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CONFIDENTIAL

GRID-CONNECTED INTEGRATED COMMUNITY ENERGY SYSTEM

Phase II, Final Stage 2 Report

Executive Summary

March 22, 1978

Work Performed Under Contract No. EC-77-C-02-4210

University of Minnesota
Physical Plant
Minneapolis, Minnesota

and

Helmick & Lutz Company
Engineers
Minneapolis, Minnesota

U. S. DEPARTMENT OF ENERGY

Division of Buildings and Community Systems

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GRID-CONNECTED INTEGRATED COMMUNITY ENERGY SYSTEM

PHASE II FINAL STAGE 2 REPORT

EXECUTIVE SUMMARY

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March 22, 1978

UNIVERSITY OF MINNESOTA PHYSICAL PLANT
319 15th AVE. S.E.
MINNEAPOLIS, MINNESOTA 55455
612-373-4521

Prepared For
The U.S. Department of Energy
Under Contract No. EC-77-C-02-4210

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VOLUME 1

EXECUTIVE SUMMARY

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The following institutions have furnished documentation or planning reports from which information was extracted for preparation of this report.

University of Minnesota - Physical Plant
University of Minnesota - Physical Planning
St. Mary's Hospital - Administration
Fairview Hospital - Administration

We would also like to express thanks to the directing boards of the following institutions for their support and participation.

Northern States Power Company
St. Mary's Hospital
Fairview Hospital
Augsburg College

A special thanks are extended to the Burlington-Northern Railway and Northern States Power Company for their cooperation and assistance in the development of unit train shipments of coal from Montana.

In addition the support and information provided by various federal, state, local regulatory agencies, community organizations and industry is appreciated.

BASIC PLAN

- The University of Minnesota as the Community.
- Rehabilitation of the Southeast Generating Station as the Grid Connected source utilizing Western sub-bituminous coal and providing electric power generation as the by-product of Community thermal load.
- Northern States Power Company as the Grid Connected utility.

OPTION I - ADD-ON CUSTOMERS (ST. MARY'S/FAIRVIEW HOSPITALS, AUGSBURG COLLEGE)

- Expansion of the Community thermal load by extension of the University steam system.

Add-On Customers to the extension--

- St. Mary's Hospital
- Fairview Hospital
- Augsburg College

OPTION II - PYROLYSIS AND WASTE HEAT RECOVERY

- Addition to the Southeast Generating Station of solid waste disposal by the Pyrolysis method with waste heat recovery.
- Pyrolysis process to provide high temperature, sterile reduction of contaminated Hospital and municipal type waste.
- Waste heat recovery of pyrolysis to augment the Grid Connected source plant fuel requirement.

OPTION III - HOT WATER DISTRIBUTION AND BUILDING CONVERSIONS

- Conversion of a portion of the University steam distribution system to variable temperature, variable volume hot water distribution.
- A Demonstration system to provide maximum by-product electric generation, minimum thermal system losses, and maximum thermal transport range and operation.

GRID - CONNECTED ICES OVERVIEW

GENERATION OF BYPRODUCT ELECTRICITY

- Plant Efficiency Increased by 54% over large utility operation
- Utility benefits by added capacity, capital expense offset and reduced coal usage

HEALTH CARE INDUSTRY WASTE DISPOSAL

- Health Care Incinerators are Marginal Operations with regard to emissions
- Pyrolysis Process is 70% Efficient
- Energy Recovery from Wastes Provides 3 lbs Steam Per Pound of Waste
- Landfill Reduction - 97% By Volume
- Pyrolysis Waste is Inert Landfill material or commercially saleable
- Pyrolysis allows for research of other fuels such as woodchips and biomass

THERMAL DISTRIBUTION

- Steam Co-Generation of Electricity and Community Heating Improves plant Efficiency
- Hot Water Increases Generation of Electricity by Usage of Lower Level Heat
- ICES - Expandable to Heat Pump and Solar System Technology

CENTRAL PLANT SITE

- Reduced Plants in Community
- Transfer of Critical Resources (Oil, Gas) to Coal
- Improved Use of Primary Resource - Coal
- Lesser Fuel Costs

ENVIRONMENTAL QUALITY

- Public Facilities and Usage Enhanced
- Improved Coal Handling System
- Improved Air Quality in Region
- One Central Plant versus Many Smaller Gas/Oil Plants
- Closed System Operating Cycles
- No Thermal Pollution of Bodies of Water
- Increased Water Conservation

SOCIO-ECONOMIC

- Improved Utilization of Natural Resources
- Improved Environment
- Reduced Heating Costs as Deregulation of Gas and Curtailment of Natural Gas & Oil Supplies Occur
- Model System Ready for Integration with Urban District Heating Schemes
- Provides Economical Site for Future Study of Energy Systems
- Fuel Cost Stabilization in Community

The University of Minnesota Grid-ICES was divided into four identifiable programs in order to study the feasibility of each of the parts of the ICES independently. The total program involves cogeneration, fuel conversion, fuel substitution and energy conservation by system change.

This Phase II report substantiates the theory that the Basic Grid ICES is not only energy effective but it will become cost effective as unit operating costs adjust to supply and demand in the 1980's.

To support the economic plausibility of the ICES, we have taken the Phase II capital cost estimated for construction (based on a 1978 price index) and with estimated operating costs projected both to 1981. Realizing the risk of projecting unit costs, it can be said that cogeneration and Option I of the ICES program are both energy and cost effective. Option II requires considerable capital support. Option III would become cost effective as the thermal loading of hot water distribution is increased by adding more buildings.

A brief description of the Basic Program and the three Options follows:

- a. The Basic Program involves the cogeneration of steam and electricity. The University of Minnesota has been following an orderly process of converting its Central Heating Plant from gas-oil to 100 percent coal since 1973. The first step in the transition is complete. The University of Minnesota is presently 100 percent on coal, and will begin the second step, the test burning of low BTU Western coal during the spring, summer and fall, and high BTU Eastern coal during the high thermal winter period. The final step to 100 percent Western coal is planned to be completed by 1980. In conjunction with the final step a retired N.S.P. generating plant (located adjacent to the University of Minnesota Heating Plant) has been purchased and is in the process of being retrofitted for topping the existing plant steam output during the winter months. The Basic Plan of ICES involves the add-on work and expense of installing additional boiler capacity at Southeast Steam and non-condensing electric generating capability. This will permit the simultaneous generation of electricity and heat dependent upon the thermal requirements of the heating and cooling system in University buildings. This type of cogeneration is 54% more efficient than the normal fossil fuel fired utility company generating plants. The fuel requirements for ICES electric generation is in the area of 4,600 BTU/KWh as compared to utility generation requirements of 10,000 BTU/KWh. The key to capital recovery plus some return on investment of the Basic Plan is how accurate our projection that Western coal will be less than \$21.00 a ton and electric credits will be at least 2.8 cents per kilowatt-hour by the year 1981.
- b. Option I involves fuel conversion of two neighboring hospitals and a college wherein they will decommission their gas-oil fired boiler and purchase steam generated by coal from the University of Minnesota. This will not only substitute approximately 2.9 million gallons of oil per year with 23,718 tons of coal and increase cogeneration, but will be a significant future cost savings for the add-on customers, St. Mary's and Fairview Hospitals and Augsburg College.

- c. Option II involves the displacement of a portion of the coal for the ICES by heat recovery of solid waste as well as a long term solution to the problem of disposing of critical wastes in an environmentally clean manner. Combined waste disposal-energy recovery plants relate to size when attempting to reach a cost effective status. Since slagging type pyrolysis units have limited operating experience, especially in the United States, we have sized this installation based upon institutional and community constraints. This report does not indicate that a unit this small (132 tons/day) will be cost effective, however, it can demonstrate an effective way of disposing of hospital and health care solid waste. The two products of pyrolysis will be utilized. The generated off gas (160 BTU per Cu. Ft.) will be burned in the plant as a displacement for the coal requirements and the inert frit will be used either in the manufacturing of blocks or as a material for road construction.
- d. Option III involves a system change. The present University of Minnesota thermal transport system is steam. This Option proposes the conversion of part of the steam system to a modulating temperature and pressure hot water system. The lower the temperature of the transport medium for heating and cooling buildings the higher the electric output will be from the cogeneration plant. This is an important factor in evaluating the cost effectiveness of the system. The inability of the interface of hot water distribution with all the end users' building equipment is a problem that could be studied in more detail if a demonstration system such as Option III becomes operational. Use of low quality energy (under 200° F) will increase in the future as district systems of heat pumps and solar energy coupled to cogeneration come into being. Though this report indicates that in 1981, Option III is not cost effective, it also indicates that when the debt service has been satisfied (1990's) the conversion will become cost effective.

