# THE MINNESOTA ALTERNATIVE ENERGY RESEARCH AND DEVELOPMENT POLICY FORMULATION PROJECT

DRAFT EXECUTIVE SUMMARY AND RECOMMENDATIONS.

PEAT

MARCH 1978

MINNESOTA ENERGY AGENCY

# THE MINNESOTA ALTERNATIVE ENERGY RESEARCH AND DEVELOPMENT POLICY FORMULATION PROJECT

## DRAFT E.S.R. - PEAT

Executive Summary and Legislative Recommendations covering the findings of Subcommittee 8 of the Task Force: Peat.

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## 1. INTRODUCTION

The Energy Agency has a statutory responsibility to develop an energy plan for the state. It has done this. One of the six goals is the rapid development of alternative energy sources. This specific responsibility is spelt out in Minnesota Laws 1976, Chapter 333,15 -- codified as section 116H.128 of Minnesota Statutes, which states that the Energy Agency Director shall:

1. Identify, monitor and evaluate in terms of potential implementation in Minnesota, research studies and demonstration projects of alternative energy systems and methodologies.
2. Provide data and recommendations for the development of a state alternative energy research, demonstration and development program.
3. Establish a pool of information and expertise on alternative energy from which responses to questions of a technical nature can be provided.

In pursuing this particular goal, it is necessary to more closely identify the potential of each different alternative energy source together with appropriate conversion processes and how their development can be encouraged. In order to achieve this refinement, the Energy Agency created a task force -- The Minnesota Alternative Energy Research and Development Policy Formulation Project Task Force. Agency Director John Millhone initially placed responsibility for the project with Dr. James Carter, Director of Research. When Dr. Carter resigned in June 1977, responsibility was assumed by Ronald Visness, Assistant Director for Data and Policy Analysis. More recently direction has been taken over by Dr. Carl Glewwe, the Agency's new Director of Research. Assisting him with co-ordination and analysis is Roger Aiken, Energy Research Analyst with the Agency. Eight subcommittees, each assigned to a different energy alternative were directed to research information for their alternative and present their findings in the form of technical reports. The eight subcommittees involved are:

1. Solar Thermal I (Active)
2. Solar Thermal II (Passive)
3. Wind
4. Urban Solid Waste
5. Agricultural and Wetland Sources
6. Biomass Conversion
7. Timber
8. Peat

The Task Force itself comprises the eight Subcommittee Coordinators and/or their alternates together with Dr. Glewwe and Mr. Aiken.

Seven of the technical reports have now been completed. The final Solar I (Active) and Solar II (Passive) reports were completed first, and were published in March, 1977. Then followed Urban Solid Waste in April, Timber in June, Biomass Conversion in August and Agricultural and Wetland Sources in September 1977. The final technical report for Peat is thus the seventh in the series to be completed. The report on Wind is nearing completion and will be published soon. The opinions expressed in these reports are those of the Subcommittee members, and do not necessarily reflect that of the Energy Agency.

## 2. BACKGROUND ON ALTERNATIVE ENERGY SOURCES

Alternative Energy Sources are usually defined as those primary sources other than oil, natural gas, coal and nuclear (uranium). Nearly all alternative energy sources and particularly those indigenous to Minnesota are either direct or indirect forms of solar energy and as such are completely renewable in contrast to fossil fuels and uranium which are non-renewable. Specifically alternative energy sources refer to:

1. Direct solar radiation
2. Wind
3. Hydropower
4. Biomass
5. Geothermal Energy (There is some doubt as to whether this source is completely renewable)
6. Ocean Energy Sources; Temperature Differences, Currents, Waves and Tides.

Of the above, Geothermal Energy and Ocean Energy Sources are not applicable to Minnesota, and Hydropower for electrical generation has a total sustainable capability of less than 500 $MW_e$. Consequently, these alternative sources have not been considered by the Task Force.

Biomass in its widest sense includes agricultural and wetland crops and residues, timber plantations and residues, animal manures, the organic content of urban solid waste and food processing residues. It also includes peat since this source regenerates itself, albeit at a rate of only 1 - 2 millimeters per annum. Some researchers therefore prefer to think of peat as a fossil fuel, a fuel eminently suitable for strip mining technology without the usual overburden associated with most low sulfur Western coals. Altogether biomass energy sources including wetland plants and peat indigenous to Minnesota have a renewable potential greater than the current total state demand.

Wind as a primary energy source has an estimated harnessable potential of between 4 and 16 percent of the total state primary demand. It will be used for both small rural and possibly urban applications and for the generation of electricity to be fed into utility networks. Until the problem of storage is solved however its application in the latter area will be limited.

Direct solar radiation can be captured both by active and passive systems. Currently available hardware and systems have the potential of supplying about 50% of Minnesota's hot water and space heating (provided building heat losses are reduced first by energy conservation measures) demands which in turn account for 30% of the state's current energy usage at source. Direct applications of solar radiant energy to hot water and space heating alone in Minnesota therefore have a potential equal to 15% of the total primary demand.

## 3. LIST OF LEGISLATIVE RECOMMENDATIONS

For a more detailed discussion of these recommendations with justifications, please refer to § 6 pp. 23-35.

### 3.1 Surveys, Inventories, Resource Management and Analysis

a) Conduct detailed surveys to identify specific peatland areas of suitable quality and quantity for energy purposes. These should be located near cities with municipal heating plants, taconite processing plants and paper mills or wood processing plants in Northern Minnesota. Minnesota Power and Light Company and other utilities in Northern Minnesota should be required to study the possible use of peat instead of coal in their proposed electric power generating plants.

b) Supply the peat resource data now being compiled to the State Planning Agency for their MLMIS (Minnesota Land Management Information System) for analysis and data retrieval.

c) Locate peatland areas of sufficient size and suitability for biomass production (energy farms) in Northern Minnesota for such energy producing plant species as cattails, sedges, grasses, lowland brush, etc.

