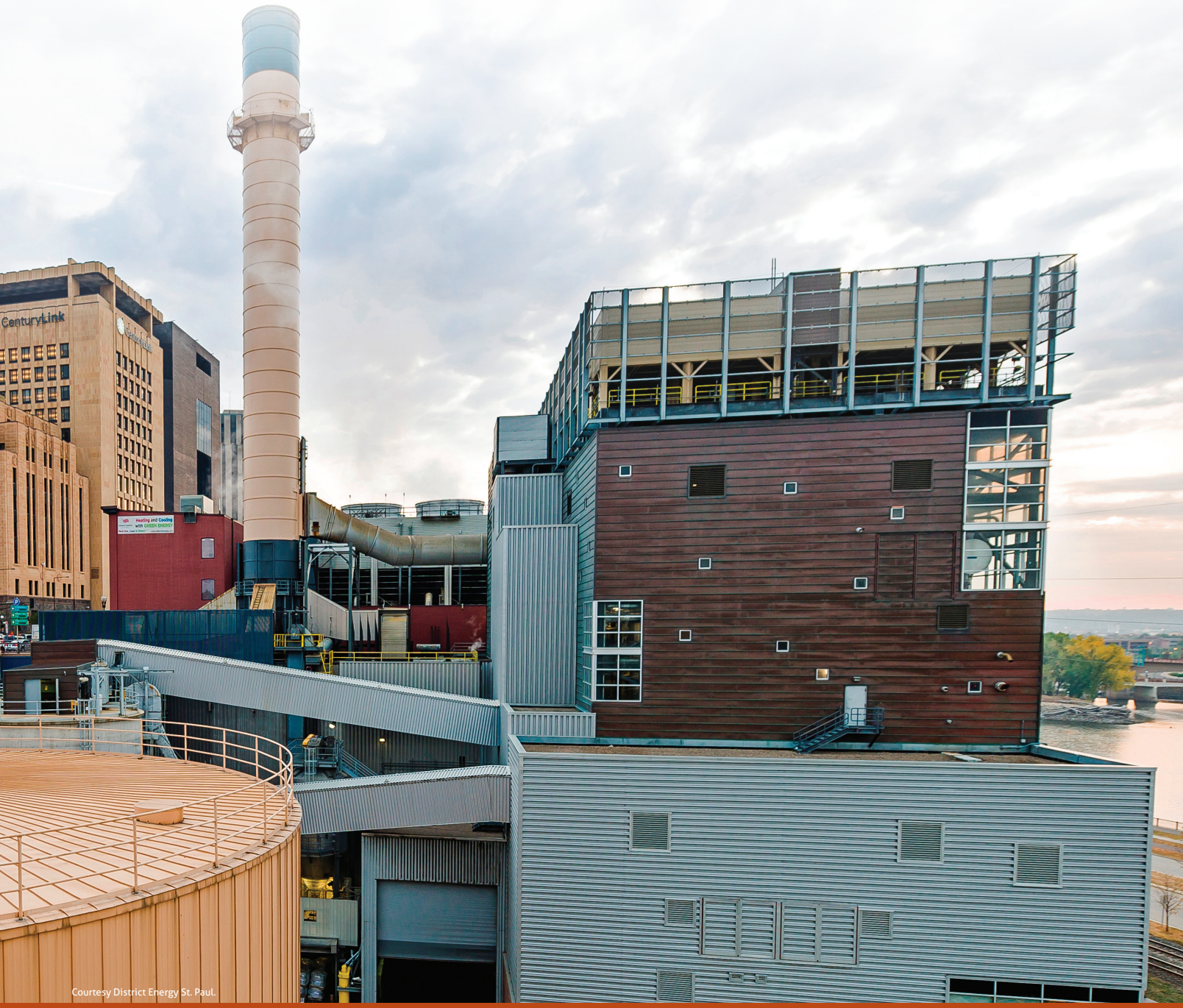
COVER STORY

Building community energy in St. Paul

Focused on innovation and partnerships, this historic downtown system has become an industry role model.

Nina Axelson, Vice President – Public Relations, District Energy St. Paul



Courtesy District Energy St. Paul.

At the District Energy St. Paul location along the Mississippi River in downtown St. Paul, a significant amount of activity takes place on a very small parcel. This central facility integrates biomass-fired combined heat and power, thermal storage, and the primary heating and cooling production for this system.

