Local Power: Lessons from Recent District Energy System Development

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ABSTRACT

District energy systems convey substantial efficiency benefits to users and are widely used to provide heating and cooling to cities around the world. However, district energy in the United States today is largely limited to decades-old legacy steam systems that have not been updated to take advantage of new opportunities. Though district energy uses well-developed and widely available mature technologies, it faces economic barriers, policies, and regulatory structures that tend to limit its deployment in the United States.

Several U.S. and Canadian cities have recently worked to expand or update existing district energy systems, and multiple examples of successful new district energy systems around North America can now be found. In this paper we look at three recently developed or expanded district energy systems at three different stages of development and identify the political, economic, policy and regulatory factors that led to their success. We discuss lessons learned from these systems and possible challenges that must be addressed if there is to be additional growth in district energy in the United States.

Introduction

Almost one-third of the U.S.'s consumed energy goes to the heating and cooling of buildings and industrial processes (Spurr 2011). District energy (DE) systems can efficiently heat and cool water and spaces while taking advantage of local fuel opportunities and reducing energy-related emissions. DE is a reliable and proven technological approach that can be found in cities around the world. DE paired with combined heat and power (CHP) can generate additional electricity and yield even greater efficiency and corresponding reductions in emissions.

DE conveys systems efficiency because it delivers heat that is already being produced as a byproduct of industrial processes or electricity generation to end-users who require heated water or air, such as homes or commercial buildings. Absent DE systems, these same customers would typically use purchased electricity or natural gas to power on-site hot water heaters and furnaces. Electricity would have likely been generated in an ineffecient manner many miles away, where waste heat from the generation process was discarded into the air or into surrounding water bodies. Natural gas would have been burned in individual boilers or furnaces and used in an overall less efficient manner than in a highly efficient DE system using natural gas-fired CHP. A typical newer DE system changes the energy generation paradigm, maximizing all of the useful energy in a type of closed-loop design that matches thermal energy supplies to thermal energy needs.

Though DE systems have been in the United States since the late 1800s, their deployment is still limited largely to legacy systems that have been around since the turn of the *last* century and newer systems installed at universities and other institutions. Many of these systems are old and far less efficient than they could be, and many haven't been updated to encompass new technologies. Over 800 DE systems can be found in the United States today, most at colleges, universities, hospitals, government campuses, and other institutional settings (IDEA 2012). In additional to the extensive thermal energy generated by these systems, DE systems in the United States also have the capacity to generate over 9 gigawatt of electricity (IDEA 2011).

While these systems provide tremendous benefits, they are capital-intensive projects that can take years to fully reach potential. They are a challenge to undertake and require long-term dedication by multiple stakeholders focused on project success. They also require political efforts and will that have not yet become commonplace in the United States. So while DE had an early toehold in the U.S., it is other countries that continue to best utilize DE systems and CHP.

Denmark and Sweden are often cited as exemplary DE users. Sweden has completely decoupled its gross domestic product growth from carbon dioxide emissions by leveraging DE and networked heating grids, and Denmark has done the same, relying significantly on DE and CHP to serve over half of its power production and heating. Aggressive climate goals and policies that encourage DE and require its use in certain situations have helped these countries reduce their energy-related costs and emissions and become more self-reliant in their energy use loads (IEA 2009; Spurr 2011; Antonoff 2004).

Several recent DE projects in the U.S. and Canada shine some light on how such major infrastructure projects can move forward successfully in North America. In this paper we will discuss three of these, focusing less on the technical elements of the projects themselves and instead on the reasoning behind the projects' continued progress toward successful implementation. The case studies include a new DE system in Vancouver, B.C.; the complete redevelopment of an existing DE system in Nashville, Tennessee; and the planned expansion of a century-old DE system in Seattle, Washington.

Since so much of the potential for DE relies on a reliable and stable thermal load such as that found in heterogeneous urban cores, we focus specifically on DE systems that serve a multitude of buildings owned or operated by different parties. While hospitals and college campuses are excellent and important users of DE, the policy, financial, and regulatory hurdles are often less due to the single ownership of all related buildings, lots, and infrastructure. DE systems that serve a variety of types of buildings owned by a multitude of owners are better models for potential future DE systems that could serve dense residential, commercial, and industrial areas of the country.

