

District Heating & Cooling

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A Delicate Balance for Planet Earth

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Increased Pressure Brings Valued Comfort to Mile High City

By Jan Wagner and
Michael ElDorado
Public Service Company
of Colorado

The cry of "gold" still echoed through the heart of the Mile High City in 1879 when a bewhiskered pioneer named Smith decided he wanted modern heating for his new hotel on Larimer Street in Denver's original business district. Shortly after his steam company went into operation, several Denver merchants told Smith they would like to heat their establishments with the steam produced at his plant—and with this expanded operation, a district steam system was born in Denver.

Until 1949 that same steam plant provided most of the steam used in downtown Denver buildings. As the customer base grew, materials previously destined for warship gunbarrels were laid for distribution piping, and the district steam business was "booming."

Today the same location—now a modern, expanded plant and long-time owned by Public Service Company of Colorado (PSCo)—still plays a major role in completing an energy portfolio meeting modern PSCo customer needs. Choice-conscious, value-minded customers continue to opt for steam. As a result, PSCo is stepping out with a renewed commitment to district steam, and Public Service Company sales have grown 7.3 percent in the last twelve months.



Chuck Jenkins

***Choice-conscious,
value-minded customers
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A Strategy with Substance

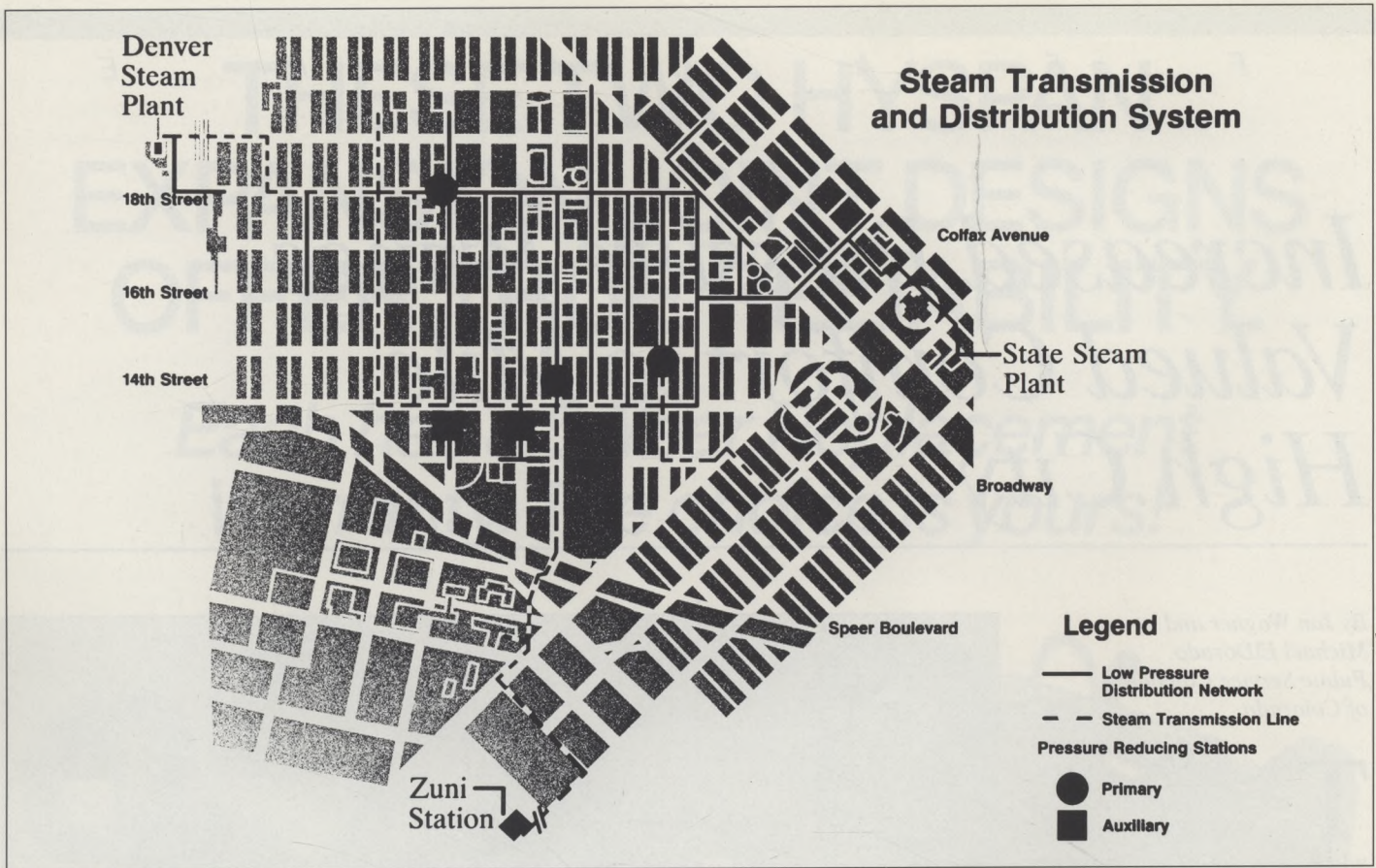
This renewed commitment is not being left to chance; customers have played a major role in Public Service Company's