Nestled along the Mississippi riverfront in St. Paul, Minn., a unique energy system has been a critical part of the city's development for over 100 years. Entrenched in history, District Energy St. Paul has become a showcase through continued efforts to evolve, to reinvent and to integrate solutions that have earned the operations a global reputation. Testing and demonstrating the technology has been key to system achievements. Just as importantly, the people inside this operation are committed to bringing customers and community stakeholders into the story to share in the success. Whether it is multifaceted efforts to bring combined heat and power to this downtown area or to build the Saint Paul EcoDistrict sustainability platform, District Energy is dedicated to merging partnership and innovation to advance St. Paul's community energy model.

IT ALL STARTED WITH STEAM

Initiated as part of the power and light developments in the early urbanization era, this plant was part of the first generation of district energy facilities, bringing the first electricity to cities in the United States and, with it, excess steam to heat buildings. In Minnesota winters, this was a critical service.

By the 1970s this steam system was serving approximately 40 buildings in downtown St. Paul, but the Clean Air Act had ushered in new rules, and this plant and distribution system were showing their age. Although all signs pointed toward a decommissioning, a public-private partnership with the city of St. Paul and the leadership of a brilliant engineer from Stockholm, Sweden, Hans Nyman, gave this plant new life. More than 30 years later, this system serves as an international case study for community energy and the great potential for these systems to provide modernized and resilient solutions to cities.

ADVANCING THE SYSTEM

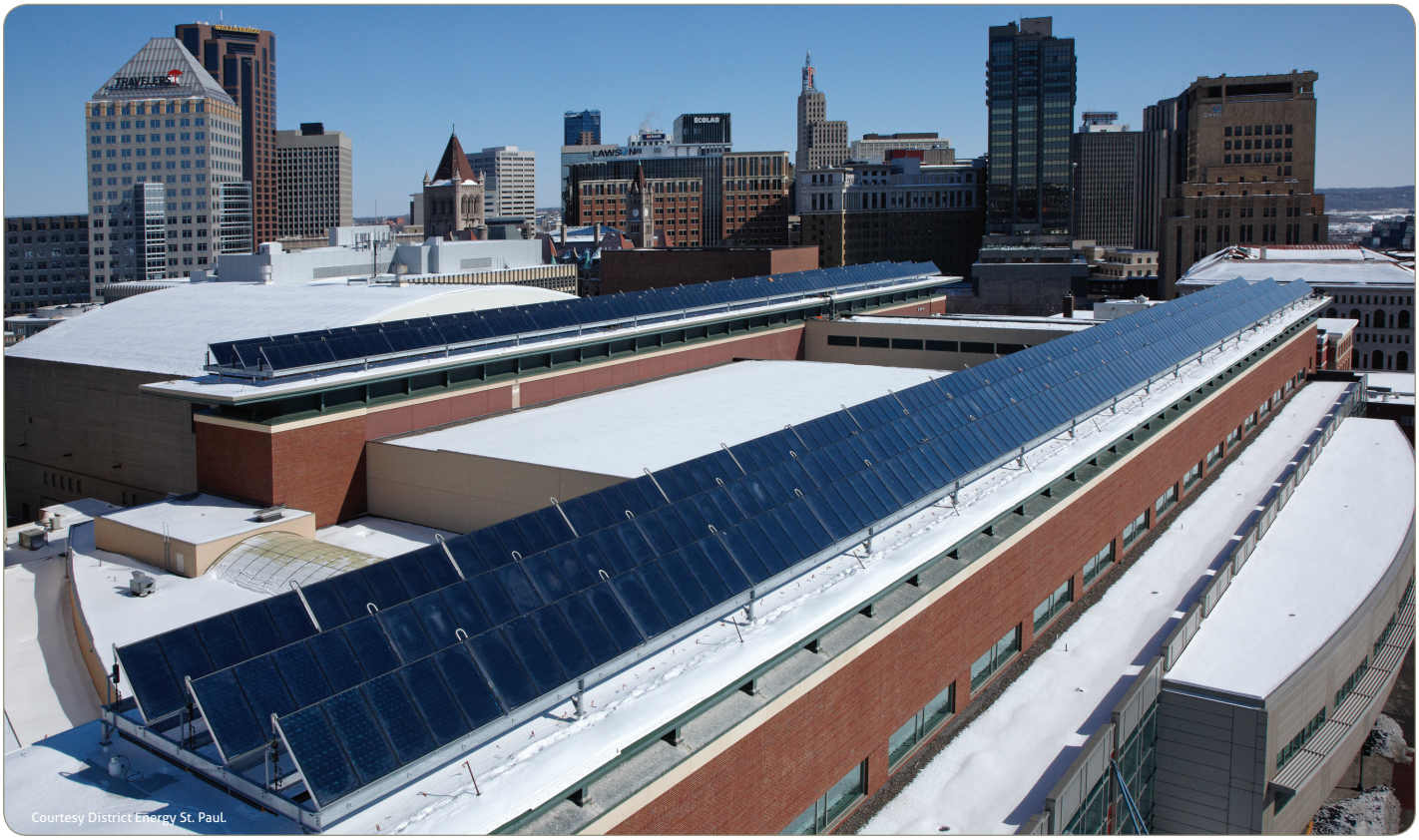
Today, District Energy St. Paul hosts thousands of tour guests seeking to learn from the advancements of this system. With coal destined for elimination, how was this system able to move from using 100 percent coal to primarily renewable heating? The solution starts with the transition from the once-through steam system to the high-temperature hot water loop in 1983. This major infrastructure change is still one of the largest efficiency projects the system has undergone and allowed District Energy to continue to add customers while using less energy than in its previous years.

