City Centre District Energy Utility

A Guideline for On-Site Low-Carbon Energy Systems

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Abbreviations

ASHP	Air-Source Heat Pump
BAS	Building Automation System
CCDEU	City Centre District Energy Utility
CEP	Central Energy Plant
DDC	Direct Digital Control
DES	District Energy System
DE	District Energy
Delta T; ∆T	Temperature Difference
DEU	District Energy Utility
DEP	District Energy Plant
DHW	Domestic Hot Water
DPS	Distribution Piping System
ETS	Energy Transfer Station
FDC	Future DEU Connection
GFA	Gross Floor Area
GHG	Greenhouse Gas
GSHP	Ground-Source Heat Pump
HEX	Heat Exchanger
HMI	Human Machine Interface
HVAC	Heating, Ventilation & Air-Conditioning
LCES	Low-Carbon Energy System
LCEP	Low-Carbon Energy Plant
LIEC	Lulu Island Energy Company
MAU	Makeup Air Unit
MCC	Motor Control Centre
OAT	Outdoor Air Temperature
OI	Operator Interface
PCW	Primary Side Chilled Water
PHW	Primary Side Hot Water
PLC	Programmable Logic Controller
RTD	Resistive Temperature Detector
SC	Space Cooling
SH	Space Heating
SCW	Secondary Side Chilled Water
SEP	Standalone Energy Plant
SHW	Secondary Side Hot Water
SSHP	Sewage-Source Heat Pump
STES	Solar Thermal Energy System
UPS	Uninterrupted Power Supply
VFD	Variable-Frequency Drive

Definitions

Building (or Strata)	The shared owners of the common property and assets, on which the owner's possess individual lots.
City	The City of Richmond, including subsidiary Lulu Island Energy Corporation (LIEC) and the district energy service area City Centre District Energy Utility (CCDEU).
Customer	Refer to Building (Strata).
Developer	The party responsible for providing the majority of professional engineering work in the overall development of the LCES.
District Energy (DE)	See section 2.1.
Energy Transfer Station (ETS)	The interface between the LCEP and the Building (or Strata) HVAC.
Low-Carbon Energy Plant (LCEP)	The energy source for the LCES.
Low-Carbon Energy System (LCES)	The entirety of the district energy utility, including the LCEP, DPS, ETS and FDC.
Low-Carbon System	An energy system that provides at least 70% of annual energy from a renewable source while incorporating heat recovery or energy sharing.
Owner	The owner of the LCES (unless otherwise specified); ownership changes throughout the development process, with final ownership being granted to LIEC.
Renewable	Energy sources that will be naturally renewed at a rate that is sustainable for continuous human exploitation.
Service Provider	The person or company contracted by the City to operate, maintain, and manage the DEU on behalf of the City.

1 Document Purpose

The City of Richmond (City) is committed to sustainability and reduced environmental impact. To this end, the City is creating a new district energy service area in the City Centre neighbourhood. The new City Centre District Energy Utility (CCDEU) provides space heating, space cooling, and domestic hot water heating for buildings within the service area. The CCDEU is owned and operated by the City's wholly owned subsidiary and district energy service provider, Lulu Island Energy Company Ltd. (LIEC).

Eventually, all buildings within the service area will be required to connect to the CCDEU to satisfy their thermal energy needs. To this end, the City requires that any new developments must be compatible with the CCDEU. Furthermore, as the CCDEU is being developed, an interim connection strategy is being implemented which involves use of a Low-Carbon Energy System (LCES) to satisfy all thermal energy demands for the development and allowance for a future connection to the CCDEU.

The purpose of this document is to provide preliminary information to Developers, Building owners, engineers, and architects to tailor their designs for optimal compatibility with the LIEC's requirements. The Developer is responsible for the design, construction and commissioning of the plant. LIEC will work closely with Developers to ensure superior design integration between buildings and the CCDEU. The information in this document applies to all building types within the service area. It should be read in conjunction with the *CCDEU Technical Requirements for Onsite Low-Carbon Energy Systems*.

In accordance with City of Richmond Bylaw 9895, it is essential that the Developers collaborate with LIEC on the LCES and building HVAC systems as part of the Development Permit, Building Permit, and Construction processes.

2 City Centre District Energy Utility

2.1 What is District Energy?

District Energy (DE), also known as Community Energy, Neighborhood Energy, or 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.

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.

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 On-Site Low Carbon Energy System

LIEC is developing a new district energy utility within the City Centre neighbourhood. Depending on the building's location within the service area, the system will either be a 2-pipe system providing district heating, with cooling supplied from a Discrete Cooling Plant (DCP) on site or a 4-pipe system providing heating and cooling from the district.

As an interim connection strategy prior to start-up of the CCDEU, new developments within the CCDEU service area are required to install a LCES to satisfy the development's thermal energy requirements. Ownership and operation of the LCES will be transferred to LIEC following system start-up and prior to occupancy. The LCES must be compatible with the future CCDEU system and in conformance with LIEC's technical and operational requirements. A LCES is essentially a small-scale district energy system servicing one or more Strata within a single development. The LCES uses centralized equipment to generate thermal energy for the development, which is then distributed to each Building (or Strata) through a hydronic piping network.

To be considered low carbon, the LCES must provide a minimum 70% for each of space heating, cooling and DHW heating annual energy use from a renewable (low carbon) energy source, and it must incorporate some heat recovery or energy sharing capabilities. The 70% renewable energy requirement can be achieved by using one or more technologies and energy sources (e.g., ground source, air source, waste heat). Electricity is considered 93% renewable as per the Clean Energy Act. Inclusion of a future connection to the CCDEU is also required as part of the LCES. Upon taking ownership of the LCES, LIEC will be fully responsible for operation and maintenance of the system as well as Customer billing.

