

# **Demand side management and demand response in municipalities**





**Electricity demand side management  
and demand response in municipalities:  
workshop background paper**



**INDECO** 

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IndEco report A3238

27 January 2004

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# Contents

<b>1</b>	<b>Introduction.....</b>	<b>1</b>
1.1	Purpose of this report.....	1
<b>2</b>	<b>Ontario’s electricity market.....</b>	<b>3</b>
2.1	How does the electricity system operate?.....	3
2.2	How does the electricity market work? .....	4
2.3	Supply and demand pressures.....	6
<b>3</b>	<b>Demand side management and demand response .....</b>	<b>8</b>
3.1	What is demand side management? .....	8
3.2	What is demand response? .....	9
3.3	DM versus DR .....	10
3.4	What is Ontario doing about DM and DR? .....	11
<b>4</b>	<b>Municipal electricity DM &amp; DR .....</b>	<b>14</b>
4.1	Why should municipalities be interested in DM and DR? .....	14
4.2	What can municipalities do?.....	15
4.3	Developing DM and DR programs.....	15
4.4	Preparing for the workshop.....	16



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# 1 Introduction

The GTA Clean Air Council is hosting a workshop on February 24<sup>th</sup>, 2004 on “**Electricity demand side management and demand response for municipalities – opportunities in Ontario’s changing electricity market**” at Toronto Metro Hall. The Workshop is being designed in response to Article 6.11 of the *Toronto and Region 2003 Intergovernmental Declaration on Clean Air*, which states that the Greater Toronto Area Clean Air Council (GTA-CAC) should “*work to create greater awareness of municipal electric demand management and response techniques*”.

The purpose of the workshop is to:

- Improve municipalities’ understanding of electricity demand side management (DM) and demand response (DR) and how it applies to them;
- Identify benefits of DM & DR including lower energy bills, more comfortable work environments, and reduced air pollutant emissions;
- Identify possible municipal opportunities and incentives for DM & DR;
- Discuss opportunities and barriers for developing DM & DR initiatives; and
- Provide a process for developing municipal DM &DR programs.

## 1.1 Purpose of this report

This background paper will be provided to registrants in advance of the workshop to help them prepare for the event. It will provide registrants with:

- an overview of how Ontario’s electricity system operates, including the generation and distribution of electricity and the process and impact of electricity pricing;
- an introduction to the principles and practices of electricity demand side management (DM) and demand response (DR) and

a review of recent provincial government actions related to DM and DR; and

- an initial understanding of why DM and DR is important to municipalities and how to become involved.

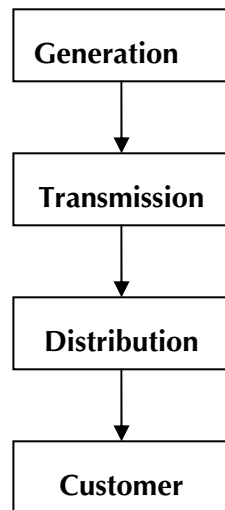
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## 2 Ontario's electricity market

The electricity system in Ontario has changed quite substantially in recent years. In order to understand DM & DR it is important to understand how Ontario's electricity system and market operate and what demand and supply pressures the system is currently facing.

### 2.1 How does the electricity system operate?

Ontario's electrical power system is one of the largest in North America, serving the power needs of more than 12 million people<sup>1</sup>. The power system in Ontario consists of three main parts – generation, transmission and distribution (Figure 1).



Generation is the production of electricity from natural resources, such as fossil fuels or the sun. Ontario currently has the capacity to generate electric power from 94 generating stations across the province. The breakdown of energy sources used to generate Ontario's electricity, sometimes referred to as the provincial electricity fuel mix, is shown in Table 1.

Figure 1 - Electricity system

Table 1 – Ontario's electricity mix (2000)

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<sup>1</sup> Independent Electricity Market Operator Website  
[http://www.theimo.com/imoweb/mktOverview/pres/role\\_opower.asp](http://www.theimo.com/imoweb/mktOverview/pres/role_opower.asp) Accessed December 22, 2003

Electricity source	Province wide average
Water power	26%
Alternative power sources	1%
Nuclear energy	37%
Natural gas	7%
Coal or oil	29%

**Source: Statistics Canada Catalogue no. 57-003-XPB (2000)**

The transmission system allows for the transfer of electricity from generating stations to distribution utilities across the province using high-voltage transmission lines, most of which are owned by Hydro One. Ontario's high-voltage lines interconnect with those of Manitoba, Quebec, New York, Michigan and Minnesota, allowing electricity to be imported into and exported out of the province.

