City of Vancouver *Planning - By-law Administration Bulletins*

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LOW CARBON ENERGY SUPPLY FEASIBILITY SCREENING - TERMS OF REFERENCE

Authority - City Engineer
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1 INTRODUCTION

These Terms of Reference are to be followed for development projects requiring an evaluation of low carbon energy supply opportunities. Where the developer/applicant is seeking BC Hydro co-funding for the study, BC Hydro's *Minimum Requirements for A Sustainable Communities District Energy Pre-Feasibility Study* must also be met. Although less detailed in scope, these City of Vancouver Terms of Reference have been designed to be compatible with BC Hydro's study requirements.

1.1 Purpose

The purpose of this document is to provide an outline of the requirements for completing a Low Carbon Energy Supply Feasibility Screening Study (also known as a Pre-Feasibility or Phase I Study) to the satisfaction of the City Engineer. A Feasibility Screening Study is a preliminary technical and business case analysis used to assess whether viable district- or development-scale low carbon energy opportunities are present warranting further evaluation. The purpose of such a study is to support the advancement of affordable, low carbon energy solutions throughout Vancouver.

This study must be completed by qualified professional with proven expertise in the evaluation of low carbon energy supply opportunities. Should the preliminarily results indicate that a district- or development-scale energy system may be viable and beneficial, a more detailed feasibility study may be required.

In locations where rezoning applications are being proposed for several nearby sites, the City strongly encourages developers to undertake joint studies of potential district energy solutions. This approach generally results in a higher probability of finding a viable low carbon energy option, and also typically results in a lower feasibility study cost for developers.

1.2 Objectives

The City's objectives with respect to the implementation of low carbon energy supply technologies, including district systems, are reductions in GHG emissions, and the long-term flexibility to adapt to new and more sustainable technologies and fuels. The City also has an interest in improvements to energy efficiency and supporting the development of local green technologies and jobs.

The Feasibility Screening Study aims to identify the potential impacts of low carbon energy supply options, relative to a realistic reference case scenario, on:

- Long-term GHG emissions;
- Long-term life-cycle energy costs to energy end users;
- Risks to energy end users, including financial and reliability considerations;
- Qualitative benefits to energy end users (e.g. reliability, quality of service, etc.);
- Resource consumption (e.g. electricity, natural gas or recovered waste); and
- Other significant environmental impacts or benefits (e.g. local air quality, waste management, water use, space requirements, etc.).

1.3 Background

In June 2008, Council approved the *EcoDensity* (now referred to as *EcoCity*) *Revised Charter and Initial Actions*. Revised Action A-2 (May 2008) establishes a rezoning policy to achieve higher sustainability standards as an essential component of large developments. The policy was revised in 2012 to refine the definition of a large site to include large developments, and is now known as the Rezoning Policy for Sustainable Large Developments, and can be found online at: vancouver.ca.

Under Action A-2, the City requires completion of Low Carbon Energy Supply Feasibility Screening studies for rezonings over 2 acres in size or 45,000 m^2 of new development floor area.

The evaluation of low carbon energy supply opportunities is a phased process which begins with the completion of a Feasibility Screening Study. In cases where the screening study suggests there are district- or development-scale low carbon energy opportunities offering environmental benefits with life-cycle energy costs comparable or lower than a business as usual approach, taking into consideration uncertainties in the capital and operating cost estimates, a more detailed Feasibility Study (also known as a Phase II study or business case analysis) may be required. The purpose of the detailed Feasibility Study is to further confirm costs and benefits of preferred short-listed option(s), and to address implementation issues such as ownership and operations strategies. In some cases (i.e. for smaller systems), a full Feasibility Study may not be necessary and the developer may choose to proceed directly with identification of a utility provider, site testing, and/or other supplemental technical or financial evaluations supporting the development of a low carbon energy system.

1.4 Primary Deliverable

The primary deliverable of the Feasibility Screening Study is a report identifying and ranking potentially technically viable low carbon energy supply solutions, both at a district and development scale, based on lifecycle energy costs and benefits. The study must focus on energy supply system options which reduce GHG emissions associated with space, ventilation, and domestic hot water heating. Low carbon energy supply options for cooling and power generation may be considered where there is a financial or GHG reduction benefit to doing so.

2 FEASIBILITY SCREENING STUDY MINIMUM REQUIREMENTS

At a minimum, the screening study should include the following elements:

2.1 Executive Summary

The Executive Summary should clearly highlight the following:

- Development location, size, and use;
- Regional context (potentially connectable surrounding loads of interest);
- Site loads and connectable surrounding loads including percentage of annual energy to be serviced through low carbon technologies;
- Reference case energy supply scenario description with levelized reference case energy supply costs, GHG emissions, natural gas and electricity consumption;

- Low carbon energy supply options short-listed with associated levelized energy supply costs and GHG emissions, natural gas and electricity consumption;
- Summary of risks associated with the reference case and short-listed low carbon energy supply options.
- Recommended next steps.

