Towards An Energy Utility for the False Creek Precinct: Feasibility & Options

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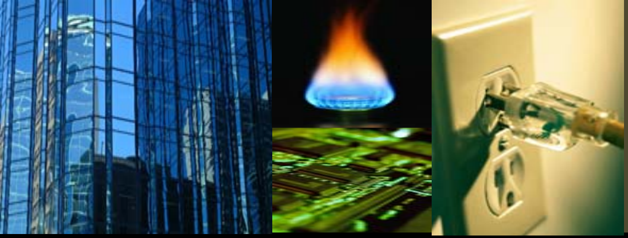
March 3, 2005



Conclusions

- An energy utility providing heating, cooling and emergency power services in the False Creek Precinct is feasible and offers opportunities for increased efficiency, lower costs, lower risks, lower environmental impacts and more flexibility to adopt new technologies over the full life of the development.
- A municipal utility with a mixed ownership and operations model is recommended.
- Strategy:
  - Leverage synergies with municipal infrastructure
  - Heating technologies: Emphasis initially on waste heat recovery, geo-exchange, sewer heat recovery and higher-efficiency gas-fired technologies in first investment cycle; consider options to adopt other technologies in future equipment renewals
  - Emergency power technologies: Diesel gensets initially; consider option to adopt co-generation and other technologies in future
  - Consider offsets for residual environmental impacts

Conclusions – cont'd

- The next step is to prepare a more detailed study and business plan including:
  - Load forecast(s)
  - Form and configuration of distribution infrastructure
  - Initial heating and emergency power sources
  - Utility ownership and governance model
  - Pricing
  - Financial and environmental analysis
  - Near-term action plan

Study Goals & Scope

- City needs an assessment of feasibility and options for an energy efficient and environmentally responsible integrated neighbourhood utility, a business model for its sustainable operation, and an incremental growth strategy for up to 550 acres of land in and around the False Creek Flats area.
- High-level feasibility study is required to determine whether City should proceed with an in-depth analysis and development of a full business case.
- High-level feasibility study is intended to support development of an RFP for the more detailed study, and requests for funding to complete the more detailed study.

Proposed Precinct Boundaries

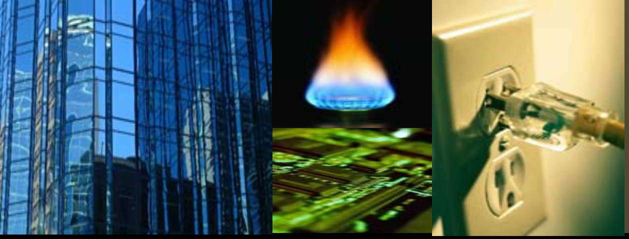
Total area: ~200 ha

Existing floor area:

Total new floor area: ~1.6 million m^2

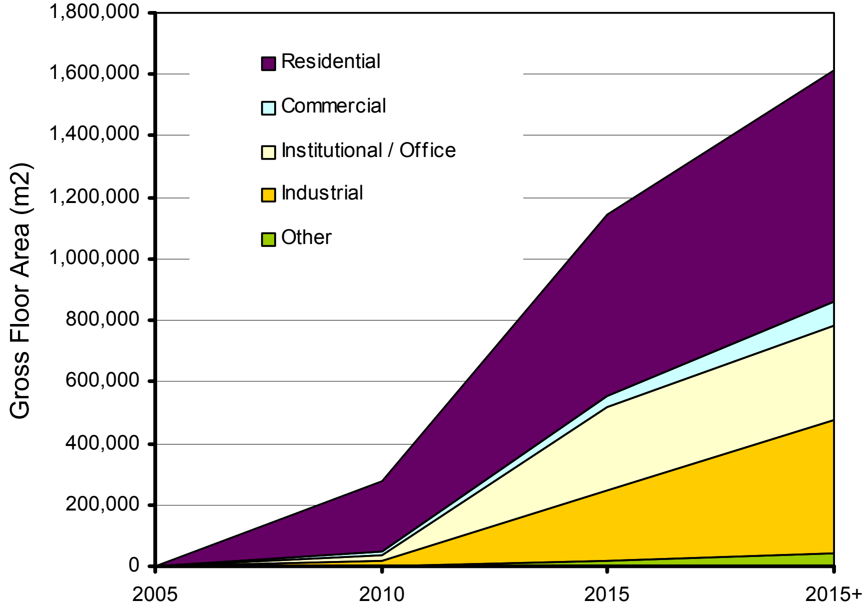
Encompasses:

- Southeast False Creek (incl. Athletes Village)
- Northeast False Creek
- False Creek Flats
- Providence Health Care
- Great Northern Way Campus
- Trillium Park
- Concord Cooper's Lookout
- Plaza of Nations
- BCPED/Indy Park
- Discovery Parks
- Science World (park)
- City Gate (existing)

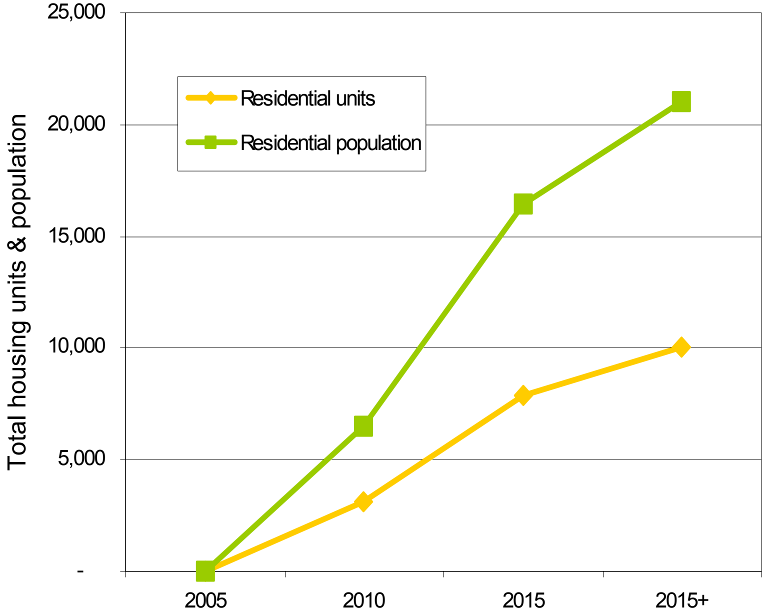


Projected Development Timeframe

Developed Area



Housing & Population

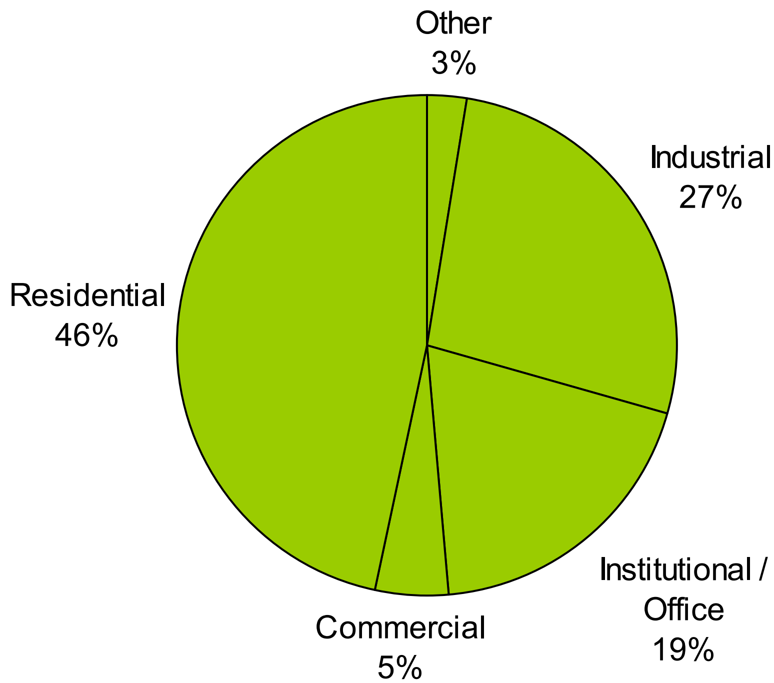


Assumptions: Average unit size = 75m^2 and Average occupancy = 2.1 people/unit

Projected Development Mix

Total Floor Area:

~1.6 million m^2



Status Quo Energy System

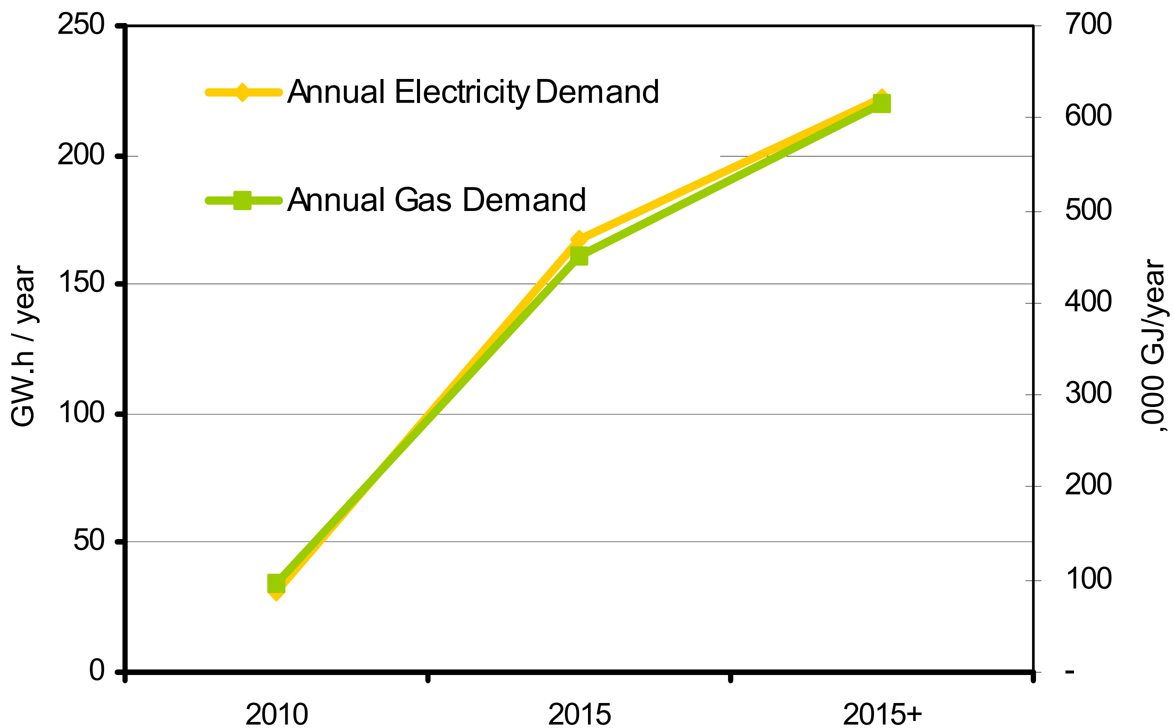
- Each development responsible for its own heating, cooling and emergency power systems
- Systems installed by developers
- Systems ultimately owned and operated by building owners
- Majority of heating and cooling met with electricity and smaller portion with natural gas
- Diesel gensets used to meet emergency power loads
- Regular electricity service provided by BC Hydro
- Natural gas provided by Terasen
- Standard efficiency heating and cooling equipment

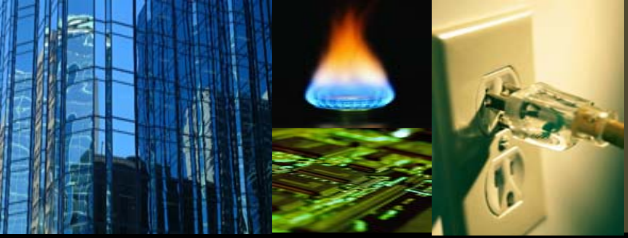
Projected Site Energy Use (Status Quo)

Key Assumptions:

- 70/30 split between high-rise & low-rise residential floor area
- 50/50 split between large & small office
- Predominantly electric heat in residential construction

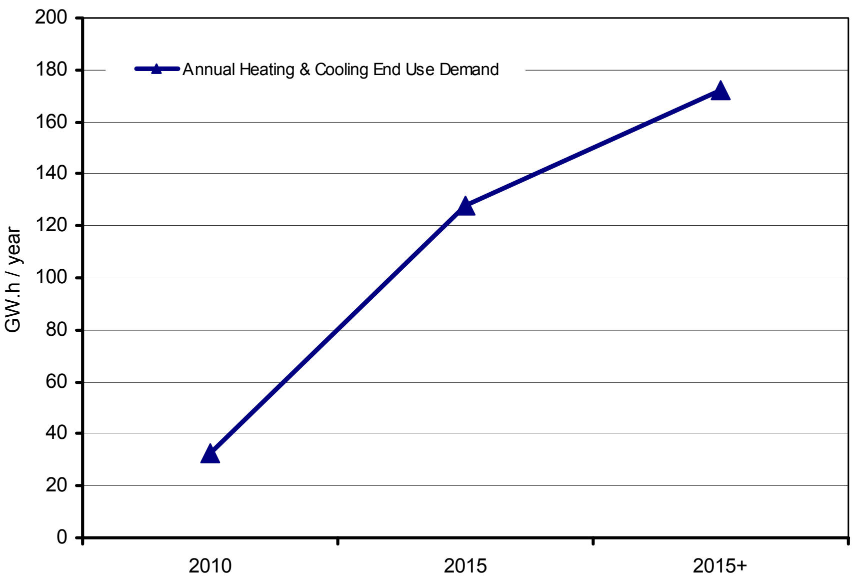
- Energy use assumptions from:
  - *Costs & Benefits of Hydronic Heat in Lower Mainland* (Compass 2003)
  - *Life-Cycle Economic Assessment of Energy Performance Standards Applied to British Columbia Phase II: Cost Effectiveness of Achieving CBIP in Vancouver* (EnerSys 2004)