The following materials present an overview of the Community and the ICES.

Twin Cities Metropolitan Area

base map by Metro Council

metro location

GRID ICES DEMONSTRATION COMMUNITY

4-28-78

South East Generating Station

SOUTHEAST
STEAM PLANT

EXISTING MINNEAPOLIS
CAMPUS HEATING PLANT

INT 35W

10th AVE

EXISTING VIEW LOOKING NORTH

VIEW LOOKING NORTHWEST
WEST BANK CAMPUS

ANDCO-TORRAX SYSTEM

university of minnesota
minneapolis

BY	GDM	CHECKED	DATE	4-30-78	REVISD	DRAWING
BUILDING	SCALE	SHEET				

GRID ICES
COMPARISON OF CONVENTIONAL, SELECT,
TOTAL AND ICES ENERGY SYSTEMS

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GRID ICES
COGENERATION SYSTEM
PROCESS DIAGRAM FOR TOTAL PROGRAM

BY	BUILDING	SCALE	SHEET
GDM			
CHECKED	DATE	REVISED	DRAWING
JCO	4-30-78

FUEL NEEDED TO PRODUCE 44,775,000 KWH OF ELECTRICITY

UTILITY

ICES

FUEL NEEDED TO PRODUCE 741,278,000 KWH OF USEFUL ENERGY

UTILITY (ELECTRICITY ONLY)

ICES

NOTE: NORMAL CARLOADS ARE 100 TONS

GRID ICES-1981
SANKEY AND FUEL COMPARISON DIAGRAMS
UTILITY VS ICES (BASIC PLAN+OPTION I)

BY	BUILDING	SCALE	SHEET
SCM			
CHECKED	DATE	REVISED	DRAWING
JCO	5-7-77	6-22-77 4-26-78	55

SYSTEM EFFICIENCY = 72.40%
 SYSTEM PRODUCTION = 3.45 POUNDS STEAM PER POUND REFUSE

20

GRID ICES
 PYROLYSIS SYSTEM
 MASS BALANCE DIAGRAM
 132 U.S. TONS PER DAY

BY GDM	BUILDING	SCALE	SHEET
CHECKED JCO	DATE 4-30-78	REVISED	DRAWING

ELECTRIC GRID CONNECTIONGeneral

Four modes of operation were considered for the electric connection of the by-product generated power:

- A. Parallel operation with Northern States Power Company with synchronizing at the existing 4th Street Switching Station (main service point of the East Bank Campus).
- B. Parallel operation with Northern States Power Company with synchronizing to the Main Street Substation, with the Southeast Station on the synchronized bus only. (Sale of surplus power.)
- C. Parallel operation with Northern States Power Company, including a wheelage agreement with Main Street to 4th Street and simultaneous demand interval metering. (Self use of all generated power.)
- D. Parallel operation of the generator only to Main Street. (Sale of all generated power.)

Conclusion

On the basis of economics, simplicity of operation, and in conformance with existing rate schedules, the sale of all generated power (Scheme D) will be used.

It should be pointed out that this electrical arrangement does not preclude changing the mode of operation in the future. Should there be dramatic rate or regulatory changes that would favor cogeneration via a wheelage agreement or other service agreements, they could be implemented at a future date. Northern States Power Company has been very cooperative in helping attain the best available return to the ICES.

MAIN STREET
SUBSTATION

SOUTHEAST
STEAM PLANT

CORPS OF ENGINEER'S
LOCK AND DAM

INT 35W

VIEW LOOKING NORTHWEST

GRID ICES DEMONSTRATION COMMUNITY

4-28-78

As a result of a formal and legal review by the State of Minnesota Environmental Quality Board and the member state and local regulatory agencies the Environmental Quality Board based upon no formal objection to a negative declaration for an Environmental Impact Statement (E.I.S.) for ICES declared that the ICES project can now commence.

Significant to the review were the additional reports generated for formal MPCA review of emissions related to the Clean Air Act and upcoming enforcement of amendments which establish lower pollutants standards and tradeoff policies coupled to "Lowest Achievable Emissions Rates."

Positive results of the EQB review for all of ICES or any portion follows. The procedures and results of calculations, accompanying letters, etc. are fully included in other volumes of this report.

Because of detailed calculations and meetings with the MPCA, the ICES program is into permitting discussions and negotiations. Formal permitting filing of ICES can begin with Phase III design.

During the 30 day review period, which began March 27, 1978, there was no formal filing of an opposition to the negative declaration for an E.I.S. (see letter from governing Environmental Quality Board).

This however does not constitute final actions that may be taken by any member agency of the Environmental Quality Council. The 30 day review established the following:

1. That an Environmental Impact Statement is not required for ICES and that ICES can proceed into the permitting and construction phases.
2. That any environmental effects or litigation regarding ICES can be addressed through the necessary construction and operating permit procedures. This process would begin in Phase III and end in Phase IV of the ICES program.
3. The latest determination of the MPCA is that the "lowest achievable emission rate" policy of upcoming EPA amendments will be in force at Southeast Steam Plant. The University will continue to negotiate with the MPCA to obtain a satisfactory solution to LAER policy.

Minnesota
Environmental Quality Board

100 Capitol Square Building
550 Cedar Street
St. Paul, Minnesota 55101
Phone 296-8255

April 28, 1978

Warren E. Soderburg, Director
Physical Plant
University of Minnesota
319 - 15th Avenue S.E.
Minneapolis, MN 55455

RE: Grid ICES

Dear Mr. Soderburg:

The 30-day review period for the environmental assessment worksheet (EAW) on the above project ended on April 26, 1978. No objections to the EAW's determination that no environmental impact statement (EIS) is needed on the project were received. Therefore, the decision stands.

Final actions to approve or commence the project can now be undertaken.

Sincerely,

Nancy Salustro
Nancy Salustro
Environmental Planner

NS/dh

Minnesota Pollution Control Agency

(612) 296-7265

May 23, 1978

Mr. James C. O'Gara
Principal Plant Engineer
Physical Plant Maintenance and Operations
University of Minnesota
200 Shops Building
319-15th Avenue, S.E.
Minneapolis, MN 55455

Dear Mr. O'Gara:

This letter describes conditions applicable to the U of M's proposal to reactivate the Southeast Steam Plant as described in your "U of M Grid Connected Integrated Community Energy System Report on Plant Emissions" revised April 12, 1978, and additional information attached to a letter from you to Louis Chamberlain dated May 9, 1978. These conditions arise from EPA's emission offset policy, published in the Federal Register December 21, 1976, beginning on page 55524 as incorporated into the Clean Air Act by Section 129 of the 1977 Amendments.

1. The SE plant and the main UM facility are in an area not attaining particulate and SO₂ standards. The tradeoff policy applies to major modifications and new sources in nonattainment areas.
2. The information submitted by the U of M on May 9, 1978, regarding existing and future emissions at the UM plant and the SE plant indicates that at full-rated capacity, operating within existing emission regulations emissions from the SE plant will be:

56.51 tons per year of particulate and
2,363.33 tons per year of sulphur dioxide.

Therefore, the SE plant is a major source of SO₂ but not particulates.

Not reactivating the 1932 oil-fired peaking boiler as described in table 2.19d of the May 9 submittal would reduce these emissions to 51.18 t.p.y. of particulates and 2043.70 t.p.y. of SO₂. This would still be a major SO₂ source.

