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GRID CONNECTED INTEGRATED COMMUNITY ENERGY SYSTEM

EXECUTIVE SUMMARY

FINAL REPORT

PHASE I

For Period

FEBRUARY 1, 1977 TO MAY 31, 1977

UNIVERSITY OF MINNESOTA PHYSICAL PLANT

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MINNEAPOLIS, MINNESOTA 55455

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JUNE 1977

Prepared For

THE U.S. ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION

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GRID-CONNECTED INTEGRATED COMMUNITY ENERGY SYSTEM FOR UNIVERSITY COMMUNITY

GENERATION OF BYPRODUCT ELECTRICITY

PLANT UTILIZATION INCREASED BY 54%
UTILITY BENEFITS GAINED BY PEAKING CAPACITY

HEALTH CARE INDUSTRY WASTE DISPOSAL

HEALTH CARE INCINERATORS ARE MARGINAL
PYROLYSIS PROCESS IS 70% EFFICIENT
ENERGY RECOVERY FROM WASTES PROVIDES 2 LBS
STEAM PER POUND OF WASTE
LANDFILL REDUCTION - 97% BY VOLUME

THERMAL DISTRIBUTION

STEAM - GENERATION OF BYPRODUCT ELECTRICITY AND
COMMUNITY HEATING
HOT WATER - REGENERATION OF ELECTRICITY AND
COMMUNITY HEATING

THERMAL STORAGE

DIURNAL - DEGRADATION ENERGY CONSERVING, INCREASE IN
BYPRODUCT GENERATION
SEASONAL - REDUCTION IN PLANT CAPACITY AND INVESTMENT

CENTRAL PLANT SITE

REDUCED PLANTS IN COMMUNITY
TRANSFER OF CRITICAL RESOURCES (OIL, GAS) TO COAL
IMPROVED USE OF PRIMARY RESOURCE-COAL

ENVIRONMENTAL QUALITY

PUBLIC FACILITIES AND USEAGE
IMPROVED COAL HANDLING
IMPROVED AIR QUALITY
ONE CENTRAL PLANT
CLOSED SYSTEM CYCLE

SOCIO-ECONOMIC

IMPROVED UTILIZATION OF NATURAL RESOURCES
IMPROVED ENVIRONMENT
REDUCED HEATING COSTS AS DEREGULATION OF GAS AND OIL AND
CURTAILMENT OF NATURAL GAS - OIL SUPPLIES OCCURS
MODEL SYSTEM READY FOR INTEGRATION INTO URBAN
DISTRICT HEATING SYSTEM
PROVIDES ECONOMICAL SITE FOR FUTURE STUDY

FOREWORD

The information contained in this Executive Volume represents a summary of the University of Minnesota's Phase I efforts and program outline for a Grid-Connected Integrated Community Energy System. It also includes some add-on information generated by the University.

The main work described by this Executive Summary consists of eight complete and separate volumes having the following titles:

- VOLUME 1 Summary and Demonstration Site Description
- VOLUME 2 Conventional Community Systems
- VOLUME 3A Integrated Demonstration Systems and Costs
- VOLUME 3B Integrated Demonstration Systems and Costs, Continued
- VOLUME 3C Integrated Demonstration Systems and Costs, Continued
- VOLUME 4 Integrated Solid Waste Management Systems
- VOLUME 5 Institutional and Socio-Economic Assessments
- VOLUME 6 Management Plan

EXECUTIVE SUMMARY

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OVERVIEW

The information contained in this Executive Summary has been prepared to present a brief review of the University of Minnesota's program for a Grid-Connected Integrated Community Energy System (ICES).

Schematics at the end of this overview discussion portray the location of ICES (Minneapolis Campus), and the general layout of the Community. An aerial photograph depicts the major facilities of ICES in relation to the overall Community. Finally a simplified process diagram of ICES is shown.

The Community energy system focuses on modifications to the University of Minnesota, Minneapolis Campus, central heating plant, wherein the capability of generating additional steam and by-product electricity will be established by acquiring a retired Northern States Power Company generating plant, Southeast Steam. The amount of by-product electricity will be controlled by heating and cooling requirements of the Community. What this really means is that the amount of electricity to be generated and fed into the Power Company's Grid will only occur when all the off-heat from the generation of electricity can be gainfully utilized by the Community's established heating and cooling systems. River water or cooling towers will not be utilized in this ICES concept. We project an energy reduction of 5,270 Btu per kilowatt of generation by ICES when compared to the Utility Company's large fossil fuel-fired plants. This is equivalent to a 54 percent increase in fuel utilization over a large utility.

A second area of importance is the adding on of Community gas/oil committed loads to the University of Minnesota coal-fired system. For several years, the two Hospitals--St. Mary's and Fairview--have had deep concern about the future reliability of natural gas and oil. The St. Mary's Hospital steam plant, as well as others (such as the plant at Augsburg College) will be decommissioned by this ICES.

The third area of importance in the proposed total ICES involves the installation of a pyrolysis system for the safe disposal of infectious and hazardous waste. In addition to furnishing a long-term method for disposing of this type of waste, a low Btu gas will be generated, which will be burned in the plant as a supplement to its primary fuel requirements.

A fourth area being investigated is the conversion of part of our steam distribution system to a variable flow and variable temperature hot water system. Economics indicate that hot water will most likely be the distribution system for co-generation plants in the future. As a part of the University's conversion to a hot water distribution system we are recommending the installation of a thermal storage system for an improved operation of the proposed turbine-generator, and for load shaving of peak thermal demands to reduce plant peaking requirements.

Since our proposed ICES has many facets, we have separated the project into priority categories as follows: Basic Program, the existing U of M Community with add-on electric generation: Option I - Add-On Steam Customers; Option II - Pyrolysis; and Option III - Thermal Distribution Revisions.

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be found folded in the back.

The figure for this page will
be found folded in the back.

GRID ICES
PROCESS DIAGRAM
COGENERATION OF ELECTRICITY AS A BYPRODUCT OF HEAT

by G.D.M.	building	scale	sheet
checked J.O.	date 6-28-77	revised	drawing 69

BASIC PROGRAM

Introduction

The basic program involves retrofitting a retired generating plant, Southeast Steam, back to coal, adding electrical, noncondensing co-generation capabilities to the retrofitted plant and selling the electricity, generated on the University of Minnesota's thermal demand for heating and cooling, to the Northern States Power Company (N.S.P.) at their Main Street Substation. None of the electricity generated will be fed into the University of Minnesota grid. The in-plant electrical requirements amounting to 10% of the installed generator capacity will be handled by the co-generated output with all the remaining output being fed into the N.S.P. electric grid. For the following discussion beginning on page 18, are the photographs of the Southeast Steam Plant, the University Heating Plant and the two plants together.

In order to get the Southeast Steam Plant and its auxiliaries into an operating standard that will approach a cost effective state on co-generation for an installation this small, many costly modifications will have to be made.

Our study on the ICES indicated there were four areas that made by-product electricity non-competitive with a large Utility such as N.S.P. The first area was the present cost of fuel. It is difficult to sell electricity competitively when the cost of coal is double for the small users when compared to the large Utilities. This will be further discussed under the heading of "Fuel."

The second area is generator output. With a large diversity of thermal demand between summer and winter operation, the sizing and selection of the turbine generator had to be thoroughly optimized. This will be addressed under the heading of "Turbine-Generator Selection."

Labor requirements for plant operation was a third area of concern. With a generator of only 12.5 megawatts the dedicated labor for electric output had to be kept below the level of one man per shift. This will be further discussed under "Plant Labor."

The fourth area was boiler modifications and interconnection of the two plants. The fact that we were able to acquire the Southeast Steam Plant from N.S.P. at a very modest cost significantly lowered the burden of front-end costs. This is addressed under the heading "Boiler Modifications and Interconnection of the Two Plants."

In addition to these problem areas, the required modifications involved directly with central heating plant expansion will be discussed under the heading, "Central Heating Plant Expansion."

Prior to the ICES Program, the University of Minnesota was involved in a straight central heating plant expansion program, wherein generation of electricity was not a factor except for small amounts of load shaving on the University electric system. It included the acquisition of the Southeast Steam Plant, the interconnection of that plant's steam output to the University of Minnesota's existing steam plant, Southeast Plant rehabilitation, and the retrofitting of one boiler in the Southeast Plant back to western coal. Under this arrangement, the Southeast Steam Plant would be used for topping and therefore be operating only during the heavy winter heating months (December, January, February, March). The ICES Program has necessitated the

following planning shifts and additions to the University of Minnesota original expansion program. Two boilers (instead of one boiler) will be retrofitted in the Southeast Steam Plant. The Southeast Steam Plant will become the base loaded plant and the existing University of Minnesota plant will be used for winter topping. A 7.5 megawatt, single automatic extraction non-condensing turbine generator (SAENC) will be installed in the Southeast Plant. Modifications will be made to the rail unloading facilities at both plants to reduce the freight costs on coal. The University will upgrade its existing incinerator and will be limited to disposing of only University-generated solid waste.

Fuel

The University of Minnesota's present coal unloading facilities cannot cover the rapid unloading requirements of unit trains at either central plant. Our coal dock on the Mississippi River has the capability of unloading a barge in approximately twelve hours and the rail facilities are slower yet. Although we can spot twelve rail cars, we are pressed to unload five or six cars a day.

For our first approach, we looked to the coal unbarging dock with a goal to improve the facilities to a point where we could unload five to six barges in two days. Under this arrangement, we would split unit trains at one of the Twin Cities trans-shipment docks. A portion of the yearly coal requirement (the months of December, January and February when the River shipment is restricted) would have to be stored off-campus and truck delivered. Robbins Engineering Company did a preliminary coal handling layout for the central plants. Under this arrangement, we would interconnect the two plants via a multipurpose overhead enclosure instead of a tunnel in the St. Peter Sandstone. The estimated cost for the coal unloading and transfer conveyors exceeded \$5,000,000.

We next looked to our rail facilities, and with the help of Burlington Northern Engineers and Robbins Engineering Company, an improved facility was laid out (see Appendix). This improvement would allow us to spot and offload 35 to 45, 100 ton cars per day. The estimated cost for this improvement was \$1,726,500. The modifications include two new housed car unloaders, repairs to the two coal

trestles, purchase of two small switch engines, environmental modifications and approximately 5,000 ft. of rail replacement. The decision was made to improve the rail facilities instead of the barge facility.

We are optimistic, as we continue to negotiate with Burlington Northern and N.S.P., that an arrangement will be made for splitting of 105 car unit trains with 35 to 45 cars spotted at the University of Minnesota and the remaining cars spotted at one of N.S.P.'s two Twin City plants or one of the three trans-shipment docks that they use.

Shown in the Appendix are schematics of the various coal unloading schemes and the overhead enclosure.

Turbine-Generator Selection

Selection of the appropriate turbine generator required extensive optimizing. Prior to the ICES, the University of Minnesota had reviewed several approaches to generating load shaving electricity for our own use. We had reviewed the advantages of various sizes of straight non-condensing turbines (SNC), single extraction condensing turbines (SAEC) and a single automatic extraction noncondensing turbine (SAENC). For "time of day" load shaving, the extraction condensing turbine had the fastest payback. For fuel savings, the SNC and SAENC were better, but with its variable output created by the requirement to follow a varying diversified thermal load duration curve the payback was longer.

With the ICES Program, we ruled out a condensing turbine for two reasons. First, by definition to the EFDA RFP, capacity utilization and energy end use should be maximized. Secondly, every KW of generator output accomplished by using a cooling tower or river water for condensing increased the base fuel costs for energy production to 19.7 mills. Without condensing, our fuel cost/KW is in the 9 mil range. Generating on a straight thermal demand basis and with some capital assistance, our projected total cost per kilowatt-hour is 19 mills (1.9¢) plus or minus. This is within the rate structure on which N.S.P. presently buys peaking electricity from other utilities.

After reviewing and optimizing many different operating arrangements and turbine designs (a 5 megawatt SNC, a 7.5 megawatt SNC, a 10 megawatt SNC, 2 - 7.5 megawatt SNC's, a 7.5 megawatt SAEC, and a 7.5 megawatt SAENC) and also varying our extraction or back pressure

on the above units from 150 psig to 175 psig, we have selected a 7.5 megawatt SAENC unit coupled to a 12.5 megawatt generator for two reasons. First, it offers the most flexibility for future system modification and growth. We are certain, if not now, that sometime in the future, the University of Minnesota steam distribution system will be converted in part to a hot water distribution system. This will increase the generator output by taking better advantage of the low pressure section of the turbine. Secondly, though the 7.5 megawatt SNC is lower in first cost, the annual generated kilowatt-hours fed into the utility grid would be approximately 10 percent less and therefore, the payback period would not be considerably different over the equipment life. The 7.5 megawatt rated SAENC turbine will perform efficiently up to 15 megawatts. This allows for future expansion beyond a 7.5 megawatt SNC which must be coupled to a 7.5 megawatt generator. All other arrangements had higher initial costs or operating costs with no beneficial improvement of yearly kilowatt-hours sent to the grid and considerable waste of primary fuel.

Shown in the Appendix is a process flow schematic of the SAENC turbine arrangement at Southeast Steam Plant. Site schematics of the electrical grid connection are also shown.

Labor

Wherever possible, we have automated the operation to minimize operating labor cost. The coal will be conveyed by belt from the exterior storage bunkers to active overhead bunkers in the plant. In-plant, the coal will gravity feed from the overhead bunkers to the coal scales to the feeders for the pulverizers on the No. 3 boiler or the spreader stokers on the No. 4 boiler. All points of ash emission will be emptied and transmitted pneumatically to an ash silo. From the silo, the ash will be transferred via a moisture conditioning dust control drum directly to trucks for hauling to an established landfill. The boilers and turbine will be completely automated for maximum plant efficiency. For system analysis, our present plan is to feed the analyzing and monitoring data to a Physical Plant computer via our existing building automation Delta 2000 console. If the Physical Plant computer has not been purchased by some decision point in Phase III, the central plants will require the installation of a data logger and the use of the University of Minnesota's large Cyber 74 computer system at its Lauderdale Computer Center.

