House of Commons Committee on Natural Resources

T. D. Ellison
Executive Director
and
Sean Bolongaro, P.Eng.
Chair - CWWA Energy Committee

Canadian Water and Wastewater Association
Unit 11, 1010 Polytek Street
Ottawa, ON K1J 9H9
Tel: (613) 747-0524
Email: tdellison@cwwa.ca

Introduction

The Canadian Water and Wastewater Association represents the interests of municipal water and wastewater services in respect of federal or national legislation, policies and programs. More than 24 million Canadians receive drinking water from municipal services and discharge wastewater to those services. The services are provided on a not-for-profit, public service basis. Revenues derived from these services are in most instances, intended to fully pay and maintain the service and the infrastructure however, there has developed an infrastructure gap. Although these services are subject primarily to Provincial or Territorial legislation, there are a number of federal statutes which affect their operations.

I GENERAL COMMENTS

Energy management is a pan-Canadian, all stakeholder concern. Municipal water and wastewater services throughout the country are cognizant of the need to reduce their use of energy, in particular electrical energy, in their treatment and distribution and collection services. Water and wastewater services combined are typically the biggest single consumer of electrical energy within the total of all municipal operations and services. Efforts are being made to reduce electrical energy demand in two manners: introducing energy efficiency programs and introducing energy recovery or renewable energy programs.

There are barriers to introducing these programs. Some are financial (e.g., a lack of funds to replace capital equipment and infrastructure) and others maybe regulatory or public perception (e.g., prohibition of incinerators for energy recovery).

The following provides the Committee with information on opportunities that are known to exist in parts of Canada or from other countries that could be promoted to, and potentially applied in all municipal operations if the financial and other barriers could be reduced or removed.

Energy Efficiency Programs

The most significant use of electrical energy in water and wastewater systems is the energy consumed in pumping water through the distribution system to storage tanks or directly to customers, or in pumping systems associated with wastewater collection systems (not all of which are gravity fed).

The installation of modern "energy-efficient" pumps is impeded by the availability of funds to do so and the fact that the existing pumps may still have a long operating "technical" life before them. As pumps are replaced on a life-cycle sustainability cycle, they will eventually be replaced; however it is possible to accelerate this rate of replacement. Other countries have provided financial incentives (e.g., accelerated depreciation allowances or reduction in applicable sales taxes) to hasten the replacement of aging pumps and other energy-based equipment. Some of these incentives work best in a private sector environment (which is not the case in Canada) but can work in a public sector "utility-based environment" where the utility is expected to operate on a full-cost recovery basis.

Renewable or Recoverable Energy Programs

Water and Waste Water infrastructure often offers great opportunities for renewable energy generation or energy recovery. Some of the necessary infrastructure is often already in place and expensive civil construction is not necessarily required. In addition, water treatment plants and wastewater water treatment plants tend to be near or within the communities which they serve. This is an advantage as any associated renewable energy can be fed directly into the community power grid, if it is not used on-site to replace otherwise off-site sourced energy. This proximity advantage is often not the case with other renewable technologies such as hydro or wind.

II WATER TREATMENT AND SUPPLY

Micro hydro systems

In water treatment and supply, the most obvious renewable energy opportunity is associated with micro hydro generation. Depending on the arrangement of a water supply system, it is often possible to harness the hydraulic energy in the water system. There are many water systems in Canada that employ this technology. Some systems date back to the 1920' and 1930's. The City of Calgary has a 500 kW generator at the inlet to the Glenmore Water Treatment plant. In recent years the technology has been extended to include energy recovery at pressure reducing stations. Many communities are looking at this as a way of generating renewable energy.

Heat exchange/recovery systems

Another opportunity in water supply is the application of geo-exchange principles. By exchanging heat with a geo-exchange system, inherent water heat can be taken and factored up by heat pumps for space heating. Although not energy generation, this type of technology is very effective in reducing space heating or cooling energy needs.

The most significant of the current systems include the installations of the Enwave Energy Corporation in Toronto and Windsor. Enwave, in their Toronto operation, distributes steam and chilled water to over 140 buildings via a 40km underground pipe network that covers most of the city's downtown core. The company's innovative Deep Lake Water Cooling (DLWC) business has been recognized world-wide and has cemented Enwave's leadership role in the renewable energy sector. In Windsor, Enwave manages a district energy system that delivers heating and cooling to the Windsor casino and the Windsor Utilities Company.

Other communities, notably Peel Region, are planning to use similar technology to recover energy through these systems.