3 Low-Carbon Energy System (LCES)

3.1 LCES Overview

A LCES is a small-scale district energy system limited in service to one or more Buildings (or Strata's) within a single development. The LCES must satisfy all thermal energy demands of the development and use renewable (low carbon) energy for at least 70% of the total annual space heating and domestic hot water heating energy demands, and 70% of the annual energy of space cooling demand. The LCES will be owned and operated by LIEC and must include an allowance for a future connection to the CCDEU. In addition, the LCES and building HVAC systems must be hydronic and designed such that all thermal energy demands can be satisfied by the future CCDEU connection once it is implemented.

3.2 LCES Components

A LCES is comprised of four major components:

1. Low-Carbon Energy Plant (**LCEP**) – the energy source for the system supply minimum of 70% of annual demand from renewable energy.

2. Distribution Piping System (**DPS**) – piping network to distribute thermal energy within the development up to the ETS.

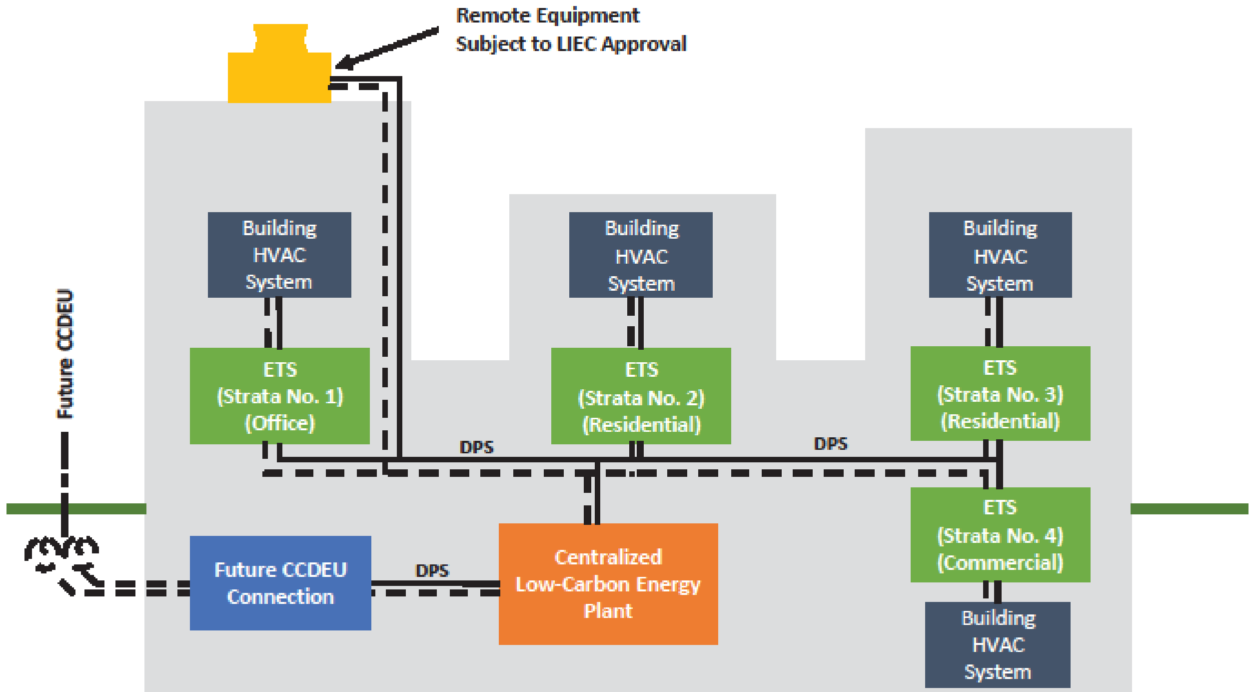
3. Energy Transfer Station (**ETS**) – the interface between the LCES and the building HVAC system.

4. Future DEU Connection (**FDC**) – the future interface between the LCES and the CCDEU.

These four components will be fully owned by LIEC. The ownership of the LCEP, DPS and ETS will transfer to LIEC following system start-up and prior to occupancy. The ownership demarcation point between the Building system and the LCES is at the outlet of the ETS. In the future, the CCDEU DES will connect to the Building LCES via the FDC, which will be designed, built, and fully owned by LIEC.

A high-level diagram for a theoretical development incorporating a LCES is illustrated in Figure 1.

FIGURE 1: TYPICAL LOW-CARBON ENERGY SYSTEM SCHEMATIC



This theoretical development contains a commercial stratum, two residential Strata, and an office Strata. Each individual Strata is serviced by an ETS, and in general all thermal generating equipment should be located in the central energy plant. The ETS acts as the interface between the Strata's HVAC system and the LCES providing hydronic separation between the systems and a billing point. The FDC will be installed by LIEC at a later date, when the building is connected to the CCDEU, but the Developer is required to allow space for the future FDC connection.

Each of these components are discussed in more detail below.

3.3 Low-Carbon Energy Plant (LCEP) Overview

The LCEP provides all thermal energy for the building. This is where the hydronic fluid is heated or cooled before being distributed throughout the development.

The LCEP has the following characteristics:

- It supplies 100% of the space heating, space cooling and DHW heating requirements of the entire building. The key components of a LCEP include:
    - Thermal energy generating equipment used to heat or cool the system's hydronic fluid.
    - Pumps used to distribute hydronic fluid throughout the development or to feed individual pieces of equipment.
    - Supply and return piping connecting each piece of equipment and distributing the system's hydronic fluid.

- Various types of valves (isolation, control, balancing, check, etc.) used to control the flow of the system's hydronic fluid.

