A District Energy Strategy for the City of Seattle: Background and Directions

Prepared for:
City of Seattle
Office of Sustainability and Environment

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Statement of Limitations

This strategy has been prepared by Compass Resource Management Ltd ("Compass") for the use and benefit of the City of Seattle ("Client") with respect to policy options to support modernization and expansion of district energy in Seattle. This strategy represents the best professional judgment of Compass, based on the information available at the time of its completion and as appropriate for the scope of work. Services were performed according to normal professional standards in a similar context and for a similar scope of work.

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Executive Summary

Long a center of green technology, the City of Seattle has adopted progressive policies for urban design, building standards, clean energy and climate change. The City has established aggressive climate protection and energy conservation goals, and is working towards a goal to be carbon neutral by 2050, defined as net zero greenhouse gas (GHG) emissions. To be successful, the City will need to develop and implement an aggressive and diversified approach that incorporates both innovation and best practices.

The City recognizes that district energy systems, with their capacity to provide buildings with efficient and affordable clean (low carbon) energy for space heating, domestic hot water and in some cases cooling, have proven to be an effective way to reducing GHG emissions in the right circumstances. There is also significant interest within the community for district energy solutions (Yesler Terrace, Interbay, University of Washington, and Capitol Hill). The City believes the expansion and development of district energy systems in some developments and neighborhoods of Seattle has the potential to be an important element of the City's carbon neutral strategy.

Seattle already has several district energy systems, including a large, privately held legacy system (Seattle Steam) serving the City's downtown core and First Hill neighborhood. This legacy system was instrumental to the rebuilding of Seattle after the Great Seattle Fire in 1889, and was also instrumental to the early development of the electric power infrastructure in Seattle through its early reliance on the production of combined heat and power. Seattle Steam has recently undertaken several initiatives to expand and modernize its legacy system including ongoing efficiency improvements in its generation and distribution systems, programs to support efficiency upgrades among its customers, and installation of a biomass plant to displace a large portion of its natural gas use. But there are challenges to Seattle Steam's further efforts to modernize its legacy system, in particular its plans to install a combined heat and power system and to begin the long-term process of introducing modern hot water distribution systems in Seattle.

There are other examples of missed opportunities for introducing or expanding district energy in Seattle. One notable example is the South Lake Union area of Seattle, where a 2004 study found that district energy could offer a viable opportunity to reduce both electrical load and GHG emissions. District energy was not implemented during the first few phases of redevelopment because of rapid development timelines, multiple decision makers, lack of understanding of full costs and benefits, lack of community vision and leadership, and lack of incentives as a result of existing utility rate structures and price levels. As a result, a large amount of new development proceeded with electric heating and cooling and today this area is experiencing significant local electric system constraints and reliability issues that will be costly to address and could hinder further development in this area.

District energy is a capital-intensive, long-lived and flexible infrastructure platform that provides both private and public benefits. Some broader and longer-term public benefits may include, among others, GHG reductions, local energy security, local economic development and overall quality of life.

The challenges faced by Seattle Steam and other missed opportunities for district energy such as South Lake Union have highlighted the need for more proactive City vision and coordination to assist with the modernization and expansion of clean district energy systems within strategic neighborhoods to support broader City objectives. City vision and leadership is particularly important given a current lack of consensus and trust within the community about the full costs and benefits of district energy, as well as specific alternative energy sources such as biomass. Current energy prices and utility incentive programs may also be promoting sub-optimal decisions from a broader and more long-term community perspective. And some City policies and plans may be working against the City's broader and more long-term objectives by increasing the costs of installing or upgrading district energy infrastructure.

In parallel with this study, the City's Office of Sustainability and the Environment (OSE) engaged AEI (Seattle) and COWI (Denmark) to screen the district energy potential in ten pre-selected neighborhoods in Seattle. The study involved analyzing thermal supply and demand, both existing and future, in order to develop a prioritized list of near-, medium-, and long-range opportunities for district energy in Seattle. The sites were selected based on development densities and potential sources for thermal energy. The project involved a high-level analysis and does not constitute a full feasibility analysis. In additional to high-level financial viability, the study also considered possible impact on GHG emissions. Four areas were identified as having high (near-term) promise: First Hill (including Yesler Terrace), Capitol Hill, University of Washington, and South Lake Union (incremental development). These represent areas with imminent potential and a need for City vision, leadership and planning support. This exercise was intended as a top-down screening of entire neighborhoods to support larger area visioning and planning exercises. It is not intended to preclude the development of smaller, stand-alone (at least initially) nodal district energy systems within the system (e.g., the Freehold Group's proposal for district energy in a sub-area in the northeast portion of the Interbay neighborhood).

The City recognizes it does not currently have the expertise to own and operate district energy systems. However, the City also acknowledges its energy policies (existing and absent) may impede the modernization, expansion, and implementation of district energy. The City also recognizes it has an important role to play in establishing and promoting a long-term community vision for district energy and coordinating among multiple public and private interests to achieve the potential community benefits of district energy. There are many examples and models of community leadership and support for district energy. Some highlighted in this report include District Energy St Paul (Minnesota), South East False Creek (Vancouver, BC), and South Hampton (UK).

This report outlines four sets of recommendations for moving district energy forward in Seattle to support the City's overarching objectives and vision for deep carbon reductions, local energy security and a vibrant economy:

1. **An Expanded and Formalized District Energy Interdepartmental Team (DE IDT):** Coordination amongst multiple City departments is critical to successful modernization and expansion of district energy in Seattle. The City should expand and formalize the DE IDT to oversee the remaining recommendations below.

2. **A Strategic District Energy Partnership for First Hill:** The City should seek a new retail district energy provider and establish a strategic public-private partnership for district energy

on First Hill. This initiative would provide a model for City vision and leadership in modernizing and expanding district energy, without requiring direct City ownership or operation of district energy. This model could eventually be expanded to other areas of the city as required. A partnership on First Hill would capitalize on the neighborhood's high existing thermal energy density (which includes three large hospitals), Seattle Steam's existing district energy infrastructure, and large potential for increased density, including the Seattle Housing Authority's proposed redevelopment of Yesler Terrace.

3. **Policy Reforms to Remove Barriers and Enhance Support for District Energy:** The City should undertake policy reforms to remove barriers or provide additional support to district energy systems that would meet broader and long-term City objectives. Key areas for policy reform include infrastructure costs, green building policies and assistance, utility policies and incentives, and a municipal bioenergy policy.

4. **Further Planning Studies in High-Priority Neighborhoods:** Further district energy feasibility work will need to be conducted with City leadership in the other priority neighborhoods of Capitol Hill, South Lake Union, and the University of Washington to confirm potential and establish a long-term vision, possibly in partnership with key stakeholders in each neighborhood.

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1. Introduction

Long a center of green technology, the City of Seattle has adopted progressive policies for urban design, building standards, clean energy and climate change. In particular, the City has established aggressive climate protection and energy conservation goals. More recently, the City has begun is working towards a goal to be carbon neutral by 2050, defined as net zero greenhouse gas (GHG) emissions. To be successful, the City will need to develop and implement an aggressive and diversified approach that incorporates both innovation and best practices.

Seattle's GHG emissions are produced from three main sources: transportation, buildings, and industry. At 62%, the transportation sector is the largest source of current GHG emissions. Energy use in Seattle's residential and commercial buildings is the second largest source (21%) of the City's current GHG emissions. Space heating and domestic hot water, in turn, make up a large portion of building energy use and associated emissions. Industrial operations and processes make up the remaining 17% of total GHG emissions in the City.

Increased efficiency in existing and new construction can lower building emissions, but achieving net zero GHG emissions in the building sector will ultimately require greater reliance on low-carbon sources of energy. In the case of heating, which accounts for a large share of building GHG emissions, there are a variety of potential low-carbon energy sources. To date, much of the City's policy has focused on building-scale options. However, there are many low-carbon heating sources that are not technically or economically viable at a building scale.[1] Good examples include co-generation and biofuel-based heat sources. There are also many sources of waste heat from industrial or other processes in Seattle that could be captured and used to supply buildings. These opportunities require district-scale heating systems.[2] District energy refers to infrastructure systems that supply multiple buildings from larger, neighborhood-scale heating (and sometimes cooling) plants via a network of steam and/or water distribution pipes. Attachment 1 provides a general primer on district energy.

The Office of Sustainability and Environment (OSE) recently commissioned a study to develop a scenario of how the city might be able to achieve carbon neutrality. The study considered all possible options of getting to carbon neutrality, without considering political or economic constraints. In the buildings sector, the study indicated that at least 50% of multifamily and commercial buildings would

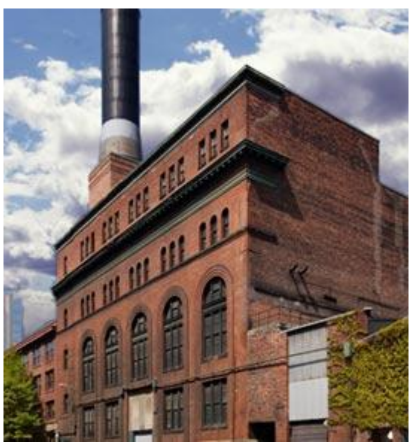
[1] In some cases, even where there are viable options at a building scale, there may be additional drivers that favor district energy. For example, district energy systems can help increase the efficiency of the electricity system through heat recovery at thermal power plants. Alternatively, district energy systems can reduce the cost and environmental impact of solid or liquid waste management through energy recovery in treatment and disposal processes.

[2] District-scale cooling is also possible but cooling represents a much smaller component of total building sector energy use and GHG emissions in Seattle. Give the lower number of cooling degree days in Seattle, there will be fewer locations where district cooling would be economically competitive with on-site solutions. Some exceptions may include sites with high density and commercial uses, large sources of "free cooling", high real estate values, and a demand for green roofs. Sites located in reasonable proximity to major bodies of water could utilize for deep water cooling. As shown in a recent study for the South Lake Union area, this can be a cost effective means of providing cooling to a district with sufficient density. In applications that can rely on 100% outside air and do not have high internal heat gains (such as occurs at hospital, medical labs, and data center), Seattle should be prioritizing passive cooling strategies (natural ventilation, shading, etc.) to meet occupant space comfort needs before considering active cooling approaches.

need to be served by on-site heat pumps or low-carbon district energy systems by 2050 in order to realize deep carbon reductions in this sector. The City is using this study as a resource for updating its climate action plan.

The City recognizes that district energy systems, with their capacity to provide buildings with efficient and affordable clean (low carbon) energy for space heating, domestic hot water and potentially cooling, have proven to be an effective way to reducing GHG emissions in the right circumstances. The City believes the expansion and development of district energy systems in some developments and neighborhoods of Seattle has the potential to be an important element of the City's carbon neutral strategy. Furthermore, the City recognizes that it must take a more proactive role going forward to realize the benefits of clean district energy systems for Seattle. This report discusses the history of district energy in Seattle, reviews some case studies of successful district energy initiatives in other cities, discusses some key opportunities and issues facing district energy in Seattle, and recommends strategies for advancing district energy in the city.

2. A History of District Energy in Seattle



Seattle's Existing Legacy Steam System

Seattle already has a large, privately held legacy district energy system. Founded in 1893 as the Seattle Steam Heat and Power Co., Seattle Steam now supplies steam to nearly 200 buildings in downtown Seattle and on First Hill for heating, domestic hot water, humidity control and sterilization purposes (Figure 1). These customers represent about 7% of the energy currently consumed by buildings in the City. The system was instrumental to the rebuilding of Seattle after the Great Seattle Fire in 1889. A steam engine simultaneously provided power for the new tram and heated 17 new fire-resistant buildings downtown. This combined approach to generating heat and power was essential to developing the early electric power industry.

Today, Seattle Steam`s system consists of two steam plants and approximately 18 miles of high and low pressure steam pipelines, ranging in age from 5 years to 110 years old. One steam plant is located on Western Avenue at Union Street, just west of the Pike Place Market. The other is located on Post Street at Yesler Way in Pioneer Square. The oldest infrastructure in the Seattle Steam system is generally located in the Pioneer Square neighborhood.

Many early district energy systems used steam distribution. There were several reasons for this. First, many systems were built to capture high-temperature waste heat from electric power stations. Second, many systems served industrial and other end use loads such as hospitals that had a direct need for steam. And finally many older buildings required relatively high supply temperatures for heating.

Today, there are fewer direct uses of steam in many city cores. Many hospitals still use steam for sterilization, but this need can also be met on-site through stand-alone steam sterilization systems and/or a growing range of alternative sterilization technologies. Few buildings still utilize steam directly for heating and could in theory be supplied with hot water, albeit older building may still require higher hot water supply temperatures than newer construction.

Given the reduction in steam end uses, there are several disadvantages of continuing to use steam as a distribution medium. First, there are typically higher heat losses in steam distribution systems. This was less of an issue when the source of energy was waste heat. But this can greatly reduce the efficiency advantages of district energy relative to distributed gas-fired boilers where the source of steam is also gas-fired boilers.

In the case of Seattle Steam, there is a second potential source of inefficiency. Seattle Steam's system is an open system. That is, the condensate produced when energy is extracted from the steam is not returned to the central plant. This has two implications. First, some energy is potentially lost to the sewer system. Second, the system requires a continuous input of water. The amount of energy rejected to sewer is in part a function of building system design and maintenance. With poor energy transfer, condensate may have a temperature as high as 140 degrees Fahrenheit, requiring the use of additional potable water to cool the condensate before discharging to sewer. Although different types and ages of buildings will vary in terms of the amount of energy they can ultimately extract from steam, cooling condensate with potable water is considered poor operating practice. Seattle Steam offers customers assistance to ensure customer energy transfer stations are kept in prime operating condition. In 2009, Seattle Steam, together with MacDonald-Miller Facility Solutions and the Washington State Housing Finance Commission, also developed a program to provide technical and financial assistance for Seattle Steam customers to improve overall building energy efficiency and utilization of steam energy.

Water use is a growing concern in the Seattle region. While the open nature of the steam system contributes to water demand, there are two offsetting factors that must also be taken into account. First, the highest rate of water use for district heating occurs during the peak heating season. Currently, summer water use poses the most financial and environmental concern for the region because of limits to storage and competing uses for water in summer and fall such as minimum stream flows. Second, condensate can be used for a wide range of on-site services prior to discharge to sewer, thereby offsetting other demands for potable water. Seattle Steam has several customers that use 100% of their condensate. Seattle Public Utility has for several years offered Seattle Steam's customers rebates on capital invested to recover and reuse condensate, a very successful program.[3]

A final disadvantage of legacy steam systems is they can only utilize high-grade sources of heat – e.g., gas-fired boilers, biomass and co-generation. In addition to these sources, modern hot water distribution systems are also able to integrate lower-grade energy sources such as solar thermal, geo-exchange and sewer heat recovery. In the case of combined heat and power (CHP), hot water distribution systems also allow the use of technologies with a higher ratio of electricity to heat output,

[3] Seattle Steam has indicated it is exploring some other supply-side strategies to reduce potable water consumption for the steam system and overall costs to its customers. One of the most promising is drilling a well on their Pike Place plant site and using this water to cover their base load needs. Seattle Steam may also be able to draw from the future daisy chain of proposed cisterns along the Seattle waterfront (if they are built) to cover their peak load.

which can improve economics and environmental performance compared with systems supplying high-grade steam heating.

While important, water and energy efficiency are not the only considerations when evaluating Seattle's existing legacy steam system. Carbon and capital efficiency are also important. Carbon efficiency refers to the carbon intensity of heat supplied. While on-site gas-fired boilers may be more energy efficient than centralized steam boilers, when taking into account distribution losses, the central system may allow the use of alternative fuels with lower carbon intensity than natural gas.

According to the City's latest GHG emission inventory from 2008, Seattle Steam accounted for 12.3% of total GHG emissions from Seattle's building sector. In 2010, Seattle Steam began commissioning a biomass boiler at its Western Avenue Plant to burn recovered urban wood waste. Based on current international carbon policy, which considers biomass fuels carbon neutral, Seattle Steam expects biomass will reduce carbon emissions of supply to existing customers by 50 - 60% per year on average.[4]

Seattle Steam has other strategies to reduce carbon emissions from its existing steam system. One is the addition of a CHP plant within its Post Street Station adjacent to Pioneer Square. Seattle Steam has received an $18.75 million grant for construction of the plant and is currently exploring options for selling the electricity from the plant, which could provide additional local security and other system benefits to the larger regional electricity grid.[5] The steam would be used to displace natural gas use in Seattle Steam's existing steam system. Electricity produced in a CHP plant has lower carbon emissions than electricity produced in a stand-alone gas-fired electricity plant because of additional heat recovery. These savings would likely be shared between the purchaser of electricity and Seattle Steam. Based on the proposed sizing and carbon sharing scheme, the addition of the CHP plant could reduce the GHG intensity of steam service to existing Seattle Steam customers by an additional 20% or more. Depending upon the type of CHP system implemented, the plant could also produce low-grade waste heat that could not be captured for use in Seattle Steam's existing steam system but could be used to supply a new hot water-based neighborhood.[6]

In addition to carbon efficiency, there is also the issue of capital efficiency. While a modern hot water system can reduce distribution losses and access additional sources of alternative energy, there are high capital costs (and potential traffic disruptions) associated with the installation of new infrastructure. The capital sunk in the existing steam system is both used and useful. Rather than abandoning outright the current system, an alternative strategy is to leverage the existing system as part of a long-term transition to modern hot water distribution systems. This is somewhat analogous to the experience with mass transit systems. In response to the rise of personal automobiles, many cities abandoned their mass

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4 The biomass plant commenced operation in 2010. The plant reduced Seattle Steam emissions by 6% in 2010. However, the plant is not yet fully commissioned and Seattle Steam is still expecting to displace 50 – 60% of historical gas use once the plant is fully commissioned.

