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A PROPOSAL FOR

BIO-ENERGY RESEARCH IN MINNESOTA

SUBMITTED BY THE

INTERAGENCY PEAT TASK FORCE

SEPTEMBER 15, 1981

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STATE OF MINNESOTA

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## INTRODUCTION

A major question facing Minnesota concerns future use of the peatlands and associated wet mineral soils owned by the State. The subject of this proposal is use of those lands for biomass production. The workscope covers pilot scale land preparation for biomass production, growth and productivity of biomass crops on peatlands, measurement of the environmental impacts of biomass production, and wetlands inventory and site selection.

Past study efforts by the State can be characterized as a determination of current conditions of peatlands. A large part of the work was aimed at defining the acreage and composition of the resource base. The federal government also supported the inventory work, but its principal funding has been directed primarily to a specific conversion technology- gasification of peat.

A third course of action is suggested in this proposal. Up to now questions of peatland development for energy purposes have centered on extraction and gasification in a large plant. The issue has centered on saying "yes" or "no" to large scale gasification. The workscope laid out in this document could lead to energy production which is more benign environmentally. In any case, biomass production is the long run outcome of any peatland development, so seeking for ways to optimize long run productivity is a worthwhile goal.

This proposal was developed by the Minnesota Energy Agency (MEA), and the Minerals Division of the Department of Natural Resources (DNR). It is supported by the other Peat Task Force member agencies: the Pollution Control Agency (PCA), the Department of Agriculture (Ag), the Department of Economic Development (D.E.D.), the State Planning Agency

(SPA) and the Iron Range Resource and Rehabilitation Board (IRRRRB). The proposal has been coordinated with work supported by the U.S. Department of Energy (DOE) through Minnegasco and the Institute of Gas Technology (IGT). It blends various efforts into a coordinated structure which will yield answers necessary for land use policy decisions.

## BACKGROUND AND JUSTIFICATION

This project proposal represents an intersection of need and opportunity. The need is based on Minnesota's energy situation and its relationship to the problems facing the country. The opportunity is the possible development and use of peatlands and wet mineral soils to meet these needs.

In order to become energy independent using traditional fuel sources by the year 2000, the United States would have to discover petroleum and natural gas in the amount of billion barrels. This amount exceeds current United States proven reserves and requires discoveries the same size as the Alaskan field every year for the next ten years. Most energy analysts believe that traditional fuel resources in these amounts are not available, therefore, attention has focused on synthetic fuels. Synthetic fuels currently under consideration are based primarily on fossil energy resources, such as coal, oil shale or other mineral deposits.

Producing sufficient energy to support our economy through either traditional fuels or fossil synthetic fuels, regardless of the source (OPEC countries, North Dakota, Colorado oil shale or gas from Canada), will result in significant dollar drain for Minnesota. The State would have to increase production of agriculture, minerals, forestry and manufactured goods to compensate for the dollar drain or suffer economic decline. However, increases in these sectors will be difficult to achieve because of resource limitations and the negative influence of high fuel costs. A competitive Minnesota renewable fuel industry, and economic development based on Minnesota's traditional industries, could provide support for each other.

Past studies by the Energy Agency have shown that biomass technologies offer the most significant, and most effective, near-term renewable energy systems for Minnesota. However, Minnesota cannot produce large percentages of our State's energy needs from our agricultural or forest lands on a sustainable basis. Since the State has no conventional fossil fuel resources, it must look to other land areas for biomass energy production. The 5.9 million acres of organic soils (peat) located in the northern part of the State represent a significant opportunity as do the 12 million acres of non-peat wetlands.

Peat can be considered an alternative fossil energy source to be mined for its energy content. Significant amounts of synthetic fuel could be produced from peat feedstock, but long term production would be limited by its non-renewable nature and mining economics. However, peat can also be considered a soil to be used for growing biomass. Not only can biomass be converted into the same fuels as the original peat, but it is also renewable.

One of the major policy questions facing the State of Minnesota, is what to do with the peatlands. Should the State advocate leaving all of them in their natural state, or should it encourage using part of the peatlands for other purposes such as agriculture, forestry, mining, or as land for growing special energy crops? A major consideration in answering this question is the lack of uniformity in Minnesota peatlands. Not all are peat bogs. Some contain a mixture of organic soil (peat) and wet mineral soils. This soil mixture is often scattered throughout any peatland region. Secondly, peat depths vary considerably within any given land area. The biomass production emphasis in this proposal considers these characteristics by defining a

workscape that tests a wide variety of possible conditions. In addition, this project will make technical data available by late 1983 to help answer the leasing question.

The State owns about fifty percent of the available peatlands and therefore is in a position to control major wetland development. Since the State also implements environmental laws governing the use of Minnesota's resources, it is interested in the impacts of resource production and conversion. It is perhaps less interested in the engineering needed to develop conversion technologies, for example, gasification. However, these two elements must be coordinated so that impacts of the total system can be defined when leasing decisions are made.

This proposal focuses on developing data which will allow the State to assess impacts resulting from use of peatlands for growing special energy crops. The special energy crops grown would be used as feedstock for an energy conversion industry which would convert the biomass resource into solid, liquid or gaseous fuels. Excavation would be conducted to prepare the land for growth of special energy crops.

## PAST EFFORTS

The State of Minnesota, triggered by a Minnegasco lease request, initiated substantial studies of peatlands in 1976. Those studies can be characterized as measurements of baseline or currently existing conditions. Work included an inventory of resources, measurements of baseline environmental conditions, estimates of economic impacts of peat utilization, plus legal research on the utilization of peat. This work led to preliminary policy alternatives which were considered by the Minnesota Legislature in 1978.

