SURREY CITY ENERGY

Design Criteria Manual

Energy Services Design Requirements

A Design Guide for Connection to District Energy

May 2018

Updates and current Versions

Please verify the City of Surrey web site before using this document to ensure you are using the most up-to-date version. The current version of the criteria is available at the website by following the on-page links to Plans & Strategies > Engineering Infrastructure > Engineering Publications.

Section Page

SECTION 1

Introduction

1 INTRODUCTION

1.1 Definitions / Acronyms

BAS	Building Automation System
City	City of Surrey
DE	District Energy
DE-Connected	Developments that are connected to and receive service from SCE.
DE-Ready	Developments that are not immediately connected to SCE, but can easily connect in the future.
DES	District Energy System
DHW	Domestic Hot Water
DPS	Distribution Piping System
EC	Energy Centre
ETS	Energy Transfer Station
FAR	Floor Area Ratio; calculated by dividing the area of all floors of a building by the area of the lot.
Full Compatibility	All space and DHW heating is served (or able to be served) by SCE.
GHG	Greenhouse Gas
HVAC	Heating, Ventilation & Air-Conditioning
MAU	Makeup Air Unit
OAT	Outdoor Air Temperature
Partial Compatibility	Residential in-suite heating may be by electric baseboards
SCE	Surrey City Energy
ΔT	Delta-T; change in temperature (typically between supply and return water)

1.2 Document Purpose

The City of Surrey (City) is committed to sustainability and is currently developing a District Energy System (DES) to serve space heating and domestic hot water needs of buildings in the Surrey City Centre. The City has established an energy utility, Surrey City Energy (SCE), as a business unit of the Engineering Department. SCE is responsible for delivering the City's DES.

This document provides preliminary information to developers, building owners, engineers and architects to tailor their designs to DES conditions, thereby optimizing the benefits of the DES. SCE will work closely with the developers of new buildings in City Centre and their HVAC engineers to ensure good design integration between buildings and the DES.

1.3 Requirements for your Development Project

Surrey's DES By-law (No. 17667) establishes City Centre as a District Energy (DE) service area. The DE service area is divided into two areas: Service Area A and Service Area B (illustrated in Appendix I of the bylaw). The following table explains the level of DE compatibility that is required of your development project.

Service Area	Floor Area Ratio (FAR)	DE Compatibility	DE Connection
Service Area A	Equal to or Greater than 1.0	Full	DE-Connected
Service Area B	Equal to or Greater than 2.5	Full	DE-Ready
Service Area B	Between 1.0 and 2.5	Partial	DE-Ready

All new developments within Service Area A with a build-out floor area ratio (FAR) equal to or greater than 1.0 will be required to provide full hydronic thermal energy systems including (but not limited to) domestic hot water, make-up air units, and hydronic space heating. These developments will be immediately connected to SCE (i.e. prior to occupancy).

All new developments within Service Area B with a build-out FAR equal to or greater than 2.5 will also be required to provide full hydronic thermal energy systems including (but not limited to) domestic hot water, make-up air units, and hydronic space heating. These developments will be "DE-Ready" for future connection to SCE when it is available.

All new developments within Service Area B with a build-out FAR between 1.0 and 2.5 will be required to incorporate hydronic thermal energy systems to allow for future connection to SCE but will not be required to utilize hydronic systems for space heating within individual residential units. Hydronic systems will be required for all other space heating and hot water heating in the building. Developers may elect to exploit the full benefit of district energy by making all heating loads "DE-Ready".

1.4 Introduction to District Energy

1.4.1 What is District Energy?

District Energy (DE), also known as Community Energy, Neighbourhood Energy, and District Heating, is a system that distributes thermal energy, typically in the form of hot water, from a central energy centre through a network of buried piping to individual customer buildings. The DE System (DES) interfaces indirectly via heat exchangers with the buildings' space heating and domestic hot water systems. No other heat sources are required.

The DES consists of three main components:

1. Central Energy Centre(s) (EC) – the energy source
2. Thermal Distribution Piping System (DPS) – the network
3. Energy Transfer Stations (ETS) – the building interface

1.4.2 DES Owner

The City of Surrey has established an energy utility, Surrey City Energy (SCE), as a business unit of the Engineering Department. SCE is responsible for delivering the City's DES.
SCE will bill customers directly or through a service provider.

1.4.3 Building Heating System Design Implications

Developers are generally required to heat their buildings using hot water only, but have flexibility in designing the building internal heating systems in accordance with their preferences and specific requirements. The building hydronic space heating winter design temperatures cannot exceed 70°C supply and 50°C return. The domestic hot water supply temperature may remain at up to 60°C year round. The building designers will receive support and guidance from SCE in designing their heating, ventilation and air-conditioning (HVAC) systems to derive the most benefit from the DES. See Section 3 for more details.

