

INTEGRATED COMMUNITY ENERGY SYSTEM **BUSINESS** CASE STUDY

**SOUTHEAST FALSE CREEK
NEIGHBOURHOOD ENERGY UTILITY**

OCTOBER 2011



SAUDER
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QUEST
BUSINESS CASE

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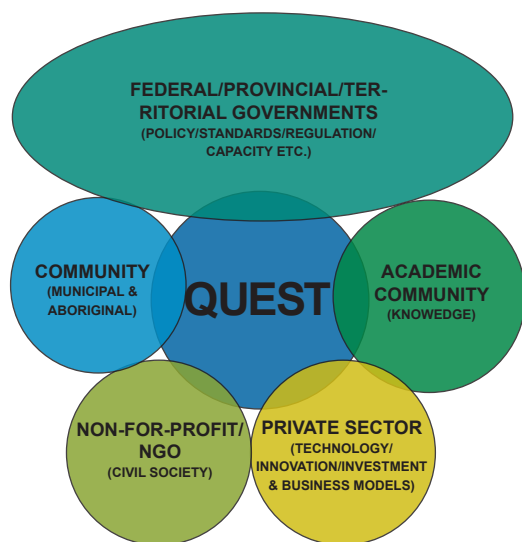
LIST OF ACRONYMS

BAU	Business as Usual
BCUC	British Columbia Utilities Commission
CEC	Community Energy Center
CEP	Centralized Energy Plant
CFF	Capital Financing Fund
CoV	City of Vancouver
CPCN	Certificate of Public Convenience and Necessity
DPS	Distribution Piping System
ERRP	Expert Rate Review Panel
ETS	Energy Transfer Station
GHG	Greenhouse Gas
ICES	Integrated Community Energy System
IRR	Internal Rate of Return
LED	Light Emitting Diode
LEED	Leadership in Energy and Environmental Design
NEU	Neighbourhood Energy Utility
NPV	Net Present Value
REF	Rate Escalation Factor
ROE	Return on Equity
ROI	Return on Investment
RSR	Rate Stabilization Reserve
SEFC	Southeast False Creek
WACC	Weighted Average Cost of Capital

1. PREAMBLE

1.1. QUEST (QUALITY URBAN ENERGY SYSTEMS OF TOMORROW)

QUEST - Quality Urban Energy Systems of Tomorrow – is a national non-profit organization advancing education and research for integrated energy systems (linking energy with land-use, buildings, transportation, waste, water and wastewater at a community, neighbourhood or site level) to develop and support sustainable communities in Canada. QUEST does research, policy analysis, outreach, and capacity building to assist communities, utilities, and the broader community-building sector.



WHO MAKES UP QUEST CANADA?

QUEST Canada is a collaborative network of organizations - from energy, technology and infrastructure industries, gas and electric utilities, all levels of government, civil society groups and community leaders, researchers and the consulting community - actively working to make Canada a world leader in the design, development and application of integrated energy solutions.

QUEST'S MISSION:

Mobilize community builders to create integrated energy solutions that are central to sustainable community development.

QUEST'S VISION:

By 2035 every community in Canada is operating as an integrated energy system, and accordingly, all community development and redevelopment incorporates an integrated energy system.

QUEST is achieving its mission and vision by working with community builders to:

- Encourage a balanced and informative conversation about energy;
- Support the development of expertise and capacity across Canada for integrated energy systems;
- Prepare inclusive and independent applied research for the broader public interest; and,
- Create a collaborative framework for communities and key stakeholders to understand and to work on their energy futures.

1.2. INTEGRATED COMMUNITY ENERGY SYSTEMS

Integrated Community Energy Systems (ICES) capitalize on cross-cutting opportunities and synergies available at the community level by integrating physical components from multiple sectors:

- Land use and community form;
- Energy supply and distribution;
- Water, waste management and other local community services;
- Transportation;
- Housing and buildings;
- Industry.

ICES describe projects that are driven by local issues and community stakeholders and are integrative in nature.

The integration is threefold – first, integration among the various energy sources and technologies, energy users, distributors and producers within a community; second, integration of energy as it relates to other community services, including water, waste, transportation, land use, buildings, and third; integration of energy policy considerations, as these cut across municipal/provincial/federal mandates and priorities.

1.3. BUSINESS CASE STUDY SERIES

While considerable momentum exists in Canadian communities for developing community energy plans and planning for ICES projects, there remains limited Canadian documentation about completed ICES accomplishments. QUEST is working to break-down knowledge barriers and address this important information gap for researchers, developers, investors, and public and private sector decision makers.

QUEST has engaged five of Canada's top business schools to produce QUEST's first Business Case Series featuring ICES initiatives in British Columbia, Alberta, Ontario, Québec and Nova Scotia. The Business Case Series is designed to bring forward the key factors contributing to successful ICES project implementation.

Each ICES business case describes the project, outlining key factors related to governance, financial, technical and economic aspects of project planning and implementation. Taken together, the series provides:

- A vehicle for communicating the ICES concept to the business community and potential supporters of QUEST's work;
- An educational resource describing financial aspects of ICES project planning and development and a foundation for further business-related ICES research; and
- A capacity-development tool for developers, municipalities, energy players, other project proponents and the investment community.

2. EXECUTIVE SUMMARY

This case study details and examines the development of the Southeast False Creek Neighbourhood Energy Utility in Vancouver, British Columbia with special attention paid to its project financing, ownership and governance structure. Strategies and best practices that contributed to the Neighbourhood Energy Utility's success have been identified along with key lessons learned that can be applied to future projects in order to aid municipalities, real estate developers and communities in the successful implementation of Integrated Community Energy Systems.

The Southeast False Creek Neighbourhood Energy Utility is a low-carbon district heating system that recovers waste heat from the City of Vancouver's (CoV) wastewater system and in turn supplies heat energy for space heating and hot water to mixed-use buildings in the Southeast False Creek community. The wastewater heat exchange technology is the first of its kind in North America. The utility is owned and operated by the CoV

The utility's construction financing was provided by a combination of a provincial grant (a transfer from a federal source), a low interest federal loan, and capital from CoV's Capital Financing Fund.

Energy rates for consumers connected to the utility are competitive with alternative space and hot water heating options however, the community's carbon emissions have been significantly reduced by employing a district energy system with a clean and renewable energy source.

Key development strategies employed by CoV that contributed to the project's success were:

- 1) Staged approach to installing energy generation equipment – Matching energy supply with energy demand by spreading out the deployment of capital and reducing the debt interest burden.
- 2) Public consultation – Engaging stakeholders in the project's development to ensure buy-in.
- 3) Public funding - Assistance of a federal grant for a portion of the phase 1 cost and the access to low interest debt financing.
- 4) Capital cost recovery structure – Utilizing a levelized¹ rate setting approach with access to a revolving line of credit to offset capital cost under-recovery in the early years of operation due to a low number of ratepayers during that period.
- 5) Granting of 'General Supervision' status by the BC Safety Authority - This reduced the utility's operating costs by the elimination of 24/7 supervision by a Power Engineer.
- 6) Experienced design team - The selection of experienced engineering consultants with district energy design in order to minimize the cost associated with the technical and performance risks associated with the incorporation of renewable generation.
- 7) Previously tested and flexible systems - The use of well-established European Standard district energy distribution systems design standards (e.g. pre-insulated piping with leak-detection and energy transfer stations). A key strategy is to design the system to be compatible with a wide range of future heat source technologies and expandable to serve areas outside of the SEFC area to existing buildings heated by natural gas boilers and hydronic systems.
- 8) Building integration – Utilizing an integrated system design approach with the building and utility systems at the outset of the project to ensure the buildings mechanical systems are appropriate for the type of district energy system used and vice versa. The building envelope and hydronic heating and cooling systems are essential to the district energy system's performance by reducing the peak demand, total consumption and allowing the system to operate efficiently.
- 9) Steering Committee - Formation of a steering committee (or project team) consisted of the various City departments responsible for the project including finance, legal, planning, engineering, and

1 A standardized series of equal, periodic payments.

utilities. The steering committee streamlined the decision making process, provided sound decision making, reduced project timelines, and ensured timely implementation.²

Additional strategies revealed during the development that can be applied to future ICES projects to ensure successful implementation are:

- 1) Flexible physical design - Matching the energy supply in stages closer to the forecasted energy demand by ensuring that the Energy Centre's physical design allows for the addition of incremental capacity as demand grows.
- 2) Delay installation of higher cost equipment - Install the capital intensive renewable portion of the generation only after there is enough base-load demand to utilize the asset at an efficient operating point and there is sufficient revenue to service the debt costs of the asset.
- 3) Long lead times for public consultation - Allow excess lead-time for the public consultation process to properly disseminate information and address stakeholder questions on the potential heat source options.
- 4) Ownership and Procurement - Consider alternative utility ownership and project procurement models (Design-Build-Finance-Operate-Maintain) based on performance outcomes rather than prescriptive specifications and to effectively allocate risk (construction, technical, performance, financial and demand), to the parties most able to bear that risk, and to foster competition and innovation.

The Southeast False Creek Neighbourhood Energy Utility is an example of a successful Integrated Community Energy System which delivers clean energy at competitive rates to consumers, provides an appropriate return on investment to the utility owners, reduces the City's greenhouse gas emissions and increases the energy independence of the community. It provides important lessons for future developers of Integrated Community Energy Systems and showcases the leadership the CoV has demonstrated in this field.

2 Chris Baber, City of Vancouver, NEU Utility Manager (personal communication, Aug 2011).

3. PROJECT OVERVIEW AND TECHNICAL DESCRIPTION

3.1. SOUTH EAST FALSE CREEK DEVELOPMENT

The South East False Creek (SEFC) development is located in the City of Vancouver (CoV), British Columbia, on the south side of False Creek adjacent to Science World, an iconic symbol of the 1986 Vancouver World Expo. The SEFC development is built on a 32 hectare brownfield development historically home to a ship-yard, rail-yard and works-yard, and zoned for redevelopment to include a mix of multi-family residential, retail, commercial, and community buildings totalling over 6 million square feet and an estimated 40 buildings (see Figure 1).³ The first mixed-use buildings constructed on the SEFC site were a group of 9 mixed-use buildings,⁴ completed in January 2010, which made up the Vancouver 2010 Winter Olympic Athlete's Village.



