District Energy in Richmond Oval Village

A Design Guide for Connection to District Energy

Clean, efficient energy for now and the future

Lulu Island ENERGY COMPANY

corix Utilities

4889078

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Definitions

BAS . . . . Building Automation System

CEP. . . . . Central Energy Centre

DE. District Energy

Delta T; ΔT. . . . . Temperature Difference

DE-Ready. . . . . New buildings that are designed and constructed to be compatible with DE, but do not initially receive DE service.

DEU. . . . . District Energy Utility

DHW. . . . . .Domestic Hot Water

DPS. . . . . Distribution Piping System

EC. . . . . Energy Centre

ETS. . . . . Energy Transfer Station

Four-pipe radiator. . . . . . . A type of radiator that allows for both heating and cooling via hot and chilled water distribution; e.g. Jaga brand (http://jaga-usa.com/).

GHG. . . . . .Greenhouse Gas

HVAC. . . . . .Heating, Ventilation & Air-Conditioning

MAU. . . . . .Makeup Air Unit

OAT. . . . . Outdoor Air Temperature

VAV. . . . . Variable Air Volume; a HVAC system involving a central air handling unit that distributes air through the building for ventilation and space conditioning. Air flow rate is varied to serve the loads.

VRF. . . . . Variable Refrigerant Flow; a HVAC system that uses refrigerant as the cooling and heating distribution medium and allows one condensing unit to be connected to multiple fan-coil units.

1 Document Purpose

The Lulu Island Energy Company (LIEC) is the district energy utility serving the Oval Village service area located in Richmond, BC. LIEC is committed to providing energy that is more sustainable and reduces environmental impact. To this end LIEC has partnered with Corix Utilities Inc. through a Concession Agreement to plan, design, install, maintain and operate the district energy system for Oval Village. The system will serve space heating and domestic hot water needs for the Oval Village service area.

This document provides preliminary information to developers, building owners, engineers and architects to tailor their designs to district energy operational conditions, thereby optimizing the benefits of the District Energy Utility (DEU). Corix and LIEC will work closely with developers of new buildings and their Heating, Ventilation & Air-Conditioning (HVAC) engineers to ensure good design integration between buildings and the DEU. The information in this document applies to all building types and uses, including residential, office, retail and industrial.

In accordance with City of Richmond Bylaw 9134, it is essential that the developer collaborate with Corix and LIEC on the HVAC and plumbing design, in accordance with this document, prior to issuance of the Building Permit.

2 District Energy at Oval Village

2.1 What is District Energy?

District Energy (DE), also known as Community Energy, Neighborhood Energy, and District Heating and Cooling, 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 interfaces indirectly via heat exchangers with the buildings' space heating and domestic hot water systems. No other heat sources are required.

LIEC and Corix through extensive studies and evaluation have concluded that the DE will best serve the community utilizing a thermal energy system capable of servicing all domestic space heating and domestic hot water loads. The DE system may also connect nearby existing buildings.

The DE system consists of three main systems:

1. Central Energy Plant (CEP) – the energy source
2. Distribution Piping System (DPS) – the distribution network
3. Energy Transfer Stations (ETS) – the building interface

2.2 Benefits of District Energy to Developers & Building Owners

EASE OF OPERATION, LESS MANAGEMENT, LESS COSTS

Individual buildings connected to the DE do not require major equipment for space heating. The utility operates this type of equipment in central energy plants. This results in reduced ongoing operating, maintenance and labour costs for stratas and avoided replacement in the future.

IMPROVED EFFICIENCY/RELIABILITY

DE technology is proven and reliable, has built-in backup systems and performance is monitored continuously. It increases energy use efficiency by matching the energy source with the use. DE systems increase community energy resiliency by reducing reliance on external energy sources.

ENVIRONMENTAL

DE systems enable building owners to conserve energy and improve operating efficiency, thus protecting the environment. By reducing the need to burn natural gas once sewer heat extraction technology is implemented, it is estimated that the greenhouse gas emissions will be 80% less than buildings not connected to DE.

COMFORT AND CONVENIENCE

DE provides more affordable energy for their customers. Hydronic heating is generally considered more comfortable than other forms of space conditioning.

FUEL FLEXIBILITY

DE systems are adaptable to future technologies and sustainable energy sources such as ground source heat, ground water heat, sewer heat, biomass and solar.

2.3 DEU Owner

In 2013, the Lulu Island Energy Company (LIEC) was established as a wholly-owned corporation of the City for the purposes of managing district energy utilities on the City's behalf. Oval Village District Energy Utility Bylaw No. 9134 (the Bylaw) was established as the regulatory framework for the Oval Village District Energy Utility (OVDEU) service area. The City as the sole shareholder of the LIEC is setting rates to customers.

LIEC has an agreement with Corix Utilities to design, build, finance and operate the DEU in the Oval Village service area. As such, LIEC is the utility service provider with Corix acting as the utility operator. Customers will interact with Corix regarding DEU operational concerns.