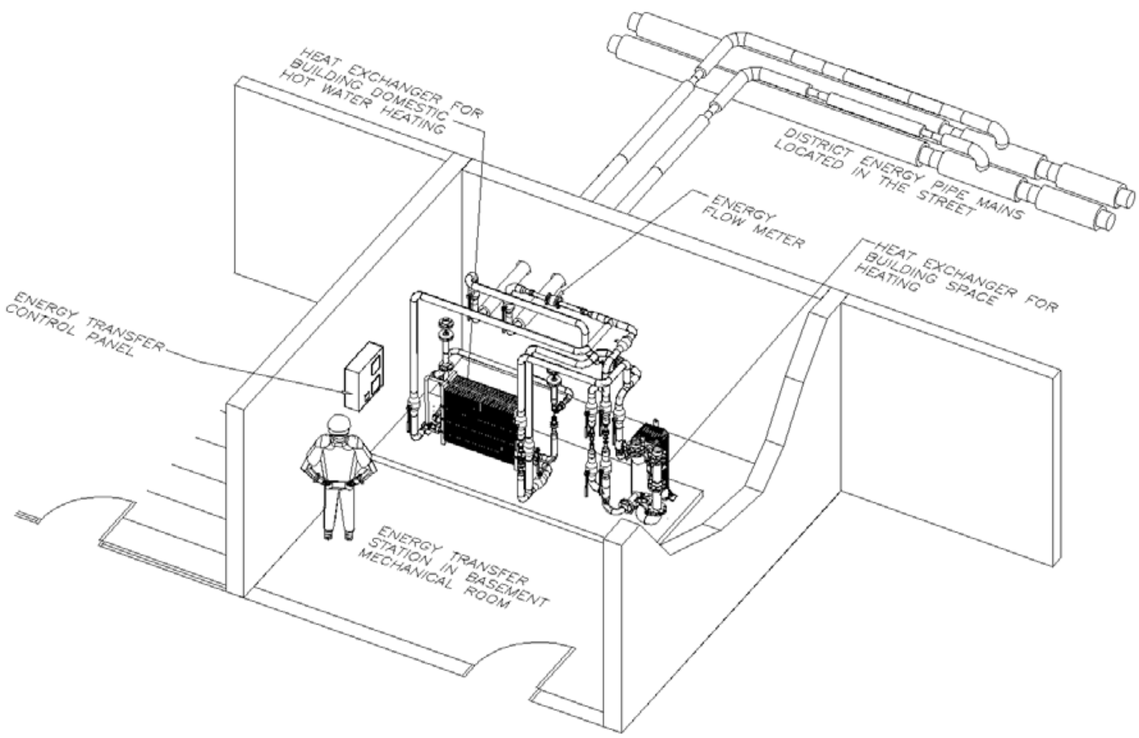
Partial connection buildings are permitted to use electric baseboards for residential in-suite space heating.

1.4.4 Energy Transfer Station Space Requirements

SCE will design and install the necessary pipes, heat exchangers, associated controls, and energy meters to interface with the building heating systems. This equipment, referred to as the Energy Transfer Station (ETS), will be owned and operated by SCE and located inside the customer's building. ETSs are generally located in the basement or parkade, and typically occupy approximately 20% of the space of the conventional boiler plant that they replace. See **Figure 1** as an example of a typical ETS located at an exterior wall near the DE piping mains in the street. Section 2 contains more details on mechanical room requirements.

The DES distribution pipelines are buried in the roads throughout City Centre. Branch lines from the DES distribution pipelines will connect to each building's ETS.

Figure 1: Typical ETS Installation in Building Basement



1.4.5 DE-Ready Buildings

Some buildings in City Centre will not be immediately connected to the DES, but must still be compatible with the system. These "DE-Ready" buildings require their own hot water boilers to serve space heating and DHW requirements. DE-Ready buildings are designed such that they can readily connect to SCE in the future, which includes compatibility of the HVAC and domestic hot water systems and provision for future installation of DE equipment and interface with the building mechanical systems.

1.5 DES Description

1.5.1 Central Energy Centre(s)

As with many other recent DE utilities, SCE will be constructed in phases. The first ECs will use high efficiency natural gas boilers to provide heat to the system. As the system grows, alternative energy sources, such as waste heat and biomass from local wood residues, will be introduced. These alternative energy sources will serve base load requirements of the system and deliver the majority (>70%) of the annual heating energy. Once there is sufficient renewable capacity online, natural gas boilers will provide peak heating and reliable backup capacity to ensure full and uninterrupted service to customers.

The production equipment and controls are state-of-the-art, based on the best of today's commercially proven technology. Other energy conversion technologies will be continually evaluated in light of new opportunities and changing circumstances. The DE infrastructure is designed to facilitate the future use of new renewable energy sources for heating and power.