Future ACEEE research will identify additional U.S. case studies as well as profile several failed recent U.S. DE projects. Identifying reasons for failure will help illuminate the policy, economic, and regulatory changes that could be made to better encourage greater DE deployment in the U.S.

District Energy Today

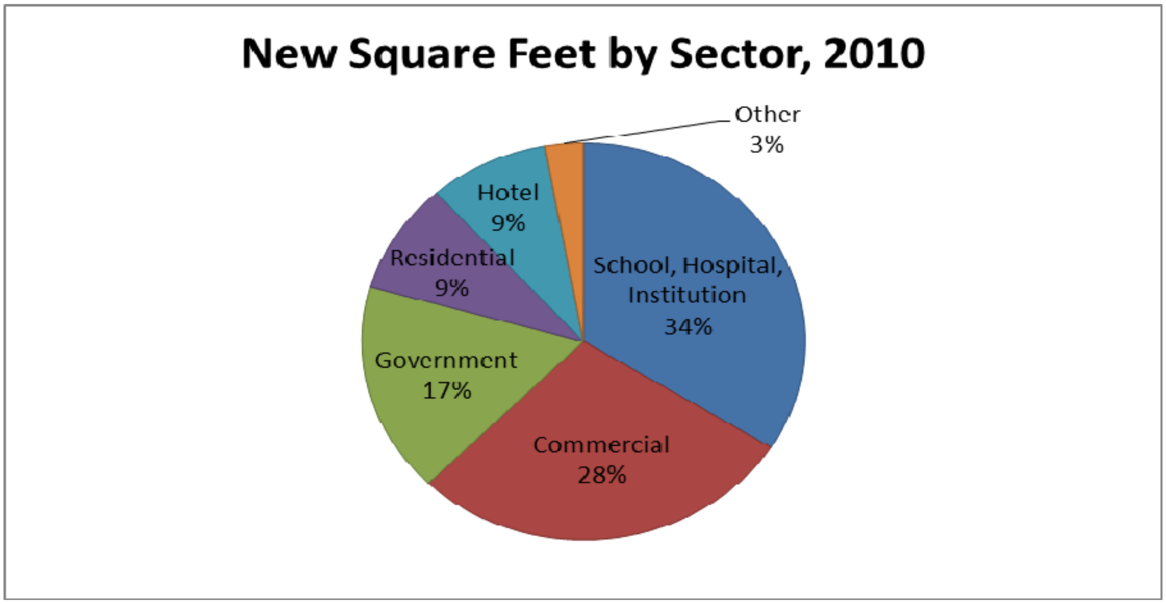
DE itself is first and foremost an infrastructure investment. DE infrastructure is fuel-neutral in that it can move steam, hot water, chilled water, or electricity among buildings regardless of original energy source. Natural gas, biomass, municipal refuse, industrial process waste, oil, and coal are some of the most typical fuel sources for the boilers and CHP systems that generate a DE system's energy. Most of the older DE systems in the world have used multiple fuels throughout their lives, moving to progressively cleaner fuels over the years (Compass 2011). Systems that once burned coal turned to oil and then natural gas, and are now just as likely to burn biomass or rely on local sources of waste heat. The DE infrastructure has allowed them the flexibility to adapt over the years.

One of DE's most important traits is its ability to aggregate the energy loads of multiple buildings. This can yield many benefits:

- The larger number of customers in a DE scheme can negotiate better terms when buying fuel and equipment than individual customers who might be interested in investing in alternative energy technologies on their own (PGL 2010).
- The aggregated demand of many customers yields a smoother and more unified load than that of a single building. Since equipment can thus operate at higher load factors, greater efficiencies and reduced maintenance costs are obtained. Additionally, the total backup capacity required for the DE system users is lessened (Thornton 2011; Compass 2011).
- Certain types of energy generation resources, such as highly efficient CHP, are more cost-effective when they can be sized at a larger scale. The risks of investments in new technologies are spread out over a larger group of users, reducing individual risk. DE systems can be built to take advantage of mature technologies today, but can integrate new technologies in the future.
- Renewable sources with intermittency issues, such as solar and wind resources, can be integrated into the system if desired, and the DE system as a whole can act as a virtual "battery" for the power produced by these resources by converting electricity to heat (Shetland Heat 2012).

