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PROMOTIONAL MANUAL FOR DISTRICT ENERGY SYSTEMS

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PROMOTIONAL MANUAL FOR DISTRICT ENERGY SYSTEMS

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IEA Consulting Group

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Part A Introduction

This part of the manual explains why the manual was prepared and its role in assisting developers and promoters of district systems with their promotion activities. Important terms are defined related to the preparation of a promotion plan.

Section 1 Promotion Activities in Support of District Systems

1 Promotion Activities in Support of District Systems

1.1 Purpose of This Manual

District heating and cooling (DHC) systems are a well proven approach for meeting the thermal energy requirements of buildings in an efficient and reliable manner. DHC systems compete in the market for thermal energy services with individual building technologies. Competitive success for DHC is determined by the extent to which the district system approach is preferred by decision makers to individual building heating and cooling options which are available.

The installation and operation of DHC systems can provide significant economic, energy and environmental benefits to the community in which they are located as well as to the customers of the system. Both the extent and desirability of these social benefits are being increasingly recognized by many national governments. This recognition has been translated into support for DHC systems by many governments and energy-related organizations.

In recent years, the International Energy Agency (IEA), through the District Heating Implementing Agreement, has provided support to many technology development projects related to district energy systems. The technology development projects supported by the IEA and national governments have made significant contributions related to technical issues of DHC system design and operation.

It has become increasingly clear, however, that the most significant obstacles to the implementation of new or expanded district energy systems can come from institutional rather than technical issues. The

goal of this district energy system promotion manual is to address one set of institutional issues, those which are related to the effective promotion of new or expanded district systems.

Proponents of major district system projects may work for several possible types of organizations. In many cases, the general manager of an existing system will take the initiative to identify a major expansion project. In other cases, an older system which requires renovation may be purchased and revitalized by a DHC company. Other project proponents may be elected officials or administrative managers within municipal governments.

What all of these project proponents have in common is the challenge of gaining support for their district system concept from a diverse group of organizations whose interests may be affected by its implementation. Many different types of organizations, such as municipal governments, utilities, owners and managers of large buildings and private developers, are affected by district systems. Each of these organizations has its own mandate, interests and method for making commitments for capital investments. Each also has its perceptions and, in many cases, misperceptions of district heating and cooling systems.

A major challenge exists, therefore, for the proponent or "champion" of a district system project to gain the acceptance and support from this diverse set of organizations for a project being proposed. Similarly, an established DHC system must also maintain support for its ongoing operations from those groups whose interests it affects.

Gaining support for a new district system or maintaining support for an established system requires the effective promotion of the benefits of the district system approach in general and the proposed or established DHC system in particular. More specifically, the proponent must clearly and credibly communicate the ways in which district systems can contribute to meeting each group's self-interest.

Most of the people who are involved with district heating and cooling have a sound understanding of the technology and are eager to operate a business which provides efficient, reliable thermal energy to their subscribers. However, many do not have experience in marketing and promotion and have difficulty seeing themselves in the role of promoters. It is not surprising that the business disciplines required to organize and deliver activities to persuade others of the merits of district systems are quite different from the technical disciplines required to plan, install and operate the system itself.

The IEA has therefore identified the need to provide practical assistance to those people who are attempting to solicit support for proposed or established district energy systems. The most useful form for this assistance has been judged to be a promotion manual.

The purpose of the promotion manual which follows is to help promoters and developers first identify the groups which must be approached and then organize a set of targeted promotion activities which will communicate the most factual and persuasive evidence available. Through these activities, the promotion objectives of awareness, credibility and ultimately support for the project being developed can be achieved among the target groups and organizations.

In order to organize promotion activities, it is important to understand that three types of decisions determine the degree of success of district systems in penetrating the market for thermal energy services. These three

types of decisions provide the basis for organization of this manual:

- First, building owners must decide to connect and remain connected to the DHC network. They must be persuaded that their needs will be better met through connection to the district system than through individual building systems. The decision process of building owners and how promotion activities can influence this process are discussed in Part C of this manual.
- Second, the DHC system itself must be conceived, implemented and supported on an ongoing basis. For municipal systems, many organizations and business firms, various municipal government departments, political officials and the electric and gas utilities serving the community, are affected by the implementation of a DHC system.

The decision makers in each of these groups must be persuaded that a district system represents a sound approach. The steps associated with the establishment and continued viability of district systems and the role of promotion in this process are discussed in Part D.

- Third, the attractiveness of district systems to decision makers is strongly influenced by government policies and programs at the state/provincial, national and international levels. These policies and programs can take several forms:
 - Regulatory measures, such as energy efficiency standards or environmental controls
 - Economic instruments, such as taxes, subsidies and price controls
 - Informational programs, which distribute data on technologies or provide moral support for technologies viewed as desirable. As discussed in Part E of this manual,

the net result of these policies and programs can be either to enhance or to inhibit the market prospects for district systems.

1.2 Planning a Promotion Campaign

The term "promotion" can have different meanings in everyday usage. Furthermore, it is possible to confuse promotion with the terms "marketing" and "sales." For the purposes of this manual, a simple definition of promotion will be followed, a definition which is consistent with that found in marketing courses and textbooks.

Promotion consists of communication which is initiated between district system developers and operators and those groups whose interests are affected by the district system operation. The purpose of these communication activities is to influence the attitudes and decision behaviour of these groups in order to maintain or increase their level of understanding, acceptance and support for district systems. Due to the nature of many promotion activities, sales and public relations can be seen as major components of promotion.

Promotion can be seen as one of several activities performed within the more general function of marketing. In addition to promotion, marketing is concerned with such issues as the determination of a district system's competitive positioning, setting priorities among new customer prospects, establishing a customer service orientation and managing the system's pricing policy.

A promotion plan is required to organize an effective set of promotion activities. To prepare a promotion plan, the developer or operator of a DHC system must carry out four steps:

- 1 Identify target groups for promotion activities and understand their current attitudes and behaviour patterns.
- 2 Establish realistic promotion objectives based on current attitudes and behaviour patterns of the target group.
- 3 Select the specific promotion activities to reach the objectives.
- 4 Utilize the most persuasive benefits and examples in communication activities.

Each of these components of a promotion plan is discussed below.

Target Group Attitudes and Behaviour

The groups with whom communication takes place are many and varied. When a promotion effort is directed at a particular group, it can be referred to as a target group. As depicted in Figure 1-1, groups can include:

Groups which provide resources to the system:

- Employees
- Suppliers of Goods and Services
- Customers
- Capital Markets

Groups which provide the regulatory and fiscal environment and business direction for the system:

- Public Authorities
- The System's Board

Groups whose attitudes affect the system's success:

- Employees' Family and Friends
- Mass Media
- Potential Customers
- Engineers and Architects
- Interest Groups

An additional group – competitors – is also associated with the world within which the district system operates. However, district systems will rarely initiate communications with this group.

Attitudes and Current Behaviour

The starting point for the development of a promotion campaign is to determine existing attitudes and behaviour patterns among the DHC system's target groups. For example, some groups may have no knowledge of district systems, others may have misperceptions about the DHC concept and still others may be enthusiastic supporters.

Clearly, the nature and extent of appropriate promotion activities will vary for each of these situations. Through formal and informal surveys of a cross-section of members of each group, it is possible for a DHC system proponent to identify and understand the current attitudes and behaviour patterns which affect DHC.

Promotion Objectives

The communication activities which comprise a promotion program should be based on clearly stated objectives. These statements of objectives can ensure that there is a realistic expectation of what the communication program seeks to achieve with each group of decision makers who are targeted. Furthermore, when realistic specific objectives are established, it is possible to measure the extent to which intended results have been attained.

Appropriate objectives for a promotion program will vary depending on the nature of current attitudes and behaviour found among each target group. However, general objectives can be established for new systems or for established systems.

For new systems or systems which seek major expansions, the general promotion objective can be expressed as follows:

- To establish awareness and support among those groups whose interests are affected by a major district system project.

For systems which are mature and well-established, the promotion goals can be stated as follows:

- To maintain support among those groups whose ongoing backing is needed for continued system viability.

In addition to a general objective, specific objectives are needed to guide the communication activities established for each target group. These objectives are based on the premise that the role of promotion is to influence the current attitudes and behaviour patterns of the various target groups. Based on an understanding of which current attitudes are supportive of DHC and which are not, precise objectives can be established.

Several types of specific objectives may be required. Examples of these types of objectives include the following:

To Create Awareness of Strategic Opportunities

Examples:

- Operators of existing group systems may be made aware of the possibilities for using their system as a base for a new municipal (subscriber) system.
- Municipal planners may be made aware of the opportunities to incorporate energy from municipal or industrial waste as energy sources for district systems.

To Suggest New, Relevant Criteria Which Highlight DHC Benefits

Examples:

- Municipal planners may not have considered the relationship of building space heating systems to outdoor air quality levels as a relevant criterion or factor which should be included as they prepare long range plans for their community.
- Building owners may not have realized that district systems may offer their tenants increased comfort, lead-

ing to the addition of comfort levels as a criterion in the selection of heating and cooling systems.

To Provide Factual Information on Technology Options

Examples:

- Representative costs for alternative approaches to chilled water systems may be provided to consulting engineers.
- Statistics on the improvement in air quality in Scandinavian cities which have implemented extensive district systems may be given to government officials.

To Correct Misperceptions and Inaccurate Information

Examples:

- Engineers and others may hold the incorrect belief that the principal heat source for a district system must be within a few kilometres of the heat load. This misperception could be corrected by the communication of credible evidence that, where a very large heat load is available, thermal energy can be transported cost effectively through hot water piping for distances of 10 - 20 km or more (such as the 17 km pipeline which links Mannheim, Germany with a large power plant).
- Building owners may believe that district systems are less reliable than individual building systems, a belief which can be countered with such evidence as the high levels of maintenance at central plants and the availability of back-up boilers.

To Enhance Credibility

Examples:

- Descriptions of successful systems, such as those in Helsinki, Finland, Malmö, Sweden, Copenhagen,

Denmark, St. Paul, Minnesota and New York City, can increase the level of confidence that district systems do represent a proven, low risk approach.

- Site visits to established plants can show local officials, building owners or consulting engineers that district systems represent a dynamic, contemporary approach which can adapt and grow to meet the community's thermal energy needs.

It should be stressed that the specific objectives for each promotion program must be developed based on the circumstances of each situation. Further guidance for the establishment of appropriate objectives is provided in Parts C, D and E which follow.

Promotion Activities

Communication activities which are carried out as part of DHC promotion are typically simple and straightforward. Most, for example, consist of one-to-one meetings, during which the advantages of district systems are discussed with influential members of key groups. Other communication activities may consist of plant tours and group presentations.

Communication materials, such as periodic newsletters, sales brochures and position papers for specific issues or projects, are also frequently used to support promotion activities.

Benefits of DHC Systems

A DHC system can provide significant benefits to system customers as well as to the community in which it is located. For building owners, important economic and non-economic advantages will accrue upon connection to the system. These advantages are highlighted in the "8 Reasons" selling sheet prepared by the International District Heating and Cooling Association (IDHCA), shown in Figure 1-2.

The benefits to customers are discussed more completely in Part C.

For the community and society in general, the benefits offered by a DHC system include:

- The positive economic impacts of construction investments and retention of energy expenditures within the community.
- Energy impacts of substitution of imported energy sources such as oil with locally available resources such as biomass and municipal waste.
- Environmental impacts such as the improvement of local air quality and reduction of CO₂ emissions. A more detailed discussion of DHC's benefits to a community and society is presented in Parts D and E.

1.3 How to Use This Manual

This manual seeks to provide assistance for those who are learning about DHC for the first time as well as those who have

been in the DHC industry for many years. Thus, Part B, an overview of DHC, should be of interest primarily to the first group. Parts C, D and E, which discuss Promoting to Customers, Promoting a Municipal System and Promoting at the Level of National Governments and International Organizations, should be of widespread interest.

The appendices include case studies, project examples and lists of additional sources of information. These sources of information include a bibliography of reports, studies and other material, a directory of district energy associations and a list of government agencies and departments with interests in district systems. The use of this part of the manual will depend on the specific areas of interest of the reader.

Through the use of this manual, the system proponent can learn about the "basics" of district systems and prepare an effective promotion plan. The manual should serve as a useful ongoing reference as the proponent participates in the development and ongoing operation of a district system.

Figure 1-1 Eight Reasons Sheet Prepared by the IDHC

8 Reasons You Should Utilize District Heating and Cooling For Your Building

Plan to save money, energy, and reduce pollution with district heating and cooling

For the prospective building owner/manager, district heating and cooling (DHC) service provided by a central thermal energy system offers a number of short- and long-term economic and technical advantages by eliminating or greatly reducing many of the operating, maintenance, staff, and capital costs associated with boilers and chillers in individual buildings.

1. PLAN ON LOWER CAPITAL COSTS

The principal and interest payments, property taxes, and insurance costs associated with new boiler and chiller installations are all eliminated with district heating and cooling. The only initial costs in most buildings opting for DHC service are for a heat exchanger and related piping and valves.

2. PLAN ON LOWER ENERGY COSTS

With district thermal energy, a building purchases only the energy it needs to meet its requirements. There is no ongoing capital expense to upgrade, rebuild, or maintain excess capacity. In-building boilers and chillers typically carry excess capacity to meet occasional peak demand, which leads to inefficient partial boiler and chiller loading during most of the year. This results in poor seasonal efficiency. By contrast, central boilers and chillers are operated to achieve the highest seasonal efficiency possible.

3. PLAN ON LOWER OPERATING AND MAINTENANCE COSTS

With district energy a building has less need for highly trained on-site maintenance and operating personnel, and costly annual maintenance contracts. Boiler and chiller operating expenses (i.e. electricity, water treatment chemicals, insurance, refrigerant and make-up water) are all eliminated.

4. PLAN ON STABLE COMPETITIVE ENERGY RATES

Central DHC systems can convert to the least costly and most available fuel, and thus achieve economies of scale with volume purchasing. Systems are able to take advantage of municipal solid waste systems where they are available. They can also utilize waste heat from electrical generation plants, which is not practical with in-building systems due to an imbalance of electric and thermal loads.

5. PLAN ON MORE REVENUE-GENERATING SPACE

Elimination of production systems and their auxiliaries within a building frees up valuable floor space for income-producing purposes, and increases architectural flexibility. The use of DHC reduces vibration and noise problems and eliminates the need for stacks going up through a building.

6. PLAN ON RELIABLE HEATING AND COOLING SERVICE

Central utility systems typically are better maintained and operated than in-building systems. They are manned 24 hours a day by highly qualified operators, are on strict maintenance schedule, and can be switched to a reserve fuel source as needed. Backup capacity, and backup energy plant redundancy is always readily available, without the need for in-building reserve boilers.

7. PLAN ON LOWER COSTS THROUGH SYSTEM EXPANSION

As more customers join each DHC system, the fixed capital and operating costs are spread over a larger base, and individual energy bills are reduced or stabilized.

8. PLAN ON A CLEANER ENVIRONMENT

Central energy service from a thermal plant reduces the number of smokestacks throughout a city, and protects air quality by rigid control of emissions. DHC eliminates problems associated with fuel delivery through a city's congested streets, concerns over fuel availability and storage, as well as other operating and maintenance responsibilities. Many central heating and cooling production plants have oil or gas pipelines to facilitate volume fuel delivery. When they are fueled with coal or municipal waste, central plants typically have state of the art combustion and pollution control systems.

For more information contact:

THE INTERNATIONAL DISTRICT HEATING AND COOLING ASSOCIATION
1101 Connecticut Avenue, NW • Suite 700 • Washington, D.C. 20036 • (202) 429-5111

Part B Overview of District Energy Systems

This part of the manual provides an introductory overview of district heating and cooling (DHC) systems. Numerous terms are defined which are used throughout the remainder of the manual. Section 2 begins the overview with descriptions of the various types of district systems. A summary of the principal benefits or advantages offered by district systems is presented in Section 3. The range of available technology options is highlighted in Section 4. A discussion of market acceptance – past, present and future – concludes this part of the manual.

- Section 2 Types of DHC Systems
- Section 3 Summary of Benefits of DHC Systems
- Section 4 Technology Options
- Section 5 Market Acceptance for DHC Systems

2 Types of DHC Systems

2.1 The Basic Approach

District energy systems supply building energy requirements for heating and cooling from a central plant rather than from individual heating or cooling systems in each building (see Figure 2-1). The central plants are connected to the buildings they serve through networks of underground, insulated pipes.

District systems are often referred to as district heating and cooling systems, or DHC systems. If the system does not provide cooling, it may be referred to as a district heating (DH) system.

District systems require a sizable capital investment in plant and piping. However, they produce and distribute energy very efficiently and reliably and save building owners both the capital and operating expenses associated with individual building systems. A summary of the advantages of district systems, including the benefits of environmental enhancement and community economic development, is presented in Section 3.

Figure 2-2 shows how district systems are different from individual building systems.

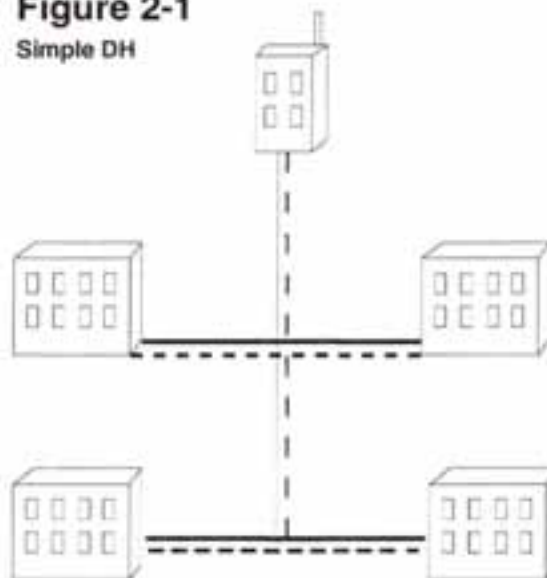
The piping networks of a district system may distribute thermal energy in the form of steam, hot water or chilled water. Piping networks consist of two parallel pipes. One pipe supplies the steam, hot water or chilled water to buildings. Later buildings extract the thermal energy from the supply, the re-

turn pipe takes the liquid back to the central plant to be heated or cooled again.

The networks can range in length from several hundred metres to many kilometres. In many cases, the central plant will produce electricity as well as thermal energy. These cogeneration plants are referred to as combined heat and power (CHP) plants.

Figure 2-1

Simple DH



Many energy sources may be used with district systems. Central plants may be fueled by natural gas, oil, coal, municipal solid waste or other available fuels such as wood chips, peat and straw. Heat which is normally "wasted" may also be extracted from industrial plants and other sources and used to supplement the energy produced at the central plants. In addition, the energy content of

Figure 2-2

Principal differences between the district system and individual building system approaches

Conventional Energy System - based on individual building systems



For communities which employ individual building systems, conventional energy sources are brought in for building heating and cooling. Sources of waste energy cannot be utilized and the efficiency of heating equipment and power plants is limited.



For communities which develop the district system approach, greater efficiencies in energy conservation are achieved and locally available sources of energy, such as industrial waste heat, refuse, incineration and wood chip fuel, can be utilized. As a result, emissions are reduced and less money is spent for imported sources of energy.

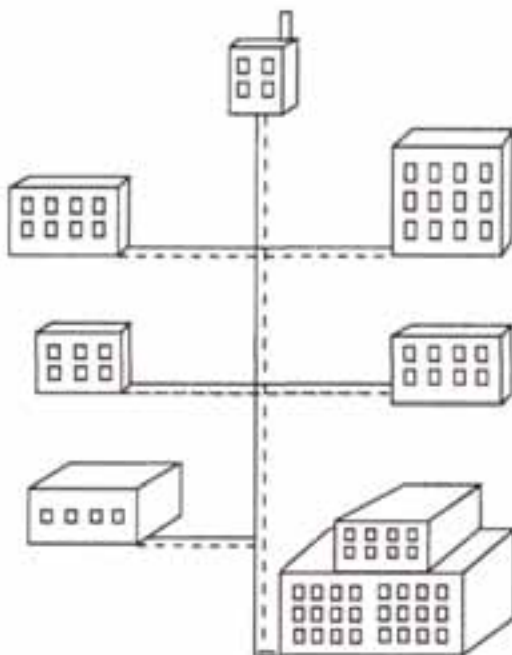
geothermal, underground aquifers or rivers and lakes may be extracted for a DHC system.

2.2 District System Configurations

District systems can be established in a wide variety of configurations.

Group (Institutional) Heating

Figure 2-3
Group DH



Systems

A central plant may supply several buildings under common ownership such as a university campus or office complex. This approach is often called group heating (see Figure 2-3). These systems are also referred to as institutional or system user systems. Many

thousands of group heating systems are in place. The most common applications for group heating systems are:

- Office Complexes
- Apartment Building Complexes
- Hospitals
- Colleges and Universities
- Military Bases
- Correctional Facilities

Municipal (Subscriber) Systems

Larger district energy systems can serve multiple users or subscribers. These are all based in city centres or downtown areas where a high concentration of thermal load is found. For this manual, the terms subscriber, municipal and community energy system will be used interchangeably. It should be noted that the term "municipal" is derived from the location of the system within a municipality. Such systems may be owned by either a private district heating company or the local government (see Section 7.3).

Figure 2-4
Municipal DH



A municipal system can serve a variety of facilities, including office, apartment and institutional buildings (see Figure 2-4). As the system is established, it may use existing heating plants or new plants can be installed as required.

The central heating and cooling plants can realize significant economies of scale in comparison to individual building systems. For example, the labour required to operate a large plant is only marginally greater than that required for a small plant. Furthermore, the use of solid fuel (such as biomass or municipal waste) can become economically attractive with a large-scale plant. Also, the significantly higher efficiency of combined heat and power (CHP) plants, which cogenerate electrical as well as thermal energy, is economically achievable in large-scale plants.

Industrial plants also provide energy for processing requirements through the distribution of thermal energy from a central plant or plants. Opportunities may exist for an industrial facility to be linked with a district energy system, either by providing waste energy to the DHC system or purchasing energy from the system. However, the predominant requirement at these facilities is usually for process energy for production rather than building heating and cooling. For this reason, industrial facilities are typically self-contained in terms of thermal energy requirements.

The distribution network for a municipal system is designed to serve those buildings where the investment in piping is justified by the value of thermal energy to be delivered or by its positive effect on the environment. For most systems, it is not economical to connect single family homes or other buildings with

less than 50 kW of peak demand (approximately 500 m²). Since policies, costs and other factors vary considerably by locality, an assessment is required to determine the minimum building load to be connected for each system. Such buildings may be connected in areas where government policy has provided financial incentives (such as Denmark) or where the network can be installed at exceptionally low cost, such as construction of a new, "green field" project where installation of the piping network occurs at the same time as all utilities and roads are being installed.

As a result of historical developments, some municipal systems serve only the largest buildings in downtown areas. In other cities, the municipal systems are much more extensive, serving areas with sizable thermal loads (heating or cooling requirements) which extend several kilometres from the downtown commercial centres.

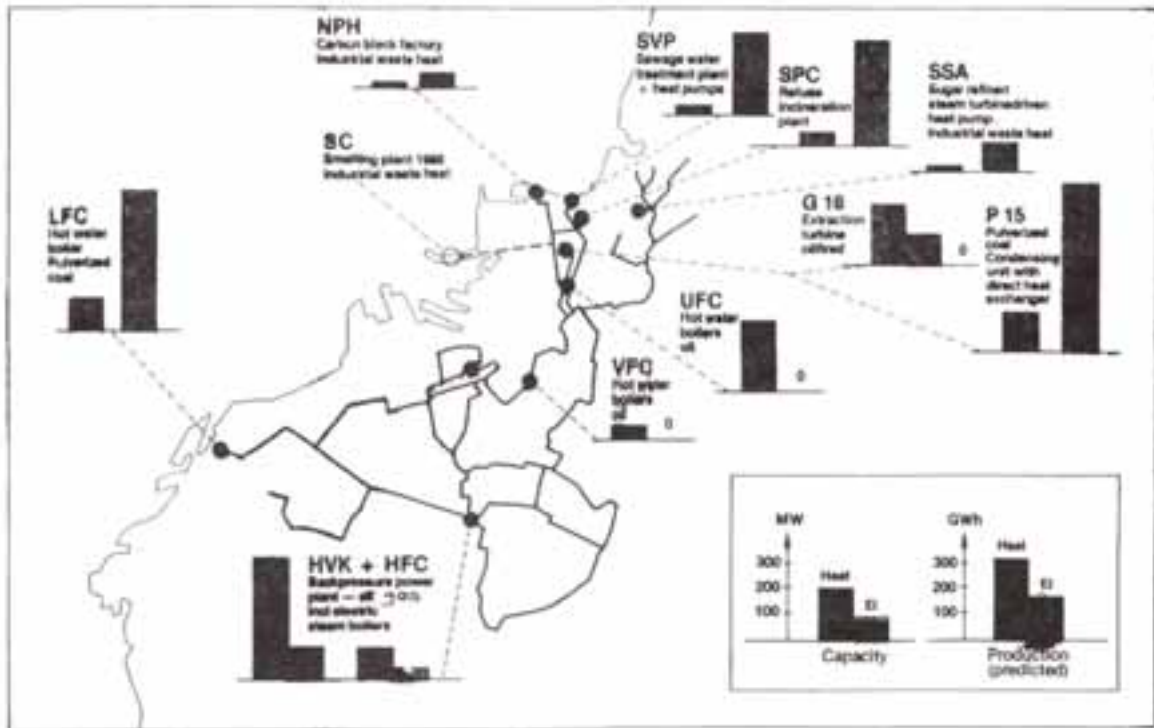
Integrated Energy Systems

When a municipal system expands its distribution network beyond a concentration of downtown buildings, it is able to consider additional energy sources which may be available. These sources may be based on municipal waste incineration, industrial waste heat or a variety of other technologies (see Section 4.1). Based on an analysis of technical feasibility and economic attractiveness, these sources may be integrated within the expanding municipal system.

The Malmö, Sweden system, shown in Figure 2-5, is a good illustration of the integrated energy system concept.

Figure 2-5 District Heating Network with Production Plants in Malmö

District Heating Network with Production Plants



Features of the Malmö system include:

- The municipal utility introduced district heating in 1951, the second DH system in Sweden. The utility also operated the electricity and gas distribution systems.
- The system serves approximately 8 000 subscribers with a nominal heat load (peak demand for heat) of 1 500 MWth. The length of the network is almost 470 km.
- From its origins, the district system utilized combined heat and power plants to meet the community's electricity as well as heating requirements.
- Initially, the district system was heavily dependent on oil. Through the implementation of investments in various energy sources during the 1970's and 1980's, this dependency has been essentially eliminated.

- For 1989, the following energy sources were utilized to provide the 2 500 GWh of delivered thermal energy:

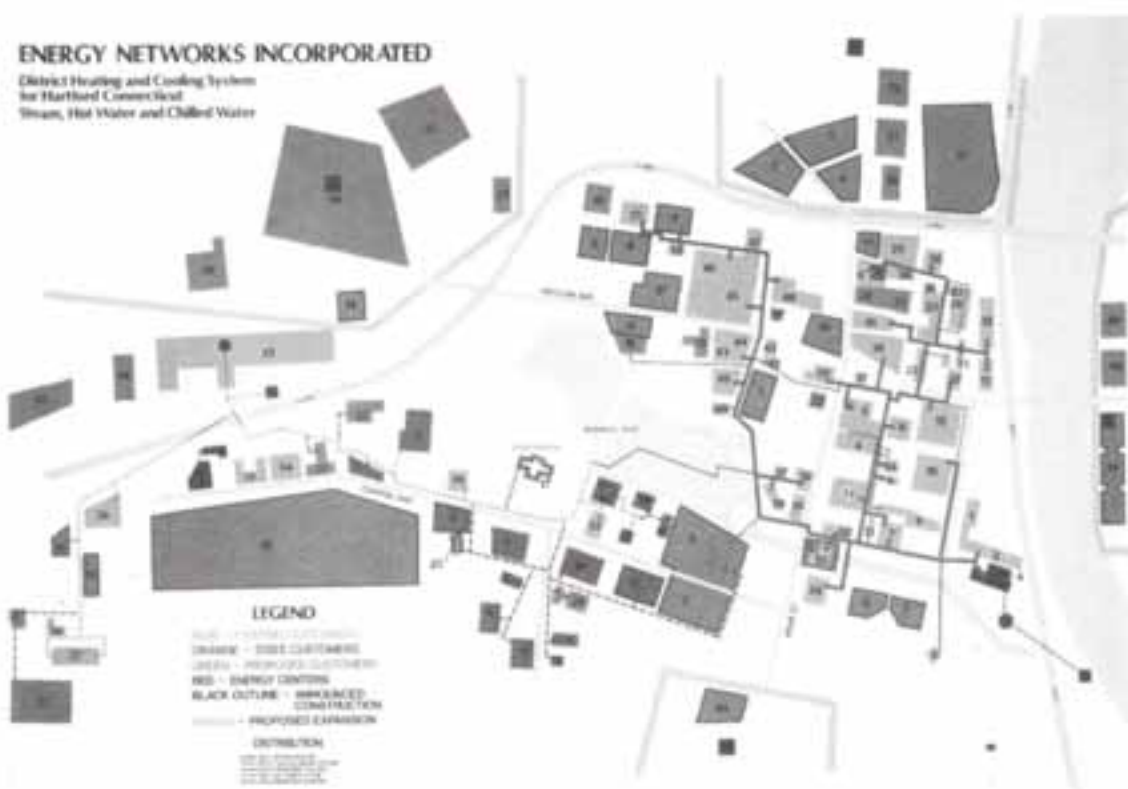
- Natural gas	36%
- Refuse incineration	22%
- Industrial waste heat	22%
- Coal	12%
- Oil	2%

In 1991, the Malmö system was purchased from the municipal government by SYDKRAFT, the privately owned electric utility which serves southern Sweden.