3.2 Applied and Directed Technical Studies, Research and Development

a) Develop the small scale technology and harvesting equipment needed for the support of local heating plants and small industries (taconite plants and paper mills). Specifically this includes:

1. The development of techniques for cutting and turning ($90^{\circ}$) peat sods with grass cover. Experimental cutters will need to be developed.
2. The determination of drying cycles using the grass transpiration technique.
3. Studies to identify the best harvesting, loading and transportation techniques.
4. Studies to determine the possibility of reseeding grass for two or three crops per year.

b) Develop the large scale harvesting technology needed for the supply of peat fuel for a high B.T.U. gasification plant or a large taconite plant. The use of large suction dredges in the peatlands and pipes for conveying the peat slurry to the plant is recommended.

c) Investigate the possibility of producing several wetland species under proper management practices on peatlands. Cattails, sedges, wetland grasses and rushes are all capable of high biomass yields on peatlands.

3.3 Demonstration Projects

a) Assess by demonstration the technical, economic and institutional feasibility of using peat for a local heating plant. This could be done using either a municipal heating plant (e.g. Virginia) or a local paper mill (e.g. Conwed Corporation, Cloquet).

b) Evaluate the Swedish wet carbonization method for peat dewatering. It is recommended that the Minnesota Energy Agency obtain from Sweden all information pertaining to wet carbonization as a technique and establish contact with researchers there and in Finland for the purpose of information exchange.

c) Demonstrate peat sludge dewatering systems and equipment developed by the U.S. Bureau of Mines in co-operation with the Ingersoll Rand Corporation and dredge manufacturers. It is recommended that this equipment be demonstrated in several bogs in Minnesota and that extensive trials be conducted in several locations with different peat types.

3.4 Incentives and Institutional Concerns

a) Economic Options

1. Support and encourage federally sponsored demonstration projects using peat as an energy source.
2. Assess the possibility of obtaining Federal guaranteed loans for industrial peat for energy development.
3. Consider the allocation of State-sponsored bonds similar to municipal bonds or industrial revenue bonds as an incentive to peat development.
4. Consider direct tax incentives to industry during the peat development phase.

b) Regulations

1. Set royalty fees, charged by the state and counties, low enough, during the early stages of development, to make peat competitive with North Dakota lignite and Western coals.
2. Legislate early decisions on leasing policies and regulations to promote the development of peat.
3. Initiate early action to establish a legal definition for peat. i.e. Is it a mineral, or is it an agricultural or horticultural product (biomass). This is important for establishing a valid tax base.

c) Policy Options: Establish more meaningful dialogues between scientists and engineers working on technical aspects of alternative energy sources and legislators, government and public interest representatives who formulate policy.

### 3.5 Information Collection and Dissemination

a) Plan and give a series of educational programs on peat and other alternative energy sources for policy makers and interested laymen at several towns throughout the state.

b) Establish a central data source for the location of peat information in the State. It is recommended that the existing Renewable Energy Environment (TREE) Collection at the University of Minnesota be expanded to include the peat data.

c) Initiate a thorough on-going analysis of the data on our peat resource now being collected by D.N.R.

d) Set up an on-going program to monitor, collect and disseminate information on peat development and use for energy in Europe.

e) Appoint a half-time professional at the Minnesota Energy Agency to work specifically on the peat alternative.

## 4. DESCRIPTION OF PEAT AS AN ENERGY SOURCE

### 4.1 The Potential of Peat as an Energy Source

Data on world peat resources, although incomplete, has been compiled from several published sources. From this data it is estimated that peatlands occupy 408.8 million acres of land in the world, 56% of which is found in the Soviet Union. Estimates for the U.S.A. give it 12.9% of the total i.e. 52.6 million acres.

Of the U.S.A.'s 52.6 million acres, more than half, i.e. 27 million acres are found in Alaska; however Minnesota with 7.2 million acres has the largest acreage of any of the states in the "lower 48". The average depth of Minnesota's peat is approximately 7 feet although many of the deposits vary in thickness from 10 to 20 feet or more. At the present time, only 2.7% of the state's total peatlands are utilized for crop production. Over 60% are forested and 26% are open. The most extensive peatland areas occur in the northern and central areas of the state, principally in the large glacial lake basins. See Figure 1 and Table 1.

Very little agricultural development has taken place on the peatlands of northern Minnesota, yet this is an area of the state with a very high potential energy demand. The area already has several large paper mills, taconite plants and district heating plants for which peat is a suitable fuel. In addition, this resource is potentially available for large scale gasification and for direct burning to generate electricity.

Assuming Minnesota's 7.2 million acres of peatland have a mean depth of 7 feet, a bulk density of 15 pounds per cubic foot and a caloric value of 6000 Btu per pound (at 35% moisture content) the total peat resource potential of the state is 16.1 billion tons or $1.95 \times 10^{17}$ Btu (195 Quads). If 10% of this resource (720,000 acres) were allocated specifically for energy, it would be sufficient to satisfy the equivalent of Minnesota's total energy needs for 16 years at the current rate of usage. To put these numbers in perspective they are compared with some potential selected energy demands in Table 2.

