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# District Energy Within The Planning Context: Exploring The Barriers And Opportunities For District Energy And Community Energy Solutions In Ontario, Canada

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# DISTRICT ENERGY WITHIN THE PLANNING CONTEXT:

# EXPLORING THE BARRIERS AND OPPORTUNITIES FOR DISTRICT ENERGY AND COMMUNITY ENERGY SOLUTIONS IN ONTARIO, CANADA

by

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## ABSTRACT

Urban land-use planning guides the way cities look and grow. Good planning leads to orderly growth and helps shape goals and policies for development while addressing important social, economic and environmental concerns. The efficiency benefits that may be garnered by linking land use planning and energy planning remain largely untapped throughout Ontario. In the case of district energy (DE), the absence of a regulatory and policy framework at the national and provincial levels results in much uncertainty regarding the associated costs and benefits of DE relative to traditional energy delivery systems.

The purpose of this work is to explore Ontario's planning framework with respect to meeting energy needs at the community level – including electrical and thermal (heating and cooling) energy needs, providing broad recommendations to all three levels of government that could help facilitate the development of district energy systems and offer more consideration to integrated community energy solutions.

Key words:

An article on the potential for district energy expansion in Ontario, Canada, used the key words: district energy; integrated community energy solutions; thermal energy; urban design; energy efficiency; resiliency; policy leadership.

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## Executive Summary

Efficiency benefits that may be garnered by linking land use planning and energy planning remain largely unexplored throughout Ontario. As many of our European counterparts innovate and embrace reliable community-scale energy solutions, Ontario continues its focus on large-scale energy delivery strategies that are incompatible in meeting the changing and diverse needs of communities. For decades, cheap energy sources including hydroelectric and natural gas have offset the costs of large-scale coal plants and nuclear projects throughout the province. It is now difficult to imagine a future where we do not have large conventional electricity generation facilities to power the economies of first world and industrialized nations. As population continues to rise, and electricity use increases, we will continue to need the base, intermittent and peaking capacity offered by large scale generation facilities. However, in Ontario, we have not achieved an optimum portfolio of large, medium and small energy facilities to best respond to the needs of communities. Instead, the province is over-dependent on large centralized electricity plants. This exposes communities to risk of supply interruptions, price shock, and results in communities being less nimble to adapt to technology and supply changes over time. With much of the energy infrastructure in Ontario reaching its end-of-life, along with rising fossil fuel prices and the associated high costs and dangers of nuclear, the Province would be well served to consider district energy and embedded community energy solutions, where appropriate.

The province is very diverse with both urban and rural areas; therefore, consideration should be given to strategic energy solutions that adequately reflect the needs of Ontario's communities rather than continuing to invest in 'one-size-fits-all' energy systems.

The purpose of this work is to explore Ontario's planning framework with respect to energy generation and thermal energy distribution, providing broad recommendations to all three levels of government that could help facilitate the development of district energy systems and offer more consideration to integrated community energy options.

This research highlights the planning opportunities and challenges uniquely associated with district energy systems and other community energy solutions, with a focus on energy efficiency, resiliency, as well as economic and environmental benefits. The objectives of this research include:

1. To provide a rationale for addressing energy solutions at the community planning level, and to engage municipal planning departments at the outset of the energy planning process in order to maximize community benefits and opportunities for energy efficiency.
2. To contribute to the literature available on district energy system development with a focus on available policy tools that would allow for local energy generation and delivery within Ontario.
3. To examine how district energy and other community scale solutions have been implemented in other jurisdictions - specifically focusing on best practice approaches in Sweden and in British Columbia.
4. To highlight opportunities for district energy expansion in Ontario by showcasing potential for its growth within the City of Toronto.
5. To craft policy recommendations that will help the province, as well as municipalities, to facilitate the development of district energy systems, where appropriate; and, to consider other embedded community energy solutions.

The methodology applied for this research includes a literature review on the evolution of Ontario's energy approach until current day. A scan is completed on the benefits and challenges of district energy systems and, of various planning tools within both the provincial and municipal contexts that may assist in growing the industry. Furthermore, case study research is collected mainly from secondary sources in literature, and professional interviews were conducted with key informants to further assess the opportunity and planning tools that could facilitate district energy expansion.

The potential impact of district energy is highlighted through case study examination of system expansion and benefits in Sweden and British Columbia. The Canadian district energy industry is still

in the process of slow growth and has not achieved the same scale of success as many of our European counterparts. Therefore, to highlight the opportunity of district energy implementation –as well as the integration of other community energy solutions- this research documents the successes achieved in Sweden. Sweden was chosen for this research because of its highly advanced 'Symbio City' applications that address a range of planning and energy needs in tandem to achieve greater community benefits. The notion of Symbio City is unlike any planning strategy applied in Canada. Symbio City represents a practice in holistic planning for sustainable development that includes energy efficiency, resiliency, sustainability, economic competitiveness and increased quality of life for residents.

The decision to profile B.C.'s approach to district energy development was informed by results from the 2011 survey conducted by the Canadian District Energy Association (CDEA) in which respondents frequently referenced successful policy initiatives in that province as critical drivers for district energy development in Canada (Candian District Energy Association, 2011, p. 30). Interestingly, policy leaders in B.C. cited that they received inspiration to address district energy after a study visit to Sweden (Compass Resource Management, 2009). Lessons from both the Swedish and British Columbian experiences of district energy expansion are applied in considering how more municipalities across Ontario can improve their energy standing and plan communities that are more integrated and energy efficient.

Findings from this work underline that Canadian decision makers from all levels of government are faced with challenges regarding urban intensification, growing energy demands and aging or outdated energy infrastructure and building stock (Candian District Energy Association, 2011, p. 5). Innovative approaches to addressing energy needs are crucial; therefore, decision makers must also consider embedded or cross-sector opportunities for planning resilient, healthier and more energy efficient communities in order to position Ontario as a better place to live and invest.

## Chapter 1: Research Background

### Why is energy an urban planning issue?

Urban land-use planning guides the way cities look and grow. Good planning leads to orderly growth and helps shape goals and policies for development while addressing important social, economic and environmental concerns. Land use planning is also considered a tool to curb sprawl as well as manage land and resources by directing where residential, commercial, institutional, industrial, recreational and other infrastructure and essential services are located (Ministry of Municipal Affairs and Housing, 2010). In the case of district energy (DE), the absence of a regulatory and policy framework at the national and provincial levels causes much uncertainty regarding the associated costs and benefits of DE relative to traditional energy delivery systems.

Conventional energy planning sees energy options tackled secondary to building or community design. This approach misses the opportunity to not only to gain energy efficiencies, but it also fails to acknowledge the many tertiary benefits of including DE as a planning tool that can help influence how communities grow. This 'reactive' approach promotes business-as-usual practices that result is conventional energy systems that lock communities into a long-term, less adaptable energy scenario.

The district energy approach to energy planning is more responsive to community needs and can be juxtaposed to current energy system planning practices. Ontario's current energy system has significantly impacted our landscapes with characteristic one-way distribution, and large-scale energy infrastructure. Most common in Ontario is an energy system wherein large central plants are located up to hundreds of kilometres away from the communities they serve. To support this system additional infrastructure such as hydro towers and transformer stations are required. This is not only an expensive approach, but it is also one that is geared towards a 'one-size-fits-all' model that is often out-of-synch with the needs of communities. Instead, these centralized large systems are built to address energy anomalies and spikes. Apart from the missed opportunity of local scale planning,

other pitfalls of such large infrastructure include vulnerability to high costs, uni-fuel dependency, large-scale system failure and energy loss during transmission.

There is an opportunity for Ontario's municipalities to evaluate their energy needs through a community energy plan that incorporates land use planning strategies that can optimize energy efficiencies. Effective land use planning that promotes compact, mixed-use communities can serve as a catalyst for district energy opportunities and vice-versa (King & Shaw, Community Energy: Planning, Development and Delivery, 2010, p. 2).

Land-use planning decisions affect residents in ways that we are only just beginning to appreciate: health, social opportunities, air quality, and energy use are important elements of our lives and they are influenced by the design of our communities. The importance of urban design and the incorporation of green energy infrastructure are important strategies for economic and environmental considerations, which have important impacts on the overall attractiveness of a place both for people and businesses.

In Ontario, the importance of urban planning is largely framed in human health and sustainability terms. The old adage that "an ounce of prevention is worth a pound of cure" is reflected in Ontario's strategy for minimizing health care costs by implementing tactics that reduce chronic diseases and the prevalence of obesity (Ministry of Municipal Affairs and Housing, 2009). Interestingly, the urban design elements that promote human health –such as walkable neighbourhoods, concentrated land uses, green infrastructure and the design of buildings in relation to the street- are mainstays of district energy compatible communities. Ontario's current priorities reveal the potential for achieving compounding benefits of improving human health, achieving emissions reductions (which further influences human health), and improving the way that we heat and cool our buildings.

Planning consideration of integrated community energy solutions and district energy systems can achieve compounding community benefits that transcend the obvious benefits of energy efficiency and resiliency and work to make communities healthier and more sustainable. However, to

date Ontario's energy policy has focused on the environmental benefits from greening the electricity grid and has not contemplated the potential of the thermal energy network (Elenchus Research Associates Inc., 2010).

### What are Integrated Community Energy Solutions?

The move towards planning healthier and more sustainable communities can be further promoted when recognizing district energy as part of the strategic investment in municipal infrastructure to deliver on sustainability goals by facilitating and enabling more environmentally benign sources and compact design. DE provides the opportunity to install infrastructure that is catered to meet community energy goals, allow for fuel substitution over time and enable other components of integrated community energy solutions (ICES) to be implemented (Candian District Energy Association, 2011) Natural Resources Canada defines ICES as:

> *…solutions [that] capitalize on the cross-cutting opportunities and synergies available at the community level by integrating physical components from multiple sectors, including energy supply and distribution; transportation; housing and buildings; industry; water, waste management and other local community services; and land use and community form… ICES can be scaled to meet the needs of all types of communities, ranging from rural and small remote towns to medium-sized municipalities and large cities… In every case, the potential results are the same: improved energy performance, a sharply reduced carbon footprint, job creation, improved air quality, improved quality of life and many other benefits* (Council of Energy Ministers, 2009, p. 1).