District cooling services were introduced in 1993, with the eventual addition of chilled-water storage tanks to optimize system efficiency, reliability and climate resilience. This also helps the local electric utility shift this significant load to off-peak production. One of these tanks also has the ability to seasonally shift from cooling to heating storage, readying it for incorporation of low-grade heat sources. These tanks (2.5 million and 4 million gal of capacity) are critical to the cooling infrastructure and its success and serve as very visible markers of the district system serving the city.

In 2003, the integration of the 33 MW-peak biomass-fired CHP plant shifted a significant portion of the heating burden from fossil fuels to locally sourced wood waste (approximately 550,000 MMBtu per year). This also created a very tangible and successful example of biomass and CHP to serve as a living lab. As well, it created an industry exchange for local forestry and energy professionals looking to develop more biomass and

Courtesy District Energy St. Paul.

Wood residuals, including tree trimmings and clean industrial and construction debris, become a benefit instead of a disposal challenge when utilized as renewable biomass fuel. Ever-Green's staff operates and manages the Environmental Wood Supply facility as part of maintaining a steady supply of renewable boiler fuel for the CHP plant.



Courtesy District Energy St. Paul

Mounted on the roof of the Saint Paul RiverCentre complex, District Energy's 144 solar collectors are collecting over 900 MWt of energy every year. The energy collected is first used on-site to meet the building's heating and hot water demand. Excess energy is then exported into the district energy loop.

bioenergy opportunities in Minnesota and the Midwest.

In 2011, 144 solar panels were also integrated, making this installation the largest solar hot water heating project in North America. This 1.4 MWt installation sits atop the site of the 2016 annual IDEA conference, the Saint Paul RiverCentre. The highly visible location and easy rooftop access have made this another attraction for energy enthusiasts looking to integrate solar into district energy or other operations with large heating demand.

The use of hot water, steam, chilled water, thermal storage, solar thermal, advanced leak detection, energy modeling and efficiency programs, and other technologies has helped District Energy thrive. Innovation, integration and fuel flexibility have been key to competing in the market during periods of low natural gas prices and financial challenges in the real estate sector. Having multiple fuels to dispatch has helped to avoid fuel market volatility and availability constraints. Beyond the technologies and fuels, the system's success has always depended on the people and the partnerships behind the business.

A UNIQUE APPROACH

When developing the business model in the 1970s, District Energy was intentionally structured as a 501(c)(3) nonprofit, a reflection of its public-private partnership with the city of St. Paul and several other local and national agencies, including the U.S. Department of Energy, the U.S. Department of Housing and Urban Development, the Environmental Protection Agency, the local Building Owners and Managers Association, the Saint Paul Area Chamber of Commerce and Minnesota state government. Together they worked toward the common goal of making this system an asset for St. Paul. These agencies have continued to be partners of this system, helping to develop new research (energy islands and microgrids), test new technologies (large-scale solar hot water) and use District Energy St. Paul as a resource and collaborator to find the next best energy solutions.