commitment. Comments from the City of Denver staff express the level of this support:

We feel that a great benefit of using Public Service Company's district steam is the expertise that is included in this service. We view this as a specialized business. We can benefit from PSCo's active posture in the steam business.

These days, there is a strong commitment to provide better services and there is a resultant greater demand on public sector resources. Use of district steam is a concept for the public good. Converting to steam is an example of what we can do to better utilize our public resources. The bottom line is that PSCo's service is substantially more economical than our cost of production from the City's now-closed steam-generation plant.

In 1988, after an intensive review of its steam service, Public Service Com-



A map of Denver's downtown district steam network. Chuck Jenkins

pany decided to implement a strategy to focus the operation of the business through a Thermal Energy Department (TED) responsible for optimizing customer value and emphasizing the commitment to PSCo's district steam customers.

To learn about district energy's revitalization movement in the United States, TED became involved with the International District Heating and Cooling Association (IDHCA) to learn how other steam systems were modernized, designed and operated. It was through this combination

of customer input and technical evaluation that an overall plan unique to the Denver system began to emerge. A major focus of this plan was to modernize the piping network into a true transmission and distribution system. Part of the modernization included converting portions of the distribution system to intermediate-pressure steam.

Public Service Company of Colorado utilizes two major steam plants—one is a cogeneration facility built in 1949; the other is a base-load steam-generation plant. By installing intermediate pressure on portions of its distribution network, PSCo would be able to more economically dispatch steam and help lower fuel costs for customers. In addition, it would provide pressure support for the low-pressure network.

The Stage is Set

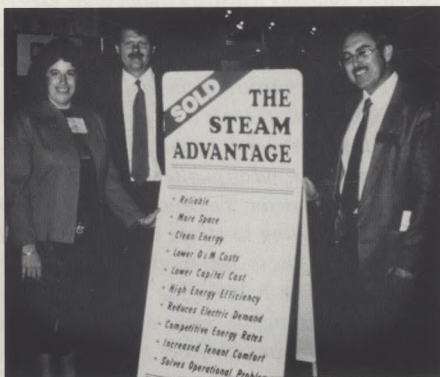
Until 1990, the PSCo steam system consisted of an 8.1-mile grid-like low-pressure distribution network supplied by three natural gas- and oil-fired steam generation sources. In March 1989, PSCo began the conversion of 3.3 miles of the 40 pounds per square inch (psi) low-pressure

distribution piping system into a 120 psi intermediate-pressure steam transmission system. The accompanying map shows the configuration of the new transmission and distribution system.

The project required a major logistics plan. It was acknowledged that although every customer would enjoy long-term benefits of higher steam pressure and lower fuel costs, most customers would notice the short-term effects of periodic service disruptions and traffic snarls that have come to signify progress in and around most cities. Adding to the concern was the fact that a winter heating season would fall midway through the pipeline conversion project.

However, when complete, the system upgrade would allow the most effective economic dispatch of the steam plants to provide customers with long-term, lower costs. The line would also provide more consistent and better distribution pressure all the way to the ends of the low-pressure network.

