



## DESIGN GUIDELINE FOR DISTRICT ENERGY-READY BUILDINGS

If you have comments or questions please direct them to:

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## Introduction

This document provides information to building developers and owners, architects, and engineers to design buildings that are district energy-ready (DE-ready).

**DE-ready is defined as having a mechanical and building design that makes a building ready to connect to a future district energy system (DES) when it becomes available.**

The key elements of a DE-ready building are:

- **Ability to supply thermal energy from ground level;**
- **Adequate space at or below ground level for a future energy transfer station;**
- **An easement between the mechanical room and the property line to allow for thermal piping;**
- **Two-way pipes placed in the building to carry the thermal energy from the district energy network to the section in the building where the future energy transfer station will be located;**
- **A low temperature hydronic heating system that is compatible (i.e. large temperature differential or  $\Delta T$ ) with a district energy system in order to reduce the pipe sizes and associated valves, fittings, etc.;**  
**and**
- **Appropriate thermal energy metering.**

## Purpose

**The intent of this document is to ensure that future connection to a DES is not precluded by design.** Generally, there are three options for developers:

- 1) At a minimum, developers may provide the space needed for future equipment and thermal piping.
- 2) An additional step would be to design the building mechanical systems to be compatible with a future DE service (e.g. hydronic systems sized for large temperature differentials).
- 3) Finally, in the case of a multi-building development, developers have an opportunity to establish a small DES on their own site by designing a single, slightly larger mechanical room in one building and connecting the other buildings through a thermal energy distribution network. The mechanical room would include the equipment necessary to serve other buildings being constructed on the site, and connected buildings would be designed to be DE-ready.

The next section outlines design standards for a DE-ready building. The Appendix provides an overview of district energy systems, including opportunities in Toronto, the rationale, and benefits to developers.

## Design Standards

A building that is to be connected to a future DES would have a designated space where a future Energy Transfer Station (ETS) will be located. An easement would be provided for the two-way pipes that carry hot and cold water from the DES piping network to the future ETS. The building would also be required to have a hydronic heating system designed to produce a large  $\Delta T$  for maximum efficiency.

### Energy Transfer Station (ETS)

A typical ETS room as shown in Figure 5 has:

- Pipe connections or rough-in with knockout panels on exterior wall
- Heat exchangers for space heating, domestic hot water, and space conditioning
- Controls and meters

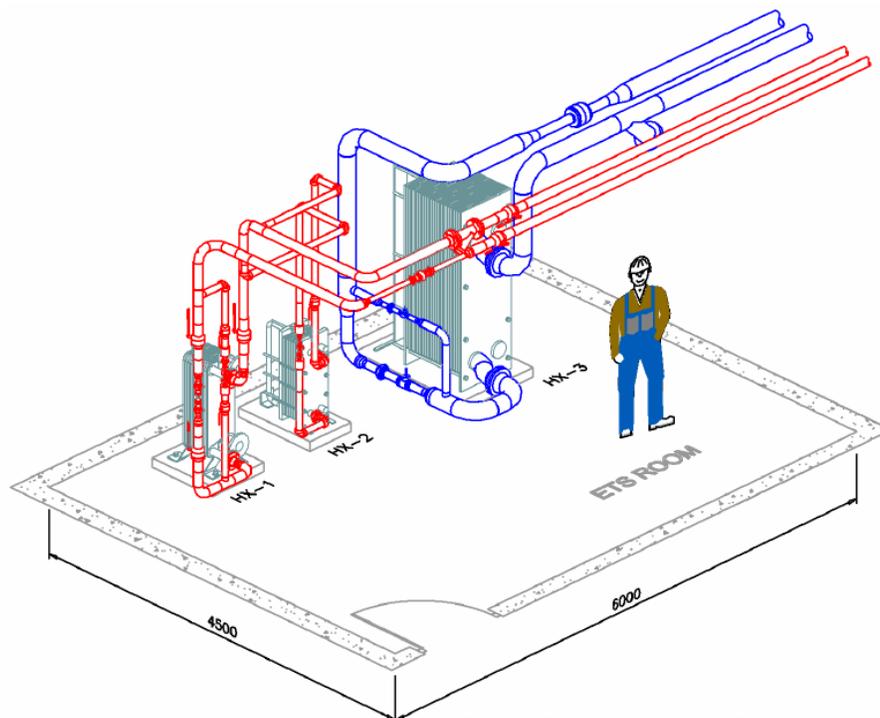
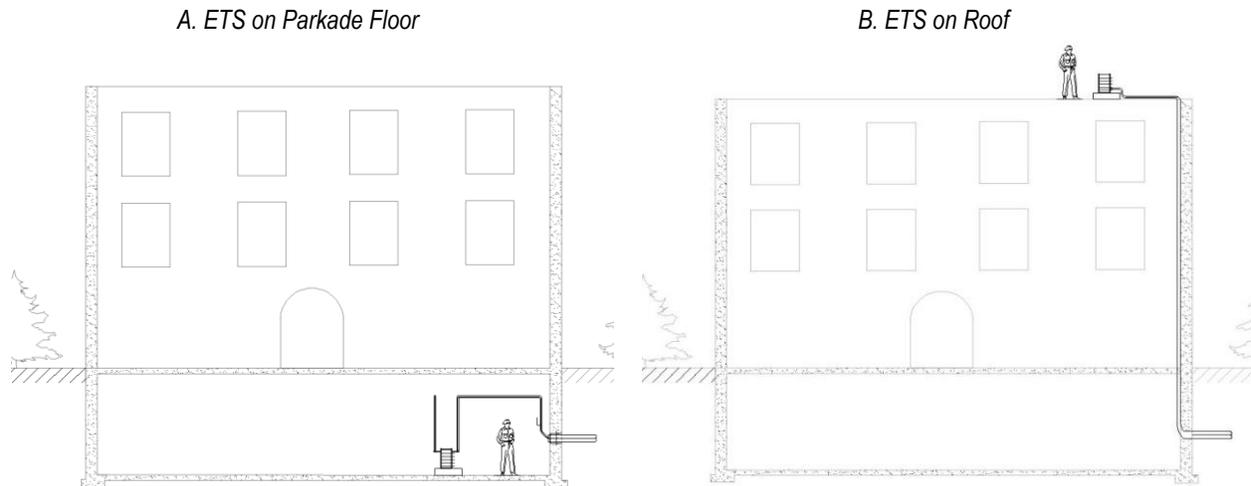