5 A significant portion of SCL power comes from the east side of the Cascade Mountains. This power is subject to significant line losses, especially during peak hours. Generation in the load center could reduce line losses and also provide reactive power, increasing the benefits of local CHP. In addition, Seattle Steam has also suggested that electric steam boilers could also be added to the system to allow excess power from wind or hydro to be directed to thermal energy production to reduce spill and/or low-value power sales.

6 The City and Seattle Steam have identified other large sources of industrial waste heat within the City that could potentially be recovered and used to supply district energy systems, including Ash Grove Cement and Nucor Steel.

transit systems in favor of roads and limited transit systems based primarily around buses. Today, many of these cities are spending vast sums (with associated construction disruptions) to try and recreate mass transit systems. A smaller number of cities maintained mass transit systems and are now expending less to modernize those systems.

A long-term transition to hot water distribution represents a second element of Seattle Steam's vision for modernizing the existing steam, system. Specifically, Seattle Steam has proposed the introduction of hot water neighborhoods at the periphery of its existing distribution system supplied through a combination of larger steam to hot water converter stations (to interface with the existing steam supply) and supplemental new low-grade energy sources. These new systems could be owned by Seattle Steam or other entities, but would continue to leverage existing (sunk) assets to support ongoing efficiency improvements and the development of new alternative energy sources. Over time, it may be possible to expand hot water distribution upstream from these new neighborhoods (or as discussed below to develop a larger interconnected hot water distribution ring around Seattle). This is a common strategy in modernizing legacy steam systems. Copenhagen is a good example of this approach to legacy systems. But it requires a long-term vision to take advantage of opportunities for cost-effective modernization, together with ongoing load commitments to finance that modernization.

Figure 1: Existing Seattle Steam System

There are two other notable district (institutional) energy systems in operation in Seattle: Seattle Center and the University of Washington (central campus) both operate district energy systems. These systems provide cost-effective and efficient service but currently do not extend beyond their institutional boundaries. In addition, there may be opportunities to introduce alternative sources of energy into these existing and expanded systems. These systems are another example where partnerships may be essential for realizing the full benefits of district energy in Seattle.

Missed Opportunities

The history of district energy in Seattle is also one of missed opportunities. One notable example is the South Lake Union area of Seattle. In 2004, the U.S. Department of Energy, Seattle City Light (SCL), American Public Power Association, and Vulcan funded a comprehensive feasibility study for a hot water district energy system for the South Lake Union and Denny Triangle area.[7] At the time, the study predicted significant growth in electrical demand from new development in the area. District energy was found to offer a viable opportunity to reduce both electrical load and GHG emissions, utilizing a variety of technologies including bioenergy, co-generation and deep lake cooling.

A district energy system was not implemented. As a result, a large amount of new development proceeded with electric heating and cooling. Today, this area is experiencing significant local electric system constraints and reliability issues. These will require costly capacity additions and they potentially hinder further development, and in particular the ability to attract additional power sensitive users to the area such as high-tech, biotechnology and health care firms. There were several reasons a district energy system was not developed. These included rapid development timelines, multiple decision makers, lack of understanding of full costs and benefits, lack of community vision and leadership, and lack of incentives as a result of existing utility rate structures and price levels.

It is rarely economically feasible to convert buildings with electric resistance heating to district heating. However, the recent screening study described below has suggested there may still be an opportunity for developing district energy to serve substantial new loads planned in the South Lake Union and Denny Triangle area.

[7] *Energy District for South Lake Union / Denny Triangle – Phase 1 Feasibility Study Final Report.* Prepared by FVB Energy and Washington State University Energy Program. Prepared for Seattle City Light. February 19, 2004.

3. New Opportunities for District Energy in Seattle

In parallel with the policy analysis, OSE engaged AEI (Seattle) and COWI (Denmark) to screen the district energy potential in ten pre-selected neighborhoods in Seattle. The study involved analyzing thermal supply and demand, both existing and future, in order to develop a prioritized list of near-, medium-, and long-range opportunities for district energy in Seattle. The sites were selected based on development densities and potential sources for thermal energy. The project involved a high-level analysis and does not constitute a full feasibility analysis. In additional to high-level financial viability, the study also considered possible impact on GHG emissions. The screened sites included:

- Capitol Hill
- Interbay
- Mount Baker
- Northgate
- Seattle Center
- South Lake Union
- UW East Campus
- UW West Campus
- Yesler Terrace / First Hill
- Pioneer Square

Figure 2 summarizes the results of the neighborhood screenings. Four areas were identified as having high (near-term) promise: First Hill (including Yesler Terrace), Capitol Hill, University of Washington, and South Lake Union. High priority represents areas with imminent potential and a need for City vision, leadership and planning support. Some of the reasons these areas screened high include the following.

- *First Hill/Yesler Terrace:* This area already has district energy infrastructure. It also has among the highest existing development and energy densities in the city, as well as large probable future development, most notably Yesler Terrace, a large, contiguous proposed redevelopment being led by Seattle Housing Authority (SHA).

- *Capitol Hill:* This area has high existing density and probable future development. In addition, this district's existing buildings have a higher percentage of hydronic heating systems that could be connected to district energy.

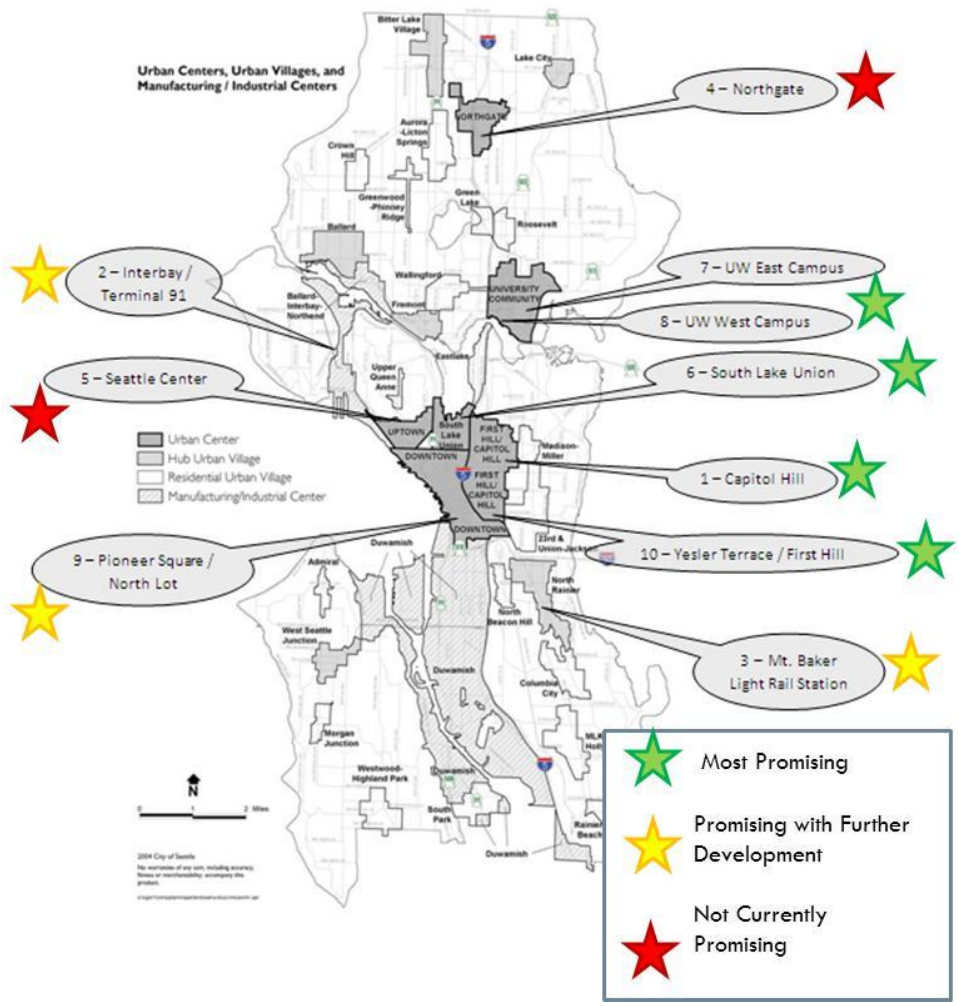
- *South Lake Union:* This area has a high projected density. The presence and recent history of Vulcan Development is a good indicator that this area will continue to grow at a rapid pace in the next five to ten years.

- *University of Washington:* The University of Washington (UW) has an existing district energy system that serves many of its own facilities. UW is actively exploring ways to modernize and expand this system. At the same time, there is some significant potential new growth around UW. There may be opportunities to leverage UW's existing system and future plans to serve a broader area. Realizing this opportunity will require some collaboration between UW and the City.

Figure 3 summarizes anticipated growth in these priority neighborhoods. As shown, total floor area in these neighborhoods could increase up to 40% by 2030.

Lower priority areas may have future potential with further development. Given their existing district energy infrastructure, their proximity to high priority areas and interesting waste heat sources (e.g., Ashgrove Cement), and other planned or required infrastructure upgrades, the Pioneer Square and South Downtown areas could present unique opportunities for district energy modernization and expansion in the future.[8]

Figure 2: Neighborhood Screening Results



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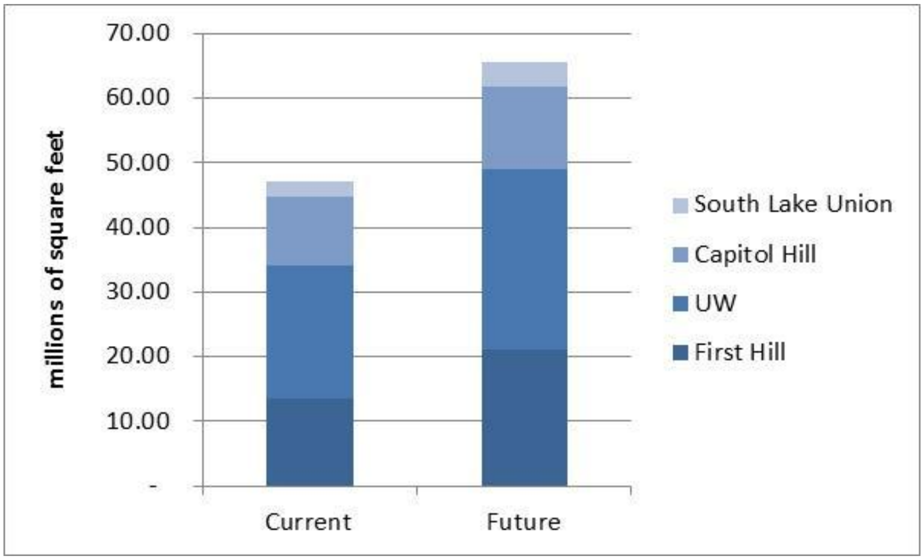
[8] A preliminary analysis of Seattle Steam's modernization strategy found that, in the absence of additional new loads, beginning a hot water modernization starting with Pioneer Square would be cost-prohibitive. Securing new load and beginning to modernize around First Hill could produce a more economical outcome.

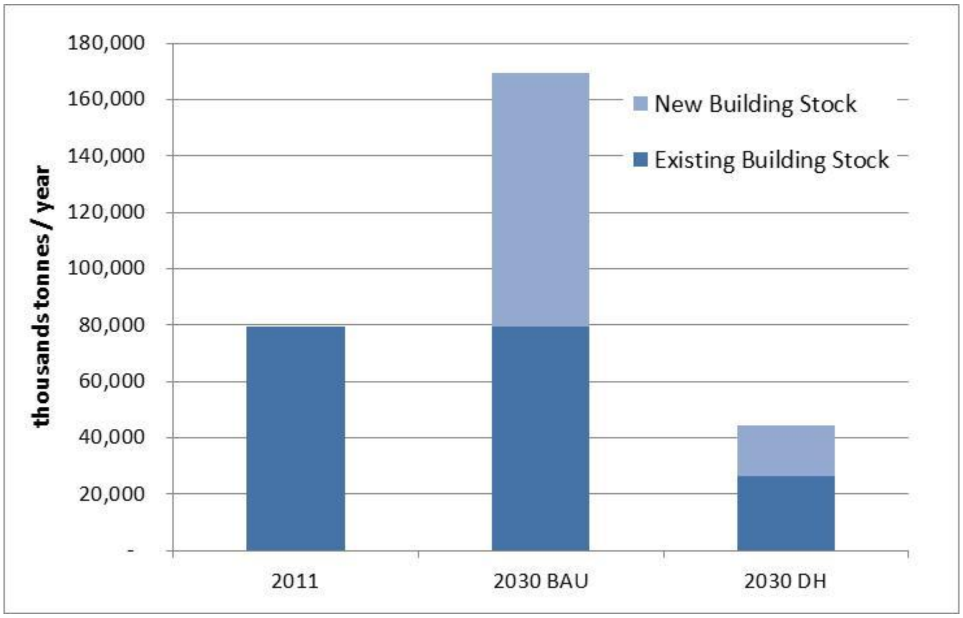
Figure 3: Anticipated Growth in High Priority Neighborhoods



It is also important to recognize this exercise was intended as a top-down screening of whole neighborhoods to support larger area visioning and planning exercises. It is not intended to preclude the development of smaller, stand-alone (at least initially) nodal district energy systems. A good example of the latter is the district energy system being proposed by Freehold Group for a sub-area in the northeast portion of the Interbay neighborhood. The broader Interbay neighborhood screened as lower priority because of the low heat density and variable (very nodal) future development plans.

Figure 4 illustrates the potential carbon reductions from implementation of district energy in the high priority neighborhoods. Existing emissions reflect existing building stock and average GHG emission factors for electricity. Future business as usual (BAU) emissions assume new construction has high building envelope efficiency and a similar mix of heating technologies as existing construction. Future emissions with district heating assume 100% of all new and compatible existing buildings are connected to district energy by 2030. Further, this scenario assumes marginal GHG emission factors for all reductions in electricity demand. For district energy, emission factors assume 30% of heating is met by natural gas while the remainder is met from a zero GHG alternative. This is a typical target for district new energy systems using alternative technologies, where about 70% of annual load can typically be supplied from a baseload plant. The district energy scenario is aggressive and may be considered an upper bookend for potential savings. As shown in Figure 4, under BAU heating approaches, GHG emissions from buildings in the priority neighborhoods could potentially double by 2030 with new development. In contrast, under the aggressive district scenario, GHG emissions in the prior neighborhoods could be reduced to nearly half of today's levels, even after factoring in new development.

Figure 4: Potential Carbon Reductions from District Energy Expansion in High Priority Neighborhoods*



* The 2011 and 2030 BAU emissions assume the hospitals on First Hill currently connected to Seattle Steam remain on district energy. If these hospitals were to convert to stand-alone natural gas boilers for their current loads, GHG emissions would increase roughly 9,000 tonnes (about 11%) given the projected contribution of biomass to Seattle Steam's energy supply and the zero GHG intensity currently attributed to biomass.

Interestingly, the high priority neighborhoods identified by AEI/COWI fit well with a larger, long-term vision recently put forward by Seattle Steam of a hot water "ring main" around the downtown core (Figure 5). This ring main could be developed in stages and eventually connect Pioneer Square, First Hill (possibly following the path of the First Hill Streetcar up Jackson Street around Yesler Terrace), South Lake Union, Denny Park, Seattle Center and Seattle's downtown waterfront. In addition to added distribution system reliability and efficiency, this approach would enable future conversion of appropriate existing steam customers along the path to hot water, and extensions from the main into new hot water neighborhoods (e.g., Yesler Terrace). This would also enable further development and sharing of low grade heat sources. Future extensions of this ring main north and south may also be possible, including a possible spur all the way to the University of Washington. Seattle Steam has proposed this as part of a community vision and does not necessarily propose owning or operating the ring main, or all of the individual neighborhoods that may be served by the ring main. But the ring main could interface with the existing steam systems of both Seattle Steam and Seattle Center, as well as new hot water systems along the route. Large steam or hot water transmission connections form an important part of the district energy infrastructure of many communities including Copenhagen and St. Paul, for example.

