

# Eye on Innovation in Seattle:

## District energy positioned for continued success

Stan Gent, PEng, President and CEO, Seattle Steam Co.



Thoughts of the Pacific Northwest often conjure up images of majestic mountains, towering pine trees and salmon swimming upstream. While they seem a stark contrast to the area's growing high-tech companies, together they reflect the region's commitment to both green living and innovation. It is the perfect setting for the continued growth and acceptance of district energy, a technology that has proved environmentally responsible and flexible enough to adapt to industry advances.

Seattle Steam Co. has long carried the district energy torch in Seattle, from its founding in 1893 to its position today as a leader in the city of Seattle's carbon reduction efforts. The company's switch to renewable biomass fuel in 2010 helped pique the city's interest in district energy expansion, which is detailed in a city-commissioned report titled *A District Energy Strategy for the City of Seattle: Background and Directions*.

Prepared for the city of Seattle's Office of Sustainability and Environment by Compass Resource Management, the 2011 report outlines how Seattle Steam and a collabora-

tive team can use district energy to help the city meet its carbon reduction goals by the year 2050.

Seattle Steam is up to the challenge and is committed to a sustainable business model that embraces innovative technologies and best practices. The company's recent energy, environmental and customer service accomplishments have set the stage for new initiatives that feature a new-age steam engine, combined heat and power and virtual electricity storage, and biofuel use – all distinct possibilities for a vibrant, 121-year-old district energy system.

## TEAM FOCUSED ON CARBON REDUCTION

Former Seattle Mayor Greg Nickels solidified the city's commitment to the environment during his two terms as mayor, from 2002 to 2010. Through the U.S. Conference of Mayors, whose Climate Protection Agreement he launched in 2005, Nickels convinced fellow mayors to agree to meet or beat the carbon reduction targets laid out in the Kyoto Protocol (7 percent reduction from 1990 levels by 2012) in their own communities.

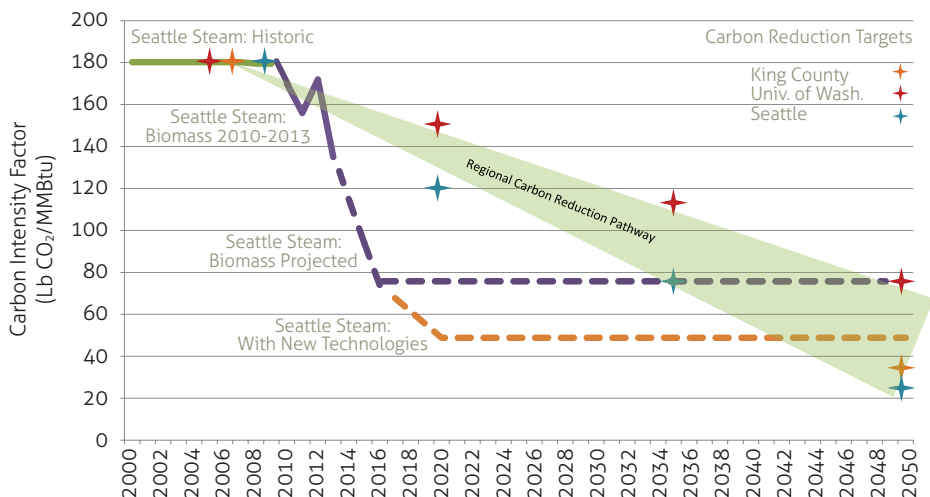
Soon thereafter, the city of Seattle, King County and University of Washington each released carbon reduction targets that reach out to the year 2050 (fig. 1). Now, the city of Seattle is focused on developing and implementing an action plan to ensure its climate protection goals are met.

Through its 2011 study, the city of Seattle learned that buildings account for more than 20 percent of the city's greenhouse gas emissions. As a result, Seattle decided that one of its goals should be to encourage connection of new and existing buildings to renewable fuel-based district energy service, which has less environmental impact than on-site boilers in each building.

The report identified several areas in the city where such district energy growth would make the most sense. Four areas were identified as having high near-term potential: First Hill, including Yesler Terrace; Capitol Hill; University of Washington; and South Lake Union (fig. 2). Each site is adjacent to the existing steam district heating service; each is experiencing high-density development. (To learn more on the siting criteria, download the full report at <http://tinyurl.com/seattleDE>.)

After analyzing study results, the city selected Corix Industries to serve as its district energy development partner. In coordination with Corix, the city's strategy is to partner with district energy utilities, provide overall

**Figure 1. Seattle Steam's Carbon Reduction Strategies Align With Regional Carbon Reduction Targets.** The city of Seattle, King County and University of Washington have set aggressive carbon reduction targets through 2050. Seattle Steam's biomass plant and projected new technologies will help the city reach those goals.