In the distribution system, transformers are used to 'step-down' the high-voltage electricity from transmission lines to low-voltage electricity which can be provided to customers by distribution companies. Distribution services in Ontario are provided by Hydro One Networks Inc. and 92 local distribution companies (LDCs).

## 2.2 *How does the electricity market work?*

Figure 1 illustrates how the physical electricity system operates (i.e. how the electricity flows). It is also important to understand how the electricity market operates (i.e. how the money flows).

### **Market players**

There are six main types of players in the current Ontario electricity market: generators, distributors, transmission companies, retailers, the Independent Market Operator (IMO), consumers and the Ontario Energy Board (OEB). The roles of generators, distributors and transmission companies were discussed in the previous section.

The IMO operates Ontario's electricity grid, dispatching electricity across the transmission system from generators to distributors, and operates and regulates the wholesale electricity market. The IMO records and reports data that links usage with market price at 5-minute intervals and oversees settlement, billing and payment among market players. The IMO is an

independent non-profit company, governed by an independent board whose budget must be approved by the Ontario Energy Board.

Retailers are companies who sell electricity (commodity) to customers at a fixed price. When a customer buys electricity through a retailer, the electricity is still delivered to their building by the local distribution company's wires. Retailers who offer fixed price contracts have power purchase agreements with generators that shelter both the generator and the retailer from market volatility.

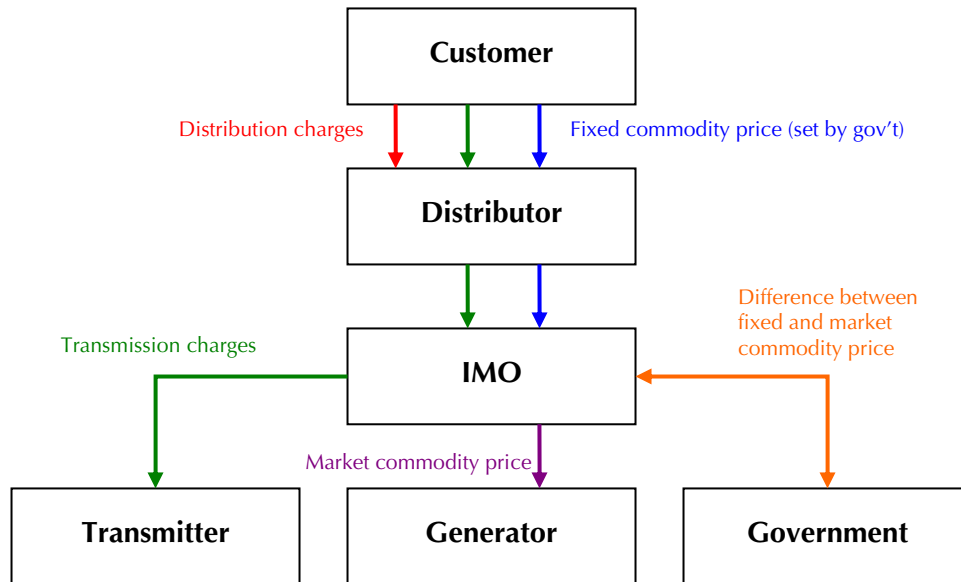
Consumers are the actual individuals and organizations that purchase and consume electricity. Consumers are generally divided into classes such as residential, industrial and commercial. Municipalities tend to be categorized with universities, schools and hospitals, referred to collectively as the 'MUSH' sector.

All market players (except consumers) require a licence from the Ontario Energy Board (OEB) to operate in Ontario. The Ontario Energy Board also regulates the transmission and distribution of electricity in Ontario. The rates charged for electricity by the local distribution companies and by Hydro One must be approved by the OEB.

## **The price of electricity**

There are three main components to the price of electricity: the generation cost, the transmission cost and the distribution cost (Figure 2).

The generation cost is often referred to as the commodity cost as it relates to the actual production of electricity (the commodity), whereas transmission and distribution refer to the transfer of the commodity. Prior to market opening, electricity rates were regulated by the provincial government for Ontario Hydro and by Ontario Hydro for the local municipal electricity distribution companies. In May 2002, a competitive commodity market opened, wherein the commodity price was set by market forces, every five minutes. However, in November 2002, the government instituted a 4.3 cents per kWh retail price cap on the electricity commodity for all residential and certain designated customers, including municipalities (including those that had signed a contract with an electricity retailer). The price which generators are paid for producing electricity, however, continues to be determined by market forces (purple line in Figure 2). If the market price is higher than the fixed charge to customers (as has been the case on average for the past year), the government makes up the difference (orange line, Figure 2). Since 2002, this 'difference' has accumulated to more than 600 million dollars.