DE systems are often regarded as the backbone of ICES because they allow for the integration of renewable technologies such as biomass, geothermal storage, combined heat and power (CHP) and, they can be designed to seasonally store thermal energy (Chow, 2009; Lund & Moller, 2010; Beurskens, Langniss, Seyboth, & Sims, 2008; International Energy Agency, 2008).

### What is District Energy?

District energy (DE) systems -also referred to as distributed energy or community energy systems- generate and distribute thermal energy (heating and/or cooling) at a community or neighbourhood scale. It addresses the thermal component of the energy equation; the other component is electricity. DE infrastructure includes a localized centre where energy is generated, and a network of buried insulated pipes that comprise a thermal grid distributing energy to buildings within a defined geographic area (Canadian District Energy Association, 2008). The medium for transmitting the thermal energy along the thermal grid is either steam (for legacy systems), or water (for modern systems) (International District Energy Association, 2009). District energy may not be an optimal delivery system for every community. The success of these systems depends on the urban form, which is informed by land use planning, and the many associated policies, directives and bylaws. DE is typically most suited for communities that feature compact design with a mixture of medium and high- density residential, industrial, commercial, office or institutional land uses (Garforth International LLC , 2009, p. 20).

District energy is often referred to as the "third" energy grid, alongside the grid of pipelines that distribute natural gas, and the grid of wires that transmit electricity (Canadian District Energy Association, 2008). One of the primary benefits of DE systems is that they can be more efficient and more adaptable than conventional energy systems. Research by MK Jaccard (2010) suggests that through market transformation that includes integrated energy generation and distribution at the community level, Canada can achieve a significant reduction of approximately 35 MT of GHG per year (MK Jaccard and Associates Inc., 2010, p. 55). This represents a significant contribution to Canada's targeted annual reductions, and can be achieved in part because DE systems enable the use of heat recovery strategies such as combined heat and power (CHP). CHP systems capture waste heat from electricity generation and feed it into the thermal grid (International Energy Association, 2011), thus maximizing scales of efficiency.

District energy and DE with CHP are not new forms of technology or energy delivery system. However a 2011 Canadian District Energy Association (CDEA) study highlights that district energy

has not achieved strong market penetration within Canada, comprising only 1 - 3% of overall market share (Candian District Energy Association, 2011, p. 5). These distributed energy systems are placed at or near the point of energy consumption and are typically connected by microgrids. DE systems can operate autonomously or be integrated into the power grid. More importantly, district energy systems provide the necessary infrastructure that support community energy goals and enable other components of integrated community energy systems (ICES) to be implemented including renewable energy like solar or wind. These systems vary from renewable small- scale generation facilities, CHP to thermal storage (King & Shaw, Community Energy: Planning, Development and Delivery, 2010, p. 5).

The popularity of DE systems, especially in Europe, signals their strong potential as an alternative to the current energy paradigm. CHP systems are particularly of interest as they achieve very high efficiencies by using 'waste' heat to deliver electricity; as a result, these systems are well positioned to become strong pillars of a new distributed power grid in Ontario. Interest in and application of, DE systems is gaining momentum in some parts of Canada for various reasons including: community benefits, efficiency standards, resiliency of infrastructure and adaptability of fuel sources. These features of DE can help with national, provincial and local goals of greenhouse gas reductions and help to facilitate the revived interest in designing more compact communities.

### *District Energy: Community Benefits and Challenges*

By moving the generation of electricity via combustion closer to populated areas, the heat that is normally wasted can be distributed to buildings through district heating networks. This means gas would no longer be needed in individual buildings for heating and, as the electricity is generated closer to where it is used, less energy is lost during transmission (Church, 2007, p. 78). If well managed, it can also help to ensure energy is affordable to consumers. This does not mean building large power stations in the middle of towns and cities, rather putting smaller generators, using different fuel types, within urban areas. Doing this creates diversity and helps ensure supply security.

However, one of the challenges of implementing DE systems in Ontario's communities may be opposition to the small scale distribution plants in dense areas. People may oppose an energy plant (regardless of scale) in their community (White, 2011). This reveals a need for strategic planning and siting of facilities as well as the need for education, transparency of decision making and community involvement in the process of energy planning.

Furthermore, the traditional approach to energy planning largely focuses on electricity demand, or natural gas demand—as opposed to the need to heat or cool homes, businesses, public and recreational facilities and other places that comprise the building stock. Too often, energy is considered relatively late in the development process, and is almost uniformly handled by connection agreements with either or both of the local distribution companies, Hydro One and one of the private natural gas entities for heating.

According to research from the Council of Energy Ministers (2009), nearly 60% of the nation's energy is consumed at the community scale, pointing to the opportunity for energy efficiency improvements on the community and neighbourhood level (Council of Energy Ministers, 2009, p. 1). In Ontario alone, upwards of 60 - 70% of total energy used in residential and commercial sectors is related to stationary uses of energy needed to heat or cool buildings (Candian District Energy Association, 2011, p. 36). Bearing in mind the heavy thermal needs of Ontario's communities, it is surprising that the province does not have a strategy to address the cooling and heating requirements of community building stock. This policy gap points to a general lack of awareness of the importance of the thermal component of our energy needs and a lack of awareness of the resiliency, efficiency and security associated with distributed energy systems.

Considering the many benefits of integrating land use planning and energy planning, there is a huge opportunity for Ontario's municipalities to significantly improve their energy performance while planning for more integrated and self-sufficient communities. To capitalize on the advantages associated with district energy systems and overcome implementation barriers, energy planning

must become fully integrated into the municipal planning process, giving thorough consideration to future energy demand and delivery, early on in the allocation of land and resources.

The adoption of a DE system in a community can be limited by several factors which center around a lack of knowledge of enabling policies, and regulatory constraints; a concern that a DE system will overcomplicate the planning and development process; and, hesitation in coordinating the project among various agencies and interest groups involved in a DE system planning, implementation, and operation (CDEA 2011, p. 53; NRCan, 2007, p. 3). Research shows that low general awareness and a poorly integrated understanding of DE issues across the Canadian industry resulted in relatively few champions and innovators to expand the industry. As was noted in the 2011 CDEA study, "DE is at the beginning of a typical innovation adoption curve" and as such, access to information is a necessary precursor for creating leadership (Candian District Energy Association, 2011, p. 34).

### *District Energy: Achieving Efficient Energy Use and Minimizing GHG Emissions*

Governments of all must help citizens and communities to adapt to climate change and act responsibly to curb the negative impacts associated with depleting natural resources and the GHG emissions all while ensuring reliable energy delivery. One of the most tangible opportunities we have as Canadians to effectively reduce our greenhouse gas emissions and improve the health of our neighbourhoods is in how we plan, build and develop our communities. Community design and building envelope considerations in many ways define the practical technology and fuel choices available for providing energy services (Cleland & Laszlo, 2012, p. 13). Investing in modern district energy systems as well as in other efficient or renewable energy solutions can help manage pollution and help improve local air quality. This is because district energy systems are far more efficient in their operations. Also, DE systems allow for high-grade energy to be used more effectively therefore reducing primary energy consumption and associated GHG emissions. The traditional approach to

energy delivery systems typically ignores the potential for land use planning in achieving greater energy efficiency returns.

Traditional energy delivery systems operate at much lower efficiencies than modern district energy systems with advanced environmental monitoring equipment. The efficiency of a fossil-fuelled power plant is typically between 30 - 45% (Gilmour & Warren, 2008, p. 20). This means that nearly two-thirds of the energy produced during combustion at large centralized power stations is rejected into the atmosphere as 'waste' heat during production, or is lost in transmission and end of use. When considering efficiencies of 30 – 45%, that means that given the significant proportion of end-use energy consumption associated with space heating and cooling (65% residential and 53% commercial or institutional), the savings associated with higher-efficiency district energy systems can be significant when compared to conventional heating and cooling technologies (Natural Resources Canada, 2007).

Efficiencies are gained by having electricity generated closer to densely populated areas where 'waste heat' from the system can be captured to heat buildings through heat networks (King & Shaw, Community Energy: Planning, Development and Delivery, 2010, p. 2). District energy systems with CHP capacity can capture energy to achieve system efficiencies of 80% or more by the production of thermal and electrical energy. Because of the improved efficiencies of district energy systems, less fuel is required than in a conventional system to produce the equivalent amount of energy (Gilmour & Warren, 2008). The reduced fuel consumption can also result in reduced air emissions.

When considering energy efficiencies, the concept of 'exergy' is also an important element to address. Exergy refers to 'the available energy to do work' and to optimize exergy, it is necessary to avoid using high-quality energy in low-quality applications (Cleland & Laszlo, 2012, pp. 13, 15). For example, the heat required to warm a room or a building in winter is of lower quality than the electricity needed to run a stove for example. Electricity is the highest quality form of energy, therefore the fundamental elements of optimizing exergy deal with using the right tool for a given job.

In order to gain maximum efficiency, our energy system should be designed to address the demand for specific energy uses while considering community needs (Cleland & Laszlo, 2012, p. 15).

Optimizing efficiency would mean allocating electricity, the highest form of energy, to uses other than keeping a room at 22 degrees Celsius; this would require a shift from electric baseboard heaters and electric furnaces and boilers to avoid wasting energy. District energy systems enable beneficial use of surplus thermal energy from dispersed sources therefore tapping into lower grade energy to condition a room or a building. To allow for the viable application of DE systems within Ontario's communities, we need to focus on how we build and develop our communities. Lastly the way we organize our communities is also important not only for fostering conditions wherein we can assign the right 'energy to do work' but more importantly, so we can have arrangements where we do not require as much energy. This notion is echoed by the Canadian Council of Chief Executive who call on Canadians to embrace the maxim that "…the cheapest form of energy is the unit that is not used" (Canadian Council of Chief Executives, 2011, p. 2).