III WASTEWATER COLLECTION, TREATMENT AND DISPOSAL

Heat exchange/recovery systems

Wastewater collection is normally achieved by both pumped and gravity elements in the collection system. In the case of gravity systems, it is theoretically possible to recover energy through turbines - although in reality this is not practical. Collection systems however, do offer opportunities for heat recovery. The raw wastewater can be directed over heat exchangers and the heat recovered for use with heat pumps. The heat exchange technology employed is quite specialized and so far only installations in Europe and California have proceeded. In Canada there has been some uptake on this type of technology but with final effluent not with raw wastewater. Extracting heat from raw wastewater may pose operational problems either within the collection system (congealing of fats, oils and greases on sewer surfaces causing blockages) or to reduced temperatures in the bio-reactors at the treatment plant requiring additional energy input to ensure the necessary biological reactions. Recovery of heat energy from the post-treatment plant effluent is generally without operational or environmental consequences. Perhaps the best example of this is the Whistler Olympic Athletes village. In that project the village homes will be heated by heat recovered from Whistler’s wastewater treatment plant effluent. Cooler effluents being discharged into environmental waters will have a lower temperature plume which can have a beneficial impact on the receiving body’s aquatic ecosystem, particularly in winter.

In wastewater treatment there is perhaps the greatest range of opportunities for renewable energy generation. The most prevalent example is biogas creation and re-use. Biogas is generated as a by-product of solids reduction by digestion. Historically the biogas was used only for building and process heating. The excess biogas would be flared. In recent decades there has been a move to use the biogas for cogeneration installations. In cogeneration, the biogas is used to fuel a reciprocating engine. The engine is in turn used to drive an electrical generator thereby, producing electrical energy. Waste heat from the engine is captured and used for process heating. There is great potential in Canada to augment wastewater cogeneration by digesting other organic wastes. This practice is quite common in Europe and typically involves abattoir wastes with wastewater solids. The result is greater biogas generation and a solution to other waste disposal problems.

Biogas can also be purified to remove contaminants and used as a fuel source for automotive or transport purposes. Several cities in Scandinavia provide methane gas for this purpose and actually provide fuel for municipal vehicles such as service and transit vehicles.

One of the products of wastewater treatment is the sludges resulting from treatment. These sludges are essentially cellulose, and they offer the potential for the production of alcohols that can be blended with gasoline and diesel fuels to supplement or replace the production of fuel alcohols from agricultural products. Unlike agriculturally-based cellulose and sugars which have to be produced and transported to the production plant, the sludges are "free". The cellulose comes from sanitary products purchased by the user (and then disposed into the wastewater system) and they are collected at a central point (the wastewater treatment plant) also "free" of charge as the collection process will be carried out in any case for public health reasons. These sludges are treated to produce a range of environmental valuable products including biosolids that can replace fertilizers, or can be incinerated for energy recovery, or can be used to produce building materials. The production of alcohol, as already mentioned is an emerging use.

IV CONCLUSION

Proving or accepting innovative ideas and technologies is a slow process. Incentives have to be provided to encourage their adoption. This may be in part the provision of financial incentives (infrastructure funding, or the adjustment of taxation policies, or the funding of demonstration projects). It can also require regulatory changes or changes in perception of what is acceptable, or simplifying the environmental impact assessment process. Promoting and publicizing information and awareness of new and emerging technologies as well as proven technologies from other countries can also be beneficial.

The Committee may wish to encourage any of these steps or actions, not just because of the current circumstances of tackling greenhouse gas reduction and fighting climate change, or the current circumstances of the struggling economy, but because there are demonstrated environmental advantages of bring these new technologies and processes into Canada and these systems.

The Canadian Water and Wastewater Association submitted a Briefing to the Parliamentary Standing Committee on Natural Resources, identifying opportunities for energy recovery and generation from municipal water and wastewater infrastructure and treatment facilities. The Committee has asked the Association to expand on some of the information provided in the original brief. The following provides additional information on three options – heat recovery and the generation of biogas from sewage systems and the use of wastewater residuals for bio-fuel production.

An excellent summary of resource (energy) recovery projects can be found at the Georgia Strait Alliance website:
www.georgiastrait.org/files/share/PDF/Resource_Recovery_Examples_2008.pdf

Heat Exchange Recovery from sewage systems

Sewer heat recovery captures heat from municipal liquid waste to heat buildings, most often using heat pumps. The sewer system can also be used as a heat sink to cool buildings, This process has great potential with studies from Germany suggesting that up to 3% of buildings could be heated using the waste heat from sewage. However, there are practical challenges to using such a system in Canada's cold climate since the ambient temperature of sewage flowing through the collection system and entering the treatment plants must be maintained at a reasonable level to ensure the avoidance of sewer back-ups or to ensure appropriate biological reactions in the treatment processes. Notwithstanding this, it is expected that some heat recovery can take place as the chilled wastewater will reheat from thermal flows from the surrounding soils.

