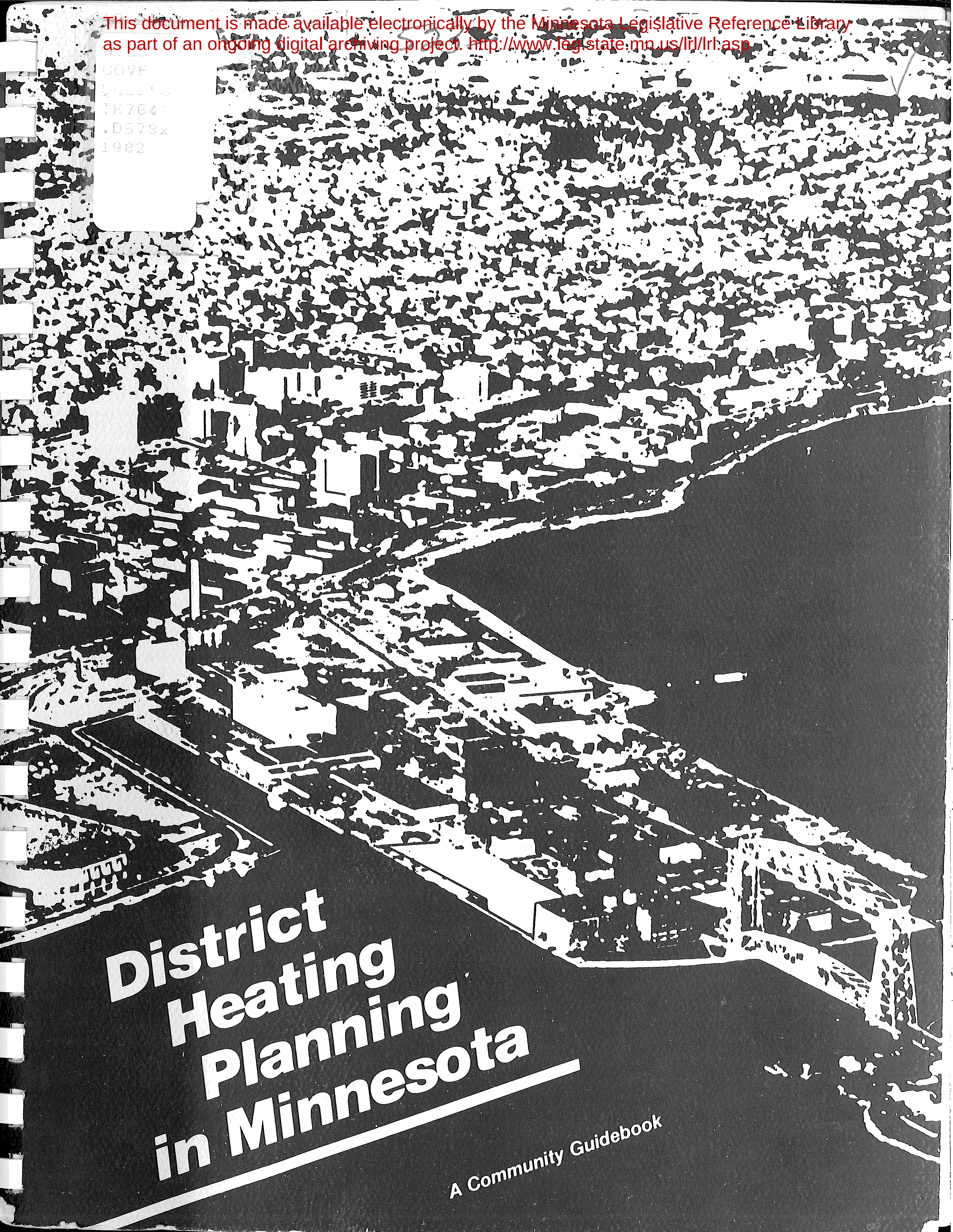


District Heating Planning in Minnesota

A Community Guidebook

523-767792-300

District Heating Planning in Minnesota

A Community Guidebook

Prepared for the

epd

Energy Division
Minnesota Department of Energy, Planning & Development

by
Planning and Management Services, Inc.

Foreword

Minnesota faces three significant energy problems. The state imports all its energy supplies from other states and countries. Second, those supplies are shrinking while their costs are rising. Finally, future demand for these fuels is expected to exceed supplies.

In order to balance this supply and demand picture, Minnesota must consider developing alternative energy technology. Solar, wind and biomass are the most commonly mentioned resources, but district heating is another that merits careful study.

District heating is the distribution of heat energy from a central source to commercial, industrial and residential customers for space heating, process needs and domestic hot water.

District heating offers several advantages for Minnesota communities:

- It encourages economic growth by reducing energy costs, building local self-reliance and attracting new business.
- It provides better long-run energy price stability.
- It reduces thermal pollution and improves air quality.

District heating, however, has one major disadvantage. It requires significant initial capital investment. Capital, not fuel or labor, is the most expensive cost element in the first few years and can run 60-85 percent of heat costs.

For this reason, district heating development requires a joint effort by private and public sectors. No one sector can assume total risk and secure the necessary financing.

The task is not impossible, however. Several Minnesota communities are meeting the challenge now with success.

District Heating Planning in Minnesota: A Community Guidebook is intended for use by local officials, planners and citizens. It will help people determine whether a district heating system is feasible in their community. It also will guide people through each step of district heating development.

Acknowledgements

This publication was prepared by the Minnesota Energy Agency with acknowledgements to the League of Minnesota Cities, the Minnesota Department of Economic Development, the State Planning Agency, the Minnesota Municipal Utilities Association, Petrie Development Company, Piper Jaffray and Hopwood, The Minnesota Project, the St. Paul District Heating Development Corporation, and the Cities of Moorhead, Willmar, and Minneapolis.

The preparation of this publication was financed by a federal grant to the Minnesota Energy Agency by the United States Department of Energy.

Note: The 1981 Minnesota State Legislature established the Minnesota Department of Energy, Planning and Development (EPD), which combined the existing Minnesota Energy Agency, the Department of Economic Development, the State Planning Agency and the Minnesota Crime Control Board. The merger was completed March 1, 1982.

Consulting services were provided by Planning and Management Services, Inc., Bloomington, Minnesota, with assistance from Scantec, Inc. (district heating engineering services), Graven and Associates (economic research), and the Carroll Easton Company (district heating consulting services).

The preparation of this Guidebook occurs at a time when significant events in district heating are underway both in Minnesota and across the nation. The results of district heating development projects only now in the planning and construction phases will add greatly to the current base of knowledge. New legislation, changed tax rulings, revised policies, fuel price changes, and the experience gained on completed district heating projects may significantly alter the accuracy of portions of the material contained herein, especially the information concerning the ownership and funding questions, the most crucial aspects of district heating development.

Table of Contents

Summary of Contents

This Guidebook was written to help communities evaluate the feasibility of local district heating and to guide proponents through the development process.

Section 0.0 District Heating Development: An Overview highlights the major activities involved in such a project.

Section 1.0 Independent Assessment is the first step communities take in the process. A questionnaire is provided to help proponents evaluate local conditions for district heating.

Section 2.0 Feasibility Screening provides a step-by-step method for estimating the capital investment costs of a district heating system proposed for a specific community. These procedures enable a community to make an invaluable early assessment of the economics of their proposed system and begin a detailed investigation and determination of the characteristics of each development component.

Section 3.0 Planning And Conceptual Design describes how to plan and design a district heating system. This section also describes how a community acquires the engineering, economic, and financial expertise required for this and subsequent phases.

Section 4.0 Design/Construction/Operations outlines special considerations for final design, construction and operation of your system.

Section 5.0 Ownership And Operational Control Options reviews in detail the various system ownership options available to communities. It describes the primary criteria for selecting the most suitable alternative as well as additional considerations regarding the options for the separate system components. With this basic information, communities may begin to assess the best ownership option for their particular circumstances.

Section 6.0 System Funding Strategies summarizes the various funding sources for district heating development. It examines in detail the more promising funding options available for each development phase. With this information, communities may begin planning their own funding strategies and defining the detailed requirements of the proposed funding sources.

Section 7.0 Appendices is a collection of materials applicable to community planning and development of district heating systems.

0.0 District Heating Development: An Overview

District Heating Planning & Development Matrix

	Planning & Development Phases				Implementation Phases	
Development Components	Independent Assessment	Feasibility Screening	Planning & Conceptual Design	Detailed Design & Commitment	System Construction	System Operations
Organization						
Heat Loads						
Heat Sources						
Distribution Systems						
Building Heating System Conversions						
Economic Analysis						
Marketing						
System Ownership						
System Funding						
Environmental Assessment						

This section provides a basic overall understanding of the district heating development process. It introduces the *planning and development process*, the sequential *phases* of development, and the *components* which represent the principal areas of development activity.

0.1 District Heating Development

The development process is represented graphically in the preceding "District Heating Planning and Development Matrix". The phases, or time stages, of district heating development are listed across the top of the matrix.

Each development phase has a purpose:

System Planning And Development

- *Independent Assessment* — a no-cost evaluation of the favorability of local conditions for district heating
- *Feasibility Screening* — a preliminary assessment of the feasibility of a proposed district heating system
- *Planning and Conceptual Design* — preliminary project design and development and feasibility assessment
- *Detailed Design and User Commitment* — completion of detailed system design and planning; final assessment of development feasibility; and commitment to system construction and operation

System Implementation

- *System Construction* — installation and physical implementation of system design and plans
- *System Operations* — startup and operation of district heating system

This incremental development process contains interim feasibility checkpoints at the end of the first four phases. With each succeeding phase, the information, resources, commitment required and the test of feasibility become more specific.

This Guidebook concentrates on the first three phases: **Independent Assessment, Feasibility Screening, and Planning and Conceptual Design.**

0.2 Development Components

Development components, or principal work areas, are listed on the left side of the matrix. Each component is crucial to a successful district heating project. Some tasks involved with each component must be completed at or about the same time. In this way, all components are developed in a consistent manner.

0.2.1 Organization

The organization involves project management, participants and planning.

Project management should be the responsibility of the entity that will likely own and operate a completed district heating system. Until that entity is identified, however, project management responsibilities may temporarily reside with the proponent group or with the municipality or some municipally designated committee or commission.

Solid project management experience is a prerequisite for undertaking district heating development. Knowledge or exposure to district heating must be developed, acquired or retained before proceeding far into the development process. The project manager will be required to organize and coordinate many activities:

- engineering studies and design
- economic feasibility analysis
- marketing studies
- financial/investment analysis
- public relations/information dissemination

Community district heating development involves many participants with different roles, responsibilities and interests. It requires customers, investors, developers, owners and operators.

Each prospective participant has their own objectives that may conflict with others' interests. These objectives determine the goals for a successful district heating development project. Therefore, a cooperative effort is essential to mutually satisfy participants.

Community district heating development also affects many people and organizations. They all should have the opportunity to participate in its planning and development. The many diverse local interests should be represented in the development process.

Formation of an advisory or steering committee with broad representation is an effective way to hear all sides. There already may be such a group in the community that would be appropriate for this project.

General community support is necessary to the extent that the general public is affected by the system. Obviously, end users are directly affected, but consideration also should be given to neighboring businesses and residences. They may be future users plus they are likely to be affected by any construction activity and disruption. At the very least, they are taxpayers who deserve to participate in community development decisions.

Local municipal government involvement is important. Its support and cooperation is essential for a successful district heating system. Ideally, local government should take an active, if not the lead, role in the development process.

Community district heating development also requires significant specialized knowledge and expertise that communities may not have locally. Therefore, the selection and use of appropriate consultants and resources will have a major impact on the development process.

Before a district heating system returns its first operating revenues, substantial investments of planning resources and construction capital must be made. The organization of the development process, therefore, must be thorough and methodical to ensure that these commitments to future benefits are made wisely. These commitments require the community and the separate participants to assume the risk that the system will be feasible and will be implemented.

0.2.2 Heat Loads

The heat load for a building is the amount of heat needed to keep the building warm on the coldest day. The heat load must be known when conventional heating systems are installed in order to properly size the furnace. A typical residence, for example, may require about 100,000 BTU/Hr. (British Thermal Unit per hour) or, equivalently, 30 KW (kilowatts) of heat.

The heat load for a district heating system is comprised of total individual heat loads of those prospective end users such as the space heating needs of residential, commercial, industrial buildings, and agricultural and industrial plants process needs.

0.2.3 Heat Sources

Heat sources are boilers which use the combustion of various fuels to produce the thermal energy (heat) used in the system. Although such heat sources most likely would be used in new district heating systems, almost any energy source may be used for the relatively low temperatures required in hot water district heating. It is possible to use geothermal energy, solar energy, nuclear energy and varieties of so-called waste energy.

0.2.4 Distribution Systems

The distribution system is comprised of pipes that carry heat from the central heat source to the individual buildings.

There are two common heat distribution systems - steam and water. In a steam system, heat is supplied to the buildings by the condensation of the steam. The condensate may be returned through a second pipe or disposed of through the sewers. Both types are used today.

Steam may be useful in some industrial processes and is often attractive from the building owners viewpoint because onsite equipment may be cheaper. However, on a system basis, steam distribution is being superceded by hot water.

Hot water distribution systems are similar to the hot water heating systems found in many homes. One pipe carries hot water from the heat source (furnace) to the individual buildings where it is used to heat radiators. It is then returned through a second pipe to the heat source for reheating and reuse.

0.2.5 Building Heating System Conversions

The conversion is the addition, modification, renovation and hookup of a building's mechanical, electrical, and control system to use district heating thermal energy. To use thermal energy from a district heating system, a building may be equipped with a heat exchanger. It transfers thermal energy from the distribution medium--hot water or steam--to the medium used internally, most likely hot water, steam or forced air.

0.2.6 Marketing

The marketing component of the development process includes two elements: (1) promoting the general concept of district heating and (2) attracting potential customers.

General public support is often necessary for planning and implementation. Therefore, it is important that the public have information on costs, benefits and potential barriers to make proper decisions about district heating.

Secondly, successful and efficient systems depend upon attracting customers with sufficient heat loads. The marketing component of each phase involves activities intended to obtain commitments from potential customers.

0.2.7 System Ownership

This component considers who will own and operate the proposed district heating system or its parts. It involves determining who may be willing to accept the responsibility of ownership and operation, who can obtain needed funding and who can operate the system most efficiently for the benefit of customers and the general community.

Section 5.0 Ownership and Operational Control Options describes various options in detail.

0.2.8 System Funding

This component determines appropriate funding for planning and implementation. Funds are needed for each phase, ranging from relatively small amounts for the feasibility screening phase to the substantial investment needed for system construction.

Section 6.0 System Funding Strategies outlines both funding sources and their application to various development phases.

0.2.9 Economic Analysis

District heating project feasibility is largely determined by its economics. The economic analysis required is a cost/benefit comparision with the more common alternative heat sources for buildings, domestic water, and industrial uses. Favorable long-term cost benefits are essential for district heating to be a viable investment. Successful financing and marketing of the system may necessitate a favorable cost/benefit analysis for the short term as well.

The costs associated with a district heating system are heat source energy costs, system construction costs, conversion costs, financing charges and operating expenses. These costs are further determined during the planning and development process. This makes comparisons possible with the projected costs of alternate heat sources. (Although cost comparisons always will require price projections which are speculative, reasonable assumptions can be made to estimate the cost/benefits.)

This analysis must be done for the system as a whole and individually for each part.

Other potential costs and benefits, such as dependability, safety, and impact on economic development and revitalization, also require consideration.

0.2.10 Environmental Assessment

The environmental impact of each district heating development project should be assessed and cleared through normal regulatory channels.

District heating is normally recognized as an environmentally beneficial technology. Its primary impact relates to air quality and to activities during system construction. If cogeneration can be used as the heat source, the heat normally rejected to the environment also can be substantially reduced. The environmental impact of the construction phase depends on the location of the heat source and rate of distribution system development. These impacts are usually short term and can be minimized with proper management. The impact on air quality is long term and should be addressed.

Efficient district heating normally will mean reduced fuel use. This is particularly true in communities where there is a significant amount of electric heating. Since district heating can use various fuels, it can often mean a change in the type of emissions. For example, a community with primarily natural gas heating that converts to a coal-fired district heating system may increase the emissions of some environmentally objectionable products. This, however, has not proved to be a significant problem even in an environmental nonattainment area such as St. Paul.

A central heat source allows emissions to be more effectively controlled and dispersed at a higher altitude. Unless a district heating project has unusual characteristics, it will not be hampered by environmental obstacles.

The State of Minnesota has simplified the environmental approval process. The environmental assessment worksheet (EAW) was developed to quickly determine whether the more detailed environmental impact statement (EIS) is necessary. Preparation and review of the EAW should take less than six months. However, preparation and review of an EIS can often take a year or more. With most district heating projects, the EAW will confirm there is no need for an EIS.

A sample EAW and more information is included in the Appendices. Anyone needing assistance should contact the Department of Energy, Planning and Development. It is recommended that the Energy Division of EPD, be contacted prior to completing an EAW, since pending legislation may affect the environmental assessment process.

0.3 Feasibility

Feasibility assessment determines whether design concepts result in a system which makes sense technically, is financially possible and will provide cost or other benefits to the potential users and the general community. Project feasibility must be reevaluated during each phase of the planning and implementation process as more detailed information is obtained regarding heat loads, construction and operating costs, users' interest and commitment, funding availability and terms, and other factors affecting the likely success of the system.

Although feasibility assessment continues throughout the entire planning process, there are several formal checkpoints:

1. **Independent Assessment.** Feasibility is initially evaluated in this phase.

2. **Feasibility Screening.** The second test is based upon estimated capital costs and an initial evaluation of development options and alternatives.

3. **Planning And Conceptual Design.** Feasibility assessment is based on detailed cost estimates and project-specific decisions and assumptions.

4. **Detailed Design And User Commitment.** If a project is found to be feasible here (based on final detailed project cost estimates and with nearly complete project definition), bids may be solicited and contracts awarded for system construction.

There are several important factors to consider when determining feasibility:

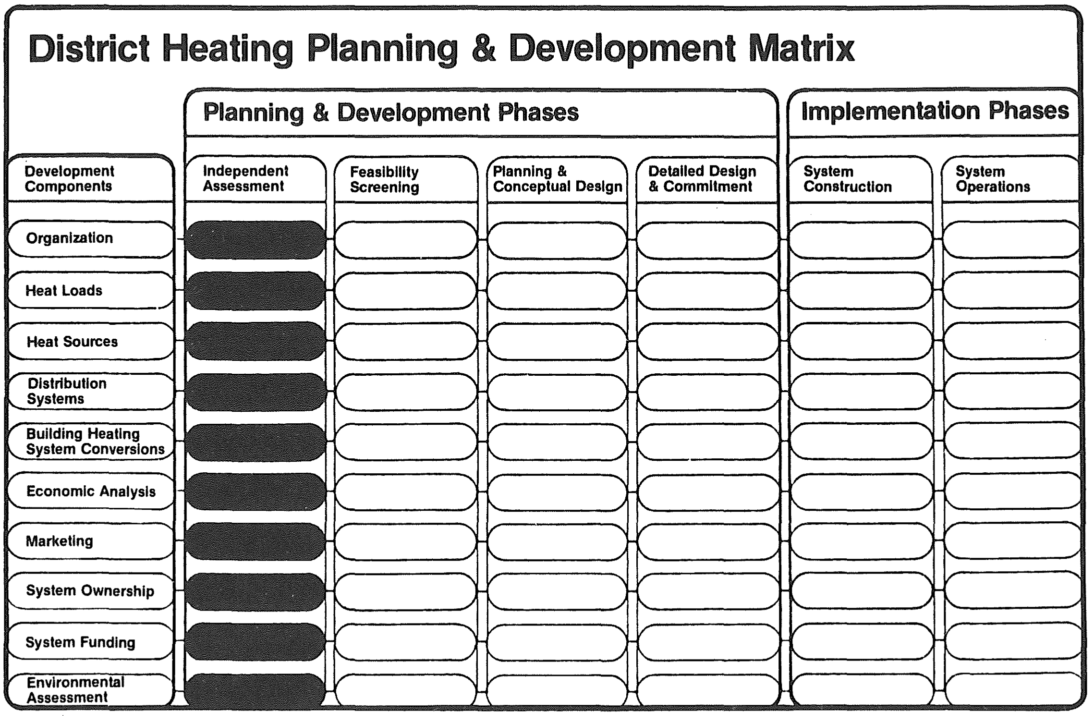
- Feasibility is relative to the current time frame. A project which is not feasible now may become feasible in the future because of changing factors. Conversely, current feasibility does not guarantee future success.