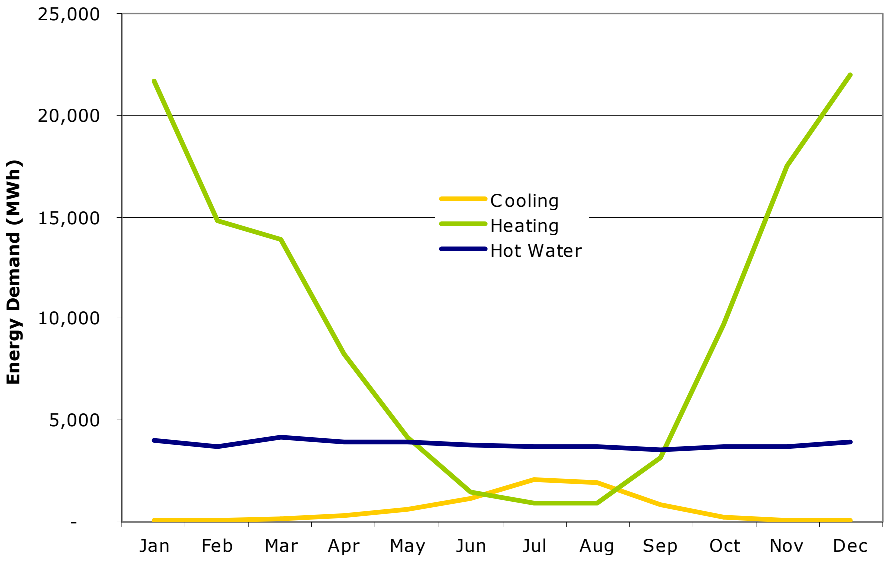


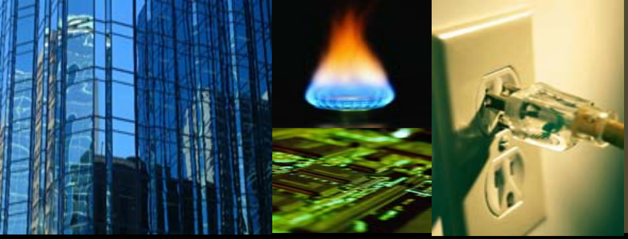
Heating & Cooling Demands

Annual End Use Demand (GW.h)



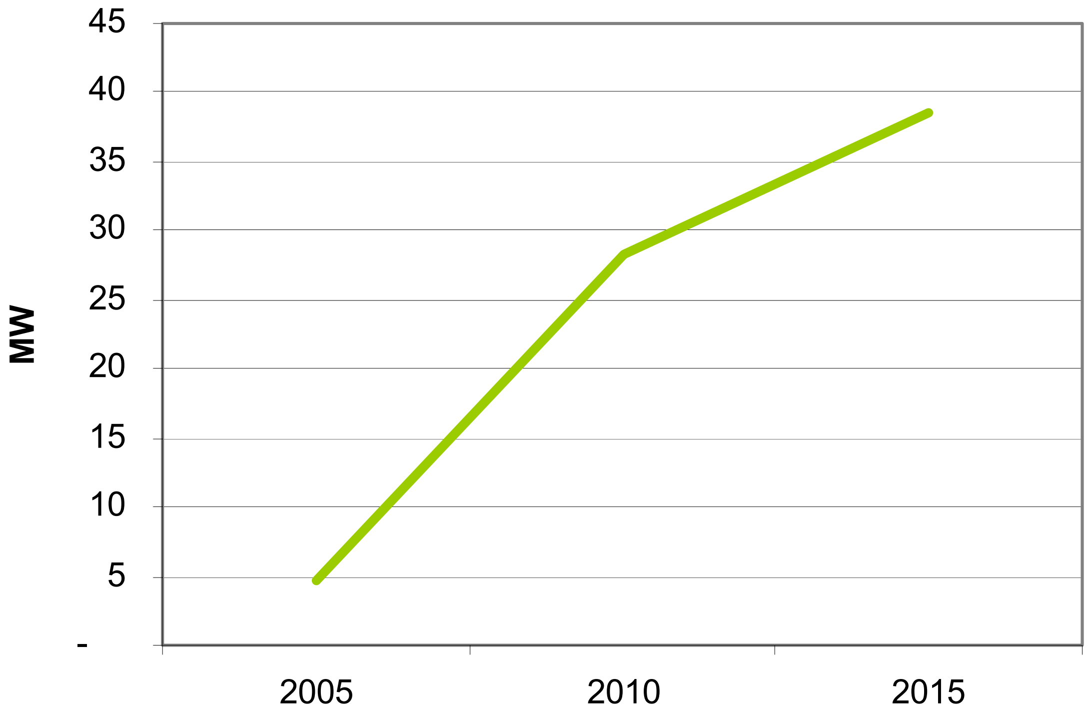
2015+ Monthly End Use Demand (MW.h)





Emergency Power Requirements (Status Quo)

Up to 40 MW of emergency power capacity may ultimately be required within the site.



SEFC Energy Management Plan

- Key recommendations to:
  - Reduce embodied energy in buildings and infrastructure;
  - Increase energy efficiency of buildings;
  - Increase use of local, efficient, and/or renewable sources of energy (heating);
  - Enhance energy management in the site;
  - Establish a micro-grid for a pooled emergency power solution;
  - Reduce energy use in management of parks and open space;
  - Reduce energy use for transportation; and
  - Acquire low-cost offsets to mitigate any residual impacts from energy use and supply for the site.
- This initiative focuses on:
  - Increasing the use of local, more efficient and/or renewable energy sources for heating and possibly electricity supply
  - Establishing a pooled emergency power solution (micro-grid)

What is a Utility?

- Provides a monopoly service to multiple customers
- Upfront costs amortized and recovered together with operating costs through a rate
- May be regulated by the B.C. Utilities Commission or a municipal council
- A utility model is not necessarily synonymous with centralized technologies. For example, several developers in B.C. provide geo-exchange heating from individual systems in each home under a utility service model.

Why a Utility Model?

Key benefits:

- Longer time horizons and lower discount rates
- Economies of scale and integration
- Higher equipment utilization and efficiency
- Other operating efficiencies
- Pooling of financial and operating risks
- Better environmental performance
- Improved quality of service

These benefits must be weighed against possible additional costs:

- Additional infrastructure required to aggregate loads (e.g., heating loops; emergency power circuits, control technologies, etc.)
- Additional metering, billing and administrative costs
- Set-up, regulatory and other governance costs

Longer Time Horizon & Lower Discount Rate

- Extensive empirical evidence that consumers and businesses use short time horizons and high discount rates when selecting energy technologies.
- This tends to favour technologies with lower capital costs and higher operating costs
- This bias may be further exacerbated when the building owner is not also the building tenant
- Utility investors have longer time horizons (particularly institutional investors such as large pension funds) and lower discount rates
- A utility model provides a win-win opportunity for consumers and investors and is more likely to support investments in technologies with higher capital costs and lower operating costs.

Financing Example

Heating Equipment	MW	112	
Capital Costs	,000 $	18,993	33,238
Annualized Capital Costs			
Customer perspective	,000 $/year	3,900	
Utility perspective	,000 $/year	2,231	3,904

Customer – 20% discount rate

Utility – 10% discount rate

A utility could carry almost 75% more capital for the annual payment customers would be willing to pay.

