# Advancing District Energy Development in Canada: A Process for Site Selection, Review and Community Participation

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# Executive Summary

Municipalities and businesses are giving greater consideration to the role of energy in the design, development, and operation of communities. As world demand continues to increase and supplies of energy become more difficult to access and more expensive to produce, there is general agreement that the price of energy will rise. It is expected that jurisdictions around the world without a large supply of indigenous energy will be more vulnerable to volatile energy markets. Countries, world organizations, and Canadian provinces and municipalities are beginning to assess various energy risks beyond just the generation or delivery of energy.

Long-term planning for municipal or corporate sustainable growth and economic vitality is requiring an approach that looks beyond traditional areas of concern. For municipalities, planning for population growth no longer just includes potential increases in revenue from property taxes or the requirement to expand urban growth boundaries to accommodate new development. It also requires an understanding of how communities can reduce greenhouse gas (GHG) emissions and local energy consumption.

The same considerations are also true of business. Embracing sustainability is now smart business. Investing in energy security – securing a regular supply of energy at an affordable rate – is as much an opportunity for innovation as it is a priority for maintaining long-term profit and growth. Responding to emerging market forces also means being proactive by reducing risk for investors while, at the same time, achieving savings to the bottom-line. Benefiting from intangible opportunities provided through reduced energy consumption and improved efficiency can bring a competitive advantage.

The implication for municipalities and businesses alike is that inexpensive energy for use in space heating, cooling, transportation and electricity generation will be at a premium. It is generally acknowledged that within the lifecycle of buildings and urban form being created today, changes in the design, efficiency and technology will be required for how we heat, cool and power built spaces and transport people.

Planning for and adapting to energy change begins by asking how energy can become part of an organization's long-term planning process. This report presents the development of a process, as part of the Urban Energy Solutions initiative, which can help decision makers, business leaders and local citizens begin to assess the role of energy in urban regions and how district energy can be part of the solution.

The report provides an overview of the approach developed to identify 10 communities across Canada for the potential application of district energy to assist with urban revitalization, brownfield remediation, community economic development, and sustainable energy conservation. It also outlines the development of an energy selection framework and how the framework can be replicated in urban regions to identify the interest in a community for district energy.

The district energy selection and review process proposed in this report can serve as a useful approach for bringing together stakeholders to assess the potential application of a district energy system in a community, while also helping a community to better understand the role of energy in community growth and sustainable development.

# 1. Introduction

With the rising cost of energy, increasing energy supply demands and growing concerns around greenhouse gas (GHG) and other air emissions, there is considerable interest in applying district energy (DE) systems by all levels of government and within the development community. DE systems are assisting cities across Canada to meet energy conservation goals, minimize energy waste, reduce reliance on centralized grid generation, improve air quality, stimulate economic investment, contribute to the provision of affordable housing and advance sustainable development.

This report is part of a series of products and tools prepared for the Urban Energy Solutions (UES) initiative. The UES is a national knowledge building, outreach and awareness initiative exploring how DE can contribute to local community infrastructure and energy conservation requirements for urban regions. Part of the UES initiative involves encouraging people to become involved in addressing the challenges and being part of the solutions to use DE and expanding the applications of DE to meet energy needs in new urban intensification and revitalization activities.

The report presents an approach developed to identify 10 communities across Canada for the potential application of DE, and the development of an energy selection framework (ESF) to assist community stakeholders with evaluating local interest in the development of a DE system.[i] The report provides lessons from the development of the community site selection approach and identifies the potential for DE systems to contribute to urban revitalization, brownfield remediation, community economic development, and sustainable energy conservation. It also outlines how the process can be applied to engage a broad-cross section of stakeholders to evaluate community interest in DE.

Production of this report has been made possible through a financial contribution from Infrastructure Canada and the Toronto Atmospheric Fund. The collaborative research effort was made possible through contributions by the Canadian District Energy Association (CDEA), the Toronto Atmospheric Fund (TAF), and the Canadian Urban Institute (CUI).

## 1.1. Report Structure

The remainder of this report is organized as follows:

- Sections 2 and 3 outline the approach developed to identify 10 communities across Canada for the potential of DE and presents suggestions for how the approach can be improved and more broadly applied.
- Section 4 presents the energy selection framework and the factors that can be considered for assessing the interest in a community for DE.
- Section 5 outlines how community stakeholders can be brought together using the energy selection framework to discuss interest in advancing with DE in a community.

## 1.2. Defining District Energy

DE is a recognized approach to meet the space heating and cooling needs of residential, institutional, commercial and industrial buildings and supporting processing requirements of local industry. DE systems can use a central energy plant, mini plants (a combination of several smaller systems) or even multiple plants connected through a network of piping to service buildings with space heating, hot water, steam and chilled water. DE systems now have the ability to provide electrical power, also referred to as combined heat and power (CHP). CHP is the simultaneous production of two forms of useful energy (referred to as cogeneration) from a single fuel source, typically electricity and steam. DE systems generally consist of three sub-systems:

- Generation of thermal energy (heating/cooling) and electricity.
- Distribution of the thermal energy from plant sites to a network of end users.
- Transfer of thermal energy to the end user.

For the purposes of this report, DE is defined as providing thermal energy (heat and/or cooling) and/or electricity (through the process of cogeneration) from a central plant or network of plants to residential, institutional, commercial, industrial and municipal customers.

## 2. Approach for Selecting 10 Communities for the Potential Application of District Energy

A four step approach was developed to identify 10 communities across Canada and, within each community, a specific site where DE could contribute to one or more of the following: urban revitalization, brownfield remediation, community economic development, and sustainable energy conservation. In the development of the approach, emphasis was placed on identifying urban form characteristics supportive of DE and a measure, referred to as the GJ energy intensity factor, was developed to classify land use configurations with a particularly high level of energy demand.[ii] Figure 1 provides an overview of the process developed to identify the 10 communities.

Two assumptions made prior to the development of the process for community selection included:

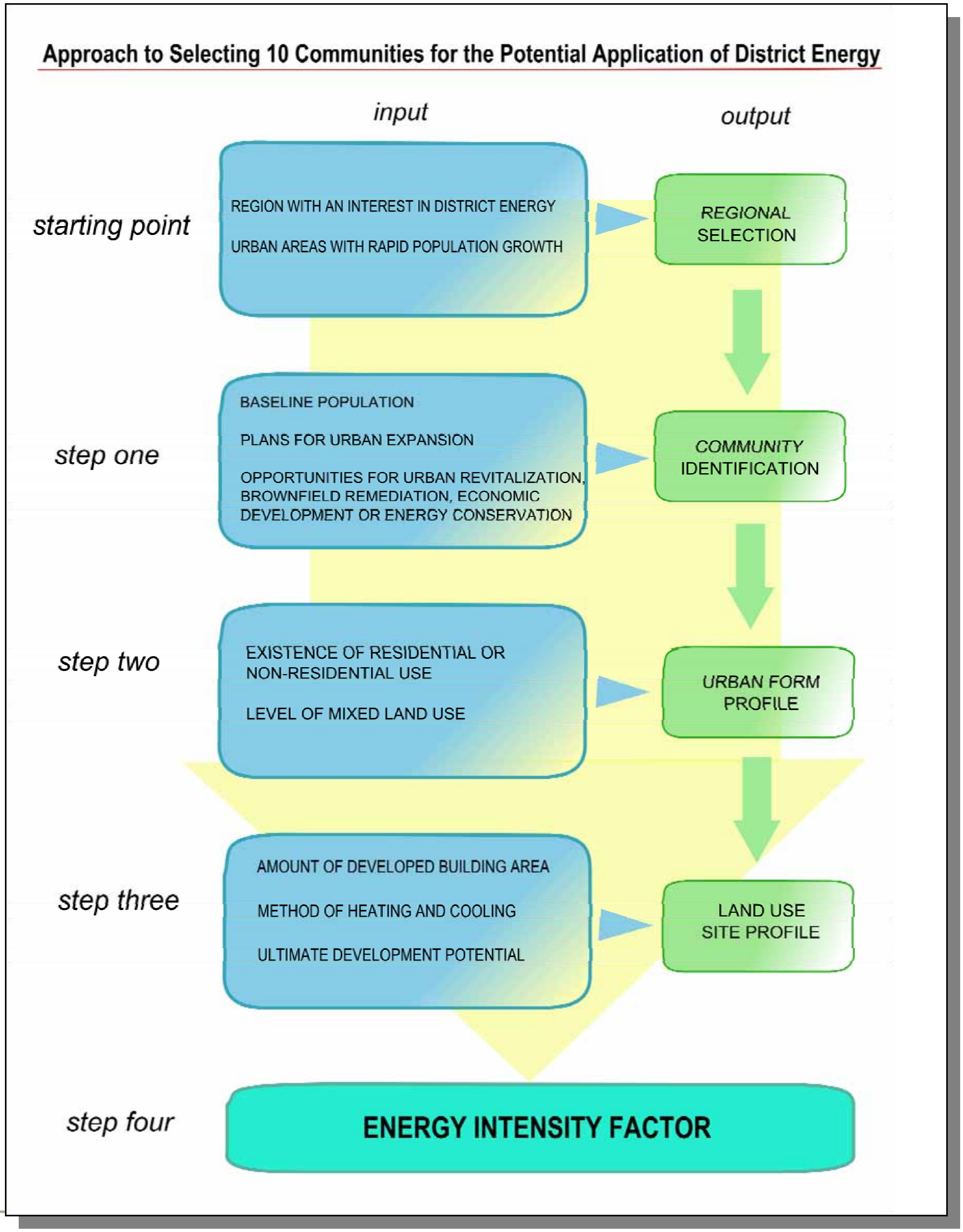
- The best sites for DE are those that have either existing or a high density of heating/cooling energy demand, and that have a mix of land uses to provide stability in energy demand.[iii]
- Higher-density intensities of demand for energy reduce the per unit costs of district energy infrastructure and result in reduced energy losses, increased efficiency and improved emissions reductions compared with conventional energy supply systems.

During the preliminary development of the community site selection approach, it was noted that there are regional variations in energy intensity and mixes of conventional fuels used by each province that can have a direct impact on the commercial competitiveness and financial viability of DE projects. These regional factors were incorporated into the modeling process.

The starting point for community identification involved selecting several provinces where communities had expressed interest in DE and where related Urban Energy Solutions workshops were to be held. New Brunswick, Ontario and Alberta were selected. Within the three provinces, the search for 10 communities was directed towards urban regions experiencing rapid population growth. In Eastern Canada, a number of new census metropolitan areas (CMAs) have been created. Although these areas are not experiencing new growth, the designation of a CMA provides a good indicator that a community will have a high density population within the urban core.

In New Brunswick, the City of Moncton, recently designated as a CMA, was selected. For Ontario the search concentrated on the Greater Golden Horseshoe area, while in Alberta the scan focused on communities in the vicinity of the Calgary–Edmonton Corridor.

**Figure 1 Process for Selecting Communities**



## 2.1. Step 1: Community Identification Using Population Growth

The first step applied was to limit community selection within each of the provinces. To do this, population and land use criteria were used.

The criteria applied included:

- A baseline population. Standard Statistics Canada measures used to classify communities in Canada were selected to define a population baseline. For communities in Ontario and New Brunswick, the Census Metropolitan Area (CMA) requirement of 50,000 people for an urban core was selected. In Alberta, the Census Agglomeration designation of 10,000 people in an urban core was used. Larger communities, usually CMAs, typically have dense concentrations of land uses, and, as a result, are more likely to also have a favourable GJ energy intensity factor requirement. [iv]
- A community that recently enacted or was developing a plan of subdivision, secondary plan or official plan that included a new or expansion of an urban centre, node, or corridor. This criterion was applied to help focus on known characteristics of land-use that are favourable to DE, such as clustering and mixed-use buildings with variable energy load requirements.
- The potential for a community to use DE to assist with integrated urban revitalization, brownfield remediation, community economic development and sustainable energy conservation.

To assist with refining the selection process, only communities with on-line accessible official plans and planning reports containing data on existing and forecasted population and employment, as well as estimated residential and non-residential development were selected.

## 2.2. Step 2: Candidate Site Identification Using Urban Form

The second step involved locating high density, mixed use land areas in each community. This was carried out by obtaining the official plan maps and relevant planning studies. For each community, criteria were applied to select a site for the application of DE.

The criteria applied included:

- High density urban form characteristics in terms of residential and non-residential use (where applicable) whether existing or forecasted, and mixed land use characteristics (residential with office or office with industrial or residential, office and industrial).[v]

Consideration was also provided to the proximity of a candidate site to the siting of a plant or network to reduce capital costs, operation and maintenance, and thermal transmission loss. Within each community, one specific candidate area, excluding the City of Toronto, was selected that met the various criteria tests. Appendix One – Identified Site Land Use Characteristics provides an overview of the land use and built form characteristics identified as contributing to the application of DE in each community.

The 10 communities and 12 candidate sites identified are outlined in Table 1.

**Table 1 Identified Communities for DE**

| Province | Community | Candidate Area Identified |
|---|---|---|
| New Brunswick | City of Moncton | Franklin Yard |
| Ontario | City of Toronto | Scarborough Town Centre |
| | | North York Centre |
| | | North York, Sheppard Corridor |
| | City of Oakville | Palmero |
| | City of Barrie | Waterfront |
| | City of Oshawa | Oshawa Harbour |
| | City of Mississauga | Mississauga City Centre |
| Alberta | City of Red Deer | Aspen Ridge |
| | City of Lethbridge | Southgate Area |
| | City of Aidire | Northeast Community Area |
| | City of Calgary | South East Plan |

## *2.3. Step 3: Development of a Land Use Site Profile*

The third step involved the development of a land use site profile. For each of the 12 candidate sites, the existing and potentially fully developed building area by land use type was prepared using the official or secondary plan maps for each of the candidate sites. Existing population and population change were obtained from census tract(s) using GIS. Other relevant information, including gas and electricity prices were obtained from reviewing local utility rates for each community. Appendix Two - Community Profiles of Potential Locations for District Energy contains summaries for each of the sites identified in a community, including energy intensity statistics, the potential for DE to contribute to sustainable land use development and additional information to assist with assessing the competitive environment for DE.

## 2.4. Step 4: Calculation of the GJ Energy Intensity Factor

The final step was to generate the GJ energy intensity factor for a candidate site. Estimates for the existing and fully developed energy demands for the candidate site, which incorporated regional energy demand factors, were calculated based on a Gigajoule (GJ)/ yr/ $M^2$ . The calculations used to generate the GJ energy intensity factor are provided in Appendix Three – GJ Energy Intensity Worksheet.[vi]

The energy intensity factor, expressed as GJ/ yr/ $M^2$, represents the estimate of space heating, cooling and hot water energy that will be consumed annually per square metre of land for each community at full development (build out as estimated for residential and non-residential). Factors varied from 0.18 to 26.55 GJ/yr/$M^2$. These estimates were based on the annual heating and cooling intensity in each district and represent the consumption of energy inside the building after any losses in generation and transmission of energy.

In a given community, a high GJ energy intensity factor suggests lower infrastructure costs for DE per unit of building development and is a good indicator that further investigation of DE might be considered using the ESF.

For Ontario communities, estimates of energy and GHG emission reductions were made based on representative DE systems in operation in Ontario. It was estimated that GHG emission reductions of approximately 250,000 tonnes/ year of $CO_2$ could be obtained by application of DE for identified Ontario sites. This represents approximately 0.04 percent of Canada's current annual $CO_2$ emissions. The calculations include credits for reduced grid electricity generation based on the Ontario grid mix of fuels used for electricity generation.

Table 2 lists the GJ energy intensity factors identified for each of the candidate sites across Canada. Among the sites identified, North York Centre resulted in an exceptionally high GJ energy intensity factor. This is largely a result of the high residential density already present and continued development of residential high density.