Additional information needs were then defined and work programs were initiated to include further studies of reclamation, inventory and alternative uses, plus development of more precise environmental measurements. Current work focuses on two potential uses for peat and four traditional uses including preservation, use of peat soils for agriculture and forestry purposes, and mining of horticultural peat. New uses include peat mining for production of industrial chemicals and energy. The major emphasis of peat for energy works was on using peat as a feedstock in a large scale gasification process.

During this same period, the University of Minnesota, supported by DOE and the State, was investigating the growth and productivity of both woody and herbaceous biomass crops on peat and mineral soils. The University Soil Science Department undertook a major DOE project to evaluate the growth and productivity of woody biomass species. The College of Biological Sciences, supported mainly by the State of Minnesota, has been investigating the growth, productivity and chemistry of wetland plants for energy purposes. The plant receiving the most intense study is the common cattail. The current study effort is divided into four



major topics: growth and productivity of the plant material, plant biochemistry, harvesting, and an analysis of the land areas which might be used to grow wetland plants.

During the summer of 1980, the work on both wetlands and woody biomass expanded greatly. The University of Minnesota developed propagation techniques for woody biomass that has allowed the researchers to move to acre size plots. Several large areas of willows have been planted at the Iron Range Resources and Rehabilitation Board (IRRRB) research farm at Zim. The wetlands plant work has expanded at both Godward's wild rice farm, north of Aitkin, and at Zim. Three 100' by 50' areas were excavated and prepared at Zim for studies of growth and productivity. The research on both types of species is now at the "field station" stage, and it is expected that plot sizes will increase dramatically in the future.

In another project, the IRRRB purchased and installed a small scale low-Btu gasifier. It plans to experiment with this system using peat and combinations of peat and biomass, such as wood chips. The object of this work is to determine whether low-Btu gasification can be practical for a community scale cogeneration system.

The U.S. Department of Energy has sponsored several large studies of peat gasification through Minnegasco and the Institute of Gas Technology. This work concentrated on conversion technology assuming that a satisfactory resource could be made available. Work has proceeded from laboratory scale gasification tests to the pilot-scale tests currently underway at the Institute of Gas Technology. The DOE supported work is aimed at determining whether the gasification process can be commercialized. DOE has also supported a minor amount of work on lab-scale biological conversion of peat to methane gas and lab-scale gasi-

fication on biomass.

The United States Bureau of Mines completed a small amount of work on mining and dewatering technology. This work consisted of a single test and did not lead to any positive conclusions. Its results cannot be used as a basis for scale-up to a commercial size.

Minnegasco has received a \$4 million grant from the Department of Energy for a feasibility study of the peat gasification system. Their study will be completed in March or April of 1982. It should provide the basis for a federal determination of whether to proceed with a demonstration of peat gasification, if DOE remains interested in those kinds of activities.

The federally supported work could lead to pressure for construction of a commercial scale gasification facility in Minnesota. A major question facing the State is whether it wants to support that construction.

Past federal efforts can therefore be characterized as a concentration on conversion technology with little or no emphasis placed on resource questions. It is, of course, these resource questions which are of primary interest to Minnesota.

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## POLICY SUMMARY

Peatlands are a valuable resource, capable of serving many uses, including horticulture, agriculture, forestry, energy, industrial chemicals, sewage treatment, recreation, scientific study, wildlife habitat, water filtration, and preservation. Accordingly, the Department of Natural Resources recommends that peatlands be managed cautiously so that the resource can be used by present and future generations, and that the management of this resource be flexible, to allow for changing needs and expanded knowledge.

### Peatland Uses

#### Department of Natural Resources

At present, peatlands that have high potential for forestry, wildlife management, or natural area preservation should not be offered for lease, so that peatlands will be preserved for such uses.

Forestry - Peatlands that are highly valuable for their forest resource should be managed for that purpose. The present and future potential of peatlands for forestry should be considered when evaluating lease proposals.

Wildlife Management - Peatlands that have significant value for wildlife habitat should be managed for that purpose. Existing and proposed wildlife management areas need to be protected from incompatible development. The value of peatlands as wildlife habitat should be one of the criteria used in the evaluation of proposals to lease peatlands outside of existing or proposed wildlife management areas.

Peatland Protection and Preservation - Peatlands should be set aside that will preserve endangered, threatened, and rare peatland fauna and flora, representative types of peatlands, unique geomorphic features,

and peatlands having significant scientific value. Candidate peatlands of such distinction are now under study by the Task Force on Peatlands of Special Interest. These peatlands should not be used until the appropriate management of these areas is determined.

#### Leasing

Peatlands available for leasing should be allocated for many uses so that the needs of a variety of developers can be met and particular uses can be demonstrated.

#### Development Siting

To guide the wise development of the State's peat resources, the peatlands available for lease based upon several site-selection criteria, including development interest, existing and potential use, available resource information, availability of transportation and utilities, existing disturbances, location in the state, location in the peatland and watershed, and potential environmental effects should be determined.

#### Conflicting Uses

Certain uses of peat could preclude other uses. At present, the need to prioritize extractive uses does not exist, given the current supply and demand. Should major use conflicts arise, it will be necessary to study and recommend the appropriate use.

#### Size

As a guideline, leases should not exceed approximately 3,000 acres (approximately five square miles) of peatland. The size of each lease should be determined on the basis of the peatland, the watershed, and the mining method.

Leases for larger-scale development should not be granted until the technological, economic, and environmental feasibility is well documented both conceptually and by demonstration.