Prior to final commissioning of any new building, SCE will be capable of serving 100% of its thermal energy requirements, from either temporary or permanent energy supply facilities.

The capacity of SCE will gradually increase as City Centre grows, and is sufficient to meet the total thermal energy needs of all connected, in-service buildings. The system has a higher level of reliability than is generally found in stand-alone heating systems in individual homes or commercial and multi-use residential buildings.

1.5.2 Thermal Distribution Piping System

The DES consists of a closed loop two-pipe hot water distribution piping system (DPS); the same water is heated in the Energy Centre(s), distributed to the buildings, through the ETS, and returned back to the EC to be reheated and redistributed. No water is drained or lost in the system and no additional water is required during normal operation.

The DPS is generally composed of an all-welded, pre-insulated direct bury piping utility in City streets. The distribution network is designed based on the size and location of customer buildings and EC's. Distribution network modelling is completed to optimize system performance and efficiency, and to ensure that all customers will always receive sufficient thermal energy. This modelling is updated periodically as the system grows and evolves.

Variable speed pumps located at the EC control flow through the distribution system to maintain sufficient pressure and flow at every ETS. The DE supply temperature is automatically adjusted based on the outdoor air temperature (OAT), but is never less than 65ºC, such that it can always serve all domestic hot water (DHW) loads directly[1].

Achieving a large temperature difference (delta-T; ΔT) between DE supply and return water is critical to system operation. Low DE return water temperature is important for the optimal use of renewable and low-grade heat sources. DE return temperature is determined by the HVAC systems in customer buildings; hence, it is crucial for SCE to ensure that buildings connected to the system meet performance requirements.

1.5.3 Energy Transfer Stations

Each building will normally have its own ETS that is owned by SCE. The key components of an ETS generally include:

- DE supply and return pipes from the building penetration (interface with distribution system);
- Heat exchangers to transfer the heat to the building's hydronic space heating and DHW systems;
- Controls to regulate the flow required to meet the building's energy demand and maintain the DES return temperatures; and,
- Energy meters to monitor the energy used by each customer for billing and system optimization purposes.

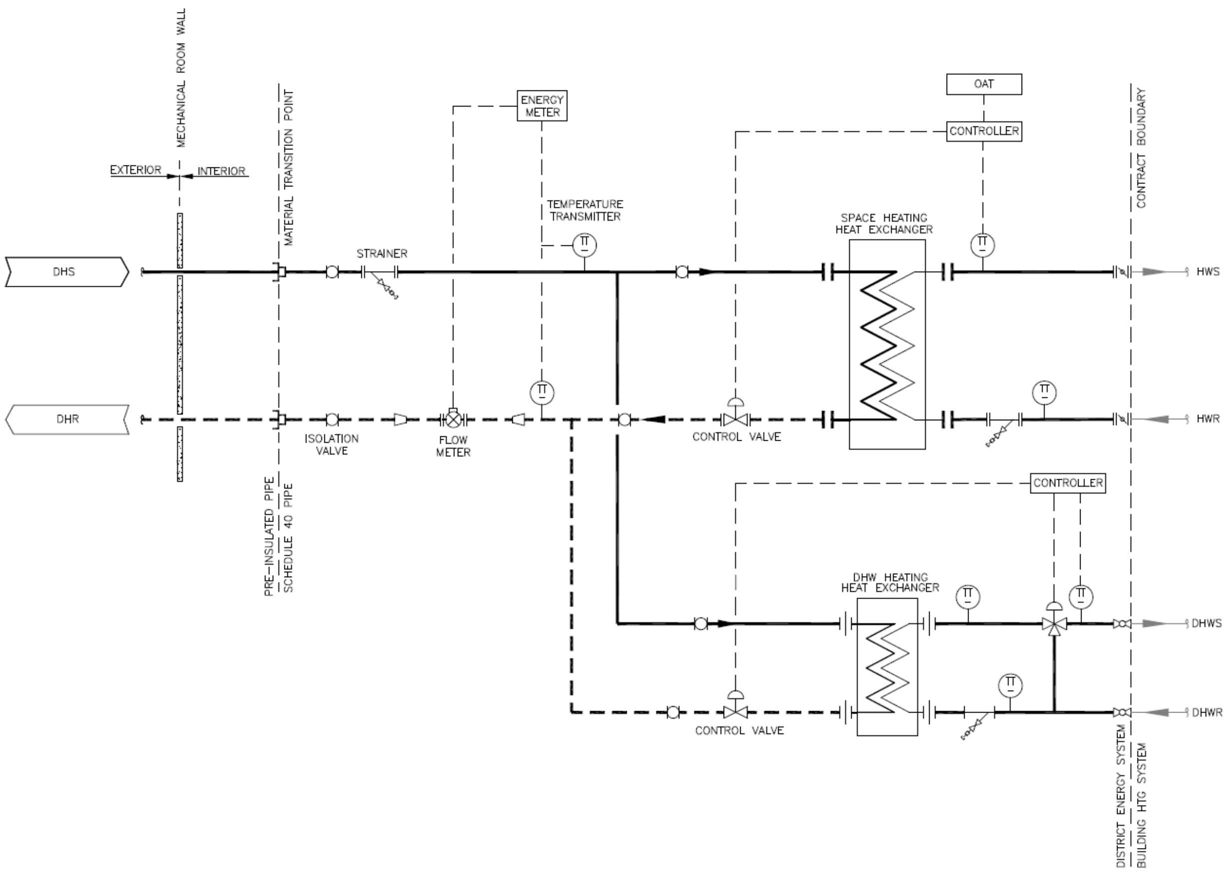
ETS's generally have two heat exchangers: one for space heating, and a second to directly serve DHW. This is typical of most hot water DES in North America and around the world. There is a vast amount of experience and data regarding DES performance and reliability with this configuration. Heat exchangers are very reliable (with no moving parts) and it is not necessary to have redundant units in an ETS. Though very unlikely, SCE is able to repair or replace a faulty heat exchanger quickly and on short notice. It is important to note that a leaking or faulty heat exchanger can often continue to supply heat, and the repair/replacement can be scheduled for a convenient, low demand period.