- Various instrumentation (temperature sensors, pressure sensors, flowmeters, etc.) and gauges (pressure, temperature, etc.) to monitor operation of the plant and trigger alarms or equipment shutdown/start-up. This includes an outdoor air temperature sensor for temperature reset.

- Expansion tanks, chemical addition equipment, corrosion monitoring, and hydronic fluid make-up system.

- Motor control centre and electrical distribution equipment.

- Central control panel (PLC) used to control overall operation of the plant. This is separate from the Building control system. The PLC must be capable of communicating with LIEC's VT-SCADA based central operations centre.

- Dedicated natural gas and electricity connections, including dedicated BC Hydro and FortisBC meters, and dedicated network / internet provider account for the LCEP.

- Sound barriers for all outdoor equipment.

All equipment must meet the requirements of the CCDEU Technical Guidelines.

- All equipment is installed in one, centralized location. This location must be above the floodplain elevation as per Richmond Bylaw 8204. Where equipment has specific space requirements, such as outdoor equipment or sewage heat recovery equipment, LIEC may grant an exception for remotely installed equipment if it can be shown that the equipment and plant cannot be located adjacent to each other. By centralizing all the equipment in one location, the plant is easier to operate and maintain, larger equipment can be used which typically has higher operating efficiencies, there only needs to be one set of redundant equipment, and it is easier to incorporate energy recovery between heating and cooling.

- To be considered 'low-carbon', the LCES must provide at least 70% of the annual energy use for space heating, cooling, and DHW shall be from a renewable (low-carbon) energy source, and the LCES must incorporate heat recovery or energy sharing capabilities. The 70% renewable must be calculated separately for heating and cooling loads. The 70% renewable energy requirement can be achieved by using one or more technologies and energy sources (e.g., ground source, air source, waste heat). Electricity shall be considered 93% renewable as per the Clean Energy Act. To support their claim of satisfying the 70% renewable target, the Developer shall submit an hourly 8760 energy model for evaluation.

The Developer may use a combination of renewable energy sources to meet the 70% renewable requirement. The following technologies have proven to be effective, low-carbon thermal sources for energy systems:

1. Air-source heat pumps.
2. Water-to-water heat recovery heat pumps.
3. Geoexchange heat pump system.
4. Sewage-source heat pump system.
5. Solar thermal energy system.

Systems utilizing alternative renewable energy technologies not listed above can be proposed for LIEC review and approval.

3.4 Energy Transfer Station (ETS) Overview

Each individual Building (or Strata) within the development shall be serviced by an ETS. As the ETS is the interface between the LCEP and building HVAC and plumbing system, the ETS also reflects the change in ownership of equipment. LIEC shall own and operate the thermal energy equipment upstream and including the ETS, and the Building is responsible for all equipment downstream of the ETS. The ownership demarcation point shall be clearly indicated on the ETS mechanical drawing. The ETS must be sized to handle the full thermal energy demand of the Strata. The key components of an ETS include:

- Supply and return piping with pressure and temperature gauges.
- Three heat exchangers to transfer heat between the LCES and the Building (or Strata) HVAC systems:
    - One heat exchanger for space heating.
    - One heat exchanger for space cooling.
    - One heat exchanger for domestic hot water heating.
- Control valves and temperature sensors to regulate the flow to the Building (or Strata).
- Energy meter package complying with CSA C900.1/EN1434-1, including a flow meter, temperature sensors, and an energy calculator, for billing and system optimization purposes. Energy meters are required for each heat exchanger.

Energy delivery to the customer is managed by controlling the flow through the LCES side of the ETS to achieve the Customer supply temperature set point. Flow through the Building (or Strata) side of the ETS is controlled by the Building (or Strata) HVAC system’s distribution pumps. The energy meter package records how much energy is delivered for billing purposes.

3.5 Distribution Piping System (DPS) Overview

A closed-loop distribution piping network is used to deliver thermal energy from the LCEP to each ETS. The hydronic fluid can be water or a water-glycol mixture to suit the designer’s preferences. The fluid is heated or cooled in the LCEP, distributed to an ETS at each Building (or Strata), and returned to the LCEP where it is heated or cooled again. No water is drained or lost in the system, and no additional hydronic fluid is required during normal operation.

In addition, four pipes must be provided by the Developer to connect the FDC to the plant. These pipes shall be installed as part of the LCEP but valved shut and nitrogen filled. The piping must be connected to the LCEP in such a way that when the CCDEU system connects to the FDC in the future, these connections will be able to supply hot water and chilled water to the Building.

3.6 Future DEU Connection (FDC) Overview

Each LCES requires space for a Future DEU Connection (FDC) to facilitate connection to the future CCDEU. The FDC will be designed and installed at a future date by LIEC. The intent is the CCDEU to be able to supply the full heating and cooling demand of the building from this connection.

At this point, the Developer needs to provide the following, to ensure the FDC space can accommodate the equipment:

- Space to accommodate the following equipment. At minimum, an area 5 m x 8 m is required. A minimum room height clearance of 2m is required. This space shall be located in a location agreed with LIEC and be clear of other equipment and piping. The FDC must be located above the floodplain, but at an elevation of no more than 4 m to avoid hydraulic issues with the CCDEU.
    - Space heating and space cooling heat exchangers, to connect the CCDEU to the LCES. Space heating and DHW must be capable of being served by a single heat exchanger.
    - Pumps to circulate fluid between the FDC and the LCEP.
    - Controls as required, including control valves, temperature sensors and energy meters, to regulate the flow on the CCDEU side and the LCEP side of the system.
    - Associated piping, valves, fittings, and instrumentation as required.
- Lockable breaker and disconnect switch. The size must be reviewed by the Developer engineer and LIEC during the building permit stage, so that an estimate of pump power can be developed.
- Four pipes connecting between the FDC and the LCEP, as noted in the DPS section.
- 1x 50 mm communication conduit with pull wire between the FDC and the LCEP.

