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DISTRICT HEATING DECISIONS IN IOWA— NON-DECISION DECISION MAKING

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ABSTRACT. District heating in Iowa developed in the early part of this century expanded to include at least eleven systems. Over the years, all but two of these systems have been terminated. A variety of decisions, related to the operation of the system but unrelated to their closing, ultimately resulted in the closing of nine of the eleven identified systems.

Certain functioning and closed systems are described. Actions taken which caused some of the closings are described. It is reasonable to suggest that we may ultimately have no district heating systems unless actions are taken to prevent similar situations resulting in the loss of these energy conserving systems.

Index descriptors: district heating—Iowa; energy conservation.

INTRODUCTION

Policy relative to district heating in Iowa is the subject of this paper. In the recent past a number of Iowa communities have had district heating systems.[1] There were once eleven such operating units in Iowa.[2] Two of them are still in operation.[3]

A number of Iowa district heating systems existed thirty years ago. These systems were operating under conditions determined by the economic conditions of the times. Rational decisions at a particular time such as conversion from coal to oil or natural gas, conversion from cogeneration to heat generation only, and decisions relating to system maintenance and to the building of larger electrical generation plants distant from the heating systems have resulted in the ultimate closing of many of these energy-saving systems. This study points to the need for greater knowledge when such decisions are made. Perhaps greater public input, both funds and knowledge, into the decision could result in determinations more beneficial to goals of energy efficiency.

It is desirable to reconsider the development of district heating systems, both old and new, to help energy deficient states of the midwest that are seeking ways to avoid high cost fuels and the resultant capital transfer to energy rich states. Thus, this study is an

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effort to examine the nature of "district heating" in Iowa and to explain the reasons for the decline of such systems. Cases studied here indicate a termination of a substantial number of district heating systems in recent years. The bases for terminations appear to be ill defined and not necessarily planned. Rather, they appear to be based upon prior decisions made under other circumstances; these, then, ultimately led to the decision to end the service.

These terminations, four of which occurred in the recent past (1980-84), were made in the face of efforts in other states to develop new district heating systems. These new systems are being developed because of evidence which has clearly shown that district heating is a significant way to conserve energy.

DISTRICT HEATING EFFICIENCY

Much energy is wasted through electrical generation. (The maximum energy recovery of the medium used in electrical generation is 40%; the norm is from 25-35%.) The remaining energy—steam and hot water—is lost as heat, which must be dissipated. District heating systems seek to recover part of the remaining energy through distribution of hot water or steam to various needs, i.e., commercial and industrial uses, public buildings and private dwellings. Some district heating systems are structured for heat only. Through district heating, the useful energy gained from the medium is increased from 25-35% to 70-90% depending upon the efficiency of the system.

Economics of district heating include: better utilization of existing energy sources; space saving—buildings using district heating save some space otherwise required for furnaces and boilers; and reduced risk of fire through lowered fire insurance rates.

ENVIRONMENTAL BENEFITS

The evident environment benefits to district heating include the confinement of air pollution to a single source for the area served. Such a confinement allows for the dissipation of the pollutants through one high chimney or the control of the pollution, at the source, through the pertinent technologies. This makes it possible to use energy media such as coal or solid waste which, if otherwise used, are greater pollutants than natural gas. The Iowa examples indicate that the conversion from coal to oil or natural gas negated some of the coal-use benefits.

EXAMPLES OF DISTRICT HEATING

Under conditions of energy shortage, it would appear that public policy should encourage the continuation of existing systems and the development of new systems wherever feasible. A number of groups is pushing for the development of new district heating systems in the United States.[4] Minnesota has a number of district heating systems operating within the state, and a state agency is developing additional systems that include downtown St. Paul and parts of Moorhead. One-third of downtown Minneapolis is heated by district heat.

Energy conscious European countries are developing new systems and expanding existing systems. Urban centers in France, West Germany, Denmark, Sweden, Finland, and the Soviet Union depend upon district heat for commercial, residential, and public buildings. Copenhagen district heating heats some 40% of its commerical structures—its larger apartment buildings, schools, and hospitals. District systems heat 65% of Helsinki.