The redundancy needs of specific buildings may be considered. An ETS with redundant heat exchangers is more costly and requires more space in the customer building. The customer will have to provide this additional space in the mechanical room. Ultimately, SCE is responsible for the cost, maintenance and reliable operation of the ETS, including the heat exchangers.

[1] I.e. without requiring other heat sources or equipment to elevate the temperature to meet the requirements of the building.

As shown in **Figure 2** below, flow though the primary (DE) side of the ETS is controlled to achieve the building's supply temperature setpoint.

Figure 2: Typical ETS Installation in Building Basement



1.5.3.1 Thermal Energy Metering

The thermal energy metering system is an important component of the ETS. Thermal energy meters consist of a flow meter, temperature sensors on both supply and return pipes, and an integrator / calculator.

The energy meter collects data on cumulative water flow, cumulative energy, peak thermal power demand, flow rate, and supply and return temperatures. Data from each meter is transmitted to a central DES computer for utility billing purposes and to monitor and optimize performance of the DES and customer buildings.

Utility energy meters consist of high quality and accurate components: a magnetic or ultrasonic flow meter, matched pair platinum temperature sensors, and a sealed factory-programmed integrator (i.e. calculator). Magnetic and ultrasonic flow meters have low pressure drop and good range and accuracy while requiring very little maintenance. The matched pair temperature sensors allow for very accurate measurement of temperatures (required in thermal energy calculation).

1.5.4 DE-Ready Buildings

DE-Ready buildings are not immediately connected to SCE. They do not house an ETS, though are required to provide space for future installation of an ETS. Provision must be made for future installation of an ETS and service lines through the building foundation to the ETS.

DE-Ready buildings provide their own thermal energy for space heating and DHW (likely using natural gas boilers). This equipment is the sole responsibility of the building. SCE will provide guidance and support to ensure that DE-Ready buildings meet all DE design criteria requirements.

No equipment may be installed in the space allocated for the future ETS, including but not limited to natural gas boilers or other thermal energy generating equipment. Designers should consider how district heating lines will connect in the future without disruption to the system's operation. Provision of tees and valves for seamless integration of the future ETS is preferable.

1.6 SCE Contact Information

For more information on the DES and requirements of customer buildings, please check the following website for contact information: http://www.surrey.ca/community/3475.aspx.

SECTION 2

Division of Responsibility

2 DIVISION OF RESPONSIBILITY

The following section outlines the responsibilities of the Developer and SCE to ensure efficient and seamless integration of the DES into the customer building.

2.1 Developer's Responsibility

2.1.1 HVAC System

The building developer is responsible for designing and installing the building HVAC systems. There are some differences and similarities with conventional systems, as explained below.

The following conventional building elements are not required for DE-Connected buildings[2]:

- Boilers, furnaces, heat pumps, domestic hot water heaters or any other heat production equipment.
- Auxiliaries to heating systems such as stacks and breeching.
- Natural gas service.

The building will require internal thermal distribution systems, including:

- Internal distribution pumps and piping (i.e. a hydronic space heating distribution loop)
- Heating elements such as fan-coil units, air handling unit coils, and/or perimeter (baseboard) or in-floor radiant heating systems.

