Alexandra District Energy Utility

A Guide for Connection to District Energy

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Table of Contents

Abbreviations

ADEU	Alexandra District Energy Utility
BAS	Building Automation System
CEP	Central Energy Plant
DDC	Direct Digital Control
DE	District Energy
Delta T; ∆T	Temperature Difference
DEU	District Energy Utility
DHW	Domestic Hot Water
DPS	Distribution Piping System
ETS	Energy Transfer Station
GFA	Gross Floor Area
GHG	Greenhouse Gas
HVAC	Heating, Ventilation & Air-Conditioning
MAU	Makeup Air Unit
OAT	Outdoor Air Temperature

1 Document Purpose

The City of Richmond is committed to sustainability and reduced environmental impact. To this end, the City of Richmond operates an ambient energy sharing system called the Alexandra District Energy Utility (ADEU) in the West Cambie neighbourhood. The system serves space heating, cooling and domestic hot water needs for buildings within the West Cambie service area.

This document provides preliminary information to developers, building owners, engineers and architects to tailor their designs for optimal compatibility with the ADEU. The City of Richmond will work closely with developers to ensure good design integration between buildings and the ADEU. The information in this document applies to all building types within the service area.

In accordance with City of Richmond Bylaw 8641, it is essential that the building developer collaborate with the City of Richmond on the HVAC and plumbing design as part of the Building Permit process.

2 District Energy at Alexandra

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 produces thermal energy from a central location, typically in the form of hot/chilled water, and distributes the energy through a network of piping to individual customer buildings.

The energy transfer is controlled and metered at the point where the DE system interfaces with the building HVAC system through a heat exchanger.

Connection to the ADEU replaces a portion of the conventional boiler plant or chiller plant located inside building. In essence, the cost of capital and security of energy supply is transferred from the building owner to the district energy utility.

2.1.1 What is Ambient District Energy?

ADEU will utilize an ambient thermal energy system to service the customer space heating, cooling and domestic hot water systems.

The system will extract heat from geo-exchange fields and supply it to buildings during heating season. The system will accept rejected heat from buildings and return it to geo-exchange fields during cooling season. If required, supplemental heat energy will be added or removed at the Central Energy Plant.

2.2 Benefits of District Energy

EASE OF OPERATION, LESS MANAGEMENT, LOWER COSTS

Individual buildings connected to the DE require less 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 of HVAC equipment 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. The ADEU uses geo-exchange technology as an energy source, which reduces the need for buildings to burn natural gas and use electricity, which reduces carbon emissions.

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 and Operator

The City of Richmond is the owner of the system. The City of Richmond may engage a third-party firm to provide operations support.

2.4 ADEU Service Area

Refer to Figure 1 for a map of the ADEU Service Area. As outlined in Bylaw 8641, any building, new or proposed for construction, within the ADEU Service Area will connect to and utilise the ADEU for internal space heating and cooling, and domestic hot water in accordance with the terms of the bylaw.