Figure 5: A Larger Vision for a Potential Hot Water Ring Main around Central Seattle

4. Two Case Studies of Successful District Energy Initiatives

Illustration of:

- *Modernization and expansion of a legacy system*
- *Value of strong political vision and community partnership*
- *Non-profit corporate structure*
- *Staged approach to development (adoption of alternative technologies and additional services over time)*
- *Biomass-based system using local wood waste*

St Paul, Minnesota

District Energy St Paul (DESP) started off as a demonstration project in 1983. The initiative was spearheaded by then Mayor George Latimer, who lobbied state and federal governments for assistance in replacing a former steam system with a modern hot water district energy system serving the downtown core. Established in part as a response to the oil crises of the 1970s, the system was designed to be energy efficient, provide local fuel flexibility, and secure stable rates for customers. It was developed through a public/private partnership among the City of St Paul, the State of Minnesota, the U.S. Department of Energy and the downtown business community.

The system started with high-efficiency fossil fuel heat. In 1993, DESP began offering district cooling service to downtown building owners. In 2003, DESP developed an affiliated combined heat and power (CHP) plant fueled by urban wood waste. Some excess biomass heat is used to provide renewable cooling via absorption chillers. The system also has thermal storage to reduce peak electricity demand for cooling.

Today, DESP is one of the largest biomass-fired systems in North America. Both the installed capacity and service area of DESP have grown steadily over time, and as of 2010, DESP has 289 MW of heating capacity and annual heat sales of over 300,000 MW.h. DESP heats approximately 185 buildings and 300 single-family homes (30 million square feet) and cools approximately 95 buildings (19 million square feet) in downtown St Paul and adjacent areas. DESP now serves twice as much building area as the former steam system it replaced while consuming the same amount of fuel. Rates have been relatively stable and generally below the cost of on-site natural gas heat production.

DESP was set up as a private, non-profit corporation, governed by a seven-member board. Three members are appointed by local government, three members are selected by customers, and the seventh member is selected by the other six. DESP has created several non-profit affiliated companies to develop and manage different aspects of the system, and to seek growth opportunities in other communities. District Cooling St Paul provides district cooling service to downtown St Paul building owners. Ever-Green Energy was formed to develop the biomass-fueled CHP and to manage the operations of DESP, its affiliates, and another St Paul district energy system. The company is also involved in a variety of projects outside St Paul related to renewable energy, biomass and deep water cooling. St Paul Cogeneration owns and operates the St Paul CHP plant. Environmental Wood Supply locates, collects, processes and hauls wood waste to the CHP facility. Renewable Energy Innovations, an affiliate of Ever-Green Energy, develops deep-water cooling renewable energy projects.

South East False Creek Neighborhood Energy Utility, Vancouver

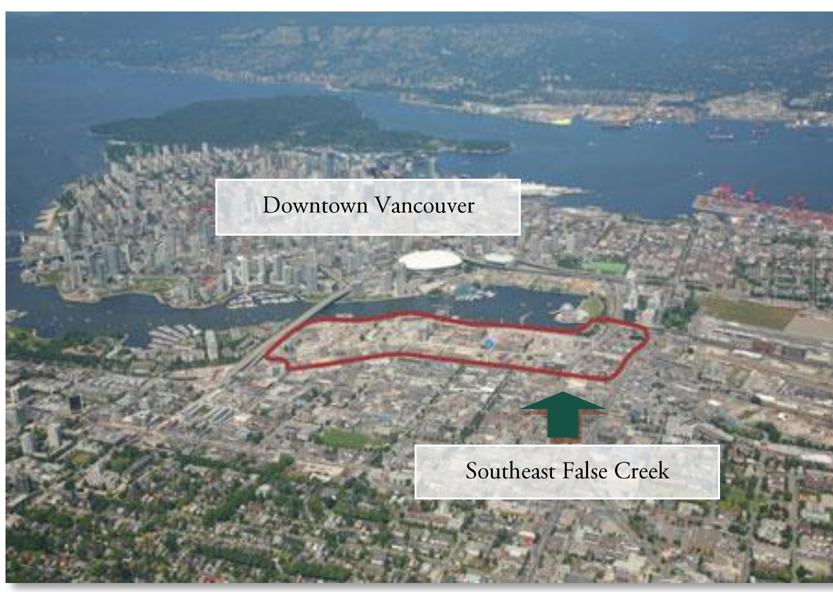
Southeast False Creek (SEFC) is an 80-acre waterfront industrial brownfield site near downtown Vancouver. In March 2005, Vancouver City Council approved an Official Development Plan for a sustainable, mixed-use community. SEFC will eventually contain about 6 million square feet of development. About 90% of floorspace will be residential with a population of approximately 16,000. A 15-year development timeframe is currently anticipated for the full site. Phase 1 of the development was home to the Athlete's Village for the Vancouver 2010 Winter Olympics (about 20% of the total anticipated floor area). The Village is being converted to a mix of market-rate and subsidized housing post-games.

Illustration of:

- *Development of a new modern district energy node*
- *Municipal leadership and ownership*
- *Commercial approach to rate setting*
- *Levelized approach to rates*
- *Heat recovery from municipal (sewer) infrastructure*
- *Net metering with individual solar domestic hot water systems on some buildings*

As one tool to achieve its sustainability goals, the City of Vancouver created the SEFC Neighborhood Energy Utility (SEFC NEU) to produce and distribute hot water for space heating and domestic hot water in buildings. There were three key goals for the creation of NEU: provide reliable, comfortable and cost-competitive thermal energy; lower GHG emissions; and reduce the use of high-quality energy (electricity) for the provision of low-grade space and hot water heating.

Figure 6: Southeast False Creek Official Development Area, Vancouver, BC

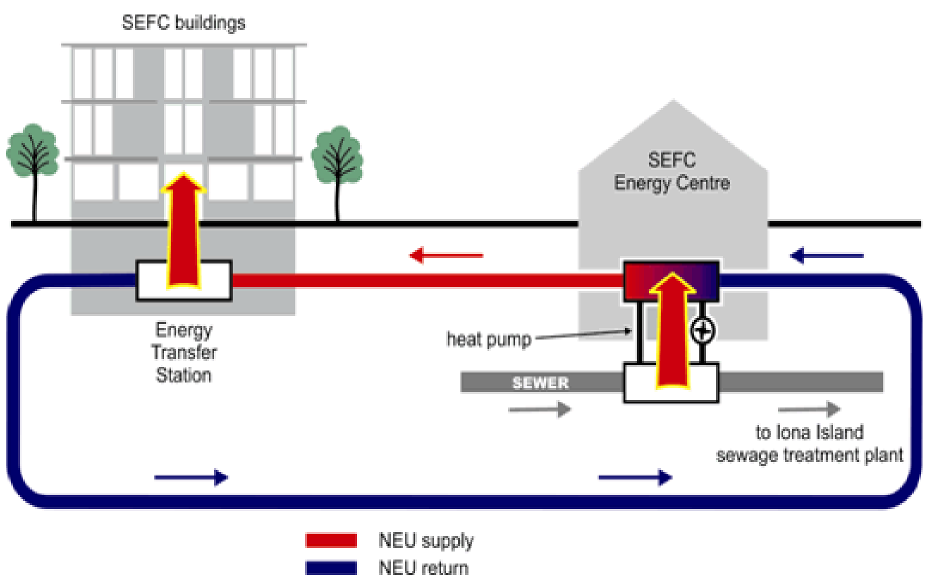


The SEFC NEU draws low-grade heat from the sewer system, and uses centralized heat pumps to provide high-grade heat to customers. The heat pump is sized to about 30% of peak demands but supplies 60 - 70% of annual energy requirements on average. Peaking and back-up is provided with natural gas boilers. There are only three other such systems in the world recovering heat directly from raw sewage on a large scale.

Energy Transfer Stations are capable of moving energy in both directions between the NEU and the customer-building system. In the first phase of development, three buildings have roof-top, solar-domestic hot water collectors that deliver energy not used by building to the NEU. Building owners receive a credit for this energy. This has allowed building owners to oversize their solar systems and to achieve effectively net zero energy on an annual basis more cheaply than if building-scaled systems were used with no net metering to balance seasonal imbalances in supply and demand.

The system began operating in early 2010, and is able to add additional capacity as further development takes place in Southeast False Creek. The system will provide approximately 64,000 MW.h of heat per year at build out. However, the City is already discussing voluntary connections by other loads outside the mandatory connection service area.

Figure 7: SEFC Sewage Heat Recovery System



The City chose to develop and own the system, given the Olympics timeline for completing Phase 1 and the tight integration with the City's new sewer pump station in the development. However, the City established a business model (e.g., used a notional capital structure and return comparable to a regulated private utility) that would allow it to divest itself of the system in the future.

The estimated total capital cost of the system will be $42 million by build out ($2010). The system is expected to generate a levelized total return of about 8% over 25 years, comparable to a regulated private district energy utility in British Columbia. A two-part tariff was established: a fixed monthly tariff per unit of building area to recover fixed costs (e.g., capital costs) and a variable tariff per unit of heat used to recover variable costs (e.g., fuel).

The City's rate policy seeks to recover all costs, including a commercial rate of return, subject to a soft rate cap that prices be no more than 10% above electricity rates. Electricity was used as the competitive benchmark for the business case because electric resistance heat is most prevalent in Vancouver, at least in the multi-family residential sector. Electricity rates are also projected to rise considerably in the next few years.

Under the levelized rate approach, the utility will operate with a revenue shortfall in early years, which will be made up with surpluses in later years, with the growth of loads and increase in electricity prices. A rate stabilization account was established to finance operating deficits in early years. The operating deficit reflects accounting costs and in fact is financed in part through deferral of items such as property taxes, corporate overheads, and return on equity.

The system is expected to reduce GHG emission by 6 to 8 kt/year (50 – 65%), relative to the business-as-usual approach to heating.[9]

5. Key Challenges for District Energy in Seattle

The following are examples of some key challenges for district energy in Seattle. They are not intended as exhaustive but represent some of key issues that will be addressed by the policy recommendations later in this report. Some of these issues are universal challenges for district energy. Others are unique to Seattle.

Community Vision, Coordination, and Trust

District energy represents a long-lived community infrastructure platform that provides both public and private benefits. Public benefits include long-term energy security, flexibility, economic development, and GHG reductions among others. At the same time, district energy, like virtually all sustainable technologies, tends to be characterized by higher capital costs but lower lifecycle costs than conventional technologies.[10] As such, long-term commitments are required to justify higher capital costs.[11] And district energy, as with many sustainable energy technologies, also exhibits economies of scale.

[9] There are different benchmarks for business-as-usual emissions and there is some uncertainty in the long-term efficiency of the heat pump system.

[10] District energy may in some cases have a comparable or lower overall capital intensity than other distributed alternative heating technologies (e.g., geoexchange systems) but because district energy is intended to serve a larger area, capital is typically more "lumpy" in nature – i.e., some infrastructure may be installed in advance of loads - creating some additional risks.

[11] Long-term commitments allow capital to be amortized over a longer timeframe (commensurate with the useful life of assets) and reduce financing costs. Both of these effects lower the cost of district energy (and other sustainable) solutions.

Simultaneous commitments by multiple customers will often be required to realize the benefits from economies of scale and long-term financing.

There are many examples of district energy systems without direct government support or involvement. However, the majority of these are legacy systems and/or systems that only serve a single-owner institution (e.g., universities and hospitals). The existence of campus systems is a testimony to the economic case for district energy, but these systems also highlight another challenge of creating, modernizing and/or expanding district energy systems within the community at large. Campus systems serve individual institutions with a common decision maker, an overarching campus vision, a long-term perspective, and a mix of financial and non-financial objectives. Other than large master-planned and developed communities, district energy systems outside of a campus context require some other mechanism to provide vision, direction and coordination among different decision makers. Cities are the logical choice for guiding and supporting the development of long-lived infrastructure with both public and private benefits. Seattle Steam has put forward a vision of district energy for Seattle but to date the City has not had its own explicit vision of or proactive support for district energy.

Unlike gas and electricity, in Seattle district energy is not directly regulated.[12] The assumption is that competitive pressure from other forms of heating provides a natural form of regulation. But this lack of regulation can also create challenges for district energy. For example, retail natural gas prices and to a lesser extent retail electricity prices can be very volatile.[13] When prices drop, even for a short period, new customers may be swayed from connecting to district energy and existing customers may seek alternatives, even though they may pay less on average under long-term expectations for average energy prices. This creates additional challenges and risks for modernizing and growing district energy systems. A lack of trust and understanding of district energy can exacerbate these issues.

Today's gas and electric grids would not have developed without government vision and support in many cases due to their high capital costs, economies of scale and natural monopoly features, at least in the early days of industry development. The case study on St. Paul in the previous section illustrates the value and impact of a community-wide vision and strong leadership in producing long-term community benefits from district energy.

Current Energy Prices and Incentives

The need for strong city vision and leadership in district energy is even more important in the context of current energy prices and incentives in Seattle. Natural gas prices are highly volatile. Current prices are low by historical standards (more than 50% below recent highs in real terms) but are expected to rise over the long term (Figure 8).[14] As discussed further below, long-term investment decisions should take

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[12] PSE is regulated by the Washington State Utilities and Transportation Commission (WUTC). As a municipally-owned utility, Seattle City Light is not regulated by the WUTC but City Council, although for certain activities it must still comply with the requirements of other regulatory agencies such as FERC.

[13] There are other challenges with the pricing of electricity that are discussed further below.

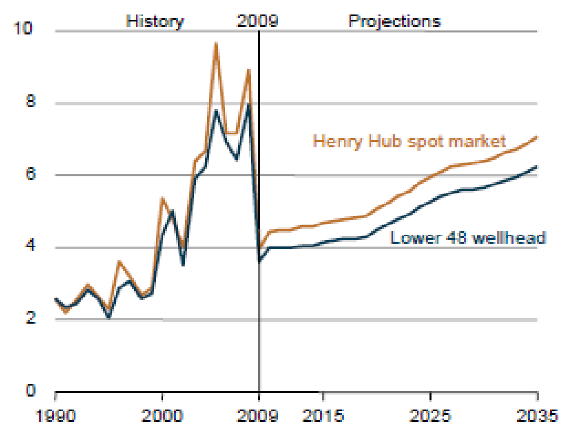
[14] Figure 8 shows two different indexes of commodity prices in real (2009) dollars. Regional natural gas markets in North America are highly integrated and tend to move in parallel, although absolute price levels will vary from hub to hub based on transportation costs. These prices do not include the cost of local delivery and so are lower than retail (delivered) rates to final customers, but they do reasonably depict the relative historical variations in delivered

a long view of energy prices but for many reasons may not adequately reflect these long-term price projects.

Seattle also enjoys relatively low electricity prices. However, current electricity prices reflect the average embedded (historical) cost of existing assets. They are not necessarily reflective of the higher marginal costs of new or replacement supplies and distribution assets. This poses a challenge for utilities and governments. Customers make individual consumption and investment decisions based on low historical costs but Seattle City Light must in turn invest in higher cost supplies and assets to serve growth and replace older assets over time. This is one of the rationales for paying customers to conserve energy. If rates do not reflect marginal costs, it may be cheaper in the long run to pay customers to reduce demand more than they normally would when they are considering only current rates.[15] These rates also influence customer fuel and technology selection decisions (e.g., electric resistance heat vs. natural gas heat vs. district energy), but as discussed further under recommendations below, conservation incentives may distort individual decisions because of constraints on funding fuel switching.

Finally, energy prices do not reflect possible future costs of carbon. Long-lived investments are being made assuming no future price on carbon. While carbon regulation is uncertain, communities with low-carbon and/or more flexible heating systems may experience additional competitive advantages if and when carbon regulation and pricing is formalized. Conversely, communities with access to low-carbon electricity may find that the value of those resources increases significantly with carbon regulation or pricing. With future monetization of carbon impacts Seattle City Light's hydro-based and carbon-free electrical supplies may prove to be much more valuable for sale in open markets rather than being used to meet local heating needs where cheaper alternatives exist to low-carbon heating.

Figure 8: Historical and Project Natural Gas Commodity Prices ($2009/ million Btu)



Source: The *Annual Energy Outlook 2011,* U.S. Energy Information Administration (EIA).

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prices of natural gas.

15 Other strategies may include regulations requiring more efficient appliances or building practices that are justified based on marginal costs of energy, or the introduction of stepped and time of use rates that send additional price signals to encourage more efficient consumption and investment decisions at the margin.

General Understanding of District Energy

Through the course of this project, issues surfaced with respect to customer and stakeholder perceptions of district energy. Two are highlighted here: costs and GHG emissions.