**Table 2 GJ Energy Intensity Factor**

| Province | Community | Candidate Area Identified | GJ Energy Intensity Factor (Gj/yr/M$^2$ at full development build out)* |
|---|---|---|---|
| New Brunswick | City of Moncton | Franklin Yard | 0.23 |
| Ontario | City of Toronto | Scarborough Centre | 3.0 |
| | | North York Centre | 26.55 |
| | | Sheppard Corridor | 2.0 |
| | City of Oakville | Palmero Village | 0.51 |
| | City of Barrie | Waterfront, Downtown | 0.57 |
| | City of Oshawa | Oshawa Harbour Area | 0.76 |
| | City of Mississauga | Mississauga City Centre | 9.71 |
| Alberta | City of Red Deer | East Hill | 0.18 |
| | City of Lethbridge | South Gate Area | 0.68 |
| | City of Airdrie | Northeast Community Area | 0.86 |
| | City of Calgary | Southeast Plan Area (Town Centre) | 0.24 |

* GJ Energy Intensity Factors reported are conservative. Actual energy intensity may be higher in total for each site identified.

Assessing when DE represents a good investment involves a variety of considerations, including the capacity of DE to contribute to a community's energy and planning needs, the existence or development of a sizeable energy demand that can be addressed by DE, and prevalent support for the concept of DE in a community. While the community site selection process developed was not intended to compare the various technical merits of sites, it can assist organizations at the early outset of integrated energy planning to give greater consideration to the potential role of DE in community building. In particular, municipal staff should consider applying the approach as means to model different land use patterns and densities that would support DE as part of a land use development process.

# 3. Lessons from Applying the Community Site Selection Approach

The community site selection approach has the potential not only to identify gaps in information that are important for assessing the potential of DE, but also provide assistance with recording important information on energy use in a community. At the same time, opportunities exist to improve access to information for the identification of DE sites, as well as expand site identification at the neighbourhood level.

Suggestions for how the community site selection approach can be improved, more broadly applied and used to support sustainable community growth are addressed below.

## *3.1. Making Baseline Metrics Accessible*

One of the challenges for implementing the community site selection approach identified was obtaining estimations for residential and non-residential development growth, as well as accessing information on existing residential and non-residential development for a community. In some cases, municipalities examined provided estimated residential development in terms of number of units and not the total floor area (a measure important for estimating space heating and cooling requirements for DE). As well, there was also difficulty experienced in distinguishing on community land use maps where residential and non-residential boundaries for a candidate site ended. To address these challenges, detailed mapping and average residential unit sizes were calculated to approximate the fully developed floor space density (floor area per square meter of service area) of residential development within a candidate site. To assist with identifying potential sites for DE, municipal officials should be encouraged to make available the amount, type and location of housing units and total floor area, population growth, and non-residential development for a community. This will enable preliminary estimates of energy demand to be quickly generated and facilitate a priority setting process for the establishment of or expansion of a DE system.

## *3.2. Applying Broader Identification Criteria*

There are several additional criteria that can be applied to improve the identification of land uses supportive of DE. These include:

*Minimum floor space densities for development*. The type and arrangement of a community's land use has a direct effect on the GJ energy intensity factor. Establishing a minimum floor space density (floor area per square metre of service area) can contribute to identifying a suitable service area for DE. In compact and high density floor space areas, the heat load per metre of piping for DE is generally high and installation of a DE system potentially less expensive per unit of development when considering costs associated with pipe installation in private and public right-of-ways and easements. For low density floor space, the heat load per metre of pipe is smaller and installation costs are, therefore, more per unit of development.[vii]

*Energy intensive land use configurations conducive to DE*. Generally, DE is well suited to areas that have a high residential or non-residential density, as well as a winter and summer peaking demand, such as a central business district. Land use configurations that have a high level of continuous energy demand are also good locations for DE. These can include: nodes, corridors, and urban/town centres. Multiple buildings and campuses under single land ownership is another good proxy for identifying optimal land use configurations for DE and can include: universities, hospitals, institutions and government agencies. Additional land use configurations that can support DE include: clusters of building (i.e. shopping centres, commercial parks, high-rise residential complexes or transit oriented development), and low density residential areas.

*Processing activities with a high intensity thermal load requirement*. Traditional areas requiring large volumes of steam, hot water or both include industrial processing facilities. Combined heat and power (CHP) and industrial process are a natural fit, since there is a constant demand for thermal energy. In urban regions, light industrial facilities are more likely to be the prevailing land use type. Examples of these industries include: food processing facilities, greenhouses, agricultural applications, and municipal organic waste processing stations.

## *3.3. Supporting Sustainable Community Growth*

The community site selection approach can be used to assist communities with evaluating managed growth and innovation. Several applications are outlined below.

*Identify opportunities to achieve GHG reduction goals.* Municipalities across Canada are developing comprehensive GHG emission inventories for reduction plans as part of moving towards a sustainable future. In undertaking the community site selection approach, potential reductions in energy consumption and GHG emissions were identified for Ontario communities when connected to a DE system. In some communities across Canada, GHG targets are being aligned with various green municipal infrastructure programs, including the establishment of CHP systems, to reach targets. Municipalities can enhance inventories by applying the community site selection approach to identify GHG reductions with the establishment of a DE system in an existing neighbourhood or proposed new sub-division.

*Generate information for modeling energy consumption and reduction*. Information generated from the community site selection approach can be quickly converted into powerful visual maps through GIS systems allowing for the storing, analysis, and management of various attributes related to a site for DE. Multiple variables can be recorded and assessed, including total service area, density, peak heating demand, heating utilization, ground type, total energy demand and cost of pipe installation, utility rates, development restrictions, land use designations and other variables. Incorporating community service utility information on roads, sewer and water networks, street lighting and vegetation can also help to assess additional costs and limitations for DE systems early on in the site location process. Providing publicly accessible maps and data on local underground utility and community energy information enhances the ability of energy developers and other businesses interested in developing and delivering DE systems in a community to perform early engineering risk assessments.

*Contribute to advancing land use and economic goals.* As part of the community site selection approach, consideration was given as to whether a DE system could assist with integrated urban revitalization, brownfield remediation, community economic development, or sustainable energy conservation. For each community identified, DE was noted to have the potential to reduce GHG emissions and energy consumption.

It was also observed that when applying the community site selection process, DE could contribute to or complement various community development objectives including:

- Intensification for greenfield development, in terms of encouraging higher density and more compact development.
- Integration of different urban forms, such as residential and non-residential.
- Stimulate economic development investment, particularly for brownfield reinvestment.[viii]

Appendix One – Identified Site Land Use Characteristics provides a more detailed discussion of the contribution of DE to integrated urban revitalization, brownfield remediation, and community economic development.

# 4. Development of an Energy Selection Framework

The development of a DE system is a multi-stage process. Major stages of a system development include market assessment, technology analysis and conceptual design and system implementation and operation. At different stages of DE development, decisions are required on whether to proceed with implementing a DE system, as well as system design. Increasingly, project specific information is needed to advance with the development of a system. Information is required to help decision-makers to: assess energy demand and supply factors, system distribution options, environmental and social-economic considerations, as well as issues related to system financing and ownership. A list of factors identified during the development of the energy selection framework focused on the design and development of a specific DE system are provided in Appendix Four - District Energy System Specific Factors.[ix]

A number of system assessment and design methodologies have been prepared to aid organizations with reviewing the major considerations for DE. A few of the processes, such as one developed by the Washington State University, Extension Energy Program, address aspects related to the potential thermal market demands required for the competitive opportunity of CHP systems.  More technical approaches using software, such as the HEATMAP/TM©, provide a highly integrated analysis of extensive technical, economic and environmental information regarding a specific application for DE.[x]

While the above assessment methods provide a solid economic and technical analysis of the potential for DE in a community, few assessment approaches stress the importance of identifying the general conditions, with regards to community interest and supportive frameworks, required within a community for advancing DE.

Through interviews with plant owners and operators, planners, engineers and others involved with DE across Canada, as well as a review of existing assessment processes used in the U.S. and Canada, an ESF was developed that could assist organizations in assessing the potential interest in a community for DE. To contribute with integrating land use considerations into the review process, criteria developed for the community site selection approach were incorporated into the ESF under the  Energy Market Optimization category.

Eight broad based categories and 16 factors where identified as contributing to measure the interest in a community for DE, as well as basic site criteria for the establishment of a DE system. The relevant factors are enumerated under the eight category headings. The categories and factors were divided into two streams – the first set of factors identified focus on assisting communities to evaluate community wide issues, while the second set of factors address the practicality of DE for a specific site within a community. An overview of the relative importance of each factor for measuring the interest and viability of DE is provided in Appendix Six – Energy Solutions Framework Factors, as well as the ESF worksheet.

**Community wide issues identified include:**

*1. Sustainability At the Community Level*

Municipalities across Canada are responding to the impact of climate change and acting to reduce local activities that contribute to increased energy consumption and GHG emissions. Some municipalities are responding by developing comprehensive action plans that provide clear targets for energy and GHG reductions through the built environment, while other communities are enacting new guidelines and legislation that encourage decentralized energy production. Municipalities that have identified energy as part of long-range planning or a central objective of managed community growth are likely to be more receptive to the potential application of DE. Key factors identified:

Factor 1: Established community energy and GHG reduction targets and implementation program
Factor 2: The incorporation of energy into decision-making processes
Factor 3: Identified community leadership and support (of a public or private nature) for GHG and energy reduction

*2. Resiliency and Security of Supply*

Communities across Canada are faced with the twin threat of energy security and climate change. Major weather events such as the 1997 Red River Flood in Manitoba emphasized the value of effective mitigation measures. The 1998 ice storm in eastern Ontario and Quebec, and the 2003 blackout that left the Eastern seaboard without power confirmed the vulnerability of local communities to an overly centralized power grid. As world energy prices continue to rise due to increasing demand and tighter supply, energy security has become an issue of importance for municipalities with regards to providing affordable energy for space heating and cooling, transportation and electricity generation. Municipalities and businesses concerned with energy security and impact of climate change on day-to-day economic activities are likely to consider DE an important option for minimizing risk. Key factor identified:

Factor 4: Concerns for thermal and electricity supply/ resiliency and security

*3. Knowledge, Know-How and Technical Skills*

Advancing DE projects from start to finish requires a broad-based team of experts with a diverse array of experience and skills. As well, there is increasing recognition that in order to achieve the benefits of a high performance building and community development, DE design teams need to be involved from day one of a project in order to apply an integrated design process (IDP) and achieve the highest efficiency levels possible for a DE system. IDP focuses on assessing every phase of construction comprehensively, from site selection of a building to the selection of the HVAC system, to ensure the maximum environmental potential of a building is achieved. Some smaller and medium-sized communities and organizations might not have the technical skills to adequately evaluate DE projects or undertake larger scale project management. Access to local expertise on DE can enhance the development of any project. Key factor identified:

Factor 5: Access and availability of experienced DE design team

*4. Legislative Authority*

Provincial governments across Canada are providing communities with more regulatory flexibility to encourage distributed and decentralized power production. While municipalities have a great deal of direct and indirect influence over energy use through land use planning, building codes, and municipal operation, restrictions remain on the ability of some municipalities to establish electrical or energy based utilities or influence energy use within local building stock directly. Municipalities with authority to invest in energy related businesses and planning frameworks encouraging DE are in a good position to advance DE development. Key factor identified:

Factor 6: Support for DE from local and provincial policies

*5. Capital Access and Partnerships*

DE is a capital intensive technology that requires front-end investment by the developer or owner/operator and, to a lesser extent, end users to replace or retrofit existing in-building systems to connect to a DE system. One of the main constraints to the development of a DE system is securing sufficient funds to cover the feasibility studies, customer conversions and for capital investments. Financers and developers consider DE to be a more financially challenging investment than other supply options stemming from the long lead time required to establish a network, begin revenue production and build sufficient customer demand for substantial revenues to be generated. Because of the long payback period of a DE system, private sector investment is difficult to achieve upfront. Municipalities and businesses involved in public private partnerships are likely to understand the level of public sector involvement required to allocate risk among the parties and for accessing required capital for project start-ups. Key factor identified:

Factor 7: Community comfort and experience with cooperative ventures

*6. Market Demand and Business Drivers*

Municipalities are increasingly faced with deferred infrastructure deficient and are seeking to lower long-term costs for infrastructure services, while also improving return on investments through delayed capital outlays and lower maintenance costs. On the other hand, businesses are concerned with asset management and are focused on achieving savings to the "bottom-line", as well as benefiting from intangible opportunities, such as improved worker productivity from better designed buildings. Municipalities and businesses seeking to reduce risk, or are in the process of revitalization infrastructure activities, are in a good position to consider the benefits provided by DE.

Key factors identified:

Factor 8: Requirement to expand or renew energy infrastructure and other community services

Factor 9: Private and public sector interest in direct and intangible benefits of improved building operation

**Site specific issues identified include:**

*7. Competitive Environment*

The wide spread application and uptake of DE has been limited by competing interests, including regulated utilities, both public and private, promoting their respective services and fuel services resulting in a notable disinterest in diversification into DE. An important consideration for the financial success of a DE project also includes being competitively priced against local prevailing fuels or energy services. Expansion of combined heat and power (CHP) has also been affected due to an inability to receive a fair market rate for the production of electricity in some provinces and various utilities levying asset charges, backup rates or imposing prohibitive interconnection arrangements. Communities with public or private utilities expressing interest in lowering energy consumption, GHG emissions, or protecting a customer base and improving load profiles are likely to be supportive of DE. Key factors identified:

Factor 10: Fossil fuel intensity of grid electricity
Factor 11: Cost of conventional fuel
Factor 12: Duration of cooling season

*8. Energy Market Optimization*

DE systems need to be close to the potential market users to achieve optimal system and economic performance. This requires the siting of plants and networks in high visibility areas within a community. Although there is interest in reducing reliance on centralized energy, encouraging alternative and renewable generation and reducing GHG emissions by residents and businesses in a community, local opposition can result due to concerns from impacts of local emissions, noise, and aesthetics. In addition to addressing potential local concerns related to the establishment of a DE system, careful consideration is also required for the integration of a system with existing uses (built form and thermal demand), permitting and regulatory constraints, and with properly assessing population growth and land use development. Communities with supportive residents of climate change initiatives and energy reduction goals, as well as established estimations for residential and non-residential development are well placed to assess DE. Key factors identified:

Factor 13: Mix of different land uses and urban form
Factor 14: Compatibility of DE with built form
Factor 15: Existing energy intensity
Factor 16: Energy intensity at full development (GJ Energy Intensity Factor)

## 4.1. Applying the Energy Selection Framework

The ESF is designed to be applied as a questionnaire by any organization in a community without significant professional assistance to assess whether local community conditions favour DE. It is not intended to be used to make evaluations or comparisons on the suitability of a DE system in one province, region or community versus another.

The ESF can also be used without the need to identify sites in a community with a high GJ energy intensity factor. However, it is recommended that a short list of sites for consideration be prepared using steps 2, 3 and 4 of the community site selection process. This can contribute to developing a better understanding on the different land configurations supportive of DE and provide an early assessment of the challenges for advancing with a DE system.

The factors outlined for consideration in the ESF are not exclusive. There are many factors that can be used to screen for the interest of DE. In the development of the ESF, consideration was given to the importance of addressing regional specific issues that might be of greater interest and importance to a community. For instance, some communities might want to ask questions that address more technical issues related to combined heat and power (CHP). The ESF can be modified as necessary to address the issues of importance to a local community.

The process undertaken to apply the ESF will have an important impact in the success of implementing DE in a community. It is expected that the ESF will be completed in a facilitated workshop environment by interested individuals from a broad-cross section of a community. This will help to ensure that all relevant issues related to DE are discussed and evaluated early in the screening process, as well as provide a higher probability that subsequent decisions on DE will be supported by a wider range of stakeholders.

### 4.2. Use of Variable Weighting

The ESF uses a weighting process to help assign a score to evaluate community interest for the establishment of a DE system. The weights assigned reflect the relative importance of each factor in assessing the potential of DE and are entirely subjective. Higher priority was placed on various factors that have an impact on the potential economic performance and on the design of a DE system. Appendix Six – Weighting Values for the Energy Selection Framework outlines the rationale for each of the weighting factors assigned in the ESF.

