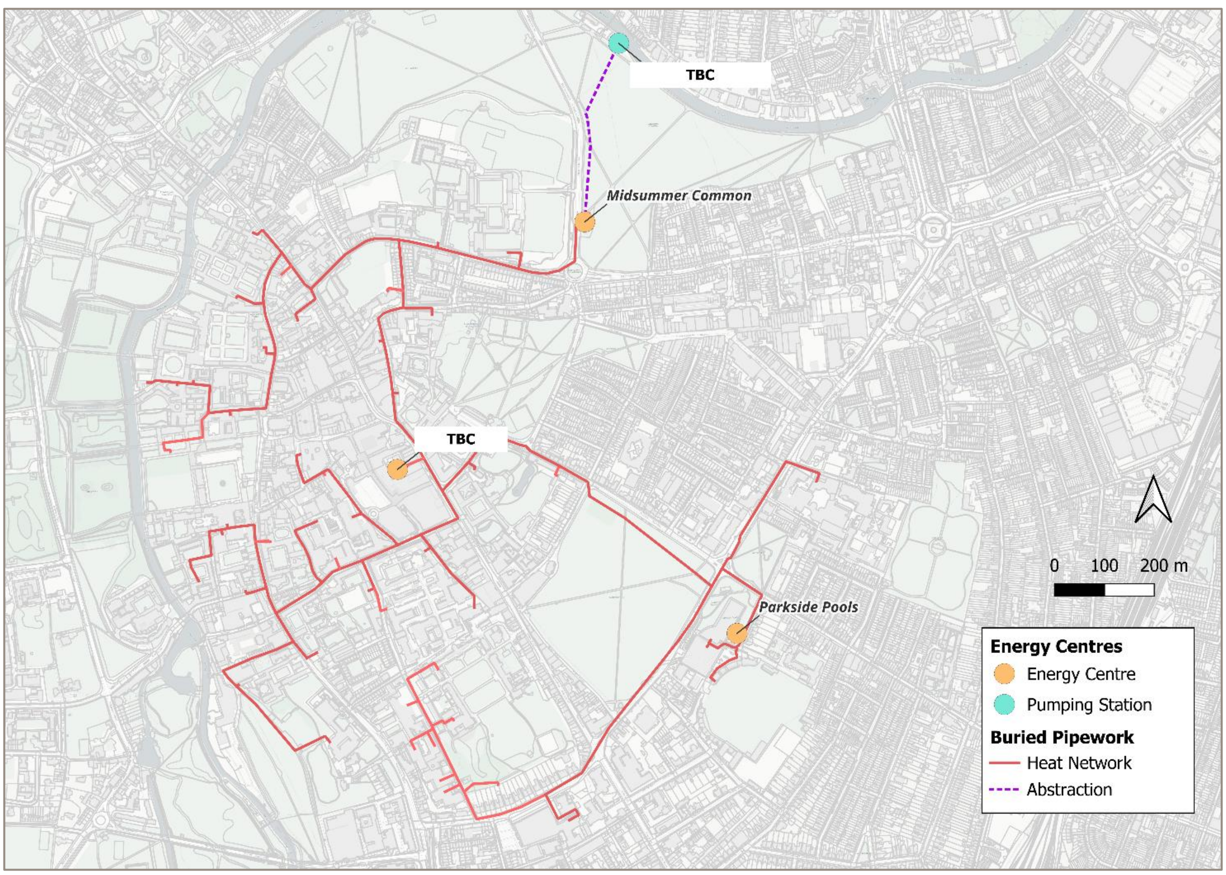


Figure 1—1 CCCHN Proposed Network Route

2 Connecting to the CCCHN

2.1 General Principles

The heat network will bring insulated flow and return pipework into an agreed connection point location with buildings / clusters of buildings looking to connect. The connection point will include a heat substation which transfers the heat from the heat network to the consumer (the building and occupants where the heat is required).

The substation will be owned and operated by the heat network project, with the secondary system continued to be operated by the existing operator.