Source: Cyan Strategies using data gathered from Seattle Steam Co., city of Seattle, King County and University of Washington.

**Figure 2. Areas of District Energy Opportunity, City of Seattle.** In addition to Seattle Steam's district heating system that serves downtown and a portion of First Hill, there are two other existing district heating systems in the area: Seattle Center and University of Washington. The university system is primed for growth, plus there are district energy opportunities near South Lake Union, Capitol Hill and Yesler Terrace.



leadership and vision, set policies to facilitate cost-effective district energy development and provide incentives for district energy connections.

As a result, district energy development in Seattle has become a three-legged stool: the city of Seattle as the leader, Corix as the development part-

ner and Seattle Steam as the existing utility. Each has a role to play, and the absence of any one of the “legs” would make development much more challenging. To clearly define the working relationship, Seattle Steam and Corix entered into a principles of cooperation agreement. Together they are evaluating district energy expansion using hot water district heating service beyond Seattle Steam’s core steam distribution network.

Per its plan, the city of Seattle has spearheaded policies to support district energy development. New construction in some neighborhoods will be required to use renewable district heating if it is available. Seattle Steam is working with the city to finalize the “renewable” criteria.

In the South Lake Union neighborhood, buildings with LEED (Leadership in Energy and Environmental Design) Gold or Silver certification that are connected to a renewable district heating system qualify for an

increase in their allowable floor area ratio. Plus, the city’s new energy code (2012) focuses on metered energy at the property, which makes district heating more attractive for developers since it is a final product rather than a fuel that needs combustion.

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**DISTRICT ENERGY DEVELOPMENT HAS BECOME A THREE-LEGGED STOOL, WITH THE CITY, CORIX INDUSTRIES AND SEATTLE STEAM EACH PLAYING A ROLE.**

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**INNOVATION DRIVES PROGRESS**

Seattle Steam’s commitment to sustainability is not just for the sake of slowing climate change; it also serves the long-term health and viability of the organization. To continue to be responsive to their customers in a carbon-constrained future, utilities like Seattle Steam must continue to evolve and change.

With 120 years of operational history to look back on, Seattle Steam has dozens, if not hundreds, of accomplishments that have changed its course and made the company what it is today. Even more is yet to come.

**Recent Accomplishments**

**Biomass boiler.** The company’s \$30 million investment in a biomass boiler and related equipment at its main Western Avenue Plant stands out as a game changer. Completed in 2010, the biomass boiler is the single-largest carbon reduction investment made to date by a private company in the region.

Seattle Steam’s 80,000-lb/hr biomass boiler can produce up to 55 percent of its customers’ energy needs using locally sourced clean urban waste wood. It is projected to reduce carbon dioxide emissions by more than 50,000 metric tons annually. (For more information on the biomass project, see “Paving the Way: Seattle Steam’s road to renewable energy” in First Quarter 2011 *District Energy* magazine.)

When the project was in its planning stages, Seattle Steam specified the maximum emission-reducing equipment available at the time to ensure it would not have to invest in future equipment upgrades as regulations tightened and evolved. It was a significant investment above what was then required, but its subsequent installation has turned out to be a savvy decision.

In its recent issue of new rules for stationary energy generation facilities, the U.S. Environmental Protection Agency lowered the maximum allowable level of emissions from biomass plants. Since Seattle Steam originally selected high-grade equipment, however, its boiler continues to perform at emission levels much lower than required by the new EPA rules and its local permit.

**Potable water.** Seattle Steam is on track to making its water use as sustainable as its fuel use. After detailed study, the company concluded that it could drill its own new well

System Snapshot: Seattle Steam Co.	
	Steam System
Startup Year	1893
Number of Customers	167
Number of Buildings Served	201
Total Square Footage Served	~18 million sq ft
Central Plant Capacity	602,000 lb/hr steam
Number of Satellite Plants	1
Satellite Plant Capacity	100,000 lb/hr steam
Number of Boilers	5 boilers (4 central plant, 1 satellite plant)
Fuel Types	Natural gas, biomass
Distribution Network Length	18 trench miles
Piping Type	Direct-buried carbon steel
Piping Diameter Range	4 to 18 inches
System Pressure	15 and 140 nominal psig
System Temperature	360 degrees F

Source: Seattle Steam Co.



and tap a deep aquifer for water just before it entered Elliott Bay in Puget Sound. The benefit? It could “borrow” this water for a few days, make steam with it and return the water to either the storm or sewer system. As a result, within just a few days, the water would enter Elliott Bay – where it was already heading – creating a sustainable circle where a valuable resource is neither consumed nor lost to the environment.