## Environmental Management

### Rules

It is recommended that the rules of the Environmental Quality Board be amended to require a mandatory Environmental Assessment Worksheet for conversion of 640 or more acres of peatland to an alternative use, for the construction of a facility using 5,000 dry tons or more of peat per year to produce a fuel, and for the construction of a peat mining operation which will use 160 or more acres of land. It is further recommended that an Environmental Impact Statement be required for the construction of a facility using 250,000 dry tons or more of peat per year to produce a fuel and for the construction of a peat mining operation which will use 320 or more acres of land.

### Permits

Drainage of all peatlands should be subject to water permit rules promulgated under Minnesota Statutes, Chapter 105, and other applicable legislation and the water quality rules of the Pollution Control Agency, in order to protect the resource and the public health, safety, and welfare of the people of Minnesota. Rules have been promulgated for appropriation of waters of the state that pertain to peatland.

Peatland development projects should also be subject to other applicable rules of the Pollution Control Agency regarding air quality.

### Mitigation

Mitigation of potential adverse environmental effects should be required to protect water, wildlife, and air and the public's health, safety, and welfare.

### Monitoring

Monitoring of air, water, and land should be required in all leases.

Before a lease is granted, an approved monitoring plan should be required. The lessee should be responsible for conducting or providing

for all required monitoring.

#### Reclamation

To insure the future land-use capability of peatlands, and to protect downstream and adjacent resources, reclamation should be required on lands disturbed by peat development activities.

To insure adequate reclamation, a bond, security, or other assurance should be required when there are reasonable doubts as to the operator's financial and technical ability to comply with the reclamation plan.

Reclamation should be staged over the term of a lease to enhance the process of reclamation and to reduce the environmental effects of unused disturbed peatlands.

#### Leasing

##### Rents and Royalties

Both rents and royalties should be charged for extractive uses, while only rents should be charged for nonextractive uses, so that the State receives an adequate return for the resource.

Royalties should be price indexed to fluctuate with the rate of inflation so that the return to the State is commensurate with current dollars.

##### Competitive Bidding

Leases greater than 160 acres should be awarded through competitive bids for rents and royalties above an established minimum so that the State receives the maximum return for the use of the resource. Negotiated sales may be employed for lease expansions and when only singular interest or use is documented.

##### Expansion

Peatland parcels offered for lease should be chosen with consideration of adjacent peat resources for potential development, consistent

with the goals and policies of the Department of Natural Resources.

Speculation

Peatland speculation should be discouraged by requiring a certain amount of development to be performed on a leased area within a prescribed time.

## INFORMATION EXPECTED FROM THE CURRENT STUDIES

Studies supported by State and federal governments will yield information in the following areas:

- 1) Location of peat resources - Inventory work should define surface locations of peat resources and the approximate quantity of that resource available in Minnesota.
- 2) Peatland locations that should be left in a natural state - Inventory work has identified certain bogs which should be preserved because of their unique characteristics. These areas, of course, subtract from the resource base which is available for other purposes.
- 3) Existing environmental conditions in peatlands - Current studies have developed extensive data on baseline water chemistry, vegetation and wildlife characteristics in peatlands. This data can be used as a yardstick to measure potential use.
- 4) Gasification of peat using one conversion technology - Gasification work supported by the U.S. Department of Energy has concentrated on the "PEATGAS" process developed at the Institute of Gas Technology. However, other conversion technologies which could yield gas, liquid, or solid fuels have not been investigated at the same level of detail.
- 5) Conceptual analysis of peat mining, dewatering and gasification - Current feasibility studies by Minnegasco will provide a conceptual basis for one peat gasification system. The conversion technology portion of this study will be supported by empirical data, but the mining and dewatering portion will not, since little field work is underway.



- 6) Growth and productivity of cattails and other species on peat soils and in natural stands - Current work at the University of Minnesota should define the potential size of several types of renewable biomass resources. It can be thought of as the first phase in the development of a new industry.
- 7) Bio-gasification of biomass in laboratory scale equipment - There is a small amount of work currently underway at IGT to test the anaerobic digestion potential of some forms of biomass.

## INFORMATION NOT PROVIDED BY THE PAST AND CURRENT WORK

Several important information areas are virtually untouched in past efforts. The most important of these empirical data need areas are:

- 1) Methods for and environmental impacts of peat mining, dewatering and transportation;
- 2) Biomass growth in large managed stands and the associated environmental effects;
- 3) How to combine peat mining and biomass production in order to optimize biomass growth;
- 4) Gasification of biomass and peat/biomass combinations, as well as conversion to liquid and solid fuels;
- 5) Analysis of methods for selecting a "best" energy production strategy using peatlands in the State of Minnesota.

The information the current studies won't provide must be available before the State makes any significant leasing decision in relation to energy production. Therefore, work should be initiated to insure that this information is available at the appropriate time.

## RESOURCE DEVELOPMENT - ALTERNATIVE STRATEGIES

Figure 1 shows the development strategy being pursued by private industry and DOE. This development strategy assumes only minor participation by State agencies and concentrates on the use of peat as a fossil fuel feedstock for a gasification process. The strategy assumes DOE will participate in the construction of a demonstration plant. Discussions about this time schedule with representatives of Minnegasco have indicated two critical dates:

- 1) Late 1982 for the selection of a size for a large scale gasification plant. Selection of a site would require commitment of approximately 200,000 acres of peatland.
- 2) 1986 for acquisition of a Certificate of Need and construction permits.