Capital vs. Operating Cost Trade-offs

		Capital Costs	
Operating Costs		Utility Perspective	Customer Perspective
10% savings	,000 $	7,925	4,186
20% savings	,000 $	15,850	8,371
30% savings	,000 $	23,775	12,557

Utility could carry additional $23 million in capital with a 30% operating cost savings. On their own, customers would pay $12 million to secure same savings,

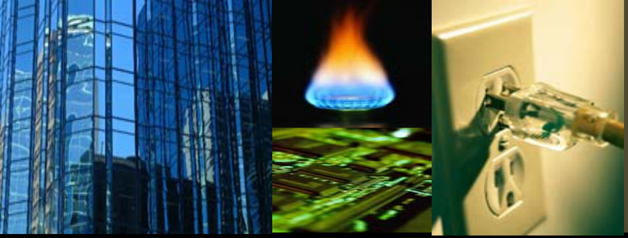
Customer – 20% discount rate

Utility – 10% discount rate

Annual operating costs = $8.4 million / year

Economies of Scale and Integration

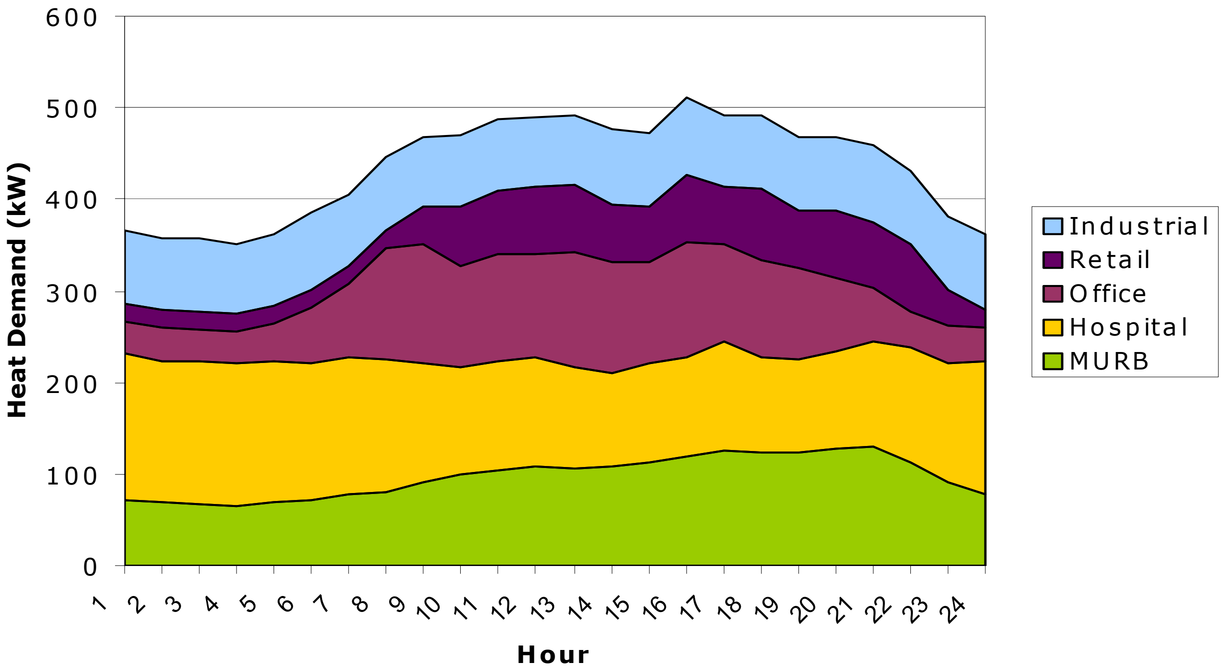
- Size and footprint of required equipment may be reduced with aggregation of loads and resources
- Economies of scale in many types of equipment
- Opportunities to optimize among multiple technologies – e.g., combine a large and efficient baseload sewer heat recovery project with less efficient supplemental gas-fired heat
- Possible savings from bulk purchasing of equipment
- Possible savings from coordinated installation of systems (e.g., drilling costs associated with geo-exchange)



Sample Load Diversification Benefits

Combining diverse loads can result in higher baseload demand and lower peak demands relative to individual building loads.

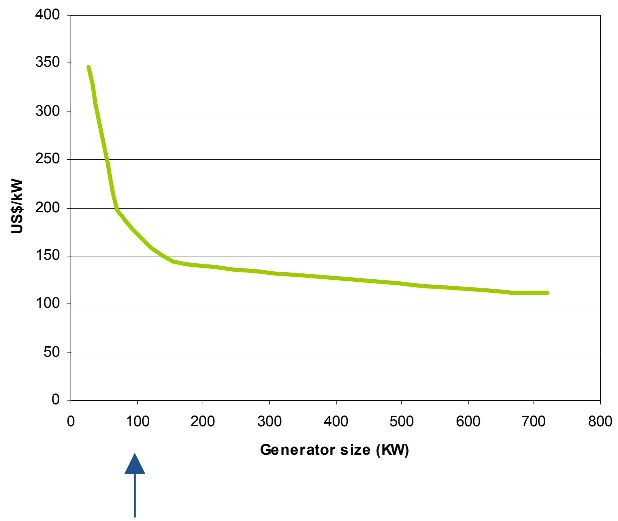
Result: Lower capacity and higher capacity utilization rates.



Sum of individual baseloads		297		
Sum of individual peak loads		582		
	Combined base load	350	**18%**	**Increase**
	Combined peak load	511	**-12%**	**Decrease**