The ESF is designed to allow for the comparison of multiple sites within a community. When applying the ESF, it was assumed that only relevant factors deemed important for assessing a site would be scored for consideration. It is expected that communities will only apply the community wide factors at the outset of an evaluation process and not to each site identified as a potential location for DE.

### 4.3. Interpreting the Scoring

The ESF score is entirely open to interpretation and discussion. High scores indicate a good potential for DE both in the community and for specific site(s). Lower scores suggest that there might be greater difficulty in advancing DE within a community or at a specific site.

The importance of obtaining consensus on the types of factors of importance to a community for evaluating DE will be largely decided upon by ensuring the participation of a broad-cross section of stakeholders in the ESF process. The interest and discussion created by the application of the ESF might generate creative solutions and be of more value and interest than any number produced in the evaluation process.

# 5. Focusing Community Stakeholder Interests Using the Energy Selection Framework

There are a number of reasons why community members and businesses may begin to look at alternative ways to meet local energy demands. Some communities might become involved in the process as a response to concerns over heavy reliance on imported fuels or as a result of examining options for waste disposal within the community.  Often, the process begins by examining how energy is being incorporated into the long-term growth and sustainable development of a community.

As a community begins to consider the use of DE, the identification of stakeholders will become increasingly important for assessing the potential interest in advancing DE. Municipalities are well positioned to identifying key stakeholders and begin a discussion on the opportunities provided by DE.  They represent the interest of all businesses and residents, and tend to recognize the benefits and challenges of implementing DE at the broadest level.

Stakeholders for a DE initiative can include businesses, governments, and organizations that are involved in the design, build and operation of a system. Local, regional, provincial and federal authorities are important public stakeholders since many of the benefits of a DE system are societal.  Public stakeholders in a community, including the federal government and local school boards may own, operate, or lease a large portfolio of properties. Their involvement early on in the development of a DE project could also contribute to improving the economics of a DE system, particularly if a public institute is identified as a benefiting customer.

Additional stakeholders to consider involving in the development of a DE system include the largest potential customers and suppliers of thermal energy to a network (e.g. local industry, and larger institutions with existing thermal capacity).  Not only will large users, thermal providers and public stakeholders benefit from the operation of a DE, but their energy requirements will likely directly influence the design of a system and contribute to greater flexibility in system design to accommodate future needs.

Table 3 provides a listing of some of the known stakeholders that can become involved in the decision making process for DE.

**Table 3 Stakeholders Involved in District Energy**

| Areas of Interest | Stakeholders |
|---|---|
| Federal Government | Natural Resources Canada |
| | Public Works and Government Services |
| | Department of National Defence |
| | Finance Department |
| | Environment Canada |
| | Crown Corporations, ex Canada Mortgage Housing Corporation, Canada Lands Corporation, Canada Post |
| Provincial Government | Ministry of Energy |
| | Ministry of Environment and/or Parks |
| | Ministry of Infrastructure |
| | Ministry of Planning and Municipal Affairs |
| | Provincial crown agencies and ABC, such as Energy Boards |
| Municipal Government and ABCs | Planning |
| | Engineering and Works |
| | Infrastructure |
| | Permits and Licenses |
| | Building Standards/ Real-Estate |
| | Local Utility |
| Utility Companies Private and Public | Electricity, Gas and Alternative Energy Company |
| Private Companies | Professionals (Designers, Architects Engineers) |
| | Equipment Suppliers |
| | Building Owners, Managers and Developers |
| | Financial Institutions, Pension Funds and Investors |
| | Independent power producers |
| Independent Groups | Federation of Canadian Municipalities |
| | Canadian District Energy Association |
| | Environmental Groups |
| | School Boards |
| Community and Users | Benefactors of DE – Building occupants, residents, etc. |

Source: Modified table derived from The Sheltair Group, *Community Energy Systems: A Study of the Sector, and Analysis of Opportunities and Barriers and an Assessment of Potential,* 1999, p. ix.

As a result of the number of stakeholders that can be incorporated into a decision making process for DE, various challenges can arise impacting the interest to begin a discussion on DE in a community, including:[xi]

- Difficulty for a distinct 'voice' to emerge as a champion for advancing DE.
- Likelihood for conflicts among stakeholders and the potential for long delays in arriving at consensus decisions.
- Not seen as complementary to community activities underway to address GHG and energy reduction, adaptation and impact planning, and emergency management preparedness.
- Reluctance of stakeholders to become involved in a discussion that might encourage local utility and energy service provider competition.

- Tendency to focus only on a technical discussion concerning technologies for use in a DE system.

The ESF is designed to connect a broad-cross section of stakeholders involved in any local project and to generate a discussion on DE by encouraging stakeholders to focus not just on the technical and financing challenges of a DE system, but also on the broader social, environment and economic benefits which can be provided through the establishment of a DE system.

The ESF can be used to:

*Develop partnerships and strengthen linkages between stakeholders* – This can be done by using the ESF as a method to scan for local actors, initiatives and related activities to the development of a DE system. The ESF is not a substitute for established community consultation approaches; however, it can contribute to creating an open two way discussion on the merits and challenges for developing a DE system. Key participants should include the full spectrum of community interests, including public and private sector decision makers, government officials, local utility representatives, works and infrastructure staff, researchers, energy and building practitioners, and building owners and operators.

*Enhance stakeholder knowledge of DE* – Assembling a group of knowledgeable and influential individuals in the community provides for an opportunity to address potential misconceptions about DE, reaffirm community objectives that can be addressed by DE and foster collaboration. The ESF does not require a group of individuals to have an in-depth knowledge of DE technologies or experience with the best approach for ensuring the successful design, development, finance and operation of a system. Alternatively, the process can begin to convey general information important for decision-making throughout the design and development of a DE system including potential energy requirements, the level of integration of energy into municipal planning, financing options, and familiarization with the technical, environmental and socio-economic factors of DE.

*Enable stakeholders to become better informed on the challenges and solutions to implementing DE* – The ESF can contribute to helping community stakeholders begin to identify where information gaps exist in understanding what might limit the success of a DE project. Understanding the challenges early on in the decision-making process can help better define the project and avoid costly delays.

The ESF does not set out how participants should be approached or the process that might be taken to encourage active participation of all stakeholders. Arrangements for initial stakeholder engagement should include using experienced professional community consultation assistance. In addition, as communities advance with the application of DE, early involvement of experts with advanced knowledge of DE systems and sustainable building design will be required to guide the decision making process. Arranging to have experts involved early on in the ESF process can help ensure constructive dialogue among all stakeholders.

Several well developed programs have been launched by Natural Resources Canada, Community Energy Planning and the Canadian District Energy Association (CDEA) that work to bring together a variety of stakeholders to discuss the potential of DE. Natural Resources Canada (NRCan) has developed a comprehensive Community Energy Planning Guideline that can assist communities with advancing development of community plans to reduce overall energy consumption, while the CDEA has prepared workshops and charrettes to explore the potential of DE to address local energy infrastructure requirements and challenges to implementation.[xii]

# 6. Conclusion

Development of a DE system is complex. It requires consideration for the interaction of land use policies and energy supply goals, the support of senior decision makers at the public and private level, an open dialogue between planners, engineers, utility operators and developers, as well as an informed and involved citizenry. The process outlined in this report for identifying sites with a high GJ energy intensity and for assessing community interest in DE can contribute to improving the overall quality of life in urban regions, by helping communities to better understand the role of energy in community growth and sustainable development.

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[i] This report is not intended to replace required technical feasibility assessments for DE, including demand forecasts, energy and economic modeling, identification of potential heat sources, assessment of thermal and building distribution technology, maintenance and operation requirements and other technical assessments required to make informed decisions on the design and development of a specific DE system. The report is intended to establish a process to assist organizations at the early outset of integrated energy planning to give greater consideration to the potential role of DE in community building and allow for the early identification of multiple locations within any community for DE.

[ii] Standard industry practice for identifying potential locations for the establishment of DE systems within a community can involve many factors. Most approaches begin by cataloguing the thermal resources – the types of alternative, renewable, fossil and waste heat fuels used in a community – to supply heating, cooling and electrical needs.

For the purposes of identifying urban form characteristics more supportive of DE, emphasis was placed on obtaining a relative measure that could reflect the potential number of customers that might use a system once fully operational. Consideration was given to applying standard industry measures including thermal load density (energy load per unit of land area) and thermal load factor (ratio of total annual energy use to total annual consumption). Both thermal load density and load factor are critical measures required for DE system design and for modeling financial feasibility.

In order to extract a measure that would identify land use configuration requiring a high level of energy demand, thermal load density was selected. Thermal load density generally includes all thermal energy required to meet space, water and industrial processes for heating and cooling in residential, commercial, institutional and industrial developments. In this report, we have created a proxy measure, referred to as the GJ Energy Intensity factor, which provides a relative measure of thermal load intensity. Due to the variation of communities examined, a scoped exercise was undertaken with some information being aggregated or approximated for a community and, subsequently, not all information required for a thermal load density measure collected.

[iii] A number of Canadian and U.S. reports have documented the importance of interrelating land use mix and population/employment density with thermal density and factor load including the MacRae, Morgan. Realizing the Benefits of Community Integrated Energy Systems. (1992). Canadian Energy Research Institute's*.;*and*,* Bloomquist, R.G. ; Nimmons, J.T. ; Rafferty, K. *District Heating Development Guide, Legal, Institutional and Marketing Issues. (1988).* Successful district energy systems are an integral part of a community's planning, design and development. By encouraging land use planning to consider long-range energy requirements and opportunities for energy efficiency, a greater opportunity exists to encourage the development of compact urban form through various planning practices and polices, as well as establish a land-use framework that is more conducive to DE.

[iv] General breakdowns for the community screening were developed using Statistic's Canada Standard Geographic Classifications. For the purposes of the census, Statistics Canada uses a variety of standard geographical entities to perform analysis of economic and social data. Two commonly applied measures used in Canada to define urban areas include Census Metropolitan Areas (CMA) and Census Agglomerations (CAs). For a community to obtain classification as a CMA, it must have an urban core minimum of 50,000 people and must have a population of at least 100,000, while a CA status requires a minimum of 10,000 people in the urban core. CMAs and CAs are further subdivided into census subdivisions (CSD) if the entire CSD falls within the urban core. To assist with refining community selection–communities with a CSD designation where selected.

[v] The majority of sites selected were based on data that could be obtained through official plans and secondary plans concerning existing and forecasted population, developed area by land use and employment growth from planning departments.

[vi] One gigajoule equals 1 x $10^9$ joules. A joule has become the international unit of measure of energy and is used by most government agencies across Canada when analyzing energy reduction opportunities and financial incentives. The GJ was selected over other common metric measures of energy because of the use of GJ with national assessment standards used across Canada, such as the Canada Green Building Rating System, Model National Energy Code for Buildings and the EcoLogo labelling program.

[vii] For more information on how to use floor space density for evaluating the potential for DE see Wiggin Michael. *District Energy Economic Assessment of Distribution Networks.* Natural Resources Canada (date unknown) Available from: www.cetc.nrcan.gc.ca

[viii] For a comprehensive overview of the ability of DE to contribute to community economic development, integrated urban revitalization/intensification, and sustainable energy conservation, please visit www.cdea.ca/decrc to download informative case studies on Canadian and U.S. plants and networks enhancing community growth and development.

[ix] A comprehensive examination of the various steps involved in the design and development of a DE system is provided in a guideline developed by the State of Minnesota, Planning and Management Services, *District Heating Planning in Minnesota: A Community Guidebook*. Available from: http://www.hud.gov/. Additional information is available from: Skagestad, Brad and Mildenstein, Peter. *District Heating and Cooling Connection Handbook.* International Energy Agency. (2002); Maker, Timothy and Penny, Janet. *Heating Communities with Renewable Fuels: The Municipal Guide to Biomass District Energy* (1999). Natural Resources Canada and United States Department of Energy; and, FVB Energy Inc. and The Sheltair Group. for the City of Vancouver. *Potential Heat Sources for Neighbourhood Energy Utility*, *City of Vancouver, False Creek Precinct.* (2006).

[x] Heatmap is a software tool that can assist designers, planners, engineers, operators, facility or physical plant managers, and owners with comprehensive simulation of existing and proposed DE systems, including combined heat and power. The software provides technical economic and air emission information on DE system that can be used for evaluating existing system performance and for modeling alternative system strategies.

[xi] Limitations impacting the development of DE are well documented in Canada in several reports including: Edwards. G. *Overcoming Barriers to Implementation of District Energy Projects Volume 2.* Canadian Energy Research Institute. (2000); and The Sheltair Group. *Community Energy Systems: A study of the Sector, An Analysis of Opportunities and Barriers and an Assessment of Potential Measures*. (1999).

[xii] For more information on the NRCan community energy development assistance, please visit www.sbc.nrcan.gc.ca. For information on the CDEA workshops, please visit www.cdea.ca.

# 7. Appendices

**Appendix One – Identified Site Land Use Characteristics**

It was observed during the community site identification process that DE systems can contribute to various community development objectives, such as intensification for greenfields, integration of different urban forms and community economic development. Table 1 provides an overview of where DE could contribute to integrated urban revitalization/ intensification, brownfield remediation or community economic development for each of the identified community sites.

*Encouraging Intensification Using Mixed Use Development*

Mixed use development – concentrations of residential, commercial, industrial, office, institutional, or other land uses – are recognized as helping to create places where people can live, work, play and meet everyday shopping and lifestyle needs within a single neighborhood. Mixed use developments also contribute to creating pedestrian friendly environments, while supporting various forms of high order transit, such as light rail.

DE systems can aid in pulling together the various land use types and built form required to create a mixed use community. For instance, a DE system can meet all of the thermal and electrical needs of the various built forms in a mixed use community. DE systems also assist to create compact urban form, particularly in new greenfield development, by catering to high density development which has a high thermal and electrical demand, and by concentrating development closer together through the use of piping infrastructure.

Integrating different land uses also contributes to community economic development. For instance, a mixed use development generally incorporates some form of office space. Office development within a mixed use area provides advantages to employers, such as improved access for employees to transit, which can help retain and attract talented workers, as well as increased savings by not having to contract out for services normally required for a corporate campus environment.

The benefits of locating in a mixed use development can be further enhanced from the savings provided by a DE system. Building owners who connect to a DE system in a mixed use environment receive the added benefit of reduced capital costs by not installing an on-site energy system, reducing operational and maintenance costs, and can improve returns by having more space available from the removal of large boilers or chillers for income production or other purposes.

*Stimulating Economic Development Investment and Brownfield Remediation*

Another contributing land use benefit of DE systems is the capacity to serve as a strategy to contribute to brownfield remediation and intensification in urban centres. Real estate developers and investors have tended to shy away from brownfield sites where real or perceived issues of environmental liability exist. Whether a site is contaminated or not is secondary to the risk presented in terms of a developer or investor willing to invest time or money in the revitalization of a site. This has caused valuable and accessible lands in urban environments to lie dormant and contributed to developers and builders pursuing greenfield type developments.

The challenge for municipalities is to improve sites to a state where developers or investors find them attractive to development. In addition to various financial incentives in use to encourage private sector investment, such as tax breaks and loans, DE provides an equally attractive financial proposition by lowering initial upfront capital investments for heating and cooling systems, as well as reducing financial risks for prospective developers and building owners in terms of operating an on-site energy system.

Incorporating DE systems as part of revitalization strategies and greenfield development can contribute to creating a more attractive development opportunity, produce significant environmental gains and further economic growth.