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Mr. James O'Gara
Page 2
May 23, 1978

3. The SE plant is a new source and/or major modification for purposes of the offset policy because modifying the boilers at the SE plant will increase the allowable emissions from those boilers by more than 100 tons per year. The SE plant has not been in operation since 1975 and, at that time, was burning oil. Allowable emissions from that plant are now zero.
4. The seven-county Twin Cities nonattainment area contains areas which attain standards as well as areas where standards have been violated. It is likely that the UM plant and the SE plant are and will be affecting an area where standards are being violated, since monitors located in the midway and downtown Minneapolis areas have shown violations in the past year. However, should the University wish to prove, through approved dispersion modeling, that the SE plant will not be contributing to or creating a violation of air quality standards, that option is open. That would be a complex modeling project including many other sources in the vicinity and would require close cooperation with our Technical Services Section. Given that the SE plant is a new source and that its emissions will exceed 100 tons per year, showing that the plant's emissions would not create or contribute to a violation is the only way the plant could be exempted from the tradeoff policy.
5. The tradeoff policy requires four conditions be met by new sources and major modifications:
 - a. A net air quality benefit.
 - b. Lowest achievable emission rate (LAER).
 - c. Emission offsets (reduction) more than equal to new emissions.
 - d. All commonly-owned or -operated sources in the nonattainment area in compliance with emission regulations and air quality standards.
6. An unofficial draft of revisions to the tradeoff policy allows certain exemptions for resource recovery projects and "temporary emission sources such as pilot plants." These exemptions are applicable to the emission offset condition but not to the LAER requirement. Until it is officially changed, we will enforce the existing policy, which does not contain these exemptions.

May 23, 1978

7. The only exception in the emission offset policy to the LAER requirement is that the applicant has the option to demonstrate that it cannot achieve a rate lower than a given level. In no case may that level be below the new source performance standard as listed in Table II of APC-4.
8. The four conditions identified in the existing regulation apply to the new or modified portion of the facility--i.e., LAER would not be required at the UM plant, only at the SE plant.
9. In the case of oil or coal fired boilers, LAER requires the use of flue gas desulphurization. Based on a 1976 survey of scrubbers, the allowable emission rate would be 80% removal efficiency.
10. Tradeoffs (offsetting emission reduction) are documented in the May 9 submittal as follows:

<u>Source</u>	<u>SO₂ Emissions</u> (tons per year)
UM plant--conversion to western coal	-2203.76
St. Mary's-Farview Hospitals--close down existing boilers	-287.78
Augsburg College--close down existing boilers	<u>-121.05</u>
Total	-2612.59

These tradeoffs are adequate to offset the additional 2,363 tons per year to be emitted by the SE plant.

11. In order for the considerable portion of the above reduction due to conversion to western coal to qualify as an emission offset, conversion must be undertaken as a phase of the overall Grid-ICES project. If you wish to convert to coal immediately, it would be advisable for you to enter into a written agreement with the MPCA to the effect that the conversion is a part of the Grid-ICES project.

Operating a new or significantly expanded power plant within the Twin Cities nonattainment area is an action that has the potential to significantly degrade air quality. By meeting the conditions set forth in this letter, the U of M will ensure that air quality improves as a result of their participation in the Grid-ICES project.

Mr. James O'Gara
Page 4
May 23, 1978

If you have any questions, please call Susan Wierman, Environmental Planner (296-7358), Frank Blackhall, Engineer (296-7275), or me.

Yours truly,

Bradley J. Beckham
Deputy Director
Division of Air Quality

BJB/SW/rg

Metro Square Building, 7th Street and Robert Street, Saint Paul, Minnesota 55101 Area 612, 291-6359
May 24, 1978

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

Dear Mr. Soderberg:

Metropolitan Council staff appreciated the opportunity to hear your presentation of the plans and tour the site of the University's proposed Grid-Connected Integrated Community Energy System (Grid-ICES). Your presentation, in response to our letter of April 26, 1978, concerning the potential impact of this project on the proposed regional park and the consistency of this project with Mississippi River Corridor Critical Area standards, was valuable in answering our concerns. The staff has reviewed the additional information presented at this meeting and concluded that a number of our original concerns have been resolved. Staff feels that the remaining concerns can be addressed and resolved during the next phase of project design and engineering, the on-going planning for the regional park, and the preparation of the comprehensive Critical Area plan for that segment of the river corridor. The latter plan is to be developed by the University and coordinated with the City of Minneapolis Critical Area plan for the entire river corridor within the city.

Staff has identified as a major concern the continuity and usability of the regional open space between the Grid-ICES plant and existing University heating plant. Council's park objective and Critical Area standards call for the development of a continuous regional trail along the river in an open and natural setting where practical. It appears that the potentially disruptive and hazardous truck traffic through the park to the proposed project and existing plant can be mitigated by gaining service access to the plants from above the bluff rather than via 6th Street S.E. This would eliminate most of the truck traffic from the park and trail routing, except for city and University service vehicles. The latter should be minimized to the extent possible.

Mr. Warren Soderberg
May 24, 1978
Page 2

Finally, a "public recreational right" must be acquired for the use of the University land between the Grid-ICES site and existing heating plant, linking park lands along the river above and below the area. This could be achieved through fee title or long-term easement, but must provide assurance that the benefit from the recreational investment will be realized. Grant contracts for Regional Parks require this interest. If and when the Central Riverfront Open Space Master Plan is approved, this issue must be addressed.

Critical Area Interim Development Regulations and planning standards require the protection and management of the bluffs along the river. Staff understands that every effort will be made to keep the enclosed gallery and conveyor system off and above the bluffs. This could also protect the regional park from the visual impact. Staff recommends that this issue be examined carefully in the next phase of the project study and include an analysis of the feasibility of underground placement of the gallery as well as above ground alignments above the bluff with adequate vegetative screening. An underground placement would mitigate visual impacts and potential obstructions to continuous trail uses.

The proposed Grid-ICES facility appears to offer substantial energy savings for the University and immediate community. Because of the additional design and engineering study the University will undertake for the project, the Council will not perform a final Critical Area review of the Grid-ICES project at this time. Staff feels that the issues outlined above can be addressed and resolved in the detailed design and engineering study, the City of Minneapolis' master plan for the regional park, and in the preparation of the City's and University's comprehensive Critical Area River Corridor plans which are now in development: Laszlo Fulop, University of Minnesota, and Ollie Byrum, City of Minneapolis, are responsible for preparing the river corridor plans.

Yours truly,

John Boland
Chairman

JB/mas

cc: Peter Vanderpoel
Robert Ready
Ollie Byrum
Laszlo Fulop
Cliff Aichinger

The ICES system concept offers technical, environmental and institutional economic advantages to the University of Minnesota and the surrounding Community.

The energy savings afforded by an ICES are in several forms. The overall energy savings of ICES are 698,400 million BTU per year. The energy savings relative to the existing system is 36 percent.

Since the efficiency of an ICES, wherein electricity is generated, is gained by utilizing exhaust heat normally expelled to a body of water, the reductions in thermal pollution of water bodies are proportional to the savings in energy.

Particulate and sulphur emissions are determined by regulations and operations. Given the same equipment performance, the reduction in sulphur dioxide pollution is proportional to energy savings. Baghouses will reduce particulates significantly.

The coal burning and waste heat recovery boilers, and electric generation to be implemented as a part of the ICES will displace the burning of 5.75 million gallons of oil per year. A further reduction of 1.8 million gallons of oil per year by the local power utility occurs due to the reduced electrical power production requirements brought about by ICES generation.

Pyrolysis of the solid waste with heat recovery will reduce the volume of landfill requirements by 97 percent and the ash sent to the landfill will be a dense sterile material. Heat recovery from the solid waste will be equivalent to 16 percent of the present heating requirements and will increase electric generation by 10% through increased steam production. Implementation of the pyrolysis system will provide the Health Care Community with an environmentally improved method of critical waste removal. It will also eliminate many hospital incinerators.

The use of treated return water in the thermal distribution systems will conserve 280 million gallons of ground water annually. An additional 126 million gallons are conserved annually by pyrolysis.

Siting of the coal-fired co-generating plant and pyrolysis is on University property adjacent to the existing plant in an area governmentally designated for power production operation.

Railed or barged coal supply and transportation to the University are available. And, while the University presently burns barged coal, the establishment of unit train coal delivery will lessen fuel costs. The barge unloading facility will be retained for equipment shipments and as a back-up to the unit train in event of coal strikes and bad weather. The unit trains will eliminate off campus coal storage and reduce truck hauling in the Community.

