CASE STUDY: VANCOUVER'S DISTRICT HEATING PROGRAM

1. THE CONCEPT OF DISTRICT HEATING

A district heating system (sometimes called a community energy system) is an integrated, large-scale and flexible way to distribute heat to a number of buildings. It consists of a network of underground pipes linking suppliers with consumers, enabling energy consumption (steam, hot or chilled water) to be managed at the community level. The network approach leads to greater overall efficiency, lower and more stable energy costs. The variety of processes and the use of local resources help mitigate the impact of a volatile fossil fuel marketplace (though some district energy networks and CHP systems do run on fossil fuels).

Cities characterized by high-density development, such as technology parks, malls and multi-unit residential clusters, are the best candidates for connection to a district heating system. Cities characterized by low-density developments (such as distributed single-family housing) are less suitable for district heating, due to the larger distances over which heat must be distributed.

New developments, where the purchase of heating equipment for individual buildings can be avoided, are ideal candidates for district heating. Existing buildings can also be good candidates for district heating, particularly if the fuel source is free or low-cost. Even using natural gas initially as the primary fuel may be cost-effective, when operations and maintenance are taken into account. This may be viewed as a temporary stage en route to a future, renewably-based district heating system.

2. BACKGROUND

In the early 1990s, the City of North Vancouver launched a planning initiative to redevelop the City's waterfront and urban core areas. In approving this initiative, City Council required that planners address energy considerations along with land use. This requirement was unusual, since energy planning in British Columbia is normally left to provincial-scale organizations, such as BC Hydro for electricity and Terasen Gas for natural gas.

Local Councilors were invited by the Federation of Canadian Municipalities (FCM) to join an "energy mission" to Europe to visit up-to-date energy installations. The study tour of centralized district energy systems in Europe led the City to retain consultants to explore the potential for a district heating utility.

The pre-feasibility study found that land for a central, stand-alone plant was scarce in the area. The study also noted that a central plant would require significant up-front capital to develop and that in creating a central plant, the City would have to forgo funds from some other potential revenue-producing redevelopment on municipal land. Further, a central plant would result in high operating costs for 24-hour on-site staffing to monitor system operations.

3. THE POLICY

A team of consultants identified an alternative to the central plant approach - interconnected mini-plants, which rely on mini-boilers to heat hot water. The City's decision to pursue this option led to the establishment of the Lonsdale Energy Corporation (LEC). LEC is a public utility governed and regulated by the City of North Vancouver. The City entered into an agreement with Corix Utility, formerly Terasen Utility Services, which handles the development, maintenance, monitoring, servicing and the day-to-day operation of the Lower Lonsdale service area mini-plants.

The Bylaw

The city of North Vancouver established a Hydronic Heat Energy Service Bylaw to create a district heating service area for Lower Lonsdale, with a requirement that all new or retrofitted buildings greater than 10,000 square feet be connected to and use the system. This bylaw requires developers in the district to provide infrastructure to connect to the system, avoiding the construction of baseboard heating in the district. The bylaw also led to the establishment of the LEC. In 2003, the FCM provided $4 million in funding through the Green Municipal Fund. Ultimately, the local government retained the services of Corix Utility to handle development maintenance, monitoring, servicing, and day-to-day operation of the Lonsdale mini-plant. Since that time LEC has created two additional service areas and are currently managing these service areas directly without the involvement of a third party operator.

The System

In order to develop an efficient district heating system, local government staff needed to identify potential areas that would have a high demand for heating. Also, optimum areas would need to have a strong mix of land uses to allow for a variety of different energy demand cycles. The project required a close working relationship between planning staff and developers to ensure the proper integration of the district energy infrastructure into city works operations. Anticipated demand for heating was modeled for residential buildings, which influenced the size of the mini- plants. Currently, the LEC has developed detailed guidelines for developers' design teams to help implement the infrastructure design and controls needed to efficiently connect to the system.

Lonsdale Energy Corporation's system relies on high-efficiency gas mini-boilers to heat hot water, which is then piped underground to provide a heat source to residential towers, commercial space and a community center in the local service area. Once used, the water is recirculated back to the mini-plant for re-heating, then recirculated again to the connected buildings. The system avoids each building having its own boiler. System costs are recovered through usage charges authorized by bylaw.