The project was therefore planned in two phases: the first phase converted 1.8 miles of low-pressure piping from Zuni Station to downtown Denver; the second



Jan Wagner, Mike ElDorado and Mike McCoy of Public Service Company of Colorado are set to acquaint Denver with district steam. Chuck Jenkins

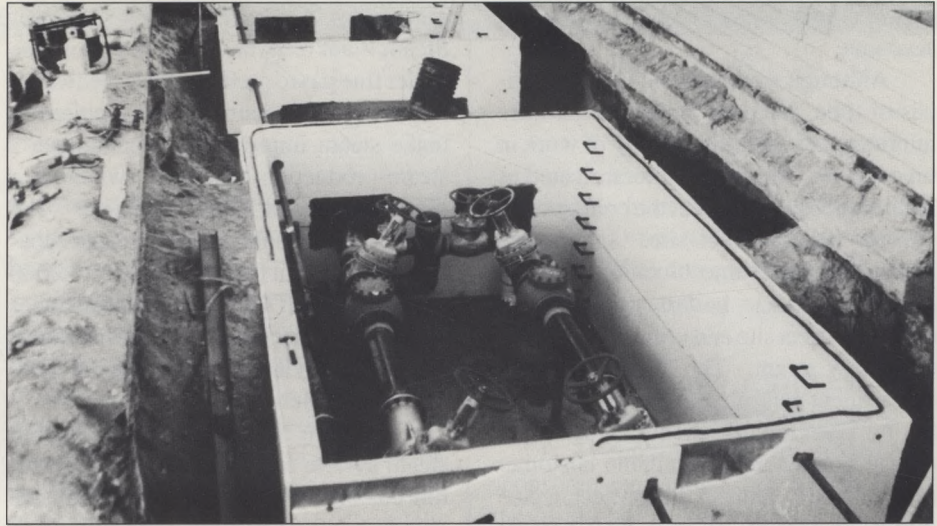
phase completed the conversion of 1.5 miles of low-pressure piping from downtown to the Denver Steam Plant.

Coincidentally, within this same time frame, the City and County of Denver were searching for ways to reduce overall operating costs at the seven-building City/County Complex. Although the complex was using an on-site boiler for heating, it was determined that using district steam could not only cut operating costs, but could potentially better serve the buildings by developing other uses for the boiler room. As a result, PSCo added its largest new customer since 1974 when the City and County decided to convert the complex's on-site steam system to district steam supplied by PSCo. Service was scheduled to begin by January 1, 1990. This required that the installation of 1,800 feet of new 10-inch steam pipe be completed concurrent with Phase 1 of the conversion plan.

The system upgrade would allow the most effective economic dispatch of steam plants to provide customers with long-term, lower costs. The line would also provide more consistent and better distribution pressure all the way to the ends of the low-pressure network.

Principal design work for the upgrade was done by Public Service Company Engineering Department. IDHCA Distribution Committee members provided valuable applications and experience which served as a reminder that these kind of upgrades, although unique to Denver, exist all over the country and are playing an important role in the effective utilization of district steam services.

PSCo Engineering Department used a computer model to simulate flow condi-



Below-ground concrete vaults house steam regulators, bypass valves and isolation valves for Denver's district steam system. Chuck Jenkins

tions and develop the design for the transmission line. Decades of data—including customer use and locations, system pressures and temperatures and steam production data—were processed and analyzed to obtain the correct component sizing. The design included extensive engineering analysis to assure that the existing piping, which had been operated at 40 psi, could be used for the transmission line and still maintain safe operation of the system at the higher pressure. Components such as expansion joints, anchors, valves and fittings were replaced when needed.

Along with the conversion project, PSCo reviewed the planned five-year distribution system capital maintenance program. When possible, work associated with this five-year program was performed on a schedule concurrent with the transmission line to minimize costs, customer interruptions and public inconvenience.

Meeting Customer Needs Head-On

The computer analysis indicated a need for three major pressure-reducing stations to feed steam from the transmission line into the low-pressure network. One reducing station is sized for a flow of 200,000 pounds per hour and the other two stations for a flow of 150,000 pounds per hour. Each reducing station has a low-flow and high-flow leg which reduces the pressure from 120 psi to 25 psi. Trip-stop valves prevent pressure above 40 psi in the low-pressure network. This offers more

flexibility by allowing PSCo to direct steam into different, higher-use areas of the low-pressure network. The regulating valves are widely used in the industry.

The reducing stations are housed in prefabricated concrete vaults which are 48 feet long, 13 feet wide and 11 feet high. The vaults employ a unique ventilation system to keep them cool to allow for better employee comfort when maintaining the stations. PSCo decided to locate the vaults underneath the sidewalk rather than in the street in order to reduce installation costs and minimize disruptions of city traffic.

A computerized data acquisition system was installed as a part of the project to monitor key pressures and flows in the system. This data is telemetered to the Denver Steam Plant, giving the control operator continuous information about the system and allowing the operator to better respond to changes in system load and customer energy needs. It also allows the operator to more closely monitor the pressure serving individual customers and fine-tune their flow.