FIGURE 1 - SEFC development boundary, Vancouver, BC, Canada⁵

3 Bayley, Roger. 2010. The Challenge Series: Millennium Water: The Southeast False Creek Olympic Village. Retrieved from <http://www.thechallengeseries.ca/chapter-05/neighbourhood-energy-utility/>

4 Chris Baber, City of Vancouver, NEU Utility Manager (personal communication, Aug 2011).

5 Ballem, Penny; Pander, Sean; City of Vancouver. Integrated Energy Systems and Planning in Vancouver. Retrieved at <http://www.questcanada.org/documents/IntegratedEnergySystemsandPlanninginVancouver-CityofVancouver.pdf>

3.2. DECISION TO BUILD AN INTEGRATED COMMUNITY ENERGY SYSTEM

In 2007, the CoV finalized a 2007 SEFC Development Plan⁶ whose objective was to establish an energy efficient, greenhouse gas neutral neighbourhood based on renewable energy sources (see Figure 2 for the development timeline). The plan included the consideration of a district energy system, wastewater heat recovery, solar thermal collectors and use of efficient heat pumps to provide space heating and hot water requirements to the community.⁷

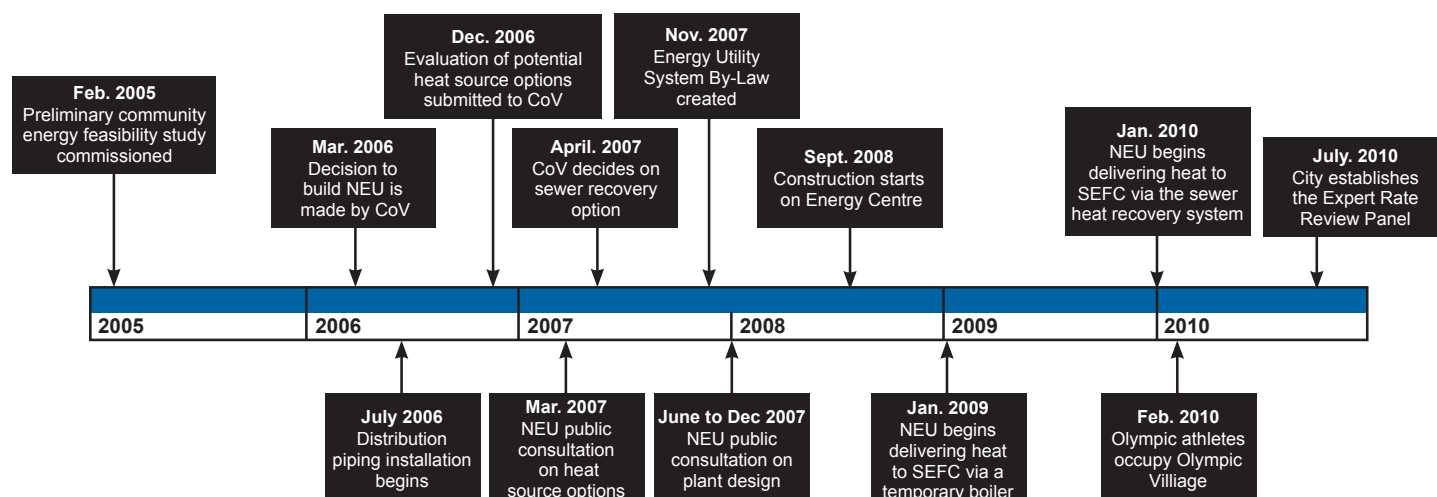


FIGURE 2 - NEU Development Timeline

Under a traditional Vancouver residential development model, a building's space heating and hot water requirements are normally provided by a combination of electric and natural gas systems located in each building (electric resistance base-board heaters and gas-fired forced air units). Developers are responsible for selecting these systems and generally build to the minimum requirements of the building code as there is no economic incentive to take a total cost of ownership strategy into the building's operational efficiency as this is not demanded by condominium purchasers. Owners of ICES, by contrast, take a long-term economic perspective due to the long-term ownership of the energy generation asset.

Implementation of an ICES for the SEFC allowed the CoV to meet the long-term objectives of the SEFC Development Plan since it offers the flexibility of employing renewable and waste energy sources located on the site. For these reasons, the decision was made that developing an ICES for SEFC was the best way for the community to reduce carbon emissions and provide competitive energy rates to SEFC residents.⁸

⁶ The 2007 SEFC Development plan is based on the 1999 SEFC Policy Statement, part of the 2005 Vancouver Community Climate Change Action Plan and congruent with the Province's Clean Energy Act.

⁷ City of Vancouver. (2007). SEFC Official Development Plan. Retrieved at <http://vancouver.ca/commsvcs/southeast/documents/index.htm>

⁸ City of Vancouver. (2008). Administrative Report (RTS No.07248).

In 2005, FVB Energy Inc. and Compass Resource Management consultants were retained by the CoV to develop both a technical and business feasibility analysis for a district energy system.⁹ In the analysis a variety of energy source options were considered for the system based on which technology would best meet the social, environmental and economic objectives and constraints of the community.¹⁰ These included technologies such as solar thermal, gas-fired boilers, gas-fired co-generation, biomass thermal generation, ground-source heat, sewer heat recovery, and combinations of these systems. All the options relied on natural gas boilers for peak demand and back-up to reduce costs and increase reliability.¹¹ The options were shortlisted to five (see Figure 2) using an initial pre-screen process. Two options emerged that were examined in further detail - biomass and sewer heat recovery.

The decision that the CoV would be the owner/operators of the ICES was made in March 2005, due to the fact that Olympic athletes were going to be occupying Olympic Village in early 2010, and the assurance of implementation of a low-carbon energy source.¹² This tight development schedule did not allow the necessary time required for a private utility owner to get BCUC approval for construction (for more details see Section 4.2.).

9 City of Vancouver. (2007). Administrative Report (RTS No.06806).

10 Bayley, Roger. 2010. The Challenge Series: Millennium Water: The Southeast False Creek Olympic Village. Retrieved at <http://www.thechallengeseries.ca/chapter-05/neighbourhood-energy-utility/>

11 City of Vancouver. (2006). Administrative Report (RTS No.05706), pg.21.

12 Chris Baber, City of Vancouver, NEU Utility Manager (personal communication, August 2011).

The Neighbourhood Energy Utility (NEU) team explored the biomass and sewer heat recovery options in greater detail since these options had substantial carbon emission reductions and were competitive on a dollar per megawatt hour basis with a Business as Usual (BAU)¹³ scenario (see Figure 3). The team simultaneously hosted a series of public consultations on the type of energy source to be used. The biomass option had the lowest supply costs for NEU customers and provided the largest reduction in GHG emissions¹⁴ however, other factors influenced the CoV to choose the sewer heat recovery option. The primary factor was the lack of time, imposed by the Olympic schedule, to both overcome public resistance to the perceived negative impacts of the biomass option, and the risk associated with obtaining the necessary air emissions permits from Metro Vancouver.¹⁵ The CoV also determined that the sewage heat recovery was a technically viable option especially given a similar Norwegian system built in 2006 was functioning well.¹⁶

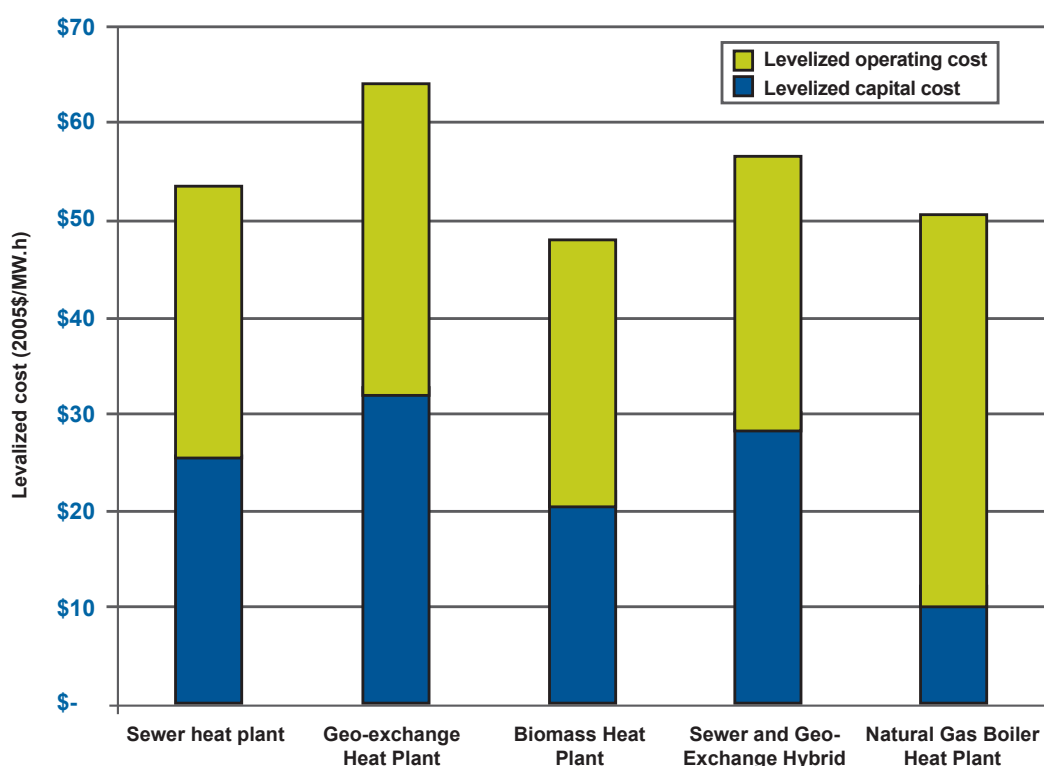


FIGURE 3 - Lifecycle Cost Comparison of Alternative Heat Sources¹⁷

13 Business-as-usual is defined as the method of space and hot water delivery (and associated energy rates) that would have been installed in a traditional Vancouver mixed-use development. For SEFC this would have been electric baseboard space heaters, and gas-fired hot water heaters.