Reduced operation of the barging facility will environmentally enhance the area.

Community fuel cost is stabilized by the use of lower cost Western coal.

Integration of the thermal and electric sub-systems will make the operation and management of an ICES more complex. In particular, the higher operating pressures and temperature of the boilers will require training of personnel. In addition purchasing, cost accounting and state and federal reporting will become more complex.

The installation of an ICES will require considerable capital outlay. Thus, the ICES will be in competition for funds within the University, the State University System and the State as a whole. In contrast, increased utility costs with the present system will place pressures on operating budgets of academic programs. The important economic impact of an ICES is that the ICES will pay for itself in a short time and reduce future fuel, utility and expansion costs that would be borne by state taxpayers.

The ICES would be of national interest as a model demonstration of cost effective energy conservation, energy operation and environmental improvement.

The ICES concept has been determined to be an environmentally improved method of generating steam and electricity from coal and solid waste. An Environmental Impact Statement, as determined by a state review process (Environmental Quality Board), is not required. All litigation has now been determined to be fully addressable within the state permitting procedures for construction and operation of the ICES.

GRID ICES EXISTING PLANT FACILITIES

4-28-78

The following material represent the capital cost summary as determined by the Phase II preliminary design and the official University financing and cost sharing proposal.

UNIVERSITY OF MINNESOTA

Office of the Vice President for Finance
301 Morrill Hall
100 Church Street S.E.
Minneapolis, Minnesota 55455
(612) 373-5940

April 24, 1978

Mr. John Rodousakis, Program Manager
Buildings and Community Systems
U. S. Department of Energy
Mail Station: 2221C
Washington, D. C. 20545

RE: Attached University of Minnesota Capital Funding Program
for Phases III and IV, Grid-Connected Integrated Community
Energy System, Contract No. EC-77-C-02-4210

Dear Mr. Rodousakis:

As an authorized representative of the University Board of Regents, I am submitting the University's proposed capital funding program for the Grid-Connected Integrated Community Energy System.

At my request, Assistant Vice President C. T. Johnson, Assistant Vice President C. L. Carlson, W. E. Soderberg and the Physical Plant staff have assisted in preparing the enclosed cost sharing program.

The development of this community project presents possible future opportunities for cost benefits, but at this time, the University can only emphasize the significant conservation of energy associated with this program. The more efficient method of generating electricity, the adding on of community loads to the University's coal-fired plants, and the improved method of disposing of critical solid waste all will show significant energy gains for the community. The program estimates a reduction of 2,600,000 gallons of oil or equivalent natural gas, fuels which are rapidly becoming extremely critical. In addition, there will be an offsetting of approximately 40,000 tons of coal as a result of the co-generation of electricity and the waste-heat recovery from the disposal of solid waste.

The primary obstacle to implementation of ICES, whether it is in Minnesota or elsewhere, is the breaking down of capital, regulatory and socioeconomic barriers. The University has overcome the regulatory and socioeconomic barriers. The program is capital intensive and will require the University to obtain loans for design and construction as the project progresses.

April 24, 1978

Large loan commitments are not new to the University of Minnesota. Housing, Student Unions and other self-support units normally cover their facility expansions by establishing some type of debt service. The cost sharing proposed in the capital funding program obligates the University to undertake a debt of over \$11,000,000, which is a sizeable undertaking, since all previous capital funding requirements at the Minneapolis Campus Heating Plant were provided by State appropriations.

In addition to the \$431,888 grant already received, we are requesting a total of \$9,795,604 from the Department of Energy to assist the University in funding the Basic Plan and Options I, II and III as outlined in the attached documentation. In reviewing this project, we feel that this is exactly the type of activity that the Department of Energy ought to be encouraging and supporting if you are to carry out the mandate of Congress and the American people to encourage innovative approaches to the energy problem. There are, I am sure, few projects which are submitted for your consideration which have been as carefully developed and as widely supported by the community and by the appropriate State officials as the University's Grid-ICES proposal. While we have very much appreciated the support which you have given to the various feasibility studies, it is our considered opinion that at this time it is very appropriate that you provide us with the assistance necessary to allow this project to be completed so that it may serve as a singular illustration of how a large institution can effectively address the energy problems of this country.

We will be looking forward to receiving a favorable response to the funding program, and as always, my staff will be available to meet with you at any time to further discuss or negotiate cost sharing in Phases III and IV.

Very truly yours,

Donald P. Brown
Vice President for Finance

DPB/pj

Attachment

cc: H. Miller, DOE
 Jess Pascual, DOE
 C. T. Johnson
 C. L. Carlson
 W. E. Soderberg

COST SUMMARY

The funding requirements and the cash flow program developed for this Phase II report were influenced by the descriptive material on cost sharing in the RFP and by institutional framework and restraints of the University. The University of Minnesota's understanding of the DOE program on Grid-ICES is that assistance beyond Phase II is negotiable and negotiable probably only in the areas of program inclusions that the DOE wants or parts of the program that involve high risks.

The question of risk is difficult to address. Whenever a not-for-profit institution enters into unrelated areas of activity, such as the generation of electricity, the sale of steam to nonaffiliated customers, or the disposal of community waste, it exposes the institution to risks involving capital recovery that are not generated by institutional needs.

Since we were not able to determine areas of risk that were specifically compatible to the DOE's RFP, our preliminary proposal included no funding assistance other than add-on instrumentation. The funding requirements and cash flow have been modified to show needed cost sharing in the following segments:

	<u>Cost</u>
1. Normal Heating Plant expansion	\$14,829,520
2. Add-on cost for the Basic Program	4,885,280
3. Add-on cost for Option I	1,828,000
4. Add-on cost for Option II	7,700,800
5. Add-on cost for Option III	1,930,000
Construction Cost Total, Phases III and IV	<u>\$31,173,600</u>
Phases I and II (DOE)	431,888
Cash Flow Assistance	<u>1,058,984</u>
Total	<u>\$32,664,472</u>

The University strongly supports its entire Grid-ICES Program. Briefly, the energy gains are as follows.

The Basic Plan is a 50 percent plus improvement over the normal method of generating electricity; Option I is a very cost effective way of converting gas/oil fired units to coal; Option II is an improved and acceptable method of disposing of health care material whereby waste normally disposed of in landfill will be converted to a burnable low BTU gas; and Option III is an improved method of transporting thermal energy for a cogeneration system. With these gains in mind, the Federal Government should be making every effort to assist in the funding of projects such as the University of Minnesota's Grid-ICES so that they may meet the time restraints of being on line in the 1980's.

The conclusion is that without the new proposed cost sharing program, the University of Minnesota should continue its normal plant expansion, programmed to the Grid-ICES Basic Plan and Options. As unit prices on energy approach our projections and the risks are better defined, ICES can be phased into normal plant expansion.

In the Phase II, Stage I final report, a funding program with low interest loans was developed. Since HEW funds are not presently available, a funding program based on grants or low interest loans is not viable at this time. The University will continue in its attempt to obtain funding assistance from the various Federal, State and local agencies. 34

1.5.2

HEATING PLANT EXPANSION (WITH OR WITHOUT GRID-ICES)

I. Requirements:

	Cost - 1977 Price Index
A. Heating Plants	
1. Pollution Control, University of Minnesota Plant	\$ 2,600,000
2. Southeast Plant Acquisition	500,000
3. Plant Interconnecting and Coal Handling	4,799,160
4. Southeast Utilities	270,000
5. Southeast Fuel Systems	1,863,000
6. Southeast Plant Systems	3,134,160
7. Southeast Remodeling	991,000
8. Southeast Instrumentation	339,200
9. Demolition, Surveys, etc.	170,000
B. Upgrading of Incinerator	163,000
Total	<u>\$14,829,520</u>

II. Cash Flow:

Year	Requirement	Cost
1977	A-1, A-2	\$ 3,100,000
1978	A-9, B	333,000
	Part of A-3	1,573,000
1979	A-3 through A-8	5,749,190
1980	Completion and Startup	4,074,330

III. Project Funding:

Legislature	\$11,422,190
Operating Funds	333,000
Loan	3,074,330
Total	<u>\$14,829,520</u>