Boiler Modifications and Interconnection of the Two Plants

The existing Minneapolis Campus heating plant has seven boilers, six with coal-firing capabilities and one that is limited to gas-oil firing. In 1975, as we looked for low sulfur Western coal as our most reliable future fuel source, we made three projections for the plant. Projection one was to continue with the present plant relying heavily on oil. Projection two was to modify the existing plant for basic coal firing with minor reliance on oil. The third projection involved the acquisition of the Southeast Steam Plant and full conversion to Western coal. The 1975 summary of projected costs, (See Appendix) the reliability of Western coal and the increased capability of plant expansion assisted in enforcing the decision to expand to the Southeast Steam Plant. Campus building expansion plans indicated that we would have plant capacity problems with projections 1 and 2 by the year 1980.

The 1975 cost for retrofitting the plant, the interconnection of the two plants and the acquisition of the land and plant totaled \$8,678,580. Of this total the dedicated cost to retrofit the two boilers was \$1,995,750. To replace these two boilers with units of the same size, pressure and temperatures, the cost was estimated at \$11,340,000 for ICES (see Appendix). Since the two boilers to be retrofitted have less than 10 years of total operating time, they each should have 20 years of reliable service remaining after retrofitting and modernizing.

The interconnection of the two plants will be accomplished by constructing a tunnel in the St. Peter Sandstone at a cost equivalent

to the overhead enclosure. The tunnel will be 7' wide and the crown height will be 7 1/2'. The University of Minnesota has designed, in house, over a mile of tunnels for construction in the St. Peter Sandstone in the last 15 years. About half of this steam tunnel construction was done on contract with the remaining one-half mile of construction by University of Minnesota Physical Plant employees. As an alternate to the tunnel, a plan of interconnecting the two plants with a multipurpose overhead enclosure was developed and is included in the Appendix. The advantages of this plan were lost when we abandoned the costly plan to improve our barge unloading facilities with an extensive and costly conveyor system.

The decision to retrofit the two boilers at Southeast Steam Plant and interconnect the two plants by tunnel is economically sound. We should add that the University of Minnesota has retrofitted or is in the process of retrofitting six boilers for 100 percent coal firing. The oldest of these boilers is the Minneapolis Heating Plant boiler No. 1, installed in 1951.

Central Heating Plant Expansion

This section will address the work required in the Southeast Steam Plant beyond boiler work, tunnel construction and turbine generator installation.

Interior Work

Piping - New steam and condensate piping required for tie-in to the new tunnel system is extensive when compared to the short run from the boilers to the turbine. Therefore, all piping will be new. The existing piping is a mixture of deteriorated, patched and new and would be more costly to restore to fit new needs than to remove for the installation of an efficient new distribution system.

Electrical - The electrical system in the plant does not meet present day codes for coal-fired plants, and the motor drives are 35 cycle. It will be more economical to install a new system for the building than attempting to restore the existing system, major parts of which are 20 or more years old.

Coal and Ash Handling - Not only is the present system inefficient and deteriorated beyond recovery, but restoration to its original design would not allow it to pass an OSHA inspection. Both will be replaced by new dust-tight state-of-the-art automated systems.

Exterior Work

Building - the building exterior needs tuckpointing and cleaning as well as some brickwork. The roof drains will need immediate replacement. The roof in general is in good condition. Our initial investigation does not indicate any need for major repair on the four stacks.

Coal Storage - Some structural repair is needed on the exterior storage bunkers. They also need to be gunited to repair the extensive spaulding that has occurred. A new storm drain system will be installed and will be piped to the sanitary sewer system. Acid neutralizing equipment will be installed if required.

River Front - What could be called the inlet apron used for servicing and operating the River water existing condenser inlet and outlet pipes will be restored as a pedestrian walk with hand rails and lighting. This will become part of the Community's River Front development. The inlets and outlets will be completely sealed.

Quantitative Changes

We anticipate the following changes and gains with the basic ICES:

1. The plants coal (Western) requirements will increase from 124,535 tons/year to 136,125 tons/year.
2. The plant will generate an estimated 45,000,000 KWh of electricity/year.
3. We estimate a savings of 13,788 tons of Western coal/year through the co-generation process.

GRID-ICES
UNIVERSITY HEATING PLANT

EXISTING VIEW LOOKING NORTH

OPTION I - ADD-ON STEAM CUSTOMERS

Addition of St. Mary's, Fairview and Augsburg as Steam Customers

The steam customers to be added on with this Option are St. Mary's Hospital, Fairview Hospital and Augsburg College, shown in photographs on pages 25 and 26. This will be accomplished by installing a tunnel 1,600 feet in length in the St. Peter Sandstone from the University of Minnesota's existing deep heating tunnel system at Middlebrook Hall to the St. Mary's Hospital heating plant. Final connection will involve a shaft from the deep tunnel up to a point adjacent to their heating plant. Since St. Mary's has furnished steam to Fairview for many years and they have agreed to connection of Augsburg to their system, our connection will be to the main steam header in the St. Mary's plant and just ahead of the condensate receiver.

The present-day unit costs for natural gas and coal causes this Option its only problem. Approximately 50% of the Hospitals' primary fuel is still natural gas, which they buy at a lower rate per million Btu's than the University of Minnesota presently purchases coal. Assistance from ERDA on this Option is requested to eliminate the need for speculation and ensuing risks. Many of us believe that natural gas will be severely curtailed or eliminated as a fuel source for these customers in the 1980's. When oil becomes their primary or only fuel source, steam generated from coal will be a definite improvement in their steam production costs.

Now that the University of Minnesota Grid-ICES Program has been reviewed and has received significant support by the community,

modifications to this Option, we are certain, will be made in the future. An Urban Redevelopment Project adjacent to the University's West Bank Campus has made inquiries as to the possibilities of purchasing steam or hot water from the University of Minnesota plant in lieu of installing a gas/oil fired boiler. One of the proposed sites for a new stadium for the Twin Cities is Industry Square. Industry Square is only 2,400 feet west of the University of Minnesota's West Bank heat distribution system. The Industry Square stadium committee has made inquiries as to the possibility of purchasing steam or hot water from the University.

We would hope that ERDA would give strong consideration to this Option, for there is a Community need for the ICES to be a reality within the time constraints of these new projects. Planned gas/oil fired units could be eliminated by the ICES, and the retrofitting of small units to coal could be delayed and possibly eliminated by a successful demonstration.

We anticipate the following changes and gains with Option I:

1. The plants coal (Western) requirements will increase from 136,125 tons/year (Basic ICES) to 151,656 tons/year.
2. Electric Generation will increase to 50,000,000 KWh/yr.
3. Coal savings will increase from 13,788 tons/year (Basic ICES) to 15,329 tons/year.
4. The add on customers will transfer the equivalent of 1,700,000 gallons of No. 6 oil to 14,244 tons of coal by purchasing steam from the University of Minnesota plant.

OPTION II - PYROLYSIS

Add-On Pyrolysis

For nearly seven years, the University of Minnesota has urged that somewhere in the public sector, a safe and efficient system of disposing of hospital generated, critical waste should be established in the Twin City area. We have felt that our high temperature incinerator (borderline environmentally) was at best an interim holding operation. The public sector cannot be criticized for its failure in developing a waste disposal system with energy recovery. First, to be cost effective, the system becomes large and creates the following problems. There is a need for a large capital investment. Centralizing large disposal units close to a heat sink creates transit problems. Large waste flows and varying operations of private collectors makes long-term commitments needed in a large unit hard to negotiate. Many of the newly established units in the United States are short on waste flow requiring considerable capital outlay for standby sources of fossil fuel.

A small unit, such as requested in this Option, is relatively low in capital cost. It has a captive market that can be legally assigned as far as waste flow is concerned. It will not have to totally compete with present-day landfill costs. It can demonstrate on a smaller scale what could be required, as regards to size, for future units.

We have recommended an Andco Torrax pyrolysis waste reduction unit for several reasons. First, it does not require front-end processing, a requirement for isolation material and research waste. Second, its two emissions are a burnable gas and a sterile frit. Third, since it

does have an operable unit with success in Luxembourg, it should be considered State-of-the-Art. A process flow schematic of this system is shown on page 29. The waste heat recovery boiler and baghouses are not part of the purchased unit, but will be designed, purchased and installed under a separate contract.

If we were to continue in Phase II, we would make a further investigation into a Copeland fluidized bed reactor because of significant reduction of initial capital. We question slightly its proven reliance on this type of waste—the fact that it has operable units on wood chips and bark warrants a further review as to whether it is State-of-the-Art equipment.

We have settled on a 132.5 ton/day unit that matches the critical waste requirements of our seven-county area with some room for growth and turn down conditions matching diurnal and seasonal waste generation patterns. Growth beyond present projections would be handled by reverting the University of Minnesota's non-critical waste to another source so that the primary purpose of critical waste handling could be increased. Besides solving a long-standing health care waste disposal problem, the following advantages could be gained:

1. The off-gases would replace approximately 18,517 tons of Western coal per year at the central plant.
2. We would test bio-mass energy recovery with the system.
3. We would test sewage sludge disposal with the system.
4. We would determine the optimum ratio of coal fired boilers to waste heat recovery boilers to allow future sizing of large municipal plant standby requirement.

ANDCO - TORRAX SYSTEM

OPTION III - THERMAL DISTRIBUTION REVISIONS

Partial Conversion of the Existing Steam Distribution System to Hot Water Plus Thermal Storage of Energy

Until our involvement with the ICES Program, the University of Minnesota, like many other institutions and industries, looked to steam for the distribution of their thermal energy. Since steam can be distributed with a much higher energy carrying capability (5 to 1) than water (Delta h of 1,000 Btu/lb versus hot water at a Delta h of 80 to 200) we stayed with the low first cost system of steam distribution. The advantages of hot water distribution versus steam distribution are illustrated in the Appendix.

Co-generation of electricity is causing engineers to take a new look at the efficiencies of hot water distribution systems versus steam distribution. The lower the quality of the thermal distribution system, the greater amount of co-generation when hot water production is integrated with the turbine heat outputs.

The University of Minnesota has many hot water heated buildings (the entire West Bank Campus) where the design is steam distribution to the building and conversion to hot water within the building via a steam to water heat exchanger. The only steam requirements left in the buildings are steam operated preheaters for outside air, but with the switch to recovery units, the preheaters are gradually disappearing.

The hot water segment of Option III is to install new parallel hot water lines in the existing steam tunnels and convert selected hot water buildings closest to the central plant that are presently

on the steam distribution system. Steam heated buildings will be bypassed, but the hot water lines will be sized so that they can be added to the new system at a later date. In most cases, we will reuse the existing convertors at each building by changing them from steam to hot water conversion to hot water to hot water conversion.

Without the hot water loop it will not be possible to demonstrate the thermal storage and recovery of energy, a second segment of this Option.

The proposed thermal storage of energy will be done in a relatively dry layer of sand that is 80 to 100 ft below grade. This sand layer is called St. Peter Sandstone and lies just below a limestone ledge under the campus, as shown in the Appendix. There is 18 to 22 feet from the limestone ledge down to the water table level in the St. Peter Sandstone.

A review was first made (performed under the direction of the University's, Dr. Blackshear and Dr. Riaz) on storing high level energy in the sand by heating the sand to 350⁰ F to 450⁰ F without the use of a heat pump for either energy storage or withdrawal. Their estimated yearly thermal losses on this system indicated that it could be as high as 29 percent. We felt that since this energy came from burning coal, we could not economically justify this method of thermal storage.

Late in Phase I, we asked Dr. Blackshear and Dr. Riaz to review the storage system wherein heating the sand to a lower level of 240⁰ F and utilizing a closed circuit air heat pump. We have inquired of both Ingersoll-Rand and Turbodyne for information on State-of-the-Art compressor-expander system (see Appendix).

The University of Minnesota is continuing its investigation into a high quality heat pump for thermal hot water generation, thermal storage and thermal recovery.

What we are really looking for is the partial replacement of a condensor system that normally discharges its waste heat into a cooling tower or a river, so that during the low thermal demand periods we can improve our turbine generator by-product power coefficient thereby increasing co-generated output. During the periods of high thermal requirements (December - March), we would take energy out of storage using the compressor-expander for use in heating water in the distribution loop. If we can regain 70 percent of the energy required for this storage system (losses are thermal and some H.P. in and H.P. out), the system will be cost effective. Besides improving on co-generation, resulting improvement in the thermal demand curve will lower peaking capacity investments inherent in central heating plants.

We anticipate the following changes and gains with Option III:

1. The Plants coal requirement will increase from 134,169 tons/yr (Option II) to 135,199 tons/yr.
2. Electric Generation will increase to 54,000,000 KWh/yr.

university of minnesota
minneapolis

GRID-ICES
DISTRICT HOT WATER HEATING SECTOR

MANAGEMENT

The management plan proposed for Phase II of the demonstration will incorporate additional features from the plan used in Phase I. The University will be retaining the key investigating personnel developed in Phase I for continuing work in Phase II. These members of the demonstration team are shown on the Management Flow Diagram. Helmick and Lutz Company, have been selected as the prime consultant. Briefly, the members and titles of key investigative personnel for Phase II are as follows:

1. Warren E. Soderberg, Director, Physical Plant, Univeristy of Minnesota (Program Director, ICES)
2. James C. O'Gara, Principal Electrical Engineer, Physical Plant, University of Minnesota (Assistant Program Director, ICES)
3. Robert A. Reid, Principal Environmental Engineer, Physical Plant, University of Minnesota (Program Manager, ICES)
4. Richard P. Lewis, Senior Chemical Engineer, Physical Plant, University of Minnesota (Project Engineer, ICES)
5. J. J. Roback, Superintendent of Heating Plants, Physical Plant, University of Minnesota (Central Plants Specialist)
6. Anton Potami, Director, Research Administration, University of Minnesota (Contract Administrator)
7. John C. Pearce, Assistant to the Director of Research, Northern States Power Company
8. M. K. Ervasti, Vice President, St. Mary's Hospital (Hospitals and College Coordinator, ICES)
9. Paul Kopietz, Director, Engineering and Construction, Physical Planning, University of Minnesota (Administrator of Construction, ICES)

10. Laszlo Fulop, Director, Planning, Physical Planning,
University of Minnesota (Administrator of ICES)

Special Consultants

Dr. Perry L. Blackshear, Jr., Head, Power and Propulsion Division,
Department of Mechanical Engineering, University of Minnesota;
Director, Center for the Studies of Physical Environment,
Institute of Technology, University of Minnesota (Thermal
Storage Research)

Dr. Kenneth Thomas Whitby, Professor of Mechanical Engineering,
University of Minnesota; Chief, Environmental Division,
Mechanical Engineering Department, University of Minnesota

Dr. Richard Guy Bond, Professor of Environmental Health, School
of Public Health, University of Minnesota.