District Cooling Systems

In communities where buildings have significant cooling requirements, such as in many parts of North America, district cooling systems may be established.

Figure 2-6



The simplest method for providing district cooling is based on the installation of steam absorption chillers or steam-turbine centrifugal chillers at buildings connected to a steam-based district heating system. Through this method, a single piping network can deliver energy for both heating and cooling. The New York City, USA district system operated by Consolidated Edison is an example of this approach. This system produces approximately 250 000 tons of steam-driven refrigeration to buildings in the borough of Manhattan.

With other technical designs, district cooling networks can be established which are separated from district heating distribution systems. For example, the new chilled water network in Indianapolis, USA is totally independent of the district heating network.

Through a third approach, the development of a combined district heating and cooling system can be implemented at the same time. While the planning and construction of the heating and cooling distribution networks can be coordinated, in almost all cases, the piping systems themselves are separate.

An example of this approach is found in Hartford, USA. Operated by Energy Networks Incorporated, this system was the world's first commercial district heating and cooling system (i.e., a system not owned by a municipality or electric utility) when it started in 1962. As shown in Figure 2-6, the system currently serves over 70% of the buildings in downtown Hartford. Through existing and proposed networks, the system is expanding beyond the downtown area to serve many of the state government buildings. A natural gas fueled co-

generation plant, completed in 1990, produces hot water and chilled water for the DHC system as well as electricity for the grid of the electric utility which serves Hartford.

2.3 System Ownership and Mandate

In addition to the differences in the way district systems are configured (described in Section 2.2), significant differences also exist in the ownership structures of DHC systems and the mandate of system managers.

Ownership

Most municipal district systems in Northern Europe are owned and operated by public or not-for-profit organizations. These organizations report either directly or indirectly to the political officials of the municipal government.

In France, Italy and North America, a sizable number of municipal systems are privately owned, either by firms specializing in the operation of municipal DHC systems or by electric power utilities.

Ownership of group systems can be either private, such as in the case of an office building complex, or public, as in the case of institutions such as universities or hospitals.

Objectives and Mandate

Financial objectives can vary among district systems. Some seek only to recover operating costs or minimize annual expense budgets. Other DHC

systems seek to achieve profit and return on investment targets.

For some systems, organizational mandates may encourage expansion of the district system wherever feasible. In

other cases, particularly group systems, the mandate for system managers limits operations to the existing network.

3 Benefits of District Systems

District systems offer many significant benefits to building owners, the local community and society in general. Figure 3-1 presents a summary of the most important of these benefits:

3.1 Enhanced Energy Utilization

District systems can utilize combined heat and power plants, which produce useful energy very efficiently. DHC systems can also incorporate several different energy sources, including municipal waste incineration or waste heat from industry, thereby reducing the dependency on the supply of any single source, such as oil. Central plants increase efficiency of operation through high degrees of automation and high standards of preventive maintenance. Operation of boilers at inefficient low load levels is avoided.

3.2 Improved Operations Management

For building owners, district systems simplify the management of building heating and cooling systems by eliminating the requirement for on-site boiler operation and maintenance. Reliability of a building's thermal energy supply is increased with district systems.

For municipalities and society in general, district systems reduce the complexity of operating government-owned buildings and provide an option for disposal of wastes, including municipal solid waste

and industrial wastes, with minimal environmental degradation.

3.3 Economic Attractiveness

From the perspective of financial attractiveness to individual building owners, capital expenditures for installation of on-site systems are avoided and labour costs for boiler operation and management are saved. Floor space not required for on-site systems becomes available for income or other purposes. Designs for new buildings benefit from the architectural freedom achieved through the elimination of stacks and boiler rooms. Increased comfort levels in buildings served by DHC systems can help retain tenants.

DHC also can offer benefits from the perspective of societal economic attractiveness. For a municipality, district systems generate significant employment during construction and may utilize locally available energy sources, thereby keeping energy expenditures in the community. District systems can also contribute to economic vitality of a downtown core. In addition, district systems may reduce the long-term costs to energy users, increasing their competitiveness and contributing to a higher standard of living.

3.4 Environmental Enhancement

The environmental benefits offered by DHC systems are of particular relevance in view of the heightened concerns of the 1990s. Compared to individual

FIGURE 3-1 Major Benefits of District Systems

Types of Benefits	Building Owners	Municipalities	Society
Energy Utilization and Management	<ul style="list-style-type: none"> • Assure access to lowest cost energy sources 	<ul style="list-style-type: none"> • Utilize available energy sources within the community diversity of supply 	<ul style="list-style-type: none"> • Increase efficient use of energy security through
Operations Management	<ul style="list-style-type: none"> • Increased reliability of supply of thermal energy • Eliminate on-site boiler operation and maintenance 		
Economic Attractiveness	<ul style="list-style-type: none"> • Eliminate capital for on-site energy system • Reduce labour and maintenance expenses for on-site system expenditures in the community • Make space available for income or other purposes 	<ul style="list-style-type: none"> • Significant employment during construction • Enhancement of downtown core • Local sources keep energy expenditures in the community 	<ul style="list-style-type: none"> • Improve balance of payments through more efficient use of imported energy • Reduced capital for power and heating plant frees capital for other needs
Environmental Enhancement	<ul style="list-style-type: none"> • Avoid future more stringent regulations of stacks, etc. • District cooling or steam absorption systems may provide options to management of CFC replacement 	<ul style="list-style-type: none"> • Greater efficiency reduces total emissions • Single tall stack dispenses emissions from metro area • Single stack easier to monitor and control • Utilization of waste energy sources helps waste 	<ul style="list-style-type: none"> • Greater efficiency reduces total emissions • Single tall stack easier to monitor and control • District cooling or steam absorption systems may provide options to management of CFC replacement
	<p><i>Note: Promoting to customers is discussed in Part C</i></p>	<p><i>Note: Promoting to a municipal DHC system is discussed in Part D</i></p>	<p><i>Note: Promotion at the National and International level will be discussed in Part E</i></p>

building systems, the efficient, large-scale central plant of a district system produces less CO₂ and other emissions to serve the same number of buildings. The emissions from a DHC central plant are easier to monitor and control. District systems increase options for the utilization of waste energy sources. District cooling or steam absorption systems may provide options for the phase out of CFCs.

A complete discussion of the benefits of district systems is included in the remaining sections of this manual.

It is important to point out that the potential benefits of district systems are not of equal relevance and importance to the three main constituencies of building owners, municipalities and society in general. Building owners, for example, have financial and operational interests which are at the center of their consideration of the relative attractiveness of district systems.

Municipalities, by way of contrast, focus on the public as well as private interests of their community. Community economic development and environmental enhancement, for example, are primary areas of concern for municipal officials but are of secondary interest to building owners.

The interests of society, reflected at the level of national governments and international organizations, are somewhat similar to those of the municipality. However, policy concerns related to energy efficiency and security and long-

term economic and environmental well being become paramount.

Because of these differences in the basic interests of the three major constituencies, a separate section of this manual is devoted to providing guidance in promoting district systems to each:

Part C Promoting to Customers

Part D Promoting a Municipal System

Part E Promotion at the National and International Level

4 Technology Options

4.1 General

The discussion of the possible configurations for district systems in Section 2.2 highlighted flexibility as one of the important features of the district energy approach. District energy technology is essentially a mechanism for linking available energy sources with building energy requirements in a community (See Figure 2-1).

Many choices of available technology are, however, available which enable district systems to adapt over time to changes in:

- The availability and cost of energy sources.
- The magnitude and location of thermal energy demand
- Government policy initiatives in the energy and environmental areas. Furthermore, research and development progress continues to bring new and improved technologies to the market which increase the cost effectiveness and flexibility of DHC systems.

Figure 4-1 depicts the array of possible technology options which might be incorporated in a district energy system.

4.2 Energy Sources

District systems may incorporate many different energy sources:

Conventional Fuels

Most commonly used are the conventional fuels: coal, natural gas, light and heavy fuel oil.

Alternative Energy Sources

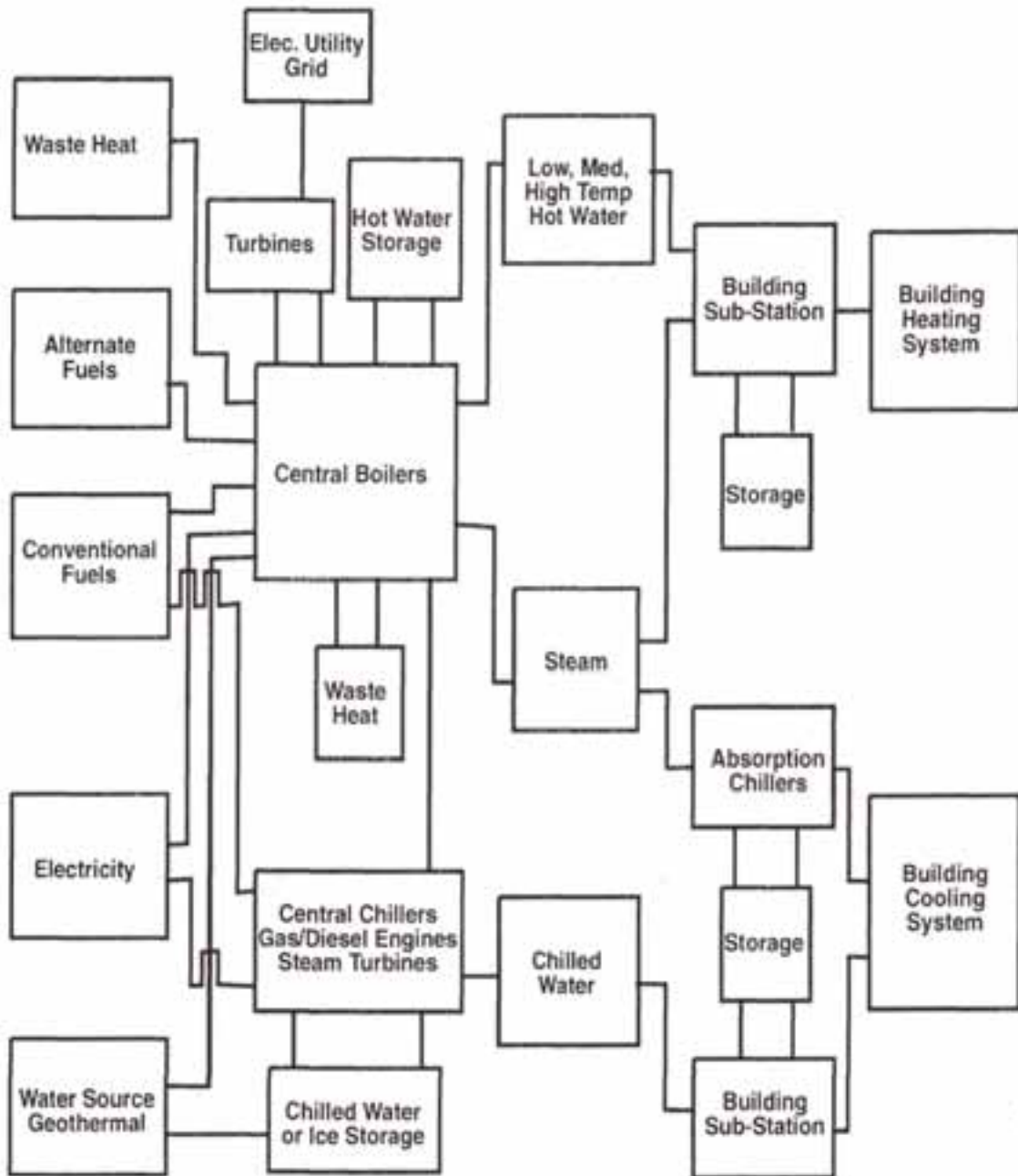
In some areas, alternative fuels represent viable options. These include municipal waste (many countries in Europe and North America), peat and wood waste (Finland and Sweden), and straw (Denmark). Some experience has also been gained with solar energy as a non-conventional energy source.

The Herring, Denmark DH system is particularly noteworthy as it obtains heat from landfill gas, a wood waste gasification plant, a biogas from manure plant, and straw and sludge incineration.

Waste Heat

The extraction of waste heat from industrial plants is an increasing source of energy for district systems. For example, the Vanersborg, Sweden system receives 75% of its heat supply from a nearby smelting plant. Waste heat can also be recovered from sewage (such as Sandvika, Norway system) and wastewater streams (such as the sewage wastewater system under consideration in Seattle, USA).

Figure 4-1 Components of District Energy Systems



Electricity

In a few areas, electricity may still be used as an energy source for district system boilers when a surplus of supply exists. In Sweden and Norway for example, inexpensive hydropower may be seasonally available in some parts of the year. On an infrequent basis, electricity may be used to drive central chillers for a district cooling system.

Water Source

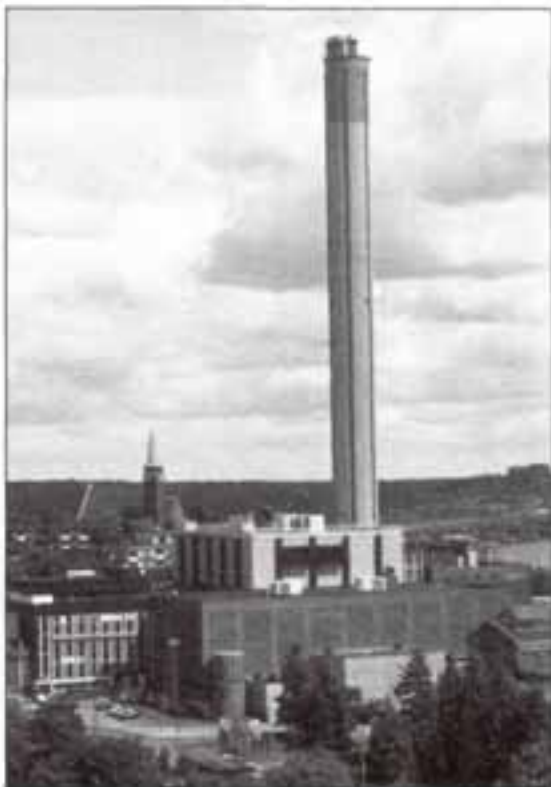
Increasingly, water from rivers, lakes and underground aquifers is being used in conjunction with large heat pumps as an energy source for district systems. For example, the Carleton University system in Ottawa, Canada has installed a large heat pump for its group system. Geothermal energy has been utilized in the Boise, USA municipal system since 1892 and dozens of other systems (mainly group/institutional systems around the world).

These conventional and non-conventional sources may be given different priorities by government policies related to energy and the environment. For example, utilization of waste heat and alternative fuels may be given preference in comparison to conventional fuels.

4.3 Energy Conversion Technologies

Several different technologies can be utilized at central plants to convert energy sources into useful energy which is then distributed to the buildings connected to the DHC system.

Figure 4-2



Combined Heat and Power Plants

CHP plants cogenerate electricity and thermal energy through two basic approaches. In the first, large boilers combust one or more fuels to produce high pressure steam. This steam drives a turbine which, in turn, drives a generator to produce electricity. Steam extracted at lower pressure from the turbine can either be:

- Distributed directly to the DHC network
- Condensed to make hot water for the DHC distribution network

CENTRAL PLANT TECHNOLOGY DEVELOPMENTS

Central plant technologies are advanced and well proven. Development work continues to improve combustion efficiencies and reduce the level of undesirable emissions, such as SO₂ and NO_x. Progress is being made in improving the cost effectiveness of central plants which utilize non-conventional energy sources, such as the combustion of biomass and utilization of large heat pumps for water energy sources. Enhancements are being undertaken to a range of technologies for increasing efficiency and lowering costs for district cooling systems. Recent USA feasibility studies have assessed district cooling systems based, for example, on ammonia chillers, electric chillers with ice storage, steam from solid waste and cold sea water.

- Utilized to drive chillers. These plants usually employ a condensing section of the steam turbine as well, so that electricity can be made as required in excess of that produced by the extracted steam.

A second approach to cogeneration is based on either a large internal combustion piston engine (such as the Trenton, USA system) or a gas turbine (such as the Nassau County, USA system). These units produce steam which drives a generator. Exhaust gas then goes through a heat recovery boiler, producing steam to drive a second, smaller turbine-generator set. Finally, steam is extracted at lower pressures for use in the DHC distribution system.

The first approach has the advantage of being able to utilize all fuel types. The second approach, while limited to oil and natural gas as fuels, is more efficient in producing electricity.

Heating Plants

Many DH plants produce only thermal energy in the form of steam or hot water from the combustion of various fuels. The determination of whether a central plant will be CHP or heat only is usually highly dependent on pricing terms and conditions offered by the electric utility for the electricity which would be produced by a CHP plant. It is usually technically feasible to retrofit existing heating plants producing only thermal energy and existing utility power plants producing only electricity to cogeneration configurations.

Central Chilling

Chilled water for distribution in district cooling systems can be produced in several ways. Steam-based chilling utilizes the steam produced at CHP or heating plants. Ammonia-based chillers are also gaining increasing acceptance for central chilling systems.

Thermal Storage

Many systems incorporate one or more large storage tanks of hot or chilled water or ice linked to their central heating or cooling plants. These thermal storage tanks are designed to:

- Contribute to delivery of peak energy demands.

- Allow for more efficient utilization of boilers and/or chillers.
- Enable waste heat from cogeneration systems to be recovered and stored until it is required.

DISTRIBUTION TECHNOLOGY DEVELOPMENTS

Distribution technologies for steam and hot water are well established. Active development work is underway to improve the cost effectiveness of hot and chilled water systems. In particular, friction reducing additives show promise for reducing required pump pressures, pipe sizes and pumping costs. In addition for chilled water systems, several ice slurry technologies are being explored. If laboratory results can be duplicated in operating systems, a greater cooling capacity for a given pipe size will be possible, thereby reducing investment costs in the distribution network.

BUILDING RELATED TECHNOLOGY DEVELOPMENTS

Technology advances have occurred in the efficiency of steam based chilling systems, which can utilize district steam. Also, attention is being placed on the improvement of the cost effectiveness of building metering equipment.

4.4 Distribution Technologies

Thermal energy may be distributed in various forms:

Hot Water

Buildings may be supplied with hot water as their source of heat. Hot water is pumped through a piping network consisting of a supply pipe containing higher temperature water which "delivers" heat to the buildings and a return pipe which brings the water back to the central plant for reheating.

Most common, especially in Europe, are medium temperature hot water systems designed for 120°C supply, 80°C return. High temperature systems which operate at higher temperatures and pressures are also in place.

In order to increase system efficiencies, efforts are underway, for example in Germany, to reduce return temperatures to as low as 40°C. In Denmark, low temperature systems, with a supply temperature between 60-70°C and return temperature of 40°C or lower, are becoming the rule rather than the exception.

Figure 4-3



Steam

Steam is the medium most commonly used in North American district systems and some well-established European systems. The use of steam was initially related to the presence of steam heated buildings and a demand for chilling.

Steam is distributed at various pressures [typically between 125 and 200 psig (8.3 to 13.5 bar)], depending on customer requirements, the extent of the distribution system and other factors. Steam is commonly transported at high pressure from the central plant and then converted to lower pressure steam or hot water for distribution to buildings.

Steam is condensed to water as the thermal energy is extracted at the building. In many systems, this condensate is returned to the central plant through a separate pipe system located adjacent to the larger steam pipes.

Chilled Water

District cooling systems based on central chillers distribute chilled water at 40-44°F (5-7°C) supply and 55-60°F (13-17°C) return.

4.5 Building Sub-Stations

The interface between the DHC distribution system and the building heating and cooling system takes place at the sub-station located in the building's basement. The sub-station may also be called the mechanical room. Sub-stations typically consist of:

- Heat exchangers to transfer thermal energy from the piping network to the building's system.
- Meters to measure the amount of thermal energy transferred from the DHC system to the building. In some cases, called direct systems, no heat exchangers are used. In Germany and Denmark, for example, direct systems are the most common approach, with building heating systems designed for the temperature and pressure of the hot water distributed in the network. Another type of direct system is found in district cooling systems where the chilled water is pumped directly through the building.

Figure 4-4



5 Market Acceptance

5.1 Current Market Acceptance of DHC

As stated at the outset of this manual, district systems compete with individual building systems in the thermal energy marketplace. Accurate estimates of the level of market penetration of district systems are not available on a comparable basis for the major countries of the world. To indicate the approximate level of penetration for municipal DHC in the heating markets for selected countries, the members of the IEA country experts group which participated in the preparation of this manual prepared Figure 5-1.

It should be noted that data for group heating systems are even less available than for municipal systems. It has been estimated that group systems may be equivalent to municipal systems in terms of energy supplied to connected buildings.

As Figure 5-1 shows, in countries such as Denmark, Finland and Sweden, district systems have achieved very significant levels of penetration of the heating market. In the USA, by way of contrast, the percentage market penetration is low, although the total amount of energy delivered is very substantial.

Building cooling is found most extensively in the USA, due to warm climates,

Figure 5-1 Market Penetration of Municipal DHC Systems in Heating Markets of Selected Countries, 1990

Country	Production of District Heating (PJ)	Share of DH in Total Heating Market (%)
Denmark	83	43
Finland	80	45
France	90	4
Germany-East	n/a	23
Germany-West	190	8
The Netherlands	13	2
Norway	3	3
Sweden	129	33
USA	300	3

Source: Estimates prepared by members of IEA country experts group, IEA District System Promotional Manual Project

reasonably priced energy and a relatively high standard of living. District cooling systems, which are currently found most often in the USA, are gaining rapidly in acceptance.

A brief history of district energy systems is presented on page 29.

5.2 Trends and Forecast of Market Acceptance

The factors which will influence the relative competitiveness and market penetration of district systems in the IEA member countries are many and varied. Several factors are, however, broadly based:

Competitive Options

Building owners usually have alternatives to connection to district systems. Capital,

fuel and operating costs for thermal energy from DHC competitors, almost all based on conventional energy sources, therefore represent a ceiling which caps the revenues and returns for DHC systems.

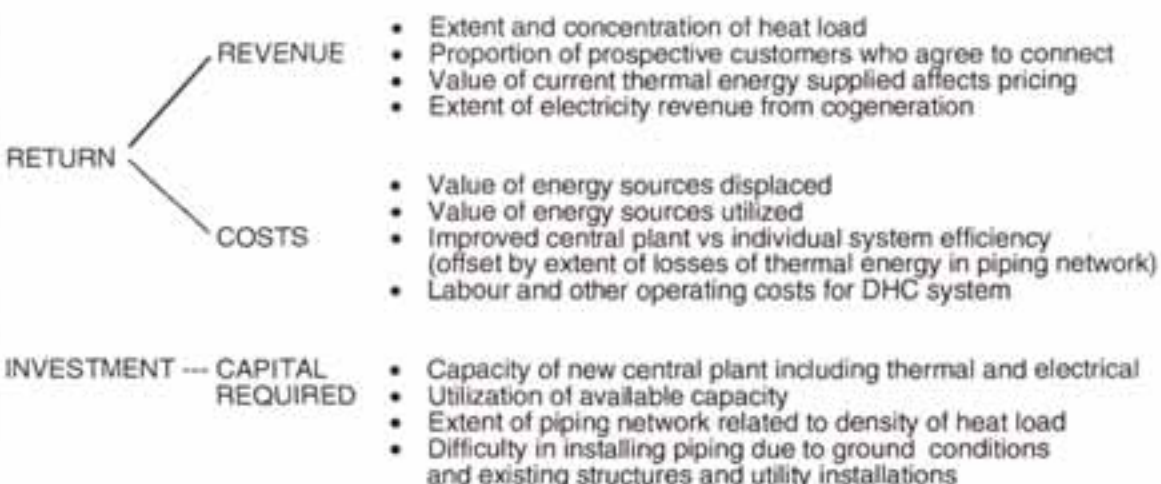
Limited Return on Investment

District systems require very large initial capital investments with returns spread over a lengthy period. Few opportunities exist for investments in district systems which yield short paybacks (i.e., high returns on investment) for their sponsors (see Figure 5-2). The economic advantages for new district systems, when based on calculations of project costs and returns, are, in fact, marginal in many cases.

Only when economic, environmental and other social benefits are included in

Figure 5.2 Principal Factors which Determine the Return on Investment of Major DGC Projects

Return on investment (ROI) is a measure of financial attractiveness of a proposed project calculated by dividing the Return (Revenue less Cost) by Investment (Capital Requirements). The factors affecting ROI are highlighted below.



This presentation of ROI is a simplification of the more sophisticated analyses of project cash flows which are typically conducted to assess the financial attractiveness of proposed DHC projects.

History of District Energy Systems

The following historical review is reproduced from the "Introduction" to District Heating Development Guide, Volume 1, (Bloomquist, Nimmons and Rafferty) Washington State Energy Office, 1987, pages 1-3.

The delivery of heat from a central source is not a new idea. During Roman times, warm water was circulated through open trenches to provide heating for buildings and baths in Pompeii. . . . In many places it is still possible to see how the heated water was circulated from home to home through a network of trenches that went through the cellars of the buildings. Hundreds of years later, . . . in Chaudes-Aigues Cantal in France, warm water was distributed through wooden pipes that are still used today. . . .

In 1877, Birdsill Holly established the first commercial district heating system in the U.S. in Lockport, New York. He used a boiler in his cellar as the central heat source and built a loop consisting of steam pipes, radiators, and condensate return lines. The system began with 14 customers and by 1880 the system served several factories as well as residential customers and had extended to a three-mile loop.

In 1893, the Municipal Council Building in Hamburg, Germany, was receiving heat from a central power station and in 1900, in order to minimize risk of fire damage to valuable art treasures, government buildings in Dresden, Germany, were linked to a central heating system (Swedish District Heating Association, 1986).

By the turn of the century, district heating systems were being established or expanded in most large cities in the U.S. Heat for many of these systems was provided by the electrical generating plants that were being established throughout the country. The heat was in the form of exhaust steam from these facilities.

The same was true in Europe and Scandinavia. In Denmark, the first district heating system was established in Frederiksberg (a suburb of Copenhagen) in 1891. The heat was provided by the "Hortensiaaerket" electrical generating plant and supplied a hospital and several government buildings.

Throughout the first half of this century, district heating prospered in the U.S. and to a lesser extent in Scandinavia and Europe.

However, following the Second World War, the U.S., Europe, and Scandinavia went in different directions. In the U.S., rapid urban growth as well as economics of scale forced most major electrical generating plants to locate outside urban areas. The cost of building central heating plants solely to supply DH systems was prohibitively expensive and an abundance of inexpensive electricity, oil, and natural gas spelled doom for many district heating companies. In Europe and Scandinavia, without the abundance of electricity and natural gas that was available in the U.S., district heating prospered as more and more cogeneration plants were built to supply an ever increasing demand for electricity. The 1970s, however, brought major changes to district heating in the U.S. as well as Scandinavia and Europe. The oil shortages of the early and late 1970s caused countries such as Sweden and Denmark, who depended upon imported oil for nearly 90 percent of their district heating systems, to look at alternatives such as garbage incineration, waste heat, and renewable resources. (As described in Section 4, several of these countries also initiated aggressive government programs in support of new and expanded DHC systems.) The oil crises of the 1970s also caused a renewal of interest in district heating in the U.S. . . . Old systems began to be refurbished and communities across the U.S. began to investigate if and how district heating could benefit their community.

the assessment do most new DHC systems become attractive. Established systems can, however, find opportunities for development and expansion on a site specific basis, as evidenced by the projects in Baltimore, Cleveland, Jamestown and Nassau County, USA.