## TABLE 1

### Peat Resources and Present Use in Minnesota
### Counties with Most Extensive Acreage

| Rank | County | Area (Thousands of Acres) | % Peatlands | | % Peatlands > 5' Deep | Present Utilization %s | | | | Est. Reserve* Quantity ($10^9$) | Potential/Energy* (Quads**) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | County | State | | Crop-Land | Pasture-Forage | Open | Forest | | |
| | U.S. (including Alaska) | 52,600 | | | | | | | | 117.8 | 1,410 |
| | U.S. (minus Alaska) | 25,600 | | | | | | | | 57.3 | 690 |
| | Minnesota | 7,200 | | 100 | | | | | | 16.1 | 193 |
| 1. | Koochiching | 1,155 | 60.0 | 16.1 | 90.1 | 0.0 | 0.3 | 0.0 | 99.7 | 2.59 | 31.1 |
| 2. | St. Louis | 810 | 26.6 | 11.3 | 67.9 | 0.0 | 0.2 | 15.6 | 84.2 | 1.81 | 21.8 |
| 3. | Beltrami | 786 | 51.9 | 11.0 | 84.8 | 0.0 | 3.0 | 20.4 | 76.6 | 1.76 | 21.1 |
| 4. | Lake of Woods | 483 | 58.8 | 6.7 | 84.0 | 2.5 | 1.2 | 59.8 | 36.5 | 1.08 | 13.0 |
| 5. | Aitkin | 394 | 34.9 | 5.5 | 58.4 | 0.0 | 2.9 | 47.3 | 49.8 | 0.88 | 10.6 |
| 6. | Itasca | 357 | 26.4 | 5.0 | 60.5 | 0.0 | 1.0 | 0.7 | 98.3 | 0.80 | 9.6 |
| 7. | Roseau | 245 | 23.4 | 3.4 | 79.0 | 2.3 | 1.1 | 43.9 | 52.7 | 0.55 | 6.6 |
| 8. | Cass | 200 | 20.1 | 2.8 | 78.7 | 0.0 | 4.8 | 64.3 | 30.9 | 0.45 | 5.4 |
| 9. | Ottertail | 192 | 15.9 | 2.7 | 95.2 | 0.9 | 28.4 | 52.4 | 18.3 | 0.43 | 5.2 |
| 10. | Pine | 174 | 20.0 | 2.4 | 80.8 | 0.5 | 12.7 | 26.8 | 60.0 | 0.39 | 4.7 |

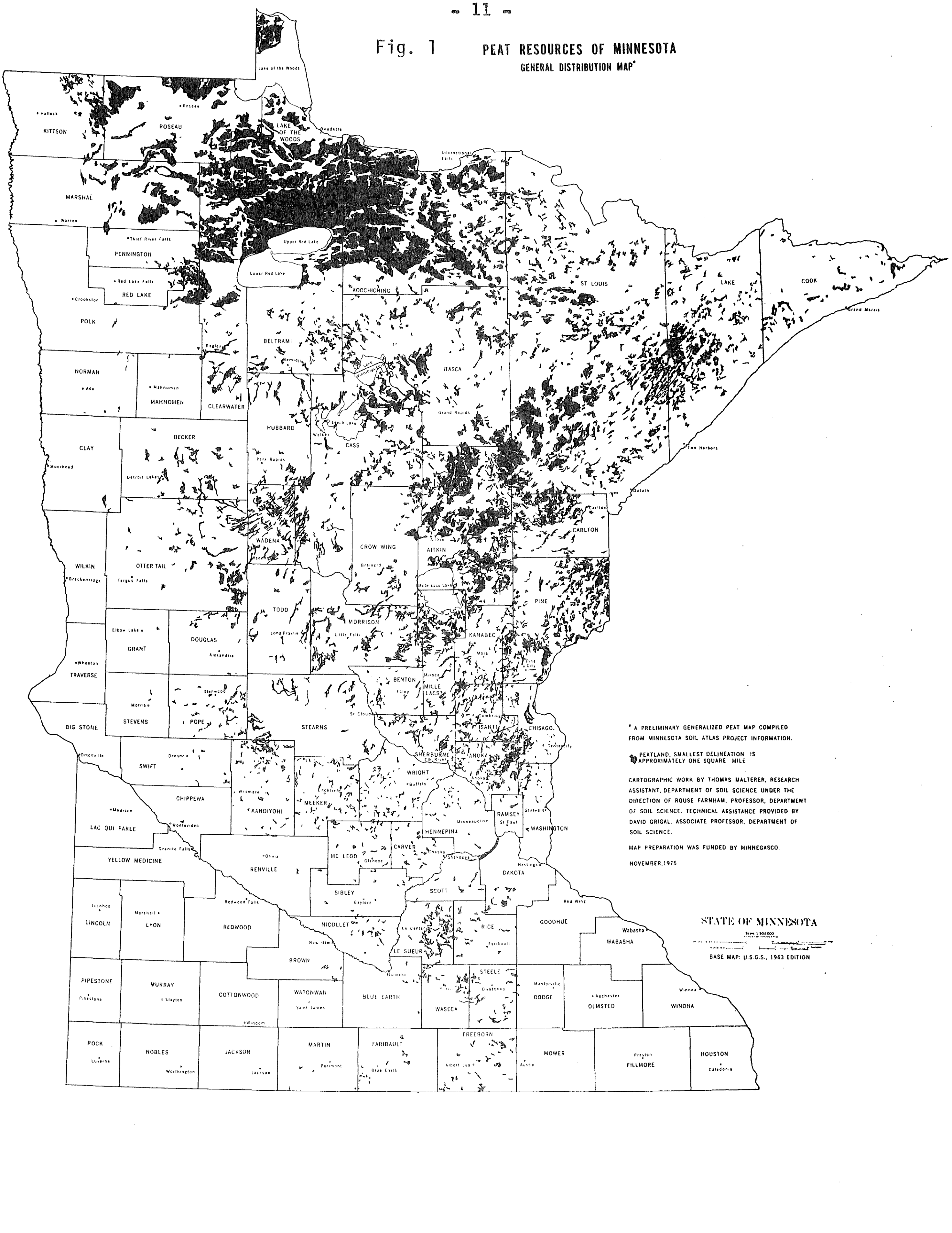
* Basis of reserves and potential energy: peat assumed uniformly 7 feet deep, bulk density 15 lbs/ft$^2$, caloric value (35% moisture) 6,000 Btu/lb. Assuming 2% ditch losses, one acre of peat 7' deep equals 2240 tons or 2.69 x $10^{10}$ Btu of energy.