Figure 1. Schematic of a typical Energy Transfer Station (ETS).

### Single Buildings

As seen in Figure 6 on the next page, the two-way pipes are to be included within the design of the building to minimize future costs and complexity, whether the ETS is located on the parkade floor (A) or roof (B).



**Figure 2. ETS Design Requirements.**

In buildings with existing mechanical rooms, equipment such as boilers and chillers must be removed to allow for the installation of an ETS and associated equipment, as well as connection to the DES piping network. If the mechanical room has more than one existing boiler, no additional space is required for the future connection to a DES. In these cases, one or more boilers would be removed, while an ETS for the DES connection is installed. If only one boiler is required in the interim then the mechanical room shall be oversized by approximately 10 m<sup>2</sup>.

### Multiple Buildings

A developer of two or more buildings on a single property would include a mechanical room in only one of the buildings to serve as the heating and cooling centre for all buildings on site. Each building is required to have a hydronic heating system that can be connected to the thermal distribution network using an Energy Transfer Station (ETS). The shared mechanical room is commonly located in the basement or parkade level. The heating and cooling centre in the shared mechanical room can potentially serve adjacent off-site buildings as well.

### HVAC Systems

Table 1 identifies key elements or strategies that should be followed when designing the building HVAC system.

**Table 1. Key HVAC Design Strategies for DE-ready Buildings.**

<b>Large temperature differentials</b>	<ul style="list-style-type: none"> <li>• Reduces piping capital cost.</li> <li>• Reduces pumping capital &amp; operating costs.</li> </ul>
<b>Variable volume flow with variable speed pumps</b>	<ul style="list-style-type: none"> <li>• Reduces pumping operating costs.</li> <li>• Improves system control.</li> </ul>
<b>Two-way control valves</b>	<ul style="list-style-type: none"> <li>• Necessary to achieve variable flow and a large temperature differential.</li> </ul>
<b>Return temperature kept to a minimum</b>	<ul style="list-style-type: none"> <li>• Improves energy efficiency.</li> </ul>

## Pumping and Control Strategies

The building heating and cooling systems shall be designed for variable volume flow operation (preferably with variable speed pumps to minimize the pumping power). All control valves (terminal units and zone valves) to be of 2-way modulating (or on/off for Fan Coil Units) type. Three-way valves that allow flow to by-pass the heating or cooling elements are not permitted as they result in lower  $\Delta T$ , hence lower system capacity. The secondary supply temperature (from the ETS) shall be reset based on outside air temperature.