Sustainability requires decisions be made on the basis of full lifecycle costs. In their simplest form, lifecycle costs reflect both upfront capital costs and ongoing direct operations and maintenance costs.[16] Developers tend to be more sensitive to first (capital) costs. In theory this would normally result in some preference for district energy as this transfers the capital costs of energy systems to a district energy provider, who will install infrastructure and recover costs in ongoing rates. One exception is electric resistance heat, which can have lower capital costs than the hydronic systems required to connect to district energy. This is primarily an issue in multi-family residential construction where there is currently some preference for electric resistance heating within individual units. However, even in buildings with electric resistance heating, recent audits show a large amount of actual heating energy (in many cases in excess of half) still comes from natural gas.[17] In lifecycle analyses, it is important that the expected costs reflect likely fuel splits.

In addition to an accurate reflection of fuel splits, it is important that expected operating costs reflect a long-term perspective on energy prices. As noted in the previous section, current rates are not necessarily reflective of long-term prices over the life of a building. In addition, rates, in particular electricity rates, may not reflect the actual marginal costs of service.

There are also many misunderstandings concerning the pricing of district energy and how to compare it with alternatives. This study found examples of existing and potential customers of district energy comparing district energy rates solely with natural gas rates. This is not a full or direct comparison and can result in distorted (sub-optimal) decisions. District energy rates cover the cost of fuel, operations, maintenance and capital. To use natural gas for heating, customers must also purchase equipment to convert natural gas into useful heat. In the process there will be conversion losses to get the same amount of heat delivered by district energy. And over time customers must operate and maintain their equipment (or alternatively experience a reduction in efficiency over time and/or higher rate of replacement).

Figure 9 provides an illustration of the proper comparison of district energy with on-site options. The left column represents the average rate for a large customer of Seattle Steam.[18] The lower portion represents an average current rate based on usable heat (meter and fuel rate). The upper segment is an additional allowance for a higher fuel rate based on long-term levelized natural gas prices.[19] The right

[16] A more comprehensive perspective on lifecycle costs might reflect other societal costs and benefits not incurred directly by customers and/or with no explicit monetary value.

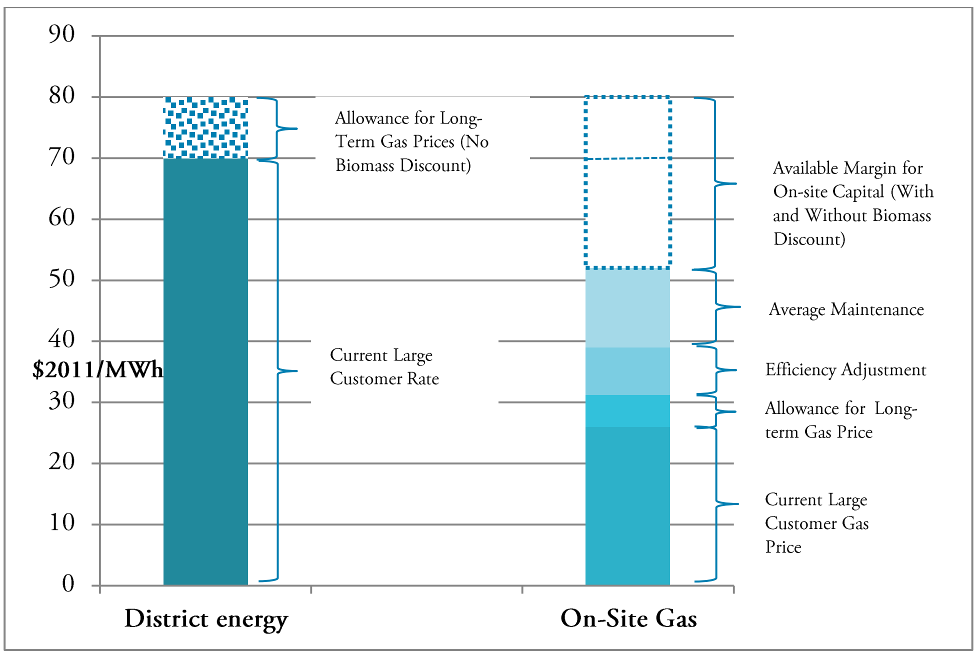
[17] *Multifamily Billing Analysis: New Mid-Rise Buildings in Seattle*. Final Report. 2009. Prepared for City of Seattle Department of Planning & Development. Prepared by Ecotope Inc.

[18] This is intended to be illustrative. Average Seattle Steam costs may vary across customer types and sizes. In addition, district energy rates may vary across systems.

[19] A levelized price converts a long-term price curve into a constant rate, taking into account the discount rate. It is a convenient and common tool for comparing different fuels and technologies. For the purposes of this exercise we assume a 10% discount rate. The long-term levelized cost of natural gas in this analysis assumes delivered natural gas prices rise about 33% (in real terms) from current lows over the next 20 years. This is still well below historical highs reached prior to collapse of natural gas market in 2008. For comparison purposes, all unit costs are shown on a dollars per MW.h basis. A current delivered natural gas price of $26/MW.h is equivalent to approximately $7.65/mmBtu or $7.62/dtherm.

column reflects the cost of supply for a similar unit of heat on-site. The lowest segment reflects current natural gas prices for a large commercial user. The next segment is an additional allowance for the same long-term natural levelized natural gas price forecast used in the Seattle Steam rate.[20] This long-term natural gas price curve is derived from forecasts from PSE. The next segment is an adjustment reflecting the conversion losses to produce a comparable unit of useful heat from natural gas. This analysis assumes an average conversion efficiency of 80%.[21] The final segment is an allowance for typical lifetime maintenance costs for gas-fired equipment. On-site fuel and maintenance costs represent only 65% of the district energy rate. The remaining margin is what would be available to pay for the capital costs of on-site equipment. Assuming a typical heating (space and domestic hot water) load of 5 – 10 kWh/sf, an average equipment life of 15 years and a discount (financing) rate of 10%, this margin would carry between $1 to $2 of upfront capital per sf. That is a very modest allowance for conventional heating equipment, and relatively low for alternative energy systems. This analysis does not take into account the potential effect of Seattle Steam's biomass discount for long-term contacts and the possible effect of future carbon taxes, which would affect district energy and on-site supply differently.

Figure 9: Illustration of District Energy Pricing vs. On-Site Supply Costs (Large Seattle Steam Customer)



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[20] Under Seattle Steam's discount for biomass in long-term contracts, rates would not increase under the forecast increase in natural gas prices used for this illustrative analysis.

[21] Although some new gas-fired equipment has efficiencies as high as 90%, that is the efficiency under optimal conditions. In normal operation, average annual efficiencies for equipment tends to be lower than the nameplate efficiency, reflecting partial loading conditions and long-term equipment degradation factors. Also, typical efficiencies vary across end uses (e.g., domestic hot water versus ventilation air).

There is a common perception in Seattle that electricity has low GHG emissions. While SCL relies largely on low-GHG sources and currently purchases offsets of residual emissions, existing SCL resources are largely committed.[22] Further, Seattle is part of a larger electricity market with a much higher average emission factor. At the margin, reductions in electricity use or growth in electricity demand within Seattle will free up low-GHG sources or advance higher GHG sources in regional markets. For evaluating conservation and alternative resources, the City uses a higher marginal emission factor for electricity to reflect this broader regional perspective. Both gas and electricity emission factors must also be adjusted to reflect the relative efficiency of technologies. There are also different perspectives on the GHG intensity of biomass fuel and the efficiency of the existing Seattle Steam system. Table 1 summarizes the emission factors of various fuels and heat produced with these fuels. For electricity, there is a range of heating GHG factors depending upon the specific conversion technology (e.g., resistance heating vs. heat pumps).

Table 1: GHG Emission Factors for Seattle (kg/MWh)

Source	Delivered Fuel GHG Factor	Heating GHG Factor
Electricity		
- Current	0	0
- Marginal	600*	600 (resistance heat) 200 (heat pumps)**
On-site Natural Gas	180	225**
Seattle Steam		
- Historical	254	254
- Future (with biomass plant)****	102	102

*Emission factor used by the City for planning purposes to assess the GHG benefits of
**Assumes an average COP of 3.
***Assumes average efficiency of 80%.
***Expected factor after full commissioning of biomass plant.

Installation Costs for Infrastructure in Seattle

Distribution piping represents a significant upfront cost for district energy systems. Seattle Steam has indicated that the unit cost of installing distribution piping in Seattle can be up to 50% higher than in other jurisdictions because of certain standards somewhat unique to Seattle for construction in public

[22] According to SCL's 2010 Integrated Resource Plan, before taking into account additional conservation plans, SCL requires new firm resources immediately. Planned conservation delays the need for additional firm resources until about 2020. However, SCL will require additional purchases of renewable energy or renewable energy credits (RECs) by 2016 to meet the requirements of I937. As district energy reduces electrical demand, and in particular electrical demand in the critical peak winter periods when SCL most needs supplemental electrical resources, district energy may contribute to the deferral of other conservation programs (which have a cost) or new resource requirements (including renewable energy requirements under I937).

right of ways. Some of the issues include requirements for police officers for traffic control, permit costs based on square footage, meter hood charges, requirements for full panel replacement of concrete surfaces, and minimum three foot depth requirements for piping infrastructure. Further reductions in installation costs may be possible through better coordination with other infrastructure upgrades. In addition to lowering costs, coordination can also greatly decrease inconvenience to residents from multiple, uncoordinated construction projects.

Consensus on Sustainability of Alternative Energy Sources

Based on international standards and perspectives on biomass energy, Seattle Steam invested nearly $25 million in a new biomass energy system to eventually displace nearly 60% of natural gas use in its system. The system is fueled primarily by "recovered urban wood waste" which includes wood shipping pallets and crate materials, wood recovered from local land clearing, woody debris residuals from local composting operations, and sawdust and wood trimmings from cabinet shops and sawmills.

During the permitting process for the plant, no public objections were raised. However, over the course of this study, several community stakeholders raised questions concerning the long-term sustainability and viability of biomass-fired district heating. Some existing and potential customers of Seattle Steam have also questioned the GHG benefits when evaluating ongoing supply or new connections.[23]

Given Seattle Steam's existing investment in bioenergy, new investments in bioenergy being considered by other institutional district energy owners such as University of Washington, and the growing emphasis on bioenergy in other district energy systems in the U.S. and internationally, it is important for the City to establish some community consensus and policies regarding the potential role of bioenergy in meeting community objectives. Bioenergy encompasses a wide range of technologies and fuels so it is important the vision and policies consider the full range of opportunities in order to provide guidance for investors and consumers.

[23] By convention, biomass has been widely classified as carbon-neutral, since trees regrow and absorb the carbon dioxide released by their combustion. But some scientists and advocates point out there can be a considerable delay between release of carbon from biomass energy production and new growth. The US Environmental Protection Agency's 2010 final rule determining which sources will be subject to GHG permitting requirements did not exempt biomass power, setting off some controversy. The Environmental Protection Agency is currently taking public input on how its climate regulations should treat carbon dioxide emissions from different types of biomass. Wood biomass continues to be a qualifying renewable resource under Washington state law. Washington State's I-937 classifies as a qualifying renewable resource "biomass energy based on animal waste or solid organic fuels from wood, forest, or field residues, or dedicated energy crops."

6. A Way Forward

A key objective for this study was to identify ways the City can be proactive in advancing district energy to support carbon reduction energy security and economic development goals, both from a policy perspective and implementation standpoint. Based on recent studies of options to meet Seattle's carbon reduction goals and the recent neighborhood screening study, the City recognizes that district energy represents a key strategy for realizing the City's carbon reduction goals. There is also significant interest within the community for district energy solutions (Yesler Terrace, Interbay, University of Washington, and Capitol Hill). The City recognizes it does not currently have the expertise to own and operate district energy systems. However, the City also acknowledges its energy policies (existing and absent) may impede the modernization, expansion, and implementation of district energy. The City also recognizes it has an important role to play in establishing and promoting a long-term community vision for district energy and coordinating among multiple public and private interests to achieve the potential community benefits of district energy.

There are four sets of recommendations for moving district energy forward in Seattle in order to support the City's overarching objectives and vision for deep carbon reductions, local energy security and a vibrant economy:

1. An Expanded and Formalized District Energy Interdepartmental Team
2. A Strategic District Energy Partnership for First Hill
3. Policy Reforms to Remove Barriers and Enhance Support for District Energy
4. Further Planning Studies in High-Priority Neighborhoods

These are described in detail below.

Recommendation #1: An Expanded and Formalized District Energy Interdepartmental Team

District energy is affected by multiple functions and departments within the City. Coordination within the City is critical to successful modernization and expansion of district energy and to support multiple City objectives. The City's Office of Sustainability and the Environment (OSE) created a District Energy Interdepartmental Team (DE IDT) to guide the initial district energy neighborhood screenings and policy development, with representatives from the Department of Planning and Development (DPD), Seattle City Light (SCL), Seattle Public Utilities (SPU) and the Central Budget Office (CBO). The first recommendation of this report is to expand the membership of the DE IDT and establish a clearer policy and implementation mandate for the DE IDT going forward. The expanded DE IDT would continue to be led by OSE and report to the Mayor (Figure 10). The work of the DE IDT would be guided by the following City objectives with respect to district energy:

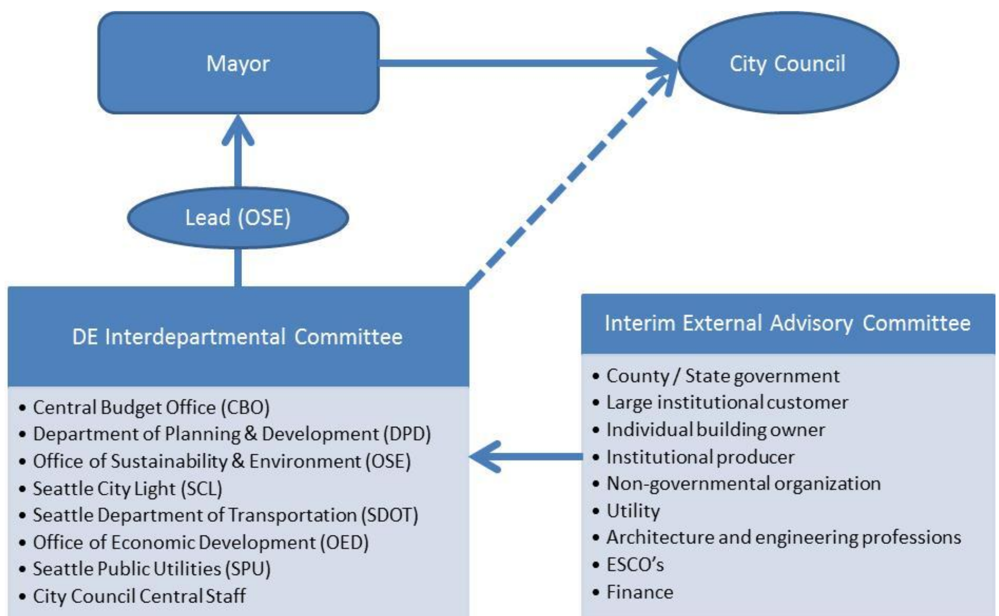
- Promote deep, long-term GHG reduction goals;
- Increase local energy security;
- Promote flexible and adaptable infrastructure platforms;

- Support local economic development; and
- Enhance solid and liquid waste management activities (e.g., through additional waste recovery).

Given the findings of this study and policy issues to be addressed, the membership of the DE IDT should be expanded to include at a minimum representatives from the City Council Central Staff, Seattle Department of Transportation (SDOT), and Office of Economic Development (OED). SDOT is important given the findings concerning the costs of installing infrastructure in Seattle and the possibility of coordinating district energy modernization and expansion efforts with transportation infrastructure projects such as the street care project. OED should be involved given the possible role of district energy in promoting local energy security and technology development, both important for economic development.

Initially, the DE IDT should focus on overseeing the other three recommendations in this report. In fulfilling its mandate, it is also recommended the DE IDT engage an interim external advisory committee composed of representatives from key stakeholders of district energy. The role of this committee would be to provide input on general policy reform. More focused and site-specific stakeholder committee will be required for some of the other initiatives, in particular the strategic partnership on First Hill and additional planning studies in high-priority neighborhoods.

Figure 10: DE Policy and Legislation Organization



Recommendation #2: A Strategic District Energy Partnership for First Hill

First Hill was identified in the screening study by AEI/COWI as one of the most promising areas for expansion of district energy in the City. First Hill has one of the highest current energy densities in the City. More than 40% of Seattle Steam's existing load is located on First Hill, including three large hospitals - Harborview, Swedish and Virginia Mason. In addition, significant new development is anticipated on First Hill. By 2030, housing supply is expected to grow by nearly 165% and employment by nearly 15%.