2.4 Energy Sources for the DEU

DEU customer buildings are heated by hot water supplied by one or more CEPs. The CEPs may employ different technologies to produce hot water; this will likely evolve over time in response to changing market conditions, technologies and social concerns.

Initially, thermal energy will be provided using high efficiency natural gas-fired boilers. As the DEU grows, an alternate renewable energy, a sewer heat recovery from a sewer force main trunk along Gilbert Road will be added to the system. Once a base load alternate energy source is implemented, natural gas boilers will provide peak heating and reliable backup capacity to ensure full and uninterrupted service to customers.

2.5 Cost of District Energy

DEU capital costs are financed through rate recovery from customers. Charges will be competitive with conventional heating costs. DEU charges will be more stable and less sensitive to changes in electricity and natural gas prices, because the DEU is more efficient and it uses alternate heat sources. As with conventional systems, the developer/building owner is responsible for the in-building hydronic system. See Section 5 for details on customer and DEU responsibilities.

2.6 Building Heating System Design Implications

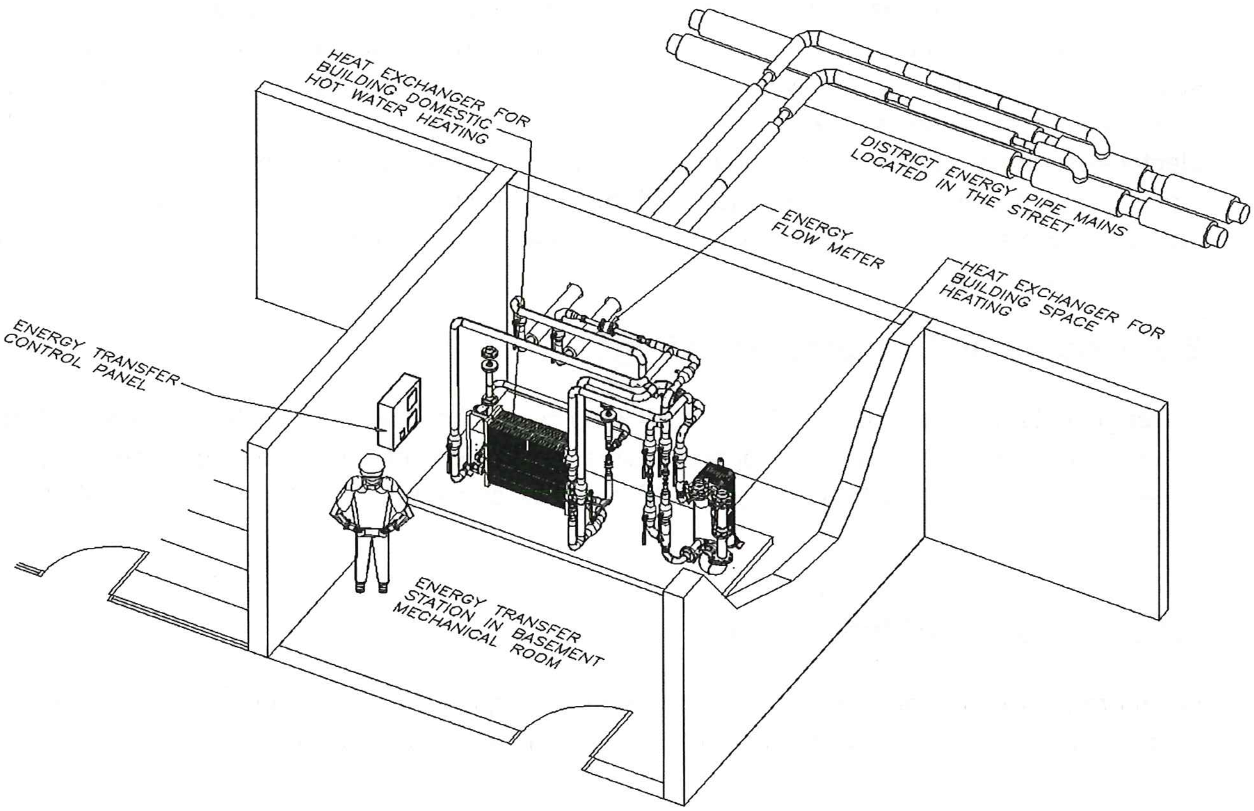
Developers are required to heat their buildings using the DEU, but have flexibility in designing the building internal heating systems in accordance with their preferences and specific requirements. The building hydronic space heating winter design temperatures cannot exceed 70°C supply and 50°C return. The domestic hot water supply temperature may remain at up to 60°C year round. The building designers will receive support and guidance from Corix in designing their HVAC systems to derive the most benefit from the DEU. See Section 6 for more details.

2.7 Energy Transfer Station Space Requirements

Corix 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), is owned by LIEC and operated by Corix and located inside the customer's building.

ETS's will be asked to be located in the basement or ground floor on an exterior wall, and typically occupy approximately 20% of the space of a conventional boiler plant. The ETS can be located within the same mechanical room as the building heating and domestic hot water system equipment. Figure 1 below shows a typical ETS located near the DPS mains in the street. See Section 5 for more details on mechanical room requirements.