It is worth noting that environmentally attractive alternative energy sources, such as incineration of biomass or municipal waste, can, in many cases, become economically feasible when configured as part of a DHC system.

Environmental Concerns

Concerns over the greenhouse effect and other environmental issues are increasing. The policy responses of governments are only now being formulated. As a response to greenhouse effect concerns, it is likely that, in most countries, energy efficiency will be strongly supported and the adoption of combined heat and power systems will be encouraged. The use of coal may, in some countries, be discouraged.

It is important to note that, based on CHP plants, district systems can derive energy from fossil fuels in what is probably the most environmentally friendly and efficient manner currently attainable. Since these plants produce electricity as well as thermal energy, the success of DHC systems becomes highly dependent on the degree of interest and cooperation from the electric utilities serving the area. Unless so directed by their regulatory or political "masters", electric utilities tend, at best, to view DHC with caution. At worst, utilities view DHC as a direct competitor.

With the committed phase-out of ozone-destroying CFCs rapidly approaching, central chilling systems based on ammonia

may represent a technically and financially attractive alternative to the retrofit of existing chillers with replacement CFC's.

Electric Utility Demand Side Management Programs

Closely associated with environmental concerns are the increasingly difficult siting problems for new electric power plants. As a result, in North America and other countries, interest is growing in promoting the efficient use of electricity which can delay the requirement for new generating capacity. It is expected that regulatory commissions will direct an increasing number of electric utilities to offer subsidies for the installation of efficient lighting, motors and other equipment. These subsidies and other measures in support of energy conservation, such as facility energy audits and information campaigns, are usually referred to as demand side management (DSM) programs.

District Cooling Opportunities

In markets where cooling requirements are high, many opportunities will be explored for the establishment or expansion of district cooling networks. The activity will likely be the greatest where a compatibility with electric utility demand reduction programs exists.

Overall, it is expected that the main market acceptance challenge in Northern Europe and Scandinavia will be to maintain the current share of market held by district systems. In North America, it is expected that a large number of assessments will be conducted, particularly for district cooling opportunities, and that numerous projects will be initiated by the end of the decade.

Part C Promoting to Customers

This part of the manual discusses the promotion of district systems to new and existing customers. Section 6 provides an overview of the role of promotion at each step in the decision process customers undertake in their assessment of DHC in comparison to decentralized building system options. Section 7 discusses the preparation of a promotion plan targeted to new customers while Section 8 discusses promotion to established customers.

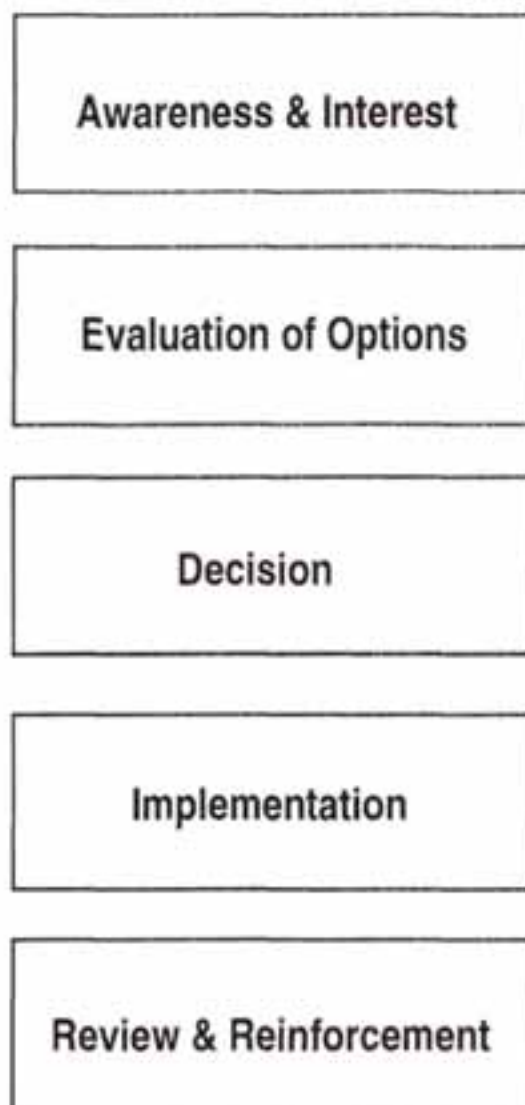
- Section 6 General Overview
- Section 7 Promotion to New Customers
- Section 8 Promotion to Established Customers

6 Overview of Promoting to Customers

A DHC system necessarily places considerable emphasis in its promotion program on gaining the support of its customers, who are the source of the system's revenue. Section 6 provides an overview of

promotion as related to the decision process of building owners. Section 7 discusses promotion programs aimed at new customers and Section 8 outlines an approach for promotion to established customers. It should be noted that, although not discussed explicitly in this manual, occasionally a DHC system operator will assist building owners who are connected to the Review & Reinforcement system as they promote the benefits of DHC to prospective tenants.

Figure 6-1 Steps of Customer Decision Process



Building owners must be convinced that connection to a district system is preferable to the installation of individual building heating and cooling systems. The most apparent concern of owners is the comparative energy cost between district and individual building systems. Since district systems do not necessarily offer dramatic energy cost savings to an owner, promotion activities must be carefully planned and executed in order to communicate the full range of DHC benefits in a persuasive manner.

In order to establish a clear target for promotion activities, it is useful to understand how customers typically make decisions to connect to a district system. Figure 6-1 provides a representation of the sequence of steps in the customer decision process. These steps begin with the customer's initial awareness of district systems and continue to the detailed evaluation of DHC in comparison to individual building systems. The point of decision is followed by project implementation and an ongoing review of satisfaction with the decision.

For each of these steps, it is important to identify the role played by others in influ-

Figure 6-2 Promotion Issues at each Step in Customer Decision Process

Steps in the Decision Process	Issues for Promotion
Awareness & Interest	<ul style="list-style-type: none">• Is the customer aware of DHC as a credible option?• Is the customer interested in learning more about DHC?• Who influences the building owner? (e.g. property manager, engineers)• Are they aware? interested? able to make an evaluation?
Evaluation of Options	<ul style="list-style-type: none">• Is the customer familiar with all the technology options which DHC may offer?• Is the customer considering all the relevant factors besides direct energy costs?• Is the customer using accurate information in the comparison of DHC with individual building systems?
Decision	<ul style="list-style-type: none">• Who makes recommendations? Who makes the financial decisions? (e.g. senior official or board)
Implementation	<ul style="list-style-type: none">• Where and how can decision makers be reached?• Who is liaison with the DHC company during project implementation?• Are all the questions and concerns promptly addressed?
Review & Reinforcement	<ul style="list-style-type: none">• Is the customer satisfied with the DHC service? (e.g. cost, reliability, service, administration)• Is the customer considering a change? (e.g. building renovations/expansion)• Does the customer have new operating or property managers on staff who are not familiar with DHC?

encing the building owner. It is reasonable to assume that, in many cases, the owner will rely heavily on the advice of his experts, such as property managers and consulting engineers.

At each step in the owner's decision process, specific issues are raised related to the possible requirement for promotion activities. These are shown in Figure 6-2.

It cannot be assumed that all current or prospective customers have the same set of attitudes toward DHC or are at the same step in the decision process. Thus, a suggested starting point for preparing a

promotion plan is to conduct a survey to identify how many customers are at each of the steps. See Figure 6-3 for an outline of key areas to include in a survey of customers. For example, if it is found that customers or their engineers lack awareness of district systems, promotion objectives can be set to provide introductory information. On the other hand, if several prospects are reaching the conclusion that district systems are not appropriate, then promotion should be directed toward overcoming the negative perceptions of those individuals who are recommending against DHC.

Figure 6-3 Major Question Areas for Survey of Prospective and Current Customers

For current customers, all of the following question areas would be relevant. For prospective customers, only areas 1-3 and 5 would be relevant.

1. Descriptive Information
 - Respondent name/responsibility
 - Building owner/manager (location, size, function, heating and cooling system, etc.)

2. Level of awareness of DHC competitive advantages
 - e.g. Reliability of supply
 - Cost effectiveness
 - Investment and space
 - Environmental control

3. Likes and dislikes: re DHC system
 - What is liked the most? (with reason)
 - What is liked the least? (with reason)

4. Degree of satisfaction with DHC
 - Day to day (technical support, administration, etc.)
 - Overall level of satisfaction (with reason)

5. Plans and Expectations
 - Changes in buildings (remodel, expand, etc.)
 - Intentions re DHC connection

7 Promoting to New Customers

7.1 Current Attitudes and Behaviour

Subscribers are building owners who agree to connect their buildings to a district system for heating and cooling requirements. Thus, subscribers provide the load for a multi-subscriber system and system proponents seek to persuade them to connect and stay connected. For most large DHC projects, connection commitments must be obtained from large prospective subscribers before funding can be secured and approval to proceed with construction is received.

The subscriber's interests can be represented or influenced by building property managers and other owners as well as by their consulting engineers. In order to convince potential subscribers to connect, the district system proponent must establish an awareness of the full range of financial and operating advantages of district systems.

There are two types of decision situations which involve promoting to new subscribers:

- Systems which are expanding or starting up are seeking to add subscribers before the investment commitments for the piping network have been finalized.
- Established systems which are seeking to sign up new customers to add to the load of the established distribution network. The new customers may be owners of new buildings, buildings with major expansions or buildings in which energy systems are being replaced.

In both types of situations, these prospective subscribers may be operating existing buildings with decentralized heating and cooling systems or may be investing in new buildings. The most significant "window of oppor-

tunity" to gain acceptance for DHC occurs at the time design concepts are being considered for a new building or when the heating or cooling equipment in an existing building is in need of replacement. In these cases, the most attractive time to promote is well in advance of the energy system decisions being finalized. DHC promoters should identify such projects and initiate promotion activities at the earliest possible stage.

Opportunities to add subscribers can also be greatly enhanced through changes in energy or environmental regulations (such as the phase-out of CFCs), changes in the price or assurance of supply of conventional fuels (such as the result of an "oil crisis") or the availability of newly proven technology (such as large heat pumps or circulating fluidized bed combustion units for solid fuels). Any of these or similar changes which affect the market for thermal energy services offers the opportunity for DHC proponents to approach new subscribers with a "fresh story".

In many countries, building owners have extensive experience with, and confidence in, district systems. In other countries, most experience has been with natural gas or oil fueled decentralized systems.

The factors or criteria used by potential subscribers in assessing their thermal energy system options are straightforward. The most important is financial attractiveness. A comparison of the financial attractiveness of the district system with decentralized options is the single most important consideration for subscribers in all cases. Capital as well as operating costs and savings are assessed. Estimates prepared by the system proponents may not agree with those prepared by the subscriber's consulting engineers, who may

use "rules of thumb" which are not based on current cost and performance factors.

Some potential subscribers may be unnecessarily concerned that connection to a district system will mean that they lose control of their building energy systems and that reliability may suffer.

Consulting engineers who lack familiarity with district systems tend to be sceptical of the advantages of district systems. Furthermore, because their fees can be dependent on total project costs, architects and engineers may have a vested interest in maximizing the use of decentralized systems, which have higher initial costs than building systems connected to DHC.

For new building designs, engineers may not have sample drawings of connections to district systems readily available from other projects whereas it is easy for them to prepare drawings for "packaged" boilers and chillers used in independent building systems. The recently published International Energy Agency report on the conversion of existing heating and cooling systems to district system sub-stations should provide assistance in the preparation of cost effective plans for connection.

Few district energy systems outside the USA provide cooling. However, the demand for building chilling in North America is growing as the transition continues to a service-based, "white-collar" economy and the high standard of living can afford chilling in those areas with warm, humid summer climatic conditions.

District system developers are actively investigating options for meeting chilled water requirements. Approaches such as the Nassau County, USA project, which can spread district system overhead over a larger base, will become increasingly attractive due to the following developments:

- Replacements for CFCs in centrifugal chillers may reduce the efficiency or cost effectiveness of these units
- Utility demand charges may increase, resulting in increased disincentives for electric chiller use in peak demand time periods
- Technology developments improve the cost effectiveness of systems based on
 - absorption cooling which can utilize district system steam
 - central chillers using ammonia or other refrigerants
 - lake water or other low cost sources of chilled water.

While financial attractiveness tends to be the most important consideration, potential subscribers will use additional factors in their decision process. Although not easily quantifiable, district systems offer important, tangible benefits in several areas (see Section 7.4).

7.2 Promotion Objectives

For prospective subscribers and the property managers and consulting engineers who influence their decisions, establish awareness of and credibility for:

- The many financial advantages of connection to district systems.
- The important non-financial benefits offered by connection.

7.3 Promotion Activities

Promotion activities to subscribers are best conducted through personal selling presentations. Selling materials (financial calculations, professionally prepared sales literature, fact sheets, etc.) should be left behind after the presentation. Testimonials from satisfied customers can be especially

useful in gaining credibility. Site visits can also be very useful to enhance credibility and provide the opportunity to answer questions.

For new systems, an initial priority should be placed on obtaining commitments from the largest and most influential building owners. In addition to the business reasons for their commitment to DHC, they can be approached on the basis of their providing a leadership role in investing in the future prosperity of the community.

In view of the very influential role played by mechanical engineering companies, it is suggested that attention be placed initially on the few largest firms. As the key individuals in these firms accept DHC as a credible alternative, they will be opinion leaders in shifting the attitudes of other engineers.

It should be noted that, in many cases, building owners will have property in other cities which is currently connected to DHC systems. Contact with the owner's representatives for these buildings can provide credible testimonials for DHC.

7.4 District System Benefits

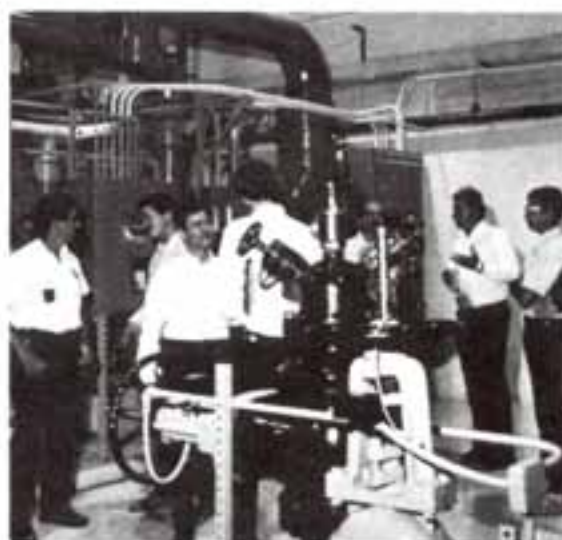
It may be useful to present the full set of DHC advantages under the following "umbrella":

DHC systems provide a specialized, expert service which is concerned with – and committed to improving – all aspects of the efficient and reliable long-term supply of reasonably priced thermal energy. DHC system operators continually invest in the enhancement of all aspects of system operation, including forecasts of energy price and availability, developments in the regulatory framework and technical improvements in combustion and distribution efficiency. Connection to a DHC system represents the same kind of commitment which building owners make without hesitation in their supply con-

tracts for electricity, natural gas and water and sewer services.

Specific selling "messages" can be provided in the areas of financial and non-financial advantages.

Figure 7-1



Financial Advantages

A comprehensive, credible method for calculating and presenting financial information is essential. Such a method should take into account what connection to a district energy system may offer. See Figure 7-1.

- Avoidance of capital expenditures for boilers and related equipment. Some DHW systems will subsidize a portion of the connection costs, including building sub-stations, to encourage owners to commit to the system.
- Elimination of labour and other expenses of boiler maintenance and repair.
- At buildings with large boilers, avoidance of 24-hour attendance by stationary engineers.
- Making space available for income production or other purposes.
- Possible reduction in fire insurance premiums.

Figure 7-2 Financial Factors for Comparison of DHC with Decentralized Systems

Guidance for conducting a comparison of the costs of connection to a district system with a decentralized system was provided in a paper presented at the 1990 Annual Conference of the International District Heating and Cooling Association. The paper focused on the necessity of providing a prospective customer with a comprehensive assessment of all factors which influence the capital and operating costs for an in-building boiler plant. The factors discussed in the paper included:

- Capital costs which include all auxiliary components on an installed basis, avoiding rules of thumb.
- Operating labour required by regulation and needed to ensure sound and safe operating practices, including preventive maintenance for long boiler life.
- Boiler efficiency expected with normal scale build-up on boiler tubes and other factors.
- Costs of insurance, including boiler, open flame in building, on site fuel storage.
- Impact on net rentable space, including footprint for boiler and fuel storage plus stack space on each floor.
- Property tax assessment related to higher building investment.
- Cost (as well as time) required for permitting, including costs if non-compliance with environmental regulations should occur.

Addington, Bill et al. "What Does it Really Cost to Install, Operate and Maintain an In-Building Boiler Plant", presented at the 81st Annual Conference of the International District Heating and Cooling Association, Toronto, June 1990.

- It is highly desirable that all third parties conduct an energy analysis of the building considering DHC. The analysis should establish an objective estimate of the building's thermal load and the costs of using an individual building energy system.

Many developers of new buildings have a strong preference for the principle of "least first cost" as a design criterion for their new building, regardless of annual operating costs. This can lead to the specification of low cost electric heating and cooling systems, even though tenants are left with excessively high annual energy costs. In these situations, the financial and other advantages must be presented in a manner

which stresses the enhanced attractiveness to prospective tenants of a building connected to DHC.

Additional Advantages

Non-financial benefits offered by a district system connection should also be presented. These benefits include:

- Potential for the long term least cost energy supply since the district system is able to switch to the lowest cost energy source (e.g., heavy fuel oil vs natural gas at interruptible rates) and waste energy supply (e.g., industrial waste heat, cogenerated heat or incineration of municipal wastes).

- Greater reliability in meeting day-to-day thermal energy requirements since a district system usually operates with greater redundancy of capacity, flexibility of fuels used, ongoing staff training and rigorous maintenance procedures.
- The removal of concerns regarding future regulations of emissions, stacks, oil storage tanks and other environmentally sensitive factors.
- Convenience to property managers through reduced maintenance management requirements for energy systems and better capability for monitoring building energy costs.
- Assured comfort to building tenants through the DHC system capability of meeting unexpected peak heating and cooling requirements as well as through reliability of supply.
- Utilization of computerized communication linkages with customers (for monitoring and controlling the DHC network) may provide the basis for future service offerings, such as building security systems.

8 Promoting to Established Customers

8.1 Current Attitudes and Behaviour

In the competitive marketplace for building energy requirements, it is important that DHC system managers ensure that they maintain a close relationship with their customers. As Figure 6-1 shows, the decision process of building owners does not terminate with the decision to con-

nect to the DHC system. Where the connection is made, the owner continually receives feedback on how well the relationship with the DHC company is developing. In addition, information on competitors' systems continues to be available.

Typically, the DHC company relates to two groups within the customer's building management organization. The financial or administrative group handles billing and contract matters and the building operations group deals with the day-

to-day issues of supply and return flows, temperatures and pressures. With both these groups, it is useful to ensure that the benefits of connection to the district system are understood and that specific problems and concerns are brought forward for resolution.

A periodic survey (see Figure 6-3) of customers can be invaluable in obtaining feedback. Energy Networks Incorporated, operator of the Hartford, Connecticut system, for example, identified areas of satisfaction and dissatisfaction through a survey of its customers. Useful feedback was obtained in several areas, including why customers would or would not recommend district systems to their colleagues. District Energy St. Paul also conducts a periodic survey of its customers.

Figure 8-1

THERMAL UPDATE®

A Periodic Survey of Customers

Winter 1991
Vol. 1, No. 1

Philadelphia Thermal Unveils Cogen Plans

Philadelphia Thermal, through its affiliate company, United Thermal Development, recently announced a five-year contract with leading energy program developer ETEC Energy Services and the United Engineering Group, as affiliate of the Philadelphia Electric Co. to design, construct, operate and maintain a 100 MW cogeneration plant in Philadelphia.

Construction of the cogeneration plant, located at the University City campus, is expected to start in late 1991 and will be completed by late 1993.

The project will use a district energy system to provide heating, cooling and power to the University City campus. In addition, a five-story office building, which is well over half completed, being built on the grounds of the new campus. The benefits of this is that the project can use the flexibility of the district system to provide capacity to meet a wide range of building and industrial use over time. About 100,000 sq ft of office space is currently under construction and the total campus area is expected to be completed by late 1993.

Continued on page 10

Philadelphia Thermal Announces New Service Company

Philadelphia Thermal Energy Company (PHTEC) recently announced the formation of a new company, designed to provide additional energy services to the owners and operators of energy systems in the Philadelphia area.

The new company, a subsidiary of PHTEC will be called Philadelphia Thermal Service Company (PTSC). PTSC will provide quality plant, equipment, and personnel services to owners and other energy program and systems in a timely, cost-effective and professional manner in connection with Philadelphia Thermal.



U.S. Congressman Robert Byrd (D-W.Va.) and Mayor R. Bruce Singsen (Mayor of Washington, D.C.) visit Philadelphia Thermal.

Government Leaders Visit Philadelphia Thermal

The past several months have seen a steady stream of federal and local government leaders visiting Philadelphia Thermal to learn of the value and role it plays in the City's infrastructure, contribute to local development, and in providing facilities and services to the community.

Visitors included U.S. Congressman Robert Byrd (D-W.Va.), Mayor R. Bruce Singsen, and Mayor of Washington, D.C., R. Bruce Singsen.

Services such as the installation, maintenance, and repair of building energy systems and other services will be offered to owners and other customers.

Other services will include a Performance Incentive Program, which allows energy users to improve their energy efficiency by using the "Incentive Program," which allows users to maintain quality and accuracy in determining the operating efficiency of the system, and whether they require repair or replacement of specific systems or equipment, such as air conditioning, heat exchangers, etc.

The services will help customers achieve a more efficient operating plant and power system, as well as having quality personnel, with extensive working knowledge and experience with energy systems.

PHTEC provides a 24-hour-a-day heat and power operation.

The benefits for using PHTEC include: a) better control of the system; b) better control of the system; c) better control of the system; d) better control of the system; e) better control of the system; f) better control of the system; g) better control of the system; h) better control of the system; i) better control of the system; j) better control of the system; k) better control of the system; l) better control of the system; m) better control of the system; n) better control of the system; o) better control of the system; p) better control of the system; q) better control of the system; r) better control of the system; s) better control of the system; t) better control of the system; u) better control of the system; v) better control of the system; w) better control of the system; x) better control of the system; y) better control of the system; z) better control of the system.

PHTEC will begin full-scale operations on January 1, 1991. In the interim, it will provide assistance with your system. Please contact our Customer Service Department at 710-441-1111. We want to give you the best service.

Among current customers, current attitudes can vary. Some, for example, may lack knowledge of their district system connection while others are enthusiastic supporters. Lack of satisfaction may be found, for example, when older DHC systems have not maintained the level of investment in improved efficiency measures necessary to contain costs at reasonable levels. Promotion can help retain customers during a period of system upgrading.

8.2 Promotion Objectives

Among established customers:

- reinforce the level of awareness of the financial, operating and other benefits of connection to the DHC system
- identify opportunities to provide technical assistance, such as in the area of heat exchanger maintenance and operation
- explain administrative and operating policies of the DHC company, such as its pricing policy and the concern over optimum temperature changes through the customer's sub-station.

8.3 Promotion Activities

Surveys of a cross-section of customers will identify current levels of understanding of DHC benefits and concerns to be addressed. Ongoing contact with the very largest customers is required through personal meetings.

User groups can bring together building operating engineers to discuss common problems and issues related to connection to the district system as well as operation of their building systems. For example, Trigen-Oklahoma, a private district system company, which operates district cooling systems in Tulsa and Oklahoma City, USA, has established a "Builders Opera-

tions Advisory Board". This board, made up of 12 customer building operators from each system, provides a forum to share expertise, solve problems and improve communications with Trigen.

Periodic newsletters can be a useful activity to highlight the future plans of the district system to improve the scope, quality and cost effectiveness of service.

Throughout these activities, the DHC company conveys the image that they are truly interested in helping customers improve their energy management, not simply function as a supplier of steam or hot water. This requires an investment in marketing and technical support as well as a customer-oriented attitude among all DHC employees.

8.4 District System Benefits

The benefits to be stressed to customers are identical to those discussed in Section 7.4. For convenience, they are repeated here.

The full set of DHC advantages can be presented under the following "umbrella".

DHC systems provide a specialized, expert service which is concerned with – and committed to improving – all aspects of the efficient and reliable long-term supply of reasonably priced thermal energy. DHC system operators continually invest in the enhancement of all aspects of system operation, including forecasts of energy price and availability, developments in the regulatory framework and technical improvements in combustion and distribution efficiency. Connection to a DHC system represents the same kind of commitment which building owners make without hesitation in their supply contracts for electricity, natural gas and water and sewer services.

Specific selling "messages" can be provided in the areas of financial and non-financial advantages.

- Making space available for income production or other purposes.
- Possible reduction in fire insurance premiums.

Many owners of new buildings have a strong preference for the principle of "least first cost" as a design criterion for their new building, regardless of annual operating costs. This can lead to the incorporation of electric heating and cooling systems, even though tenants are left with excessively high annual energy costs. In these situations, the financial and other advantages must be presented in a manner which stresses the enhanced attractiveness to prospective tenants of a building connected to DHC.

Additional Advantages

Non-financial benefits offered by a district system connection should also be presented. These benefits include:

- Potential for the long term least cost energy supply since the district system is able to switch to the lowest cost energy source (e.g., heavy fuel oil vs natural gas at interruptible rates) and waste energy supply (e.g., industrial waste heat, co-generated heat or incineration of municipal wastes).
- Greater reliability in meeting day-to-day thermal energy requirements since a district system usually operates with

greater redundancy of capacity, flexibility of fuels used, ongoing staff training and rigorous maintenance procedures.

- The removal of concerns regarding future regulations of emissions, stacks, oil storage tanks and other environmentally sensitive factors.
- Convenience to property managers through reduced maintenance management requirements for energy systems and better capability for monitoring building energy costs.
- Assured comfort to building tenants through the DHC system capability of meeting unexpected peak heating and cooling requirements as well as through reliability of supply.
- Utilization of computerized communication linkages with customers (for monitoring and controlling the DHC network) may provide the basis for future service offerings, such as building security systems.

These benefits can be illustrated by recent situations experienced by the DHC system, such as the impact of major energy price changes or new environmental regulations. New investments in plant efficiency and reliability and employee training can also be described.

Part D Promoting a Municipal System

This part of the manual discusses the issues associated with promoting a municipal system. Much attention is placed on the development of new municipal systems. In Section 9, an overview of promoting a municipal system is presented, including a discussion of project development steps, key factors for success and timing considerations. Sections 10 through 14 then discuss the preparation of plans for promotion campaigns targeted to municipalities, utilities, regulatory agencies, financial institutions and system owners. This part concludes in Section 15 with a discussion of the special issues involved with promotion for an established system.

