Richmond Hill Centre Secondary Plan Study Report

APPENDIX D:
District Energy White Paper (Urban Equation)

MAY 16, 2019

DISTRICT ENERGY WHITE PAPER DRAFT

RICHMOND HILL REGIONAL CENTRE SECONDARY PLAN

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EXECUTIVE SUMMARY

The City of Richmond Hill is currently developing a secondary plan for the Richmond Hill Regional Centre (RHRC)..

Previous studies have indicated that RHRC has the most economic potential for district energy, of the urban growth areas identified in Richmond Hill's Official Plan.

This white paper builds on the past studies and explores how a District Energy System (DES) at RHRC can support the city in achieving its climate goals.

About District Energy Systems
At the most basic level, a DES locally produces and distributes energy to multiple buildings within a confined geographic area – typically a neighbourhood, district or campus.

A DES can supply thermal energy (heating and/or cooling), electricity, or a combination of both. Due to the greenhouse gas emission reduction potential and as directed by the RFP, the primary focus of this white paper is on district thermal energy.

A DES can offer the following benefits:
- Energy and carbon savings
- Improved resilience for communities,
- Stable energy pricing,
- Increased property value and attraction of prominent companies,
- Revenue source for owner/operator, and
- Increased usable building area and capital savings for developers.

Considerations for RHRC
The built form and density of a community is a factor in determining the feasibility of district energy. Generally, district energy is optimized in communities with high density and built floor area, with compact land-use patterns.

Based on the 'RHRC Design and Land Use Study: Final Recommendations' report (2010), the proposed development of RHRC provides an opportunity for successful implementation of a system. Specifically as:
- The study area will see a significant increase in density and floor area.
- New roads will provide opportunity for coordinating infrastructure.
- The Yonge Street Subway extension project could spur development to provide anchor loads and underground work coordination.
- Open space can be used to locate DES infrastructure.
- Phasing of the study area can be planned to benefit a DES.

The site characteristics of the RHRC could support either a traditional high-temperature four-pipe or low-temperature two-pipe distributed ambient loop DES. As described in Section 2 of the report, both systems have unique benefits and challenges.

Energy and Carbon Savings
The Richmond Hill Official Plan encourages new development to use renewable or alternative energy systems that produce 25% of building energy use. All DES scenarios considered in this paper would meet this goal, as a DES is considered by the Province to be a renewable or alternative energy system.

A low-temperature two-pipe distributed ambient loop with geothermal exchange or sewer heat recovery can reduce carbon emissions by more than 50% compared to stand alone building systems.

Ownership Options for DES
Ownership models of DES range from wholly public to wholly private, with many hybrid variations in between.

The type of ownership model chosen by a municipality is often dependent on: the city's resources, capacity, regulatory authority, desired degree of control, risk tolerance, and external market conditions. The scale and number of buildings connecting to the DES can also impact the ownership model.

This report explores how other municipalities have approached DES ownership to give Richmond Hill an understanding of potential options.

Regardless of the ownership model, the majority of successful business models for DES involve a municipality to some degree, typically through policy, planning, and/or partial or full ownership. For RHRC, there is a unique opportunity to work with Markham District Energy.

Collaboration with Markham and the Langstaff Gateway Area

The Langstaff Gateway development area in Markham is exploring a new DES operated by Markham District Energy.

Given the proximity to the RHRC, there is potential for collaboration with this district energy provider. Our discussions with Markham District Energy indicate a willingness to create a DES servicing RHRC as well as Langstaff Gateway.

Phasing, Density and Establishing a Customer Base – A Key Challenge

To get started, a DES requires a stable base load of customers. The first phase of most DES is often the most challenging as significant capital needs to be deployed with only a portion of anticipated density or customer base. Phasing, scalability of systems and commitment from developers/ building owners to connect to the system are critical to establishing a stable DES business.

Policies and Strategies for Successful DE Implementation

Planning, financial, policy and public awareness tools can increase the likelihood of success of a DES for the Richmond Hill Regional Centre. Best practices from other municipalities include:

- Mandating increased levels of energy efficiency;
- Creating a partnership with a district energy utility to identify synergies and opportunities for cost-effective district energy;
- Financial incentives for developers to pursue alternative energy strategies or connect to an existing DES;
- Incorporating policy to make “DE readiness” a requirement of development approvals in RHRC;
- Providing density bonuses for buildings connecting to DES;
- Raising awareness and understanding of DES through education campaigns such as workshops, webinars, and dedicated websites

Next Steps – Richmond Hill

Urban Equation recommends the following next steps for the City of Richmond Hill to advance DES planning for RHRC:

1. Ensure senior management at the city reviews this document and understands the benefits of DES.
    a. Internal alignment on the benefits of DES and the opportunity at RHRC will play an important role in future stages.
2. Identify a district energy champion within the city, who will be responsible for implementation.
3. Connect with Markham District Energy to initiate conversations about potential partnerships with the Langstaff Gateway project.
4. Discuss the opportunity and potential partnerships with other utility providers.
5. Consider the listed policy, financial, or planning tools for integration into the RHRC Secondary Plan with Urban Strategies.

Next Steps – Informing Secondary Plan

The next phase of work in the creation of the secondary plan is to complete land use scenario planning for RHRC. Urban Equation recommends using the DES considerations when completing scenario planning, as described in Section 3.

TABLE OF CONTENTS

1 Background Context

The City of Richmond Hill is currently developing a secondary plan for the Richmond Hill Regional Centre (RHRC), a critical point in determining the future development and infrastructure for the plan area.

A district energy system (DES) in the RHRC is an opportunity for Richmond Hill to become a more climate-resilient and low-carbon city. Exploring the potential for DES at the Secondary Plan phase is the ideal opportunity for successful implementation.

1.1 Drivers - Current and Future Policies and Plans

The provincial and municipal context around RHRC shows strong support for DES, and clear alternative energy use targets. Using the vision and targets in these policies is crucial in providing long-term guidance and political attention, as well as generating public interest.

The following table summarizes the high-level policies supporting DES. Additional detail on specific policies and plans can be found in Appendix A – Current and Future Policy Plans.

Table 1: Summary of Plans and Policies Supporting District Energy in Richmond Hill

Provincial	The province of Ontario has set a long-term goal of 'net-zero communities' in the Growth Plan for the Greater Golden Horseshoe (2017), and promotes the use of 'alternative energy systems' in the Provincial Policy Statement (2014).
Regional	The York Region Official Plan (2010) and the York Region Sustainability Strategy (2007) encourage all new developments to include on-site renewable or alternative energy systems which produce 25% of building energy use, and promote the use of district energy to meet this target.
Municipal	The Richmond Hill Official Plan (2018) mimics the targets of York Region, which encourage all new developments to include on-site renewable or alternative energy systems which produce 25% of building energy use. Further, the Official Plan states that all new secondary plans must investigate the feasibility of incorporating a district heating or cooling system for the secondary plan area. The Urban Master Environmental Servicing Plan (2014) concludes that Richmond Hill Regional Centre has the most economically viable district energy potential of the urban growth areas identified in Richmond Hill's Official Plan. Although not a mandatory requirement, the Richmond Hill Sustainability Metrics Guidebook and Implementation Tool includes an aspirational target of: "In an intensification area, where district energy has been deemed viable by the municipality, carry out a district energy feasibility study."

Although not directly applicable to Richmond Hill, the City of Markham has created a secondary plan for the Langstaff Gateway community, which is located directly south of the RHRC. The Langstaff Gateway Secondary Plan (2010) states that district heating and cooling facilities, to serve all development within the Secondary Plan area, shall be a component of development. This represents a potential opportunity for partnerships between Richmond Hill and Markham, explored further in Section 4.2.

1.2 Why District Energy - Reducing Emissions from Ontario’s Energy Supply

As previously mentioned, Richmond Hill’s Official Plan states that all new secondary plans must investigate the feasibility of incorporating a DES to supply heating or cooling energy for buildings in the plan area.

Why the Emphasis on Heating? – Natural Gas and Greenhouse Gas Emissions

The building sector is the third highest GHG emitter in the province, where space heating represents the highest energy end use for buildings[1]. Typically, space heating energy loads for buildings in Ontario are supplied by natural gas combustion (i.e. boilers), which represents the highest building energy source[1]. On average, natural gas combustion is 3.6 times more greenhouse gas (GHG) emission intensive than electricity supplied by the Ontario grid.

In the Climate Action in Ontario: What’s Next? Report (2018), the Environmental Commissioner of Ontario heightens the urgency of reducing non-electricity GHG emissions in order for the province to meet its reduction targets.

DES, specifically thermal systems, have the potential to reduce emissions by providing alternative energy sources for natural gas-consuming end uses.