A large new redevelopment planned by the Seattle Housing Authority (SHA) at Yesler Terrace represents a particularly important opportunity for expanding and modernizing district energy on First Hill. Yesler Terrace could add 2 – 5 million square feet of new floor area to First Hill by 2030, up 50% of the floor area of the existing hospitals on First Hill. SHA has expressed interest in district energy as one tool for achieving high levels of environmental performance at Yesler Terrace. This development could be served via a local hot water distribution network, providing the first anchor for a larger hot water network on First Hill and beyond. A hot water network can reduce distribution losses and open up possibilities for integrating low-grade, low-carbon energy sources in the future such as solar thermal and waste heat, possibly including waste heat recovered from the nearby hospitals. At the same time, the existing steam system on First Hill represents a potentially cost-effective, low-carbon source of bridging, peaking and back-up supplies for any new development on First Hill. Over time, new development could in part be served through capacity freed up by ongoing efficiency upgrades among existing customers, reducing the costs of energy supply for all First Hill customers.

Energy decisions on First Hill also have significant implications for district energy supply elsewhere in the City, as well as the City's overall GHG reduction goals. Given their size, any changes in demand by the hospitals will affect costs for other customers of Seattle Steam. Based on Seattle Steam's projected emission factor (with biomass) switching from district energy and relying instead on 100% gas-fired heat in the hospitals would increase their GHG emissions on First Hill by as much as 12,000 tonnes per year. First Hill is also adjacent to Capitol Hill, which was identified as another promising area for district energy given density, retrofit potential among existing building stock, and anticipated new development.

By all accounts, First Hill is a strategically important neighborhood for district energy within Seattle. Stakeholders on First Hill have expressed support for a new type of district energy partnership to achieve a long-term district energy vision that balances financial, environmental and social objectives. The City has an important role to play in this partnership. In particular, City involvement is required to:

- Coordinate interests / perspectives among different stakeholders;
- Support a common district energy vision / plan for First Hill;
- Ensure community objectives for GHG and other outcomes are met;
- Support modernization and expansion of district energy; and
- Increase transparency / credibility of district energy services.

At the same time, the City does not currently have the desire or expertise to own and operate district energy systems. A strategic community partnership model is proposed based on similar models in the

UK that would ensure a strong role for the City in maintaining and expanding district energy on First Hill, without requiring direct ownership or operation support. An overview of several UK examples is provided in Attachment 1.

The partnership would involve a new retail district energy provider on First Hill (Figure 11).[24] Under the proposed partnership model, the City would lead the search for and selection of the provider, and establish a Joint Cooperation Agreement (JCA) with this new provider. The JCA would outline the objectives, roles and responsibilities of the City and the partner (retail provider). The details of the JCA would be developed through negotiations with the selected retail provider and in consultation with key stakeholders. In general, it is contemplated the new provider would take over responsibility for existing Seattle Steam customers on First Hill, as well as all new district energy customers on First Hill, including Yesler Terrace. This would include expanded distribution (primarily hot water distribution extensions), new local energy supplies, and could also include assistance with efficiency upgrades at the hospitals, which could be funded in part through reallocation of freed up energy supply to new development. The new retail provider would also be responsible for working with the three hospitals to develop a joint strategy for meeting their unique reliability needs.[25]

This partnership could be implemented under powers granted by existing statutes in Washington, in particular Chapter 35.97 RCW: Heating systems. Enacted in 1983, Chapter 35.97 RCW authorizes a municipality (including counties, cities, towns, port districts and water-sewer districts) "to establish heating systems and supply heating services" through a municipal heating utility through an ordinance or resolution, without any public hearing or vote. Once established, there are a variety of ownership structures possible, from full municipal ownership to a public-private partnership to a full contracting out model. Further analysis will be required to determine whether this statute is necessary or useful to assist in the creation of the proposed partnership.

One of the principles for the partnership should be to minimize stranded investment and leverage existing district energy infrastructure on First Hill. Seattle Steam would continue to supply First Hill under a wholesale agreement with the new retail provider. Together, the new retail provider and Seattle Steam would develop a long-term strategy for leveraging Seattle Steam's existing infrastructure to support growth on First Hill. The new provider would be responsible for expansions of district energy infrastructure on First Hill, which would involve mostly hot water systems and could include incremental alternative energy sources over time. It is anticipated the arrangement would be run under

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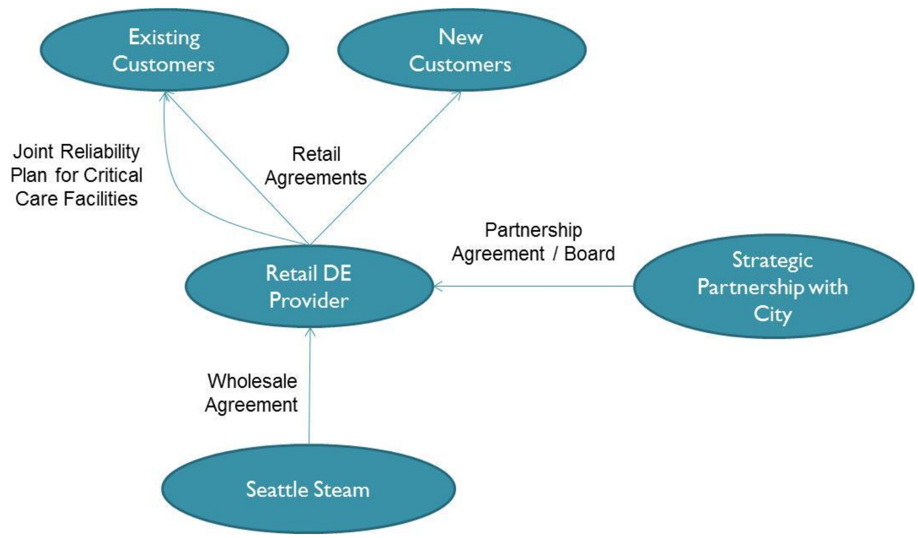
[24] The exact boundaries of the partnership should be developed during the solicitation phase by would likely include all Seattle Steam's current service area and customers east of I5.

[25] All three hospitals provide essential regional services and must be able to continue operating in a major seismic event or other emergency. Harborview is the only Level I adult and pediatric trauma center in Washington, Alaska, Montana and Idaho. The hospitals have expressed some concerns about the reliability of current steam supply in a major seismic event. Concerns should be weighed against the cost and reliability of alternative or supplemental reliability strategies. Given their proximity and reliance on similar infrastructure, a joint reliability plan for the hospitals is likely to offer higher security at lower cost than individual plans and strategies. Clear measures of reliability should be developed for such a planning exercise, including inputs like susceptibility of supplies; redundancy and back-up characteristics and diversity, as well as outcomes such as probability and duration of outages (or duration hospitals could operate in the event of longer regional outages). The Seattle Fault Scenarios, developed in 2005 with funding from Earthquake Engineering Research Institute (EERI) and Federal Emergency Management Agency (FEMA), provide a unique backdrop for evaluating the robustness of different supply scenarios in the event of a major earthquake (http://www.eeri.org/site/projects/eq-scenarios/seattle-fault).

an "open books" model, similar to regulated utilities.[26] Initially, there would likely be limited changes in assets, operation or pricing on First Hill. But it is anticipated that over time there would be cost savings to existing customers as a result of growth on First Hill, and opportunities to integrate new distribution assets and local (low-grade) resources owned and operated by the new retail provider.

Figure 11: Strategic Partnership for First Hill



In the UK examples, the scheme is governed by a Strategic Partnership Board (SBP), chaired by an Executive Director within the City. The SBP consists of members from City departments and the partner. It could also include representatives from major customers or customer groups. The Board would likely report to Council. In the UK examples, a technical committee composed of City and partner representatives was also established for strategic direction and land use and infrastructure co-ordination. The technical committee could be a sub-set of the Strategic Project Board and would meet more frequently than the Board. Typical tasks could include:

- Identifying potential new customers;
- Communicating future land use and infrastructure plans;
- Discuss and assess capacity expansion and/or required refurbishing (the original borehole and pumps are currently being refurbished); and
- Assessing distribution piping layout routing, among other technical tasks.

Some possible roles for the City in the strategic partnership include:

- Developing and promoting a common, neighborhood-wide vision for district energy;

[26] Under an open books approach, the terms, conditions and pricing of any negotiated wholesale service arrangements with Seattle Steam would be transparent but Seattle Steam would not be directly regulated.

- Granting a retail franchise;
- Providing access to resources and land as required;
- Coordinating infrastructure development to support cost-effective district energy development;
- Developing taxation and other policies to support district energy;
- Marketing support / relationship management;
- Ensuring consideration of environmental and social priorities in long-term district energy expansion and supply decisions;
- Committing to connection of City-owned buildings and City-led developments; and
- Funnelling grants and other financing support to reduce the costs of district energy and alternative energy supplies.

The JCA could include provisions for future equity participation or acquisition of the retail provider by the City. If successful, the partnership could eventually be expanded to other neighborhoods within the City where district energy is given a high priority. Given upfront development time and costs, as well as potential efficiencies for the City and retail provider, it is not recommended that the City pursue multiple partners or partnership models at this time.[27]

A smaller partnership development team within the IDT should be tasked with the search and selection process for a partner, as well as negotiating a Joint Cooperation Agreement and any other definitive agreements required with the City to enable the strategic partnership. This team would report to the IDT and Council at key milestones, and would also be responsible for consultations with key stakeholders throughout the process including, among others, the hospitals, SHA, Seattle Steam, King County (owner of Harborview), and University of Washington (manager of Harborview and responsible for capital planning and budgets).

The retail provider should be selected through a competitive process. The first step would be for the City to develop a Request for Expressions of Interest (RFEOI) from the private sector. The RFEOI should be developed in consultation with internal and external stakeholders. The RFEOI should provide background on the nature of the opportunity and the general vision for the partnership. The vision should provide specificity while allowing room for negotiation and creative approaches brought forward by the selected proponent. Reference to other potential opportunities within the City should be included in the RFEOI to stimulate sufficient interest. There is no preconception at this point as to the preferred technology that would be used to meet future heating demands, other than the expectation that Seattle Steam would continue as the initial wholesale provider. Part of the criteria for evaluating the respondents should be that they are technology neutral, and can demonstrate experience working with multiple types of energy sources based on a business case that takes into account the unique and evolving situation on First Hill.

The RFEOI should also outline requirements for submissions. Evaluation criteria should be established by the partnership development team but could include, among others:

- Understanding of and alignment with City and stakeholder objectives for First Hill;

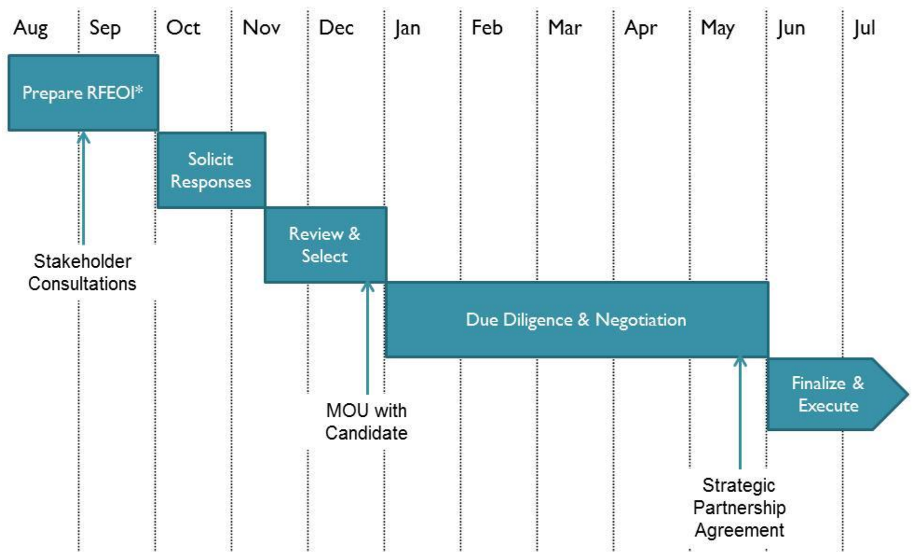
[27] For example, this partnership could be expanded to the proposed district energy system for Interbay being proposed by the Freehold Group. More due diligence will be required on that proposal and the partner selected by the City could be engaged to assist with that due diligence if the City considers this a priority.

- Management and financial capacity (to finance growth);
- Relevant expertise and experience;
- Openness to creative district energy approaches and solutions; and
- Ability to work with key stakeholders (including hospitals and Seattle Steam).

The successful proponent could be a single company or consortium, provided it meets the requirements of the City.

Following a short-listing and interview process, the City should select a single proponent to enter into detailed due diligence and negotiations. This is necessary given the cost and complexity of the exercise. The negotiations should be guided by an MOU including principles, timelines and responsibilities, as well as ownership of any intellectual property developed during the due diligence and negotiation phases. The MOU should also include provisions to be followed in the event an agreement cannot be reached, at which point the City may enter negotiations with another short-listed candidate. The main outcome of the MOU stage would be a full JCA. The JCA may include other conditions that must be met before coming into force, such as retail agreements with existing customers and wholesale arrangements with Seattle Steam. A tentative timeline for partnership development is provided in Figure 12. This is for illustrative purposes and should be refined by the implementation team.

Figure 12: Tentative Timeline for First Hill DE Partnership Development



* Request for Expressions of Interest

Recommendation #3: Policy Reforms to Remove Barriers and Enhance Support for District Energy

Through this study four higher priority areas for City policy reform and development were identified.

A. Infrastructure Costs

As noted above, there is evidence that certain City standards for the installation of infrastructure in public rights of way may be contributing to higher costs for district energy infrastructure compared to costs observed in other communities. Seattle Steam and other parties have highlighted some key issues together with possible solutions (Table 2). The City should consider how these policies could be modified, without compromising public safety, to reduce infrastructure costs, thereby increase the viability of district energy and support other community objectives.

Table 2: Issues Driving Higher District Energy Infrastructure Costs in Seattle

Issue	Possible Solution
Require officer for traffic control	Permit use of qualified flaggers
Permit costs based on square footage	Blanket permit charge
Full panel replacement	Waive or share cost with City
Waterfront trolley	Deactivate overhead lines if operational during construction
Three foot minimum depth	Waive
Meter hood charges at daily rates	Reduced weekly / monthly rate

In addition to installation standards, there may also be opportunities to reduce the costs of district energy infrastructure through better coordination with other infrastructure projects. This would have the added benefit of reducing public inconvenience associated with multiple, uncoordinated infrastructure projects.

In addressing this recommendation, it will be important to build on relevant past and current initiatives. In the 2009, the City looked at sweeping systemic changes that should be made to capital budgeting processes to encourage more holistic thinking and planning.[28] The goals were to save money and/or

[28] *Sustainable Infrastructure Initiative: Interdepartmental Planning for Better Capital Projects.* Prepared by City of Seattle Department of Planning and Development, Gibson Economics, and CollinsWoerman NEXT. Funded by the City of Seattle and The Washington State Department of Community Trade and Economic Development. June 30, 2009.

achieve greater environmental/public benefits by thinking strategically about integrated solutions that could address a multitude of individual challenges, as identified by different departments. By April 2010, the City decided to focus on identifying two target locations within the City where it could find appropriate pilot projects to demonstrate the value of a sustainable infrastructure planning approach. By looking at the number/type of potential capital projects on the horizon, and the alignment with other ongoing planning efforts, the City decided to work within the two neighborhoods that were also the focus of its parallel Neighborhood Planning Process.

In June 2010, the City laid out a two and a half year roadmap to identify opportunities for cost savings through better coordination within the two targeted neighborhoods, and then use these successes to demonstrate the broader applicability of this approach. The Sustainable Infrastructure IDT working on this has since reached the conclusion that there are limited opportunities within the two neighborhoods that were being considered. This initiative has now begun to evolve away from coordination within the neighborhood planning areas back to exploring opportunities for improving city-wide infrastructure coordination.

The technical steering committee proposed as part of the strategic district energy partnership for First Hill may provide a new opportunity to test neighborhood-specific coordination of infrastructure development, in addition to City-wide strategies.

B. Green Building Policy and Assistance

Green building policies and assistance can have a large impact on district energy viability or desirability. The City should review current and future green building policies and technical assistance programs to ensure they provide proper consideration of and credit for district energy solutions and remove any unintended disincentives for district energy. As noted below, issues created by reliance on LEED in building policies may require particular attention in this review.

This review may initially involve several internal workshops involving staff responsible for green building policy and the broader DE IDT. The purpose of these initial and ongoing reviews is not to promote district energy for its own sake, but rather to ensure district energy where it achieves clearly stated environmental and efficiency gains, as well as other community objectives better than other solutions. As noted throughout this report, these policies need to consider both short- and long-term perspectives, consider both the robustness and risks of different policies, and balance multiple community objectives (energy efficiency vs. carbon reductions vs. economic development, etc.)

There are three issues that should receive higher priority in this review by the City.

- Show leadership by developing policies and processes that will ensure all municipal buildings connect to district energy systems when district energy is viable, available, and balances City objectives.