Labor

5 Principal Operating Engineers	at \$22,630	\$ 113,150
5 Sr. Operating Engineers	at \$21,730	108,650
5 Operating Engineers	at \$20,840	104,200
10 Jr. Operating Engineers	at \$19,947	199,470
Chief Engineer	at \$28,000	28,000
Asst. Chief Engineer	at \$25,000	25,000
Crane Operator	at \$21,320	21,320
M & O Mechanic	at \$20,850	20,850
Trades and Contract Labor		50,000
		<u>\$ 670,640</u>
Custodial		10,000
	1978	\$ 680,640
	1979	\$ 735,091
	1980	\$ 793,898
	1981	\$ 857,410

<u>Fuel</u>	
20.78 ton x 146,489 =	\$ 3,044,041
<u>Ash</u>	87,120
<u>Administration</u>	124,000
<u>Utilities</u>	292,820
<u>Supplies, Chemicals, Lubricants, etc.</u>	163,500
<u>Miscellaneous Insurance, Parts, Equipment Adjustments, etc.</u>	194,000
<u>Debt Service</u>	
\$3,074,330 x .0996256	306,282
<u>Depreciation</u>	
\$20,000,000 x .04	800,000
Total	\$ 5,869,173/Year

<u>Steam Cost</u>	
1,946,834 x 10 ³ lbs/Year	
Cost/MLbs	\$3.01/MLbs
<u>Tunnel Maintenance</u>	
\$150,000 ÷ 1,946,834	.08
10 percent Line Loss	.30
Steam Cost at Buildings	\$3.39/MLbs

1.5.3

BASIC PROGRAM

I. Additional Requirements:

A. Heating Plants

1. Low Pressure Piping	\$ 343,840
2. Primary Electric	268,800
3. Southeast Boilers, Nos. 1 and 3 Rehabilitation	225,200
4. Condensate and Makeup Water Treatment	416,640
5. Baghouse	672,000
6. Computer and Interface	324,800

B. Turbine-Generator

2,634,000

Total

\$ 4,885,280

II. Cost Sharing and Cash Flow:

<u>Loan Payments</u>	<u>Year</u>	<u>Requirement</u>	<u>U of M</u>	<u>Requirement</u>	<u>DOE</u>
	1978-79		0	Phase III Design, 10%	\$ 488,528
\$ 80,446	1979-80	(A-3,A-5)90%	\$ 807,480	(A-1,A-2,A-4,A-6) 90%	1,218,672
				Cash Flow Assistance	80,446
316,618	1980-81	(B) 90%	2,370,600	Cash Flow Assistance	316,618
			<u>\$3,178,080</u>		<u>\$ 2,104,264</u>

III. Additional Yearly: Cost and Recovery

A. Steam
Fuel

20.78 tons x 10,888

\$ 226,253

Labor

5 Operating Engineers

131,313

Ash

1,089 x \$6.00

\$ 6,534

Administration

No Charge

Supplies

No Charge

Miscellaneous

No Charge

Debt Service

3,178,080 x .0996256

316,618

Depreciation

4,560,480 x .025

114,012

Total Addition

\$ 794,730/Year

Added Recovery, Electrical (28 mils)

1,137,387/Year

Gain

\$ 342,657/Year

NOTE: At 22 mils credits and \$26.00 coal, there is no gain.

1.5.4

OPTION I

I. Additional Requirements:

C. Tunnel and Piping

1. Design	\$ 182,800
2. Construct Tunnel and Piping	1,630,080
3. Computer Interface	15,120
Total	<u>\$ 1,828,000</u>

II. Cost Sharing and Cash Flow:

<u>Loan Payment</u>	<u>Year</u>	<u>Requirement</u>	<u>U of M</u>	<u>Requirement</u>	<u>DOE</u>
	1978-79		0	Phase III	
				(C-1)	\$ 182,800
\$ 81,199	1979-80	1/2 (C-2)	\$ 815,040	(C-3)	15,120
				Cash Flow Assistance	81,199
162,398	1980-81	1/2 (C-2)	815,040	Cash Flow Assistance	162,398
			<u>\$1,630,080</u>		<u>\$ 441,517</u>

III. Additional Yearly: Cost and Recovery

A. Steam	317,132 x 10 ³ lbs/yr	
<u>Fuel</u>		
24,549 tons at \$20.78		\$ 510,128
<u>Ash</u>		
2,455 x \$6.00		14,730
<u>Debt Service</u>		
1,630,080 x .0996256		162,398
<u>Depreciation</u>		
1,811,200 x .025		45,280
Total Additional Costs		<u>\$ 732,536/Year</u>
<u>Added Recovery, Electrical</u>		\$ 117,450
<u>Steam Sales</u>		
*3.57 x 317,132		1,132,161
Total Recovery		<u>\$ 1,249,611/Year</u>
Gain		\$ 517,075

*\$162,398 ÷ 317,132 Debt Service	\$.51
45,280 ÷ 317,132 Depreciation	.14
	<u>.65</u>
	2.92
	<u>\$3.57/MLbs</u>

1.5.5

OPTION II

I. Additional Requirements:

D. Pyrolysis	
1. Design	\$ 770,000
2. Pyrolysis - Waste System	6,930,800
Total	<u>\$ 7,700,800</u>

II. Cost Sharing and Cash Flow:

<u>Loan</u> <u>Payments</u>	<u>Year</u>	<u>Requirement</u>	<u>U of M</u>	<u>Requirement</u>	<u>DOE</u>
	1978-79		0	Phase III Design	\$ 770,000
\$ 96,178	1979-80	Part of D-2	\$ 965,400	Part of D-2 Cash Flow	2,500,000
				Assistance	96,178
192,357	1980-81	Complete D-2	965,400	Complete D-2 Cash Flow	2,500,000
				Assistance	192,357
			<u>\$1,930,800</u>		<u>\$ 6,058,535</u>

III. Additional Yearly Cost and Recovery

<u>Debt Service</u>	
1,930,800 x .0996256	\$ 192,357
<u>Depreciation</u>	
7,000,000 x .04	280,000
<u>Total Operation</u>	
46,200 x 17.40	803,880
Total Yearly Cost	<u>\$ 1,276,237</u>
<u>Steam Credit</u>	
301,920 x 10 ⁶ x 2.11	\$ 637,051
<u>Electric Credit</u>	
3,458,000 x .028	96,824
<u>Drop Charge Credit</u>	
18,900 x 4.00 (Phoenix Industries)	\$ 75,600
27,300 x 17.10 (Hospitals)	466,830
Total Yearly Credit	<u>\$ 1,276,305</u>

1.5.6

OPTION III

I. Additional Requirements:

E. Hot Water Loop

1. Design

\$ 193,000

2. Hot Water Loop and Modifications

1,737,000

Total

\$ 1,930,000

II. Cost Sharing and Cash Flow:

<u>Loan</u> <u>Payments</u>	<u>Year</u>	<u>Requirement</u>	<u>U of M</u>	<u>Requirement</u>	<u>DOE</u>
	1978-79		0	Phase III	
				Design, 10%	\$ 193,000
\$ 43,263	1979-80	1/4(E-2)90%	\$ 434,250	1/4(E-2)90%	434,250
				Cash Flow	
				Assistance	43,263
\$ 86,525	1980-81	1/4(E-2)90%	434,250	1/4(E-2)90%	434,250
				Cash Flow	
				Assistance	86,525
			<u>\$ 868,500</u>		<u>\$ 1,191,288</u>

III. Additional Yearly Cost and Recovery:

Fuel

1,749 tons at \$20.78

\$ 36,344

Debt Service

868,500 x .0996256

86,525

Depreciation

1,700,000 x .025

42,500

Total Additional Costs

\$ 165,369/YearRecovery - Electric

5,802,000 x .028

\$ 162,456/Year

1.5.7

PROPOSED COST SHARING

	<u>University of Minnesota</u>	<u>DOE</u>	<u>Total</u>
Without Grid-ICES	\$14,829,520	\$ 431,888	\$15,261,408
Basic Plan	3,178,080	2,104,264	5,282,344
Option I	1,630,080	441,517	2,071,597
Option II	1,930,800	6,058,535	7,989,335
Option III	<u>868,500</u>	<u>1,191,288</u>	<u>2,059,788</u>
Total	\$22,436,980	\$10,227,492	\$32,664,472