The major shortcoming of this strategy is its lack of emphasis on resource development and production. This shortcoming could be partially overcome by "paper" studies or evaluations of similar procedures in other parts of the world. However, this data might be suspect because it would not relate specifically to the company's permit application. It should be emphasized that industry's leasing timetable does not constrain the State's decision on whether to lease the land. However the time table does point out the need for acquisition of data pertinent to the leasing decision process.

Figure 2 presents another development strategy leading to the same goal in the same time frame. However, it opens up several new areas of information production and therefore augments the DOE/Minnegasco strategy. The second development strategy considers:

- 1) New resources - Biomass grown on partially excavated peatlands is evaluated as a feedstock for energy production.
- 2) Empirical data on the impacts of mining, dewatering and biomass production will be collected early in the development process.
- 3) Gasification of biomass/peat combinations will be tested in coordination with the peat gasification work currently underway at IGT.
- 4) Minnesota based socio-economic studies will be completed.

In the second development strategy, the critical decision on whether or not to select a site for energy production occurs one year later, in 1983. If this decision is positive, the result is little or no delay in plant construction.

A major question raised by the second strategy for peatland use is the assignment of responsibility for the various research tasks. This proposal focuses on biomass production because the logical first step is to verify the existence of that resource. The proposal assumes that industry will support the work needed in peat mining and dewatering, and the conversion of the resource to fuel. The State will encourage industry to fund these efforts, so that the broadest possible information base is available to State decision-makers.

## CONCLUSION

The Peat Task Force member agencies agree that the second alternative is better as it:

- provides more data to the decision-makers prior to the time when the critical decision must be made;
- develops more cooperation among State government agencies, private industry, the public, and the federal government;
- allows for active participation by the State;
- provides the opportunity for additional positive outcomes beyond using Minnesota's peat resources for non-renewable energy production.

An evaluation of Minnesota's biomass resource might yield the economic benefits of energy production plus the environmental benefits of using renewable resources. Therefore, the agencies, as members of the Peat Task Force, advocate initiation of the second development strategy plus appropriation of State funds to complete the work defined in this proposal.

## POTENTIAL FOR FEDERAL FUNDS

The potential for federal funding is difficult to assess at this time. In the past, DOE has supported a moderate level of peat gasification work. The federal government supports synthetic fuels development, but current initiatives concentrate on fossil fuel resources such as coal and oil shale. In the past, DOE also strongly supported grain alcohol production. The biomass area has received minimal funding. The new Administration will modify the current situation, but cutbacks, not increases are expected.

The following outlines the current division of responsibilities within the federal government.

- 1) The Department of Agriculture is primarily responsible for forest productivity. In our region, Region V, the North Central Research Station in Rhinelander, Wisconsin, is the primary resource. However, it is anticipated that only moderate to small amounts of funding will be available through the Department of Agriculture.
- 2) The Fossil Energy Group within DOE has supported peat gasification through Argonne Laboratory. It is expected that the Fossil Energy Group will continue its interest in peat gasification. However, no FY 1982 funds are allocated to this purpose. Past funding of peat work has been small and an increase in funding would come only at the expense of reducing funding in other fossil fuel areas. Competition for those dollars will be intense.
- 3) The Conservation and Solar Division within DOE has the responsibility for biomass energy. Their work includes wood utilization, species identification and growth, and productivity of aquatic

plants. The Biomass Branch within Conservation and Solar has an arrangement with USDA for research work on herbaceous species. However, DOE has retained control of work on woody species and aquatic plants. Aquatic plants work has been assigned to the Solar Energy Research Institute (SERI) in Golden, Colorado. SERI became a sponsor of the cattails work at the University of Minnesota by providing a grant of \$150,000. Woody species work is conducted by Oak Ridge National Laboratory. The University has received \$95,000 from DOE for its woody biomass research. It is possible though, that this work will be transferred to the U.S. Forest Service. Negotiations between DOE and Agriculture are underway, but the outcome of these negotiations is uncertain.

A major problem facing this special energy crops proposal is that it does not fit neatly at the focus of any single federal effort. The State will need to generate significantly more interest in the program among federal agencies before funding will be available. Therefore, the State should speak with one voice and have a single strategy that State government, private industry and environmental groups can support. The State could fund all work contained in this proposal out of its current appropriations, however, it would be better to try for joint funding by the State, the federal government and private sources. Since there is no focused federal effort on biomass/peat combinations, the State must take the initiative to create the program and sell it to the federal government.

## PROJECT DESCRIPTION

The Special Crops/Peat Project is designed to provide data needed to decide whether, and how, Minnesota peatlands should be used for energy production. As a first step, the Department of Natural Resources and members of the Peat Task Force will establish site selection criteria to identify one or more sites representative of potential energy development sites. These new sites will provide areas for expansion of plots. Existing sites, such as the IRRRB research farm, will be used while the new land is being prepared. The area at Zim will probably continue as a nursery for propagation studies and smaller scale experiments for an extended period of time. However, the Zim site has already been ditched and drained so it cannot accomodate all of the experiments included in this proposal. The field work contained in this proposal will be conducted at Zim and the new test sites when they are ready. Peat will be excavated to various depths to prepare land for production, and biomass species will be grown and harvested.

This project differs from existing peat and biomass studies in that its goal is to product biomass materials on a reasonable scale, test those materials for energy conversion, and measure the environmental impacts of the production systems. Minnesota production and conversion costs for these resources can thus be meaningfully estimated, prior to any peatland leasing decision leading to significant peatland energy production.

Overall project management will be the responsibility of the Energy Agency with task management responsibilities for the Department of Natural Resources, the University of Minnesota, the Institute of Gas Technology, and as yet unspecified consultants in the areas of environmental measurement, excavation, harvesting equipment construction, and economic



analysis. The proposal covers two years' effort, but it fits into a ten year development program. The total State cost will be approximately \$1,000,000 for the biennium. A federal government and/or industrial cost share of about \$3,000,000 is needed.