14 City of Vancouver. (2006). Administrative Report (RTS No.05706), pg.21.

15 City of Vancouver. (2006). Administrative Report (RTS No.05706), pg.21.

16 City of Vancouver. (2006). Administrative Report (RTS No.06419), pg.6.

17 City of Vancouver. (2006). Administrative Report (RTS No.05706), pg.21.

3.3. PUBLIC CONSULTATION PROCESS

The CoV's public consultation process included reaching out to stakeholders via public assembly. The stakeholders included surrounding SEFC residents, future SEFC residents, SEFC developers (Millennium Development Group), environmental NGO's and city taxpayers. Both biomass generation and sewer heat recovery were relatively foreign concepts in Vancouver and the public responded with interest and concern. There was a widely held perception that the biomass combustion process would result in harmful, localized air pollution in addition to the negative effects of biomass fuel deliveries (woodchips, pellets, etc.), and unsightly industrial smokestacks. The public was more supportive of a sewer heat recovery option, though concerns were raised about the possibility of sewer odour, potential cross-contamination in the exchange process, siting of the plant and the unsightliness of the boiler stacks. In retrospect, the CoV has stated that an additional six to twelve months would have been ideal to continue to work with the public to address the negative perception of the biomass option.¹⁸

After the sewer heat exchange decision had been made, the CoV initiated a second public engagement process in June 2007 concerning the design of the False Creek Community Energy Centre (CEC) which would house the NEU operations. Representatives from a local neighbourhood association expressed concern about an industrial energy facility amidst a dense residential neighbourhood. The local representatives were included in the CoV's design charrettes and when the process expanded to the wider community, the neighbourhood association co-hosted public forums and assisted in explaining the rationale behind the project to the wider community. The public was able to view the designs and provide comments on key elements. Public sentiment was that the presence of an industrial energy facility in the neighbourhood would be acceptable as long as the design conformed to the aesthetic of the neighbourhood. The part of the project which prompted the most concern was the need for the five boiler stacks that protruded out from under the bridge. However, the stacks garnered a high level of support after local artists were commissioned to develop the stacks into a public art piece. In the end, the residents association provided both verbal and written support to the CoV's Development Permit Board for the project.

3.4. ENVIRONMENTAL BENEFITS

Roughly 50% of the CoV's total greenhouse gas emissions come from natural gas that provides heat and hot water in buildings.¹⁹ The SEFC NEU provides environmental benefits by decreasing GHG emissions, increasing energy independence and providing rate stability to the community as compared to the BAU alternative. These benefits are achieved by the district energy system's increased energy efficiency through economies of scale and flexibility to integrate local clean energy resources. These, in turn, isolate the community from volatile energy prices. District energy systems in general are 20% more efficient than building-based systems²⁰ even without the incorporation of a renewable energy source. The NEU is anticipated to produce at least 64% less GHG emissions as compared to the conventional heating methods since the clean sewer heat recovery source is designed and forecasted to supply 70% of the community's total heating and hot water demand over the long term operation of the utility.²¹ This 70% design point is on the basis of achieving a balance between cost-competitive rates and environmental performance. A larger portion supplied by the renewable energy component would improve the environmental performance but increase the energy rates to an unacceptable level. The future incorporation of local waste heat recovery and the rooftop solar thermal collectors as the development expands will further increase these environmental benefits.

18 Bayley, Roger. 2010. The Challenge Series: Millennium Water: The Southeast False Creek Olympic Village. Retrieved at <http://www.thechallengeseries.ca/chapter-05/neighbourhood-energy-utility/>

19 Chris Baber, City of Vancouver, NEU Utility Manager (personal communication, August 2011).

20 Retrieved at http://www.seatoskygreenguide.ca/buildings/sefc_neighbourhood_energy_utility

21 City of Vancouver. (2010). Administrative Report (RTS No.0880), pg.2.

There is also the social benefit of a higher level of user comfort, at lower energy use, as a result of the radiant heating system compared to convective style space heating.²² With convective air heating systems the air is dried and, in some cases, re-humidified, which is difficult to control. Dry air can be a respiratory irritant, the heat tends to collect at the top of the room, there are cold spots due to poor air circulation and the system carries and deposits dust. With radiant systems the heat tends to stay low in the room at the occupant level. Radiant systems allow one to maintain a lower room air temperature but still feel comfortable – like standing in the sun on a cold winter day. The absence of building heating and ventilation equipment on the roof creates more space for public use or green roofs while reducing building maintenance.²³

3.5. TECHNICAL DESCRIPTION

The SEFC NEU is designed to distribute heat energy to an estimated 16,000 future residents on 32 hectares from a variety of waste heat, renewable and conventional energy sources.²⁴ The system became fully operational in January 2010, has a peak load of 19.5MW²⁵ and is expected to supply 63,000 MWh of heat energy per year at full build-out.²⁶ The NEU's sewer heat recovery system is the first application of this technology in North America and is one of only four sewer heat recovery systems in the world – two in Oslo, Norway and one in Tokyo, Japan.²⁷ Sewer heat recovery is ideally suited for a dense urban environment where there is access to significant wastewater heat – both characteristics of the SEFC development. The NEU heat recovery system consists of sewage filtration, wastewater heat exchangers and heat pumps. The heat exchange equipment was integrated with the existing but upgraded municipal sewage pump station to recover the waste heat from untreated urban waste water lines (e.g. warm water from showers, dishwashers, clothes washers, toilets, etc.), while on its way to a waste water treatment facility. The facility has a travelling screen filter that removes all sewage solids larger than 2 mm before entering the heat exchange system. These solids are mixed back with the sewage after the heat is removed.

Heat pump technology, using a relatively small amount of electricity to power it, transfers and upgrades the wastewaters' low-grade thermal energy (20 degrees C, +/- 2 C depending on time of year)²⁸ to a higher grade temperature (65C) that is effective for residential space and domestic hot water heating. All the buildings within the SEFC boundary are required by city bylaws to connect to the NEU's system that distributes the thermal energy via underground distribution piping.²⁹ The sewage heat recovery system is co-located at the sewage pump station housed in the Community Energy Centre (CEC) along with the heat pump and gas fired boilers. On cold days in the winter when the space heating demand is at its highest, the waste heat recovery system will be augmented by three high-efficiency natural gas boilers, one of which has a condensing economizer on the exhaust gas for further energy recovery.³⁰ The generation capacity of the boilers is in fact enough to meet the full peak load demand of the system. This was done as a precautionary measure so, if the heat pump system fails, there will be enough energy to heat the buildings and supply potable hot water.³¹ Using natural gas boilers for base load back-up ensures overall system reliability however, it significantly adds to the NEU's overall cost.

22 Retrieved at http://vancouver.ca/sustainability/building_neu.htm

23 Retrieved at http://vancouver.ca/sustainability/building_neu.htm

24 Bayley, Roger. 2010. The Challenge Series: Millennium Water: The Southeast False Creek Olympic Village. Retrieved at <http://www.thechallengeseries.ca/chapter-05/neighbourhood-energy-utility/>

25 Compass Resource Management. (2011). SEFC Pro forma Financial Model.

26 Chris Baber, City of Vancouver, NEU Utility Manager (personal communication, August 2011).

27 Bayley, Roger. 2010. The Challenge Series: Millennium Water: The Southeast False Creek Olympic Village. Retrieved at <http://www.thechallengeseries.ca/chapter-05/neighbourhood-energy-utility/>

28 Chris Baber, City of Vancouver, NEU Utility Manager (personal communication, August 2011).

29 City of Vancouver, Energy Utility System By-Law No.9552. Retrieved at <http://vancouver.ca/bylaws/9552c.pdf>

30 Sorensen, Jean. 2009. Thermal system at 2010 Olympic Village will recover heat from spent sewage. Journal of Commerce. Retrieved at <http://www.journalofcommerce.com/article/id33548/watersewer>

31 Chris Baber, City of Vancouver, NEU Utility Manager (personal communication, June 2011).

The main distribution header circulates hot water from the CEC out to the buildings and slightly cooler water is returned. Energy Transfer Stations (ETS) at each building exchange heat from the main circulation header and transfer it up to occupants via variable speed pumps. Controls are located in each suite which circulates water through the radiant heat ceiling tiles (via innovative polymer capillary mats) that provide space heating and deliver hot water to each unit and shared spaces. Each building also has an additional ETS which is required for heating the potable hot water since the NEU's circulation water is not fit for consumption.

Metering is incorporated in each building's ETS for measurement and billing purposes by a system of water flow meters and temperature sensors. These sensors will determine if the building is either a net consumer or net supplier of thermal energy over the monthly billing cycle.

The NEU was designed using a staged approach to allow for future generation and connection in order to meet the growing energy demand as the community develops over a number of years (see Figure 4). The peak SEFC demand in 2010 of 6.1MW is equivalent to the energy demands of approximately 1,800 average sized Vancouver condos (i.e. 80m² or 860ft²) and will rise up to 24MW servicing 16,000 people when the development is completed.