SCHEDULE A to BYLAW NO. 8641

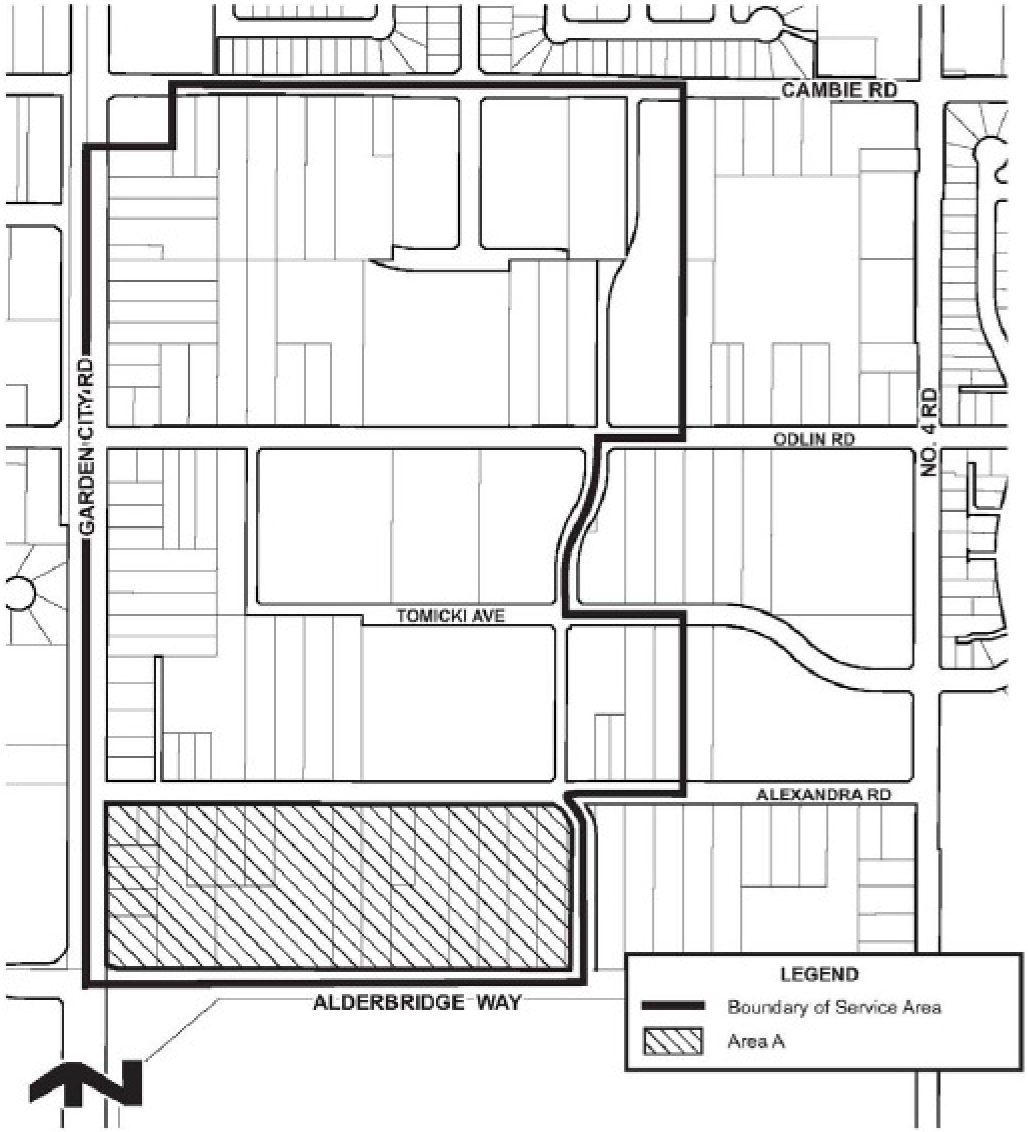


FIGURE 1: SERVICE AREA

3 DEU Description

3.1 Overview

The ADEU 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

3.2 Central Energy Plant (CEP)

The CEP is the central source of heating and cooling energy in the system. This is where the water and propylene glycol solution is heated or cooled before being distributed throughout the service area. The CEP houses the thermal energy generation and distribution equipment. The CEP energy generation equipment includes geo-exchange fields, boilers and cooling towers. The CEP distribution equipment includes pumps, piping and controls.

The CEP may employ different technologies to generate and distribute energy. This could evolve over time in response to changing market conditions, technology or social requirements. Presently, the majority of the heating and cooling demand is serviced from two geo-exchange fields located under greenways within the neighbourhood. These geo-exchange fields provide 100% renewable clean energy.