- Feasibility strongly depends upon forecasts for fuel costs, interest rates, energy usage and conservation rates, alternative energy costs and availability, as well as estimates of capital expenditures for construction. Forecasts will never be exact. Thus, developers must accept the risk that district heating may not provide energy at lower cost than any present or future technology.

- Fortunately, technical feasibility is not a problem. With the proper engineering expertise, any Minnesota community can install a working district heating system.

The question of feasibility also concerns matters beyond economic and technical questions such as long term goals related to the construction of the district heating system and to community and cultural factors. Community services often are extended to members of the community for reasons other than economic gain. District heating service is likely to be viewed in the same manner. The community should consider both the positive and negative aspects that district heating might bring to the community beyond the narrow prospects for short-term economic considerations.

1.0 Independent Assessment



With a basic understanding of **District Heating Development**, a community may now begin planning a district heating project.

Section 1.0 describes the Independent Assessment; how community organizations can be involved and how to evaluate local conditions for district heating.

The Independent Assessment Questionnaire is a useful tool and has been included to assist communities with this task.

1.1 What is Independent Assessment?

Independent Assessment is a general and nontechnical survey of the community characteristics and local conditions that affect district heating development. It is conducted locally using only community resources and personnel.

Independent Assessment will help community leaders gain further understanding of district heating as it relates to their community. It will give a preliminary indication of whether it is practical to proceed with the development process.

The cost to the community for this independent assessment is the donated time of individuals and organizations that participate. It can be accomplished comfortably in less than one month. It does not require professional consultation.

1.2 Methodology

Independent Assessment consists of two steps:

1. Determine whether local conditions and characteristics favor district heating development.

2. Seek a local commitment for the continued investigation of district heating.

The first step consists of evaluating the local factors that significantly affect project feasibility. Even without knowledge of or experience with district heating, a community may make this independent assessment using this Guidebook. The development matrix leading this Section identifies important factors for consideration. Further explanation is found in Section 1.3 Development Components. The Independent Assessment Questionnaire found in Section 1.4.

One way to complete this initial evaluation is to assemble a group of knowledgeable and influential members of the community to collectively address the Independent Assessment Questionnaire. This group should represent the spectrum of community interests and include at least those people that are likely to be directly affected.

This meeting should be used to familiarize community leaders with district heating development and its potential, to generate discussion and interest, and to assess the possibility of local district heating development. Arrange for a speaker that understands district heating. Provide descriptive handout material. Use the Independent Assessment possibilities and benefits. Favorable reaction from these people is critical to further development.

The second step of Independent Assessment also may be initiated at this meeting. You will need to know how much interest in this project exists in your community because the next phase, Feasibility Screening, requires personnel and financial resources plus official municipal endorsement. (See Section 2.0)

1.3 Development Components

There are several major Development Components that must be considered during this assessment. Information gathered about them will be speculative and soft (without substantial documentation), but it will be pertinent to the decision-making process.

The following sections outline considerations for each component. A basic description and general discussion of each component is found in Section 0.2.

1.3.1 Organization

No formal organization is necessary to complete **Independent Assessment**. It is essential, however, to bring together for discussion all the diverse local community groups, organizations, and interests that may be affected. This broad spectrum is necessary for a proper assessment of local interest and conditions.

Participants should include district heating proponents, elected municipal officials, private or municipal utility representatives, prospective major customers, business or chamber of commerce representatives, municipal government staff, interested professionals, community leaders, labor and contractor officials, members of the financial community, developers, and other interested parties.

Leadership and management of this initial phase likely will fall on the district heating proponents. If a community already has an energy advisory committee, it may appropriately make this initial assessment.

The planning group also should consider the most appropriate organizational structure for the **Feasibility Screening** and **Planning and Conceptual Design** phases. The responsibility for these phases may be an organization which potentially may own or operate the system.

1.3.2 Heat Loads

A district heating system requires customers. Therefore, it is important here to identify the large heat loads that represent major potential customers. These include larger industries, hospitals, schools and larger businesses. These loads will have more impact on system feasibility than the numerous smaller loads and therefore should be singled out for greater attention.

Both existing and planned buildings should be considered. Buildings that require substantial heating system modification to connect with district heating should not be excluded.

Planned construction should receive particular consideration since building equipment then could be designed specifically for connection.

1.3.3 Heat Sources

A district heating system requires one or more primary generating sources for the thermal energy it distributes to its customers. The sources may be either existing systems modified to supply thermal energy or new plants built specifically for district heating.

Currently, the most promising heat source is an existing coal-fired electrical generating plant modified to extract thermal energy for the district heating system. Some excess or unused capacity in the generating plant is necessary, however, for its use.

Other existing or planned heat sources in the community such as underutilized boiler capacity or incinerators may also be possible system heat sources.

1.3.4 Distribution Systems

The network of pipes that distributes thermal energy from the source to district heating customers is usually the single most expensive part of the system. If more customers are located closer together, distribution costs are reduced and the entire system is more feasible.

It is best to have one or more major users rather than numerous smaller customers who could jointly equal that demand. A major user requires fewer connections than several smaller customers, again reducing costs.

A final consideration is physical and geographical barriers. Obstacles encountered in underground pipe laying will increase the cost of installation. Other utilities, substantial rock, or ground water may hamper construction. Physical features such as rivers and lakes present obstacles that are expensive to cross or go around. Right-of-ways and easements for major highways and railroads also present considerable difficulties in crossing.

1.3.5 Building Heating System Conversions

During **Independent Assessment**, it is too early to investigate individual buildings. It is possible, however, to note any significant general patterns in building heating systems, their type, age or condition.

The need to replace individual furnaces, for example, may be eliminated by switching to district heating. The need to modernize internal building heat distribution systems reduces the total additional cost of implementation. If a major potential customer plans to upgrade an antiquated system, it may be even more economical to connect to a district heating system.

If an existing district heating system is deteriorating or may be abandoned soon, the option of a modern or thoroughly refurbished system may be more economical than installing and operating many individual boilers and furnaces.

1.3.6 Marketing

During **Independent Assessment**, two factors should be considered:

1. the community's knowledge of and interest in establishing a district heating system; and

2. the capability of a district heating system to provide heating at a lower cost.

The community should be aware that a district heating system is under consideration. Therefore, it is important that all potentially affected interests become involved at this early stage.

Particular emphasis should be placed upon major potential users who tend to be most concerned about energy costs and already may be investigating methods of containing those costs. The participation of one major customer or decision-maker may be the difference between success and failure.

Successful future marketing will depend upon the system's capability to provide heat at a lower cost than existing or potential alternative sources of energy. Therefore, existing energy sources used by the community and potential alternative energy sources should be identified. Cost projections for current energy sources can be reviewed to determine the likelihood of a district heating system providing cost benefits over a short term or long term.

1.3.7 System Ownership

Most communities can consider several options for the ownership and/or operational control of a district heating system. During **Independent Assessment**, it is appropriate to identify prime candidates, but it is not necessary to make a final choice.

If there is an existing system or if the likely heat source is owned or operated by a municipal or private utility, proponents should explore the willingness of that utility system to own or operate the proposed system as well. Their involvement is most advantageous.

More information about ownership options is found in Section 5.0.

1.3.8 System Funding

The primary focus of the funding activities during **Independent Assessment** will be on determining the types and amount of funding, staffing, and technical assistance needed for **Feasibility Screening**. The following potential funding sources may be explored:

- *Federal Grants.* It is doubtful that any federal Department of Energy grant funds will be available for planning district heating projects. However, it may be possible to use other federal grant funds in the planning process. These include Housing and Urban Development (HUD) community development block grants, HUD urban development action grants (UDAG), and if the agency is still in existence and funded, economic development or public works grants from the Economic Development Administration.

- *State Grants.* The State of Minnesota has $200,000 for district heating preliminary planning available to municipalities in Fiscal 1982. The amount of each grant is limited to 90 percent of eligible planning costs and must not exceed $20,000.

- *Special Governmental Funds.* A review should be made of any special governmental funds such as Iron Range Resources and Rehabilitation Board (IRRRB) grants which may be available to communities located in proximity to taconite mining operations.

- *Municipal.* Funds and staff time may be provided by a city or its public utilities commission.

- *Foundations.* Grants may be available from some private foundations. Locally based foundations including those related to local industries, should be contacted.

- *Potential Users.* Major potential users can be contacted to determine their willingness to provide funds or staff time to assist in the planning process.

- *Business and Community Groups.* Business and community groups such as the Chamber of Commerce, downtown councils, social service clubs and other community groups may be potential funding sources for the planning process.

In addition to funding sources, staff time and technical assistance may be available from a variety of sources including the Department of Energy, Planning and Development, regional planning commissions, private or municipally owned utilities, the city, the county, other cities operating district heating systems, major potential users, local industries, universities, colleges, or vocational-technical schools, or the staffs of community organizations.

Additional information about system funding is found in Section 6.0.

1.3.9 Economic Analysis

An early economic indicator of district heating feasibility for a community is a significant existing or projected price disparity between the predominant fuels or energy forms currently used and the fuels anticipated for use in a proposed district heating system. Such a price disparity would result in significant operational cost savings arising from fuel substitution alone, without considering the additional opportunities for improved energy conservation measures.

A local fuel source that is economically competitive (such as waste products from an industrial process or the incineration of solid waste) may also enhance the prospects for district heating development. To be viable, these energy sources should already have demonstrated their own technical and financial feasibility.

1.3.10 Environmental Assessment

An evaluation of environmental impact is not a factor at this stage and, therefore, requires no special consideration.

1.4 Independent Assessment Questionnaire

Now that you are familiar with the major considerations for the district heating components, you can complete the Independent Assessment Questionnaire.

This questionnaire can be used in the community, without professional assistance, to determine if local conditions favor a district heating system. This is a good first step to complete before spending a lot of time and money for further planning and development.

A broad cross section of community leaders and citizens, including leaders from municipal, community, financial, and business interests, should complete this questionnaire jointly.

After completing the questionnaire, total the yes and no responses. If there are ten or more positive responses, the community is justified in proceeding with development. If there are fewer positive responses, district heating development is less promising and perhaps should not be pursued. (This is, however, a subjective response and perhaps the interest and discussion generated may be of greater value than the numerical response.)

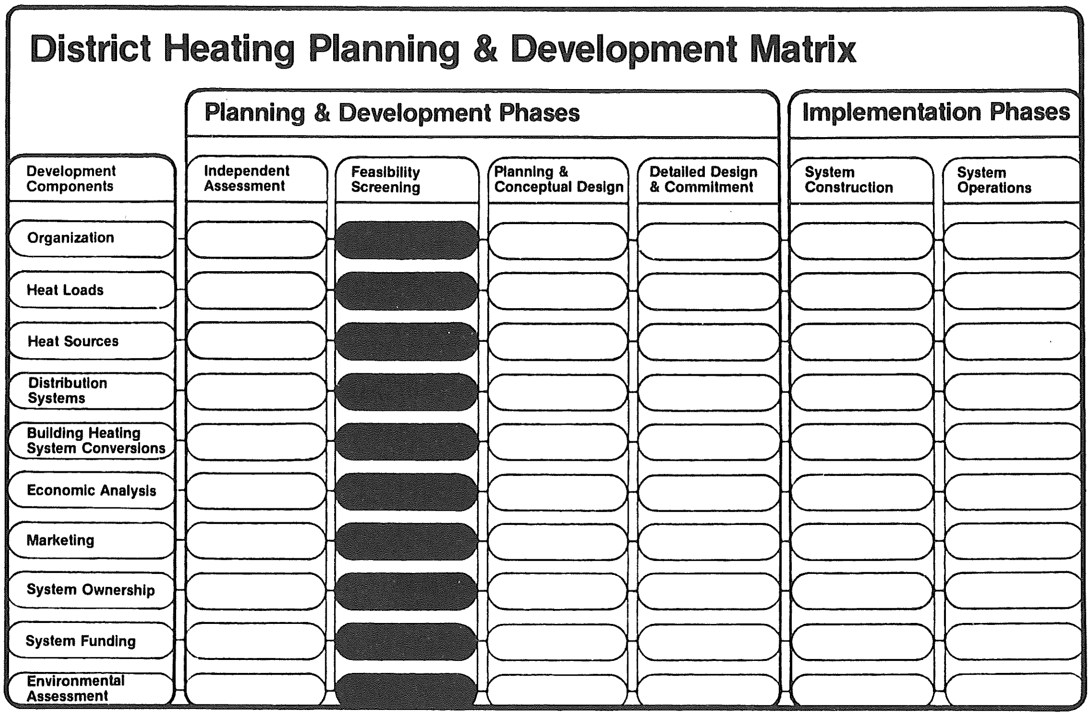
	More Favorable	Less Favorable
Does your community have one or more large users of thermal energy for space heating, water heating or processing?	Yes ☐	No ☐
Is there major new construction or development planned or underway in your community?	Yes ☐	No ☐
Is there an electrical generating plant in or near your community that offers the opportunity for cogeneration of electrical energy and thermal energy?	Yes ☐	No ☐
Are there existing or planned heat sources in or near your community that may be possible sources of district heating thermal energy?	Yes ☐	No ☐

	More Favorable	Less Favorable
Do any existing or planned local heat sources have excess or potential excess capacity to dedicate to local district heating thermal energy production?	Yes ☐	No ☐
Are most of the major potential customers and large thermal energy users located close together?	Yes ☐	No ☐
Is there a single or small group of thermal energy users that comprise a significant proportion of the community's total thermal energy load?	Yes ☐	No ☐
Is the primary heat source located within one mile of the major concentrations of potential customers?	Yes ☐	No ☐
Are there any significant physical or geographical barriers that divide or present difficulties in serving the entire potential heat load?	No ☐	Yes ☐
Are there any thermal energy users that are planning to replace and/or upgrade their internal heating systems in the near future?	Yes ☐	No ☐
Is there an existing deteriorating district heating system in the community that may be abandoned?	Yes ☐	No ☐
Are community officials and other influential local people interested in district heating? Do they support it?	Yes ☐	No ☐
Does a possible district heating system permit the substitution of a significantly lower cost for higher priced, currently used fuels?	Yes ☐	No ☐
Do major thermal energy users in the community know about district heating and understand its comparative advantages?	Yes ☐	No ☐
Does the community have an existing district heating company or utility?	Yes ☐	No ☐

	More Favorable	Less Favorable
Does the community operate a municipal energy utility system?	Yes ☐	No ☐
Is there private developer interest in district heating development?	Yes ☐	No ☐
Is the community free of other major capital investment projects that might limit the capital availability for district heating development?	Yes ☐	No ☐
Is the municipal government readily able to raise the capital necessary for district heating development either through its bonding capability or its tax base?	Yes ☐	No ☐
Does the community have an economically viable and technically feasible alternative energy source?	Yes ☐	No ☐

	More Favorable	Less Favorable
Total Number of Responses	________	________

2.0 Feasibility Screening



Having determined through **Independent Assessment** that local conditions appear favorable for district heating, proponents can now proceed to **Feasibility Screening**. This phase requires a more thorough examination of the factors previously explored.

Section 2.0 **Feasibility Screening** provides a step-by-step method for roughly estimating the capital investment costs of a district heating system. This estimate is critical since capital costs represent such a major investment.

This section also outlines how a community can investigate each development component.

2.1 What is Feasibility Screening?

The **Feasibility Screening** phase is a low-cost overall review of community conditions and their impact on district heating development. Options and alternatives are identified. Factors for a successful district heating project are more fully explained. Cost estimates are extremely useful during this phase, but should not be used after this step because they are only approximations.

The purpose of this phase is to determine whether a project is feasible as early as possible. The project will meet the criteria if:

1. the estimated capital costs are comparable to those of other Minnesota district heating projects; and

2. there are no major obstacles that would seriously limit or prevent the system's success.

Although the evaluation during this phase is qualified and relative, it is important. This brief, inexpensive and comparative measure of feasibility will add substance to requests for resources to continue the planning and development.

2.2 Screening Methodology

The methodology for **Feasibility Screening** consists of two parts. The first part compares the economics of a proposed district heating system to systems in other Minnesota communities. The second part is the definition of viable options, alternatives and opportunities for system ownership and funding. (The process also will identify options that are not possible plus other potential obstacles and constraints.)

The following tasks are required to arrive at capital costs estimates:

1. Heat loads — Estimate individual building heat load requirements. Identify on a map the geographical areas of greatest heat load concentration or highest heat load density.

2. Heat sources — Identify potential primary heat sources. Determine the willngness of the sources' owners to participate. Estimate the capital costs of expanding, renovating and converting these sources.

3. Balancing — Define several geographical service areas with a total heat load that is approximately equal to the capacity of the proposed heat sources.

4. *Distribution systems* — Develop capital cost estimates for piping to distribute thermal energy to end users.

5. *Building heating system conversions* — Develop capital cost estimates for the end user building conversions.

6. *Economic analysis* — Add together the separate component cost estimates for the total system cost. Compare with the range of equivalent values for other communities.

7. *Fuel source substitution* — Identify potential savings and problems for substituting a more abundant and less costly fuel source for one that is scarce and more expensive.

The following areas are reviewed in the second part of **Feasibility Screening**:

1. *System ownership* — Determine if there is a logical ownership selection. Identify the realistic ownership alternatives.

2. *System funding* — Identify funding options for system construction. Identify and secure funding sources for system planning.

3. *Marketing* — Determine whether major users are willing and interested in participation. Assess the interest of the entire community and of potential user groups.

4. *Organization* — Define the group or organization that will assume project management responsibilities, either on a permanent or temporary basis. Define and implement a plan to ensure community participation for at least those persons and organizations that are directly affected by this district heating development. Develop and implement a public information program.

5. *Environmental analysis* — Identify potential difficulties or constraints to system development.

2.3 Development Components

2.3.1 Organization

Project management responsibilities should be assumed by the logical future district heating system owner/operator or interest, such as an existing private or municipal utility. If there are several options, either the municipal government or a municipally designated agency or commission may be the most appropriate group to assume temporarily the project management responsibility until an ownership selection is made.

The following groups and interests should be involved in this phase: the local adhoc group or other public or private entities assuming responsibility for local planning; local engineering, economic, financial, and legal expertise; local utilities, and major potential customers. The *Energy Planning Guide for Minnesota Communities* from the Department of Energy, Planning and Development, is a good resource for community organizations.

Initial project management responsibilities consist of identifying the organizational and planning requirements for **Feasibility Screening** and outlining requirements for following development phases. Factors to consider include budget, schedule, resource availability, work scope, and task assignments.

Resources must be secured to support the initial work efforts. It is important at this stage to secure a formal commitment of interest and support from municipal government in the form of an official resolution or order.

Estimated time for **Feasibility Screening** is one to six months. Estimated costs range from $5,000-$30,000 depending on the size of the community and the complexity of local conditions. This would include the value of donated and volunteer time.

2.3.2 Heat Loads

The thermal power requirements, or building heat loads, of the end users must be known to determine all subsequent technical and economic calculations. The maximum thermal power requirements of the users (the rate energy is used during the period of maximum use), must be known in order to size both the piping system and the heat sources.

Building loads may be approximated from building floor areas. Structural base maps showing outlines of the buildings, often available from the building or planning departments or the assessor's office, may be used to calculate heat loads. Measure the ground area from the map and multiply it by the number of heated stories of each building. Compute the heated floor area. Multiply this figure by ten watts per square foot.

For example, a 2,000 square foot home (excluding the basement) would have an estimated heat load of 2,000 square feet x 10 watts per square foot or 20,000 watts (20 KW).

Maximum thermal power requirements for end users may also be determined through two other basic, but more rigorous, paths. The first way is to analyze past energy consumption records. The second way is to analyze the building envelope itself (walls, roof, doors, windows, etc.).