** 1 Quad = $10^{15}$ Btu

Source: Conservation Needs Inventory, Soil Conservation Service, U.S.D.A. (1967) and Soil Science Dept. - Univ. of Minnesota

Fig. 1 **PEAT RESOURCES OF MINNESOTA**

**GENERAL DISTRIBUTION MAP***




* A PRELIMINARY GENERALIZED PEAT MAP COMPILED FROM MINNESOTA SOIL ATLAS PROJECT INFORMATION.

PEATLAND, SMALLEST DELINEATION IS APPROXIMATELY ONE SQUARE MILE

CARTOGRAPHIC WORK BY THOMAS MALTERER, RESEARCH ASSISTANT, DEPARTMENT OF SOIL SCIENCE UNDER THE DIRECTION OF ROUSE FARNHAM, PROFESSOR, DEPARTMENT OF SOIL SCIENCE. TECHNICAL ASSISTANCE PROVIDED BY DAVID GRIGAL, ASSOCIATE PROFESSOR, DEPARTMENT OF SOIL SCIENCE.

MAP PREPARATION WAS FUNDED BY MINNEGASCO.

NOVEMBER, 1975

## TABLE 2

### Peat Required for Potential Selected Energy Demands

| Location and Type of Plant | 1 Year Supply: Source Energy $10^{12}$ Btu | 1 Year Supply: Amount $10^3$ Tons | 1 Year Supply: 5' Depth Area Acres | 20 Year Supply: Source Energy $10^{12}$ Btu | 20 Year Supply: Amount $10^6$ Tons | 20 Year Supply: 5' Depth Area $10^3$ Acres |
|---|---|---|---|---|---|---|
| 1. Municipal Heating Plant Virginia, MN - steam heat | 1.44 | 120 | 80 | 28.8 | 2.4 | 1.6 |
| 2. Paper Mill (drying paper) Potlach, Cloquet | 1.92 | 160 | 100 | 38.4 | 3.2 | 2 |
| 3. Taconite Plant - Iron Range, low Btu gas for drying pellets (5 million ton capacity) | 3.00 | 250 | 150 | 60.0 | 5.0 | 3 |
| 4. Electric Generation (direct burning) [33% thermal efficiency, 70% load factor] Iron Range Area — 10 MWe | 0.63 | 53 | 33 | 12.7 | 1.1 | 0.66 |
| 100 MWe | 6.34 | 530 | 330 | 127 | 11 | 6.6 |
| 1000 MWe | 63.4 | 5300 | 3300 | 1270 | 110 | 66 |
| 5. Gasification - Synthetic Natural Gas (high Btu) $80 \times 10^6$ ft3/day | 72.0 | 6000 | 3750 | 1440 | 120 | 75 |
| N.W. Minnesota - Red Lake Area $250 \times 10^6$ $ft^3$/day | 216 | 18,000 | 11,200 | 4320 | 360 | 224 |

## 4.2 The Feasibility of Peat as an Energy Source

Peat is classified into three types. These are:

a) Fibric - the least decomposed type, with lowest ash content and bulk density, highest saturated water content and greatest amount of plant fiber.

b) Hemic - moderately decomposed with medium bulk density saturated water content and fiber content. Best suited for fuel.

c) Sapric - the most decomposed type with high bulk density, relatively high ash content, and lowest fiber content and saturated water value.

The hemic or partly decomposed peat types have the highest energy values. Sapric types are relatively high but they are higher in ash content then hemic types. The fibric sphagnum moss type, which is very valuable as a commercial horticultural peat, has the lowest energy value of all peat types and should not be used for fuel production.

Peat can be used as a fuel directly when dried, for the generation of electricity and for district heating to produce steam. It can also be converted to gas in either low or high Btu forms for industrial or home use. A wet combustion process eliminating the need to dry peat is being studied by the Zimpro Company of Rothschild, Wisconsin, to produce steam. Briquettes are presently being produced in Russia and Ireland for home and factory heating. Peat also could be used either in combination with biomass--e.g. grasses, sedges, cattails, or it could be mixed with conventional coals and lignites for gas production, by a thermo-chemical conversion process.

4.2.1. Direct Burning

Sod or milled peat when freshly cut has a 90-95% moisture content. If it can be mechanically dewatered and dried to 35% or lower moisture content it may be burned directly for electricity generation and steam production, as is already done extensively in Europe, e.g. Russia, Finland, Sweden, and Ireland. Electrical generation requires the large scale burning of peat, particularly milled peat, in steam boilers. The milled peat is burned in much the same way as pulverized brown coals.

Plant sizes are dictated by the economics of utilizing peat versus coal or oil fuels. If the plant is kept small to match the supply capacity of a given bog, then peat can compete. Plant sizes ranging on the order of 20-40 MWe would correspond to operational bog resource capacities of 20-25 years.

Typically a 40 MWe plant, operating at 35% thermal efficiency, 70% load factor, using peat of bulk density 15 $lb/ft^3$ and 6000 Btu/lb (35% moisture) and assuming 2% ditch losses, will require 203,000 tons per year or 125 acres per year mined to a depth of 5 feet.