4. ENERGY EFFICIENCY POTENTIAL

4.1. Policy Uptake

Lonsdale Energy Corporation was incorporated in 2003 to operate the system. The council acts as the tariff setter, regulating the rates charged by LEC. In February 2007, the City established a service area bylaw to introduce a second system, to be served by LEC, in the expanding Central Lonsdale neighborhood.

Currently, there are there are three energy service areas, 1133 customers and 3,000 units that use approximately 6 MWs of heat (expected to grow to approximately 11 MWs by 2010). To date 1,000,000 square feet of mixed-use buildings have been connected to the system. This is expected to increase to 3,000,000 square feet by 2010.

4.2. Energy Savings Potential

Anecdotal evidence suggests that buildings connected to the district heating system reduced their energy costs by approximately 15%.

From a performance standpoint, the district heating is much more reliable than conventional heating sources. If one plant fails the other plants continue to provide hot water. Mini-plants are well suited for urban environments, easily fitting into small areas in residential and commercial parking lots. The boilers are extremely efficient, providing a 95% rate of capture on heat energy and providing a production capacity of 6 MW serving 1,000,000 square feet so far. The boilers are very flexible, allowing for the use of a variety of different fuels and the easy integration of alternative energies like solar power. Although the system is performing well, the high grid temperature of 82 degrees Celsius constrains the number of fuel sources that can be used. The experience from the project has shown that running the grid at a lower temperature, provides greater access to a higher quantity of lower heat sources.

The project improves air quality through reducing nitrous oxide emissions by 64% and carbon dioxide emissions by 21% relative to conventional heating practice. The project has reduced GHG emissions by 4,070 tons a year, saving roughly 49,098 GJ in energy a year. The water based delivery system is ideal for integrating alternative fuel source such as solar energy. Economically, the rates for energy within the system are very competitive. The rates include a capacity meter and a commodity charge which allows for the energy demand for each customer to be tracked. The LEC operates on a 20-year financial cycle, providing roughly 4.5% rate of return on investment.

5. COST OF IMPLEMENTATION

5.1. Cost to the City

The total system capital cost was $8 million (in 2003 dollars): (1) $2 million loan from the City of North Vancouver; (2) $2 million from CORIX utility, and; (3) $2 million loan from the Federation of Canadian Municipalities.

Currently, there are 3 part-time employees at Lonsdale Energy Corporation (each employee has a dual role with the City and LEC). Contractors do some project review.

5.2. Cost of District Heating System

Several years may pass between the initial feasibility study and final completion of a district heating system, and a substantial investment in study and design fees will be needed prior to starting construction. An initial scoping study to

investigate whether there is any potential for district heating may be done for $10 – $15,000 or less. Much of the work can be carried out by local government staff, such as determining the availability and cost of fuel, the willingness of local building owners to participate, the likelihood of new development and distances between potential customers. Companies involved in developing district heating projects will often be willing to assist with early opportunity assessments at nominal cost. The Community Energy Association can also provide valuable help at this stage.

If the scoping study shows promise, a full feasibility study may be undertaken, involving a detailed investigation of technical and financial aspects of the project. This may include building demand loads, plant configuration, piping distribution, fuel supply and energy costs as well as potential financing arrangements. The cost of a feasibility study can vary widely depending on scope and complexity. A relatively simple study looking at district heating from natural gas in a new development might cost $25,000 – $50,000, while a complex study for a district heating system combined with wood waste cogeneration might be $150,000 – $250,000. Energy service companies may perform the feasibility study for free in exchange for the right to develop the project.

Construction costs will vary widely depending on the scope of the project, and will be different for each community. The following table includes numbers from actual projects.