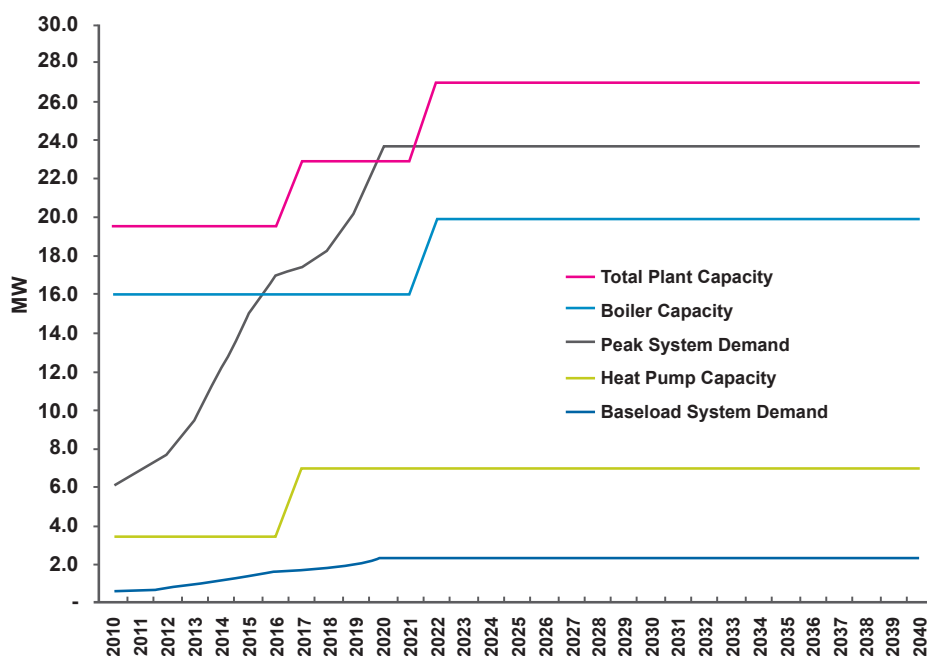


FIGURE 4 - NEU Capacity vs. Forecasted Demand³²

The CEC is ultimately designed to house four heat pumps and three large boilers. In the first stage two heat pumps totalling 2.7MW, two boilers at 4MW each and one larger boiler at 8MW have been installed. The primary energy source for the system is sewer heat recovery and as the system expands it has the ability to accept heat energy from a variety of waste heat and renewable energy sources in the SEFC area. This flexibility enables the system to keep pace with technology advancements and ensures long-term energy security and affordability for the community by utilizing local and renewable heat energy along with allowing other micro-utilities to connect to the system and potentially sell energy back to the NEU.

32 City of Vancouver. (2010). Administrative Report (RTS No.0880), Appendix G.

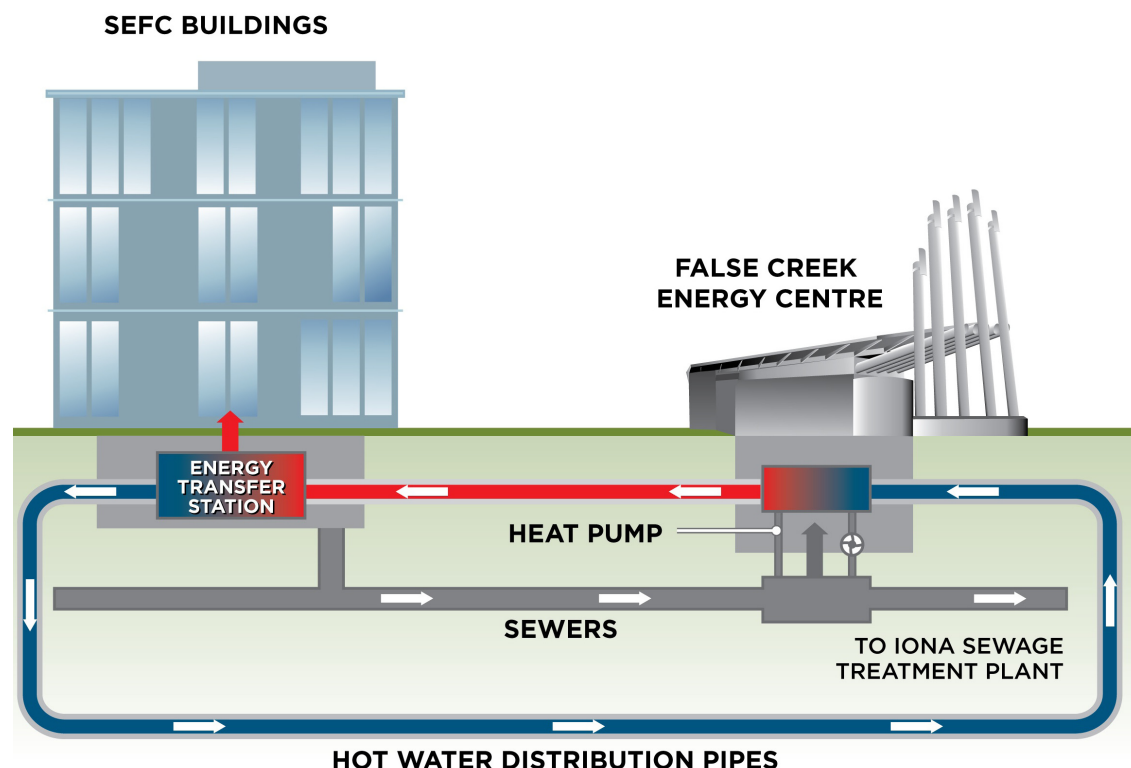


FIGURE 5 - NEU System³³

Currently, three of the buildings in the Olympic Village community feature roof-mounted solar thermal arrays which capture thermal energy from the sun. During peak sunlight periods, the solar systems could generate a surplus of heat in excess of the building's demand. This excess heat will be sold back to the NEU through each building's ETS and will be shared through the main piping system for use in other buildings that are net energy users - effectively reducing the electrical energy consumption of the heat pumps. The energy transfer is regulated through a 'thermal net metering' provision in the CoV's Energy Utility System Bylaw, whereby the NEU purchases excess energy from the individual customer at a set rate. This two-way energy transfer and metering system enables micro-producers of thermal energy connected to the system to sell their excess energy to the NEU at a rate of \$0.019/kWh³⁴ (see Buy-Back Rate Section for more details on the calculation of this rate).

The CoV worked with Ausenco Sandwell Engineering and subcontractor Walter Francl Architecture to determine the CEC building's concept, aesthetics and detailed facility design.³⁵ The CoV decided that the CEC would act as an interpretive facility to showcase the innovative use of sustainable energy technology. The building targeted LEED™ Gold certification, incorporated innovation throughout the facility design and put an emphasis on transparency of its operations and the benefits of its ICES technology by incorporating public education into the design. Most of the facility's operation takes place underground so street-level viewing portals were installed to allow the public to view machinery below grade and its above-ground portion is designed to accommodate tours and serve as a public education resource complete with a phone assisted walking tour.

³³ Retrieved at <http://vancouver.ca/sustainability/neuTechnology.htm>

³⁴ City of Vancouver, Energy Utility System By-Law No.9552, Schedule C, Part 4 – Credit. Retrieved at <http://vancouver.ca/bylaws/9552c.pdf>

³⁵ Retrieved at <http://www.bcbusinessonline.ca/bcb/top-stories/2010/05/05/vancouver-sustainable-energy>

Challenges included designing an attractive building for a sewage pump station and keeping the building's footprint as small as possible to preserve the public right-of-ways in the vicinity of the NEU. The reduced footprint, due to the two level design, freed up half of the site for landscaping (which includes a community garden). At the CoV's open houses the public expressed overwhelming support for the technology and design of the CEC.³⁶

The project also commissioned local artists to provide a design for the emissions stacks that were necessary for the gas-fired boilers. The approach was to instill a 'human quality' to the five emissions stacks. The stacks extend into a stainless steel 'hand,' with each 'finger' topped by a 'fingernail'. Each fingernail contains an LED light that changes colour to reflect the amount of energy being produced by the system. This artistic interpretation adds visual appeal to the NEU, inspiring residents and passers-by to take an interest in the neighbourhood's sustainable energy infrastructure.³⁷



FIGURE 6 - NEU Community Energy Centre's Emission Stacks³⁸

36 Bayley, Roger. 2010. The Challenge Series: Millennium Water: The Southeast False Creek Olympic Village. Retrieved at <http://www.thechallengeseries.ca/chapter-05/neighbourhood-energy-utility/>

37 Bayley, Roger. 2010. The Challenge Series: Millennium Water: The Southeast False Creek Olympic Village. Retrieved at <http://www.thechallengeseries.ca/chapter-05/neighbourhood-energy-utility/>

38 Retrieved at <http://knightarchitecturalproducts.com/2010/05/vancouver-sustainable-energy/>

4. GOVERNANCE AND INSTITUTIONAL CONTEXT

4.1. MUNICIPAL UTILITY GOVERNANCE

The CoV is a Charter City in which the governing system is defined by the CoV's charter document rather than by state, provincial, regional or national laws and therefore it is not regulated by the Local Government Act. The Province of British Columbia amended the CoV charter in order for CoV to own and operate an energy utility, as this was not originally defined within its powers.³⁹ Municipal utilities in British Columbia are not governed by the British Columbia Utilities Commission (BCUC) and are able to set up their own governance structure, normally accountable to City Council.

In December 2006, the CoV approved five governing principals for the NEU:⁴⁰

- 1) The NEU will seek to minimize GHG emissions consistent with the direction established in the Community Climate Change Action Plan.
- 2) The NEU will be operated to ensure long term financial viability.
- 3) The NEU will strive to maintain customer rates that are competitive with long-term capital and operating costs of other heating options available to customers.
- 4) The CoV will support the development and demonstration of flexible and innovative technologies through the NEU.
- 5) The CoV will consider and evaluate the potential to expand the NEU to other neighbourhoods with the merits and feasibility of each expansion phase to be determined separately.

The CoV's governance of the NEU is conducted via regulations set out in its Energy Utility System By-Law No.9552⁴¹ (the 'By-law') which includes, but is not limited to, connection requirements, ownership boundaries, maintenance, metering, and rate setting.

