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# Private Power: Worldwide Development

COGENERATION

# The District Heating Renaissance

By Robert S. Seeley

**District heating and cooling systems represent a growing steam host market for cogeneration developers. However, barriers to continued expansion remain.**

Carl Avers is president of a growing company. His company, Pittsburgh, Pa.-based Thermal Ventures Inc., has plans to expand the district heating and cooling (DHC) systems it owns in Youngstown, Ohio, and Pittsburgh and is also planning to acquire the San Francisco, Calif., steam system owned by Pacific Gas & Electric.

Thermal Ventures, along with the United States' three other largest DHC companies —United Thermal of New York City, Trigen Energy Corp. of White Plains, N.Y., and Indianapolis-based Mid-America Energy Resources— are expanding as demand for their services grows.

Their success reflects a potential renaissance for district heating and cooling in the United States. Cogeneration tied to DHC is receiving more attention, as concerns about energy efficiency, indoor air quality and ozone-damaging chlorofluorocarbons (CFCs) in refrigerants make the technology increasingly attractive. Further, international interest is growing in American district cooling expertise — an expertise that may eventually have export potential.

Given these trends, however, DHC industry experts won't venture to say how large the industry could grow. While the benefits of DHC are strong, the capital intensive nature of these projects presents a barrier to expansion.

## Expanding Systems

District heating and cooling has been expanding steadily in the past decade. A particularly healthy year was 1988, when 35.5 million square feet of building space was added to 21 DHC systems in the United States, according to the International District Heating and Cooling Association (IDHCA), Washington, D.C. Since 1980, DHC industry has climbed from 59 systems in the U.S. to more than 100.

One way the industry is expanding is through development of satellite systems. Thermal Ventures' Pittsburgh DHC system is expanding into satellite systems served from a small boiler in an outlying facility. In this system the company builds a satellite facility that will serve a small cluster of buildings from an area away from the main pipeline. "When we get enough concentration, we'll build pipelines back to our main facility," Avers says.

The United Thermal systems in Baltimore, Philadelphia, and Boston are adding customers as well, and Trigen has announced a proposal with Peoples Gas to provide the energy for Chicago's McCormick Center, from which a district heating and cooling network could radiate.

Satellite facilities may spread to other networks. Trenton District Energy Co., a Trigen subsidiary, is considering satellite cogeneration plants in conjunction with an outlying hospital. Also, St. Paul District Energy Inc. of St. Paul, Minn., grew to 1.5 million square feet of building space and has built a system to serve a low-cost housing development.

In Pennsylvania, the Harrisburg Steam Works is working to expand because it is sending out only about 40 percent of its district steam capacity. "A few years ago two large customers, a Conrail locomotive facility and steel company, went off the system," says Bill Goodwin, vice president of the Harrisburg Steam Works. "At around the same time, a cogeneration plant and a waste-to-energy plant deposited additional capacity into the system." The company has already laid new pipe in anticipation of a developing area near the capitol.

## Denmark: A District Heating Model

District heating (DH) covers almost half the heating demand in Denmark. That's a world record.

About 350 DH systems throughout the country supply 40 percent of the total demand for space heating and hot water. This is expected to increase to 55 percent by 1999. Before 1995, 450 MW of new capacity is planned.

Denmark's major cities —Odense, Aarhus and Copenhagen— are expanding their cogeneration-district heating systems. For example, the capital city of Copenhagen supplies heating to more than 250,000 households, which saves 46 million gallons of oil yearly. Nationally, about 900,000 homes receive DH, half of those are one family houses.

Most DH energy comes from cogeneration plants. Thirteen such plants supply 22 percent of Denmark's heating. The other major sources are waste heat from industrial plants and refuse incineration.

The Danes also deploy small plants fired with domestic fuels such as waste, straw, sawdust, wood, biogas and natural gas. The country intends to operate a number of these small decentralized plants in the next decade.

For instance, Denmark's largest straw fired central heating plant is being built at Masnedo. It will burn about 80,000 tons of straw annually to heat the town of Vordingborg.

### National Energy Plan

Denmark established its national energy plan in 1976 after the energy crisis of 1974 tripled oil prices. The goal was to reduce dependence on any single source of energy. Power plants were converted from oil to coal, and converted to cogeneration and DH.