The description of the technology of the Iowa systems is presented here with the general explanation of the current nature of the systems to give the reader some indication of the varieties of technology used.

Cedar Rapids

Cedar Rapids epitomizes the most successful surviving district heating system in Iowa. The system dates to 1896, when it was installed in a modest fashion downtown during the early years of Iowa Electric Light and Power, the system's current operator. This system is being updated and services are being expanded.

The steam system is an open-ended one which originates at a power plant located about one-half mile from the core of the downtown area. A 116 megawatt coal-fired power plant co-generates steam at two pressures. The low pressure system runs at ten pounds per square inch. A high pressure route is maintained at one hundred pounds per square inch and serves seventeen commercial customers year round. Process steam is supplied to, among others, Quaker Oats, National Oats, Cargill, and Mercy Hospital. Another institutional customer to which the system provides steam heat in the winter months is Coe College. The furthest distance that steam is shipped in the Cedar Rapids network is the thirteen-block distance from the power plant to a hospital.

Spencer

Spencer is the second operating district heating system in Iowa. The municipally-owed system was established in the 1910-20 period as a co-generating system and in 1965 converted to steam for heat only. It is a low pressure, closed system that heats the business district of forty customers.

After the association of customers served by the system concluded it was worth keeping, they sought methods to upgrade and retain the system. Recent planning has resulted in changing the system to economize on energy. Summer service was terminated. Steam pressure was reduced to a minimum, and on-line time is being staggered to meet peak loads with off-time during no load periods, i.e., 3 a.m.—6 a.m. Hence, the Spencer system appears viable for the near future.

TERMINATED DISTRICT HEATING SYSTEMS

Sioux City (the best documented case)

This northwest Iowa city has a district heating system which dated back to approximately 1900. Sioux City's system incorporated both a high- and a low-pressure steam arrangement. The low-pressure segment that operated at one to ten pounds per square inch was the mainstay of the system. Installed by a now defunct utility concern, the original system was used only during the winter months. Iowa Public Service, Incorporated (IPS) bought this system in 1922 and operated it until it was terminated in 1980. The high-pressure portion fed steam year around to industrial customers. This part of the system was developed by IPS in the late 1940s and had four industrial users who received large quantities of process steam.

At its peak in the mid-1950s, the Sioux City system served over 500 customers. Over 75% of the city's business district was heated by the system that originated at a now-dismantled electrical generating plant in the heart of the downtown area. The furthest distance that steam was transported was about twenty blocks from the plant. Originally co-generating steam and electricity using a coal-fired system, the plant later converted to fuel oil.

According to IPS officials and the Iowa Commerce Commission (ICC), conversion of the electrical generating station to oil and the deterioration of the network of steam-carrying pipe were the two chief causes for the heating system's demise. A study of the system in 1974 by IPS resulted in the firm's request to the ICC for permission to terminate the system. The utility's arguments during the Commission

hearings in 1979 were chiefly the following: (1) Converting the aging, inefficient Kirk Station plant from coal to fuel oil to meet EPA's regulation on stack emission would have required charging steam customers at higher rates than if they had converted to natural gas or electric furnaces. (2) The cost of the restoration of the deteriorating steam pipe network would have been prohibitive. The company pointed out that, since the construction and operation of their new large generating plant, the downtown plant had been producing only steam for the heating system, and the resulting elimination of the co-generative aspect of the operation was a major factor in driving up the cost of operating district heating. (3) The company stated that due to urban renewal, etc., they had steadily lost customers over the years, their clientele reduced to 170.