If you use the first method, you must obtain energy consumption records from current suppliers or building operators by interviews or questionnaires. These records include gas bills, electric bills and oil delivery records.

With the annual energy consumption data provided by these records, an estimate may be made of the maximum thermal power requirements. This estimate normally will require an estimated energy conversion efficiency and estimated effective annual load factor, often taken as 2,000 hours in Minnesota. The thermal load requirement for a building may be estimated as the annual fuel input times the energy conversion efficiency times the ratio of 2,000 divided by the number of hours in one year.

The accuracy of this method depends on an estimate or knowledge of the heat source conversion efficiencies, accurate information on fuel consumption, and the assumption that the building will not be modified or reconfigured in a way that would affect future fuel consumption rates.

The second approach is the analysis of the building envelope. Information on building size, construction, windows and use are combined to calculate peak thermal power requirements. This method normally requires engineering expertise. The building may be analyzed based on its expected configuration rather than its present configuration.

In analyzing heat load, it is wise to survey an area larger than that expected to become the initial service area. The **Feasibility Screening** phase may appropriately include the investigation of different service areas and different sections of the community.

Nonheating or process loads must be treated individually for two reasons. First, it is impossible to generalize the energy consumption needs of industrial and process loads. The best approach for estimating these loads is to contact the plant or process owner/operator. If the present load is known in pounds of steam per hour, it may be converted to kilowatts by dividing the pounds per hour by 3.4.

The second reason for individual estimation is that some industrial and process loads will not be suitable for conversion to district heating. It is best to defer consideration of industrial and process load suitability until the next phase. Any industrial or process load identified during this phase should be assumed to be a potential load contingent upon further analysis.

2.3.3 Heat Sources

Sources of thermal energy for district heating systems already may exist in your community or they may have to be constructed. Heat sources are needed for the prime heat load, peaking of demand, and emergency standby.

2.3.3.1 **Existing sources.** Existing sources can serve two purposes in a system. First, they can provide the base load or prime source for heating. Second, they can provide peak or standby capacity during periods of high heat demand or outages of the base unit.

Any existing power plant or large fuel consumer (relative to the overall size of the community) should be considered as a potential prime heat source. The type of plants to consider include:

- *Electrical generating plant.* Any power plant within 5 miles of the community should be considered if it is coal or wood fired. This may be the best source.

- *Oil-fired power plants.* A number of these power plants have operated as district heating sources in Minnesota, primarily as peak power suppliers. A community with an existing diesel or dual fuel power plant might consider this option. Gas turbine plants will not be good sources due to the cost and/or availability of their fuel.

- *Coal-fired plants.* There are few usable coal-fired heat sources in Minnesota other than electrical generating plants and existing district heating plants. Any active coal-fired device should be considered, because of fuel economics.

The best existing heat source for the prime load will often be a coal-fired electrical power plant. An estimate of the potential thermal power available from existing coal-fired electrical power plants can be made by assuming it to be equal to the plants' rated electrical output.

The advantages of existing coal-fired electrical plants are unlikely to be duplicated by other existing sources. These include fuel flexibility and a utility design emphasizing reliable continuous service. Reliability is an important consideration for a potential heat source.

At this level of investigation, it is safe to assume that any coal-fired power plant is a technically feasible source for district heating.

The best information regarding potential heat sources comes from the owners and/or operators of the plant. These individuals have information on the overall size, condition, fuel costs, and other matters.

General types of information to be obtained from owners/operators include:

- *Size*
  - KW electrical output
  - Lbs/hr. steaming capacity
  - Fuel consumption
    - Max/hour
    - Annual
- *Type of Fuel Burned Now and Before*
  - Emission regulation status
  - Future plans
  - Expected lifetime
  - Excess capacity

With the cooperation of the owner/operators, it should be possible to estimate costs for conversion. Without their cooperation, only rough estimates may be made since every plant will require specific evaluation. Recent evaluations of various power plants in Minnesota show a cost range of $20 to $50 per kilowatt of heating capacity for conversion. These numbers may be used with the understanding that specific investigations should take precedence.

Almost any existing heat sources within the service area can be used for peak standby: the boilers in a hospital, school or other large buildings may be adapted as peak or standby units. The type of fuel used does not matter as long as availability is guaranteed. These boilers do not need to be investigated in detail at this time.

The Department of Energy, Planning and Development can provide a list of large combustion devices which may be suitable as heat sources (the "N.E.D.S." data file). Neighboring counties with potential heat sources may also be contacted. For potential smaller local sources, the simplest check is to look for stacks.

Other possible existing heat sources include:

- Existing underutilized boilers (e.g., old creameries—these can be quantified by the available capacity and fuel used as well as physical descriptions.

- Industrial boilers are difficult to quantify due to the process, their sometimes proprietary nature, seasonal variations, and too low temperatures.

Important factors to consider regarding potential heat sources are:

- *Thermal Requirements:*

  - Medium (steam, water)
  - Temperature
  - Peak load
  - Annual consumption
  - Peak supply
  - Fuel
  - Reject conditions
    - Medium
    - Temperature
  - Daily cycle

- *Ideal conditions include:*

  - Coal/wood fired (low cost fuel) boiler
  - Summer use only (as either a load or a source this type of cycle will improve economics as a load and provide capacity for heating as a source)
  - Peak supply ~ load-excess capacity
  - Reject energy - 10 psi steam (as a source)
  - From 95 - 200 F water (as a load)

Seasonal variations can be beneficial or detrimental depending upon the situation. These sources should be investigated and considered potential consumers as well as suppliers.

2.3.3.2 **New Sources**. It is acceptable to use generic cost figures for new sources, realizing that inflation and local building conditions will affect these costs. New oil and gas-fired boilers will probably cost approximately $10 per pound per hour of steaming capacity.

Small coal and wood-fired boilers will probably cost between $50 and $100 per pound per hour of steaming capacity, while large coal-fired units may cost between $100 and $125 per pound per hour of steaming capacity. (All costs are in 1981 dollars.)

Federal new source performance standards for emissions take effect at 250,000 pounds per hour of steaming capacity. Units of this size or units planned for this size or larger will require significantly more complex and expensive emission control equipment. While economies of scale would normally dictate lower costs for larger units, it is likely that the smaller coal—and wood—fired units actually will be less expensive than the larger units. All values may be multiplied by 3.413 for the cost per kilowatt installed. The costs of these units do not reflect any electrical generating capacity (these are not cogenerating heat sources).

The decision to consider cogeneration is essentially an economic one, depending on the cost of producing electricity and the local market for electricity. It is recommended that this consideration be deferred until the next phase since it is unlikely that economic benefits from cogeneration will be of a magnitude to alter significantly the feasibility of the overall project.

2.3.3.3 **Balancing Loads and Sources.** With information on existing heat sources and heat loads, it is possible to make a first attempt at balancing the loads with the sources. The following considerations may reduce the number of possible service areas and source combinations to a manageable number. Basic rules to use are the following:

1. Do not consider new sources if existing sources are available. A first estimate on the size of the service area may be one that can be appropriately serviced by the existing sources.

2. A new heating source may be constructed to serve any size load desired. Economies of scale generally favor larger units and larger loads. If a new heat source is required it will not limit the service area.

3. Consider areas with the highest heat load density first followed by surrounding area. Areas closest to the source and transmission lines also may be considered as prime candidates, since the distance from the heat source and the routing are important.

2.3.4 Distribution System

When a rough idea of the service areas is known, piping cost estimation may begin. A reasonable approach is to consider several alternatives ranging from large to small within the limits of the service area chosen.

First Estimate

1. Draw the *smallest* diameter circle that will encompass all of the proposed loads - measure its diameter in miles.

2. Find the sum of the loads to be served in MW.

3. Add up the number of customers.

4. Measure the distance from the heat source site to the center of the circle drawn in (1).

5. Add the following values:

(diameter, in miles)^2	= $
(load in MW) x (180,000)	= $
(number of customers) x (2,000)	= $
(distance of source, in miles)	=
x (700,000) x (load/50)	= $
Total Piping Cost	= $

Take, for example, the following data for City A:

General Information

- Approximately 15,000 population
- The downtown is chosen for the initial service area
- There is a 30 MW(e) power plant 1.5 miles from the city
- In the downtown area there are approximately 50 customers or loads totalling 12.5 MW(t).
- This service area can be completely circumscribed by a circle .7 miles in diameter, the center being 1.72 miles from the plant.

Calculation of piping cost:

(diameter)^2 x 100,000	
(.7 mi)^2 x 100,000	=$ 49,000

(heat load) x 180,000 (12.5 MW) x 180,000	=$2,250,000
(# of customers) x 2,000 (50 customers) x 2,000	=$ 100,000
(distance to source) x 700,000 x load (1.72 mi) x 700,000 x 12.5 MW	=$ 301,000
Total Piping Cost:	=$2,700,000

Different configurations will result in different costs even for the same total load. Ideally, a system should have the lowest dollars per load. The nature of the load also will affect this result.

Even when the dollars per load is increased by expanding the circle to include a process customer, the fact that this is a nonheating load may make it worthwhile. Such exceptions should be considered individually after the basic costs are ascertained.

Some fundamentals should be clear. First, it is important for all involved to understand the nature of district heat. Unlike other projects (e.g., a new shopping center) it has *fluid boundaries*. Similar to the beginning of local electrical, water or sewer service, there is no clear-cut end to the project. This can be unsettling but is in fact one of the positive features of district heat.

Boundaries are merely assumptions required for the purpose of analyzing economics and finances. They do not necessarily relate to what is actually built, and do not limit future growth. It is normal that the minimum initial viable system will not encompass an entire community. Prospective customers outside the area chosen for analysis should be apprised of this fact lest they become concerned about being left out of the process.

2.3.5 Building Heating System Conversions

Numerous studies of technology and costs of converting building heating systems to hot water district heat have been far from conclusive. Estimated costs have ranged from $50 to $500 per KW. These costs will vary with the types and condition of the existing building systems. Nevertheless, it is reasonable in this phase to estimate conversion costs on an overall basis of $150 per KW.

2.3.6 Marketing

The feasibility of a district heating system depends upon attracting major heat users to the system. Therefore, the potential cost benefits to major users should be investigated in the feasibility screening phase.

The primary emphasis of this investigation should be upon the potential cost benefit to users. Other factors not related to energy costs, however, may affect a user's decision and will need to be investigated. Factors which should be considered where appropriate include:

- Comparing district heating costs with existing heating systems or potential alternative sources on a short-run and long-term basis.
- Estimating the cost of converting the user's heating system to use heat supplied by the district heating system.
- The buildings owners' long-term plans for the building or business enterprise.
- The buildings owners' willingness or ability to finance the investment required to convert to district heat.
- Determining whether the major users are interested only in short-run cost benefits or are willing to plan on a long-range basis.
- Determining who will make the decision regarding the use of district heat and how the decision will be made.
- Determining the users' current level of interest in the possibility of district heating and their willingness to assist in the further investigation of potential benefits.

The objective of **Feasibility Screening** is to determine the reasonable likelihood of district heating providing a cost benefit to the users and their willingness to consider district heating as a serious option for meeting their energy needs.

The general community attitude towards district heating should be assessed during this phase. If district heating may be feasible, information should be disseminated to the community and potential users by means of public meetings and local media.

2.3.7 Ownership and Operational Control Options

During the **Feasibility Screening** phase, proponents should take a closer look at who can own or operate the system. A determination regarding ownership and control can be made if there is a logical choice such as an existing system owner or utility, who is willing to accept the responsibility and who is acceptable to potential users.

Existing entities to consider as possible owners include: the public or private electrical utility serving the community, the municipality, the owner of an existing district heating system, major heat and energy users, and the owners of potential sources of heat whether from existing boilers, waste heat from industrial processing, or sources of fuel such as burnable wastes.

The primary emphasis during this phase, however, is to determine which alternatives are possible. This involves determining which existing entities (if any) would be interested in accepting the responsibility. Since new public or private organizational structures can always be created to own or operate the system, options will be available for the ownership and control of a system if it is financially feasible.

It should be emphasized that ownership and control can change during development. Another choice can be made as plans progress. (For further information, see Section 5.0).

2.3.8 System Funding

At this time, proponents should identify all possible funding sources for development and construction. Several sources probably will be necessary.

During this review, you may want to identify sources that would be preferable if reasonable terms could be arranged. You should also identify and list those that are not available.

Although this review should identify funding for the entire development and construction process, emphasis should be on financing the planning and design phases. Funds may be available from state planning grants, but most likely should be raised locally by the community, the municipal or private utility or other private sources. (Donated staff time and technical assistance from these and other groups can reduce financial need).

Funding for the later development stages may come from state loan funds or short-term borrowing. These funds, however, are only available if the project is certain.

Another financial area that should be considered at this time is loan assistance for converting heating systems. Many building owners may have to convert their existing systems to participate in district heating. Since this can be costly and the burden is assumed by the owner, you may want to arrange low-cost, long-term financing for conversions. This may make the project more attractive to those potential customers.

Although potential funding for system construction is reviewed at this time, a final decision cannot be made. This is determined later in the process when a funding package is completed and agreed upon by funding sources.

The following funding sources should be considered by proponents (for further information about funding, see Section 6.0):

- *State loan funds.*
- *General obligation bonds* of the city.
- *Federal loan funds,* if available, through HUD, EDA, or Farmers Home Administration.
- *Revenue bond financing.* These may be pure revenue bonds or backed up or guaranteed by the general obligation of the city; tax increment revenues; special assessments; revenues of other utility operations; user contracts or commitment; other independent sources of revenue; or other types of insurance or guarantees acceptable to revenue bond purchasers.
- *Private loan funds.*
- *Equity investment* either for a system to be privately owned and operated or to be leased to the city or other public or quasi-public agency or corporation.

2.3.9 Economic Analysis

Taking the sum of the estimated costs for heat sources, distribution systems and building heating system conversions, the estimated cost of the proposed system can be compared with others that have been studied in greater detail. Past studies in Minnesota have indicated a range for total district heating capital costs of $300 to $500 per KW. If the proposed system's estimate is near or above the $500 per KW, there may be problems with feasibility.

It should not be inferred, however, that a capital cost greater than $500 per KW rules out feasibility. Specific circumstances in a community, such as extremely low fuel costs for the district heating source and/or extremely high fuel costs (Canadian gas or fuel oil) for the conventional heating alternative may make even this system more cost effective.

On the other hand, a value near $300 per KW is very good. Unless there are unusual circumstances, such as the existence of very high fuel costs for the heating source or very low competitive fuel costs, the system should be considered relatively attractive. Any cost between $300 and $500 per KW deserves further consideration.

Local conditions may be used to bias the results at this point, however. If the community is presently dependent on fuel oil or Canadian natural gas for the bulk of the heating needs and is apparently going to remain on such sources, then costs near the high end may still be attractive. If the community uses primarily low cost fuels and that use pattern is not expected to change in the future, then costs near the high end may indicate that further work is not justified. Systems presently in operation and being developed in Minnesota are generally near the lower end of this range.

Again using City A, as an example:

Heat Source Costs:

(heat capacity, in KW) x $20-50/KW (t)	= $
(12.5 MW x 1000 KW/MW) x $20-50/KW (t)	= $250,000 - 625,000

Heat Load Costs:

(heat load, in KW) x $150/KW (t)	= $
(12.5 MW x 1000 KW/MW) x $150/KW (t)	= $1,875,000

Distribution System Costs:

(see example in section 2.3.5)	= $2,700,000

Total System Cost:	= $4,825,000 - 5,200,000

Cost per KW:

(total system cost) / (heat load, in KW)	= $ /KW
($4,825,000 - 5,200,000) / (12.5 MW x 1000 KW/MW)	= $386/KW - $416/KW

Conclusion: Estimated system cost is within the $300 - $500/KW range and therefore deserves further study.

A word of caution is necessary concerning the use of this numerical model of economic feasibility. This methodology is intended to indicate the potential for feasibility at this early project stage. Falling within the $300-$500 range of potential feasibility in no way guarantees project success. Also, the values of the range of potential feasibility are subject to further discussion and refinement as additional project data becomes available.

2.3.10 Environmental Analysis

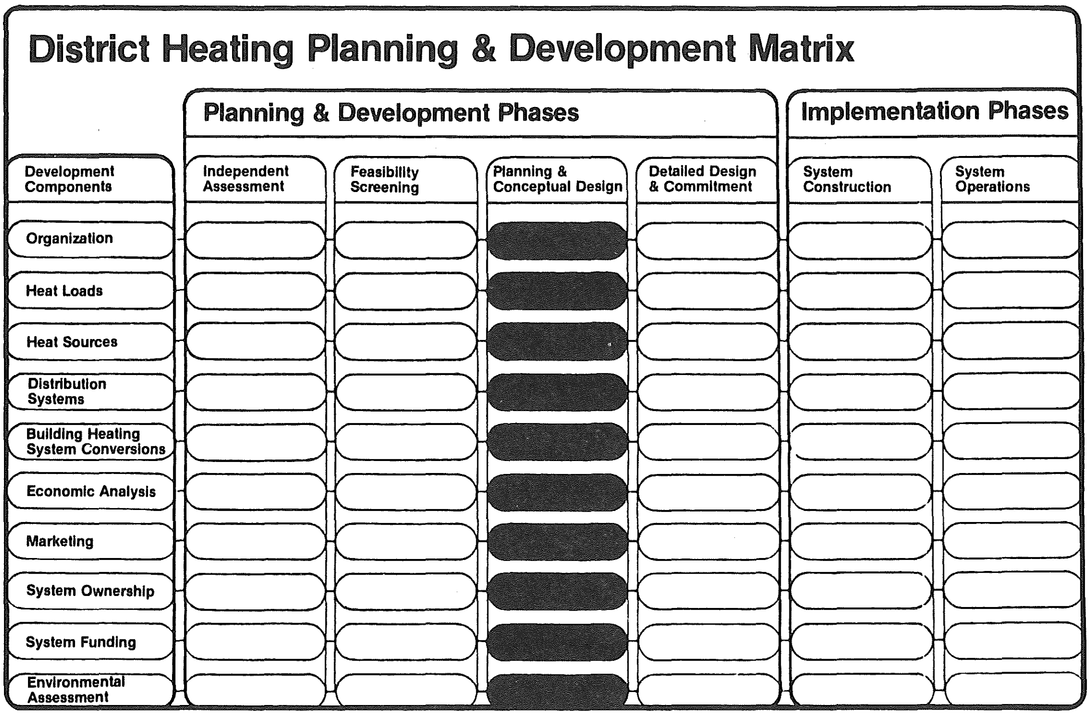
The only direct environmental impact of converting to district heating is a possible change in air quality because of the changing fuel mix used for heating.

With most heat today provided by natural gas, propane, electricity and fuel oil, one benefit of district heating is the capacity to use all of these fuels plus coal, biomass, and others. The efficiency of district heating will mean a reduction in overall fuel use, thereby changing types of emissions.

One conversion deserves special consideration. Some communities with primarily natural gas heating may convert to a coal-fired district heating system. This may increase emissions of some environmentally objectional products. Recent results in St. Paul indicate that even within an environmental nonattainment area, regulatory authorities have not objected to this increase. Instead, they see the benefits of controlling emissions from a single source and dispersing them to higher altitudes. Nevertheless, communities, especially those within nonattainment areas, should consider this problem.

There are many environmental advantages to district heating, stemming from reduced fuel use and reduced rejected heat. In addition, there are no insurmountable environmental roadblocks to district heating conversion. Proponents, at this time, can assume that the project will be environmentally acceptable.

3.0 Planning and Conceptual Design



Section 3.0 describes how to plan and design a district heating system. It outlines important considerations for each planning component and describes how communities acquire engineering, economic and financial expertise for their projects.

3.1 What is Planning and Conceptual Design?

All components are evaluated and a conceptual design is developed. During this phase sufficient data should be collected for a decision to proceed with or to terminate the project.

Proponents beginning this phase should be seriously committed to a district heating project. Planning and design work is expensive and resources should not be wasted on a project that probably will not be feasible.

Although a commitment to proceed is necessary, proponents also should realize that project termination is still an option. Problems warranting project cancellation can still develop.