District heating has helped Denmark cut its energy consumption for heating by about 45 percent since 1972.

The Danish system has evolved to a transmission and distribution network where large lines run between major plants and population centers. Smaller lines branch off to individual users and heat exchanger stations transfer heat from the transmission lines to the distribution lines. This way DH reaches even lower populated areas.

Denmark's extended DH use has fostered accompanying technological development. For example, Danish systems operate at low temperatures and pressures compared with systems abroad. Most operate between 212 F and 175 F, and new systems operate at lower temperatures. Lower temperatures permit less costly pipelines, less complicated equipment, less fuel consumption and less heat loss. All combine to lower costs. Lower pressures permit direct connections to houses without using heat exchangers and permit a wider range of heat sources.

Even though Denmark represents only 0.25 percent of the world's energy supply, the country aims to set an example for DH development in other parts of the world. International interest in Danish district heating technology and supply runs high, and the Danes are able to export equipment and expertise.

This year, for example, the Danish Board of District Heating and the energy ministries of Latvia, Lithuania and Estonia are signing agreements of cooperation. Last year such an agreement was signed with Czechoslovakia. In Hungary, a Danish straw-fired DH plant will supply heat to the town of Mayor.

Over the next 10 to 15 years Denmark expects to cover 70 percent of its total heat demands by collective supply systems such as DH and natural gas.

### Future Potential

There is likely room for more DHC companies. "It's a matter of desire and opportunity," Avers says. "DHC should be more prevalent throughout the country. Japan, Europe, Eastern Europe and Russia are ahead of us in using district heating to conserve energy."

One example is the DHC system in Buffalo, N.Y., a municipally owned system which has not grown since it was completed in 1987. Avers sees this as an opportunity for an entrepreneur to take over and expand. "It's really not the function of a city to operate district heating. It is an entrepreneur's function."

Donald Leibowitz, president of Trenton District Energy Co., says potential may also exist to expand district systems such as those serving military bases and airports. A 1982 survey by the U.S. Army Corps of Engineers documented more than 4,900 miles of DHC piping on U.S. Army installations.

### Government Help

One way the industry may grow will be through private companies working with states. The state most actively encouraging DHC is New York.

As an example, the district steam system in Syracuse, N.Y., encouraged by the New York State Energy Research and Development Authority, is expanding. Fred V. Strnisa, project manager for the authority, says his office is currently talking with more than one electric utility about laying pipe that would supply hot water to small groups of customers. "We've done studies in 15 communities and can point to six successes where we built or expanded a system, or, like Rochester, kept something from going out of existence," Strnisa says.

Strnisa's office provides financial support for DHC development. In Jamestown, his office funded the initial feasibility studies, and together with the city, provided $450,000 for the initial system design. As a result, Jamestown has grown from a pilot system in 1984 to having more than 40 customers on line today, including manufacturing plants, hospitals, office buildings and residences.

Other states are becoming active as well. "As states seek ways to conserve energy and control emissions, you may see encouragement of district systems," Leibowitz says. The California energy office encourages the district concept, and there is also interest within the New Jersey Department of Environmental Protection & Energy to encourage more development of cogeneration coupled with DHC. Early signs in Newark, N.J., indicate a system might be developed. Camden, N.J., is also looking at tying district heating into two cogeneration developments.

At the federal level, the U.S. Department of Energy (DOE) is part of a planning committee that recently issued a national action plan for district heating, cooling and

cogeneration. The plan will be followed by feasibility studies and implementation plans. In fact, the IDHCA credits the rebirth of DHC in part to projects initiated by the DOE and the U.S. Department of Housing and Urban Development.

## Cogeneration

Cogeneration coupled with DHC is gathering more interest. It is difficult to ignore the 75 percent efficiency offered by cogeneration, compared to the 33 percent efficiency of a separate power plant.

For example, Trigen explores cogeneration for all its DHC locations. Its Trenton subsidiary generates 12 MW —which may be expanded— and the company's Nassau County, N.Y., system generates 57 MW of electricity which it sells to Long Island Lighting Co. There are also plans to cogenerate its London, Ontario plant. Among others considering cogeneration are Philadelphia Thermal, which is also expanding its loop into chilling.