### *District Energy: Resilient Infrastructure*

As highlighted earlier in this work, traditional energy delivery systems are characterized by large central plants which are far removed from the communities they service. These plants require the support of thousands of generators linked by tens of thousands of kilometres of transmission lines, crossing international, provincial and regional borders (Ministry of Energy, Ontario, 2011, p. 12). Interestingly, the current energy delivery model follows a similar sprawling pattern characteristic of much of Ontario's suburban cities and towns. This sprawling pattern of energy delivery systems is vulnerable to interruption and energy loss. It is important to consider how the make-up of these large systems limits their resiliency to severe weather events or to energy demand spikes.

The vulnerability of traditional energy delivery systems has been highlighted during significant weather events. Consider for example, the Ice Storm of 1998 that hit Ontario, Québec and portions of the northeastern United States from January 4 - 10, 1998. Unusually long in duration

and large in geographical coverage, this storm is widely acknowledged to be one of Canada's costliest natural disaster leaving over 4.7 million Canadians without power (Risk Management Solutions Inc., 2008). Again in August of 2003, central Ontario and seven US states experienced a power blackout that according to the US-Canada Power System Outage Task Force "could have been prevented… [had action been] taken in both the United States and Canada to ensure that our electric system is more reliable" (US-Canada Power System Outage Task Force, 2004). Interestingly enough, while most of southern Ontario was without power, the communities of Markham that are connected to the district energy system were largely unaffected. This is the resiliency that district energy introduced to residents of Markham and to many Americans during severe weather events.

Hurricane Katrina in 2005 and Hurricane Sandy in 2012 devastated parts of the United States and had catastrophic impacts on the distribution of electricity and thermal energy in the US and Canada. Reports show that businesses, hospitals and universities who had subscribed to decentralized CHP plants were often unaffected by power loss or had their power restored much faster than those serviced by large centralized plants (Distributed Energy, 2012). This is largely because CHP plants avoid the need for high-voltage transmission lines (many of which were knocked down during the storms) and, at a community scale, the application of district heating, cooling and renewable energy generation is more scalable, cost-effective and resilient than their use in individual building applications (Distributed Energy, 2012). In the long run, sustainable systems must be resilient to changing climatic conditions and adaptable to evolving technologies.

### *District Energy: Adaptable and Future Ready*

Understanding the connection between land use, proximity, and energy consumption is critical to developing a framework in which district energy systems are viable options. Furthermore, renewable energy technologies can be incorporated into district energy systems to reduce GHG emissions or to respond to the availability of new fuels or technologies. Large-scale integration of

renewable energy sources can reduce a community's environmental impact by 30–40% (Church, 2007, p. 5) and position the municipality as a good place to live and do business.

DE systems can use a variety of input fuels that can be substituted over time, including biomass, natural gas, renewable natural gas, other forms of renewable energy including solar and geothermal, and cool water from adjacent water sources (Canadian District Energy Association, 2008) (Quality Urban Energy Systems of Tomorrow, 2012). This fuel flexibility offers communities the opportunity to introduce more renewable fuel types, such as wood biomass or urban-based forest biomass, and to achieve commensurate GHG emission reductions while stimulating local economic development related to the fuel supply (Canadian District Energy Association, 2008). Fuel flexibility also provides communities with greater price protection and security of supply over time than reliance on any one fuel source or technology. In essence, the ability of a system to adapt in the face of technological change reveals an element of 'future proofing' that is attractive for many Ontario municipalities.

Planning a systems fuel source is an important element. However it can be complicated, if not impossible to predict future fuel opportunities and challenges. Fossil fuels are subject to variable market prices whereas less conventional fuel sources such as biomass and industrial waste heat or by-products may not be available over the lifespan of a system's operation, and must therefore be carefully considered. Conversely, access to a renewable fuel may not be feasible when dealing with individual building stock; however, application of the fuel at a district level facilitates opportunities for switching (CDEA 2008; QUEST 2012).

Enabling infrastructure to support distributed renewable generation, can be incorporated within a DE network to further support community scale thermal storage, use waste heat, and add CHP units, thus improving overall energy efficiency and significantly reducing GHG emissions (Candian District Energy Association, 2011, p. 60). Communities can also realize economic benefits from district energy system implementation. System resiliency and adaptability is important for municipalities as well as businesses looking to have reliable energy connections in order to

safeguard their operations. Not only can DE systems offer fuel flexibility and reduced risk from exposure to uni-fuel price shocks, DE planning can also spur local investment, jobs, and utilize local fuel resources. Planning DE systems reflects a long-sighted approach to addressing community needs and allows for system flexibility to respond to new opportunities.

It is important to note that local and regional trends throughout Ontario (as well as in the rest of Canada) are emerging that present added challenges and potential opportunities for more efficient energy infrastructure. While the specifics vary by jurisdiction, many cities and regions are facing infrastructure deficits due to the aging of capital equipment. This means that our government leaders will soon be faced with a choice between further refurbishment or replacement of major energy infrastructure.

### *District Energy: Costs and Opportunities*

#### Costs

There are specific opportunities and challenges uniquely associated with district energy systems. DE systems are built to respond to community needs, they are highly efficient, resilient and adaptable. Furthermore, these systems are capable of producing heat, cooling, and with the application of CHP, they can even generate small-scale electric power. All the technological requirements to implement DE systems are available throughout Canada; however the regulatory framework to support the development and expansion of these community systems is not established. There are no national or provincial directives that set a price on carbon emissions that would propel Ontario's industry to innovate in order to achieve higher efficiencies and reduce the emission of GHGs. This is compounded by the lack of competitive fuel costs and an established large conventional energy delivery system that is supported by a regulatory framework which mitigates the risks of expansion, and which has accomplished economies of scale that allow new additions to be supported by existing networks. Due to the reasons cited above, the economic case for district

energy in Ontario is not as apparent to municipalities or developers as it is in Sweden or even in British Columbia.

The case for district energy is made by the potential to offset the initial capital investments with long-term lower energy costs. The return of a DE system is calculated by the difference between the revenues and the costs. The revenues increase with the number of candidate customers that connect to the system and the rates charged. The costs decrease with improved efficiency of the central DE plant compared to individual boilers in each building, both in terms of maintenance and operating efficiency. The site of energy generation system is an important consideration in community planning and economic viability. DE plants must be located within a few kilometers of the customer base, to curtail high capital cost associated with buried distribution pipe networks, and to minimize energy losses during transmission (Bloomquist, Kuby, & Sommer, 2003). Further cost savings can be realized by systems that use excess thermal energy or those that generate heat from waste materials as opposed to purchasing fuel.

The capital investment required depends on the thermal and/or electrical capacity of the plant and the utilization of that capacity versus the cost of installing the equipment and the piping network. The cost of system installation depends on the extent of the network, the geological or soil conditions of the area, potential construction challenges, and whether the network is being installed in greenfield land or in areas that are already built up. The costs of installing piping under existing buildings or other infrastructure is more financially burdensome; however, when done in conjunction with a brownfield redevelopment project or with other municipal services that are being installed or replaced (such as water mains), these costs can be significantly reduced.

Many Canadian DE systems generate returns of 8 – 12%, and have payback periods that typically range between five to 20 years (Gilmour & Warren, 2008, p. 23). Different suppliers of capital have different minimum thresholds for returns on their investments. Private equity investors expect returns in excess of 20%; public entities about 12%; and, fund investors about 8% (Bookbinder, 2012).

In the case of DE, building owners enjoy lower capital costs because they need not install heating and cooling systems and, typically they will experience lower operating costs. Furthermore, with the need for boilers and furnaces eliminated, building owners will enjoy more space that can be sold (in the case of condominiums), rented or enhanced for other purposes. Once the system is in operation, the monthly bill to customers includes a fixed charge based on the customer's pro-rated share of energy use that provides economic rent towards cost recovery of system infrastructure costs, and a variable rate that reflects energy consumption.

### Opportunities

It is important to note that municipalities looking to develop district energy systems have several options that would enhance their economic viability and attractiveness for district energy system development. An investment in district energy yields many benefits. These systems can serve as local economic investment and employment catalysts, as discussed above, and allow for municipalities to achieve reductions in electricity demand. Ontario is a summer peaking jurisdiction for electricity which means that the highest demand for electricity occurs in the summer for air conditioning. Because DE systems, with distributed CHP units and thermal storage units create thermal energy to cool buildings in a community more efficiently than conventional heating, ventilation and air conditioning (HVAC) systems, the load on the provincial grid for electricity is reduced, thus reducing the need for additions in generation on the provincial grid. This reduces overall capital investment and costs. Economic viability of DE systems needs to be considered beyond simply capital costs and energy savings; DE investment should also consider benefits of investing in infrastructure that is future-ready, resilient, adaptable and by nature of its design, achieves high rates of efficiency.

Below are a few funding opportunities that can further enhance the economic feasibility of DE system planning:

*NRCan ecoENERGY Innovation Initiative*

As part of the Government of Canada's strategy to achieve emissions reductions, Natural Resources Canada (NRCan) received funding in the 2011 Budget to support energy technology innovation aimed at producing energy in a cleaner and more efficient way (Natural Resources Canada, 2012). The Initiative consisted of two funding streams. One for research and development ("R&D") projects, and the other for demonstration projects; applications for these streams could have integrated community energy systems as DE expansion meets the energy efficiency requirements of the Initiative and depending on the fuel source of the system, DE projects could have also been considered under the 'unconventional oil and gas' priority or 'bioenergy' (Natural Resources Canada, 2012). Even though this funding opportunity is not projected to be renewed, it is important to highlight that municipalities can take advantage of various federal grants and initiative designed to meet goals of sustainability and efficiency.

*FCM Green Municipal Fund*

At the federal level, the Federation of Canadian Municipalities' Green Municipal Fund has an endowment from the federal government of $550 million to support successful municipal governments in environmental projects (Federation of Canadian Municipalities, 2013). Funds are available for a number of initiatives including capital projects; however a long-standing criticism of this program is that the application process is very burdensome and many municipalities or their partners may not have the resources to prepare an application.

*Federal Gas Tax*

The Federal Gas Tax Fund provides municipalities with long-term, stable and predictable funding for environmentally sustainable infrastructure that helps achieve cleaner water, cleaner air, or reduce greenhouse gas emissions. In Ontario, the Federal Gas Tax Fund commits more than $4.8 billion to Ontario's communities for sustainable infrastructure

between 2005 and 2014 (Lambie, 2009). The funding committed is contingent on a municipality having a sustainability plan and funding allowance is also tied to population. The municipality of Markham successfully secured gas tax funding for district energy system expansion which includes thermal storage and cogeneration. This shows that municipalities looking to incorporate DE as part of their sustainability initiatives may be eligible for funding through the Federal Gas Tax.