The results of work in this phase should include:

- A detailed supportable cost estimate of all aspects of the project
- A preliminary detailed economic analysis of the project
- A determination of system ownership
- Funding sources for the next development phase, **Detailed Design and User Commitment**
- Identification of the principal funding sources and their requirements for system construction and startup
- A preliminary market analysis
- Conceptual designs for each of the system's components (heat source, distribution network, and building conversions)

This phase requires professional expertise. Sufficient technical, financial and systems information is necessary for a detailed design.

3.2 Planning Methodology

How communities plan district heating systems will vary because of differing local conditions. What may be important in one community may not be as important in another. Therefore, there is no single planning methodology. General guidelines, however, are discussed below.

At this stage, the initial designs for the heat source construction or modification, the distribution system and general building conversions are being prepared. Decisions and assumptions will be made based on the unique circumstances and conditions of the community.

3.3 Development Components

3.3.1 Organization

3.3.1.1 **Project Management**. This phase should be administered by a project manager available to work with consultants. The position requires:

- Familiarity with district heating processes and technology (or ability to develop that knowledge)
- Sufficient technical expertise to continue through the construction phase
- Familiarity with community resources
- Confidence and support from the community

Generally, a local manager will be more effective than someone from outside the community. Technical understanding of district heating (not necessarily engineering expertise) is a more important prerequisite for this position than administrative experience.

3.3.1.2 **Goals and objectives**. The goals and objectives of the conceptual design process must be understood clearly by all involved at the outset of the project. If goals are not defined concisely there is a strong tendency for further study and significant delay.

Two important minimum goals of **Planning and Conceptual Design** are the following:

- A detailed cost estimate must be developed. If properly done, this estimate should be acceptable to most community factions and potential funding sources. A cost estimate that is guaranteed, however, is unrealistic. Reputable consultants will not provide such a guarantee.
- The information generated for this phase must be sufficient to make a decision to proceed with or to terminate the project. A deadline should be set for this decision to avoid project delays.

3.3.1.3 **Schedule**. A schedule for this phase should be prepared in conjunction with the selected consultant. The following factors should be considered:

- Excessively long time spans will usually result in expensive work, excessive attention to detail and a tendency to bring in irrelevant or secondary factors. Proponents may lose interest and momentum and become oblivious to outside events such as financial and energy questions. The conceptual design may become outdated before it is completed.

- Arbitrary or unrealistically short schedules also may result in expensive studies. Focusing on schedules rather than the actual project goals and objectives may result in work that is technically complete, but lacking enough detail for evaluation by the funding community.

- Flexibility in the schedule is important. Some delays should be anticipated. Latitude in the timing of critical events also should be planned.

- The schedule should be developed to follow project goals. Since this phase requires decisions, sufficient evaluation time should be allowed for making those decisions.

3.3.1.4 **Choosing a Consultant**. A district heating system must be designed by an engineering consultant. A community may issue a formal request for proposals (RFP) or simply choose a firm. The following factors should be considered:

- Experience is important and should be checked carefully. Few U.S. firms have any direct experience in hot water district heating.

- An engineering firm with good fundamental capabilities combined with creativity and a willingness to learn may be acceptable.

- The cost of engineering consulting services is a minor concern compared to the range and size of construction costs. The construction costs of workable systems have varied widely with differing design experience levels.

- The best firms often are very busy and may not respond to your request. Do some groundwork and try to find candidates instead of waiting for them to find you.

- In dealing with large firms, it is important to determine which individuals will actually be responsible for your work.

3.3.2 Heat Loads

The conceptual design of the physical aspects of a system is both a prerequisite to the final detailed design and a final product of a detailed feasibility study.

To complete a conceptual design, detailed information on prospective heat loads must be available for each major building or system and for the most common building types to be served by the system:

- building heating system type
- fuel type used
- an estimate of the heating load

Similar information for process loads must be available on a load by load or company by company basis.

3.3.3 Heat Sources

A conceptual design for the heat sources should provide a heating plant schematic for each separate source. Considerably more effort may be required to describe the modifications to an existing plant than that required to design a totally new plant since conditions specific to an existing plant may require technically unusual, difficult, or controversial changes.

3.3.4 Distribution System

A conceptual design for a distribution system should provide the following information:

- Pipe routing with due consideration of cost, reliability, and the presence of other buried utilities.
- Pipe sizing.
- Details of installation techniques such as expansion compensators, manholes, etc.

3.3.5 Building Heating System Conversions

Studies that estimate the costs of converting building heating systems for use of district heat should be undertaken. Cost estimates should be developed for each type of posed service individual building heating system found in the proarea in your community:

- hot water system
- one pipe steam system
- two pipe steam system
- forced air
- others

Generic cost estimates are usually accurate enough to develop overall conversion costs for the economic studies in this phase. Using these generic costs on individual buildings, however, can be misleading and should be avoided.

Past experience demonstrates that building conversion cost estimates will vary widely for individual buildings. Because owners usually will be responsible for the costs of converting their buildings' heating systems, it is important that they know what costs they will incur. It is important that this information be accurate.

Presenting cost estimates for specific buildings to their owners at this stage is not recommended. The potentially wide variation between estimate and actual cost may simply raise doubts about feasibility among building owners. Uncertainty about the project from this influential group can only be detrimental to the project's success.

Building owners should be encouraged, however, to conduct their own conversion studies when they want individual estimates. The involvement of building owners and their estimating contractors is good because competitive (lower) bids likely will result. Building owners should discuss costs with their colleagues since the contractors and techniques to be used may vary. This interaction between building owners may be their most effective way of obtaining accurate and firm estimates.

3.3.6 Preliminary Market Analysis

The preliminary market analysis consists of determining which potential customers (heat loads) are interested in a district heating system, whether potential major customers needed for system feasibility are willing and able to use district heat, and whether smaller users, in general, are interested in the system.

A major task in this phase is contacting individual potential customers to determine under what conditions they would purchase heat from the district heating system.

Steps to be taken as part of this market analysis and marketing program include the following:

- Initiating a plan to provide the public and potential customers with information about the benefits, costs and risks of a district heating system and the specific conceptual designs being considered.
- Identify and contact the decisionmakers (owners, managers, corporate presidents, board of directors, etc.) for major potential users to determine whether they will purchase heat from the district heating system.
- Conduct a preliminary market survey of all potential customers in proposed service areas to provide information about the system and its benefits, and to determine their interest in using it.
- Prepare a marketing plan for securing commitments from potential customers.
- Prepare detailed cost/benefit analyses for potential major users and illustrative analyses for various types of smaller users.

Based on this information, estimates can be made of which major users and what percentage of smaller users are likely to purchase heat from the system. The analysis also will determine what activities or conditions will be needed to obtain required commitments and develop a plan which will meet those conditions.

3.3.7 System Ownership Selection

The selection of ownership and operational control options should be made early in the planning and conceptual design phase. Ideally, the proposed owners and managers of the system assume the primary responsibility for the planning and conceptual design. However, it is possible for the planning and conceptual design steps to proceed under the sponsorship of the ad hoc committee or the city with the intention of preparing a development package to present to potential owners. (See Section 5.0 for a detailed explanation of System Ownership and Operational Control).

Steps in the selection procedure include the following:

1. Determine which existing public or private entities are willing to assume the

responsibility of ownership or management control.

2. Determine whether municipal ownership or operational control, either directly or through a public utilities commission or other public agency, would be possible. This requires the municipality's willingness to accept the responsibility, its experience in managing and operating utility systems, the preferences of potential users and the general attitude of the community as to whether this is an appropriate activity for the municipality.

3. Determine whether the financial feasibility of the proposed project and the potential return on investment are sufficiently strong to attract interest from private investors.

4. If ownership or operational control by the municipality, private utility or private investors are not likely options, it probably will be necessary to form a nonprofit corporation or quasi-public agency. A user cooperative also may be an appropriate option. However, this could present organizational difficulties as the system is developed and expanded before user members are determined.

5. If a nonprofit corporation or quasi-public agency is established to develop and operate the district heating system, decisions must be made regarding the organizational structure and how the directors are to be selected or replaced. Normally the directors would include representatives of the potential users, affected units of government, and the community.

3.3.8 Funding Strategies

All funding options available to the community should be thoroughly investigated during **Planning and Conceptual Design**. Each funding option will have differing conditions, requirements, limits and terms which vary by the community involved, the size of the system and its apparent feasibility. Each potential funding source should be investigated to determine:

- If funds can be obtained from that source to assist in financing a district heating system

- The amount of available funding and when it is available

- Conditions, limits and requirements of obtaining the funding as they may affect the system's size and ownership options, and the type of repayment guarantees which are required or acceptable

- Criteria used by the funding source to determine financial feasibility of the system

- The information, analysis and documentation required by the source and the procedures to be followed for obtaining the funding

- Likely terms, conditions and interest rates

The best source of information about the requirements and terms is the funding source, especially for state loan funds, potential federal loan programs or other identifiable single sources.

In the case of bond funding or equity investment funding, however, the funding source (potential bond holders or equity investors) cannot be determined or contacted. If general obligation bonds, revenue bonds or equity investment certificates are to be sold to obtain necessary financing, it is necessary to work with bond consultants, bond counsels and financial consultants to determine the legal requirements and market considerations involved. This is particularly true in the investigation of possible revenue bond financing, since the amount of actual or perceived risk normally will require provisions for guaranteeing repayment or spreading the risk. The investigation of revenue bond financing, therefore, will involve further research into the availability and acceptability of potential methods of guaranteeing repayment.

There are several alternatives which may be available to guarantee the repayment or minimize the risk involved in revenue bond or private investment financing. These all involve the assumption of all or part of the risk of repayment if the district heating system revenues are insufficient, by other entities or sources of funds. Potential alternatives include:

- *General obligation* of the municipality which, in effect, would be an assumption of the risk by all persons paying taxes to the municipality. The municipality could minimize this risk to a certain extent by its control over rates and its power to encourage or discourage alternative heating systems.

- *Tax increment finance revenues* could be pledged if the system were located in an existing or proposed tax increment financing district which presently or in the future is likely to generate sufficient revenues to provide adequate security.

- A *special assessment district* could be created to include properties benefited by the proposed system. Provisions could be made to levy special assessments sufficient to cover any shortfalls in revenues necessary for bond repayments.

- *Revenues of other utility operations* could be pledged for repayment of district heating bonds.

- The repayment of the bonds or loans could be *guaranteed by user contracts or commitments* to pay their appropriate share of the system cost over the financing.

- The repayment also could be *guaranteed by* any *other independent revenue sources* which may be available to the owners or the community in general.

If revenue bond financing is contemplated, each of these methods of guaranteeing all or part of the repayment should be investigated to determine the amount of risk which is likely to be involved, the willingness of the entities to assume the risk and the likely acceptability of the guarantee to potential bond holders.

The conditions, limitations and requirements of the alternative funding options must be coordinated with other planning and design decisions. The requirements of funding options may determine the most appropriate option for ownership or operational control.

The project size may be limited by the amount of available funds. Therefore, the system design may be affected by the need to maximize the ratio of projected revenues to required investment or other requirements of funding sources or entities assuming the risk.

Consideration also must be given to funding of the **Detailed Design and User Commitment** phase. Normally the cost of **Detailed Design and User Commitment** will be folded into the construction costs and paid over time by user revenues. State loan funds and/or other local sources of funds probably will be required to finance this phase.

The primary risk involved in this funding is whether or not the system is built. This risk will be minimized if the planning and conceptual design phase clearly indicates that the proposed system is feasible and that all parties necessary to the establishment of the system are willing to participate.

Consideration also should be given to providing assistance in obtaining financing for individual users to convert their buildings for district heating. If obtaining financial assistance on reasonable terms appears to be a significant obstacle to marketing a system, consideration can be given to providing revenue bond financing for conversion or providing guarantees of private conversion loans.

For additional information about funding options, see Section 6.0.

3.3.9 Preliminary Economic Analysis

An analysis of the likely cost benefits of proposed conceptual designs should be conducted. As more detailed cost estimates are developed for alternative system configurations, the projected cost benefits to individual major users and various categories of smaller users can be determined.

The goal of preliminary economic analysis is to demonstrate the economic feasibility for prospective customers and for funding sources. The unit cost of district heat, based on detailed planning and conceptual designs of the system, is compared with the projected unit cost of heat energy from the existing sources.

Individual end user cost/benefit analysis must also show favorable results based upon the factors considered in the system analysis plus consideration of conversion costs, projected heat loads and projected costs for their present heating system, and fuel sources for a specific building or buildings.

3.3.10 Environmental Impact Assessment

Prepare and submit to the Environmental Quality Board the completed Environmental Assessment Worksheet. Sample forms are included in the Appendices.

3.4 Implementation Strategies — Examples

Minnesota communities may be classified into three categories for implementation.

3.4.1 Community With A Municipal Electric Utility Supplying Steam

Municipal utilities are experienced in producing and distributing thermal energy. It is important that a municipal utility be a fundamental part of any district heating development effort.

Experienced utility personnel can best judge which implementation strategy to follow as long as they update themselves on district heating technology and funding. They also can follow through on implementation, even if the new district heating system takes a different form.

The project should start with a review of the existing district heating system, its condition and market, plus a look at competitive thermal energy suppliers, if any exist in the community.

3.4.2 Community With A Municipal Electric Utility Without Generation Capability

Since the municipal utility distributes electricity purchased from outside suppliers and does not generate power, these utilities may have limited technical and financial expertise in the areas needed for district heating implementation. While each community situation differs, it is usually appropriate to conduct the initial investigation independent of the distribution utility. The utility's support and participation should be obtained later in the development process.

3.4.3 Community With No Municipal Electrical Utility

A community without a municipal utility has one major problem. Along with developing a district heating system, the community faces the question of starting a municipal utility. While this is not impossible, it may be both difficult and controversial in many communities. Communities may want to contact the Minnesota Municipal Utilities Association (MMUA) for assistance.

These communities also will investigate nonmunicipally owned options for district heating development. This can be more difficult, but it also offers the community a broader choice of options.

3.4.4 Problems and Pitfalls

There are many ways in which a project can go awry. Common ones include the following:

- *Fluid Service Area.* There is a tendency during the planning stages to continually modify the proposed service area, usually making the system larger. The result often is an expensive study, a service area that goes beyond the economic area chosen by consultants and a project too large for initiation with the financial resources available to the community.

  It is quite easy to make a project completely unworkable through enthusiasm and well-meaning expansion. Prospective customers should understand that the initial service area must be fixed to allow for analysis, that inclusion or exclusion in the study phase is not at all binding on either the early or later development phases.

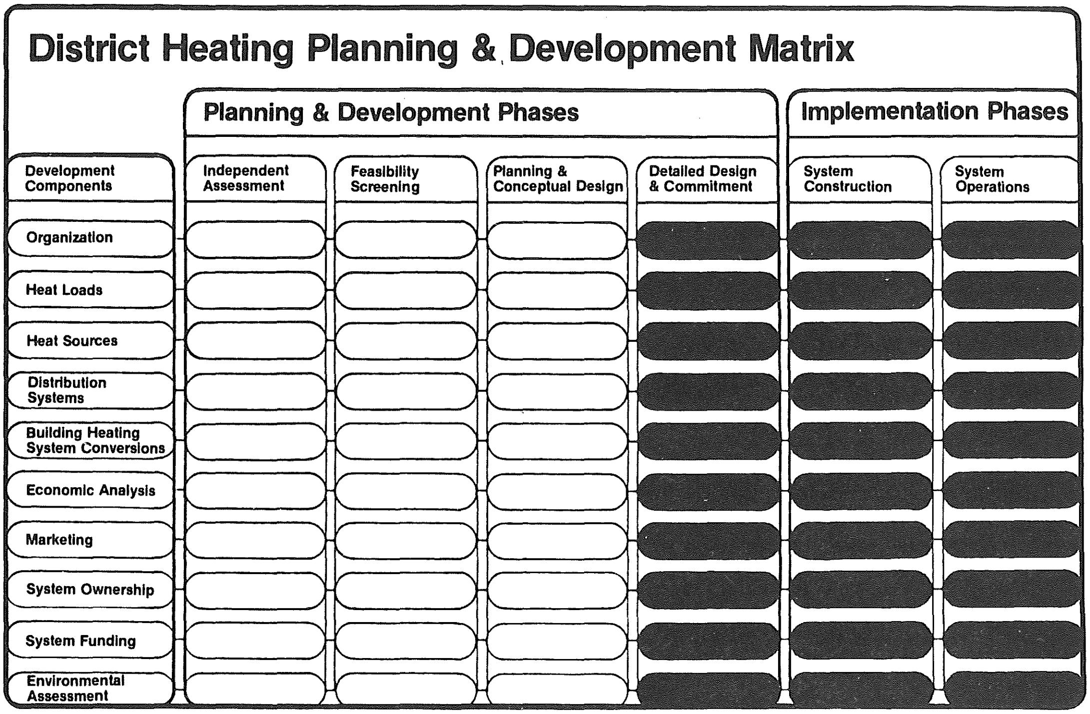
- *The Wrong Consultants.* Experience shows that an otherwise knowledgeable consultant, if lacking in direct experience and/or creativity, usually will develop needlessly expensive concepts. It is not necessary to go outside the U.S. for consulting services. American consultants have been acquiring knowledge and experience with modern European hot water district heating technology.

- *Risk Avoidance.* There is a natural tendency for individuals and institutions to attempt to avoid financial risk. Unfortunately, this often means transferring risks to others.

  An economically successful district heating system is not yet considered a sure thing by the financial community. Someone must take this risk and there may be a temptation to transfer it to the least vocal or least immediate group. It appears the best way to solve this difficulty is to appropriately share the risk amongst various participants.

- *Lack of Communication in the Community.* District heating development is difficult if any significant portion of the community feels left out of the decisionmaking process, or if established power blocs perceive threats. If those initiating development are obviously working towards personal gain, the balance of the community may work to stop the project, regardless of its merits. The importance of peripheral issues should be recognized.

4.0 Design/ Construction/ Operation



Section 4.0 **Design/Construction/Operation** outlines special considerations for final design and construction.

4.1 Detailed Design and User Commitment

Detailed Design and User Commitment phase completes system planning. With the preparation of construction plans and specifications, final economic analysis, final market analysis, and with the securing of acceptable construction bids, funding sources and customer base, a community may begin construction.

Detailed design of a district heating system may be approached in much the same manner as design of other capital improvements for the community, such as water and sewer systems, and schools. Since modern district heating technology is relatively new to the United States, extra care must be taken in choosing consultants. The community should be assured that the chosen designer has sufficient experience in this particular area. Also in this regard, it is important to schedule sufficient time for the design process to allow for proper technical input and careful review before the bidding process.

4.1.1 Design and Construction Choices

Capital projects today are being constructed with the traditional design and bid process or the design/build approach. With municipal ownership, the design and bid approach is often the only legally acceptable approach. Design/build may offer significant advantages, however, such as the opportunity to obtain relatively firm project costs for funding sources with a minimum initial investment. For a project that has reached this stage, the design/build approach should be investigated in conjunction with the professional consultants and the municipal legal staff.

4.2 System Construction

The **System Construction** phase consists of the installation, renovation, and/or conversion of the physical components of the system (heat sources, distribution network, and end user equipment and systems).

Like design, construction of a district heating system is similar to other capital improvements for the community. However, construction skills required for installing district heating piping are somewhat unusual. Again, a contractor should be properly qualified before the bidding process to ensure that construction errors do not occur.

System construction should be scheduled during warm weather months, normally between April and November. Sufficient time should also be allowed for startup and troubleshooting as well as service connections before actual heating is expected from the system. It should be noted that typical delays in construction may become serious if customers are left without heat into the winter. It is also wise to plan for significant resident services from the engineer on the job.

4.3 System Operations

The final phase, **System Operations**, consists of startup and operation of the district heating system. It represents successful completion of the development process.

The actual operation of a hot water district heating system, especially a small one, is relatively simple and usually highly automated. However, there is no experience at the present time in this country with such operations. It is important for the community to require sufficient training and startup services from the system designer or builder so that the district heating operations staff can deal with potential problems.