Dr. Roger L. DeRoos, Assistant Professor and Research Officer,
School of Public Health, and Associate Director for Environ-
mental Health and Safety, University Health Service, University
of Minnesota

Dr. George S. Michaelson, Professor of Public Health and
Occupational Health Engineer, University of Minnesota

New members are added for continuing review, research, and future
activities as ICES develops in Phase II. They are noted on the manage-
ment diagram. These people are presently a part of Physical Plant,
Physical Planning, Institute of Technology, or Environmental Health and
Safety, have expertise in the indicated area, and will become key members
throughout the remainder of the demonstration.

Mr. Soderberg has been given overall University direction for ICES
by Mr. D. P. Brown, Acting Vice President for Finance, University of

Minnesota. Mr. O'Gara in acting under this authority has made with concurrence of Mr. Soderberg all relevant decisions regarding Phase I development and will continue in this capacity through the remaining Phases of ICES.

Mr. Fulop and Mr. Kopietz derive their authority from the Acting Vice President for Finance. The management chart shown indicates the general flow of the ICES organization except for Mr. Soderberg's ultimate responsibility in ICES. Normally, the management flow for Mr. Fulop and Mr. Kopietz is through a separate Assistant Vice President for Planning to Mr. Brown. This is primarily the management scheme being used for another ERDA program and should not cause conflict or inefficiency.

It might be worthwhile to note that the following management diagram will flow properly no matter which option of ICES is chosen. The diagram is drawn to depict the management for the complete ICES program.

CONSULTING ENGINEERING SERVICES FOR ICES

The University of Minnesota Physical Plant began consultant selection procedures through the Office of the Assistant Vice President for Physical Planning, Clinton N. Hewitt, May, 1977. This process was completed on July 6, 1977.

Primary to the University of Minnesota was the ability to cause the selected consultant to commission design assistance in areas they do not indicate clear expertise. This design assistance would be in the areas of pyrolysis, coal handling, instrumentation and control, turbine-generation, and plant computerization with tie in to the University's automation system for building systems.

The following letter was sent out to A/E's as a solicitation for the ICES prime consultant. From the reply, five local consulting firms of applicable experience were selected for interviews. Two of the consultants, Pfeifer, Schultz/HDR and Orr-Schelen-Mayeron and Assoc., had national corporate ties. The remaining three, Helmick and Lutz Company; Michaud, Cooley, Hallberg, Erickson and Assoc., and W. J. Sutherland and Assoc., are local, small business engineering firms. The first interview reduced the selection process to three consultants: Pfeifer, Schultz/HDR; Orr-Schelen-Mayeron and Assoc.; and Helmick and Lutz Company. The second interview resulted in Helmick and Lutz Company being chosen for the Prime Consultant. Their projected heat related experiences are included in the Appendix.

UNIVERSITY OF MINNESOTA
TWIN CITIES

Office of the Assistant Vice President

Physical Planning
340 Morrill Hall
100 Church Street S.E.
Minneapolis, Minnesota 55455

Gentlemen:

I would like to ascertain your interest in providing Consulting Engineering Services for 1) expansion of the Minneapolis Campus Heating Plant to meet needs for the heating and cooling of University Buildings, and 2) a possible ERDA sponsored program for a Grid-Connected Intergraded Community Energy System (Grid-Connected ICES).

The University submitted a proposal to ERDA on a Grid-Connected ICES that included supporting efforts by both Northern States Power and St. Mary's and Fairview Hospitals. The University was one of five applicants selected to participate in a Phase I effort for this project. It is assistance with this effort and additional phases, if successful, for which the University is seeking Engineering Services.

The following is a brief outline of the major portions of the project:

1. The University Heating Plant Expansion, which includes (a) interconnection with the NSP Southeast Generating Plant, (b) improved barge unloading and coal handling and (c) NSP Southeast Generating Plant Rehabilitation.
2. Generation of electricity to be fed into the NSP Grid.
3. The add-on of thermal loads from the community now fired by gas and oil. The handling of these loads by coal firing will relieve the use of critical fuels.
4. The disposal of critical solid wastes by pyrolysis, thus supplying additional steam to the system.
5. The study of possible conversion of a portion of existing steam distribution system into hot water distribution.

PAGE TWO

It should be pointed out that the University reserves the right to request the successful consultant to use additional help if it is determined very specialized types of expertise are required for certain tasks.

Please indicate your interest to me in writing not later than May 16, 1977 and complete the enclosed questionnaire. Please also submit a brochure of your firm's work and qualifications. In the event that such material is already on file with us, you may wish to update it.

If you have any questions, please contact Paul Kopietz of my staff at 373-4523.

Sincerely,

Clinton N. Hewitt
Assistant Vice President
Physical Planning

CNH:DG
Enclosure

DIRECTION OF TASK ASSIGNMENTS

Prime direction of work task assignments will be under the control of the Assistant Director for ICES. All activities regarding ICES concepts, work managements, assignments and operations will flow through this position.

Financing and administrative level coordination of ICES will be through the Program Director of ICES.

Detailed costs, scope of work, and work assignments will be made when the following action takes place:

1. A Phase II award has been made and indication of programs and options to develop in ICES during Phase II is directed by ERDA.

The ICES team of Phase I has demonstrated the capability to direct and report upon a development such as ICES utilizing state-of-the-art equipment and upon emerging art such as thermal storage and heat pump systems. We have added additional expertise to the team for work during Phase II. We will not only continue our proven engineering and management expertise, but will add construction and consulting engineering expertise both from the University and the prime consultant, Helmick and Lutz Company.

GRID-ICES PERSONNEL RETAINMENT AND REPLACEMENT

All members of the key staff of Grid-ICES for Phase I have been employed by the University for two or more years. The University operates a personnel department controlling an equal opportunity hiring and working policies for over 15,000 employees. Their hiring programs' include national advertising procedures should the necessity for replacement of a key person arise. However, the University is known for retention of its key people through good working conditions, adequate payment programs, promotion incentives and exceptional retirement policies. Retention of key people is also promulgated by participation in programs such as ICES and the ERDA coal gasification program at the University's Duluth Campus. This program is also headquartered within Physical Plant.

The University of Minnesota is committed to the policy that all persons shall have equal access to its programs, facilities, and employment without regard to race, creed, color, sex, or national origin.

PROJECT SCHEDULE

This section contains a graphical display which identifies by title and sequence major tasks that must be performed and the time of performance during the course of the full multiphase program.

The following descriptive narrative of the PERT schedule is a briefly stated recommended program for continued development of ICES.

Primary to the University's needs is additional boiler capacity from Southeast Steam Plant by 1980. St. Mary's-Fairview has also indicated a desire to be brought onto the University's steam distribution system at the earliest possible date. Augsburg College needs a firm commitment from the University so that it can decide upon the type of heating system for its new Music Education Building.

The cash flow presented depends heavily upon the University's request for Legislative funding. These requests must be known by September 1 of each year to insure Legislative action being taken.

The University and its partners are committed to an accelerated program so that the Basic Plan and as many options as possible of ICES become an eminent reality.

10-5-4

45

- 1 DECISION POINTS
2 REVIEW POINTS
3 REPORT-DOCUMENT SUBMITTAL

PROJECT SCHEDULE
GRID-CONNECTED ICES
UNIVERSITY OF MINNESOTA

PAGE 2

MILESTONES

With any program as complex as ICES there are many milestones that can be envisioned. It is the purpose of this discussion to relate the significant milestones that must be achieved.

1. Notification of a Phase II award.
2. Cost Sharing Concept Negotiated Between ERDA and the University prior to September 1, 1977.
3. Development of sufficient data and plant heat balance to allow computer modeling and final determination of ICES operation and co-generation credits by October 31, 1977.
4. Development of working drawings for steam grid connections to St. Mary's by April, 1978.
5. Final construction of St. Mary's steam connection by January, 1979. St. Mary's would continue to use their boilers for topping until one boiler goes on line at Southeast Steam during the winter heating season of 1980.
6. Development of "Special Train" for coal shipment from the West by May of 1979, for shipments early fall of 1979. (Includes retrofitting of Southeast Steam Plant coal storage and rail unloading).
7. Development of working solutions to instrumentation and control of ICES by November, 1977.
8. Development of the TCMR Solid Waste Management program by November, 1977. All related legal and contractual arrangements are to be dealt with and formalized in Phase III, by March, 1978.

9. Resolution of all legal and contractual problems to ICES
by December, 1977. Final terms to be signed by March, 1978.

COST SUMMARY

Cash Flow Program and Cost Sharing

The University of Minnesota will present a cash flow basis developed upon present funding commitments, requested funding and future cash requirements for development of ICES. The unit costs for steam, electricity and pyrolysis are developed from the cost sharing and cash flow dollars.

In developing the cash flow and the cost sharing, the non-risk items of the funding requirements (I-A and I-B) will be fully funded by the University of Minnesota.

The risk items have been adjusted for cost sharing during a 5 year demonstration program to meet reasonable unit costs for steam and electricity as well as drop charges on the pyrolysis unit.

Our cash flow does not include reporting costs for Phases IV, V, and VI. These add-on costs we would expect would be funded 100 percent by ERDA. The following is our estimate of the ERDA funding requirements for Phase IV, V and VI.

To provide a comparison between the work contained in Volume 3C related to development of energy production costs per 1000 pounds, a different approach was used to develop the Cash Flow Program because of Cost Sharing and complicated timing and program phasing. The costs between either method are comparable.

An overall operating summary is presented in the Appendix on Drawings 70 and 71.

Phase IV Overview

We anticipate that with the exception of the pyrolysis unit (we would prefer turn key), all construction work will be by bid packages with lump sum contracts.

Built into the construction cost (Phase IV) is the anticipated expense of normal University of Minnesota construction supervision costs (1 1/2 percent). This includes a resident construction superintendent with part-time assistance from mechanical and electrical construction superintendents. It also includes technical assistance from University of Minnesota staff in the various engineering disciplines. The resident superintendent keeps a daily log, submits a weekly report and conducts a progress meeting with the Contractors once a month. Minutes of the progress meeting are prepared by the Consulting Engineer.

If ERDA accepts the present University of Minnesota method of contract management and reporting, the add-on cost would be minimal--\$25,000 to \$40,000 for duplicating, printing, report writing, mailing, photos, slides, travel, etc.

Phase V Overview

The University of Minnesota presently has test procedures for boilers and baghouses, ASME power tests for boilers, and MPCA tests for particulate emission and baghouse efficiencies. We have developed some preliminary test procedures for the pyrolysis system at University of Minnesota expense.

If ERDA accepts the normal University of Minnesota testing procedures, the Phase V add-on cost would be similar to Phase III--\$25,000 to \$40,000.

Phase VI Overview

The University of Minnesota keeps daily logs in all of its boiler plants. These logs for the Minneapolis Campus will be expanded to include logs for generation and pyrolysis. The University of Minnesota's present procedure includes monthly and yearly reports as well as periodic shortform boiler testing.

If ERDA accepts the University of Minnesota's management recording procedures, the add-on costs per year would be as follows:

1.044 man hours for ERDA Coordinator.....	\$20,000
Student help.....	10,000
Printing, duplicating, mailing, etc.....	6,000
Travel, lodging, meals (to ERDA headquarters).....	<u>4,000</u>
Total Annual Costs - ERDA	\$40,000

We are aware that both the extent of the proposed program and the cost sharing are negotiable, and the final decision will be made by ERDA.

Further comments are made under the heading Project Commitment.

CASH FLOW EXECUTIVE FUNDING PROGRAM

BASIC PROGRAM

I. Requirements:

Escalated Cost

A. 1975 Projection

1. Baghouses	\$2,709,400	\$ 3,000,000
2. Plant interconnecting	1,973,790	2,200,000
3. Exterior, Southeast Plant.	547,560	700,000
4. Southeast Plant rehabilitation	5,564,230 (10,794,980)	6,000,000
B. Southeast Plant Acquisition (Estimate)		500,000
C. Turbine Generator		3,000,000
D. Improved coal handling.		<u>1,726,500</u>
		\$17,126,500
Phases I and II		<u>256,125*</u>
		\$17,382,625

II. Cost Sharing and Cash Flow:

<u>Year</u>	<u>Requirement</u>	<u>U of M</u>	<u>Requirement</u>	<u>ERDA</u>
1977	A-1	\$3,000,000	Phases I and II*	\$ 256,125
1978	A-2, A-3, B Design, Ph. III***	3,400,000 706,325	Design Assistance, Phase III**	211,900
1979	A-4, C	7,331,775	Risk Assistance on Turbine Generator	500,000
1980	D	1,726,500	Cash Flow Assistance	<u>250,000</u>
Total ICES		\$16,164,600		\$ 1,218,025

*Phase I - \$44,225

Phase II - 1 1/2 percent of (\$17,126,500 - 3,000,000) = \$211,900

**Phase III - ERDA Engineering Costs, 1 1/2 percent of 14,126,500 = 211,900

***Phase III - U of M Engineering Costs, 5 percent x 14,126,500 = 706,325

III. University of Minnesota Cost Sharing \$16,164,600

Legislature. \$10,794,980

Bonds or Bank Loans

1. Steam. 2,869,620

2. Electric Generation 2,500,000

Debt Service: 10-year bank loan with 5-year balloon (.135866)

1. Steam -

$$2,869,620 \times .135866 = \$389,884/\text{year}$$

2. Electric -

$$2,500,000 \times .135866 = \$339,665/\text{year}$$

Steam Costs

Electric: 202,500 MLbs./year

Thermal: 1,955,000 MLbs./year

Fuel at \$17/ton (Montana coal - 17.2×10^6 Btu/ton)

$$= \$.9884/10^6 \text{ Btu}$$

at 80 percent efficiency

$$= \$1.235/\text{MLbs. of steam}$$

Labor -

$$4/\text{shift at } \$10/\text{hr.} = \$40/\text{hr.}$$

$$8,760 \text{ hrs.} \times \$40 = \$350,400 \text{ (Southeast)}$$

$$3/\text{shift at } \$12/\text{hr.} = \$36/\text{hr.}$$

$$2,880 \text{ hrs.} \times \$36/\text{hr. (operating)} = \$103,680$$

$$5,880 \text{ hrs.} \times \$36/\text{hr. (maintenance)} = \$211,680$$

$$\text{Purchased maintenance and trades} = \$47,840$$

$$\text{Total labor: } \$713,600 + 2,157,500 = \$.331/\text{MLbs.}$$

Supplies -

$$200,000 + 2,157,500 = \$.093$$

Debt Service -

$$389,884 + 2,157,500 = \$.181$$

Amortization -

$$\$20,000,000 \times .025 + 2,157,500 = \$.232$$

Administration -

$$\$100,000 + 2,157,500 = \$.046$$

Total Steam Costs:

Fuel	\$1.235	
Labor.	.331	
Supplies, Expense and Utilities	.093	
Debt Service	.181	
Amortization	.232	
Administration.	.046	
	<u>\$2.118</u>	MLhs. steam (in plant)
Line Loss, 10 percent	.212	
	<u>\$2.330</u>	

Electric Costs

45,000,000 KWH/yr.