*OPA Conservation Fund and the Combined Heat and Power Standard Offer Program*

Municipalities can consider applying for grants from the Ontario Power Authority (OPA) Conservation Fund. This fund aims to achieve energy conservation improvements and to promote "innovation and creativity in Ontario through financial support for new conservation and demand management programs, practices and technologies" (Ontario Power Authority, 2013). Municipalities can also apply to the OPA for the Combined Heat and Power Standard Offer Program (CHPSOP) which is designed to support "efficient use of natural gas-fired electricity generating facilities that use CHP technology up to a maximum capacity of 20MW" (Ontario Power Authority, 2013).

*Private Investment*

It is important to note that municipalities across North America have been successful in developing DE projects when engaging in public private partnership agreements with private sector investors. Considering system efficiencies, and projected payback periods, DE expansion initiatives may be appealing for private businesses or even pension plan investment.

It is important for municipalities to carry out their own research on the costs and opportunities of investing in DE infrastructure. This work outlines several funding challenges and opportunities, however municipalities need to consider what type of funding arrangement may be appropriate based on their community needs.

## Chapter 2: Methodology

### Method

The methodological approach employed for this research is qualitative in nature, relying on an integrative review as a means to contribute to research development and conduct informed analysis. An integrative review outlines the "current state of knowledge on a topic, highlighting agreements and disagreements within it" (Neuman, 2011, p. 125). This approach is useful in determining the current knowledge of a specific topic, identifying research gaps, as well as analyzing and synthesizing results of studies thereby contributing to the state of knowledge on the topic.

This type of review summarizes past empirical or theoretical literature and is typically organized "around core common findings of a field and the main hypothesis tested" (Neuman, 2011, p. 138). The characteristics of a qualitative study are best suited to address the outlined research questions and objectives because this methodology provides a framework to explore how energy and land use planning are integrated in practice. In exploring these issues, challenges and potential solutions are uncovered.

Energy planning has been historically regarded as a technical problem that requires the attention of engineers; the potential to explore energy efficiency with reference to land use planning remains largely unexplored in literature and within North American practice. To explore the barriers and opportunities of DE expansion in Ontario with a focus on community benefits, energy efficiency and resiliency, system adaptability as well as with regard to environmental and economic, I proceed in the following steps: (1) prepare the research question; (2) search and sample available literature and primary sources; and (3) carry out critical analysis (4) conduct case study research and, (5) develop conclusions and recommendations for Ontario's municipalities on how incorporate DE and ICES into their communities.

#### *Step 1: Preparing the research question*

The initial stage of any review method is a clear identification of the problem and research purpose. The problem explored in this work is two-fold. It is both an energy issue as well as a land

use planning issue. Innovative approaches to addressing energy needs are crucial; decision makers are urged to consider embedded or cross-sector opportunities for planning resilient, healthier and more energy efficient communities throughout the province. The process of conducting a literature review was instrumental in identifying key research goals. Key research questions include:

1. Why is energy a planning issue that deserves consideration within municipal planning departments? How can land use planning inform opportunities for increased energy efficiency through community energy planning?
2. What are the benefits of district energy –also known as community energy?
3. What are the policy tools that municipalities and other Ontario leaders can reference to build or expand the thermal network within their community?
4. What are the opportunities to expand district energy and related embedded community energy solutions within Ontario?

*Step 2: Background research*

Various research strategies are employed to complete this work. Most information is obtained by conducting a background review of available literature from industry, government and academic sources. Furthermore, an examination of case study best practices related to district energy expansion is performed with a focus on one international and one Canadian jurisdiction. Both case studies examined were selected because these jurisdictions represent leaders in DE expansion. The international case study of Sweden is examined in order to gain perspective on the opportunities associated with a network of district energy systems; and, the Canadian province of British Columbia is examined in order to gain insights on potential policy tools that may help guide system expansion in Ontario. Case study research offers real-world context, and captures the dynamic details of real-life events, such as the managerial and organizational processes particularly relevant to this research (Yin, 1994).

Lastly, in an effort to triangulate research findings, consultation of industry conference materials and personal professional interviews were conducted. This triangulation approach of

consulting three different data types ensures a more holistic approach to content gathering and aids in analysis of information.

Professional staff member opinion was obtained through an interview with a City of Toronto representative. Ethics approval was not sought because the interview was limited to professional opinions on energy planning within Ontario, and more specifically, on the available tools that the City of Toronto can access to pursue district energy expansion.

*Step 3: Critical analysis and informed conclusions and recommendations*

Through analysis of the research collected, conclusions have been drawn to address the initial research questions of this study. At this stage of work, it is important to become familiar with a wide scope of data as well as the key research findings. Research revisions are a natural component of this rather long process of information gathering and evaluating.

## Limitation of research

The focus of this study is to examine opportunities and challenges of district energy expansion in Ontario with reference to industry, government and academic sources. The use of key informants strengthened this research, however it was not the focus for data gathering. It is the author's recommendations that to build on this work, future research should include a focus on data collection from key informants such as industry professionals and public sector decision makers.

Furthermore, once key informants were identified and interviews were set up, obtaining the desired information proved challenging. This is because as noted below, this research still represents a fairly new and innovative component of energy planning in Ontario. Ontario's energy needs focus primarily on electricity needs; there is no policy that addresses thermal needs of communities.

The examination of community energy and embedded community energy solutions in reference to land use planning is a relatively new field– particularly within Canada. Cheap and accessible energy supply has been a hallmark of the Canadian lifestyle. Unlike many of our European

counterparts, leaders in Ontario did not have to consider alternative energy sources because looming energy constrains were not apparent throughout most of the 1900s. Other jurisdictions have more experience with community energy planning because these solutions were considered and widely implemented earlier in the 20th century while Ontario enjoyed its geographic positioning of being able to capture energy from Niagara Falls and sourcing fossil fuels from the national supply.

Times have changed, and for reasons of energy security, environmental targets and economic pressures, municipalities throughout Ontario are considering their energy options and looking at planning tools to enhance their competitiveness for attracting people and businesses. In addressing many of the concerns and challenges facing municipalities, the relevance and significance of this timely research is established.

## Chapter 3: Exploring the DE Opportunity

### Why District Energy Expansion in Ontario?

Ontario's per-capita energy consumption is among the highest in the world. The province's per-person consumption is 50% higher than New York State's with the overall energy consumption at more than double that of the United Kingdom (Ontario Clean Air Alliance, 2011, p. 1). Ontario's culture of energy consumption has significant consequences on energy security, the environment, public health and economic performance. Economic energy concerns in particular are escalating with the rising costs of fossil fuels, the peaking of global oil reserves and overall growing energy insecurity (King, Community Energy: Planning, Development and Delivery, 2012, p. 3).

As the era of cheap fossil fuel energy draws to an end, the province remains without access to additional, low-cost, made-in-Ontario energy supplies (pending further developments in renewable technologies) (Ontario Clean Air Alliance, 2011). This creates an opportunity for effective policy and planning strategies to help dramatically reduce electricity and natural gas consumption that would also allow the province to meet its GHG emission reduction targets of 80% below 1990 levels, by 2050 (Ontario Clean Air Alliance, 2011) (Environmental Commissioner of Ontario, 2010, p. 4). It is important to note that from a practical and risk management perspective, societies will always want to build and maintain a portfolio of supply options that maximize the utility of existing infrastructure while building new increasingly energy efficiently and environmentally benign sources of electricity production to meet increasing electricity needs. The challenge in Ontario (especially urban Ontario) is that we are predominantly dependent on one kind of electricity infrastructure -large central plants- and on one kind of heating infrastructure namely, natural gas distribution. This over-dependence on one kind of infrastructure and fuel exposes us to risk of supply interruptions, price shock, and makes us less nimble to adapt to technology and supply changes over time.

Ontario's approach to energy planning has a significant impact on the way that growth has been managed and directed. The province has a history of relatively low energy prices, which promoted costly sprawling development patterns that are all too typical of a hallmark of its

landscape, and which further compound concerns of climate change, health, resiliency and energy security. The population of Ontario is projected to grow by approximately 30% by 2030 – this represents the equivalent gain of nearly 3.7 million people (Ministry of Energy, Ontario, 2011, p. 8). What is more, the population will become increasingly urbanized with the majority of projected growth to occur in cities. Urban intensification presents the thermal load density and infrastructure replacement opportunities that improve the shorter-term economics of DE infrastructure (Canadian District Energy Association, 2008, p. 7).

With the projected rise in Ontario's population, there is a serious need, as well as an opportunity, to address energy and land use planning in tandem.

### Overview of Ontario's Energy History

Ontario's history of low cost of energy -particularly electricity- is a result of numerous subsidies from cheap hydroelectric power at Niagara Falls and major rivers. The development of low-cost electricity attracted energy intensive industry, forming the foundation of the Province's economic development until the late 20th century (Deewes, Karney, & Reeve, 2010). For decades, Ontario's abundance of hydroelectric energy disguised the true cost of fossil fuels and nuclear energy development (Deewes, Karney, & Reeve, 2010).

Eventually, demand outpaced the supply of Ontario's hydroelectric systems and by the 1960s, the Province began investing in fossil fuel and nuclear power plants. The completion of the TransCanada pipeline system in 1958 meant that Ontario could import low-cost natural gas from Alberta to heat our homes and fuel our industries (Ontario Clean Air Alliance, 2011, p. 1). Since that time, the province further expanded its fossil fuel mix and added six coal-fired generating stations. Between 1970 and the early 1990s three nuclear power generating facilities were brought online (Ontario Clean Air Alliance, 2011, p. 5). The energy investments made during these decades characterize Ontario's energy mix to present day, and reveal a historic preference for one-size-fits-all energy stations over smaller scale solutions.