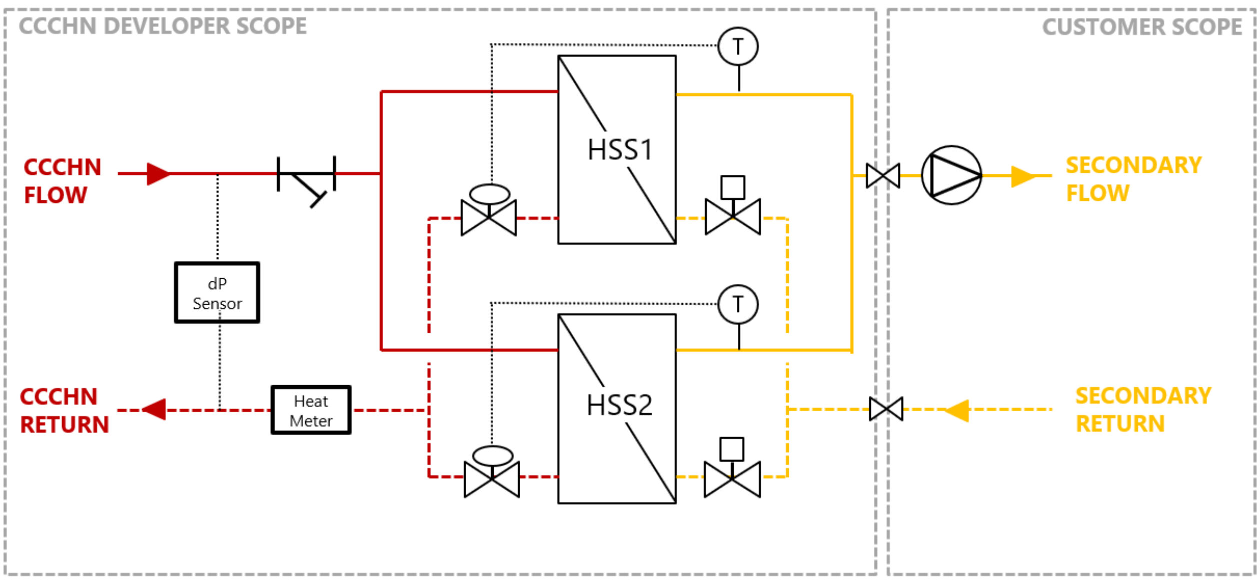


Figure 2—1 Heat substation responsibilities demarcation

2.2 Plantroom Works

2.2.1 Hydraulic Connection to the DHN

It is proposed that a hydraulic break in the form of a heat substation is installed between the network and the building or site-level distribution circuits (see example schematic in Appendix A). 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/pressure/leakage 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).

A heat substation typically includes plate heat exchanger(s), valves, pumps, heat meter and controls. This heat substation typically comprises of 2 heat exchangers arranged in a duty and assist arrangement, with each sized at 50% of the buildings' peak heat demand such that if one were to fail the supply of heat (up to a limit) will still be available.

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, which may be in the form of a network entry pit for below ground pipework entry. The heat network operator will provide this pipe entry and pipework up to the heating substation.

A controls panel will also be provided by the heat network developer for control of the heating substation.

Typical spatial requirements for the heating substation and control panel are provided Appendix C.

2.2.2 Decommissioning of Existing Plant

In order to facilitate the connection to the district heating network, space will be required to accommodate the heat substation. For existing buildings this would typically be found in existing heat plantrooms by removing existing heat plant (e.g. gas boilers, CHP) to make space for the substation.

If there is sufficient space, by agreement with the heat network developer, the existing heating plant can be retained if desired for resilience. However, the network will have resilience with multiple heat sources and strategic disaster prevention connection points for temporary plant can be connected – see previously issued CCCHN Resilience Note for more details. Therefore, it is unlikely existing building or site plant would need to be retained once the heat network connection is operational.

The heat substation space should ideally be made available as close to the site boundary where the connection is proposed to minimise connecting pipework (noting this will be highly dependent on existing plant rooms and space availability), and typically close to the existing heat generation plant, as possible to reduce complexity in connecting to the secondary side distribution system. Clearance should be provided around the heat substation skid (as detailed by manufacturers) for access/maintenance.

2.2.3 Design Temperatures

The district heat network primary design temperatures are 85°C flow / 65°C return.

Secondary building temperatures should be ≤80°C flow (allowing for ~5°C approach temperature across the heat exchangers) and ≤60°C return at the substation secondary header for efficient operation. It is important to achieve the lowest possible return temperature at the connection. This is to maximise the temperature difference (dT) between the flow and the return in the connection and therefore, maximise heat transfer and network efficiencies. The customer's heat substation shall be designed and operated such that the primary return temperature is not higher than the design return temperature under normal operation. For options to reduce secondary return temperatures, see Appendix B.