Table 1 – Identified Site Land Use Characteristics

| Province | Community | Candidate Area Identified | Contribution of DE* | Major Land Use(s)† | Built Form |
|---|---|---|---|---|---|
| Ontario | City of Toronto | Scarborough Centre | Urban Revitalization | Residential & Commercial | High-rise |
| | | North York Centre | Integrated Urban Revitalization | Mixed Use | High-rise |
| | | North York, Sheppard Corridor | Integrated Urban Revitalization | Mixed Use | High-rise, Mid-rise |
| | City of Oakville | Palmero Village | Urban Intensification | Commercial & Residential | Row Mid-rise |
| | City of Barrie | Waterfront, Downtown | Integrated Urban Revitalization | Mixed Use | Mid-rise and Smaller |
| | City of Oshawa | Oshawa Harbour Area | Brownfield, Community Economic Development | Commercial & Residential | T.B.D |
| | City of Mississauga | Mississauga City Centre | Integrated Urban Revitalization | Mixed Use | High-Rise |
| Alberta | City of Red Deer | East Hill | Urban Intensification | Mixed Use | Mid-Rise |
| | City of Lethbridge | South Gate Area | Urban Intensification | Residential & Commercial | Detached Homes, Power Centre |
| | City of Airdrie | Northeast Community Area | Urban Intensification | Mixed Use | Mid-Rise and Smaller |
| | City of Calgary | Southeast Plan Area (Town Centre) | Urban Intensification | Mixed Use Core, Residential Periphery | Unknown/T.O.D. |
| New Brunswick | City of Moncton | Franklin Yard | Brownfield, Community Economic Development | Residential & Future Mixed Use | Brownstones |

| * Contribution of DE nomenclature defined: | |
|---|---|
| Integrated Urban Revitalization: | A revitalization and intensification process that involves little or no public investment and is achieved through increasing the level of integration between sectors working in the fields of natural environment, built environment, and socioeconomics with stakeholders. |
| Community Economic Development: | CED is a process used to entice employers to locate in a community thus providing new or higher paying jobs in order to stimulate demand for land and increase the assessment base and improve quality of life. |
| Brownfield Site: | Sites that have been used previously for some urban, industrial, or other use which is no longer viable and therefore can be redeveloped for a new use. Brownfield sites often face the expensive challenge of soil remediation. |
| Sustainable Energy Conservation: | The concept of developing energy solutions which conserve fuel resources, are increasingly environmentally sustainable, and involve educating energy users about conservation in the household/workplace. |
| † Built Form Definitions: | |
| Brownstone / Row: | A style predominant in New England architecture, 1800-1900. 3-5 storey single family (typically) row houses. |
| Detached Homes: | Single family detached dwelling units. |
| High Rise: | Residential or Commercial Buildings taller than 10 storeys. |
| Mainstreet-Row: | Traditional mainstreet retail row development typified by ground level retailing or professional office activities. |
| Mid-Rise: | Residential or Commercial buildings ranging from 4-10 storeys. |
| Power Centre.: | Large "big-box" retail agglomerations, typified by large parking lot areas. |
| Unknown/T.O.D.: | An area where built form has not been specified but will be impacted by Transit Oriented Development policies. |

## Appendix Two - Community Profiles of Potential Locations for District Energy

Profiles were prepared for each of the identified 12 sites for DE (see Table Below). The profiles contain brief descriptions of community demographics, energy intensity statistics, local fuel costs, and context maps illustrating various types of land uses.

**Table: List of Profiled Communities for DE**

| Province | Community | Candidate Area Identified |
|---|---|---|
| Ontario | City of Toronto | Scarborough Centre |
| | | North York Centre |
| | | North York, Sheppard Corridor |
| | City of Oakville | Palmero Village |
| | City of Barrie | Waterfront, Downtown |
| | City of Oshawa | Oshawa Harbour Area |
| | City of Mississauga | Mississauga City Centre |
| Alberta | City of Red Deer | East Hill |
| | City of Lethbridge | South Gate Area |
| | City of Airdrie | Northeast Community Area |
| | City of Calgary | Southeast Plan Area (Town Centre) |
| New Brunswick | City of Moncton | Franklin Yard |

# POTENTIAL LOCATION FOR DISTRICT ENERGY:
Scarborough Centre, Ontario

The Scarborough Centre is one of many rapidly growing areas in the City of Toronto. Characteristics of the area include:

- a community vision that includes the creation of a centre of cultural, governmental, retail, and business uses;
- between 1996 and 2001 the population in census tracts within and surrounding Scarborough Centre grew at a rate of 11%;
- most of the recent growth in the area has been caused by intense residential development;
- the area is designated in the Provincial *Growth Plan for the Greater Golden Horseshoe* as an Urban Growth Centre with a target density of 400 people-and-jobs per hectare by 2031;
- its role as an inter-modal transit hub;
- the Scarborough Rapid Transit System is expected to be upgraded with new, larger rapid transit vehicles;
- the presence of a large regional shopping centre, the Scarborough Town Centre;
- municipal *Green Development Standards* and a *Climate Change, Clean Air and Sustainable Energy Action Plan* that call for increased use of district energy; and,
- access to data sources and information needed to calculate DE potential.

## Energy Intensity Statistics

Ultimate Energy Intensity:
3.0 GJ/yr/m2

Potential Energy Consumption Reduced: 1,296,000 GJ/yr

Potential GHG Reduced:
64,000 Tonnes/yr

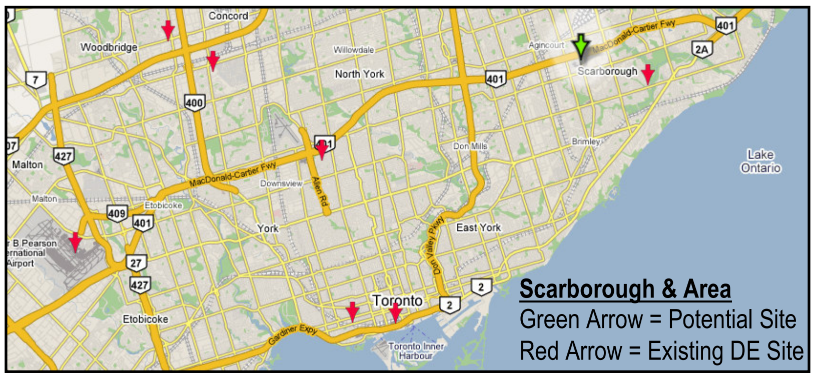
*see associated table for notes

**Canadian Context Map**

## Potential Contribution of DE:
Integrated Urban Revitalization

## Site Statistics for Scarborough Centre:

Population (2001): 22,546
Population Growth Rate: 25%
Land Area: 8km$^2$
Estimated Developable Area (m$^2$):1,600,000
Electricity Cost (Cost/GJ): $37.75
Gas Cost (Cost/GJ): $16.20





**Scarborough Centre (Yellow Outline) –** All data provided on this page refers to the area highlighted in yellow.

Map Layer Source: CanMap Route Logistics 2006.3, Other maps from Googlemaps.com

# POTENTIAL LOCATION FOR DISTRICT ENERGY:
## North York Centre, Toronto, Ontario

The North York Centre is a focal point for transit-based employment and residential growth in Toronto. Site characteristics include:

- a mandated urban density of 400 people-and-jobs per hectare by 2031 (*Growth Plan for the Greater Golden Horseshoe*),
- 23.5% growth rate within the census tracts making up North York Centre between 1996 and 2001,
- the area is served by the well established Yonge Street subway line and, at the south edge, the city's new Sheppard Avenue subway,
- the City is striving to achieve mixed-use development by encouraging office, retail, institutional, service, hotel, entertainment, and residential users to locate in the area,
- a high energy intensity factor,
- municipal *Green Development Standards* and a *Climate Change, Clean Air and Sustainable Energy Action Plan* that call for increased use of district energy,
- access to data sources and information needed to calculate DE potential.

### Energy Intensity Statistics

Ultimate Energy Intensity: 26.5494 GJ/yr/m2

Potential Energy Consumption Reduced: 1,383,488 GJ/yr

Potential GHG Reduced: 69,174 Tonnes/yr

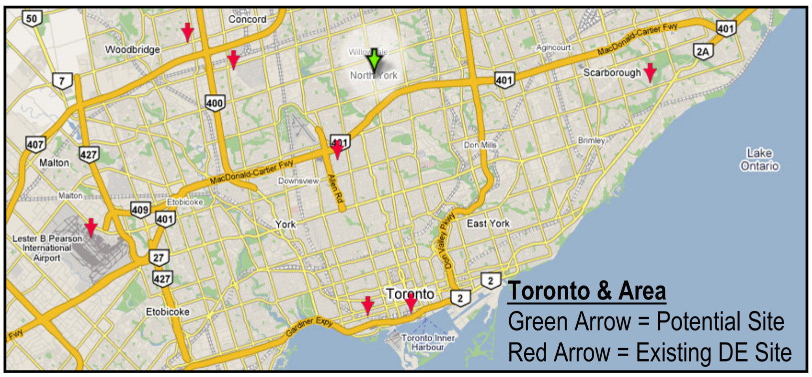
*see associated table for notes

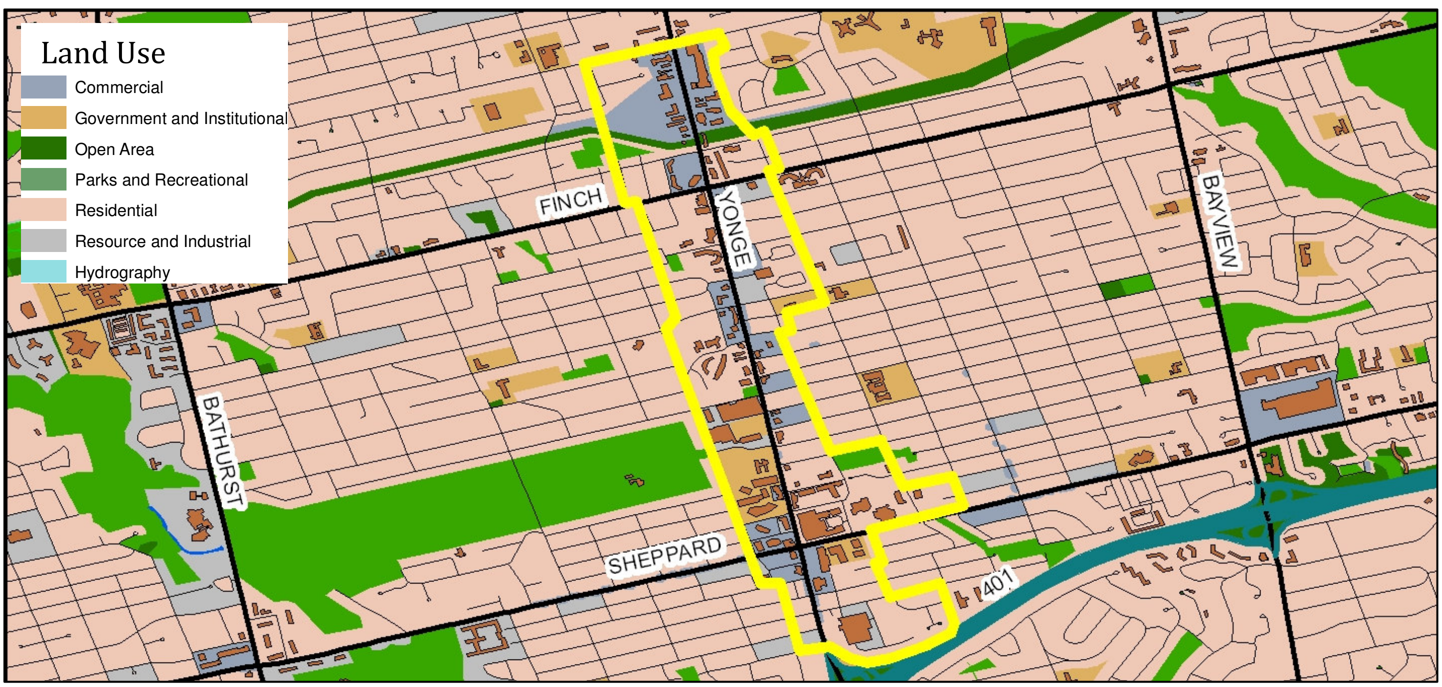
**Canadian Context Map**

### Potential Contribution of DE:
Integrated Urban Revitalization

### Site Statistics for North York Centre:

Population (2001): 51,880
Population Growth Rate: 24% (1996-2001)
Land Area: 13.2 km$^2$
Estimated Developable Area: 193,000m$^2$
Electricity Cost (Cost/GJ): $37.75
Gas Cost (Cost/GJ): $16.20




**North York Centre (Yellow Outline) –** All data provided on this page refers to the area highlighted in yellow.

Map Layer Source: CanMap Route Logistics 2006.3, Other maps from Googlemaps.com

# POTENTIAL LOCATION FOR DISTRICT ENERGY:
## Sheppard Corridor, Toronto, Ontario

The Sheppard Avenue Corridor is one of Toronto's most rapidly developing districts. Characteristics of the corridor include:

- a high energy intensity factor;
- a high population growth rate;
- a new subway line (opened in 2002) running east from Yonge Street to the Don Valley;
- new mixed use development is occurring with high floor space densities
- municipal policies that encourage the preservation of green space and established neighbourhoods in the area and call for intensification at nodes and along major corridors;
- the established municipal *Green Development Standards* and a *Climate Change, Clean Air and Sustainable Energy Action Plan* call for increased use of district energy; and,
- access to data sources and information needed to calculate DE potential.

### Energy Intensity Statistics

Energy Intensity Factor:
2.12 GJ/yr/m2

Potential Energy Consumption Reduced: 1,431,000 GJ/yr

Potential GHG Reduced:
71,551 Tonnes/yr

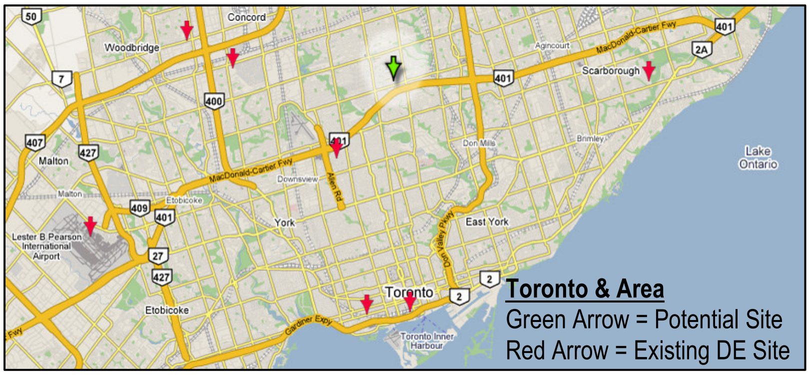
*see associated table for notes

**Canadian Context Map**

### Potential Contribution of DE:
Integrated Urban Revitalization

### Site Statistics for the Sheppard Corridor:

Population (2001): 23,778
Population Growth Rate: 12.3% (1996-2001)
Land Area: 7.74 km$^2$
Estimated Developable Area: 2,500,000 m$^2$
Electricity Cost (Cost/GJ): $37.75
Gas Cost (Cost/GJ): $16.20





**Sheppard Corridor (Yellow Outline) –** All data provided on this page refers to the area highlighted in yellow.

Map Layer Source: CanMap Route Logistics 2006.3, Other maps from Googlemaps.com

# POTENTIAL LOCATION FOR DISTRICT ENERGY:
## Palermo Village, Oakville, Ontario

Palermo Village Centre is Oakville's most recently designated growth area and is expected to become a centre for commercial and residential growth. Site characteristics include:

- the area is still predominately a greenfield site and has experienced only limited development relative to its total size;
- the Centre will serve as a "secondary transit node" in the city;
- land will be used for commercial and residential uses and also major institutional, civic, and recreational uses;
- the Centre's is expected to reach a residential density of up to 185 residential units per hectare;
- Palermo is already experiencing growth and had a population of approximately 11,000 by 2001, twice that of the previous census period; and,
- Oakville's *Environmental Strategic Plan* (2005) and the *Oakville Alternative Energy Factsheet* (2007) promote green energy technologies within the City.