Depending on the demands of the connected buildings, the CEP can operate in either heating mode or cooling mode. In heating mode, the central energy plant extracts heat from the ground through the geo-exchange fields. Natural gas boilers are installed to provide peaking and backup capacity as required. In cooling mode, the central energy plant rejects heat into the ground through the geo-exchange fields. Cooling towers provide additional peaking and backup capacity as required.

3.3 Distribution Piping System (DPS)

Thermal energy is delivered to customers through a closed-loop distribution piping network. To transport the energy, a water and propylene glycol solution is used as a medium. The fluid is heated or cooled in the CEP, distributed to an Energy Transfer Station at each building, and returned back to the CEP where it is heated or cooled again. No water is drained or lost in the system, and no additional water is required during normal operation.

The DPS is composed of both HDPE DR17 piping and EN253 pre-insulated steel piping. Customers can expect either type of piping to service their building.

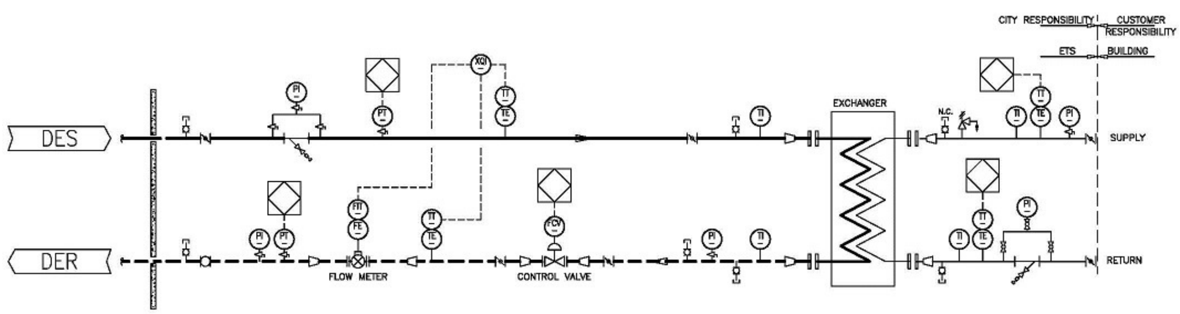
3.4 Energy Transfer Stations (ETS)

Each building houses an ETS that is owned by the City of Richmond. The key components of an ETS include:

- Supply and return piping with pressure and temperature gauges;
- Heat exchanger to transfer heat between the district system and the building HVAC systems;
- Control valves and temperature sensors to regulate the flow to the building; and,
- Energy meter package, including a flow meter, temperature sensors and an energy calculator, for billing and system optimization purposes.

The flow through the district side of the ETS is controlled to achieve the building supply temperature set point. Figure 2 shows a typical ETS process and instrumentation diagram.