Fuel - 4,430 Btu/KW

$$4,430 \div 1,000,000 = .00443 \times 10^6 \text{ Btu/KW}$$

$$.00443 \times \$2.118 = \$0.0094/\text{KW or } 9.4 \text{ mils}$$

Labor -

$$\$10/\text{shift} = 10 \times 8,760 = \$87,600$$

$$87,600 \div 45,000,000 = \$0.0019/\text{KW or } 1.9 \text{ mils}$$

Maintenance and Operation -

$$10,000 \div 45,000,000 = \$0.0002/\text{KW or } .2 \text{ mils}$$

Amortization -

0 for five years

Debt Service -

$$\$339,665 \div 45,000,000 = \$0.0075/\text{KW or } 7.5 \text{ mils}$$

Administration -

$$\$20,000 \div 45,000,000 = .0004/\text{KW or } .4 \text{ mils}$$

Total:

Fuel	9.4
Labor.	1.9
Maintenance and Operation	.2
Debt Service	7.5
Administration.	.4
	<u>19.4 mils</u>

OPTION I - ADD ON STEAM CUSTOMERS

ADD ON ST. MARY'S HOSPITAL, FAIRVIEW HOSPITAL AND AUGSBURG COLLEGE

I. Requirements:

Escalated Cost

A. 1975 Projection

1. Baghouses	\$2,709,400	\$ 3,000,000
2. Plant interconnecting	1,973,790	2,200,000
3. Exterior, Southeast Plant.	547,560	700,000
4. Southeast Plant rehabilitation	5,564,230 (10,794,980)	6,000,000

B. Southeast Plant Acquisition (Estimate) 500,000

C. Turbine Generator 3,000,000

D. Improved coal handling. 1,726,500

E. Tunnel to Hospitals (includes Phase III Engineering). 700,000

\$17,826,500

Phases I and II 266,625

\$18,093,125

II. Cost Sharing and Cash Flow:

<u>Year</u>	<u>Requirement</u>	<u>U of M</u>	<u>Requirement</u>	<u>ERDA</u>
1977	A-1	\$3,000,000	Phases I and II*	\$ 266,625
1978	A-2,A-3,B	3,400,000	Tunnel to Hospitals,E	700,000
	Design,Ph.III***	706,325	Design Assist.,Ph.III**	211,900
1979	A-4,C	7,331,775	Risk Assistance on Turbine Generator	500,000
1980	D	1,726,500	Cash Flow Assistance	250,000
Total ICES		\$16,164,600		\$ 1,928,525

*Phase I - \$44,225

Phase II - 1 1/2 percent of (\$17,826,500 - 3,000,000) = \$222,400

**Phase III - ERDA Engineering Costs, 1 1/2 percent of 14,126,500 = \$211,900

***Phase III - U of M Engineering Costs, 5 percent x 14,126,500 = \$706,325

OPTION II - PYROLYSIS

ADD ON PYROLYSIS

I. Requirements:

Escalated Cost

A. 1975 Projection

1. Baghouses	\$2,709,400	\$ 3,000,000
2. Plant interconnecting	1,973,790	2,200,000
3. Exterior, Southeast Plant.	547,560	700,000
4. Southeast Plant rehabilitation	5,564,230 (10,794,980)	6,000,000
B. Southeast Plant Acquisition (Estimate)		500,000
C. Turbine Generator		3,000,000
D. Improved coal handling.		1,716,500
E. Tunnel to Hospitals (includes Phase III Engineering).		700,000
F. Pyrolysis		6,000,000
G. Incinerator		250,000
		<u>\$24,076,500</u>
Phases I and II		<u>360,375</u>
		<u>\$24,436,875</u>

II. Cost Sharing and Cash Flow:

<u>Year</u>	<u>Requirement</u>	<u>U of M</u>	<u>Requirement</u>	<u>ERDA</u>
1977	A-1	\$3,000,000	Phases I and II*	\$ 360,375
1978	A-2, A-3, B Design, Ph. III***	3,400,000 706,325	Tunnel to Hospital, E Design Assist., Ph. III**	700,000 211,900
1979	A-4, C	7,331,775	Risk Assistance on Turbine Generator	500,000
1980	D	<u>1,726,500</u>	Cash Flow Assistance	<u>250,000</u>
	Total ICES	\$16,164,600		\$ 2,022,275
1981	F-4	<u>3,000,000</u>	F-4, G	<u>3,250,000</u>
		\$19,164,600		\$ 5,272,275

*Phase I - \$44,225

Phase II - 1 1/2 percent of (\$24,076,500 - 3,000,000) = \$316,150

**Phase III - ERDA Engineering Costs, 1 1/2 percent of 14,126,500 = \$211,900

***Phase III - U of M Engineering Costs, 5 percent x 14,126,500 = \$706,325

OPTION III - THERMAL DISTRIBUTION REVISIONS

ADD ON HOT WATER DISTRIBUTION AND THERMAL STORAGE

I. Requirements:		<u>Escalated Cost</u>
A. 1975 Projection		
1. Baghouses	\$2,709,400	\$ 3,000,000
2. Plant interconnecting	1,973,790	2,200,000
3. Exterior, Southeast Plant.	547,560	700,000
4. Southeast Plant rehabilitation	5,564,230 (10,794,980)	6,000,000
B. Southeast Plant Acquisition (Estimate)		500,000
C. Turbine Generator		3,000,000
D. Improved coal handling.		1,726,500
E. Tunnel to Hospitals (includes Phase III Engineering)		700,000
F. Pyrolysis*		6,000,000
G. Incinerator		250,000
H. Hot water loop		1,400,000
I. Season Thermal Storage (Demo)		<u>516,500</u>
		\$25,993,000
Phases I and II		<u>389,125</u>
		\$26,382,125

*Includes boiler, footings, structural steel, cranes, etc., not covered in Andco proposal.

II. Cost Sharing and Cash Flow:

<u>Year</u>	<u>Requirement</u>	<u>U of M</u>	<u>Requirement</u>	<u>ERDA</u>
1977	A-1	\$3,000,000	Phases I and II*	\$ 389,125
1978	A-2,A-3,D	3,400,000	Tunnel to Hospital,E	700,000
	Design,Ph.III***	706,325	Design Assist.,Ph.III**	211,900
1979	A-4,C	7,331,775	Risk Assistance on Turbine Generator	500,000
1980	D	1,726,500	Cash Flow Assistance	250,000
1981			H,I	<u>1,916,500</u>
	Total ICES	\$16,164,600		\$3,967,525
1981	F-1	<u>3,000,000</u>	F-1,C	<u>3,250,000</u>
		\$19,164,600		\$7,217,525

*Phase I - \$44,225

Phase II - 1 1/2 percent of (\$25,993,000 - 3,000,000) = \$344,900

**Phase III - ERDA Engineering Costs, 1 1/2 percent of 14,126,500 = \$211,900

***Phase III - U of M Engineering Costs, 5 percent of 14,126,500 = \$706,325

III. University of Minnesota Cost Sharing \$19,164,600

Legislature. \$10,794,980

Bonds

1. Steam. 2,028,473

2. Electric Generation 2,500,000

3. Pyrolysis 3,000,000

4. Surcharge, 10.05 percent of 8,369,620*** . . . 841,147

Five-Year Debt Service (.232573)

1. Steam -

$2,028,473 \times .232573 = \$471,768/\text{year}$

2. Electric Generation -

$1,500,000 \times .232573 = \$348,860/\text{year}$

3. Pyrolysis -

$3,000,000 \times .232573 = \$697,719/\text{year}$

Steam Costs

Electric: 225,000 MLbs./year

Thermal: 2,200,000 MLbs./year

Fuel at \$17/ton (Montana coal - 17.2×10^6 Btu/ton)

$= \$.9884/10^6 \text{ Btu}$

at 80 percent efficiency

$= \$1.235/\text{MLbs. of steam}$

Labor -

4/shift at \$10/hr. = \$40/hr.

8,760 hrs. $\times$ \$40 = \$350,400 (Southeast)

3/shift at \$12/hr. = \$36/hr.

2,880 hrs. $\times$ \$36/hr. (operating) = \$103,680

5,880 hrs. $\times$ \$36/hr. (maintenance) = \$211,680

Purchased maintenance and trades = \$47,840

Total labor: $\$713,600 \div 2,425,000 = .294$

Supplies -

$200,000 \div 2,425,000 = .082$

Debt Service -

$471,768 \div 2,425,000 = .1945$

*** $243,712.5 \div 2,425,000$

Amortization -

$$\$20,000,000 \times .025 \div 2,425,000 = \$.206$$

Administration -

$$\$100,000 \div 2,425,000 = \$.041$$

Total Steam Costs:

Fuel	\$1.235
Labor.	.294
Supplies, Expense and Utilities	.082
Debt Service	.195
Amortization	.206
Administration.	.041
	<u>\$2.053</u> Mlbs. steam (in plant)

$$\text{Surcharge: } 841,147 \times .232573 = 195,628$$

$$195,628 \div 243,712 = .803$$

St. Mary's Hospital)

Fairview Hospital) $2.053 + .803 = 2.856/\text{Mlbs. steam}$

Augsburg College)

Actual charge including 10 percent line losses:

$$2.053 \times 1.1 = \$2.258$$

$$2.856 \times 1.1 = \$3.142$$

Electric Costs

Fuel - 4,430 Btu/KW

$$4,430 \div 1,000,000 = .00443 \times 10^6 \text{ Btu/KW}$$

$$.00443 \times \$2.053 = \$.0090/\text{KW or } 9.00 \text{ mils}$$

Labor -

$$\$10/\text{shift} = 10 \times 8,760 = \$87,600$$

$$87,600 \div 50,000,000 = \$.00175/\text{KW or } 1.75 \text{ mils}$$

Maintenance and Operation -

$$10,000 \div 50,000,000 = \$.0002/\text{KW or } .2 \text{ mils}$$

Amortization -

0 for five years

Debt Service -

$$\$348,860 \div 50,000,000 = \$.00698/\text{KW or } 6.98 \text{ mils}$$

Administration -

$$20,000 \div 50,000,000 = .0004/\text{KW or } .4 \text{ mils}$$

Total:

Fuel	9.00
Labor.	1.75
Maintenance and Operation	.20
Debt Service	6.98
Administration.	.40
	<u>18.33 mils</u>

Pyrolysis

Debt Service -

$$3,000,000 \times .232573 = 697,719$$

$$697,719 \div 42,396 = 16.48$$

Expenses:

Debt Service	16.48
(Labor.	5.20
(Fuel	1.11
* (Power.	1.09
(Water and Sewer	.80
(Maintenance.	2.50
(G and A	<u>Incl.</u>

Cost/Ton \$27.18

Revenues:

Energy \$12.33

Urban ore -

Credits/Ton \$12.33

Drop Charge/Ton. \$14.85

*From Andco report

PROJECT COMMITMENT

To indicate to ERDA that this project will be carried through to an operating unit, it is our intention to have under contract by July 15, 1977 approximately \$3,000,000 worth of contract work I-A-1.

We further intend to solidify our intent by finalizing the acquisition of the Southeast Steam Plant by August 1, 1977 (I-B).

QUANTITATIVE GAINS

1. Savings in by-product electricity: 53,944,080 kw Hours/year
 $53,944,080 (10,662 - 4,430) = 3.3618 (10^{11}) \text{ BTU/year}$
Savings, Montana coal at $17.2 \times 10^6 \text{ BTU/ton} = 19,545 \text{ tons/year}$
2. Proper disposal of 44,167 tons of critical waste generating 43,500 pounds per hour steam per year (8000 hours operation) plus recovery of a by-product heat equaling 30,008 equivalent tons of Montana coal per year into the plants

$$\text{Tons Coal} = \frac{43,500 \text{ pph} \times 8000 \text{ hrs} (1379.74 - 193.2)}{.8 \times 8600 \times 2000}$$

3. The addition of gas/oil fired steam loads to the coal-fired plants:
Critical fuel conversion results:
 - a. St. Mary's-Fairview-Augsburg = 1,575,378 gallons of oil and natural gas equivalent per year.
 - b. Pyrolysis Equivalent = 3,809,925 gallons of oil per year
 - c. Total Equivalent oil/year = 5,385,303 gallons per year.The savings in critical fuel from the add-on customers could exceed 3,000,000 gallons of oil per year.
4. Conversion from steam to hot water distributing systems will increase the plant electrical output and will result in lower line losses for the distribution systems. Allows for heating degradation and energy conservation because of distribution heat storage.
5. Thermal storage of energy will allow load shaving during peak loads, and as a result, lower future capital expenditures for

plant peaking investment. It will improve the load duration impact on the plant as well as stabilize the plant operation. Provides regeneration for increased electrical output.