## Hydronic Heating System

The hot water hydronic heating system shall be designed to provide the space heating and ventilation air heating requirements for the individual suites, hallways/stairwells and other common areas in the building, supplied from a central Energy Transfer Station (ETS) location within the shared mechanical room.

Hot water generated by the ETS shall be distributed, via a 2-pipe (direct return) piping system, to the various heating elements throughout the building. The building (secondary) heating system shall be designed according to the design temperatures specified below. The specified differential temperature ( $\Delta T$ ) shall be regarded as a minimum requirement, and larger  $\Delta T$  is desirable to further reduce the pipe sizes and associated valves, fittings, etc., and pumping requirements in the secondary system. The building return temperatures must be kept to a **minimum** to allow the central energy system to take advantage of alternate energy efficient technologies.

Secondary System	Description	Design Temp.
<b>Hydronic Radiant (Under-floor) Floor Heating</b>	Radiant floor heating provides the best opportunity to heat a building using low grade energy streams. The radiant floor heating shall be provided by PEX tubing installed within the floor structure just below the surface.	HWS: 45°C HWR: 35°C
<b>Fin Type Baseboard Convectors / Perimeter Radiators</b>	The radiant (transmission) heating requirements shall be provided by 2 pass commercial fin type radiators or perimeter style radiant panels (European style) mounted on the perimeter of the (outside) walls.	<i>Convectors:</i> HWS: 70°C HWR: 55°C  <i>Radiators:</i> HWS: 60°C HWR: 45°C
<b>Fan Coils</b>	Packaged fan coil units designed with hot water coils mounted on the inside walls can be used to provide individual unit heating. The fan coil units shall be designed for a minimum of a two row coil.	HWS: 60°C HWR: 45°C
<b>Ventilation Make-Up Air Units</b>	The ventilation (make-up air) requirements shall be provided by one (or several) air handling units designed with hot water/glycol heating coils. The coils shall be provided with freeze protection circuits.	HWS: 65°C HWR: 45°C

## Domestic Hot Water

The Domestic Hot Water (DHW) system shall be designed to provide all DHW requirements for the individual suites, and for all common areas in the building, supplied from a (dedicated) ETS location within the building.

Secondary System	Description	Design Temp.
<b>Domestic hot water</b>	The DHW system is to be designed for instantaneous heating or preferably with storage tanks in accordance with the design temperatures specified. The DHW distribution systems are to be designed with re-circulation lines and pumps.	HWS: 45°C HWR: 35°C

## Hydronic Cooling System

The chilled water hydronic cooling system shall be designed to provide the space cooling and ventilation air dehumidification requirements for the individual suites, hallways/stairwells and other common areas in the building, supplied from a central Energy Transfer Station (ETS) location within the building.

Chilled water generated by the ETS shall be distributed, via a 2-pipe (direct return) piping system, to the various cooling elements throughout the building. The secondary cooling system shall be designed according to the design temperatures specified below. The specified differential temperature ( $\Delta T$ ) shall be regarded as a minimum requirement, and larger  $\Delta T$  is desirable to further reduce the pipe sizes and associated valves, fittings, etc., and pumping requirements in the secondary system. The building return temperatures must be kept to a maximum to allow the central energy system to operate efficiently and possibly take advantage of alternate energy efficient technologies.