The network temperatures have been chosen to facilitate the connection of existing buildings. 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.

In the future the heat network may operate at lower temperatures, in order to improve the operating efficiency of the heat network. Weather compensation during summer months should be implemented on secondary flow temperatures to reduce standing losses and improve dT at part load.

Where a new building or development wish to connect to the heat network, that building should be designed for lower operating temperatures, ensuring the building will be able to continue using the heat network. New buildings should be designed for a flow temperature of ≤60°C flow and ≤40°C return.

2.3 Secondary / Tertiary Systems

To maintain compatibility with the CCCHN 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(s) that produces hot water which is distributed across the building. A district heating connection will not be compatible with a system with no water based heating systems or electrical heating systems.

In general, it is proposed that the existing secondary ancillary systems (pumps, water treatment, controls etc.) are retained following heat network connection. O&M of this equipment will remain the responsibility of the customer. For optimal efficiency customers should ensure that:

- Secondary side pumps are variable-speed driven (VSD) and controlled by remote differential pressure to maintain stable flow and dT.
- Variable Temperature (VT) circuits are converted to Constant Temperature (CT) as much as possible.
- Differential pressure control at branch level / terminal units uses Pressure Independent Control Valve (PICVs); no 3-port control valves or uncontrolled bypasses.
- Existing vessel calorifiers typically see secondary return temperatures ≤60°C; if not, adopt plate calorifiers where possible or modify control strategy to prevent high secondary returns.

It is further recommended that:

- Sub-metering is installed within connected buildings where not already present. This 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. Metering should be in full HNTAS compliance.
- Dynamic TRVs are in place for emitter-level control for self-balancing and stable return temperatures.
- It is recommended to prioritise the implementation of energy efficiency measures as much as possible in the connected existing buildings. This will have a beneficial impact in the overall performance of the network and will also improve building thermal comfort. It is noted that many of the buildings proposed for connection have heritage constraints and therefore the scope of these interventions is limited.

In cases where a bulk supply point is proposed, a new secondary network is required on-site to connect buildings, associated pipework and connecting plant will be required to enable this. The configuration will depend on the design approach at each site – it is possible to configure an on-site network as either:

- A 'direct' to the heat substation - no hydraulic break between bulk supply point and building connections) or
- An 'in-direct' connection - another set of plate heat exchangers provides a hydraulic break between the bulk supply point and building connections.

Note there is a temperature drop associated with each hydraulic break, however this option allows isolation of heating circuits across the site. It is preferred to use 'direct' secondary systems to avoid heat losses across the hydraulic break. It is recommended that customers engage experience system designers/advisors for guidance on the optimal configuration for their site.

2.4 BMS requirements

The building monitoring system (BMS) will need to be able to recognise the district heat 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 overarching heat network BMS/control systems. 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 heat network control systems and the building/site control systems. This may include the facility to request a temperature set-point from the district heat network control systems. The heat network operator may wish to be able to monitor all heating and hot water circuits connected to the district heat network 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/control system for the heat network has not been selected.

2.5 Customer Information

Where available the customer should submit key information to the heat network developer ahead of connection to inform the connection design process, including but not limited to:

- **Load and profile data** – annual heat consumption (space heating and domestic hot water (DHW)), peak heat demands and hourly heat demand profiles for a representative heating year. If metered data is unavailable, information relating to building typology / utilisation / floor areas which will enable modelled profiles to be developed.
- **System drawings and equipment schedules** – as-built schematics, layouts (including dimensions) and equipment schedules for plantrooms and associated systems.
- **Plant space and access statements** – confirmation of spatial availability for heating substation installation, floor loading and lifting/egress routes for skid and plate packs. Customers will work with the heat network developer, who will inform them of typical spatial requirements, to identify suitable locations for heating substation install.
- **Water Quality report –** secondary circuit (i.e. building system) water quality sample analysis and existing water treatment arrangement details.

- **Controls readiness –** confirmation that controls can operate with a heat network as a lead heat source, including removal of uncontrolled bypasses / 3-port valves and incorporation of variable-flow architecture. Action may be required in cases where the existing systems are not compatible. The heat network operator will inform the customer of the controls specification requirements, after which it will be the customer's responsibility to ensure systems are compatible.