FIGURE 1: TYPICAL ETS INSTALLATION IN BUILDING BASEMENT



2.8 Supplemental Heat Sources

The DEU provides a competitive, cost effective and efficient source of thermal energy to customers. One of the most cost effective ways of meeting Richmond's environmental targets is for customers to use the DEU to serve all heating and DHW requirements. However, LIEC understands that some customers may prefer to supplement the DEU with alternative energy sources. These will be reviewed on a case-by-case basis. Solar heating systems are typically acceptable, as is heat recovery from cooling or other waste heat sources. Gas-fired or electric-resistance heating or ventilation equipment (boilers, roof top units, air handling units, electric coils, electric baseboards, etc.) and the use of vapour compressors to provide heating are not acceptable. Alternatives such as hybrid heat pumps, four-pipe radiators, four-pipe fan-coils, or VAV are preferred.

2.9 Cooling in Customer Buildings

Developments in Oval Village will generally employ mechanical cooling. Small packaged heat pumps are often installed in residential suites to provide this service. Commercial spaces generally use distributed heat pumps, VRF systems or centralized chillers with a VAV HVAC system.

2.10 DEU Contact Information

For more information on the DEU Service and requirements for customer building connections, please contact Corix Utilities Inc. at energy.utilities@corix.com.

3 DEU Description

3.1 Central Energy Plant (CEP)

As with many other recent DE systems, the Oval Village DEU will be implemented in phases. An alternative energy source (sewer heat recovery) is expected to be introduced when warranted by development density. This alternative energy source will serve base load requirements for the system and likely deliver the majority of annual heating energy. Natural Gas boilers will continue to provide peak heating and reliable backup capacity to ensure full and uninterrupted service to customers.

Production equipment and controls will be based on current commercially proven technology. Sewer heat recovery technologies will be continually evaluated in light of new opportunities and changing circumstances. The DE infrastructure will be designed to facilitate the future use of new renewable energy sources for heating and power.

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

The DEU will have a higher level of reliability than is generally provided by standalone heating systems in individual homes or commercial and multi-use residential buildings.

3.2 Thermal Distribution Piping System (DPS)

Thermal energy is delivered to customers with a closed loop two-pipe hot water distribution network: the same water is heated in the CEP, distributed to the buildings, through the ETS, and returned back to the CEP 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 composed of an all-welded, pre-insulated direct buried piping system in City streets. The DPS is designed based on the size and location of customer buildings and CEPs. Distribution network modeling is completed to optimize system performance and efficiency, and to ensure that all customers will always receive sufficient thermal energy.

Variable speed pumps located at the CEP control flow through the DPS 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 DEU supply and return water is crucial to system operation. Low DE return water temperature is essential to system efficiency

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[1] i.e. without requiring other heat sources to supplement or elevate the temperature to meet the building's requirements.

and the optimal use of renewable and low-grade heat sources. DE return temperature is a function of the HVAC and DHW systems in customer buildings; hence, it is essential for the utility to ensure that buildings connected to the system meet performance requirements.

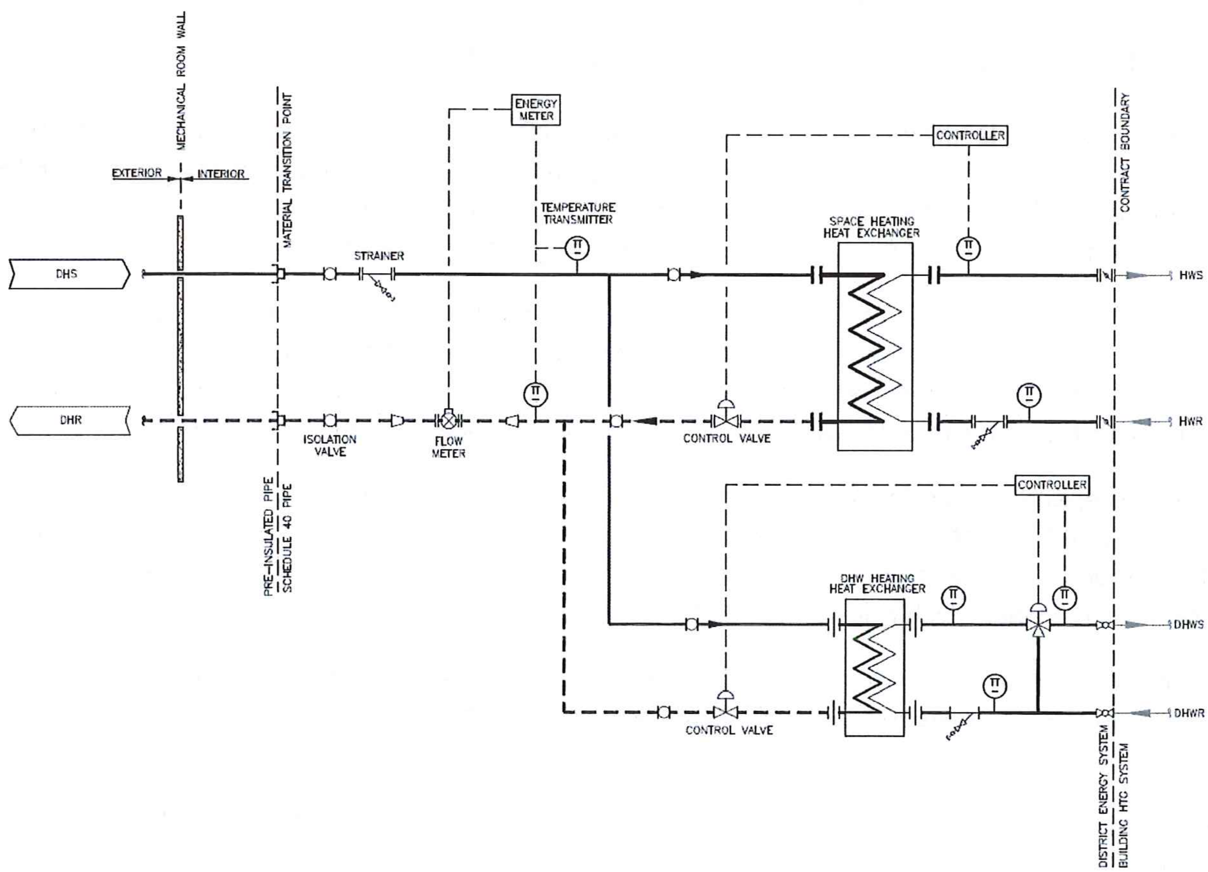
3.3 Energy Transfer Stations (ETS)