5.0 Ownership and Operational Control Options

Ownership Options	System Components		
	Heat Sources	Distribution System	Building Heating System Conversion Equipment
Municipal			
Municipal Utilities Commission			
Special Public Agency			
Privately-owned Public Utility			
User Cooperative			
Private Profit Motivated Non-utility Company			
Non-profit Corporations			

This section explains various ownership options for district heating systems. It describes the primary criteria for selecting the most suitable options and outlines additional considerations regarding ownership options for the separate system components. (This information is referred to in previous chapters).

5.1 Ownership and Operational Control

There are a number of ownership options for all or portions of a district heating system. Each community will need to determine and select the most viable options in the community in terms of obtaining financing, assuming risk, and operating efficiently.

Various parts of a district heating system can, and often may, be owned by different entities. For example, the central heat source may be owned by a public utility; the distribution lines may be owned by the city; and the individual space heaters may be owned by final consumers.

Furthermore, the operation and control of the system may be separate from ownership through lease arrangements. A system also may be developed by one group with the idea that ownership or operation may be transferred in the future by lease or sale to a permanent owner or operating agency.

The internal distribution system within the buildings of various users normally would be owned and maintained by the users. However, some equipment such as meters and heat exchangers, although located on the users premises, may be owned, operated and maintained as part of the distribution system. This is similar to a water utility.

Ownership options include:

- *Municipal Ownership* — This may be a department of the municipality or a public agency owned and controlled by the municipality such as a Public Utilities Commission (Minnesota examples of such district heating systems include Hibbing, Rochester, Virginia, Willmar, and most other existing steam systems).

- *Quasi-public Agency* — This is a separate independent agency with a governing board appointed in whole or in part by governmental units.

- *Nonprofit Corporation* — A nonprofit corporation may be established to own or operate the system. The governing board may be self-perpetuating, consist of representatives of various segments of the community or be elected by members. (Example: St. Paul District Heating Development Corporation).

- *Private Utility* — The system may be owned or operated by the private electrical or natural gas utility serving the community or having a nearby source of heat. (Example: Minnegasco Central Heating Company in Minneapolis).

- *Private For-profit Corporation* — Established as an independent profit-making business which may involve a franchise from the municipality. (Example: Minnegasco Central Heating Company in Minneapolis).

- *Cooperative* — The system may be owned and operated by a user cooperative. (Example: Duluth).

- *Private Equity Investment* — The system may be owned by private equity investors although leased to and operated by a private company, utility or public agency. (Example: Minnegasco Central Heating Company in Minneapolis).

Ownership options depend upon the willingness of existing entities or potential new ones to assume the risk of ownership or to accept the responsibility of operational control. Other important factors are: the availability of financing at reasonable rates and terms, acceptance of an ownership choice by potential users, control over development of the system, and long-term control over the operation, maintenance, and rates of the system.

5.2 Selection Criteria

The most appropriate ownership option for each system will vary in each community. Factors which should be considered include:

1. *Willingness to accept the responsibility and assume the risk of developing or owning the system.* Private utilities, cities, municipal utilities commissions, or other existing entities may decide that they are unwilling to accept ownership. There may be no private investors interested in the project either as equity investors or for the business itself. Potential users may not be interested in forming a cooperative.

   If these groups are unwilling to accept ownership or operating control, it may be necessary to create a new agency or corporation to develop, own and operate the system.

2. The *availability, types and terms of financing* will vary depending upon who owns, develops and operates the system. Revenue bond financing normally would be available under all ownership alternatives but the rates and terms may vary. Government grants, state district heating loans, general obligation bonds and private financing, however, may be legally unavailable or not realistically available under some ownership options. Since the financial package may not be completed until late in the planning process, the ownership option may not be resolved until then.

3. The third criterion involves *acceptance by potential users.* The feasibility of a district heating system depends upon attracting potential users. If needed major users or numerous small possible users have preferences, selecting other options may significantly affect the marketing of the system.

4. *Long-term management and control* over the system, including rate setting, can be separated from ownership by means of contracts or lease arrangements. Rate setting may also be separated from ownership by means of contract or franchise terms. The owner or operator, however, will have a substantial impact upon the future development and operations of the system. Factors to be considered include: Experience in operating business enterprises, responsiveness to the needs of users or potential users, likely amount of interest in expanding the system and responsiveness to community goals and objectives.

5.3 System Components

Various components of a district heating system may be owned or operated by separate entities. Major sections of the system are the primary and backup heat sources, the distribution system, plus the equipment and internal distribution system within the user's building for actual heating. Some options available for ownership or operational control of various system components will be discussed in this section.

5.3.1 Heat Sources

5.3.1.1 **Primary Heat Sources**. Existing heat sources are likely to be electrical generating facilities which provide heat through cogeneration or from separate boilers. Each benefits the generating plant's fuel handling capability and fuel supply contracts.

Private utilities often are willing to provide heat to an independently owned-and-operated distribution system. However, they have shown minimal interest in owning and operating a distribution system. This lack of interest is due primarily to the difficulty of generating an adequate return in the short run on the high initial investment and fears of how electric rate regulators may allocate district heating costs and investments.

If the municipal utility is the potential primary heat source, it is also the preferred selection for owning and operating the distribution system. Municipal utilities need not be concerned with return on investment or how outside agencies may allocate cost for rate purposes. Although municipals must be concerned about debt service obligations, the revenue needs to meet these obligations can be delayed or minimized during the early years of the project (debt financing of early years' interest payments and delayed or graduated repayment of principal).

Municipal utilities are often able to obtain better financing terms. They have experience in operating utility systems. If appropriate, they may pledge surplus revenues from the electrical system as a guarantee for district heating revenue bonds.

Other existing potential heat sources such as businesses or institutions with excess energy capacity, or those having waste products which can be used as fuel, are unlikely to be interested in new enterprise requiring investment, responsibility, and assuming the risk of owning and operating a district heating system.

If a new heat source is established, it is likely that the heat source and distribution system will be owned and operated as a single operation.

5.3.1.2 **Backup Heat Sources**. Backup heat sources are essential to provide continued heat if the primary heat source becomes inoperable. Individual users, such as hospitals, need guaranteed supplies or reasonably available backup sources capable of meeting the needs of the entire system.

Backup systems can include mobile boiler systems or readily available temporary boiler systems. These normally would be owned and operated by the system.

Another way to provide backup is to maintain existing heating systems of major users for operation if necessary. The existing backup capacity could be purchased and operated (if necessary) by the system, or ownership could be retained by the existing owner subject to contractual obligations to provide heat in an emergency.

5.3.2 Distribution Systems

The ownership and operation of a distribution system may be entirely separate from that of the heat source. The owner and operator of a distribution system may contract with one or more primary and backup sources to purchase heat which is resold to users.

There are several options available for owning and operating a distribution system. These include municipal ownership, public agency, quasi-public agency, privately owned public utility, user cooperative, and private profit or nonprofit companies.

Furthermore, the ownership of a distribution system can be separated from operational control. A private profit or nonprofit corporation, a quasi-public agency, a user cooperative, or a group of private investors may be willing to accept the responsibility and assume the risk of ownership but prefer to contract with a private utility, a municipal utility, or private operating company to operate and maintain the system.

5.3.3 User Equipment

In most district heating systems, the user would own and maintain on his premises the facilities and equipment needed to use and distribute heat supplied by the system. The system, however, could own, operate and maintain heat converters, meters and gauges located on the user's premises. The owner of the distribution system also could help finance the costs of converting the internal distribution systems to use district heat.

5.4 Ownership Options

There are several options for owning and operating a district heating system or its primary components. This section will review some salient characteristics, plus the possible advantages and disadvantages of various options.

5.4.1 Municipal Ownership

This option involves direct municipal ownership of the system operated as a department of municipal government. Direct management of the system would depend upon the organizational structure of the municipality. The manager of the system could report either to a public works or public utility's department head, a city manager, or directly to the mayor or city council.

The city council would be responsible for all policy decisions relating to the ownership or operation. Rates would be set by the council subject to contractual obligations to heat suppliers, funding sources and users.

Funding options available under municipal ownership include state loans, most federal loan programs, general obligation bonds or revenue bonds and, possibly, private equity investment. State loan funds, general obligation bonds or revenue bonds backed by the general obligation of the city or other municipal revenue sources would be the most likely funding sources under this ownership option.

The primary advantages of a municipally owned system, whether managed directly by the municipality, a utilities commission, or a municipally owned corporation, include the ability to obtain financing at advantageous rates and terms and the ability to ensure the system would be established and operated in accordance with community goals and objectives.

State loan funds are available only to municipalities, municipal utilities commissions, or municipal corporations (although it may be possible for them to reloan to other entities). The proceeds of general obligation bonds or revenue bonds backed by the general obligation of the municipality also may be loaned to other nonmunicipal entities. Many municipalities, however, may be reluctant to use their general obligation credit to finance a district heating system which the municipality does not own, operate or control.

The interest rates on state loan funds, general obligation bonds or revenue bonds backed by the general obligation of the municipality normally will be lower than other potential finance sources. Lower financing costs presumably will result in lower user charges. This would tend to enhance the feasibility of the system and provide cost benefits to users.

The primary disadvantages of municipal ownership include potential reluctance to be involved in a project which only benefits a portion of the community, and the possibility that general community goals and objectives may prevent the system from being operated in the most efficient businesslike manner.

Marginally feasible extensions of district heating systems may be beneficial in terms of providing the services to as many persons as possible, but may require subsidization by large nearby users.

In summary, municipal ownership is an attractive option if the municipality is willing to accept the responsibility and assume the potential risks of owning and operating the district heating system.

5.4.2 Municipal Ownership — Municipal Utilities Commission

Under this option, a system would be owned, operated and managed by a municipal utilities commission. The directors of a public utility commission may consist of the city council or, pursuant to statute or home rule charter, may be selected in another manner. The community, however, retains control of a public utilities commission through their elected representatives.

The advantages and disadvantages of this option are similar to those of direct municipal operation. Municipal utilities commissions have experience in owning and operating a utilities system. They have a track record for obtaining credit on favorable terms. They have other revenue sources which may be available to assist in handling cash flow problems or which could be used as a guarantee for revenue type bonds.

If a municipality has a utilities commission operating other utilities, the ownership and operation of a district heating system by the commission is a good option.

5.4.3 Special Public Agency

A municipality or other governmental body could establish a public or quasi-public agency to own and operate a district heating system. Such agencies could be organized in several ways with varying degrees of direct or indirect control by the municipality or other governmental body. If a public nonprofit corporation were organized pursuant to Minnesota statute 317 (whereby membership is limited to the mayor and governing body of the municipality), it would qualify as a direct recipient of loans or grants from the state pursuant to the Minnesota District Heating Loan Act.

Control of the system under this option would be by the members or board of the corporation or agency. If the board consisted of the mayor and council, the municipality would retain complete control over the management and operation of the system. Under other alternatives, the municipality would retain only indirect control through the power of appointment and removal of board members.

The rates under this option would be set by the board of the corporation subject to contracts with the users and subject to contract or franchise agreements with the municipality.

A special public agency would have no source of income prior to construction of the system and therefore would depend upon grants or possibly loans for planning the system. Revenue bond financing would be the most likely financial source under this ownership option. The municipality, however, could loan the agency or corporation the proceeds of general obligation bonds or pledge the general obligation of the city in support of revenue bonds.

The primary advantage of organizing a special public agency or corporation, compared to direct municipal ownership, is to separate it from operations of municipal government. This may permit operating and expansion decisions to be made on a strict cost/revenue basis without considering other factors which can and often necessarily do affect decisions by governmental bodies. Such agencies or organizations also may have more freedom of action in terms of contracting for system construction, fuel or heat, staffing, and operating procedures.

The primary disadvantage of a special public agency or corporation is that it may have greater difficulty in obtaining financing unless guaranteed by the municipality or by other means. Such an agency or corporation would have no credit rating, no financial reserves, and no experience owning and operating a utility system.

5.4.4 Privately Owned Public Utility

A district heating system can be owned by a privately owned public utility system. This could include utility cooperatives. The utility would be managed by the board of directors or stockholders of the corporation or by the members of the cooperative. Rates would be set by the utility subject to contractual or franchise requirements of the municipality and subject to contracts with various users.

Under this option, normal funding sources used by the utility, including equity investments, corporate bonds and private loans, would be available for the district heating system. The municipality also could loan the utility the proceeds of tax exempt revenue bonds or general obligation bonds issued by the municipality.

The primary disadvantage of a private public utility is that its goal of maximizing profit and minimizing risk may be inconsistent with the community's desire to provide district heating to as large a portion of the community as is economically and financially feasible. Also, large utilities are heavily regulated which greatly restricts their options. They are less likely to get concessions on rates or pollution standards. Although willing to provide heat on an individual basis to very large users, private public utilities presently are exhibiting little or no interest in establishing district heating systems.

The primary advantage of a private public utility is their experience in owning and operating a public utility system. They also have experience in developing, designing, monitoring and operating utility systems. Joint use of technical, management and maintenance personnel could result in cost savings.

Furthermore, this ownership option normally would be considered only if the utility owned the proposed primary heat source. Ownership and operation of the distribution system as a unified system would avoid any potential problems arising from separate ownership. Ownership and operation of a district heating system by the private utility operating in the community may be an attractive option if the utility itself is interested.

5.4.5 User Cooperative

A district heating system could be owned and operated by a user cooperative. Each heat user would be a member of the cooperative which could be established on the basis of one vote per user or votes based on heat loads. This would permit management and control by the users who would have the greatest direct concern in the efficient and effective operation of the system.

The system would be controlled by a board of directors that is elected by the users, each of whom would be a member of the cooperative. The board would have the power to set rates subject to any contractual obligations to funding sources, the municipality or the heat source.

Potential funding sources under this option would be private loans or bonds which, most likely, would need to be guaranteed by the members, the municipality or by other means. Loans from the municipality of the proceeds of the general obligation or revenue bonds also are a possibility.

A user cooperative would appear to be a good ownership alternative for a fully established operating system. However, the administrative problems of organizing a cooperative and making decisions prior to the time when membership is clear make this an unattractive option for the planning, construction or expansion of a new system.

5.4.6 Private Profit-Motivated Company

A district heating system can be developed, owned, and operated by a private profit-motivated company in a manner similar to other business enterprises. This could include companies whose primary business would be developing and operating a system, or developers seeking to enhance the attractiveness of new developments, or major users seeking to spread the cost of building or operating their own heating systems.

The owners of the company would control the operation of the system subject to contracts or franchise agreements with the municipality and contracts with users. Rates would be set by the company.

At this time one major disadvantage overshadows the benefits. District heating requires substantial initial investment and there is considerable actual or perceived risk involved. Most private businesses currently consider the return on equity investment to be too low to justify the financial risk.

A private company can obtain necessary funding from private sources in the form of equity investments, loans, or proceeds of revenue bonds or general obligation bonds from the city. Unless the company has substantial assets, some form of repayment guarantees normally would be required.

Private investors would be able to take advantage of various investment credits and depreciation and deductions which would increase the profit potential of such investments. If a number of district heating systems are established and successfully operated, it can be anticipated that private businesses and investors will exhibit increased interest in district heating investments.

5.4.7 Nonprofit Corporations

A district heating system could be owned and operated by a private nonprofit corporation. This system would be controlled by a corporation board of directors who in turn would be selected by the members. Nonprofit corporations have great flexibility in determining membership. If membership is limited to the board of directors, the corporation would be controlled by a self-perpetuating board. The membership base, however, could be substantially broader and include representatives of various segments of the community or could include all users or potential users.

Rates would be set by the board of directors subject to any contractual obligations to the municipality, users or funding sources.

The most likely funding source under this option would be revenue bonds guaranteed in whole or in part by the municipality, users, individual commitments or other sources of revenue.

One advantage of nonprofit corporation ownership is that it is always available even if no other entity is willing to accept the responsibility and assume the risk of ownership. A nonprofit corporation also has at least the potential ability to make timely decisions regarding the planning and development of a system.

The primary disadvantage of nonprofit corporation ownership is its lack of independent resources and funding sources. Funding sources normally will require loan or bond repayments guarantees by potential users, the municipality, or other revenue sources. Outside entities may be reluctant to guarantee loan or bond repayments if they have little or no control over the planning, development and operation of the district heating system owned or operated by a nonprofit corporation.

6.0 System Funding Strategies

Funding Sources / *Development Phases*	Independent Assessment	Feasibility Screening	Planning & Conceptual Design	Detailed Design & Commitment	System Construction	System Operations
Federal Grants						
State Planning Grants						
Municipal Contributions						
Business / Community Groups						
Potential Users						
Foundations						
Private Investment						
State Loans						
General Obligation Bonds						
Revenue Bonds						
Private Loans / Equity Investments						

This section summarizes various sources of district heating development funding. It examines in detail the more promising funding options available for each development phase. With this information, communities may begin planning their own funding strategies and defining the detailed requirements of the proposed funding services. (This information is referred to in previous chapters.)

6.1 Funding Sources

There are several funding sources which may be available for planning and implementing a district heating system. Appropriate sources will vary considerably from community to community. Furthermore, potential funding sources available for the various planning phases also will be different. Funding sources for construction will be different than those for the planning process.

The costs of establishing a system should be paid over time by the system users. The detailed design and construction phases normally would be funded with borrowed money repaid with interest from user charges.

Loans are not appropriate for early planning phases. Until final commitments are obtained to establish a system, there is no certainty that the system is feasible or will be built. Thus, there may be no revenue to repay the loans.

Funding for the early planning phases, therefore, must depend upon grants, contributions of staff time or money, private equity risk investment, or loans whose repayment is conditional upon the system being built. Potential sources of planning funds are outlined below.

- *Federal grants.* Although federal energy grants are unlikely to be available in the future, it may be possible to include district heating planning as part of other types of grants such as HUD Community Development Block Grants or Urban Development Action Grants.

- *State planning grants.* The state has $200,000 available in Fiscal Year 1982 for planning grants to municipalities interested in establishing district heating systems. Limited to $20,000 per municipality, these grants would be available during the planning process after the apparent feasibility of the system has been determined.

- *Municipal contributions of staff time and funding.* The municipality, particularly if it operates an existing district heating system or electrical utility, could invest the required staff time or funds to hire outside assistance to plan a system and determine feasibility.

- *Business or community groups.* Business or community groups could contribute time and funding to assist in planning the system.

- *Potential users.* Potential users of district heating systems, particularly major energy users, may be interested in contributing time or money to plan a system.

- *Foundations.* Foundations may be willing to assist in funding district heating planning. This is particularly true of foundations sponsored by major local industries who are interested in local projects.

- *Private investment.* A private utility, other potential sources of heat, or private investors may internally finance the planning and feasibility determination if they contemplate owning or operating the system. A private utility or other heat source may also contribute time and money to plan a publicly operated distribution system which would purchase their heat.

There are also a number of potential funding sources for the planning and conceptual design phase, plus the construction phase:

- *State loans.* The State of Minnesota has authorized the issuance of up to $50 million in state bonds, the proceeds of which are to be used to make loans to municipalities or municipally owned agencies for detailed planning and construction of district heating systems. The regulations regarding this program are presently being drafted.

- *General obligation bonds.* A municipality may issue general obligation bonds, the proceeds of which may be used to construct a municipally owned system or may be loaned to the public, nonprofit, or private corporations or agencies which would own or operate the system. General obligation bonds require a commitment from the general taxing authority of the municipality to repay the loans. The interest rate will vary depending upon the bond rating of the municipality and general market conditions for tax exempt bonds.

- *Revenue bonds.* Tax exempt revenue bonds also can be issued by a municipality. These include pure revenue bonds with repayment coming only from revenues of the system or revenue bonds guaranteed in whole or in part with revenues from other sources. Since district heating systems now are perceived to involve significant risk, pure revenue bonds likely could not be marketed in the general bond market. Private placement within the local community (consortium of financial institutions, private investors, major users) may be possible for smaller projects.

  There are various guarantees which may be available and useful in making revenue bonds marketable or reducing their interest rates. If they are guaranteed by the municipality, the bonds, in effect, become general obligation bonds.