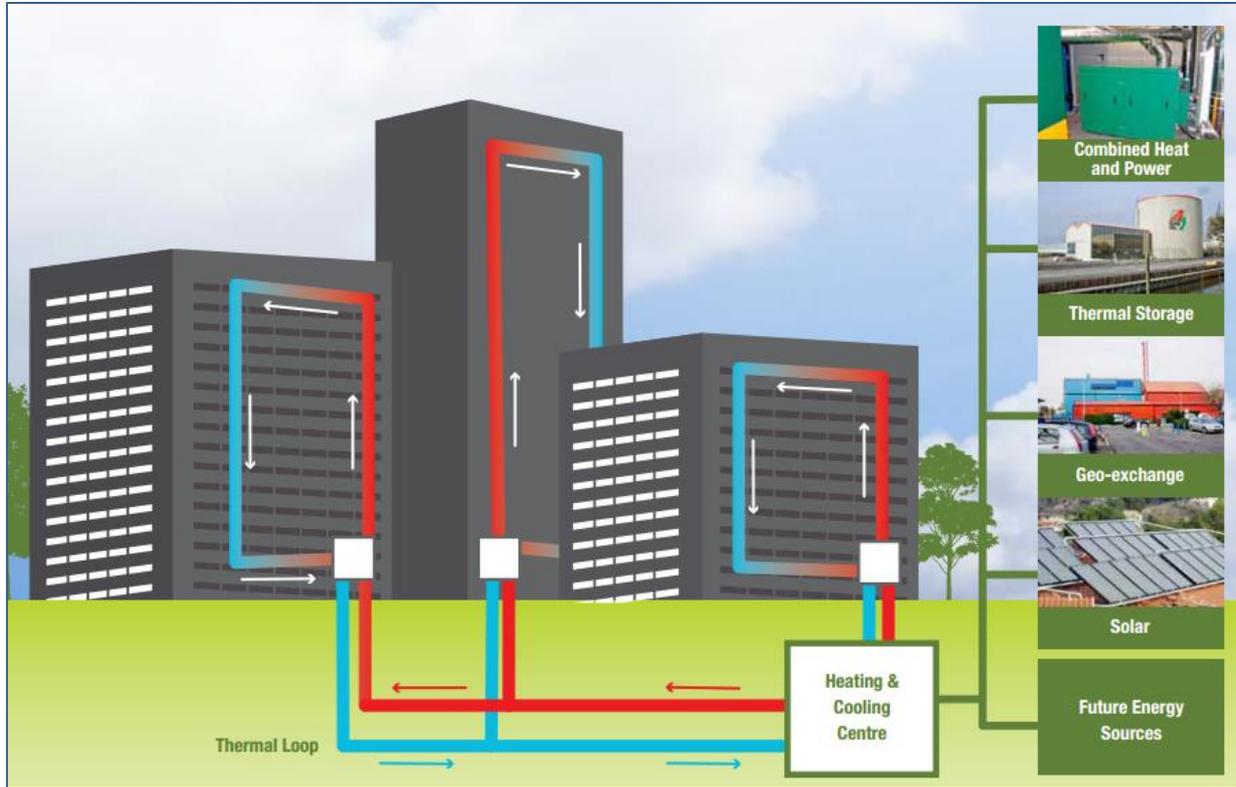
Secondary System	Description	Design Temp.
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<b>Fan Coils</b>	Packaged fan coil units designed with chilled water coils mounted on the inside walls can be used to provide individual unit cooling. The fan coil units shall be designed for a minimum of a two row coil.	CWS: 7°C CWR: 17°C
<b>Ventilation Make-Up Air Units</b>	The ventilation (make-up air) requirements shall be provided by one (or several) air handling units designed with chilled water/glycol cooling coils. The coils shall be provided with freeze protection circuits.	CWS: 7°C CWR: 17°C
<b>Hydronic Radiant (in concrete slabs between floors) Cooling</b>	Radiant cooling is an advanced method of providing sensible cooling only (i.e. not latent cooling). Radiant cooling can be provided through the same tubes as used for radiant heating, which are PEX tubes installed within the floor structure, in this case approximately in the middle of the slab. It is critical to employ effective controls against condensation (i.e. to keep temperatures above dew-point).	CWS: 18°C CWR: 20°C

## Appendix: Introduction to District Energy

### What is District Energy?

A DES is a thermal energy distribution strategy for multiple buildings at the block scale. A DES consists of a heating and/or cooling centre, and a thermal network of pipes connecting groups of buildings (Figure 1).



**Figure 3. Illustration of a District Energy System (DES).** The heating & cooling centre can incorporate various low-carbon energy sources/storage.