1.5.8

PROPOSED CASH FLOW

1.5.6

Year	Program	U of M	Program	DOE
I. Additional Requirements:				
E. 1977-78	Expansion	\$ 3,100,000	Expansion	0
1. Design	Ph. I & Ph. II	0	Ph. I & Ph. II	\$ 431,888
2. Hot Water Loop and Modifications				
1978-79	Expansion	1,906,000	Basic, Ph. III	488,528
			Opt. I, Ph. III	182,800
			Opt. II, Ph. III	770,000
			Opt. III, Ph. III	193,000
II. Cost Sharing and Cash Flow:				
1979-80	Expansion	5,749,190	Expansion	0
	Basic, Ph. IV	807,480	Basic, Ph. IV	1,299,118
	Opt. I, Ph. IV	815,040	Opt. I, Ph. IV	96,319
	Opt. II, Ph. IV	965,400	Opt. II, Ph. IV	2,596,178
\$ 43,263	Opt. III, Ph. IV	434,250	Opt. III, Ph. IV	477,513
1980-81	Expansion	4,074,330	Expansion	0
\$ 86,525	Basic, Ph. IV	2,370,600	Basic, Ph. IV	316,618
	Opt. I, Ph. IV	815,040	Opt. I, Ph. IV	162,398
	Opt. II, Ph. IV	965,400	Opt. II, Ph. IV	2,692,357
	Opt. III, Ph. IV	434,250	Opt. III, Ph. IV	520,775
III. Total Cost				
Phases I to IV		\$22,436,980	\$10,227,492	
1,749 tons at \$20.78				
Debt Service				
868,500 x .0996256				
Depreciation				
1,700,000 x .025				
Total Additional Costs				
Recovery - Electric				
5,802,000 x .028				

NOTE 1: Expansion is the normal required Heating Plant expansion.

NOTE 2: Phases I, II, III and IV are the Grid-ICES Program

On April 6, 1978 the Director of Grid ICES and the University Treasurer met with Dr. Wilton Anderson of the Department of Health, Education and Welfare. While some news releases reported a significant DHEW energy conservation funding package, Dr. Anderson could not confirm any DHEW funding releases at that time.

Subsequently, on April 29, 1978 Mr. Hale Champion, Undersecretary of DHEW visited the University. The results of that visit with the University's Vice President for Finance is indicated in a following letter.

The University is continuing to investigate low interest federal loan guarantees and grants.

UNIVERSITY OF MINNESOTA

Office of the Vice President for Finance
301 Morrill Hall
100 Church Street S.E.
Minneapolis, Minnesota 55455
(612) 373-5940

May 24, 1978

TO: Warren Soderberg

FROM: Don Brown

A handwritten signature in ink, appearing to be 'Don Brown', written over the 'FROM:' line.

During Hale Champion's recent visit to the Twin Cities, I had the opportunity to briefly discuss with him the Grid ICES project. Hale indicated that this type of project is one which ought to be very competitive for HEW funding to institutions for the purposes of energy conservation. He is particularly intrigued by the involvement of the University with the other institutions on the West Bank.

Obviously, he cannot guarantee funding, but did suggest that in all communications with HEW on this subject that we send our correspondence to him, and he will be sure to route it to the appropriate part of DHEW.

I believe that his interest is quite sincere and think that this augurs well for our application for assistance.

DPB/pj

April 7, 1978

Dr. Wilton Anderson, Director
Energy and Education Action Center
Office of Education, DHEW
300 - 7th Street N.W., Suite 514
Washington, D.C. 20202

Dear Dr. Anderson:

I have enclosed a copy of our Phase I Executive Summary on the Grid-ICES Project. Within the next 30 days, we anticipate having an Executive Summary on the Phase II report completed, and at that time, I will send you a copy.

I am enclosing a magazine article that was published in June of 1974 on our central control system. Also enclosed is a copy of a report I submitted to the Big 10 Physical Plant Directors in March of 1975 at our annual one-day meeting.

We are presently preparing a report that will update the system development and also include some additions that will be made in the next two to four years, such as installing a fairly sophisticated computer for interfacing with our three Honeywell consoles. When this report is completed, we will forward a copy to you.

Mr. Johnson and I greatly appreciate the time that you gave to us on Wednesday, and we also appreciate your assistance in giving us some additional names that we can contact in HEW and HUD for further information on energy programs.

Sincerely yours,

WES:VP
Encs.

W. E. Soderberg
Director, Physical Plant

cc: C. T. Johnson

APPENDIX

A.1

PLANT CAPABILITYSoutheast Generating Station (450 psig 750⁰ F)

<u>Boiler No.</u>	<u>Coal (8,890 BTU/lb)</u>	<u>No. 2 Oil</u>
1 (Emergency)	-	160,000 lb/hr
3	108,000 lb/hr	-
4	128,000 lb/hr	-
	<u>236,000 lb/hr</u>	<u>160,000 lb/hr</u>

Turbine-Generator (Capability)

Throttle Capacity	350,000 lb/hr
180 psig Extraction	0 to 330,000 lb/hr
20 psig Exhaust	8,000 to 140,000 lb/hr
Turbine rating, pressure rise point	7,500 KW
Turbine rating, maximum output	12,750 KW
Generator rating	12,500 KW, 0.85 PF,
	13,800 volts

University Heating Plant (180 psig Saturated)

<u>Boiler No.</u>	<u>Coal (8,890 BTU/lb)</u>	<u>Oil</u>
1 (Standby)	60,000 lb/hr	-
2	60,000 lb/hr	-
3	60,000 lb/hr	-
4	75,000 lb/hr	-
5	94,000 lb/hr	-
6 (Emergency)	-	200,000 lb/hr
12 (Standby)	68,000 lb/hr	-
	<u>417,000 lb/hr</u>	<u>200,000 lb/hr</u>

Total System

	<u>Coal</u>	<u>Oil</u>
Southeast Station	236,000 lb/hr	160,000 lb/hr
University Plant	417,000 lb/hr	200,000 lb/hr
	<u>653,000 lb/hr</u>	<u>360,000 lb/hr</u>

Projected Peak Community Load

Expected Range = 505,000 to 555,000 lb/hr

A.2

HEAT BALANCE QUANTITIES
(ANNUAL BASIS - 1981)

	<u>BASIC PLAN</u>	<u>OPTION I</u>	<u>OPTION II</u>	<u>OPTION III</u>
Lbs Steam Generated (10^6)	1,947.1	2,272.6	2,259.9	2,281.8
Total Coal (Tons)	157,377	181,925	156,334	157,982
Total Solid Waste (Tons)	-	-	46,200	46,200
Total No. 2 Oil (Gallons)	-	-	179,470	179,470
Total Natural Gas (MCF)	-	-	17,232	17,232
Total Tons, Coal Ash	12,590	14,554	12,507	12,639
Total Tons, Frit	-	-	9,009	9,009
Gross MWH Generated	40,566	44,775	48,233	54,035
Peak KW - Winter	7,332	7,494	8,462	9,876
Summer	6,390	6,466	7,434	9,389
Average Peak (Capacity Credit)	6,861	6,980	7,948	9,632
Coal to Electric Generation (4,619 BTU/KWh)	10,888	11,730	12,422	13,579
Net Coal to Steam Generation	146,489	170,195	143,912	144,403
In-Plant MWH (S.E. & U of M)	9,328	9,762	13,762	14,412
By-Product Power Rate	21.75	22.56	23.63	25.17
Thermal Capacity Utilization Factor	73.2%	77.5%	69.0%	72.0%

A.3

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PERCENT OCCURRENCE					

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

[illegible]