Construction on the system was handled by PSCo Construction and Thermal Energy maintenance crews and local contractors. Almost 30 percent of TED customers were affected by the project construction; about 14 of the customers had pressure-reducing station modifications installed in their buildings. Public Service Company of Colorado worked with the 14 customers individually, while marketing representatives helped communicate the changes to other customers

during routine service calls on downtown accounts.

Although work went on for long periods of time, customer interruptions were minimized by careful planning of work in time blocks. Piping was prefabricated as much as possible either at the construction yard or on the street site. In the two instances where time blocking was not possible, package boilers were brought out to the street site and utilized to provide temporary steam. The Thermal Energy Department measures customer availability by tracking unscheduled customer outage hours against available customer service hours. During this project, a customer availability of over 99.9 percent was accomplished.

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The complete project, including design, construction and startup was completed in 16 months. Phase 1 was completed in December 1989, and Phase 2 in May 1990. The transition was very smooth and the system design and components are working reliably.

"There was some customer apprehension about putting a different face on a system that's been an energy service provider for over one hundred years," said Dennis Elliott, TED operations supervisor. "Getting involved with customers on a large project puts everyone on a fast track to greater awareness of what each other's expectations are. Customers are excited about an energy alternative that's here to stay."

The Thermal Energy Department is currently upgrading the steam system in

other areas. A new economizer at Denver Steam Plant recovers waste heat from the boiler flue gas to preheat boiler feedwater. Reducing the amount of fuel required to make steam improves the economizer's steam-production efficiency, which is a direct benefit to TED customers. The economizer also increased the peak capability of the plant from 280,000 to 295,000 pounds per hour. Water treatment upgrades have been completed at the two largest plants, improving steam quality for TED steam customers.

All these changes in the old district steam system ensure that present and future customers will have process steam, be able to serve up just the right amount of comfort for their customers, allow office personnel to work in cool comfort on a Denver clear-air summer day and be able to enjoy a growing Denver for new businesses.

Tallying the Results

The payoff for Public Service Company is sales which utilize existing assets and defer more expensive electric investments. Customer additions include the 1,112,000-square-foot, seven-building Denver City/County Complex and the 303,000-square-foot, 422-unit Housing and Urban Development Housing Complex. Both of these customers converted an in-house boiler and their own networked steam system to PSCo-supplied district steam.

Many all-electric customers are looking at and selecting steam as a way to reduce their electric demand and energy costs while improving tenant comfort. Improved comfort is the result of the more evenly distributed and better quality steam heating provided by the upgraded PSCo steam system. Republic Plaza, a 1,500,000-square-foot, 56-story office and retail complex converted part of its building heating system from electricity to steam in 1988. The conversion reduced building electric demand by 500 kW, reduced energy costs and provided more available and cost-effective energy to solve building comfort and operational problems. Installation of steam helped solve a comfort problem which allowed the lobby of the building to be leased to a major Denver bank.

Two all-electric office towers in downtown Denver will convert to district steam in early 1991 to reduce electric

demand and building energy cost. A major upscale hotel will convert from a 1 MW electric boiler to PSCo's district steam in 1991. In November 1990, the Denver Mint converted its old gas boiler system to PSCo-supplied district steam. The Mint is using steam for process heat in coin-making and space heating.

"Getting involved with customers on a large project puts everyone on a fast track to greater awareness of what each other's expectations are. Customers are excited about an energy alternative that's here to stay."

One of PSCo's major marketing focuses for 1991 is to determine how to better meet its customers' cooling needs. Because of public perception that steam cooling is difficult and less cost-effective than steam heat or chilled-water cooling, PSCo feels expanding the cooling load will have to be preceded with a re-education of potential cooling customers. The company currently maintains a cooling load of about 700 tons. Potential cooling marketing options being considered include a steam air-conditioning rate to make steam cooling more attractive, or possibly exploring chilled-water opportunities. Public Service Company has enhanced customer comfort with steam heat and is confident the same can be done with district cooling.

District steam in Denver helps Public Service Company to customize energy packages including electric, gas and steam. Steam can provide electric peak-shaving cost savings to customers, steam alternatives to gas customers looking at major capital investments, and a centralized steam service provides an energy-efficient way to keep Denver's air clean. Customers who choose steam for heating or cooling may be eligible for capital improvement monies through a recently announced

Continued on page 49

ing plant. The facility was selected for its application of supercritical steam cycles for a DH plant. A multi-unit gas-fired station of five supercritical 250-MW units and two 80-MW subcritical units produces up to 1410 MW and 3640 MWt of district heat.