3.6.1 Foundation Penetration

The Developer shall coordinate with LIEC to determine the exact size and location of the foundation penetration for the future CCDEU service connection. The preference is to provide sleeves or blockouts for the penetrations during construction of the foundations. However, as an alternative, the penetrations can be cored in the future if the foundation reinforcement is designed to accommodate the future cores and an indent is provided on the foundation exterior to precisely indicate the penetration location.

In addition, two 50 mm communication conduits shall penetrate the exterior foundation wall. One of these conduits will penetrate the exterior wall adjacent to the CCDEU service connection and will be utilized for a direct connection between the LCES and LIEC's central operations centre. The other conduit will be connected to an outdoor air temperature sensor, shall be located on a north facing side of the development.

Isolation valves (for the CCDEU service connection) and pull boxes (for the communication conduits) are typically required immediately after the penetration into the development. Access to these valves and pull boxes must be maintained at all times without confined space constraints. These future building penetrations will be sealed and waterproofed by LIEC.

3.7 Building (or Strata) HVAC System Overview

The mechanical design of the Building (or Strata) must utilize energy from the LCES to satisfy all the space heating, space cooling, and domestic hot water demands. All thermal energy shall come from the LCES; supplemental energy sources are not permitted. The Building (or Strata) system is after the ETS and LIEC will not be taking ownership of, operating, or maintaining this equipment.

3.8 Technical Requirements

For detailed technical requirements related to all components of the LCES, the Developer shall refer to the latest edition of "*City Centre District Energy Utility: Technical Requirements for Onsite Low-Carbon Energy Systems"* produced by LIEC.

4 LCES Compliance and Approval Process

The Developer and the Developer's engineer must work closely with LIEC and their representatives throughout the development permit, building permit, design, and construction processes to ensure compliance with the LIEC's performance and quality requirements. Early involvement of LIEC is highly recommended so a mutual understanding of project goals can be achieved. The information required throughout the compatibility review process is outlined below. Any deviation from these guidelines or the Technical Guidelines must be highlighted to LIEC for approval.

4.1 Development Permit Stage

LIEC will review the general configuration of the Developer's proposed LCES and provide comments on general compliance with LIEC's requirements. LIEC will work closely with the Developer to ensure that the Development Permit process is not unduly delayed. The Developer is responsible for submitting preliminary design information to the satisfaction of LIEC to confirm that the Developer's design concept conforms to LIEC's requirements. This information shall include, but is not limited to:

- Completed LIEC Connection Form (See Section 9).
- Preliminary design drawings (schematics, plans, sections, elevations, details, equipment schedules, and others as required). The drawings should clearly indicate the proposed location of the ETS, DPS, LCEP and FDC, and the ownership demarcation boundary for the LIEC owned equipment.
- Acknowledgement that a signed section 219 statutory right of way and covenant has been executed and registered against title.
- Hourly (8760) energy modelling report and peak design demand (kW) for the LCES and all connected Buildings (or Strata). See section below discussing energy modelling requirements.
- Preliminary design information regarding the Building (or Strata) side HVAC system including schematics, equipment information, etc.
- Data sheets and selection criteria for proposed major equipment within the LCES and confirmation that all equipment will be installed as per the manufacturer's guidelines.
- High-level control philosophy describing the operation of LCEP and the integration between the major equipment.
- Confirmation that the design is in line with the CCDEU Technical Guidelines. Any deviations shall be highlighted to LIEC for approval.

4.1.1 Energy Modelling

An hourly (8760) energy model shall be completed for the entire development showing compliance with the 70% renewable energy target. Estimation of the Building (or Strata) peak heating, peak cooling, and domestic hot water loads is the responsibility of the Developer's engineer.

The 70% low carbon energy requirement is based on annual thermal energy supplied, and is calculated separately for space heating and DHW, and space cooling. Refer to the calculation in Section 9.

Peak heating energy use intensity is expected to be in accordance with the Energy Step Code per City of Richmond Bylaw 9769 and Bylaw 9771. Since the LCES equipment is sized to meet the peak demand of the Building (or Strata), over estimation of Building (or Strata) loads will result in over-sized equipment and higher capital costs. Therefore, it is critical that loads are estimated accurately to avoid over or under sizing of the equipment.

Energy modelling shall be conducted by a 'Qualified Modeller' in accordance with the National Energy Code of Canada for Buildings and BC Hydro's New Construction Energy Modelling Guidelines.[1] The energy modelling software shall be tested and in compliance with ASHRAE 140. The Developer shall use the following greenhouse gas emission intensities:

- Electricity 3.0 gCO_2e/MJ.
- Natural Gas 49.87 gCO_2e/MJ. [2]

An energy modelling report shall be submitted to LIEC for review. The report shall include the entire development and include a breakdown showing specifics for each individual Customer. The report shall bear the seal of a Qualified Modeller or the Energy Modelling Supervisor. Refer to the EGBC/AIBC Joint Professional Practice Guidelines: Whole Building Energy Modelling Services.

The energy model must be submitted and approved by LIEC prior to issuance of the development permit to showing that the 70% renewable energy requirement has been satisfied. An updated energy model, incorporating any design changes which would impact the results of the energy model, must be submitted, and approved by LIEC prior to issuance of the building permit.

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[1] Refer to New Construction Program's Energy Modelling Guideline from BC Hydro Power Smart, October 2018 https://www.bchydro.com/content/dam/BCHydro/customer-portal/documents/power-smart/builders-developers/energy-modeling-guidelines.pdf

[2] BC Ministry of Environment and Climate Change Strategy, 2017 B.C. Best Practices Methodology For Quantifying Greenhouse Gas Emissions, December 2017, p. 13 & 17.