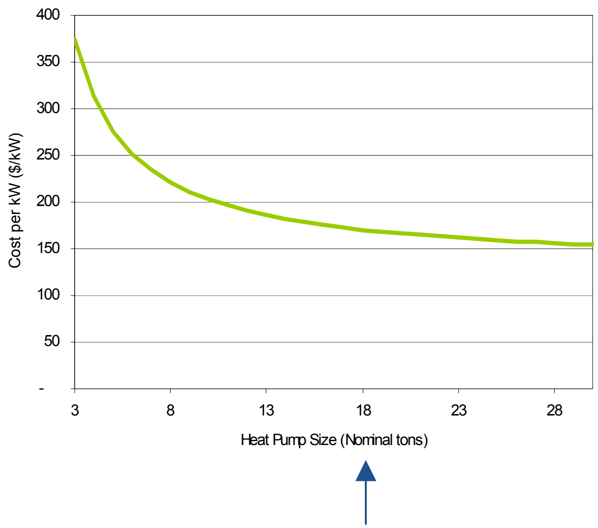
Sample Economies of Scale

Back-up Diesel Gensets

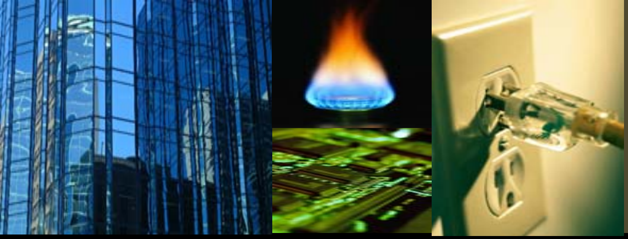


Individual
MURB

Commercial Heat Pumps

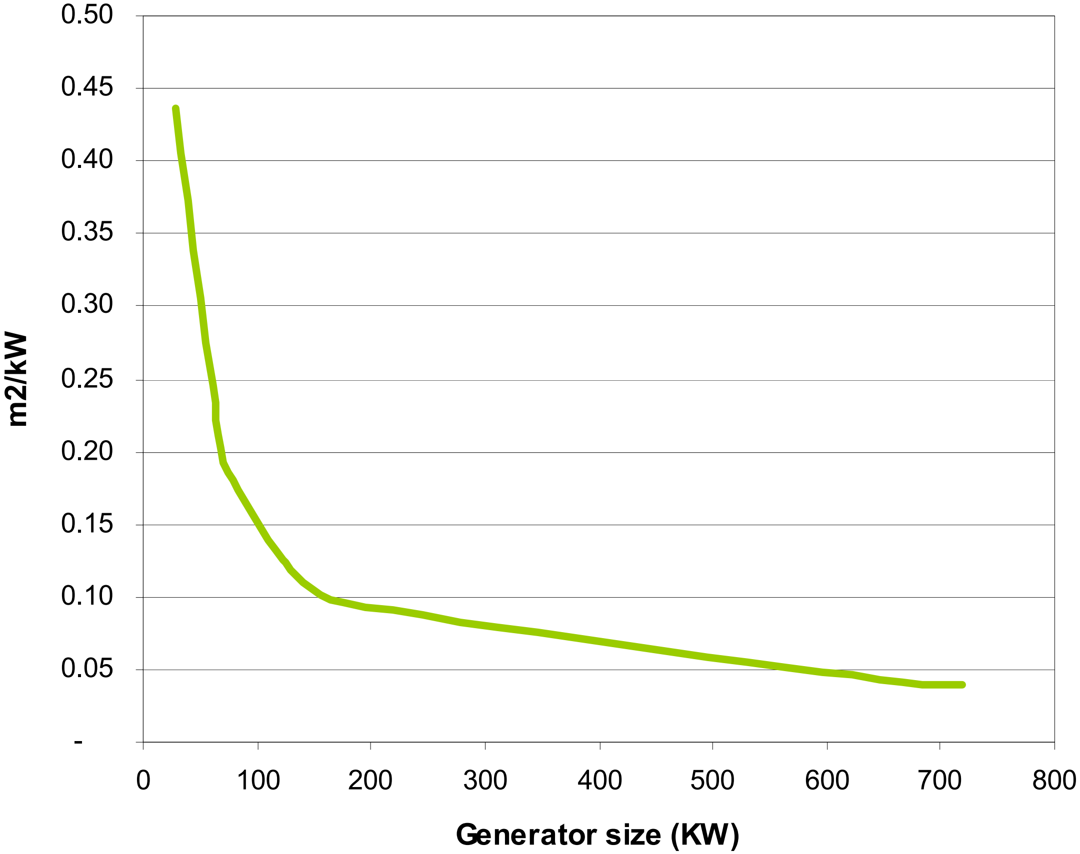


Individual
MURB



Possible Savings in Land Costs

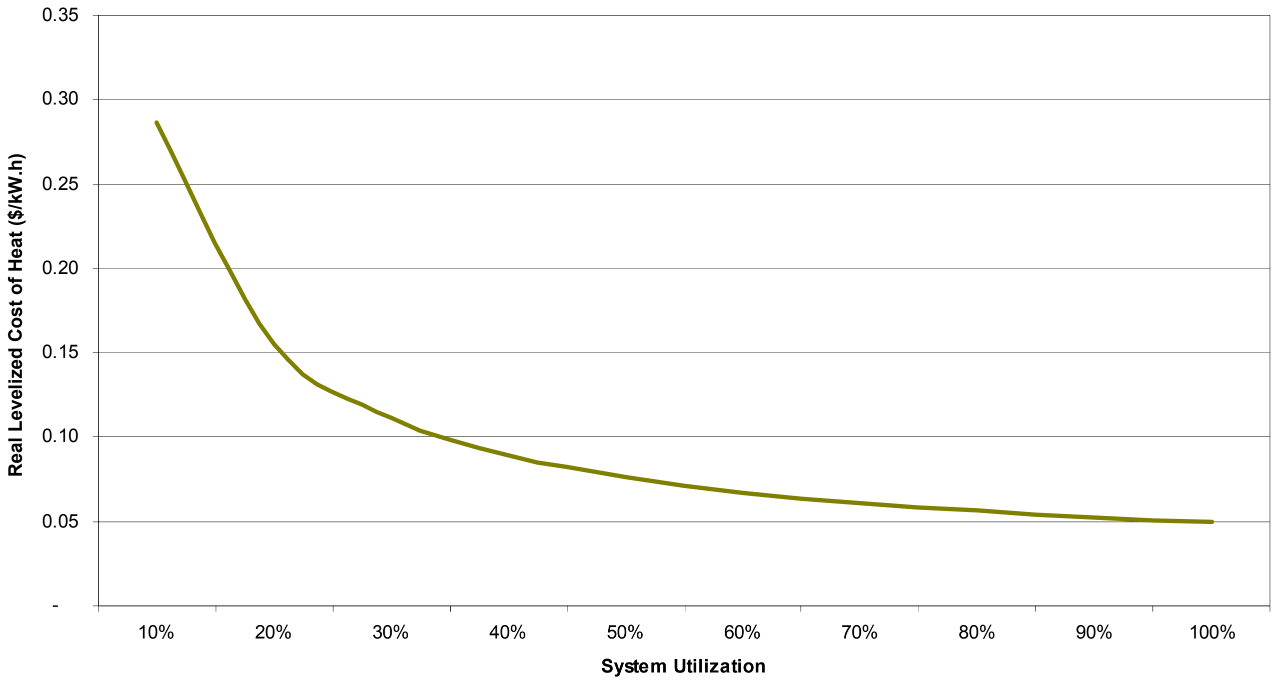
Possible space savings of >50% from aggregation of back-up generation (up to 2,000 m2).



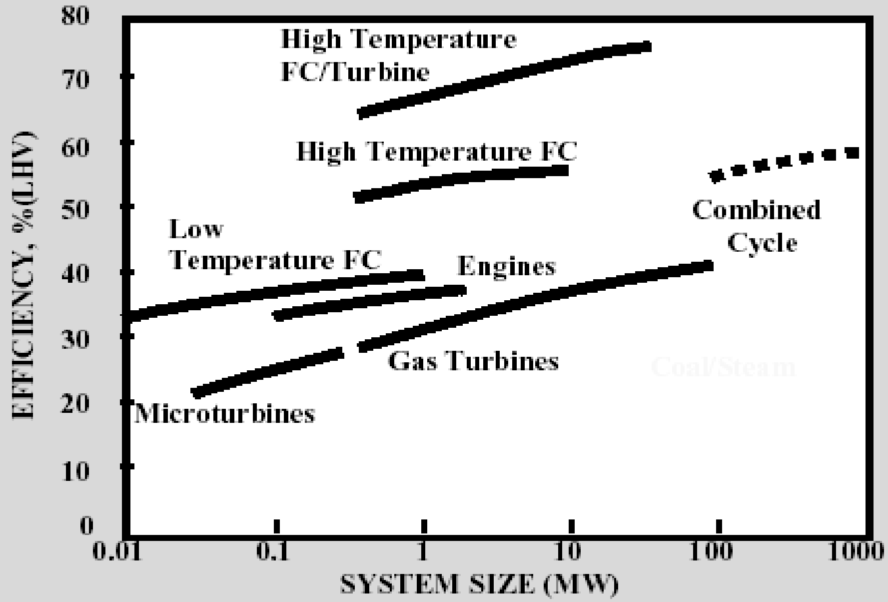
Economics Improve with Higher Utilization

Unit cost of sewer heat improve dramatically as system utilization increases. Similar pattern exhibited by all capital-intensive technologies.

With aggregation of loads and addition of storage technologies, a utility may require less capital and the capital is utilized more efficiently.

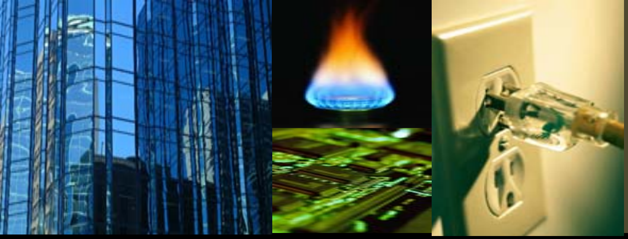


Higher Efficiency with Scale



Comparative Efficiencies

Source: M. Farooque and H. C. Maru



Lower Operating Costs

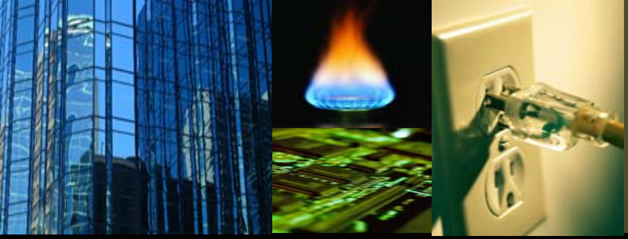
- Many technologies exhibit increased efficiency as size of systems increases.
- Efficiency of many technologies also increase as utilization rates increase.
- A utility may be able to pay higher capital costs of more efficient technologies with savings in capital costs, financing costs and operating costs.
- Savings in maintenance costs with a larger system.

