City of Mississauga

District Energy in the Downtown: Feasibility Study

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By:

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EXECUTIVE SUMMARY

Significant, large scale action is required in order for Mississauga to meet its greenhouse gas (GHG) reduction targets and to respond to the climate emergency. The largest source of GHG emissions in Mississauga is buildings: approximately 50% of the city's emissions come from heating and cooling residential, commercial, and industrial buildings. In addition, the City's own corporate buildings (e.g., community centres, libraries, fire stations) account for approximately 20% of the City's corporate emissions; that means it is critical for the City to focus on reducing GHGs from this sector.

As an efficient system for heating and cooling buildings, district energy (DE) has the potential to substantially reduce GHGs, particularly if it is fueled using renewable energy. A district energy system (DES) consists of three main components: (1) a central plant that produces thermal energy; (2) pipes that distribute the thermal energy (i.e., hot and cold water) to buildings; and (3) an energy transfer station at each building.

A DES has numerous benefits. To start, it is more efficient: thermal energy is produced at a central plant, rather than each building generating its own heating and cooling. This makes heating and cooling production more efficient. DE also provides flexibility with respect to technology and fuel sources, making it easier to switch from one fuel source (e.g., natural gas) to another (e.g., electricity, waste heat, geothermal). At the same time, since DESs are able to use local energy and fuel sources, they increase energy security, stabilize energy prices, and improve community resilience. While DESs come with some challenges such as high upfront costs, the clear benefits are some of the reasons why DESs are prevalent in every corner of the world, from college campuses to military bases to indigenous communities, to bustling downtown cores.

Study Purpose

The purpose of this study is to consider the feasibility of a low carbon DES in the City of Mississauga's Downtown. In 2019, City of Mississauga Council approved the City's first comprehensive Climate Change Action Plan (CCAP). That plan includes 89 actions, which are intended to help the City achieve its two main goals: (1) reduce GHG emissions 80% by 2050; and (2) increase resilience and the capacity of the city to withstand and respond to climate events. This study addresses one of the CCAP actions: "conduct a district energy feasibility study in the downtown…" FVB Energy Inc. (FVB) conducted the study.

Study Results

Estimated System Demand with a Phased DE Approach

FVB has developed a low carbon DES concept based on existing buildings and the forecasted new development in Mississauga's Downtown over approximately 30 years to 2050 – a period that could see upwards of 3 million m² (30 million ft²) of development. FVB recommends that the buildout of the DES take place over six major phases, with each phase taking approximately five years. The cumulative gross floor area (GFA) for each phase is shown in Table A.

Table A: Cumulative GFA Over the Six Phases

Phase	Cumulative GFA m²
Phase 1A	118,100
Phase 1B	641,700
Phase 2	1,439,900
Phase 3	1,929,700
Phase 4	2,729,200
Phase 5	3,197,900
Phase 6	3,718,700

FVB has split the first phase into Phase 1A and Phase 1B. Phase 1A includes three existing municipal buildings – Living Arts Centre, Mississauga Civic Centre, and the Hazel McCallion Central Library – as well as the three Sheridan College buildings. Phase 1B includes other privately owned buildings located in close proximity to the Phase 1A buildings. Phase 1A and Phase 1B together make up the same timeframe as the other phases, but this division in phasing allows for separate evaluation of the municipal and Sheridan College buildings. An overview map of the study area showing the phasing plan is included as an appendix to this report.

Three scenarios were considered to evaluate the benefit of a low carbon DES:

1. **Business-as-Usual (BAU) Standalone**: Buildings remain disconnected from a DES and are heated and cooled with their own stand-alone system.
2. **Low Carbon Standalone**: Buildings remain disconnected from a DES and are heated and cooled with their own standalone system. The Low Carbon scenario assumes that new buildings would be constructed to progressive Green Development Standards over the duration of the study period.
3. **Low Carbon DES**: Buildings are connected to a DES. The demand and energy of the buildings, as well as their emission targets, are the same as in the Low Carbon Standalone; however, the DES allows for increased system diversification, which reduces the total peak demand.