Despite some of the barriers and challenges mentioned in the following section, DE systems continue to expand and new ones are built all over the world. In 2010, North America saw 121 buildings representing over 23 million square feet connect to DE systems, bringing the total of "connected" square feet in North America to over 500 million (IDEA 2011). Of the new square footage connected in 2010, about one-third of it was in schools, hospitals, and other institutions. Figure 1 shows the breakdown of the sectors in which new square footage was added to DE systems in North America in 2010.

Figure 1: New Square Feet in North American District Energy Systems, 2010



Source: IDEA 2011

Institutions and other organizations with campus-like sets of buildings continue to be the prime sectors served by DE (IDEA 2012), due in large part to their comfort with longer payback periods and ability to secure government-backed financing. Previous studies suggest that DE is most viable where a diversity of loads aggregated together creates a situation in which an energy resource can operate at a relatively high capacity factor, because it can be sized to meet some minimum thermal needs of all the aggregated buildings (Wilson et al. 2006).

While DE is most easily deployed in a greenfield development, its preference for a critical mass of high density buildings means that it is most economically deployed in dense urban areas or areas with substantial industrial thermal needs. In the growing economies of the Middle East, DE-provided cooling services can be found in many of the new greenfield developments in cities like Abu Dhabi. The U.S. has little current need for greenfield development, but its urban areas are constantly being redeveloped. Such redevelopment can open the door for more strategic urban energy planning than was done decades ago.

As the following case studies show, climate goals appear to be driving many of the new DE deployments and expansions today. As noted by Baber and Damecour, "it is virtually impossible to cost-effectively achieve efficiency and greenhouse gas emission targets in neighborhood-scale developments without district energy infrastructure" (Baber and Damecour 2008). External greenhouse gas and efficiency goals and green building requirements offer an opportunity for DE to be brought to the table of many developments that would not otherwise consider it due to its major up-front capital costs (Wilson et. al 2006). The challenges to DE are substantial, but locking in energy flexibility, reliability, affordability, and efficiency for decades is the ultimate reward for those cities willing to put in the work.

The District Energy Challenge

DE systems are literally miles and miles of pipes in the ground, below streets and buildings that often already exist. Deploying new DE systems in extant urban areas requires the ripping open of streets and parts of buildings and the installation of major new pieces of equipment, such as new boilers. The capital costs are immense and, while DE systems eventually offer economic returns, they may do so only over a long period of time. In Europe, the major DE systems were developed with payback periods of over 20 years (Antonoff 2004). All of these capital costs are risks that a DE developer must take on.

DE systems face a principal agent problem that resembles one found in other aspects of energy efficiency. Developers of new buildings or redeveloped buildings want to make money and sell or rent their properties, but they themselves might not have a long-term incentive to pay upfront for a DE system that will ultimately benefit their new tenants who pay the monthly bills. Prospective tenants might be interested in enjoying the convenience, efficiency, and comfort of a DE system, but may not have the means or the inclination to pay upfront for a DE system (Wilson et al. 2006).

The upfront capital costs would be less of a concern if it were not for the fact that DE systems must be built before even a single customer begins to pay for service. Like utilities concerned about the future of generation assets sited at individual facilities that then go bankrupt, DE developers need to feel confident that their major capital investments will not become stranded assets if the promised energy load fails to materialize. DE developers plan systems by assessing the building stock, energy usage, and arrangement of area buildings to determine the economic feasibility of a system. However, those data points are not always known, and buildings are typically under no obligation to connect to a DE system. Absent such obligations and a guaranteed customer base, developers take immense risks in building a DE system (Yamaguchi et al. 2004; Wilson et al. 2006).