Opposition to ending the system was initially strongest from the steam heat customers in downtown Sioux City. Opponents argued that not only could they literally be left in the cold if IPS shut down the system but also that the cost to them in installing furnaces in each building, the problems caused by a situation in which a limited number of heating contractors and design engineers available in the Sioux City area would all be called upon at roughly the same time, and the short length of time available to convert heating arrangements would combine to put customers in an untenable position. By using over 50,000 cubic feet of natural gas per day, the downtown steam users were fearful that they would be put into the interruptible service category. Earlier, IPS had proposed installing a network of electrode boilers throughout the downtown area to keep the steam system alive. Even though two were installed, the proposal was not implemented.

Finally, the system was shut down. When the Iowa Commerce Commission gave its permission to end the arrangement, they provided that all the steam customers be put on an uninterruptible service basis as some compensation for the problems caused in converting to individually installed furnaces from a system which had been in operation for over seventy-five years. The district heating system in Sioux City ended service July 1, 1980.

Sibley

The system was installed at about 1900 and was a self-contained, two-pipe steam heat arrangement. Surplus steam heat was created as part of a 4500 kilowatt generator fueled by coal or natural gas. The mains were contained in concrete tunnels five to six feet under the city's streets and carried steam to approximately one-hundred customers

at a pressure of 125 pounds per square inch. The network included a pipe for condensate which returned to the plant under vacuum.

The Sibley system was originated by a group of the town's business and civic leaders who were disturbed by the wasted heat, pooled their financial resources, and installed the grid. Later taken over by the city (as the founders had intended), at one time it served over one-hundred-and-fifty customers. In debt about $750,000, following a study which proposed that the system be closed, it was terminated in 1984.

Perry

The Perry system originated in 1898 and utilized a coal-fired plant that co-generated electricity and hot water for both commercial and residential customers. At its peak in about 1945, their system distributed heat to about 200 customers.

Perry's network served about an equal number of commercial and residential customers. Only two downtown buildings were not served by the system. The power plant was converted from coal to fuel oil and natural gas during the 1930s. The system's pipes for carrying the hot water began with a ten-inch service line into each structure. Buried two to three feet deep with an isolating valve at each city block, hot water was pumped through the pipes at fifty-five pounds per square inch. The furthest heated building from the generating plant was about one mile. The Iowa Electric Light and Power Company system in Perry billed customers on the basis of the size of their radiators and the BTU rating per square foot. Among other customers, the Perry system heated the Chicago and Northwestern Railroad depot.

District heating in Perry was terminated due to boiler inefficiency and deterioration, a constant electrolysis problem with the hot water pipes, and, according to one source, one year of spotty maintenance on the delivery system. According to the plant engineer, a decision not to replace the boiler system in 1962 determined that the plant would ultimately be shut down. By 1976 or 1977 the turbine at the Iowa Electric plant in Perry had run its course as a useful mechanism, and the boiler was used only for heating. Electricity was obtained through the Iowa Electric grid. The system with approximately 165 customers still using it was closed on June 14, 1981.

Spirit Lake

About 1929 a new electric generating plant was built in Spirit Lake. By 1933 the plant's operator, North Western Light and Power

Company, put into use a steam district heating operation. Unlike many of the other systems in Iowa, the operation in Spirit Lake was a one pipe non-venture system. It operated under low pressure (from three to fifteen pounds per square inch) and originated in an eight-inch main at the plant, graduating down to a six-inch line and a two-inch line into each structure using the system. The condensate was then "dumped" after having been utilized.

Orignally, the Spirit Lake system was dependent upon an oil-fired power plant. In 1940 the system switched to natural gas. Later, electrical generation was provided by a separate set of diesel plants, and the original boilers provided solely for the steam system. In 1954 the network was bought by Iowa Electic Light and Power. At its peak, the system had about sixty customers. The Spirit Lake heating system was terminated in December 1980.

Boone

A concern known as Iowa Railway and Light installed the Boone system during the late 1920s. It served 80% of the commercial section of the city and a scattering of residential customers. The arrangement used hot water and was a "closed" or two-pipe system which reused water many times. In this version, steam was generated from a coal-fired power plant, then fed into a heat exchanger to create hot water that was pumped into the pipe network at thirty to forty pounds per square inch. The heating main was a six-inch pipe that led to entrance pipes of two inches. The return line was smaller. This network was buried at a depth of five to six feet and was valved every few blocks. The system's billing process was based upon the square footage of heat radiation in a nine-month heating season.