Each customer's building houses an ETS that is owned by the DEU. The key components of an ETS include:

- DE supply and return pipes from the building penetration (interface with distribution system);
- Heat exchangers to transfer heat to the building's hydronic heating and DHW systems;
- Controls to regulate the flow required to meet the building's energy demand and maintain DEU return temperatures; and,
- Energy meters to monitor the energy used by each customer for billing and system optimization purposes. See Section 4 for a discussion of DE metering.

As shown in Figure 2 on below, flow through the primary (DE) side of the ETS is controlled to achieve the building's supply temperature set point.

FIGURE 2: TYPICAL ETS FLOW SCHEMATIC



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 DE in North America and around the world. There is a vast amount of experience and data regarding DE 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.

Corix will be responsible for the maintenance and reliable operation of the ETS, including the heat exchangers.

3.4 DE-Ready Buildings

DE-Ready buildings may not be immediately connected to the DEU. In this case, they will not house an ETS, though are required to provide space for future installation of an ETS. Provisions must be made for future installation of an ETS and service lines.

DE-Ready buildings provide their own thermal energy for space heating and DHW, or through a service provider, including potentially LIEC, or through direct ownership of the equipment. This equipment is the sole responsibility of the building. LIEC will provide guidance and support to ensure that DE-Ready buildings meet all DE compatibility requirements including location of future connection points for integration into the established DES.

No equipment will be installed in the space allocated for the future ETS, including natural gas boilers or other thermal energy generating equipment if it obstructs access to a service connection, heat exchanger or meter set. 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 required. Future connection for these buildings may occur when new services are available at the site and/or at the time of equipment replacement.

4 Billing and Cost of DE Service

4.1 Energy Metering

Thermal energy meters consist of high quality and accurate components installed in the ETS: a flow meter, temperature sensors on both supply and return pipes, and an integrator/calculator. The energy meter collects data on water flow, cumulative energy, peak demand, and temperatures. Data from each meter is transmitted to a central DEU computer for utility billing purposes and to monitor and optimize performance of the DEU and customer buildings. The meters are utility-grade integrated thermal energy meters that achieve high accuracy and performance and meet existing international (OIML R75 and EN1434) and Canadian (CSA C900) standards for thermal energy metering.

4.2 DEU Bill Structure

Customers are billed to rates determined by the Council on an annual basis and defined in the Bylaw 9134.The total cost of DE service to customer buildings is competitive with heating costs for a conventionally-heated building. DE rates are expected to be more stable than gas and electricity costs over time.

Tariffs consist of two components:

- Volumetric Charge, based on thermal energy use in the period.
- Capacity Charge, based on the heating capacity required by the customer.

Volumetric Charges cover variable costs, which are primarily energy inputs (i.e. fuel costs). Accordingly, the cost will vary with consumption and the local prices for any fuel consumed by the DEU. As with natural gas and electricity, energy use and charges should be less in summer months than in winter.

The Capacity Charge covers DE fixed costs (non-commodity operation, maintenance and capital recovery costs, taxes, etc.). This charge is a function of the thermal capacity required by the customer and/or size of the building (i.e. floor area).

In order to minimize unnecessary additional capacity and cost, it is important that building developers do not overestimate building capacity requirements. Overestimation of peak demand results in higher fixed capacity charges for customers. Corix will work closely with building developers to establish realistic system demand requirements. Similar to other energy utilities in B.C., tariffs will be adjusted periodically based on changes in costs over time.