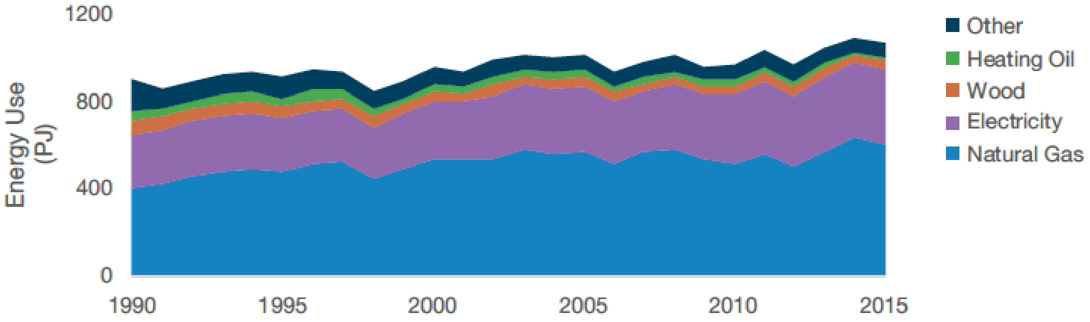

Figure 1: Ontario's Building Energy Use by Energy Source[1]

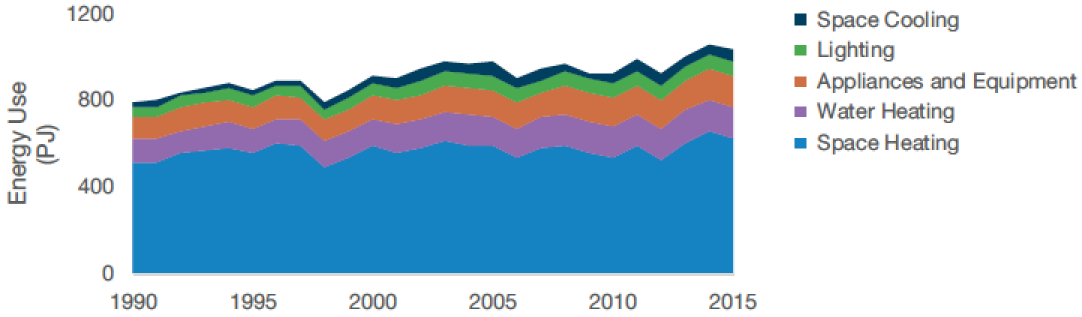

Figure 2: Ontario's Building Energy Use by End Use[1]

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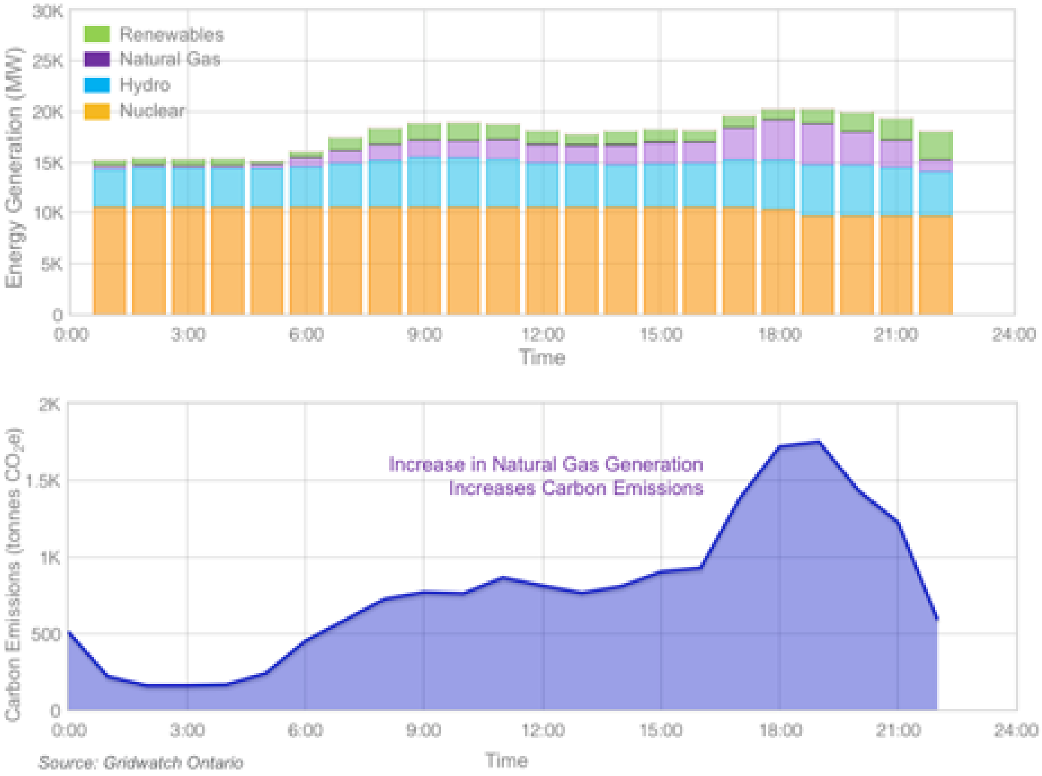
[1] Climate Action in Ontario: What’s Next? 2018 Greenhouse Gas Progress Report, Environmental Commissioner of Ontario

The Electricity Grid – An Opportunity for Further Emission Reductions

In Ontario, electricity is generated by a mix of sources, including nuclear, hydro, renewables, and natural gas. This mix is constantly varying, resulting in a unique carbon emission factor at every hour, as shown in Figure 3.

Fuel sources that are “on the margin” (i.e. fuel sources that are engaged as needed) respond to peaks in electricity demand. Because of their quick response time, natural gas plants are a common marginal fuel source in Ontario. During off peak times, Ontario’s electricity grid has a relatively low emissions factor.

Using a combination of building load diversity, and thermal lag, any district heating and cooling system can be optimized so that its operation can reduce peak demand on the grid. Furthermore, an electrical or combined heat and power district energy system, described in Section 2, can reduce the peak electricity demand for a development, reducing the need for marginal natural gas plants to be activated.



Source: Gridwatch Ontario

Figure 3: Ontario Electricity Grid Energy Source and Emissions - Typical Work Day (Source: Gridwatch Ontario)

2 District Energy Systems Overview

District energy systems refer to systems that generate and distribute energy to multiple buildings within a confined geographic area – typically a neighbourhood, district or campus. As the density of the geographic area increases, the economics of the system typically become more favorable due to the number of customers served vs the amount of costly horizontal distribution piping required.

District energy systems can supply either electrical energy, thermal energy, or a combination of both. In most cases District Energy Systems can generally offer the following benefits:

- Energy and carbon savings
- Improved resilience for communities,
- Stable energy pricing,
- Increased property value and attraction of prominent companies,
- Revenue source for owner/operator, and
- Increased usable building area and capital savings for developers.

The following diagram depicts the DES types, their potential distribution strategies and the potential services each can provide.

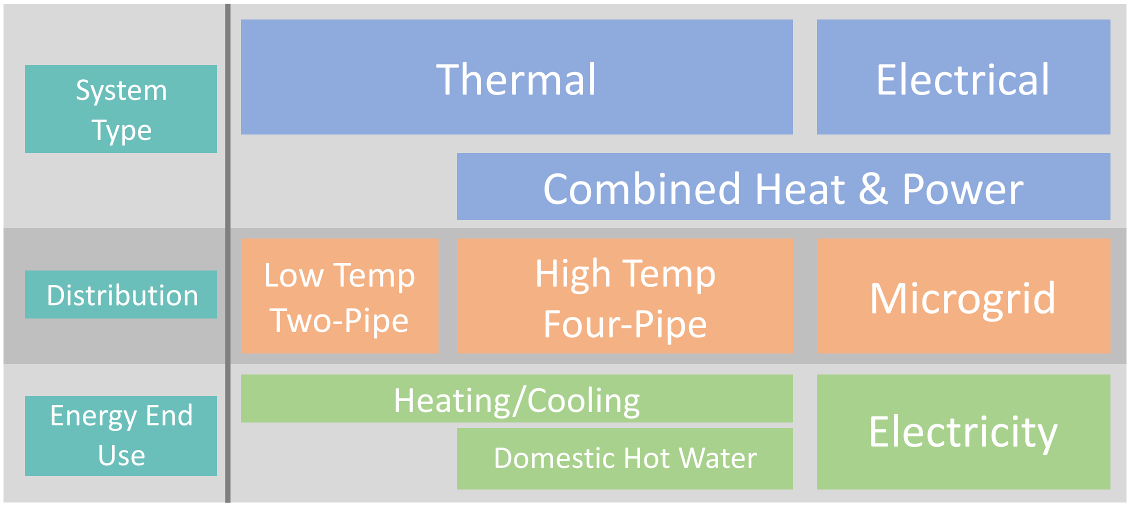


Figure 4: Summary of DES Types

2.1 District Energy System Types

The following sections describe the main types of district energy systems and their benefits.

2.1.1 Thermal District Energy Systems

District thermal energy provides a means of relocating the generation of thermal energy, including heating, cooling, and/or domestic hot water, from individual buildings to a community scale. When DES interconnect multiple buildings, they aggregate diverse heating and cooling load profiles, achieving economies of scale that reduce peak demand and increase the impact of local renewable energy resources. This allows district energy systems to significantly cut carbon emissions, often unachievable on a building to building basis.

At a community scale, thermal energy can be generated at a centralized location from a number of technologies which is then distributed through one of two system types: a four-pipe high temperature loop or a two-pipe low temperature loop. The generation technologies can include a combination of boilers, chillers, cooling towers, heat recovery from combined heat and power systems, geothermal exchange, or sewer heat recovery. The generation equipment is typically housed in one or more centrally located Energy Centre buildings connected to the distribution loop.

Benefits
In addition to the general befits described previously, thermal district energy systems specifically have the following benefits:

- Economies of scale allow more efficient operation of a central plant compared to standalone systems
- Connecting multiple buildings allows for energy sharing between buildings, reducing overall energy consumption and peak demand.
- Opportunity to incorporate low carbon/renewable technologies
- Provides opportunities to incorporate energy storage technologies at scale, increasing resiliency and allowing for peak shifting.
- Reduced space requirements for mechanical rooms in buildings, increasing usable floor area.

2.1.2 Electrical District Energy Systems

Electrical DES, or micro-grids, are a similar concept to a district thermal energy system, but deal with the local generation, storage, and distribution of electrical energy rather than thermal energy.

A micro grid typically works in conjunction with the central electricity grid, and can provide benefits to the local electricity company, such as reducing strain on the grid.

A micro-grid may take several forms, including:

- Behind-the-meter optimization: Storage of grid supplied electricity overnight to deploy during peak periods throughout the day – avoiding electricity cost and carbon impact of the grid peak;
- Storage of excess solar PV production to be used overnight or during periods with less sunlight – increasing local usefulness of renewable energy; and
- Integration of plug-in Electric Vehicle (EV) batteries as a storage device for on peak use of stored electricity.