4.2.2. Peat Briquettes

Traditional production of heat from peat has been from the burning of briquettes. This practice is widely used in the USSR, Ireland, and other European countries. Plant sizes in the USSR, the largest producer, range from 30,000 to 200,000 tons a year.

The peat briquette is a very convenient type of fuel as compared to coal or wood for home heating; its constant thermal property allows easy furnace demand feeding, and its thermal density is 2.5-3.5 times that of wood.

To produce briquettes, different quality peats are blended and screened, dried to 9-12% moisture and compacted into 3" x 7" bars by reciprocating presses.

4.2.3. Carbonization

The carbonization process, for char, charcoal or coke, submits peat to high temperature (700-1400°F) and pressure (350 p.s.i.). Peat produces more ammonia and gas than coal, but the latter yields more coke and tar. Hence, large scale production of coke from peat could prove more economical than production from coal, by virtue of the by product revenues.

4.2.4. Gasification

Gasification to produce a natural gas substitute involves reaction between steam, hydrogen, carbon monoxide, carbon dioxide and methane in contact with the solid carbon in peat. Heat is added to meet the needs (endothermic) of the steam-carbon reaction. The heating value of the desired output gas determines how the heat is added.

Low Btu or synthesis gas, which can be produced at a significantly lower cost per unit of heat than high Btu or pipeline quality gas, has as its primary combustible constituents, hydrogen, carbon monoxide and some methane. However, there is no specific catalytic methanation step and the gases leaving the gasifier must be cleaned to remove sulfur and other undesirable compounds. The most advanced low Btu gas producing method is known as the Lurgi process.

Only high Btu natural gas is presently used in the U.S.. However, if low Btu gas could be used near the point of gasification, i.e., electrical power plants or large industrial installations (e.g. taconite pellet drying), then it will likely have an economic advantage.

There are several approaches to the production of high Btu gas. These include:

1. The Hygas-Electrothermal (Institute of Gas Technology) process which carries out an electrically heated steam-carbon reaction to produce synthesis gas in one unit coupled to a second for the methane forming reaction.
2. The Bigas (Bituminous Coal Research Inc.) process which uses oxygen to produce the heat required for the steam-carbon reaction instead of electricity.
3. The Hydrogasification (U.S. Bureau of Mines) process which adds hydrogen to steam to improve methane formation, with heat from this reaction in turn used to produce more hydrogen from the steam-carbon reaction.
4. The $CO_2$-Accepter (Consolidation Coal Company) process which uses dolomite (limestone) to provide heat for the steam-carbon reaction while at the same time removing $CO_2$ and increasing the proportion of hydrogen.

The process being considered by Minnegasco for SNG production from peat in northern Minnesota is IGT's Hygas-Electrothermal process shown diagramatically in Figure 2. IGT has found that peat's higher volatile matter content (as compared to coal) leads to greater gas yields (in terms of the carbon content gasified) at lower temperatures. The process appears to be a most promising one, with the following predicted characteristics for a 250 million cubic feet per day peat-to-SNG plant.

| | |
|---|---|
| Quantity of peat needed (air dried - 35% moisture) | = 17.5 million tons per year |
| Plant stream factor | = 90% |
| Heating value of SNG produced | = 950 Btu per cubic foot |
| By-products: | |
| Oil (benzene, naphthalene & phenols) | = 29,000 barrels per day |
| Ammonia | = 465 tons per day |
| Sulfur | = 48 tons per day |
| Plant investment (1976 dollars) | = $900 million |
| Cost of air dried peat as delivered | = $5 per ton |
| 20 year average cost for SNG | = $2 per 1000 cubic feet |
| By produce credits - oil | = $.15 per gallon |
| ammonia | = $140 per ton |
| sulfur | = $25 per ton |