FIGURE 2: TYPICAL ETS PROCESS AND INSTRUMENTATION DIAGRAM



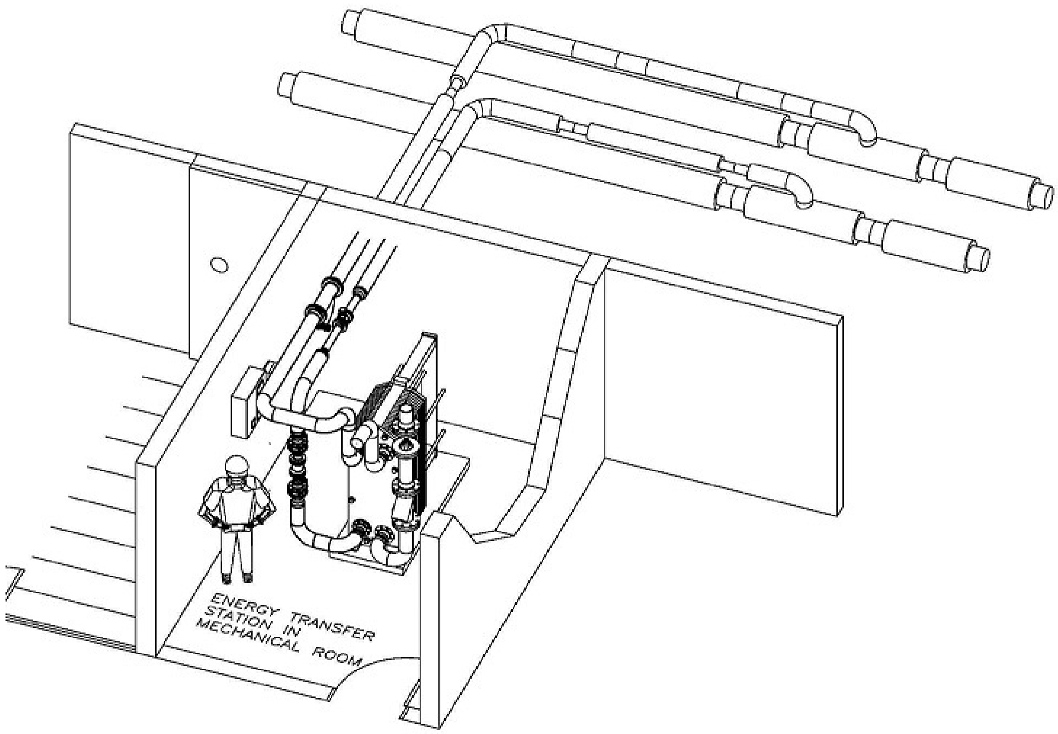
Heat exchangers are very reliable (with no moving parts) and it is generally not necessary to have redundant units in an ETS. The City of Richmond is responsible for the maintenance and reliable operation of the ETS, including the heat exchanger.

3.5 Space Requirements

The ETS is to be located above the floodplain elevation in the customer building. The ETS can be co-located with other mechanical equipment or installed in a dedicated room. An allowance must also be made for the entry of the DPS service branch into the building.

The mechanical room containing the ETS must be sufficiently large to allow for access, inspection, maintenance, removal and repair of equipment. A location for the installation of the ETS is agreed upon between the Service Provider representative and the Building representative. This location must have a minimum opening dimension of 2.0m x 2.0m to the mechanical room for installation and placement of ETS equipment, and a housekeeping pad in accordance with the drawings. The maximum dimensions for the ETS equipment are 6.0m L x 3.0m W x 3.0m H. The actual dimensions and lay-out of the ETS is to be confirmed upon completion of the building permit peer review and subsequent ETS design.

Figure 3: Typical ETS Installation in Building



3.6 Design Temperatures

The design district temperatures are:

Mode	Supply	Return
Heating (minimum)	-1.1℃ (30 ℉)	-6.7℃ (20 F)
Cooling (maximum)	32.2℃ (90 F)	37.8℃ (100 F)

The temperature difference between the inlet and outlet measured on the Building System side of the heat exchanger(s) at peak design conditions is required to be a minimum of ∆5.5 ℃ or ∆10F.

In practice, the district loop may operate at temperatures anywhere between the design limits, and as a result the building can expect to operate at temperatures anywhere between the design limits.

3.7 Heat Exchanger Sizing Criteria

The heat exchanger will be sized according to the peak demands of the building system as defined in an energy modelling report prepared by the building's mechanical design engineer.

4 Billing and Cost of DE Service

4.1 Energy Metering

The City of Richmond will install, maintain and operate customer metering to measure total thermal energy supplied to each building, and for submitting quarterly bills to each building owner for DE service. The energy meter collects data on water flow, cumulative energy, peak demand, and temperatures. Data from each meter is transmitted to a central DEU server for utility billing purposes and to monitor and optimize DEU and building performance. The meters are revenue-grade thermal energy meters that achieve high accuracy and performance and meet existing International and Canadian standards for thermal energy metering.