4.2 Building Permit Stage

LIEC will review the detailed configuration of the Developer's final LCES design and provide comments on general compliance with LIEC's requirements. LIEC will work closely with the Developer to ensure that the Building Permit process is not unduly delayed. LIEC's engineer will review the LCES design to ensure the design intent of the CCDEU is met and that it is compliant with LIEC's requirements. This information shall include, but is not limited to:

- All documents specified within Bylaw No. 9895. This includes:
  - An acknowledgement that the building is located on a Designated Property.
  - An executed Energy Services Agreement.
  - An executed Asset Transfer Agreement.
  - All fees.
- Updated design drawings including but not limited to (schematics, plans, sections, elevations, details, equipment schedules, and others as required). Drawings shall clearly indicate access provisions and plans for operations and maintenance (LIEC) personnel, and LCES mechanical spaces shall be clearly dimensioned.
- Process control narrative describing operation of the LCES.
- Final hourly (8760) energy modelling report updated with any changes. The report shall be signed and sealed by the Qualified Modeller or Energy Modelling Supervisor. This shall include at a minimum:
  - Peak energy demand for space heating and cooling.
  - Peak heat energy demand for domestic hot water.
  - Combined peak heat energy demand for any uses other than space heating and domestic hot water.
  - Hour by hour consumption of energy for space heating, cooling and domestic hot water heating.
- Schedule for installation of Energy Generation Plant including key milestones and proposed commencement date for delivery of energy by LIEC.
- Performance Validation Plan outlining how the LCES can be tested in the future to confirm the 70% renewable target has been met and which items were incorporated into the design to facilitate performance validation in accordance with the plan. The LCES shall incorporate a Historian to record performance data for this purpose.
- Class C (±25-40%) capital cost estimate.
- Operational cost estimate.

4.3 Construction Stage

LIEC will advise the Developer of any special design or construction standards that LIEC may have, and such standards will be incorporated into the specifications for the LCES and all connected Building (or Strata) mechanical systems. The Developer shall be responsible for the engineering, design, construction, installation, and commissioning of the LCES, as well as obtaining required regulatory permits including TSBC design registration, installation, and operating permits for applicable equipment. Similarly, the Developer shall be responsible for the engineering, design, construction, installation, commissioning, or operation of the Building (or Strata) mechanical systems. The following information is required:

- Complete IFC drawings set and specifications for Mechanical, Electrical, Structural, and Architectural design for LCES. Mechanical rooms layout and the equipment general arrangement shall be indicated on the drawings.

- Construction schedule to be provided in advance of the start of construction, highlighting each milestone and hold point for LIEC notification and review.

- LIEC's representative shall be granted access to site for periodic inspections of the work during construction. The Developer shall provide a representative to guide LIEC's inspection and answer questions as they arise. In addition, the Developer shall notify LIEC of major milestones at least one (1) week in advance to facilitate scheduling an inspector. At minimum, the following milestones should be identified:

    - 75% piping/equipment installation (prior to piping insulation).
    - 100% piping/equipment installation (prior to commissioning).
    - Commissioning verification/demonstration.
    - Training on equipment / plant operation.

- Shop drawings for major mechanical, controls, and electrical equipment shall be submitted to LIEC representative for approval prior to returning approved shop drawings to the Developer's contractor. Shop drawings shall be signed and sealed by the Engineer of Record (EoR) and include any commentary made by the EoR or the EoR's supervisee.

- Following construction, the Developer shall submit an Owner's Manual to LIEC for records purposes. For Owner's Manual requirements, refer to supplementary document "*City Centre District Energy Utility Technical Requirements for Onsite Low-Carbon Energy Systems*".

4.4 Commissioning Stage

Start-up and commissioning of the LCES and all connected Building (or Strata) mechanical systems is the sole responsibility of the Developer. The Developer shall notify LIEC of the date and time of commissioning so that LIEC can provide an on-site representative to witness commissioning.

A non-exhaustive list of commissioning responsibilities is listed below, but there may be additional requirements depending on the configuration of the development and LCES.

- Obtain the services of a third party commissioning agent, acceptable to LIEC, to oversee and report on the commissioning process.
- Provide schedule for commissioning including milestones for LIEC review.
- Before starting, provide commissioning plan including all checklists to be used for commissioning for review by LIEC.
- Prior to commissioning, provide written verification that the system is ready for startup. This includes, but is not limited to the following requirements:
    - Submit all construction quality reports related to LCES infrastructure including, but not limited to, field review reports, material testing reports, hydrostatic testing reports, radiographic examination results, water quality reports, balancing reports, equipment testing and start-up reports, and equipment warranty information.
    - All safety controls installed and fully operational (dry run test).
    - Flushing, chemical cleaning (as required), charging, fluid operating (as required), are complete.
    - Start-up verification checks by manufacturers representatives completed.
    - All deficiencies to be recorded, reviewed by the commissioning team and, subsequently corrected before proceeding to the next phase.
- Commissioning shall include, but is not limited to the following:
    - Testing and signoff of all equipment by supplier's representative.
    - Performance checks on all equipment.
    - Activation of all systems.
    - Testing, balancing and adjustment of all systems by a balancing firm, approved by LIEC.
    - All deficiencies are to be recorded, reviewed by the Commissioning team and, subsequently, corrected. The process at the point of the deficiency shall be repeated before proceeding forward.
- Verification of commissioning by LIEC will commence only when the commissioning process has been totally completed. Submit test procedure completion test certificates at the time of requesting the commencement of the verification procedure. The verification process will include the demonstration of operation of all equipment and systems, under each mode of operation.

- The system performance must be verified in accordance with the performance validation plan approved at the Building Permit Stage.