This project compliments and expands the scope of existing biomass and peat for energy studies and is expected to provide timely siting data. The project consists of five major tasks as summarized below:

Task I - Peatlands Land Preparation for Biomass Production

Peat is being extracted in several European countries using sod and milled peat technologies. In both cases, land preparation is needed before production starts. Land preparation techniques for Minnesota conditions are known, but their environmental effects have not been determined. The work included in this task will identify potential land preparation technologies and select at least two systems for demonstration on the selected peatland test sites. The Department of Natural Resources will designate the areas and will monitor the environmental effects of the testing as discussed in Task IV.

Peat excavation to various depths will be demonstrated using hydraulic, mechanical, milling, or other system methods. The excavation will allow testing of a range of soil conditions and water levels. Industry will be encouraged to test transportation of peat for various distances using slurry pipelines, conveyor belts, bog transporters, a railway, or combinations of methods in the same test areas. Laboratory scale tests of dewatering to selected moisture levels will be conducted using filter presses, centrifuges, air drying systems, or other methods or combinations of methods. It is expected that test costs can be reduced by requesting equipment demonstrations and/or by equipment leasing.

The peat excavation portion of this task will provide field areas

with peat depths necessary for testing biomass production as discussed in Task II. Also, the peat produced will be available for gasification and other conversion testing as described in Task III.

#### Task II - Biomass Resource Production Testing

A few species of high productivity crops which can be grown on peatlands have been researched over the past three years. They are:

1. Cattails and reeds - State of Minnesota/University of Minn.
2. Willows and alders - U.S. Dept. of Energy/University of Minnesota
3. Hybrid Aspen - U.S. Department of Agriculture

Several other promising special crop species have not yet been tested.

Preliminary data indicate that special energy crops can produce a renewable feedstock material with cost and conversion characteristics that may be better than the non-renewable peat on which they would be grown. However, no harvesting, processing, or transportation tests have been conducted. Perpetual production of an economically competitive energy source on peatlands appears more desirable from a long-term State perspective than peat mining.

The biomass energy option should be evaluated before allowing a peat mining technology that could harm the soil's biomass production potential. Also, preliminary information suggests that some peat removal may be desirable to optimize crop productivity. It is the purpose of this task to:

- generate productivity data for selected biomass species;
- conduct harvesting and transportation tests;
- determine what degree of peat removal is optimal for energy crop production;
- determine the effect of peat stratigraphy on biomass production.

Small scale propagation and productivity tests will also be conducted on previously untested species. The previously researched species would be grown starting with one-half to one acre plots on unexcavated peat areas and peat areas excavated to various depths (i.e. those areas provided by Task I testing). Various nutrient applications, water levels, and preparation methods will be tested. Harvesting, drying, and transportation tests will be conducted using equipment purchased for the current "Cattails for Energy" project and new equipment. Additional equipment needed will be acquired from equipment manufacturers, either by lease or purchase.

Task management will be the responsibility of the Bio-Energy Coordinating Office at the University of Minnesota. Biomass produced on peatland test acreages will be supplied to IGT for gasification and other conversion testing as described in Task III. The DNR will monitor biomass production environmental effects as described in Task IV.

### Task III - Biomass and Biomass/Peat Conversion Testing

Peat gasification tests are now being conducted at the Institute of Gas Technology (IGT) under U.S. Department of Energy sponsorship. Preliminary energy crop conversion tests using digestive processes also have been conducted. However, no attempt has been made to gasify combinations of special energy crops and peat. Samples of the biomass species grown in Task II will be tested in combination with peat at the lab at a process development unit scale to obtain engineering design data and estimated costs of production. The primary thrust will be directed toward gasification technologies, but analysis of direct burning and liquid fuel production technologies will also be conducted. In addition, the relationship of conversion system size to cost will be determined for use in the overall system evaluation described in Task V.

Task III will be primarily carried out at IGT using test equipment available from the peat gasification test programs.

#### Task IV - Environmental Effects Monitoring

Data on current environmental conditions in the peatlands have been gathered over the past four years by the Department of Natural Resources. No empirical data on the environmental effects of biomass production in the State. Based on technologies and methods selected in Tasks I and II, DNR and PCA will design a plan for monitoring both peat excavation and biomass production to determine the environmental effects of producing each energy resource. DNR will then be responsible for executing the planned work. Peatland water quality, water use and runoff, as well as any impacts on groundwater, vegetation, wildlife, and air emissions will be documented. The end product will be a comprehensive data base on peatland biomass production environmental impacts that will be used in energy-related peatland leasing decisions. Estimates of air and water emissions, water use, and solid waste generation for various energy conversion technologies will be made by IGT and other consultants as part of their work in Task III.

#### Task V - Peatland Energy Production and Conversion System Evaluation

At present, one peatland energy production system (large-scale, thermal-chemical peat gasification) is being analyzed under a U.S. Department of Energy grant. Interest has been expressed in medium-scale direct burning of both wet and dry peat for electric production, smaller-scale direct combustion of peat and/or biomass and biological conversion of peat and/or biomass. However, funding has not been available to analyze these processes.

The organization(s) selected to perform this task will analyze data obtained from Tasks I, II, III, and IV to determine the economics of var-

ious energy production systems at several sizes (i.e. large, medium, or small scale). This information can be used to evaluate development options. In addition, a portion of this task's effort will be devoted to assessing the socio-economic impacts of peatland energy development. This task would be conducted by the new Department of Energy, Planning and Development, and an as yet unspecified consultant.