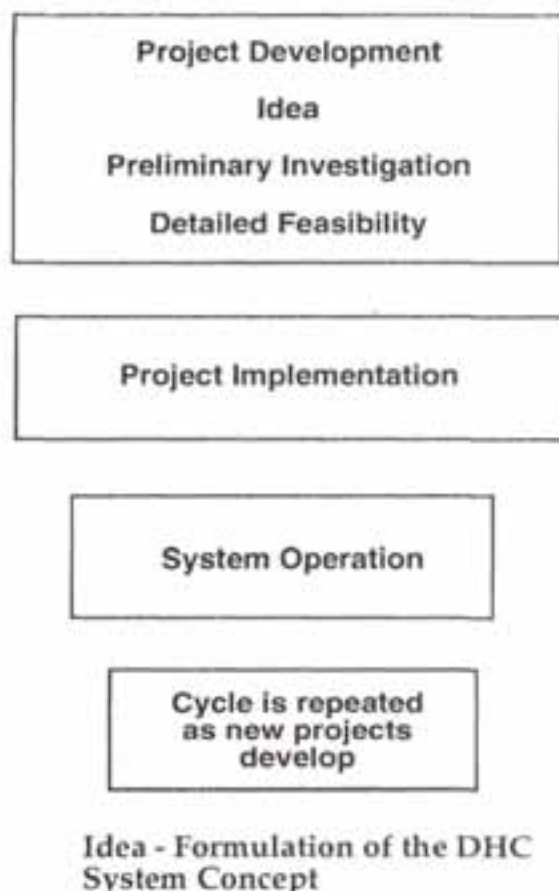
- Section 9 Overview of Promoting A Municipal System
- Section 10 Promoting to a Municipality
- Section 11 Electric and Gas Utilities
- Section 12 Regulatory Agencies
- Section 13 Financial Institutions
- Section 14 System Owners
- Section 15 Promotion for Established Municipal Systems

9 Overview of Promoting a Municipal System

9.1 Project Development Steps

The development of a municipal (subscriber) district system (see Section 2.2 for a description of municipal DHC systems) can be seen to follow a sequence of stages, from the point at which the idea for the system is conceived through the investigation of its technical and economic feasibility to its installation and operation. These stages are outlined in Figure 9-1 and are described more completely below.

Figure 9-1 Project Development Stages



The basic concept for the DHC system is usually created on the basis of special circumstances of a municipality's situation. Examples of these circumstances include availability of alternative energy sources, an under utilized heating plant and government energy or environmental program initiatives.

Preliminary Investigation

The objective of the initial investigation is to assess the technical, economic, market and organizational feasibility of the proposed system. It seeks to identify critical factors for success and to prepare a preliminary business plan for implementation and operation.

Detailed Feasibility Study

The detailed feasibility study addresses the same considerations as the preliminary investigation. However, its economic analysis is much more rigorous, with cost assumptions in the +/- 10% range of confidence rather than the +/- 30% level of accuracy which is sufficient for the preliminary work. Also, the implementation plan must provide, at a minimum, a rationale for estimates of connected thermal loads (marketing to the potential demand for heating and cooling), system ownership and operational management and sources of capital. Socioeconomic and environmental impact assessments will also be required.

Project Implementation

Upon approval, implementation of the project commences, with all elements of the detailed implementation plan closely supervised.

System Operation

Operation of the system is managed to provide customer satisfaction, economic efficiency and consideration of approaches for ensuring the long-term viability of the DHC system.

After municipal systems are established, most continue to explore opportunities for system expansion and improved efficiency of operation. These opportunities might include possibilities for adding customers through an expanded distribution network, utilization of new energy sources and conversion technologies or improving the quality of service to customers. Thus, the project development stages shown in Figure 9-1 may be undertaken on a repetitive basis, as each new idea for system improvement is considered, studied and, where support is received, implemented.

The interests of many groups in the community are affected by the establishment and operation of municipal (subscriber) district energy systems. These groups include officials within the municipality, electric and gas utilities, regulatory agencies, financial institutions and owners of existing group or subscriber systems. The preparation of promotion plans for each of these target groups is discussed in Sections 10 through 14.

9.2 Factors Determining Success

Many factors determine how successful a system developer will be in promoting a new or expanded DHC system. However, four factors are usually the most significant:

- Government Policies and Programs (see Part E)
 - Influence or establish energy prices
 - Establish environmental regulations which directly or indirectly

influence attractiveness of technology options.

- Determine the processes for obtaining the necessary permits for construction and operation of the new system.
- Density of Thermal Load and Direct Project Costs
 - Determine, to a large degree, the economic attractiveness of DHC projects by providing the basis for prospective system revenue (connected load proximate to the thermal energy source) relative to system costs (plant and network capital, fuel and operating costs) See Figure 5-2.
- Municipal Government Support
 - Shows leadership for the community.
 - Translates social benefits into financial investment or incentives.
- Promotion Effectiveness
 - Requires a "champion" for the proposed project from within the community.
 - Develops support from key groups at each stage of project development.

9.3 The Role of Promotion

It is crucial that developers of a new DHC system understand how to conduct each of the five stages outlined in Figure 9-1. However, it is also crucial that system developers understand that promotion plays the critical role of providing the linkage from one stage in project development to the next. In other words, effective promotion ensures that:

- the results of each stage will be reviewed by the groups whose interests are affected
- approvals are obtained so that the next stage can be initiated and carried out as smoothly and efficiently as possible.

Experience has shown that the effectiveness of promotion in the project development process is highly dependent on:

- the involvement of a "champion" for the project from within the community
- the establishment of an advisory working group with membership from all of the major interest groups in the community (including municipal government officials, the business community, utilities, environmental and other interest groups).

Development of a project can proceed most efficiently when the team of project developer, champion and advisory group begins working together at the initial stages of formulation of project concept.

At each stage of project development, important promotion issues must be addressed. These are shown in Figure 9-2 and are discussed in greater detail in the remainder of this part of the manual.

9.4 Timing

When government programs are supportive and DHC is well understood, a period of 3-5 years may be required for the project concept for a new municipal system to be translated into an installed system. Many systems have been installed in Northern Europe within this time frame. On the other hand, a DHC project may re-

Figure 9-2 Role of promotion during stages of development and implementation of major DHC projects

General Rule: Provide the linkage from each stage to the following stage

Project Development

- Ensure that a project "champion" with influence and credibility has taken charge.
- Ensure that an advisory working group gains support from key groups affected by the project.
- Ensure that all currently available DHC technology options are considered.
- Ensure that all relevant benefits and advantages of the proposed project are "packaged" for the use of the working group.

Project Implementation

- Solicit commitments from prospective customers
- Conduct active public relations campaign with the public and the business community during construction.

System Operation

- Ensure that ongoing support is maintained from customers, regulators, suppliers and DHC company employees.

quire 10-15 years or more to come to fruition when faced with obstacles. These obstacles can include:

- opposition from entrenched interests (such as an electric utility) which must be countered.
- lack of credibility for DHC among the local community.
- project economic attractiveness is limited and can be improved only through increases in costs for conventional energy sources, decreases in costs of DHC technology or increase in revenue from cogenerating electricity.

10 Promoting to a Municipality

10.1 Current Attitudes and Behaviour

Municipal governments can relate to district energy systems in many possible ways:

- The municipal government may own the system directly or control a non-profit corporation which owns the system.
- Municipal buildings may be connected as subscribers.

Figure 10-1

DISTRICT HEATING IN STOCKHOLM

District heat distribution



- Construction permits are issued by the municipality.
- Economic development departments may support the construction activity, the strengthening of the urban core and the substitution of "imported" fuel with locally available energy sources.
- Traffic may be disrupted during construction.

- Environmental conditions (especially outdoor air quality) can be expected to improve with the introduction of a district system; however, siting problems may be encountered for central plants.
- Incineration of municipal waste may provide a low cost energy source while reducing landfill requirements, although public support for this technology is not always positive.
- Tourism and business activities may be somewhat affected during construction due to traffic disruptions and the temporary impacts on streets and sidewalks. However, the presence of a district system can contribute to an image of a "clean, vibrant and modern" city.

Extensive municipal district heating systems are common in Scandinavia and other European countries. However, few cities in North America have moved beyond older, downtown systems to estab-

Figure 10-2



lish comprehensive municipal systems. Many municipalities have a general reluctance to start new municipal services. Furthermore, the advice they receive from electric utilities tends to be negative toward DHC.

Particularly in North America, many municipal leaders are not aware of the environmental and economic benefits of district systems which can have positive impacts on their community. More significantly, it has not been possible to translate these social benefits into municipal commitments to use tax dollars, regulatory authority and planning direction to enhance the economic attractiveness of district systems.

Figure 10-3



District energy systems offer many prospective benefits to a municipality. However, the process of determining the magnitude of these benefits, having them understood and appreciated by the political decision makers and translating a political will into action is not an easy task. At a minimum, a "champion" of district systems must be found among influential

municipal politicians such as the mayor. For example, then Mayor Carlson proved to be the driving force behind the implementation of the DHC project in Jamestown, USA.

In seeking opportunities for new DHC systems, it is desirable to identify a specific set of circumstances which can provide the rationale in that community. Examples: a) In Kingston, Canada, the existing boiler plant at Queen's University had excess capacity and is now being considered for possible use as the basis for a new municipal system. b) Some thermal loads may already be connected (establishment of the Toronto, Canada system). c) Utilization of municipal waste or other waste streams may represent a cost effective source of energy (Norway). d) Government funding support may be available for feasibility studies (district cooling in the USA), demonstration projects (Charlottetown, Canada) or system construction (Finland and Denmark during the 1980s).

It may also be important for local community officials to be aware that the prospective DHC system can be owned or operated by either the municipality itself or by a private company.

10.2 Promotion Objectives

When a system developer or operator is promoting to a municipality, the target audiences may include elected officials as well as members of the municipality's planning, energy, environmental, economic development and public works departments. Promotion objectives should include:

- To encourage the mayor or other senior official to take on the role of project champion.
- To establish awareness of and credibility for district energy technology and

the benefits to be realized at the municipal level, including:

The economic benefits offered by district systems.

The environmental benefits offered by district systems; and

The range of technical options which are available for linking available energy sources with current and future loads.

10.3 Promotion Activities

Consideration of a district system may be triggered in several ways. For example, a major

Figure 10-4



urban redevelopment project may be proposed or an available energy resource (such as available waste energy or excess boiler capacity) may be identified. Pre-feasibility studies are usually required to assess the alternative technical concepts. For each of these, the costs and benefits to the municipality can be determined and an appropriate way to implement the project can be identified.

As identified in Section 9.3, an advisory working group should be established at an early stage. This group should provide on-going advice regarding the opportunities and implications for the target groups represented by its members. The group should also solicit feedback from a cross-section of target group members on key project development issues.

Visits to other systems may contribute to the credibility of the "new" district concept (as well as provide a learning experience for engineers and contractors). At a minimum, several years will be required to develop the idea of a district system into an approved, funded project.

10.4 District System Benefits

Specific selling "messages" may be required in several areas:

Figure 10-5



Economic Benefits

Promotion of local economic benefits offered by district system investment programs should be of interest in most municipalities. These benefits include:

- Employment required during construction and installation is significant. District systems are capital intensive and the labour content of many projects is extensive.

Figure 10-6



- District systems can enhance the attractiveness of urban cores as locations for development. The vitality and viability of downtown areas, which have municipal services in place, can be strengthened by district systems, negating some of the pressures toward suburban "sprawl".
- Where district systems incorporate a locally available fuel source, energy dollars stay in the community rather than being "exported" for fuel purchases. For example:
 - utilization of wood chip fuel can create an energy supply system while contributing to the productivity of nearby forests
 - utilization of industrial waste energy can increase the profitability of the industry and support its ongoing contribution to the local economy.

Environmental Benefits

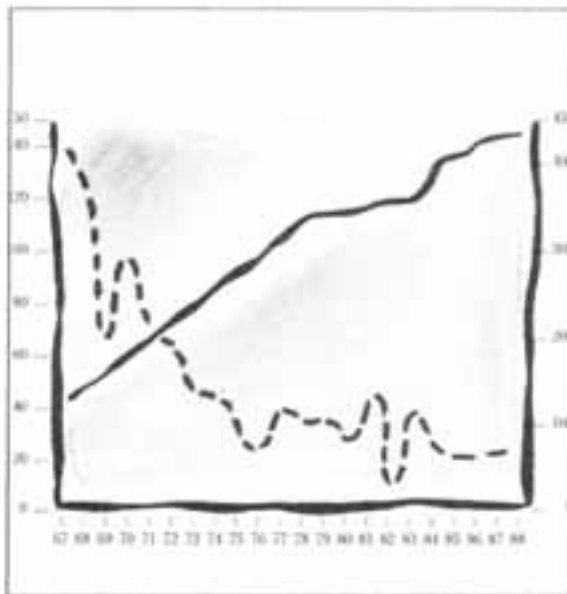
Municipal officials should be fully aware of the ways in which the district system will relate to the growing set of environmental interests and concerns. District systems offer many current and prospective environmental advantages over decentralized systems. Greater efficiency in fuel use reduces the amount of CO₂ emitted, thereby reducing the impact on global warming. When calculated on the basis of efficiency over a full heating season, the efficiency of CHP plants is approximately 85%, compared to as low as 60% for decentralized boilers. Reasons: Elimination of most standby losses; better maintenance; more highly trained operators; better boiler controls; incorporation of stack heat recovery systems. It should be noted that the increased combustion efficiency of central plants compared with individual systems is much greater than the distribution system losses, which can range from 8-12% of distributed energy.

- Centralized systems for chilling are up more efficient than decentralized chillers.

Figure 10-7



Figure 10-8



- Besides reducing the total amount of emissions through improved combustion efficiencies, a central plant utilizes a single tall stack which disperses emissions away from the municipal area. As a result, local pollution levels are reduced without any material impact on surrounding areas.
- The single point of combustion emissions is much easier to monitor and control with state of the art pollution control equipment.
- Where support for incineration of municipal solid wastes exists, the utilization of available waste streams as an energy source rather than landfill provides for the displacement of conventional fuels (reducing CO₂ emissions) and reduction in landfill requirements. In Trondheim, Norway, for example, the driving force behind the new DHC system was the capability of DHC systems to utilize energy from the incineration of municipal waste.
- Disruption of local traffic during construction represents a temporary, additional environmental problem which occurs with the implementation of a new DHC system. Although current construction and plan-

ning techniques can minimize such disruptions, it is important that the DHC developer initiate a public relations campaign to inform the public as to the reasons for the temporary inconvenience.

District System Options

The municipal officials should become aware and knowledgeable about the major technical options available for establishing an extensive municipal district system. For reference, a description of the range of district system technology options is provided in Section 4. These options may include:

- Incorporating a locally available energy source, such as heat recovery from a municipal waste incineration plant or a nearby industrial plant or utilization of wood waste or wood chip fuel.
- Installing cogeneration equipment to increase overall plant efficiency (Edmonton, Canada), reduce peak electrical demand and generate supplemental revenues from the sale of power (Charlottetown, Canada).

Figure 10-9



- As building cooling requirements increase, installing central chilling equipment with a chilled water distribution system or high efficiency steam absorption chillers which can utilize available steam distribution lines.

- Connecting an existing system to nearby buildings to increase the load on an under utilized boiler plant (Baltimore, USA; Kingston, Canada).
- Retrofitting existing steam lines with a lower cost, efficient hot water distribution network.
- Saving capital and operating expenditures for new municipal buildings and subsidized housing which can be efficiently connected to the system.

The experience of many consulting engineers with these technology options may be limited. Thus, system proponents may

find that engineers who specialize in these areas are the most appropriate sources of appraisals of costs, benefits and risks of technical alternatives.

The situation facing each municipality is different and the relative costs of competing energy sources can be expected to shift over time. Furthermore, technology developments are emerging which may significantly improve the cost effectiveness of district options. Therefore, the potential attractiveness of major system options available to municipalities should be periodically assessed.

Despite apparent environmental advantages, a major challenge to a district system project can be found where a new central plant is required. In some areas, a polarized view has emerged that equates a stack with a source of new and dangerous pollution which will negatively impact regions downwind from its site. although no simple approach may overcome these siting concerns, it may prove useful to:

Prepare credible, objective assessments of "before" and "after" emissions patterns from the experience of other district systems, such as Lund, Sweden (see Figure 10-8).

Provide evident that one stack, subject to emission control requirements in continuous monitoring, will be "cleaner" than the individual, small stacks which it replaces. A reduction in the total amount of fuel consumed, better combustion/emissions controls and the top of the stack located above local down drafts all combined to improve air quality in the community.

Wherever possible, gain the understanding and support of municipal and provincial/state environmental officials regarding the factual evidence; and, over time attempt to educate community opinion leaders, including environmental interest groups, regarding the implications of the environmental choices which will have to be made for their community.

11 Electric and Gas Utilities

11.1 Overview of Utility Relations

Promotion activities for new and established DHC municipal systems must take into account the challenge of dealing with several target groups in addition to the municipal government. These target groups can include electric and gas utilities, regulatory agencies, financial institutions and system owners. Organizing a promotion plan for these groups is discussed in Sections 11 through 14.

Proponents of district energy systems will likely find themselves dealing with electric and, quite possibly, natural gas distribution utilities. In Europe, the DHC operator is typically part of an energy company which provides electricity and gas as well as thermal energy. In North American municipalities, the electric and gas utilities may be publicly or privately owned and may or may not be under common ownership. In some cases, electric utilities still own and operate downtown DHC systems while many have divested themselves of their DHC operations which were established during the early to mid 1900s.

The nature of the current and prospective relationships with electric and gas utilities may be quite different. In many cases, the proponent may find utilities to be initially hostile toward the prospect of a new or expanded district system. While DHC can be seen fundamentally to be a competitor of both electric and gas utilities, efforts should be made to find approaches which will work to mutual advantage. As discussed below, the proponent should attempt to find approaches for structuring the project whereby the interests of both the utility and the district system can be met. It should be noted that some utilities

in the USA (such as those in New York City and Indianapolis) are supportive of DHC.

11.2 Electric Utilities

Attitudes and Current Behaviour

For almost all district systems, electric utilities supply the relatively small amounts of electricity required for the operation of the central plant and distribution networks. If the DHC system has centralized chillers, a significant amount of electricity will be required.

When new buildings are constructed in the vicinity of a district system, electrically-based systems, based on low initial costs, may represent a competitive source of energy for heating and cooling through the use of heat pumps or chillers. Increasingly, as in Germany, governments and utilities are discouraging the use of electric heating in buildings.

Three types of system developments may, however, add significantly to the complexity of the relationship between a district system and its electric utility:

If the district system seeks to install cogeneration equipment, then the system must negotiate with the electric utility to establish the terms and conditions of the line connection, standby power cost and the utility's buy back rate.

- If the system seeks to introduce district cooling, it may have a significant impact on the utility's peak load with a relatively low reduction in quantity of annual energy sales.
- If the electric utility seeks to sell heat or cooling from a generating station,

then the district system may become a large customer of the utility.

Such developments are relatively common in several countries, such as those in Northern Europe. In other regions, such as North America, the attitudes and policies of electric utilities reflect a traditional belief that they have a monopoly on the supply of electricity and that their sole mandate is to produce and distribute electricity in the most efficient manner possible. As a result, such utilities are reluctant to become involved in DHC, either as a supplier of their waste heat or as a system developer and operator. In fact, during the past 20 years, many utilities have divested themselves of their downtown DHC systems.

As a district energy system seeks to expand its subscriber network, add cogeneration capability and incorporate district cooling, it may encounter a very difficult negotiating situation with its electric utility for several reasons.

- Most utilities are strongly supply oriented and view moves to take away load (customer energy requirements) or contribute to supply as undesirable competition.
- Many utilities which are capacity constrained are formulating policies and programs to encourage a reduction in electricity demand (so-called "demand side measures") or investment in non-utility, parallel generation projects. Increasingly, constraints in transmission and distribution capabilities in selected areas provide specific targets for DSM programs. However, it appears that many of these policies and programs are neither anticipating nor incorporating a legitimate role for district systems.
- Utilities tend to be cumbersome in their decision-making processes. This characteristic is accentuated because they are under the direction of public

utility regulatory bodies (see Section 12) and because the new organizational structures established to pursue demand side and parallel generation approaches continue to evolve.

Promotion Objectives

Proponents of district systems can establish two main promotion objectives for their dealings with electric utilities.

- To establish awareness of the ways in which district systems can contribute to the realization of utility demand side and parallel generation objectives.
- To establish awareness of the ability of a district system to become a customer for heating or cooling which can be produced at an electrical generating station.

Promotion Activities

Promotion activities related to electric (and gas) utilities will consist mainly of "face-to-face" meetings. Discussions will be required with senior and junior utility personnel in all affected departments (Generation, Transmission and Distribution, Research, Demand Side Management, Integrated Resource Planning, etc.). The challenge is to educate the wide range of personnel whose functions, areas of expertise and level of management all influence the utility's policies, programs and individual project decisions.

Short formal presentations should be supported with succinct "leave-behind" working papers, prepared in a manner which reflects the utility's way of analyzing options.

District System Benefits

A major opportunity exists to promote the ways in which district energy systems can contribute to the realization of electric utility interests in demand management and parallel (non-utility) generation. :

- District cogeneration systems would provide power coincident with winter electric peak demands. Also, on an emergency basis, such systems could provide power to meet summer peaks.
- Depending on the technology which is utilized, the impact of district cooling systems on peak electrical loads can vary. In the USA, most utilities are summer peaking. If steam absorption systems were to be substituted for electric chillers, the total chilling load would be removed, resulting in a very significant reduction in peak demand.

Figure 11-1



- If central chillers with accompanying chilled water storage tanks were employed, a somewhat lower reduction in peak demand could result from two factors. First, central chillers would operate more efficiently than individual chillers, especially with the expectation that the refrigerants which will replace CFCs may result in lower chiller efficiency or require chiller modification. Second, the central chillers would have a significant proportion of operating hours during the night (rather than peak daytime) to take advantage of

low, non-peak, "time-of-use" rates where available. The water chilled during the night would be stored until required during the afternoon peak.

- The utility could also find it easier to deal with problems of unexpectedly high summer peaks if a district cooling system were in place. Rather than employ brown-outs or other arbitrary measures, the utility could arrange with the central plant of the district system to reduce its total load gradually, thereby utilizing the momentum in the system and spreading the impact evenly among district subscribers.
- An enormous amount of thermal energy produced at electric power plants is currently wasted. This waste represents a sizable potential loss in revenue which could be realized on an ongoing basis by utilities which can establish this source of thermal energy as the base load for DHC systems.

11.3 Gas Utilities

District systems using natural gas as their thermal energy source find themselves as both a customer as well as competitor of the local gas distribution company. Because the district system may be a more efficient approach than the use of decentralized boilers, less gas may be required to meet the heating requirements for the buildings served. Also, because of its volume, the district system can likely negotiate lower interruptible rates with its gas utility or, where permitted, buy directly from gas suppliers at the wellhead. Furthermore, with the capability to switch to heavy fuel oil and utilize waste energy sources, the district system has the capability of displacing all of its gas purchases if fuel prices are not competitive. As a result, expansion of district system activity will likely result in a significant reduction in the gas utility's gross profit.

On the other hand, some natural gas distribution companies may see opportunities associated with district system projects. With the district system served on an interruptible rate basis, the gas company can add to its firm supply customer base without having to increase pipeline capacity. Also, growing concerns over global air quality will likely lead to a preference for natural gas over coal and heavy fuel oil because of its lower level of CO₂ emissions. In many areas, urban cogeneration with natural gas will be preferred over all other energy sources because of its superior emissions characteristics.

Figure 11-2



Particularly in the USA, natural gas distribution utilities have long been frustrated that the electric utilities sell virtually all the energy requirements for building cooling. More recently, gas sales for building heating have been eroded by electric heat pumps or special pricing for all-electric buildings. In response, several gas companies formed district energy networks (such as in Hartford, Tulsa, Oklahoma City, Minneapolis and Omaha) in order to utilize gas for centralized chilling and gain a larger share of thermal energy business in the summer. While some of these systems (such as Hartford), maintain their gas utility ownership, some were sold to private DHC companies in the 1980s. Currently,

gas only utilities reflect a range of business strategies, from head-on competition with DHC to active support for DHC.

Dealings between district systems and natural gas utilities have tended to be watchful, reflecting the essentially competitive nature of the relationship. It is essential for the district system proponent to attempt to identify specific opportunities where common interests exist with the gas distribution company. For example, as noted earlier, the district system's capability to utilize large quantities of gas on an interruptible basis can increase the total volume of gas sold through the available gas distribution network. These opportunities may be based on cogeneration or cooling which utilizes gas-fired thermal energy.

Promotion Objectives

Promotion to gas distribution utilities can be based on the following objective.

- To establish awareness of the ways in which district systems can facilitate the competitiveness of gas as an environmentally attractive energy source, particularly through large urban cogeneration systems.

Figure 11-3



Promotion Activities

As with electric utilities, promotion activities for gas utilities should consist mainly of personal presentations to a variety of groups within the gas utility. Simple formal presentations and well-documented working papers will be useful in reinforcing points made in discussions.

District System Benefits

Very attractive opportunities may exist to promote district systems with natural gas utilities. For those gas utilities which find

themselves capacity constrained, the capability of district systems to take interruptible supplies (by switching to back-up heavy oil capability during winter peaks) can increase total gas volume sold.

Also, as electric utilities seek to reduce summer peak loads associated with cooling demands, gas-fired technologies may represent a cost effective alternative. Because of their larger scale, district systems would likely be more attractive sites for these technologies than individual buildings.

12 Regulatory Agencies

12.1 Current Attitudes and Behaviour

Regulatory agencies give approvals to a district energy system project during the design and construction phases. Drawings must be approved to indicate conformance to the governing pressure vessel code. Permits for construction of distribution networks are necessary due to the lengthy periods of road disruption. Environmental siting permits may also be required, especially when new energy sources, combustion equipment and stacks are part of the project. In addition, multi-subscriber systems may find that their tariff structure is regulated by the local public utilities commission.

Project delays can be encountered, especially at the planning stages, when regulatory officials are not familiar with district systems. It is essential, therefore, that project proponents understand the steps in the approval process which each agency follows and become acquainted with the key officials who influence this process.

In most countries, few difficulties have been encountered in obtaining construction permits for district systems. District technologies are well proven in most jurisdictions. On the other hand, hot water distribution technology has not been well established in North America. Such systems may be designed to utilize components equivalent to those well established in European practice. In such cases, inspectors may have difficulty in relating local code requirements with what are essentially European specifications and, in some cases, European component sourcing.

Environmental siting permits may be difficult to secure, especially if there is no formal municipal, state/provincial or federal

government policy toward district heating and the acceptability of specific technologies (such as incineration of municipal solid waste). Local citizens groups can polarize public opinion against any new combustion/stack project due to uncertainties regarding the effectiveness and reliability of pollution control equipment.

Multi-subscriber district systems do not appear to have had any difficulty in establishing relationships with public utilities commissions. The standard practice appears to be to allow the district energy system to establish rates which provide for the recovery of costs plus a reasonable return on investment. Where CHP plants are involved, a significant issue exists in each case to allocate the capital and operating costs between the electrical and thermal outputs. Figure 12-1 provides an overview.

Figure 12-1 Public Utilities Commission Regulation of DHC--USA

Although 35 states regulate investor-owned thermal utilities, 24 regulate co-operatives and only 15 regulate municipally-owned thermal utilities (and in several of these stated, PUC regulation.

of municipally owned systems is limited, e.g. to intra territorial operations.

Source: Kier, P.H. and Meshenberg, "State Laws and Regulations Affecting Development and Renovation of District Heating.

A special case may exist for some projects where technology and material sourcing

may be desired which is not familiar to the regulatory bodies. The developers of the Charlottetown, CDA system, for example, dealt with the need to familiarize pressure vessel code authorities with the ways in which European design practices and component standards could be related to North American codes. Through a series of meetings, a relationship of mutual understanding was developed in which both the system designer and the code interpreter understood each other's objectives, constraints and areas of flexibility. Particular attention was given to steel quality specifications. It should be noted that experience exists in several North American projects for European sourced designs and materials.

12.2 Promotion Objectives

Promotional campaigns can be targeted at PUCs and environmental regulatory agencies with the following interrelated objectives:

- To establish awareness of the potential role for district systems in electric utility integrated resource planning (see Section 11.2).
- To establish awareness of the environmental implications of district system technologies in comparison with de-

centralized heating and cooling options.

12.3 Promotion Activities

Formal briefs presented to PUC staff can discuss the rationale for an expanded role for DHC in utility integrated resource planning. Such briefs must reflect familiarity with the current issues and developments in this field.

As discussed in Section 10.3, several approaches can be taken to familiarize regulatory officials with the environmental (and other) benefits of district systems. Factual information derived from the experience of other district systems can be shared with environment department staff and influential elected figures. Visits to successful systems, including meetings with local environmental officials, can be arranged to provide credibility for claims of technical performance and political acceptability. Meetings with environmental interest groups can be organized to reinforce the promotion efforts with environmental regulatory bodies.

12.4 District System Benefits

The specific environmental benefits of district systems which can be emphasized are outlined in Section 10.4.

13 Financial Institutions

13.1 Current Attitudes and Behaviour

The source of capital funds for district energy systems can vary depending on the type of system ownership.

For group systems, funds are provided through the organization's capital budgeting and funding processes. Relationships with banks and other financial institutions are maintained by financial officers. District system managers typically have no direct involvement in this area.