In the early 1970s, oil prices experienced a sharp increase, drawing the federal government's attention to the cost of energy (Harris, 2006). The result was the development of demand-side management policies. In reaction to oil peak prices the Government embedded a conservation criterion into the 1973 National Building Code to reduce energy demand. This move was followed by the National Home Builders' Association's development of the R2000 building program for new home development in 1981 (Harris, 2006). Additional fuel shortages in the 1980s and early 1990s combined with an increasing international awareness of the linkages between global warming and fossil fuel consumption fostered the 1997 Kyoto Accord, committing participants, including Canada, to GHG reductions (Clean Action Network Canada, 2002).

Improving energy efficiency represents the lowest cost solution, and is the fastest way to save energy and reduce the negative impacts of energy generation. The good news is that Ontario has a lot of untapped energy efficiency potential that can help meet the province's needs. Energy efficiency measures can take much of the burden of re-building the electric power system and accommodating our heating and cooling needs. Focusing on efficiency measures is a proven way to meet the Province's goals. Ontario's investor-owned natural gas utilities set a precedent for conservation that proves its economic viability.

Ontario's investor-owned natural gas utilities, Enbridge Gas Distribution and Union Gas, have proven that significant costs savings can be achieved if investment is directed toward energy conservation. Their energy conservation programs achieved $3.1 billion in savings after an investment of $191 million; meaning that for every one dollar of utility spending, $16.2 dollars of savings were achieved (Ontario Clean Air Alliance, 2011, p. 3). This highlights the magnitude of opportunity for Ontario to improve its energy, environmental and economic standing.

Ontario's electricity infrastructure is aging and given the cost pressures on electricity ratepayers from increasing commodity and infrastructure costs, every effort should be taken to ensure that energy infrastructure is replaced in a way that delivers the most cost effective and energy efficient solution for consumers. An estimated $25 - $40 billion in new investment will be

needed over the next 20 years to fix Ontario's electricity system because several of Ontario's nuclear plants will reach the end of their useful life in this decade (Gilbert, 2006), and the Province confirmed its commitment to phase out of coal by 2014.

A mix of conventional and emerging generation technologies will be needed to meet both system demand growth and plant replacement needs. The technology for improving Ontario's energy performance is already available. The greater issue facing the Province deals with a lack of policy directives that recognize district energy as part of the integral energy equation. The Province has been silent on the potential community and efficiency gains that may be captured from a thermal energy network, and in particular the integration of the thermal grid with small scale CHP and thermal storage units.

### Evolution of Ontario's Energy Policies

The Province has a large responsibility in how cities and communities are powered and how buildings are heated and cooled. Ontario's energy policy reflects its historic ties to electricity production. The realities of climate change have placed pressure on jurisdictions of all levels to consider measures of efficiency and sustainability. In response to these pressures, the Province has enacted some changes aimed at greening the electricity network. Apart from supporting the development of CHP as outlined in the Long Term Energy Plan that was released in November 2010 (Ministry of Energy, Ontario, 2011), Ontario's current energy framework revolves mainly around the electricity grid, and does not reflect a comprehensive strategy to efficiently address the thermal needs of its communities. Ontario's overall energy needs will increase commensurate with economic, development and population growth. The population of Ontario continues to grow and usher new development and infrastructure, which are being poorly addressed through the continual development of high-cost, centralized sources (Deewes, Karney, & Reeve, 2010). Furthermore, these business-as-usual approaches to energy are limiting Ontario's success in designing communities that better reflect residents' needs and attract industry investment.

Municipalities play an important role in coordinating a vision to guide the development of their communities. To date, most DE projects in Ontario have been the result of local vision and leadership at the municipal level that were achieved with the support of federal and provincial funding (Elenchus Research Associates Inc., 2010). Municipalities in Ontario are considered 'creatures of the province' and are required to take direction from the Province when deciding on land-use planning matters (Ministry of Municipal Affairs and Housing, 2010).

The Planning Act is the overarching provincial legislation that governs land use planning in Ontario. Under section 3 of the Act, the Province identifies its interests in sustainable growth which limits sprawl, protects natural resources and promotes efficient growth. All decisions affecting land use planning matters "shall be consistent with" the Provincial Policy Statement (PPS) (Ministry of Municipal Affairs and Housing, 2010). The PPS provides overarching policy direction for the planning and development of compact, transit-supportive communities. It also offers policies that promote energy efficiency and the uptake of alternative and renewable energy sources that produce fewer GHGs than traditional fuels (Ministry of Municipal Affairs and Housing, 2010a). No prescriptive policy instruments exist to directly address district energy.

From time to time, the Province also issues other policy directives in order to reflect government priorities for land use planning. Relatively recently, the Province encouraged energy efficient buildings, the protection of environmentally sensitive land, the development of more compact communities, sustainable transportation options, and renewable energy through updates to the Building Code (1992), and the release of The Greenbelt Act (2005), Places to Grow (2006), The Big Move (2009), and, the Green Energy and Economy Act (2009) (Ministry of Municipal Affairs and Housing, 2011).

Analysis of provincial policies and regulations reveals that energy efforts to date have been largely focused on matters related to electricity, and silent on matters related to thermal energy policy thus revealing a big legislation gap which represents an opportunity for furthering conservation and efficiency measures within the Ontario energy system.

In the Canadian context, municipalities are 'creatures of the province', meaning that the authority conferred on the municipality is not local in nature but derives from the provincial government (Tindal & Tindal, 2004, pp. 10-11). Nonetheless, cities continue to gain prominence through high growth, revealing need for more policy direction to ensure thoughtful planning and development of energy efficient communities. These types of communities are achievable through the integration of DE and integrated community energy solutions as appropriate.

If in the long term district energy is to be part of the energy solution in Ontario, it must be considered in the Ontario government's energy, land use and technology plans, legislation and regulations. In order to make deep inroads with energy efficiency, municipalities require more support from the Province in integrating DE and ICES into the planning framework.

## The Importance of Cities

**"The City is not a problem – it is a solution"**
**- Jamie Lerner former Mayor of Curitiba, Brazil**

Cities are for people. They are the drivers of political, economic and cultural development – therefore, making them attractive, safe, healthy and livable is crucial for a more sustainable future. Urbanization and urban development are complex and dynamic processes. With increasing urbanization, the challenge is to develop more equitable, environmentally sustainable and economically viable cities, in order to offer residents opportunities for a high quality of life (Groth & Ranhagen, 2012, p. 6).

Cities provide a wide range and choice of social, educational, cultural and economic opportunities to satisfy people's collective and practical needs. Well-designed, sustainable cities can achieve minimal environmental impact. Dense and coherent urban structures also enable economies of scale, with shorter supply and access distances for services, which can save energy and other resources.

In the Ontario context, municipalities are often the drivers of DE projects. Municipalities use various planning tools to coordinate a vision to guide the development of their communities, establish growth directives and support their strategic long-term goals. These tools include official plans, secondary plans, sustainability plans, energy plans, intensification targets, or other directive and policy documents. As noted above, all municipal plans must be consistent with provincial directives. Nonetheless it is important to showcase the opportunity that municipalities have to make significant impacts on the sustainability of their operations, and the quality of life for their residents.

Long-term planning is an essential component of advancing a cohesive energy vision. Effective planning tools outline a stable platform that is appealing to businesses, and can serve to attract community investment or skilled workers (Ontario Power Authority and Canadian Urban Institute, 2010, p. 13). It is important to note that in the Ontario context, despite the lack of clear provincial policy direction specifically on district energy, municipalities have a variety of tools they can use to facilitate the implementation of DE, as well as to take advantage of other integrated energy solutions (Ontario Power Authority and Canadian Urban Institute, 2010).

Most municipalities are comprised of multiple sectors that tend to operate independently of one another. When considering DE opportunities, it is imperative to integrate the activities and functions of various sectors –particularly economic development, planning and engineering. This integration can help municipalities to operate as a system, maximizing community benefits. In this way, it is possible to take advantage of cost savings as well as energy and emission reduction opportunities that cut across various municipal sectors.

Reducing energy use and improving efficiency is a complex process. It not only requires collaboration and cooperation of various municipal sectors, but also requires participation from industry professionals and stakeholders. Municipalities and local utilities can play an important leadership role in highlighting the associated community benefits of integrating community planning issues with district energy and integrated energy solutions.

Climate change is recognized as the most pressing global challenge of the 21st century. Rapid urbanization is placing cities at the forefront of the climate challenge and the way our cities are planned has enormous implications on the quality of life for residents and the quality of our natural resources (El Sioufi, 2010, p. 1). Energy plays a critical role in our quest to reverse climate change and its associated harmful impacts as such, it is particularly important to consider the way energy is planned, managed and delivered to and within our cities.

Considering the extent to which cities consume energy, primarily as a result of burning fossil fuels, it is not surprising that energy use is the largest contributor to global climate change (Romero-Lankao, 2012, pp. 8-9). According to a study released by the United Nations Human Settlements Programme (2010), 75% of commercial energy is consumed in urban and semi-urban areas. In addition, up to 60% of GHG emissions, which cause global climate change, originate from cities (El Sioufi, 2010, p. 5). Considering our energy scenario, it is not surprising that energy production and delivery are among the confluence of trends likely to bring about significant challenges for sustainability. When considering our climate challenge, one cannot ignore the rapid population growth that will need to be accommodated within urban areas.

Planners will need to design communities in a manner that will accommodate the growing population without placing much strain on environmental resources. Nandi and Bose (2010) estimate that 70% of the global population will live in cities by the year 2050, further amplifying the strain placed on municipalities to provide energy services. Interestingly, the International Energy Agency (IEA) estimates that the proportion of global energy consumed in cities is greater than the proportion of the world's population living in cities – thus signaling that intervention is needed to address energy demand issues.

In 2006, the global primary energy use in cities was 7,900 Mtoe (million tonnes oil equivalent), or 67% of global demand; however global city energy use is projected to grow by 1.9% per year, and make up 73% of global demand by 2030 (International Energy Agency, 2008, pp. 182, 184). Therefore, urban areas will continue to increase in importance as strategies for mitigating

climate change are developed. Reducing urban energy demand and implementing local embedded energy solutions including district energy and distributed generation technologies must be a component of these strategies if climate change goals are to be realized. This positions our cities at the crux of the climate challenge where solutions to critical energy issues will have most significant impacts. However municipalities generally cannot adequately meet these complex challenges on their own. This scale of a problem requires multi-government cooperation and intervention of city planners working in tandem with the community, technical experts and policy makers.