The NEU's rates are set by the CoV on advice of an independent third party review board, the NEU Expert Rate Review Panel (ERRP), appointed by City Council and consisting of three members who have expertise in three specific areas; utility rate setting, finance and green energy.⁴² Restrictions stipulate that EERP members cannot be CoV employees, an elected CoV official, an NEU customer, or an employee or major shareholder of a competing utility in order to avoid conflicts of interest. Their terms are limited to three years and the panel's annual rate recommendations must ultimately be approved by City Council.

All buildings within the SEFC community boundaries are required to connect to the district energy system as mandated by the By-Law. These buildings are prohibited from installing conventional heat generating equipment (gas-fired boilers, electric heaters, etc.) with the exception of solar thermal or systems for the purpose of recovering waste heat from commercial refrigeration or space cooling.

39 City of Vancouver. (2010). Administrative Report (RTS No.08880), Appendix B.

40 City of Vancouver. (2009). Administrative Report (RTS No.7292).

41 City of Vancouver. Energy Utility System By-Law No.9552. Retrieved at <http://vancouver.ca/bylaws/9552c.pdf>

42 City of Vancouver. (2010). Administrative Report (RTS No.0880), Appendix E, E-2.

4.2. OWNERSHIP AND OPERATING MODEL

The NEU is the first energy utility owned and operated by the CoV and managed by CoV's Engineering Services Department. Financial responsibilities related to the NEU are shared by CoV's General Manager of Engineering Services and Director of Business Planning and Services.

The decision of the CoV to be the owner-operator of the utility was made in part due to the compressed Olympic time schedule that reduced the project's procurement time, and CoV wanted to ensure that a low-carbon source was a priority. The NEU is unlike the CoV's water, solid waste and sanitary utilities, in that its services are available to only a small subset of Vancouver's taxpayers and it competes with existing private-sector energy providers. For this reason, as per Council's direction, it is to be operated as a standalone commercial business, without subsidy from taxpayers.⁴³ The merits of continued ownership of the NEU by the CoV are set to be reviewed before any expansion of the system or three years after commercial commencement, in January, 2013.⁴⁴ The CoV reserves the right to sell the utility to a private owner in the future if it is found that private ownership would provide more value to stakeholders. The CoV may also decide to procure future district energy projects using a fully private, Public-Private Partnership (P3) or other models if it is deemed to be in the public interest.

4.3. PROVINCIAL UTILITY GOVERNANCE

The British Columbia Utilities Commission (BCUC) is a regulatory agency of the Provincial Government, operating under and administering the Utilities Commission Act ("UCA"). The BCUC's mission is to ensure that BC ratepayers receive safe, reliable, and nondiscriminatory energy services at fair rates from the utilities it regulates, and that shareholders of those utilities are afforded a reasonable opportunity to earn a fair return on their invested capital. Utilities under BCUC jurisdiction, as stipulated by the Utilities Commission Act (the Act), that wish to construct a district energy system must file for a Certificate of Public Convenience and Necessity (CPCN) for its construction and operation. This is to ensure the proposed asset's construction is in the public's interest and that utilities are not making unwise investments that they later expect to recover in rates from their customers.⁴⁵ Proposed revenue requirements, asset base, rate design and rates are also approved by the BCUC. Under the Act, however the Commission does not regulate municipally owned utilities providing services within their own boundaries.⁴⁶ On the other hand, if a private utility owner within a municipalities' boundary does not have public ownership, governance of the utility falls under the BCUC.

The SEFC NEU, being 100% municipally owned, is not governed by the BCUC. However, the municipal governance structure put in place is similar in design. If the CoV was to sell the asset to an investor-owned utility, governance would return to the BCUC.

43 City of Vancouver. (2009). Administrative Report (RTS No.7292), pg.9.

44 City of Vancouver. (2009). Administrative Report (RTS No.7292), pg.2.

45 BCUC. (1999). Understanding Utility Regulation-A Participants Guide to the BCUC, pg. 47.

46 Retrieved at <http://www.bcuc.com/CorpProfile.aspx>

5. FINANCING AND ECONOMICS

5.1. PROJECT FINANCING

The CoV developed the NEU and also arranged the project's financing. CoV describes the NEU as fully self-funded through NEU customer fees. The utility has a dual mandate:⁴⁷

- 1) Provide a Return on Investment (ROI) to the utility's owners (currently CoV).
- 2) Provide competitive energy rates to NEU customers.

The inclusion of a competitive ROI in the economic model was to ensure that the NEU could attract future private buyers of the utility if it was decided that the public could be better served if the owner of the utility was an investor-owned, rate regulated utility.⁴⁸ At the same time, the ROI had to be conservative enough to provide NEU consumers with energy rates competitive with BAU rates for the area. In addition the inclusion of a ROI ensured that CoV taxpayer at large is compensated for the risks associated with financing the system.

5.1.1. FUNDING SOURCES

The capital cost of the NEU facility as of 2011 was \$33.8 million⁴⁹ (the cumulative cost grows each year as the connected floor area grows and future distribution piping, energy transfer stations and energy generation is added). This figure does not include an additional \$8.5M for the pump station upgrade that was a mutually exclusive and necessary project⁵⁰ which fell under the CoV's maintenance budget. The NEU project received funding from the following three sources⁵¹:

- 1) A \$10.2 million provincial grant provided by the Government of Canada's federal Gas Tax Fund - a tripartite agreement between Canada, British Columbia and Union of British Columbia Municipalities which delivers infrastructure funding to local governments for capital projects that lead to cleaner air, cleaner water or reduced greenhouse gas emissions.⁵²
- 2) A 20 year loan for \$5.0 million at 1.7% from the Federation of Canadian Municipalities (FCM) Green Municipal Fund (GMF).⁵³
- 3) The CoV of Vancouver self-funded the remaining \$17.5M via interim financing through CoV's Capital Financing Fund (CFF) at a rate of 5.0% percent.

The CoV plans on refinancing their \$16.0M portion currently carried by the CFF, via municipal debt issuance in the future. Ideally the debt maturity of the bonds would match the average expected 25 year depreciation of the utility assets however, it is more common for CoV to issue five or 10 year municipal bonds. Attracting buyers for a 25 year bond issue, normally large institutional investors, for such a small loan value (\$16M) may prove to be difficult unless it can be pooled with other similar bonds.

47 City of Vancouver. Neighbourhood Energy Utility. Retrieved at http://vancouver.ca/sustainability/building_neu.htm

48 Chris Baber, City of Vancouver, NEU Utility Manager (personal communication, June 2011).

49 City of Vancouver. (2010). Administrative Report (RTS No.0880), Appendix G.

50 Retrieved at <http://www.journalofcommerce.com/article/id33548/watersewer>

51 Additional funding sources and knowledge resources for ICES projects can be found at the Community Energy Association's website <http://www.communityenergy.bc.ca/>

52 City of Vancouver. (2010). Administrative Report (RTS No.0880), Appendix G.

53 FCM Green Municipal Fund. 2010. Updated GMF Funding Offer for Capital Projects, pg.13. Retrieved at <http://gmf.fcm.ca/files/GMF/GMF-New-Funding-Offer-Application/UpdatedGMFFundingOffer-FIN-e.pdf>

5.1.2. CAPITAL STRUCTURE

The Expert Rate Review Panel (ERRP) has made the assumption of a project capital structure of 60% debt, 40% common equity (even though the utility is 100% debt financed).⁵⁴ The 60/40 split is comparable to the capital structure of a privately financed project and is in accordance with the Utility Accounting Method used by the BCUC and necessary if a transfer to an investor owned utility were to occur. It could be argued that if the CoV decides to own the utility in perpetuity, and the capital structure is 100% debt financed, that this would lower the fixed rate portion of the energy charge as no Return on Equity (ROE) would be included as a line item under operating expenses.

Public infrastructure projects that are procured as public-private partnerships, such as the Sea-to-Sky highway or the Canada Line, can approach debt to equity ratios of 90/10. This is the case when the government agrees to pay the private owner a fixed monthly payment, generally over 30 year period, with little or no demand risk assumed by the private owner. This is a bankable investment allowing for a highly leveraged capital structure due to the security of a city's debt rating and balance sheet. In the case of the NEU, demand risk is borne by the utility owner, thereby requiring a significant equity component in the capital structure or the project would have difficulty securing debt financing from the private market.

5.1.3. COST OF DEBT

The weighted average cost of debt for the NEU is a weighted average of the annual interest rate of the \$16.0M CFF financing at 5.0%⁵⁵ (currently with an indefinite term length), the 20 year \$5.0M FCM loan at 1.7%,⁵⁶ and the additional short-term working capital debt requirement of \$0.840M (4% of the approved asset base) at a rate of 2.5%.⁵⁷ The lower interest rates of the short-term debt and FCM loan effectively reduce the actual average cost of debt for the NEU from the ERRP's allowable 5.0% down to 4.15%. This will have the effect of increasing ROI. However, it is CoV's intention to secure long-term outside financing for the \$16.0M in the future in which there may be risk of the actual weighted average cost of debt exceeding the 5.0% assumption - this would have the effect of decreasing ROI.

Allowable cost of debt assumptions by the BCUC are generally based on the Government of Canada's 30-year bond yield plus a basis point credit spread to reflect the utilities unique risk to creditors. The point spread can be determined by the spread between the Government of Canada's 30-year bond yield and the Canada 30-year A-Rated Utility Bond Index yield if the risk of the specific utility is considered to be similar to the index. The spread can also be determined by comparing other individual utility's corporate bond spreads with similar debt ratings.

A financial advantage of employing a district energy system is the shift in capital costs for an individual building's heating systems from inclusion in the capital cost of the building, to the capital cost of the NEU. The cost of debt for the NEU owner is lower than the individual condo owner's cost of debt (i.e. mortgage rate) thereby lowering the owner's long-term carrying costs. This benefit holds true as long as the total cost of ownership of the NEU equipment is equal to or less than the total cost of ownership of the individual buildings BAU mechanical systems. The NEU allows an investment to be made in the lowest life-cycle cost of operation rather than the lowest up-front capital cost which generally occurs when the heating system is supplied by building developers.