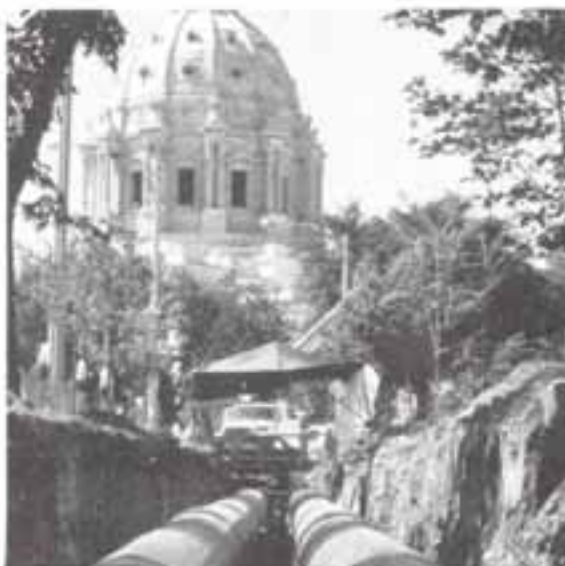
In some cases, multi-subscriber systems raise capital through financial instruments which are obligations of (or are guaranteed by) a municipal or provincial/state government entity. Access to funding (and the cost of such funding) is typically related to the government entity's credit rating and only secondarily a function of the financial attractiveness of the project itself. Thus, the system proponent will usually seek to gain support from the government body rather than deal directly with financial institutions.

For other multi-subscriber systems, the ability to raise capital is a function of the proponent or developer being able to convince financial institutions of the long-term soundness of their business plan. In these cases, the relationships which must be established are similar to those required between any business and its sources of financing.

Most major multi-subscriber system projects have enjoyed some form of government backing, such as subsidies for construction, loan guarantees or access to low interest loans.

In the USA, subscriber systems operated by both non-profit and for-profit DHC companies have benefited from the lower interest rates of a special financing mechanism called tax-exempt revenue bonds. Examples of DHC systems which have used these bonds to raise capital would include the Trenton, Oklahoma City and St. Paul systems. The latter system used tax-exempt bonds to support its major revitalization projects during the 1980s and followed up in the early 1990s with a combination of \$6 million in tax-exempt revenues bonds (with security provided by long-term customer contracts) and a \$3 million subordinated loan from the City of St. Paul.

Figure 13-1



In those financing situations where governments have not been directly involved, no difficulties have been encountered in securing funding on reasonable terms when a system has a sound history of operating and financial performance.

However, when a proposed system is new, the financial community may react with scepticism and a lack of interest if they

have not become familiar with the viability of district systems on a worldwide basis. Most major multi-subscriber system projects have enjoyed some form of government backing, such as subsidies for construction, loan guarantees or access to low interest loans. In those situations where governments have not been directly involved, no difficulties have been encountered in securing funding on reasonable terms when a system has a sound history of operating and financial performance.

Support from a financial institution can be expected only when:

- The institution has confidence in the technical, marketing, management and financial components of the proposed business plan.
- The type of financing which is sought matches one of the types of lending in which the institution specializes. For example, many banks focus on operating loans rather than long-term obligations. On the other hand, pension funds are more likely to make long-term loans.

Since the main capital requirement of a district system is for long term capital related to its investments in central plant and distribution network, it is appropriate that sources for this type of funding be identified. Then, formal presentations of the proposed business plan can be made, with a copy of the business plan and financing requirements left with the lending officer.

Financial institutions prefer to see their loans backed by collateral which offers them some measure of security in the event of default. Unfortunately, buried pipes and other district system components provide little residual value in such an event. Thus, the financial institution will be placing most of its attention on the reasonableness of the cash flow projections in the business plan as the primary basis for its lending decision.

13.2 Promotion Objectives

Promotion of DHC targeted to sources of long term capital can direct activities to senior loan officers with the following objective:

- To establish awareness and credibility for the proven viability of district systems.

13.3 Promotion Activities

Potential lenders should be approached at the early stages of project development, especially if they are not familiar with or have had experience with district systems. Site visits along with general promotional material can help DHC systems gain credibility in the eyes of lending officials before a specific request for funding support is made.

Relationships with several lending organizations should be "nurtured" since it is not possible to predict which will be supportive of the final DHC business plan which is presented for their consideration.

13.4 District System Benefits

Presentation of the formal business plan lies at the heart of a request for specific project funding support. The business plan must provide clear evidence that investment in the district system will be a prudent use of the lenders' funds, that is, that the project will meet the lenders' guidelines for risk and return.

In order to provide this assurance, the business plan must show that:

- The technology is sound and well-proven.
- The subscribers will agree to connect, signing 20-30 year contracts, and the heat/cooling load projections are reasonable.
- The pricing structure provides for demand and energy charges which correspond to a) fixed costs required for amortization of capital investments

and operating overheads and b) variable fuel prices.

- The gross profit (that is, the difference between revenue and fuel costs) can not be jeopardized by:
 - future shifts in prices and availability of alternative fuels;
 - constraints in adjusting tariffs to levels required to ensure financial solvency.
- The management plan is sound.
- The financial plan identifies a reasonable balance between debt and equity funds and a reasonable amortization schedule for the debt.
- Technical, operating, marketing and political risks are identified, assessed and where necessary, transferred or otherwise managed.

14 Promotion to System Owners

4.1 Current Attitudes and Behaviour

In some cases, a developer of a major DHC system expansion project will not be the current owner of the group or municipal system. The developer must, in these cases, deal with the necessity of gaining support from this target group.

System owners must approve substantial capital budgets for major district system projects or approve the terms and conditions on which their current system will be incorporated in the new system. Thus, owners (and their senior managers) can be expected to be cautious or even negative toward the commitment of scarce financial resources for system expansion or renovation. In order to influence these attitudes, it is important to understand the responsibilities and decision processes of those individuals involved with approving capital expenditures for district systems.

Group Systems

In North America and other countries, group systems serve thousands of institutions such as hospital complexes and universities. These systems typically connect 10-100 buildings. For these systems, the responsibility for operation of a group system's central plant and heating and chilled water distribution systems lies with the buildings and grounds/physical plant group. This group is responsible for meeting building energy and comfort needs at the lowest cost possible.

Typically, securing approval for major capital projects involves several steps:

- The proposed project is first developed in conjunction with consulting engineers.
- The proposal is then reviewed by the institution's financial officer.
- Finally, approval is given by the institution's management board. The funding agency for the institution, such as a provincial/state education ministry, may be required to give final approval for such capital projects.

The physical plant group, therefore, seeks to gain the support of senior management through the institution's capital budgeting process. This process places the proposals for district system projects in direct competition with the institution's other spending priorities. For a hospital, these priorities may include sophisticated diagnostic equipment or additional beds while, for universities, they may include books for the library or new computer facilities.

Multi-Subscriber Systems

Differences can be found in the ways in which owners of multi-subscriber district systems view prospects for renovation or expansion projects. For example, some may not fully appreciate the importance of capital investment for renovating distribution networks or improving central plant efficiency in ensuring the longer-term viability of their existing systems. Others, in contrast, develop aggressive multi-year plans for expanding the areas served and integrating new, cost-effective energy sources, such as industrial waste heat or biomass fuel.

Typically, the general manager of a multi-subscriber system will report to a board of directors which has the authority to approve capital projects. Projects may be developed by an "in house" team in the case of large, municipal systems or with the assistance of consulting engineers in the case of smaller systems. It should be noted that,

for publicly owned or supported systems, the board will be directly or indirectly accountable to elected officials.

For some group or multi-subscriber systems, physical plant managers may not be aware of the options available for cost effective improvements to their central plant or distribution system. Hence, over time, system performance can deteriorate both physically and financially. As a result, pressure from customers to disconnect from the district system and install decentralized systems can emerge.

Consulting engineering firms which advise these managers may not always be aware of, let alone experienced with, the range of possible investment opportunities. On the other hand, engineering firms which specialize in technologies associated with district systems may provide more relevant and accurate appraisals of costs, benefits and risks of alternatives.

Many institutions, such as hospitals and universities, face significant capital funding shortages. Regardless of the level of economic attractiveness, energy-related projects can be given a low priority by management of these institutions and their funding agencies.

Figure 14-1



An increasing number of major DHC projects are based on the privatization of existing publicly owned and operated facilities. For example, in the USA, the Nassau County project was based on a private DHC company taking over the ownership of an existing power plant. The Baltimore system, for another example, has recently expanded by taking over a district heating plant from the local housing authority, merging the plant and its heat load with the existing system. Evidence of the privatization of thermal energy supply for government buildings is found in several countries besides the USA.

Privately-funded systems can also suffer from a lack of interest or support from their owners. This occurred, for example, in the USA when many electric utilities found that their downtown steam-based systems did not fit with a corporate focus on the supply and distribution of electricity. In addition, a private firm's rigorous return on investment thresholds for new capital investments may result in consideration being given to selling or closing the district system.

At some institutions, such as correctional facilities and military bases, senior managers are transferred every two to three years. Also, the highest operational priority is usually given to non-energy objectives. As a result, it is difficult to focus the attention of local managers on possible district system retrofits and similar projects. In addition, fragmentation of engineering expertise and budget responsibilities between national headquarters and individual facilities may be found.

Many district systems, however, do not face these problems of lack of senior management interest and access to funding. Typically, these systems employ a planning process which identifies the long term strategy for the system and the major capital projects required to implement this strategy. Support and commitment is se-

cured from the boards of management and, where necessary, the politicians who oversee the systems' operations.

Decision criteria for capital investments at both group and multi-subscriber systems are heavily weighted toward financial considerations: minimize capital and operating costs. However, since most institutions and many multi-subscriber systems are publicly-funded, significant secondary interests lie in supporting actions which are socially desirable. For these systems, financial investment criteria are usually less stringent than for private sector firms, especially where such investments can be related to:

- Use of a locally-available fuel source.
- Energy conservation.
- Local economic development, including the generation of local employment and the strengthening of downtown cores.
- Positive environmental impacts.

Government-Owned Buildings and DHC Systems

Governments at the provincial/state and national levels own and operate thousands of group district energy systems. These are found at office building complexes, military bases, correctional facilities and other locations. Governments also provide funding, either directly or indirectly, for additional thousands of health care and educational institutions which may or may not have autonomy in the management of their physical plants.

In many jurisdictions, governments at the provincial/state and national level are heavily involved with the generation and distribution of electricity, activities which are closely associated with district systems. For example, electric utilities are frequently publicly owned. Rate structures

and capital expenditures are subject to the regulatory control procedures of public utilities commissions.

In Europe, many countries translate policy support for DHC into commitments for greater district system investments for government-owned buildings. On the other hand, in North America, a low level of additional investment in district systems is taking place in facilities owned or operated by provincial/state or federal governments.

14.2 Promotion Objectives

The emphasis placed on the following objectives may vary depending on the level of management being targeted in a promotion campaign.

For Managers of Physical Plant/Directors of Operations and Consulting Engineers

- To establish awareness of and credibility for the range of technical options which are available (or are at the demonstration stage) for improving operating performance, optimizing system capabilities and adapting to new factors (such as environmental concerns and utility electricity buy back policies).
- To provide guidance as to how preliminary and detailed feasibility assessments should be undertaken for the technical options which may be relevant to their systems.

For General Managers/Boards of Directors/Funding Agencies

- To establish a level of awareness and credibility for the long term, cost effective and socially responsible role which district systems can play in their facilities.

14.3 Promotion Activities

Major capital projects related to the renovation or expansion of existing district systems require several years of study and development before final approval to proceed is received. Thus, promotion activities should be organized in a way which recognizes the lengthy gestation period for project development.

It can also be expected that the relative costs of competing energy sources will shift over time and new district technologies will be developed. Thus, the potential attractiveness of major system options should be periodically assessed.

Ideally, the manager of the plant or senior general manager for an existing system will become the "champion" for a renovation or expansion project. In order for this to take place:

- Interest must be present on the part of the manager.
- The manager's job description must identify initiation of such projects as a key part of the position.

The time and resources must be available for such managers to learn about technology developments and, at a minimum, to initiate preliminary feasibility studies of possible options.

The specific technology options which most managers should be familiar with are as follows:

- Adding nearby buildings to the system load to improve central plant cost effectiveness.
- Installation of cogeneration capability to increase overall plant efficiency, reduce peak electrical load and provide supplemental income.
- Introduction of district cooling through such approaches as chilled

Figure 14-2



water distribution or steam absorption chillers.

- Retrofit or replacement of distribution lines to reduce line losses due to leakage and other factors.
- Utilization of a locally available energy source, such as municipal solid waste, industrial waste heat, biomass fuel or heat from a utility power plant.

The communications activities which can contribute to the establishment of awareness of technology options include newsletter articles on recent R&D and demonstration projects, district energy association workshops on specific technology areas (such as cooling) and sales calls by suppliers where managers have expressed interest in a particular technology.

Guidance for carrying out feasibility studies can be provided by district energy industry associations or government agencies. (See listings in Part F of this manual.) The terms of reference of studies which have been performed efficiently and effectively can be made available for "project champions". Methodologies for the assessment of technical and financial viability along with economic and environmental impacts can be described.

In order for project initiatives taken by a system manager at the operating level to be successful, senior management must ac-

cept the legitimacy of district energy systems within their organization's mandate. Thus, key senior managers must be introduced to credible descriptions of the current and possible roles for district energy systems (either group or multi-subscriber as appropriate).

Activities for communicating this information include presentations at conferences and articles written in trade magazines targeted at senior managers. Visits to progressive district systems can also be arranged.

14.4 District System Benefits

The benefits of district systems can be communicated in terms of:

- Technical: system efficiency and optimization

- Economic: return on investment
- Operational: reliability and service
- Societal

Economic benefits of employment during construction, keeping energy dollars in the community and strengthening the economic viability of the community;

Environmental benefits of reduced contribution to acid rain and global warming, reduced local air pollution levels (reducing damage to health and property), reduced waste streams and reduced transport of oil to individual sites.

Section 10.4 provides further description of the benefits of district systems.

15 Promotion for Established Systems

This section of the manual provides a brief discussion of promotion to all of the significant target groups for established systems.¹

15.1 Current Attitudes and Behaviour

Many district systems, such as those in the Nordic countries, have realized their full market potential. For the municipal markets which these systems serve, DHC can be viewed as a mature, established technology which has achieved a significant share of the building heating market. Although the district system approach has been well accepted in these areas, it is important to understand that promotion activities are still required to ensure ongoing commercial success and system viability.

The marketplace for building thermal requirements is rarely static. Changes can occur over a several year period (or less) which result in new competitive challenges for the DHC company. For example:

- New taxation measures can be introduced which put DHC at a disadvantage.
- Customers may feel that they are being taken for granted by the DHC company and may be receptive to aggressive marketing by competitors.
- Public authorities may not appreciate the role which DHC plays in contributing to the enhancement of the environment.

In the face of these changes in the marketplace, the promotion issues facing opera-

tors of mature systems are significantly different from those facing developers of new or expanded systems (which were discussed in Section 3.2). The source of many of these differences is the fact that, while new systems must establish sound relationships with many groups, a mature system seeks to support the continuation of positive relationships which contribute to its ongoing success.

As depicted in Figure 1-1, these groups are many and varied.

Groups which provide resources to the DHC system

- Employees
- Suppliers of goods and services
- Customers
- Capital markets

Groups which provide the regulatory and fiscal environment and business direction for the DHC system.

- Public authorities
- The System's Board

Groups whose attitudes affect the system's success:

- Employees' Family and Friends
- Mass Media
- Potential Customers Engineers and Architects
- Interest Groups

Relationships with each of these groups can easily evolve over time. Among these groups, customers and public authorities are clearly the most important. Emphasis is given to these groups in Part C, which deals with promoting to individual customers, and

Part E, which considers promotion at the level of national governments and international organizations.

Promotion activities for an established DHC company should be based on a periodic review of how it positions itself with its customers in the market. In the Nordic countries, for example, the positioning of district systems has shifted significantly over the years, as shown in Figure 15-1. From the 1920 position of being a facilitator of CHP, district systems have evolved over the ensuing 70 years to being a provider of comfortable, environmentally-safe heat supply and services which aid the customer's management of energy.

Promotion to public authorities at the state/provincial, national and international level is discussed in Part E. At the municipal level, it is especially important that elected officials understand the extent of the community's investment in district systems, the benefits which the district system delivers and the importance of supporting this investment on an ongoing basis.

15.2 Suggested Promotion Approach

Customers

It is important that customers be familiar with the products and services offered by the DHC company, the quality of these offerings and the customer orientation which the company reflects in all of its dealings with customers. Ongoing promotion to customers is especially important due to periodic turnover of the building managers and operators with whom the DHC company has its day-to-day dealings.

Customers can be reached through both mass communication and direct contact (newsletters, bill stuffers, etc.). Information meetings and open houses can also be used. The day-to-day contact between company employees and the customer,

such as meter readers, provides another opportunity for communication.

Section 8 of this manual provides a complete discussion of promotion approaches for established customers.

Suppliers

The ability of suppliers to meet the needs of the DHC industry will be enhanced if they are encouraged to become aware of the DHC operation, customer relations and future plans. Supplier participation at open houses and exhibitions is desirable.

Capital Markets

As a special kind of supplier, the providers of long-term capital should be kept informed of the district energy company's commercial viability and future plans. An image of a progressive, thriving business should be established. Periodic meetings with senior lending officials should be held, supplemented by the distribution of newsletters and other communication.

Public Authorities

As noted earlier, it is important that sound personal relationships be established between the district energy company and the key municipal government officials (See Part E).

Mass Media

The mass media provide the vehicle for public relations activities initiated on behalf of the district energy company. These activities build awareness and goodwill for the company within the community. Local media, usually understaffed, are receptive to newsworthy information and appreciate receiving such information in a professional news release format. Representatives of the media should be invited to all events, such as plant openings and meetings with important visitors.

The handling of unpredictable events such as accidents should be anticipated. A member of the district system staff should be the single point of contact with the media. A straightforward approach in describing the problem, what is and is not known and the steps being taken to solve the problem is usually the most appropriate.

The Board

The importance of ensuring that all members of the board which oversees the district system company are fully informed of current operations, issues and plans should not be underestimated.

Employees

Employees are goodwill ambassadors for the district system company, both on and off the job. Employees will generate goodwill for the company when they understand the importance of a customer service orientation and the many social benefits which their district system provides to the community. It is important that employees be informed of all events, decisions and other factors which affect how the company relates to its customers and other groups.

Figure 15-1



Interest Groups

Certain interest groups within the community have objectives which are compatible with those of the district system company. For example, environmental groups may support district system technology. A relationship with such groups should be established which can result in the support for DHC being leveraged by their efforts.

Figure 15-2 Evolution of Market Positioning of District Systems in the Nordic Countries

The market positioning arguments used for establishing DH plants have varied with time. Reasons such as effective power production, flexibility and environmental advantages have persisted, though with varying emphasis. The following lists some of the arguments used.

- 1920
 - DH allows the combined production of electricity and heat
 - DH can utilize heat from incineration and industry
- 1950
 - DH is virtually maintenance-free for end-users
- 1960
 - DH requires less space in the home
 - The development of residential areas illustrates the advantages of building homes without chimneys, furnace rooms and oil tanks
- 1970
 - All forms of energy (coal, oil, natural gas, straw, electricity, etc.) can be used, which allows utilization of whichever type of energy has the lowest costs
 - Customers enjoy flexibility and certainty of supply
 - The change from concrete tunnels to pre-fabricated pipes makes further installation possible
 - DH gives lowest heating costs
 - DH gives cleaner flue gas
 - DH is more efficient and gives a higher performance than individual heating systems
- 1980
 - DH maximizes energy utilization, distributing hot water in well-insulated pipes
 - DH plants can utilize fuel with a low energy content
- 1985
 - DH can utilize products which otherwise are a source of environmental problems
 - DH makes comfortable living possible
- 1990
 - DH stations offer new services, eg., monitoring of energy consumption, total energy supply, operation/maintenance of heat exchangers and secondary equipment, snow melting, chilled water for cooling, etc.

Current market positioning emphasized the offering to end-users of **comfortable, environmentally safe heat supplies.**

Source: "Marketing of District Heating in the Nordic Countries", pp. 5-6.

Part E Promotion at the National and International Levels

This part of the manual focuses on issues related to the effective promotion of district energy systems at the level of national governments and international organizations. Where jurisdiction exists, the following sections are also relevant to DHC promotion at the state and provincial level. Section 16 provides direction for the promotion of district systems to government policy and program officials who serve as agents for the public interest. Promotion of DHC related to the operation of government-owned buildings and group DHC systems is included in Section 14 in Part D.

Section 16 Policy and Program Officials

16 Policy and Program Officials

16.1 Current Attitudes and Behaviour

District energy systems offer benefits which are very consistent with the major policy interests of many governments and international organizations in the areas of energy, the environment and the economy. For example:

Energy

Most governments provide active support for the policy goals of energy efficiency, diversity of energy supplies and utilization of locally available energy sources; district energy systems contribute to the achievement of all three of these goals.

Environment

The environmental benefits offered by district systems address concerns at the local, national and international levels. District systems facilitate the reduction, dispersion and control of air pollution levels, thereby ameliorating both local and long range air pollution problems. Incineration and other treatments of waste streams can also provide positive net environmental impacts.

The Economy

All governments support the goals of economic efficiency and productivity which can be realized through technically sound capital investments. These goals represent the underlying basis for the economic viability of district systems.

Among International Energy Agency member countries, major differences are found in the extent to which provincial/state and national governments understand the role of and provide support for district energy systems. In some Euro-

pean countries, as shown in Figure 16-1, district systems are supported by clear policy positions and various forms of legislation and public subsidies.

In North America, on the other hand, the situation is characterized by a significantly lower level of government policy and program support. Until recently, governments in North America have been reluctant to provide more than token recognition of the social benefits of district systems or other energy technologies which have positive environmental impacts.

In the USA, for example, government initiatives have provided support primarily at the R&D level, with some demonstration activity. It is not generally seen as a justifiable role for government to select and provide overt support for one of a number of commercialized technologies which are competing in the marketplace.

Until recently in Canada, the predominant orientation of energy policy has been to justify the intervention of government in the energy marketplace when market barriers are preventing the potential penetration of economically attractive technologies. Thus, the marginal level of economic attractiveness of many potential district system projects has meant that little policy or program support has been forthcoming. However, beginning in the 1990s, recognition of the full range of social benefits of district systems has resulted in increased support for R&D, demonstration and information transfer activities in support of DHC.

In most countries, electric utilities face greater costs and difficulties in siting new generation facilities. The recognition is growing, however, among both government policy makers and utility planners that district systems, when based on com-

bined heat and power (CHP) plants, can contribute to electrical generating capacity in a manner which overcomes many of the siting difficulties. Many obstacles remain, however, in translating this recognition into tangible forms of support for the development of district systems.

During the 1970s and 1980s, concerns over the assured availability of oil and gas at reasonable prices provided a major impetus underlying government support for district systems. This support was most apparent in the Nordic countries.

More recently, the markets for oil and gas have been characterized by expectations of relative stability of supply and prices. The threat of shortages of conventional fuel has not, therefore, provided a special stimulus for government policy makers to consider a greater level of support for district systems.

Environmental concerns, expressed on a worldwide basis, are clearly the major driving force behind the current receptivity of policy officials in considering a greater role for district systems. These concerns, related to such issues as acid rain, ozone depletion and global warming, are based, in large measure, on the immediate and long term environmental degradation caused by energy production and consumption patterns.

Governmental responses to these environmental issues are beginning to emerge. In many countries, a carbon tax is being contemplated as a means for encouraging the use of fuels which produce less carbon dioxide (CO₂). On the multi-lateral level, the phase-out of CFCs to counter the rapid depletion of atmospheric ozone has been supported by most national governments. Consensus has not been reached among governments, however, related to commitments for concerted multi-national action to deal with global warming and other issues.

In some countries, multi-departmental governmental efforts have been initiated

to provide an integrated response to environmental issues. Acceptance of district systems when such initiatives are formulated provides an ideal point of entry and source of credibility for further promotion of district systems within individual departments.

Several sections of this manual have discussed how district systems provide significant benefits in addressing environmental issues compared with individual building systems. These benefits are summarized in Section 16.4.

16.2 Promotion Objectives

Promotion to policy and program officials within provincial/state and national governments and international organizations should be targeted to the pertinent departments/ministries. It should be noted that, as an integrative technology, district energy systems are associated with a variety of fuels, conversion and distribution technologies and social impacts. Thus, several groups within each department/ministry, such as the energy conservation, electricity and natural gas branches within a department of energy or the acid rain, greenhouse effect and municipal solid waste groups in a ministry of the environment, must be identified as the specific targets for promotion activity.

The principal objective of DHC promotion targeted to government policy and program planning groups should be:

- To establish awareness of and credibility for the social benefits to be realized by increased acceptance of district energy systems.

16.3 Promotion Activities

Promotion activities related to government policy and program decision makers can be delivered with more influence and credibility by associations or coalitions of

interests than by individual district system owners or developers.

These activities should recognize the nature and extent of lobbying efforts in support of district system competitors. Such efforts have most likely been undertaken for a longer period and supported with greater resources than are available for district system supporters.

In general, face-to-face presentations are the most effective approach for communicating with the targeted decision makers and their key staff members. Opportunities will also exist for presentations at public or legislative hearings.

For these meetings and presentations, many persuasive messages can be used. For example, strong energy efficiency, economic development and environmental benefits can be associated with district systems.

The main challenges for promotional effectiveness are:

- To "package" and deliver these messages in a professional manner.
- To ensure that the specific benefits relevant to each audience, rather than the general district system "story", are featured.
- To counter the arguments and approaches employed by competitive lobbying efforts.
- To provide evidence of the credibility of the district system approach through reference to the policy support provided by the International Energy Agency and other high profile organizations.

Use of case examples and other information contained in this promotion manual can contribute greatly to the effectiveness

of formal presentations, discussions and leave-behind materials.

Visits to successful district systems by influential policy makers may provide another approach which translates the theoretical arguments in support of district systems into tangible, credible terms.

Meetings with policy and program officials provide the opportunity to table recommendations for support for DHC in two areas:

- Inclusion of DHC R&D and demonstration projects in available government programs.
- Identification of regulatory, administrative and procedural barriers which are impeding the acceptance of DHC in the marketplace. These barriers can range from double taxation of DHC at the fuel, or gross revenue levels to environmental project review procedures and criteria which discriminate against DHC.

The policy formulation approach of some governments has emphasized the relative economic attractiveness of alternative energy sources and systems like DHC to conventional technologies. Methodologies have not been available for translating the social benefits "externalities" offered by district systems, particularly the environmental advantages, into factors which can be analyzed through traditional policy analyses.

It is important to note that a great deal of attention is currently being placed on the quantification of environmental costs and benefits of available energy sources and systems. For example, *Environmental Costs of Electricity*, a report prepared for the New York State Energy Research and Development Authority and the United States Department of Energy, was published in 1990. This report and others provide a description of methods used to quantify

the significant environmental costs of different energy systems.

16.4 District System Benefits

Specific messages which can be delivered to policy and program formulators would include an emphasis on the major energy, environmental and economic benefits which district systems offer to society. While similar to the benefits of DHC discussed for promoting a municipal system (see Section 10.4), these benefits take a broader, societal perspective.

Energy Efficiency and Security

The energy policies for many governments and international organizations are based on support for enhanced energy efficiency and reduced dependency on insecure energy sources. The benefits of district systems support these policy goals.

District systems provide opportunities for greater energy efficiency, especially where they are based on combined heat and power plants. When calculated on the basis of efficiency over a full heating season, the efficiency of CHP plants is approximately 85%, compared to as low as 60% for decentralized boilers and 35% for electric power stations.

The reasons for the greater efficiency of a central plant include:

- Elimination of most standby losses
- Better maintenance
- More highly trained operators
- Better boiler controls
- Incorporation of stack heat recovery systems

It should be noted that the increased combustion efficiency of central plants in comparison to individual systems is much greater than the distribution system losses, which can range from 8-12% of distributed energy.

In most countries, investments in energy technologies based on locally available en-

ergy sources have been limited because these technologies require large scale plants to achieve an economic scale of operation. Because district systems can utilize the output of large-scale central plants, many alternative energy or waste energy sources can be used to displace imported fuels.