6. The ICES will assure the present goal of the University of Minnesota, Minneapolis plant to be 100 percent on coal by 1980. The central plant's equivalent fuel requirement on ICES will be 23,682,156 gallons of oil per year. This oil requirement will be replaced by 160,000 tons of Western coal per year and 30,000 tons of equivalent coal from solid waste heat recovery.
7. Environmental changes would be as follows:
 - a. One large central coal-fired plant would be an improvement over many smaller units in the community.
 - b. The air quality level of burning coal in the central plant will be equal to or improve on a level when firing No. 6 oil.
 - c. The additional environmental problems would be in the movement, unloading and storage of coal. The ICES program will incorporate improvements in coal handling and develop methods of more economical fuel delivery resulting in lower fuel cost.
8. The ICES will stabilize the economics of fuel costs for the Community. Coal, being the more abundant fuel, should have a lower escalation of cost, which will result in dollar savings to the Community.
9. The ICES is a vital part of the University of Minnesota program to transfer 95 percent of its multi-campus fuel requirements to coal or lignite by 1980.

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TOTAL PHASE I REPORT

VOLUME 1

SUMMARY AND DEMONSTRATION SITE DESCRIPTION

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Abstract

Executive Summary

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- 1.2 Spatial Description
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- 1.4 Transportation Inventory
- 1.5 Environmental Data
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CONVENTIONAL COMMUNITY SYSTEMS

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INTEGRATED DEMONSTRATION SYSTEMS AND COSTS

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INSTITUTIONAL AND SOCIO-ECONOMIC ASSESSMENTS

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- 6.3 Legal Assessments
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CENTRAL PLANT SITES FOR ICS

BY	DATE	SCALE	SHEET
A.E.A.		1"=333'	
CHECKED	DATE	REVISED	DRAWING
J.O.	3/23		65

A - 7

GRID ICES
EXISTING COAL UNBARGING FACILITY

A - 9

SECTION A-A

SCHEMATIC DEVELOPMENT ELEVATED MULTIPURPOSE ENCLOSURE

by	building	scale	sheet
GDM		NONE	
checked	date	revised	drawing
J.O.		4-21-77	1

GRID ICES
HEAT BALANCE DIAGRAM
STEAM AND HOT WATER DISTRICT HEATING WITH SAENS TURBINE

by	building	scale	sheet
A.C.A.		N.S.	
checked	date	revised	drawing
J.O.	3/22/71		22

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MINNESOTA**

7500 KW SAENG
435 PSIG - 735°F
EXHAUST - 5 PSIG
EXTRACTION - 160 PSIG

BY
A.E.A.
CHECKED
J.O.

BUILDING
DATE
4/13/77

SCALE
REVISED
6-28-77

SHEET
DRAWING
49

GRID CONNECTED INTEGRATED COMMUNITY ENERGY SYSTEM
13,800 VOLT ONE LINE DIAGRAM - ICES GENERATOR CONNECTIONS TO NSP GRID

ICES BOILER COST

I. University of Minnesota Latest Experience (July, 1977 Startup)

(St. Paul Unit No. 6, 70,000 lbs./hr. at 300 psig saturated, spreader stoker, 8600 Btu coal)

Boiler and Auxiliaries.	\$1,334,750
General Construction	339,750
Electrical.	196,807
Mechanical.	479,000
Ash and Coal Handling	<u>486,300</u>
Total Construction	\$2,836,607
Non-Construction Costs.	<u>100,000</u>
Total Cost Less Engineering	\$2,936,607
Cost/lb. of steam	\$ 41.95

II. Verbal Estimates - 1977

Foster Wheeler Energy Corporation - \$19.00+/lb. Raw boiler and auxiliaries in place.

Riley Stoker - \$19.00 to \$25.00/lb. Raw boiler and auxiliaries in place.

III. Estimate, Southeast Steam Plant

Since little change had occurred in the new estimate for raw boiler cost, the St. Paul plant cost of \$42.00/lb. was used.

Cost - 270,000 lbs./yr. x 42 - \$11,340,000

SUMMARY OF COST PROJECTIONS

LESS LAND ACQUISITION

	<u>Capital Investment</u>	<u>Operating Cost Savings/Yr.</u>
Projection I	\$ 9,360,860	-0-
Projection II	\$ 9,360,860	\$1,283,650
Projection III	\$10,887,980	\$1,602,780

TUNNEL LONGITUDINAL SECTION

TUNNEL CROSS SECTION B-B

SANDSTONE CHARGING SCHEMATIC

HOT WATER CHARGING SCHEMATIC

SCHEME I
DIURNAL AND SEASONAL STEAM
TO HOT WATER STORAGE STEAM
(NO HOT WATER TANK)

IN METERS

PIPING ISOMETRIC

CHARGE AND DISCHARGE
CYCLE SCHEMATIC

TUNNEL LONGITUDINAL SECTION

SECTION A-A

SCHEME II
DIURNAL AND SEASONAL
WATER TO WATER STORAGE
(NO HOT WATER TANK)

A-14

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GRID JCES
COMBINED DIURNAL-SEASONAL THERMAL STORAGE SYSTEM- CONCEPTUAL DESIGN

DESIGN	DATE	BY	CHKD
J.D.	5/9/77		AM

INPUT SUMMER OPERATION

CHARGING STORAGE BED - SUMMER OPERATION

(For Improved SAEMC Turbine Generator Operation)

OUTPUT WINTER OPERATION

DISCHARGING STORAGE BED - WINTER OPERATION

(For Plant Peaking Load Relief)

LEGEND

DR - DRIVE STEAM TURBINE
OR ELECTRIC

C - COMPRESSOR

EXP - POWER RECOVERY TURBINE
EXPANSION

CALCULATION

ASSUMING $T_4 = 40^\circ\text{F}$
 $T_1 = 160^\circ\text{F}$

$$Q = W C_p \Delta T$$

$$100,000 = W (24) (140)$$

$$W = 2976 \text{ LBS/MIN}$$

$$= 49.6 \text{ LBS/SEC}$$

MODEL

NEED T_1 , T_2 , T_3 , T_4 , AND
POWER REQUIREMENTS FOR
DR (DRIVE HP)MODEL AT $P_2/P_1 = 2.5$ AND AT $P_2/P_1 = 4.0$

AT 50 LBS/SEC

GRID ICES
AIR TO HOT WATER CLOSED CYCLE AIR SYSTEM
SEASONAL THERMAL STORAGE ACCUMULATOR SYSTEM

by	G.E.R.	building	scale	sheet
checked	J.O.	date	revised	drawing
		5/19/77	6-22-77	62

RELATIVE COMPARISONS OF STEAM VERSUS

HOT WATER DISTRIBUTION SYSTEMS

	<u>Steam</u>	<u>Hot Water</u>
Thermal Transmission Effects (Insulation)	-	3 to 5% greater - Smaller pipe
Feedwater System	Condensate Flashing, Trap Leakage	No Flashing, No Traps
Blowdown	Losses of up to 1% unless returned to process	All water is recirculated
Boiler Firing and Control	Elevated Stack Temp. Uneven firing because of peaking and pressure drops	Peaking minimized by heat storage. Better System Control because of reduced pressure losses.
Pumping Costs	Larger, constant volume	Variable and less
Piping	Larger, pipe and water treatment	Smaller pipes, no scale, closed system
Operation	-	Savings in operation costs by degeneration during off peaks
Maintenance	Leaking traps, etc.	Less required no traps, etc.
Investment	-	Less

COMPARISON OF MAXIMUM PIPING SIZE REQUIREMENTS AND HEAT DEGRADATION - STEAM HEISERS HIGH TEMPERATURE WATER DISTRIBUTION

East Bank Requirements - 34,000,000 BTU/hr - Maximum Winter Rate

West Bank Requirements - 48,000,000 BTU/hr - Maximum Winter Rate

Discharge Requirement	BTU/hr	EAST BANK			WEST BANK		
		Steam 34,000,000	Hot Water 34,000,000		Steam 48,000,000	Hot Water 48,000,000	
			T ₁	T ₂		T ₁	T ₂
Operating Pressure	PSIA	174	25	67	174	25	67
Discharge Temperature	°F	370	240 (LOW)	300 (HIGH)	370	240 (LOW)	300 (HIGH)
Return Temperature	°F	180	160	180	180	160	180
Enthalpy @ Discharge, h	BTU/lb	1,198	208	270	1,198	208	270
Enthalpy @ Condensate, h	BTU/lb	148	128	128	148	128	128
Difference, Δh	BTU/lb	853	80	142	853	80	142
Flow Rate	lb/hr	39,858	428,000	238,456.62	63,897.39	576,000.00	323,943.68
Density of Fluid	lb/ft ³	0.38	59.10	57.31	0.38	59.10	57.31
Volume	ft ³ /Sec	28.14	2.00	1.18	39.42	2.70	1.57
Design Velocity	ft/Sec	25.00	8.00	8.00	35.00	8.00	8.00
Required Cross Section	Sq. Ft.	1.17	0.33	0.19	1.13	0.34	0.20
Pipe Size (Sch. 80)	Inches (DIA.)	18 (18.125 ID)	10 (9.564 ID)	6 (7.625 ID)	*24 (21.86 ID)	*12 (10.75 ID)	8 (7.625 ID)
Pipe Volume/5000 ft ³	ft ³	7,091.00	2,495.00	1,585.50	11,850.00	3,151.00	1,585.50
Available Heat	BTU/ft ³	324.14	4,728	8,138.02	324.14	4,728.00	8,138.02
Heat Storage/5000 ft ³	BTU (10 ⁶)	2.30	11.80	12.80	3.87	14.80	12.80
Time Required to Absorb Stored Heat	Minutes	6.05	20.76	22.78	5.05	19.45	16.82

*12", 24" allow for pressure drop

**RIVER BLUFF STRATIFICATION
SECTION SHOWING THERMAL STORAGE TUNNEL**

by DH	building	scale	sheet
checked JO	date 1/4/77	revised	drawing 52

CAPACITY OF COAL STORAGE BIN AT THE
SOUTH PLANT USING 60,000 TON COAL PILE

NO.	THICK LEVEL	MAXIMUM
NO. 1	3000 TON	4000 TON
NO. 2	2500	3500
NO. 3	2000	3000
NO. 4	1500	2500
NO. 5	1000	2000
NO. 6	500	1000
NO. 7	250	500
NO. 8	125	250
NO. 9	62.5	125

SOUTHEAST STEAM PLANT SITE FOR I.C.E.S.
SITE PLAN AT EXISTING SOUTHEAST STEAM PLANT

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OF
MINNESOTA

DATE	NOV 1977	BY	W. J. H. H.
NO.	5-2-77	BY	W. J. H. H.

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OF
MINNESOTA

COMPARISON OF ENERGY COST
AND HEAT RATE FOR TYPICAL
ENERGY - CONVERSION
SYSTEM COMPARED TO ICES.

BY A.E.A.	BUILDING	SCALE N.S.	SHEET
CHECKED J.O.	DATE 3/25/77	REVISED	DRAWING 40

NON-INTEGRATED SYSTEMS STEAM CONSUMPTION DATA--1976									
FACILITY	ANNUAL STEAM CONSUMPTION, LB/HR	% OF TOTAL DEMAND	LAND OWNERSHIP ACRES	STEAM CONSUMPTION DENSITY - LAND LB/ACF - YEAR	BUILDING SPACE, SQ FT	STEAM CONSUMPTION DENSITY - SPACE LB/CSF - YEAR	AVERAGE STEAM CONSUMPTION LB/HOUR	BASE STEAM CONSUMPTION LB/HR	PEAK STEAM CONSUMPTION LB/HOUR
UNIVERSITY OF MINNESOTA	1,831,896,000	87.33	232	7,885,078	10,969,710	157	180,000	110,000	475,310
ST. MARY'S - FAIRVIEW HOSPITAL	197,668,785 162,089,930	9.49	31 (11)	6,382,851	1,173,432 1473,180	169	21,000	10,000	46,000
AUSBURG COLLEGE	67,781,520	3.23	25	2,708,741	494,800	137	770	3815	30,870
TOTALS	2,096,780,905		288	7,280,489	12,637,939	166			551,220

(BRACKETED) = FAIRVIEW HOSPITAL

ICES STEAM CONSUMPTION DATA--1976				
FACILITY	ANNUAL STEAM CONSUMPTION LB/HR	AVERAGE STEAM DEMAND LB/HR	BASE STEAM DEMAND LB/HR	PEAK STEAM DEMAND LB/HR
COMBINED UNIVERSITY, ST. MARY'S - FAIRVIEW AUSEBURG	2,096,780,905	235,000	130,000	551,220

NON-INTEGRATED VERSUS ICES CENTRAL PLANT OPERATING DATA--1977 COMPARISONS																			
CENTRAL PLANTS RELIABLE FUEL CAPACITY--POUNDS PER HOUR										BOILER STEAM CONDITIONS									
NON-INTEGRATED SYSTEM (1977) AS FIRED										CONDITION		PRESSURE, PSIG		TEMPERATURE, °F		ENTHALPY, BTU/LB		BOILER LOADING BASIS	
FACILITY	STEAM BOILER NUMBER	COAL 12,600 BTU/LB	OIL 138,000 BTU/LB	GAS 1000 BTU/CU. FT.	SOLID WASTE 4500 BTU/LB	COAL 8600 BTU/LB	OIL 138,000 BTU/LB	GAS 1000 BTU/CU. FT.	SOLID WASTE 4500 BTU/LB	NON-INTEGRATED	ICES	NON-INTEGRATED	ICES	NON-INTEGRATED	ICES	NON-INTEGRATED	ICES	NON-INTEGRATED	ICES
SOUTHEAST STEAM PLANT	1		160,000				160,000			SH	SH	405	405	775	775	1380	1380	NONE	STANDARD
	2	SALVAGE				SALVAGE				NO LIFE	SALVAGE		SALVAGE					NONE	NONE
	3			160,000			130,000			SH	SH	405	405	775	775	1380	1380	NONE	BASE
	4			160,000			130,000			SH	SH	405	405	775	775	1380	1380	NONE	BASE
	WASTE HEAT SUBTENDS	0	160,000	350,000	0	280,000	160,000	0	43,500	NONE	SH	405	405	775	775	NONE	1380	NONE	BASE
UNIVERSITY HEATING PLANT	1	75,000				60,000				SAT	SAT	200	200	388	388	1199	1199	TOPPING	TOPPING
	2	75,000				60,000				SAT	SAT	200	200	388	388	1199	1199	BASE	SHING
	3	75,000				60,000				SAT	SAT	200	200	388	388	1199	1199	BASE	SHING
	4	200,000				75,000				SAT	SAT	200	200	388	388	1199	1199	BASE	SHING
	5	125,000				90,000				SAT	SAT	200	200	388	388	1199	1199	BASE	SHING
	6		200,000				200,000			SAT	SAT	200	200	388	388	1199	1199	BASE	STABILITY
	12	90,000				60,000				SAT	SAT	200	200	388	388	1199	1199	BASE	EFFICIENCY
ST. MARY'S HOSPITAL	1		60,000	OR 60,000			DECOMMISSIONED			SAT	NONE	155	0	368	0	1196	0	SHING	NONE
	2		35,000	OR 35,000			DECOMMISSIONED			SAT	NONE	155	0	368	0	1196	0	BASE	NONE
	3		35,000	OR 35,000			DECOMMISSIONED			SAT	NONE	155	0	368	0	1196	0	BASE	NONE
	WASTE HEAT SUBTENDS	0	130,000	130,000	0	0	0	0	0	NONE	NONE	NONE	0	NONE	0	NONE	0	NONE	NONE
AUSBURG COLLEGE	1		17,637	OR 17,637			DECOMMISSIONED			SAT	NONE	13	0	286	0	1162	0	BASE	NONE
	2		17,637	OR 17,637			DECOMMISSIONED			SAT	NONE	13	0	286	0	1162	0	BASE	NONE
	3		350	OR 350			DECOMMISSIONED			SAT	NONE	9	0	217	0	1160	0	BASE	NONE
	4		350	OR 350			DECOMMISSIONED			NONE	NONE	9	0	217	0	1160	0	BASE	NONE
	WASTE HEAT SUBTENDS	0	42,294	42,294	0	0	0	0	0			0	0	0	0	0	0	NONE	NONE
POUNDS / HOUR TOTAL*		560,000	532,294	492,294	0	677,000	200,160	0	43,500										