The cumulative heating and cooling demand as the system attains its full buildout are shown in Figure A and Figure B respectively. The reduction in demand for the Low Carbon DES compared to the standalone scenarios represents the fact that all of the buildings connected to the DES will not have their peak demand occur at the exact same time. This allows for equipment capacity savings for the DES compared to the standalone cases.

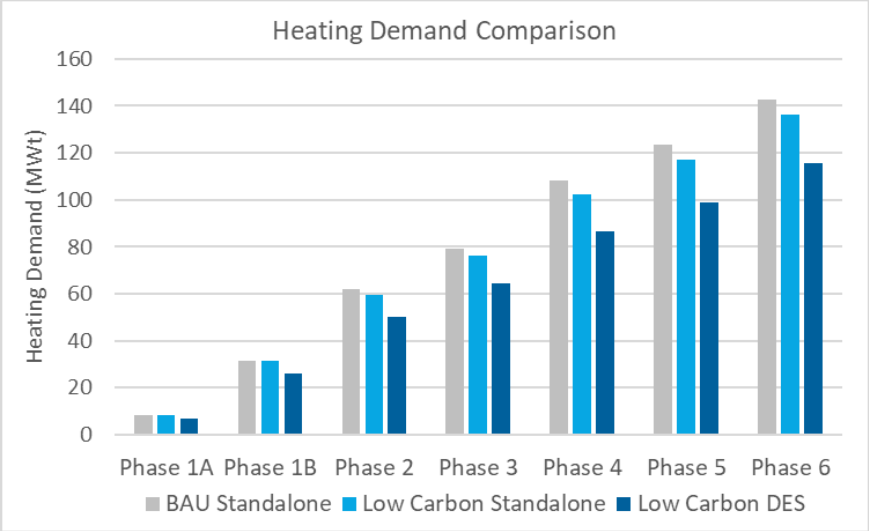

Figure A: Cumulative Heating Demand by Phase

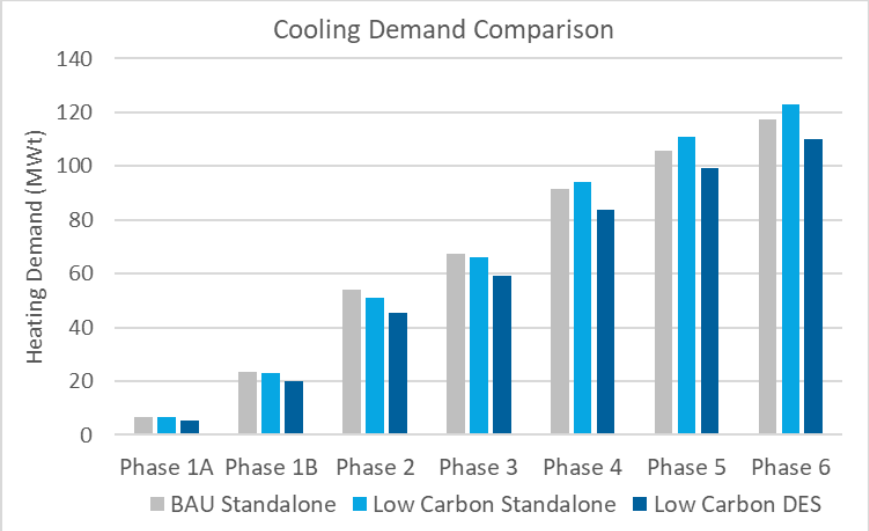

Figure B: Cumulative Cooling Demand by Phase

Low Carbon DES Concept

At full buildout, the low carbon DES would consist of geo-exchange, sewer heat recovery, electric boilers, natural gas boilers, and centrifugal chillers with associated cooling towers. This combination allows for a significant decrease in GHG emissions for the existing buildings, including the municipal buildings, while being financially competitive with current and future building standards. Thermal energy would be delivered from five (5) energy centres at full build out through a four-pipe distribution piping system (DPS). Each building would be connected to this distribution system indirectly through an Energy Transfer Station (ETS).