Examples of these locally available energy sources include:

- Wood chips and wood waste
- Peat
- Underground aquifers
- Rivers and oceans
- Municipal waste
- Industrial waste heat

Environmental Enhancement

Government policy and program officials should be fully aware of the ways in which district systems relate to the growing set of environmental interests and concerns. District systems offer many immediate and long term environmental advantages over decentralized systems.

Greater efficiency in fuel use reduces the amount of CO₂ emitted, thereby reducing the impact of meeting building energy requirements on global warming. As noted above, greater efficiency is realized through the inherent performance advantages of district system technology as well as the professional management of central plants.

Centralized systems offer proven technological options to individual building chillers which utilize CFCs. For example, central chilling systems based on ammonia, the refrigerant which dominates the industrial chilling market, can provide safe as well as efficient operation. District cooling can also be based on steam-based chilling systems located at either central plants or individual buildings. Important technology developments continue to improve the attractiveness of district cooling systems.

Besides reducing the total amount of emissions through improved combustion efficiencies, a central plant utilizes a single tall stack which disperses emissions away from the municipal area. As a result, local pollution levels are reduced without any material impact on surrounding areas.

The single point of combustion emissions is much easier to monitor and control with state of the art pollution control equipment.

Where support for incineration of municipal solid wastes exists, the utilization of available waste streams as an energy source provides for the displacement of conventional fuels (reducing CO₂ emissions) and reduction in landfill requirements. In Norway, for example, the driving force behind the recent support for DHC has been the capability of DHC systems to utilize energy from the incineration of municipal waste.

Economic Development

Promotion of the economic development benefits offered by district system investment programs should be of interest to many policy and program officials.

Employment required during construction and installation is significant. District systems are capital intensive and the labour content of many projects is extensive.

District systems can enhance the attractiveness of urban cores as locations for development. The vitality and viability of downtown areas, which have municipal services in place, can be strengthened by district systems, negating some of the pressures toward suburban "sprawl".

Where district systems incorporate a locally available fuel source, energy dollars stay in the community rather than being "exported" for fuel purchases. For example:

- Utilization of wood chip fuel can create an energy supply system while contributing to the productivity of nearby forests.
- Utilization of industrial waste energy can increase the profitability of the industry and support its ongoing contribution to the local economy.

Figure 16-1 Examples of Government Policies and Programs in Support of District Systems

Country	Regulation	Economic Instruments	Information Consultation
Finland	Environmental regulations indirectly support DH	Subsidies for DH (1970s) contribute to joint R&D program	Encourage acceptance of DH
Denmark	Mandatory energy plans supported DH prescriptive technology (NG replacing coal)	15% incentives for DH based on certain fuels (e.g. straw) CO ₂ tax	
Sweden		Subsidies for DH systems (1982-84) Subsidies for certain new technologies (e.g. bioenergy) for DH and other applications)	
Germany		Financial support for R&D and, earlier, use of German coal	Some consultative activity
U.S.A.	Environmental regulations (e.g., Clean Air Act) indirectly support DHC	Tax incentives for certain energy sources (especially in the 1980s) for DH and other applications Financial support for feasibility studies and demonstration projects	Some information dissemination and consultative activity
Canada		Tax incentives for certain energy sources for DH and other applications Financial support for feasibility studies and demonstration projects	Information dissemination
The Netherlands		25% incentives for construction costs of CHP plant	Information dissemination
Norway	Environmental regulation indirectly support DHC Franchise (concession) granted based on societal economical attractiveness	Subsidies for DHC under consideration 20% subsidies DHC based on certain fuels	

APPENDICES

The following appendices serves as a reference for sources of additional information on district systems. The 8 case studies in Appendix 1 and the 29 recent municipal projects briefly described in Appendix 2 illustrate the many possible configurations for district systems and the benefits associated with the DHC system installation and operation. Appendix 3 provides bibliographical references for published material. A directory of district energy associations is presented in Appendix 4 and a directory of government agencies and departments with direct interests in district systems is presented in Appendix 5.

Appendix 1	Case Studies
Appendix 2	Recent Municipal DHC Projects
Appendix 3	Bibliography Reports and Studies, IEA and Other Organizations Periodicals
Appendix 4	Directory of District Energy Associations
Appendix 5	Directory of Government Agencies and Departments

APPENDIX 1

Case Studies

The following case studies of municipal DHC systems have been selected to illustrate the broad range of types of projects which have been undertaken during the past 10 years. These systems incorporate many different energy sources and technologies for energy conversion and distribution. They provide documented evidence of the energy, environmental and economic benefits of district systems.

CANADA: Edmonton -- a new district heating and cooling system is being established in a northern municipality to compete with low cost natural gas. A municipal power station will be converted to combined heat and power to provide the system's thermal energy.

DENMARK: Herning -- a district heating "showcase" has been established to demonstrate how district systems can serve smaller towns with locally available energy sources. The system is an integral part of the community's commitment to energy efficiency and a reduction in environmental degradation.

FINLAND: Helsinki -- the district heating system which serves Finland's capital has achieved 90% penetration of the building heating market. The resulting improvement in air quality is well documented.

GERMANY: Mannheim -- two large transport pipeline have been installed, one of 18 km within the extensive Mannheim district heating system (which has achieved significant penetration of the residential heating market) and a second 13.5 km to connect the Mannheim and Heidelberg systems.

THE NETHERLANDS: Purmerend -- two features of the comprehensive district heating plan for a growing city North of Amsterdam are connected to 25 000 single family housing units and the extensive use of heat storage.

NORWAY: Sandvika/Baerum -- a new district heating and cooling system has been developed in an area with plentiful conventional energy sources. Large heat pumps extract useful energy from municipal sewage.

SWEDEN: Vanersborg -- A medium-sized city constructed a new district heating system in the 1980's utilizing waste heat from a nearby smelting plant as the principle energy source. The positive environmental benefits of the system are significant.

USA: Baltimore -- an older downtown steam system, purchased and re-vitalized by a private district energy company, is expanding through investments in a new central plant and distribution network and connection to 15 major facilities operated by all levels of government.

Edmonton, Canada*

A new district heating and cooling system is scheduled to start operations in downtown Edmonton in 1994. The project is sponsored by Edmonton Power, the municipally-owned electrical utility which serves this northern Canadian city of 250,000. Edmonton is the capital of the province of Alberta and is located in the middle of a large oil and gas producing region.

The project originated when the feasibility of converting an older power station located near downtown to a cogeneration configuration was assessed. Initially, only a hot water district heating network was considered. However, after determination that a significant cooling load existed, the scope was expanded to include both district heating and cooling.

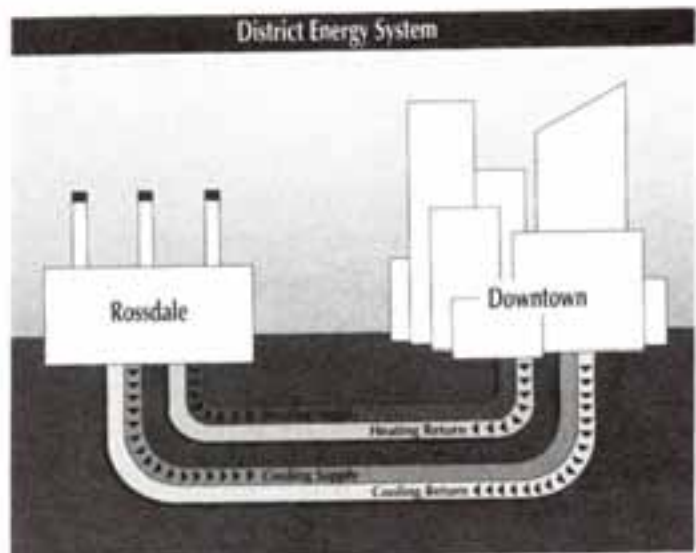
The load for the system will be derived from the total of 3,000,000 m² of commercial and institutional buildings which can be served by the heating and cooling networks. The project is based on delivering a peak of 270 MW of heat and 120 MW of cooling.

The estimated investment in the new system is CAN \$100 million. One-fourth of the capital has been provided in the form of equity investment from Edmonton Power. The remaining three-fourths consists of bonds guaranteed by the municipality.

Through a special exemption, the project's investment will qualify for a federal tax incentive normally not available for government projects. The incentive permits depreciation of selected energy efficiency and alternate energy investments over a three year period rather than the useful project life.

Marketing of the project to the municipality and to prospective subscribers has emphasized the benefits which will be realized. Among the benefits for the city are:

- Efficiency in the production and distribution of energy
- Contribution to security of energy supply
- Enhancement of the environment through reduced overall emissions
- Community economic development
- Significant source of employment during construction



* This case study was prepared on the basis of material provided by ELTEC, a subsidiary of Edmonton Power.



Benefits for buildings which connect to the system include:

- Savings in capital and operating expenses
- Simplified building operations
- Facilitation of phase-out of CFCs
- Ease and reduced cost to control emissions
- Reliability of supply through range of fuel sources and more rigorous system maintenance
- Reduction in building owners' fire insurance premiums
- Greater tenant comfort

For further information:

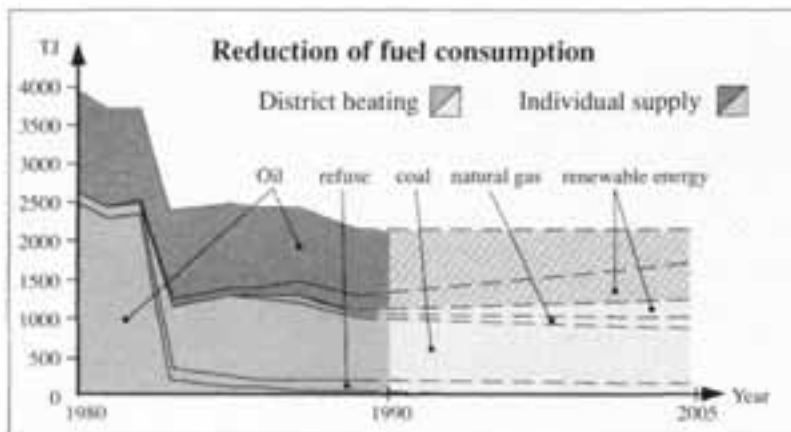
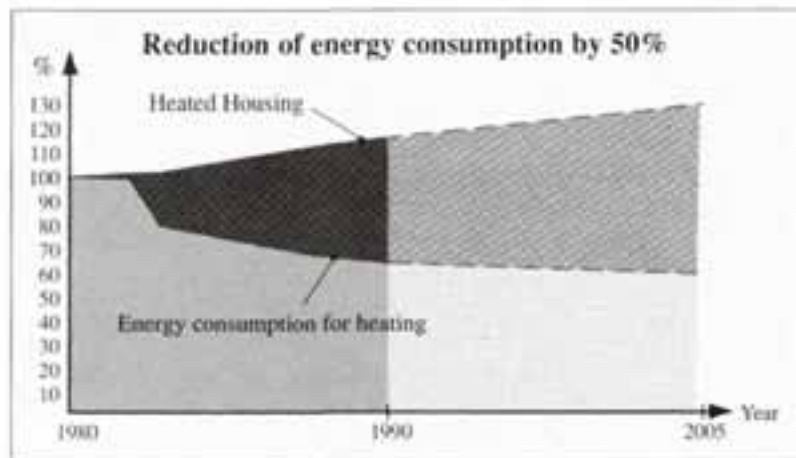
Mr. A.S. (Stan) Gent, P.Eng.
Vice-President, Market Development
ELTEC (Edmonton Power)
9th Floor, Capitol Square
10065 Jasper Avenue
Edmonton, Alberta
CANADA T5J 3B1

Tel: 1-403-448-3453
Fax: 1-403-448-3434

Herning, Denmark*

Herning is a medium-sized city with a population of 56,000 in the center of Jutland, Denmark. The community has implemented an energy policy which is based on the concerns expressed in the Brundtland report regarding the long-term environmental impacts of using fossil fuels. The cornerstones of Herning's energy policy are:

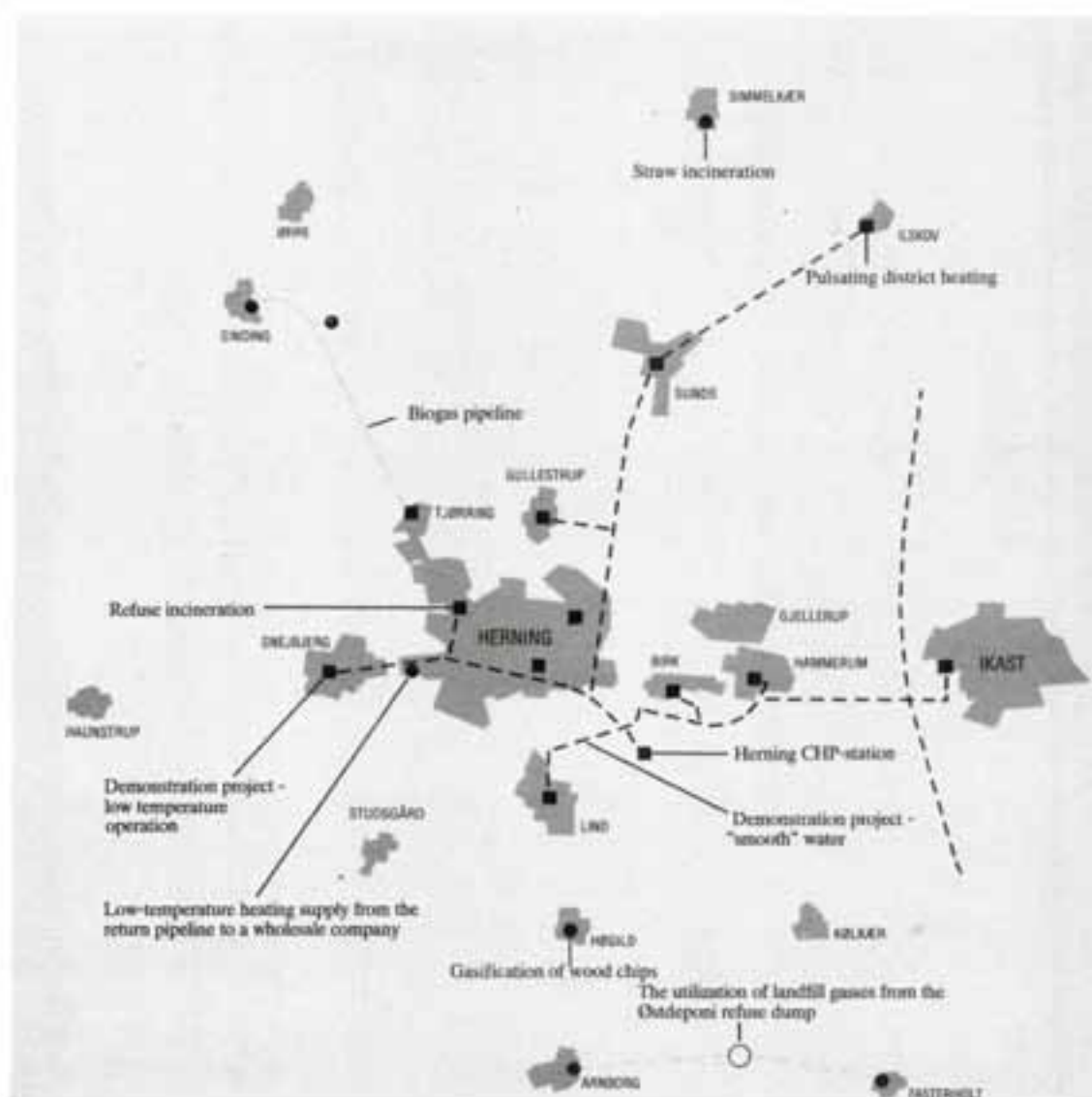
- support for residential energy conservation measures
- utilization of combined heat and power production facilities
- installation of the most modern techniques for the distribution of district heating and electricity to the largest possible number of consumers
- development and utilization of locally available renewable energy sources



the year 2005 even though total building area will have increased by 30%. Figure 2 shows how the consumption of oil and coal will be reduced by 2005, with 30% of energy requirements being supplied by renewable energy sources.

This policy shows that the role for district heating falls within the commitments to energy conservation and reduction of harmful environmental impacts. These commitments are reflected in Figures 1 and 2. Figure 1 shows how energy for the heating of buildings is projected to decline to 65% of 1980 levels by

*This case study was prepared on the basis of material provided by Herning Kommunale Vaerker (Herning Municipal Works)



The extent of the Herning district heating system and its linkages to nearby towns is shown in Figure 3.

As noted, the Herning system is committed to a substantial increase in the utilization of renewable energy sources. These will include:

- A biogas plant was established in 1988 for the treatment of 56,000 tonnes liquid and solid manure and animal offal from the food industry in the surrounding area. The plant produces 22,000 GJ of heat and 1,500 MWh of electricity annually in addition to its environmentally desirable waste treatment function.
- In 1990 a landfill gas project was completed, with annual output of 16,500 GJ of heat and 2,200 MWh of electricity. It is planned to double the capacity of this plant.
- A thermal gasification plant for the utilization of wood chips and wood waste was completed in 1991. Annual output is 5,000 GJ of heat.
- A straw and sludge incineration plant was also completed in 1991. This plant utilizes surplus straw and sludge from the Herning sewage treatment plant and produces 8,400 GJ of heat annually.

The hot water distribution network for the Herning district system is extensive. The transmission network, which distributes heat from heating plants to urban areas, is 40 km in length. The piping network to distribute heat to buildings consists of 260 km of main piping and 173 km of piping from branches to buildings.

The Herning system is a direct system. Customers' heating systems utilize the water being pumped through the district system itself rather than rely on the transfer of heat through heat exchangers located in basement sub-stations.

Several technology development projects are being undertaken at the Herning system. These include the lowering of temperatures from the design level of 90° to reduce pumping costs and piping losses and the use of friction reducing additives in one section of the network to reduce energy required for pumping.

For further information:

Herning Kommunale Vaerker
Herning Municipal Works
Enghavevej 10
DK-7400 Herning, Denmark

Tel: 45 97 12 10 11

Fax: 45 97 22 03 52

Helsinki, Finland*

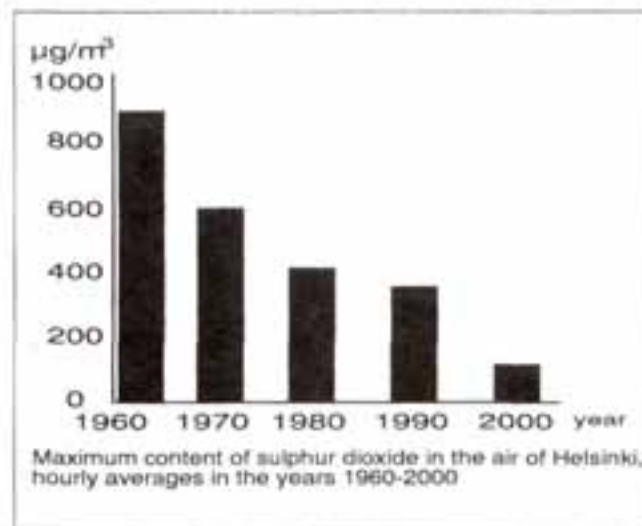
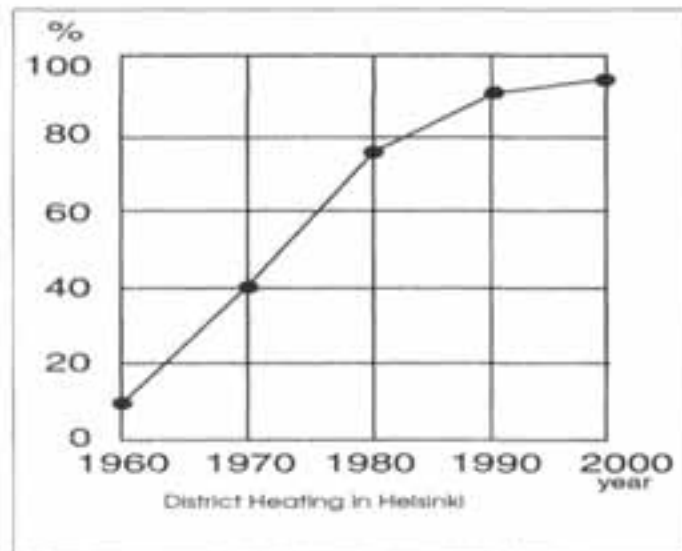
Helsinki is the capital city of Finland. With a population of approximately 500,000, Helsinki began its district heating system in 1952. Owned and operated by the Helsinki Energy Board, a non-profit agency of the city government, the system has achieved a penetration of 90% of the market for building heating (see Figure 1). In fact, Helsinki has achieved the greatest penetration of district heat in Western Europe.

Expansion of the system was supported during the 1970's by government subsidies for construction. More recently, environmental regulations have indirectly supported an increased role for district heating.

The peak load of the system in 1991 was 1,392 MW and 5,790 GWh of heat are supplied annually. The energy sources for the system are coal, oil and natural gas.

Three combined heat and power plants provide approximately 80% of the delivered thermal energy. Thirteen heating plants and several transportable plants (for temporary use) supply the remaining 20%.

The distribution network is a total of 910 km in length. Essentially all buildings with a heat load of more than 50 kW are connected.



As a result of the very significant increase in penetration of district heating, the air quality in Helsinki has improved dramatically since 1960 (see Figure 2). For example, maximum sulphur dioxide content has been reduced by almost two-thirds between 1960 and 1990. Technical improvements are continuing to be implemented, such as the desulphurization plant at the Salmisaam coal fueled power station in Helsinki. As a result, the SO₂ content is forecast to be reduced to 10% of 1960 levels by the year 2000.



*This case study was prepared on the basis of material provided by Finnish District Heating Association.

In recognition of the positive environmental impacts which have been realized through the use of CHP plants and an extensive district heating system, the City of Helsinki received the United Nations Environmental Prize in 1990.

PRESENTED
BY THE
UNITED NATIONS ENVIRONMENT PROGRAMME



TO
THE CITY OF

 Helsinki,  Finland

IN RECOGNITION OF ITS DEDICATION, LEADERSHIP
AND COMMITMENT TO THE ENHANCEMENT OF THE
QUALITY OF THE URBAN ENVIRONMENT.

5 SEPTEMBER 1990

For further information:

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Case Study Mannheim, Germany*

Extensive studies conducted in 1954-55 showed that a district-heating system using high-temperature water could be operated economically. In 1956, the first district-heating service was established. A district-heating pipeline ran from the Herchelbad Heat Plant to the downtown area of Mannheim to supply individual buildings. In 1959, the energy utility (Energie-und Wasserwerke Rhein-Neckar Akiengesellschaft [RHE]) began work on a systematic build-up of city district heating.

A district-heating demonstration project created the basis for the expansion of district-heating service. Within the framework of this promotional program, district-heating service was expanded with the aid of considerable Federal and state subsidies between 1977 and 1982. Pipelines were laid covering nearly the entire Mannheim area. An additional key component of this cutting-edge concept for energy service is one of the longest transport pipelines for district heating in Western Europe; it transports high-temperature water from the Mannheim Central Power Plant (MCP) all the way to the northern part of Mannheim to Coleman Barracks in Sandhofen (18 km).

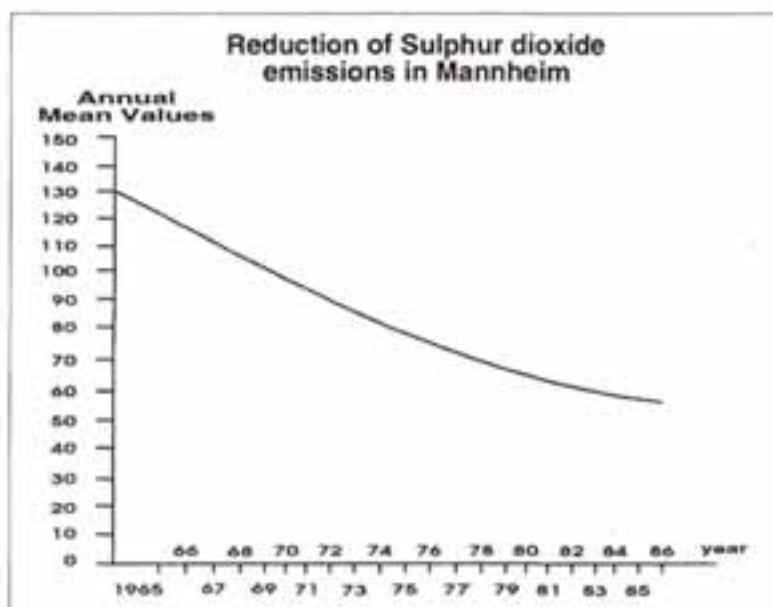


The success of our sales efforts has been the result of a number of innovations in district-heating technology. These include the use of cost-effective methods in laying district-heating pipelines in new housing developments as well as the development of an economical and compact consumer substation.

Economical generation of district heating in a power plant near potential consumers is of paramount importance for the development of district-heating service. A suitable facility for supplying the needs of this Rhine-Neckar metropolis is the Mannheim Central Power Plant, of which MVV has a 28% share through its RHE subsidiary. The MCP supplies a major share of the district-heating for Mannheim. The second-largest source of heat for this system is the Cogeneration Plant North (CPN) on the Friesenheim Island. It is used

**This case study has been prepared by the Statutwerke Mannheim AG (SMA), a subsidiary of the Mannheim Verkehrs- und Versorgungsgesellschaft mbH (MVV).*

especially to supply steam for the industries in the northern part of the city. Fossil fuels are primarily used to meet Mannheim's district-heating demand; these fuels include anthracite coal. What speaks for the utilization of this energy source is the guaranteed availability of its supply as well as the cost-effectiveness. In the CPN, natural gas and waste are normally used as fuel.



District heating is generated in the MCPP and in the CPN according to the principle of cogeneration. Both plants have been equipped with high-capacity flue-gas desulphurization equipment to ensure environmentally friendly generation.

The district-heating transport pipeline comprises tow pipes running parallel (outflow and return-flow). The inner diameter varies from 1000 mm for the largest transport pipelines to 25 mm for connection pipes for individual buildings.

In addition to Mannheim, the cities of Heidelberg, Schwetzingen, and Ottersheim are supplied with district heating. Transport for this is accomplished by means of a 13.5 km long pipeline using DN 800 and DN700 pipes. Without booster pumping stations, transferable capacity amounts to 380 MW with a temperature differential of 130°/60° C.

Because of our comprehensive experience and know-how in the planning, engineering, construction, and operation of district-heating networks, the next step seemed obvious: To take on consulting assignments. Consequently, for several years now, SMA has played an active consulting role, especially in Eastern Europe and in the new states in the eastern part of FRG. It does the engineering for pipelines and networks, hydraulic calculations, works out concepts for energy service, feasibility studies, and master plans (for the World Bank in Warsaw and in Budapest).

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Annex to Mannheim Case Study Description of the Heidelberg - Mannheim Pipeline Project

Heat Demand

When the district-heating service from Mannheim to Heidelberg went on line during the heating season of 1987-88, a peak load of 175 MW was expected in Heidelberg at a connected load of 290 MW. According to contract, of this total 120 MW was supplied by Mannheim and a peak capacity of 55 MW could be fed into the network from existing heat plants in Heidelberg.

A utilization period of 2140 h/a was calculated for Heidelberg's consumer structure; this equates to an annual heat demand of approximately 375 GWh.

At a design outside temperature of -12°C , an outflow temperature of high-temperature water of 130°C would be required. With increasing outside temperatures, this would be lowered to a minimum of 80°C to supply water-heating facilities during transitional periods and in the summer.

During the heating season of 1987/88, a maximum volume of 2100 t/h of high-temperature water from Mannheim was required to cover Heidelberg's heat demand.

By 1995, an increase in maximum heat load up to 230 MW has been calculated, of which approximately 150 MW, which corresponds to a volume of water of 2300 t/h, will be supplied by Mannheim.

Meeting Heat Demand

The basic load of the heat demand, i.e., approximately 60% of maximum demand, which corresponds to ca. 95% of annual heat demand, is produced by cogeneration. By this is meant the simultaneous generation of electricity and heat, with a minimum of primary energy consumption in a combined heat and power plant.

The average load of the heat demand, i.e., approximately 20% of maximum demand, which corresponds to ca. 4% of annual heat demand, is covered by steam at 20 bar, which has also been used to generate electrical energy in turbines. Peak loads, which amount to ca. 20% of maximum load and approximately 1% of annual demand, are generated in peak heat plants using primary energy (natural gas/fuel oil).

These peak heat plants also serve as backups in case of upsets in plants generating average loads or in distribution systems for high-temperature water.