4.3 Sub-Metering

Customers may install energy meters on individual units, suites or sub-systems within the heating and/or DHW systems in their building. These sub-meters are the sole responsibility of the customer, and will not affect the obligation of the customer to pay the DEU bill based on the 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. DEU billing to the customer will be based on the ETS meter only.

4.4 DE-Ready Buildings

DE-Ready buildings are not customers of the DEU and therefore are not billed by LIEC. DE-Ready buildings bear their own costs that are typically associated with conventional stand-alone buildings, such as fuel costs, capital costs for heating equipment, and costs associated with the operation and maintenance of that equipment.

Once connected to the DEU, DE-Ready buildings become DE customers and charges from the DEU will commence. These bills replace the fuel, capital and O&M costs related to heat production previously borne by the DE-Ready building.

5 Responsibilities of Customer and DEU

The following section outlines the responsibilities of the developer and LIEC/Corix to ensure efficient and seamless integration of DE service, and to ensure full compatibility for DE-Ready buildings.

5.1 Developer's Responsibility

5.1.1 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 customer buildings[2]:

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

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 units, and/or perimeter (baseboard) or in-floor radiant heating systems.
- Normal building controls and control systems.

The following are some design conditions that are specific to DE:

- Customer buildings host branch (service) lines from the DPS. The DEU branch lines enter the building, similar to other utilities, and transfer heat to the ETS.
- The building owner and Corix agree on a suitable location for the ETS. The ETS invariably requires less space than comparable heat production equipment (e.g. boilers) that it replaces. To reduce DEU piping inside the building, the ETS should be located as close as possible to the DEU branch pipeline entering the building – generally on an exterior wall in the basement or ground floor of the building, nearest to the DE main line.
- The DEU operates most effectively and efficiently with the use of low temperatures in the building heating systems.

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[2] DE-Ready buildings will require boilers to serve space and DHW heating requirements.

The DEU will provide heating only (i.e. district heating); customer buildings are responsible for any cooling systems they choose to employ. Section 6 discusses specific requirements of the hydronic space heating and DHW systems for compatibility with hot water district heating.

Corix reviews the HVAC and plumbing design of each building, but is not responsible for the design (which is executed by the builder). Corix may make suggestions as necessary to ensure appropriate integration with the DEU.

5.1.2 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 demarcation point for the service boundary on the secondary side of the heat exchangers. This demarcation point will be clearly marked on the DEU engineering drawings for the ETS. A typical example is shown in Figure 2.

DE-Ready buildings are responsible for all equipment within their building, including boilers for space heating and DHW. Delineation from the DEU will be determined at time of connection to the DEU. DE-Ready buildings must have provision for future connection to the DEU, such as full-size tees and isolation valves for connection of the hydronic heating and DHW system to an ETS.

5.1.3 Preparation of Building for DE Service

All customers 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 with sufficient access opening for the ETS. The ETS should generally be located at an exterior wall facing the street, in the basement or ground level, and in compliance with the Flood Plain Bylaw 8204.

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 in the Building Automation System (BAS), if one exists, to provide heating pump on/off status to the ETS control panel. If a BAS is not planned for the building, the DEU will directly monitor heating pump on/off status via a hardwire connection. 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 (OAT) 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. Typical dimensions are 1.8 m deep by 4 m wide by 2 m high. One meter clearance is required on two sides and .3 m clearance on the remaining two sides. The ETS will fit through a standard double door. Housekeeping pads are not required as the ETS is pre-manufactured on a steel skid.

The customer is responsible for the DE service line building or foundation penetration, which meets Corix's requirements (size of opening, etc.), in a mutually agreeable location. Corix will produce a penetration drawing during the detailed design stage. Penetrations may be core drilled (after foundation construction) or sleeved (during foundation construction). DE-Ready buildings will have cored penetrations installed at the time of DE connection. Corix will install the DE service line; however, as with other utilities, the customer is responsible for providing and maintaining the penetration.

Corix 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 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).

Corix will require uninterrupted access to the ETS and service line within a customer's building for installation, regular maintenance and repairs. This will be defined by an easement with the City of Richmond.

5.1.4 Hydronic Heating Water Quality & Expansion

Building owners are responsible for filling and managing their own building hot water heating system. The DEU requires that 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 shall 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. ETS 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 before 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 Corix.

Building owners will manage the expansion of water in their hydronic hot water system(s).

5.1.5 ETS Commissioning

Prior to commissioning of the ETS, the building owner shall flush and clean the building's internal hot water system to meet the water quality requirements in Section 5.1.4 above. The customer is responsible for commissioning all equipment and systems on the building side of the demarcation point. During ETS commissioning, the building operator is responsible for the building's internal hot water system.

5.1.6 Changes to the Building System

The Customer shall not materially change the design or substitute any pertinent equipment during installation without Corix's approval. After commissioning, any changes to the building's hydronic or DHW system that may impact DEU performance shall be reported to Corix.

The ETS is owned by LIEC and maintained by Corix. 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 altering the controls and control panel.