The *Power Awards* were presented on October 11 at a reception in Brussels, Belgium.

25th UNICHAL Congress in Budapest Slated for June 4-6

In keeping with the themes of other major conferences scheduled for 1991, the 25th Congress of UNICHAL in Hungary next summer will focus on the state of our planet's environment. The 25th Congress will be held in conjunction with the International Exhibition "For the Environment: District Heating for Europe" at the Congress Centre in Budapest. Reports from six UNICHAL study committees as well as presentations on DH generation and distribution will dominate the conference program. Technical tours have been organized to follow the meeting. For more information contact the UNICHAL General Secretariat, Bahnhofplatz 3, CH-8023 Zurich, telephone: +41 1 211 36 35.

NARUC Releases Report on Utility and Carrier Regulation

NARUC has released its 1,006-page *1989 Annual Report on Utility and Carrier Regulation* to help put regulatory information at readers' fingertips. A "virtual encyclopedia of regulatory policy," the five-part report incorporates information not available from other sources. Rate cases, ratemaking, competitive bidding, agency funding, Canadian agencies, state-by-state comparisons and profiles of more than 100 regulatory agencies are just a few of the treats in store for anyone interested in the A-Z of regulatory policy. To order your copy for \$60.00 from the National Association of Regulatory Utility Commissioners (NARUC), write the group at P.O. Box 684, Washington, D.C. 20044.

IDHCA Urges Congressional Reps to Support DHC

More than fifty letters urging support of DHC have been sent recently by IDHCA members to their Congressional represen-


tatives. Several representatives and senators have responded by contacting the Department of Energy and others to express interest in the status and promotion of district heating and cooling in the government's energy efforts.

Among the elected officials to respond to IDHCA member appeals are Senators Howard M. Metzenbaum (OH) and John Glenn (OH) and Representatives Joseph M. McDade (PA), John Miller (WA), Chalmers P. Wylie (OH) and Harris W. Fawell (IL).


In a letter to Representative McDade acknowledging the Pennsylvanian's interest in DOE's DHC program, J. Michael Davis, Assistant Secretary, Conservation and Renewable Energy, characterized as "useful" a recent meeting with IDHCA representatives. He also noted that DOE is facilitating meetings between IDHCA and other federal agencies.

Are Uncle Sam's Buildings Leaking?

Sixty-five congressmen have signed a letter asking Department of Energy Secretary James Watkins to urge President Bush for an Executive Order that would mandate energy conservation in federal facilities. Noting that the federal government is the world's largest purchaser of energy, the group pointed out that the investment in energy conservation technologies and equipment for federal buildings has declined 80 percent since 1981. Yet federal expenditures increased by \$2.2

billion during that same time period, according to Douglas A. Decker, Johnson Controls manager of federal government markets. The letter from Capitol Hill to Watkins states that the federal government should "serve as a model for the rest of the nation on energy conservation and efficiency strategies." 

Increased Pressure *Continued from page 44*
program to manage customer electric demand.

Through continued improvements to the district steam system, the Public Service Company of Colorado has made an investment in Denver's future. 

Con Edison *Continued from page 38*
resolve our energy and environmental problems.

Con Edison recognizes that energy is a cornerstone of America's infrastructure; reliable, low-cost and environmentally safe energy supplies are essential for a prosperous and competitive business climate, as well as for improving individual quality of life. Accordingly, Con Edison has an energy strategy that is consistent with NES's goal of balancing the concerns of energy efficiency, environmental considerations, fuel diversity, adequate generating resources, and new technology.



W A N T E D :

A FEW GOOD... ARTICLES

District Heating & Cooling is looking for both technical and non-technical manuscripts for publication in future issues of the magazine. Submissions are welcome from members and non-members of IDHCA. Only unpublished materials will be considered for review.

Because *DHC's* audience includes both industry and non-industry readers, topics ranging from cutting-edge technological advances to behind-the-scenes DHC "success stories" are welcomed. All manuscripts are critiqued in a blind review and, if accepted, are professionally edited prior to publication.

Manuscript guidelines and additional information are available by calling IDHCA headquarters at (202)-429-5111 or writing to Editor, *DHC*, International District Heating and Cooling Association, 1101 Connecticut Avenue, N.W., Suite 700, Washington, D.C. 20036.