Heat Transport

Generation of high-temperature water for both Mannheim and Heidelberg is accomplished in two heat turbines in the MCPP.

Having taken into account the customer consumption along the way, the transport pipeline to Heidelberg has been rated as far as Schwetzingen for a transport capacity of 4500 t/h with DN 800, which corresponds to 360 MW. From Schwetzingen to the transfer station in Heat Plant West, it has been rated for a capacity of 3500 t/h with DN 700, or the equivalent of 285 MW.

District-Heating Transport Pipeline Mannheim-Heidelberg Technical Data

Transferable maximum heat capacity without booster pumping stations	380 MW
of this, for Heidelberg/Eppelheim	250 MW
Schwetzingen/Friedrichsfeld	70 MW
Rheinau	60 MW
Transferable maximum heat capacity with booster pumping stations	530 MW
Maximum outflow pressure in the Mannheim Central Power Plant	11 bar
Minimum return-flow pressure in the Mannheim Central Power Plant	0.5 bar
Static pressure in the Mannheim Central Power Plant	4 bar
Minimum return-flow pressure in Heat Plant West of the Stadtwerke Heidelberg in the Heidelberg district, Pfaffengrund	3 bar
Outflow/Return-flow temperatures	Sliding operation, as in the Mannheim network
Maximum outflow temperature from the Mannheim Central Power Plant	140°C
Admixing in Shaft No. 12 (Extraction lines to Friedrichsfeld and Schwetzingen)	130°C
Maximum outflow temperature in the Heat Plant West	130°C
Expected maximum return-flow temperature from Heat Plant West	60°C
Design temperature average daily outdoor temperature	-12°C
Length of pipeline	13.5 km

However, to transport such volumes of water, construction of a booster pumping station has been necessary.

During the heating season, i.e., with adequate loads on the transport system for high-temperature water, heat losses between Mannheim and Heideberg are so low that the temperature drop between the MCPP and Heat Plant West amounts to less than 1K.

Heat Distribution and Consumer Installations

Heat transfer from Mannheim to Heideberg is accomplished in Heat Plant West with heat metering and pressure-booster pumps in out-flow and return-flow for distribution of high-temperature water in Heidelberg. Heat transfer from the main distribution network to secondary distribution networks takes place in heat exchanger stations. Consumer installations themselves are in turn connected to the main or secondary distribution networks by means of heat exchangers.



Water losses in secondary networks can be made up from the primary network, i.e., over the feed pipeline from backup water-processing facilities of the MCPP.

Network Monitoring Station

Supervising and controlling of district-heating generation and transport is performed in the central monitoring station in Mannheim. Essential data is transmitted to this station by means of a telemetering system; this allows regulation of temperature and/or pressure as required.

Moreover, the conductivity of circulation water is monitored to detect seepage from leaks in water-heating systems. The distribution system for high-temperature water is monitored by remote-detection technology. A detection-wire system embedded in the pipeline insulation reacts to moisture, permitting immediate and exact locating of leaks in the network. When upsets occur, the monitoring station coordinates all necessary measures.

Heat Storage

The transport line with DN 800/700 between Mannheim and Heidelberg can also serve as a temporary heat accumulator. In periods of low heat consumption and lower electrical loads, i.e., primarily during the night, the return-flow pipeline is filled with higher-temperature water by opening connection lines from the outflow line. The heat stored in this way is then available for discharging, that is, for consumption by customers, in the early morning hours.

The advantage of this operating procedure is that during periods of peak electrical loads, capacity for producing district heating can be reduced so that steam capacity freed up in this way can then become available for generating electricity.

Case Study

Purmerend, The Netherlands*

A typical example of the combined heat and power (CHP) generating concept in district heating is being demonstrated in the municipality of Purmerend, a growing town with almost 75,000 inhabitants located north of Amsterdam.

Presently, the equivalent of 18,000 single-family housing units have been connected. By 1995 the planned equivalent of 27,000 units will be realized.

The district heating system may be supplied with heat by the following means of production:

- mobile boiler units,
- auxiliary boiler house, and
- combined heat and power plant

The auxiliary boiler house, the CHP plant and three geographically spread heat storage tanks are interconnected. The mobile units will be used only in case of emergency.

Heat produced by the CHP plant will minimally cover 95% of total heat demand, the remaining 5% will be produced by auxiliary boilers or, in extreme cases, by mobile boiler units. The relatively high ratio of over 95% coverage by CHP is also due to the extensive use of heat storage tanks.

The CHP plant, capacity 65 M_e W_e and 68 MW_{th} incorporates:

- a gas-turbine with fuel, air and exhaust systems
- an exhaust-boiler with its steam, condensate and feed circuits
- a steam turbine with condensers
- a generator
- an auxiliary cooling system for independent operation

The gas turbine is directly connected to the generator and steam turbine by means of a gearbox and an overriding clutch.

The transfer of heat from the CHP plant to the district heating system takes place in the condensers of the steam turbine and in a water/water heat exchanger taking heat from the exhaust of the boiler. The heat exchanger is fitted in a closed circuit incorporating a cooler that draws remnant heat from the smokestack.

The system functions properly with a temperature spread of 45-65° C (return) to 85-98° C (supply).

**This case study is reproduced from Basic Aspects of Application of District Heating. A THERMIE Program Action, Energy Centre Denmark - OPET, for the Commission of the European Communities.*

During periods of low demand for heat and/or of advantageous electric power production, hot water may be stored in the above-mentioned storage tank as well as in strategically located storage tanks incorporated within the district heating circuit. Total storage capacity is 15,000 m³, sufficient for 14 hours of operation of the CHP plant in case no heat is transferred to the consumers.

Heat is pumped into the district heating system from the storage tank located at the CHP plant. Within the district heating system two more storage tanks are situated at strategic locations.

At peak demand a production unit, CHP plant or boiler house, and storage tanks will all be supplying heat. At less than full capacity any combination is possible.

The CHP plant is owned and operated by the power company N.V. Una, whereas the distribution system is operated by the Municipality of Purmerend.

The buying-in price is made up by the operating costs of the CHP plant, including financial costs and depreciation, minus the sales of electric power to the national grid.

The resale price of heat is kept at a competitive level - with direct heating by natural gas, for example.

Energy savings because of CHP/DH amount to 20 million m³ natural gas.

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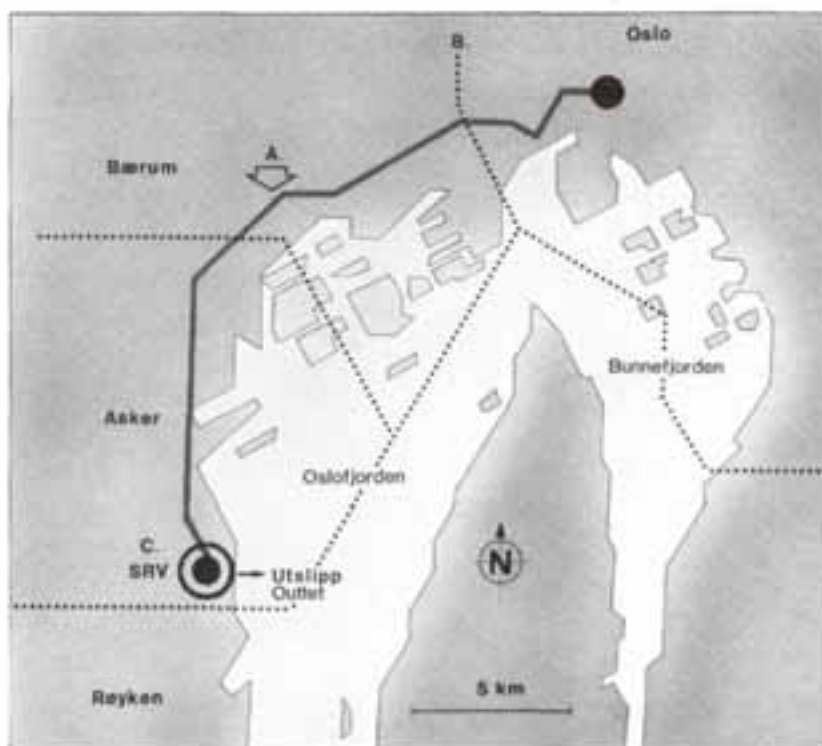
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Case Study Sandvika, Norway*

Sandvika is a community located in the county of Baerum, approximately 10 km west of Oslo, Norway. In 1985, the development of 300,000 square meters of land was being planned for commercial and residential purposes. Alternatives for meeting the long term heating and cooling requirements of existing buildings in the city, as well as those in the new development, were considered on the basis of technical and financial feasibility and environmental factors. A district heating and cooling approach, based on the use of large heat pumps to extract energy from mechanically treated sewage, was selected because it was the most financially attractive option and offered distinct environmental benefits.

The owner and operator of the system is Bærum energiverk, the Baerum energy company (BEV). The Norwegian Ministry of Oil and Energy, together with the Royal Norwegian Council for Scientific and Industrial Research provided financial support for the project.

Approval to implement the project was received in 1986. The central plant was completed in 1988 and the distribution system began supplying hot water and chilled water in 1989.



The Sandvika system was able to take advantage of the fact that the tunnel transporting mechanically treated raw sewage from Oslo to its outlet passed under the city. This tunnel provides an assured year round energy source. Large heat pumps extract useful energy from this waste stream and are particularly efficient when both heating and cooling requirements are to be met.

The heat load is project is projected to grow from the current 5 MW to 24 MW as the Sandvika development is completed around the year 2000. The peak cooling load is projected to be 9 MW at that time.

*This case study was prepared on the basis of material provided by Bærum energiverk (Baerum energy company).

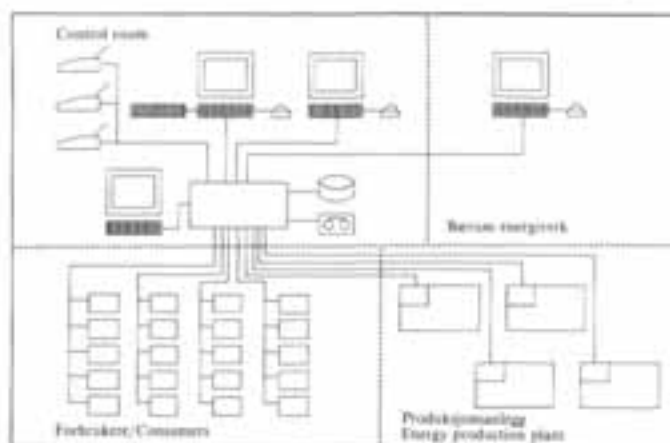
To meet this demand, the system is designed for 90% of the heating energy and all of the cooling to come from two large heat pumps. The capacity of each heat pump is 7 MW for district heating and 4.5 MW for district cooling. In addition, three boilers fired with light fuel oil provide 22 MW of capacity for heating peak loads and emergency back-up for the district heating system.

The district heating and cooling distribution networks utilize separate piping systems. Hot water is distributed through a network of 10 km of pre-insulated pipe. The chilled water network consists of 4 km of un-insulated piping.

The system transfers energy to customers' building energy systems through the indirect approach. The building sub-stations utilize separate heat exchangers for heating and cooling.

A computerized monitoring and control system connects the BEV master control room with the production plant, distribution system and individual customers, as well as the BEV main office.

Environmental considerations have played an important role in the decision to implement the Sandvika system. The system will displace individual oil burners and air conditioning systems through the heat pump approach. Available hydropower and the municipal sewage provide energy sources which displace consumption of oil and relatively inefficient (and noisy) building chillers. Officials of BEV are therefore pleased that their system provides an example of how resources can be conserved and environmental and economics merged in project decision making.



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Case Study Vänernborg, Sweden*

Following the requirements of Swedish federal law, the city of Vanersborg, county seat for the county of Alvsborg, developed a plan for reducing the consumption of oil for building heating. Vänernborg is a medium-sized city with a population of 22,000. Acceptance of this plan in 1982 led to the implementation of a new municipal district heating system.

The principle source of energy for the system is waste heat produced at a large smelting plant in an adjacent town. As a result of successful implementation of the system, the use of oil for heating was reduced by 12,000 tonnes with a corresponding reduction in the emissions of sulfur, nitrous oxides, carbon dioxide and dust.

Critical to the success of the new system was the establishment of an agreement between the municipality and the owners of the smelting plant. The smelting plant had been selling some of its surplus heat, in the form of steam, to an adjacent paper manufacturing plant. None of the parties wished to jeopardize that arrangement nor interfere with the ability of each to respond to future energy market conditions.

Vänernborg District Heating System Reduction in Emissions

Emission	Reduction Due to Oil Displaced (Tonnes)	Addition for System Peaking (Tonnes)
Sulfur	100	16
Nitrous Oxides	66,000	11
Carbon Dioxide	33,000	6,500
Dust	18	7

Note: Figures are approximate

The result was an agreement in which:

- No obligation to supply or to receive heat energy was made. Rather, the potential profitability for both parties was seen as sufficient incentive for cooperation.
- The smelting plant could meet the needs of the paper plant and, then, if additional surplus energy were available, supply the municipal district system. In fact, it was anticipated that a large surplus of waste heat in excess of the 240 GWh supplied to the paper plant would be available.

*This case study was prepared on the basis of an article "Municipal heating Network in Vänernborg," prepared by Lars E. Borg, Managing Director, Vänernborg Energi AB, 1990)

-
- The smelting plant agreed to make a modest investment in a heat exchanger to convert the waste steam to medium temperature hot water, which was required for the district system.
 - A pricing formula was established which linked the price of the energy supplied to the price of oil. Due to market volatility, this formula was later abandoned in favor of a periodic negotiation of prices based on the market situation for both parties and the general economy.

The Vänersborg district heating company (VFAB) expected to receive 75-90% of its energy demand from the smelting company's waste heat. However, with no guarantee of supply from the smelting plant, the production plant for the system required a capacity to meet demand in the event of a short or longer term interruption in that supply. Four 15 MW oil fired boilers were installed to meet this need.

Within the system's network, several group (institutional) district system central plants were maintained to provide peaking and emergency capacity. By 1990, the connected load had reached approximately 65 MW. This provided justification for the construction of a separate peak/reserve plant (3 - 10 MW oil fired boilers) located as far as possible from the main production plant.

The results of the experience with district heating were summarized in the article from which this case study was developed.*

A district heating system is a capital intensive system. In Vänersborg we have found, as has been seen elsewhere, that a considerable initial capital is necessary for a healthy economic development of the venture. It is also important that the plant can be expanded in a short space of time so that as much link-up as possible can be achieved at an early stage and thereby a bigger base for heat sales if prices are to be kept at a reasonable level. We, like almost all other Swedish district heating companies, have chosen to work only with voluntary connection. We are convinced that the advantages of district heating as compared with other heating alternatives lead to the desired results.

It has been possible from the start to hold heating prices at a reasonable and competitive level. The alternatives available to property owners have been electricity, oil or electrically driven heating pumps. District central heating has always been able to hold its own as far as prices go, even if the competition some years has forced a price level, which was not in fact adequate. In the long run there is every chance that VFAB will win back earlier deficits and sell heating at very competitive prices.

The main advantages with district central heating are all the same on the environmental side. The exploitation of waste heat, which previously could not be put to use, means not only that the energy is used twice over but also that large amounts of oil for heating purposes have been replaced. Thus, we calculate that during 1989, we cut down use of oil by the equivalent of 12,000 tonnes of heating oil. The oil replaced by heat energy from waste heat has also meant that emissions into the air have been greatly reduced.

VFAB's own supplementary oil-firing of course also contributes to emissions. This is however a matter of relatively small amounts as compared with the reduction we have achieved thanks to waste heat exploitation.

Among the positive environmental effects as regards emissions, concentrating the stack gas chimney emissions to a few high chimneys instead of a number of lower chimneys must be mentioned.

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Case Study Baltimore, USA

Baltimore Thermal Energy Corporation (BTEC), a private district energy company, purchased the Baltimore downtown steam system in early 1985 from the local electric utility. BTEC was faced with an eroding customer base, a customer perception that the system did not provide a reliable steam supply and a system which had been earmarked for retirement by the previous owner. In response, BTEC instituted a four-year, multi-million dollar program to upgrade the system's boilers and distribution system.

A two-part promotional initiative was also begun. The first consisted of an immediate customer awareness program to announce a price stability policy and safety and reliability program for the system. The second promotional initiative established cooperative relations with city, state and federal government officials and members of the architectural and engineering (A&E) community.

As of 1991, the BTEC system had retained a base of approximately 400 metered customers in the Baltimore business district. Approximately 1.4 billion pounds of steam were delivered through a 13.6 mile

concrete encased steam loop distribution system. Most customers used the steam for heating while some customers used steam for both heating and cooling. An independently owned municipal waste incineration plant provided about 75% of the system steam requirements, with the balance provided at two oil and gas fired plants.

At the same time as the existing business was being solidified, BTEC undertook the development of a long range market expansion program. Significant opportunities for expansion through connection to public buildings had been identified in a 1981 study funded by the federal department of Housing and Urban Development. Government-backed projects planned after the study provided additional opportunities.

Facilities Connected in BTEC Expansion	
Facilities	Annual MLBS
8 Public Housing Developments	319
City Jail, State Penitentiary	100
Health Care Facility	35
2 Public Schools	20
Sub-Total	474
<i>(Customers identified in 1981 study)</i>	
Veterans Affairs Medical Center	45
Baseball Stadium	20
Sub-Total	65
<i>(Other new customers)</i>	
Grand Total	539
<i>(New Customers)</i>	

As a result of BTEC's marketing efforts, all but two of the major loads identified in the 1981 study were successfully placed under steam service contracts by 1991. In addition, a new veterans affairs medical facility and the new Baltimore Orioles baseball stadium and

**This case study was prepared on the basis of material provided by the Baltimore Thermal Energy Corporation*



adjacent office complex were signed up as BTEC customers. In total, these facilities represented 539 million pounds of annual steam requirements.

One of BTEC's boiler plants was located within the site selected for the new baseball stadium. An

agreement was reached whereby this boiler plant was sold to the stadium developers for \$18.8 million, with all proceeds to be spent on a replacement of the plant and the cost of connection of the stadium to the district systems.

Capital expenditures for the new boiler plant, including connection to the system, will total \$20 million. An additional \$10 million will be invested in the 10,000 feet of steam lines required to connect the new customers.

The success of BTEC in signing long-term service contracts with local, state and federal government agencies has given the company added credibility in its marketing efforts. Furthermore, the ongoing promotional efforts targeted to architects, engineers and developers have been bolstered by the multi-million dollar investment program to establish a permanent alternative energy source in Baltimore, a source which will be an important contributor to the economic development of the city.

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Appendix 2

Recent Municipal DHC projects in Appendix 1, case studies provided descriptive information on a cross section of municipal DHC projects in countries which supported the development of this promotion manual. Many additional projects have been undertaken in these countries. Of these, 29 have been selected as being of possible interest to DHC system proponents faced with particular opportunities and promotion issues.

Recent Municipal DHC Projects Canada

Projects selected for Canada:

Central Heat Distribution Limited (Vancouver, British Columbia)

- A privately owned district energy company, which has grown steadily over its 25 year life, is undertaking a significant expansion to provide service to buildings being developed on the site of a recent world exposition.

P.E.I. Energy Corporation (Charlottetown, Prince Edward Island)

- Under the direction of the provincially-owned P.E.I. Energy Corporation, a municipal district heating system based on locally available wood chip fuel is being implemented on a staged basis.

Corporation de chauffage urbain de Montreal (Montreal, Quebec)

- A district heating system established in 1960 to serve a small group of downtown buildings has a new partner and is planning a significant expansion which will include investments in cogeneration and district cooling.

Toronto District Heating Corporation (Toronto, Ontario)

- A cooperatively-owned, downtown district heating system, formed through the amalgamation of several group (institutional) systems, will be replacing one of its main plants with one or more cogeneration facilities.

Trigen-London District Energy Corporation (London, Ontario)

- An older district system in a medium-sized city is being re-vitalized by its new owners, with current plans calling for the installation of a cogeneration plant and a new chilled water loop.

Recent Municipal DHC Project Canada

Location

Central Heat Distribution Limited
Vancouver, British Columbia

Configuration

District heating system utilizing natural gas as the primary energy source and light fuel oil as the secondary source. High pressure steam is distributed through 8 km of piping to 110 commercial and institutional buildings.

Size

Peak: 489,000 pounds of steam/hour
16 million Btu/month

Distinctive Features

A privately-owned district energy company, Central Heat Distribution has grown steadily since 1967 in its service to buildings in downtown Vancouver (a city of over 1 million population). A cross-section of publicly and privately owned buildings are served, including offices, residential high rise, department stores, hotels, universities and a domed stadium. The system is regulated by the B.C. Utilities Commission, which allows a return on the rate base of 11.60%. Central Heat is planning for the addition of a cogeneration facility and a satellite plant at the outer extremity of the system to meet the needs of commercial development taking place on the grounds of the recent world exposition held in Vancouver.

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Recent Municipal DHC Project Canada

Location

Charlottetown, Prince Edward Island

Configuration

Wood-chip fueled district heating system which utilizes a hot water distribution network, being implemented in several stages.

Size

(At full system development): Peak: 58 MW

184 subscribers

Distinctive Features

The Charlottetown system has developed as an option to the dependence of the area on imports of oil and electricity. Half of Prince Edward Island is covered by wood lots and a plentiful supply of whole tree chips from forest salvage is available. The first two stages of the system utilized available capacity in two wood chip boilers and established small networks, one reaching part of downtown and the other reaching out from the university to a shopping mall. These will be linked when a new cogeneration plant is constructed and the remainder of the distribution system is completed. Consideration is also being given to connection with the nearby regional waste incineration plant. The project is owned by the P.E.I. Energy Corporation, a provincially owned corporation with the mandate to develop and operate energy projects appropriate for the province.

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Recent Municipal DHC Project Canada

Location

Corporation de chauffage urbain de Montreal (CCUM), Montreal, Quebec

Configuration

Steam district heating system serving 10 downtown customers from a central plant fired primarily by natural gas with heavy oil back-up.

Size

Peak: 225,000 pounds of steam per hour

Distinctive Features

The system was established in 1960 to serve a small group of downtown commercial buildings. In 1990, Compagnie Parieienne de Chauffage Urbain joined as partners with the original owner (CN Rail) to form CCUM. Significant expansion and capital investments are taking place, including cogeneration and district cooling.

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Recent Municipal DHC Project Canada

Location

Toronto District Heating Corporation, Toronto, Ontario

Configuration

Two plants provide 200 psi saturated steam to 100 commercial, institutional and government customers through 15 km of underground piping.

Size

Peak: 900 000 pounds per hour of steam

Annual Sales: 2×10^{12} Btu's

Distinctive Features

The downtown Toronto system was established in the early 1980's through the amalgamation of group systems serving hospitals, provincial government buildings, Toronto City Hall and other buildings. Set up as a non-profit, cooperative form of ownership, annual revenues of approximately \$16 million are equal to operating costs. With one of the two production plants requiring replacement, plans are being made for a new cogeneration plant and the possibility of cogeneration capability at some customers' facilities.

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Recent Municipal DHC Project Canada

Location

Trigen-London District Energy Corporation, London, Ontario (A subsidiary of Trigen Canada Inc.)

Configuration

Old: Steam system serving 70 customers from an old central plant, originally coal-fired but converted to natural gas, with No. 6 fuel oil as backup, in the early 1970s.

New: New steam and chilled water production facility in process of commissioning, providing steam for district heating and non CFC production of chilled water for air conditioning of downtown London buildings. Natural gas-fired, with No.2 fuel oil as back-up, low NOx steam boilers and 2-stage absorption chillers--with plans to add a gas turbine electricity generator, to complete the trigeneration loop, economic electricity sales to the utility grid can be achieved.

Size

Peak: 55 MW

Distinctive Features

The original system, started in 1927, faltered from the late 1960's until its purchase by Trigen in 1989. The heating customer base has stabilized and is beginning to climb, with a 35% increase in sales volumes contracted in 1992 and chilled water sales have just begun an inaugural project to cool three City of London buildings - the first commercial district cooling system in Canada. Promotion to downtown building owners, in this city of 300,000 is stressing the benefits of environmental improvement, energy conservation, security of supply and economic attractiveness, particularly when an owner faces the necessity of capital investment in a building's existing heating and or chilled water production systems.

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Fax: 1-519-661-0178

Recent Municipal DHC Projects Denmark

Projects selected for Denmark:

Metropolitan Copenhagen Heating Transmission Company (CTR):

- A very large heat transmission company (759 MW_{th}) completed production and transmission installations to serve 5 metropolitan municipalities in less than 6 years.

Helsingor, Sealand

- A biogas-fueled cogeneration plant and a 15 km transmission line are included in expansion of an extensive DH system.

Laurbjerg Kraftvarmeværk A.mb.A, Jutland

- A very small (2.5 MW_{th}) "village scheme" has been developed with a natural gas fueled cogeneration plant.

Slagelse, Sealand

- A new CHP plant (22 MW_{th}, 22 MW_e) fueled by straw and refuse has been incorporated within the city's DH system.

Recent Municipal DHC Project Denmark

Location

Metropolitan Copenhagen Heating Transmission Company (CTR)

Configuration

Heat transmission company with the scope to: a) Purchase heat from production units, b) Produce heat on its own peak load and stand-by load installations, c) Transport heat through the CTR transmission network to five member municipalities and to Vestegnens Kraftvarmeselskab I/S (VEKS), an adjacent heating company.

Size

Peak: 759 MW
approximately 250,000 subscribers (when fully extended)

Distinctive Features

The CTR system is one of the world's largest district heating projects. As of 1992, the system includes a total of 52 km of double piping, 25 heat exchanger stations, 3 pumping stations, 9 peak load installations and a computer-based control, regulation and monitoring system. All were installed in a period of less than 6 years.

In 1991, CTR supplied a total of 9,984 TJ of heat. The goal targeted for 2002 envisions an annual gross heating requirement of 17,500 TJ.

CTR is a partnership founded in 1984 by five Metropolitan Copenhagen municipalities. The objective is to supply the individual partner municipalities with district heat energy, based primarily on the utilization of surplus heat. Heat from waste incineration and CHP plants is given the top priority.

Plans call for several heat accumulators to be installed. These were found to provide both financial and operational advantages with regard to both power and heat. The first accumulator will be completed at the end of 1992 at the Avedørevaerket site in Hvidovre. This accumulator consists of two tanks with a total volume of 44,000 m³.

For further information:

Metropolitan Copenhagen Heating Transmission Company
Mr. H.C. Mortensen
Managing Director
Krumtappen 4 Postboks 4
DK-2500 Valby

Tel: 45-36-44-02-11
Fax: 45-36-44-16-18

Recent Municipal DHC Project Denmark

Location

Helsingor, Sealand, Denmark

Configuration

Biogas, supplemented with natural gas, will fuel a cogeneration plant to be commissioned in 1992 as part of an extensive district heating system which also includes a waste incineration plant.

Size

Peak: 55 MW

Distinctive Features

The first phase of the current project involves completion of the biogas fueled cogeneration plant and connection with the Helsingor Varmeforsyning district heating system. The second phase will consist of the construction of a 15 km transmission line to the city of Hornbaek. The third phase will entail the construction of a 25 to 30 km transmission line to nearby cities and a large refuse incinerator.

For further information:

IFV Energi I/S
Mr. Jens Ricken
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2900 Hellerup

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Recent Municipal DHC Project Denmark

Location

Laurbjerg Kraftvarmeværk A.m.b.A, Jutland, Denmark

Configuration

Natural gas fueled cogeneration plant for a small, privately owned district heating "village scheme."

Size

Peak: 2.5 MW

250 subscribers

Distinctive Features

A small town with local initiative achieved a cleaner environment through the commissioning in 1992 of a district heating system. Construction of the 6.5 km network was completed in 6 months. Business and institutional customers are connected. Total cost, including a CHP plant and the distribution network, was Dkr. 24.000.000. Annual system production: Electricity: 5000 MWh; Heat: 6000 MWh

For further information:

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c/o Mr. Per Kvorning
Chairman of the Board
Ostergade 21
8870 Langa
Denmark

Tel: 45-86-46-82-04

Recent Municipal DHC Project Denmark

Location:

Slagelse, Sealand, Denmark

Configuration:

CHP plant fueled by straw and refuse supplies heat to the city's district heating system.

