MDE LEED® Canada-NC 2009 PRIMER

The purpose of this Primer is to assist building owners and developers that are connecting to the Markham District Energy (MDE) system in Markham Centre and are contemplating LEED certification. This Primer has been prepared by Fluent Group Engineers Inc. on behalf of MDE. Fluent is an Ontario based engineering consultant with specialized expertise in LEED certification.

What is LEED®?

Leadership in Energy & Environmental Design (LEED) Canada for New Construction (NC) 2009 is a point-based, third party verified rating system for buildings that are designed and constructed using environmental best practices. LEED is administered by the Canada Green Building Council (CaGBC), and awards successful projects one of four certification levels (Certified, Silver, Gold, or Platinum) depending on the project point total. There are 110 points available, as well as 8 prerequisites, distributed within 7 categories.

Interpretation Guide for District Energy Systems

The LEED Canada 2009 Interpretation Guide for District Energy Systems (DES) describes the treatment of district energy systems for LEED Canada NC (2009) and CS (2009) projects. The 2009 Interpretation Guide may also be applied to LEED Canada NC v1.0 and LEED Canada CS v1.0 projects. This primer summarizes how LEED treats a building connected to a DES and what impact Markham District Energy (MDE) may have on LEED projects.

Earning LEED Points with Markham District Energy (MDE)

There are some misconceptions in the Canadian green building industry that connecting projects to District Energy Systems (DESs) will restrict the capability of those buildings to achieve LEED certification. Some consultants have incorrectly concluded that projects cannot earn LEED points by connecting to district energy systems, thus limiting the level of LEED certification that can be achieved.

District energy is industry terminology that describes the creation of a thermal grid to provide heating and cooling energy to multiple buildings, typically in a dense urban centre. There are numerous types of district energy systems that deploy a wide variety of technologies with varying fuel sources and efficiencies. For this reason, the energy performance of the district energy system must be understood and analyzed in order to determine the LEED points that can be earned.

MDE's Markham Centre system utilizes (a) high efficiency boilers and chillers (b) combined heat and power technology (c) thermal storage and (d) absorption cooling technology. Fluent has analyzed the MDE energy performance and concludes that connection to the MDE system in Markham Centre may reasonably earn projects up 6 LEED points subject to the building design and load characteristics.

> Connecting to the MDE system in Markham Centre may earn projects up to 6 LEED points.

Scope of Primer

This Primer will address the following LEED credits and prerequisites that a building can earn when connecting to the MDE system in Markham Centre.

- ❖ EAp2 Minimum Energy Performance
- ❖ EAp3 Fundamental Refrigeration Management
- ❖ EAc1 Optimize Energy Performance
- ❖ EAc4 Enhanced Refrigeration Management
- ❖ RPc2 Regional Priority

EAp2 and EAc1 – Energy Performance

The DES Guide describes two paths for documenting EAp2 and EAc1: the Prescriptive Path and the Performance Path. Project teams should select the appropriate path based on the EAc1 Option that is being pursued.

- Prescriptive Path: This option is for LEED projects following the Prescriptive Approach to EAc1/EAp2 (Option 2 on page 273 or Option 3 on page 274 of the 2009 BD+C Reference Guide). Compliance for EAp2/EAc1 is demonstrated by meeting all prescriptive requirements for the building and applicable DES equipment – as specified in the applicable reference standard. This path is not available for LEED Canada NC/CS v1.0 projects.
- Performance Path: This option is for LEED projects following the Performance Approach to EAc1/EAp2 (Option 1 on page 270 of the 2009 BD+C Reference Guide). Compliance for EAp2/EAc1 is demonstrated via energy modeling and one of the following two methods:
    - Method 1 (EAc1 points are restricted to 10/19 for NC or 12/21 for CS)
    - Method 2 (All EAc1 points are available for NC/CS)

Note: Table 1 of the DES Interpretation Guide provides some limitations on the number of LEED points achieved

Method 1

In Method 1, the performance of the DES is not modeled. Instead, the total building energy cost for the Proposed building is calculated using the modeled energy loads and default energy rates for chilled water, hot water and steam. These default rates, as provided by the DES Guide, can be translated into the following seasonal plant efficiencies:

- District Chilled Water – COP = 4.13
- District Hot Water – ηth = 62.5%
- District Steam – ηth = 55.5%

These rates are meant to be performance-neutral to a Reference Building, and use of Method 1 is not likely to improve a project’s energy performance with respect to LEED.

The Reference building is modeled using the normal modeling procedures outlined by either the MNECB or ASHRAE 90.1 – with a few HVAC modifications made for buildings using ASHRAE 90.1-2007 Appendix G (per Table 3 of the DES guide).

