District Heating & Cooling

Volume 76 Number 1 Third Quarter 1990

Urban Waste

Turning Problems into Energy Opportunities

Also In This Issue

District Heating:

A Scandinavian Strategy for Cleaner Air

With a population of over 650,000, Stockholm has increased its use of district heating and decreased its emissions levels.

By K. Dorothea Stierhoff

In North America we recognize that immediate action is needed to improve air quality, or there will be long-range health and economic risks. But we also know that these improvements could carry a big price tag. As we analyze the technologies available to aid in the reduction of emissions, district heating and cogeneration present excellent opportunities to reduce site specific air pollution while generating revenue which would balance out the cost of new pollution control technology.

Increased Fuel Efficiency Shows Direct Air Quality Improvements

By investigating reports on reductions in pollution in Sweden and other Scandinavian countries since the establishment of district heating in the early 1960s, we can project the benefits of expanded use of district heating and cooling in the United States. The Scandinavian countries have documented substantial decreases in SO_2 particulates in urban areas as the use of district heating increased. In Sweden they have found that increased use of district heating and other pollution control technologies have led to substantial atmospheric reductions of sulfur and particulates. This is a direct result of more fuel-efficient operations.

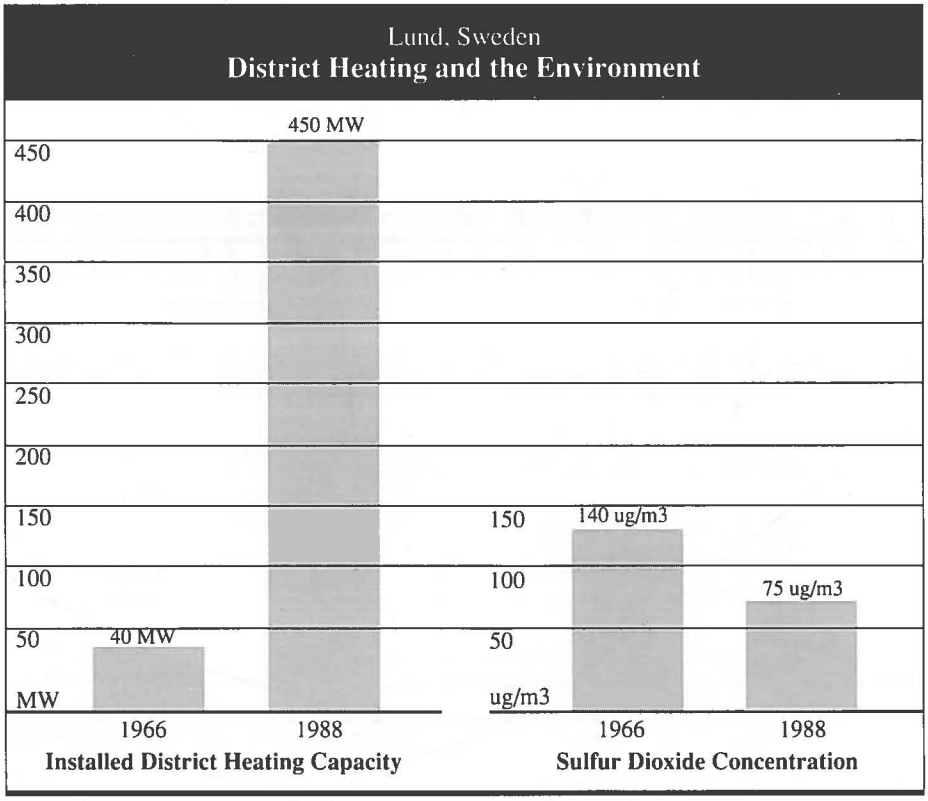
Many of the district heating systems in Scandinavia were started in the late '50s and early '60s. The price of fossil fuels has always been high, encouraging utilities to investigate and develop technologies that take advantage of fuel efficiency. The phased development of district heating throughout many Swedish cities and communities replaced individual oil-based heating systems with more efficient central oil-fired plants. These plants could burn the fuel more efficiently than single-source boilers while incorporating the latest pollution control devices. As the district heating systems expanded, the utilities made use of other sources of heat including the waste heat in cooling water and otherwise wasted heat from electrical generation, which further increased their overall fuel efficiency. Waste heat from waste-to-energy systems including waste wood products are also being utilized now as district heating continues to expand rapidly.