54 City of Vancouver. (2010). Administrative Report. RTS No.08880, Appendix F, F-2.

55 City of Vancouver. Administrative Report. RTS No.08880, December 2nd, 2010.

56 City of Vancouver. Administrative Report. RTS No.08880, December 2nd, 2010.

57 Compass Resource Management. (2011). SEFC Pro forma Financial Model.

5.1.4. RETURN ON EQUITY

The allowable Return on Equity for a low-risk benchmark utility was determined by the BCUC to be 8.47% for 2009 (this rate is reviewed and can change annually).⁵⁸ A premium is then applied to the low-risk benchmark to other utilities according to their unique business risk. The utilities achieve this allowable ROE through a combination of fixed and variable rates charged to their consumers.

The allowable ROE for the NEU has been set by the ERRP at 10.0%.⁵⁹ The risk premium, equal to 1.53%, is added to this benchmark rate for the unique risk the NEU faces as compared to the low-risk benchmark. This risk factor is a function of the project's construction risk, operating risk, financial risk, revenue risk, and the capital structure. The allowable portion of equity in the capital structure is equal to 40% and from this an ROE line item is calculated that appears under operating expenses.⁶⁰ This approach is in accordance with financing a comparable privately owned utility - one of the guiding principles of the NEU. CoV is essentially following the BCUC's method of determining ROE - the Utility Accounting Method. The BCUC's decision on the allowable ROE for the soon to be constructed Simon Fraser University (SFU) Neighbourhood Utility System (NUS) district energy project is the benchmark utility rate of 8.47%, plus a 50 basis point risk premium for a total ROE of 8.97%. The CoV's ERRP arrived at a slightly higher ROE of 10.0% for the SEFC NEU, an indication that the risk of the NEU 'should be' higher than the risk faced by the NUS. However these two decisions on allowable ROE were not made by the same governing body and therefore may not have a consistent methodology in determination of ROE or the utility's risk.

In the 2011 rate review, the NEU ERRP made mention of the subjectivity of the ROE required to cover CoV's risk for operating a utility. However, this risk premium subjectivity is faced by all utilities regulated by the BCUC and is effectively negotiated. If investor-owned utilities found the BCUC's decisions on allowable ROE were not sufficient, projects would simply not attract private financing and would not be constructed until the allowable ROE reached a competitive level.

The NEU's ERRP is not bound to the same decisions as the BCUC and there is the possibility of divergence between the two regulators allowable ROE for utilities facing identical risk. Private investors may prefer regulation of the BCUC accountable to the Province as opposed to a municipal rate review board accountable to the CoV to ensure the determination of ROE is as equitable as possible. At this time it is difficult to determine if investors would prefer to invest in BCUC regulated projects or alternatively prefer the more direct accountability faced by municipal government officials elected by the utility's users.

5.1.5. INTERNAL RATE OF RETURN

The utility's Weighted Average Cost of Capital (WACC), based on a 60/40 capital structure, 4.6% cost of debt, 10.0% return on equity and the absence of corporate tax,⁶¹ is calculated to be 6.4%.⁶² Energy rates are set based on the forecasted energy consumption and net connected floor area, the utility's operating costs, and the WACC. The corresponding energy rates are set in order to achieve a Net Present Value (NPV) of the cash flows equal to zero. If the forecasted values are accurate, the actual IRR and the WACC will match.

58 Retrieved at http://www.bcuc.com/Documents/ReturnOnEquity/2008/DOC_20663_L-55-08_2009-ROE.pdf

59 City of Vancouver. (2010). Administrative Report (RTS No.08880), Appendix F, F-2.

60 City of Vancouver. (2009). Administrative Report (RTS No.7292), Appendix B.

61 The NEU does not pay corporate tax as the utility's shareholders and taxpayers are one and the same.

62 Compass Resource Management. (2011). SEFC Pro forma Financial Model.

5.2. PROJECT ECONOMICS

5.2.1. CAPITAL AND OPERATING COST RECOVERY

The \$21.0M NEU capital cost (net of the \$9.5M grant) will be fully recovered through a fixed energy rate charge to connected users over the 25 year asset life. The CoV decided on a linear levelized rate recovery approach which under-recovers the capital cost at the front-end of the amortization period and over-recovers in the back-end of the amortization period, when both the energy rates and the number of total connected users are higher. The deficit from under-recovery in the early years is topped-up by the CoV's Rate Stabilization Reserve (RSR) borrowed from the CoV's CFF. The RSR, effectively a revolving line of credit with CoV, is capped at a maximum of \$8.0M which the NEU can draw upon when needed to cover shortfalls in the early years. It is forecasted that the NEU will draw \$1.6M from the RSR in 2010, and a lesser amount in each subsequent year until year 12 of operations at which point the outstanding RSR will total approximately \$9.5M.

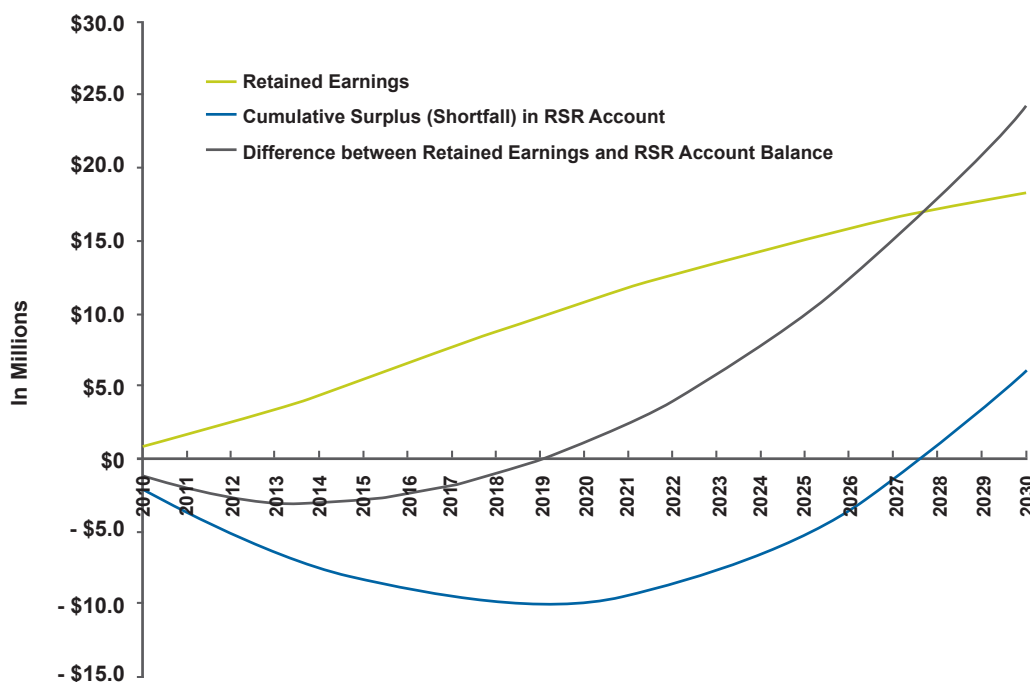


FIGURE 7 - RSR Balance vs. Retained Earnings⁶³

The RSR limit was set in 2009 to \$8.0M but may be adjusted by council in future years if necessary. It should be noted in an investor-owned utility model that the allowable ROE would be lower during the years the RSR fund is accessed.⁶⁴ This would provide an incentive for the investor-owned utility to pay down the RSR balance as quickly as possible. In the NEU model however, the ROE is maintained at a constant 10.0%. It is worth noting that the ERRP in a December 2010 City Administrative Report indicates that the RSR could be accessed to a lesser extent if the retained earnings from the ROE were applied to the operating shortfall.⁶⁵ Since approved rate increases are a function of the CFF debt level it could be argued that at least a portion of the rate increase is not necessary if retained earnings are used to cover operating shortfall.

⁶³ City of Vancouver. (2010). Administrative Report (RTS No.0880), Appendix G.

⁶⁴ John Turner, Director of Energy Solutions, FortisBC (personal communication, June 2011).

⁶⁵ City of Vancouver. (2010). Administrative Report (RTS No.0880), Appendix F, F-3.

In the existing model, at year 11 the NEU's net income is expected to be positive and able to contribute to reducing the RSR balance from its \$9.5M peak and eventually maintain a positive reserve surplus balance in order to provide rate stabilization for unforeseen conditions. The maximum level of this surplus fund is to be determined by the ERRP⁶⁶ at a later date.

In the event of lower demand than anticipated (less users coming on-line than forecast due to slower than expected development), the target 6.2% IRR can be achieved by increasing the Rate Escalation Factor (REF) over and above the proposed 1.15% real rate (on top of an anticipated 2.0% inflation rate). In a sensitivity analysis of the delayed uptake scenario over the 25 year period, REF required to maintain an IRR of 6.2% is a 2.3% real rate (i.e. the real rate of 2.3% is added to the expected inflation rate of 2.0% to arrive at a nominal rate of 4.3%). This rate increase may or may not be in-step with BC Hydro's rate increases.

5.2.2. RATE STRUCTURE

The combined fixed and variable rate structure is designed so that 60% of revenue comes from the fixed portion and 40% from the variable portion. The variable portion of the rate has to be proportionally large enough to encourage ratepayers to lower their energy costs by conservation – a 60/40 fixed vs. variable rate split has been determined in other cases by BC Hydro to be sufficient to provide an incentive to conserve. The district energy project at Simon Fraser University in Burnaby also has this 60/40 proportional fixed and variable rate structure. The NEU may adjust this rate structure in future years to increase the demand management incentive.⁶⁷

The energy rate structure for SEFC residential and commercial users is designed so the total cost for heating and hot water consumption are comparable to costs incurred using typical Vancouver multi-family dwelling heating systems. The rate structure for residential users within the SEFC area boundary is split into two components: a fixed rate levy and a variable rate charge and also includes an excess demand fee.