- Training should be arranged for LIEC staff or LIEC representative on operating the components of the LCES, and LIEC staff or LIEC representative should attend any equipment training session provided by equipment vendors and manufacturers.

4.4.1 ETS Commissioning

In addition to the requirements for the LCES, the ETS has some additional requirements for commissioning. Prior to commissioning of the ETS, the Building Owner (or Strata) shall flush and clean the Building's (or Strata's) internal hydronic systems. The ETS heat exchanger shall be bypassed during flushing and testing of the Building (or Strata) hydronic systems.

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 Building (or Strata) HVAC system can flow through the heat exchanger in the ETS. The Developer shall also provide commissioning, testing, and flushing reports to LIEC for approval before commissioning the ETS.

The Developer is responsible for commissioning all equipment and systems on the Building (or Strata) side of the system including the internal hydronic systems.

4.5 Occupancy Requirements (Close-Out)

A non-exhaustive list of close-out, or pre-occupancy, requirements is listed below, but there may be additional requirements depending on the configuration of the development and LCES.

- Submit Owner's Manual containing, but not limited to, record drawings, construction specifications, approved shop drawings, field review reports, material testing reports, equipment test reports, warranties, commissioning reports, balancing reports, performance validation plan, and copies of the BC Building Code Letters of Assurance for everything related to the LCES (including the base building).

- Address all outstanding deficiencies to the satisfaction of the Engineer of Record.

- Address all outstanding items identified by and to the satisfaction of LIEC.

- Provide signoff from the engineer that all required TSBC inspections and operational checks have been completed.

- The Developer shall provide LIEC with substantial completion documentation related to the development indicating that all Contractors and Sub-Contractors have been paid and confirmation from the Victoria Land Titles Office that no Liens placed on the work.

- Sign/execute the General Conveyance as per the Asset Transfer Agreement.

- Prior LIEC's final acceptance of the system, the Developer's engineer shall submit a sealed letter confirming that the LCES and connected Building (or Strata) mechanical systems have been designed, constructed, and installed in full compliance with the drawings and specifications approved and agreed to in the Development Permit and subsequent Building Permit review stages.

- Completed Energy Services Agreement Schedule B (Assignment and Assumption Agreement) and Schedule C (Thermal Energy Delivery Parameters).

- Provision of letters of credit pursuant to the bylaw and/or any covenant registered on the title.

- Transfer of utility accounts (FortisBC, BC Hydro, etc.), internet provider account and access keys / FOB access.

Note that reviews by LIEC are not intended to replace the in-house technical review by the Developer's engineer. As such, the Developer bears full responsibility for the engineering, design, construction, and commissioning of the LCES and connected Building (or Strata) HVAC and domestic hot water systems.

5 Billing and Cost of District Energy Service

5.1 Energy Metering

LIEC will maintain and operate Customer metering to measure total thermal energy supplied to each Building (or Strata), and for submitting quarterly bills to each Building Owner (or Strata) for DE service. The energy meter at each ETS collects data on water flow, cumulative energy, peak demand, and temperatures. Data from each ETS meter is transmitted to a central DEU server for utility billing purposes and to monitor and optimize the DEU. 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.

5.2 CCDEU Bill Structure

Customers are billed to rates determined by Richmond City Council on an annual basis and defined in the Bylaw 9895. The total cost of DE service to Customer Building (or Strata) is competitive with space heating, cooling, and domestic hot water heating costs for a conventionally heated/cooled building providing the same level of service. DE rates are expected to be more stable than gas and electricity costs over time.

Tariffs consist of three components:

1. Volumetric Charge, based on thermal energy use in the period.
2. Capacity Charge, based on the square footage of the Development.
3. Excess demand fees.

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 will vary throughout the year.

Capacity Charges cover fixed costs, which include operation and maintenance, equipment replacement, overhead, and the cost of interconnection with the future offsite DEU.

To minimize unnecessary additional capacity and cost, it is important that building Developers do not overestimate Building (or Strata) capacity requirements. Overestimation of peak demand results in higher fixed capacity charges for Customers in the form of an excess demand fee borne by the Developer. LIEC will work closely with building Developers to review realistic system demand requirements.

Similar to other energy utilities in BC, tariffs will be adjusted periodically based on changes in costs over time. The CCDEU service rate is reviewed annually by City of Richmond Council against the objective to keep the annual energy costs for Customers competitive with conventional energy costs, based on the same level of service.

5.3 Sub-Metering

Customers may install energy meters on individual units, suites or sub-systems within the heating, cooling, and/or domestic hot water (DHW) systems in their Building (or Strata). These sub-meters are the sole responsibility of the Customer and will not affect the obligation of the Customer to pay the CCDEU bill based on LIEC's thermal energy meter (part of the ETS) for the whole Building (or Strata). 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.

6 Division of Responsibilities

This section outlines the responsibilities of the LIEC, the Developer, and the eventual Customer (or Strata) to ensure efficient integration of DE service and system compatibility.

6.1 Developer Responsibility

6.1.1 Building HVAC System

The Developer is responsible for designing and installing the building HVAC system. Ownership of the building HVAC system will remain with the Building (or Strata). The building HVAC system will be supplied with heating water, chilled water and DHW from the LCES. Specific requirements are outlined in the sections above. The Developer shall not materially change the design or substitute equipment without written approval from LIEC.

6.1.2 Building Energy Supply (LCES)

The Developer is responsible for engineering, designing, installing, and commissioning a LCES including the LCEP, DPS and ETS. The FDC component will be designed, installed, and commissioned by LIEC in the future. The LCES will meet the thermal energy demands of the building, with 70% of the energy provided from a low carbon energy source. After commissioning, the ownership of the LCES will be turned over to LIEC. Specific requirements for each of these components are discussed in the sections above. The Developer shall not materially change the design or substitute equipment without written approval from LIEC. After ownership is turned over to LIEC, the Developer/Strata shall not adjust, modify, or tamper with any equipment.