The system also serves as a dynamic case study for others to consider when developing their own district systems. In 2015, St. Paul was one of the three U.S. cities included in the United Nations Environment Programme's District Energy in Cities reports. Additionally, President and CEO Ken Smith has served as chair of the IDEA board of directors and participated in international delegations to Sweden, Denmark, Germany and India seeking answers to the major challenges facing our energy systems.

BUILDING THE SYSTEM THROUGH ENGAGEMENT

Although District Energy has seen great success in this industry, like other district systems, it has often gone unrecognized closer to

Sharing expertise beyond District Energy St. Paul

District Energy St. Paul was founded in 1979 as a 501(c)(3) nonprofit organization designed to serve the downtown community, working in partnership with the city of St. Paul, Minn., and other public entities. Since that time, the company has formed several affiliates that allow it to extend its expertise and service beyond St. Paul.

EVER-GREEN ENERGY INC. was initiated by District Energy St. Paul in 1998 to develop St. Paul Cogeneration in an effort to advance the initial St. Paul system. Since that time, Ever-Green has developed into one of the country's premier energy system experts, leveraging decades of experience in developing, operating and managing community energy systems that began with District Energy St. Paul. Ever-Green's current client base includes Arlington County, Va.; Pittsburgh, Pa. (in collaboration with NRG Thermal); Lincoln Electric and District Energy Corp., Nebraska; District Energy St. Paul and Duluth Energy Systems, Minnesota; and Milwaukee Regional Medical Center Thermal, Wisconsin. Ever-Green works with these systems, campuses and communities to advance the study, development and operation of integrated energy systems. Ever-Green is also the co-owner of affiliates Environmental Wood Supply and St. Paul Cogeneration, in partnership with DTE Energy.

ST. PAUL COGENERATION (SPC) is co-owned by Ever-Green Energy St. Paul LLC and DTE St. Paul LLC. The facility was developed to add a critical production efficiency and renewable energy source to the downtown heating grid as well as for the local power grid. The CHP plant simultaneously produces approximately 65 MW of heat for the downtown thermal network and up to 33 MW of electricity, which is supplied to the local electric utility as part of a power purchase agreement. Every day, the plant receives approximately 40 truckloads of wood chips, sourced from municipal and private tree and brush sites, storm-damaged trees, tree trimmings, land clearing, clean construction residues (pallets), habitat restoration and other wood waste. SPC plays an important role in providing renewable energy to St. Paul and the region and showcasing the efficiency of CHP.

ENVIRONMENTAL WOOD SUPPLY (EWS) is co-owned by Ever-Green Energy St. Paul LLC and DTE St. Paul LLC. Ever-Green's staff operates the facility, which provides a steady supply of boiler fuel for St. Paul Cogeneration. In 2015, EWS processed approximately 250,000 tons of wood residues, grinding or screening the product in a final sizing process before transporting it to the CHP plant. Using wood residuals helps keep a valuable renewable resource out of the waste stream and keeps energy dollars circulating in the local community. This effort also provides a valuable service to local communities that are dealing with habitat restoration, storm-damaged and infested tree inventory, and general collection.

ENERGY PARK UTILITY CO. is managed and operated by Ever-Green Energy. It serves a 218-acre business center developed and owned by the Saint Paul Port Authority. It is one of the nation's first urban villages that includes manufacturers, commercial/office buildings and housing units. The district energy system provides heating and cooling to a customer base that includes hotels, residential complexes, small businesses and an environmentally focused charter school. In 2012, this system was upgraded from a two-pipe to a four-pipe hot water and chilled-water system, increasing its efficiency, service reliability and customer comfort.

DULUTH ENERGY SYSTEMS serves the Canal Park and central business districts in Duluth, Minn., a city of 86,000 residents located on the shores of Lake Superior. The city-owned steam plant has been in operation since 1932 and currently provides heating service to 165 buildings. As the system manager, Ever-Green Energy is working closely with the city to plan and implement major updates that will yield additional energy savings and position the system for another 80 years of service. Most critical to this effort is the steam-to-hot water transition for 16 blocks of downtown Duluth, slated to start in 2017 in parallel with major street construction. This work will save water and energy for the system and create the opportunity to integrate renewable energy and other advancements.

home. Despite extensive efforts to host tours and participate in education outreach, still more needed to be done to help broader audiences understand the system's role in providing critical energy services and environmental leadership. It was this gap in public engagement that led District Energy to develop two unique community projects: the Saint Paul EcoDistrict and the Plume Project.