Financing a DE system can be a large challenge, as lenders are reluctant to lend until a guaranteed customer base is assured (Gent 2012). Even if a DE system is somehow guaranteed that paying customers will eventually materialize, those customers cannot be charged now for energy they will not use until the system is constructed.

DE systems also face a timing challenge. The systems take a while to develop, and sometimes they might not be operational until a certain critical mass of customers is in place. Rehabilitating older buildings and connecting them to new DE systems requires a long-term holistic plan that can move forward regardless of changes in owners or tenants. Additionally, existing utility incentives sometimes inadvertently work at cross-purposes to DE systems, such as when electric utilities offer incentives for individual heat pumps that, while efficient, are not compatible with DE systems (Compass 2011).

These major challenges are where local and state governments can play a significant role (Wilson et al. 2006). By using locally vested powers such as zoning, building codes, property tax policies, utility regulation, and energy franchise agreements, cities and states can help encourage and ensure a reliable future energy load for a DE system. Such activity is akin to how state utility regulatory commissions help guarantee utilities rates of return on major investments in generation assets. Cities can also leverage their financing tools such as bonding authorities to help DE systems pay for the initial infrastructure investments (Wilson et al. 2006).

In the following case studies, we discuss the kinds of tools available to cities around the continent interested in deploying DE.

Case Studies

The System from Scratch: Vancouver, B.C.

Vancouver's Southeast False Creek Inlet neighborhood is the product of a full city-sanctioned redevelopment of a brownfield once completely contaminated by industrial uses. The redevelopment of the 80-acre site was planned in phases, with the first developed in time to serve as the Olympic Village for the 2010 Winter Olympics (Wilson et al. 2006). Despite that unique economic driver, the remainder of the site was to be a more traditional mix of dense urban development – eventually 6 million square feet – by a number of different private entities (Baber and Damecour 2008).

The city's major driver for encouraging a DE system in the False Creek project was its environmental goals, with greenhouse gas emissions reductions a paramount goal, followed by potable water reduction goals (Baber and Damecour 2008). To have full control over the desired DE system and better align the system with the city's own goals, the city created a Neighborhood Energy Utility (NEU) to both generate and distribute hot water to be used to heat spaces and for domestic hot water needs (Baber and Damecour 2008; Compass 2011). In part the desire to own the NEU itself stemmed from the city's desire to expedite the project so as to meet tight Olympic timelines. However, the NEU was designed in a manner that allows the city to sell the entity at a future date if so desired (Compass 2011).

A unique aspect of the Southeast False Creek DE system is its reliance on the city's sewer system for low-grade heat (Compass 2011). Using the heat from untreated municipal sewage to power a DE system is an uncommon choice; it was only the fourth system in the world to do so and the first in North America (Baber and Damecour 2008).

Customers of the NEU are charged energy prices akin to those they would pay for more traditional energy delivery. A fixed cost for all customers and a variable cost dependent on actual energy use make up the tariff used to charge NEU customers (Compass 2011). In this manner, the utility can operate at a loss in the beginning, while future years' growth will help produce revenue down the line. All told, $42 million in total capital expenditures for the South False Creek DE system will be recovered eventually through rates charged by the NEU (Compass 2011).

A major challenge in the development of the Southeast False Creek area was encouraging developers to agree to build and make arrangements for the DE infrastructure. Developers were highly concerned about the building capital costs relative to their business-as-usual development costs (Wilson et. al 2006). Additionally, the city itself already had green building requirements in place for the area, so a perceived "green building" premium was already present. Additional costs for DE connection, then, were possibly conflated with these premiums and inflated in the minds of developers (Wilson et al. 2006). The city had to work to overcome these perceptions.

Success Factors and Policy Tools

Communication with developers was instrumental to securing their long-term commitments to build in the area and connect to the DE system. Their input was sought as the system was developed, responding to their needs and economic concerns as the project progressed (Wilson et al. 2006). The benefit of not having to plan for in-building generation of heat and hot water resources was eventually viewed as one of the many benefits of building in the area.