COMBINED EAST BANK, WEST BANK, ST. MARY'S, FAIRVIEW, AUGSBURG

	<u>Annual Gains</u>
<u>BASIC PLAN</u>	
• Co-Generation Gain	40,566,000 Kilowatt-hours
Large Utility Heat Rate	10,662 BTU/KWh
Co-Generation Heat Rate	4,619 BTU/KWh
Heat Gain per KWh	<u>6,043 BTU/KWh</u>
• Annual Gain of ICES	245,140 Million BTU or 13,787 Tons, Coal
<u>OPTION I - ADD-ON CUSTOMERS</u>	
• Incremental Co-Generation Gain	4,209,000 Kilowatt-hours
• Annual Electric Gain	25,435 Million BTU or 1,430 Tons, Coal
• Directly displaced customer fuel equivalent of 2,900,000 gallons of fuel oil.	
<u>OPTION II - PYROLYSIS WASTE DISPOSAL</u>	
• Incremental Co-Generation Gain	3,458,000 Kilowatt-hours
• Annual Electric Gain	20,897 Million BTU or 1,175 Tons, Coal
• Waste Fuel Saving per Year	371,868 Million BTU or 20,915 Tons, Coal
<u>OPTION III - HOT WATER DISTRIBUTION</u>	
• Incremental Co-Generation Gain	5,802,000 Kilowatt-hours
• Annual Electric Gain	35,061 Million BTU or 1,972 Tons, Coal
<u>SUMMARY OF FUEL CONSUMPTION GAINS</u>	
Basic Plan	245,140 Million BTU/year
Option I	25,435 Million BTU/year
Option II	
a. Electric	20,897 Million BTU/year
b. Fuel	371,868 Million BTU/year
Option III	<u>35,061 Million BTU/year</u>
• Total Annual Gain	698,401 Million BTU/year
<u>SUMMARY OF ELECTRIC GENERATION</u>	
Basic Plan	40,566,000 Kilowatt-hours
Option I	4,209,000 Kilowatt-hours
Option II	3,458,000 Kilowatt-hours
Option III	<u>5,802,000 Kilowatt-hours</u>
• Total Annual Gain	54,035,000 Kilowatt-hours

FUEL AND POWER BENEFITS¹

-1981-

NORMAL EXPANSION

- Full Thermal Demand Conservation of Scarce Resource
 - Conversion of No. 2 oil to Coal 18,873,730 gallons
 - Conversion of Natural Gas to Coal 2,605 MMCF
- Full Thermal Demand Fuel Conversion Cost Benefits
 - Conversion of High BTU coal to Western Coal \$ 2,320,245
 - Conversion of Natural Gas to Western Coal 4,171,810
 - Conversion of No. 2 Oil to Western Coal 8,187,716

ADD-ON BASIC PLAN TO NORMAL EXPANSION

- Generate 40,566,000 KWh Annually
- Net Generation Cost Benefit \$ 911,137

- Discontinue 13,787 tons of coal Consumption
- Somewhere by a Large Utility for generating 40,566,000 KWh annually

ADD-ON OPTION I TO BASIC PLAN

- Displace No. 2 Oil Usage of Customers With Western Coal 2,902,000 gallons
- Displace Cost of 2,902,000 gallons of No. 2 Oil with Western Coal \$ 1,258,930
- Generate 44,775,000 KWh Annually
 - Net Incremental Generation Cost Benefit 50,734
- Discontinue 15,218 Tons of Coal Consumption some-
- where by a Large Utility for Generating 44,775,000 KWh annually.

ADD-ON OPTION II TO BASIC PLAN AND OPTION I

- Displace No. 2 Oil Usage with Heat Recovery from Solid Waste 3,368,408 gallons
- Displace Cost of 26,144 Tons of Western Coal with Solid Waste in plant \$ 543,270
- Generate 48,233,000 KWh annually
 - Net Incremental Generation Cost Benefit \$ 113,906
- Discontinue 16,393 tons of coal consumption some-
- where by a Large Utility for generating 48,233,000 KWh annually

ADD-ON OPTION III TO BASIC PLAN, OPTION I, AND OPTION II

- Generate 54,035,000 KWh annually
- Net Incremental Generation Cost Benefit \$ 196,171
- Discontinue 18,365 tons of coal consumption some-
- where by a Large Utility for generating 54,035,000 KWh annually

¹Benefits do not include total owning and operating cost reductions.

A.7

RELATIVE COMPARISONS OF
STEAM VERSUS HOT WATER
DISTRIBUTION SYSTEMS

	<u>Steam</u>	<u>Hot Water</u>
Boiler Operation	Uneven firing because of demand peaks	Peaks minimized by the heat storage capacity of the water in the system
Heat Loss	More because of larger lines	Less because of smaller lines.
Piping	Lines are larger	Smaller lines, no scaling
Feedwater	10% condensate lost	All water returned
Maintenance	Traps, condensate pumps	Circulating pumps, heat exchangers, controls
Investment	All existing	Circulating pumps, heat exchangers, controls
Operating Cost	None	Circulating pumps
Return	Requires high pressure (180 lbs) steam to carry the heat load	Able to carry most of the heat load with low pressure (20 lb) steam

SUMMARY OF UTILITY UNIT COSTS

	<u>1978</u>	<u>Escalate</u>	<u>1981</u>
<u>Coal (Per Ton)</u>			
Western, 8,890 BTU/lb	\$16.78	7.40%	\$20.78
Eastern, 12,726 BTU/lb	\$42.31	7.40%	\$52.42
<u>Natural Gas (MCF)</u>			
Interruptible	\$ 1.92	13.00%	\$ 2.77
Firm, Process	\$ 2.60	13.00%	\$ 3.75
<u>Fuel Oil</u>			
No. 2 - Per Gallon	.4125¢	13.00%	.5951¢
Per 10 ⁶ BTU	\$ 2.946	13.00%	\$ 4.25
No. 6 - Per 10 ⁶ BTU	\$ 2.678	13.00%	\$ 3.864
<u>Ash Disposal</u>			
Coal Ash, Per Ton	\$ 6.12	6.15%	\$ 7.32
Frit, Per Ton	\$ 1.53	6.15%	\$ 1.83
<u>Electric Power</u>			
Per MWH	\$26.20	10.00%	\$34.87
<u>Electric Power Sale</u>			
Capacity Credit (KW)	\$64.00		\$83.00
Energy (MWH)	\$11.00		\$14.00
<u>Water & Sewer</u>			
	.535	10.00%	.712
	per 1,000		
	gallons		

RIVERFRONT
DEVELOPMENT
COORDINATION
BOARD
235 City Hall
Minneapolis
MN 55415

March 30, 1978

Mr. W. E. Soderberg
Director, Physical Plant
Maintenance and Operations
200 Shops Building
319 15th Avenue South
Minneapolis, Minnesota 55455

Dear Warren:

On behalf of the Riverfront Development Coordination Board, I wish to thank you for an informative presentation on the University's proposed Grid-Connected Integrated Community Energy System. If, at any time, you feel that our Board can lend additional support on this project, please feel free to contact me as needed.

In addition, I would appreciate remaining informed at all times as to the progress of the design development of that project, specifically, as it relates to open space and pedestrian and bicycle systems within that portion of the Central Riverfront area.

At this time, I would also like to mention to you another matter of which we share a mutual concern; that being, your Workshop Presentation at the Minnesota Chapter of the American Institute of Planners' Conference in Duluth on Friday, June 9th, 1978. As President of the State Chapter of AIP, I have been taking a very active interest in the formulation of the program for this conference. At your convenience in the near future, I would like to meet with you to discuss certain modifications to your slide presentation. For our conference workshop, I believe we should have as clear and concise an audio-visual presentation as possible. I'd be very happy to have my office provide assistance to you in revamping your slide show to accommodate the desired effect for our anticipated Statewide audience.

Chairman --
Pat Daugherty
City Council

Vice-Chairman
Patricia Hillmeyer
Park Board

Mary Grace Flannery
HRA

Judy Corrao
City Council

William Holbrook
Park Board

Emily Peake
HRA

RWR/jm

Sincerely,

Robert W. Ready
Executive Secretary

STATE OF
MINNESOTA
DEPARTMENT OF NATURAL RESOURCES

CENTENNIAL OFFICE BUILDING • ST. PAUL, MINNESOTA • 55155

DNR INFORMATION
(612) 296-6157

April 18, 1978

Mr. W. E. Soderberg, Director
University of Minnesota
Physical Plant Maintenance and Operations
200 Shops Building
319 - 15th Avenue S.E.
Minneapolis, Minnesota 55455

Re: Draft Grid Connected Integrated Community Energy System

Dear Mr. Soderberg:

The concept and proposal outlined in the draft environmental assessment is a good one from the standpoint of energy conservation.