Method 2

In Method 2, the performance of the energy systems within the LEED project building as well as the DES plant are used to determine the total Proposed energy cost. The Reference building is modeled using the normal modeling procedures outlined by either the MNECB or ASHRAE 90.1 using energy sources corresponding to the DES.

For the Proposed building, all of the energy use associated with the DES must be accounted for, including: pump power, distribution losses, part load effects, etc. For projects pursuing Method 2, the following options can be used to determine the DES plant efficiency (listed in order of preference according to the Interpretation Guide):

- Monitored Data
- Engineering Analysis
- Default Values

Monitored Data

In order to calculate the energy cost of the Proposed building, actual efficiency performance data from the DES is preferred. With this method, measured seasonal efficiency values for heating, cooling and/or Combined Heat and Power (CHP) systems are used to determine total building energy use. The total cost for the Proposed (and Reference) building is calculated using local rates as they would normally apply to the building for the energy sources under consideration. No guidance is provided in the DES Guide on acceptable time period of the data – a Credit Interpretation Request (CIR) may be utilized to answer this question on a project-by-project basis.

Engineering Analysis

If monitored data is not available or incomplete, an analysis can be conducted on the plant to determine seasonal plant efficiencies (engineering analysis may be used to supplement any incomplete monitored data). The analysis may be performed at any level of time resolution ranging from hourly to annual as long as it is sufficiently granular to capture and reasonably represent any significant time and/or load-dependent interactions between systems (e.g. thermal storage, CHP).

Default Values

If the project team cannot obtain or determine the DES performance, the following default values are to be used for the Proposed building:

- District Cooling Plant – COP = 4.4
- District Heating Plant – η_{th} = 70%
- Thermal Distribution Losses:
  - Chilled water district cooling = 5%
  - Hot water district heating = 10%
  - Steam systems: closed loop = 15%, open loop = 25%
- Pumping Energy – must be estimated where applicable (no default)

Treatment of a CHP Plant for Method 2

The average electric generation, fuel input, and heat recovery of the CHP shall either be calculated or the defaults shall be used.

- Defaults: If the project team cannot obtain or determine the CHP performance, the following default values may be used:
  - Generator Electrical Efficiency = 22%
  - Generator Thermal Efficiency = 25%
- Calculated: The project team can use either monitored data or simulation software to model the generators performance (using rules and procedures defined in ASHRAE 90.1 Appendix G).

Once the CHP performance has been determined, the electricity generation of the CHP must be allocated to the building based on the fraction of the thermal loads to the building from the DES sources that use recovered waste heat. For plants in which the recovered waste heat is used directly in the DES and where that heat serves only heating loads in the connected buildings, the allocated electricity for the project is based on the following two ratios:

- The ratio of waste heat to total heat generated by the DES, and
- The ratio of heat serving the project building to total heat generated by the DES.

To determine the LEED project-specific allocated electricity, these two ratios are multiplied by one another, and then by the total electrical generation of the CHP.

The total gas use (and gas cost) of the CHP for the project can subsequently be calculated as a function of the project-specific allocated electricity above.

Energy Performance of Markham District Energy (MDE)

The DES plant at MDE consists of chilled water, hot water and CHP systems. Since MDE meters the plant energy use, monitored data is available for LEED projects (preferred option). The monitored production data from MDE for the past few years (2010 & 2011) demonstrates an elevated level of energy efficiency – well above the aforementioned default DES seasonal efficiencies.

The impact of the MDE plant on a given LEED project will require careful engineering analysis and detailed calculations. It is recommended that project-specific calculations be performed by professionals having experience with the MDE facility and a strong knowledge of LEED and energy modeling.

Although the number of LEED points for any project will vary based on connected load, determination of allocated CHP electricity (and gas use), annual MDE production data, and other highly influential variables, it is expected that buildings connected to MDE will gain quantifiable savings (compared to a typical Reference model) that will contribute towards EAp2 and EAc1.

Buildings connected to MDE will typically gain savings (compared to a Reference model), earning the equivalent of between 1 and 4 LEED points under EAc1.

Refrigerants (EAp3 and EAc4): LEED Requirements and Calculation Parameters

To meet the requirements of EAp3 and EAc4, projects must account for all refrigerants used to heat or cool the building and any process loads. Since MDE provides cooling to many of its connected facilities, its refrigerants must be included in LEED calculations.

EAp3: This prerequisite requires that buildings do not use chlorofluorocarbon (CFC) based refrigerants in HVAC systems. MDE does not utilize any equipment that contains CFCs. A sample LEED Letter Template has been provided as an attachment.