- Develop policies and regulations that require or encourage hydronic heating systems that are compatible with district energy in neighborhoods that have existing district energy systems and/or high potential for district energy development. Hydronic heating systems provide the maximum flexibility for integrating alternative energy sources now or in the future, whether using on-site systems, such as solar thermal or geoexchange systems, or district energy systems. Developers tend to place greater weight on first costs (upfront capital costs) rather than lifecycle costs (capital and lifetime operations and maintenance costs). This creates some bias towards electric resistance heating, even where this would have higher lifecycle costs for consumers. In addition, electricity prices in Seattle do not reflect the marginal costs of new, green electricity supplies and so lifecycle costs from a customer perspective may not reflect lifecycle costs of electric heat from a utility or societal perspective. For these reasons, policies and regulations that would discourage electric resistance heat and encourage hydronic heating systems represent an important strategy to promote long-term energy flexibility and better opportunities for district energy where this makes sense.

- Develop tools and support for building owners to properly assess the costs and benefits of connecting to district energy. As noted above, there are many different conceptions among developers and consumers of the lifecycle costs of district energy and the relative environmental performance of on-site vs. district energy systems. Similar to the kind of support the City provides building owners in assessing efficiency opportunities, the City could be a source of credible facts and methods to support better lifecycle analysis of energy supply decisions. These could include providing defensible methods and tools for conducting a proper lifecycle evaluation; providing guidance on key input assumptions such as current and future fuel prices, GHG emission factors, equipment performance, fuel splits and avoided capital or maintenance costs; and providing examples and case studies of credible lifecycle analyses of district energy connections.

In reviewing building policies there is one issue that may receive some special attention by the City. Most building regulations and policies focus on individual building strategies. With district energy there is an emphasis on potentially larger and more broadly penetrating neighborhood-scale solutions. However, these larger, district-scale solutions may require some short-term bridging strategies that could conflict with building-focused policies and regulations, and with the short-term perspective and drivers of individual developers and building efficiency providers. For example, when establishing new district energy systems and/or modernizing existing systems, the investment in alternatives may be deferred until loads reach sufficient threshold to reduce the costs and risks associated with a larger alternative energy solution.[29] In the interim, initial buildings may be supplied entirely by natural gas boilers. In some cases, temporary boilers may even be used to supply individual building sites or clusters until it is cost-effective and convenient to connect these buildings to a larger distribution network and central plant. Once an alternative energy solution is implemented, the natural gas boilers that were installed first will continue to supply necessary peaking and back-up services.[30] In the absence of large grants and

[29] Most alternative energy sources are characterized by higher capital costs and lower operating costs. In order to reduce long-term costs, the ideal sizing and timing of these capital-intensive energy sources would result in maximum utilization as early as possible.

[30] These issues are discussed further in the backgrounder on district energy that is attached to this report. Briefly, whether they use alternative energy sources or not, virtually all district energy systems will typically rely on natural gas boilers for peaking and for back-up. Natural gas is typically more cost-effective for peaking because of the very peaky nature of heating demands and high capital costs of alternative energy sources. An alternative energy system sized to one third of peak demand could provide 70 – 80% of annual heating requirements. On-site alternative

other drivers (e.g., opportunities to coordinate with other infrastructure projects) this is often the most cost-effective and least risky strategy for establishing and growing a new district energy system.

The LEED rating system is a good example of a system that may in some cases have some conflicts with a long-term vision for more lasting, district-scale solutions. In recent years, the U.S. Green Building Council has updated its LEED rating system to take into account district energy when calculating LEED points. However, LEED points are still awarded based on energy efficiency and sources at the time of building commissioning. No points are awarded for buildings that serve as anchors to a larger, more lasting district-scale infrastructure solution. In fact, there is an incentive for developers to gain points by pursing sub-optimal strategies that may affect the business case for a more optimal long-term solution.

Since LEED is used as the basis for many of the City's green building policies, such as Priority Green Permitting and the proposed new Sustainable Building Policy, any new district energy policies considered must be sensitive to how the desire to meet long-term sustainability goals will impact the programs which currently use LEED as a criterion for measuring performance.

C. Utility Policies and Incentives

There are several potential barriers or disincentives to district energy created by existing SCL policies and incentives. Some of these may require changes to state legislation or policy.[31]

1) Financial incentives for conservation

SCL offers financial incentives for the installation of equipment and controls that go beyond energy code requirements. These include incentives for more efficient HVAC equipment such as heat pumps (versus electric resistance). Incentives are based on electricity savings. Currently SCL offers customers incentives of 20 to 23 cents per kWh saved for the installation of heat pumps. SCL does not currently offer explicit incentives for buildings to connect to district heating or incentives for providers of district heating that utilize centralized heat pumps (similar to the sewer heat recovery system in the Southeast False Creek neighborhood of Vancouver).

Part of the challenge is that the Washington State Constitution does not allow utilities to lend credit for switching from one fuel source to another.[32] District energy could in some

heating systems such as geoexchange will also typically use gas boilers to optimize capital costs. The exact sizing of gas-fired peaking in district energy systems will vary depending upon the mix of demands and type of alternative energy supply. In new systems, it is often cheaper to install the peaking and back-up boilers first and then install the alternative energy system once connected loads reach an optimal threshold. Alternative energy sources may be installed earlier at higher cost or risk. Temporary boilers may be purchased or leased during the initial set up phases (either at individual building sites or collections of sites). In either case, the district energy provider will typically be responsible for these and not developers. If located on-site, temporary boilers are typically housed outside a building. No permanent on-site equipment or redundancy is typically expected in a district energy system.

[31] The emphasis in this section is on policies and utilities more directly under the influence of the City.

[32] Article 8, Section 10 states: "Any financing for energy conservation authorized by this article shall only be used for

situations be constructed as fuel switching. However, as noted above some district energy systems could in fact be based on heat pumps with the only difference that heat pumps are centralized. In these cases, an SCL incentive for district energy may not be contrary to the State Constitution. This should be further explored by the City and SCL. In these cases, an additional issue for SCL is whether the incentive should be paid to the customer connecting the district energy system or the district energy provider.

In the case of district energy systems that use other fuels (e.g., biomass), any incentive from SCL may be construed as fuel switching. In these cases, under current laws SCL may not be able to offer an incentive for district energy. However, the City and SCL should still consider the possibility that incentives paid to customers for on-site heat pumps could result in a sub-optimal outcome. One option would be to introduce an additional test to determine if district energy would be competitive with the customer BAU without the SCL incentive. In these cases, SCL may simply choose not to offer an incentive for on-site heat pumps. In cases where district energy is not competitive with the customer BAU, SCL could continue to offer incentives to customers for heat pumps or other options that would reduce electricity consumption further from the customer BAU.

This raises a common challenge with utility incentives: how is the BAU case defined? In the case of new construction, SCL must make some assumption about what the customer would have done without the incentive. Developers obviously have a natural motivation to select a BAU case that maximizes electricity use in order to maximize the magnitude of the incentive they could receive. Some standards need to be applied to evaluating these situations. As noted above, an economic test of the customer's BAU case may be used to determine if an incentive is in fact warranted or justified. In addition, some benchmarks should be used in evaluating the magnitude of potential electricity savings. For example, recent evaluations of actual energy use in multi-family construction in both Seattle and Vancouver (B.C.) suggest that most domestic hot water is still provided by natural gas and even in buildings with electric resistance heat a large portion of a building's space heating is still provided by the gas-fired make-up (ventilation) air units. These surveys should be incorporated in evaluations of the likely electricity savings from heat pumps.

A final challenge with incentives is the issue discussed previously under building green policies and regulations, namely the need in some cases for bridging strategies to larger more lasting alternative energy strategies. In particular, there may in some situations be some increased reliance on natural gas during the early phases of developing a district energy system as a bridging strategy until loads reach an optimal threshold to sustain an investment in a larger alternative energy system, including a larger-scale heat pump system.

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conservation purposes in existing structures and shall not be used for any purpose which results in a conversion from one energy source to another" While this Section prohibits the lending of credit for converting from one energy source to another (i.e., fuel switching), it does not explicitly prohibit utilities from offering other types of financial or technical assistance for that purpose. It also only refers to existing structures and further clarification is required regarding the authority and constraints for utility incentives related to new construction, which is far more relevant for district energy expansion in the city.

BC Hydro's incentive policy for district energy provides an interesting illustration of approaches to balance utility requirements and objectives with the realities of developing larger district energy solutions. BC Hydro views district energy as a useful strategy for reducing electricity consumption, increasing overall energy efficiency, and reducing GHG emissions. Like Seattle, BC Hydro's electricity rates are lower than the marginal cost of new supplies, and substantially lower than the marginal cost of new green (low GHG) supplies. In addition to funding pre-feasibility and feasibility studies of district energy, BC Hydro recently started to offer capital incentives for the implementation of district energy systems.[33] The magnitude of the incentive is driven by electricity savings. Those savings must reflect a reasonable estimate of BAU electricity use, taking into account recent studies confirming the relative contribution of electric resistance heat to overall heating demands in new buildings. Under the rules, incentives are highest for biomass and other sources of waste heat that do not require any significant input of electricity, but systems that continue to rely on efficient heat pumps will still receive some incentive.

BC Hydro was also concerned about incenting fuel switching from electricity to natural gas. As a result, the incentive is tied to electricity savings and GHG reductions, meaning overall natural gas use cannot go up. BC Hydro does not have any constraints in terms of incenting either heat pump systems or systems that use bioenergy. Systems must also demonstrate a need for an incentive to be economically viable. Finally, BC Hydro recognized that new systems may require some increased use of natural gas as a bridging strategy to a larger alternative energy system. To overcome this hurdle, BC Hydro establishes a funding agreement with customers prior to commencing their projects but final payment is contingent upon the construction of the alternative energy source and realization of expected GHG savings. The incentive may be paid to either individual building owners or the district energy provider, and both publicly or privately owned systems are eligible.

2) Policies and incentives for combined heat and power

In many jurisdictions combined heat and power (CHP) is a key source of energy for many district energy systems. CHP plants are more efficient than stand-alone thermal electricity plants – i.e., coal- or gas-fired plants that produce only electricity without any useful heat recovery. Baseload thermal electricity plant efficiency can range from 30 – 50 % depending upon the technology. With recovery of waste heat for use in a district energy system, overall plant efficiency can increase to 80% or more. District energy is therefore sometimes developed more as a means for enhancing electrical system efficiency.

Most of Seattle's current electricity comes primarily from hydroelectric sources with low GHG emissions. SCL also purchases offsets for any residual GHG emissions associated with its current electricity supplies. However, existing resources are largely committed and new sources are required to meet ongoing demand growth. SCL has policies to purchase new supplies from green (low GHG) sources such as small hydro and wind. But Seattle is part of a larger electricity market which still relies on a high proportion of thermal electricity supplies

[33] http://www.bchydro.com/powersmart/ps_communities/district_energy/capital_incentives.html

such as coal and natural gas. There will be growing reliance on wind and other non-thermal sources, but given the high and continued use of thermal energy sources, there will also need to be more reliance on CHP to dramatically increase the efficiency and lower the GHG emissions of the regional electricity system.[34] And CHP must be located near heating loads such as found in dense urban centres like Seattle. In addition to regional GHG benefits, CHP in Seattle also offers other potential local benefits such as reduced transmission line losses, increased reliability, and energy diversity. Significant local generation may be particularly important in an earthquake prone region such as Seattle. Policies and strategies are required to reconcile the City's own desire for low GHG sources of new electricity with the broader regional need for CHP located near load centres such as Seattle.[35]

In addition to City policies, some additional clarification may be required of State policy. In the 2006 general election, Washington voters approved Initiative 937, the Energy Independence Act (EIA), now codified in Chapter 19.285 of the Revised Code of Washington (RCW). Among other measures, the EIA established a Renewable Portfolio Standard for electric utilities in the state of Washington serving more than 25,000 customers. RCW 19.285.030(18) and WAC 480-109-007(18) explicitly list nine types of "renewable resources":

a) Water;
b) Wind;
c) Solar energy;
d) Geothermal energy;
e) Landfill gas;
f) Wave, ocean, or tidal power;
g) Gas from sewage treatment facilities;
h) Biodiesel fuel as defined in RCW 82.29A.135 that is not derived from crops raised on land cleared from old growth or first-growth forests where the clearing occurred after December 7, 2006; and
i) Biomass energy based on animal waste or solid organic fuels from wood, forest, or field residues, or dedicated energy crops that do not include
    (i) wood pieces that have been treated with chemical preservatives such as creosote, pentachlorophenol, or copper-chrome-arsenic;
    (ii) black liquor by-product from paper production;
    (iii) wood from old growth forests; or
    (iv) municipal solid waste.

If a CHP project is fueled by an eligible renewable energy resource then it could also meet the renewable energy standard criteria. High efficiency gas-fired CHP projects are not explicitly eligible for meet the renewable energy standard criteria, but they are within I-937's definition

[34] Displacing electricity used for low-grade services such as heating when better alternatives exist could also be important for reducing overall regional GHG emissions. Any reduction in the demand for electricity from Seattle could free up green electricity sources to displace other sources of electricity with higher GHG emissions.
[35] Part of the challenges remains that broader markets do not yet place the same value on GHG reductions as the City of Seattle does.

of energy efficiency if they reduce the demand on the electric utility (i.e., CHP is located behind a customer meter). This distinction between designating CHP supply or efficiency is somewhat artificial and would seem to preclude gas-fired projects that are more efficient than other stand-alone thermal plants currently supplying the grid but are not located behind an individual customer meter. Greater clarification of eligible resources may be required by SCL and serious consideration should be given by both the City and State on the potential role of CHP in meeting requirements of both I937 and GHG reduction goals.

Two state entities share responsibility for developing rules and implementing the policy—the Washington State Utilities and Transportation Commission (WUTC) and the Washington State Department of Commerce. The WUTC is responsible for developing and implementing regulations, as well as the administration and enforcement of the standard as it applies to investor-owned utilities (IOUs). The Department of Commerce is responsible for adopting rules concerning only process, timelines, and documentation to ensure the proper implementation of the policy as it applies to qualifying utilities that are not IOUs (such as municipal utilities).

The WUTC has recognized that IOUs and project developers may be investigating the use of technologies or resources that are not expressly described in RCW 19.285.030 and WAC 480-109-007, but which, nevertheless, may be "eligible renewable resources" and this uncertainty creates impediments for financing, establishment of project partnerships, and commitments of renewable research and development funding, such that utilities and developers may desire assurance that a specific project would qualify as an "eligible renewable resource" under the EIA if it were built as proposed. The WUTC has recently issued a Policy Statement under RCW 34.05.230 to describe options available to these entities for determining whether a proposed project would qualify as an "eligible renewable resource."

3) Customer information

SCL and other City utilities can play a role in communicating the true costs and benefits of district energy (versus electric resistance heat) to customers, as well as providing technical support and tools in the evaluation of alternatives (as discussed under green building policies above). Two issues in particular have been noted previously. First, many customers and stakeholders in Seattle do not have information on the true marginal costs of new electricity supply or forecasts of future electricity rates, both of which may be important inputs to customer investment decisions. Similarly, many customers and stakeholders in Seattle do not seem to be aware of the GHG emission factors for regional electricity markets or the City's policies for using regional emission factors in evaluating savings from DSM and alternative supply technologies.

D. Municipal Bioenergy Policy

As noted above, there is a lack of community consensus about the long-term sustainability and viability of bioenergy. Some consensus is required to inform long-term investor and consumer decisions. A consensus is required to support both district energy and transportation initiatives, since as bioenergy is often a major element of sustainable transportation plans.

Some key issues include the sustainability of different bioenergy feed stocks and the sustainability of different forms of bioenergy conversion technologies. Bioenergy encompass a wide range of feed stocks and conversion technologies. The community consensus should clarify which fuels and conversion technologies may be considered sustainable and/or under what conditions they would be considered sustainable. Ideally, the consensus would also consider transitional strategies, that is feed stocks and conversion strategies that may not be considered lasting solutions but reasonable stepping stones on the path to long-term sustainability. Sustainability must consider multiple dimensions of impacts and any consensus will need to grapple with potential trade-offs across issues such as GHG savings vs. other possible aesthetic impacts.

Four steps are recommended to develop a community consensus.

- Background research: Consolidate existing international and national perspectives, experience and standards on bioenergy; together with local/state perspectives, experience, and standards. Provide some structure to community discussion by organizing feed stocks and conversion technologies into suitable sub-categories.

- Convene expert / stakeholder panel: Convene a panel of local experts and key stakeholder representatives to review the background research and develop an initial consensus on the types of feed stocks and conversion technologies that should be considered sustainable, and/or the conditions under which they may be considered sustainable.

- Broader community engagement: Hold open houses to solicit broader community feedback on the results of background research and expert panel / stakeholder recommendations.

- Council presentation: Present final staff recommendations for Council approval.

This work would be undertaken under the direction of the DE IDT.