### Energy Intensity Statistics

Ultimate Energy Intensity:
0.5073 GJ/yr/m2

Potential Energy Consumption Reduced: 112,320 GJ/yr

Potential GHG Reduced:
5,616 Tonnes/yr

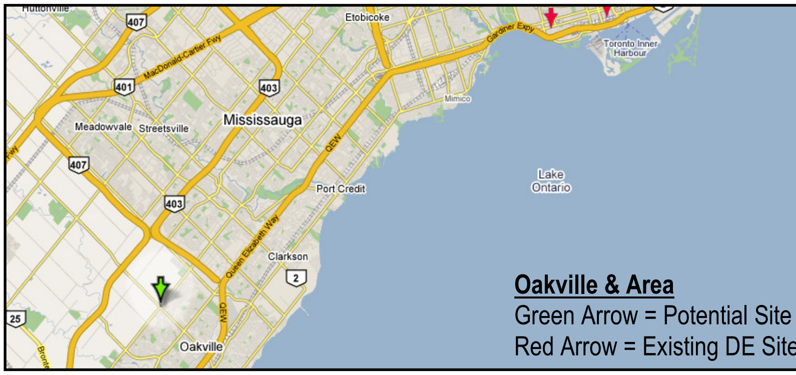
*see associated table for notes

**Canadian Context Map**

### Potential Contribution of DE:
Urban Intensification

### Site Statistics for Palermo Village

Population (2001): 10,862
Population Growth Rate: 52% (1999-2001)
Land Area: 4.35 km
Estimated Developable Area (m$^2$): 820,000
Electricity Cost (Cost/GJ): $37.75
Gas Cost (Cost/GJ): $16.20





**Palermo Village (Yellow Outline) –** All data provided on this page refers to the area highlighted in yellow.

Map Layer Source: CanMap Route Logistics 2006.3, Street map from Googlemaps.com

# POTENTIAL LOCATION FOR DISTRICT ENERGY:
## Downtown Barrie, Ontario

With its downtown situated on the shores of Lake Simcoe, the City of Barrie is currently striving to revitalize its historic core and waterfront by constructing a mixed-use development that creates a safe and vibrant place to live and work. Characteristics of the area include:

- 2006 census data shows that the City of Barrie is at the core of the most rapidly growing Census Metropolitan Area (CMA) in Canada (19.2% CMA Growth, 2001-2006); and,
- new provincial density targets of 150 residents and jobs per hectare in downtown Barrie by 2031 (*Growth Plan for the Greater Golden Horseshoe*);
- new development will consist of mixed land uses in order to achieve the population and employment densities needed;
- adjacency to free fuel source (Simcoe).

### Energy Intensity Statistics

Ultimate Energy Intensity:
0.5725 GJ/yr/m2

Potential Energy Consumption Reduced: 18,549 GJ/yr

Potential GHG Reduced:
927 Tonnes/yr

*see associated table for notes

**Canadian Context Map**

### Potential Contribution of DE:
Integrated Urban Revitalization

### Site Statistics for Downtown Barrie:

Population (2001): 3,509
Population Growth Rate: 7.9% (1996-2001)
Land Area: 190,000 $km^2$
Estimated Developable Area: 120,000$m^2$
Electricity Cost (Cost/GJ): $37.75
Gas Cost (Cost/GJ): $16.20



**Downtown Barrie (Yellow Outline) –** All data provided on this page refers to the area highlighted in yellow.

Map Layer Source: CanMap Route Logistics 2006.3, Street map from Googlemaps.com

# POTENTIAL LOCATION FOR DISTRICT ENERGY:
## Oshawa Harbour Area, Ontario

Approximately 19 hectares of Oshawa's waterfront are currently in the process of being revitalized. Site characteristics include:

- the Oshawa Harbour Area, which contains underutilized parcels of land, is to be redeveloped into residential communities with a commercial component;
- three built form options have been proposed (industrial, mixed-use, and residential-focused);
- where residential uses are proposed, it is expected that the built form will comprise of three or four storey town homes, duplexes, and apartments – some with ground floor retail.[1]; and,
- a commitment by Oshawa to ensure that the development of land is done in a "green and sustainable [way that will be recognized] for its leadership in smart growth management, environmental protection, and transportation systems."[2]

[1] http://www.oshawa.ca/harbourrd/HarbourRoadReport.pdf
2 City of Oshawa Community Strategic Plan, 2006.

### Energy Intensity Statistics

Ultimate Energy Intensity: 0.7568 GJ/yr/m2

Potential Energy Consumption Reduced: 37,800 GJ/yr

Potential GHG Reduced: 1,890 Tonnes/yr

*see associated table for notes

**Canadian Context Map**

### Potential Contribution of DE:
Brownfield, Community Economic Development

### Site Statistics for the Harbour Area:
Population (2001): 3,302
Population Growth Rate: 3.38% (1996-2001)
Land Area: 6.61 km$^2$
Estimated Developable Area: 185,000m$^2$
Electricity Cost (Cost/GJ): $37.75
Gas Cost (Cost/GJ): $16.20



**Oshawa Harbour Area (Yellow Outline) –** All data provided on this page refers to the area highlighted in yellow.

Map Layer Source: CanMap Route Logistics 2006.3, Street map from Googlemaps.com

# POTENTIAL LOCATION FOR DISTRICT ENERGY:

## Mississauga City Centre, Ontario

The City of Mississauga is in the process of encouraging high density, mixed use development in its City Centre. Characteristics of the Centre include:

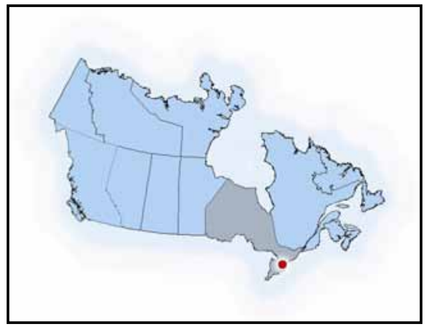
- a provincial growth target (*Growth Plan for the Greater Golden Horseshoe*) of 200 residents and jobs per hectare by 2031, the current density is approximately 160 jobs and people her hectare;
- mixed-use residential, commercial, and retail development taking place;
- a high energy intensity factor;
- role as a major regional retailing centre (Square One Mall);
- its emergence as a civic and cultural core of the city;
- a population that grew (city-wide) by 13 percent between 1996 and 2001; and,
- future plans to connect the City Centre with the rest of Mississauga through the installation of an LRT system on Hurontario Street, and a BRT on 403/Rathburn.

### Energy Intensity Statistics

Ultimate Energy Intensity:
9.71 GJ/yr/m2

Potential Energy Consumption Reduced: 1,048,680 GJ/yr

Potential GHG Reduced:
52,434 Tonnes/yr

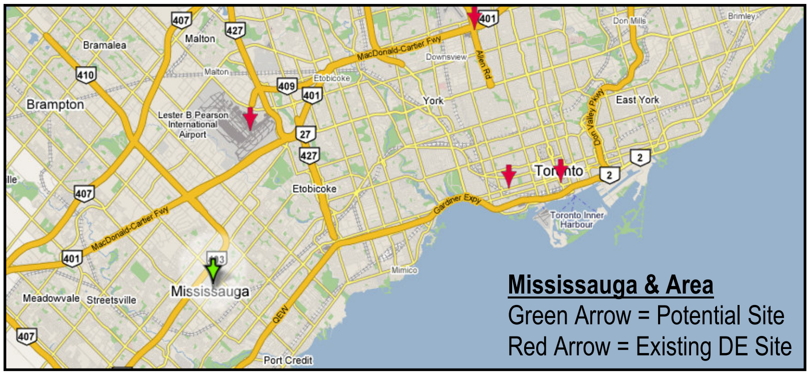


### Potential Contribution of DE:

Integrated Urban Revitalization

### Site Statistics for City Centre:

Population (2001): 4,212
Population Growth Rate: 13% (citywide, 1996-2001)
Land Area: 2.46 km
Estimated Developable Area ($m^2$): 400,000
Electricity Cost (Cost/GJ): $37.75
Gas Cost (Cost/GJ): $16.20





**Mississauga City Centre (Yellow Outline) –** All data provided on this page refers to the area highlighted in yellow.

Map Layer Source: CanMap Route Logistics 2006.3, Street map from Googlemaps.com

# POTENTIAL LOCATION FOR DISTRICT ENERGY:

## Red Deer Town Centre, East Hill, Red Deer, Alberta

The proposed development of Red Deer Town Centre is to be a 112 hectare site with a variety of land uses. Characteristics of the site include:

- an existing plan to create a transit-oriented community with compact land use patterns;
- Town Centre is expected to become the civic, residential, commercial, entertainment and retail centre for Red Deer and is planned to become a local commercial office district;
- three-to-five-storey medium-rise buildings will be constructed along the major vehicular corridors traversing the neighbourhood; and,
- municipal policy states that all servicing requirements in East Hill are to be conducted in an environmentally-friendly and energy efficient manner by implementing green infrastructure, recycling, and energy conservation methods.

### Energy Intensity Statistics

Ultimate Energy Intensity: 0.1773 GJ/yr/m2

Potential Energy Consumption Reduced: NA

Potential GHG Reduced: NA

*see associated table for notes

**Canadian Context Map**

### Potential Contribution of DE:

Urban Intensification

### Site Statistics for East Hill

Population (2001): 7,349

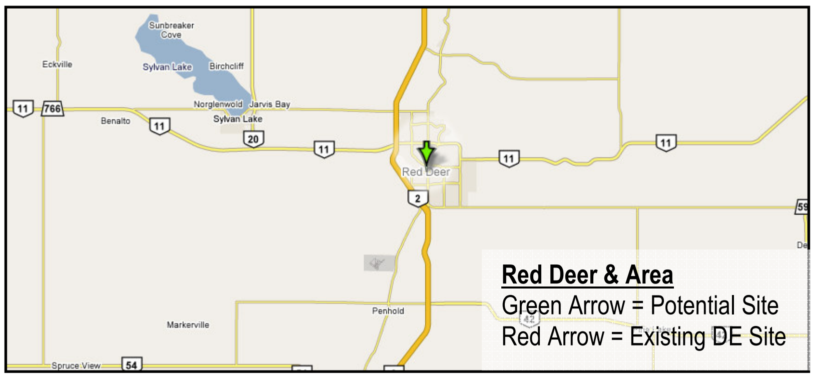
Population Growth Rate: 88.92% (1996-2001)

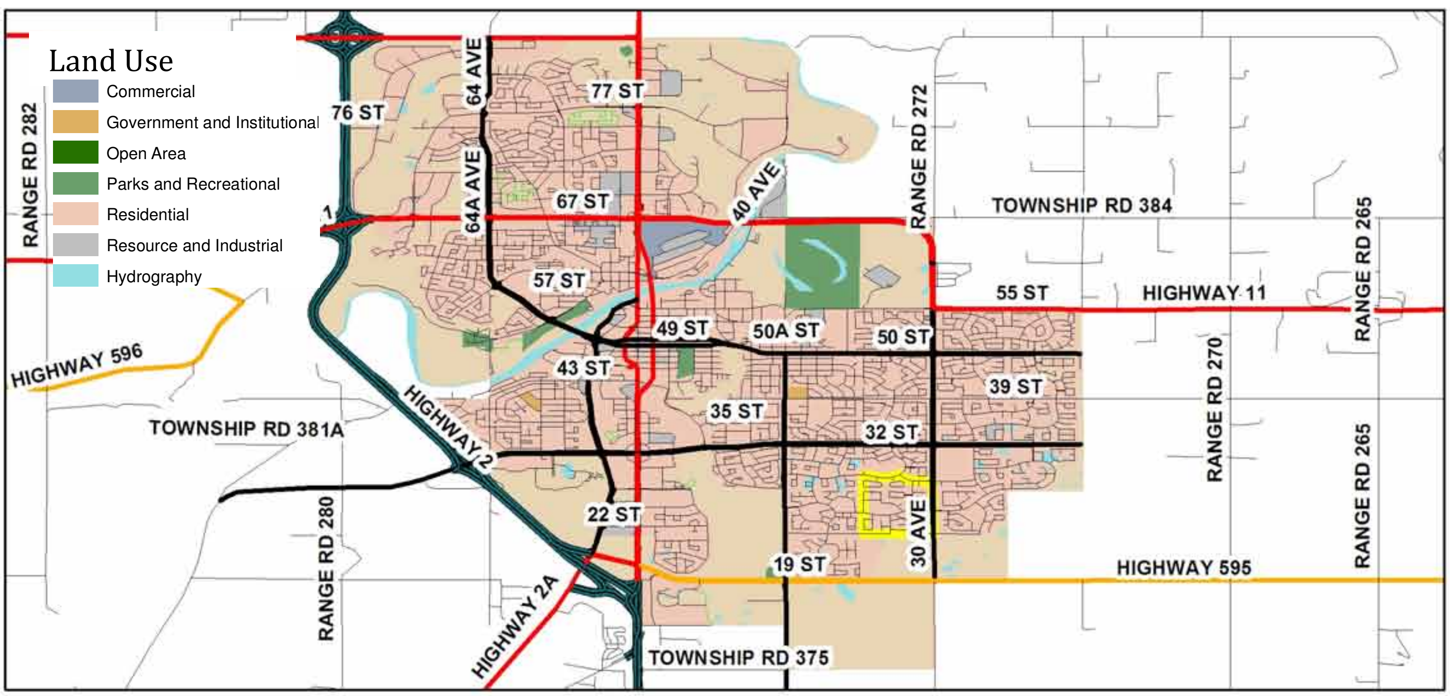
Land Area: 10.9 km$^2$

Estimated Developable Area: 602,500 m$^2$

Electricity Cost (Cost/GJ): $22.35

Gas Cost (Cost/GJ): $6.762




**East Hill Town Centre, Red Deer (Yellow Outline) –** All site statistics collected at census tract level due to limited available local data.

Map Layer Source: CanMap Route Logistics 2006.3, Street map from Googlemaps.com

# POTENTIAL LOCATION FOR DISTRICT ENERGY:
## Southeast Planning Area, City of Calgary, Alberta

The City of Calgary's Southeast Planning Area contains 2,280 hectares of mostly-undeveloped land for which the City has developed a long term vision. Characteristics of the planning area are:

- a vision for the future of the area that includes "five vibrant residential neighbourhoods" with diverse housing types including multi-family buildings;
- a vision that illustrates the importance of local retailing and employment opportunities inside each neighbourhood, limiting the need for automobile use;
- LRT will link each community to the central City;
- the mixed-use town centre will also be the site of a new high school and regional health centre;
- the City of Calgary's past positive experience with public-private ventures; and,
- the City of Calgary's *Community Sustainability Initiative* and *Environmental Assurance & Sustainability* program demonstrate the City's commitment to sustainability.