The city itself had to become comfortable with playing the role of energy utility for the first time (Wilson et. al 2006). The city has now fully embraced its role and sees "district energy (as) the 'link' between emission reductions and sustainable investment decisions" (Baber and Damecour 2008). The NEU itself is set up such that additional investments in renewable energy can be integrated into the system, as well as updates to heat production technologies and applications.

While the Olympic Village development showed the near-term possibility of DE, the Southeast False Creek area's continued build-out is a testament to the fruitful public-private engagements that can yield the cities of tomorrow. Vancouver now requires that all projects over two acres in size must at least consider the feasibility of connecting to DE systems, even if such systems do not currently exist (PGL 2010).

Replacing existing heating and cooling equipment with equipment that ties into a DE system can be viewed as fuel switching, and thus not eligible for utility incentives. To address this, the local utility, BC Hydro, now offers some incentives that are linked to overall reductions in electricity consumption and greenhouse gas emissions. BC Hydro also encourages developers to work with them early on, with incentives scaled up if earned earlier in the development process. This early involvement can help offset the increased cost of construction of new developments (Compass 2011).

The Major Overhaul: Nashville, Tennessee

Nashville's DE system began service in 1974 as a waste-to-energy plant, eventually providing heating and cooling to eight million square feet of space in 40 buildings in the city's downtown core. After three decades of service as the country's first waste-to-energy plant, the system was in major need of repair and customers were hesitant to believe that the system could continue to offer them lower energy prices than they would otherwise face with in-building services. Customers and nearby residents were also increasingly uncomfortable with the burning of trash in the middle of the downtown core (Ragsdale 2012). A new mayor in 2000 conducted a full study of the site to evaluate the possible alternatives, and a fire at the existing plan then expedited the transition to a new plant model (Gershman 2006).

The most cost-effective alternative was the complete demolition of the existing plant, given that the equipment was so old and the reliance on municipal waste was undesired by the community. The mayor's analysis also noted that for the 40 buildings connected to the system, retrofitting them so they could provide their own heating and cooling services would be costly and complicated. The majority of the connected buildings were owned by the city or state, so it was viewed as in the city and state's best interests to pursue the most cost-effective option to replace the DE system plant.

In place of the old plant, the city government decided to construct a new DE plant that would continue to provide service to the connected office buildings and government buildings of the area. Economic, reliability, and environmental benefits were viewed as the most critical reasons to maintain a DE system downtown. However, the city no longer wanted to be responsible for the operation of a DE system and decided to put out for bid an attractive 11-acre site for a future DE system operator (Gershman 2006; Ragsdale 2012).

Using a long iterative process to identify potential respondents and better understand the benefits and challenges of entering into a public-private partnership, the city finally issued a request for proposal requesting the development, management, operation, and maintenance of a new DE system at a fixed price, with allowances for inflation (Gershman 2006). The city itself offered to help finance the new plant, and Constellation Energy Projects and Services won the bid and benefitted from a $66.7 million bond issuance by the city. Ground was broken in late 2002 at the new site, and service of the new natural gas-powered boilers began to customers in late 2003 (Gershman 2006; Ragsdale 2012).

The system is run as the Metro Nashville District Energy System, with the infrastructure itself owned by the local metropolitan government organization and the daily operation of the system run by Constellation (PGL 2010). As the contracted administrator for the system, Thermal Energy Group, Inc. works constantly to develop additional business for the DE system. The system was built to accommodate more buildings than are currently on the system, specifically to improve economic development in the downtown core (Ragsdale 2012).

Today the system serves 39 buildings representing about 9 million square feet. In addition to offices and government buildings, an arena, hotels, and residential developments all receive service from the system (Metro Nashville 2012). The city believes the economic development aspects of the DE system will yield long-term benefits for the downtown. A new convention center will be a major new customer for the system in the near future (Ragsdale 2012).