Connecting a bulk supply point to a heat network requires bespoke design to ensure the connection is sized correctly and heat transfer between the network and building(s) can be maximised.

2.6 Transitioning to the Heat Network

2.6.1 Pre-commissioning

Pre-commissioning the customer should carry out pressure testing, chemical clean and flushing of secondary circuits, verifying strainers are clean, valves stroked, pumps rotated and sensors calibrated.

2.6.2 Functional Tests

The heat network operator will carry out functional testing of the heat substation and connection prior to handover. This would include reduced-temperature tests and simulated load tests on substation controls.

2.6.3 Post-commissioning

The heat network operator will provide as-built drawings, valve settings, pump curves, balancing records, controller parameters and a 12-month seasonal commissioning plan, O&M plan and guides with performance reviews.

2.6.4 Temporary Boiler Heat Supply

A temporary boiler setup can be provided as a packaged external plant to maintain continuity of heat supply during installation of the heating substation. This is connected to the building's existing secondary flow and return headers to maintain full heating and hot-water services while the existing heat plant is removed, and the new district heat substation is installed. These temporary boilers are normally containerised gas or electric units sized to match the building's peak load so that space heating and DHW systems continue operating as normal. The heat network developer will coordinate with the customer to identify suitable locations where disruption to normal site operations will be limited.

This arrangement allows the building to remain fully heated while plantrooms are cleared, pipework is reconfigured, and the new heat substation is installed and commissioned. Once the district heat substation is live and tested, the temporary boilers are simply isolated and removed with no interruption of service, aligning with the resilience and continuity expectations.

2.7 Building Systems Testing

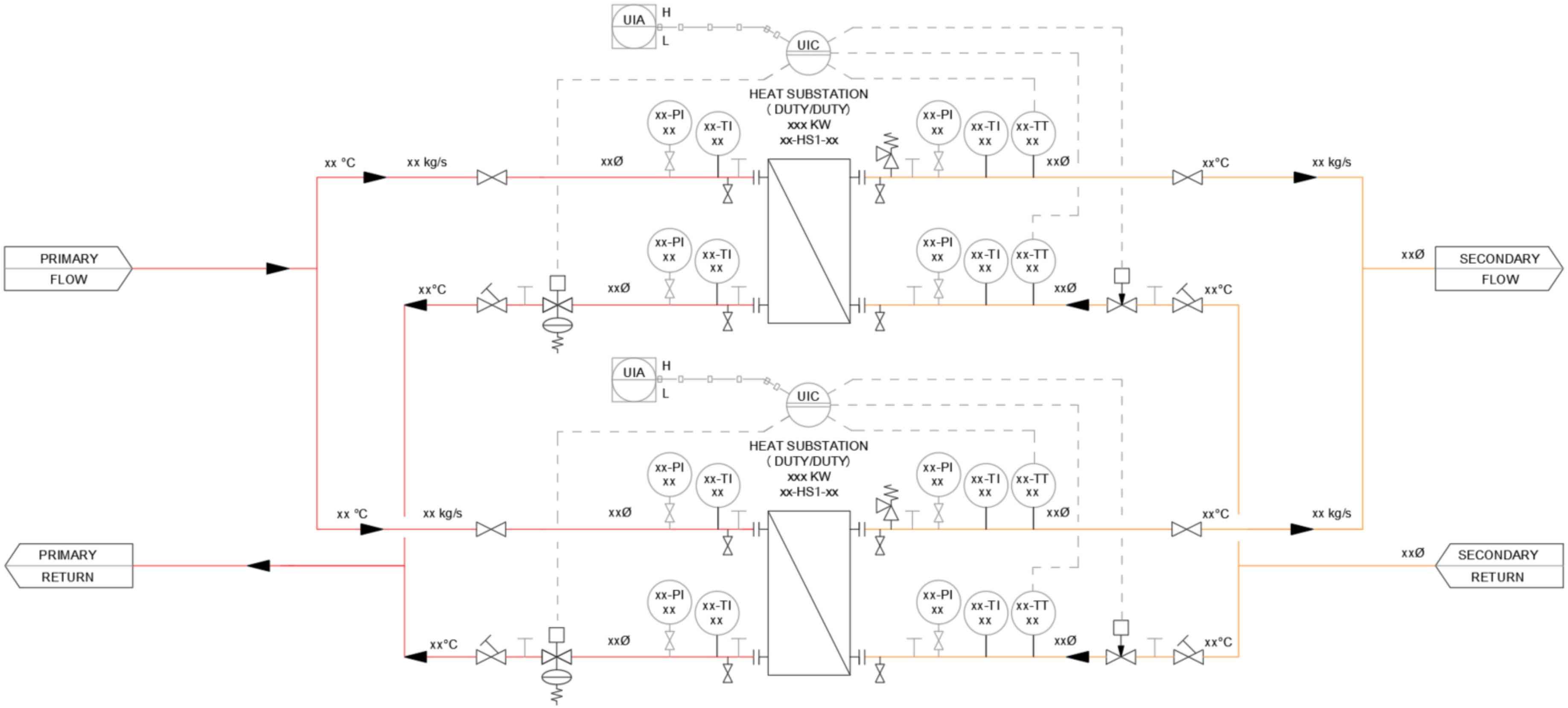
In the cases where building flow/return temperatures are in excess of those required for heat network connection, testing building operation at the intended network design temperatures is crucial to ensure efficient design and operation.