The Scandinavian countries also found as they increased the use of district heating in urban areas, that the amount of sulfur dioxide and particulates decreased dramatically. In Finland, district heating now meets 45 percent of the country's heating requirements. In its capital city of Helsinki, sulfur dioxide concentrations were reduced

by 78 percent between 1960 and 1985. Swedish cities have had the same success. From 1966 to 1988, Lund, a city of 63,000 people, increased its installed capacity of district heating from 40 megawatts to almost 450 megawatts. In that same period, the concentration of sulfur dioxide was cut by two-thirds, from 140ug/ m3 to under 75ug/m3.

In Stockholm, district heating has not only reduced the multiple sources of emissions, but also reduced the dependence on high-sulfur oil as the primary fuel for the area. The city saw a ten-fold increase in the square-feet of space connected to district heating from 1965 to 1985. In that same period, Stockholm reduced sulfur dioxide emissions from approximately 55,000 tons per year to approximately 11,000 tons per year. Particulate emissions have also dropped from approximately 2,200 tons per year to approximately 800 tons per year.

As Stockholm added district heating capacity, it also diversified its fuel selection. Much of its early growth was based on high-sulfur oil. But in the late 1970s, refuse incineration was added as a heat source, and in the early 1980s the city greatly increased the use of large-scale heat pumps to expand the system's capacity.



Sulfur dioxide concentrations in Lund, Sweden, have dropped in conjunction with the significant increase in district heating use.

District Cooling Makes U.S. Potential Even Greater

These examples of pollution reduction in Scandinavian countries took place with the use of technology that is commonly available today. Expanded use of district heating throughout the United States could produce similar results. This is a low-technology approach to solving the problem. The employment of district heating as a method of energy supply that can positively impact the environment is further supported by the United Nations' World Commission on Environment and Development. The Commission asserts that cogeneration and district heating and cooling technology are an important element in the efficient supply of electricity, heating and cooling for buildings worldwide.

Because of a cooler climate, the systems in Sweden and Finland provide heat only. Although the United States has a high heat demand that has been met through burning fossil fuels, we have an even higher cooling demand. Burning fossil fuels in the summer to produce electricity for cooling leads not only to increased sulfur dioxide and particulate emissions, but also to increased carbon dioxide levels that further add to the greenhouse effect. Most important is the fact that electric generation by America's large-scale, single-purpose electric generating plants is only 33 percent efficient. The balance of 66 percent is wasted to rivers, lakes or the air through cooling towers. In addition, most commercial buildings in our cities use large-scale chillers containing chlorofluorocarbons (CFCs) for a refrigerant to cool their space. CFCs have been shown to lead to the destruction of the ozone layer.

Stockholm reduced sulfur dioxide from approximately 55,000 tons per year to approximately 11,000 tons per year.

In-building absorption chillers and large-scale district cooling systems can be used in place of relatively small, in-building CFC-based chillers. Generally, when coupled with district steam, these systems can take advantage of the waste heat from electrical generation or waste-to-energy systems. This helps reduce the amount of fuel that needs to be burned to meet total energy demand, thus reducing the output of CO_2, SO_2 and other pollutants, while reducing the use and release of CFCs to the atmosphere.

Fuel-Efficiency Question Largely Absent from Policies

During the early days of the energy crisis, Argonne National Laboratory estimated that DHC could replace four quads of energy in the United States. A number of new systems have developed in the past decade and existing ones are expanding, but the implementation of DHC has not reached the levels planned. They need more policy support to keep the competitive situation between competing energy suppliers consistent with fuel efficiency and the reduction of emissions. We can now see that this development not only would conserve a great quantity of fuel,

Continued on page 48

Upcoming DOE Programs

The DOE is implementing a District Cooling Engineering and Design Studies program to support district cooling in communities where its technical and economic feasibility has already been established. A total of $800,000 will be available on a cost-shared basis. A solicitation was planned for release before the end of September 1990.