### Energy Intensity Statistics

Ultimate Energy Intensity: 0.2417 GJ/yr/m2

Potential Energy Consumption Reduced: NA

Potential GHG Reduced: NA

*see associated table for notes

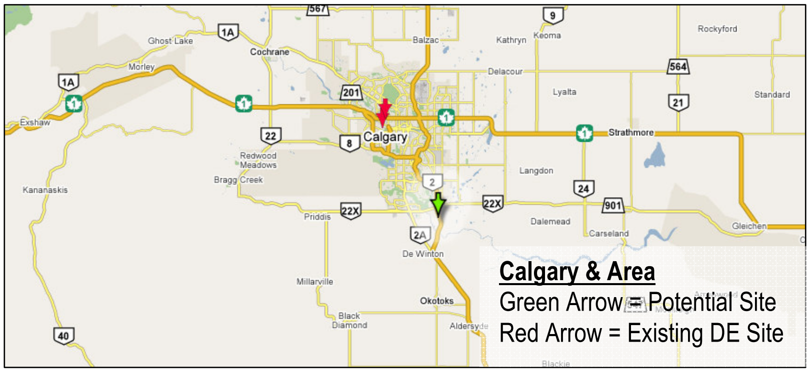
**Canadian Context Map**

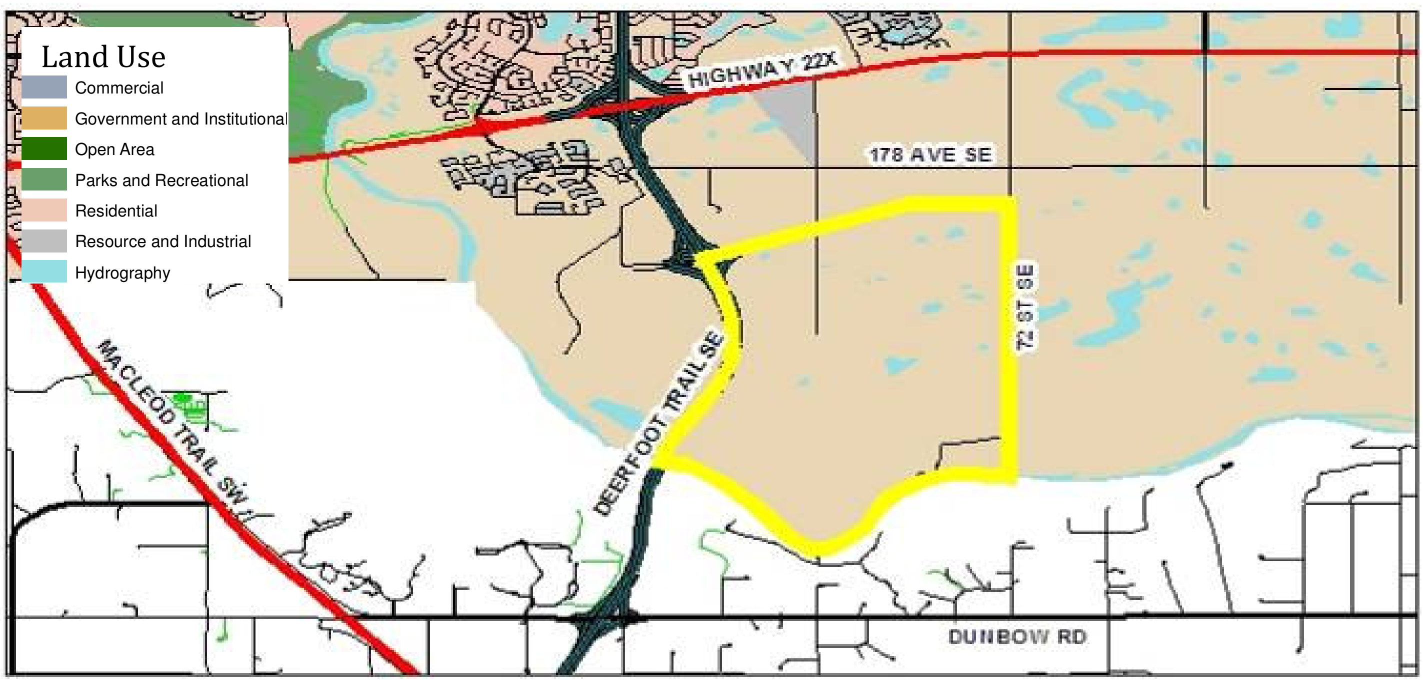
### Potential Contribution of DE:

Urban Intensification, Sustainable Energy Conservation

### Site Statistics for Red Deer Area:

Population (2001): 3,429
Population Growth Rate: 2,643% (1996-2001)
Land Area: 48.1 km$^2$
Estimated Developable Area: 22,800,000 m$^2$
Electricity Cost (Cost/GJ): $22.35
Gas Cost (Cost/GJ): $6.762




**Southeast Planning Area, City of Calgary (Yellow Outline) –** All data provided on this page refers to the area highlighted in yellow.

Map Layer Source: CanMap Route Logistics 2006.3, Other maps from Googlemaps.com

# POTENTIAL LOCATION FOR DISTRICT ENERGY:

## South Gate, Lethbridge, Alberta

The development of Lethbridge's South Gate Area will result in a transit friendly environment within a moderately dense, mixed-use, urban built form. Site characteristics include:

- a new low- and medium-density housing stock that is to be built on 1.3 square kilometers;
- transit service that is to be provided within 400 metres of 95% of residents, commercial facilities, and public services;
- the construction of a new school;
- population growth that continues at a steady rate;
- retail-commercial related uses are being promoted and it is expected that the area will become a regional shopping centre; and,
- it is one of the warmest and sunniest cities in Canada.

### Energy Intensity Statistics

Ultimate Energy Intensity: 0.6795 GJ/yr/m2

Potential Energy Consumption Reduced: NA

Potential GHG Reduced: NA

*see associated table for notes

**Canadian Context Map**

### Potential Contribution of DE:

Urban Intensification, Sustainable Energy Conservation


### Site Statistics For South Gate:

Population (2001): 1,159
Population Growth Rate: 4.24% (1996-2001)
Land Area: 1.33 km$^2$
Estimated Developable Area: 1,560,000 m$^2$
Electricity Cost (Cost/GJ): $22.35
Gas Cost (Cost/GJ): $6.762


**Lethbridge (Yellow Outline) –** All data provided on this page refers to the area highlighted in yellow.

Map Layer Source: CanMap Route Logistics 2006.3, Street map from Googlemaps.com

# POTENTIAL LOCATION FOR DISTRICT ENERGY:
## Northeast Airdrie, Alberta

The City of Airdrie, Alberta, was selected, in part, based on the following criteria:

- Airdrie is the fastest growing city in Canada with annual growth rates of up to 8.5% and the City is growing at a rate beyond its own projections made in 2001[1];
- the City is experiencing a commercial growth rate of 17% (2005-2006);
- a recent annexation of 1,200 hectares of land from the District of Rocky View which has resulted in a new Community Area Structure Plan (CASP);
- the CASP calls for development of 85 acres of regional commercial land, 44 acres of mixed use commercial land, and 300 acres of industrial land;
- a recent market study demonstrates pent-up demand for industrial land in the area; and,
- residential land is expected to be developed surrounding the employment lands at a variety of densities.

[1] http://www.canada.com/calgaryherald/news/story.html?id=9699d9db-301f-4952-8089-7fe75ab2959d

### Energy Intensity Statistics

Ultimate Energy Intensity: 0.8571 GJ/yr/m2

Potential Energy Consumption Reduced: NA

Potential GHG Reduced: NA

*see associated table for notes

**Canadian Context Map**

### Potential Contribution of DE:

Urban Intensification, Sustainable Energy Conservation

### Site Statistics for Northeast Airdrie:

Population (2001): 5,725

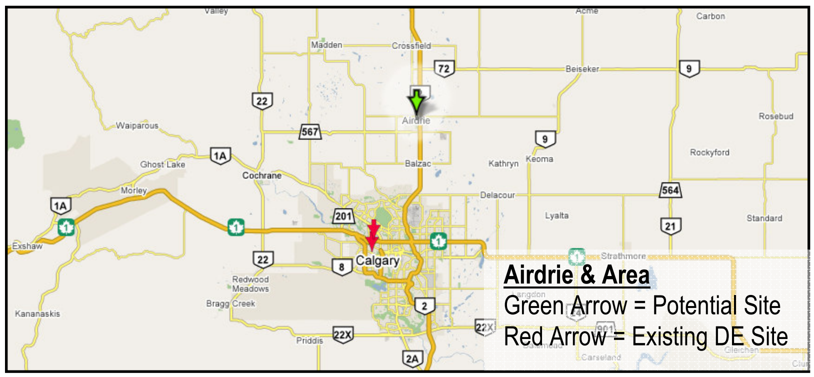
Population Growth Rate: 33.9% (1996-2001)

Land Area: 16.3 $km^2$

Estimated Developable 1,750,000Area: $m^2$

Electricity Cost (Cost/GJ): $22.35

Gas Cost (Cost/GJ): $6.762





**Airdrie, Alberta –** All data provided on this page refers to the area highlighted in yellow.

Map Layer Source: CanMap Route Logistics 2006.3, Street map from Googlemaps.com

# POTENTIAL LOCATION FOR DISTRICT ENERGY:
## Southeast Planning Area, City of Calgary, Alberta

The City of Calgary's Southeast Planning Area contains 2,280 hectares of mostly-undeveloped land for which the City has developed a long term vision. Characteristics of the planning area are:

- a vision for the future of the area that includes "five vibrant residential neighbourhoods" with diverse housing types including multi-family buildings;
- a vision that illustrates the importance of local retailing and employment opportunities inside each neighbourhood, limiting the need for automobile use;
- LRT will link each community to the central City;
- the mixed-use town centre will also be the site of a new high school and regional health centre;
- the City of Calgary's past positive experience with public-private ventures; and,
- the City of Calgary's *Community Sustainability Initiative* and *Environmental Assurance & Sustainability* program demonstrate the City's commitment to sustainability.

### Energy Intensity Statistics

Ultimate Energy Intensity: 0.2417 GJ/yr/m2

Potential Energy Consumption Reduced: NA

Potential GHG Reduced: NA

*see associated table for notes

**Canadian Context Map**

### Potential Contribution of DE:

Urban Intensification, Sustainable Energy Conservation

### Site Statistics for Red Deer Area:

Population (2001): 3,429

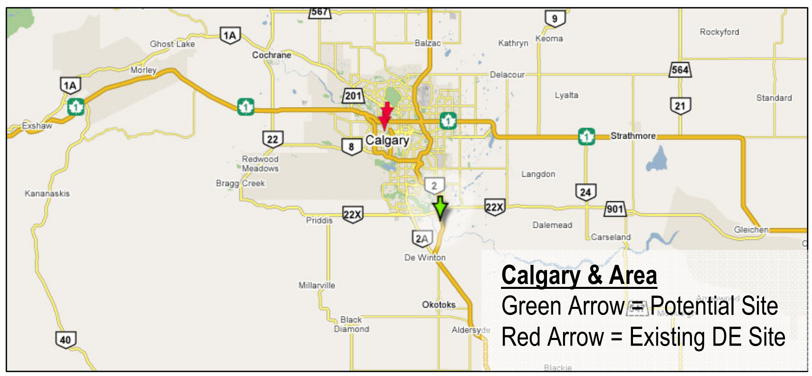
Population Growth Rate: 2,643% (1996-2001)

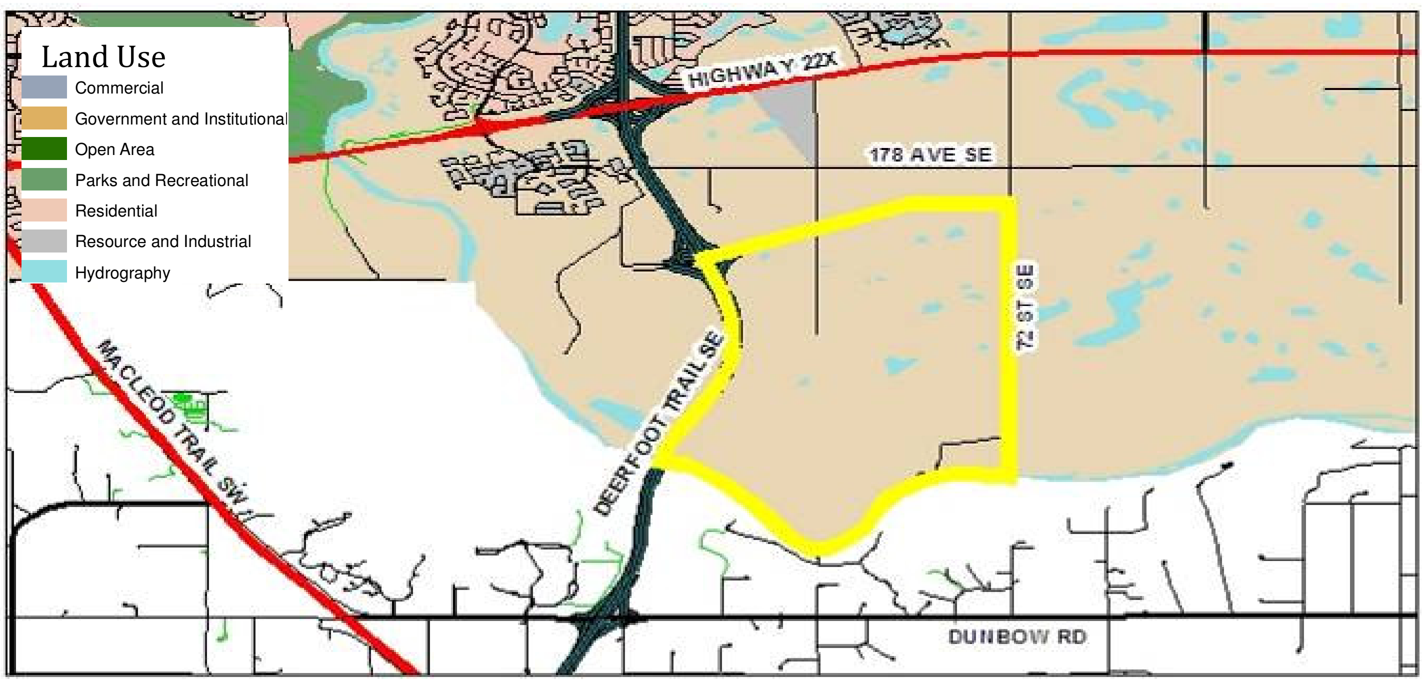
Land Area: 48.1 km$^2$

Estimated Developable Area: 22,800,000 m$^2$

Electricity Cost (Cost/GJ): $22.35

Gas Cost (Cost/GJ): $6.762




**Southeast Planning Area, City of Calgary (Yellow Outline) –** All data provided on this page refers to the area highlighted in yellow.

Map Layer Source: CanMap Route Logistics 2006.3, Other maps from Googlemaps.com

# POTENTIAL LOCATION FOR DISTRICT ENERGY:
## Franklin Yard, Moncton, New Brunswick

At 115 hectares Franklin Yard in Moncton's west-end is presently one of the largest brownfield redevelopment sites in Canada. Characteristics of the site include:

- 24 hectares dedicated to a high-technology business park, 26 hectares of residential land (enough space for 900 residential units), and more than 44 hectares allotted to recreational uses;
- Canada Lands Company (CLC), began soil remediation and redevelopment of the former industrial land (railway maintenance yard) yard in 1997;
- phase one, Franklin Crossing, is under construction and will consist of 'brownstone-style' attached two-storey houses;
- future phases are entering the planning stages and will be built as 'urbanistic' communities with integrated natural and green space systems[1] ; and,
- environmental sustainability is an ongoing priority for the CLC on this site.