Benefits
In addition to the general befits described previously, electrical district energy systems specifically have the following benefits:

- Behind-the-meter optimization may prove to be economically attractive considering on- and off-peak electricity rates.
- The storage of grid supplied electricity during off peak times for use during peak periods results in a net decrease of carbon emissions as peak electricity generation is often provided by natural gas power plants, the primary source of carbon emissions for the Ontario electricity grid.

Additional considerations of micro grids include the cost and efficiency losses associated with battery storage, as well as regulatory approvals and end user education. Battery storage may be centralized in the community or could involve the use of batteries at the individual building level.

Though outside of the scope for this study, a microgrid system could have applicability for the RHRC, and can be assessed in a separate study if desired.

2.1.3 Combined Heat and Power Systems

Combined Heat and Power (CHP), or cogeneration, combines the on-site generation of electricity, typically by a natural gas powered engine, with the recovery of waste heat from that electricity generation for space heating, domestic hot water or other thermal energy uses.

Benefits
In addition to the general benefits and specific thermal district energy benefits listed previously, CHP systems specifically have the following benefits:

- Reduction of wasted energy from transmission losses in the central grid
- Assuming electricity generation is needed, the waste heat is essentially “free” to add into the heating loop
- An absorption chiller may be added to the system, using the waste heat in the summer to produce “free” cooling, referred to as tri-generation.
- Increase resilience of a building by providing heat and power independent of grid connections. A CHP system may double as or replace the need for an emergency generator in some cases.

While attractive cost savings can be achieved using CHP, this technology works by replacing grid electricity with local electricity production most commonly fueled by natural gas. Given the current GHG intensity of Ontario’s electric grid, this results in a net increase in GHG emissions. To counteract this, CHP operation may be limited to peak times when the electricity grid relies more heavily on natural gas power plants. However, this decision would impact the financial model of the system by reducing the revenue generated from electricity supply. A detailed technical and financial model, built in conjunction with the utility provider, is recommended to evaluate how to best balance carbon and cost savings.

2.2 Distinctions of a Thermal District Energy System

As per the Town of Richmond Hill’s Official Plan, this study focuses on thermal energy systems. The main distinctions of a thermal DES are the types of distribution and the methods for generating the thermal energy. The following sections describe the types of distribution and the thermal energy generation systems.

2.2.1 Distribution

Distribution networks can be broken down into two main types:

1. Distributed Ambient/Two-Pipe Network – “Low Temperature”
2. Four-Pipe Network – “High Temperature”

One important note of clarification is that many of the publicly available resources on district energy would consider the four-pipe networks described in the following sections of this report as a relatively low temperature. The four-pipe networks described in this report are what the industry generally considers to be “4th Generation” distribution networks that, with respect to previous generations of district energy distribution, are lower in temperature. However, the ambient loops described in this report are even lower in temperature than the four-pipe loops and therefore will continue to be referred to as “Low Temperature” while the four-pipe loops will be referred to as “High Temperature”.

2.2.1.1 Low-Temperature Distributed Ambient/Two-Pipe Thermal Distribution System

A distributed ambient thermal distribution system is connected to a low temperature (typically 12 to 30°C) distribution loop, through which building-level heat pumps can reject heat to or extract heat from to provide both space heating and cooling. Because of the lower loop temperatures, these systems are typically not able to provide water hot enough for domestic hot water needs in a building. Domestic hot water is best suited for a building level system if a distributed ambient system is present.

While it is possible for the central plant serving the distribution loop to consist of conventional boilers and cooling towers, this type of system can also support renewable low-carbon energy generation sources such as: ground source heat pump, sewage heat recovery, or low grade solar thermal technologies.

The distributed ambient loop facilitates the sharing of thermal energy as it allows heating and cooling to be moved around when certain areas in a building, or buildings in a community, require heating while others require cooling.

The pipes in these systems are generally not insulated, due to the ambient ground temperature, which provides a cost savings. The piping can be made from HDPE plastic instead of steel, which provides cost savings over other distribution systems. A well-designed ambient district has sufficient mass and flexibility to grow with the community over time; various energy sources can be added to supplement the system and improve emissions performance.

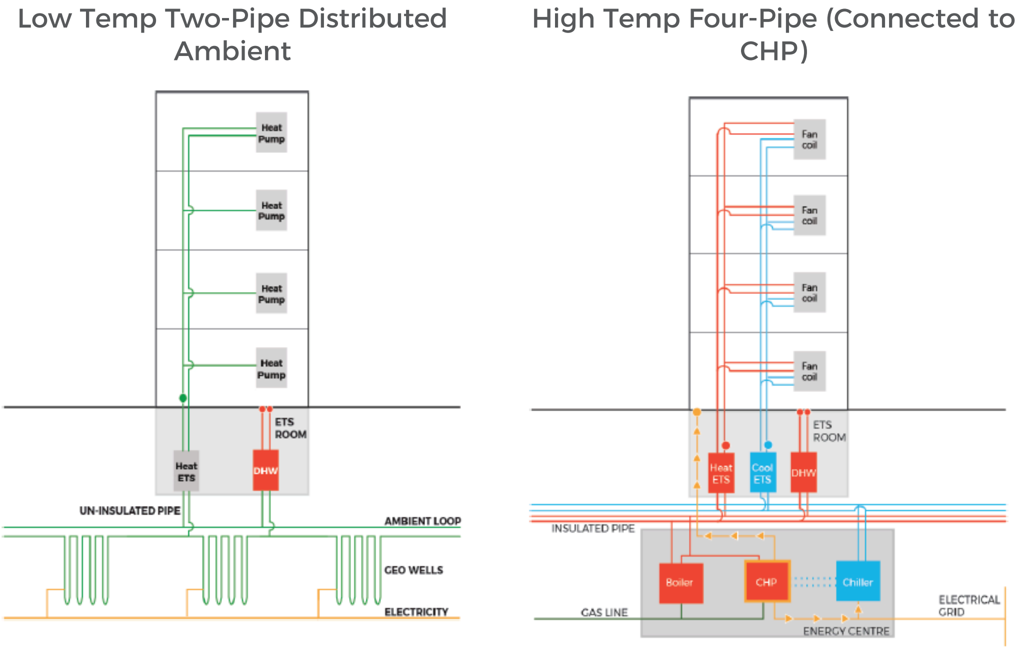
2.2.1.2 Four-Pipe Thermal Distribution System

This system distributes thermal energy to the buildings via an insulated, ‘high-temperature’ thermal piping network. In a four-pipe loop, hot water temperatures range from 50 °C - 60 °C while chilled water temperatures range from 3 °C - 8 °C. The hot water temperatures may be higher than 60 °C but most four-pipe systems today are optimised for the lower range.

The central energy generation plant serving the distribution loops typically consists of electric chillers and gas fired boilers. This distribution can provide heating, cooling, and domestic hot water loads for buildings. The addition of combined heat and power generation to the central plant provides an additional mechanism to deliver heat to the loop as well. The temperatures of the waste heat from CHP are generally better suited for a four-pipe distribution system than a two-pipe distribution system.

In-building heating and cooling plants are replaced by heat exchangers to connect the buildings to this loop to distribute space conditioning via local fan-coil units. In this system, the water in the piping systems is heated or cooled to the temperature required to meet the loads.

Figure 5 depicts the general components and distinctions of distributed ambient loops and four-pipe loops.



Low Temp Two-Pipe Distributed Ambient

High Temp Four-Pipe (Connected to CHP)

Figure 5: Conceptual Diagrams for Distribution Systems

2.2.1.3 Building Connections

Individual building connections to the district energy system, often referred to as energy transfer stations, are typically located in basement level mechanical rooms of buildings. Energy transfer stations include a heat exchanger to transfer heat from the DES to the building's secondary HVAC system. Energy transfer is generally metered by both a thermal meter, as well as a flow meter.

2.2.2 Generation

One of the key benefits of district energy systems is the economies of scale that enable the use of renewable energy resources to supply local energy.

A single district energy system can generate energy from one or multiple sources. The following technologies are common energy generation systems, that could be applicable for Richmond Hill Regional Centre.

2.2.2.1 Chillers/Boilers

For district energy systems with a central plant, natural gas-fired boilers and chillers can be used to generate heating and cooling, which are then distributed to buildings typically through a four-pipe high temp distribution system.

When combined with a micro-grid, this energy generation can be used for a CHP system. The waste-heat from the generation of electricity is used to reduce the loads needed by the boilers for thermal energy.

Benefits

- Economies of scale at the central plant, and diversity of multiple building loads connected to the loop allow for greater operational efficiency of the boilers and chillers

when compared to a building level plant sized for peak loads much higher than typical operating condition.
- Reduced space requirements for mechanical rooms in buildings, increasing usable floor area.
- Reduced upfront capital cost from the building owner.

Challenges
- This system relies on natural gas for energy generation, which has higher carbon emissions compared to a renewable energy system. For CHP systems, this results in a net increase in GHG emissions, considering the low-carbon electricity grid in Ontario.

2.2.2.2 Geothermal Exchange

Typically part of a distributed ambient system, geothermal exchange system works by using the stable temperatures of the ground to reject heat into in the summer and extract heat from in the winter through a series of bore holes. That heat is transferred via fluid to in-suite high efficiency water source heat pumps or similar compressor-based systems to provide heating and cooling to a space. The ground acts as a supplier and seasonal storage of thermal energy. Geothermal energy meets the heating and cooling needs of buildings in the system.

Benefits
- Geothermal energy is renewable and widely used to accelerate communities to net zero energy.
- Reduced space requirements for mechanical rooms in buildings, increasing usable floor area.
- Potential for developer to save capital cost of in building mechanical systems.