5.1.7 DE-Ready Buildings

DE-Ready building owners are responsible for design, installation, commissioning, operation, and maintenance of all systems within their building, including all boilers. The DEU has no responsibilities within DE-Ready buildings.

5.2 DEU Responsibility

5.2.1 DEU Equipment within Customer Buildings

Corix designs, installs, operates and maintains the ETS on behalf of LIEC at the agreed-upon location, as well as the primary (DE) distribution pipes to the ETS. Branch pre-insulated pipelines are generally direct buried from the mainline to the building penetration. From that point, DE piping runs inside the building to the ETS.

Corix provides strainers on the DE and building side at each heat exchanger in the ETS, which are cleaned as necessary. Corix services the energy metering equipment and verifies accuracy at regular intervals per manufacturer recommendations.

Corix provides temperature transmitters, pressure gauges, temperature gauges, thermowells, control valves, energy meters, and a control panel for the ETS. Temperature transmitters for the secondary side of the heat exchangers are also provided to facilitate monitoring and ETS control of the secondary side heating and DHW systems.

5.2.2 District Energy Side Water

The DEU provides the make-up water requirements for the DE system side. All necessary water treatment is accomplished at the CEP. Thermal expansion of water in the DE system is accommodated at the CEP.

5.2.3 Commissioning

Corix, together with the developer or building operator, 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 DEU. Corix is responsible for commissioning all components up to the DE service demarcation point.

6 Requirements for Building HVAC and DHW Systems

This section summarizes technical requirements for hydronic heating and domestic hot water systems for new developments at Oval Village. 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. Corix will provide technical assistance to developers to improve integration of the customer building with the DEU. Heating system schematics, layouts, equipment schedules and sequence of operation or control strategies are required to assist in the DEU review process.

6.1 Design Strategies

The following table identifies the key elements or strategies that should be followed when designing the building heating system.

Strategy	Rationale
Centralized hydronic system	• Water has four times the specific heating capacity of air. • Benefits from system load diversification. • Reduces utility interconnect costs. • Minimizes noise from mechanical systems.
Low[3] supply temperatures Large temperature differentials	• Improves DE efficiency. • Allows use of lower grade energy sources. • Reduce piping capital cost. • Reduce pumping capital & operating costs.
Variable flow with variable frequency drives	• Reduces pumping operating costs. • Improves system control.
Two-way control valves	• Necessary to achieve variable flow and a large temperature differential.
Seasonal reset of supply temperatures	• Improves energy efficiency. • Improves system control.

[3] "Low" relative to traditional building HVAC design, which is typically >80°C on the building side of the ETS. The DEU is referred to as a "medium" temperature water system since it supplies water from 65°C up to 95°C and needs to be higher than the building side temperature.

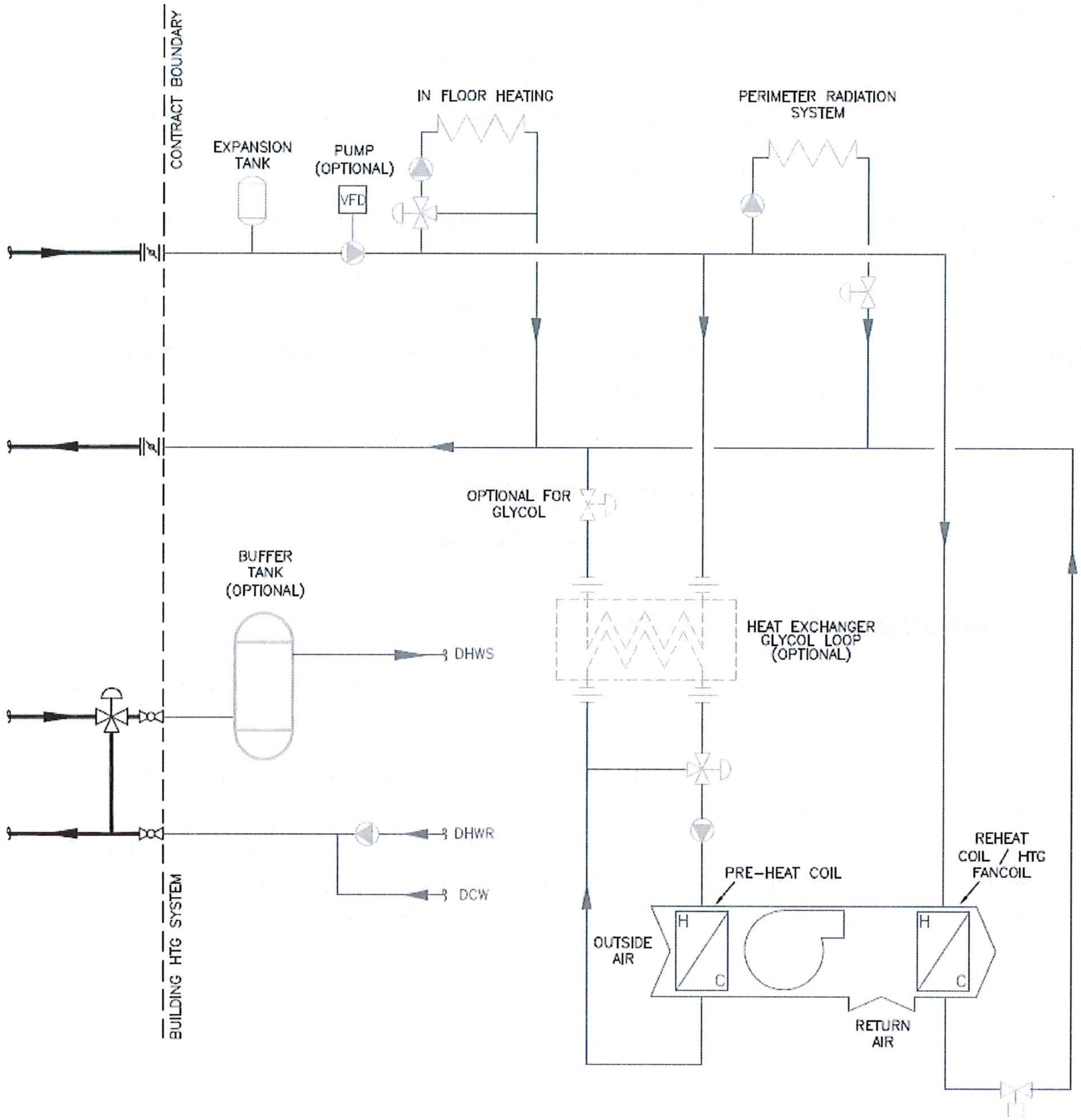
Strategy	Rationale
Return temperature limiting	• Improves energy efficiency.
Direct Digital Control System	• Allows more accurate control and greater control flexibility. • Potential opportunities for energy savings.
Night setback settings & recovery times	• Minimize equipment sizes by allowing reasonable recovery times. • Maximize recovery times from unoccupied to occupied mode.
Hybrid heat pumps or central chillers (4-pipe fan coils, 4-pipe radiators, VAV, etc.)	• More efficient operation, with significantly reduced electricity consumption. • Reduced maintenance costs and requirements. • Longer equipment life. • Quieter operation in heating mode.