5.2.2.1. FIXED RATE COMPONENT

The fixed rate, referred to as the Capacity Levy, is based on the square metre floor area of each building and charged to the building's strata on a monthly basis (a strata is a condominium ownership structure in BC). The levy has been designed to recover the fixed cost associated with constructing and operating the utility and includes the following: the amortized capital cost of the utility's construction over the average life of the utility (25 years), CAPEX, ROE, debt interest service, proportional share of CoV's administrative corporate overhead (equal to 5% of the fixed operating costs of the utility), maintenance, direct costs of NEU staffing, insurance, land rent, and property taxes.⁶⁸ The 2011 Capacity Levy is set at \$0.454 per square metre per month.⁶⁹ The Capacity Levy is set to increase annually at a real rate of 1.15% above inflation for an estimated nominal rate of 3.15%. This rate is subject to yearly review by the ERRP, and must also have approval by City Council.

5.2.2.2. VARIABLE RATE COMPONENT

The variable rate component, referred to as the Energy Use Charge, is based on actual energy used by the individual buildings and is designed to cover the variable cost of operating the NEU which includes only the natural gas purchased for the boilers, electricity purchased for the heat pumps and other small non-fuel variable costs.⁷⁰ Each building's strata council is responsible for charging the individual condo owner's their proportion of the variable rate component based on the strata's method of choice; generally the square metre floor area or energy sub-metering in each suite.

66 City of Vancouver. (2010). Administrative Report (RTS No.0880), Appendix E, E-1.

67 Chris Baber, City of Vancouver, NEU Utility Manager (personal communication, August 2011).

68 City of Vancouver. (2010). Administrative Report (RTS No.0880), Appendix G.

69 City of Vancouver. Energy Utility System By-Law No.9552. Retrieved at <http://vancouver.ca/bylaws/9552c.pdf>

70 The price projections used in the economic model for electrical and natural gas rates were from BC Hydro's Projected Real Price Index of Electricity and the Sproule Commodity forecast respectively.

The energy use charge in 2011 was set at \$0.038166 per kWh⁷¹ and as with the Capacity Levy, the Energy Use Charge Rate is set to increase annually at a real rate of 1.15% above inflation for an estimated normal rate of 3.15%. This rate is also subject to yearly review by the ERRP, and must also be approved by City Council.

The combined Capacity Levy and Energy Use Charge approximately equates to BC Hydro's effective comparator rate.⁷² For residential consumers, BC Hydro charges a \$0.1448 per day fixed Basic Charge and a two-step variable Usage Charge (\$0.0667/kWh up to 2,240 kWh and \$0.0962/kWh beyond that level).⁷³ As an example, for an average 65m² Vancouver condo (700 square feet), the NEU's 2011 fixed charge for the condo owner would be \$29.50 per month. Based on the buildings expected energy intensity of 109.5 kWh/m²/year,⁷⁴ the 65m² condo would consume 593 kWh per month at \$0.038166/kWh, and the variable charge would equal \$22.64. This would be a combined total of \$52.13 per month for 593 kWh of energy consumed. Converting this total cost to a per kWh rate for comparison with BC Hydro's 2011 forecasted effective rate of \$0.087/kWh, the NEU's effective rate would be \$0.088/kWh⁷⁵ – almost exactly the same rate, demonstrating that NEU consumers are receiving competitive rates for energy.

For buildings located outside the SEFC boundary, there is no fixed rate charge based on floor area, rather there is a demand charge set at \$6.829 per kW of peak energy recorded in that month⁷⁶ in addition to a \$0.038166 per kWh consumption charge.⁷⁷ This is due to the high variability in peak energy demand due to the existing buildings design. For a demand rate comparison, BC Hydro's commercial demand charge is \$0/kW up to 35kW, \$4.51/kW for the next 115kW, and \$8.66/kW beyond 150kW – demonstrating the NEU charge is within this range.⁷⁸

5.2.2.3. EXCESS DEMAND FEE

There is also an estimated total peak power rating for each building within the SEFC boundary based on 65 watts per meter squared of floor space. For every 1 watt in excess of the estimated peak power for the building recorded that month, an excess heat energy charge of \$1.50 per watt is levied.⁷⁹ The excess demand fee is there to incent developers to not request more energy demand capacity than they need for the building. There have been cases where developers subscribe to unnecessary capacity, which results in a more capital intensive system than necessary and higher customer rates. The NEU's excess demand fee has not been levied due to pro-active work with SEFC developers.⁸⁰

71 City of Vancouver, Energy Utility System By-Law No.9552, Schedule C, Part 3 – Monthly Charge. Retrieved at <http://vancouver.ca/bylaws/9552c.pdf>

72 An effective comparator rate is necessary due to the two tiered rate system employed by BC Hydro. For details on this calculation see the CoV's Administrative Report 08880, pg. 6.

73 BC Hydro Residential Conservation Rate 1101.

74 Compass Resource Management. (2011). SEFC Pro forma Financial Model.

75 City of Vancouver. (2010). Administrative Report (RTS No.0880), pg.6.

76 City of Vancouver, Energy Utility System By-Law No.9552, Schedule C, Part 3 – Monthly Charge. Retrieved at <http://vancouver.ca/bylaws/9552c.pdf>

77 The By-Law states that the building owner outside the SEFC boundary will make a cash 'contribution' to the cost of connecting to the NEU system – they are not required to pay for the entire cost of connection only a portion - which includes the ETS.

78 Retrieved at https://www.bchydro.com/youraccount/content/business_bill.jsp

79 City of Vancouver, Energy Utility System By-Law No.9552, Schedule C, Part 4 – Excess Demand Fee. Retrieved at <http://vancouver.ca/bylaws/9552c.pdf>

80 Chris Baber, City of Vancouver, NEU Utility Manager (personal communication, August 2011).

5.2.2.4. BUY-BACK RATE

The NEU energy buy-back rate, for a building selling energy back to the NEU, is set to 50% of the sell rate, or \$0.019/kWh.⁸¹ The buy-sell rate spread is based on the avoided cost of energy generation by the NEU when the solar thermal collectors put energy back in the system. Solar thermal collectors provide the majority of energy in the summer months at a time when the efficiency of the heat pump system is significantly reduced. The result is 1 kWh of energy provided by the solar thermal collectors does not offset 1 kWh of energy generated by the central plant. As time progresses this efficiency effect on the system performance will be monitored and the rate reviewed if the value of energy provided to the system by the solar collectors rises above the 50% level.

5.2.3. ECONOMIC BENEFITS

The total life cycle costs of the NEU system are expected to be equal to or less than the BAU alternative. This is evidenced by the fact that the combined fixed and variable energy rates of the NEU are approximately equal to the BAU energy rate in Vancouver and yet the buildings operate more efficiently (lower energy intensity). Economic benefits are realized by this efficiency and the use of multiple sources of energy creates the effect of risk pooling from an energy supply and price perspective. After all, there is a low probability that gas prices will be high, electricity prices will be high, the sun will not be shining, and the sewer heat recovery will be low, all at the same time. If natural gas and/or electricity prices rise significantly, it will provide an economic incentive for building owners (utility owners) to install solar thermal units or look for waste heat recovery sources. Since the investment in the distribution piping and net metering infrastructure has already been made, new waste energy or solar thermal projects are possible and more attractive to develop.

81 City of Vancouver, Energy Utility System By-Law No.9552, Schedule C, Part 4 – Credit. Retrieved at <http://vancouver.ca/bylaws/9552c.pdf>

6. ANALYSIS AND DISCUSSION

The SEFC NEU development utilized numerous strategies in the project's design, financing, governance and rate structure that were critical to its success. There were also lessons learned during the course of the project that have been studied and should be transferred to future ICES projects both locally and nationally. The key strategies for successful implementation of this ICES project and ICES projects in general are as follows:

6.1. STAKEHOLDER ENGAGEMENT

Local residents were concerned with an industrial energy generation facility located within the community (specifically the biomass option) and developers shared concerns regarding the additional cost of hydronic heating systems compared to the BAU electric resistance baseboard heaters. If more time had been available for the public consultation process to provide detailed information on the number of fuel deliveries per week, size of the biomass delivery trucks, and details on stack emissions, biomass may have emerged as the base load energy source of choice as the life cycle costs and GHG emissions of the biomass technology are lower.⁸² In future ICES projects, the added upfront cost and the long-term benefit to each condo owner as a result of the hydronic heating system should be communicated clearly to developers and their potential clients. Condo owners are starting to recognize the long-term value of paying a premium for energy efficient buildings identified via LEED certification.

The necessity for public outreach and proactive dialogue with stakeholders cannot be overstated. Sufficient time needs to be allocated ahead of the project development for multiple public consultations to ensure buy-in from stakeholders and ensure their input is truly considered and implemented. The public consultation process should include open house sessions, bulletins in local newspapers, on-site development signage, and direct mail to residents within a certain radius of the project. The more dissemination of information and transparency into the project's details, the more chance that stakeholders will support and even advocate for the project.

6.2. PHASED APPROACH TO CAPITAL DEPLOYMENT

Significant up-front capital costs are incurred to build any district energy project, specifically the renewable energy portion of the NEU system, even though the maximum energy demand for the SEFC community is not expected to be reached until year eleven of its operation.⁸³ Ideally, the energy demand of any development is met with a slightly greater energy supply as the area builds-out in order to match cash inflows from rate fees with cash outflows from capital expenditures. A solution to mitigate the high up-front capital costs would be to closely stage the construction of the project with installed floor area (i.e. add capacity as new buildings are constructed). This includes the Distribution Piping System (DPS), ETS and Centralized Energy Plant (CEP) components and more specifically, delay the construction of the most capital intensive portion of the project, the renewable energy asset, towards the end of the district's build-out when a certain demand threshold is achieved. Energy could be provided to users during build-out via a traditional, less expensive energy generation technology (e.g. gas fired boilers). Once a demand level has been reached that closely matched the renewable energy generation, the renewable asset could be constructed and put into service, with the boilers allocated for peak demand or back-up conditions.