**Figure 2:**

The newly elected provincial government announced in November 2003 that they will be raising the level of the price cap in order to better reflect the true cost of electricity

### 2.3 Supply and demand pressures

Since its opening, the electricity market has been faced with very large supply and demand pressures. On the demand side, monthly record amounts of electricity have been consumed since the opening of the market, reaching an all time peak in August, 2002. The winter peak for electricity was exceeded on January 16<sup>th</sup> 2004 due to the recent cold weather snap.

The introduction of a price cap on electricity at the retail level shifted the burden of paying for the high electricity rates above the price cap from the consumer to the taxpayer. In addition, the price cap reduced the incentive for consumers to conserve, thereby increasing electricity demand. The IMO responded to these demand pressures by shifting load to off peak hours, encouraging large consumers to cut back on power consumption, public appeals to consumers to cut consumption during critical time periods, and by purchasing record amounts of electricity from other jurisdictions.

Compounding the high demand situation is generation availability that is below expectations. Some generating units have experienced forced

outages or delays in returning to service (Bruce and Pickering nuclear power plants), low water levels have reduced available hydroelectric generation and environmental restrictions have limited fossil-fuelled generation. The Province has responded to these supply pressures by again relying heavily on imported power and acquiring temporary generators last summer at a significant premium cost.

The vulnerability of the electricity system in Ontario was highlighted on August 14 2003, with the largest and longest sustained power outage ever in North America. This blackout affected 50 million electricity consumers including the 5 million people in the GTA. While the exact cause of the blackout has not been established, the impact on Ontario and the GTA has dramatically illuminated the crisis that is facing the Ontario electricity market, and demonstrated how costly interruptions in electricity supply can be for the GTA's economy.

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## 3 Demand side management and demand response

### 3.1 What is demand side management?

Demand side management (DM) was originally conceived to include any action on the demand side that changes the shape of a customer's energy load profile. In Ontario, however, demand management became narrowly focussed, almost synonymous with energy efficiency.

Because of the recent Government announcements regarding energy policy and the expanded mandates given to both the Ontario Energy Board (OEB) and the IMO to promote energy conservation, energy efficiency, load management and the use of cleaner energy sources, an expanded definition of DM is warranted.

A more broad definition of DM is:

*Demand side management programs alter customer load shapes and reduce the total cost of energy for program participants, specifically and 'society' generally.<sup>2</sup>*

Under this definition, a DM program includes any measure that:

- Reduces a customer's overall energy demand
- Reduces a customer's demand for purchased energy

Specifically, DM for municipalities would include:

- **Energy efficiency** –technical and operational changes that reduce the amount of energy required to provide a particular service. e.g. building retrofits, switching to compact fluorescent light bulbs.
- **Conservation** – behavioural and operational changes that reduce overall energy consumption, e.g. turning down thermostats, turning off lights and equipment over night.

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<sup>2</sup> IndEco Strategic Consulting and Fraser and Company. 2003. *How to Reward and Encourage Milton Hydro Customers to Conserve Power: Milton Hydro's 2003 DSM Plan.*

- **Fuel switching** – particularly the use of green power such as wind turbines, or solar power.
- **Distributed energy** – includes tri-generation, co-generation, ground source heat pumps and district energy.

### 3.2 What is demand response?

In a recent discussion paper by OEB staff<sup>3</sup>, demand response (DR) activities are defined as “actions voluntarily taken by a consumer to adjust the amount or timing of his energy consumption. Actions are generally in response to an economic signal (e.g. energy price, or government and/or utility incentive).”

The discussion paper also identifies three possible types of DR actions – price response, demand bidding and voluntary load shedding.

#### Price response

Price response refers to situations where customers voluntarily reduce energy demand due to high prices during times of peak demand. Only those customers that pay the spot market price for electricity (i.e. are not covered by the retail price cap) are likely to undertake this type of voluntary reduction as residential and designated customers, including municipalities, currently pay a fixed price for electricity regardless of the true market cost as determined by supply and demand. In reality, however, electricity demand in Ontario has been shown to be quite ‘inelastic’, meaning that even when prices have been very high, facilities have not been reducing the amount of electricity that they demand.