6.1.3 Contract Boundary

The contract boundary between the LIEC owned equipment for the LCES and the building HVAC system at the Strata will be at the ETS. A set of valves on the building side of the heat exchangers will provide a clear demarcation point.

6.1.4 Compliance and Approval Process

The Developer is responsible for initiating the Compliance and Approval Process described in Section 4 and providing all documentation requested. LIEC will not be held responsible for any delays resulting from this process. The Developer shall not materially change the design or substitute any pertinent equipment during installation without LIEC's prior approval.

Note that reviews by LIEC are not intended to replace the in-house technical review by the Developer's engineer. As such, the Developer bears full responsibility for the engineering and design of the LCES and connected Building (or Strata) HVAC and domestic hot water systems.

The Developer will take all required steps to remedy any defects in the design, construction, and installation of the LCES and connected Building (or Strata) mechanical systems identified by the engineer of record within seven days of notification of the defects. The Developer shall obtain certification under seal from a professional engineer that the LCES and all connected Building (or Strata) mechanical systems have been designed constructed and installed in full compliance with the drawings and specifications approved and agreed to in the Building Permit review stage, prior to LIEC's final acceptance of the system. The Developer will cooperate with LIEC to allow LIEC to work in a timely manner compatible with the construction schedule of the Developer including the installation of municipal services.

6.1.5 Start-Up and Commissioning

Start-up and commissioning of the LCES and all connected Building (or Strata) mechanical systems is the sole responsibility of the Developer. The Developer shall notify LIEC of the date and time of commissioning so that LIEC can provide an on-site representative to witness commissioning.

The Developer is responsible for training LIEC staff or LIEC representative on operation of the LCES, including any specific training from manufacturers/vendors.

6.1.6 Warranty

For three (3) year following the final Building Permit inspection by the City permitting occupancy in respect to the last Building in the Development (the "Warranty Period"), the Developer will correct any defect arising from an error or deficiency in any aspect of the design, workmanship, labour or material in connection with the On Site DEU, save and except normal wear and tear, acts of God, lack of improper maintenance and damage caused by the City or the Service Provider, or those for whom the City or the Service Provider are at law responsible, or by those for whom the Owner is not vicariously liable.

The City or the Service Provider will promptly give the Owner notice in writing of observed defects and deficiencies that occur during the Warranty Period, provided that failure to give notice will not diminish or invalidate the obligation of the Owner to correct defects during the Warranty Period.

Should any repair or replacement work be required (the "Replacement Work") during the Warranty Period, to the extent the City and the Service Provider determine such repair or replacement to be major or significant, the City or the Service Provider may, by written notice to the Owner cause the Warranty Period for the Replacement Work to be extended, together with all consequential obligations of the Owner under this Agreement, related solely to the Replacement Work, by a period of two years from the date of such Replacement Work (the "Extended Warranty Period").

6.1.7 Statutory Right of Way

The Owner shall grant LIEC right of access on, over, and under the Development lands for the purpose of managing, operating, and maintaining the LCES and facilitating the future connection to the CCDEU by way of statutory right of way. In addition, LIEC requires security for payment of the fees and charges relating to the DES and provision of District Energy Services and will grant or cause to be granted to LIEC Statutory Rights of Way over each connected property. Each Statutory Right of Way shall be registered on title for the full lands before the Strata plans are filed against the applicable Strata Plan Lot or Lot in the Victoria Land Title Office and have priority over any financial encumbrance (except-as to the rent charge included in the Statutory Right of Way).

6.2 LIEC Responsibility

6.2.1 Building Energy Supply (LCES)

Following LCES acceptance and ownership transfer, operation, and maintenance of the LCES is the sole responsibility of LIEC. This includes the LCEP, FDC, each ETS, and all connecting DPS. For ETS, LIEC is only responsible for components of the ETS up to the demarcation point. The demarcation point will be clearly marked on each ETS engineering drawing.

6.2.2 Compliance and Approval Process

Once the Developer initiates the compliance and approval process, as outlined in Section 4, LIEC will advise the Developer of any special design or construction standards that LIEC may have. These standards shall be incorporated by the Developer into the specifications for the LCES and all connected Building (or Strata) mechanical systems. LIEC will be involved throughout the design, construction, and commissioning process. LIEC will work closely with the Developer to ensure that the Development and Building Permit processes are not unduly delayed.

Note that reviews by LIEC are not intended to replace the in-house technical review by the Developer's engineer.

6.2.3 Close-Out Requirements

LIEC has the following responsibilities at Close-Out:

- LIEC will review the Developer's submissions and advise of any changes required, or any outstanding items required before the *Certificate of Acceptance* is issued.
- LIEC will issue a *Certificate of Acceptance* once the LCES has been completed to LIEC's satisfaction in accordance with, but not limited to, this document, and that all required documentation has been submitted.
- LIEC will take over ownership of the LCES following issuance of the *Certificate of Acceptance*, and all operation and maintenance items associated with ownership excluding '*Warranty Period*' work which is the Developer's responsibility.

6.3 Customer (Strata) Responsibility

6.3.1 Operation and Maintenance

Operation and maintenance of the Building (or Strata) mechanical system is the sole responsibility of the Customer. This includes all piping and other components necessary to connect the Building (or Strata) mechanical system to the associated ETS at the agreed demarcation point. The demarcation point will be clearly marked on each ETS engineering drawing.