The DOE is also planning a program to promote commercialization of advanced district cooling technologies through joint-venture demonstrations. In the joint ventures, the DOE will provide up to $1 million in funds annually for three years to one or more consortiums of public or private organizations for 50 percent cost-shared research, development and demonstration. Funds for the program have not yet been appropriated, and a solicitation is not likely until next year.

International Energy Agency Research Results

The International Energy Agency (IEA) recently released several reports relating to DHC. Below are highlights of these new publications:

- **"Advanced Energy Transmission Fluids—Final Report of Research"**

This report summarizes recent research on advanced fluids, including hydraulic characteristics of ice slurries, impact of friction reduction additives on corrosion and interaction with other additives, and technical and economic evaluation of application of surfactant friction reduction additives in district heating systems.

- **"Guidelines For Converting Building Heating Systems For Hot Water District Heating"**

These guidelines are described on page 19.

- **"A Technology Assessment of Potential Telemetry Technologies For District Heating"**

Technologies currently available in North America for remote metering are analyzed, including systems using telephone networks, power lines, radio, cable television, satellite, fiber optic and manual meter reading.

- **"Static Problems in the Laying of Plastic Jacket Pipes" and "Fittings in Plastic Jacket Pipes"**

These two reports describe practices for installing plastic jacket pipe and the use of fittings with such pipes in a variety of countries, and suggestions are made for designing these pipe systems.

- **"District Heating and Cooling R&D Project Review"**

This overview of more than 200 district heating and cooling R&D projects touches on a wide range of DHC topics.

Copies of the above reports are available from the U.S. representative on the IEA District Heating Project Executive Committee, Mr. Floyd Collins, U.S. Department of Energy, CE 133, Room 5E066, 1000 Independence Ave., Washington, D.C. 20585.

CADDET Marches On

IDHCA is a member of the National Team representing the U.S. in the Center for the Analysis and Dissemination of Demonstrated Energy Technologies (CADDET). Hans Nyman, president of IDHCA and of District Energy St. Paul, Inc., represents IDHCA.

The goal of CADDET is to accelerate the international exchange of information on demonstrated energy-efficient technologies. Dissemination of information takes place through a newsletter and assorted brochures on projects, and through documentation in a database maintained by CADDET. This database is also available on computer disk in a standard DOS format.

The database currently includes reports on district heating projects, including a straw-fired district heating plant, a wood-chip and bark-fueled district heating system, and use of sewage water as a heat source for district heating.

Summaries were recently published on two new projects of particular interest to the DHC industry. In Denmark, a system was designed to replace conventional natural gas pressure reduction with an expansion turbine to generate electricity. To avoid freezing, the gas will be preheated by using heat from a cogeneration system. In Finland, a project demonstrated the use of boiler fire-room cameras and digital image processing for the supervision and control of heat recovery boilers.

The CADDET newsletter and brochures are provided free of charge. If you are interested in receiving the newsletter or the brochures, call or write to Trudy Sherwood at District Energy St. Paul, 76 W. Kellogg Blvd., St. Paul, MN 55102 (Phone 612-297-8955).

Mark Spurr is principal of Resource Efficiency, Inc. a Minnesota-based consulting firm, and is chair of the IDHCA Research and Development Committee.

District Heating *Continued from page 44*

but would help reduce emissions and improve air quality throughout the country.

But efforts need to start now to encourage expanded use of DHC. Communities and development companies need to be informed on the benefits of this technology. And more importantly, Congress, as it addresses the clean-air issue, needs to be reminded of the Scandinavian model and become forward-thinking about fuel efficiency, i.e., ratio of usable energy output to energy input rather than just the traditional emissions from a single energy producer. The U.S. Environmental Protection Agency needs to get to a new plateau on its thinking—this fuel efficiency idea has been applied successfully by the EPA on automobiles. "Miles per gallon" is a ratio of usable output to energy input. It works to reduce emission and total energy use at the same time. It is time it is used on energy production sources.

K. Dorothea Stierhoff was formerly with the Catalyst Thermal Energy Corporation. The author thanks Rolf Stalebtant, executive director of the Swedish District Heating Association, and Thomas C.J. "Jack" Gleason, a consultant in alternative energy systems, for the background information provided for this report.