6.2 Pumping and Control Strategy

The building hydronic 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: TYPICAL BUILDING HEATING SYSTEMS

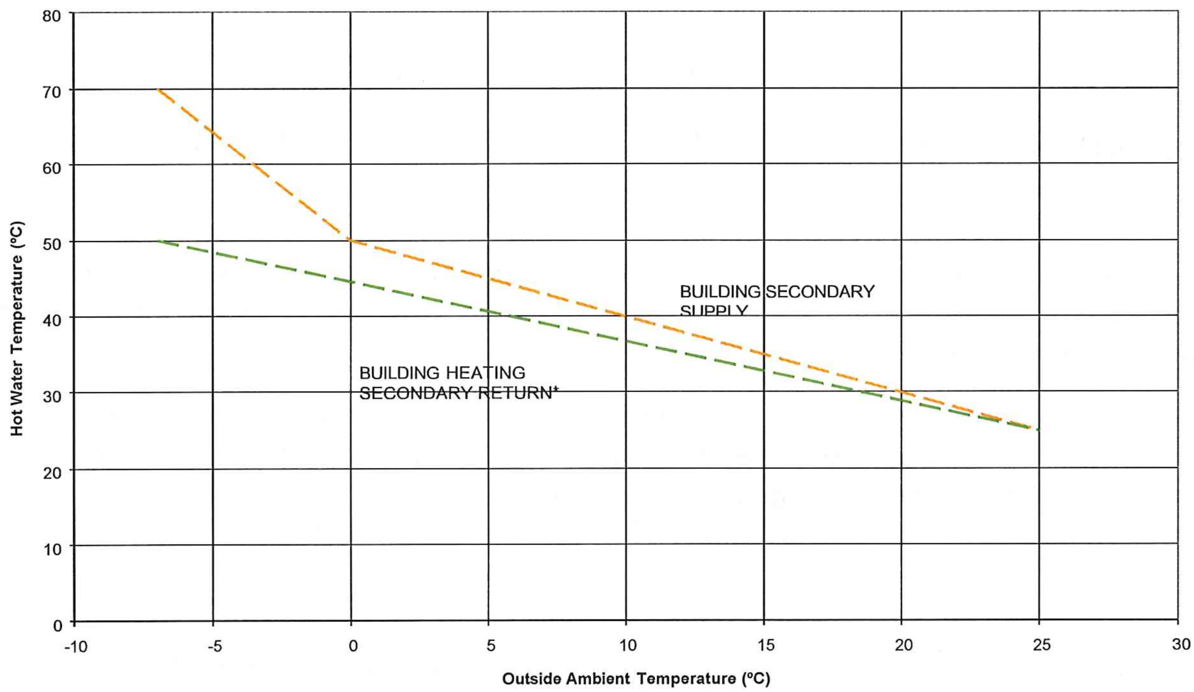


6.3 Hydronic Heating and DHW System (Minimum) Requirements

Optimization of the hydronic heating system temperature difference or ΔT is critical to the successful operation of the DEU. 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 VANCOUVER

Typical Building Temperature Reset Curve for Vancouver Area



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

6.3.1 Hydronic Space Heating

The hydronic heating system shall be designed to provide **<u>all</u>** space heating and ventilation air heating requirements for the whole building, supplied from a central ETS. Gas-fired or electric-resistance heating or ventilation equipment (roof top units, air handling units, electric coils, electric baseboards, etc.) are not permitted.