The following are some design conditions that are specific to district energy:

- The building will host branch (service) lines from the DES distribution piping. The DES branch lines will enter the building, similar to other utilities, and transfer heat to the ETS.
- The building owner and SCE will agree on a suitable location for the ETS. The ETS will invariably require less space than comparable heat production equipment (e.g. boilers) that the ETS displaces. To reduce DES piping inside the building, it is best if the ETS is as close as possible to the DES branch pipeline entering the building – generally on an exterior wall in the basement of the building, nearest to the main street.
- Whereas buildings not connected to DE may or may not have hydronic systems, buildings covered by the DE Bylaw are always hydronically heated[3].

[2] DE-Ready buildings will require this equipment to serve hydronic and DHW heating requirements.
[3] Partial connection buildings may use electric baseboards for residential in-suite space heating.

- The DES will operate most effectively and efficiently with the use of low temperatures in the building heating systems.

Section 3 discusses specific requirements of the hydronic heating and DHW systems for compatibility with hot water district heating.

SCE will review the HVAC and plumbing design of each building, but will not be responsible for the design (which is executed by the builder). SCE will make suggestions as necessary to ensure appropriate integration with the DES.

2.1.2 Required Compatibility

As described in Section 1.3, individual customer buildings may have different connection requirements. With the exception of buildings in Service Area B with a FAR between 1.0 and 2.5, Full Compatibility is required (i.e. for all heating requirements). This includes but is not limited to all rooftop and air handling units, fan coils, perimeter baseboards or radiators, and in-floor heating throughout the building.

Buildings in Service Area B with a FAR between 1.0 and 2.5 have Partial Compatibility requirements. For these buildings, electric baseboards are permitted for residential in-suite space heating.

2.1.3 Installation and Operation Contract Boundary

The customer is responsible for all piping and other components necessary to connect the hydronic heating and DHW systems to the ETS at the agreed DE service demarcation point on the secondary side of the heat exchangers. SCE and the customer will establish the exact location of the demarcation point during the design process. A typical example is shown in Figure 2.

2.1.4 Preparation of Building for DE Service

The customer will provide suitable space for the installation of the ETS, including space for service lines and interconnecting piping, in a mechanical room in an agreed-upon location.

The ETS room shall be ventilated and maintained at a temperature between 10ºC and 35ºC. A floor drain connected to the sanitary sewer system should be provided in the ETS room, as well as a domestic water source. A dedicated 15A 120V electrical service, with a lockable breaker, is required to power the ETS control panel. Allowance should be made to provide heating pump on/off status to the ETS control panel. SCE will directly monitor the heating pump on/off status via a hardwire connection for both the space heating and domestic hot water circulation pumps. As well, one 20mm electrical metallic tubing (EMT) conduit from the ETS room to a north facing exterior wall is required for the outdoor air temperature sensor wiring.

The footprint of an ETS depends on a number of factors, including customer load, number of heat exchangers, configuration of the hydronic heating and DHW systems, and specific restrictions within the customer building. Generally, a typical ETS requires between 4 and 10 m^2

of floor space, with a minimum ceiling height of 2.7 m. The customer may be required to provide a concrete housekeeping pad of the required size, on which the ETS heat exchangers will be installed. The exact size and location of the housekeeping pad will be established by the customer and SCE during the design process.

The exact location of the service line penetration will be established by the customer and SCE during the design process. The penetration may be a core drill (after the foundation is poured) or a sleeve installed prior to foundation pouring. The customer is responsible for providing and maintaining the penetration for the service line.

SCE may also install one or more plastic (PVC or PE) conduits into the customer building to facilitate remote communication with the ETS. Communication allows for remote controls and monitoring of the ETS, as well as remote reading of the energy meter. The customer is also responsible for providing and maintaining the penetration for communication conduit(s).

SCE will require access to the ETS and service line within a customer's building for installation, regular maintenance and repairs. This will be facilitated through a statutory right-of-way and covenant.

2.1.5 Hydronic Heating Water Quality & Expansion

Building owners are responsible for filling and managing their own building hot water heating system. The DES requires that the water treatment for the building system meet the minimum criteria set forth below:

Chloride:	< 30 ppm
Nitrate:	< 5%
Hardness:	< 2 ppm
pH Level:	9.5-10
Iron	< 1 ppm

The customer will employ the services of a water treatment subcontractor to provide the necessary chemicals, materials and supervision for a complete cleaning and flushing of all piping to the ETS demarcation point. System startup and commissioning will only occur after acceptable water quality analysis results have been obtained. **Certification from the water treatment contractor verifying that the water quality is adequate is required <u>before</u> the customer can flow water through the ETS.**

Upon request by the customer, and with suitable compensation, the ongoing water quality may be maintained by SCE. If the building owner maintains water quality in the building heating system, annual testing and reporting will be required by SCE.

Building owners will manage the expansion of the water in their own hot water system.