## PROJECT TASK LIST AND RESPONSIBILITIES

### Task I. Peatlands Land Preparation (Engineering Consultant)

- A. Site Selection (DNR/MEA)
- B. Assess Potential Methods and Equipment (MEA/Peat Consultant)
- C. Contact, Arrange and Manage Selected Systems Testing Schedule (Engineering Consultant)
- D. Initial Land Preparation (Engineering Consultant)
- E. Excavation Tests/Task II Preparation (Engineering Consultant/U of M)
  - 1. hydraulic method
  - 2. mechanical removal method
    - a. drained bog
    - b. undrained bog
  - 3. other technology/European technology
- F. Transportation System Tests (Engineering Consultant)
  - 1. pipeline slurry
  - 2. conveyor belts
  - 3. mechanical bog transporter
  - 4. transporter/railway
  - 5. other
- G. Dewatering Equipment Tests (Engineering Consultant)
  - 1. slurry dewater methods
    - a. filter press
    - b. centrifuge
    - c. drying bed
    - d. other
  - 2. Undrained peat dewater methods (same as I.G.1)

3. Drained peat dewater methods (same as I.G.1 except add:

- e. in-situ drying techniques)

- H. Economic Evaluation of Systems (Engineering Consultant/MEA)

Task II. Biomass Resource Production Testing (U of M)

- A. propagation of Biomass Crops (U of M)

1. Screening potential biomass crops

- a. cattail (Typha)
    - b. reed (Phragmites)
    - c. sedges (Carex)
    - d. reed canary grass
    - e. willow
    - f. aspen (Hybrid)
    - g. other (two unspecified species)

2. propagation studies

- a. micropropagation (tissue culture)
    - b. macropropagation (cuttings/grafting)

- B. Field Trips (small scale) (U of M)

1. Site preparation

- a. No peat removal
      - 1) mechanical preparation tests
      - 2) chemical tests
      - 3) combination tests
    - b. peat removal to various depths - mechanical preparation tests on drained and undrained areas.

2. Planting and cultural methods

- a. establishment with seeds

- 1) water level tests
    - 2) time of planting tests
    - 3) mixed planting tests
  - b. special herbaceous crop tests
    - 1) spacing tests
    - 2) time of planting tests
    - 3) water level tests
    - 4) fertilizer response
  - c. competition control tests
  - d. insect and pathogen control tests
- C. Establishment of Large Scale Plots (U of M/Engineering Consultant)
- 1. Procure sufficient planting material
  - 2. Plant test plots with four available species
    - a. willow
    - b. cattail
    - c. aspen
    - d. crop identified under II-A
    - e. combinations
  - 3. Monitor Task II.C.2 results
  - 4. Plant additional plots as determined from Task II-B
  - 5. Conduct coppicing studies on woody crops
- D. Biomass Harvest and Processing Methods (U of M/MEA)
- 1. Harvest Equipment Tests
    - a. wetland harvesting development/test
    - b. test equipment for woody crop harvest
    - c. other mechanical removal method tests
    - d. hydraulic harvest test
  - 2. Transportation System Tests (Engineering Consultant)



U of MN) (same as I-F)

3. Biomass Drying Tests (U of M/Engineering Consultant)
  - a. air dry in-situ
  - b. baled air-dry
  - c. filter press
  - d. other
  - e. combination
4. Biomass Scheduling Economic Assessment (U of M/  
Economic Consultant)
  - a. single season harvest/storage
  - b. multi-season harvest/storage
  - c. year-round harvest
5. Economic Evaluation of Systems (U of M/MEA/Economic  
Consultant)

Task III. Biomass and Biomass/Peat Conversion Testing (IGT)

- A. Lab-scale Gasification (IGT)
  1. thermobalance tests
  2. fluidization and fluid tests
- B. Process Development Scale Tests (IGT)
  1. hydrogasification
  2. fluidized bed gasification
- C. Process Kinetic Modeling
- D. Gasification Process Economics (IGT/MEA)
- E. Liquification Process Economics (IGT/MEA)
- F. Solid Fuel Process Economics (Consultant/MEA)

Task IV. Environmental Effects Monitoring (DNR)

- A. Water Quality Monitoring (DNR)
  1. Biomass field outlet

2. Peat mining pond
  3. Peat mining area outlet
  4. Downstream sites
- B. Water Quantity Monitoring (DNR)
1. Surface water volumes in biomass fields
  2. Ground water volumes in biomass fields
  3. Water consumption/run-off
- C. Vegetation Effects Adjacent to Biomass Fields (DNR)
- D. Wildlife Effects and Population (DNR)
- E. Air Emissions at Resource Site (PCA/DNR)
- F. Possible Air Emissions from Various Conversion Technologies (PCA/IGT)
- G. Solid Waste Generation from Various Conversion Technologies (PCA/IGT)

Task V. Peatland Energy Production and Conversion System Evaluation (MEA/SPA)

- A. System Economic Analysis (MEA/Economic Consultant)
1. Resource production and conversion system (MEA/Economic Consultant)
    - a. Gaseous fuel production
    - b. liquid fuel production
    - c. solid fuel production
  2. State economic impact assessment (MEA)
- B. Social Impacts of Energy Development (SPA/MEA)

## PROJECT MANAGEMENT

Overall project management will be the responsibility of the Energy Agency. It will prepare a detailed work plan showing designated tasks. It will also exercise budget control over independent subcontractors. The Peat Task Force will monitor the project and provide advice and assistance to the project manager. At the time of the merger, the new Department of Energy, Planning and Development will become the project manager.