2.2 Site and Neighbourhood Overview

Prepare a general description of the site and surrounding area including:

- Project location;
- Site constraints and amenities;
- Planned site density and use mix;
- Regional context (current and planned surrounding land use by archetype and density);
- Proximity to other redevelopment sites and major infrastructure;
- Development timeframes;
- Connectivity analysis to nearby buildings, future development sites and other district energy systems within 500 m radius of the site.

Note: Key Connectable Buildings must be identified which considers building size/load, existing heating/cooling mechanical design, age of equipment, and distance from the site, where information is available or reasonably easy to acquire or infer.

2.3 Energy Profile and Load Analysis

Base Case Loads

Using proposed floor areas and City-approved end use Energy Use Intensity[1] factors (energy use per m^2 of floor area), prepare an expected (base case) forecast of annual and peak end use heating (space heating, domestic hot water and ventilation air) and cooling demands for buildings within the development. Reflect the proposed phasing schedule in the demand forecasts. For larger sites, loads may be separated into sub-areas for the purposes of evaluating layout, siting, and phasing issues.

Annual heating load duration curves must be provided for full build-out of the development including any existing buildings that will remain on-site. Annual cooling load duration curves must also be provided where annual cooling loads exceed 5% of annual heating loads. The proposed percentage of peak and annual energy requirements to be served through low carbon sources must be stated. A target of 70% annual heating energy to be met through low carbon sources is recommended, however it is at the discretion of the energy consultant to select an appropriate split between low carbon and conventional energy sources. **Approval must be granted from the City to consider low carbon energy approaches that serve less than 70% of annual heating energy requirements**.

Energy Use Intensity assumptions are provided in Section 5. Alternative demand scenarios may be prepared reflecting higher or lower energy demands based on higher end use efficiency assumptions (beyond code requirements) or alternative development assumptions.

Neighbourhood Loads

For the purpose of evaluating district energy opportunities, also identify and estimate existing or proposed loads within an approximate radius of 500 m of the site. **For existing surrounding loads, only significant building energy loads that may be suitable for interconnection with a district energy system should be included**. Potentially connectable loads are those which satisfy all of the following requirements:

[1] Energy Use Intensity is a unit of measurement that describes a building's energy use, specifically the energy consumed per m^2 (or other area unit) of building floor space.

- Heated floor space exceeding 2,000 m^2 per building;
- Existing hydronic heating systems with minimal electric resistance heating or gas fired roof-top ventilation air heaters (does not apply to proposed developments); and
- Located within 500 m of the site.

All nearby building loads satisfying these requirements should be summarized. Assumptions on connectability may be inferred based on building archetype and age, where building-specific mechanical information is not available.

Considering both on-site and potentially connectable off-site loads, prepare combined heating and cooling load duration curves at full build-out. Where no connectable loads have been identified, consider entire site loads only. The combined load forecast should consider the effects of diversification on central equipment requirements.

Summarize the expected optimal sizing of any district energy solutions at full build out including the percentage of peak and annual energy to be serviced by low carbon energy technologies and the percentage to be covered by conventional boilers, or alternative means, for peaking and back-up.

2.4 Reference Case

Reference case energy supply scenario refers to the preferred form of the mechanical heating and cooling system in the absence of a low carbon energy system. A description of the reference case energy supply scenario should indicate the delivery method for each heating and cooling end use (i.e. residential, non-residential and common area space heating and cooling, make-up and ventilation air, and domestic hot water).

The reference case analysis should include the following:

- Estimates of the levelized unit cost of energy ($/MWh/yr) for the reference case over a 25 year timeframe (including annual boiler/heating equipment capital, operating and maintenance costs);
- Estimates of gas consumption, electricity consumption, and GHG emissions over the analysis timeframe.

Estimates of costs, GHG emissions, and electrical and gas energy consumption should be Class D level estimates (estimate variance of -25%, +50%).

2.5 Screening of Low Carbon Energy Sources

(a) Review of Opportunities

Identify potentially viable low carbon energy sources for consideration, including, but not limited to, process/waste heat recovery, sewage heat recovery, geoexchange (open loop, closed loop, surface water exchange), air source heat pumps, bio-energy (biomass combustion, biogasification, anaerobic digestion), and other nearby district energy systems. Provide a high level assessment of the technical and logistical viability of each potential opportunity considering study area loads, location, and resource capacity. The opportunity to serve any existing buildings that will remain on-site with low carbon energy sources as well as potential demand side management strategies for existing buildings should be evaluated and summarized.