The NEU project was designed using this staged approach however, due to the fact that half the equipment is underground (which makes future access difficult and expensive), two small boilers, one larger boiler and two heat pumps were initially installed for a combined energy generation capacity of almost three times the estimated peak demand of its first year. Not until three years after start-up is forecasted peak demand expected to

82 City of Vancouver. (2010). Administrative Report (RTS No.05606), pg.21.

83 City of Vancouver. (2010). Administrative Report (RTS No.0880), Appendix G.

grow to 75% of the installed generation capacity (this ratio is maintained until full build-out – see Figure 3).⁸⁴ If the NEU equipment was all above ground, it may have been possible to stage the project in a way that more closely matched the energy demand. The renewable generation portion of the project could be constructed, and used at full capacity, when the rate payer base was available to service the cost recovery of the capital intensive renewable asset. A closely staged approach to construction would have had the effect of lowering the carrying costs of the project and reducing the total lifecycle cost to ratepayers.

6.3. ENERGY CENTRE BUILDING DESIGN

The Energy Centre building accounts for approximately \$7.5M of the capital cost⁸⁵ with a significant portion due to the aesthetic architectural design necessary to guarantee public acceptance of a utility operating adjacent to busy residential neighbourhoods. There was also a necessity to locate the heat pump and boiler equipment partially underground due to site constraints, materially increasing the cost of the project. Cost reduction on future projects could be achieved if design restrictions allowed all above ground construction and less sensitive aesthetic design.

6.4. DISTRICT ENERGY DESIGN EXPERTISE

Additional costs were incurred for the NEU project due to the pioneering risks and conservative measures associated with building the first sewer recovery system in North America. This included the additional flexibility to implement sewer filtration (if required) to reduce fouling of the exchangers, the high degree of customization of the heat pump system and the very high safety factors for the heat exchangers which all increased the cost of the system. If a similar sewer heat recovery project is developed in the future, cost savings should be realized from elimination of this filtration flexibility, and knowledge gained from the heat pump and heat exchanger design and performance.

Familiarity with district energy system design, particularly ones that incorporate renewable sources, is critical. Systems may be over-designed in order to achieve an improbably peak load demand to mitigate the liability of under-performance or alternately over-designed to handle load conditions which have a very low probability of occurrence (e.g. every hot water fixture in the building to be operating simultaneously on the coldest day of the year). Capacity over-design results in an increase in overall project cost. The more experienced the developer's agent has in peak demand forecasting, the less propensity to over-design. In addition, the generation capacity should not be sized so that the peak load demand is achieved solely via the renewable energy portion of the system. Doing so would cause the capital requirements to result in an uneconomical business case. Instead, the renewable energy generation capacity should be designed to supply only the base load demand, while the remainder is supplied using a less expensive conventional energy generation technology.⁸⁶ This approach balances GHG reductions with project costs.

The use of European standard district energy distribution system design best practices was critical in the NEU's success (e.g. pre-insulated leak-detecting pipes, energy transfer stations and building design integration process). It was a challenge to find multiple design consulting companies with experience in European standard district energy distribution systems, sewer heat recovery systems, and large-scale custom-built heat pumps. The limited number of consultants with experience with these systems potentially added to the cost of the project. After completion of the NEU there are both social and economic benefits of local contractors and consultants having gained new knowledge with the unique systems employed on the project. This local experience and capacity building will reduce risk and cost on future district energy projects along with providing local economic benefits.

84 City of Vancouver. (2010). Administrative Report (RTS No.0880), Appendix G.

85 Chris Baber, City of Vancouver, NEU Utility Manager (personal communication, August 2011).

86 Chris Baber, City of Vancouver, NEU Utility Manager (personal communication, June 2011).

6.5. CO-LOCATION AND POWER ENGINEER REQUIREMENTS

Attention should be paid to the benefits of co-locating the conventional and renewable energy generation sources. In the case of the NEU, gas boilers have been employed which, under certain conditions, require 24/7 on-site supervision by a registered Power Engineer by code. If the generation systems are located too far apart, this could require even more than one Power Engineer on site, significantly increasing the fixed costs of operation. The NEU was granted “General Supervision Status” meaning the BC Safety Authority has granted scheduled visits and off-site supervision by a Power Engineer as the NEU met certain safety requirements including installation of automated controls, alarms and remote communication systems. This classification can significantly reduce the fixed operating costs of the utility and was a key element in making the business case. Efforts should be taken to ensure the necessary systems are in place to allow for remote supervision - at least in the early stages of the energy utility’s scale-up.

6.6. APPROVED ASSET BASE

The BCUC is responsible for approving proposed capital and operating costs (approved asset base or rate base) for utilities within their governance which factors into the ROI calculation. In the case of the NEU there was mention of a rate base approval but there are no details of the process or the level of scrutiny.⁸⁷ The CoV’s construction tendering process may be sufficient to ensure competitive pricing but there is potential of moral hazard by a developer over-designing the system, in-turn inflating the capital cost. When there is a fixed ROE, the higher the capital cost, the higher the justification of the energy rate charge and the larger dollar value of return to shareholders. The advantage of inflating the approved asset base is obvious when the utility is private, however there is a unique situation when the utility is 100% municipally owned, as the recipient of the returns is the CoV. It is assumed that the utility’s retained earnings would go into general CoV revenue - inflating the capital cost will raise these retained earnings. Regardless of the use of the retained earnings, it is suggested that future municipally governed ICES projects consider a comprehensive rate base review process.

6.7. PROCUREMENT MODEL

The project schedule of the SEFC development was compressed due to the 2010 Winter Olympics. If a district energy utility was to be constructed for the SEFC community, it needed to be completed in an expedient manner – the project could not wait for a private developer to attain the necessary approvals from the BCUC.⁸⁸ Additionally the BCUC’s regulatory objectives are not the same as the CoV’s high priority objective of a low-carbon development. This contributed to the decision to procure the NEU under a traditional model of outsourcing the design and construction while financing, ownership and operations were provided by the CoV. If more time was available for the procurement process, the CoV may have considered procuring the project under an alternative procurement model (e.g. Design-Build, Design-Build-Finance, Design-Build-Finance-Operate-Maintain, etc.) with construction, finance, operating and performance risk in part allocated to parties best able to bear that risk. The heat pump performance risk, a highly specialized and expensive piece of equipment, was successfully transferred to the manufacturer - an example of effective project risk allocation.

6.8. RISK MANAGEMENT

As the CoV is the sole owner of the utility, all the risk of the utility is assumed by the CoV. As mentioned earlier, this includes initial construction risk, financing risk, operating risk, performance risk and demand risk. If an unforeseen event occurs, for example lower than expected development or occupancy, there will be no cash flow to cover the debt service and the utility could face insolvency. Under a private development model, first the dividends to shareholders would be suspended and then equity in the utility would be wiped out – this is a known and accepted risk by the utility’s shareholders. In the case of a municipally owned utility, the shareholders are the CoV’s taxpayers, who have indirectly given consent to City representatives to make the

87 City of Vancouver. (2009). Administrative Report (RTS No.7292), pg.7.

88 Colleen Kimmert. 2010. Vancouver Sustainable Energy. Retrieved at <http://www.bcbusinessonline.ca/bcb/top-stories/2010/05/05/vancouver-sustainable-energy?page=4&#featurelist>

decision to proceed with the project on their behalf by way of democratic election. In this case, the financially affected parties in the event of insolvency would be all CoV taxpayers, as an increase in energy rates to SEFC users to cover the shortfall would be far too excessive to bear alone.

It has been argued that the risk of one district energy project should be spread out over a larger base of district energy ratepayers in general – even if they are not physically connected. The rationale for this is that all district energy consumers, essentially early adopters both present and future, benefit from the knowledge gained during the construction and operation of these systems (in addition to the reduced energy consumption, environmental and social benefits). Therefore the idiosyncratic risk of one district energy project should not be borne by that project alone rather it should be spread over all district energy ratepayers so that a single failed project will not compromise the development of future ICES projects.⁸⁹

6.9. PROJECT DEVELOPMENT TEAM

Numerous departments within the CoV were responsible for the project including finance, legal, planning, engineering, and utilities. These departments' independent functions were eventually consolidated into a single NEU team responsible for the development of the utility. The formation of this combined project team streamlined the decision making process, reduced project timelines, and simplified the decision making process.⁹⁰

6.10. BUILDING DESIGN INTEGRATION

An integrated design process with Millennium Development Corporation and the CoV was essential to building a high-performance district energy and building heating system.⁹¹ The buildings' envelope, hydronic heating and cooling systems, and water design and return temperatures are critical to the district energy system's heat pump performance by reducing the peak demand, reducing overall energy consumption, and ensuring the system runs at an efficient operating point. An integrated design strategy with the building and utility developers from project inception will minimize the size and maximize the efficiency of the district energy system by reducing capital and operating costs.

7. CONCLUSION

The Southeast False Creek Neighbourhood Energy Utility in Vancouver is considered a successful ICES project from an economic, social and environmental perspective. The project's technical design and governance structure were well planned and executed and the NEU is a key piece of infrastructure that will contribute to meeting the Province's and City's climate change objectives along with meeting the two key objectives of the NEU – providing a reasonable ROI to the owner and competitive energy rates to users.

Building on the success of the project, the CoV is committed to expanding Integrated Community Energy Systems across the CoV.⁹² This case study should serve as a sound business model for other municipalities to reference and replicate.

89 John Turner, Director of Energy Solutions, FortisBC (personal communication, June 2011).

90 Retrieved at http://canmetenergy-canmetenergie.nrcan-rncan.gc.ca/eng/buildings_communities/communities/publications/false_creek.html

91 Observers have noted that the integrated design process could be improved upon as there was some debate as to whether the choice of a high-temperature vs. a low-temperature system was appropriate and if the same low temperature system infrastructure could have served dual purpose for cooling in the summer.

92 Retrieved at http://vancouver.ca/greencapital/pdf/VGC_FCEC_FactSheet.pdf