### Municipal Planning Tools to help expand DE

As noted earlier, Ontario's municipalities hold considerable influence over how their communities grow and develop. They can define growth nodes, determine areas and levels of density, and have authority over development decisions with opportunities to blend residential, commercial, institutional, industrial or cultural uses through zoning bylaws (Compass Resource Management, 2010). This positions municipalities as significant players in district energy expansion. Many industry stakeholders feel that municipalities need to be at the forefront of any community opposition by educating and building awareness of DE from the outset. Municipalities not only have the jurisdiction to drive a DE project, but also contribute to the longevity and success of a project. They are responsible for local infrastructure and, they often own local utility companies and are in a position to either directly or through a public/private partnership invest in DE projects (Richardson, 2013). Municipalities can also influence developers to connect new builds to district energy or to incorporate community energy solutions through policy tools, moral suasion or by mandating connections. This further highlights the authority that municipalities hold over the success of a system.

When evaluating DE opportunities, it is important to consider if a community has sufficiently dense demand for thermal energy; or if there is an opportunity to plan a community along a denser grid with mixed-use development. District heating and cooling equipment is most efficient when

there is a mix of demand profiles to balance the rate of energy generation (Zizzo, 2009). Broad community objectives, including growth strategies, are outlined in municipal official plans. The land use planning strategies outlined below are referenced from the Ministry of Municipal Affairs and Housing (2008) and the Ontario Integrated Community Energy Solutions - Municipal Policy Toolkit (2010). They are not fully exhaustive nor are they mutually exclusive; instead they can be used in combination to achieve energy efficiency, economic and other development goals linked to the built environment.

*Official Plans (OPs)*

Municipal official plans are documents that outline growth objectives and guide the future land use planning of a community. They reflect a municipality's broad objectives including economic development and sustainability objectives. Considering that DE is most suitable in mixed-use, dense urban areas, OPs can help to align community intensification objectives with energy strategies to supply residential, commercial and institutional buildings. Energy-related policies can be included in an official plan in order to incorporate integrated community energy solutions into the community's future growth strategy. Examples could include plans for GHG reductions, energy efficiency measures, renewable energy projects, and requirements for community energy planning.

*Zoning Bylaws (s. 34 of Planning Act)*

Zoning by-laws state how land will be used in a community and outline specific requirements for building use, density, height, size, lot coverage, building envelope specifications and location. Zoning bylaws and amendments could be used to promote conditions that would make DE more appropriate within a community such as intensification, compact development, mixed use development, renewable energy infrastructure, and better support for public transportation.

*Transit Policies*

Transit policies can be used to improve urban form and intensification. It is important to highlight that nearly the same demographic/density conditions –and policy objectives of cities– that foster economic feasibility of transit systems also foster conditions that would support DE or ICES. These policies can incentivize people to adopt alternative forms of transportation, reduce travel distances and make public transportation a more viable option. These policies could also help to stop the negative effects of urban sprawl by promoting transit-oriented development.

*Site Plan Control (s. 41 of Planning Act)*

Site plan control is a tool that municipalities can use to ensure that certain requirements are met before a site is developed. Development cannot occur before the community reviews and approves the plans. Once they are approved, a site plan agreement is created that outlines the terms by which the developer must abide. By including design considerations in site plans, communities can promote district energy and other integrated energy solutions.

*Height and Density Bonusing (s. 37 of Planning Act)*

Height and density bonusing is used in order to allow buildings to exceed the height and/or density of a development outlined in existing zoning-bylaws, in exchange for community benefits. These arrangements, if strategically negotiated, can help to foster the conditions for density that support DE. Benefits are negotiated on a case-by-case basis and the cost of negotiated benefits is borne by the developer. In order for municipalities to use this tool, bonusing policies must be detailed in municipal official plans. DE and ICES could be advanced through this tool by encouraging community benefits such as intensification, mixed-use communities, transit support and improvements.

*Development Permit Systems (DPS)*

Development permit systems combine site plan control, zoning, and minor variance together in one application format. They provide development certainty and help to streamline the planning review process by providing for faster timelines, eliminating potential duplication, incorporating flexibility for uses and development standards, and providing a 'one-stop' planning service. The framework for the DPS must be established in the municipal official plan before a municipality can issue any development permits. Development permit systems are a useful tool to promote district energy opportunities and ICES. This permit system can include requirements for brownfield redevelopment, green roof installation, water conservation measures, street and lot layout that reduces energy consumption, transportation demand management, and installation of renewable energy systems.

*Protection of Settlement Area Boundaries*

Settlement area boundaries prevent development expansion into undeveloped areas such as rural and agricultural areas, and when protection is applied, no appeals for development outside of the boundary can be made to the Ontario Municipal Board. Settlement area boundaries discourage low density and sprawl development, thus reducing the cost of public service infrastructure and GHG emissions. Encouraging the development of compact communities offers significant opportunities for energy efficiencies and for DE implementation.

*Local Improvement Charges (LIC)*

Local improvement charges are used when a municipality provides new services, or makes enhancements to one or more properties. These services or enhancements can include sidewalk and curb installation, public transportation service, or sewer and water infrastructure. LICs could therefore potentially be used to include energy efficiency improvements to a property or a set of properties. To implement LICs, the municipality pays

for the improvements and arranges for the work to be carried out. Then, calculations are laid out in the LIC on how affected properties benefited from the improvements. LICs represent a charge in addition to the usual municipal tax. They are an attractive option for building owners because the loan is attached to the property rather than the owner. This arrangement offers incentive for investing in more capital-intensive energy efficiency projects that offer long term benefits. LICs address several barriers to energy efficiency upgrades, including a hesitancy to accept long paybacks, a preference for low-cost improvements, lack of access to capital, and construction industry resistance.

*Community Improvement Plans (CIPs) (s. 28 of Planning Act)*

Community improvement plans are created to target an area of the city that is slated for development or redevelopment. It is important to note that each community faces unique challenges and opportunities for CIP areas and no 'prescription' is outlined of what a community improvement plan should be or include. CIPs can provide incentives or loans to developers in order to affect the desired outcome, or they can include changes to land-use and zoning regulations. As examples, these could include municipal programs focused on public-space improvements such as park improvements, and financial incentive programs intended to stimulate private-sector retrofitting of existing buildings for energy efficiency. To encourage district energy and other integrated community energy solutions, CIPs can also target densification and intensification, diversity of built form, increased support for public transit, or the development of alternative energy systems.

Having outlined several of the key land use planning tools available to municipalities in Ontario, it is important for municipalities to review these tools within the context of their own community. In order to better position district energy as a key piece of infrastructure, it must be considered as part of the community development from the onset and clearly articulated in the planning tools outlined above.

When considering new approaches or technologies, it is beneficial to examine other jurisdictions in order to learn from their successes and navigate away from common pitfalls. The next section of this research looks at key features including policy tools that enabled DE expansion in Sweden as well as promoted its growth in British Columbia.

# Chapter 4: Case Study Research

## Innovative Energy Solutions in Sweden

To highlight the opportunity for district energy, this work examines the Swedish approach of "Symbio City" wherein synergies among urban systems are explored in an integrated manner to curb environmental impacts and deliver social and economic benefits to citizens (SymbioCity, 2013). Sweden is selected for a case study examination because it has a similar climate as Canada, and therefore many of the innovations applied there could be transferable to the Canadian context. Also, Sweden's DE is a supplement to the large conventional electricity infrastructure found in many of the country's leading cities. Sweden serves as an inspiration case for many Canadians who are keen on seeing an integrated approach to city planning that encompasses the needs and opportunities of various stakeholders and community participants including federal stakeholders.

Symbio City is a unique form of city planning that originated from Sweden and has been used in municipal development strategies around the globe. The main goals of Symbio City relate to maximizing benefits by either strategically locating municipal services, or by ensuring very little externalities or waste as a result of a 'closed loop' planning approach where waste feeds energy systems, and public transportation is the primary commuting mode for urban areas (Ekh, 2009 ). Symbio City helps municipalities achieve goals of sustainable development through the application of a "holistic approach to urban development, with particular focus on the environmental aspects and with clear links to economic and socio-cultural dimensions within the physical and spatial environment" (Dixelius, Groth, Lindberg, & Ranhagen, 2010). This approach to energy and city planning drastically reduced the country's dependence on oil and secured its position as an energy leader.

The Swedish experience is instructive: since the 1970's district energy has tripled to supply 50% of the country's building area (Elenchus Research Associates Inc., 2010). Over the same time, systems have transitioned from relying almost entirely on imported oil to using a diverse mix of resources, including biomass, refuse and waste heat (Compass Resource Management, 2009).

Equally interesting is that the typical district energy system in Sweden has 3 to 4 energy sources per system.

It is important to highlight the regulatory approach for district energy (primarily district heating) in Sweden. Much of the success garnered by the Swedes in the district energy market is a result of directed policies. Sweden has a mature DE market that is very different from the Canadian context. Sweden mandates community energy planning by statute, whereas community energy planning is a relatively new concept in North America (Church, 2007, p. 276). However it is important to keep in mind that Sweden's system was developed over the course of nearly four decades. The Swedish example provides insight into how most of the country was able to further its environmental, economic and social goals by planning communities with district energy. Its national approach is highly advanced in its energy planning, generating and distribution processes.

The Swedish DE industry is very transparent when compared to the Canadian model. System operators and municipalities release annual reports disclosing system performance information so that governments, private businesses and the general public are aware of system competitiveness. It is important to note that energy suppliers are instructed to negotiate the price and other terms of delivery with the customer; this approach has raised concerns of monopolistic behaviour and high prices (Elenchus Research Associates Inc., 2010). Interestingly, if parties are unable to reach an agreement, Sweden's public authorities step in and arbitrate on their behalf.