Success Factors and Policy Tools

The success and continued presence of a downtown DE system relied heavily on the involvement of the system's existing customers. The city kept in constant communication with the system's customers during the period of transition and involved them in all the stages of private partner selection (Gershman 2006). A continued commitment by the city helped the project move forward, and the city's use of its bonding authority helped convince private respondents that there was much to be gained from a partnership (PGL 2010).

Once the city recognized that its citizens did not want the air pollution or other real and perceived nuisances from a waste-to-energy system, it quickly moved to identify the most cost-effective options. By keeping the emphasis on the overall cost savings for DE customers, the city was able to maintain customer interest and involvement in the process.

Finally, and perhaps most importantly, the majority of the buildings connected to the existing DE infrastructure were public. The city and state, with a majority stake in the outcome, were able to strongly "lead by example" and help guarantee well over half the future load by committing its buildings, including the state capitol (PGL 2010). This helped reduce the perceived risk by both RFP respondents as well as private building owners.

The Major Expansion: Seattle, Washington

In Seattle, a legacy DE system has recently modernized and the city has determined that leveraging the assets of the existing system to greatly expand the reach and scope of DE in the city is a high priority. Lessons from recent lost opportunities for DE appear to be underpinning the strong commitment by the city to municipal leadership in expanding the DE system today.

In 1889, a fire destroyed nearly every building in the city's Pioneer Square neighborhood, and citizens were suddenly highly averse to open flames in their buildings. The opportunity for totally new infrastructure as new buildings were built enabled a DE system to take the place of the building-by-building boilers that had previously provided heat. In 1893, a new centralized plant offered heat to connected buildings and electricity to the city's robust streetcar system. Today that system provides steam only to 200 buildings in the city's core through over 18 miles of pipe. Seattle Steam, now an independent and unregulated utility, has customers representing seven percent of the city's overall energy use, including three hospitals, many office buildings, a university, a brewery, courthouses, the central library, and the Seattle Art Museum (Dornfeld 2011; Gent 2011a). While the current steam system used to generate electricity as well as steam, it hasn't now for some time.

The system originally burned coal, then natural gas, and then, starting in 2009, locally sourced biomass. The biomass is a byproduct of the city-sponsored composting service as well as waste wood from area construction sites (Gent 2011a, 2011b). Concerns about greenhouse gas emissions and long-term reliance on fossil fuels caused the system owners to consider a number of alternatives when planning for a new boiler. When biomass appeared to be a cost-effective choice for fuel, Seattle Steam realized they could meet their own emissions reductions goals while making a smart long-term investment in their system.

The biggest challenge in updating Seattle's system to biomass was a financing one. First conceptualized in 2005, the project was slated to cost $25 million. While the company could show that the investment was sound and would yield a required return on investment, lenders remained uncomfortable with financing a technology they had not yet seen perform. Seattle

Steam found common ground with Washington Capital Management (WCM), the firm responsible for managing the pension funds of local union members. Agreeing to use union labor for the project's construction and continuing operations, Seattle Steam was able to secure a $20 million loan from WCM (Gent 2011a). After the system was commissioned, Seattle Steam secured a New Markets Tax Credit through the City of Seattle, yielding a 39 percent reduction in federal business taxes that the company used to restructure their debt, contributing $6 million in equity to the project (Gent 2011; OED 2009).

The transition to biomass has helped catalyze Seattle Steam and city policymakers to think about ways to expand DE in the city (Dornfeld 2011; Gent 2011a). The city has a goal of carbon neutrality by 2050, and the city has officially recognized DE as a critical way to build flexibility, lower emissions, and sustainability into the city's future energy mix. Ten potential areas beyond those currently served by Seattle Steam were evaluated to determine their fitness for DE, though some included buildings already served to some degree by Seattle Steam (AEI 2011). The city has identified one of these areas, First Hill, as most opportune for immediate DE infrastructure expansion. The area includes hospitals with round-the-clock heating loads, a university, and a large swath of area slated to be redeveloped into dense housing in the near future (Antonoff 2011; City of Seattle 2012).