#### Demand bidding

In demand bidding, large customers could ‘sell’ their reductions in demand to the IMO in times of peak demand. When Ontario’s demand exceeds its local supply, it may be less expensive to pay large users to reduce their demand than to import electricity from the United States.

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<sup>3</sup> Ontario Energy Board Staff Discussion Paper: Demand-Side Management and Demand Response in the Ontario Energy Sectors. October 6, 2003.  
[http://www.oeb.gov.on.ca/html/en/industryrelations/ongoingprojects\\_ministersdirective\\_dsm.htm](http://www.oeb.gov.on.ca/html/en/industryrelations/ongoingprojects_ministersdirective_dsm.htm) [accessed Jan 21, 2004].

## Voluntary load shedding

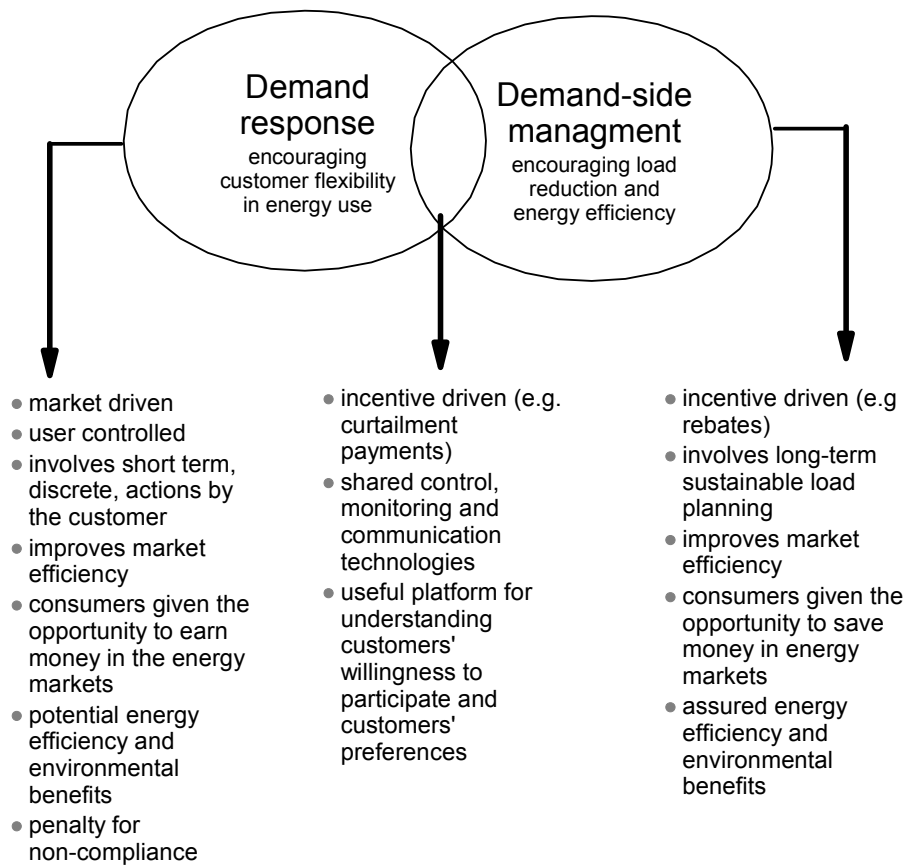
Voluntary load shedding refers to situations where customers voluntarily reduce energy demand in response to appeals from the government during times of high demand and/or constrained supply. After the blackout of August 14, 2003, government appeals to customers to limit their electricity use resulted in 15-20% reductions during peak hours of the day and an overall reduction of 394,000 MWh, over the nine days following the event<sup>4</sup>.

### 3.3 *DM versus DR*

Figure 3, below, illustrates some of the differences and commonalities of demand side management and demand response. DM is focused on achieving sustained energy use reductions and is often driven by incentives whereas DR is market driven and results in temporary reductions or temporal shifts in energy use.

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<sup>4</sup> The Independent Electricity Market Operator Website.  
<http://www.theimo.com/imoweb/EmergencyPrep/blackout2003/default.asp#8> [accessed Jan 22,2004]



**Figure 3 – Similarities and differences of DM and DR**

Source: Ontario Energy Board Staff Discussion Paper: Demand-Side Management and Demand Response in the Ontario Energy Sectors. October 6, 2003.

### 3.4 What is Ontario doing about DM and DR?

In the last year there has been a great deal of government activity regarding DM & DR in Ontario, including a directive to the OEB, the establishment of a government task force and the recent OEB Amendment Act. The provincial government has also recently established a provincial Conservation Action Team.