High-Level Analysis

~ 25 – 40 million in additional capital available under a utility model to cover costs of establishing utility, additional distribution infrastructure (e.g., heat loops), and advanced technologies.

Heating Equipment				
Stand-alone systems	MW	112		
Integrated systems	MW	98		
Base Capital Costs				
Stand-alone systems	millions $	19		
Integrated systems	millions $	17		
Annualized Capital Costs				
Customer perspective	millions $/year	4		
Utility perspective	millions $/year	2		
Additional Capital Available to a Utility	millions $	17		
Base Operating Costs	millions $/year	8		
Additional Capital Available from Operating Cost Savings				
10% savings	,000 $	8		
20% savings	,000 $	16		
30% savings	,000 $	24		
Total Incremental Capital Available for a Utility	millions $	25	to	40

Note: “Integrated system” reflects only the effects of reduced size of heating equipment, utility financing, and possible operating cost savings. Does not include incremental costs of distribution infrastructure or alternative technologies, if any. These costs are not yet available. The purpose of this analysis is to determine the amount of additional costs (compared to stand-alone customer-owned systems) that could conservatively be absorbed by a utility under potential revenue stream.



Better Environmental Performance

- Immediate improvement efficiency from larger equipment and more efficient operations
- Some of annual savings from longer amortization periods, lower discount rates, lower capital costs, and lower operating costs can be re-invested in environmental improvements such as
  - Better emission controls
  - Even more efficient equipment
  - Alternative fuels or technologies
  - Other environmental offsets
- Easier to manage environmental impact of an integrated system then many small systems with different owners.
- As partial or full owner, City can internalize environmental issues in utility operations and make trade-offs between customer rates, financial returns, and environmental performance.
- If offsets are purchased for residual environmental impacts, these costs can be recovered in utility rates.

Why City Involvement?

- A municipal utility is not subject to BCUC oversight, which provides some additional flexibility in planning and rate setting.
- Viability of neighbourhood utility is greatly dependent upon development patterns and requirements
  - Requirements for interconnection of loads
  - Synergies between installation of utility infrastructure and municipal infrastructure
- As owner, the City has more flexibility in making trade-offs between customer rates, investment returns and environmental performance

Challenges & Opportunities

Challenges

- Capital-intensive energy options are a challenge with Vancouver's mild climate and low energy prices.
- Lack of transparent prices / costs associated with GHG and local air emissions
- Asymmetric regulation of distributed facilities vs. centralized facilities.
- Potential trade-off between increasing building energy efficiency and implementing alternative energy sources.
- Mix of public and private ownership in precinct lands.
- Some of upfront costs (e.g., hydronic distribution systems in buildings) will be borne upfront by developers / owners. These may be partly offset by reductions elsewhere (e.g., avoided emergency genset).
- Lack of experience with energy utility model in the City.
- Financing.

Opportunities

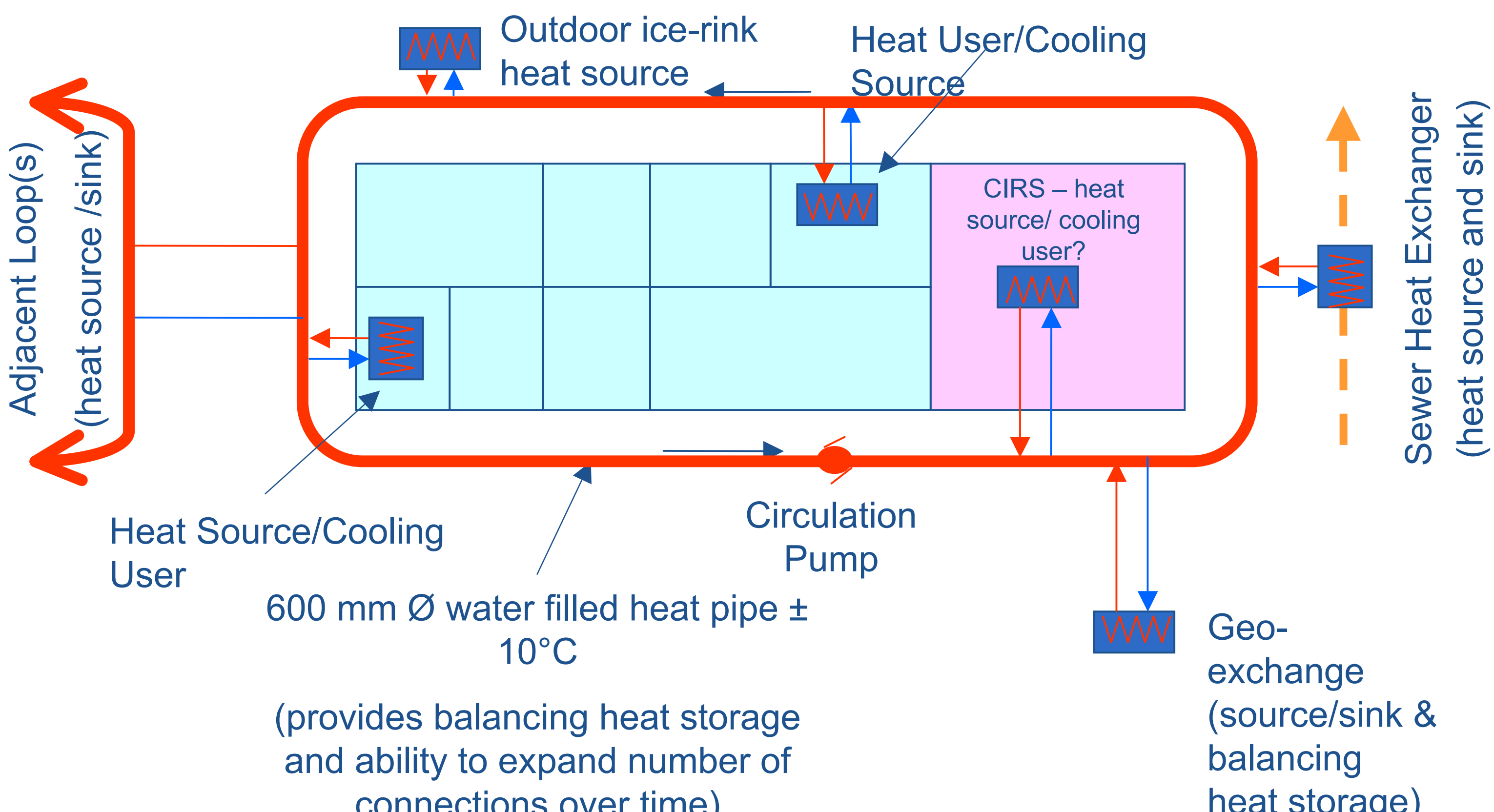
- Utilities interested in partnerships.
- Long-term investors seeking stable yields.

