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Community Energy Management – Foundation Paper

INTRODUCTION

Community energy management (CEM) is a key component in reducing urban energy requirements and enhancing greenhouse gas sinks. It involves a disciplined approach to integrating energy considerations into municipal planning and management processes.

CEM takes two broad directives. The first approach known as "livable cities" addresses the way communities are designed, with an aim to

- create communities with affordable housing in attractive environments;
- improve accessibility to services and employment;
- preserve green space;
- reduce pollution and noise; and
- create a safer urban landscape that fosters a sense of place and community.

This approach has spawned several urban planning initiatives. The key features are more efficient use of energy, waste reduction and less dependence on automobiles.

The second approach seeks to broaden the use of energy-focussed management and planning, including demand-side management (DSM) and integrated resource planning (IRP). DSM encourages consumers to minimize energy use in various ways, such as using energy-efficient appliances and setting thermostats for moderate rather than very warm or cool temperatures. Electric and natural gas utilities use IRP to assess choices between new supply and DSM alternatives.

Within the community energy management context, DSM and IRP address:

- energy delivery systems – district heating and cooling, combined heat and power, and renewable energy
- building energy and resource efficiency – passive solar design, reduced building heat loss, and reduced water consumption and wastewater production.

This research paper *Community Energy Management – Foundation Paper,* produced for Canada Mortgage and Housing Corporation, explores the potential for community energy planning to facilitate reduction of greenhouse gas emissions in Canada. The paper examines the following aspects of CEM:

- the relationship between land use and energy use;
- the potential for district energy systems in Canadian communities;
- community energy planning – the potential, key elements, actions and benefits.

The density, mix and arrangement of land uses in a community heavily influence the amount and mode of travel and, therefore, transportation energy use and its associated environmental impacts. These same urban characteristics also affect the amount of energy needed to heat and cool buildings, and to build and operate community infrastructure. Communities can improve their environments, economies and quality of life by being aware of the energy consequences of their choices.

CEM typically addresses the following aspects of urban planning and development:

- land use planning – zoning for specific land uses, land use densities and land use patterns
- transportation management – traffic management, developing high-occupancy vehicles, transit, walking and bicycling infrastructure and services
- site design – encouraging designs that improve the economics of energy efficiency measures, alternative energy supply technologies, use of passive solar energy and microclimatic considerations
- energy supply and delivery systems – district energy systems using, in some cases, renewable or waste energy.

Energy-related choices may be grouped into three levels of impact. Those related to infrastructure and land use patterns have the greatest impact because of their long-term nature; these are followed by major production processes, transportation modes and buildings; and energy-using equipment comprise the third level of impact.

In summary, community energy planning takes a comprehensive and long-term view of energy use in the community. It seeks to create conditions and influence choices that foster sustainable community development.

Level 1. Infrastructure and Land use Patterns	
■ Density ■ Mix of land uses ■ Energy supply infrastructure ■ Transportation networks	⇦ Local plans, master plans, property tax structure, lot levies, right-of-way allocation
Level 2. Major Production Processes, Transportation Modes and Buildings	
■ Choice of industrial process ■ Choice of transportation mode ■ Building and site design	⇦ Local codes and standards, user fees, parking policies and pricing, local demand management programs, industrial and economic development policies
Level 3. Energy using Equipment	
■ Transit vehicles ■ HVAC systems ■ Appliances ■ Motors	⇦ Local procurement practices, influence of local codes and regulations, education programs

Figure 1 Hierarchy of energy-related choices

LAND USE AND CEM

Culture plays a crucial role in the manner in which cities with a history of low-density development achieve higher densities and more mixed uses. Many neighbourhoods in Canadian cities present opportunities for residential intensification, although regulatory reform and public education are needed to overcome opposition. Some evidence suggests that North Americans may move to higher density and mixed use alternatives when presented with realistic alternatives to traditional suburban development. In addition to higher densities and mixed use, improved public transit and better siting and design parameters are needed to lower greenhouse gas emissions.