2.1.6 Commissioning

Prior to commissioning of the ETS, the building owner will flush and clean the building's internal hot water system (i.e. on the building side of the demarcation point). During commissioning, the building operator is responsible for the building's internal hot water system beyond the DE service demarcation point, including the internal distribution system, terminal units and building control system.

2.1.7 Changes to the Building System

The customer is not permitted to materially change the design or substitute any pertinent equipment during the installation without approval from SCE. After commissioning, any changes to the building's hydronic or DHW system that may impact DES performance shall be reported to SCE.

2.1.8 Changes to ETS

The ETS is owned and maintained by SCE. Under no circumstances can the Customer or any of its contractors adjust, modify or otherwise tamper with any ETS equipment. This includes adjusting or changing the position of any valves, gauges or instruments and tampering with the controls and control panel.

2.1.9 Sub-Metering

Customers may install energy meters on individual units, suites or sub-systems within the heating and/or DHW systems within their building. These sub-meters will be the sole responsibility of the customer, and will not affect the obligation of the customer to pay the SCE bill based on SCE’s thermal energy meter (part of the ETS) for the whole building. Sub-meters are generally not utility grade and therefore less accurate. If a customer decides to use sub-meters, it is recommended that they be used for allocation of total building thermal energy only.

2.1.10 DE-Ready Buildings

DE-Ready buildings are responsible for design, installation, commissioning, operation, and maintenance of all systems within their building, including all boilers.

2.2 SCE Responsibility

2.2.1 SCE Equipment within the Customer Building

SCE will design, install, operate and maintain the ETS at the agreed-upon location. SCE will install, own and maintain the primary (DE) distribution pipes up to the ETS. Branch pre-insulated pipelines will generally be direct buried from the mainline to the building penetration. From that point, DE piping is run inside the building to the ETS.

SCE will provide strainers on the DE and building side at each heat exchanger, which will be maintained by SCE. SCE will service the energy metering equipment and verify accuracy at regular intervals per manufacturer's recommendations.

SCE will provide temperature transmitters, pressure gauges, temperature gauges, thermowells, control valve(s), energy meter(s), and a control panel for the ETS. Temperature transmitters for the secondary side of the heat exchangers will also be provided to facilitate monitoring and control of the building side heating and DHW systems.

2.2.2 Commissioning

SCE will start and commission the ETS. Commissioning includes verifying measurement points and testing the controls under various operating modes. The building operator is required for this process as the building internal hot water system must be ready to accept heat from the DES. SCE is responsible for verifying all components up to the DE service demarcation point.

2.2.3 District Energy Side Water

SCE will provide the make-up water requirements for the DE system. All necessary water treatment is accomplished at the Energy Centre.

Thermal expansion of water in the DE system is accommodated at the Energy Centre.

SECTION 3

Requirements for Building Heating Systems

3 REQUIREMENTS FOR BUILDING HEATING SYSTEMS

This section summarizes technical requirements for hydronic heating and domestic hot water (DHW) systems for new developments in Surrey City Centre. This section applies to both DE-Connected and DE-Ready buildings.