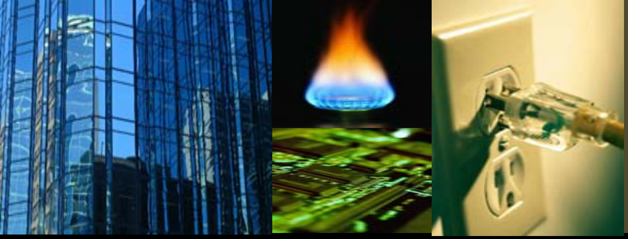
Scope of Utility Services

- Heating and cooling services to building interface via multiple interconnected “heat loops”
- Emergency power generation via a micro-grid

Sample Heating Loop Configuration

Interconnected Block-Scale Systems with Multiple Heat Sources & Sinks



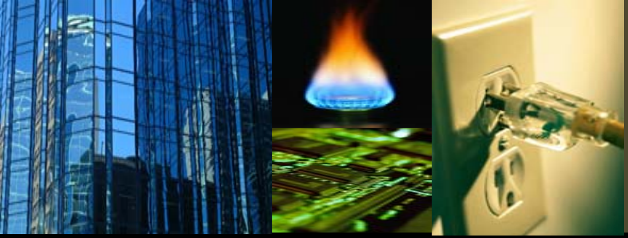


Candidate Heat Sources

- Expansion of neighbouring Central Heat
- Centralized or distributed high-efficiency natural gas boilers located within the site
- Distributed waste heat recovery
  - Air conditioning loads in commercial buildings and community facilities
  - Building sewer return lines
- Centralized or distributed co-generation systems
  - Synergies with back-up utility
  - Could be located within development or neighbouring development (e.g., upgrade one or more of Central Heat's steam boilers to co-generation)
- Distributed geo-exchange systems
  - Horizontal ground loops under parks
  - Vertical ground loops at other sites
  - Ocean thermal (False Creek)
- Centralized sewer heat recovery

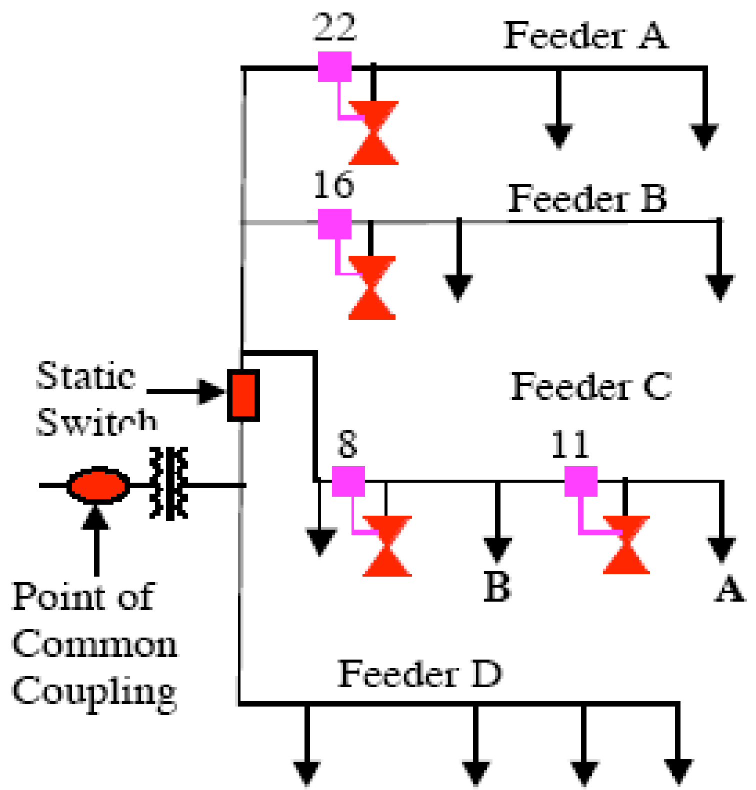
Micro-grid Concept

- A discrete local grid that can be disconnected from the “macro-grid” and operated in “islanded mode” with local generating resources.
- In a typical development, the existing local electricity distribution system would simply be extended to individual buildings sites as needed, resulting in multiple connections to the macro-grid.
- Most buildings will require emergency generation systems under existing building codes. Emergency power would typically be provided by diesel gensets. In the event of a grid outage, the diesel generator would be engaged to energy an emergency power circuit within the building that provides power to critical loads such as elevators, emergency lighting, and water pumps.
- Micro-grid can be used to deliver emergency power to emergency power circuits in individual buildings.



Sample Micro-grid Schematic

In this example, Feeder A, B and C can be islanded and supplied by local generation at nodes 22,16,8 and 11 in the event main grid is down.



From: “Microgrid: A Conceptual Solution” Robert H. Lasseter, Paolo Piagi. PESC’04 Aachen, Germany 20-25 June 2004

Micro-Grid Service

- BC Hydro would continue to provide regular electricity service.
- Micro-grid would allow pooling of emergency generation (capital, land and operations).
- Initial back-up sources will likely be traditional diesel gensets.
- In future, micro-grid creates opportunities for implementing co-generation (synergy with heating utility) and other alternative generating technologies.
- Added value possible through optional UPS service for residential suites and sensitive power users, as well as grid-support services to BC Hydro (peak capacity).
- As an add-on, utility could purchase green electricity credits (green tags) on behalf of local residents and businesses.

Opportunities for Co-Generation

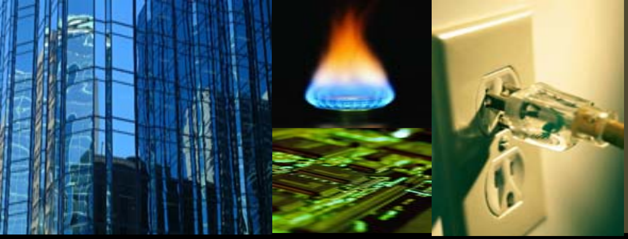
Sample Co-generation Costs ($/kW.h)

	Natural Gas Turbine
Low capacity factor / no credit for emergency power	$ 0.159
Low capacity factor / credit for emergency power	$ 0.154
High capacity factor / no credit for emergency power	$ 0.023
High capacity factor / credit for emergency power	$ 0.023

Ratio of electricity to heat output varies greatly across technologies and accounts for the large differences in costs. Heat credit based on avoided heating costs from conventional boiler.

Options for Ownership & Operations

City Ownership & Operation	City Ownership & Service Contract	Mixed Ownership & Operation **(RECOMMENDED)**	Other Ownership & Operation
City owns and operates all utility assets.	City would own all utility assets but contract construction, operations and/or customer services from a service provider.	City would own distribution assets (e.g., heat loops and emergency power circuits). Other investors would own heat and emergency power sources. City would pay annual fees for heat and emergency power services and recover costs through rates levied on customers. City may contract for additional services (e.g., construction, operations and billing).	Neighbourhood utility would be owned and operated by another entity with involvement of City limited to working with utility provider in securing loads and installing infrastructure.