The University of Minnesota - Bio-Energy Coordinating Office will manage the biomass production portions of the project. It will coordinate other University departments in their work on chemical and economic analysis, agricultural methods, plant propagation, and growth and productivity. Work done at the University will fit into the overall project management system.

The Institute of Gas Technology will manage the biomass/peat conversion work, except for possible outside consulting on liquid and solid fuel analysis. It will coordinate its work with other efforts in peat gasification. IGT will create a detailed project plan for its portion of the work which fits into the overall project plan. A representative from IGT will be added to the Peat Task Force, so that it can be part of the overall project planning.

The Department of Natural Resources - Minerals Division will manage collection of environmental data. It will work with the Pollution Control Agency to develop a monitoring plan which will yield data needed in a subsequent leasing decision. It will probably hire, with the concurrence of the Task Force, a consultant to perform actual field work.

An Environmental Advisory Committee will be appointed to review en-

vironmental data and to comment on its meaning. It will review the monitoring program designed by DNR and PCA and will suggest possible modification during the course of the project. Committee members will be selected by the project manager to represent State agencies, contractors, environmental groups and industry.

The Department of Energy Planning and Development will manage the cosio-economic impact analysis performed in this project. Work will run through the Planning Division of the Department. The Department will likely hire a contractor to perform the analysis.

Two major tasks are unassigned at this time. No organization has volunteered to manage the work on peat excavation or system evaluation and economics. There are, however, several national or international engineering firms that could manage the excavation testing task. Several of the firms have extensive experience in peat production in Finland and Ireland. If an acceptable contractor cannot be located, the Energy Agency will manage Task I. The system evaluation work could be performed by one of several consultants under Energy Agency management. It is expected that managers for these tasks will be selected using the State's Request for Proposals process.

PROPOSED BUDGET BY TASK (in thousands of dollars)

	TASK MANAGER							
	EQUIP. SUBCON- TRACTOR	IGT	U OF MN BIO- ENERGY	DNR	MEA	SPA	CON- SULTANT	TOTAL
TASK I Peatlands Land Preparation								
A. Site Selection	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-
B. Methods Assessment	-0-	-0-	-0-	-0-	10	-0-	40*	50
C. Management of Tests	-0-	-0-	-0-	-0-	10	-0-	40*	50
D. Land Preparation	25	-0-	-0-	-0-	-0-	-0-	-0-	25
E. Excavation Tests	370	-0-	-0-	-0-	-0-	-0-	30*	400
F. Transportation Tests	105	-0-	-0-	-0-	-0-	-0-	20*	125
G. Dewatering Tests	75	-0-	-0-	-0-	-0-	-0-	20*	95
H. Economic Evaluation	-0-	-0-	-0-	-0-	5	-0-	15*	20
TASK II Biomass Resource Production								
A. Propagation Tests	-0-	-0-	195	-0-	5	-0-	-0-	200
B. Field Trial Plots	20	-0-	275	-0-	5	-0-	-0-	300
C. Large Scale Plots	50	-0-	440	-0-	10	-0-	-0-	500
D. Harvest/Process Methods	-0-	-0-	480	-0-	20	-0-	-0-	500

\*Peat Mining Consultant

PROPOSED BUDGET BY TASK (in thousands of dollars)

TASK MANAGER

	EQUIP. SUBCON- TRACTOR	IGT	U OF MN BIO- ENERGY	DNR	MEA	CON- SULTANT	TOTAL
TASK III Biomass/Peat Conversion							
A. Lab-Scale Gasification	-0-	100	-0-	-0-	-0-	-0-	100
B. Process Development Gasification	-0-	700	-0-	-0-	-0-	-0-	700
C. Kinetic Modeling	-0-	100	-0-	-0-	-0-	-0-	100
D. Gasification Economics	-0-	35	-0-	-0-	5	10 <sup>†</sup>	50
E. Liquification Economics	-0-	10	-0-	-0-	5	10 <sup>†</sup>	25
F. Solid Fuel Economics	-0-	-0-	-0-	-0-	5	20 <sup>†</sup>	25
TASK IV Environmental Effects							
A. Water Quality	-0-	-0-	-0-	105	-0-	-0-	105
B. Water Quantity	-0-	-0-	-0-	69	-0-	-0-	69
C. Vegetation Changes	-0-	-0-	-0-	35	-0-	-0-	35
D. Wildlife Effects	-0-	-0-	-0-	36	-0-	-0-	36
E. Resource Air Emissions	-0-	-0-	-0-	50 <sup>**</sup>	-0-	-0-	50
F. Conversion Air Emissions	-0-	-0-	-0-	60 <sup>**</sup>	-0-	5 <sup>†</sup>	65
G. Solid Waste Generation	-0-	-0-	-0-	18 <sup>**</sup>	-0-	5 <sup>†</sup>	23

†Economic Consultant

\*\*These funds may go directly to PCA

PROPOSED BUDGET BY TASK (in thousands of dollars)

TASK MANAGER

	EQUIP. SUBCON- TRACTOR	IGT	U OF MN BIO- ENERGY	DNR	MEA	SPA	CON- SULTANT	TOTAL
TASK V System Evaluation								
A. Economic Analysis	-0-	-0-	-0-	-0-	50	10	90 <sup>†</sup>	150
B. Social Impacts	-0-	-0-	-0-	-0-	-0-	20	30 <sup>†</sup>	50
TOTALS BY TASK								
TASK I Peatlands Land Preparation	575	-0-	-0-	-0-	25	-0-	165*	765
TASK II Biomass Resource Production	70	-0-	1390	-0-	40	-0-	-0-	1500
TASK III Biomass/Peat Conversion	-0-	945	-0-	-0-	15	-0-	40 <sup>†</sup>	1000
TASK IV Environmental Effects	-0-	-0-	-0-	373	-0-	-0-	10 <sup>†</sup>	383
TASK V System Evaluation	-0-	-0-	-0-	-0-	50	30	120 <sup>†</sup>	200
TOTAL	645	945	1390	373	130	30	165* 170 <sup>†</sup>	3848
Project Management	-0-	-0-	-0-	32	58	12	-0-	102
								3950