Free-standing building to house boiler plant	$500,000 – $1,000,000+
Natural gas hot water boiler plant, 4 MW	$500,000 – $1,000,000
Wood waste hot water/steam boiler plant, 1.5 MW	$1,000,000 – $1,500,000+
Hot water distribution piping, existing development	$800 – $1.400/meter
Building connections, existing properties	$15,000 – $90,000/bldg
Engineering, construction management and other project administration	10% – 15% of capital cost

5.3. Cost to the Developer

The district heating program requires developers in the district to provide infrastructure to connect to the system, avoiding the construction of baseboard heating in the district. The cost of providing a water-piped heating system is approximately 5% of total project cost. In some cases, this incremental capital cost is financed by VanCity, a large local credit union, which recoup their costs through future energy savings.

6. ADMINISTRATIVE FEASIBILITY

6.1. Ease of Initiation

Implementation

Strong partnerships transformed the City of North Vancouver into a district heating leader in the province. For example, City of North Vancouver council provided leadership to motivate the engineering, financial, and planning professionals to mobilize the project internally. Another key partnership was the relationship with FCM, which provided low interest loans and grants for start-up funds.

As the plans progressed, the City selected the interconnected mini-plants system, requiring cooperation from the building community. All new buildings would need underground parking and selected sites would provide space in these underground lots for mini-plants of 4 to 6 high efficiency boilers. In moving from the planning of the system to the commissioning and operating of the system, the City of North Vancouver needed an experienced operator to provide design services as well as system and customer operations services (Corix). With this expertise and leadership Lonsdale Energy Corporation commenced operations in 2004.

Enforcement

The Lonsdale Corporation requires that developers post a performance bond to ensure compliance with the bylaw. This bond is normally around $50,000, but can increase to $100,000 if LEC anticipates that the project will require a high level of involvement from LEC staff and contractors.

Challenges

Taxes. Outside of local government, there was a key challenge related to the Provincial Social Service Tax Act (PST). Currently, major energy providers like Terasen and BC Hydro do not pay PST or charge it to residential customers. However, because the LEC is still a net user of natural gas they were charged PST and were also required to charge its customers PST, putting the LEC at a competitive disadvantage. The City of North Vancouver and LEC were successful in

convincing the province to amend the Social Service Tax Act. But the LEC is still required to pay PST on large natural gas purchases, an issue LEC continues to lobby to amend.

Regulation. Another key challenge relates to potentially competing regulations aimed at reducing greenhouse gas emissions and reducing particulate matter, given that some fuel sources (e.g., bio-energy) may represent a reduction in greenhouse gas emissions but an increase in particulate matter.

System Specification. Also, the efficiency of the boilers was underestimated in the original design, resulting in the over-sizing of the mini-plant boilers. The design originally estimated that five mini-plants be constructed to serve 3 million square feet, underestimating the efficiency of the mini-plants and boilers in the system and incorrectly forecasting the heating demands of the system.

6.2. Educational Outreach Requirements

The Lonsdale Energy Corporation focused their educational efforts on the developers and engineers with projects in the Lonsdale Quarter. Most of LEC's efforts were focused on facilitating project design and engineering to accommodate the necessary systems to connect to the district heating system. The level of developer and engineer education needed varies greatly.

7. STAKEHOLDER IMPACTS

7.1. Acceptability to the Developer Industry

According to Lonsdale Energy Corporation, developers have complained about additional cost of installing hydronic heating (vs. electric). This incremental cost of hydronic heat is, in part, offset by Terasen which provides boilers and recovers their cost in rates charged to City.

There have also been problems ensuring developers install hydronic systems that meet the necessary system specifications (e.g., target return water temperatures). There remains some uncertainty of if the system as designed will be capable of easily accommodating alternative heat sources.

One of the primary obstacles in implementing the program is the engineering community, which has had difficulty in designing buildings to appropriately accommodate the district heating system.

7.2. Acceptability to the Rate Payers

Lower Rates and Cost Savings for LEC Customers

LEC reduced its rate structure by more than 10% for customers. For residential customers, heating costs now vary between $0.08 and $0.09 per kWh, at an average cost of $0.0864 per kWh, LEC service is competitive considering all gas charges as well as the cost of boilers and their maintenance are included. The new rates are applied retroactively to the date when the control of each developer-built building was transferred to the building's strata corporation. Strata management companies will receive a full refund of the difference between the former rate and the new 2007 rate. This represents a more than $125,000 return to existing customers.