Size:

Peak: 22 MW (thermal); 22 MW (electric)

15,000 subscribers

Distinctive Features:

The CHP plant, which is fueled by locally available straw and municipal waste, supplies heat to public and institutional buildings as well as to approximately 15,000 of the city's inhabitants.

For further information:

Slagelse Kommunes El- og Varmevaerk

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4200 Slagelse

Denmark

Tel: 45-53-52-46-00

Fax: 45-58-50-02-58

Recent Municipal DHC Projects Finland

Projects selected for Finland:

Hyvinkaan Lampovoima Oy, Hyvinkaa

- A DH company in a medium-sized city is a leader in marketing for mature DH systems. In 1990 the system began receiving its thermal energy from a gas turbine CHP plant.

Lahti Energia Oy, Lahti

- This extensive DH system serves 90% of the population and provides DH at the lowest price of all Finnish DH system.

Kuopion energialaitos, Kuopio

- An extensive DH system has successfully utilized a peat fueled CHP plant as its source of thermal energy for over 20 years.

Lappeenrannan Energialaitos, Lappeenranta

- Starting in 1975, this system has been a pioneer in the utilization of a gas fueled CHP plant as the source of thermal energy for DH systems.

Oulun kaupungin energialaitos, Oulu

- This DH system is a leader in the promotion of energy conservation in Finland.

Recent Municipal DHC Project Finland

Location

Hyvinkaan Lampovoima Oy, Hyvinkaa, Finland

Configuration

Natural gas fueled CHPP production for municipal DH system

Size

Peak: 90 MW

1089 subscribers

Distinctive Features

District heating began in Hyvinkaan Lampovoima Oy in 1975. The population in Hyvinkaa is 40,300. Currently, 70% of the inhabitants are living in buildings connected to the DH system.

Hyvinkaan Lampovoima Oy was supplied by heat only plants for its first 15 years. Starting in 1990, the company has bought almost all of the thermal energy produced at a gas turbine CHP plant owned by the Finnish National Power Corporation, Imatran Voima Oy.

Hyvinkaan Lampovoima Oy has been a leader in Finnish district heating services. The company has paid close attention to the need for marketing by a mature DH system, including the desirability of prompt customer service.

For further information:

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Hyvinkaan Lampovoima Oy
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Recent Municipal DHC Project Finland

Location

Lahti Energia Oy, Lahti, Finland

Configuration

Natural gas and coal fueled CHP production for a municipal DH system

Size

Peak: 300 MW
3786 subscribers

Distinctive Features

District heating in Lahti began in 1962. Currently, 90% of the 93,600 inhabitants are living in DH supplied buildings.

Lahti Energia Oy provides its district heating service at the lowest price of all DH systems in Finland and is well known for its economic attractiveness.

For further information:

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15141 LAHTI
FINLAND

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Recent Municipal DHC Project Finland

Location

Kuopion energialaitos, Kuopio, Finland

Configuration

Peat fueled CHP production for a municipal DH system

Size

Peak: 250 MW
2870 subscribers

Distinctive Features

Kuopion Energialaitos began its district heating system in 1963.

The system serves 88% of the population of 81,400.

Kuopion energialaitos has successfully utilized a peat fueled CHP plant as its source of thermal energy for over 20 years.

For further information:

Mr. Kauko V. Heikkinen
Director of DH Department
Kuopion energialaitos
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70101 KUOPIO
FINLAND

Tel: 358-71-187111
Fax: 358-71-187016

Recent Municipal DHC Project Finland

Location

Lappeenrannan Energialaitos, Lappeenranta, Finland

Configuration

Natural gas fueled CHP production for a municipal DH system.

Size

Peak: 150 MW
2880 subscribers

Distinctive Features

Lappeenrannan Energialaitos began its district heating system in 1966. Lappeenranta is located in the southeast of Finland. The system serves 79% of the 55,300 inhabitants.

Beginning in 1975, Lappeenrannan Energialaitos has been a pioneer in producing thermal energy for DH from a natural gas fueled CHP plant.

For further information:

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Recent Municipal DHC Project Finland

Location

Oulun kaupungin energialaitos, Oulu, Finland

Configuration

Peat fueled CHP production for a municipal DH system.

Size

Peak: 296 MW
3592 subscribers

Distinctive Features

Oulun kaupungin energialaitos began district heating in 1969. The system serves 86% of the population of 102,000.

The topic of energy savings is currently receiving a high priority in the Finnish energy field. Under the leadership of the Ministry of Trade and Industry, DH and other organizations work hard in support of energy conservation. Oulun kaupungin energialaitos is one of the first energy boards to promote energy savings to its citizens.

For further information:

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FINLAND

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Recent Municipal DHC Projects The Netherlands

Project selected for the Netherlands:

Amsterdam

- A large natural gas-fueled steam and gas cogeneration plant is being designed for a new district heating system.

Recent Municipal DHC Project The Netherlands

Location

Amsterdam, The Netherlands

Configuration

A large natural gas fueled steam and gas cogeneration plant will be constructed in an existing power station as the central heat source for a new district system.

Plant Size

Peak output: 150 MW_{th}

225 MW_e

Distinctive Features

A new cogeneration plant to be located in the southeast region of Amsterdam is in the design stage with construction scheduled to begin in 1993. The new plant will be constructed in an existing power station.

Subscribers will be, for the most part, existing office buildings, blocks of dwellings and a hospital.

The peak heat demand for the new district heating system (167 MW_{th}) is projected to exceed the peak output of the new cogeneration plant (150 MW_{th}). To meet peak loads and provide system back-up, the heat boilers in the subscriber buildings will be integrated into the district heating distribution network.

For further information:

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The Netherlands

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Recent Municipal DHC Projects Norway

Projects selected for Norway

Oslo

Trondheim

Recent Municipal DHC Projects Norway

Location

Oslo, Norway

Configuration

Four separate hot water district heating networks, each with its own central plant, make extensive use of refuse incineration and extraction of heat from sewage as energy sources.

Size

Combined: 500 GWh of district heat production 475 subscribers

Total pipe length: 110 km

Distinctive Features

Sentrum Plant

Constructed in 1937, this plant uses oil and electricity as energy sources, serving 270 customers through a 18 km network.

Sondre Nordstand and Grorud

With construction starting in 1979 and 1980, respectively, these sections are each served by a plant which uses refuse incineration, electricity and oil as energy sources.

Skoyen Vest

Opened in 1984, this section utilizes a large heat pump and electricity boilers to serve a 6.5 km network.

For further information:

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Oslo Energi
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Solli 0202 Oslo

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Recent Municipal DHC Project Norway

Location

Trondheim, Trondelag, Norway

Configuration

Refuse fueled plant for new municipal district heating system

Size

Peak: 1992: 250 GWh/year

2000: 315 GWh/year

Distinctive Features

The origination of the Trondheim district heating system was the difficulties which existed in the early 1980's with the disposition of municipal refuse. In 1982, it was decided to build a new district heating system for the municipality which would utilize thermal energy from a new refuse incineration plant as its principal source of heat.

Two refuse boilers, each with 6.5 metric ton/hour capacity, provide base load system heating requirements. Back-up and peaking capacity is provided by electric and oil boilers. Covering an area of approximately 20 square kilometers, the DH network has a total length of about 60 km.

The total investment for building the entire system (waste incineration plant, oil and electric boilers and distribution network) was approximately 500 million Norwegian kroner (US \$85 million).

For further information:

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Recent Municipal DHC Projects Sweden

Projects selected for Sweden:

Gothenburg

- A large municipal DH system derives 78% of its energy from waste sources, including sewage, refuse incineration and industrial waste heat.

Orebro

- Faced with the requirement to reduce its consumption of oil and improve environmental performance, this system chose a new solid fuel circulating fluidized bed boiler from a wide range of technical options.

Recent Municipal DHC Project Sweden

Location

Gothenburg, Sweden

Configuration

Waste heat from sewage and industry provides 72% of energy requirements for a large DH system.

Size

Peak: 1626 MW
150,000 subscribers

Distinctive Features

Utilization of available sources of waste energy has been incorporated into the extensive Gothenburg DH system:

- through some of the world's largest heat pumps, the Rys plant extracts heat from sewage
- the refuse incineration plant at Savenas provides thermal energy to the DH system
- waste heat is extracted from the Shell oil refinery process and cooling stages, from the Volvo Lundby plant and from research fluidized bed boiler at Chalmers University of Technology

In total these waste heat sources provide 72% of annual energy requirements, with the balance supplied by fossil fuels.

For further information:

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Recent Municipal DHC Project Sweden

Location

Orebro, Sweden

Configuration

A new solid fuel circulating fluidized bed boiler has been installed as one measure to reduce the consumption of oil by a municipal DH system.

Size

Peak: 637 MW
35,208 subscribers (flats and larger)

Distinctive Features

During the early 1980's, the Orebro system had to decide how it would reduce its consumption of oil. Investments were made to convert two oil fueled boilers to coal fired CHP and a heat pump plant was installed.

In order to reduce oil consumption further, as called for in the oil reduction plans which each town district had to prepare, investigation of several technical options began. During this period, new standards were being established for environmental performance in the 1990's, the price of oil began to decline and the extension of the natural gas distribution system to Orebro was promised.

In the face of these variables, the decision was made to proceed with a solid fuel plant with fuel flexibility so that domestic peat and wood could be used as well as coal. Technical options ranged from rebuilding the existing boiler for solid fuel and building a new boiler with the same or less capacity as the boiler being replaced.

The final decision to proceed with a circulating fluidized bed boiler with reduced capacity has been justified since its installation on the basis of environmental performance as well as reliability of production with various fuels.

For further information:

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Orebro Energi AB
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701 14 Orebro
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Recent Municipal DHC Projects USA

Projects selected for the USA:

Cleveland, Ohio

- Under new ownership, a declining downtown steam DH system began to add customers and is currently constructing a district cooling system which will help building owners comply with CFC phaseout regulations.

Hartford, Connecticut

- Since its inception in 1961, the world's first privately-owned, combined district heating and cooling system has served its expanding clientele with new cogeneration facilities and attention to customer service.

Indianapolis, Indiana

- A new district cooling system began service in 1991, with coal and municipal waste utilized to provide steam for turbine-based central chillers.

Jamestown, New York

- With strong backing from the mayor, an existing municipal coal-fired power plant was converted to cogeneration as the source of thermal energy for a new hot water distribution network for public and private buildings.

Miami, Florida

- Based on a cooperative structure for ownership and operation, a new central cooling system is being designed to meet the chilled water requirements for medical facilities and public office buildings.

Minneapolis, Minnesota

- A 20 year old district heating and cooling system has met increasing demand through an expanded distribution network, the addition of unattended satellite plants and utilization of steam from the county waste incinerator.

Nassau County, Long Island, New York

- Privatization of a central plant serving county buildings will save the county \$90 million. The new owners, a private district energy company, have constructed a cogeneration plant which produces steam, chilled water and electricity.

Rochester, New York

- Steam users and the city formed a cooperative to purchase and operate an older downtown system which faced abandonment. Tax exempt bonds financed the purchase and operational improvements have been initiated.

Saint Paul, Minnesota

- Based on strong support from the municipal government, a modern hot water DH system was installed in 1983 and currently serves 70% of downtown buildings. Recent developments include a turbogenerator for cogeneration and a new district cooling system financed by tax-free bonds.

Trenton, New Jersey

- A DH system was established in 1981 to serve state offices and other facilities. The system reduced energy consumption by 30%. A new chilled water loop, augmented by thermal storage, resulted in a 30% expansion in load in 1982.

Recent DHC Project USA

Location

Cleveland, Ohio

Configuration

The system provides steam for district heating, steam-powered cooling, domestic hot water and process use. Boilers fueled by low-sulfur coal; peaking boilers fueled by No. 6 fuel oil. District cooling system is now under construction, to be available in Spring 1993, using electric-drive Carrier chillers with R22 refrigerant.

Size

Peak heating: 1.3 million lbs/hr; 207 buildings served
Peak cooling: 10,000 tons initially, 25,000 tons planned

Distinctive Features

This steam system, started in 1906 by the local electric utility, was sold in 1987 to a private company and resold in 1991. In addition to adding new customers and load to the steam system, the new owner is constructing a district cooling system to serve the downtown area. Financing will come from the parent company, which also developed the Indianapolis system. Building owners and managers, who worked to preserve district heating when the utility was disposing of the system, see district heating and the new district cooling system as a way to maintain flexibility in building operation. Environment is also a major issue increasing market attention to district cooling, as many building have older equipment using R11 refrigerant but most have no plans for complying with scheduled government regulations for CFC-phaseout.

For further information:

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USA

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Fax: 1-216-241-6486

Recent DHC Project USA

Location

Hartford, Connecticut

Configuration

The district energy system provides steam, hot water, and chilled water. Energy supply is from three cogeneration plants with total electrical generating capacity of 110 MW. Two are combined-cycle plants and the third is a simple-cycle plant. A 70 MWH chilled-water storage tank is used to optimize the capacity of existing facilities.

Size

Peak heating: 76 MW; 55 subscribers

Peak cooling: 113 MW; 57 subscribers

Distinctive Features

This system was organized in 1961 the world's first privately-owned combined district heating and cooling system to produce and distribute steam and chilled water to a downtown area. Currently serving over 75% of the Class A office space in Hartford, it is still expanding in both heating and cooling loads. Ongoing relationships with local architects, engineers, developers, and building owners/operators have led to a wide acceptance of DHC as a viable, cost-effective method of heating and cooling buildings.

For further information:

Jeff T. Lindberg
Director of Sales and Customer Relations
Energy Networks, Inc.
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111 Prestige Park Road
East Hartford, CT 06128-0247
USA

Tel: 1-203-282-4506

Fax: 1-203-282-4595

Recent DHC Project USA

Location

Indianapolis, Indiana

Configuration

District cooling; coal or municipal solid waste burned to produce steam for turbine-driven central chillers.

Size

Peak cooling: 20,000 tons, growing to 30,000 tons as demand dictates; presently a handful of subscribers but growing rapidly

Distinctive Features

Having identified district cooling as having great growth potential and significant benefits, an entirely new district cooling system began construction in 1990 to serve downtown buildings. The owner/developer is a subsidiary of the holding company owning the local electric utility, which also operates the district heating system. The City/County Council granted a 25-year franchise for the district cooling system, recognizing the community benefits of infrastructure improvement, stimulation of new building development, and environmental improvement through reduced pollution and possible CFC removal. The use of steam from the City's waste-to-energy plant also provides revenues. Customer service began in July 1991.

For further information:

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Kevin Greisl, Director of Sales
Mid-America Energy Resources
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Indianapolis, Indiana 46206-6161
USA

Tel: 1-317-261-8101
or 1-317-261-8899
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Recent DHC Project USA

Location

Jamestown, New York

Configuration

District heating with cogeneration; four coal-fired boilers and two 25 MW steam-turbine generators. One turbine is retrofitted for steam extraction to a district heat exchanger, which operates throughout the year. An auxiliary heat exchanger further increases the temperature of the district heating water when required during periods of low outdoor temperatures.

Size

Peak: 120 million Btu/hr

35 subscribers

Distinctive Features

Recognizing that its municipally owned coal-fired power plant represented an important asset that could be better utilized, in 1984 Jamestown began work on a district heating system using modern prefabricated piping technology. Development was financed by city bond issues. A key to the system implementation was the leadership role of the mayor as a "champion" of the project. The system serves both public and private buildings. Benefits include environmental advantages, demand-side management of electric power requirements, customer savings, and potential for urban economic revitalization. During the period of 1984 through 1991, customers have experienced cost savings of about 20 percent, with a cumulative savings of \$1.15 million from participating in the district heating system instead of operating their individual equipment.

For further information:

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District Heating Coordinator
City of Jamestown
Board of Public Utilities
Municipal Bldg., P.O. Box 700
Jamestown, New York 14702
USA

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Recent DHC Project USA

Location

Miami, Florida

Configuration

District cooling system using electrically driven chillers.

Size

Peak cooling: 15,000 tons

5 major subscribers

Distinctive Features

An engineering analysis has been performed for a proposed central chilled-water plant supplying the Civic Center Hospitals and the Justice Center Complex of Dade County, Florida. A cogeneration plant to supply thermal energy to the district cooling system was also included. The first increment of the system, the interconnection of the Jackson Memorial and University of Miami Medical Centers, is in the final phase of engineering design. Development effort is now concentrating on the incorporation of two additional medical centers and the Justice Center into the central system. A cooperative arrangement is being considered for system ownership and operation.

For further information:

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Joseph Technology Corporation
188 Broadway
Woodcliff Lake, New Jersey 07645
USA

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Recent DHC Project USA

Location

Minneapolis, Minnesota

Configuration

DHC system provides steam, hot water, and chilled water. Boilers are fueled with gas or oil. Chilled water is produced by steam-turbine driven centrifugal chillers and single-stage absorption chillers.

Size

Peak heating: 720,000 lbs/hr; 110 subscribers

Peak cooling: 28,000 tons; 25 subscribers

Distinctive Features

Since its beginning 20 years ago, the system has grown steadily in both heating and cooling demand. As the heating and cooling loads have reached the limits of the distribution pipes, satellite plants have been added. The North Riverfront Plant, a low-pressure steam, hot water, and chilled-water plant facility, operates totally unattended, with monitoring and control from the main plant, whose personnel also make daily system inspections. The new First Avenue Cooling Plant will allow use of steam from the Hennepin County waste incinerator.

For further information:

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USA

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Recent DHC Project USA

Location

Nassau County, Long Island, New York

Configuration

Steam boilers, steam-turbine driven centrifugal chillers, and new combined-cycle cogeneration plant. Steam, hot water, and chilled water distribution. Main fuel is natural gas, with distillate oil as back-up.

Size

Peak steam heating: 150,000 lbs/hr; 2 subscribers

Peak hot-water heating: 60 million Btu/hr; 3 subscribers

Peak cooling: 3500 tons; 5 subscribers

Peak electric: 57 MW; 1 subscriber

Distinctive Features

The Central Utility Plant, built by the County in 1971 to serve a government center, was privatized in 1990 by leasing it to a private firm, who began operating it on an interim basis three years earlier. A new cogeneration plant was added in 1991. The firm has improved system operation and added steam distribution lines and customers. Privatization brought private-sector project financing and entrepreneurial know-how. A key to the success of the project was to allow maximum flexibility in proposing system development. The net benefit to the county will be \$90 million saved over the 25-year term of the lease.

For further information:

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President and CEO

Trigen-Nassau District Energy Corporation

185 Charles Lindbergh Boulevard

Garden City, New York 11530

USA

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Fax: 1-516-794-1928

Recent DHC Project USA

Location

Rochester, New York

Configuration

Gas-fired boilers, steam distribution

Size

Peak: 52 MW (137,000 lbs/hr)

33 buildings served

Distinctive Features

When the electric utility announced plans to abandon its steam system, steam users and city officials formed a cooperative to purchase the system and operate it. Financing was through tax-exempt Industrial Development Bonds issued by the County. Keeping the steam system saved customers the \$12 million it would have cost to install individual boilers and continues to save \$3 million in energy costs annually. A new Hyatt Regency Hotel recently joined the Cooperative. Production innovations include annual infrared mapping of distribution systems, reduction of steam pressure to lower distribution costs, and personal computer-based preventive maintenance and control systems. Members remain active in system management with monthly meetings of the Technical Committee, Finance Committee and Board of Directors. Feasibility studies are under way for district cooling.

For further information:

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Rochester District Heating Cooperative
50 Chestnut Plaza
Rochester, New York 14604
USA

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Recent DHC Project USA

Location

Saint Paul, Minnesota

Configuration

Boilers fueled with coal or gas/oil, with distribution of hot water. Cogeneration primarily of in-house electricity requirements. A new district cooling system is also being developed.

Size

Peak heating: 145 MW; 430 subscribers

Peak cooling: 12 MW; 9 subscribers

Distinctive Features

Heating-only service began in 1983 with a modern hot-water system, which required the conversion of major customers previously using steam. The system now serves about 22 million square feet of building space, or over 70 percent of downtown buildings. The 1990 addition of a turbogenerator for cogeneration has provided substantial savings. A new district cooling system to be operating in 1993 was financed in late 1991 and under construction in 1992. Strong support from local government has benefitted the system throughout its development.

For further information:

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District Energy St. Paul, Inc.
76 West Kellogg Boulevard
St. Paul, MN 55102-1611
USA

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Recent DHC Project USA

Location

Trenton, New Jersey

Configuration

Hot water and cogenerated electricity from two 8400 BHP, 20-cylinder Cooper-Bessemer diesel engines burning diesel fuel or natural gas. Cooling plant consists of 3 double-effect steam absorption chillers, 2 Carrier chillers using R11, 2 chillers converted to use R123, and a 2.8 million gallon chilled water storage tank.

Size

Peak heating: 160 million Btu/hr; 32 subscribers

Peak cooling: 8400 tons, plus storage equivalent of 10,000 tons; 20 subscribers

Distinctive Features

Originally formed in 1981 as the result of a U.S. Department of Energy study, the system provided district heating only, with the State of New Jersey's Capitol Complex and its large regional prison providing 85 percent of the total thermal load. Operating experience permitted the State to reduce energy consumption by over 30 percent in the period between 1983 and 1987. It became apparent that marketing district heating without cooling was an incomplete product, especially for new buildings, both State and commercial, being designed in the late 1980s. The issue of CFC elimination added market appeal to district cooling. A compact chilled-water loop centered at the State Complex and downtown Trenton, utilizing as much available chiller production and augmented by thermal storage, was brought on line in 1989. Loads and customers grew rapidly, with a 30 percent increase in 1992. The company looks forward to replacing all its CFC chillers with HCFC or ammonia-based chillers.

For further information:

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Fax: 1-609-396-7406

Appendix 3

Bibliography

This appendix provides listings of pertinent publications related to DHC systems.

IEA District Heating Reports

District Heating and Combined Heat and Power Systems, A Technology Review, OECD/IEA, Paris, 1983.

IEA District Heating, Summary of Research Activities, 1985-87, published by National Energy Administration, Stockholm, 1988.

IEA District Heating, Summary of Research Activities, 1987-90, published by Netherlands Agency for Energy and the Environment, Sittard, the Netherlands, 1990.

NOTE: Will include a list of all summarized reports in the Annex.

Pertinent Studies and Reports

USA:

"District Heating and Cooling Program Overview," U.S. Department of Energy, Washington, D.C., 1992.

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Periodicals

Denmark:

"Fjernvarmen", DFF, Galgebjergvej 44, DK-6000 Kolding

Tel: 45 75 52 88 11

Fax: 45 75 52 89 62 (Bimonthly)

"Energi & planlaegning", Sun Media, Ryesgade 19 B, st., DK-2200 Kobenhavn N

Tel: 45 31 35 22 11

Fax: 45 31 35 65 46 (Quarterly)

"Energinyt", Energistyrelsen, Landemaerket 11, Dk-1119 Kobenhavn K

Tel: 45 33 92 67 00

Fax: 45 33 11 47 43 (Bimonthly)

Germany:

District Heating/Fernwarme International, Verlags- und Wirtschaftsgesellschaft der Elektrizitetswerke mbH, Strossenannallee 30, D-6000 Frankfurt am Main 70

Tel: 49 (069) 63041

Fax: 49 (069) 6304359

Norway:

"Energi", ENI, Boks 74-Blindern, N-0314 OSLO, Norway

Tel: 47-22 69 5870

Fax: 47-22 46 11 29

"Fernwarme-Nytt", Fjernvarmeforeningen, Boks 74-Blindern, N-0314 OSLO, Norway

Tel: 47-22-69 5870

Fax: 47-22-60 2693

USA:

ASHRAE Journal, American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE), 1791 Tullie Circle, NE, Atlanta, GA 30329

Tel: 1-404-636-8400

Fax: 1-404-321-5478

Cogeneration, Pequot Publishing, Inc., 654 Hillside Road, Fairfield, CT (Bimonthly)

Tel: 1-203-259-1812

District Heating and Cooling, International District Heating and Cooling Association, 1101 Connecticut Avenue, NW, Suite 700, Washington, DC 20036-4303 (Quarterly)

Tel: 1-202-429-5111

Fax: 1-202-429-5113

Appendix 4

Directory of District Energy Associations

Canada

Canadian District Energy Association

Tel: 1-416-397-5670

Fax: 1-416-397-0276

13 members

Europe:

Union Internationale des Destributeurs de Chaleur (Unichal)

Bahnhofplatz 3

CH - 8023 Zurich

Switzerland

Tel: +41-1-2113635

Fax: +41-1-2210442

Denmark:

Danske fjernvarmevaekers Forening (DFF) (Danish District Heating Association)

Galgebjergvej 44

DK-6000 Kolding

320 members; municipal utilities or cooperative suppliers of district heating

Tel: 45 75 52 88 11

Fax: 45 75 52 89 62

Danish Board of District Heating

Jernbanevej 65

DK-5210 Odense NV

38 members; primarily consulting and industrial companies interested in export of district heating goods and services

Tel: 45 66 17 72 28

Fax: 45 66 17 72 26

Danish Energy Group (DEG)

c/o Danish Export Association

Nygade 1B

P.O. Box 98

DK-8600 Silkeborg

11 members; primarily consulting and industrial companies interested in export of district heating goods and services

Tel: 45 86 81 38 88

Fax: 45 86 81 31 14

Finland

Lampolaitosyhdistys ry. (Finnish District Heating Association) Valkjarventie
SF-02130 ESPOO

Tel: 358 (0) 455 1866

Fax: 358 (0) 455 1848

Germany

Arbeitsgemeinschaft Fernwarme e.V. (AGFW)

Stresemannallee 23

D-6000 Frankfurt/Main 70

Tel: 49 (069) 6304-1

Fax: 49 (069) 6304-391

The Netherlands

Energiened

Postbus 9042

NL-6800 G. A. Arnhem

Tel: 31-85-569444

Fax: 31-85-460146

Norway

District Heating Association in Norway

Gaustadalleen 300

Postboks 74-Blindern

N-0314 OSLO 3

Tel: 47-22-69 58 70

Fax: 47-22-60 26 93

Sweden

Swedish District Heating Association

Postbox 1109

S-111 81 Stockholm

Tel: 46-08-676 98 00

Fax: 46-08-676 98 29

USA

American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.

(ASHRAE), 1791 Tullie Circle, NE

Atlanta, GA 30329

Technical Committee 6.2 on District Heating and Cooling

Tel: 1-404-636-8400

Fax: 1-404-321-5478

Association of Physical Plant Administrators of Universities and Colleges
1446 Duke Street, Alexandria
VA 22314

Tel: 1-703-684-1446
Fax: 1-703-549-2772

International District Heating and Cooling Association
1101 Connecticut Avenue, NW
Suite 700, Washington, DC 20036-4303

Tel: 1-202-429-5111
Fax: 1-202-429-5113

Appendix 5

Directory of Government Agencies and Departments

Canada

Energy, Mines & Resources Canada
Energy Research Laboratories
Energy Systems Technology Implementation
555 Booth Street
Ottawa, Ontario
K1A 0G1
Tel: 1-613-996-8870
Fax: 1-613-947-0291

Denmark

Energistyrelsen
Landemaerket 11
DK-1119 Kobenhavn K
Tel: 45 33 92 67 00
Fax: 45 33 11 47 43

Energiministeriet
Slotsholmsgade 1
DK-1216 Kobenhavn K
Tel: 45 33 92 75 00
Fax: 45 33 32 22 27

Miljoministeriet
Slotsholmsgade 1
DK-1216 Kobenhavn K
Tel: 45 33 92 33 88
Fax: 45 33 32 22 27

The Netherlands

NOVEM, Netherlands Agency for Energy and the Environment
P.O. Box 17
NL - 6130 AA Sittard
Tel: 31-46-595297
Fax: 31-46-528260

Norway:

Norwegian Water Resources and Energy Administration
Postboks 5091
N-0301 OSLO
NORWAY
Tel: 47-22-95 95 95

Norwegian Oil and Gas Department
Postboks 8148
N-0033 OSLO
NORWAY
Tel: 47-22-34 90 90

USA:

U.S. Department of Energy
Utility Systems Division
CE-141, Washington, DC 20585
Tel: 1-202-586-9191
Fax: 1-202-586-2826

U.S. Department of Housing and Urban Development
Energy Division
Office of Environment and Energy
Washington, DC 20410
Tel: 1-202-708-2504

New York State Energy Research and Development Authority
2 Rockefeller Plaza
Albany, NY
Tel: 1-518-465-6251

Washington State Energy Office
809 Legion Way, FA-11
Olympia, WA 98504-1211
Tel: 1-206-956-2014

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