* SH = SUPERHEATED OUTPUT
SAT = SATURATED OUTPUT

NON-INTEGRATED VERSUS ICES FUEL AND STEAM COSTS COMPARISON CHART--1977																									
FACILITY	CENTRAL PLANTS ANNUAL FUEL USAGE								FUEL STORAGE				BASE FUEL COST FOR STEAM PRODUCTION		UNIT ANNUAL M & O COSTS FOR STEAM PRODUCTION		UNIT ANNUAL CONSTRUCTION COSTS FOR STEAM PRODUCTION AND DISTRIBUTION			UNIT ANNUAL CAPITAL REPLACEMENT COSTS FOR STEAM PRODUCTION AND DISTRIBUTION			TOTAL UNIT LEVEL ANNUAL COSTS FOR STEAM PRODUCTION AND DISTRIBUTION		ICES SAVINGS IN FUEL AND M & O COSTS \$ / 1000 LBS
	COAL, TONS		OIL, GALLONS		NAT. GAS, CU. FT.		WASTE SUPPLEMENT, TONS		NON-INTEGRATED		ICES		NON-INTEGRATED \$ / 1000 LBS	ICES \$ / 1000 LBS	NON-INTEGRATED \$ / 1000 LBS	ICES \$ / 1000 LBS	NON-INTEGRATED \$ / 1000 LBS	ICES-10 YEARS \$ / 1000 LBS	ICES-20 YEARS \$ / 1000 LBS	NON-INTEGRATED \$ / 1000 LBS	ICES-10 YEARS \$ / 1000 LBS	ICES-20 YEARS \$ / 1000 LBS			
	12,600 BTU/LB.	18000 BTU/LB.	138,000 BTU/GAL	1000 BTU/CU. FT.	EQUIVALENT COAL & RESIDUAL	NON-INTEGRATED	ICES	TONS	GAL.	TONS	GAL.														
	NON-INTEGRATED	ICES	NON-INTEGRATED	ICES	NON-INTEGRATED	ICES	NON-INTEGRATED	ICES	TONS	GAL.	TONS	GAL.													
SOUTHEAST STEAM PLANT	0	160,725	0	0	0	0	0	30,568	13,072	200,000	13,072	100,000	0	1.40%	NOT IN OPERATION	.3335	0	.8184	.9619	0	.6294	.3122	3.1839	2.6152	BASE = 1.7011
UNIVERSITY HEATING PLANT	50,857	11,141	532,034	0	528,294,000	0	0	0	12,500	1,430,500	12,500	1,430,500	1.64	1.40%	.257	.3335	0	.8184	.9619	0	.6294	.3122	3.1839	2.6152	.6599
ST. MARY'S	0	0	796,680	0	125,406,000	0	0	0	0	51,000	0	0	1.75	1.40%	.642	.3335	0	.8184	.9619	0	.6294	.3122	3.1839	2.6152	.6599
AUSBURG	0	0	180,912	0	44,921,000	0	0	0	0	40,000	0	0	2.52	1.40%	.351	.3335	0	.8184	.9619	0	.6294	.3122	3.1839	2.6152	.6599
TOTAL	50,857	171,866	1,510,905	0	1,096,551,000	0	0	30,568	25,572	1,721,500	25,572	1,530,500	* DOES NOT INCLUDE A PLANT DEPRECIATION FOR UNIVERSITY		* ASSUMED ALL EQUIPMENT IS PAID FOR EXCEPT FOR										

* DOES NOT INCLUDE A PLANT DEPRECIATION FOR UNIVERSITY INVESTMENT IN RECENT PLANT EQUIPMENT. SEE DEPRECIATION CHARGE DRAWING 71.

① ASSUMED ALL EQUIPMENT IS PAID FOR EXCEPT FOR DEPRECIATION OF RESIDUAL VALUE OF UNIVERSITY PLANT. SEE SHEET 2, DRAWING NO. 71.

UNIVERSITY OF MINNESOTA

GRID ICES
NON-INTEGRATED VERSUS INTEGRATED CENTRAL PLANT,
FUEL AND ENERGY PRODUCTION COST COMPARISONS

BY	DATE	SCALE	SHEET
G.D.M.	6-28-77	1/8" = 1'	1
J.O.			20

ICES CENTRAL PLANT LOADINGS—1977 (WESTERN COAL)				
FACILITY	FUEL PRODUCTION METHOD	ANNUAL PLANT SERVICE REQUIREMENT FOR STEAM, POUNDS	ANNUAL PLANT FUEL REQUIREMENT	
			TONS COAL @ 8000 BTU/LB	TONS WASTE @ 4500 BTU/LB
SOUTHEAST STEAM PLANT	COAL BOILERS	1,702,775.036	146,832	—
SOUTHEAST STEAM PLANT	SOLID WASTE	345,000,000	30,568	1,048,000
SOUTHEAST STEAM PLANT	BYPRODUCT POWER	238,972,275	13,885	—
UNIVERSITY HEATING PLANT	COAL BOILERS	152,424,000	11,141	—
	TOTAL	2,442,169,313	202,434	1,048,000

1 EQUIVALENT WESTERN COAL FROM SOLID WASTE @ 4500 BTU/LB.

ICES CENTRAL PLANT PERFORMANCE AND UTILIZATION FIGURES (WESTERN COAL)								
FACILITY	PLANT HEAT RATE (BTU/WH)		BYPRODUCT POWER RATE (KW/WH)		ANNUAL CAPACITY UTILIZATION FACTOR %		PEAK TURBINE (KILOWATT)	
	SHC	SHWC	SHC	SHWC	NON-INTEGRATED	ICES	SHC	SAGC
SOUTHEAST STEAM PLANT	4424	4430	25.90	27.38		81.54	8821	9053
UNIVERSITY HEATING PLANT	INTEGRATED		INTEGRATED		28.25	INTEGRATED	NONE	NONE
ST. MARY'S HEATING PLANT	DECOMMISSIONED		DECOMMISSIONED		17.30	0	NONE	NONE
AUGSBURG HEATING PLANTS	DECOMMISSIONED		DECOMMISSIONED		18.28	0	NONE	NONE

INTEGRATED COGENERATION COSTS—1977 (WESTERN COAL)														
COGENERATION BASE UNIT FUEL COST— 1977 MILLS/WH	UNIT ANNUAL COSTS FOR N & O MILLS/WH	UNIT ANNUAL COSTS FOR DEBT SERVICE		UNIT ANNUAL COSTS FOR CAPITAL REPLACEMENT		TOTAL UNIT ANNUAL COSTS FOR COGENERATION		COGENERATION GASTS—1977			NET COGENERATION REVENUES— 1977			
		10 YEAR DEBT MILLS/WH	20 YEAR DEBT MILLS/WH	10 YEAR DEBT MILLS/WH	20 YEAR DEBT MILLS/WH	10 YEAR DEBT MILLS/WH	20 YEAR DEBT MILLS/WH	ANNUAL GENERATION KILOWATT-HOURS		AVG. GENERATION CREDIT —1977 MILLS/WH	SHC TURBINE		SAGC TURBINE	
								SHC	SAGC		10 YEAR DEBT MILLS/WH	20 YEAR DEBT MILLS/WH	10 YEAR DEBT MILLS/WH	20 YEAR DEBT MILLS/WH
5.4059	1.3474	9.1829	6.2775	6.9450	3.9875	22.8982	16.5463	48,000,000	\$4,080,000	18.9711	-3.9284 (CREDIT)	+2.4248 (CREDIT)	-3.3811 (CREDIT)	+2.7463 (CREDIT)

COMPARISON OF ANNUAL OPERATING COSTS--1977 DOLLARS --STEAM																						
FACILITY	TOTAL FUEL COSTS		TOTAL OPERATING COSTS		ANNUAL ICES FUEL & OPERATING SAVINGS	ICES ANNUAL CAPITAL REPLACEMENT COST		ICES ANNUAL DEBT PAYMENT		I TOTAL ANNUAL OPERATING COSTS--NON-INTEGRATED		II ICES ANNUAL COST AFTER DEBT PAYOFF		III DEPRECIATION PAYMENT (ANNUAL)		IV ICES TOTAL NET ANNUAL COST		ICES TOTAL NET STEAM COSTS--A PER 1000 LBS		V ICES TOTAL NET STEAM COSTS AFTER DEBT PAYOFF--A/1000 LBS		
	NON-INTEGRATED	ICES	NON-INTEGRATED	ICES		10 YEAR BASIS	20 YEAR BASIS	10 YEAR DEBT	20 YEAR DEBT	10 YEAR BASIS	20 YEAR BASIS	10 YEAR BASIS	20 YEAR BASIS	10 YEAR BASIS	20 YEAR BASIS	10 YEAR BASIS	20 YEAR BASIS	10 YEAR BASIS	20 YEAR BASIS	10 YEAR BASIS	20 YEAR BASIS	
UNIVERSITY	\$ 3,006,056	\$ 2,577,589	\$ 470,617	\$ 680,705	\$ 285,463	\$ 1,145,387	\$ 571,698	\$ 1,426,649	\$ 1,028,948	\$ 5,475,775	\$ 5,480,338	\$ 4,748,939	\$ 4,351,689	\$ 3,759,983	NONE	NONE	\$ 5,944,655	\$ 4,525,456	\$ 3,0279	\$ 2,4985	\$ 2.8855	\$ 2.0533
ST. MARY'S	\$ 346,270	\$ 278,520	\$ 127,082	\$ 65,989	\$ 128,735	\$ 125,548	\$ 61,775	\$ 181,935	\$ 111,182	\$ 473,302	\$ 629,935	\$ 517,465	\$ 468,058	\$ 406,289	\$ 361,935	\$ 311,182	\$ 663,135	\$ 499,855	\$ 3,3514	\$ 2,5282	\$ 2.3695	\$ 2.0533
AUGSBURG	\$ 170,650	\$ 95,340	\$ 12,934	\$ 22,594	\$ 65,680	\$ 42,283	\$ 21,142	\$ 55,420	\$ 38,051	\$ 183,584	\$ 215,807	\$ 177,057	\$ 160,147	\$ 139,046	\$ 55,420	\$ 38,051	\$ 205,347	\$ 145,468	\$ 1.0324	\$ 2.3072	\$ 2.3895	\$ 2.0533
TOTAL	\$ 3,520,976	\$ 2,951,429	\$ 610,583	\$ 699,275	\$ 479,855	I FUEL AND OPERATING AND MAINTENANCE ONLY				II REPLACEMENT COSTS CONTINUED		III ESTIMATED ON DEBT SERVICE OF NEW EQUIPMENT FOR ICES STEAM (20 YEAR BASIS)		IV ICES TOTAL ANNUAL OPERATING COSTS + DEP. PAYMENT-- FUEL AND M & O SAVINGS.								

I FUEL AND OPERATING AND MAINTENANCE ONLY

II REPLACEMENT COSTS CONTAINED

III ESTIMATED ON DEBT SERVICE OF NEW EQUIPMENT FOR ICES STEAM PRODUCTION AND DISTRIBUTION. THIS IS FOR DEPRECIATED VALUE OF UNIVERSITY HEATING PLANT. DEPRECIATION PAYMENT FOR 10 OR 20 YEARS.

IV ICES TOTAL ANNUAL OPERATING COSTS + DEP. PAYMENT—FUEL AND N & O SAVINGS.

V ASSUMES DEPRECIATION PAYMENT PAID ALSO. STEAM COSTS ARE THEN LEVEL PAYMENTS FOR ALL PARTNERS.

EQUATIONS—STEAM

TOTAL FUEL COSTS = ANNUAL STEAM CONSUMPTION X BASE FUEL COST FOR STEAM PRODUCTION.

TOTAL OPERATING COSTS = UNIT ANNUAL N & O COSTS FOR STEAM PRODUCTION X ANNUAL STEAM CONSUMPTION.

ICES ANNUAL CAPITAL REPLACEMENT COST = UNIT ANNUAL CAPITAL REPLACEMENT COST FOR STEAM PRODUCTION X ANNUAL STEAM CONSUMPTION. BASIS = 10 OR 20 YEAR DEBT AND REPLACEMENT.

ICES ANNUAL DEBT PAYMENT = UNIT ANNUAL CONSTRUCTION COSTS FOR STEAM PRODUCTION AND DISTRIBUTION X ANNUAL STEAM CONSUMPTION. BASIS = 10 OR 20 YEAR DEBT.