After nearly two years of detailed planning, permitting and construction, Seattle Steam’s new 385-ft-deep well began operation in March. The well can produce 250 gal of water a minute, which is enough to meet around 80 percent of the company’s annual water consumption. Most important, it will cover all the company’s water needs during summer months when municipal water rates and water demand are at their highest.

As a result, this new groundwater source displaces 80 percent of the municipally sourced Cedar River Basin surface water Seattle Steam previously used each year. By reducing its municipal water use this significantly, Seattle Steam becomes an even more reliable heating resource for mission-critical customers such as Virginia Mason, Swedish and Harborview medical centers in case a major disaster or event interrupts the municipal water system. In addition, if the city water system fails during an earthquake or similar event, surplus water from Seattle Steam’s well will be available to these hospitals for nonpotable uses.

In another water-saving move, Seattle Steam obtained permission from the Washington State Department of Ecology to direct condensate from the steam distribution system to storm drains instead of the sanitary sewer. Since potable water was previously used to cool the condensate prior to discharge into the sanitary sewer, diverting the condensate to the storm sewer without adding water will conserve up to 2 million gal of potable water per year.



**Heat recovery.** In 2000, Seattle Steam installed a flue gas heat recovery system, which effectively made the company’s largest gas-fired boiler into a condensing boiler. It improved plant operating efficiencies by nearly 7 percent, cutting operating costs by nearly \$800,000 per year and reducing CO<sub>2</sub> emissions by nearly 9,000 metric tons per year.

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**IN EARLY 2014, SEATTLE STEAM EXPANDED ITS FLUE GAS HEAT RECOVERY SYSTEM AND INCREASED PLANT EFFICIENCIES 2 PERCENT.**  
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The original design proved so successful that Seattle Steam in early 2014 connected the plant’s other two gas-fired boilers to the heat recovery system, increasing plant efficiencies another 2 percent. The flue gas has been redirected from boilers No. 3 and 4 using a fan to pump the flue gas from one side of the plant across the roof to the existing slightly modified heat recovery installation. The gas is then exhausted in a different stack. The new configuration includes upgraded boiler controls and a com-

plex duct interconnection design and retrofit that will effectively increase the capacity of each boiler.

**Energy efficiency guidance, on-bill financing.** Since 2011, Seattle Steam has been a member of a public-private coalition that encourages downtown building owners and managers to make energy efficiency improvements that will cut energy costs, boost profits and strengthen Seattle’s economy. Seattle Steam has partnered with MacDonald-Miller Facility Solutions, a local energy service company, to offer an energy-saving program to its steam customers. One customer, the Washington Athletic Club, reduced its energy consumption 29 percent through its participation in the program. Other customers are following suit.

MacDonald-Miller conducts all program phases. Phase I is a qualitative analysis of the building’s energy-saving potential. If savings appear possible, Phase II is initiated, providing a quantitative analysis of the building’s past energy bills, an existing equipment audit and a detailed list of energy- and cost-saving opportunities, costs and paybacks. Phase III is upgrade installation. Phase III properties can access grant funds and low-interest loans to pay for the upgrades.

Seattle Steam offers Phase III-qualifying customers on-bill financing that allows them to pay back the loans over time on their monthly utility bills. Typically, energy savings cover the entire improvement cost, so there is no increase in a building owner’s monthly utility bills. In most cases, the loan is paid off in five to seven years, after which the building owner sees a substantial drop in the monthly energy bill.

Seattle Steam’s on-bill financing program received a 2013 Vision Award from Seattle 2030, an interdisciplinary public-private collaborative working to create a groundbreaking high-performance building district in downtown Seattle (<http://tinyurl.com/seattlevision>).

**Online customer portal.** Seattle Steam customers each have a con-

fidential online portal where they can access individual building steam use data going back to 1991. Activated by Seattle Steam in 2008, the portal helps customers track energy use and evaluate their progress as they implement energy efficiency improvements. Customer steam use data is posted immediately after the monthly meter reading is taken at each building.

Seattle Steam contracts with UtilityStudio (<http://tinyurl.com/utlstudio>) to populate the portal and integrate it with Seattle Steam's own billing program. Seattle Steam uses the data to identify billing anomalies and operational inefficiencies that may occur. It can also use the data for bill audits and analysis; budgeting; forecasting; energy usage, comparison and analysis; and most recently, carbon tracking. Reporting and graphing tools enable customers to see, compare and analyze energy use.