The city has begun to seriously move forward to plan for additional DE in the First Hill area, issuing a request for qualifications (RFQ) for a third-party operator of a wholly new DE utility (City of Seattle 2012). In part, this appears to be a reaction to a missed opportunity for DE – the recently redeveloped South Lake Union area of the city – despite a study pointing to the economic and greenhouse gas benefits of DE in the area (Compass 2011).

Success Factors and Policy Tools

Greenhouse gas goals have been critical to the continued progress of the DE plans. Both Seattle and the state of Washington have greenhouse gas reduction goals that can be well addressed by DE systems (Collins and Williams 2012). Awareness of previous lost opportunities was also a catalyst for the city to avoid making the same mistakes again. Waiting to determine the exact ownership structure, which might involve or require municipal or state-level legislative changes, could take too long and cause additional missed opportunities as the First Hill area develops. Instead, the city issued an RFQ that left room for a wide variety of ownership models and public-private partnerships, in order to begin to identify the feasibility of certain technological approaches without limiting itself to a certain business structure. The selected respondent to the RFQ will then be granted exclusive responsibility for a full feasibility study and stakeholder negotiations.

Though initial research identified multiple areas of Seattle that could be well-suited to DE, the city identified only one and has thrown all of its administrative support behind successful DE deployment in that one area. Interest in developing a system that allows for future expansion and adaption is high as well, or possibly integration with other DE systems that develop independently (Baumel 2012).

The process has defined roles for all parties. One city department, the Office of Sustainability and Environment, has been the single point of coordination for all the recent DE plans and is the official voice for the city in plan development. As for the area utilities, Seattle Steam, as owner and operator of the existing DE system, is responding to the RFQ, while Seattle City Light is involved in the process but is not interested in operating the DE system. Both utilities have interests in seeing the system succeed: Seattle City Light remains interested in the system's function as a "battery" when river runs yield more hydroelectricity than can be used, and Seattle Steam stands to see their business interests strengthened by either partnering as a wholesaler of power to the new DE system or leading the development of the new DE system (Baumel 2012; Gent 2012; Collins and Williams 2012).

Lessons Learned

Process Lessons

Successful implementation and advancement of DE plans rely on clear processes maintained by effective leaders. Key process lessons learned include:

- Work to develop consensus around energy resource options. Some parties are highly averse to waste-to-energy schemes and bioenergy, depending on the source. In Nashville, citizens were vocal in their rejection of waste as an energy resource but coalesced around natural gas.
- Identify quality consultants whose views will be viewed as both neutral and informed. In Seattle, a report by Compass Resource Management outlined a number of DE opportunities and options and remains a guiding force throughout the project development.
- Work early to educate potential building owners and tenants of the economic and environmental benefits of DE systems. Clearly explain how various approaches to heating and cooling buildings have economic and environmental tradeoffs. In Vancouver, building developers were brought on board early in the process to understand that by designing buildings to connect to the DE system, they could benefit from freed-up floor space and no requirements to supply or maintain building-scale heating equipment.
- Determine which aspects of a desired DE project can be put into place in the near future. Seattle and Portland, Oregon both recognized that previous opportunities for DE systems had been lost. To address this, the cities are both engaged in long-term DE potential assessment activities to identify future DE opportunities, even years before a system might be built (PGL 2010; Compass 2011).
- Worry later about the exact ownership structure and move forward with feasibility assessments and discussions with stakeholders. Seattle was not ready to commit to a system design or ownership model, but knew that the groundwork for the First Hill area needed to begin. They issued their RFQ with an "owner-agnostic" approach to allow freedom to consider various structures during the course of project development (Compass 2011; Baumel 2012).
- Lead by example, if possible. Nashville looked to its city- and state-owned buildings to commit early to the new DE system, providing a guaranteed load and reducing the perceived risk for privately owned buildings.
- Build a regulatory structure that involves appropriate stakeholders. Vancouver's Neighborhood Energy Utility is currently owned by the city and regulated by the City Council, representing citizens' interests, with input from an expert panel of three people who do not work for the city or the NEU.