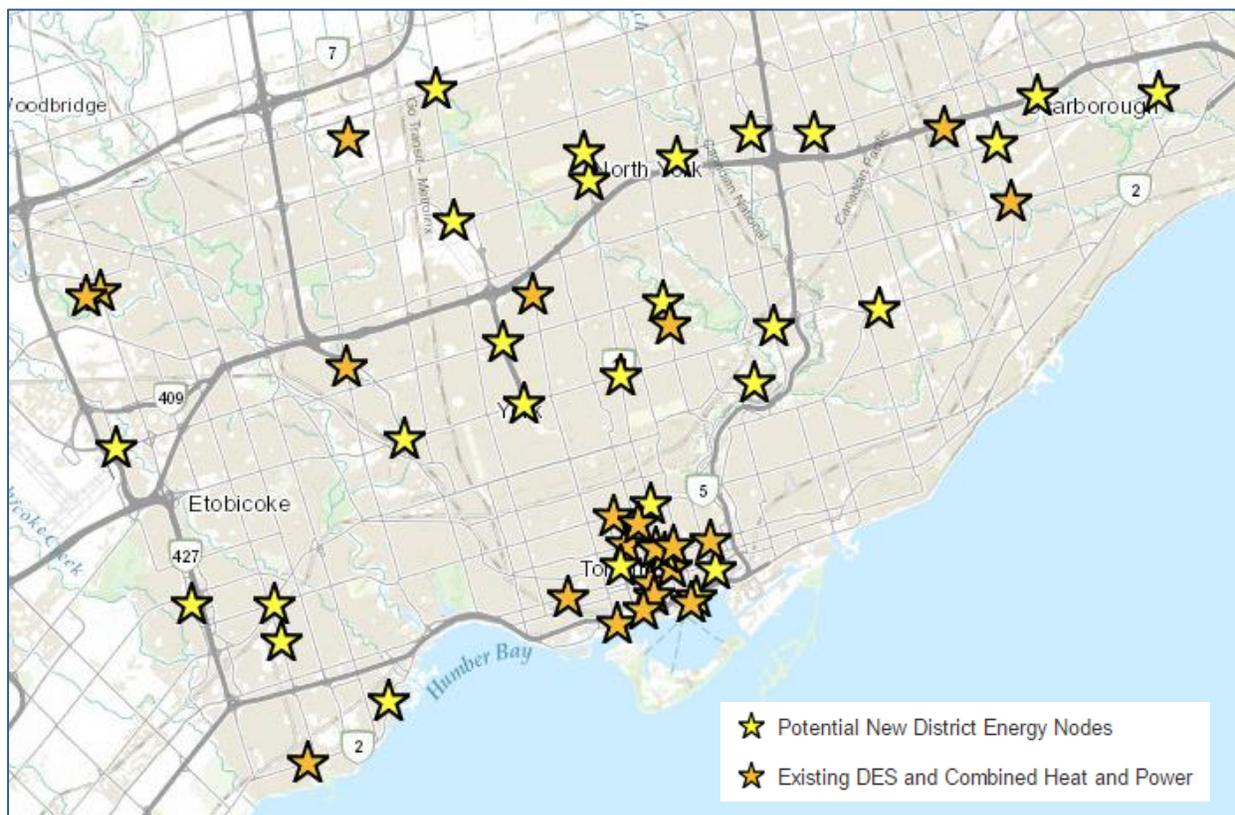
By virtue of economies of scale, compared to an individual building, the DES heating and cooling centre has the flexibility to cost effectively incorporate thermal storage, as well as clean energy in the form of combined heat and power (CHP) and renewable energy sources. In addition, a DES helps relieve stress in the existing energy infrastructure and paves the way for new building construction.

## DES Opportunities in Toronto

The City of Toronto has identified numerous DES opportunities, including specific nodes (Figure 2), in areas with completed Community Energy Plans, and at large developments. In order to make buildings within these areas ready for connection, minor provisions for mechanical designs of buildings need to be implemented. The design standards apply to buildings that are:

- In close proximity to existing or potential new DES nodes
- Within a Community Energy Planning (CEP) area\*
- Part of a large development (over 20,000 m<sup>2</sup>)\*

**\*Note:** Development proposals in CEP areas or over 20,000 m<sup>2</sup> are required to complete an Energy Strategy as part of a complete application. The Energy Strategy includes consideration of opportunities to establish/connect to a DES.



**Figure 4. Existing and Potential New District Energy Nodes.** There are at least 30 locations across Toronto with potential for new DES. Source: <http://map-intra-dev.toronto.ca/demo/evcs/des.htm>

## Why District Energy Systems?

District energy systems are a key opportunity for the City of Toronto to reduce GHG emissions from buildings and to reduce demands on energy infrastructure. As part of its commitment to meeting these objectives, the City seeks to:

- Connect new buildings to district energy where a DES is established or under development;
- Design new buildings to be district energy-ready where future DES opportunities exist; and
- Provide opportunities for existing buildings to connect to a DES once it is developed.

District energy systems create the economies of scale necessary to integrate local, low-carbon/ renewable energy sources (e.g. lake water cooling, geo-exchange, solar thermal, sewer heat, biomass, etc.) in order to achieve large-scale, cost-effective emissions reductions (Figure 3).