[1] Canada Lands Company Information Sheet: Franklin Crossing

### Energy Intensity Statistics

Ultimate Energy Intensity:
0.23 GJ/yr/m2

Potential Energy Consumption Reduced: NA

Potential GHG Reduced: NA

*see associated table for notes

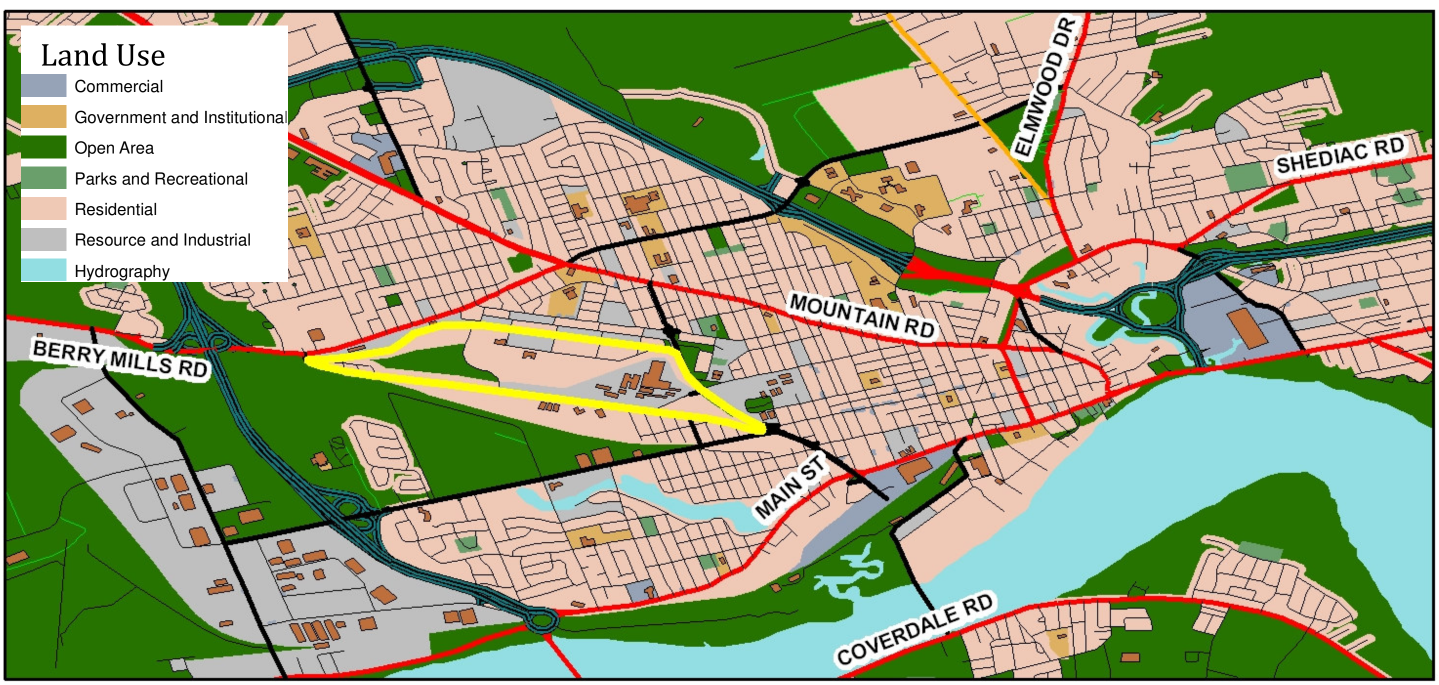
**Canadian Context Map**

### Potential Contribution of DE:

Brownfield, Community Economic Development

### Site Statistics for Franklin Yard:

Population (2001): 2.479
Population Growth Rate: -2.9 (1996-2001)
Land Area: 3.41 km$^2$
Estimated Developable Area: 500,000m$^2$
Electricity Cost (Cost/GJ): $29.21
Gas Cost (Cost/GJ): $11.95


**Franklin Yard, Moncton, New Brunswick –** All data provided on this page refers to the area highlighted in yellow.

Map Layer Source: CanMap Route Logistics 2006.3, Other maps from Googlemaps.com

**Appendix Three – GJ Energy Intensity Worksheet**

The GJ energy intensity worksheet was developed by recording and, where required, estimating the existing and fully developed built areas based on available planning information. Energy use for heating, cooling and hot water was estimated by using regional factors published by Natural Resources Canada, publicly available for download from www.oee.nrcan.gc.ca.[1]

The GJ energy intensity factor was calculated by dividing the total estimated annual energy use by the land area. Greenhouse gas (GHG) estimates were developed based on the local grid electricity generation mix and estimated DE system efficiencies assuming a Combined Heat and Power (CHP) system providing heat and cooling energy to the development and electricity to the grid based on power from natural gas. Developing comparable GHG emissions and energy reduction estimates requires a thorough understanding of regional variations, supply mix and various fuel intensities. The GJ energy intensity worksheet does not provide assistance on how to calculate energy and GHG savings for a community related to the development of a DE system.

[1] Commercial and Institutional Building Energy Use Detailed statistical report 2002

## 12 Potential Sites for District Energy in 10 Communities: Site Characteristics and Energy Intensity Data

*Table A*

| Community | Province | Existing Residential Building Area | Existing Non Residential Building Area | Total Residential Building Area | Total Non-Residential Building Area | Developable Area | Conventional Heating Method | Conventional Cooling Method | Existing Development Energy Usage | Existing GJ Energy Intensity Factor | Full Development Energy Usage | GJ Energy Intensity Factor |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $M^2$ | $M^2$ | $M^2$ | $M^2$ | $M^2$ | TYPE | TYPE | GJ/Yr | GJ/yr/$M^2$ | GJ/Yr | GJ/yr/$M^2$ |
| Franklin Yard Moncton | New Brunswick | - | - | 65,000 | 50,000 | 500,000 | Gas | Electric | - | - | 115,000 | 0.2300 |
| Scarborough Centre Toronto | Ontario | 1,100,000 | 1,000,000 | 3,120,000 | 1,680,000 | 1,600,000 | Gas | Electric | 2,100,000 | 1.3125 | 4,800,000 | 3.0000 |
| North York Centre Toronto | Ontario | 1,000,000 | 205,000 | 3,068,108 | 2,055,921 | 193,000 | Gas | Electric | 1,205,000 | 6.2435 | 5,124,029 | 26.5494 |
| City Centre Mississauga | Ontario | 1,000,000 | 509,000 | 3,000,000 | 884,000 | 400,000 | Gas | Electric | 1,509,000 | 3.7725 | 3,884,000 | 9.7100 |
| Sheppard Corridor Toronto | Ontario | 1,150,000 | 30,000 | 5,000,000 | 300,000 | 2,500,000 | Gas | Electric | 1,180,000 | 0.4720 | 5,300,000 | 2.1200 |
| Palermo Oakville | Ontario | 270,000 | 45,000 | 316,000 | 100,000 | 820,000 | Gas | Electric | 315,000 | 0.3841 | 416,000 | 0.5073 |
| Oshawa Harbour | Ontario | 70,000 | - | 140,000 | - | 185,000 | Gas | Electric | 70,000 | 0.3784 | 140,000 | 0.7568 |
| Downtown Barrie | Ontario | - | 24,300 | 8,700 | 60,000 | 120,000 | Gas | Electric | 24,300 | 0.2025 | 68,700 | 0.5725 |
| Town Centre Red Deer | Alberta | - | - | 70,000 | 15,000 | 640,000 | Gas | Electric | - | - | 113,500 | 0.1773 |
| South East Planning Area Calgary | Alberta | - | - | 4,000,000 | 400,000 | 24,000,000 | Gas | Electric | | - | 5,800,000 | 0.2417 |
| Southgate Area Lethbridge | Alberta | - | - | 700,000 | 100,000 | 1,560,000 | Gas | Electric | - | - | 1,060,000 | 0.6795 |
| Northeast Airdrie | Alberta | - | - | - | 1,000,000 | 1,750,000 | Gas | Electric | - | - | 1,500,000 | 0.8571 |

## Energy and GHG Estimates:

*Table B*

| Community | Province | Energy/yr Conventional | GHG/Yr Conventional | Energy/yr District Energy | GHG/Yr District Energy | GHG Reduction |
|---|---|---|---|---|---|---|
| | | GJ/yr | Tonnes/yr | GJ/Yr | Tonnes/Yr | Tonnes/Yr |
| Franklin Yard Moncton | New Brunswick | | | | | |
| Scarborough Centre Toronto | Ontario | 4,800,000 | 240,000 | 3,504,000 | 175,200 | 64,800 |
| North York Centre Toronto | Ontario | 5,124,029 | 256,201 | 3,740,541 | 187,027 | 69,174 |
| City Centre Mississauga | Ontario | 3,884,000 | 194,200 | 2,835,320 | 141,766 | 52,434 |
| Palermo Village Oakville | Ontario | 416,000 | 20,800 | 303,680 | 15,184 | 5,616 |
| Oshawa Harbour | Ontario | 140,000 | 7,000 | 102,200 | 5,110 | 1,890 |
| Sheppard Corridor Toronto | Ontario | 5,300,000 | 265,000 | 3,869,000 | 193,450 | 71,550 |
| Downtown Barrie | Ontario | 68,700 | 3,435 | 50,151 | 2,508 | 927 |
| Town Centre Red Deer | Alberta | | | | | |
| South East Planning Area Calgary | Alberta | | | | | |
| Southgate Area Lethbridge | Alberta | | | | | |
| Northeast Airdrie | Alberta | | | | | |

***Notes:**

1. Access to detailed planning information regarding development, growth trends, and land use was not available in every community with the same level of detail. The data in Table A was collected with the greatest level of accuracy possible in each community. Approximations for expected residential full development build out was undertaken for Scarborough Centre, Sheppard Corridor, Palmer Oakville and Oshawa Harbour.

2. Calculations of GHG reductions inside of Ontario was carried out using an existing model. Development of this model outside of Ontario was beyond the scope of this proposal.

3. Energy and GHG estimates are based on a series of broad assumptions. The assumptions have been applied in a manner returning conservative numbers for actual energy savings and GHG reductions. While energy savings and reduced GHG values may be higher then estimated using this table, it is expected that their relative percentages will remain the same.

**Appendix Four – District Energy System Specific Factors**

Specific development factors that can be incorporated into the discussion for DE in addition to the factors outlined in the energy selection framework can include thermal density, thermal sources, distribution systems, building/system conversions, economic analysis, system ownership, marketing and financing.[2]

*Thermal Load Density*

Thermal load density is based on the potential number of customers that might use the system once fully operational. Thermal load density is expressed as energy load per unit of land area. In a conventional building, the thermal load is the amount of heat or chilling required to keep a building warm on the coldest day or cool on the hottest day. For DE systems, it is an approximation of expected use in terms of a thermal demand (average use of heat, chilling and/or electricity of all buildings connected to the DE system) and is a critical component of the feasibility study of any project in terms of assessing potential capital and operating costs. At the outset of the project, it is beneficial to identify large thermal users, such as local industry, large single land owners, including hospitals and institutions or clusters of buildings, in a community that can represent potential customers for the network. Larger thermal density loads will have a direct influence on the size of the DE system, as well as economic viability, and should be identified prior to smaller thermal demands such as low density development (i.e. single housing).

*Thermal Sources*

Thermal sources are a combination of “free” energy sources (excess thermal heat from a local industry, community centre or larger institution) and the use of boilers for heating or other technology combinations, such as absorption chiller, compression chiller or deep lake/sea cooling for chilling, which use a combination of various types of fuels (alternative, renewable and fossil) to produce thermal energy. Almost any energy source (biomass, fuel cells, solar

[2] Consideration for site specific development factors were derived from interviews with planet owners, operators and energy experts across Canada, as well as from various secondary sources including: the State of Minnesota, Planning and Management Services, *District Heating Planning in Minnesota: A Community Guidebook*. Available from: http://www.hud.gov/.; Skagestad, Brad and Mildenstein, Peter. *District Heating and Cooling Connection Handbook.* International Energy Agency. (2002); Maker, Timothy and Penny, Janet. *Heating Communities with Renewable Fuels: The Municipal Guide to Biomass District Energy* (1999). Natural Resources Canada and United States Department of Energy. ; MacRae, Morgan. Realizing the Benefits of Community Integrated Energy Systems. (1992). Canadian Energy Research Institute's*.;* and, Bloomquist, R.G. ; Nimmons, J.T. ; Rafferty, K. *District Heating Development Guide, Legal, Institutional and Marketing Issues. (1988).* Washington State Energy Office.

energy, hydrothermal, natural gas, propane, hydrogen, municipal biomass and waste etc.) may be used for the relatively low temperatures required for hot water production and similar applications for chilling. The combination of various systems to meet community heating, cooling and electricity requirements will vary relative to system size, thermal demand and many other factors explored during a detailed feasibility assessment. Alternative “free” thermal energy sources in operation and under consideration in Canada include the use of sewer heat recovery systems that extract the heat carried by water in sewer flows.

*Distribution System*

DE systems in Canada tend to be comprised of pipes that carry thermal energy from a central plant or network of systems to the end users. There are several types of systems in operation in Canada providing various thermal services including: steam, hot water and chilled water. Steam tends to be used for industrial processing applications and, in some cases, is supplied to end users who use the thermal energy as a fuel source to run independent heating and cooling systems. Usually, one pipe is used to distribute the steam and a separate pipe is used to bring back the condensation of the steam for reprocessing in a plant. Hot and chilled water systems (often referred to as hydronic) use a similar process where one pipe carries the hot or chilled water from the plant and is returned through a separate second pipe to the plant for reprocessing. In a DE system, the network of pipes is likely to be the single largest expenditure, since all the capital for the project must be front-loaded (accounted for at project commencement rather than incrementally), and incorporates factors such as pipe length, piping material, and method of installation.

Locating the network close to the customer can reduce distribution costs. The unit cost of delivering DE generally decreases with an increase in size and density of thermal demand (i.e. the higher demand of energy per metre of pipeline the better). The challenge is balancing various urban forms and activities with system design costs (the infrastructure required to develop the network for DE and the return on the investment). Consideration should be given to the physical and geographical barriers in a community. Cost overruns for projects often occur as a result of the many “unknowns” exposed during excavation. Early community utility identification and geographical analysis (rock and ground water) should be considered for excavation and restoration considerations. Rights of ways and easements can also present challenges in accessing the customer or for laying pipes.

*Building/System Conversions*

Conversions can involve the modification, renovation and connection of building mechanical and controls systems to benefit from DE or the restoration of a deteriorating or abandoned system with a refurbished modern high performance DE system. Buildings that are transferred to a DE system or connected during construction use a heat-exchanger, allowing for the transfer of thermal energy from the DE system to a customer's in-building closed thermal system. In modern high-performance DE systems, thermal energy (hot and chilled water) may never enter a building directly. Only the thermal energy potential (heat or cold) is transferred to a customer for recirculation within a building. If infrastructure supporting an aging DE system exists, consideration should be given to retrofitting, which could be more economical and environmentally beneficial, in terms of reduced greenhouse gases, rather than installing and maintaining a number of individual boilers. Conversions can provide a stable thermal density load and economic return for both the customer and for the plant/network operators. At the same time, conversion costs can also be a strong deterrent for customers, including owners of older buildings heated by steam systems or have recently upgraded a conventional hydronic heating and cooling system.

*Marketing*

Marketing for DE begins the day a community becomes aware of the potential for a system. From the commencement of a DE project to operation, attracting customers is an ongoing activity. Identifying the end user market early on in project assessment will contribute to ensuring the development of an adaptive DE system that can grow and meet changing customer demands, as well as provide for an attractive competitive marketing advantage. Positioning DE to be successful in a community can start with engaging a broad cross-section of stakeholders to become informed about the concept, the benefits, the costs and the potential challenges limiting the development of a DE initiative. Emphasis for stakeholder engagement should include the largest potential end users (whether industry, developers, building operators or other governments) who have a direct interest in the potential savings generated through lower building operating and capital costs, security of supply concerns, exposure to volatile energy price markets and an interest in improved air quality and reduced greenhouse gas emissions. An important feature of the competitive assessment of DE is the capacity to offer various thermal services and electricity at similar rates (or lower) relative to existing or other potential alternative sources of energy in a community.

*System Ownership*

Ownership is an important consideration from the outset of any discussion for DE. Key aspects to consider during the evaluation include, who can operate the system most effectively for all customers and the general community, and who has access to potential sources of private equity and government grants. There are several ownership models in use across Canada including: wholly city owned, wholly-owned subsidiary of a municipality, owned by a municipality and operated by a third-party, and owned/operated by a private entity. Each ownership option has various benefits and challenges associated with developing and operating a DE system and should be carefully considered during the feasibility study of a project. If a community has an existing DE system, it should be explored as to the desirability of the local operator to own and operate any proposed new system.