The first energy centre would be constructed to serve Phase 1A and would include a geo-exchange system along with boilers, chillers, and power generation systems to provide peaking capacity, system redundancy, and back-up power capabilities. As the system expands, additional geo-exchange systems as well as sewer heat recovery systems would be installed and interconnected to achieve the desired GHG emission targets. The details of these systems are outlined within the report.

Financial Analysis, Expected Costs, and GHG Reductions

The key financial results of this study and anticipated GHG emission reductions are summarized in Table B. These results are indicative of the system at full buildout. The unescalated annual expenses and revenue represent the costs to operate the system and the anticipated revenue from the buildings connected to the DES at full buildout. The internal rate of return (IRR) and the net present value (NPV) are metrics that can help determine the overall business case of a project. In this case, they show that there is a promising business case for implementing a DES in Mississauga's Downtown.

Table B: DES Financial Results and GHG Benefit

	Financial (Unescalated)		Financial (Escalated)		Reduction in GHGs vs. BAU Standalone @ Full Build-Out (tonnes)
Description	Annual Expenses ($/yr) 2022	Annual Revenue ($/yr) 2022	Projected IRR 25 Years (%)	25-Year NPV 3.0% ($)	
Low Carbon DES	$ 24 million	$ 44 million	8.3%	$ 300 million	28,288 (88%)

With a low carbon DES, there is an 88% reduction in GHG emissions compared to the business-as-usual (BAU) Standalone case and a 78% reduction over the Low Carbon Standalone case at the full buildout of the system (i.e., after the final phase is built).

The total estimated DES capital costs realized by the end of project buildout are summarized in Table C below.

Table C: DES Capital Cost Summary (Full Buildout)

Low Carbon DES Class D Preliminary (-25%/+50%)	Full Phased Buildout	
	Installed Capacity	Total (2022$)
Heating Plants	138.0 MW	$ 113.7 million
Cooling Plants	31,400 tons	$ 144.8 million
Energy Transfer Stations	85 ETSs	$ 65.7 million
Distribution Piping System	10,840 tm	$ 57.6 million
Total DES Capital Cost		**$ 381.8 million**

Table D shows a breakdown of the incremental capital spent in each phase to expand the Low Carbon DES. It also shows the estimated cumulative annual GHG emission reductions in each phase of the system buildout compared to both the BAU Standalone, where new buildings are constructed to current building code, and the Low Carbon Standalone, where new buildings are constructed to more aggressive standards.

Implementing low carbon standards will be a vital component of achieving GHG reductions in the Downtown. However, connecting buildings to a low carbon DES provides significantly more emission reductions than simply implementing the standards, as buildings that are already constructed can also benefit from the low carbon production of heating and cooling.

The BAU Standalone and Low Carbon Standalone emissions are very similar in Phase 1A and Phase 1B, as the majority of the buildings are existing buildings that would not incur a change to their demand and energy profile with increased restrictions on new building construction energy consumption and GHG emissions.

Table D: GHG Emission Reductions of DE Compared to BAU Standalone and Low Carbon Standalone

DES Summary		Incremental DES CapEx Spent	BAU Standalone Cumulative GHG Emissions	Low Carbon Standalone Cumulative GHG Emissions	Low Carbon DES Cumulative GHG Emissions	Low Carbon DES vs. BAU Standalone
Phase	**Year**	**2022 CAD$**	**tonnes/year**	**tonnes/year**	**tonnes/year**	**% Reduction**
Phase 1A	2025	$ 47.5 mil.	2,980	2,980	610	80%
Phase 1B	2028	$ 88.0 mil.	15,870	15,860	4,550	71%
Phase 2	2030	$ 83.3 mil.	30,620	23,930	5,100	83%
Phase 3	2035	$ 17.0 mil.	38,790	25,350	5,500	86%
Phase 4	2040	$ 76.7 mil.	51,300	27,070	6,230	88%
Phase 5	2045	$ 54.4 mil.	57,590	27,640	6,300	89%
Phase 6	2050	$ 14.9 mil.	65,990	36,030	7,750	88%
Total	**2050**	**$381.8 mil.**	**65,990**	**36,030**	**7,750**	**88%**

Connecting the three City buildings in Phase 1A reduces their combined emissions by 1,650 tonnes annually. Early action to kickstart the DES will be vital in driving this project forward and will provide a foundation for building out the rest of the system. Investments to make the City buildings “DE Ready” will benefit these buildings regardless of the final ownership.