The online portal also allows customers to sign up with ENERGY STAR® for automatic benchmarking through ENERGY STAR's Portfolio Manager, EPA's energy benchmarking tool. This helps steam customers comply with the city of Seattle's mandatory energy benchmarking program ([www.seattle.gov/environment/benchmarking.htm](http://www.seattle.gov/environment/benchmarking.htm)).

### New Initiatives

**New-age steam engine.** Seattle Steam has teamed with Practical Steam, a Seattle-based startup company, to develop a new-age steam engine that could help Seattle Steam's high-pressure steam customers optimize their steam energy use. Called an advanced uniflow Rankine engine generator, the new engine would take the place of the valve that now converts high-pressure steam to low pressure inside each building. While the engine would still make the high-to low-pressure conversion, it would simultaneously produce up to 80 kW of electricity for the customer's use within the building. Steam use efficiencies could reach 96 percent.

**CHP and virtual electricity storage.** Long an impossible challenge in the Pacific Northwest because of the region's low-cost electricity and high hydro and wind power availability, CHP may now become financially attractive when paired with a newly developed concept called virtual electric storage. Here is how it is proposed to work: A CHP facility would also have electric steam generators in parallel so the plant can use electricity to make heat for the steam system when there is excess electricity due to hydro and wind generation. In effect, that could convert the whole of downtown Seattle's heating load from natural gas (and wood) to electric heat within minutes.

The unused natural gas could then be left in storage for later use. When there is no surplus electricity from wind and hydro, the CHP plant would start, delivering electric-

ity back to the system and making steam from the waste heat in the CHP cycle. Although it is not storing electricity (it is the gas that is stored), the outcome is the same, and it uses technology that exists today.

An added benefit is that the energy switching would happen where the electricity is needed, resulting in improved electric performance at the generator sites in the mountains as well as transmission and distribution networks.

Seattle Steam is studying this option along with the local electric utility for possible installation at Seattle Steam's Post Street Plant, where biofuel use is also being considered.

**Biofuel.** If financial and technical studies turn out as expected, Seattle Steam could further reduce overall emissions from its Western Avenue facility – in addition to its Post Street



Courtesy Practical Steam.

Seattle Steam is testing a production engine similar to this one, which is essentially a converted Detroit Diesel engine block. Installed at its Post Street Plant, the test unit is approximately 7 ft x 3 ft in size. If test results in 2014 prove favorable, Seattle Steam could begin offering the engines to customers by 2015.

### THERMAL ENERGY RECS

In 2012, the Washington State Legislature passed a law to allow utility companies to use "thermal energy" as part of their voluntary alternative energy programs. The biomass fuel used by Seattle Steam Co. is defined as a "qualified alternative energy resource" (RCW 19.29A.090, section 3, part h) by the state of Washington. Renewable energy credits (RECs) generated by Seattle Steam are equivalent in all respects to electric RECs. This means Seattle Steam can sell its RECs to willing buyers, either customers or other entities that wish to reduce their carbon footprint. For example, Seattle Steam could sell its RECs to a local university that might want to purchase RECs to meet its own carbon reduction goals.




Plant – by using biofuel to replace much of the company’s remaining natural gas use.

Seattle Steam is now testing the use of Renewable Fuel Oil™ (RFO), a second-generation biofuel made by Ensyn Corp., which produces advanced renewable fuels from cellulosic, non-food-based biomass. Using RFO could be Seattle Steam’s next step toward carbon neutrality, potentially helping to reduce overall plant emissions to just one-fifth of what they were before the company’s use of biomass fuel began in 2009. Test results are expected in 2014.

### SYSTEMATIC SUSTAINABILITY IS BYWORD

Through its willingness to embrace innovation, Seattle Steam has been able to reduce its carbon footprint and increase energy efficiency, making it an ideal partner on the city of Seattle’s district energy development team.

It has taken a strategic approach to adopting new technologies for itself and its customers, which has positioned the company as a viable – and sustainable – business enterprise in downtown Seattle for decades to come.

**Editor’s note:** Seattle Steam will serve as host for IDEA’s 105th Annual Conference & Trade Show, June 8-11. Attendees will have the opportunity to tour Seattle Steam’s Western Ave. Plant, which includes a biomass boiler and related equipment. 



**Stanley Gent, PEng,** joined Seattle Steam Co. as president and CEO in 2004. He previously was president of Comfort Link, a district cooling company located in Baltimore, Md.

During the 1990s, he was employed as vice president of engineering and development for Chicago-based Unicom Thermal Technologies and became a leader in the development of various district cooling technologies. He may be reached at [sgent@seattlesteam.com](mailto:sgent@seattlesteam.com).

# district COOLING 2014



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