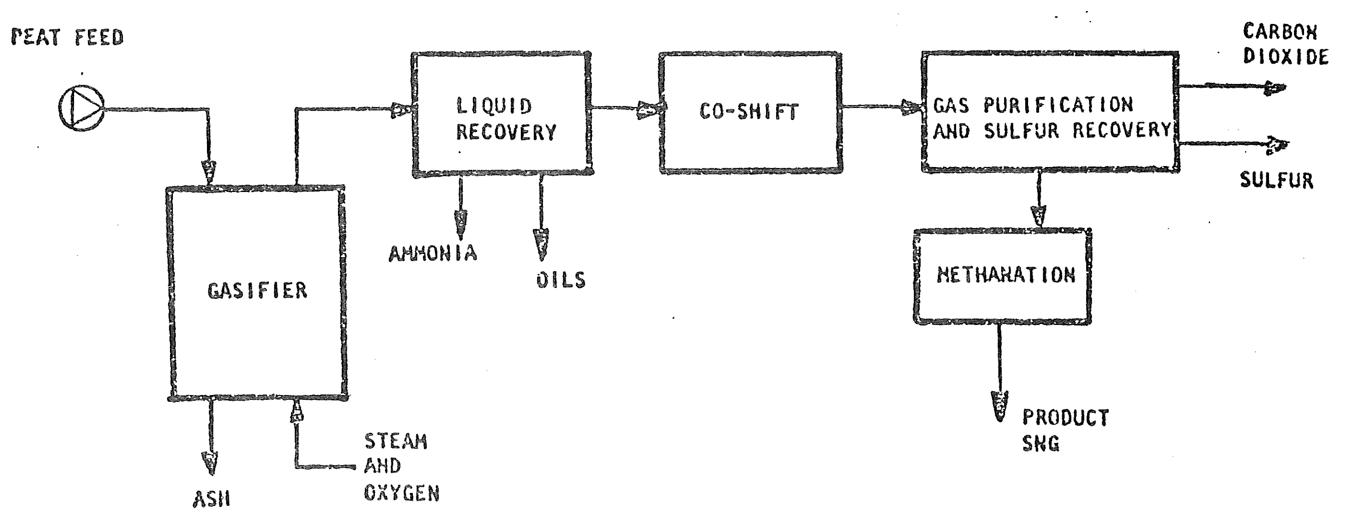



Figure 2 — SCHEMATIC BLOCK-FLOW DIAGRAM FOR SNG PRODUCTION FROM PEAT

## 4.3 Peat Harvesting Technology

Before a peat bog is suitable for peat harvesting, the surface vegetation including buried stumps and large wood fragments must be removed. In the U.S., conventional excavating and earth moving equipment is employed while in Europe, clearing machines specifically designed for this purpose are often used. For example, the Finns have developed a multipurpose "base machine" with attachments for dozing, grubbing, leveling, ditching and harvesting and the Soviet Peat Industry has developed a universal excavator with attachments for clearing timber and also harvesting peat. Costs (1970 figures) of clearing range from $20/acre for open sedge bog to $100/acre for forested areas.

Some degree of drainage is normally required before the bog surface will support large equipment. For saturated conditions, removal of 10-15% of the volumetric water content is required. This is usually done by ditching with ditches 50 feet apart and four to eight feet deep for milled peat. Ditching cost (1970) using a small dragline has been estimated at $.15 per cubic yard.

Peat harvesting falls into three main categories, the sod-peat method, the milled peat method, and peat excavation.

### 4.3.1. Sod Peat

In this method, peat is excavated from a deep vertical trench by a bucket dredger, called a "bagger" in Ireland.

This machine mascerates the peat and extrudes it into long ribbons by means of a spreader arm. Cutting discs drawn behind the bagger cut the peat into sods which are approximately 14 inches long and 5 inches square. After extensive drying, the sods are collected into ricks and transported to their point of use.

### 4.3.2. Milled Peat

Sod peat production in Europe is being phased out in favor of the milled peat process which can be completely mechanized and has lower capital and labor requirements. Milled peat production is a multi-step process consisting of milling, harrowing, ridging and stock piling. The peat itself is finely shredded by a toothed rotating drum prior to being left to dry on the production field surface.

Russian technologists have developed a pneumatic or vacuum harvestor which collects only the driest peat. This reduces the drying and harvest cycle from two or three days to one day.

### 4.3.3. Peat Excavation

When there is no need to completely dry the peat, and mechanical dewatering methods are sufficient (e.g. peat for gasification, liquefaction and the Zimpro wet combustion process), it can be excavated directly from the bog. This can be accomplished by dragline, bucket wheel excavator or by an hydraulic method. One method uses barge-mounted dredges designed for excavation of submerged materials and transport of the resulting slurry to a discharge outlet. Dredging costs for removal of light, easily dug material such as peat have been estimated at $.27 per cubic yard as compared to $.70 for drag-line excavation. Another method, the one envisioned by Minnegasco for their proposed SNG operation in northern Minnesota and being developed by the U.S. Bureau of Mines, reduces peat to an aqueous suspension by the action of water under high pressure. The peat slurry is then pumped by suction through pipelines onto drying beds. The excess water is then returned to continue the operation. This process has been chiefly used to date in the USSR.

Removal of peat by excavation has certain advantages over surface mining. In general, excavation processes are less labor intensive, they permit longer season operation, require a relatively small working area, and may not require extensive drainage. The primary difficulties are reclamation after peat removal and mechanical peat dewatering.

## 5. JUSTIFICATION OF THE RECOMMENDATIONS - GENERAL

The latest future energy demand and supply figures for Minnesota released by the Energy Agency* are:

| | Demand | Source Availability Trillions of Btu | Energy Gap |
|---|---|---|---|
| 1975 | 1174 | 1174 | -- |
| 1980 | 1307 | 1270 | 37 |
| 1985 | 1529 | 1448 | 81 |
| 1990 | 1767 | 1539 | 228 |

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* Energy: Horizons II Presentation, John Millhone, Director, MEA, January 1977.

The demand numbers are based on a mean annual growth rate of 2.8%, a figure somewhat less than the 4.8% historical growth rate.* This reduced growth rate is based upon the future impact of conservation measures, some of which are already being put into effect in the state (e.g. assumed improvements in new car gasoline economies, continued enforcement of the energy aspects of the state building code), as well as forecasts of demographic and economic growth in the state.

The source availability numbers are predicted upon the outlook for natural gas supplies and unconstrained flows of oil through existing U.S. pipelines and the new Williams Brothers, Patoka and Kitimat Consortium pipelines which are to be built to replace the flow of Canadian crude to Minnesota refineries. The flow of oil is thus assumed to be constrained only by the pipeline diameters and pumping rates. One other constraint factored into the source availability number is that new coal fired electrical generating plants will be delayed by one year in coming on line.

Under these conditions, energy supply shortfalls of 37, 81 and 228 trillion Btu's are projected for 1980, 1985 and 1990 respectively. A dedicated commitment to develop our state's indigenous and renewable energy resources would go far towards the reduction of these shortfalls.

As already mentioned nearly all of Minnesota's alternative (renewable) energy sources are either direct or indirect forms

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* Minnesota's Energy Situation to 1985, Minnesota Energy Agency, Research Division, August 1975.

of solar energy, and most of the technologies required for their development and commercialization are already available. A large credibility gap exists however between these renewable sources and their available technology, and the public awareness. We have a number of exciting choices available to us between direct application of solar radiation, wind, biomass (agricultural residues and crops, wetland plants, timber residues and plantations, animal manures, urban solid waste) and peat. Some choices have great potential and each tends to lend itself ideally to different applications or energy end uses. Thus direct solar utilization matches beautifully with hot water and space heating applications; wind--with the generation of electricity and rural irrigation; biomass for the generation of electricity, the production of fuels and even possibly the manufacture of fertilizers (via an ammonia synthesis process) and petrochemicals (by fermentation of cellulose to sugars); and peat for the production of SNG, the generation of electricity, and the supply of space and industrial process heat.