#### **Minister's directive on DM & DR**

On June 18, 2003, the Ontario Energy Board received a directive from the Minister of Energy directing the Board to consult with stakeholders to identify and review options for the delivery of DM & DR activities within

the electricity sector. The OEB later expanded the scope to include natural gas demand side management.

In response, the OEB assembled an Advisory Group from various energy stakeholders to assist them in developing an appropriate framework, within which to facilitate DM & DR initiatives. The Advisory Group's report was submitted to the Ontario Energy Board in December 2003. On January 23, 2004 the OEB released a Staff Report to the Board, *Demand-Side Management and Demand Response in the Ontario Energy Sectors*, for public comment, due February 9<sup>th</sup>, 2004. The OEB will make final recommendations on a DM and DR framework to the Minister of Energy by March 1, 2004.

### **Electricity Conservation and Supply Task Force**

In June, 2003 the then Minister of Energy announced the creation of an Electricity Conservation and Supply Task Force. The task force was established to plan ahead for the long-term electricity supply needs of Ontario. The task force was asked to provide an action plan for attracting new generation, to identify barriers to supply and conservation, and to make recommendations for enhancing the reliability and responsiveness of the Ontario's electricity grid.

The task force's report was submitted to the Minister of Energy in December 2003. It contains recommendations calling for the creation of a "conservation culture" in Ontario. Specific recommendations include the creation of new market rules to encourage demand side bidding from large volume customers, the promotion of technologies and rate offerings that facilitate time of use shifting (demand response), and the creation of a provincial "conservation champion" to monitor and coordinate electricity conservation. In the report the Task Force also recognizes the value of renewable and distributed generation and advances recommendations to remove barriers and encourage future generation<sup>5</sup>.

### **Ontario Energy Board Amendment Act, 2003**

On November 25<sup>th</sup>, 2003 the Minister of Energy announced that, as part of the *Ontario Energy Board Amendment Act*, it will be proposing a new regulation that will remove the 4.3 cents price cap on electricity and implement an interim pricing structure as of April 1, 2004. Under the proposed interim plan, the first seven hundred and fifty kilowatt-hours of

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<sup>5</sup> Electricity Conservation And Supply Task Force Website  
<http://www.energy.gov.on.ca/index.cfm?fuseaction=electricity.taskforce>. Accessed December 22, 2003.

electricity consumed in any month will be priced at 4.7 cents per kWh. Consumption above that will be priced at a rate of 5.5 cents per kWh.

This pricing structure will stay in place until the OEB develops a new mechanism for setting prices in the future. The OEB pricing mechanism will be implemented as soon as possible and no later than May 2005.

It is expected that the new price structure will apply to municipal buildings, which, like residential customers, are currently subject to the 4.3 cents price cap. More will be known about the interim pricing structure and who it applies to when the draft regulation is released in the near future.

The government is also proposing to allow all local distribution companies (LDCs) to achieve their full commercial return, which will result in an increase on average of approximately 0.3 cents per kWh on customer's bills. This rate increase is conditional on the LDCs reinvesting the equivalent of one year of these monies in conservation and demand management activities. It has been estimated that this announcement could mean that more than \$200 million may be made available for investment in conservation and demand management. However, the exact details and rules for how this money is to be spent has not yet been established.

## **Conservation Action Team**

On January 16, 2004, the provincial government announced the establishment of the Conservation Action Team, consisting of nine parliamentary assistants across nine ministries, to champion energy conservation. The objectives of the team include engaging in outreach to sector specific stakeholders, identifying and removing barriers to conservation where possible, and developing an action plan for the government to meet its conservation target of five per cent by 2007.<sup>6</sup> The team will be lead by Donna Cansfield, MPP, Parliamentary Assistant to the Minister of Energy.

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<sup>6</sup> Ministry of Energy Website.  
[http://www.energy.gov.on.ca/index.cfm?fuseaction=english.news&body=yes&news\\_id=49](http://www.energy.gov.on.ca/index.cfm?fuseaction=english.news&body=yes&news_id=49) [accessed Jan 26, 2004].

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## 4 Municipal electricity DM & DR

There are many reasons for municipalities to be aware of and interested in DM & DR initiatives, ranging from broad environmental and societal concerns to local cost saving measures. Given the number of buildings and facilities owned and operated by municipalities, there are also many opportunities for DM & DR programs in municipalities.