*System Funding*

There are various source of funding available to contribute to developing the feasibility studies and offsetting capital costs related to the development of a DE system. An important part of the funding discussion should include system ownership. Different ownership structures can influence the type of assistance available to finance a project of a private equity or government tax benefit/loan/ granting nature. The following potential funding sources should be explored for assistance:

- *Federal Support.* There are several programs available to assist with potential building conversions for energy efficiency and access to various taxation opportunities to encourage efficient and renewable generation. Federal assistance and support can be ascertained by contacting Natural Resources Canada, Community Energy Planning.
- *Provincial Support.* Across Canada, provinces are introducing new support processes to encourage the application of DE systems, especially combined heat and power (CHP). New financing opportunities were recently introduced in B.C., Ontario and New Brunswick.  To access provincial support, contact the Local Ministry of Energy or Finance.
- *Non-Government Support.* The Federation of Canadian Communities (FCM) has periodically offered grants for project feasibility assessment and loans to underwrite system development for municipalities and businesses working in cooperation with a municipality.
- *Municipal Support.* Access to utility funds for conservation and demand management, as well as staff support might be provided at the early outset of a project to begin community engagement and feasibility studies.
- *Potential Users and Local Business.*  Additional sources of review for project feasibility development and capital development can be accessed from pension funds, community

credit unions, various quasi-governmental organizations (boards, agencies and commissions), provincial or local utilities, and community groups.

**Appendix Five – Energy Solutions Framework Factors**

Through interviews with district energy practitioners and from a review of exiting assessment processes used in the U.S. and Canada, 16 factors were identified as contributing to measure the interest in a community for DE, as well as basic site criteria for the establishment of a DE system.

*Sustainability At the Community Level*

Factor 1: Established Community Energy and GHG Reduction Target and Implementation Program

The establishment a DE system is likely to reduce GHG emissions and energy use on a cost effective basis and, thereby, contribute to the existence of any community plan and implementation program addressing reductions in GHGs and energy. Ideally, an implementation plan would reference the implementation of DE and show estimated impacts.

Factor 2: The Incorporation of Energy Issues into Decision Making Processes

Where the official plan or equivalent municipal statute references energy issues specifically, DE can likely be shown to be in accordance with planning policies.

Factor 3: Community Leadership and Support for GHG and Energy Reduction

Influential leadership in the public and private sector greatly enhances the potential for DE implementation.

*Community/Business Resiliency and Security of Supply*

Factor 4: Concerns Regarding Electricity Supply/resiliency and security

DE, based on local cogeneration of electricity, increases the security of local electricity supply by reducing dependency on grid electricity.

*Knowledge, Know-How and Technical Skills*

Factor 5: Availability of Local Resources to Implement DE

Access to local experts with DE knowledge on the design, construction, financing, maintenance and marketing of DE is a key factor for success. The lack of access to local expertise will require drawing on assistance from outside a community that might delay the project.

*Legislative Authority*

Factor 6: Support for DE from Local and Provincial Policies

Explicit support for DE infrastructure in local planning statutes and provincial energy regulations removes the need to amend planning policies and other regulations to implement DE.

*Capital Access and Partnerships*

Factor 7: <u>Community Experience with Cooperative Ventures</u>

DE has many advantages, but it requires recognition of the establishment of cooperative energy distribution infrastructure is beneficial to the community. Distribution infrastructure tends to be located on the public right of way, which is traditionally occupied by other services. Public services, such as the distribution of electricity, will be affected and private owners will need to enter into long term commitments. Close cooperation and support of both public and private sectors is essential for the successful implementation of a DE system. The existence of community support and experience with previous cooperative ventures particularly among influential community leaders is a significant factor in the establishment of a successful DE system.

*Market Demand and Business Drivers*

Factor 8: <u>Requirement to Expand or Renew Energy and other Infrastructure</u>

The planned expansion or replacement of local infrastructure provides an opportunity to co-locate DE infrastructure at a lower cost than when constructing DE facilities on a stand alone basis.

Factor 9: <u>Private and Public Sector Interest in Direct and Intangible Benefits of Improved Building Performance</u>

The application of sustainable building practices, including connecting to modern high performance CHP systems, extends beyond strictly material and energy benefits, and can provide a truly economic and efficient way to build. Recent studies have shown that when sustainable building measures are applied during the construction or renovation of a building, significant operational savings will occur over the lifecycle of a building and can be further enhanced through increased employee activity/reduced absenteeism and occupant well-being. It is also recognized that when buildings are designed with sustainability principles, reductions in terms of associated risk-mitigation, such as insurance premiums can occur, while property and market values of a building can increase.

Using DE in conjunction with improved building design can result in significant benefits. Public and private sector recognition of the tangible and intangible benefits of DE and improved building design will enhance the success of any proposed DE project.

*Competitive Environment*

Factor 10: Fossil Fuel Intensity of Grid Electricity

Because DE systems are likely to consume fossil fuels (on a more efficient basis than grid based fossil systems) the higher the fossil fuel intensity of the grid system the more a DE system will provide improved environmental performance based on resource consumption and air and carbon dioxide emissions.

Factor 11: Cost of Conventional Fuels

Since DE systems, such as CHP, are more efficient than conventional systems, fuel use is reduced. Where conventional fuel costs are relatively higher, the savings from DE are magnified.

Factor 12: Duration of Cooling Season

The longer a cooling season, the greater the opportunity for savings from electricity produced through cogeneration. In the heating season, co-generated electricity will be used for other purposes generally requiring the sale of electricity to the grid or specific electricity customers. A longer cooling season results in greater direct use of generated electricity and lowers the risk associated with relying on grid or specific customers to purchase electricity not directly required by the DE system.

*Energy Market Optimization*

Factor 13: Mix of Different Land Uses and Building Types

A mix of land uses and building types provides variations in energy demand and allows more efficient use of the DE system as a result of reduced peaking of heating and cooling demand. However, a single large user committed to DE could provide the impetus for the establishment of the system, while complementary land uses will increase the resilience and efficiency of the service.

Factor 14: Compatibility of DE with Built Form

The ability to collocate a DE system harmoniously is a significant factor in gaining support from some stakeholders. In practice, this factor can be resolved positively in most situations as a result of the relatively modest size, high efficiency and enhanced noise reduction of modern high performance DE technologies now being used.

Factor 15: Existing Energy Intensity

High existing energy intensity provides the potential for rapid uptake of connection to a DE system. However, where existing buildings and energy systems are relatively new and conversion to DE is proposed, there will be economic issues to be addressed regarding heating and cooling systems that are not fully depreciated.

Factor 16: Energy Intensity Full Development (GJ Energy Intensity Factor)

The higher the energy intensity at full build out of a community, the more economically feasible a DE system will become. Higher intensity energy use will also result in increased efficiency for the distribution infrastructure for heating and cooling, thereby lowering costs for the establishment of piping and related infrastructure for a system.

## Appendix Six – Weighting Values for Energy Selection Framework

| Category | Evaluation Factor | | Weight | Rationale for Weight |
|---|---|---|---|---|
| Sustainability at the Community Level | 1 | Established Community Energy and GHG Reduction Target and Implementation Program | 3 | Community Energy and GHG targets provide a policy rationale for the establishment of DE systems. This rationale allows a DE proposal to be shown as in alignment with existing policy. |
| | 2 | The incorporation of energy issues into decision making processes | 2 | Integration of energy issues into decision making processes is helpful in developing a rationale for a DE project. |
| | 3 | Community Leadership and Support for GHG and Energy Reduction | 3 | Community leadership has been shown to be a very significant factor in the successful establishment of DE systems. |
| Resiliency and Security of Supply | 4 | Concerns Regarding Electricity supply/resiliency and security | 2 | While electricity is conventionally provided from grid sources, concerns regarding local electricity supply will underpin arguments in favour of establishing a DE system. |
| Knowledge, Know-How and Technical Skills | 5 | Access and availability of experienced DE design team | 3 | Availability of local expertise is a very significant factor in the successful implementation of DE |
| Legislative Authority | 6 | Support for DE from local and provincial policies | 2 | Support from distributive progressive policy frameworks results in reduced obstacles to the establishment of DE. |
| Capital Access and Partnerships | 7 | Community Experience with Cooperative Ventures | 2 | DE systems across Canada predominantly involve more than one agency. Experience with cooperative ventures will positively influence the success of a DE project. |
| Market Demand and Business Drivers | 8 | Requirement to Expand or Renew Energy and other Infrastructure | 1 | Where existing infrastructure requires replacement or expansion, a DE system can be a method of facilitating this need but other factors might cause the owners of infrastructure to replace/ expand with systems similar to existing facilities. |
| | 9 | Private and Public Sector Interest in direct and Intangible Benefits of Improved Buildings | 1 | Improved buildings can provide synergy with DE for improved energy performance, but other factors will be more significant in establishment of a new DE system. |
| Competitive Environment | 10 | Fossil Fuel Intensity of Grid Electricity | 3 | The higher the fossil fuel intensity of grid electricity, the greater the potential $CO^2$ reductions and reduced fossil fuel consumption of a DE system. This results in relatively improved environmental performance and greater long term cost stability, which are significant positive factors for a DE system. |
| | 11 | Cost of Conventional Fuels | 3 | Where costs of conventional fuels are higher, the fuel savings from DE become more significant resulting in greater potential for the establishment of a DE system. |
| | 12 | Duration of Cooling Season | 3 | The longer the duration of the cooling system the greater the demand for electricity for cooling purposes. The production of low emissions electricity is a positive factor for DE systems and longer cooling seasons favour this positive benefit. |
| Energy Market Optimization | 13 | Mix of Different Land Uses and Building Types | 3 | A mix of land uses results in stability of energy demand, which is beneficial in maximizing the use of a DE system, and can positively affect the economics. |
| | 14 | Compatibility of DE with Built Form | 1 | The ability to collocate DE with the built environment without creating conflicts is positive. However, current DE infrastructure can generally be integrated into developments with very little visual and environmental impact. |
| | 1<br>5 | Existing Energy Intensity | 4 | High existing energy intensity makes the initial establishment of a DE system economically more attractive. Start up can be difficult for DE systems. |
| | 16 | Energy Intensity Full Development | 5 | A high full development energy intensity provides maximum benefits for DE from a financial perspective and is a significant positive factor. |

## Energy Selection Framework Worksheet

| | Community Wide Issues | | | | | | | | | Site Specific Conosiderations | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Category** | Sustainability at the Community Level | | | Resiliency and Security of Supply | Knowledge, Know-How and Technial Skills | Legislative Authority | Capital and Partnerships | Market Demand and Business Drivers | | Competitive Environment | | | Energy Market Optimization | | | | |
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | |
| **Factors** | Established Community Energy Reduction Target and Implementation Program | Energy Issues Incorporated Into Planning Decision Making | Community Leadership and Support for GHG and Energy Reduction | Concerns Regarding Electricity Supply/Resiliency and Security | Avaliablity of Local Resources to implement DE | Support for DE from local and provincial policies | Community Experience With Cooperative Ventures | Requirement To Expand or Renew Energy and other Infrastructure | Private and Public Sector Interest In Direct and Intangible Benefits of Improved Buildings | Fossil Fuel Intensity of Grid Electricity | Duration of Cooling Season | Cost of Conventional Fuels | Mix of Land Uses and Building Types | Compatibility of DE with Built Form | Existing Energy Intensity of Community | Energy Intensity At Full Community Build Out | **Overall Score** |
| **Weighting** | **3** | **2** | **3** | **2** | **3** | **2** | **2** | **1** | **1** | **3** | **3** | **3** | **3** | **1** | **4** | **5** | |
| Insert Community/Site | | | | | | | | | | | | | | | | | |
| Apply Weghted Score | | | | | | | | | | | | | | | | | |
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## Appendix Seven – Weighting Values for Energy Selection Framework Glossary of Terms

*Absorption Chiller:* cooling device that uses a hot medium (steam, hot water, or waste heat) to provide air conditioning.

*Biomass:* any organic matter that can be burned for energy. Can be used as a combustion fuel.

*Boiler Efficiency:* the efficiency with which a boiler converts natural gas to usable thermal energy (in the form of domestic hot water and space heating).

*Cogeneration:* the simultaneous generation of heat and power from a single fuel source, both of which are utilized. Also referred to as Combined Heat and Power (CHP).

*Combined Heat and Power (CHP): see Cogeneration*

*Compression-ignition engines:* predominantly four-stroke direct-injection machines fitted with turbochargers and intercoolers. They will accept diesel, natural gas and a mixture of both.

*District Energy (DE):* a widely recognized approach to meeting the space heating and cooling needs of residential, institutional, commercial and industrial buildings and supporting processing requirements of local industry. DE systems can use a central energy plant, mini plants, or even multiple large plants connected through a thermal network of piping to service buildings with heating, hot water, steam and/or chilled water. Some systems may support Combined Heat and Power (CHP). DE Systems consist of three subsystems: generation of thermal energy and electricity, distribution of thermal energy over a network, transfer of thermal energy to end-users. *

*Energy Intensity Factor:* represents the number of gigajoules of energy utilized per year per square metre.

*Fuel Cells:* a fuel cell converts the chemical energy of hydrogen and oxygen into electrical energy through an electrochemical reaction. Typical fuel cells produce only a small voltage (~1 volt), but combined in a series, they produce enough power to distributed generation applications.

*Generators:* convert the mechanical energy in the rotating engine shaft into electricity. Synchronous generators can operate in isolation from other generating plants and the grid. An asynchronous generator can only operate in parallel with other generators, usually the grid.

*Gigajoule (GJ):* One gigajoule equals $1 \times 10^9$ joules. (see: *joules*)* This unit is used by most government agencies across Canada when analyzing energy reduction opportunities and financial incentives. The GJ was selected over other common metric measures of energy because of the familiarity of the energy saving and potential integration with other assessment standards (such as the Canada Green Building Rating System, EcoLogo program, etc.). *

*Heat to Power Ratio:* The ratio of the thermal output to power output.

*Joules (J):* The joule is the international unit of measure for energy and represents the energy produced by the power of one watt flowing for one second. There are 3.6 million joules in one kilowatt-hour.*

*Micro turbines:* micro turbines can generate anywhere from 25kW to 200kW of electricity, and are high-speed generator power plants, with only one moving part. They are fuelled primarily by natural gas, but can also operate with diesel, gasoline or other similar high-energy fossil fuels.

*Peak Demand Rate:* a building's monthly peak demand

*Prime Mover:* may be a reciprocating engine, steam turbine, gas turbine or micro turbines and fuel cells. The prime mover drives the electricity generator and usable heat is recovered.

*Reciprocating Engine:* is an internal combustion engine similar to automobile engines. Systems range in size from $20kW_e$ to $50Mw_e$.

*Spark-ignition engines:* derivatives of their diesel engine equivalents and have provided cooling water as a heat source typically.

*System Operator:* the company responsible for the operation of the district energy system.

*Waste Heat Recovery Units:* a heat recovery boiler recovers heat from the exhaust gases of gas turbines or reciprocating engines. The simplest one is a heat exchanger through which the exhaust gases pass and the heat is transferred to the boiler feed-water to produce hot water or steam.

## Appendix Eight – Individuals Interviewed for this Report

*Greg Allen, President*
Sustainable Edge

*Chris Ball, Executive Vice President*
Corpfinance International Ltd.

*James Baird, Commissioner*
Development Services, Town of Markham

*John Barnes, President*
Central Heat Distribution Limited

*Linda Bertoldi, Partner*
Borden Ladner Gervais

*Derek Ballantyne, CEO*
Toronto Community Housing Corporation

*Geoff Battersby, Past President and Chair*
Revelstoke Community Energy

*Colin Cage, General Manager*
Victoria Park Community Homes

*John Coulter, Chief Officer*
Technical Standards Safety Authority

*Richard Damecour, Vice President*
FVB Energy Inc.

*Bruce Dodds, Director*
Utilities and Operation, University of Toronto

*Veronica Friesen, Director*
District Energy Windsor, Windsor Utilities Commission

*Jamie James, Principal*
BuildGreen Consulting

*Brett Hodson, President*
Terasen Utility Services

*Innes Hood, Senior Associate*
The Sheltair Group

*Rob McLeese, President*
Access Capital Corporation

*Mary O'Brien, Sustainable Systems Analyst*
Stantec Consulting Inc.

*Andrew Pride, Vice President*
Energy Management, MintoUrban Communities Inc.

*Susan Shaw, Director*
Ontario Business Development, EPCOR Utilities Inc.

*Bill Susak, General Manager*
Lonsdale Energy Corporation

*Tim Walach, Chief Engineer*
Northwind Windsor District Energy