4.2 ADEU Bill Structure

Customers are billed to rates determined by Richmond City Council on an annual basis and defined in the Bylaw 8641.The total cost of DE service to customer buildings is competitive with space heating, cooling and domestic hot water costs for a conventionally-heated/cooled 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.

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. The City of Richmond will work closely with building developers to review realistic system demand requirements.

Similar to other energy utilities in B.C., tariffs will be adjusted periodically based on changes in costs over time. The ADEU service rate is reviewed annually and is subject to Council's objective to keep the annual energy costs for ADEU customers competitive with conventional energy costs, based on the same level of service.

4.3 Sub-Metering

Customers may install energy meters on individual units, suites or sub-systems within the heating and/or domestic hot water (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 ADEU bill based on the City of Richmond's thermal energy meter (part of the ETS) for the whole building. Sub-meters are generally not utility-grade.

5 Responsibilities of ADEU and Customer

This section outlines the responsibilities of ADEU and the customer to ensure efficient integration of DE service and system compatibility.

5.1 DEU Responsibility

5.1.1 DEU Equipment

The City of Richmond, owner and operator of the ADEU, will design, install, operate, and maintain:

- Energy Transfer Station and service branch
- All piping and components for the ADEU on the district side of the heat exchanger
- Strainers on both sides of the ADEU heat exchanger
- Energy metering equipment
- All controls and instrumentation for the ETS

In accordance with City of Richmond Bylaw 8641, the customer is responsible for all expense of design and installation of the above equipment located on customer's property.

5.1.2 Commissioning

The City of Richmond, together with the developer or building operator, will 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 heating and cooling systems must be ready to accept or reject heat in coordination with the ADEU. The City of Richmond is responsible for commissioning all components up to the ADEU service demarcation point.

5.2 Customer Responsibility

5.2.1 HVAC System

The building developer is responsible for designing and installing the building HVAC systems.

The building HVAC systems include the following:

- Heat pumps
- Circulation pumps and piping (i.e. hydronic distribution loops)
- Heating and cooling elements such as heat pumps, fan-coil units, air handling units, or in-floor radiant 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 ADEU branch lines enter the building, similar to other utilities, and transfer heat to the ETS.

- The building owner and the City of Richmond agree on a suitable location for the ETS. The ETS invariably requires less space than comparable heat production equipment (e.g. boilers and cooling towers) that it replaces. To reduce ADEU piping inside the building and cost to customer, the ETS should be located as close as possible to the ADEU branch pipeline entering the building – generally on an exterior wall in the basement or ground floor of the building, nearest to the ADEU main line.

The ADEU will provide heating and cooling energy for interaction with the building heat pump systems. Centralized or distributed heat pumps must be designed for interaction with the ETS heat exchanger within the DEU operational temperature range.

The City of Richmond will review the HVAC and plumbing design of each building, but is not responsible for the design and installation. The City of Richmond may make suggestions as necessary to ensure appropriate integration with the DEU.

5.2.2 Installation and Operation Contract Boundary

The customer is responsible for all piping and other components necessary to connect the HVAC systems to the ETS at the agreed demarcation point. This demarcation point will be clearly marked on the DEU engineering drawings.

5.2.3 Preparation of Building for DE Service

The ETS room shall be ventilated and maintained at a temperature between 10°C 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 DDC or BAS, to provide circulation pump on/off status to the ETS control panel. A building DDC system is required to facilitate communication with the ETS control panel. As a backup, the DEU may also directly monitor circulation pump on/off status via a hardwire connection.

The customer should provide a concrete housekeeping pad of the required size, on which the ETS heat exchanger is installed. The exact size and location of the housekeeping pad will be established by the customer and the City of Richmond during the design process.

The customer is responsible for the service branch building or foundation penetration, which meets the City of Richmond's requirements (size of opening, etc), in a mutually agreeable location established during the detailed design stage. Penetrations may be core drilled (after foundation construction) or sleeved (during foundation construction).

The City of Richmond may provide wireless communication devices or 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).