Although the Boone system had about 150 customers, the switchover from coal to fuel oil as the boiler fuel by Iowa Electric, which operated this arrangement, led to its demise in 1962.

COMPARING SYSTEM DECISIONS

The two operating systems have made recent policy decisions which have resulted in both systems remaining viable. First, the Cedar Rapids companies non-decisions: (1) not to convert from coal to natural gas or oil; (2) no decision to convert from cogeneration to heat only and decisions to upgrade, i.e., maintain the system—have resulted in that system's continued viability.

Spencer's municipal system managers recent conference with its customers resulted in changing the system to make it more effective, resulting in determination of both the municipal officials and customers to keep the system operating.

In contrast the Sibley system undercharged its customers over an extended period of time, resulting in an accumulated debt of over $500,000. At the same time deteriorating conditions of the system pointed to a substantial investment needed to keep the system operating. The debt and the maintenance costs resulted in the decision to terminate the Sibley system.

Limited information from defunct systems suggests that rational economic decisions at one time resulted in conditions that did later damage to the economic viability of the system. For example, economic sense suggested that it was cheaper to buy electricity from a larger, more efficient system in Sioux City and Perry. Therefore, co-generating systems were converted to heat producing only.

SUMMARY

This study is an initial examination using limited resources. A larger study should be developed which would identify existing and potential systems and propose ways in which they could be developed.

In the four examples of terminated district heating systems, factors which resulted in the terminations include:

1. Conversion from coal-fired to gas- or oil-fired systems.
2. Construction of larger electrical generating systems.
3. Conversion from co-generation to heat generation only.
4. Failure to maintain the systems.
5. Failure to charge enough to keep the system maintained.
6. Rumors of closing resulting in the unwillingness of new potential users to use the system.
7. Lack of inter-system communication resulting in a wide variety of systems and a failure of systems to benefit from experience of other systems.
8. In the case of Sioux City, urban renewal resulted in the loss of customers.

Most of the above decisions which appeared to be rational when made resulted in conditions which ultimately resulted in the closing of these district heating systems.

The evidence cited here indicates the development of public policy contrary to the current, energy conservation policy. Through fragmented non-decision making and, in some cases, decision making by design, numerous instances of energy saving potential have been lost.

District heating, it would seem, is a system whose time has again come. Its energy efficiency advantages have been outlined above. In the United States, cities and towns in Minnesota, Michigan, Ohio, and Pennsylvania are either expanding or newly installing district systems. One question which we feel must be pursued is why arrangments already in place, such as those studied in Iowa, have been allowed to deteriorate and be terminated.

The high costs associated with the change, in many locations from coal to oil and natural gas, as the fuel for the primary co-generation system is a readily understandable factor. According to an Iowa Commerce Commission staff member, the demise of district heating is attributed chiefly to: (1) the growth of the use of natural gas, a clean, efficient, and varied-use fuel which replaced coal and fuel oil and the ensuing limitation on its use in the wake of the international "realization" of an energy crisis, (2) economic inducement, due to fuel rate reduction, to install more and more individual natural gas furnace systems, (3) urban renewal and the tendency to equip new downtown buildings with independent furnace or boiler systems, perhaps in anticipation of the ultimate demise of the district heating system. Anticipation of systems closing down resulted in customers terminating and converting to individual systems.

It also seems, upon examination, that the costs associated with the choice of fuel and the maintenance of such systems are compensated for in the benefits of efficiency resulting from the distribution of heat to many from a source which creates excess heat as a byproduct. A specific example of the possible countervailing effects of restoration and modernization of an aging district system which had been ended in favor of structure-by-structure heating is that of Sioux City. The Iowa Public Service report on the closing of the district heating in Sioux City stated that it would cost $1.5 million to refurbish the power plant and the heating piping, thus making it uneconomical to continue the system.[5] In a later report, after the decision to close was made, Iowa Public Service stated that it would cost $1.3 million to install gas mains now needed for the individual systems.[6] Adding the $1.3 million installation plus the cost of 120 plus new boilers and furnaces obviously would prove to be more costly than refurbishing the old system.