The Saint Paul EcoDistrict

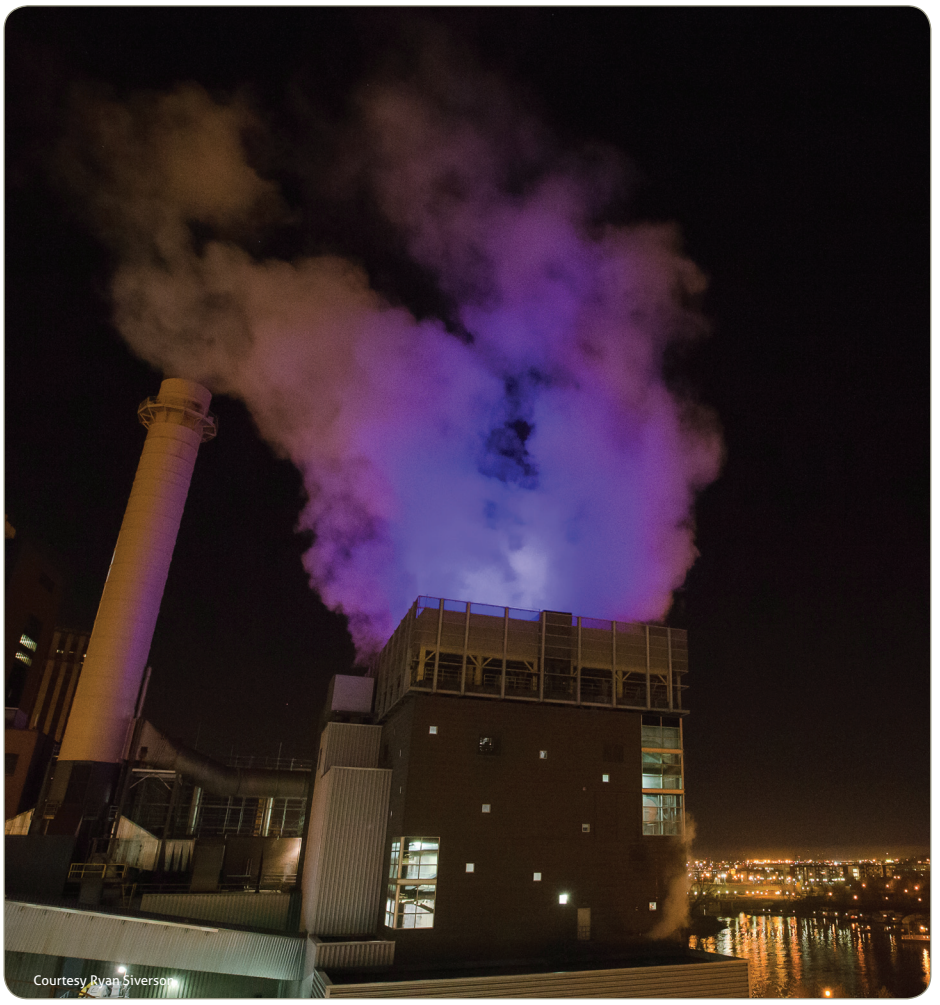
Although District Energy hosts many tours each year, it is not always possible to accommodate all requests, and technical plant tours are not always the right platform to help people understand district energy. The development of the Saint Paul EcoDistrict in 2015 offered a solution to draw in more people to learn about the system, while using more shared and virtual resources for education and engagement. The concept is still developing, but the EcoDistrict already stands out as the only place in the United States where visitors can explore nine solar installations, district energy, heat recovery, CHP, composting programs, and other renewable energy and advanced technology solutions. This showcase is all within a walkable district, which includes the Saint Paul RiverCentre as well as the Science Museum of Minnesota. The work is furthered though a partnership with the local tourism bureau and the city of St. Paul.