Milestone: Sources under consideration must be approved by the City of Vancouver at the time of project kickoff.

(b) Analysis of Short-Listed Opportunities

Create a short-list of low carbon energy options deemed potentially technically viable at a development- and/or district-scale at full buildout for inclusion in a more detailed qualitative and quantitative analysis. Short-listed options may include scenarios which

consider site loads only, but must also **include scenarios which consider a district-scale approach** incorporating surrounding proposed or existing connectable loads at full buildout, where present.

Milestone: Short-listed options must be approved by the City of Vancouver prior to proceeding with further technical and financial analysis of short-listed opportunities.

Analysis for each short-listed option must include at minimum the following:

- Description of the high level concept design of the proposed low carbon energy system including equipment requirements, equipment sizing, system capacity, backup and peaking energy supply strategy, and distribution approach (i.e. distribution temperature, equipment centralization, etc.).
- Estimates of capital, operating and maintenance costs associated with the energy centre, distribution piping, building connection, and any retrofits or upgrades required to connect buildings under consideration. Provide an itemized summary of major cost components, and supporting assumptions.
- Estimates of levelized cost of energy ($/MWh/yr) for each scenario over a 25 year time horizon. Compare results to reference case including percentage premium / saving over the reference case.
- Estimates of total natural gas consumption (GJ/yr), electric energy consumption (MWhr/yr), and GHG emissions (tonnes/yr) under each low carbon energy supply scenario at full build-out. Compare results to reference case including percentage increase/decrease over the reference case.
- Estimates of alternative fuel source consumption (i.e. biomass, biogas).
- High level qualitative summary of relevant risks and benefits associated with each supply scenario (i.e. fuel price and supply stability, long term flexibility to adapt to other heat source options, air quality, water quality, social impacts).
- Details of applicable by-laws and/or other regulatory bodies that may need to be consulted prior to detailed design; as well as a description of the design implications of and strategies for, achieving by-law compliance. A list of applicable by-laws can be found in the resources section (This list is neither exhaustive nor prescriptive.)
- Ranking of opportunities based on GHG reduction and levelized cost of energy.
- Concept design schematics for the preferred (highest ranking) low carbon energy option(s).

Estimates of costs, GHG emissions, and electrical energy consumption should be **Class D level estimates** (estimate variance of -25%, +50%). Clearly indicate any exclusions in the cost estimates provided.

Major assumptions used throughout the analysis should be clearly stated (refer to Section 3).

2.6 Sensitivity Analysis

The City will assess the need for inclusion of a sensitivity analysis based on the draft study findings. Where few or no low carbon opportunities show levelized costs competitive with the reference case, a sensitivity analysis of select input parameters and assumptions may be warranted.

Additionally, in the event that the lowest cost low carbon energy supply alternative is more expensive than the reference case, estimates of the size of grant that would be required to make the low carbon energy supply alternative cost equal to the reference case must be provided.

2.7 Recommendations / Next Steps

Provide recommendations and next steps related, but not limited, to the following:

- Further evaluating the technical and economic viability of the preferred low carbon energy supply option(s);
- Potential opportunities for improving the economic viability of the preferred low carbon energy system;
- Strategies for demand side management for any existing buildings to remain on-site;
- Strategies for improving future flexibility for the development to connect to a hot water district energy scheme and/or other energy source options; and
- Risks and sensitivities warranting further analysis moving forward.

3 STUDY ASSUMPTIONS AND COST ESTIMATES

Developers are expected to use the energy use intensity factors supplied by the City (refer to Section 5) unless there is satisfactory evidence that alternative energy intensity factors are more accurate or relevant to the study.

Energy price forecasts, GHG emission multipliers for gas and electricity, and other key assumptions (other than EUIs) should agree with the *District Energy Assumptions* provided by BC Hydro's Sustainability Communities Program, or otherwise be approved by the City.

Key assumptions influencing load forecasts and levelized cost results should be clearly summarized, including but not limited to:

- Energy use intensity
- Load diversification
- Annual average equipment efficiencies and coefficients of performance
- Low carbon fuel prices
- Commodity prices (gas, electricity, carbon)
- GHG offset value
- Equipment selection and capacities (boilers, heat pumps, etc.)
- Equipment capital costs for heat production and distribution
- Construction unit costs, where applicable
- O&M costs
- Engineering, project management, and regulatory approval costs (can be estimated as a percentage of direct costs)
- Contingency
- Equipment replacement schedule
- Discount rate
- Interest on debt
- Return on equity

The developer must identify and discuss with the City where assumptions deviate from BC Hydro and City recommended assumptions, where present, and provide rationale for any discrepancy.