However, there are some very real and difficult barriers to be addressed and overcome before we see any large scale commitment to and utilization of these alternative energy sources. A few of these are technical and recommendations are made for surveys, inventory updates and research in these areas. Others relate to the credibility gap mentioned above, and these will be addressed by project demonstrations and the provision of a central state source for the collection and dissemination of solar energy availability and utilization information. But the most formidable current barriers are institutional, legal and financial ones.

In the area of energy extraction from our peat resource these specifically include early decisions on leasing policies and regulations, zoning regulations and land use ordinances which may need to be modified to allow the orderly development of peat lands for energy. A precise definition of peat is needed. Is it a mineral, a fuel or an agricultural product? The legislature must give early attention to this matter as it is important for establishing a valid tax base. Communication barriers need to be broken down; in particular dialogues must be established between scientists working on technical aspects of alternative energy and the policy makers, as well as laymen and public interest groups.

Economic options include incentives at both the federal and state level. At the federal level, sponsored demonstration projects and guaranteed loans for industrial peat development are needed; at the state level, government or industrial revenue bonds and direct tax incentives should be considered.

Environmentalists and local residents will be concerned about the repercussions that large scale peat development might have on land, air and water. Selection of peat areas least likely to create any environmental problems is the first step. This can be accomplished by making detailed inventories of peat location, type and quality, the native vegetation present and the hydrology of the area. An environmental assessment can then be made of a specific area suitable for development. Trade-offs must be determined between uses of peatlands and water for energy development versus uses for wilderness preserves, hunting and recreation, and other competing uses such as agriculture and forestry.

Finally, there are the sociological and socioeconomic concerns of the people who live and work in the peatland areas of the state. What effects would a sudden influx of workers have on a small farming or rural community? What side effects would large scale peat development have on local employment, tax base and business income? Many of these issues are discussed in Mid West Research Institute's study "Socioeconomic Impact Study: A Preliminary Assessment of Minnegasco's Proposed Peat Gasification Project", excerpts from which are reproduced as Appendix I of the main technical report.

## 6. JUSTIFICATION OF THE RECOMMENDATIONS - SPECIFIC

### 6.1 Surveys, Inventories, Resource Management and Analysis

a) Surveys to identify peatland areas for energy: Minnesota has very large reserves of high quality peat that at present are not being utilized. The potential of these peat resources to produce energy, food and fiber crops and a variety of other uses is great.

To realize these development potentials we need accurate inventories and surveys of these peatlands as well as technological and environmental studies of the areas with greatest potential for development. For an effective assessment of these peat resources it is essential that both the government and the private sector be involved. All surveys, both government and private, should be coordinated with the present DNR peat inventory program.

Specifically, there is a need for the identification of peat resources of appropriate quality near cities with municipal heating plants, taconite processing plants and paper and wood processing plants, and for the use of utilities for electric power generation (e.g. Minnesota Power and Light Company).

b) Peat resource data to State Planning Agency:
The peat resource data now being compiled needs to be supplied to the State Planning Agency for their MLMIS (Minnesota Land Management Information System) for analysis and data retrieval. Only by feeding the pertinent information on peat resource location, type, quantity and quality through this central information processing agency, can we be sure that the right compromises and decisions optimizing the requirements and needs of all interested parties can be met.

c) Location of peatlands for biomass energy production:
Peatlands are particularly suited for the production of many high-yielding wetland species such as cattails, sedges, reeds, grasses, hybrid aspen and lowland brush. Since most peatlands are not currently used for food or fiber production, the opportunity exists for large scale peatland plant production for energy crops.

Energy cropping on peatlands would appear to be one of the most appropriate ways of land reclamation after peat harvesting. The concept here would be to allocate a specific area of peatland for energy production and management. First, the surface vegetation and peat down to a predetermined depth would be harvested, processed and used, the land would be converted to intensive crop management of the appropriate wetland plant. Ultimately, the allocated area would be producing energy crops on a rotating, completely renewable basis.

## 6.2 Applied and Directed Technical Studies, Research and Development

a) Development of small scale harvesting technology: For local heating plants and small industries (taconite plants and paper mills), there is a need to develop the technology and harvesting equipment needed to cut blocks of peat on the surface of peat fields where either native or domestic grass species are growing. The purpose of this drying technique is to utilize the process of transpiration in maximizing the loss of water through the plants in order to partially reduce the water content of the peat in the zone of plant root concentration. Harvesting equipment needs to be developed similar to the vertical German peat cutter which could be modified to cut horizontally on the peat surface, or to modify the American cultured sod cutters to cut grass and the peat. These blocks containing grass and peat would be approximately 16" x 6" x 6" in size. Preliminary studies in 1976 using this method of drying peat were very successful and water contents were only 25 to 40% by weight when peat blocks were cut.

Specifically, research is needed to:

1. Develop techniques for cutting and turning (90°) peat sods with grass cover, i.e., experimental cutters need to be developed.
2. Determine drying cycles.
3. Identify best harvesting, loading and transportation techniques.
4. Determine the possibility of reseeding grass for two or three crops per year.

b) Development of large scale harvesting technology: For large-scale peat production such as for a high Btu gasification plant or a large taconite plant, the use of large suction dredges in the peatlands and pipes for conveying the peat slurry to the plant is recommended. Equipment presently used in hydraulic mining operations could be used to demonstrate the feasibility of this mining technology using peat. Large-scale tests are suggested to evaluate the efficiency and economics of this type of mining.

c) Feasibility of production of energy crops on peatlands: There is a need to study the possibility of producing several wetland species under proper management practices on peatlands. Such crops as cattails, sedges, wetland grasses and rushes all grow well on peatlands and if properly managed are capable of high yields of biomass.