ICES ANNUAL CRITICAL FUEL RELIEF—1977	
RELIEF RESOURCE	EQUIVALENT OIL USAGE (DISCONTINUED)
BYPRODUCT BYPRODUCT (4500 BTU/LB)	1,400,325 GALLONS
OIL DECOMMISSIONING (138,000 BTU/GAL)	1,511,635
NAT. GAS DECOMMISSIONING (1000 BTU/CU. FT.)	63,752
TOTAL RELIEF	5,385,303 GALLONS

UNIVERSITY
OF
MINNESOTA

GRID ICES
NON-INTEGRATED VERSUS INTEGRATED CENTRAL PLANT.
FUEL AND ENERGY PRODUCTION COST COMPARISONS

DATE	2
BY	71

FUEL NEEDED TO PRODUCE 50,000,000 KWH OF ELECTRICITY

UTILITY

EQUIVALENT TONS OF COAL
31,000 TONS

ICES

EQUIVALENT TONS OF COAL
13,050 TONS

FUEL NEEDED TO PRODUCE EQUAL AMOUNTS OF USEFUL ENERGY

UTILITY (ELECTRICITY ONLY)

EQUIVALENT TONS OF COAL
31,000 TONS

ICES

COMMUNITY HEAT—ELECTRICITY

EQUIVALENT TONS OF COAL
12,900 TONS

NOTE: NORMAL CARLOADS ARE 100 TONS

**UNIVERSITY
OF
MINNESOTA**

GRID ICES
SANKEY AND FUEL
COMPARISON DIAGRAMS:
UTILITY VS ICES

BY GDM	BUILDING	SCALE	SHEET
CHECKED J.O.	DATE 5/5/77	REVISED 6-22-77	DRAWING 55

GRID ICES
RENOVATION SCHEMATIC
UNIVERSITY 100 TON/DAY INCINERATOR

by	GDM	building	scale	sheet
checked	J.O.	date	5-9-77	revised
				drawing
				57

DEMONSTRATION COMMUNITY STEAM LOAD DURATION CURVE
FOR YEARS 1976 - 1979

SYMBOL	DEFINITION
*	1979 ADDITIONAL STEAM LOAD TO 1978 STEAM LOAD
.	1978 ADDITIONAL STEAM LOAD TO 1977 STEAM LOAD
X	1977 ADDITIONAL STEAM LOAD TO 1976 STEAM LOAD
/	1976 STEAM LOAD

HOURS OF OPERATION OF HCLB HEATING PLANT AT DIFFERENT LOAD LEVELS
FOR 1976 CALENDAR YEAR

LOAD RANGE	NO. OF HOURS	TOTAL STEAM	LOAD RANGE	NO. OF HOURS	TOTAL STEAM
490000. TO 500000.	0	0	490000. TO 500000.	0	0
480000. TO 490000.	0	0	480000. TO 490000.	0	0
470000. TO 480000.	0	0	470000. TO 480000.	0	0
460000. TO 470000.	0	0	460000. TO 470000.	0	0
450000. TO 460000.	0	0	450000. TO 460000.	0	0
440000. TO 450000.	0	0	440000. TO 450000.	0	0
430000. TO 440000.	0	0	430000. TO 440000.	0	0
420000. TO 430000.	0	0	420000. TO 430000.	0	0
410000. TO 420000.	48.	20030900.	410000. TO 420000.	48.	20030900.
400000. TO 410000.	72.	29114800.	400000. TO 410000.	120.	49145700.
390000. TO 400000.	0	0	390000. TO 400000.	120.	49145700.
380000. TO 390000.	48.	18475500.	380000. TO 390000.	168.	67421200.
370000. TO 380000.	120.	44894150.	370000. TO 380000.	288.	113513350.
360000. TO 370000.	120.	43832800.	360000. TO 370000.	408.	154348150.
350000. TO 360000.	48.	17050500.	350000. TO 360000.	456.	173398450.
340000. TO 350000.	168.	57821950.	340000. TO 350000.	624.	231220600.
330000. TO 340000.	120.	40390200.	330000. TO 340000.	744.	271610800.
320000. TO 330000.	120.	38644350.	320000. TO 330000.	864.	310255150.
310000. TO 320000.	144.	45072550.	310000. TO 320000.	1008.	355327700.
300000. TO 310000.	120.	58548300.	300000. TO 310000.	1200.	413676000.
290000. TO 300000.	168.	49392950.	290000. TO 300000.	1368.	463068950.
280000. TO 290000.	144.	41400100.	280000. TO 290000.	1512.	504469050.
270000. TO 280000.	216.	59117300.	270000. TO 280000.	1728.	563506350.
260000. TO 270000.	192.	50837600.	260000. TO 270000.	1920.	614423950.
250000. TO 260000.	192.	49094100.	250000. TO 260000.	2112.	663518050.
240000. TO 250000.	288.	70890350.	240000. TO 250000.	2400.	734408400.
230000. TO 240000.	312.	73096600.	230000. TO 240000.	2712.	807505000.
220000. TO 230000.	336.	75172450.	220000. TO 230000.	3048.	882677650.
210000. TO 220000.	364.	56684550.	210000. TO 220000.	3312.	939362200.
200000. TO 210000.	408.	83514300.	200000. TO 210000.	3720.	1022876500.
190000. TO 200000.	744.	144859150.	190000. TO 200000.	4464.	1167735650.
180000. TO 190000.	456.	84817525.	180000. TO 190000.	4920.	1252583100.
170000. TO 180000.	816.	142949100.	170000. TO 180000.	5736.	1395522200.
160000. TO 170000.	480.	79134950.	160000. TO 170000.	6216.	1474657230.
150000. TO 160000.	792.	122663300.	150000. TO 160000.	7008.	1597320530.
140000. TO 150000.	552.	79961900.	140000. TO 150000.	7560.	1677282430.
130000. TO 140000.	528.	71606800.	130000. TO 140000.	8088.	1748889210.
120000. TO 130000.	504.	63101800.	120000. TO 130000.	8592.	1811991030.
110000. TO 120000.	168.	19320000.	110000. TO 120000.	8760.	1831311030.
100000. TO 110000.	0	0	100000. TO 110000.	8760.	1831311030.
90000. TO 100000.	24.	2336000.	90000. TO 100000.	8784.	1833647030.
80000. TO 90000.	0	0	80000. TO 90000.	8784.	1833647030.
70000. TO 80000.	0	0	70000. TO 80000.	8784.	1833647030.
60000. TO 70000.	0	0	60000. TO 70000.	8784.	1833647030.
50000. TO 60000.	0	0	50000. TO 60000.	8784.	1833647030.
40000. TO 50000.	0	0	40000. TO 50000.	8784.	1833647030.
30000. TO 40000.	0	0	30000. TO 40000.	8784.	1833647030.
20000. TO 30000.	0	0	20000. TO 30000.	8784.	1833647030.
10000. TO 20000.	0	0	10000. TO 20000.	8784.	1833647030.
0 TO 10000.	0	0	0 TO 10000.	8784.	1833647030.

STOP

SRU 1.154 UNITS.

RUN COMPLETE.

END

SERVICE DEMAND METERED HOURLY DURATION - STEAM
EAST BANK WEST BANK CAMPUSES

HELMICK & LUTZ COMPANY

PROJECT RELATED EXPERIENCE

UNIVERSITY OF MINNESOTA

Minneapolis Campus

1948 Boiler No. 1 Installation
1949 Boiler No. 2 Installation
1950 Heat Distribution System
1951 Boiler No. 3 Installation
1962 Boiler No. 4 Installation
1963 Boiler No. 5 Installation
1965 Primary Electrical Distribution - Phase I
1967 Primary Electrical Distribution - Phase II
1969 Primary Electrical Distribution - Phase III
1970 Heating Plant Addition - Boiler No. 6
Primary Electrical Distribution - Health Sciences
1971 Primary Electrical Distribution - Phase IV
1972 Fuel Conversion - Boiler No. 3
1973 Oil Storage
Primary Electrical Distribution - Zone I Facilities
1976 East Bank - Power Factor Improvement
Baghouse Installation - Boilers No. 1 thru 5

Saint Paul Campus

1952 Heating Plant, Boilers No. 1 and 2, Tunnels
1965 Heating Plant Report
1967 Fuel Conversion - Boilers No. 1 thru 4
Heating Plant Addition - Boiler No. 5
1971 Primary Electrical Distribution - Phase II
1972 Electrical Vault Conversions
Fuel Conversion - Boiler No. 5
1973 Oil Storage
Heating Plant Addition - Boiler No. 6; Baghouse
Installation - Boilers No. 5 & 6

Morris Campus

1947 Boiler Installation
1964 Campus Development Study
1966 Tunnel Extension
1967 Heating Plant, Boilers No. 1 & 2, Tunnels
Primary Electrical Distribution - Phase I
1969 Primary Electrical Distribution - Phase II

Crookston Campus

1949 Boiler
1971 Heating Plant Study
1972 Fuel Conversion - Boiler No. 3

Duluth Campus

1969 Primary Electrical Distribution - Phase I

STATE OF MINNESOTA

State Capitol Complex

1971 Power Plant Improvements - Phase I
1974 Power Plant Improvements - Phase II

Winona State College

1959 Heating Plant, Boilers No. 1 & 2, Tunnels
1963 Tunnel Extension

St. Cloud State College

1965 Heating Plant and Utilities Expansion

STATE OF WISCONSIN

State Capitol Complex

1961 Electrical Conversion, DC to AC - Power Plant
and Capitol Building
1964 Heating Plant Stack

River Falls State College

1962 Heating Plant, Boilers No. 1 & 2

Waupun State Prison

1969 Gas Turbine-Generator and Waste Heat Boiler
Installation

VETERANS ADMINISTRATION

Minneapolis Hospital

1972 Electrical System Survey

BLANDIN PAPER COMPANY

Grand Rapids, Minnesota Mill

1937 Turbine-Generator Installation
1939 Boiler No. 2 Installation
1953 Boiler No. 3 Installation
1959 Power Study
1960 Mill Expansion - Phase I
1961 Mill Expansion - Phase II
1963 Steam and Power Study
1967 Power Study
1969 Power Plant, Boiler No. 4, Turbine-Generator
No. 6
1973 Mill Expansion

HOERNER WALDORF CORPORATION

Ontonagon, Michigan Mill

1947 Kraft Liquor Recovery Boiler and Turbine-Generator
1950 Power Boiler No. 4 Installation
1954 Power Study
1964 Power Plant, Power Boiler No. 5, Turbine-
Generator, Electrical Distribution
1965 Recovery Boiler Study
1971 Fuel Conversion - Boiler No. 5
1973 Mill Expansion
1974 Recovery Boiler Study
1975 Emission Control Study - Power Boiler
1976 Dry Scrubber Installation - Power Boiler
Emission Control

MOSINEE PAPER CORPORATION

Mosinee, Wisconsin Mill

1948 Turbine-Generator Installation
1955 Electrical Distribution System

1958	Electrostatic Precipitator - Recovery Boiler Gases
1961	Hydro Plant Automation
1962	Utilities Study
1962	Mill Expansion
1965	Steam & Electric Power Study
1966	Power Boiler Installation (Burning Coal and Bark)
1972	Emission Control Study - Recovery Boiler

CHARMIN PAPER PRODUCTS

Green Bay, Wisconsin Mill

1946	Steam Generating Plant
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OWENS-ILLINOIS FOREST PRODUCTS

Tomahawk, Wisconsin Mill

1946	Power Boiler No. 7 and Turbine-Generator Installation
1950	Kraft Liquor Recovery Boiler Installation
1954	Steam and Electric Power Study
1955	Power Boiler No. 8 Installation
1956	Electric Power Study

Big Island, Virginia Mill

1955	Black Liquor Recovery System
1957	Power Study
1958	Mill Expansion

OSCAR MAYER & COMPANY

Madison, Wisconsin Plant

1938	Power Boiler No. 4 Installation
1940	Smoke Boiler Installation
1942	Turbine-Generator No. 4 Installation
1943	Power Boiler No. 5 Installation
1947	Turbine-Generator No. 5 Installation
1948	Electrical Distribution System
1951	Power Study
1956	Power Study
1957	Turbine-Generator No. 6 & -Cooling Tower Installation

1958	Power Boiler No. 6 Installation
1959	Cooling Tower
1967	Gas Turbine-Generator and Waste Heat Boiler Installation
1970	Fuel Conversion - Boiler No. 4
1971	Steam & Electric Power Study
1973	Fuel Conversion - Boiler No. 5
1976	Power Study

Davenport, Iowa Plant

1950	Boiler Conversion
1956	Steam & Electric Power Study
1957	Power Boiler No. 6 Installation
1961	Turbine-Generator No. 1 & Cooling Tower Installation
1968	Power Boiler No. 7 Installation
1971	Steam & Electric Power Study
1975	Energy Study

Los Angeles, California Plant

1970	Electrical System Study
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Perry, Iowa Plant

1969	Power Plant, Boilers No. 1 & 2
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RATH PACKING COMPANY

Waterloo, Iowa Plant

1939	Turbine-Generator Installation
1942	Electrical Distribution System
1943	Power Boiler No. 7 Installation
1949	Turbine-Generator Installation
1952	Power Boiler No. 8 Installation
1954	Fuel Conversion

JOHN MORRELL & CO.

Ottumwa, Iowa Plant

1937	Steam & Electrical Power Study
	Turbine-Generator Installation
1939	Power Boiler No. 3 Installation

1946 Power Boiler No. 4 Installation
1952 Power Study

Sioux Falls, South Dakota Plant

1938 Power Study
1948 Power Boiler No. 7 Installation
1960 Power Boiler No. 8 Installation

SUPPORT

The following documentation provides support from key organizations that will impact upon ICES development. The University spent considerable time meeting with all regulating agencies and community organizations to generate support for ICES.

We envision no public agency, or community organization that will not support ICES. Certainly, ICES will have to be designed to alleviate any of their fears regarding operation within the Community, but design techniques are available, as well as, state-of-the-art equipment to overcome these fears. We have welcomed negative, neutral and positive criticism and have not in any way attempted to coerce a positive response. We have been realistic and truthful about all entities to ICES whether it be supportive or of a negative nature.

We have included letters from those agencies, Community organizations that have the most impact upon ICES. There is a complete section in the main report devoted to support.

Congress of the United States
House of Representatives
Washington, D.C. 20515

December 22, 1976

Mr. John P. Millhone,
Director,
Minnesota Energy Agency,
740 American Center Building,
160 East Kellogg Blvd.,
St. Paul, Minn., 55101.