LEC also decreased its commodity charge by 6.7% to reflect current market prices. As of October 1, 2007, the commodity charge decreased from $0.04669 per kilowatt hour to $0.04356 per kilowatt hour. Customers saw a net decrease relative to their energy use.

The district heating program also affords the customer some cost savings. Previously, LEC was required to pay PST on its fuel purchases from suppliers and charge PST to customers who use LEC services. By comparison, utilities such as BC Hydro and Terasen Gas do not have to charge PST to its residential customers. The tax requirement placed LEC at a competitive disadvantage.

Part of the issue has been resolved through successful lobbying by LEC and the City. An amendment to BCs Social Service Tax Act & Regulations eliminated the PST on invoices to residential customers. However, PST is still required to be paid on natural gas purchases. To ensure that its valued residential customers are treated equitably, LEC is working to obtain a PST exemption on its gas purchases. Customers would then pay the same amount of PST as they would if they purchased natural gas directly from the gas providers.

Purchasing Power

LEC is in a unique position to make fuel purchase decisions based on the best rates available. Because each interconnected mini-plant is serviced by a distinct gas meter, LEC can purchase natural gas from the most economical provider and minimize costs by alternating heat generation between mini-plants. This flexibility enables LEC to offer

premium energy services to its customers at a reasonable price. As more buildings connect to the system, LEC can make high volume gas purchases that translate into additional savings for customers.

8. LESSONS LEARNED

Hybrid utility service models are a viable option for the delivery of distributed energy services. In North Vancouver, energy services were traditionally the responsibility of provincial agents, such as BC Hydro or Terasen Gas. Establishing a municipal utility service meant rethinking the best way to deliver competitive energy services to city residents. An open/expandable model allows for innovation, mitigates development and operational risk, and optimizes expertise, ingenuity, and rigor in the delivery of a particular community service.

Hybrid utility service models may be subject to requirements that do not apply to traditional utilities. As a net importer of natural gas, LEC had to pay provincial sales tax (PST) on the purchase of fuel from suppliers. LEC was also required to charge PST to customers benefiting from the thermal services provided by the LEC. Under provincial regulations, however, utilities such as BC Hydro and Terasen Gas do not have to charge PST to residential customers. The tax requirement placed the LEC at a competitive disadvantage. LEC and the City of North Vancouver have been successful at partly resolving the issue. Following an amendment of BC's Social Service Tax Act and Regulations, PST is no longer charged on the invoices to residential customers. However, PST is still required to be paid on natural gas purchases and LEC is continuing its work to have this requirement removed.

Municipalities can encourage uptake of district energy through planning practices. For the City of North Vancouver, the process of undertaking an energy plan led to identifying sites within the municipality that would have a high demand for heating, as well as a mix of building types. The process contributed to the City acknowledging a need for contractual obligations with builders purchasing City-owned land to connect to district energy. As part of the rezoning process for development on City-owned lands, connection to the LEC is required and is treated like other municipal infrastructure requests, such as provisions for sidewalks, roads, sewer connections, and stormwater management. Before any development proceeds, every builder must sign a heat service contract. Because of this agreement, every customer pays the same rate for heating.

High-performing district energy systems demand a new approach to engineering and building design. As interest in district energy systems has grown, so has the awareness of the need to accurately model the efficiency of a district energy system. For the LEC, engineering design teams at first over-estimated heating demand for residential buildings, resulting in the over-sizing of the mini-plants. Local developers' engineering design teams were also unfamiliar with the controls needed to ensure optimal operation of the mini-plant boilers. Management and operational staff of the LEC have since introduced detailed guidelines for developers' design teams to help implement the infrastructure, design, and controls needed to connect to the district energy system. LEC also works closely with owners' or developers' design engineers to streamline the preparation of designs.

9. REFERENCES

Glenn Stainton, Vice-President Operations, Lonsdale Energy Corporation

http://www.toolkit.bc.ca/success-stories/district-heating-north-vancouver

http://www.lonsdaleenergy.ca/