> If your project's cooling and/or refrigeration loads are wholly supplied by MDE, EAp3 is achieved.

EAc4: This credit requires that buildings calculate the impact of their refrigerants on global warming and ozone depletion. LEED uses a formula that accounts for a variety of parameters including equipment type, refrigerant characteristics, and leakage. Table 1 outlines the values required to calculate compliance. To meet the credit, the Average Refrigerant Atmospheric Impact must be less than 100. A full description of the LEED formaula can be found in the LEED Canada 2009 Reference Guide.

Additionally, projects must confirm that fire suppression systems containing CFCs, hydrochlorofluorocarbons (HCFCs), or halons will not be operated or installed. This requirement must be confirmed by the design team and is not influenced by connecting to MDE.

Table 1 - EAc4 Calculation Parameters

Notation	Parameter	Units	Description
Q	Cooling Capacity	Tons of Cooling	ARI rated cooling capacity as listed on the manufacturer cutsheet or shop drawing.
Rc	Refrigerant Charge	Pounds (lb) of refrigerant per ton of cooling	This is a measure of how much refrigerant is contained within the equipment. LEED restricts this value to between 0.5 and 5.0.
GWPr	Global Warming Potential	Unitless	A ratio that compares the global warming of a given substance to that of CO_2. The GWP of CO_2 is 1.0.
ODPr	Ozone Depletion Potential	Unitless	A ratio that compares the ozone depletion of a given substance to that of CFC-11. The ODP of CFC-11 is 1.0.
Life	Equipment Life	Years	This value is governed by the 2007 ASHRAE Applications Handbook.
Lr	Refrigerant Leakage Rate	Percent (%)	This is a measure of the amount of refrigerant lost per year during operation.

Mr	End of Life Refrigerant Loss	Percent (%)	This is a measure of the amount of refrigerant lost at the end of equipment service life.

Refrigerants: MDE Performance

An analysis of MDE's current cooling equipment was performed to determine compliance with the LEED Canada NC 2009 credit EAc4 requirements. Table 2 outlines the equipment currently installed at the 3 MDE plants (Birchmount, Clegg, and Warden).

The analysis includes all current plant equipment – it is not possible to associate certain equipment with a specific project that connects to MDE. A sample LEED Letter Template has been provided as an attachment.

There are a few parameters not explicitly available in the LEED Reference Guide:

- absorption chiller life is not listed:
  - the 2007 ASHRAE Applications Handbook (the same document used in the LEED Reference Guide) lists 23 years for absorption chillers.
- refrigerant charge for the lithium bromine absorption chiller was not available:
  - a conservative value of 5 (the highest allowable by LEED) was used. The overall calculation is unaffected since the ODP and GWP of water is zero (per the Draft Environment Canada Environmental Code of Practice for Eliminating Fluorocarbon Emissions from Refrigeration and Air Conditioning Systems, Appendix 3).

Table 2 - MDE Chiller Parameters

Plant	Model	Type	N	Q	Refrig.	Rc	Life	Lr	Mr
Birchmount (CH-1,2)	Carrier: 19XR-8686 506EQS68	Centrifugal	2	1450	R-134a	1.847	23	2%	10%
Clegg (CH-1)	York: YKM QM4K2-DBGS	Centrifugal	1	1250	R-134a	2.708	23	2%	10%
Clegg (CH-2)	York: YKN 3N4K3-DDGS	Centrifugal	1	1450	R-134a	2.786	23	2%	10%
Warden (CH-1,2,3)	York: YKG CFOH6	Centrifugal	3	700	R-134a	2.709	23	2%	10%
Warden (CH-4)	York: YIA HW484	Absorption	1	300	Water	5	23	2%	10%
Warden (CH-5,6)	York: YKG HGBJ2-DAF	Centrifugal	2	1100	R-134a	2.708	23	2%	10%

Using the above values in the LEED formula results in an Average Refrigerant Atmospheric Impact of 76.96; this value is less than the allowable upper limit of 100.

If there is no other significant cooling equipment (containing >0.5lbs of refrigerant) in your project, the current performance of MDE allows for this credit (2 points) to be achieved.

If your project's cooling and/or refrigeration loads are wholly supplied by MDE (with no building equipment containing >0.5lbs of refrigerant), EAc4 (2 points) is achieved.

Regional Priority (RPc2)

LEED 2009 includes a new credit category that rewards projects for pursuing Regional important design measures. These points are earned based on achieving requirements elsewhere in the LEED system (no additional design effort is required). Projects in Ontario can obtain one point if at least 10 points are earned under EAc1, including those connected to DESs.