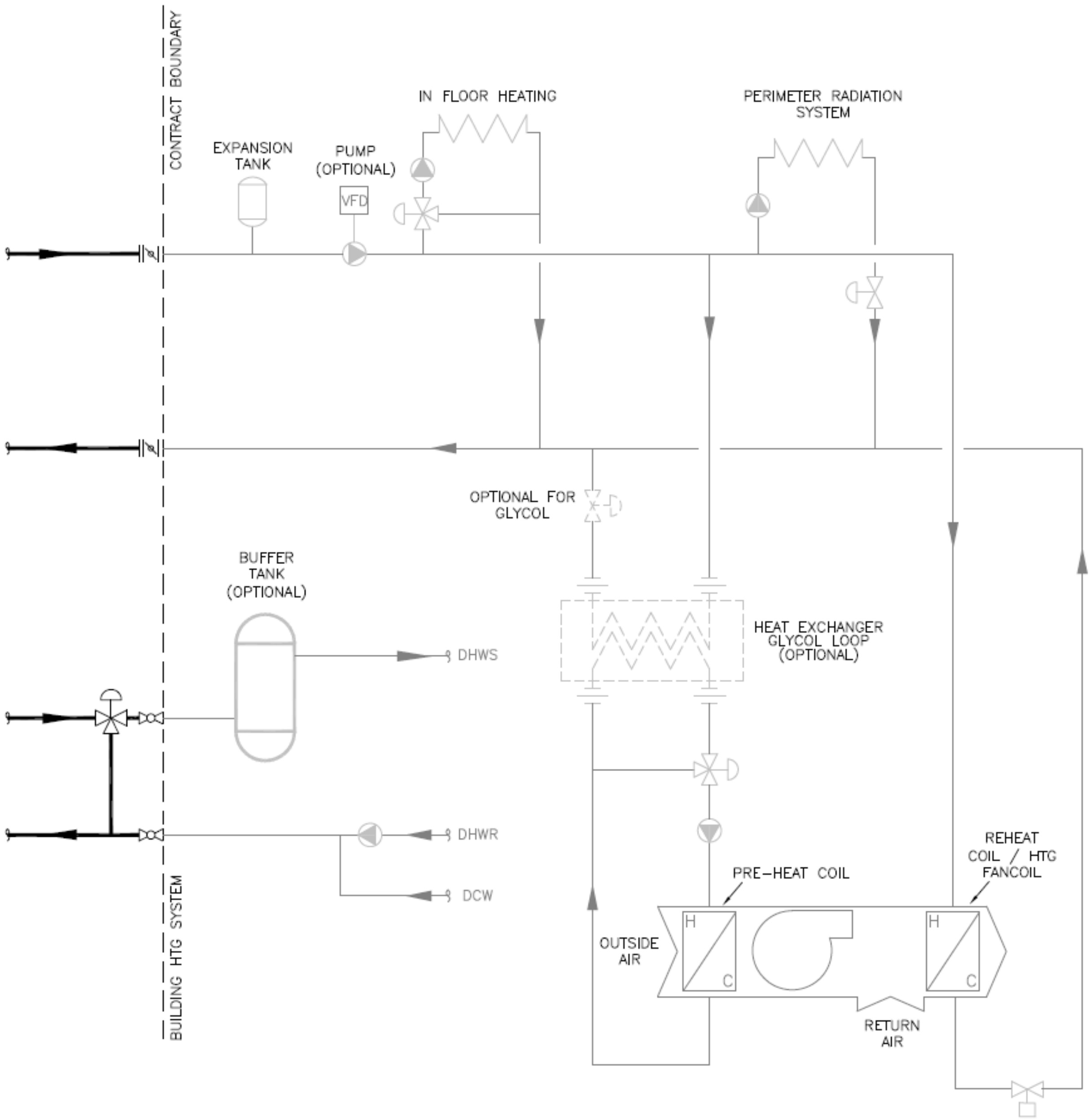
The information provided in this document should be regarded as a general guideline only, and the developer's Engineer shall be responsible for the final building-specific design. SCE will provide technical assistance to building developers to improve integration of the customer building with the DES. Heating system schematics, layouts, equipment schedules and sequence of operation or control strategies are required to assist in SCE's review process.

3.1 Pumping and Control Strategy

The building heating system shall be designed to maximize ΔT and minimize hot water return temperatures over all conditions.

The building heating system should be designed for variable hydronic flow (preferably with variable speed pumps to minimize pumping energy), using 2-way modulating (or on/off) control valves at terminal units (radiators, fan coil units, etc.). Alternatively, 3-way mixing valves at terminal units may be used. Bypass valves (e.g. 3-way bypass valves) are not permitted. See **Figure 3** below for typical hydronic heating system configurations.

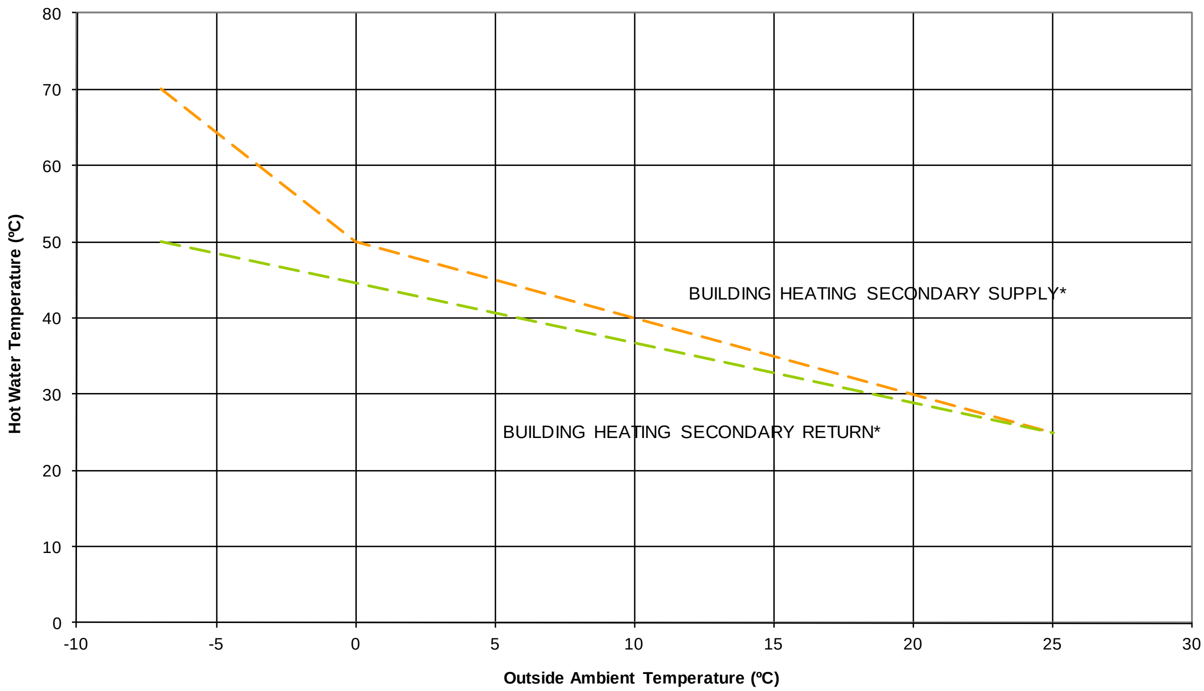
Figure 3: Conceptual building heating system configurations