Challenges
- By using the ground as a source of both heating and cooling, it is important that a GSHP system balance the heating and cooling loads. Otherwise, performance may depreciate over time as localized ground temperature gradually change.
- These systems, connected to high efficiency water source heat pumps, generally cannot produce temperatures high enough for domestic hot water. Alternate sources of supplemental heat, such as solar thermal, boilers, or other means would likely be required for domestic hot water.

2.2.2.3 Sewage Heat Recovery

Sewage heat recovery systems capture waste heat from sewage pipes for re-use in a district energy system, taking advantage of the hot water from showers and sinks that flows down the drain. Sewer water is captured in a large well, where solid waste is separated. The sewer water then goes through a heat exchanger to transfer heat to clean water connected back to the building loops. This system can provide heating and domestic hot water loads.

Benefits
- Unlike geothermal systems, sewage heat recovery systems do not require balancing. The water used for heat transfer flows down the sewer, while ‘new’ waste water consistently arrives from the buildings.
- Sewage heat is renewable and used to accelerate communities to net zero energy.
- Reduced space requirements for mechanical rooms in buildings, increasing usable floor area.

- Reduced upfront capital cost from the building owner.

Challenges

- These systems are dependent on the flow rate from the sewer system for heating energy. Flow rates of higher-density urban centres are ideal, as they provide constant sewer flows.
- These systems are generally used in combination with another energy generation technology.

2.2.3 Storage

District energy systems may include the use of an energy storage technology, although not necessarily required. Incorporating storage into a district energy system has many benefits, including:

- Chilled water or heat produced by CHP systems during peak electricity can be stored for use during peak thermal demand periods, reducing the need to burn extra fuel and reducing demand charges on customers.
- Thermal storage for cooling can reduce the peak electricity demand on the electricity grid, reducing greenhouse gas emissions and electricity costs.
- The piping networks in a distributed ambient system are already a form of thermal storage, which allow load sharing between buildings with diverse heating and cooling energy loads.

3 Considerations for Richmond Hill Regional Centre

3.1 Site Context

The built form of a community is a factor in determining the feasibility of district energy. Generally, district energy is optimized in communities with high density and built floor area, with compact land-use patterns.

The RHRC has been identified as a location for significant growth. In the ‘RHRC Design and Land Use Study: Final Recommendations’ report (2010), Urban Strategies Inc. identified that RHRC could accommodate approximately 15,800 new people and 15,700 new jobs. Unless otherwise noted, the assumptions from this 2010 report have been used as the basis of the analysis for this white paper, Table 3.

Richmond Hill’s Urban Master Environmental Servicing Plan (UMESP) outlines the following characteristics as key positive factors for economic feasibility for DES:

- New green/brownfield development over 10,000 square meters[2]
- Opportunity to coordinate DES with other infrastructure to share costs
- New development is clustered together and built over a tight timeline.

These factors generally represent good conditions for district energy systems. Based on the 2010 report, the proposed developed of RHRC meets the outlined criteria for economic success of a DES.

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[2] Based on a CHP system

Table 2: Site Assumptions based on 2010 Report

Total site area	700,000 m^2 (70 hectares) including utility corridor, exclusive of Langstaff Gateway lands
Total development parcel area	254,000 m^2
Total development gross floor area (GFA)	1,160,000 m^2
Total development GFA by space type	Residential - 710,000 m^2
	Office - 340,000 m^2
	Retail - 93,000 m^2

New Road Networks - An Opportunity to Coordinate Infrastructure

New street networks offer unique opportunities to create distribution networks for DES below grade, during the already planned construction process. Both two- and four-pipe distribution networks can be planned below new roads.

The proposed road network at RHRC will include substantial changes beyond the existing block structure. The following image depicts the proposed road network at development completion.

Figure 6: Proposed Road Network for RHRC from 2010 Report

Yonge St. Subway Extension - Bringing Anchor Loads and Coordination Opportunities

The Toronto Transit Commission (TTC) is planning an extension of the existing Yonge Street subway line, which will include a station in the RHRC. This project is currently in the preliminary planning, design, and engineering phase, to be completed in 2020.

The subway extension will likely stimulate the development of dense building growth centred around the new station. This could provide substantial thermal energy anchor loads, which could be served by a new two- or four-pipe DES.

Furthermore, the physical construction of the subway extension could provide an opportunity to construct substantial portions of the required underground distribution infrastructure concurrently.

Open Space - Ideal Locations for Infrastructure

The open space network envisioned for RHRC presents opportunities to more easily incorporate district energy infrastructure into the community.

For low temperature systems, open park space can be used for geothermal energy generation, pump houses, and distribution networks. For four-pipe systems, open space can be used for distribution networks or storage technology, if needed.

Open park space can also be used to build infrastructure that can be used for public education around DES, explored further in Section 5.4. The following image depicts the envisioned open space at RHRC at development completion.

Figure 7: Proposed Open Space Network for RHRC from 2010 Report

Development and Phasing – Providing Density Over Time

The development of RHRC will take place incrementally. The following images depict the potential growth scenario identified in the 2010 report, which is subject to change.

Greenfield Intensification

A Significant Transit Investment

Short Term Reurbanization

Long Term Reurbanization

Figure 8: Proposed Phasing of Development for RHRC from 2010 Report

Some of the proposed development has already taken shape. For example, the SkyCity Condominium towers have been constructed within the zone identified in the greenfield intensification phase. These buildings use individual HVAC equipment in each residential unit, powered by a building-level central plant. Each tower is serviced by an energy management company for metering and billing. Because these buildings were developed without district energy in mind, it is unlikely that they would be able to easily connect to a future district energy system.

It is possible, however, for building design to incorporate future connection to DES without significant effort or cost if considered from the onset of design. The City of Richmond Hill can incorporate language to mandate or encourage “District Energy Ready” buildings within the development requirements of the RHRC secondary plan, explored further in Section 5.

3.2 Potential Applicable Systems for RHRC

The site characteristics of the RHRC could support either a high-temperature four-pipe or low temperature two-pipe distributed ambient DES. As described in Section 2, both systems have unique benefits and challenges. As both these system types are applicable, we have provided a SWOT analysis for consideration by Richmond Hill specific to RHRC,

Table 3.

Table 3: SWOT Analysis of Applicable DES in RHRC

	TRADITIONAL FOUR-PIPE	**TWO-PIPE DISTRIBUTED AMBIENT**
STRENGTHS	• Mechanical equipment in building may be minimized • Compressor based unitary units not needed • Provides Economies of Scale compared to stand alone buildings • Can provide domestic hot water loads as well as heating and cooling If used with a CHP system: • Provides added resiliency in form of grid independence • Stronger business case due to high electricity price points	• Mechanical equipment in building may be minimized • Provides Economies of Scale compared to stand alone buildings • Insulation not needed with distribution piping • HDPE Piping generally provides cost savings compared to steel piping • Heat exchange with ground encouraged - can make use of planned open space in RHRC • Renewable energy sources connect directly to system • Load sharing between buildings encouraged, especially with diverse building types in RHRC
WEAKNESSES	• Distribution piping requires insulation • 2x horizontal piping required compared to distributed ambient • Steel piping required is generally cost premium compared to HDPE If used with a CHP system: • Generally larger base load required than for thermal district energy alone • Could result in a net increase in greenhouse gas emissions, due to Ontario's electricity grid	
OPPORTUNITIES	• Established system precedents locally available • Collaboration with Markham District Energy possible (See Section 4)	• Cost effective all-electric systems available with current technology
THREATS	• All electric technologies not yet cost effective. Natural gas required.	• Fewer district scale examples in operation today • Unlikely to couple with future Markham District Energy Systems

3.3 Potential Energy and Carbon Savings

As stated in the Official Plan, the city of Richmond Hill has a goal of all new developments to include on-site renewable or alternative energy systems which produce 25% of building energy use. The Provincial Policy Statement clarifies that *renewable and alternative energy systems* include district energy systems.

Based on the future development scenario in the 2010 USI report and current 'business-as-usual' building practices (as defined by the Toronto Green Standard version 3), we calculated the total annual energy demand and greenhouse gas emissions for the buildings on the site.

Natural gas consumption for space heating accounts for 41% of the total building energy demand for RHRC. Space heating and space cooling combined account for 46% of the total building energy use. Adding the domestic hot water energy to the heating and cooling energy increase the percentage to 62% of the total building energy use. Using a DES to meet the demands in any of the above listed combinations would exceed the city's goal of providing 25% of building energy use from a renewable or alternative energy source.

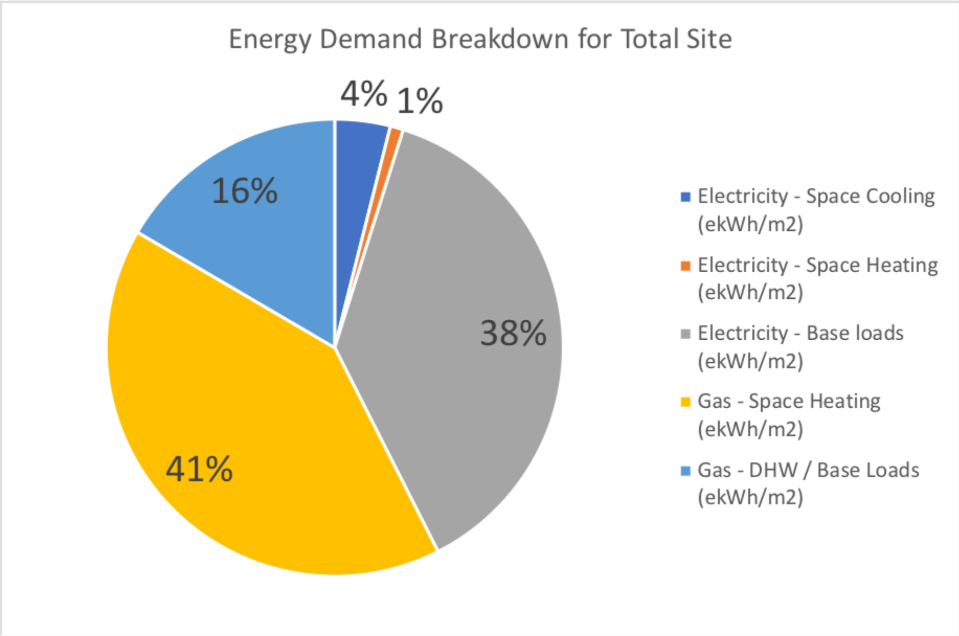


Figure 9: Energy Demand Breakdown for RHRC

Energy Efficiency

From an energy efficiency standpoint, a distributed ambient loop DES coupled with geothermal exchange and/or sewer heat recovery presents the optimal solution. Distributed ambient systems also allow for energy sharing between buildings, when one building calls for cooling (exporting heat to the loop) and another building calls for heating (importing that heat from the loop).