Many efficiencies are obtained from the interconnectedness of the district heating network throughout hundreds of communities across that country. The innovations that took place throughout Sweden did not occur in one swift step. Many small strides were taken to ensure that community energy needs were satisfied in a manner that has significant environmental, economic and quality of life benefits. As a result, at present day, Sweden is less dependent on imported fuels. Furthermore, as its population grew, the GHG emissions continued to shrink. The Swedes have reduced their per capita GHG emissions to four tonnes per person compared to Canada's average of

22; and, with B.C. faring better than the average Canadian province with 16 tonnes per person is still far behind our Swedish counterparts (Garforth International LLC , 2009, p. 4).

The Swedish example of decades of district energy investment and expansion has improved the country's GHG emissions, and increased reliance on local resources that helped to stimulate local jobs and local economic activity. The Symbio City example outlines that in dealing with municipal issues of energy, waste, transportation and zoning, there are opportunities for holistic system planning that can yield many environmental, social and economic benefits. More jurisdictions in Canada would benefit from the implementation of similar policy drivers that promote such an approach to community planning and development. To date, there has been very little direction for district energy expansion from the federal level. Municipalities tend to be DE drivers across the country, however the British Columbian approach to sustainability has allowed for DE to make inroads within that province.

### District Energy to help achieve sustainability goals in British Columbia

In Canada, British Columbia is identified as a leader on district energy expansion. District energy has been identified as a tool to help B.C.'s municipalities meet the objectives set out in B.C.'s Energy Plan: A Vision for Clean Energy Leadership and in the B.C. Climate Action Plan. This guiding plan helps to set the tone for provincial action on the topic of energy as well as other matters of provincial interest. To cement its vision of sustainability, the Province implemented the Greenhouse Gas Reduction Targets Act (GGRTA), (2007); the Carbon Tax Act (2008); the Local Government (Green Communities) Statues Amendment Act (2008), also known as Bill 27; the Clean Energy Act (2010). These legislation pieces support energy efficiency, the use of clean and 'green' energy and the replacement of fuel to decrease GHG emissions (Elenchus Research Associates Inc., 2010, p. 31).

The GGRTA mandates reductions of provincial GHG emissions of 35% by 2020; and 80% by 2050. These are fairly aggressive targets – especially within the North American context.

The province introduced North America's first Carbon Tax which places a charge on the use and consequent emissions produced by burning fossil fuels. According to B.C.'s Ministry of Finance, the carbon tax "is to ensure that a consistent long term price signal is provided to consumers so they can continue to make the choices required to reduce their fossil fuel use and emissions" (British Columbia Ministry of Finance, 2009). This tax encourages individuals and business owners to reduce their use of fossil fuels and help meet the province's legislated GHG emission reductions (Larson & Yip, 2010). Bill 27 provides municipalities with a variety of tools directed at achieving GHG savings through emissions reductions, water and energy conservation and through a revived focus on building more compact and efficient communities (Elenchus Research Associates Inc., 2010).

Canada's most significant strides to improve energy efficiency originated from B.C. Local governments, and publicly funded entities such as hospitals, responded positively to these directives from the Province. Interestingly, municipalities quickly got behind the Province's policy objectives. On September 26, 2007, sixty-two communities signed on to the B.C. Climate Charter committing to become carbon neutral by 2012; and by the end of 2009, 176 municipalities (out of a total of 188) committed to the Charter (Elenchus Research Associates Inc., 2010, p. 31). The fact that so many communities signed on, signals that with the right policy infrastructure in place, municipalities will work hard to remain competitive and to increase the efficiency of their energy and other operations.

British Columbia is Canada's only jurisdiction that addresses district energy, however when compared to many European counterparts –including Sweden- B.C.'s DE approach is still in the early stages. Unlike the situation in Ontario, in expecting the Pan-American games in the city; B.C. was also working towards meeting many sustainability goals in time for the 2012 Winter Olympic Games. The prominence associated with hosting an international event may be a propelling catalyst to achieve greater action on energy efficiency and district energy planning in Ontario or at least in the Greater Toronto Area. Unfortunately, due to a lack of policy direction from the Province of Ontario, DE growth is occurring very slowly and often in a fragmented manner with municipalities spearheading the initiative. The DE strides achieved at the Town of Markham serve as a leadership example to other

municipalities who want to develop community based energy networks. It is noteworthy to explore the leadership of the Town of Markham in developing its community energy system despite an obvious lack of federal and provincial policy guidance.

### Markham District Energy: A Success Story

Considering the lack of policy direction from both federal and provincial governments on district energy, the Town of Markham serves as a success story in district energy development. In supporting the implementation of district energy systems and other supporting community energy solutions, Markham's decision makers committed to energy efficiency and security in an effort to advance the Town's economic and environmental targets.

Markham Centre is planned in accordance to new urbanism strategies which highlight environmental sustainability, a mix of urban forum and dense population concentrations in the downtown core. The Centre, estimated to be over 1.86 million $m^2$ when fully built out, will contain residential, commercial, and institutional buildings. Urban intensification presents the thermal load density and infrastructure replacement opportunities that improve the shorter-term economics of DE infrastructure (Canadian District Energy Association, 2008, p. 7). Contributing to the development of the Markham Centre vision is a modern, high-efficiency cogeneration and district energy facility.

In 1999 an amendment to the Ontario Electricity Act was passed allowing municipal investments in energy-related businesses (Natural Resources Canada, 2007, p. 1). In the same year, the Town of Markham created Markham District Energy Inc. (MDEI) through its holding company, Markham Enterprise Corporation and moved forward with the plans for a DE system to serve the Town's newly planned greenfield development.

Three events occurred that propelled the adoption of a DE system. First, during the 1998 ice storm Markham officials recognized the Town's vulnerability to blackouts because of its dependence on a centralized power grid. Second, smart growth and sustainability principles were becoming more important and were incorporated into the plans for Markham Centre. Third, IBM, which already

employed over 5,000 people in Markham, was evaluating sites for a new 3,000-person, 24-hour-a-day software laboratory that required security of energy supply (Natural Resources Canada, 2007, p. 1). The promise of a DE system helped the Town secure the bid to host the data center. This move not only secured a customer load, but it also introduced the notion of economic multipliers and more jobs within the area which continue to positively contribute to the social fabric of the community. With the promise of a secure energy supply, the Town also attracted business from other industry giants including Motorola and Bell Canada.

The initial plant was launched in 2000 at a cost of $16 million and has since gone through several significant capital expansions (Natural Resources Canada, 2007, p. 1). MDEI currently provides heating and cooling to over 184,500 m2 of commercial, residential, institutional, and public facilities in Markham Centre. System expansions included a major extension of the distribution system to accommodate a variety of public and residential buildings; 20-year contract to produce an additional 5 MW of CHP capacity; and, currently MDEI is expanding to serve the Markham Stouffville Hospital (MDEI 2009). Even though the Town has been adding building stock since 2000, in the summer of 2010, it reduced electricity peak load by 50% (Canadian District Energy Association, 2011a).

The Town in partnership with MDEI, held public consultations and worked hard to alleviate "not-in-my-backyard" opposition to this infrastructure initiative. Public engagement and knowledge-building efforts have been successful, and the question in Markham seems to ring more along the lines of *where* to expand DE, as opposed to *whether* to expand at all.

As noted earlier, the Town of Markham invests half of its revenues from the Federal Gas Tax toward DE infrastructure expansion. Funding has been supplemented by grants from the Federation of Municipalities' Green Municipal Fund and the Ontario Power Authority. Since the commissioning of the first DE plant, the Town of Markham estimates a 50% carbon dioxide emissions reduction and has embraced DE as well as renewable energy projects as part of their Sustainability Plan, The Green Print (Town of Markham, 2011). The Town continues a new-urbanism style of planning which

promotes more compact, walkable communities with a range of buildings that serve residential, commercial and institutional needs – with district energy serving the community's thermal, and in some cases, electrical needs.

The Markham example highlights the leadership and innovation applied in the development of a greenfield community. Developing grey or brownfield sites is more challenging in every aspect – including energy. However, in municipalities like Toronto where density load and customer opportunities are present, district energy solutions should be considered. It is important to look at the opportunity for district energy expansion in Toronto, Ontario's fastest growing municipality.

### City of Toronto: Evaluating the DE Opportunity

**"Great density is coming to Toronto, like it or not. Population growth demands it. Planning policy is encouraging it" – Jennifer Keesmat, Chief Planner, City of Toronto**

Toronto is Canada's largest city and sixth largest government. The city is home to a diverse population of about 2.6 million people and identifies as the "economic engine of Canada and one of the greenest and most creative cities in North America" (City of Toronto, 2013). The city is undergoing unprecedented intensification, unparalleled to any other Canadian municipality. Currently, there are 185 construction cranes working to change the skyline and function of the city (Gee, 2013). Such growth places immense pressure on existing infrastructure; but, it also presents a significant opportunity to build DE infrastructure that is more embedded with community needs.

Toronto's 2007 Sustainable Energy Plan outlines a focus on energy efficiency. The plan acknowledges the importance of building stock in the energy equation. It specifies that "ensuring that new buildings such as office towers are constructed to be as energy-efficient as possible can increase building value, improve indoor air quality, and increase employee productivity" (City of Toronto, 2007, p. 3). The quality of building stock is an important element of energy consumption; however, arguably more important are considerations of building placement and community mix which outline where to locate residential, commercial, institutional and industry building stock in

order to maximize energy efficiency or allow for the implementation of a thermal network for heating or cooling building stock.

The high-rise projects currently under way in the city are a result of city and provincial planning policies designed to fight sprawl and encourage urban intensification. The development is also a result of municipal decisions around density areas and directives for new development. Interestingly, 84% of recent development in Toronto has been in places that are targeted as growth areas in the city's official plan (Gee, 2013). The 185 new tower buildings that will transform the Toronto skyline will be powered by traditional energy systems. This represents a big opportunity loss for the City to maximize on increased densities and on the construction that is already underway.

Toronto has a few district energy examples, however, considering the magnitude of current development, the City is missing the opportunity to plan for the efficient thermal needs of the new building stock, and is missing opportunities to be strategic about community design that could further enhance energy efficiencies.

The City of Toronto has long been considered a leader in energy retrofits of existing buildings. Its current Better Buildings Partnership (BBP) program offers, among other things, interest-free, repayable loans to building owners in the municipal, academic, school boards, and health and social service sectors referred to as "MASH" (Canadian Council of Chief Executives, 2011, p. 19). Considering the variety of buildings (energy load and demand) of MASH sector structures, these loans represent an exciting opportunity for DE connection.