Dear Dr. Millhone:

Thanks for sending a copy of the
University of Minnesota's proposal
for the Demonstration of a Grid-
Connected Integrated Community
Energy System.

I was impressed with the thoroughness
by which this creative and up-to-date
plan was prepared, and have contacted
Dr. Robert C. Seamans, ERDA
Administrator, with the request that
serious consideration be given to
this major proposal.

With best wishes.

Sincerely,

A large, stylized handwritten signature in black ink, consisting of several loops and a long horizontal stroke.

Donald M. Fraser

RIVERFRONT DEVELOPMENT COORDINATION BOARD
Room 235, City Hall
Minneapolis, Minnesota 55415
348-6558

Mr. Warren E. Soderberg
319 15th Avenue Southeast
Room 200, Shops
University of Minnesota
Minneapolis, MN 55455

Dear Mr. Soderberg:

On June 3, 1977 the Riverfront Development Coordination Board (RDCB) received a report on the University of Minnesota Grid ICES. Upon receiving the report the Board took an official action supportive of the project. The complete discussion and action are contained within the accompanying minutes from the RDCB Meeting of June 3, 1977.

I discussed this action with Mr. Jim O'Gara of the University staff. He indicated that it would be desirable to include the essence of this action with your further submissions to secure funding. So as not to have any misinterpretations I am forwarding herein the following summary of the Board action relative to the Grid ICES Project.

At their June 3, 1977 Meeting the Riverfront Development Coordination Board (RDCB) unanimously voted to support the University of Minnesota Grid ICES concept with the following additional provisions:

- (1) That the university make every effort to maintain the highest environmental standards of the plant;
- (2) That the University work on eliminating all environmental impacts on the adjacent community;
- (3) That the actual building become an integral part of a trailway system;
- (4) That the University of Minnesota provide the RDCB with the opportunity for continuing review of the development of the facility;
- (5) That reports be made by the University to the RDCB on the Grid ICES development plans prior to installation of the facility.

I am hopeful that the above action will be of assistance to you in your efforts to implement this project. As well, in light of the above action, I am hopeful that you will maintain continuing and frequent contact with our office as the project progresses. This will allow us the opportunity to review the proposal at all stages of its development and facilitate a more comprehensive understanding of the project on the part of the Board members and our staff. If you desire any further information, or would like to discuss any aspects of this project please feel free to contact me.

Sincerely yours,

Robert H. Ready
Executive Secretary, RDCB

minneapolis

THOMAS L. JOHNSON
ALDERMAN SECOND WARD

JUN 23 1 33 PM '77
city of lakes
RECEIVED PLANT

June 20, 1977

Mr. Warren Soderberg
200 Shops Building
University of Minnesota
Minneapolis, MN 55455

Dear Mr. Soderberg:

Attached is a copy of the official action of the
City Council endorsing the University's application
to ERDA for funding of a GRID-ICES project.

We look forward to working with you on this project.

Sincerely,

Tom Johnson
Second Ward Alderman

TJ:cg
Attachment

RESOLUTION 77R-145
By Aldermen Johnson,
DeMars and Rockenstein

Supporting the University of Minnesota's Application to the Energy Research and Development Administration for a Grid-Integrated Community Energy System (GRID-ICES) Demonstration Grant.

Whereas, the University of Minnesota was awarded a limited contract for a feasibility study of a proposed community energy system (GRID-ICES); and

Whereas, the University's feasibility study recommends the redevelopment of the Southeast steam plant to produce steam for heating University and community buildings, and to produce electricity as a by-product of steam generation; and

Whereas, community energy facilities are consistent with the City's energy conservation policy; and

Whereas, the University's conceptual plan offers the potential for preserving the historic Southeast steam plant in a manner consistent with overall riverfront restoration; and

Whereas, the University has agreed to cooperate fully with the community, the City and other appropriate bodies in the design of the facility so as to develop the facility as a compatible and enhancing element in the Mississippi River Corridor;

Now, Therefore, Be It Resolved by the City Council of the City of Minneapolis:

That the City reaffirms its support for community energy systems, and upon review of the preliminary design concept, strongly supports the University's application to the Energy Research and Development Administration for funding a GRID-ICES project.

Passed May 27, 1977. Louis G. DeMars, President of Council.

Approved June 2, 1977. Charles Stenvig, Mayor.

Attest: Lyall A. Schwarzkopf, City Clerk.

DEPARTMENT OF PUBLIC WORKS
CLAYTON A. SORENSON, P.E.
CITY ENGINEER - DIRECTOR
MINNEAPOLIS, MINNESOTA 55415

May 6, 1977

Mr. W. E. Soderberg
Director, Physical Plant
University of Minnesota
Room 200, Shop Building
319 - 15th Avenue S.E.
Minneapolis, MN 55455

Dear Mr. Soderberg:

I would like to thank Mr. O'Gara for his presentation regarding the University of Minnesota's Grid ICES.

As I understand from the presentation, ICES would demonstrate district steam heating, district hot water heating, by-product electrical generation, and solid waste removal of the Metropolitan Health Care System coupled to sensible heat recovery. It would also be compatible to retainment of pedestrian corridors along the River.

As you know, we have main sewer and water facilities adjacent to the power production sites. Mr. O'Gara's assurance that the road to these facilities for City crews would remain open, and possibly be redesigned, was good news.

I can see no other immediate conflict between the City of Minneapolis and ICES. We support the endeavor and wish you continued success in the development. It is a forward-looking program making best use of our available natural resources.

Very truly yours,

A handwritten signature in cursive script, reading "Clayton A. Sorenson".

Clayton A. Sorenson, P.E.
City Engineer - Director of Public Works

COUNCIL OF COMMUNITY HOSPITALS

SERVING THE SEVEN COUNTY METROPOLITAN AREA

March 23, 1977

Mr. Warren E. Soderberg
Project Manager
Director of Physical Plant, U of M
319 15th Avenue S.E.
Minneapolis, Minnesota 55455

Dear Mr. Soderberg:

The Board of Directors of the Council of Community Hospitals reviewed the Proposal for the Demonstration of a Grid-Connected Integrated Community Energy System at its meeting on March 21. Although all details of the Proposal were not completely covered, the Board voted unanimously to express its interest in the project and the desire to be kept informed as it is developed.

On behalf of the Board, I want to convey this interest and encouragement to you as well as our appreciation for the work that has been done to date. Please let me know as further details become clear and feel free to call upon me if I can be of further assistance.

Sincerely,

Douglas R. Ewald, President

DRE/rtp

minnesota hospital association

serving non-profit hospitals and nursing homes

March 29, 1977

Mr. W. E. Soderberg
Director of Physical Plant
Physical Plant Maintenance and Operations
29C Shops Building
University of Minnesota
Minneapolis, Minnesota 55455

Dear Mr. Soderberg:

Thank you for sending me information about the University of Minnesota's project entitled "Demonstration of a Grid-Connected Integrated Community Energy System." It appears that the solid waste management sub-system would be of interest to the health care industry in the Twin City area.

The Minnesota Hospital Association supports cooperative programs among health care institutions which provide economical and efficient systems which individual facilities could not establish alone. In that light, MHA would support the concept outlined in your proposal.

In order to gain participation of the health care providers, I would urge you to begin informing them of the project and to seek their participation at your earliest convenience.

Sincerely,

Stephen Rogness
Executive Director

SR:cm

minnesota department of health

717 s.e. delaware st. minneapolis 55440

March 4, 1977

**Mr. Warren E. Soderberg
Director of Physical Plant
University of Minnesota
319 15th Avenue S.E.
Minneapolis, Minnesota 55455**

**Re: Proposed High Temperature
Waste Disposal Facility**

Dear Mr. Soderberg:

The Minnesota Department of Health has for several years been acutely aware of the problems connected with proper disposal of hazardous infectious waste generated in hospitals and other health care facilities. Responding to State and Federal environmental concerns the Department and the Minnesota Pollution Control Agency cooperated in establishing recent policies and regulations which require incineration of such waste.

Presently each hospital has its own incinerator. As a rule, these incinerators are inefficient and uneconomical in operation due to their age or small size thus being in marginal compliance with present PCA and Health Department criteria for health and safety standards. The above proposal intends to include several of these Metropolitan hospitals in the disposal program, and will provide a central disposal facility, properly operated, which will meet the most stringent requirements of the health regulations.

A majority of hospitals are using sanitary landfills for disposal of less hazardous infectious waste, including ordinary waste in bulk form. Although in compliance with existing policies and regulations such landfill disposal is at best an interim solution. The Department has been a long time supporter of waste reduction through incineration prior to final disposal in a landfill. Your proposal supports this concept.

The proposal represents a total solution to the waste problem in general in that it includes both waste destruction and energy conservation. The

Mr. Warren E. Soderberg
University of Minnesota
Minneapolis, Minnesota

March 4, 1977
Page 2

pyrolysis process will not only provide safe destruction and maximum reduction of all waste, including hazardous infectious hospital waste, but will also collect generated gas and heat for use by the U of M's steam generating plant. Methodology will be developed for the safe transport of wastes from several inter-city collection points to the central processing plant. As practical application of this entire concept is basically new in this county, a successful demonstration of such a system could serve as a model for other metropolitan areas. The Department has reviewed the proposal with constructive interest and wishes to express its full endorsement and support.

Sincerely yours,

Hans P. Larsen, Chief
296-5451

Engineering Services Section
Division of Health Facilities

HPL:jlb

HENNEPIN COUNTY

30 March 1977

Mr. Warren Soderberg
Director of Physical Plant
University of Minnesota
Room 200 Shops Building
Minneapolis, Minnesota 55455

Dear Mr. Soderberg:

Hennepin County supports the University of Minnesota's application to the Energy Research and Development Administration to demonstrate a small regional pyrolysis plant to dispose of the region's health care waste and similar special wastes from the University hospital and research facilities.

The pyrolysis system as described in your application (RFP No. E (11-1) P-76-806) is desirable because the region's hospital and health care wastes could be disposed of with a minimum of handling and processing. In addition, the pyrolysis temperatures are adequate for proper disposal and energy can be recovered from the wastes.

As your application states, a pyrolysis system could also demonstrate the energy recovery from biomass fuels. We are particularly interested in the utilization of wood wastes, especially from the region's Dutch elm disease epidemic. In 1977, Hennepin County alone will open burn or landfill 28,000 tons of tree wastes. Certainly a system such as your proposed pyrolysis facility that could recover energy from these wood wastes would be more preferable than present disposal methods.

Thank you for reviewing your proposal with me and members of my staff. I hope you are successful in your ICES demonstration project.

Sincerely,

A. J. Lee, P.E.
Director of Public Works and
County Engineer

AJL/LDN:lp
cc: L. D. Nelson

Minnesota Pollution Control Agency

November 15, 1976

Mr. James F. Brinkerhoff
Vice President of Finance Planning and Operations
301 Morrill Hall
University of Minnesota
Minneapolis, Minnesota

Dear Mr. Brinkerhoff:

This letter is submitted in support of the University of Minnesota Department of Physical Plant's response to the Energy Research and Development Agency's Request For Proposal No. E(11-1)-P-76-0016 which calls for a study to determine the feasibility of demonstrating a Grid-Connected Integrated Community Energy System.

We have reviewed the proposal, and we approve of the concept. In our view, there is a demonstrated need in this area for a facility which can properly and efficiently dispose of hospital and health care wastes along with other solid wastes. The original proposal developed some time ago called only for the recovery of energy from hospital wastes. The experience gained through developing and reviewing the original proposal has resulted in a new comprehensive proposal which can have an impact on other areas having problems with hospital and other types of solid wastes.

We look forward to working with the University on this project.

Sincerely yours,

Robert A. Silvagni
Director
Division of Solid Waste

RAS:rrs

cc: Karl Klepitsch, U.S. EPA, Region V, Chicago, Illinois
Sheldon Meyers, U.S. EPA, Washington, D.C.

MINNESOTA ENERGY AGENCY

740 American Center Building
160 East Kellogg Boulevard
St. Paul, Minnesota 55101

November 16, 1976

Warren E. Soderberg
Director, Physical Plant
Room 200 Shops Building
University of Minnesota
Minneapolis, MN 55455

Dear Warren:

The Minnesota Energy Agency strongly supports the ERDA Interconnected Energy System (ICES) approach to energy conservation. The concept of producing heat and electricity in the same facility has been demonstrated in older facilities in Minnesota. However, the availability of cheap natural gas for heating purposes resulted in the phasing out of many of these combined systems. Now the time has come to re-evaluate this highly efficient method of energy conversion.

I am pleased to recommend your proposal to ERDA for the following reasons:

First, your proposal is geared toward an actual demonstration system and not just a theoretical study. Too often in the past, federal funds which could be used for a feasibility study for a practical application of a technology have been used instead for a theoretical analysis. This occurs when the users of the analysis are not committed to the program; I know that you are committed to energy efficient systems and that federal and state priorities will be met if you are successful in your bid for an ICES study.

Second, the University is uniquely suited to applications of new and rejuvenated energy systems.

If ERDA approves your project, they will be able to tap the theoretical and practical engineering and economic expertise of the University. This is essential for ERDA because the problems of ICES systems are as much institutional and political as they are technical.

Third, your project involves Minnesota's largest private utility, Northern States Power.

If the ICES concept is to become a part of our energy supply system, it must be understood and accepted by the utilities. NSP has a proven record of leadership in energy conservation programs and its involvement certainly strengthens your position.

Warren E. Soderberg
November 15, 1976
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Minnesota's natural gas supplies are falling. Our oil supplies from Canada will be terminated in the near future. The use of coal is going to expand. It is essential that this coal be used in an efficient, economical and environmentally sound manner. Your efforts toward this goal are refreshing.

ERDA approval of your ICES proposal will result in an excellent test for Minnesota and for the country.

Sincerely,

A handwritten signature in dark ink, appearing to read "John P. Killbuck", written in a cursive style.

John P. Killbuck
Director

UNIVERSITY
OF
MINNESOTA

GRID ICES.
PROCESS FLOW SCHEMATIC FOR DEMONSTRATION COMMUNITY
WITH SAEC TURBINE OPERATION

BY	BUILDING	SCALE	SHEET
A.E.A.		N.S.	
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J.O.	4/77		42