6.3.2 Changes to the Building (or Strata) Mechanical System

After acceptance of the LCES and custody transfer to LIEC, any changes to the Building's (or Strata's) mechanical systems that may impact LCES performance shall be reported to and approved by LIEC prior to installation and shall be in a manner that ensures adherence to the agreed-upon final Thermal Energy Delivery Parameters as set out in the Energy Services Agreement Schedule C.

The LCES and connected FDC, ETS, and DPS is owned and maintained by LIEC. Under no circumstances can the Customer or any of its Contractors adjust, modify, or otherwise tamper with any LCES equipment. This includes adjusting or changing the position of any valves, gauges or instruments and altering the controls and control panel.

6.3.3 Billing and Service Charges

The Customer is responsible for paying all billing and service charges as outlined in Section 6.3.3 and further detailed in the Energy Service Agreement

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7 Reference Documents

1. *City Centre District Energy Utility: Technical Requirements for Onsite Low-Carbon Energy Systems*, Lulu Island Energy Company.

2. *City Centre District Energy Utility Bylaw No. 9895*, City of Richmond.

3. *Building Regulation Bylaw No. 7230, Amendment Bylaw No. 9769 (BC Energy Step Code Implementation)*, City of Richmond.

4. *Richmond Official Community Plan Bylaw No. 9000, Amendment Bylaw no. 9771 (Energy Step Code)*, City of Richmond.

5. *District Energy in Richmond City Centre District Energy Utility, A Design Guide for Connection to District Energy,* Lulu Island Energy Company.

6. *New Construction Program's Energy Modelling Guideline,* BC Hydro Power Smart, October 2018.

7. *Corix District Energy Utility SCADA and Controls Design Standards and Guidelines*, Corix Utilities

8 CCDEU Contact Information

For more information on the CCDEU and development requirements, please contact:

Christopher David
Lulu Island Energy Company
Phone: 604-247-4902
Email: cdavid@luluislandenergy.ca

9 LIEC Connection Form

1. Development Information

Basic project information

Parameter	
Project Name	
Project Location	
Developer	
Architect	
Mechanical Engineer	

Provide a breakdown indicating the floor area included as part of each Strata, as each will be served by a separate ETS, and the total conditioned floor area that will be served by the LCES.

Space Type	Strata 1 (m^2)	Strata 2 (m^2)	Strata 3 (m^2)
Residential			
Commercial			
Retail			
Other			
Total			

2. Low Carbon Energy Plant (LCEP)

List the LCEP operating parameters.

Mechanical Statistics	Space Heating	Space Cooling	Domestic Hot Water
Supply Temp. (°C)			
Return Temp. (°C)			
Peak Flow Rate (L/s)			
Peak Energy Supply (kW)			

List the energy generation equipment (ASHP, Boilers, Chillers, etc.)

Energy Generation Equipment Type	# of Units	Heating Capacity per unit (kW)	Total Heating Capacity (kW)	Cooling Capacity per Unit (kW)	Total Cooling Capacity (kW)
Total	N/A	N/A		N/A	

3. Energy Supplied by each ETS

Provide the conditions on the building side of each ETS. An ETS is required for each Strata.

Mechanical Statistics	ETS_1	ETS_2	ETS_3
Space Heating Supply Temp. (°C)			
Space Heating Return Temp. (°C)			
Space Heating Flow (L/s)			
Peak Space Heating Demand (kW)			
Space Cooling Supply Temp. (°C)			
Space Cooling Return Temp. (°C)			
Space Cooling Flow (L/s)			
Peak Space Cooling Demand (kW)			
DHW Supply Temp. (°C)			
DCW Temp. (°C)			
DHW Flow (L/s)			
Peak DHW Demand (kW)			

4. Annual Energy

Provide annual energy for each type of space.

	Space Heating (MWh)			DHW (MWh)			Space Cooling (MWh)		
	Residential	Commercial	Other	Residential	Commercial	Other	Residential	Commercial	Other
Jan									
Feb									
Mar									
Apr									
May									
Jul									
Aug									
Sep									
Oct									
Nov									
Dec									
Total									

Confirm 70% renewable energy target is met.

[% TE_renew] = 1 – [TE_nonrenew] / [TE_total]:

- TE_renew = thermal energy from non renewable sources (i.e., air source, 93% of electricity).
- TE_nonrenew = thermal energy from non renewable sources (i.e., natural gas boilers, 7% of electricity).
- TE_total = total thermal energy output.

Ex. For an ASHP with COP in heating mode of 4:

- 75% [(COP-1)/COP] of the thermal energy output is from air (renewable source).
- 25% [1/COP] of the thermal energy output is from electricity (93% renewable).
- 98.25% [(COP-1)/COP + 1/COP * 93%] of the total thermal energy output from the heat pump is considered renewable.

- *LCEP Renewable Energy Use – Heating*

Energy Source	Annual Space Heating (MWh)	Annual DHW (MWh)	Example
Total Thermal Energy (MWh)			100
Thermal energy output from heat pumps (MWh)			80
Annual electricity consumption for heat pumps (MWh)[1]			15
Thermal energy output from gas boilers (MWh)			20
% thermal energy from renewable sources			**79%** [2]
Notes: 1. Electricity should be considered 93% renewable 2. 1 – (15*0.07 + 20)/100			

- *LCEP Renewable Energy Use - Cooling*

Energy Source	Annual Space Cooling Demand (MWh)	Example
Total Thermal Energy (MWh)		100
Thermal energy output from heat pumps (MWh)		60
Annual electricity consumption for heat pumps (MWh)[1]		15
Thermal energy output from chillers (MWh)		40
Annual electricity consumption for chillers (MWh)[1]		10
Percentage of Annual Thermal Demand (%)		**98%** [2]
Notes: 1. Electricity should be considered 93% renewable 2. 1 – (15*0.07 + 10*0.07)/100		

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