Other potential sources of guarantees for all or part of the bonds include: special assessment districts; user commitments to pay a share of the debt service regardless of amount of heat used; tax increment financing revenues; electric utility or existing district heating system revenues; or any other available revenue source. Revenue bonds with or without guarantees could be used by public or privately owned district heating systems although they would need to be issued by the municipality.

- *Private loans or equity investment.* Private loans or equity investment are potential funding sources particularly for a system to be owned and operated by a private utility or profit-making corporation. Interest on private loans would be taxable and, therefore, would have higher interest rates than most tax exempt bonds.

  However, there may be tax credits and deductions available for equity investment which could make this financing method more attractive. This is particularly true if market conditions continue to make it increasingly difficult to market long-term bonds at reasonable rates.

  There is a potential problem involved in all tax exempt funding alternatives requiring over ten million dollars. District heating bonds could be classified by the Internal Revenue Service as industrial revenue bonds which, if issued for more than ten million dollars, are not tax exempt. A revenue ruling has been requested regarding the tax exempt status of district heating bonds and a decision is pending.

6.2 Funding Options

This section outlines potential funding options which may be available during various phases of the planning and implementation process. Current projects in the planning stages are aided by substantial grants from the Department of Energy. It is doubtful that similar grants will be available in the foreseeable future. This will increase the likelihood that a significant local contribution and commitment will be necessary during the planning process. The local community, including the municipal government, potential users, and the local business community, will need to assume greater responsibility and risk in the implementation of the plans.

The purpose of this work program component is to explore all of these funding options and others which are uncovered as suggested. Factors considered for each option include:

- The total amount of funds potentially available for an individual project or for all Minnesota projects.
- Likely interest rates or required return on investment. Since tax exempt public bond financing or state loans are potentially available for most proposed systems at lower interest rates for the same risk, private financing should be considered only as a last resort.
- Amount of risk the sources are likely to deem acceptable.
- Likely conditions on the availability of funding relating to such factors as user commitments, loan guarantees, equity requirements, projected gross and net operating revenues, and debt service ratios.
- Information, analysis, and documentation necessary or desirable to obtain funding commitments.

The planning and implementation of a district heating system involves the commitment of considerable time and funds. The system will benefit the users and the community only if it is financially and economically feasible. This increases the importance of the preliminary feasibility study and development of a conceptual design which makes financial sense and can be implemented.

Funds for the ensuing phase in the planning and implementation process will be difficult to obtain locally or from outside sources unless the financial feasibility and economic benefit of the system can be sufficiently demonstrated in the current phase. The following section outlines potential funding sources for the various phases. Funding is likely to be available from any of these sources only if it can be demonstrated that there is sufficient likelihood of developing a feasible project to justify assuming the risk of funding the next phase.

6.2.1 Independent Assessment

The independent assessment phase of the planning should require little funding. This phase is designed to be conducted by local people at little expense other than some of their time.

6.2.2 Feasibility Screening

This phase will involve feasibility screening based on existing or potential energy sources, existing and projected costs for alternative fuels for district heating compared to existing heat systems costs, demand/distance ratios, and the costs of converting major users.

This phase normally is funded locally, although state preliminary planning grants may be available for latter portions.

Potential funding sources include:

- State energy preliminary planning grants
- Municipal funds
- Community or business groups
- Electric or existing district heating utilities
- Potential users
- Local foundations which have a particular interest in projects benefiting the community

Potential sources of technical assistance include:

- Department of Energy, Planning and Development
- Municipal, county, or regional commission staff
- League of Minnesota Cities
- Private utilities
- Community volunteers
- Educational institutions
- Employees of local businesses

- Foundations
- Consultants specializing in the technical, financial, or legal aspects of district heating planning

6.2.3 Planning and Conceptual Design

This phase involves analyzing the feasibility of various alternative design concepts. Factors for analysis include: capital investment requirements for generating heat, distribution system and common costs, operating cost projections for fuel (less cogeneration setoffs), operations, maintenance, debt service or return on investment requirements, current and projected costs of existing systems, demand analysis including heating requirements and market acceptance or interest. The purpose of this phase is to develop a concept plan which is financially feasible in terms of customers short-range or long-term costs and in terms of obtaining needed funding.

Funding options which may be available for **Planning and Conceptual Design** include:

- Federal or State loans or grants
- Foundation grants
- Municipal funds
- Community or business groups
- Public utilities
- Potential users

The Department of Energy, Planning and Development preliminary planning grants can be of considerable assistance in funding out-of-pocket expenses for this phase including the employment of district heating specialists for developing a feasible concept plan.

The local community or potential owners must make a commitment of time, money and energy to the program. This should involve municipal staff as well as community and business representatives. The local commitment is necessary to assist in compiling needed local data and to begin contracts with major potential users and potential primary and backup heat sources.

Funding for this phase normally will need to include grants and contributions. Loans for this phase could be repaid out of system revenues. There is the risk, however, that the loans would not be repaid if the system is not built.

6.2.4 Detailed Design and User Commitment

This phase involves detailed project planning and specific cost estimates for system construction and conversion. It requires obtaining commitments which may need to be formal long-term commitments. If necessary, financing can be arranged as part of **Planning and Conceptual Design** or it could be part of the construction and implementation phase. Normally, however, this detailed planning, including user commitments, will be necessary to obtain construction and conversion financing.

Probably only short-term financing would be needed since, if the system is built, these costs would be folded into long-term financing of the system and paid through user charges.

Risks are involved in funding this phase, however, since the costs cannot be recovered if the system for any reason is not or cannot be built. The risks may be small, however, if there are general informal commitments for funding and commitments by major potential users. Much of the cost must be funded initially by the local community, major users or potential system owners.

Funding options for the **Detailed Design and User Commitment** phase include:

- Federal or state loans or grants
- Bank loans (direct or guaranteed)
- Municipal funds
- Potential investors funds
- Public utilities
- Potential users
- Community or business groups

The funding of this phase presents numerous difficulties. For district heating projects currently being planned, this phase has been funded in part by Department of Energy grants which may no longer be available. Detailed planning cost estimates and feasibility analysis are necessary to determine user costs which in turn are an essential prerequisite to user commitment. If the system is built, these expenses can be folded into the construction financing and paid over time as part of user charges.

If the system is not built, however, there is considerable risk involved in financing this phase. This risk can be minimized only if the feasibility of the system can be demonstrated first in terms of energy costs savings and user commitments.

The cost of this phase may vary from $50,000 or less for a small system with good community support to $500,000 or more for major systems such as the system being planned for St. Paul.

6.2.5 System Construction

This phase is the construction of the system including the primary and backup sources of heat and the distribution systems. The funding sources will vary depending upon the ownership options selected. The funding options outlined here are for the combined generation and distribution systems. Separate ownership of the generation and distribution systems, however, is certainly a viable option and may be most advantageous, particularly if cogeneration is involved. Therefore, the funding options, depending upon the ownership, may involve the whole system or only part.

6.2.5.1 **Municipal Ownership.** Funding options which can be considered if municipal ownership is contemplated include:

- *General obligation bonds* — This option is the lowest cost option but it is available only if the municipality is willing to commit their general taxing authority to a project which may not directly benefit all residents or taxpayer groups.

- *Revenue bonds backed with general obligation* pledge for all or part of the issue. These bonds are similar to general obligation bonds and represent a low-cost option, but they do obligate the municipality for debt service payments.

- *Revenue bonds* — This is a good alternative if users can be committed to clearly provide income sufficient to guarantee repayment of bonds over the life of the issue.

- *Revenue bonds with guarantees* in full or in part by federal or state agencies, public utilities, users, or other revenue sources such as special assessments, tax increment financing revenues, or revenues from the electric utility or an existing district heating system.

- *Loans from the state* under the District Heating Loan Program.

6.2.5.2 **Private Ownership.** The following funding options may be considered for private system ownership:

- *Equity financing by investors* — In view of potential risks, a high return on investment would be required.

- *Private loan financing* — This would require higher interest rates than tax-exempt bonds and normally would require as much or greater security than tax-exempt bonds.

- *Industrial revenue* or other type of tax-free financing arrangements.

- *Municipal lease* — This concept permits the various municipally owned funding options but transfers operation and some or all of risk to private operators.

- *Loans guaranteed* by federal or state agencies, municipality or users. Such guarantees are currently in short supply but may be available for some projects.

6.2.5.3 **Municipal Electric Utility.** These funding options would be similar to municipal ownership although municipal utility revenue bonds would be more attractive to investors if they are backed up by the utility's assets and revenues from other operations. Utility-related bonds, even if guaranteed by the general obligation of the municipality, have less impact on bond ratings than direct municipal bonds.

6.2.5.4 **Privately Owned Public Utilities.** The funding options available to privately owned public utilities would be similar to other private investors although the financial strength of the utility could result in higher loan-to-equity ratios and lower interest rates.

It can be anticipated that electrical utilities will finance the costs of converting existing facilities for cogeneration of heat. These would be repaid through energy charges to the distribution system. The large demand on utilities for financing electrical generation facilities, however, makes it unlikely that they will be interested in establishing and funding a distribution system.

6.2.5.5 **Public or Quasi-Public Agency.** One ownership option normally available is a public or quasi-public agency. Tax exempt revenue bond financing normally would be available for public or quasi-public agencies and qualify for the state loan program if the board consists of the Mayor and Municipal Council. The revenue bond financing and state loans, however, both require demonstrated feasibility, adequate debt coverage ratios and user commitments.

General obligation bonds also can be used under this option with the municipality selling general obligation bonds and loaning the funds to the agency.

6.2.5.6 **User or Community Cooperatives.** A new cooperative would need to obtain financing in a way similar to private ownership. Since a new cooperative would not have financial reserves, the cooperative would either need substantial contribution of equity by members or loan guarantees. Potential sources of guarantees for all or part of the needed loans include:

- Federal or state agencies
- Municipality
- Cooperative members

6.2.6 Building Heating System Conversions

The costs of converting a customer's building heating system may in whole or in part be included in the overall system funding and paid through higher rate charges unless not permitted by the funding sources. Typically, however, the conversions would be financed by the individual building owner or user.

There are, however, other conversion cost funding options which could assist individual users in funding their own conversion costs. These could include:

- Federal or state grants, loans, or loan guarantees
- Local financial institution commitment to make needed loans which could be guaranteed in some manner

7.0 Appendices

The **Appendices** are a collection of materials applicable to community planning and development of district heating systems. It contains the following items:

7.1 Glossary of District Heating Terms

British Thermal Unit (B.T.U.): the amount of energy required to raise the temperature of one pound of water one degree Fahrenheit under specified conditions. 1 BTU = .000293 KW-hr.

Building Load/Demand: the peak thermal power requirement for a single building or customer. Note that the sum of building loads will not equal the system load because the building peak loads will not all occur at the same time.

Development components: Principal areas of work effort or activities that make up the district heating development process. The following development components are described in detail in Section 0.2:

- organization
- heat loads
- heat sources
- distribution systems
- building heating system conversions
- economic analysis
- marketing
- system ownership
- system funding
- environmental assessment

Development phases: stages in the development of a district heating project. The following development phases are described in greater detail in Section 1.0 through 4.0:

- Independent Assessment
- Feasibility Screening
- Planning and Conceptual Design
- Detailed Design and User Commitment
- System Construction
- System Operations

District Heating: District heating is the distribution of heat energy from a central source to commercial, industrial, and residential customers for space heating, process needs, and domestic hot water. A district heat system consists of three elements: 1) a central heat source(s) such as a coal fired electrical generating plant or a heat-only boiler; 2) a heat load or thermal energy demand, made up of end users or customers such as hospitals, businesses, colleges, apartment buildings, single family homes, and schools; and 3) a distribution network to move the heat energy from the heat source to the end users.

Heat Sources: Any energy converting facility. This may include electrical generating plants, industries, or waste disposal (incinerators). Any place that consumes relatively large amounts of fuel or generates relatively large amounts of combustion products should be included. Abandoned or inactive facilities are included.

Kilowatt (KW): 1000 watts. A metric measure of power. Commonly used for electrical power, it is equally proper to use it to describe automobile engine power (instead of horsepower) and the thermal power requirements of a building (in lieu of BTU/hr).

Load: Thermal Power expressed in units of KW, MW, or BTU/hr; the load, or district heating system heat load; often refers to the peak send-out thermal power from the power plant.

Load/Connection: The total load in an area divided by the number of metered connections required. This factor relates to the economics of service since connections and meters are significant cost items. All other factors being equal, a high load/connection is usually desirable.

Load Density: Conceptually, this term refers to the total load in a region divided by the geographical area. Units may be KW/M^2 or BTU-hr ft^2. Dimensions are power divided by area.

Heat load density is often used as a figure of merit for district heating feasibility assessment. Except in specific circumstances, though, heat load density is not a useful term for comparison. As an example, the heat load density in downtown Chicago is much higher than in downtown Virginia, Minnesota. Nevertheless, Chicago has abandoned all district heating while Virginia is actively working on an expansion. Thus, while heat load density is important, it is not the dominant issue.

Megawatt (MW): 1000 KW = 1,000,000 Watts = 3.4 million BTU/hr.

Process Load Requirements: All *nonheating* thermal loads, usually industrial in nature.

7.2 Pros and Cons of District Heating

District heating is the distribution of thermal energy from a central heat source to commercial, industrial and residential customers for space heating, domestic hot water and process needs.

The medium for distribution of thermal energy may be steam or hot water. The central energy source may be a steam boiler, the extraction from or exhaust of a steam turbine, the exhaust heat from a diesel engine or a combustion turbine, or heat generated from geothermal sources, industrial waste or from urban refuse.

The steam or hot water is distributed from the central source through a piping system to the users. They may be building owners needing energy for space heating or domestic hot water heating or industries needing process heat.

A district heating system provides thermal energy services to a community and is a more efficient means of distributing heat to many different customers.

7.2.1 Advantages

District heating offers several advantages for Minnesota communities.

One of district heating's most beneficial aspects is the *promotion of economic growth:*

- The existence of a dependable and economical source of heat, particularly in the downtown and industrial areas, may *assist in attracting new development* for the community and in revitalizing downtown areas.

- The investment of substantial amounts of capital in the community as the result of construction activity will cause an *influx of monies* to local entrepreneurs and industries.

- District heating will assist in *holding down heating costs.* If fuel costs continue to escalate at a rapid rate, they will place Minnesota communities in an increasingly competitive advantage with warmer areas where heat loads are considerably less.

- Much of the money presently spent for energy immediately leaves the community and state. This amount would be reduced and, therefore, *provides additional funds for wages and the purchase of goods and services in the local areas.*

District heating offers *greater price stability*:

- Larger and longer term supply contracts usually result in a *lower unit cost for energy.*

- The system may rely on *fuels* that experience *slower price increases* than oil (examples: coal and urban waste).

- A single central heating source can *provide thermal energy more efficiently* than a large number of individual boilers thus reducing consumption of scarce fuels.

- The *fixed* debt service on the capital outlay for a system does not increase year after year while the cost of continuous fuel purchases will continue to escalate.

District heating *benefits the environmental quality* of a community:

- The *emissions discharge* to the atmosphere from a controllable single source *can be less* than the discharges from a large number of separate furnaces and boilers.

- *Thermal pollution* of the atmosphere *is reduced* by using a more efficient and properly maintained single central heat source rather than many small boilers and furnaces.

- *Fire safety* is increased by eliminating the major combustion source from a significant number of buildings.

- *Space requirements for heating equipment* in buildings *are reduced.*

District heating is *more adaptable* to fuel source availability:

- District heating systems are *able to use the more readily available fuel sources.*

- District heating may use thermal energy generated from *multiple fuel sources* (coal, gas, oil, electricity, propane, biomass, etc.)

Most importantly, communities may use district heating as an important component of their individual economic development and energy conservation strategies.

The role district heating may play in a community depends on local needs, physical characteristics and available resources. District heating systems can be small scale such as hospital complexes, shopping centers, residences and commercial developments, or large scale, such as entire downtown or metropolitan areas. The implementation of district heating is also a social decision which can enhance the entire community welfare.

With such an impressive list of advantages, why is district heating an emerging technology in the United States rather than a continuing and expanding technology as in Europe?

The difference between United States and European district heating development is due mainly to different social structures and energy costs, two factors which strongly affected the social decision making process after World War II. Because of these differences, institutional barriers now exist in the United States which impede the implementation of district heating systems.

The advantages of district heating point to a need to overcome remaining institutional barriers and effect necessary changes. This can be done only through cooperative effort.

The advantages of a more efficient technology are apparent. District heating can increase our self-reliance. It can solve social problems through both the private and local government sectors. District heating can mean good business for the utility, the consumer, the local government and, at the same time, be in the best interest of our national objectives.

7.2.2 Problems

The cost of financing is the major influence on district heating projects because of large initial capital investment requirements.

A district heating system is a major capital project. For example, the estimated cost of the proposed district heating system in Moorhead is $26.1 million. Development costs of a proposed system for Bagley are $4.5 million.

District heating is very capital intensive. Capital, not fuel or labor, is the major cost element. Depending on the cost of finance, capital can represent anywhere from 60 percent to 85 percent of the cost of district heat in the early years of a project. Here are some complications:

- A lack of risk capital is due to the inability of business or government to assume single total risk for the planning phases.

- Highly capital-intensive district heating systems that would provide significant long run energy savings often have large initial operating deficits.

- Adequate customer demand to support the development and financing of a proposed system is difficult to ensure.

- There is limited investor knowledge of district heating as an alternative energy concept.

7.3 History of District Heating

7.3.1 United States

Steam district heating was developed in the United States over 100 years ago. The first commercial district heating project in New York was introduced about 1877 by Birdsill Holly, an engineer. Holly constructed a boiler and a neighborhood piping system and named it the Holly Steam Combination Company.

The world's first large-scale district heating system began in 1881 when Charles Emery laid the first district heating pipes in Manhattan for the Steam Heating and Power Company of New York. At the same time, Thomas Edison was installing his first electric lines in downtown New York. Steam service has been continuous in New York since 1879. Consolidated Edison of New York today has one of the world's largest district heating operations. In 1978, the utility sold 32 billion pounds of steam to 2,300 different customers.

District heating spread throughout the country. By 1910, 150 local utility companies were providing heat to downtown buildings by piping by-product steam from small, centrally located electrical plants.

Conditions changed, however. Technological improvements in electrical generation and transportation technology allowed construction of larger new plants farther away from developed areas. Utilities then closed the small plants so favorably located for district heat.

Added to this trend was the growing use of natural gas and oil. During the 1940's, government controls created cheaper prices for natural gas and oil. At that time, district heating systems were dependent on a single fuel and usually a single plant. They generally could not adapt to another fuel source. Many went out of business.

The use of district heating has dropped off in the United States since the turn of the century. In 1980, 13,142 customers in the United States were served by district heating provided by member companies of the International District Heating Association (IDHA). Statistics compiled by IDHA show that 44 member steam-supply companies are currently active in the United States. Over the past 14 years, the annual growth rate for the top 14 district heating utilities was about 3.5 percent. If the definition of district heating is expanded to include nonutility central steam hot water systems (e.g., large governmental institutions and college campuses), it is estimated that district heating provides only about one percent of the total demand for heating in the United States.

7.3.2 Europe

In contrast, European district heating systems have been growing dramatically since World War II. There are four primary reasons for the European success with district heating:

- European countries faced higher energy costs and scarce petroleum supplies long before the United States. They adopted aggressive policies to minimize the impact of these costs on their economic development.

- Business and government formed a partnership to work within a stable policy framework provided by the government. Because of the initial capital intensive nature of district heating, neither sector alone could have achieved success.

- Public and private investment in energy technologies has been consistent with the energy savings potential. France, for example, has recently launched a major program to accelerate the displacement, through district heating, of all oil used now for heating.

- Most systems in Europe use hot water to distribute heat rather than steam as used in the United States. Hot water is a better medium for transporting heat relatively long-distances. Pumps can be installed along the transmission pipes to move the hot water.

7.4 Development Potential in the United States

Although district heating does not supply a large portion of United States energy demand, studies have identified the following potential contributions:

- Oil or natural gas equivalent savings could be as much as 2.5 million barrels a day by the year 2000.

- Dollar savings range from $14 to $28 billion annually by the year 2000, based on 1980 oil prices at $30 per barrel.