One area of concern noted is the coal unloading facility of the Mississippi River. The documents mention temporary berms around coal piles as a control against polluted runoff. A better approach would be to develop permanent controls such as diversions or berms along the river to prevent runoff from the entire site.

A DNR permit will not be required for the proposed activity. Care should be taken, however, to ensure compliance with flood plain regulations.

Sincerely,

Franklin H. Knoke
Environmental Specialist

FHK:mm

minneapolis

JUN 23 1 39 PM '77

city of lakes
JUN 23 1977

THOMAS L. JOHNSON
ALDERMAN SECOND WARD

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 Rockensteln

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 that reads "Clayton A. Sorenson".

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

NON-INTEGRATED SYSTEMS STEAM CONSUMPTION DATA --1981									
FACILITY	ANNUAL STEAM CONSUMPTION, 1000 LBS/YEAR	% OF TOTAL STEAM	LAND OWNERSHIP ACRES	STEAM CONSUMPTION DENSITY - LAND LB/GSF - YEAR	BUILDING SPACE, GSF	STEAM CONSUMPTION DENSITY-SPACE LB/VSF-YEAR	AVERAGE STEAM CONSUMPTION LB/HOUR	BASE STEAM CONSUMPTION LB/HOUR	PEAK STEAM CONSUMPTION LB/HOUR
UNIVERSITY OF MINNESOTA	1,946,834	86.00	232	8,391,526	11,127,000	175	222,000	51,000	498,000
ST MARYS-FAIRVIEW HOSPITALS	245,281	10.83	31	7,912,290	1,273,000	193	28,000	11,500	61,000
AUGSBURG COLLEGE	71,851	3.17	25	2,874,040	526,000	137	8,202	3400	16,000
TOTALS	2,263,966	100.00	288	7,860,993	12,926,000	175	258,000	107,000	570,000

ICES STEAM CONSUMPTION DATA--1981				
FACILITY	ANNUAL STEAM CONSUMPTION LBS/YEAR	AVERAGE STEAM DEMAND LB/HOUR	BASE STEAM DEMAND LB/HOUR	PEAK STEAM DEMAND LB/HOUR
COMBINED UNIVERSITY, ST. MARY'S-FAIRVIEW & AUGSBURG COLLEGE	2,263,966	258,000	107,000	570,000

* ACTUAL LOAD DIVERSITY IS USED IN ARRIVING AT DEMAND

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NON-INTEGRATED VERSUS ICES CENTRAL PLANT OPERATING DATA--1981 COMPARISONS																			
CENTRAL PLANTS RELIABLE FIRED CAPACITY -- POUNDS PER HOUR										BOILER STEAM CONDITIONS								BOILER LOADING BASIS	
NON-INTEGRATED SYSTEM (1981) AS FIRED					ICES AS FIRED					CONDITION		PRESSURE, PSIG		TEMPERATURE, °F		ENTHALPY, BTU/LB		NON-INTEGRATED	ICES
FACILITY	STEAM BOILER NUMBER	COAL 12,728 BTU/LB	OIL 138,000 BTU/GAL	GAS 1000 BTU/CU.FT.	SOLID WASTE 4,819 BTU/LB	COAL 8890 BTU/LB	OIL 138,000 BTU/GAL	GAS 1,000 BTU/CU.FT.	SOLID WASTE 4,819 BTU/LB	* NON-INTEGRATED	ICES	NON-INTEGRATED	ICES	NON-INTEGRATED	ICES	NON-INTEGRATED	ICES		
SOUTHEAST STEAM PLANT	1		160,000				160,000			SH	SH	450	450	750	750	1385	1385	NONE	EMERGENCY
	2	SALVAGE				SALVAGED				NO LIFE	SALVAGED		SALVAGED					NONE	NONE
	3	NONE				108,000				SH	SH	450	450	750	750	1385	1385	NONE	BASE LOAD
	4	128,000				128,000				SH	SH	450	450	750	750	1385	1385	128,000	BASE LOAD
	WASTE HEAT SUBTOTALS	128,000	160,000	0	NONE	236,000	160,000	0	38,000	NONE	SH	NONE	450	NONE	750	NONE	1385	NONE	BASE LOAD
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	TOPPING
	3	75,000				60,000				SAT	SAT	200	200	388	388	1199	1199	BASE	TOPPING
	4	100,000				75,000				SAT	SAT	200	200	388	388	1199	1199	BASE	TOPPING
	5	125,000				94,000				SAT	SAT	200	200	388	388	1199	1199	BASE	TOPPING
	6		200,000				200,000			SAT	SAT	200	200	388	388	1199	1199	BASE	EMERGENCY
	12	90,000				68,000				SAT	SAT	200	200	388	388	1199	1199	BASE	EMERGENCY
	WASTE HEAT SUBTOTALS	540,000	200,000	0	NONE	NONE	200,000	0	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE
ST. MARYS HOSPITAL	1		60,000 OR 60,000				DECOMMISSIONED			SAT	NONE	158	0	368	0	1196	0	SWING	DECOMMISSION
	2		35,000 OR 35,000				DECOMMISSIONED			SAT	NONE	158	0	368	0	1196	0	BASE	DECOMMISSION
	3		35,000 OR 35,000				DECOMMISSIONED			SAT	NONE	158	0	368	0	1196	0	BASE	DECOMMISSION
	WASTE HEAT SUBTOTALS	0	130,000	130,000	NONE	0	0	0	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE
AUGSBURG COLLEGE	1		17,637 OR 17,637				DECOMMISSIONED			SAT	NONE	13	0	246	0	1162	0	BASE	DECOMMISSION
	2		17,637 OR 17,637				DECOMMISSIONED			SAT	NONE	13	0	246	0	1162	0	BASE	DECOMMISSION
	3		3,540 OR 3,540				DECOMMISSIONED			SAT	NONE	9	0	237	0	1160	0	BASE	DECOMMISSION
	4		3,540 OR 3,540				DECOMMISSIONED			NONE	NONE	9	0	237	0	1160	0	BASE	DECOMMISSION
	WASTE HEAT SUBTOTALS	0	42,294	42,294	NONE	0	0	0	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE
POUNDS/HOUR	TOTAL	540,000	532,294	172,294	NONE	417,000	360,000	NONE	38,000	* SH - SUPERHEATED OUTPUT SAT - SATURATED OUTPUT									

ICES CENTRAL PLANT ANNUAL FUEL USAGE AND STEAM PRODUCTION -1981										
FACILITY	BOILER FUEL	STEAM PRODUCTION (THOUSAND LBS/YEAR)				ANNUAL PLANT FUEL REQUIREMENT				
						TONS WESTERN COAL - 8890 BTU/LB				OPTION 3 & OPTION 4
		BASIC PLAN	OPTION 1	OPTION 2	OPTION 3	BASIC PLAN	OPTION 1	OPTION 2	OPTION 3	
SOUTHEAST STEAM PLANT	WESTERN COAL	1,691,032	1,824,055	1,640,666	1,649,632	139,290 ①	150,247 ①	135,142 ①	135,889 ①	
SOUTHEAST STEAM PLANT	SOLID WASTE			319,200	319,200			26,144 ②	26,144 ②	46,200
UNIVERSITY HEATING PLANT	WESTERN COAL	256,074	448,508	300,043	312,921	18,087	31,678	21,192	22,102	
TOTAL		1,947,106	2,272,563	2,259,909	2,281,753	157,377	181,926	156,334	157,992	46,200

- NOTES
- ① OF THE TOTAL COAL CONSUMED THE FOLLOWING IS ALLOCATED TO ELECTRIC GENERATION:
	ANNUAL TONS OF COAL	ANNUAL KWHR PRODUCTION
BASIC PLAN	10,860	40,586,000
OPTION 1	11,730	44,773,000
OPTION 2	12,422	48,233,000
OPTION 3	13,379	54,036,000
- ② EQUIVALENT WESTERN COAL (NOT INCLUDED IN THE TOTAL) FROM SOLID WASTE AT 4819 BTU/LB

GRID ICES
NON-INTEGRATED VERSUS INTEGRATED CENTRAL PLANTS
1981 ANNUAL FUEL USAGE AND PRODUCTION COMPARISONS