The BBP program was initiated in 1996 with a focus on curbing emissions associated with climate change. Evidence points that DE in co-operation with the building marketplace, has the capacity and momentum to increase the amount of retrofits implemented by 400-800% in both dollar value and GHG s per year. GHG emission reductions achieved to date represent 4.1% of the former City of Toronto's 20% target; the full-scale program could achieve over 3 million tonnes of GHG reductions which represent a significantly larger portion of the amalgamated City's 20% goal (Church, 2007, p. 122).

Energy is without a doubt an important consideration in how the city grows and how it continues to be competitive. The City has some precedent is implementing innovative energy solutions such as Enwave's deep-lake water cooling system and Regent Park's community energy. These systems allow for operators to capitalize on local natural resources while delivering heat and cooling. Enwave utilizes three high-density polyethylene pipes to collect cold water from 83 meters below the surface of Lake Ontario and distribute that energy in the form of heating and cooling (Enwave, 2010). Furthermore, the redevelopment of Regent Park incorporates a district energy plant in the basement of one of the new condominiums, servicing all new development within the community. The system has been integrated into a 25-year financing plan for the community and operates to meet the needs of its customers (Candian District Energy Association, 2011).

It is now understood that within the lifecycle of buildings and urban form being developed, changes will be required in how we heat, cool and power built spaces. Fernando Carou from the City of Toronto's Energy Efficiency Office noted that the City is recognizing the need for buildings to be 'district energy ready' so that when the building's heating and cooling system needs to be replaced in about 20 years from the time of construction, DE can be a prominent consideration (March 13, 2013). This type of foresight may offer the opportunity for DE to gain the market penetration required for community energy systems to make a considerable impact in addressing the thermal needs of residents, industry and businesses. It is important to note that if we miss the opportunity to lay a thermal grid at the beginning of a development, the opportunity is often gone for decades. For this reason, the Province and municipalities need to outline clear directives to address the immediate thermal energy concerns facing communities.

To better address the City's DE opportunity, it is important to consider the Toronto Green Standard (TGS). This standard is a two-tiered set of performance measures for new development. It came into effect January 31, 2010 and builds on the City's Green Building Standard by mandating Tier 1 requirements in order to achieve energy reliability and GHG reduction goals detailed in the City's Climate Action Plan (Ontario Power Authority and Canadian Urban Institute, 2010, p. 20). TGS

is consistent with the City of Toronto's Official Plan (2006) and outlines sustainable development. Tier 2 requirements remain voluntary, however developers who meet these more stringent standards, are eligible to apply for a 20% development charge refund (City of Toronto, 2013). Considering the lack of strong policy tools from the Province, the TGS serves as a means to encourage increased sustainability and energy reduction provisions at the building level.

There are many other considerations that would help guide the development of DE systems and encourage integrated community energy solutions. Toronto's Enwave and Regent Park community systems, the Toronto Green Standard, and Markham's unique leadership approach signifies that there is opportunity for municipalities to spearhead DE projects. However, if Ontario wishes to enable significant growth of DE on a more holistic level, the Province needs to enable it through public policy. Absent this change, DE will not achieve significant growth and it will remain only accessible to the few municipal leaders who may venture outside of business-as-usual practices.

## Conclusions and Recommendations

All levels of government in Canada face not only an energy challenge but also a serious planning challenge. Good design can help manage the energy supply and demands of communities. Current municipal planning practices rarely consider the role of energy in terms of land use planning initiatives. The increasing density of major urban regions throughout Ontario creates many potential DE opportunities. However, success will require greater policy direction from upper levels of government as well as strong collaboration among all land use planning stakeholders. Interest in district heating and cooling is growing across Canada as an important energy management tool for communities. It allows for energy management at the local level and offers security of heating and cooling supply. Furthermore, it contributes assets, employment and economic development. Due to challenges of climate change, economic insecurity and increasing energy demand, municipalities, with the aid of the Province, must explore options to develop local energy infrastructure that is adaptive and resilient. DE systems have a proven record of efficiency and resiliency; implementation of these systems helps municipalities to reduce their climate change burden while enabling planning for the vibrancy of local communities.

District energy systems have a long successful track record internationally, but are less prevalent in Canada. Most Canadian jurisdictions -including Toronto- are facing an 'energy contradiction' whereby high levels of energy use underwrite continued economic growth and urban expansion. These practices are increasingly acknowledged as unsustainable in light of: climate change and growing concerns about energy security; global oil supplies; and the environmental consequences of chasing after increasingly remote and 'unconventional' sources.

There is an opportunity for leadership at all three levels of government. The federal government has an opportunity to establish the broad policy framework that, like Sweden, promotes a holistic approach to meeting national and community interests. Sweden's approach of Symbio City was made possible by federal government directives that recognize urban planning as part of the

approach to addressing environmental, economic and social issues within the physical and spatial environment.

For Canadians to move forward on addressing the thermal needs of communities, the federal government needs to do the following:

1. Provide an overarching framework for dealing with climate change challenges. Similar to Sweden's approach, this framework take a holistic approach to incentivize more efficient management and planning of our energy systems and include directives on the opportunity to address serious environmental issues through land use management.
2. Emitting carbon should not be free anymore. It is and should be considered as an economic externality and charged via a carbon tax, cap-and-trade or strict regulation. Furthermore, by charging a fee for emitting carbon offers a stream of capital that should flow towards renewable and embedded community energy solutions.
3. Provide a funding framework that would incentivize efficient community scale energy infrastructure over fossil fuel systems. Canada needs to make a commitment at the national level to shift from reliance on fossil fuels and nuclear to developing a clean energy approach that supports opportunities for district systems as well as other integrated energy solutions including renewables. These systems are at the early stages of development within the Canadian industry and as such require investment.

Despite some activity on district energy, research shows that awareness in Ontario's market remains less advanced with fewer participants than observed in other jurisdictions such as Sweden and even British Columbia. B.C. provides several policy directives to its municipalities that are mainly rooted in environmental objectives of reducing GHG emissions. For Ontario to become a leader in thermal energy planning, the province must issue policy directives so as to better inform municipalities of their energy opportunities. It is undeniable that energy security, reliability and resiliency are among top priorities for local governments around the world, these local governments

need further policy and economic tools to take on community energy planning. DE planning encourages municipalities to build more connected and denser communities. These systems support compact community design, provide opportunities for increased social interaction and encourage economic development.

Energy is as much an engineering challenge as it is a planning challenge. It requires strong collaboration between the provincial and local governments as well as a strong education campaign that details the benefits and challenges of DE. It is important to assess whether the project offered the public as well as decision makers opportunities to learn about energy issues and engage in the planning process. Public participation in community design is an integral aspect of equity and social justice, therefore an assessment of community engagement –particularly during the planning phase of the project- is a vital consideration of the social criteria associated with infrastructure initiatives.

For Ontario to move forward with district energy planning, the following recommendations should be considered:

1. Provide policy direction for municipalities that would outline the conditions under which district energy opportunities are to be explored. Opportunities for DE could be addressed through the Provincial Policy Statements or in a new policy document that details the needs and opportunities of planning thermal energy networks.
2. Through the Ministry of Municipal Affairs and Housing and the Ministry of Energy, establish clear communication with municipalities regarding district energy planning tools. Offer municipalities information on district energy planning outlining – technical, community, and financial considerations. To enhance the utility of these educational tools, it is recommended that the Province hold workshops for municipalities and key stakeholders interested to learn about district energy opportunities and challenges.

3. Consider legislating permission to energy utility providers to develop and operate district energy system grids, possibly as part of their regulated strategy, and enable them to work with municipalities to champion district energy expansion.
4. Encourage provincial and municipal leaders to participate in study tours that highlight the opportunities of planning district energy systems with embedded energy solutions. These study tours should be conducted to countries, such as Sweden, that are truly leaders in district energy.

To meet the planning challenges of energy, municipalities need not only look to the province for direction, but local governments need to prepare their own community energy plans and sustainability plans through an open process that includes community participation. Obtaining community feedback on the plan helps to ensure that program offerings are informed by community needs. Potential strategies for community engagement include reaching out to local elected officials, holding public meetings and charrettes during the planning process, and assessing opportunities to partner with local businesses, community groups, major land holders such as universities and other organizations in bringing energy efficiency information and services to the community. Coordinating a formal community steering committee can also be a useful mechanism for obtaining ongoing input and support.

Municipalities that tackle energy planning are often more attractive to business and industry. Outlining energy efficiency measures, including DE, can help municipalities remain competitive in attracting investment and industry.

For municipalities to move forward with district energy planning, the following points should be carefully considered:

1. Conduct community energy plans to guide sustainable energy practices that are based on a foundation of environmental, economic and social needs. This requires conducting a scan of current conditions and an assessment of future needs.

2. Conduct sustainability plans with a focus on energy efficiency measures and conservation opportunities. Include DE as one of the ways that communities can meet green building design requirements and support community sustainability objectives.
3. Include energy planning considerations as standard criteria that developers need to consider and submit as part of development applications. An assessment should be completed identifying communities or future growth areas wherein DE applications would be suitable.
4. Use existing land use planning strategies and outline the opportunity for DE in official plans, zoning by-laws, transit policies, site plan controls, height and density bonuses, development permit systems, protection of settlement area boundaries, local improvement charges, and community improvement plans. Highlighting these opportunities can help communities attract business and people.
5. Consider the development of district energy systems as a means to increase local energy redundancy and reduce dependency on centralized energy, and as a tool to help guide more sustainable land use planning.
6. Municipal planners should have regard for future community energy demand, and include energy considerations when working on community or municipal projects. If this approach is taken, the benefits of DE systems and concentrated land uses will become evident.

It is important to close this research with a reminder that each community is different; as such district energy planning needs to respond to specific community needs and opportunities. Sometimes, district energy may not be the right choice for a community – in this case, other solutions should be considered including strategies for energy efficiency through land use planning and renewable energy. There is no one-size-fits-all approach to developing a successful portfolio of energy solutions, and the approach should be tailored to meet community goals while making use of available resources.

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