### 4.1 *Why should municipalities be interested in DM and DR?*

As described in section 2.3, it is expected that the cap on electricity prices will soon be removed and a new interim price structure will be introduced, leading to higher electricity prices. DM programs that reduce municipalities' overall energy demand (e.g. building retrofits, conservation programs) or that increase their local production of electricity (e.g. distributed generation, tri-generation) can help to offset increasing electricity prices.

In addition to bill savings, energy conservation and efficiency projects have been shown to provide more comfortable working conditions for employees and often improve employee productivity<sup>7</sup>. Municipalities could also offer residential energy programs as a benefit to their employees.

The increased demand for electricity is contributing to an unreliable electricity system in Ontario, as demonstrated by the August 2003 blackout. A reduction in municipal energy use through DM or a shift in the time of electricity use through demand response initiatives could increase system reliability and reduce the risk of service interruption and power failure.

The potential benefits of demand management and demand response initiatives are not only economic but also environmental and societal. Electricity generation is one of the largest sources of greenhouse gas emissions (GHG) in Ontario. Under the Kyoto Protocol, Canada has agreed to reduce its GHG emissions by 6%, with respect to 1990 levels, by 2008-2012. Many municipalities within Canada have adopted their own GHG emission reduction targets as well. Reducing energy demand (through retrofits and behavioural programs) will help to reduce GHG emissions. Altering the fuel or generation source (e.g. fuel switching,

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<sup>7</sup> See, for example, Joseph Romm's 1999 book, *Cool Companies*.

renewable energy and distributed generation) may also reduce GHG emissions.

## 4.2 What can municipalities do?

Sections 3.1 and 3.2 gave a general outline of demand side management and demand response activities. Some specific DM and DR activities that may be particularly well suited to and represent opportunities for municipalities include:

- Building retrofits – municipalities tend to own large numbers of buildings. There is an opportunity for municipalities to reduce their overall energy demand by improving heating, ventilation and cooling (HVAC) systems and the building envelopes (e.g. windows) of their buildings.
- Conservation programs – many municipal buildings are used for office space during business hours. There is an opportunity to reduce electricity use in municipal offices by ensuring that equipment and lighting is turned off both overnight and when not in use. This can be achieved by installing technologies (e.g. automatic thermostats and sensor lighting) and/or by behavioural changes (e.g. employee information programs).
- District energy – In district energy systems, thermal energy generated at central plants is distributed in the form of steam or water to a network of buildings in order to provide cooling and/or heating services. The central plants are often cogeneration units, meaning that they produce both electricity and heat. District energy systems are most suited to urban cores, where there is a sufficient density of customers (buildings).
- Distributed generation – Small scale, local generation of electricity (e.g. wind turbines, ‘micro cogen’ units) offers municipalities the opportunity to reduce the amount of electricity purchased from the ‘grid’, either on a permanent basis (i.e. DM) or when electricity prices and supply is low (i.e. DR). In addition to reduced dependence on the provincial electricity system, distributed generation can also have environmental benefits, depending on the local energy source used.

## 4.3 Developing DM and DR programs

Municipalities are complex and unique institutions. As such, different municipalities are likely to face different opportunities and barriers to developing DM and DR programs in their jurisdictions. While one

municipality may discover that their biggest ‘stumbling block’ is getting council approval, another may find that attaining the necessary resources for implementation to be the most challenging.

While specific circumstances, challenges and opportunities will vary, there are some fundamental steps to developing DM and DR programs that should be undertaken in all jurisdictions:

- Energy use inventory – before undertaking measures to reduce or shift municipal electricity use, it is necessary to understand how much electricity is being used and what it is being used for.
- Opportunity assessment – there will likely be a number of DM and DR opportunities for every municipality. Assessing opportunities and setting priorities based on municipal objectives and available resources, will help to ensure that only effective and efficient initiatives are implemented.
- Program design & approval – As with all municipal initiatives, a detailed program design and implementation plan, including a sound business case, will be critical to gaining public support and council approval.
- Implementation, monitoring and revision – once a program begins, it will necessary to monitor results in order to ensure that the expected benefits are being realized and to make any adjustments or changes, if necessary.

#### *4.4 Preparing for the workshop*

There will be four key themes to the workshop:

- What DM & DR activities can municipalities initiate and/or participate in?
- What do municipalities need to complete DM & DR initiatives?
- What barriers limit municipalities’ participation in DM & DR?
- How can these barriers be overcome?

These themes will underlie speakers’ presentations throughout the workshop and will be the focal point of the group discussion at the end

of the day. Participants are advised to give some thought to these questions in advance of the workshop.





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