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

Hydronic Space Heating System Temperatures (Building Side)		
	Peak Winter	*Summer*
Supply Temperature, **Max.**	70°C (158°F)	45°C (113°F)
Return Temperature, **Max.**	50°C (122°F)	40°C (104°F)
Min. Difference (Δ T)	20°C (36°F)	5°C (9°F)
Design Pressure	≤1600 kPa	≤1600 kPa

Domestic Hot Water Heating System Temperatures (Building Side)		
	Winter	*Summer*
Supply Temperature (with storage), **Max.**	60°C (140°F)	60°C (140°F)
Supply Temperature (no storage), **Max.**	55°C (131°F)	55°C (131°F)

The specified temperatures shall be regarded as maximum requirements; lower temperatures are desirable. The building return temperatures should be minimized to allow the DEU 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** hot water supply (HWS) and hot water return (HWR) temperatures for which terminal units should be designed and selected.

Type of Terminal Unit	Maximum HWS	Maximum HWR
Radiant in-floor heating	50°C (122°F)	38°C (100°F)
Perimeter radiation system	70°C (158°F)	50°C (122°F)
Fan coil units & reheat coils[4]	70°C (158°F)	50°C (122°F)
Air handling pre-heat coils[5]	65°C (149°F)	45°C (113°F)

6.3.2 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 from the ETS. It is understood that DHW systems require supply temperatures as high as 60°C (140°F); the DEU is able to supply this temperature to all buildings at all times.

DHW systems should be designed in a semi-instantaneous configuration. All domestic cold water (DCW) should enter the DHW system immediately before the ETS heat exchanger. Reducing storage capacity and recirculation requirements results in space and cost savings. Capital costs for the system are lower, maintenance requirements are reduced, and replacement costs when equipment reaches end of life are lower.

[4] Unit heaters and forced flow heaters should follow the fan coil design criteria.

[5] Make-up Air Units (MAU) should follow the air handling pre-heat coil design criteria.

With less storage capacity, the DHW has shorter residence time in the building, reducing the chance of bacteria growth such as Legionella.

A fully instantaneous DHW system has no storage tanks. This results in the greatest capital and maintenance cost and space savings. This configuration allows for lower DHW supply temperature (≤ 55°C / 130°F).

In a semi-instantaneous system, the storage capacity is small. In such a system, storage tanks act as "buffer tanks" only; there is no recirculation from DHW storage tanks directly back to the heat exchanger.

DE-Ready buildings may employ alternate DHW configurations. However, provision shall be made for conversion to instantaneous or semi-instantaneous operation. In addition, full-size tees and isolation valves in the ETS room for future connection to the ETS are to be provided.

6.4 Cooling in Customer Buildings

The DEU will provide heating only (i.e. district heating); customers are responsible for any cooling systems they choose to employ. It is understood that developments in Oval Village generally have mechanical cooling using in-suite heat pumps or VRF systems. Heat pumps and VRF systems increase customer electricity consumption and reduce the heating energy available to the DEU.

Alternatives that can provide both heating and cooling to suites, such as hybrid heat pumps, four-pipe radiators, four-pipe fan coils, or VAV are preferable. These alternatives have similar life-cycle costs with reduced O&M costs, quieter operation and longer life expectancy. Alternatives to a conventional heat pump do not use electricity to run a compressor during heating, resulting in significant electricity savings. Because there are less moving parts in heating mode, there is less maintenance, the units are more reliable, and have a longer life. In addition, eliminating compressor operation in heating mode results in quieter operation.

While mechanical cooling may be employed, Richmond is still a heating-dominant climate – especially for residential buildings. Conventional heat pumps sacrifice performance for capital cost savings. Hybrid heat pumps operate more efficiently when heating, resulting in improved overall system efficiency. Alternatives with central chillers operate more efficiently throughout the year. These alternatives also make better use of alternate energy sources implemented by the DEU.

Corix and LIEC prohibit the use of vapor compressors and VRF systems to provide heating in buildings that will connect to the Oval Village DEU.

6.5 Supplemental Energy Sources in Customer Buildings

At the discretion of Corix, some heating energy can be served by solar thermal sources and/or by heat recovery from cooling or waste heat sources within the building. 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 Corix) 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 Section 6.3).

Other than the energy sources noted above, all energy for space heating and DHW should be from the DEU. Gas-fired or electric-resistance heating or ventilation equipment (roof top units, air handling units, electric coils, electric baseboards, etc.) are not acceptable.

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