System efficiencies are often measured by the Coefficient of Performance (COP) which, for heating and cooling systems, is the ratio of useful thermal energy produced to the electricity consumed to produce the thermal energy. The higher the COP of a system, the greater efficiency.

Table 4 outlines the COP of a stand-alone building system as compared to DES. The COP of a building scale central plant containing a high efficiency gas-fired boiler and electric chiller may be as high as 0.95 for heating and 4.5 in cooling.

A four-pipe district energy system will consist of gas fired boilers and electric chillers. The COP of a district scale gas-fired boiler will be upwards of 0.87 while a district scale electric chiller plant may have a COP of 4.7. At the building level, a condensing boiler can be installed which provide for higher efficiency operation than the non-condensing boilers that are usually more economically viable for a large scale district heating plant.

If a combined heat and power system were introduced at the district scale, and the assumption was made that the heat from the electricity generating turbine is a free product of generating the electricity, then the COP of the heating system will increase to upwards of 1.2.

The distributed ambient district energy system could be powered by a gas fired boiler plant similar to that of the four-pipe system, but the chiller plant would be replaced by a series of cooling towers. However, a distributed ambient loop more easily allows renewable energy systems such as geothermal exchange or sewer heat recovery to take the place of the boilers and cooling towers. The renewable sources working in conjunction with in-building heat pumps can produce heating COPs as high as 4.5 and cooling COPs as high as 8.0.

Table 4: Plant Heating and Cooling Coefficient of Performance Summary

	STAND-ALONE BUILDING	FOUR-PIPE	FOUR-PIPE WITH CHP	TWO-PIPE DISTRIBUTED AMBIENT
HEATING COP	0.95	0.87	1.2	4.5
COOLING COP	4.5	4.7	4.7	8.0

Carbon Emissions

As discussed in Section 1.2, the average carbon intensity of natural gas is almost four times that of electricity in Ontario. From a carbon emissions perspective, the optimal solution is an all-electric system, though high electricity costs generally prohibit this.

A distributed ambient district energy system provides the most cost-effective all-electric option. It's likely a distributed ambient loop with geothermal exchange and/or sewer heat recovery can reduce greenhouse gas emissions by over 50% compared to individual building-level boiler and chiller plants.

A four-pipe district energy system with gas-fired boilers and electric chillers would have a comparable GHG intensity to that of building level plants. A combined heat and power plant would increase the GHG intensity because of the natural gas being burned on-site to produce electricity.

It is possible that the GHG intensity of a gas-fired boiler plant could be reduced in the future by switching to a biomass fuel source or other renewable natural gas, but a viable source of alternative fuel has not been identified at this time. While they are in a research and development phase, discussions with Enbridge have indicated that production of renewable natural gas to will not be commercially available within the next several years.

3.4 Implications on Land Use Planning and Phasing

Location and sizing of a DES will vary depending on the type of system chosen and the final development scenarios. In the table below, we have outlined high-level considerations for sizing and location for the main DES types described in this report.

Table 5: Considerations for Sizing and Locations of DES Types

Four-Pipe High Temp	Distributed Ambient Low Temp
• Four-pipe systems require an energy centre to house equipment used for energy generation, such as boilers and chillers. • Typically, Energy Centres are stand-alone buildings located in the community, ideally within a reasonable distance from all buildings when possible. • Energy Centers can alternatively be located on the ground floor or below grade in one of the first buildings in the development. All considerations for High Temp Four-Pipe systems, as well as: • CHP systems require four-pipe distribution system as well as a micro-grid to distribute electricity to buildings, resulting in more infrastructure space needed underground. • CHP systems may desire battery storage equipment, resulting in larger Energy Centre space requirements.	chosen, coordinate with new sewer

The following conceptual images outline possible distribution and energy generation equipment locations within the RHRC. Optimal design of distribution networks minimizes the amount of piping require to reach each building, as distribution can be a considerable cost for a DES. Exact system location and sizing can be confirmed with detailed engineering analysis once more explicit information is available regarding development phasing, timing and location.

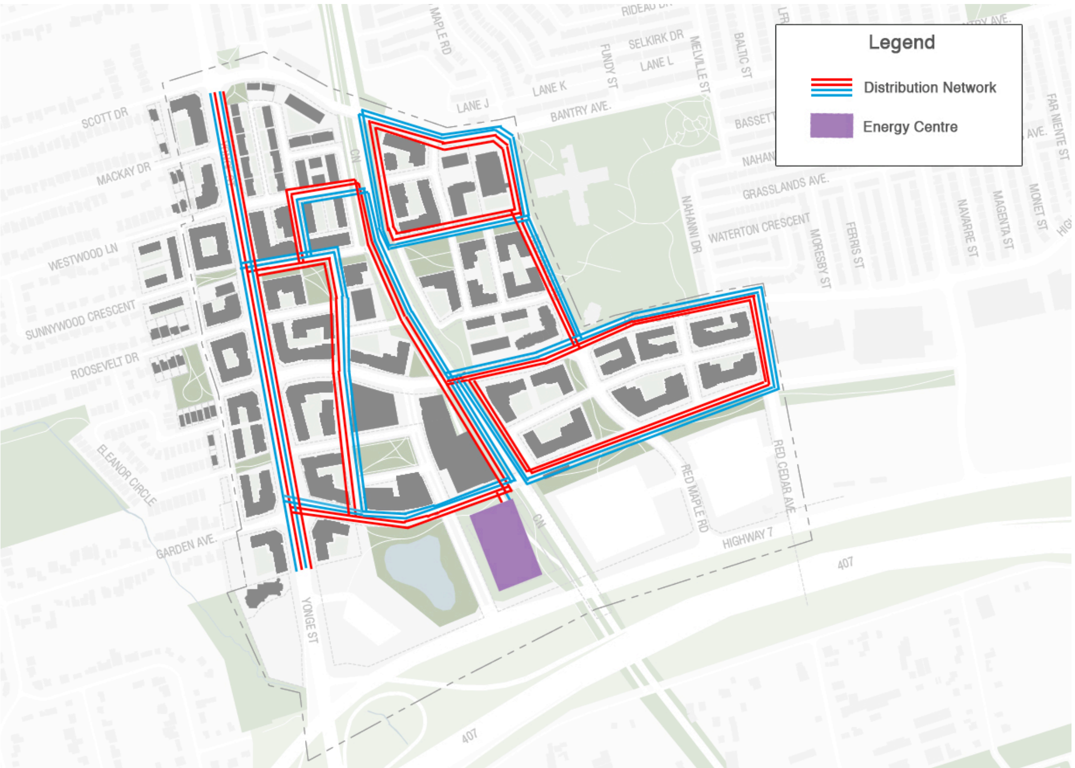


Figure 10: Conceptual Layout of High Temp Distribution Network

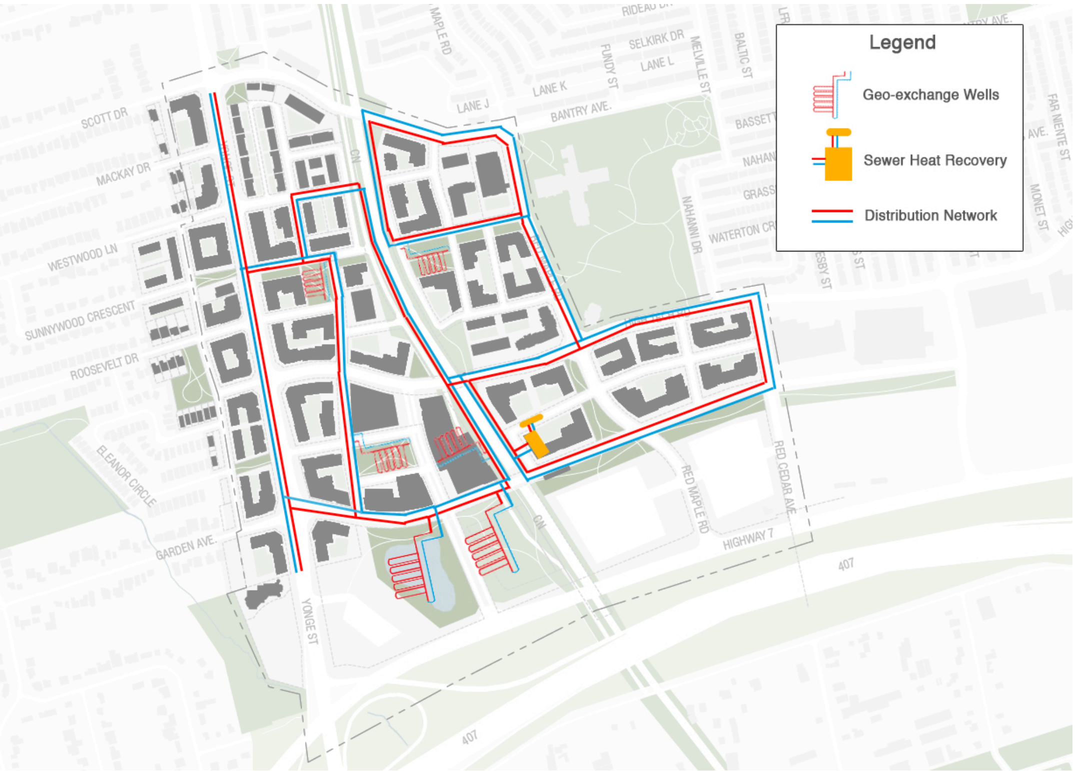


Figure 11: Conceptual Layout of Low Temp System

Phasing

District energy systems represent a substantial investment decision, spread out over a long period of time. Generally, district energy systems are designed with flexibility to grow with the community over time. Various energy sources and additional energy centers can be added to supplement the system as the community grows.