HIGHER DENSITY

Research indicates that densities above 30 to 40 persons per hectare are needed to support public transit-oriented urban lifestyles. In cities with household sizes and land uses comparable to San Francisco and densities below 30 persons, bus service becomes poor. At 20 persons, there is a marked increase in driving. Figure 2 shows typical densities for different housing types, and Figure 3 presents population densities for Canadian cities by size.

In very high-density neighbourhoods, walking and cycling become important means of transportation, in addition to public transit. High-density development also reduces building energy consumption on a per unit basis.

Density	Housing Type	Storeys	Units/Net Ha	Persons/Net Ha
Low	Single family detached	1-2	12-17	43-48
	2-family	1-2	19-29	48-84
Medium	Row house	2-3	24-48	72-144
	Garden/walkup Apt.	3-4	48-96	120-192
High	Multi-family (low)	5-10	96-192	192-360
	Multi-family (medium)	10-16	192-240	360-480
	Multi-family (high)	16+	240-960	480-1,680
Source: *D'Amour 1993, 12*				

Figure 2 Typical densities of different house forms

Population class (No. of urban regions)	Population density pop/ha
25,000 – 50,000 (26)	9.0
50,001 – 100,000 (18)	9.8
100,001 – 250,000 (13)	12.8
250,001 – 500,000 (4)	12.4
> 500,000 (9)	19.5
Average for 70 regions	16.5

Figure 3 Population densities for different sizes of Canadian cities

MIXED USE

Mixed use allows for higher levels of neighbourhood self-containment by placing residences, retail, other services and business/industrial centres in close proximity to one another. As such, it is a key element in community energy planning for lowering environmental stress. With services and employment close at hand, residents can either walk or cycle to provide for their daily needs, or reduce the distance they travel by car. A combination of mixed use and higher density also paves the way for district energy systems, as these systems work better when servicing a mix of building types in a relatively small geographic area.

IMPROVED PUBLIC TRANSIT

Better public transit service figures prominently in energy-efficient cities. Clustering high-density residential development and commercial services around major transit stops is essential. Land use strategies must be such that they encourage and support well-developed public transit systems.

BETTER SITING AND DESIGN PARAMETERS

Siting and design guidelines can improve the use of passive solar energy for heating and reduce energy consumption by taking microclimatic conditions into consideration. *Community Energy Management – Foundation Paper* identifies four general types of siting development:

- *Compact city development* concentrates redevelopment in the inner city. While this achieves higher densities and reduces travel distances, it places new residential development in areas that generally have the highest concentrations of air pollution.
- *Multi-nodal development* is the most self-contained of the four, with nodal city centres connecting to a ring highway and a radial rail and highway system. It is second only to the compact city in its energy efficiency. While travel distances can be high, travel time is short, and air pollution is lower than in most other development configurations.
- *Corridor city development* locates growth on green field sites connected to an existing city by radial rail, arterial road and highway links. While it results in higher greenhouse gas emissions from longer travel times to the city centre than for the preceding two development forms, air pollution is relatively low.
- *Ultra city development*, typical of Canada's largest urban areas, describes metropolis-based regions with dispersed development interconnected by high-speed transportation networks. Travel distances and green house gas emissions are moderate to high.

NEW URBANISM

Urban forms that place a renewed emphasis on pedestrian- and transit-friendly neighbourhoods have become known as the “new urbanism”. Neighbourhoods designed accordingly are meant to be self-contained. They incorporate a mix of land uses and housing types, ranging from apartments to non-profit housing to single-family detached homes. Streets are designed to accommodate pedestrians, and services are located within easy walking distance of all residents.

DISTRICT ENERGY SYSTEMS

Next to mode of transportation in influence on lower energy use European cities can attribute their energy efficiency to district energy systems. These systems replace the boilers, furnaces and chillers in individual buildings with a system that distributes heating or cooling through buried pipes, using hot or chilled water, from one or more central heating and cooling plants.