Recommendation #4: Further Planning Studies in High-Priority Neighborhoods with Good Near-term Potential for District Energy

In the AEI/COWI study, four areas were identified as having high (near-term) priority for further feasibility analysis: First Hill (including Yesler Terrace), Capitol Hill, University of Washington, and South Lake Union. These represent areas with imminent potential and a need for City vision, leadership, planning and coordination. It is expected that additional study of expansion and modernization opportunities on First Hill (including Yesler Terrace) will be conducted as part of the strategic district energy partnership proposed above for First Hill.

For the remaining neighborhoods, further feasibility work required to determine the actual viability of district energy and the desired approach to implementation. While City leadership is required for these studies, it is expected they would each be undertaken with strategic partners and involve local stakeholders. For Capitol Hill, there may be value to partnering with any new retail supplier for First Hill on further feasibility work given potential synergies with any initiatives on First Hill. For South Lake Union it would be important to partner with Vulcan, the largest developer interest in South Lake Union and a contributor to the original district energy feasibility study for the area completed in 2004. The UW neighborhood represents an opportunity to leverage synergies between UW and the surrounding neighborhood for the supply of cost-effective and low-carbon energy. A formal collaboration between UW and the City will be required if these potential synergies are to be identified and realized.

- Some key issues for consideration in the further feasibility studies include the following.
- Refine boundaries of study areas (initial core + additional future expansion opportunities).
- Confirm existing compatible loads (and timing of potential replacement of existing boiler systems).
- Confirm future development levels, types and timing (with scenarios).
- Consider possible role of district cooling (e.g., deep water) if relevant for all or a subset of study area.
- Establish possible staging scenarios for loads and infrastructure (distribution and energy sources).
- Identify and screen viable district energy sources based on cost, environmental profile and other community objectives.

For all studies, it is recommended that a technology and owner-agnostic approach be considered to identify the most suitable district energy strategies and establish a fundamental business case. If viable, there may be an opportunity to expand the proposed strategic district energy partnership on First Hill to these other neighborhoods. Given UW's large load and existing assets, a new form of partnership with direct involvement by UW may be required for this neighborhood.

Attachment 1 – A District Energy Primer

District energy, sometimes also referred to as neighborhood energy, involves the central provision of heating and/or cooling services. Electricity is sometimes also produced as part of a combined heat and power (CHP) system (also referred to as co-generation). CHP systems are more efficient than stand-alone electricity plants without heat recovery. The electricity from a CHP plant is typically sold into the local electric grid while the recovered heat is used within the district heating system. However, as discussed in the section on microgrids below, a CHP plant can also serve as a source of local back-up when the main electricity grid goes down.

District energy systems typically consist of one or more central energy plants connected to buildings via a network of pipes. New district energy systems typically distribute heat as hot water rather than steam, unless there is still a large requirement for steam (e.g., buildings with older heating systems, large laundry and sterilization loads, or industrial processes). Even in these cases hybrid systems are increasingly common. Individual buildings are served via energy transfer stations consisting of heat exchangers and meters, eliminating the need for on-site boilers and, in the case of district cooling, chillers or cooling towers.[36] Within buildings, thermal energy must be provided to individual suites by hydronic systems, which could include fan coils, hydronic baseboards or in-floor radiant systems.

District energy is a very old concept used as far back as the Romans. District energy helped the initial development of the electric power industry by enhancing the economics of new power plants by generating additional revenues from waste heat recovery. Today, more than 50% of all building stock in some countries of Northern Europe is connected to district energy systems and CHP systems make up a higher portion of district energy systems in countries such as Finland, Denmark and the Netherlands. There are more than 3,000 district energy systems in North America, most in older downtown cores and on medical, educational or military campuses.

[36] Some district energy systems distribute only low-grade (i.e., low temperature) energy to users. This requires the use of on-site heat pumps and boilers to raise the energy to useful temperatures. These types of systems may make sense in situations where only low-grade energy sources are available (e.g., geoexchange or sewer heat, which require the use of heat pumps anyway), densities are very low (low temperature systems may use uninsulated distribution pipes in some cases), and where there is simultaneous heating and cooling (facilitating waste heat recovery from cooling).

Figure 13: Typical District Energy System Components

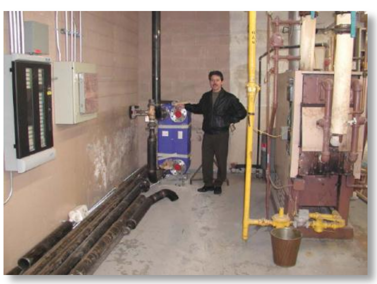
Energy Center(s)

This is a rendering of the energy center that serves South East False Creek, the site of Vancouver's 2010 Olympic Athlete's Village. The plant is co-located with a sewer pump station, as one of the energy sources is waste heat recovered from sewage.

Distribution System

This is a heating only distribution system – one pipe for hot water supply and one pipe for return. Pre-insulated pipes with integrated leak detection are buried directly underground in this application.

Energy Transfer Stations

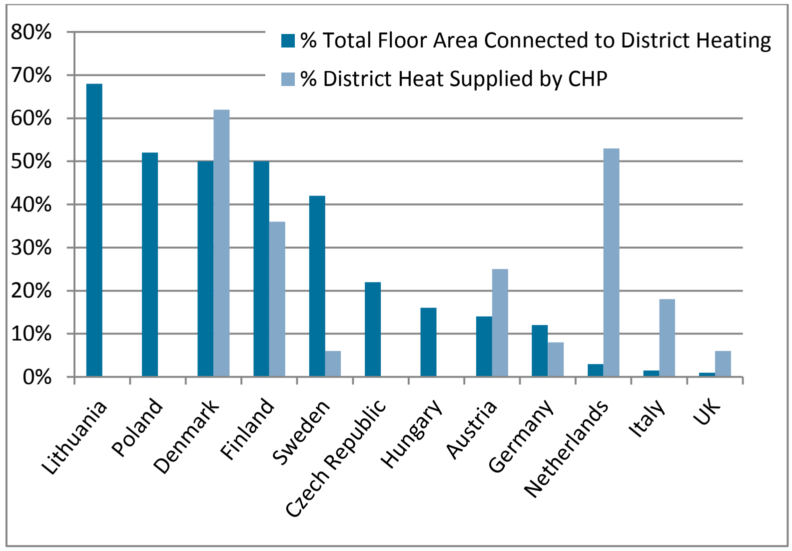


This blue box is an Energy Transfer Station. It is shown here in an old boiler room. The box contains heat exchangers and a meter. In a new building, there would be no requirement for the boiler room.

Building Hydronic HVAC

Within buildings, heat could be supplied via in-floor radiant heating systems, hot water radiators (shown in this picture) or fan coils, among other approaches. Developers can select the system appropriate to their needs. They simply have to ensure building systems are compatible with district energy supply temperatures.

Figure 14: Penetration of District Energy in Europe



Data Source: International Association for District Heating, District Cooling and Combined Heat & Power. 2003. CHP = Combined Heat and Power

What are the value propositions for district energy? Different neighborhood utilities have different potential value propositions. In the case of district energy, we are centralizing building heating and/or cooling systems. As a result there are some potential economies of scale. Larger equipment tends to have lower unit costs. But the more significant scale effect is with ancillary equipment such as electrical and gas hookups, controls, and meters. Also important are potential economies of scale in the staffing and maintenance of systems.

Economies of scale are only one of the possible value propositions for district energy. Equally important is something we call economies of integration. Heating and cooling loads are very peaky. That is, a large amount of capacity is required to meet fairly short-lived spikes in demand. When systems are centralized to serve a greater number and range of loads, the total amount of installed capacity that is required will be reduced because individual loads peak at different times. This is the same effect observed in electricity systems which take advantage of the fact that individual customer peaks are “non-coincident”. A diversification effect of 15 – 25% has been demonstrated in numerous district energy systems. On-site systems also often have higher levels of redundancy.

This may be easier to understand with a simple illustration. Take ten buildings each having a peak heating demand of 2 MW. If each installed an on-site boiler plant, they might install 3 – 4 MW of boiler capacity (two boilers of 2 MW each or three boilers of 1 MW capacity to provide some redundancy in the event one boiler fails). Total installed boiler capacity with individual systems, including redundancy, may be 30 - 40 MW. If these same buildings were integrated into a combined heating system, the total combined peak demand may be on the order of 16 MW (the exact diversity factor increases with greater numbers and types of loads). The central plant may install two 8 MW boilers (with some savings from the larger size of boilers and common ancillary equipment). In order to provide redundancy, the central plant may also install an additional 8 MW boiler, which is available in the event either of the other two boilers fails (it would be very rare for two boilers to fail at the same time). As a result, the total installed capacity in the central system may be 24 MW of boiler capacity compared to as much as 30 - 40 MW with individual building systems.

Integration has other potential benefits in terms of system efficiency. For example, boilers rarely, if ever, run at full load. At partial loading, boiler efficiency is often lower than quoted efficiency values from manufacturers. As shown above, on-site systems tend to be over-sized (increasing partial loading conditions) and also tend to cycle on and off more. This reduces average annual (seasonal) efficiency and can also affect equipment life. Centralized equipment serving larger and steadier loads (through diversification) will tend to have higher annual efficiency and a better life. The efficiency benefit will vary depending upon the system size, equipment configuration, and load diversity.

The above examples compare building boiler systems to centralized boiler systems. Many of the examples also apply to chiller systems. But district energy also offers additional opportunities to access alternative energy sources. Individual building sites typically have limited options for alternative heating and cooling sources. Solar domestic hot water is possible, but requires optimal building orientation and seasonality of output, and the optimal system sizing for an individual building will rarely provide more than 10% of annual heating requirements in the Pacific Northwest. Geoexchange systems are also common at individual building sites. These systems take advantage of the moderate temperatures in the ground to boost heat pump efficiency (and sometimes capture waste heat from cooling or solar hot water systems in warm months for use during the heating season). But in high density sites the area available for geoexchange systems is limited and systems must often be installed under building footings, increasing cost and complexity. District systems can tap resources not available or economic at individual building sites. These include waste heat recovery opportunities (e.g., sewer heat recovery, industrial heat recovery), combined heat and power (which tends to be more economic at larger scales than individual buildings), or shared geoexchange systems (to take advantage of larger public spaces and sharing of heating and cooling among a larger number of users).

Most district energy systems operate at a reliability of well over 99 percent. The San Francisco system operated through the 1989 earthquake without interruption to customer service. During the 1998 ice storms in Montreal, the only buildings that were heated were connected to the Montreal District Energy system. Those buildings became emergency shelters during an electrical outage that lasted about three weeks. Most other buildings were electrically heated (electric heat is very common in Quebec because of the large reliance on hydro power) and the ice storm affected major transmission lines supplying the City of Montreal. During the Eastern Seaboard blackout six years ago the only people that had cooling were connected to district cooling systems. A district energy system with cogeneration worked so well that during the 24-hour black out, it took patrons of a casino in Windsor, Ontario 12 hours to even realize there was a blackout.

District energy has other value propositions related more to the utility model itself rather than the specific technology. With on-site systems, the building developer and ultimate purchaser must pay these costs upfront. Developers and end users are typically more sensitive to first costs and tend to put less weight on lifecycle costs (i.e., total costs of ownership including ongoing maintenance and operation). For example, there is considerable literature showing that purchasers of efficient equipment discount future savings at very high rates when selecting between equipment with a lower efficiency and price, or equipment with a higher efficiency and price. Many sustainable technologies are also characterized by higher capital costs and lower lifecycle costs. So concern about first costs can be a major barrier to the adoption of sustainable technologies.

There are many valid reasons consumers put more weight on upfront capital costs than ongoing lifecycle costs. First, they often have constraints on the amount of capital they can borrow and therefore have to prioritize individual capital expenses. Second, they may lack information on future operating costs (operating costs) when making capital decisions. Third, there is also uncertainty over future operating costs, both in terms of actual equipment performance and future energy prices. Individuals rarely have explicit information on likely future energy prices. Fourth, there are additional risks associated with more costly equipment. For example, an incandescent bulb may use more energy but is less costly to replace if it breaks. A fluorescent bulb may use much less energy but if it fails early it would be very costly to replace and wipe out the value of any energy savings. Finally, unless buyers intend to own the asset for a long time, they must also count on future purchasers valuing the remaining energy savings in order to recoup their investment. The risk that markets will not value these future savings as much as them may cause them to discount savings.

In the case of district energy, the utility will pay for the upfront capital costs of energy systems and recover those costs, along with ongoing operating costs, through user rates.[37] In addition to addressing the first cost barrier, utilities typically have longer investment horizons allowing amortization and financing rates that better reflect actual asset life and risks. In addition, an energy utility with a long-term focus is usually in a better position to estimate and internalize lifecycle costs in their investment and maintenance decision making.

Central, professional maintenance is another potential benefit. Ongoing maintenance costs for on-site energy systems are often hidden in overall building maintenance budgets. But these costs can be significant. Boilers and chillers require regular minor maintenance and periodic major refurbishments. Equipment can fail early. Some equipment comes with unique requirements. For example, buildings with chillers must own and use refrigerants introducing refrigerant compliance responsibilities, handling regulations, rising replacement costs, and capacity-loss issues. These issues are often outsourced to professional building management companies that can pool multiple customers and establish clear maintenance policies and programs. But when equipment is centralized, maintenance becomes easier. There are typically fewer pieces of equipment to maintain. And systems owners have more explicit financial incentives and data to develop and implement explicit maintenance programs.

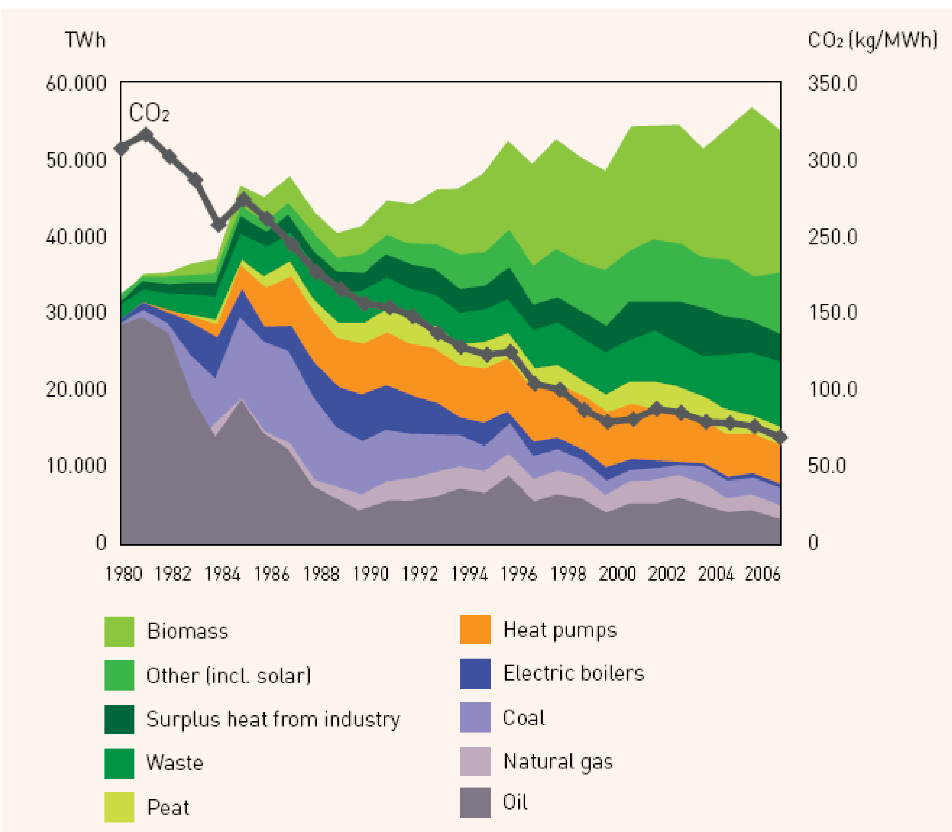
Perhaps one of the greatest benefits of district energy is that it provides a framework for sharing the risks of new technologies among a larger number of consumers, and a flexible platform for the adoption of new fuels and technologies over time. When new technologies are installed in individual buildings, risks are concentrated among a small group of owners. District energy systems pool the risks across a larger number of users. Most systems also use several technologies, creating some diversification and allowing

[37] One exception is where the customer pays a capital contribution to the system upfront. Some utilities will use customer contributions as a source of capital. Some customers, particularly large institutions, often prefer to pay an upfront contribution out of capital budgets rather than repaying capital through a rate that is paid from annual operating budgets.

arbitrage among individual technologies and fuel prices. The ability to adopt new technologies on a large scale has benefits both for individual consumers and also local economies.

The Swedish experience illustrates the potential flexibility of more centralized district energy systems. Since the 1970s, the penetration of district energy has nearly tripled so that nearly 50% of the building area in Sweden is now supplied with district energy. Over this same period, district energy systems in Sweden have transitioned from relying almost entirely on imported fuel oil to relying on a diverse mix of resources, including biomass, refuse and waste heat. In between, there were periods in which coal and electricity were more dominant sources of heat. Over the same time period, the GHG intensity of heating in Sweden has declined more than 50%. It is unlikely such a large and rapid switch in fuels and technologies would have been possible if individual buildings had been heated by thousands of smaller plants, with different technologies and vintages of equipment.