To test whether the building can function with reduced flow and return temperatures, the central heating circuit temperatures should be lowered using the existing BMS/control systems. Ideally this test should be undertaken during the winter months when outside air temperature is at its lowest and peak heat loads are seen. If systems cannot operate at lower temperatures, it is recommended the opportunities for temperature reduction in Appendix B are explored.

2.8 Regulatory Compliance

- Ofgem regulation sets customer service standards, outage response practice, price transparency and resilience provisions. Building interfaces must support monitoring and fault-finding.
- HNTAS (Heat Network Technical Assurance Scheme) sets requirements for heat network design and operation, including heat substations, distribution systems, controls, ancillaries and metering systems. This policy is currently in consultation but will become a mandatory requirement for all existing and new heat networks.
- CIBSE CP1 / Design Guide sets good practice principles to unlock system efficiency, including variable flow, low return temperatures and appropriate pump / valve control.

Appendix A – Typical Heating Substation Schematic



Appendix B - Lowering Return Temperatures

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

- **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 (e.g. radiators). 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 controlled/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), 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 generated 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 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.
- **Ensure good pipe insulation across all systems to reduce secondary heat losses**
- **Ensure good water quality is maintained on secondary sides:** avoids blockages in any HIUs or emitters.
- **Remove low loss headers** (where flow and return from the gas boilers and tertiary circuits are fed on the same very long slim vessel looking header) as much as possible. Low loss headers result in lots of uncontrolled blending of flow return.

Failure to comply with these operational criteria will impact the efficiency of the CCCHN heat pumps and result with higher operational/variable costs/carbon content of the delivered heat.

Appendix C - Typical Heating Substation Sizing

The preference for HSS install is for two plate heat exchangers, each sized for 50:50% of the peak heating demand for resilience and maintenance purposes. The below table shows indicative guidance on potential spatial requirements depending on connection heat capacity. It is important to understand that there are a lot of variables when sizing the substation plate heat exchangers, control valves and pipework. Plate heat exchanger output is one thing, but the required flow rate, flow velocity and pressure drop has a huge impact on the pipe diameter and valve sizes, so it is entirely possible that a 100kW substation could have a greater footprint, bigger pipes and valves and therefore weigh much more than a 300kW substation. It all depends on the specification of the heat network itself, which will be developed during the next stages of detailed design.

In practice, to achieve the twin configuration described above there are two options

1. A compact twin-plate unit from a suitable manufacturer with allowance for pipework, maintenance access and valves, or
2. Two separate plate heat exchangers with allowance for pipework, maintenance access and valves.

Prior to contracting a delivery partner and confirming the preference, for space planning purposes it is recommended that customers safeguard space equivalent to two times single heat exchanger units. Exact spatial requirements are to be confirmed at the next design stage once a preferred supplier is selected.

For customers with insufficient space for a twin plate-configuration, it is recommended a single-plate HSS sized for the full heat load is installed instead.