- The efficiencies of district heating and cooling can reduce our energy consumption by the end of the century by five to seven quads. (If all of the energy came from imported oil at current prices, the United States would have roughly $50 billion per year that could go into productive investments in this country rather than going abroad.) Conservatively, if even a third of these potential new district heating and cooling systems displace imported oil, more than $10 billion per year could be going into productive investments in this country by the end of the century rather than going abroad. One quad, equal to the energy used in running five million cars or heating and cooling seven million homes for one year, costs our country $7 billion in our balance of trade. The United States currently uses 78 quads of energy each year.

Some conditions have already changed:

- Large urban centers are demanding decreased reliance on oil and gas due to escalating and uncertain prices and curtailment experiences.

- Decontrol of oil and gas prices will make alternative energy supply systems more attractive.

- Several characteristics of modern district heating and cooling systems are attractive to customers. A hookup is simpler, safer and more reliable. It also requires less maintenance and repair than individual furnaces and boilers.

- Some progressive utility companies are beginning to explore the receptivity of regulatory commissions to alternative profit centers that include district heating and cooling systems as new business ventures.

Additional conditions necessary for favorable development include:

- *Regulatory reform* to allow recovery of investment on par with nonutility types of enterprise.

- *Feasibility and demonstration.* If the feasibility of district heating is reliably determined and demonstration projects are reasonable examples of technology and profitability, the industry will follow. Promptness is essential. Diversity in climate and environment necessitates multiple demonstration projects. Feasibility and demonstration programs now under way or being considered are modest in relation to the savings in critical fuels that may be realized.

- *Tax reform* is needed to allow district heating facilities to be eligible for tax-exempt industrial revenue financing, to allow an increased rate of amortization for district heating and cooling equipment, and to encourage the residential market by allowing an energy credit for district heating retrofit costs.

- *Reduce governmental constraints.* Some district heating utilities are in a no-growth state because of conflicting and misunderstood limitations imposed by the federal government. Review and revision by a joint industry/government committee with prompt correction is needed.

- *Financial Assistance.* United States utilities currently are having great difficulty raising funds for capital projects, regardless of their need. Some assistance from the federal level, such as low interest loans, is a needed incentive.

Recent studies and market assessments have attempted to measure current conditions for district heating development feasibility.

In 1979, the federal Department of Energy began a large scale demonstration program to determine whether conditions were favorable for modifying an existing electrical plant for cogeneration and the installation of a distribution piping network. The electricai plant had to be base or intermediate loaded in order to ensure adequate hours of operation and projected years of further operation. Two states (Minnesota and Wisconsin), two large metropolitan areas (Philadelphia and Detroit), one region (the northeast New Jersey region served by PSE & G Company), one medium sized city (Toledo, Ohio) and two small cities (Piqua, Ohio and Dover, Ohio) were selected. At the same time, the Minneapolis/St. Paul area was investigated in potential application of a large district heating system.

The early analyses showed that such installations should be feasible for a radius of up to ten miles from a central business district having a minimum density of 1,000 people per square mile and experiencing costs above $.04 per KWH.

7.5 # District Heating in Minnesota

Although steam district heating flourished in Minnesota in the early 1900's, only 14 district heating systems remain in operation today. The others went out of business because of changing economies and technology. The remaining systems still may be in jeopardy, despite more favorable conditions for district heating.

Minnesota has taken action to stem this abandonment process as it also seeks ways to promote new district heating as a viable energy alternative. The state has recognized that district heating is a promising option. Several factors favor district heating development in Minnesota:

- Minnesota is nearly totally dependent on energy sources outside the state.
- The state relies heavily on increasingly expensive and less available fuels-oil and natural gas.
- Minnesota has a large potential heat demand for district heating.
- Minnesota has several electrical generating plants that are suitable for cogeneration.
- The state has a cold climate and a tradition of district heating development.
- Minnesota has become increasingly aware of the availability of and the need to develop alternative local energy resources.

Preliminary designs for new hot water cogeneration district systems were developed in Moorhead, Red Wing and St. Paul/Minneapolis. These systems would use reject heat from coal-fired power plants in the communities. Preliminary designs for hot water district heating systems using waste wood from local industry were developed in Aitkin and Bagley, Minnesota.

There is significant potential for district heating throughout the state. If it were developed in all Minnesota communities with populations greater than 5,000, the total heat delivered by the year 2000 would be 44 trillion Btu's per year. This is about 3.5 percent of the state's targeted primary energy demand in the year 2000. Since about 60 percent of this would be cogenerated, the heat would be produced by fuel also used to generate electricity. The energy saved through cogeneration would be 28 trillion Btu's per year. This is equivalent to 200 million gallons of oil per year.

7.5.1 Saint Paul

A demonstration district heating system in St. Paul will contain all the elements of a full-scale system, including cogeneration, hot water transmission and distribution, and conversion of heating systems in existing buildings. The area of the city that has been selected for the demonstration system will become the nucleus of an expanded St. Paul/ Minnepolis system.

The $70 million St. Paul system will generate 165 MW and serve the downtown area and the State Capitol Complex. Construction is slated to start early in 1983 with service beginning in late 1983.

7.5.2 Moorhead

A proposed system for Moorhead, a city of 30,000, would reach 60-100 MW in 10 years with potential growth of 200 MW. Two major customers, Moorhead State University and Concordia College amount for 42 percent of the total initial service load of 65 MW.

Final engineering design will be complete in early 1982. Construction is anticipated to start in early 1983 with sevice beginning late the same year. The total estimated investment is $26 million.

7.5.3 Bagley

Bagley is a community totally dependent on fuel oil for commercial and residential heating.

Before 1979, a nonmarketable wood residue produced by a large sawmill operating in Bagley was either burned or disposed of in landfills. Now, significant quantities of wood residue are available for use as fuel. Bagley plans to use the residue to fuel a hot water district heating system to serve industry, the public school, hospital, commercial district and anticipated industrial expansion.

The district heating system will be sized at about 12 MW. Funding for final engineering design and feasibility was secured from the state. Development costs are estimated at $4.5 million.

7.5.4 Willmar

Willmar is in the process of converting an existing steam cogeneration district heating system to a new hot water system.

The existing steam system is 60 years old and has 117 customers. The total load is currently 12 MW steam.

In Phase I, 76 customers in the downtown area will convert their systems from steam to hot water. This will be done in conjunction with the downtown redevelopment project.

Phase I construction is scheduled to begin May 1, 1982. Operation of the downtown hot water system is scheduled for fall 1982. This project is the first implementation of modern hot water district heating technology in the United States.

7.6 Summaries of Other District Heating Projects and Development Experiences

7.6.1 District Heating in Sweden

Sweden's heavy dependence on imported fossil fuels forced it to look for economical energy technologies. Sweden has a readymade institutional pattern for organizing district heating, as electric power is produced by 12 major government utilities and urban distribution is provided by community-owner enterprises that distribute electricity and hot water. There are 70 district heating utilities in Sweden. At least fifty percent of the major utilities are privately owned.

The Swedish government has supported the expansion of district heating through various legislation. The District Heating Act enables local authorities to declare district heating public, obligating it to serve any applicant and to enjoin property owners to connect to mains where accessible. Loans and grants are available to subscribers to connect to district heating systems.

Because of government subsidies, Swedish utilities offer consumers heating rates equal to those of the lowest cost alternative systems. (The government, however, has recently discontinued its grants program for the expansion of hot water district heating systems).

Swedish authorities claim their step-by-step approach to hot water district heating is particularly significant. Small mobile boilers provide the heat. As the number of customers increases, more permanent boilers are installed. Later, when demand justifies, a large cogenerating plant may be built. This progression from small to large postpones heavy financial investment until there are sufficient subscribers to support it.

7.6.2 District Heating in Denmark

District heating has a long history in Denmark, originating in 1900. Cogeneration of power and heat has been ongoing in Europe since the mid-1920's. After World War II, electric power production was expanded by the construction of large base-load power stations, a few of which also supplied heat. At this time, many electric generating units in smaller stations were shut down, but due to the district heating commitment, boilers remained in service. Some stations expanded their boiler capacity for heat-only purposes, and distribution networks were gradually extended. At the same time, new heat-only plants were established, even in small communities. In the 1950's peak load boiler plants were built to supplement the cogenerated heat from large stations.

Currently, about 30 percent of heat requirements for housing are supplied by district heating, up from 15 percent in 1963. Some 43 percent of apartment units and 23 percent of individual houses were supplied by district heating in 1978. About 70 percent of district heat is furnished to dwellings and 30 percent to commercial and public buildings. Nine of the principal power stations and four of the secondary plants in Denmark are suppliers of combined heat and power, covering approximately 10 percent of the heat consumption of the country.

The Danish government attaches high priority to the expansion of the combined heat and power systems and, during recent years, has provided subsidies of up to 25 percent for new heat transmission mains. As a result of this support, it is expected that by 1985, combined systems will provide 25 percent of all space and water heating service.

There are currently about 380 district heating enterprises in Denmark, but their numbers are diminishing due to consolidations. The systems are owned by consumers either indirectly through local governments, or directly in the form of cooperatives. There are approximately 50 government run systems, producing 60 percent to 70 percent of all heat distributed.

A number of different tariff forms are employed, but the one most generally used has a combination fixed and variable cost rate structure. The fixed cost portion of the rate is based on the consumer's maximum capacity for service, usually measured in cubic meters of room volume or square meters of floor space. The variable costs are recovered in the tariff in accordance with heat consumption measured by hot water volume metering. Because of the variances among customer inlet and outlet temperature differentials, energy meters that measure both temperatures and water volume are coming into use.

7.6.3 District Heating in the USSR

The centrally planned economy of the USSR has enabled the Soviets to construct large-scale combined electric power and hot water district and process steam thermal power plant. This was possible because the location, size and composition of new communities, including industrial plants, is determined by Government Institutes in Moscow. At the end of 1975, there were 970 combined heat and power stations in the USSR. These stations carried about 57 percent of the district heating load and 37 percent of all space heating requirements.

New towns or satellite communities in the USSR are built peripherally around an existing city within a radius of 60 miles (97 km) or approximately an hour commute by public transportation. When planning new communities, loads are forecast on a five to ten year basis based on phased construction steps. Heat loads are calculated at 18.43 Btu per square foot. Before a new thermal power station is built for such communities an 8,000 to 12,000 million Btu/hr heat load and a 200 MW electrical load is required. In the interim, heat-only boiler plants supply the hot water district heating system and electric power is supplied by new transmission links to the national grid.

The majority of existing thermal plants in the USSR are 50 MW in capacity. Moscow has a hot water district heating distribution system with 24 miles (39 km) of hot water piping in diameters up to 4.6 feet (140 cm). The heating season in Moscow starts in October and ends in May.

7.6.4 Other Countries

Other European countries including the Netherlands, England, and France, adopted district heating programs to meet their energy needs after World War II. Today, Japan and Canada also have strong commitments to this technology.

Approximately 200 plants in Western Europe burn urban waste to generate heat and sometimes electricity. Munich, Germany obtains about 12 percent of its electricity as well as district heating from garbage incineration. Parisian district heating and electric generation are accomplished by processing Paris refuse. At Nottingham, England, refuse and local coal fuel the central city district heating operation.

Europeans consider accelerated district heating programs a means of relief from dependence on imported oil.

- West Germany meets nearly one third of its electricity demand from cogeneration.

- Great Britain gives grants to businesses investing in district heating.
- Austria, Denmark, the Netherlands and Norway offer low interest loans to industries putting capital into energy saving equipment.

7.7 Sample Heat Load Survey Form

Date ____________________

Building/business name and address ____________________

____

____

Owner ____________________

Name of Survey Respondent ____________________

Phone ____________________

1. Approximate age of building ____________________
2. Approximate total floor area (square feet) ____________________

   Number of Floors Heated ______

   Approximate Ceiling Height ______
3. Windows (check one): Double Pane ☐

   Single Pane ☐
4. Present heating system (check and fill in as appropriate; if a combination of systems are used, indicate approximate percentage of each):

Forced air and electric resistance systems (check one or more)

- ☐ Gas/propane-fired furnace (inside)
- ☐ Gas/propane-fired furnace (roof-top)
  - ☐ direct or ☐ indirect fired?
- ☐ Oil-fired furnace (inside)
- ☐ Oil-fired furnace (roof-top)
- ☐ Electric resistance (inside)
- ☐ Electric resistance baseboard or ceiling
- ☐ Roof top electric coil
- ☐ Roof top steam coil
- ☐ Roof top hot water coil
- ☐ Other (please specify: ________________)

Approximate age of system: ______years.

Steam/hot water boiler systems

☐ Steam ☐ Hot Water ☐ One Pipe Steam System

☐ Gas-fired ☐ Oil-fired ☐ Combination gas and oil

Number of boilers: ___________

Capacity: ___________ horsepower, or ___________lbs./hr.

Pressure: ___________ P.S.I.

Temperature: ___________ F°

Approximate age of system: ___________ years

Air handling system

- ☐ Steam coil
- ☐ Hot water coil
- ☐ Electric coil

Approximate age of system: ___________ years

5. **Domestic hot water heaters:**

   - ☐ Gas-fired
   - ☐ Oil-fired
   - ☐ Electric
   - ☐ Steam or hot water from boiler system

   Approximate age of system: __________ years

6. Do you presently have any large uses for thermal energy other than for space heating and hot water which might be supplied by a central steam hot water district heating system? If any of these potential uses have unusual peak requirements or seasonality of usage, please describe.

   ____

   ____

   ____

   Temperature needed: __________ F°

   Approximate amount: __________

7. Is any major expansion or other change planned for the near-term future which could alter your energy consumption?

   ____

   ____

   ____

8. **Fuel Purchases**

   Type of energy used for *heating* purposes:

   Oil ________________ Gal/yr.

   Natural gas ____________ MCF/yr.

   Propane ____________ Gal/yr.

   Electric ______________ Kwh/yr.

   Other ____________________

   Specify Units ______________

This data is for

- ☐ space heating only
- ☐ space heating and hot water

Question 8 looks for actual heating load of buildings—not the equivalent gross energy purchased.

9. Building Energy Consumption Estimate.

Floor Area Method

Bldg. Use	Area $(ft)^2$		(Btu/ft² yr.) Energy Use Factor		Annual Energy Use (Btu/year)
Clinic	______	x	58,000	=	______
Community Center	______	x	45,000	=	______
Gymnasium	______	x	59,000	=	______
Hospital	______	x	140,000	=	______
Hotel/Motel	______	x	74,000	=	______
Multifamily High-Rise	______	x	58,000	=	______
Multifamily Low-Rise	______	x	45,000	=	______
Nursing Home	______	x	72,000	=	______
Office Large	______	x	51,000	=	______
Office Small	______	x	48,000	=	______
School Elementary	______	x	50,000	=	______
School Secondary	______	x	57,000	=	______
Shopping Center	______	x	82,000	=	______
Store	______	x	64,000	=	______
Theater/ Auditorium	______	x	65,000	=	______
Warehouse	______	x	38,000	=	______
Total	______				______

This is a very crude estimate for those who do not have any other way of estimating building energy consumption.

Alternate Building Energy Consumption Estimate 1980-1982 Fuel Use Data Method

	Fuel Oil		Gas	
	Gallons	$	CCF	$
July				
August				
September				
October				
November				
December				
January				
February				
March				
April				
May				
June				
Total				

Building Energy Consumption Calculation

________ total gals. (oil) x 150,000 Btu/gal. x 60% = ________ Btu/year.

________ total CCF* (gas) x 100 x 1000 Btu/ft.^{3} x 70% = ________ Btu/year.

*Note: One CCF = 100 cubic feet.

7.8 Sample Environmental Assessment Worksheet

Minnesota Environmental Quality Board Environmental Assessment Worksheet (EAW) and Notice of Findings

Do not write in this space

E.R.# ____________

Note: The purpose of the Environmental Assessment Worksheet (EAW) is to provide information on a project so that one can assess rapidly whether or not the project requires an Environmental Impact Statement. Attach additional pages, charts, maps, etc., as needed to answer these questions. Your answers should be as specific as possible. Indicate which answers are estimated.

I. Summary

A. Activity finding by responsible agency (person)

☐ Negative Declaration (No EIS) ☐ EIS Preparation Notice (EIS Required)

B. Activity identification

1. Project name or title ____________________

2. Project proposer(s) ____________________

   Address ____________________

   Telephone Number and Area Code ____________________

3. Responsible Agency or Person ____________________

   Address ____________________
   Person in Responsible Agency (Person) to contact for information on this EAW:

   ____________________ Telephone: ____________________

4. This EAW and other supporting documentation are available for public inspection

   and/or copying at: Location ____________________

   Telephone ____________________ Hours ____________________

5. Reason for EAW Preparation
   - ☐ Mandatory Category-cite MEQB Rule number(s)
   - ☐ Petition ☐ Other

C. Activity description summary

1. Project location

   County ____________ City/Township name ____________

   Township number ______ (North), Range Number ______ East or West (circle one),

   Section number(s) ______ Street address (if in city) or legal description:

   ____

2. Type and scope of proposed project:

3. Estimated starting date (month/year) ____________

4. Estimated completion date (month/year) ____________

5. Estimated construction cost ____________

6. List any federal funding involved and known permits or approvals needed from each unit of government and status of each:

Unit of Government (federal, State, regional, local)	Name or Type of Permit/Approval or Federal Funding	Status

7. If federal permits, funding or approvals are involved, will a federal EIS be prepared under the National Environmental Policy Act? No ☐ Yes ☐ Unknown ☐

II. Activity description

A. Include the following maps or drawings:

1. A map showing the regional location of the project.

2. An original 8-1/2 x 11 section of a U.S.G.S. 7-1/2 minute, 1:24,000 scale map with the activity or project area boundaries and site layout delineated. Indicate quadrangle sheet name. (Original U.S.G.S. sheet must be maintained by Responsible Agency; legible copies may be supplied to other EAW distribution points.)

3. A sketch map of the site showing location of structures and including significant natural features (water bodies, roads, etc.).

4. Current photos of the site must be maintained by the Responsible Agency. Photos need not be sent to other distribution points.

B. Present land use.

1. Briefly describe the present use of the site and lands adjacent to the site.

2. Indicate the approximate acreages of the site that are:

   a. Urban development ________ acres
   b. Urban vacant ________ acres
   c. Rural developed ________ acres
   d. Rural vacant ________ acres
   e. Designated Recreation/Open Space ________ acres
   f. Wetlands (Type III, IV, V) _______ acres
   g. Shoreland _______ acres
   h. Floodplain _______ acres
   i. Cropland/Pasture land _______ acres
   j. Forested _______ acres

3. List names and sizes of lakes, rivers and streams on or near the site, particularly lakes within 1,000 feet and rivers and streams within 300 feet.

C. Activity Description

1. Describe the proposed activity, including staging of development (if any), operational characteristics, and major types of equipment and/or processes to be used. Include data that would indicate the magnitude of the proposed activity (e.g. rate of production, number of customers, tons of raw materials, etc.).

2. Fill in the following where applicable:

   a. Total project area ______ acres or Length ______ miles
   b. Number of housing or recreational units ______
   c. Height of structures ______ ft.
   d. Number of parking spaces ______
   e. Amount of dredging ______ cu.yd.
   f. Liquid wastes requiring treatment ______ gal/da
   g. Size of marina and access channel (water area) ______ sq.ft.
   h. Vehicular traffic trips generated per day ______ ADT
   i. Number of employees ______
   j. Water supply needed ______ gal/da Source: ______
   k. Solid waste requiring disposal ______ tons/yr
   l. Commercial, retail or industrial floor space ______ sq.ft.

III. Assessment of potential environmental impact

A. Soils and Topography

1. Will the project be built in an area with slopes currently exceeding 12%? No☐ Yes☐

2. Are geologically unstable areas involved in the project, such as fault zones, shrink-swell soils, peatlands, or sinkholes? No☐ Yes☐

3. If yes, describe slope conditions or unstable area and any measures to be used to reduce potential adverse impacts.

4. Indicate suitability of site soils for foundations, individual septic systems, and ditching, if these are included in the project.