Figure 15: Swedish District Energy Growth and Fuel Sources (1980 – 2006)



The benefits of district energy must be weighed against some additional costs, which include additional set up costs, distribution infrastructure costs and administrative costs. In addition, district energy will have a different risk profile compared to individual on-site systems. District energy is in some cases more capital intensive and some capital will need to be invested in advance of loads, which creates a risk of stranded costs (i.e., costs that cannot be recovered if loads do not materialize). These risks can in part be mitigated through community policies and the business model. As noted above, district energy also allows the pooling of risks and greater opportunities for diversification and fuel arbitrage to mitigate exposure to technology failures or rising fuel prices.

The value propositions, costs and risks of district energy must be weighed in project-specific business cases that consider the unique features and local context of every project. The ultimate business case for district energy will depend upon many things including:

- the ultimate scale of the expected system;
- the density and mix of loads (higher density and greater use mix will typically result in greater ratio of benefits to costs);
- the actual rate and staging of development;
- the security of loads (requirements or incentives for customers to connect);
- the options for on-site energy systems (many building sites may be limited in terms of their ability to access alternative energy sources such as solar orientation or available space and suitable ground conditions for geoexchange systems);
- the availability and cost of alternative energy sources (e.g., large nearby waste heat sources, local underutilized biomass resources);
- potential synergies with other infrastructure (e.g., as sources of waste energy and/or in the installation and maintenance of equipment);
- other opportunities for future growth or the addition of other services (sometimes referred to as "growth options" in the finance literature).

There are normally many potential challenges to overcome as well. Some key challenges often include the following.

Staging of capital. Some district energy capital is lumpy and must be staged carefully to minimize carrying costs prior to securing revenues and to minimize stranded investment risk. In new systems, one strategy to reduce these risks includes interim reliance on temporary or permanent natural gas boilers, which can then be used for peaking and back-up once loads reach sufficient levels to support investment in alternative technologies for baseload supply.

Revenue risks. Customer capture and retention is critical to ensuring economies of scale while minimizing the risk of stranded capital. Often communities and stakeholders play a critical role in mitigating these risks through vision and policy support.

Financing. District energy offers stable, utility-style returns. However, there is a need to finance pre-implementation feasibility studies and design work for new systems. New systems will also typically need a "levelized rate" structure whereby expenses may exceed revenues in early years. Additional capital will be required to finance operating deficits in early years, which would be repaid through surpluses in later years of the investment cycle. Multiple sources of financing may be required to reflect the mix of public and private benefits. For example, customers may pay a small premium over conventional heating and cooling systems to reflect intangibles such as higher reliability, better service, reduced risks, and better environmental performance. But the willingness of private customers to pay for societal and long-term benefits such as deep carbon reductions and technological flexibility may be limited. Other sources of capital will be required to maximize these societal benefits.

Coordination. Considerable coordination among land use and infrastructure planning is required to minimize implementation costs, secure energy production sites, and secure certain alternative energy sources such as waste heat sources. Building codes and enforcement can be used to promote voluntary connection and ensure system performance. Careful coordination with building developers and designers is required to ensure optimal system compatibility.

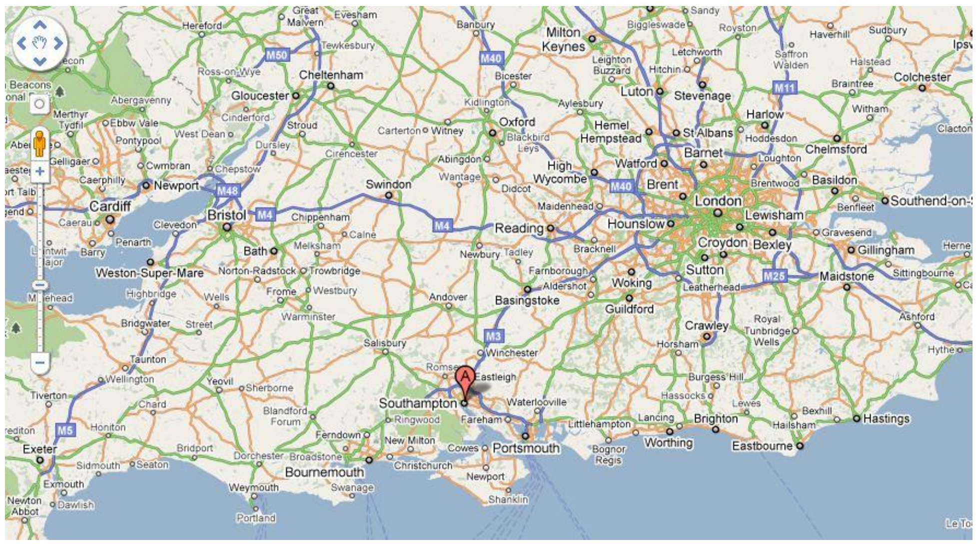
Supply and price of alternative technologies and fuels. Supply chains for some alternative technologies and fuels are not yet well developed, and there may be both supply and price risks compared to well-established conventional fuels. These can be managed in part through competitive tender processes, performance contracting, and the staging and diversification of technologies. Governments may also have a role to play in facilitating market development for technology and fuel suppliers, as well as access to resources such as waste streams and heat recovery opportunities.

Electricity market interface. The primary focus of district energy utilities is on the provision of heating (and sometimes cooling) service. Combined heat and power can reduce district energy costs and enhance the efficiency and security of the local electricity system. However, investors will often require long-term and stable power prices to financing the additional costs of co-generation. Alternatively, electric utilities or independent power producers may need to build, own and operate the plants, including the management of electricity supply contracts, and then sell waste heat to a district energy provider.

Attachment 2 – UK Strategic Community Partnership Example

Overview

Southampton, UK is located approximately 100 km southwest of London on the southern England Coast. Originally a port town, Southampton now has a fairly diverse economy, with the health and education sector providing a large percentage of employment. Other significant sectors include industrial and retail/wholesale. The City remains a major port for cruise ships and hosts the largest freight port on the Channel coast. Southampton is the region's major commercial service centre. The local authority is Southampton City Council (SCC).



The Southampton District Energy Scheme (SDES) was established in 1986. The scheme started as a geothermal heating project for the community's Civic Centre, located in the city centre. Additional city centre buildings soon followed. Once the core node was established, the scheme was expanded to include cooling service (1994), CHP (1998) and several new redevelopment areas beyond city centre were connection (1988 onwards). While CHP now supplies most of the heating needs, the original geothermal concept still contributes approximately 15% of the required heat. The open loop configuration accesses 74°C water from aquifers 1.7 km underground.

The SDES includes the following technical features:

- Annual energy sales of 70 GW.h / year generated from a mix of geothermal (open loop), gas/oil-fired CHP, and conventional gas-fired boilers. Chilled water is generated using absorption chillers that utilize waste heat from CHP and conventional vapour-compression refrigeration system.
- A 5.7 MWe Wartsila CHP engine and 2, 400 kWe gas-fired reciprocating engines. 23 GW.h / year of electricity generated and sold to a single customer at the port under a supply contract. The CHP unit is capable of running on light fuel oil or gas to optimize dispatch mix according to current and anticipated fuel prices. However, it mostly runs on natural gas. Cofely is constantly looking for

biogas supply opportunities to reduce carbon costs (UK currently levies a £12/tonne carbon tax on all carbon consumption)

- 11 km of distribution piping.

- Heating, cooling and electricity sales to over 40 public and private sector customers and hundreds of domestic customers.

Partnership Business Model

Overview

The original geothermal scheme was investigated by SCC, with European Union support. From the outset, the scheme was supported by Council and championed by a SCC Executive Director (equivalent to a Director of a municipal department in North America). Council made a decision to develop the scheme but did not want to undertake a finance or ownership role, so it partnered with Utilicom to develop the geothermal resource via a competitive selection process. Utilicom was chosen because of its extensive experience in the design, construction and operation of large district heating schemes, some of which utilized geothermal heat. Utilicom was subsequently purchased by Cofely District Energy, which forms part of the energy services branch of its parent company, GDF Suez.

Utilicom/Cofely delivered the scheme under a Design, Build, Finance, Own and Operate business arrangement. However, municipal involvement in the scheme's success was and continues to be essential. The business arrangement was formalized in a Joint Co-operation Agreement (JCA) which outlines the parties' roles and responsibilities for ensuring the scheme's success.

Under the JCA, Cofely committed to:

- Develop the scheme initially utilizing the city's geothermal resource, and then adding CHP;
- Sell heat to SCC buildings with agreed savings;
- Provide all necessary financing, technical and management expertise required to deliver the scheme;
- Provide open book accounting and a long-term profit share to SCC.

SCC committed to:

- Take heat wherever practical for SCC buildings;
- Help promote the scheme to other potential users;
- Support scheme development through co-ordinated infrastructure and land use planning;
- Providing the land for the energy centre while foregoing property taxes;
- Granting Cofely ownership of the geothermal resource;
- Treating Cofely as a 'statutory utility' within City boundaries (facilitates access to easements and rights of way for district energy infrastructure)

At start-up a SCC Executive Director allocated approximately 15% of his time to develop the scheme. This level of municipal leadership, combined with unanimous Council support is considered a key ingredient to the project's success.

Profit Sharing Arrangement

The Southampton JCA includes a profit sharing provision for the division of any annual Net Operating Profit (essentially, net profit before corporate taxes). The profit sharing provision is triggered in a given year when: a) there is a cumulative net profit, and b) there has been a full year of third party consumer connections. Third party in this instance refers to a customer other than the City. All NOP up to 5% of gross revenue is kept by Cofely. Any NOP above 5% of gross revenue is split 50/50 between Cofely and the City. To date, there has not been any profit greater than 5% of gross revenue. The JCA requires open book accounting so the municipality can access financial statements at any time. However, it appears the business arrangement is more of a trust-based model, as no formal review is conducted by SCC at present time. The municipality seemed unclear about the asset deprecation schedule and financing costs, though all of this information is available under the open book accounting approach.

As part of the profit sharing provision, Cofely pays a fixed sum of £25,000 / year to SCC, irrespective of any profits or losses. That sum has been paid every year.

Approach to Rates

Cofely sets rates independently of SCC and maintains a direct relationship with customers. SCC is not involved in the financial aspect of the scheme other than sharing in profits, when available. Thermal energy rates are based on an avoided cost model. Under this regime, customers' self-generation costs (including capital, fuel and non-fuel O&M) are estimated and compared to the cost of district energy. Where costs are equal to or lower than a customer's self-generation costs, there may be a willingness to connect.

Not all potential customers connect, nor has the City established mandatory connection. According to staff, the City is not legally able to require connection because SCC can benefit from the scheme (in the form of fixed annual payment from Cofely and any potential profit sharing). According to staff, requiring connection would constitute a conflict. However, all new buildings within a pre-determined service area are required to consider district energy connection as part of the development permit process. This requirement includes meeting with Cofely to learn about district energy service and rates.

Self-generation costs are calculated as an annualized life cycle cost (LCC) and compared to district energy rates. Customer self-generation costs include capital, maintenance, carbon tax and non-fuel O&M. Fuel prices are assumed to be flat in real terms over the projection period. Cofely justifies this on the grounds that the same escalation would also apply to centralized generation. Heat supply agreements include a commitment to remain between 5-10% below what customers otherwise would have paid.

Rates are comprised of a fixed and variable component with a connection charge that can be tailored to each customer. The fixed component is indexed to the Retail Price Index and labour rates. The variable portion is indexed to HEREN, the UK's natural gas index. The fixed component typically represents approximately 30% of the rate and the remainder is generally comprised of the variable portion. Carbon tax on central generation fuel is flowed through to customers as part of the variable rate. All heat supply agreements are for a 20 year term.

Agreement Term and Asset Transfer

The JCA was renewed in 2005 and includes a 25-year term with a renewal clause. The Agreement does not include a buy back provision that would enable SCC take ownership of the scheme or any assets at the JCA's expiry. Thus, the scheme will remain under Cofely ownership into the subsequent renewal term.

Governance Model

Overview

The Southampton scheme is governed by a Strategic Partnership Board. The Board is chaired by an Executive Director of the municipality. The board consists of approximately 10-12 board members at any given time, with 3 positions filled by Cofely and the remainder filled by senior level SCC staff. The Strategic Project Board meets 4 times per year and reports directly to Council. The Board does not have Executive power – all major decisions must be reported to and approved by Council via the Environment cabinet.

The scheme also relies on a technical committee for strategic direction and land use and infrastructure co-ordination. The technical committee is a sub-set of the Strategic Project Board. The technical group meets once every 6 weeks. Typical tasks include:

- Identifying potential new customers;
- Communicating future land use and infrastructure plans;
- Discuss and assess capacity expansion and/or required refurbishing (the original borehole and pumps are currently being refurbished); and
- Assessing distribution piping layout routing, among other technical tasks.

The technical committee consists of Cofely technical staff and mid-level City staff.

Birmingham Scheme

Cofely owns and operates another similar scheme in Birmingham, UK (160 km northwest of London).

The system was conceived in 2003 under the banner of the Birmingham District Energy Company. The company was formed after several parties considering distinct schemes within Birmingham issued a co-ordinate procurement package for an external party to Design, Build, Finance, Own and Operate the three systems in a coordinated fashion. Cofely was the successful Proponent. The schemes include:

- Broad Street – a tri-generation concept that supplies thermal energy to a number of civic and commercial customers.
- Eastside – 2 distinct schemes that provide thermal energy to the Birmingham Children's Hospital and Aston University campus. Several civic buildings are also connected within each scheme.

Combined, the schemes deliver 41 GW.h / year of heat energy and 4.9 GW.h / year of chilled water via 4 km of insulated pipes. Approximately 6.7 GW.h / year of electricity is also produced and sold to the national grid.

The combined schemes are owned and operated under a single utility company. In contrast to the Southampton scheme, there are 4 parties that participate in the Project Agreement: Cofely, the City, the Hospital Trust and the University. All partake in strategic decision making and profit sharing. In contrast to the Southampton arrangement, the Birmingham Project Agreement stipulates the profit sharing beyond 5% of gross revenue is divided by the 4 parties proportionate to heat sales. The core parties take a more active role in financial review than Southampton. Cofely is required to provide detailed statements of accounts to the parties at regular intervals.

Unlike in Southampton, the Birmingham Project Agreement includes an option for the core parties to take ownership of district energy assets at year 25 (in 2028).

In Birmingham, there is also a Strategic Board; however, membership is broader to include Cofely, the City, the University and the Hospital Trust. These members represent the core project team. Unlike in Southampton, each customer's heat supply terms are integrated into the Project Agreement. The document has become quite cumbersome with the addition of new customers and revisions to original heat supply arrangements. Cofely prefers the Southampton arrangement where heat supply contracts are established separately from the JCA and the business arrangement is directly between Cofely and the customer.

Some Key Lessons

Establish a Node – the Southampton project began in 1986 with a single customer, the City's Civic Centre. Additional city centre buildings soon followed. Once the core node was established, the scheme was expanded to include cooling service, CHP and connect several redevelopment areas beyond city centre. The key to start-up success was focusing on a core node with a proven supply concept.

Political Commitment – SCC made a commitment to develop the scheme and subsequently found an external party to assist with development and implementation. Council commitment to district energy development provided private parties with the confidence that Southampton was serious about district energy.

Partner Support – The municipality provided dedicated land for the energy centre and reduced property taxes. This helps make the scheme viable. Statutory rights of way are also important tools to ease scheme development.

Strategic Project Board – the Board serves an important co-ordination function between the partner and the municipality. Through the Board the parties can identify and co-ordinate expansion opportunities in the early stages to allow for proper planning.

Joint Co-operation Agreement – A profit sharing arrangement can incent a municipality to support the scheme's development and ongoing operation. Under a JCA, the municipality interests are going to be best served when it actively conducts financial review and understands all of the financial parameters (e.g. depreciation schedule, financing costs, and revenue). It may be helpful to include a third party review requirement. This type of due diligence would be common practice under a regulated utility mode.

Rate Setting – Rates determine the utility's gross revenue and thus net operating profit. Again, the municipal partner may want to conduct a review and possibly partake in rate setting and review in order to optimize profit sharing potential.

Co-ordinated Procurement – Where possible, several institutional parties may want to develop and issue a co-ordinate Call for Expressions of Interest for an external party to help develop and possibly operate the scheme(s). This approach has several advantages: 1) share administrative costs for procurement package preparation; 2) offers a larger opportunity that may attract a higher caliber partner; 3) establishes a foundation for long term co-ordinate planning and possibly interconnection between schemes; 4) may reduce overall cost of service through shared administration and operator staff, bulk purchasing of equipment and fuels, etc.

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