It is estimated that the emissions reduction potential is well in excess of 10 per cent of total space heating and domestic hot water emissions. District energy systems reduce emissions through higher levels of energy efficiency, combining heat and power production and better emissions control. The substations use less space and require less maintenance than conventional heating and cooling equipment. In order for widespread application to occur, district heating must be integrated into the planning and development for both the urban infrastructure and power supply system.

A wide variety of fuels and energy sources can be used at the heating and cooling plants, including waste heat from electrical power generation (commonly referred to as combined heat and power, or 'CHP'), municipal solid waste, methane gas from landfill sites, sewage gas, renewable fuels (e.g., wood, wood waste, peat) and non-renewable oil and natural gas.

Although there are over 160 such systems operating in Canada, they are generally located on large institutional campuses (e.g., universities, military bases). As such, district energy makes a relatively small contribution to total energy use. Recently, though, there has been a resurgence of interest in district heating and CHP facilities in Canada, spurred partly by concern about the environment and energy use.

At the time of this research, two Canadian municipalities were in the process of planning to upgrade and expand their existing systems, three had new systems in the planning stages, and 18 other municipalities, all partners in the Federation of Canadian Municipalities' Partners for Climate Change campaign, were considering district energy systems as part of their community energy plans.

COMMUNITY ENERGY PLANNING

While land use planning for energy efficiency and district energy systems are important elements of energy-efficient communities, community energy planning (CEP) is more than the sum of individual technological and planning measures. It involves the deliberate and strategic use of what might be called municipal "spheres of influence" on energy use in the community. Examples of spheres under municipal influence include

- buildings operated by municipalities;
- landfill gas recovery and utilization;
- solid waste reduction, recycling and composting;
- parks and community greening programs;
- utility business strategies that support greenhouse gas reductions;
- stimulating a market for "green power";
- urban transit;
- regulations that can impact on energy use, such as building codes, parking, traffic flow;
- infrastructure development;
- land use.

Innovation, initiative, clearly specified targets, political leadership, community involvement and municipal staff support are just a few of the key elements of CEP. Other important elements include:

- recognition of multiple benefits – job creation, economic development, cost savings, air quality improvement, greenhouse gas emission reduction and improvements in overall quality of life in the community
- partnerships with senior levels of government, utilities and others;
- innovative financing;
- market mechanisms;
- collaboration with other local governments;
- monitoring and evaluation;
- integration of energy considerations into day-to-day activities, policies and planning.

A 1997 study on infrastructure costs, which used an Ottawa suburb for the case study, concluded that if the area had been designed along new urbanism principles, the 75-year lifecycle cost of the infrastructure would have been reduced by $11,000 per residential unit, or 8.8 per cent, compared to the conventional plan. These savings would be roughly split between the public and private sectors.

CONCLUSIONS

Community energy management includes a wide variety of initiatives that can result in very significant energy efficiency gains and greenhouse gas emission reductions. Strategies for improving efficiency and increasing local self-reliance in energy use almost always yield net benefits for the community from:

- reinvesting fuel and electricity savings into the local economy reduced traffic congestion and increased related productivity;
- improved air quality, public health and related economic benefits;
- lower infrastructure costs;
- enhanced competitiveness in attracting business; investment to the community.

The financial rewards of CEM for municipalities appear to be as significant as the potential for emissions reduction. There are also many intangible quality of life benefits.

A lead agency or champion is needed to overcome barriers to CEM. These barriers include a lack of clear jurisdiction, lack of cooperation, lack of information, lack of political will, competing priorities and a lack of a sense of urgency. Tools that can monitor the impact of CEM and help demonstrate the benefits of CEM, and how initiatives can be applied in other communities, are few and far between. Developing these tools and conducting studies on communities using CEM are needed to further our understanding of CEM and its benefits.

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Research Report: Community Energy Management -
- Foundation Paper, 2000

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Under Part IX of the *National Housing Act*, the Government of Canada provides funds to CMHC to conduct research into the social, economic and technical aspects of housing and related fields, and to undertake the publishing and distribution of the results of this research.

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