Together, the EcoDistrict partners are working toward four key goals: education, engagement, influence and innovation. This work also includes website, field trip and curriculum development with a local climate education organization, Climate Generation: A Will Steger Legacy. This effort sets a framework that will be replicable for other district energy systems and is already being considered for other projects under development in the Twin Cities.

The Plume Project

In addition to expanding the science-based education efforts of the organization, District Energy also launched a major public art project as an alternative path to reaching new audiences. The Plume Project was initiated through a partnership with local arts organizations (Public Art Saint Paul and the City Art Collaboratory) as an opportunity to explore both the presence and the function of the energy system within this major urban setting. Since pipes can't usually be showcased, the plant itself became the focus of the project – more specifically, the plume rising from the cooling towers of the CHP unit. This steam became the canvas for three separate art installations during the winter of 2015-2016, featuring light, animation, projection and poetry as vehicles to tell a story about where our energy comes from and how it relates to us individually and as a community.

The response was overwhelmingly positive and has created an entirely new audience of people interested in district energy. It has also been a great opportunity to make the District Energy customers proud of their provider. The project helps build the District Energy "Are you connected?" community awareness campaign that is currently promoting the amazing things in the city that are all connected together by district energy. Although the Plume Project was only funded and technically developed through February 2016, there has been an outpouring of requests to consider future collaborations.



Industrial theatrical lights were affixed to the combined heat and power cooling tower to create the visual effects for the first two plume projects, animating the steam to the cadence of poetry and to mimic the activity on the surface of the sun.

ON THE HORIZON

District Energy St. Paul is already the largest hot water network in North America, but the success of the system depends on continued growth. The heating network now serves almost 200 buildings in addition to 300 single-family homes, while the cooling system serves just over 100 buildings – representing 80 percent and 65 percent of the heating and cooling market share, respectively, for the central business district of St. Paul. Looking forward, there is great potential to continue to grow the system, including greater utilization of the hot water pipe that already crosses the Mississippi River to serve the city's West Side. Beyond the central downtown system, St. Paul is in the midst of major planning and redevelopment at multiple sites that are all being considered for district energy. These opportunities extend beyond the St. Paul borders to a multitude of locations in Minnesota, with existing systems, such as Duluth, and new systems turning to district energy as a critical solution for efficiency, resilience and carbon reduction. It signals a change in the approach to planning and a growing valuation of what this infrastructure can provide to communities interested in energy and cost efficiencies, resilience and reducing their fossil fuel dependencies. It is a welcome shift, and the 2016 annual conference will present an important opportunity to learn about these specific developments, the District Energy St. Paul operations and how this relates to what is next for this industry.

***Nina Axelson** is vice president – public relations for District Energy St. Paul. She oversees public affairs for EverGreen Energy and its affiliate organizations. Her role includes communications, government relations, community energy planning, as well as development of education and engagement programming such as the Saint Paul EcoDistrict and the Plume Project. Previously Axelson worked in community and business development with a focus on energy and the environment. She holds a Bachelor of Science degree in natural resources and environmental studies from the University of Minnesota. She can be contacted at nina.axelson@districtenergy.com.*

System Snapshot: District Energy St. Paul

	Hot water and steam/cogeneration system	Chilled-water system
Startup year	1983	1993
Number of buildings served	195 (plus 298 single-family homes)	111
Total square footage served	31.8 million sq ft	21 million sq ft
Plant capacity	Central plant: 720 MMBtu/hr hot water 25 MW electricity Two satellite plants: 89 MMBtu/hr hot water	Central plant: 13,737 tons 6.7 million gal chilled-water storage Two satellite plants: 21,700 tons
Number of boilers/chillers	7 boilers	11 chillers
Fuel types	Coal, natural gas, fuel oil, wood biomass, solar	Electric, steam
Distribution network length	40 trench miles	15 trench miles
Piping type	Direct-buried preinsulated steel pipe with polyurethane insulation encased in polyethylene jacket	Direct-buried steel pipe wrapped in protective coating with cathodic protection
Piping diameter range	1.5 to 28 inches	3 to 30 inches
System pressure	Steam: 1,250 psi, 150 psi Hot water: 180 psi	150 psi
System temperatures	Steam: 360 F supply/100 F condensate return Hot water: 190-250 F supply/140-160 F return	42 F supply/56 F return
System water volume	915,000 gal hot water	1.05 million gal

Source: District Energy St. Paul.