Table 2—1 Typical heating substation spatial requirements

		Heating Substation Size		
Heat Capacity (kW)	**Number of Heat Exchangers**	**L (m)**	**W (m)**	**H (m)**
<600	1	2.3	1.2	1.6
600-900	1	2.7	1.3	2.1
900-2000	2	3.8	3.1	2.1
2000-3000	2	4.3	3.2	2.1
3000-5000	2	4.8	3.3	2.1

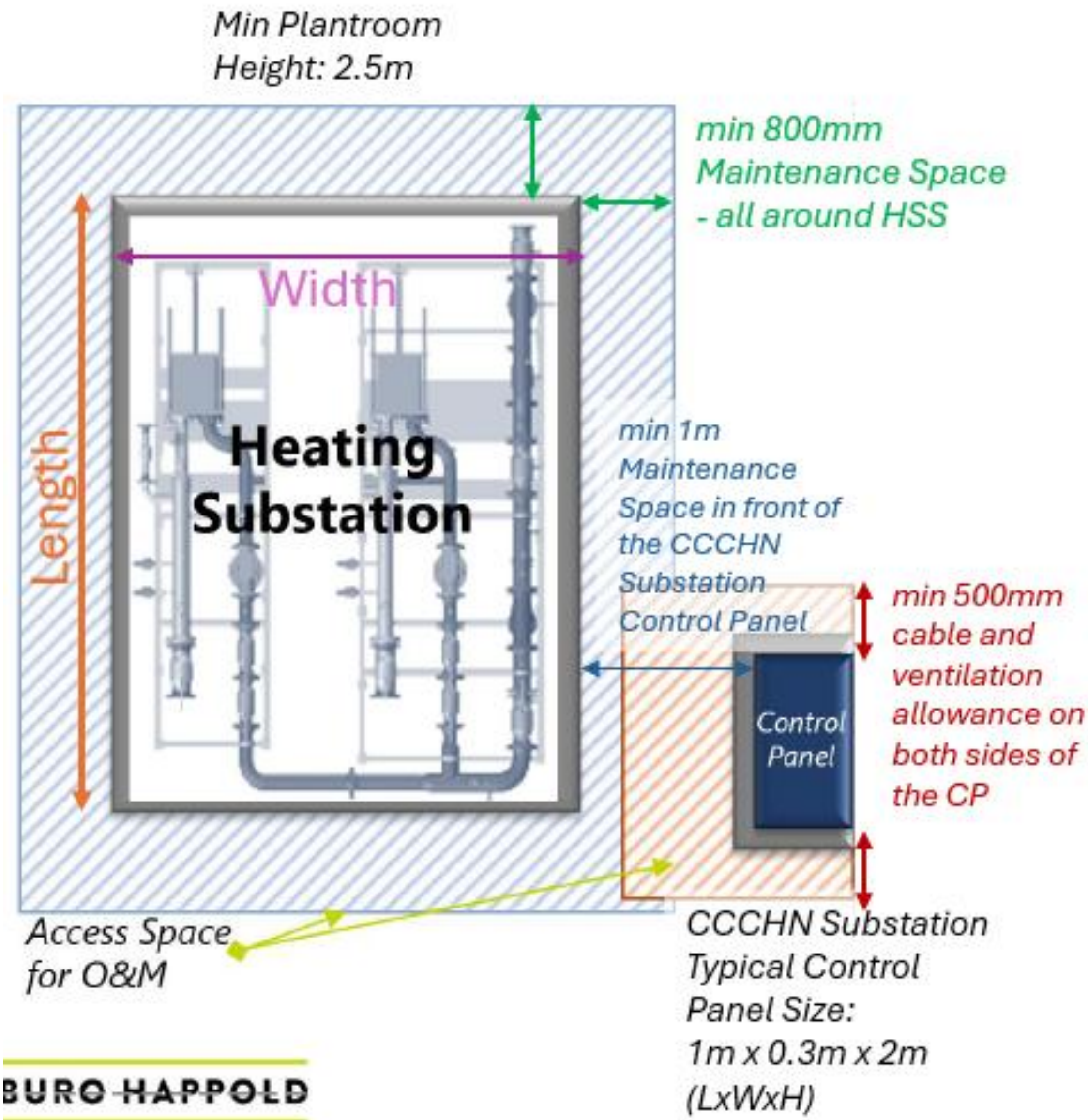


Figure 2—2 Typical Operation and Maintenance area required around heating substation and control panels

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