British Columbia Precedents

- Lonsdale Energy Corporation, North Vancouver
  - Municpally-owned community energy system with some equipment and services provided by Terasen Utility Services
- Central Heat, Vancouver
  - Privately owned steam utility in downtown Vancouver regulated by BCUC
- Sun Rivers Development, Kamloops
  - Multi-utility concept including individual geo-thermal heating and cooling services from individual units in each residence
- Wilden Estates, Kelowna
  - Optional geothermal heating and cooling provided by developer-owned utility
- Six municipal electric utilities that purchase electricity supply from BC Hydro and/or FortisBC, as well as additional services in some cases:
  - New Westminster
  - Kelowna
  - Penticton
  - Grand Forks
  - Summerland
  - Nelson

Lonsdale Energy Corporation

Description

- A district energy system, established Spring 2003, that produces hot water at a series of mini-plants within Lower Lonsdale and then distributes the hot water energy through underground pipes to buildings connected to the system. Once used in the connected buildings, the water is returned to a mini-plant, reheated and circulated back to the connected buildings.
- All buildings to be constructed on City land and the Pier Development will be required to utilize hot water heating, which is compatible with a possible future connection to a district heating system.
- Built area is about one sixth of City of Vancouver's proposed Sustainability Precinct.

Important Features

- Unique model in Canada with considerable interest from other municipalities and is strongly supported by the Community Energy Systems Group within the CANMET Energy Technology Centre (CETC) at Natural Resources Canada.
- Hot water distribution system with distributed mini-heating plants provides a more flexible, less costly and less risky approach in new development areas.
- Public private partnership.
- Participation mandatory on city-owned lands; voluntary on private lands.

Lonsdale Energy Corporation

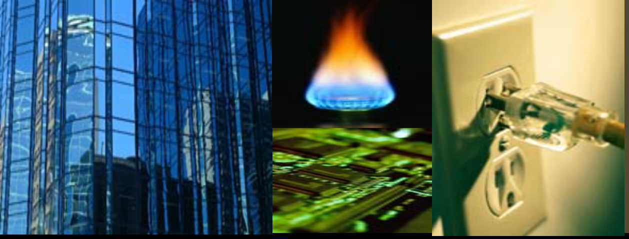
Lonsdale Energy Corporation

Ownership & Governance

- LEC is a wholly owned City corporation.
- LEC manages the system on behalf of the City, reporting regularly to Council on its performance.
- Not regulated by BCUC. Rates are approved by Council.
- Ten year agreement with Terasen Utility Services to provide operating services, customer care services, billings, as well as the design, construction installation, maintenance and operations of all boiler plants.

Cost & Funding

- Original feasibility study funded in part with Green Municipal Enabling Fund grant.
- Total project value ~$8 million
- Project received $2 million grant and $2 million loan from Green Municipal Investment Fund for initial construction and start-up.



Lonsdale Energy Corporation

Status & Outlook

- The first mini-plant is now operational, providing heating to 2 residential towers, commercial space, and the new John Braithwaite Community Centre in Lower Lonsdale.
- Within two years, the system is expected to provide energy services for 8 to 10 buildings in Lower Lonsdale.
- Within 10 years, about 20 buildings with 278,709 m^2 of building area are expected to be connected to the system. The system is expected to have a total of five “mini heating plants” containing a total of 24 natural gas fired boilers, distributed at different locations throughout the service area.
- Ability to harness other heat sources in future such as waste heat (from space cooling in commercial buildings), geothermal, ocean thermal, and co-generation.

Results

- Lower electricity use relative to business as usual (electric heat).
- Increased energy efficiency through Less reliance on electric heat (high energy losses in electricity production and transmission) and use of more efficient natural gas boilers (85-90% efficiency vs. 70% in typical installations).
- Flexibility to utilize other heat sources in future.

Awards

- National Energy Efficiency Award from Natural Resource Canada
- Canadian Association of Municipal Administrators (CAMA) Willis Award for Innovation
- UBCM Award for Excellence in Leadership and Innovation

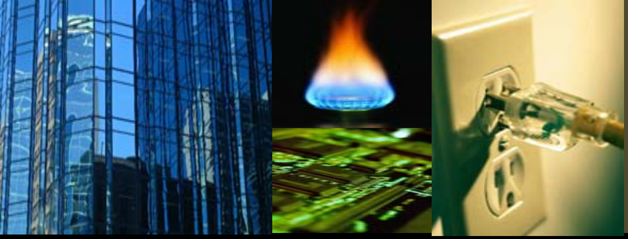
Lonsdale Energy Corporation

Reaction from Stakeholders

- Developers have complained about additional cost of installing hydronic heating (vs. electric). Incremental cost of hydronic heat in part offset by Terasen providing boilers and recovering cost in rates charged to City.

Other Issues and Events

- There have been problems ensuring developers install hydronic systems that meet the necessary system specifications (e.g., target return water temperatures).
- Uncertain if system as designed will be capable of easily accommodating alternative heat sources.
- A neighbouring existing development that is facing the need to upgrade its boiler (due to early failure) has expressed some interest in joining the system.



Immediate Priorities

- Establish utility (scope, objects, governance structure)
- Establish precinct design criteria to support utility provision of heating, cooling and emergency power services
- Initial distribution infrastructure plan (link to rest of municipal infrastructure)
- Initial heat and emergency power sources

Detailed Study Requirements

1) Load analysis

- Establish three scenarios for the likely rate, pattern, and type of development (i.e., a base case with two alternative scenarios capturing major uncertainties such as whether hospital is developed)
- Establish end-use heating and cooling demand profiles for individual and combined loads.
- Estimate emergency power requirements and potential demand for uninterrupted power service.
- Examine opportunities to interconnect existing buildings (e.g., City Gate) to system

2) Business as usual energy system analysis

- Develop a “business-as-usual” (BAU) scenario for heating and emergency power provision.

Detailed Study Requirements

3) Heat Distribution System

- Identify cost-effective technology and configuration of heating loop(s) taking into account staging of development, location of loads and possible heat sources, and other municipal infrastructure.
- Establish important operating thresholds for heat sources and loads (e.g., minimum or maximum return water temperatures)
- Identify system monitoring and control needs

4) Heat Sources

- Identify three scenarios for initial heat sources e.g.,:
    1. Capture waste heat with all remaining heating provided by high-efficiency natural gas boilers at several mini-plants
    2. Geo-exchange and sewer heat at appropriate sites, supplemented by natural gas boilers as required
    3. Co-generation located at emergency power sites
- Consider possible synergies with neighbouring resources (e.g., Central Heat, VGH)
- For each scenario, identify options for harnessing alternative heat sources in next cycle of equipment replacement.

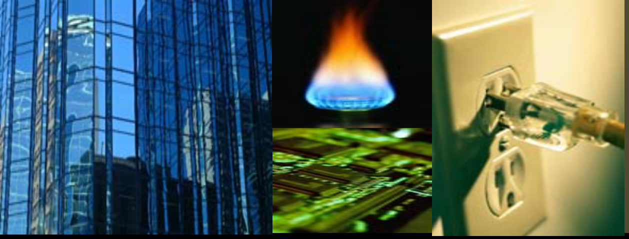
Detailed Study Requirements

5) Emergency Power System (Micro-Grid)

- Identify cost-effective technology and configuration for micro-grid taking into account staging of development, location of loads and possible heat sources, and other municipal infrastructure.
- Identify several scenarios for initial form and location of emergency power sources, e.g.,:
    1. Diesel gensets
    2. Co-generation

6) Economic and Environmental Analysis

- Estimate costs and impacts of heating and emergency power system (by major component) under BAU and Alternative Scenarios:
    - Technology costs
    - Installation costs
    - Metering and control
    - Billing
    - Operations and maintenance



Detailed Study Requirements

6) Business Case

- Ownership and governance model
- Financial analysis (pro formas)
- Legal issues (resource rights, Vancouver charter, BCUC)
- Financial, operating, legal and environmental risks
- Environmental and customer service impacts
- Near-term action plan – e.g., zoning, bylaws, infrastructure plans, etc.