Ownership Models

There are several different ownership and operation structures for a DES, each with their pros and cons. Three that were examined in detail in this report are: (1) 100% municipal ownership; (2) a joint venture model between the municipality and a private partner; and (3) 100% private ownership. These models will be further explored and a recommendation made in the detailed design stage for Phase 1A.

Next Steps: Critical Success Factors in Advancing DE in the Downtown

The development of a successful DES requires one or more anchor customers to start, and the City and Sheridan buildings provide this opportunity. It is important to keep in mind, however, that coordination with stakeholder groups and rigorous planning will be required to continually and sustainably grow and develop the DES beyond this initial phase. FVB recommends the following next steps:

1. Explore the development of a City of Mississauga standard for new buildings to be ‘DE Ready’ so that if DES in the Downtown moves forward, connecting the building will be feasible without having to complete a substantial retrofit to the building. This could be incorporated into the refresh of the Green Development Standards (GDS) for the City. (Timeline: Immediate. To be analyzed in conjunction with the refresh of the GDS).
    a. As the DES is implemented and becomes a facet of the Downtown, options that require new buildings with multiple towers or significant thermal demand to connect to the DES should be explored. Alternatively, providing incentives to developers to connect to the DES – such as what is currently being done in the City of Toronto – should be investigated.

2. Further develop the Phase 1A design to further optimize the energy centre, distribution piping, and energy transfer station design, system costs, and coordination between this phase and the other DE phases. (Timeline: In the short term). This would include:
    a. Schematic design of the first energy centre and building connections, along with refined capital costing

b. Presentation of an updated business case that would evaluate the presented ownership models in greater quantitative detail

c. The development of a detailed economic comparison report that present the avoided cost of the standalone solution required for the Phase 1A buildings to achieve their 80% GHG reduction target. This economic comparison report could be used to form the basis of Thermal Energy Service Agreements with the three City buildings, Sheridan buildings, and new developments near the proposed Phase 1A energy centre.

3. Develop a detailed drawing of the DE corridor for municipal roads and rights of way so, when new developments are being considered, there is consideration for DES infrastructure (Timeline: In the short term). In addition, this detail could be used for coordinating utility upgrades in areas where there could be synergies to install DE infrastructure to facilitate an existing or future DES.

4. Continue engagement with all relevant stakeholder group(s), including internal stakeholders (e.g., Building, Development & Design, Facilities & Property Management), Downtown landowners, developers, utilities, and other levels of government. Engage and educate the public about DE opportunities in the city and their benefits for GHG emission reductions, reliability, and resiliency (Timeline: Ongoing).

Provided all major stakeholders work together cohesively, there is an opportunity for the City of Mississauga to develop a world class low carbon thermal energy network in the City's Downtown that will make a significant contribution to the City meeting its GHG reduction targets.

NOTES:

1. BUILDINGS SHOWN IN COLOUR ARE ASSUMED TO CONNECT TO THE DES FOR MARKET PENETRATION ESTIMATE PURPOSES. THE TABLE BELOW OUTLINES THE CONNECTED GFA.

PHASE	GFA PER PHASE	CUMULATIVE GFA
PHASE 1A		118,100 m²
PHASE 1B		641,700 m²
PHASE 2		1,439,900 m²
PHASE 3		1,929,700 m²
PHASE 4		2,729,200 m²
PHASE 5		3,197,900 m²
PHASE 6		3,718,700 m²

2. LOCATIONS OF THE PROPOSED DEVELOPMENTS (PD#) ARE ESTIMATES; ACTUAL LOCATIONS TO BE DETERMINED.

HWY. 403
CENTRE VIEW DR.
CONFEDERATION PKWY.
RATHBURN RD. W
SQUARE ONE DR.
CITY CENTRE DR.
HURONTARIO ST.
ROBERT SPECK PKWY.
LIVING ARTS DR
DUKE OF YORK BLVD
BURNHAMTHORPE RD. W
KARMA DR
WEBB DR
ELM DR.
CENTRAL PKWY.
GEOEXCHANGE FIELD