In cold climates such as Richmond Hill – the heating demand is generally the governing energy demand that district systems are sized for. As a phasing plan is created for the Regional Centre, energy demands from the buildings in each phase should be modelled in order to size the district energy system appropriately.

Based on conversations with Markham District Energy, start-up of the district energy system can be the most challenging. Often for the financials to make sense, a large anchor load (ie. first building/customer) is needed to get the system up and running. However, a DES strategy should be in place before building design begins. As land use scenario planning is completed for RHRC, initial phasing should be taken into consideration.

A partnership with the Langstaff Gateway community, explored further in Section 4, could present an opportunity for an extended customer base for a DES depending on the project's timeline. This could help overcome the start-up barriers, as Langstaff could include more initial loads for the DES to service.

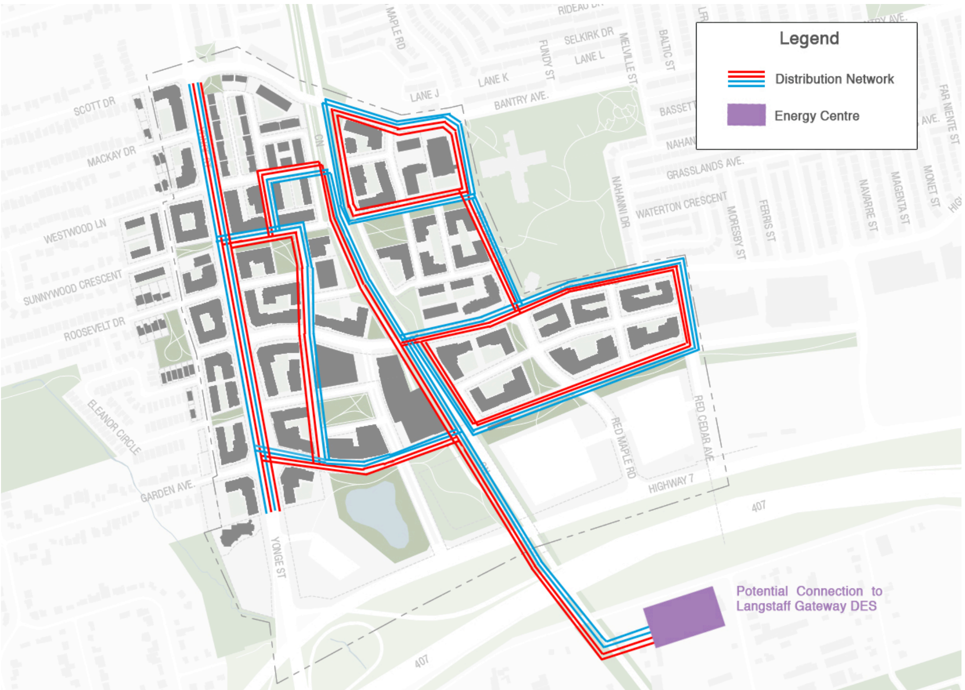


Figure 11: Conceptual Layout of High Temp Distribution Network Connected to Langstaff

Table 6 summarizes the land use planning implications for the RHRC, which Richmond Hill can use when completing the Secondary Plan.

Table 6: RHRC Land Use Planning Implications for DES

Land Use Scenario Planning Implications	
Phasing	
Building Gross Floor Area (GFA)	As mentioned in Richmond Hill's UMESP, a community with new green/brown-field development over 10,000 square meters is a key characteristic for the feasibility of district energy. With even higher building GFAs, the potential for revenue from the system is greater, which increases the possibility of success for the system. Increased floor area for the RHRC should be taken into consideration.
Density	Compact sites are favored for DES, to limit costly distribution piping as well as distribution losses. Density planning of the RHRC should take this into consideration, aiming to achieve high levels of density within the community.
Building Use Types	When DES interconnect multiple buildings, the opportunities for load sharing are maximized and economies of scale are achieved that enable local renewable energy resources. Planning for the RHRC should consider multiple building use types, including residential, commercial, industrial, etc.
Municipal Services/New Streets	As other municipal services are being designed to accommodate the planned growth in RHRC, considerations for district energy infrastructure should be made. Specifically for new underground services and new streets, where DES distribution networks can be installed. This will ensure minimizing overall infrastructure installation costs. **Yonge Street Subway Extension** As previously mentioned, the TTC is planning to build a subway station in RHRC. This project will include underground works that can be coordinated with DES infrastructure to reduce total system costs.
Energy Centre (If required)	Space provisions for an Energy Centre should be incorporated into land use planning. Energy Centres are typically stand-alone buildings, but can be located on the ground floor or below of the first building in the development. Without specifying a location for the Energy Centre, there may be issues with locating the facility once development begins.
Open Space	Depending on the system type chosen, open space in RHRC can provide the opportunity to install geothermal boreholes for thermal energy generation. Locating parks near densely developed communities provides the ideal situation for this type of energy generation.

Precedent – Blatchford District Energy Sharing System, Edmonton, Alberta

Blatchford is a community development project in Edmonton, with a goal of being carbon neutral. To help achieve this goal, Blatchford will be implementing a district energy system. The district energy system at Blatchford will use geo-exchange and sewer heat recovery for energy supply, which will be distributed to buildings through ambient loop piping.

Stage 1 of the system will involve several groupings of geo-exchange wells installed on the site, with two of these groupings located under the stormwater management ponds. This will maximize geo-exchange capacity at the beginning of the projects lifecycle to coordinate with other underground work being completed, which results in excess energy for the first phases of the communities' development. It was considered impractical to drill just enough geo-exchange wells to meet current demand, when the ground has already been dug for other works.

Once energy demand exceeds the capacity of geothermal supply, likely as development grows and different building types are online, the sewer heat recovery system will be installed.

Like RHRC, the Blatchford community will include a range of building use types with different energy load profiles. This allows Blatchford to share energy between buildings, through the ambient loop, resulting in a 15% – 20% total energy use reduction. RHRC also includes a number of open space parks, providing the opportunity for geo-exchange wells below.

Blatchford will be building an Energy Center in their park that is central to the development. The Energy Center will be open to residents to explore and learn about the system.

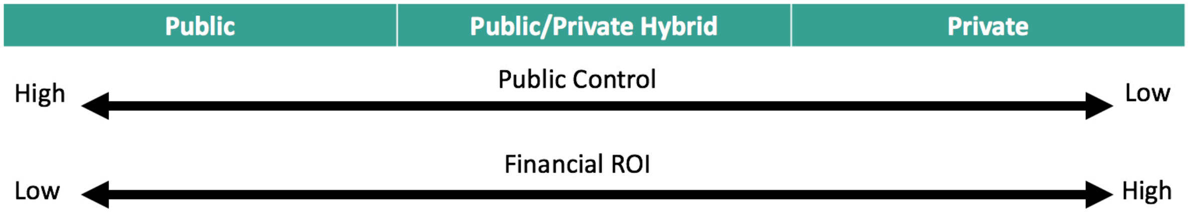
Figure 12: Proposed Energy Center at Blatchford in Edmonton

4 Ownership

4.1 Ownership Model Options

There are several different ownership types for district energy systems, which can range from 100% publicly owned to 100% privately owned, with many hybrid options in between. The type of ownership model chosen by a municipality is often dependent on: the city's resources, capacity, regulatory authority, desired degree of control, risk tolerance, and external market conditions.

In general, the municipality's degree of control and risk tolerance decreases while the financial return on investment increase as the business model moves from 100% public to 100% private. Precedent review has shown that most successful DES have involved some level of municipal involvement, even if only at the policy level.



Ownership models can generally be broken down into three main types:

1. **Wholly Public**

The local authority or public utility has full ownership and control of the district energy system. This allows the municipality to advance their specific goals, such as environmental targets or social housing connections. In this model, profits from the system are returned to the municipality.

Within public ownership models, some municipalities have chosen to set up a wholly-owned subsidiary, which benefit from increased flexibility from city operations.

Precedent – City of Vancouver, South East False Creek Neighborhood Energy Utility (SEFC NEU)

SEFC NEU, owned by the city of Vancouver, manages a district heating network primarily fueled by sewer waste heat recovery. By using sewer waste heat recovery, SEFC NEU showcases the commercial viability of *alternative* energy sources.

The business model eliminated the need for private investment with access to low-cost finance and grant funding. The NEU was 100% financed by debt the City raised, but the rates on the debt were structured as if the project was financed by 60% debt and 40% equity, showing the commercial viability for the private sector.

SEFC NEU began operation in 2010 (in conjunction with the 2010 Winter Olympics), within five years of the first feasibility study. It now serves over 4.3 million square feet, eliminates more than 60% of the GHG emissions associated with heating buildings, and provides an ROI to City taxpayers, while providing transparent competitive rates to customers.