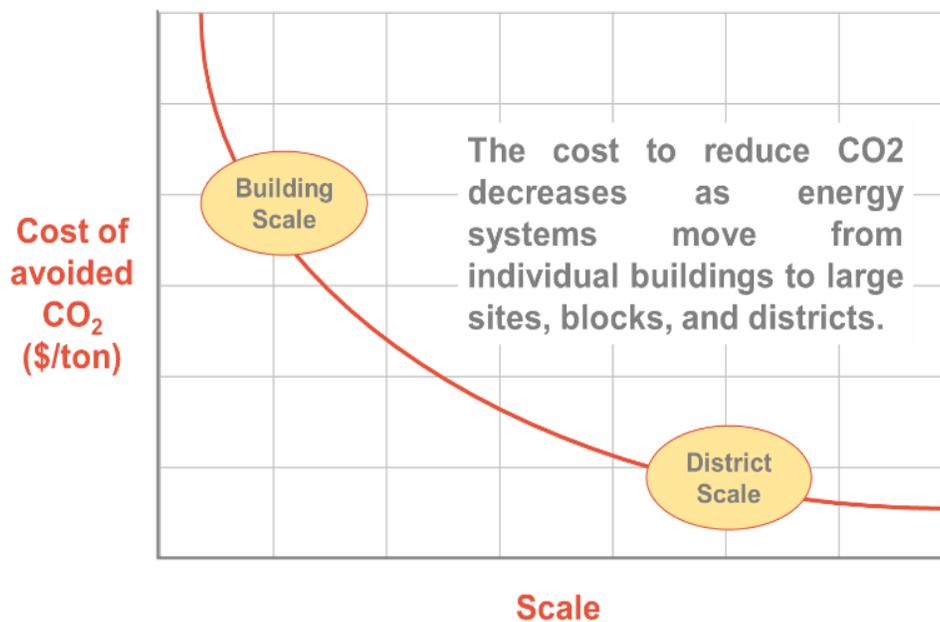


Figure 5. Building scale vs. district scale avoided CO<sub>2</sub> costs.

Toronto's experience with district energy systems began over 100 years ago at the University of Toronto, St. George campus, and now includes Enwave's steam system and world-renowned Deep Lake Water Cooling system. More recently, the Regent Park Community Energy System continues to expand, and the City of Toronto is also developing new systems at Exhibition Place and the Westwood Theatre Lands.

## Benefits to Developers for Designing DE-ready Buildings

DE-ready buildings offers benefits in the form of cost savings, energy efficiency credits and reduction of equipment space requirements. The following summarizes the benefits to developers:

**Prestige and Public Image**

A DES connectable building heightens environmental reputation through demonstrable benefits as a Green and Energy Efficient Building.

**Capital Avoidance Cost**

Initial expenses are reduced when a large mechanical room and building designs for individual utilities are no longer necessary

**Operating Cost Savings**

A DES benefits building owners by providing fuel flexibility and therefore the potential to mitigate future increases in energy costs.

**Eligibility for Energy Efficiency Ratings**

Connection to a DES provides an opportunity to meet energy and environmental standards such as LEED or Tier 2 of the Toronto Green Standard.

**Simplified Building Design**

Building functions can be incorporated more effectively and efficiently as there is no need for a cooling tower, stacks/chimneys, domestic hot water storage tanks, boilers and chillers. This way the developer can utilize space for other usages such as for profit making or attracting tenants as seen in Figure 4.



**Figure 6. Roof Space – DES Connected Vs. Conventional System.**

## Additional Resources

### **City of Toronto District Energy Systems website**

<http://www1.toronto.ca/wps/portal/contentonly?vgnextoid=81d86d820a926410VgnVCM10000071d60f89RCRD>

### **District Energy Node Scan**

<http://www1.toronto.ca/City%20Of%20Toronto/Environment%20and%20Energy/Programs%20for%20Businesses/BBP/PDFs/FINAL-GENIVAR-Report-City-of-Toronto-District-Energy-November-21-13.pdf>

### **Official Plan Amendment 262 (Official Plan Environmental Policies)**

<http://www1.toronto.ca/City%20Of%20Toronto/City%20Planning/Environment/Files/pdf/ESA/OPA%20262%20Environmental%20Policies%20and%20Designation%20of%20ESA%20Areas%20BL%20No.%201158-2015.pdf>

### **City of Toronto Transform TO website (City of Toronto's strategy for reducing GHG emissions)**

<http://www1.toronto.ca/wps/portal/contentonly?vgnextoid=ba07f60f4adaf410VgnVCM10000071d60f89RCRD>