While cogeneration and DHC seem like a perfect technical match, there are sometimes conflicts. "There is an almost adversarial relationship between the utility and cogenerator," says Leibowitz of Trenton District Energy. He suggests regulatory commissions should provide an incentive to cogeneration developers that tie into DHC, thus ensuring a fair price for the power sold.

**A welder connects a hot water pipe at a district heating system in Jamestown, N.Y. The system, fueled by the 25 MW cogeneration plant in the background, has 40 customers and is being expanded annually.**

## District Cooling Expanding

The area of district cooling represents DHC's best expansion opportunities, offering attractive energy efficiencies and a solution to the CFC problem.

Lansing, Mich., reportedly is near a decision concerning the addition of district cooling to its municipally owned heating system, and Trigen's Kansas City subsidiary plans to open new chilled-water service from its district loop. Meanwhile, District Energy St. Paul in Minnesota is digging up streets and laying chilled water pipe for its new district cooling system, which will be supplied by chillers using hydrochlorofluorocarbon (HCFC) refrigerants. HCFCs, which are believed to contribute less to ozone depletion, can replace CFC refrigerants. District Energy St. Paul has signed its first eight customers, who will take 3,000 tons of the total 4,500 tons of initial capacity. Also, the company plans to expand the system to the rest of downtown. Likewise, Minneapolis, Minn., is expanding its district cooling system, which began in 1972 and now serves 18 million square feet of building space.

Last year, Trenton expanded its chilled water downtown loop by 30 percent by adding capacity from acquired steam absorption chillers. Trenton has been adding to its chilled water system each year since 1989. Other cities are doing feasibility studies of cooling systems as well. In Indianapolis, Mid-America Energy Resources began a district cooling loop by installing four, 5,000-ton HCFC-based chillers, and the system took its first customer in July 1991. The plant has the capacity to expand to 30,000 tons, an amount Mid-America expects to have signed in a few years. "There's a lot of interest," says Kevin Greisl, Mid-America director of sales. "The demand is there. It is just a matter of getting it signed up."

Greisl expresses the same confidence in Mid-America's first acquisition, Cleveland Thermal Energy Corp. In 1991 it acquired Cleveland's steam heating system, which serves 230 buildings along with the district cooling franchise. Mid-America intends to improve the heating system, but it is currently focusing on building the district cooling plant, trenching streets and starting with 10,000 tons. Griesl says the Cleveland plant may grow to 30,000 tons. As in Indianapolis, he expects the system to be fully subscribed in a few years.

"We're determined to see DHC implemented in other cities throughout the United States," says Joseph A. Gustin, president of Mid-America Energy Resources. "We're more interested in building systems from scratch than we are in working with existing systems."

## Absorption Chilling

With absorption air conditioning, district steam provides cooling through steam with no CFCs or HCFCs. New York City's Consolidated Edison, with among the world's largest district heating systems, has 700,000 to 800,000 tons of steam air conditioning. Much of that is absorption air conditioning, with the remainder being steam turbine driven. The company has also been retrofitting its conventional cooling with absorption chilling.

Harrisburg Steam Works Ltd. is promoting absorption cooling to its customers. "In many situations, a building owner will see a distinct economic advantage in installing

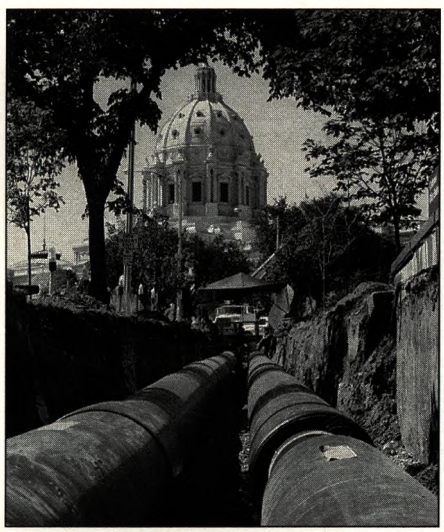
steam air conditioning in spite of its high initial costs," says Bill Goodwin, vice president. "Any economic advantage of electric air conditioning starts to erode when you have to convert CFC-based systems to HCFC."