Several European cities — including Oslo, Stockholm, and Zurich — as well as Tokyo and Sapporo in Japan are successfully using sewer heat recovery systems to provide heating and cooling for buildings (www.greencampus.harvard.edu/cre/sewerheat.php). The Harvard report states that this technology has been grossly under-utilized; sewer heat represents an untapped source of "wasted" energy that can and should be utilized. There are some successful European companies including a Swiss Company – Rabtherm (www.rabtherm.com) who are producing heat recovery systems. Energy can be captured by means of heat exchangers directly in the sewer pipes. The average 15°C warm wastewater can be cooled down to about 2°C (maximum 0.5°C over 24 hours). The energy captured is transported by a long-distance line to the group of buildings where the temperature is increased up to 65°C (using heat pumps) necessary for heating and distributing warm water in the buildings. The chilled wastewater will return to its previous temperature after a period of time through the natural heat exchange between the now "chilled" pipes and the surrounding warmer soils.

In Stockholm, Sweden for example energy which is recovered from the Henriksdal treatment plant's effluent is enough to heat 80,000 homes in the city. During the planning phase the Capital Regional District (Victoria, BC) did a detailed review of the Swedish projects, both the heat recovery and biogas generation – and a discussion paper is available at: http://www.crd.bc.ca/wastewater/documents/investigation-sweden.pdf

Several cities in Japan have developed heating and cooling systems using sewage. Some examples include the west area of Morioka Railway Station in Iwate applied district air conditioning using thermal energy of sewage. Energy consumption, CO_2 emission and NOx emission were reduced by 30%, 60% and 50% respectively. Makuhari area in Chiba applied the district air conditioning in its high-tech business area of 49ha. They supply warm water of 47°C and cold water of 7°C to clients. The amount of liquid sewage used for this system was about 58,000m^3 / day in FY2004. Tokyo Metropolitan Government developed the district air conditioning in Sinsuna and Koraku area of Kouto Ward using thermal energy of sewage and waste heat from sewage sludge incineration plant. An extensive discussion of options can be found in: http://nett21.gec.jp/GESAP/themes/themes3_3.html

Several Canadian cities are investigating or installing pilot heat recovery systems, including the Olympic Village in Whistler, BC; Kelowna BC, has installed heat pumps to heat Okanagan College; and Metro Vancouver is investigating the possibility of installing heat pumps at the Iona Sewage Treatment Plant. (http://vancouver.ca/sustainability/building_neu.htm)

Biogas Projects

The sludges from a wastewater treatment plant can be dried and used as a fuel in the MSW WTE facility or they can be anaerobically digested to create a methane rich biogas that can be used to create heat and electricity in a cogeneration facility. Alternatively, the biogas from both wastewater treatment plants and landfills can be cleaned and enriched (by removing the carbon dioxide) to create a vehicle fuel suitable for use in specially-equipped buses, cars and/or trucks.

The European Union, through its Biogasmax project, is a leader in the collection and utilization of biogas. The project creates a network of biogas-related demonstrations on the European territory with the aim of sharing experiences in terms of best practices in managing urban transportation (http://www.biogasmax.eu/).

Several cities in Scandinavia provide methane gas for this purpose and actually provide fuel for municipal vehicles such as service and transit vehicles.
(www.biogasmax.co.uk/biogas-biofuel-stockholm/biogas-biofuel.html)

Bio-fuel production.

A New Zealand company has recently announced that they have produced the world's first commercial production of bio-diesel from "wild" algae outside the laboratory - and the company expects to be producing at the rate of at least one million litres of the fuel each year from Blenheim by April.
(http://www.nzherald.co.nz/section/story.cfm?c_id=1&objectid=10381404)

Organic residuals from wastewater can be used to produce ethanol directly, or can be used to provide the fertilizer and soil supplements needed to intensively grow bio-fuel crops such as soy. The Seattle, WA Metro Transit was planning a new round-trip route from Sunnyside to Seattle. Only it's not for people, it's for waste and fuel for buses. King County Executive Ron Sims announced in April 2007, that the county will bring about 2 million gallons of homegrown biodiesel to King County to power Metro buses. "This is another case of the county turning waste into a resource," Sims said in a statement. "This time biosolids from our local wastewater treatment process are being used to grow canola that will be refined into biodiesel to power our local transit system. This ultimate act of recycling shows how far we've come in developing new approaches to creating energy independence while reducing our carbon footprint." This report can be found in The Canadian Biosolids Partnership website. The proposed Partnership developed an extensive review of beneficial reuse applications currently in place or in development across the world. The complete document is available at: http://www.cwwa.ca/cbp-pcb/databases/beneficial_e.asp#crd