Figure 13: DES in Southeast False Creek, Vancouver[3]

2. **Hybrid Model**

In Hybrid models, the municipality will enter a partnership with a private sector entity. The benefit of these models to municipalities is the risk aversion and the private sector access to capital and expertise.

Private or public Local Distribution Companies (LDCs) may be interested in engaging in partnerships to fund and operate district energy systems as they often serve their interests as well. LDC's are motivated to deliver energy as efficiently as possible, as there is a direct tie to their profit margin.

Specific types of hybrid models include:

- Joint Ventures
- Split Assets
- Concessions
- Strategic Partnerships

Precedent – Concession Contract, Paris Urban Heating Company

The Paris Urban Heating Company is a utility that is 33% owned by the City of Paris. The utility is working under a concession contract, where a private company enters into an agreement with the government to have the exclusive right to operate, maintain and carry out investment in a public utility for a given number of years. This allows Paris to overcome financial and operational obstacles, while maintaining a high degree of control. Paris has the ability to set a maximum price for heat energy to protect end users, as well as special prices for affordable housing developments.

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[3] Image Source: https://vancouver.ca/home-property-development/utility-facts-and-presentations-in-depth.aspx

Precedent – City of Toronto and Enwave Partnership

The City of Toronto entered a partnership with Enwave Energy Corporation in order to implement the city's deep lake water cooling system, one of the largest renewable energy district cooling systems in North America. The partnership emerged when the original publicly-owned Toronto District Heating Corporation had restricted powers in securing long-term financing for the system. Once the system was online and functional, the City of Toronto sold it's share to Enwave, which resulted in a net profit of $100million for city council.

This partnership helped the city overcome the financial and risk barriers associated with district energy. The city also used strategic financing tools, such as granting Enwave an exemption from water extraction fees, to ensure commercial viability. The City also undertook extensive education and awareness raising around the benefits of the system to increase potential customer base and confidence in the system.

3. **100% Private**

In the case where a municipality does not wish to have high control over the system and wants to mitigate its risk, it may choose to have the district energy system owned 100% by the private sector. These projects also generally offer higher rates of return on investment. Many projects with a high degree of private sector control are often still supported in some manner by the public sector.

As the Canadian public appetite for district energy increases, developers and municipalities alike have been increasingly turning to the private ownership model. This is due in large part to the private sector access to capital.

4.2 Opportunities for Partnerships with Markham and Langstaff Gateway

Since 2000, district energy systems have been operational in the City of Markham. The systems are operated under a municipally owned organization called Markham District Energy (MDE), which functions as a separate, for-profit entity.

MDE is a well-established organization, with 19 years of experience in the DES sector. They are currently in the early planning stages of implementing a new DES for the Langstaff Gateway development project. This project is located directly south of the RHRC, separated by the 407 Highway, and is within the municipality of Markham. As previously mentioned, this DES to serve this community is mentioned in the Langstaff Gateway Secondary Plan.

Currently, there are no further specific details on the system or it's physical location. If MDE develops a DES to serve the Langstaff Gateway area, the system would likely mimic their other systems as a traditional four-pipe thermal system providing district cooling and heating, and domestic hot water. Given MDE's previous experience with CHP systems, the system may include combined heat and power plants to provide electrical generation and additional heating capacity. It's unlikely that MDE would favor a distributed ambient loop.

Through conversations with MDE staff, we have discovered the following:

- MDE is interested in having conversations with the City of Richmond Hill to explore opportunities for DES collaboration between Langstaff Gateway and RHRC.
- Depending on the ownership structure of such a partnership, MDE has no restrictions on selling energy to RHRC.
- MDE would require some level of commitment from Richmond Hill in terms of customers to tie into the district energy system, as well as a commitment from the City to grant approvals for distribution piping routes and connections.

There are many benefits to entering a partnership with MDE:

- MDE has years of experience in the district energy sector. Their systems, ownership model, and success is often used as a case study for other municipalities looking into DES.
- A partnership can attract a wide customer base, due to MDE's reputation and reliability.
- Markham has an existing pricing and operation model.
- The proximity of the two sites provides an advantage in terms of the potential for DES customers. Both sites are planned to be high-density, compact sites, which are key for successful DES.

We recommend Richmond Hill connect with Markham District Energy to initiate conversation about potential partnerships. The first step is to engage senior leadership at the city, which could then elevate the discussion to the mayors of the two cities. Once a high level political agreement is reached, the remaining planning will involve the departments directly involved with district energy.

5 Policies and Strategies for Successful DE Implementation

Municipalities are at a unique position to advance district energy systems. The City of Richmond Hill has already deployed some best practices in this area, including:

- the development of the emerging Community Energy and Emissions Plan, and
- the goal of supplying new developments with on-site renewable or alternative energy systems to produce 25% of the building's energy use, outlined in the Official Plan.

Municipalities act as planners, regulators, role models, financial facilitators, and providers of infrastructure, allowing them the opportunity to advance DES[4]. There are a number of tools that municipalities can use to support DES, which can generally be broken down into planning, financial, policy, and public awareness tools, and can be used in combination.

5.1 Planning Tools

The City of Richmond Hill has initiated this study as part of the development of Secondary Plan for RHRC. Incorporating district energy into the initial studies in the secondary planning stage allows these tools to have the highest impact[5]. This also ensures that other municipal services planning can be coordinated with DES to minimize overall infrastructure installation costs.

Many municipalities have implemented a designated municipal department around energy efficiency and sustainability. Review of other municipalities has found that a designated 'champion' at the city, who is responsible for district energy implementation, is a key factor in successful DES[5].

Alternatively, some municipalities have created a partnership with a local district energy utility to identify synergies and opportunities for cost-effective district energy, without entering a specific business partnership to build a facility.

Other planning tools include a Community Energy and Emissions Plan, which the City is currently in the process of creating.

5.2 Financial Tools

Municipalities can use financial tools to encourage success of DES within their jurisdiction. Often, significant upfront costs are a barrier to implementation of a district energy system[5]. To overcome this, municipalities can make use of a number of the following tools:

- Grants or Rebates
- Public Lands and Buildings as Anchor Loads
- Taxation
- Backstopping
- Debt Provision
- Public Funding
- Bond Financing
- Loan Guarantees and Underwriting
- Revolving Funds
- Development Based Land-Value Capture

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[4] Plan4DE Optimizing Urban Form for District Energy, Sustainability Solutions Group

[5] District Energy Good Practice Guide, C40 Cities

Public Lands and Buildings as Anchor Loads
Public lands can play a crucial role in the feasibility of a district energy system. For example, public urban parks can provide the necessary space to install ground source heat pumps underground. Depending on the ownership type, the city can also use publicly owned buildings as anchor energy loads.

Grants or Rebates
The City of Toronto provides a development charge rebate to developers who achieve a Tier 2 or above score in the Toronto Green Standard. This rebate is based on what the property costs the municipality to service, and the avoided costs that a sustainable building provides. For example, buildings with green roofs that absorb storm water and reduce the risk of sewer overflows can reduce costs for the City on sewer infrastructure. In the same way, buildings that connect to a DES can reduce the need for the city to supply additional energy infrastructure.

Public Funding Opportunities
The municipality itself can receive funding for implementing a DES. The Federation of Canadian Municipalities (FCM) provides funding to municipalities to undertake plans, studies, and pilot/capital projects that reduce energy consumption and greenhouse gas emissions. This includes incorporating a district energy system into a community.

Specifically for Richmond Hill, the city can apply for pilot project funding from FCM for the Richmond Hill Regional Centre community, which would provide up to $350,000 in grants for a district energy system that reduces fossil fuel or grid electricity use by at least 40% compared to current. Once a pilot project is completed, presumably for the first phase of development, the city can apply for funding for the full-scale system as a capital project, which would provide a low-interest loan of up to $10 million and a grant worth up to 15% of the loan. Alternatively, the city could skip the pilot project and pursue capital funding from the beginning.

5.3 Policy Tools

Richmond Hill can also use a number of policy tools to encourage developers to connect to DES.

Some municipalities have included policies that require new buildings to be “District Energy Ready” in order to obtain development approvals, in communities where a DES is anticipated. Characteristics of District Energy Ready buildings, as outlined in the City of Toronto ‘Design Guideline for District Energy-Ready Buildings’ include:

- The 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;
- A low temperature hydronic heating system that is compatible with a district energy system in order to reduce the pipe sizes and associated valves, fittings, etc.;
- Appropriate thermal energy metering.

The city of Richmond Hill has developed a Sustainability Assessment Tool for new development applications. The current version does not include specific mention of DES. However, by encouraging energy efficiency, DES are indirectly encouraged as well. A potential update to this tool can include provisions for district energy ready buildings in the RHRC.

In addition to these policy tools, the city can

- grant density or height bonuses to developers who commit to connecting to the DES;

- grant easements for district energy infrastructure across city lands and rights of ways;
- require developer to explore the feasibility of connecting to an existing or future DES by requesting an energy study with development applications.

5.4 Public Awareness

One of the biggest challenges cities face when considering district energy is the limited recognition of the many benefits of these systems by stakeholders and potential customers, including environmental, social, health, and comfort benefits.

Raising awareness and understanding of district energy systems is a proven tool to the success of district energy systems. Municipalities can use tools such as:

- Education campaigns such as workshops, webinars, and dedicated websites;
- Competitions and awards;
- Reports and publications;
- Information centres;
- And demonstration projects.

Markham District Energy was able to achieve a 100% connection rate for buildings in the service areas of their DES through awareness and reputation alone, as connection to their system is not mandatory and they do not provide financial incentives for connection[6].

Precedent – Guthrie Park, Tulsa Oklahoma

The new public parks planned at the RHRC are an excellent opportunity for a demonstration project for the city. Guthrie Park in Tulsa, Oklahoma, is an urban revitalization public park. As part of the park development, 120 geothermal boreholes were dug below ground, which tie into a district energy system that supplies energy for the surrounding buildings. To showcase this achievement, the park includes granite rock formations that release water from the earth in the form of mist, creating a beautiful and interactive educational opportunity.