\*Peat Mining Consultant

†Economic Consultant

# A DEVELOPMENT STRATEGY PEATLAND USE FOR ENERGY PRODUCTION

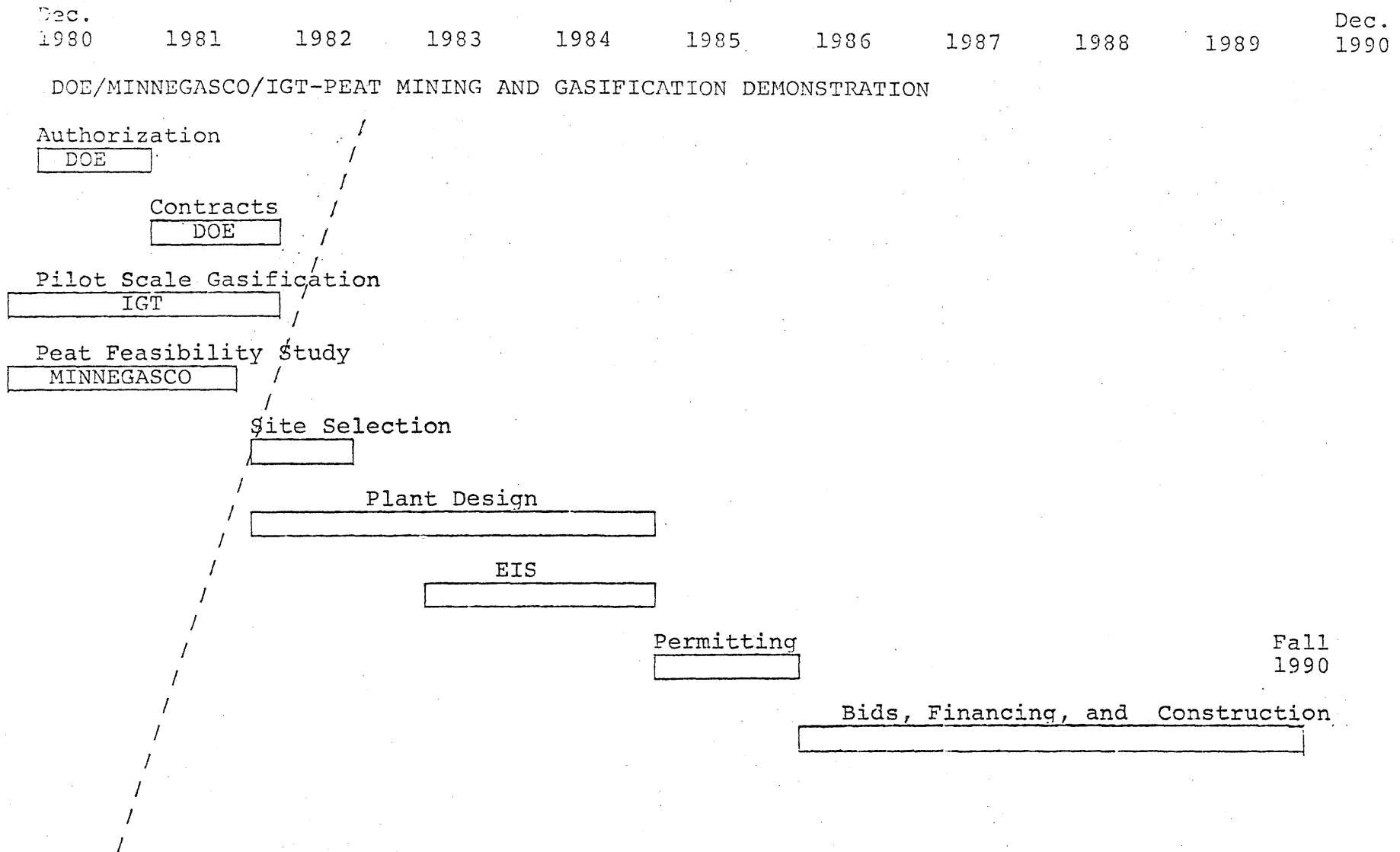


FIGURE 1



# A DEVELOPMENT STRATEGY PEATLAND USE FOR ENERGY PRODUCTION

Dec. 1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	Dec. 1990
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## MINNESOTA PEAT/SPECIAL ENERGY CROPS

### Cattails for Energy

UNIV

### Species Identification

UNIV

### Authorization

LEG.

### Land Preparation

### Lab Scale Mining and De-watering

### Lab Scale Gasification

IGT

### Harvesting of Pilot Scale Quantities from Natural Stands

### Growth and Productivity in Managed Stands

### Pilot Scale Mining and De-watering in Minnesota

### Pilot Scale Gasification

IGT

### Environmental Impact Monitoring

DNR

### Site Selection

### Plant Design

### Socio/Economic Impact Studies

EIS

### Permitting

### Bids, Financing, and Construction

### Propagation, Harvesting, Productivity, etc.

### Land Preparation for Special Energy Crops

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Fall  
1991

FIGURE 2