4 MILESTONES AND INVOLVEMENT OF THE CITY

To ensure the work being undertaken meets the Terms of Reference specified herein and incorporates appropriate assumptions and site-specific considerations, regular involvement of City staff throughout the execution of the study is required.

Developers are encouraged to consult City staff on current or expected nearby loads as well as potential energy sources, in particular sources associated with City infrastructure (e.g., sewer heat opportunities).

The following milestones shall be incorporated into the screening study schedule:

(a) **Study Kickoff Meeting**: This meeting provides an opportunity for the applicant, energy consultant, and City of Vancouver to discuss and define the scope of the screening study and appropriate assumptions surrounding low carbon technologies and nearby building loads to consider. Studies for some larger sites may be eligible for BC Hydro co-funding. These opportunities should be investigated prior to study kickoff.

(b) **Status Update Meeting**: This meeting provides an opportunity for the energy consultant and applicant to share preliminary findings with the City of Vancouver, discuss and review assumptions and selected opportunities for short-listing, and work through any barriers or challenges encountered to date.

(c) **Draft Report**: The draft report should be issued prior to the draft results meeting. The City will provide a list of comments and questions within two weeks of receiving the draft report.

(d) **Draft Results Meeting**: This meeting provides an opportunity for the energy consultant and applicant to present findings summarized in the draft report and discuss any sensitivity analysis which may be warranted.

(e) **Final Report**: The final report shall address all City comments and questions, and shall be issued to the City within one month of receiving City comments.

Sufficient time and budget should be allocated for addressing and responding to City comments and questions on the draft report, and integration of these comments into the final report. The final screening study must be completed to the satisfaction of the City Engineer.

5 SUPPORTING INFORMATION

5.1 Energy Use Intensity Factors

Table 5-1 EUIs for New Buildings

	Units	BCBC[1]	ASHRAE 90.1-2007[2]		
		Low Rise	Mid / High Rise	Office	Retail
Peak Space Heat Demand	W/m^2	41	47	47	63
Annual Space Heat Loads	$kW.h/m^2$	67	84	70	32
Peak DHW Demand	W/m^2	4	4	1	0
Annual DHW Loads	$kW.h/m^2$	24	24	3	1
Peak Space Cooling	W/m^2	N/A	14	60	38
Annual Space Cooling	$kW.h/m^2$	N/A	14	26	17

Notes:
[1] BC Building Code
[2] Assumes double pane thermal break window. Overall U-0.55.

Table 5-2 EUIs for Existing Buildings

	Units	Low Rise[1]	Mid / High Rise[2]	Office[3]	Retail[3]
Peak Space Heat Demand	W/m^2	41	51	83	66
Annual Space Heat Loads	$kW.h/m^2$	77	86	82	65
Peak DHW Demand	W/m^2	12	11	2	1
Annual DHW Loads	$kW.h/m^2$	36	35	7	5

Notes:
[1] EUIs based on City of North Vancouver MURB study. Assumes 1970s vintage.
[2] EUIs based on City of North Vancouver MURB study. Assumes 1990s vintage.
[3] EUIs based on BC Hydro 2007 Conservation Potential Review

EUIs for other building typologies (i.e. grocery stores, community and institutional buildings) should be assessed on a case-by-case basis.

5.2 Resources

Additional resources include:

(a) **Commodity Prices and Other Assumptions**: Please contact the City of Vancouver or BC Hydro for a copy of BC Hydro's latest commodity price forecasts and district energy study assumptions for use in conducting feasibility screening studies and business case evaluations.

(b) **VanMap**: Orthophoto images, cadastral (parcel) data, and other relevant property information may be viewed using VanMap, available at: http://vancouver.ca/Vanmap/index.htm. Information can be downloaded for GIS use from: http://data.vancouver.ca/datacatalogue/index.htm.

(c) **Land Use Policies**: Land use policy information can be found on the Community Services page at: http://vancouver.ca/commsvcs/guidelines/pol&guide.htm.

(d) **Boiler Database**: Information on installed boiler capacity for specific street addresses can be obtained from the BC Safety Authority.

(e) **Building Details**: Information on building square footage, age, etc. can be obtained from the BC Assessment Authority.

(f) The following **by-laws and / or regulatory bodies** will need to be referenced or consulted during the design process. This list is neither exhaustive nor prescriptive.

- Waterworks By-law
- Sewer and Watercourse By-law
- Subdivision By-law
- Vancouver Building By-law
- Utilities Commission Act (BC)
- Vancouver Coastal Health