3.2 Hydronic Heating and DHW Systems (Minimum) Requirements

Optimization of the DE distribution system temperature difference or "delta T" (ΔT) is critical to the successful operation of the DES. The ETS controls the supply water temperature to the hydronic circuit (i.e. the temperature of the water leaving the space heating heat exchanger) based on an outside air temperature reset schedule. This is the maximum temperature available to the building hydronic circuit. A sample hydronic heating circuit supply and return temperature reset curve is shown in **Figure 4** below.

Figure 4: Typical Temperature Reset Curve for Surrey



* - Space heating only, direct primary DHW heating with Max. 60ºC DHWS.

3.2.1 Hydronic Space Heating

The hydronic heating system shall be designed to provide space heating and ventilation air heating requirements for the whole building, supplied from a central ETS located within the building.

Hot water generated by the ETS shall be distributed via a 2-pipe system to the various heating elements (terminal units) throughout the building. The building (secondary) heating system **must** be designed for temperatures **no greater** than those specified below.

Hydronic Space Heating System Temperatures (Building Side)[4]		
	Peak Winter	*Summer*
Supply Temperature, **Max.**	70°C (160ºF)	40°C (105ºF)
Return Temperature, **Max.**	50°C (120ºF)	35°C (95ºF)
Min. Difference (Δ T)	20°C (40ºF)	5°C (10ºF)

The specified differential temperature (ΔT) shall be regarded as a minimum requirement, and larger ΔT and/or lower return temperatures are desirable. The building return temperatures must be kept to a minimum to allow SCE to take advantage of alternate-energy technologies. Specific types of heating systems (i.e. terminal units) can operate at lower temperatures. The terminal units must be selected based on temperatures as low as can be reasonably expected. The table below outlines maximum supply & return temperatures, for which terminal units should be designed and selected.

Type of Terminal Unit	**Maximum HWS**	**Maximum HWR**
Radiant in-floor heating	49ºC (120ºF)	38ºC (100ºF)
Perimeter radiation system	70ºC (160ºF)	50ºC (120ºF)
Fan coil units & reheat coils[5]	70ºC (160ºF)	50ºC (120ºF)
Air handling pre-heat and 100% outside air heating coils	65ºC (150ºF)	45ºC (115ºF)

3.2.2 Domestic Hot Water

The Domestic Hot Water (DHW) system shall be designed to provide all DHW requirements for the building, supplied from a dedicated DHW heat exchanger at the ETS. SCE understands that DHW systems generally must operate at 60ºC (140ºF) and the DES is able to supply this temperature to all buildings at all times.

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[4] Building supply and return temperatures should be as low as possible. Lower temperatures are possible with some systems (e.g. radiators, in-floor heating, and ventilation make-up air units).
[5] If unit heaters or forced-flow heaters are considered, these should follow the fan-coil design recommendations.

Domestic Hot Water Heating System Temperatures (Building Side)		
	Winter	*Summer*
Supply Temperature (with storage), **Max.**	60°C (140ºF)	60°C (140ºF)
Supply Temperature (no storage), **Max.**	55°C (130ºF)	55°C (130ºF)

DHW systems are typically designed with storage capacity or in a fully instantaneous or semi-instantaneous configuration. All domestic cold water (DCW) for the DHW system should enter immediately before the DES heat exchanger.

3.3 Supplemental Energy Sources in Customer Buildings

At the discretion SCE, some heating energy served by solar thermal sources and/or by heat recovery from refrigeration or waste heat sources within the building may be permitted.

If either of these "supplemental energy sources" is implemented, they are the sole responsibility of the Customer. Net metering (i.e. sale of thermal energy back to SCE) will not be considered; all energy generated by supplemental sources in customer buildings must be used within the building. Use of a supplemental energy source does not change the hydronic heating return water temperature requirements (as outlined in this Section).

Other than the energy sources noted above, all energy for space heating and DHW for Fully Compatible buildings must be served by SCE.

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