5. Estimate the total amount of grading and filling which will be done:

   ______ cu.yd grading ______ cu.yd. filling
   What percent of the site will be so altered? ______ %

6. What will be the maximum finished slopes? ______ %

7. What steps will be taken to minimize soil erosion during and after construction?

B. Vegetation

1. Approximately what percent of the site in each of the following vegetative types:

   Woodland ______ %
   Brush or shrubs ______ %
   Grass or Herbaceous ______ %
   Cropland/Pasture ______ %
   Marsh ______ %
   Other ______ % (specify)

2. How many acres of forest or woodland will be cleared, if any? ______ acres

3. Are there any rare or endangered plant species or areas of unique botanical or biological significance on or near the site? (See DNR publication *The Uncommon Ones*.) No☐ Yes☐

If yes, list the species or area and indicate any measures to be used to reduce potential adverse impact.

C. Fish and wildlife

1. Are there any designated federal, state or local wildlife or fish management areas or sanctuaries near or adjacent to the site? No☐ Yes☐
2. Are there any known rare or endangered species of fish and wildlife on or near the site? (See DNR publication *The Uncommon Ones*.) No☐ Yes☐
3. Will the project alter or eliminate wildlife or fish habitat? No☐ Yes☐
4. If yes on any of questions 1-3, list the area, species or habitat, and indicate any measures to be used to reduce potential adverse impact on them.

D. Hydrology

1. Will the project include any of the following? If yes, describe type of work and mitigative measures to reduce adverse impacts.

	No	Yes
a. Drainage or alteration of any lake, pond, marsh, lowland or groundwater supply	_______	_______
b. Shore protection works, dams, or dikes	_______	_______
c. Dredging or filling operations	_______	_______
d. Channel modifications or diversions	_______	_______
e. Appropriation of ground and/or surface water	_______	_______
f. Other changes in the course, current or cross-section of water bodies on or near the site	_______	_______

2. What percent of the area will be converted to new impervious surface? _____ %

3. What measures will be taken to reduce the volume of surface water runoff and/or treat it to reduce pollutants (sediment, oil, gas, etc.)?

4. Will there be encroachment into the regional (100 year) floodplain by new fill or structures? No☐ Yes☐

   If yes, does it conform to the local floodplain ordinance? No☐ Yes☐

5. What is the approximate minimum depth to groundwater on the site? _______feet

E. Water quality

1. Will there be a discharge of process or cooling water, sanitary sewage or other waste waters to any water body or to groundwater? No☐ Yes☐

   If yes, specify the volume, the concentration of pollutants and the water body receiving the effluent.

2. If discharge of waste water to the municipal treatment system is planned, identify any toxic, corrosive or unusual pollutants in the wastewater.

3. Will any sludges be generated by the proposed project? No☐ Yes☐

   If yes, specify the expected volume, chemical composition and method of disposal.

4. What measures will be used to minimize the volumes or impacts identified in question 1-3?

5. If the project is or includes a landfill, attach information on soil profile, depth to water table, and proposed depth of disposal.

F. Air quality and noise

1. Will the activity cause the emission of any gases and/or particulates into the atmosphere? No☐ Yes☐

   If yes, specify the type and origin of these emissions, indicate any emission control devices or measures to be used, and specify the approximate amounts for each emission (at the source) both *with and without* the emission control measures or devices.

2. Will noise or vibration be generated by construction and/or operation of the project? No☐ Yes☐

   If yes, describe the noise source(s); specify decible levels [dB(A)], and duration (hrs/da) for each and any mitigative measures to reduce the noise/vibration.

3. If yes on 1 or 2, specify whether any areas sensitive to noise or reduced air quality (hospitals, elderly housing, wilderness, wildlife areas, residential developments, etc.) are in the affected area and give distance from source.

G. Land resource conservation, energy

1. Is any of the site suitable for agricultural or forestry production or currently in such use? No☐ Yes☐

   If yes, specify the acreage involved, type and volume of marketable crop or wood produced and the quality of the land for such use.

2. Are there any known mineral or peat desposits on the site? No☐ Yes☐

   If yes, specify the type of deposit and the acreage.

3. Will the project result in an increased energy demand? No☐ Yes☐

a. Energy requirements (oil, electricity, gas, coal, solar, etc.)

Type	Estimated Annual Requirement	Peak Demand *Hourly or Daily* Summer Winter	Anticiptated Supplier	Firm Contract or Interruptible Basis?

b. Estimate the capacity of all proposed on-site fuel storage.

c. Estimate annual energy distribution for: ventilation ______ %

space heating ______ % lighting ______ %

air conditioning ______ % processing ______ %

d. Specify any major energy conservation systems and/or equipment incorporated into this project.

e. What secondary energy use effects may result from this project (e.g. more or longer car trips, induced housing or businesses, etc.)?

H. Open space recreation

1. Are there any designated federal, state, country or local recreation or open space areas near the site (including wild and scenic rivers, trails, lake accesses)? No☐ Yes☐

If yes, list areas by name and explain how each may be affected by the project. Indicate any measures to be used to reduce adverse impacts.

I. Transportation

1. Will the project affect any existing or proposed transportation systems (highway, railroad, water, airport, etc)? No☐ Yes☐

   If yes, specify which part(s) of the system(s) will be affected. For these, specify existing use and capacities, average traffic speed and percentage of truck traffic (if highway); and indicate how they will be affected by the project (e.g. congestion, percentage of truck traffic, safety, increased traffic (ADT), access requirements).

2. Is mass transit available to the site? No☐ Yes☐

3. What measures, including transit and paratransit services, are planned to reduce adverse impacts?

J. Planning, land use, community services

1. Is the project consistent with local and/or regional comprehensive plans? No☐ Yes☐

   If not, explain:

   If a zoning change or special use permit is necessary, indicate existing zoning and change requested.

2. Will the type or height of the project conflict with the character of the existing neighborhood? No☐ Yes☐

If yes, explain and describe any measures to be used to reduce conflicts.

3. How many employees will move into the area to be near the project? ____________

   How much new housing will be needed? ______________________________

4. Will the project induce development nearby—either support or services or similar developments? No ☐ Yes ☐

   If yes, explain type of development and specify any other counties and muncipalities affected.

5. Is there sufficient capacity in the following public services to handle the project and any associated growth?

Public service	**Amount required for project**	**Sufficient capacity?**
water	gal/da	
wastewater treatment	gal/da	
sewer	feet	
schools	pupils	
solid waste disposal	ton/mo	
streets	miles	
other (police, fire, etc.)		

If current major public facilities are not adequate, do existing local plans call for expansion, or is expansion necessary strictly for this one project and its associated impacts?

6. Is the project within a proposed or designated Critical Area or part of a Related Actions EIS or other environmentally sensitive plan or program reveiwed by the EQB? No ☐ Yes ☐

   If yes, specify which area or plan.

7. Will the project involve the use, transportation, storage, release or disposal of potentially hazardous or toxic liquids, solids or gaseous substances such as pesticides, radioactive wastes, poisons, etc.? No☐ Yes ☐

   If yes, please specify the substance and rate of usage and any measures to be taken to minimize adverse environmental impacts from accidents.

8. When the project has served its useful life, will retirement of the facility require special measures or plans? No☐ Yes☐

   If yes, specify:

K. Historic resources

1. Are there any structures on the site older than 50 years or on federal or state historical registers? No☐ Yes☐

2. Have any arrowheads, pottery or other evidence of prehistoric or early settlement been found on the site? No☐ Yes☐

   Might any known archaelogic or paleontological sites be affected by the activity? No☐ Yes☐

3. List any site or structure identified in 1 and 2 and explain any impact on them.

L. Other environmental concerns

Describe any other major environmental effects which may not have been identified in the previous sections.

IV. Other mitigative measures

Briefly describe mitigative measures proposed to reduce or eliminate potential adverse impacts that have not been described before.

V. Findings

A. The project is a private ☐ government ☐ action. The Responsible Agency (Person), after consideration of the information in this EAW, and the factors in Minn. Reg MEQB 25, makes the following findings.

1. The project is ☐ is not ☐ a major action.
   State reasons:

2. The project does ☐ does not ☐ have the potential for significant environmental effects.
   State reasons:

3. (For private actions only.) The project is ☐ is not ☐ of more than local significance.
   State reasons:

VI. Conclusions and certification

Note: A Negative Declaration or EIS Preparation Notice is not officially filed until the date of publication of the notice in the *EQB Monitor* section.

A. I, the undersigned, am either the authorized representative of the Responsible Agency or the Responsible Person identified below. Based on the above findings, the Responsible Agency (Person) makes the following conclusions. (Complete *either* 1 or 2.)

☐ **1. Negative Declaration Notice**
No EIS is needed on this project, because the project is not a major action

and/or does not have the potential for significant environmental effects and/or, for private actions only, the project is not of more than local significance.

☐ **2. EIS preparation notice**

An EIS will be prepared on this project because the project is a major action and has the potential for significant environmental effects. For private actions, the project is also of more than local significance.

a. The MEQB Rules provide that physical construction or operation of the project must stop when an EIS is required. In special circumstances, the MEQB can *specifically authorize* limited construction to begin or continue. If you feel there are special circumstances in this project, specify the extent of progress recommended and the reasons.

b. Date Draft EIS will be submitted: ______________________________
(month) (day) (year)

(MEQB Rules require that the Draft EIS be submitted *within 120 days* of publication of the EIS Preparation Notice in the *EQB Monitor*. If special circumstances prevent compliance with this time limit, a written request for extension explaining the reasons for the request must be submitted to the EQB Chairman.

c. The Draft EIS will be prepared by [list Responsible Agency(s) or Person(s)]:

B. Attach an affidavit certifying the date that copies of this EAW were mailed to all points on the official EQB distribution list, to the city and county directly impacted, and to adjacent counties or municipalities likely to be directly impacted by the proposed action (refer to question III.J.4. on page 10 of the EAW). The affidavit need be attached only to the copy of the E.A.W. which is sent to the EQB Administrator.

C. Billing procedures for *EQB Monitor* Publication.

State agency ONLY:

Attach to the EAW sent to the EQB Administrator a completed OSR 100 form (State Register General Order Form — available at Center Stores). For instructions, please contact your Agency's Liaison Officer to the *State Register* or the Office of the State Register — (612) 296-8239.

I hereby certify that the information contained in this document is true and correct to the best of my knowledge.

____ Signature

____ Title

____ Date

7.9 Resources

Energy Division, Department of Energy, Planning and Development
980 American Center Building
150 East Kellogg Boulevard
St. Paul, MN 55101
(612) 296-5120

Energy Information Center
(612) 296-5175

Mary Lesch, Administrator
District Heating Projects
(612) 297-2324

Ronald E. Sundberg, Manager
Engineering Analysis
(612) 296-2324

Karen Martin, Manager
Community and Special Services
(612) 296-8899

Minnesota Department of Energy, Planning and Development
480 Cedar Street
St. Paul, MN 55101
(612) 296-5005

Dana Young, Director
Development Resources Division
(612) 296-3976

Fred Grimm
Local & Urban Affairs Office
(612) 296-3088

Upper Midwest Section
International District Heating Association
138 Bremer Building
417 North Robert Street
St. Paul, MN 55101
(612) 297-8955

International District Heating Association
1735 Eye Street Northwest
Suite 611
Washington, DC 20006
(202) 223-2922

Minnesota Environmental Quality Board
Capital Square Building
550 Cedar Street
St. Paul, MN 55101
(612) 296-2723

League of Minnesota Cities
300 Hanover Building
480 Cedar Street
St. Paul, MN 55101
(612) 222-2861

Minnesota Municipal Utilities Association (MMUA)
P.O. Box B
10 Central Avenue
Buffalo, MN 55313

Minnesota Project
618 East 22nd Street
Minneapolis, MN 55404
(612) 870-4700

7.10 Abbreviations

BTU — British Thermal Unit

CDBG — Community Development Block Grant

DEPD — Minnesota Department of Energy, Planning, and Development

EAW — Environmental Assessment Worksheet

EDA — U.S. Economic Development Administration

EIS — Environmental Impact Statement

EQB — Minnesota Environmental Quality Board

HUD — U.S. Department of Housing and Urban Development

IDHA — International District Heating Association

KM — Kilometer, 0.62137 mile

KW — Kilowatt, 1000 watts

MMUA — Minnesota Municipal Utilities Association

MW — Megawatt, 1000 kilowatts

UDAG — Urban Development Action Grant

7.11 # Bibliography

Articles

"The History of District Heating," *District Heating*, July-September 1976, pp. 18-23.

"One Danish Home in Three has District Heating Service," *Energy International*, October 1976, pp. 19-21.

"Prospects for District Heating in the United States," *Science,* Vol 195, 11 March 1977, pp. 948-955.

"There is a Case for Energy Conservation through District Heating," *Energy*, Fall 1975, pp. 24-26.

"Urban Utilization of Waste Energy from Thermal-Electric Power Plants," *Journal of Engineering for Power*, July 1976, pp. 309-319.

Books and Reports

"Allocation Methods for the Separation of Electrical and Thermal Cogeneration Costs," ORNL/TM-6830/P12, January 1980.

"An Assessment of Cogeneration Potential - Inventory of Large Heat Users of Minnesota," State Planning Agency, Environmental Quality Board, Minnesota State Planning Agency.

"Assessment of Existing and Prospective Piping Technology for District Heating Applications," Burns and Roe, Inc., September 1979.

"Assessment of Existing and Prospective Piping Technology for District Heating Applications, "Oliker, I., September 1979.

"An Assessment of the Potential for District Heating in Four Major Eastern Cities: Washington, D.C., Philadelphia, Baltimore, Boston," ANL/ICES-TM-11, August 1978.

"Barriers to the Financing of District Heating Systems," Bache Halsey Stuart Shields Incorporated, July 1981.

"Community Annual Storage Energy System, Parametric Analysis of Cases," W. R. Powell and C. E. Williams, Laurel, Maryland: The Johns Hopkins University, 1978.

Comprehensive Community Energy Planning, Volumes 1-3, Hittman Associates, Inc., November 1978, prepared for U.S. Department of Energy, Office of Building and Community Systems, DOE Report Nos. NCP/MOO23-01, 02 and 03, Washington, D.C.

"Costs of Urban Area Retrofit to District Heating and Cooling Systems: North Central Cities," ANL/ICES-TM-9, March 1978.

"Definition of Model Coal-Fired Electric Generating Stations in the 50 Megawatt to 2400 Megawatt Range," Burns and Roe, Engineers and Constructors, Oradell, New Jersey. Sponsored by Environmental Quality Board, Minnesota State Planning Agency.

"Development Options for Existing Municipal Steam District Heating Systems," Touche Ross & Company, For Minnesota Energy Agency, 1980.

"District Heating & Cooling 1981 Overview," Resource Development Associates, March 1981.

"District Heating — A New Energy Analysis of a Cogeneration-District Heating System and Two Conventional Alternatives," John C. Yeoman, Oak Ridge, Tennessee: Oak Ridge National Laboratory, 1979.

"District Heating from Electric Generating Plants and Municipal Incinerators: Local Planner's Assessment Guide," W. Pferdehirt and N. Kron, Jr., November 1980.

"District Heating in Minnesota: A Strategy for Small Communities," The Minnesota Project, April 1980.

"District Heating — Methods and Cost Estimates for Converting Existing Buildings to Hot Water District Heating," Ronald E. Sundberg and Hans O. Nyman, Oak Ridge Tennessee: Oak Ridge National Laboratory, 1979.

District Heating Presentation to the St. Paul Building Owners and Managers Association, by the St. Paul District Heating Development Company, August 1981.

"Dual Energy Use System — District Heating Survey," Electric Power Research Institute, July 1980.

"Economic and Technical Analysis of Retrofit to Cogenerating District Energy System: North Central Cities," ANL/CNSV-TM-11, June 1979.

"Energy Planning Guide for Minnesota Communities, Minnesota Department of Economic Development, St. Paul, MN, 1981.

"Evaluation of Available Computer Programs for District Heating/Cooling Distribution System," February 1980.

"Feasibility of Expanding the St. Paul District Heating System," C. T. Main, Inc., December 1978.

"Financing District Heating in Minnesota: Tax Increment Financing as a Revenue Source," League of Minnesota Cities, St. Paul, MN 1981.

"Generic Cost Estimates for District Heating Piping Systems, St. Paul, Minnesota," St. Paul District Heating Development Company, August 1979.

Helping Minnesotans Help Themselves: A Resource Guide for Community Groups and Local Officials, The Minnesota Project, 1981.

"High Bridge Power Plant Retrofit," United Engineers and Constructors, Philadelphia, Pennsylvania, Sponsored by Northern States Power Company, February 1979.

"Impact of a District Heating/Cogeneration System on Annual Average S02 Air Quality in the Twin Cities," ORNL/TM-6830/P11, January 1980.

"Institutional Issues of a New District Heating/Cogeneration System-Ownership Options, Barriers, and Implementation Strategy," ORNL/TM-6830/P5, January 1980.

Local and Regional Planning in Minnesota, League of Minnesota Municipalities, St. Paul, MN 1975.

"Market Development and Economic Analysis of the St. Paul District Heating System," ORNL/TM-6830/P10, December 1980.

"A Method for the Preliminary Feasibility Analysis of Community Energy Systems," Chinmei Lee et. al. Argonne, Illinois: Argonne National Laboratory.

"Methods and Cost Estimates for Converting Existing Buildings to Hot Water District Heating," ORNL/TM-6830/P5, December 1979.

"Minnesota: Financing," Minnesota Department of Economic Development, St. Paul, Minnesota, 1980.

"Minnesota Municipal District Heating Study," Pfeifer and Shultz/HDR, Inc., for Minnesota Energy Agency, July 1978.

"Minnesota Project: District Heating and Cooling Through Power Plant Retrofit and Distribution Network," Minnesota Energy Agency, June 1979.

"Moorhead District Heating, Final Report," draft, Moorhead, MN January 1981.

"Moorhead District Heating, Third Quarterly Report," Moorhead, MN, October 1980.

"Mountain Iron District Heating Redevelopment, Businss Plan," preliminary draft, Minnesota Energy Agency, March 1981.

1980 Energy Policy and Conservation Biennial Report, Minnesota Energy Agency, 1980.

Official Proceedings of the International District Heating Association, International District Heating Association, 1978, 1979, 1980, 1981.

"Overall Feasibility and Economic Viability for a District Heating/New Cogeneration System in Minneapolis-St. Paul," ORNL/TM-6830/P3, October 1979.

"Red Wing District Heating, Preliminary Feasibility Report, Under City Ownership Option," Touche-Ross & Company, August 1981.

"A Report on Economic Consequences of District Heating for the Minnesota State Capital Complex," Scantec, Inc., February 1981.

"Report on Rebuilding the North Side Heating System, Virginia, Minnesota," Pfeifer and Shultz/HDR, Inc., December 1978.

"Saint Paul District Heating Development Company, Incorporated, Preliminary Feasibility Report," Touche-Ross & Company, November 1980.

"Saint Paul District Heating System Conceptual Design Study and Report," Minnesota Energy Agency, June 1979.

"Saint Paul Energy Park: The Potential for District Heating," ANL/CNSV-TM-31, March 1980.

"Selection of Short and Long Term Development Options for Three Existing Steam District Heating Systems with Economic Difficulties," Touche-Ross & Company/Pfeifer and Shultz for Minnesota Energy Agency, May 1980.

Steam to Hot Water Conversion by an Existing Municipal District Heating Utility," Virginia, Minnesota Department of Public Utilities, Virginia, MN 1979.

"Systems Funding: Minnesota State Plan to Implement District Heating Systems," Minnesota Department of Economic Development, St. Paul, Minnesota 1981.

"A Test Case for the Potential Application of District Energy Systems Using Thermal Energy Cogenerated at Existing Power Plants," Santini, D. J., and Davis, A. A., January 1978.

"Urban Area District Energy System Study," Burns and Roe, Inc., Brookhaven National Laboratory, November 1977.

Miscellaneous

"Finn Energy '79," Finnish Ministry of Trade and Industry, 1979.

"Insulated District Heating Pipes," Swedish District Heating Association, October 1980.

"Swedish District Heating Workshop," Swedish Trade Commission, October 1978.