PHASE 1A: E39C, E39A, E39B, PL2, PL1
PHASE 1B: E5, GEOEXCHANGE FIELD, E6A, E7A, E7B, E6B, E7C, E8A, E8B, E9A, E9B, E10A, E10B, E11, C1, C2, C3, N4, PD1, F1, E17
PHASE 2: E1A, E1B, E1C, E2A, E2B, PD2, N2A, N2B, E3A, E3B, E4A, E4B, E4C, N3, E12, E13A, E13B, E13C, E13D, E14A, E14B, E15A, E15B, E15C, E16, N5, N6A, N6B, N6C, E29, E28, E27, F2, F3, F4, E31, E32, E33, E34, E35, F5, F6, F7, E30A, E30B, E30C, E30D, E30E
PHASE 3: E36A, E36B, E37, E38, PD3, F8, E18A, E18B, E19, N9, E20, E21, N10, E22, E23A, E23B, E24, E25, E26
PHASE 4: PD4, N1, X1, X2, X3, X4, X5, X6, X7, X8, X9, X10, X11, X12, X13, X14, X15, X16, X17
PHASE 5: X18A, X18B, X18C, X19, X20, X21, X22, X23, N7A, N7B, N7C, N8

LEGEND

- EXISTING RESIDENTIAL WITHIN MAIN STUDY AREA
- EXISTING RESIDENTIAL WITHIN EXTENDED STUDY AREA
- EXISTING OFFICE WITHIN STUDY AREA
- EXISTING OTHER USE WITHIN STUDY AREA
- EXISTING CITY-OWNED BUILDING
- NEW DEVELOPMENT WITHIN STUDY AREA
- FUTURE DEVELOPMENT OF EXISTING BUILDING
- NO ANTICIPATED DES CONNECTION
- STUDY AREA BOUNDARY
- EXTENDED STUDY AREA BOUNDARY
- SQUARE ONE DISTRICT BOUNDARY

CONNECTION PHASING:

- PHASE 1A (2025) – CITY + SHERIDAN
- PHASE 1B (2028) – EXISTING & PROPOSED
- PHASE 2 (2030) – EXISTING & PROPOSED
- PHASE 3 (2035) – EXISTING & PROPOSED
- PHASE 4 (2040) – EXISTING & PROPOSED
- PHASE 5 (2045) – EXISTING & FUTURE
- PHASE 6 (2050) – NEW

ENERGY CENTRES:

- PL1 PLANT 1 (2025) GEOEXCHANGE
- PL2 PLANT 2 (2028) GEOEXCHANGE

THE LOCATIONS OF PLANT 3 (PL3), PLANT 4 (PL4) AND PLANT 5 (PL5) TO BE DETERMINED THROUGH FURTHER STUDIES AND COORDINATION WITH STAKEHOLDERS.

THIS DRAWING IS A CONCEPT AND DOES NOT REPRESENT FINAL RENDERINGS OF ALL NEW DEVELOPMENTS.

STAMP: CONCEPTUAL

REVISIONS

DATE	REMARKS	NO.	INIT.
AUG 31/22	ISSUE FOR DRAFT REPORT	D	N.P.
JUN 28/22	ISSUE FOR CLIENT REVIEW	C	N.P.
APR 19/22	ISSUE FOR DRAFT REPORT	B	N.P.
APR 01/22	ISSUE FOR CLIENT REVIEW	A	N.P.

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PROJECT TITLE: MISSISSAUGA DE STUDY

SHEET TITLE: STUDY AREA OVERVIEW WITH PHASING AND MARKET PENETRATION

DGN: M. BROWN	SCALE: AS SHOWN
DWN: M. BROWN	JOB NO.: 221244
APPR: N. PIDGEON	DATE: SEP 2021

DWG NO.: SK-1244-302

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