Policy Lessons

Despite DE's many benefits, policies are not always well-aligned with DE advocates' goals. Key policy-related lessons learned include:

- Use bonding authorities to help finance infrastructure investments, as in Nashville.
- Move to treat thermal energy as a prioritized resource in relevant energy goals or standards. In the state of Washington, thermal energy is now equal to other renewable energy in the voluntary credit-trading markets, which may offer some developers additional incentives to connect to DE systems
- Allow DE systems to rate-base investments in infrastructure. Vancouver developed a levelized rate structure that includes a fixed rate, which accounts for up-front capital costs, and a variable rate, which accounts for variable fuel and operating costs. The rates are designed to eventually cover the full cost of the DE development incurred by the city.
- Leverage existing tools and begin the groundwork for developing new tools if necessary. Since a portion of Seattle's First Hill area will be filled with affordable housing, a requirement that such housing must connect to a DE system is well within the city's policy toolkit. Conferring property tax benefits or, as in Vancouver, requiring that a feasibility assessment for DE be done before major new developments are other ways cities can entice developers and improve the economics of a DE system (City of Seattle 2012; Baumel 2012; BC Hydro 2012).
- Require that buildings in locations ripe for DE systems install compatible heating and cooling technologies, even if immediate hook-up to DE systems is unlikely. Hydronic heating infrastructure can be required in certain types of buildings through codes and standards.
- Analyze incentives offered by utilities and other programs for conflicts. Seattle City Light offers incentives for heat pumps, which work at cross-purposes with long-term DE goals by making a house or building less attractive to connect to a DE system in the future (Compass 2011). Instead, as in Vancouver, utilities could offer incentives that reflect accurate business-as-usual estimates and look at overall electricity reduction as a key evaluation data point.

Challenges on the Horizon

Recent projects have illuminated certain challenges that will continue to face cities interested in encouraging DE development. These include the fact that district energy technical opportunities are more prevalent in existing dense urban cores (PGL 2010). While new developments can more easily integrate hydronic systems and other components that are complimentary to district energy, older buildings remain an important target. Owners of buildings that long ago paid off their mortgages are not incentivized to make substantial new investments in their facilities. Building codes typically are most impactful as a building is built, not retroactively. Developing methods that address the barrier in existing buildings, such as requiring energy audits or DE feasibility assessments when buildings change ownership, are some of the ways to bring existing buildings into the fold.

Even if owners are interested in connecting older houses to DE systems, retrofitting homes to connect to DE is cost-prohibitive. Programs such as the property-assessed clean energy

(PACE) financing tool are ideal for overcoming the high up-front costs, but many states have not authorized PACE financing. Fuel-switching incentives are generally prohibited in most states, leaving regulated utilities few ways to incentivize customers to connect to DE systems that would move a customer from one fuel to another. These kinds of barriers can be overcome with state legislation and changes in regulation, but require political leadership and will.

Conclusions

District energy can offer a sustainable, reliable, and economical energy solution to cities around North America. Fuel flexibility and increased levels of energy efficiency mean DE systems can play an important role in keeping energy expenditures low and reducing harmful energy-related emissions. Despite these benefits, tremendous challenges to new system development and redevelopment exist.

Government entities can play a critical role in overcoming some of the challenges. They can help ensure long-term load and returns on investment as is done for more traditional utilities making large capital expenditures. They can develop tools to help finance the high up-front costs and offer coordination among all stakeholders to ensure project goals remain in sight.

Vancouver, B.C.; Seattle, Washington; and Nashville, Tennessee all offer compelling examples of city involvement that has yielded the development, expansion, and planned development of systems that will provide benefits city-wide. All three cities required substantial public sector involvement and continued internal and external championing of the DE systems over multiple years. Successful DE system deployments take time, money, political will, engaged stakeholders, and appropriate energy supplies and demands to work. For urban areas looking to meet long-term energy and greenhouse gas goals, district energy can be a great fit and worth the work.

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