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[6] The Perfect Storm – Markham District Energy, Sustainable Business Magazine
http://www.markhamdistrictenergy.com/wp-content/uploads/2017/09/The-Perfect-Storm.pdf

Figure 14: Geothermal Mist Rocks in Guthrie Park, Tulsa, Oklahoma[7]

Figure 15: DES Education Signage at Dockside Green, Victoria, BC

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[7] Image from: https://www.swagroup.com/projects/guthrie-green-park/

6 Next Steps

Based on our findings, Richmond Hill is in a good position to successfully implement a DES in the RHRC. As mentioned, district energy requires coordination among several stakeholders. Planning for district energy at the secondary phase gives Richmond Hill an opportunity to successfully align these stakeholders and meet the city's goals around alternative energy.

Next Steps for Richmond Hill

Further to the information documented in this report, Urban Equation recommends the following next steps for the City of Richmond Hill to advance DES planning for RHRC:

1. Ensure senior management at the city reviews this document and understands the benefits of DES.
   a. Internal alignment on the benefits of DES and the opportunity at RHRC will play an important role in future stages.
2. Identify a district energy champion within the city, who will be responsible for implementation.
3. Connect with Markham District Energy to initiate conversations about potential partnerships with the Langstaff Gateway project.
   a. The first step is to connect senior leadership at the city with MDE, which could then elevate the discussion to the mayors of the two cities.
   b. Our initial conversations with MDE staff indicate excitement and interest in exploring this partnership.
4. Discuss the opportunity and potential partnerships with other utility providers.
5. Consider the listed policy, financial, or planning tools for integration into the RHRC Secondary Plan with Urban Strategies.

Next Steps for Urban Strategies Inc.

The next phase of work in the creation of the secondary plan is to complete land use scenario planning for RHRC. Urban Equation recommends using the following DES considerations when completing scenario planning (as described in Section 3).

Land Use Scenario Planning Implications	
Phasing	Start-up of the district energy system can be the most challenging. Often for the financials to make sense, a large anchor load is needed to get the system up and running. Phasing of the RHRC should include consideration for developing large buildings with diverse heating and cooling loads at the beginning of the project life cycle.
Building Gross Floor Area (GFA)	As mentioned in Richmond Hill's UMESP, a community with new green/brown-field development over 10,000 square meters is a key characteristic for the feasibility of district energy. With even higher building GFAs, the potential for revenue from the system is greater, which increases the possibility of success for the system. Increased floor area for the RHRC should be taken into consideration.
Density	Compact sites are favored for DES, to limit costly distribution piping as well as distribution losses. Density planning of the RHRC should take this into consideration, aiming to achieve high levels of density within the community.
Building Use Types	When DES interconnect multiple buildings, the opportunities for load sharing are maximized and economies of scale are achieved that enable local renewable energy resources. Planning for the RHRC should consider multiple building use types, including residential, commercial, industrial, etc.
Municipal Services/New Streets	As other municipal services are being designed to accommodate the planned growth in RHRC, considerations for district energy infrastructure should be made. Specifically for new underground services and new streets, where DES distribution networks can be installed. This will ensure minimizing overall infrastructure installation costs. **Yonge Street Subway Extension** As previously mentioned, the TTC is planning to build a subway station in RHRC. This project will include underground works that can be coordinated with DES infrastructure to reduce total system costs.
Energy Centre	Space provisions for an Energy Centre should be incorporated into land use planning. Energy Centres are typically stand-alone buildings, but can be located on the ground floor or below of the first building in the development. Without specifying a location for the Energy Centre, there may be issues with locating the facility once development begins.
Open Space	Depending on the system type chosen, open space in RHRC can provide the opportunity to install geothermal boreholes for thermal energy generation. Locating parks near densely developed communities provides the ideal situation for this type of energy generation.

Appendix A – Current and Future Policy Plans

Provincial Context

- **The Growth Plan for the Greater Golden Horseshoe (2017)**

The Province has a long-term goal of net-zero communities. One of the guiding principles of the Growth Plan is to "Integrate climate change considerations into planning and managing growth and move towards low-carbon communities, with the long-term goal of net-zero communities, by incorporating approaches to reduce greenhouse gas emissions [1.2.1]".

The Province directs municipalities to develop and implement Official Plan policies in support of district energy. Specifically, in Section 4.2.9.1.b:

- Energy conservation for existing buildings and planned developments, including municipally owned facilities, including through:
    i. identification of opportunities for conservation, energy efficiency and demand management, as well as district energy generation, renewable energy systems and alternative energy systems and distribution through community, municipal and regional energy planning processes, and in the development of conservation and demand management plans;
    ii. land use patterns and urban design standards that support energy efficiency and demand reductions, and opportunities for alternative energy systems, including district energy systems; and
    iii. other conservation, energy efficiency and demand management techniques to use energy wisely as well as reduce consumption.

- **The Provincial Policy Statement (2014)**

The Provincial Policy Statement delineates the promotion of alternative energy systems as a matter of provincial interest. Specifically, Section 1.6.11.2 states "Planning authorities should promote renewable energy systems and alternative energy systems, where feasible, in accordance with provincial and federal requirements."

Regional Context

- **The York Region Official Plan (2010)**

The York Region Official Plan is predicated on sustainability, noting in section 1.2 that sustainability is the lens through which the Region formulates, enhances, and implements policy. The Plan supports and encourages community design that includes sustainable buildings and water and energy management, and zero carbon and waste production.

York Region encourages on-site renewable and alternative energy systems. Specifically, "It is the policy of Council to encourage all new buildings to include on-site renewable or alternative energy systems which produce 25 per cent of building energy use [5.2.28]."

The Region specifically advocates for district energy facilities: "It is the policy of Council to advocate the Province for the elimination of coal generation and the promotion of demand management and *alternative energy systems* and *renewable energy systems* such as solar, wind, water, biomass, geothermal energy, energy-from-waste, local generation and district energy facilities [7.5.13]."

- **York Region Sustainability Strategy (2007)**

York Region's Sustainability Strategy: Towards a Sustainable Region, provides a long-term framework for making sustainable decisions about municipal responsibilities that fully evaluate economic, environmental and community considerations.

One of York Region's key sustainability actions relates to district energy. The strategy encourages municipalities to: "Investigate community energy planning techniques and the use of alternative and renewable sources of energy such as building/subdivision orientation, district energy and community-based ground source heat pump systems, among others."

Municipal Context

- **The Richmond Hill Official Plan (2018)**

One of the Guiding Principles of the Richmond Hill Official Plan (OP) is 'Environment', under which Richmond Hills incorporates and promotes sustainable development practices and initiatives.

Specifically regarding district energy, Section '3.1.9.5 Energy Conservation' of the OP states that the City will "consider the use of alternative and renewable energy generation options and district energy systems". Also in Section 3.1.9.5, the City states that all new secondary plans investigate the feasibility of incorporating a district heating or cooling system for the secondary plan area.

Further, the OP states in 'Section 3.2.3.15 Sustainable Design' that "Development shall be encouraged to include on-site renewable or alternative energy systems which produce 25% of a building's energy use."

- **The emerging Community Energy and Emissions Plan (Under Development)**

The City of Richmond Hill is currently undergoing a process to create a Community Energy and Emissions Plan (CEEP). City Council endorsed the advancement of Richmond Hill's climate change mandate through the development of a CEEP in 2018, which will inform the understanding of the community's energy and emissions patterns and develop a strategy for reducing GHG emissions in alignment with other community goals. The efforts to create this plan are beginning in concert with the creation of this white paper, but will not be complete until later in 2019 or 2020.

- **Richmond Hill Sustainability Metrics Guidebook and Implementation Tool**

The Sustainability Performance Metrics were created by Richmond Hill, together with the City of Brampton and the City of Vaughan. The purpose of the scoring system is to encourage developers and builders to work with Richmond Hill staff to support the community's environmental goals through thoughtful and innovative development and to achieve healthy, complete and sustainable communities.

The Sustainability Assessment Tool helps quantify, rank and inform the Sustainability Score of proposed Draft Plan and Site Plan applications. Although not a mandatory requirement, the guidebook includes an aspirational target of: "In an intensification area, where district energy has been deemed viable by the municipality, carry out a district energy feasibility study."

- **Urban Master Environmental Servicing Plan (2014)**

The Urban Master Environmental Servicing Plan (UMESP) identifies infrastructure work needed to support urban growth in the city of Richmond Hill, including the exploration of district energy systems in the Richmond Hill Regional Centre.

Specifically, the plan explores the feasibility of implementing a Combined Heat and Power district energy system in RHRC, and outlines typical benefits and challenges to the city. The plan concludes that economic viability of a system in this area could be feasible and recommends that the city pursue further exploration of a district energy system in RHRC.

This white paper builds on the initial studies that were completed for the RHRC, with applicability to the emerging Richmond Hill Regional Centre Secondary Plan.

Other Related Policies and Plans

- **The Langstaff Gateway Secondary Plan (2010)**

The Richmond Hill Regional Centre is part of the Richmond Hill/Langstaff Gateway Urban Growth Centre (UGC) shared with the City of Markham. The Langstaff Gateway Secondary Plan is located south of the 407/ETR highway. The goal of the Langstaff Gateway Secondary Plan is to “provide for a complete, compact, vibrant, integrated, sustainable and well-designed community”.

Specifically regarding district energy systems, ‘Section 9.4 District Heating and Cooling’ of the Langstaff Gateway Secondary Plan states: “District heating and cooling facilities, to serve all development within the Secondary Plan area, shall be a component of development.” Therefore, the Langstaff Gateway development will include a district thermal energy system. Opportunities for potential partnerships are explored further in this report.