A central district chiller plant replacing individual building cooling plants goes a long way toward reducing CFC pollution. As building owners examine alternatives with the impending CFC ban in 1995, district cooling may make more sense than retrofitting individual building chillers.

When it comes to central district chillers, Hans Nyman, president of District Energy St. Paul Inc., says when the cooling system expands he may favor steam absorption chillers in his plant. "Steam absorption chillers and ammonia-based chillers will see more use in the future," he says.

Other district cooling operators will likely consider these CFC alternatives in the future. Trigen is currently experimenting with 2,000-ton ammonia chillers in two Oklahoma plants, one in Tulsa and the other in Oklahoma City. The plants also cogenerate 2 MW of electric capacity by recovering heat from the gas turbines that generate electricity to run the screw compressors of the ammonia machines. Southern states offer a better market for ammonia machines because of higher use of cooling there, but ammonia-based systems in individual buildings may be prohibitively expensive.

This district cooling activity is drawing international interest in American cooling expertise. Some Japanese firms seem interested in district cooling and Swedish representatives have toured American district cooling facilities. Sweden is installing its first district cooling system in Vasteros. District cooling in Sweden appeals for cooling office buildings, hotels, malls, and computer facilities, among other applications.



**As part of the District Energy St. Paul, Inc. DHC system, hot water district heating piping was laid to the Minnesota state capitol in 1984. The system, which supplies heat to 1.5 million square feet of building space, has expanded to provide district cooling.**

## Indoor Air Quality

More people are realizing that DHC can reduce indoor air quality problems and some predict new indoor air quality standards will evolve. This will require far more outside air than was originally designed into building codes.

New Jersey state office buildings already require the new standard of 20 cubic feet of air per person in a building set by the American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE). "This is an additional amount a building has to take in, creating a new power requirement for a building's heating and air conditioning system," Leibowitz says. He cites the example of a new state office building in Trenton that lacked the capacity to meet the ASHRAE standard. "All we had to do was properly size the chilled water pipes to the building."

In Indianapolis, district cooling has increased building comfort levels considerably. "Since we converted to district cooling, I've eliminated all tenant complaints about air conditioning," says Ken Asam, the property manager of The Meridian Centre, Mid-America's first DC customer.

In addition, district cooling eliminates the need for cooling towers on buildings, and therefore eliminates the potential for mold, fungus and bacteria that can collect in condensate water and coils and cause indoor air quality problems. District heating also provides humidification, which some observers claim is an underestimated part of the air quality problem. Harrisburg's Goodwin says buildings can be humidified by spraying steam directly from district steam pipes into a building's air duct, or by making steam for humidification from a reboiler heated by district hot water. "Several customers in Harrisburg have installed humidifiers," Goodwin says. "We think there's a good marketplace for this as part of the indoor air quality solution."

## Clearing Barriers

District heating and cooling proponents can point to many success stories in the United States. For example, St. Paul, Minn., today supplies twice as many square feet of district heating with the same amount of fuel as before the system was built 10 years ago. Likewise, Trenton's emissions are less than half of what is allowed by New Jersey. Leibowitz says, "DHC is like motherhood, with its energy efficiency, emissions control, CFC elimination or reduction, indoor air quality, reliability and the opportunity for developing urban centers."

DHC systems offer cogenerators a viable steam host alternative, but significant barriers remain. Despite its benefits, DHC is not yet widespread. Capital, including large sums of initial risk capital, forms one barrier. "If we could get low-cost loans and pay them back over 20 years, there would be greater national expansion of DHC," Leibowitz says. In many cases, financial support from federal, state and local governments may provide the incentive needed to get DHC systems off the ground.

Such incentive programs may develop as concerns increase about efficiency and CFC pollution. Says Thermal Ventures' Avers, "Because of its inherent fuel efficiency, it will be more important in the '90s and beyond that we build DHC systems." ■

Robert S. Seeley is an industrial writer in Bridgewater, N.J. He was formerly editor of the corporate publications of Ingersoll-Rand Co. and General Public Utilities.