District heating is an energy saving system, and one which works so well in many places, that, from the public policy perspective, it is advantageous to support the revival or the initiation of such systems through some type of public subsidy. Whether such funding would be available in the form of loans with which to allow the initial capital outlay required for burying pipe or grant money utilized for improvements in an existing network, long term public interest would be served through promotion of district heating. That we, in the midst of a growing consciousness concerning finite energy supplies, have allowed so many such arrangements in Iowa to end service without so much as an occasional dissenting voice is clearly not in the public interest based on general energy conservation ideas. In many cases during our interviews, we found individuals who had been part of a district heating system in one town who expressed surprise, not only that a community not far away had also ended service, but that the neighboring town had had such a system at all. One is reminded of Archibald MacLeish's poem, "The End of the World," which suggests that, in the end, we will have "nothing, nothing, nothing—nothing at all."[7]

RESEARCH NEEDS

Further study and research are needed to determine the possibilities of regenerating new defunct district heating systems and to help determine the future direction of the two remaining systems. One question seldom raised in the closing of systems was: Is the public interest well served? Research is needed to determine the public-private questions relating to district heat; does the public interest in energy conservation and pollution control outweigh the policy of closing systems that do not meet the profit needs of the company owning the system? Should public subsidies encourage the reactivation of defunct systems and aid in continuation, expansion, and upgrading of existing systems?

Research is needed to explore further the implications of energy policy relative to district heating and should seek to establish the value or lack of value of Iowa district heating. In terms of district heating, we may prove successful.

NOTES

[1]District heating is a community (privately or publicly owned) system that delivers heat in the form of hot water or steam to all or parts of a community.

The heat may come from surplus heat from electrical generation, or the system may be designed for district heating only.

[2]These cities include: Ames, Boone, Perry, Eagle Grove, Webster City, Sioux City, Grinnell, Spencer, Cedar Rapids, Spirit Lake, and Sibley.

[3]There may be more than two operating systems in Iowa. The discovery of operating and defunct systems in Iowa has been a hearsay, word-of-mouth effort. There appears to be no central information source available that can provide information on district heating history in Iowa.

[4]The Self-Reliance District Heating Group of Washington, D.C.; address: District Heating Development Co., Inc., 138 Brummer Building, St. Paul, MN 55101; District Heating Group I.S.V., International District Heating Association. Oakridge-Mixon-Rodou Sakio; Oregon, Jerry Jones; EKONO, Seattle, Washington.

[5] The preceding discussion was based upon telephone interviews noted here:

Iowa Commerce Commission: Michael McCabe

Sioux City: Dick Christy, Rate Department, Iowa Public Service, Inc., Sioux City, Iowa; Bob Gunsolley, Sioux City *Journal*

Perry: George Hyland, former power plant manager, Iowa Electric Light and Power Co., Perry, Iowa

Spirit Lake: Cork Pomerenke, Area Office Manager, Iowa Electric Light and Power Co., Spirit Lake, Iowa

Boone: Harold Anderson, Area Office Manager, Iowa Electric Light and Power Co., Boone, Iowa

Grinnell: Verl Garwood, Director of Public Works, Grinnell, Iowa

Sibley: Howard Parrott, City Administrator, Sibley, Iowa

Cedar Rapids: Del Block, Iowa Electric Light and Power Co., Cedar Rapids, Iowa

All interviews were conducted by telephone between June 10 and July 13, 1981, except the interview with Neal Drefke, Plant Manager, Spencer, Iowa, on 23 October 1981.

[6]Sioux City *Journal*, Sunday, April 6, 1980, p. A6.

[7]The last line from MacLeish's poem, "The End of the World."