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

5.2.4 Water (Glycol) Management

Building owners are responsible for filling and managing their own building hydronic systems. The DEU requires that water treatment for the building system include a 23.5% concentration of inhibited propylene glycol.

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 start-up 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.

Building owners will manage the make-up, expansion, and concentration of glycol in their hydronic system(s). It is recommended that the building regularly monitor levels of inhibitor, pH and glycol concentration to ensure their mechanical system is properly maintained.

5.2.5 ETS Commissioning

Prior to commissioning of the ETS, the building owner shall flush and clean the building's internal hydronic system. The customer is responsible for commissioning all equipment and systems on the building side of the system. The ETS commissioning, the building operator is responsible for the building's internal hydronic systems. The building operator shall provide, for the City's record, commissioning, testing and flushing report prior to ETS commissioning.

5.2.6 Changes to the Building System

The customer shall not materially change the design or substitute any pertinent equipment during installation without the City of Richmond's approval. After commissioning, any changes to the building's systems that may impact ADEU performance shall be reported to the City of Richmond prior to installation.

The ETS is owned and maintained by the City of Richmond. 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.

6 Requirements for Building Mechanical Systems

6.1 General

The City of Richmond will provide technical assistance to developers to improve integration of the building with the ADEU. HVAC system schematics, layouts, equipment schedules and sequences of operation are required to assist in the City's review process. 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.

6.2 Energy Targets

The DEU system will provide a minimum of 70% of the collective annual space heating and cooling and domestic hot water thermal energy. Refer to City of Richmond Bylaw 8641 for complete details.

6.3 Design Strategies

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

Strategy:	**Rationale:**
Heat pump system	• Heat pumps must be used to enable the temperature lift between source and sink. • Centralized or distributed heat pumps may be utilized. • Heat pump operation to be sequenced in coordination with ETS to maximize DEU utilization.
Direct Digital Control System	• Allows more accurate control and greater control flexibility. • Opportunities to optimize for energy savings. • Permits communication between on-site equipment, building automation system and ETS control system.
Night setback settings & recovery times	• Reduce loop heating or cooling requirements and ventilation rates during unoccupied periods. • Minimize equipment sizes by allowing reasonable recovery times. • Maximize recovery times from unoccupied to occupied mode.

6.4 Fluid

The building-side fluid flowing through the ETS heat exchanger must be a propylene glycol solution. The glycol concentration must be sufficient to satisfy the range of customer operating temperatures, including sub-zero temperatures.

6.5 Pumping and Control Strategy

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 (heat pumps, fan coil units, etc).

6.6 Space Heating

The ADEU will operate as a heat source during heating mode. The district glycol solution will circulate through the ETS heat exchanger to transfer heat to the building. The space heating system will utilize heat pumps to lift the building-side fluid to a higher temperature.

6.7 Space Cooling

The ADEU will operate as a heat rejection system during cooling mode. This enables connected buildings to reject heat when cooling their spaces. Buildings can avoid the capital and operating costs of cooling towers or fluid coolers.

6.8 Domestic Hot Water (DHW)

The DHW system shall be designed to utilize the ADEU as a source of heating energy. The building heat pump(s) for DHW pre-heat should be selected with this goal in mind. The ADEU heating energy may be at a temperature requiring further boosting by on-site gas boilers or electric water heaters.

6.9 Supplemental Green Energy Sources

Supplemental “green” renewable energy sources, such as solar thermal or solar photovoltaic, may be considered and will be reviewed on a case-by-case basis.

6.10 Communication

The building shall provide a DDC system to facilitate communication with the ETS control panel. DDC points should include equipment run status, fluid temperatures, flow rates, etc. Using this information, the building can effectively stage and modulate the equipment and the ETS can operate in a coordinated manner.

7 Contact Us

7.1 ADEU Contact Information

For more information on the ADEU and requirements of customer buildings, please contact:

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