Because of the potentially high yields of energy on peatlands, research is needed to determine methods of planting, water control, harvesting, drying, etc. The potential exists for harvesting entire plants (tops and roots) together with surficial peat (all burnable biomass) and replanting peatland for continued energy production on a partially renewable basis. Peatlands are extensive, they are flat and thus well adapted to machinery harvesting, they have optional available water for plant growth and these lands are not presently being utilized to any extent.

6.3 Demonstration Projects

a) Feasibility of peat for a local heating plant:
Using either a municipal heating plant such as in Virginia, Minnesota, or a local paper mill such as Conwed Corporation in Cloquet, the following information needs to be developed:

1. The total peat raw material needed for a specific plant such as the examples given above.
2. The location of a suitable peatland area with sufficient reserves available for energy.

3. A detailed inventory of the quality and quantity of peat in this area for energy.
4. The harvesting technology to be used, transportation costs, lead time needed for peatland development and technology to be used at the plant.
5. Needed and appropriate drying technologies.
6. The royalties and rental fees that will accrue (assuming state or county lands) and the financial benefits to the local community resulting from this peat operation.
7. A complete reclamation plan for the peatland area prior to removal, including information on what crops have potential for recreation, forestry, wildlife, etc.
8. Predetermination of any possible environmental problems.

b) Evaluation of the Swedish wet carbonization method for peat dewatering:

The most difficult technological problem to overcome before peat is to become an economical fuel source is that of adequate dewatering. The Swedish wet carbonization method was in a pilot plant stage for several years prior to 1965 and extensive tests were conducted with peat. The Swedish Energy Agency is presently reevaluating this process for use in their peat for energy research. It is recommended that the Minnesota Energy Agency obtain from Sweden all information pertaining to wet carbonization as a technique for dewatering peat and further establish contact with researchers in Sweden and Finland for the purpose of exchanging information with them on aspects of dewatering peat. Some sort of collaborative effort between U.S. and Scandinavian peat researchers should be established. Sweden has recently sent two different groups to the U.S. to obtain information regarding the use of peat as an energy source.

c) Demonstration of peat sludge dewatering systems: The milled and machine peat processes used in Europe both depend on solar energy to dry peat on the surface of fields. Using these methods, which are highly dependent upon the weather, would require farming about 100,000 acres to produce the peat for an 80 million cubic feet per day demonstration SNG plant, and as these operations are only practical during the summer, it would require huge stock piling of dried peat for winter operation of the gasification plant. Hence, if peat is to become a major source of energy supply for Minnesota, new dewatering techniques are necessary.

The U.S. Bureau of Mines in cooperation with the Ingersoll-Rand Corp. and dredge manufacturers are planning several demonstrations of peat hydraulic dredging and mechanical dewatering techniques on peatlands in South Carolina and Minnesota. It is recommended that this equipment be demonstrated in several bogs in Minnesota and that extensive trials be conducted in several locations with different peat types.

6.4 <u>Incentives and Institutional Concerns</u>

a) Economic options:

It is to the economic advantage of the State of Minnesota that peat, our local source of fossil (or biomass - see incentive b3 below) energy, be given high priority considerations and incentives over sources of energy which must be imported into the state. Large-scale development in the northern part of the state could involve tens to hundreds of thousands of acres of peatlands. These northern counties are not well suited to agricultural development and presently have little employment except in the iron ore and taconite mining industries. Peat development in the region would provide summer and fall employment for harvesting operations and would supplement the winter logging operations.

As an example, a large peat harvesting operation using 100,000 acres would employ between 3,000 and 4,000 workers for mechanical harvesting, handling and processing peat as raw material for a large synthetic natural gas plant. In addition, this large SNG plant would employ at least 1,000 workers year around to operate it. If one considers the multiplier effect of such an operation, including equipment repair and service industries, the economic potential of such a peat enterprise becomes readily apparent.

The following economic incentives should be pursued:

1. State support and encouragement of federally sponsored demonstration projects using peat as an energy source.
2. Assessment of the possibility of obtaining federal guaranteed loans for industrial peat development for energy.
3. Consideration of the allocation of state-sponsored bonds similar to municipal bonds or industrial revenue bonds as an incentive to peat development.
4. Reconsideration of direct tax incentives to industry during the development phase.

b) Regulations:

1. Royalty fees. As a result of the probable high cost of mining and dewatering peat for energy use, particularly in the early stages of development, the royalty fees charged by the state and counties should be low enough to make peat competitive with North Dakota lignite and Western coals.

2. Leasing policies and regulations. To meet the energy needs of Minnesota's future, most agree that additional energy plants will be needed both for gas (SNG) production and electricity. Present plans for such plants envision increasing use of both coal and nuclear energy. If peat is to be used to help alleviate our energy situation in the near future, early decisions are urgently needed regarding leasing policies and regulations.
3. Definition of peat. Peat that is used as a source of energy will be replacing or used along with other fossil fuels that are considered minerals. Therefore, early action is needed to establish a definition of peat - Is it a mineral, or is it an agricultural or horticultural product, i.e., biomass? This is important for establishing a valid tax base.
4. Land zoning regulations. Some land use ordinances or zoning regulations may need to be modified to allow the orderly development of peat lands for energy. Peat development should be compatible with other existing land uses.

c) Policy options:

There is a need to establish more meaningful dialogues between scientists working on technical aspects of alternative energy and groups such as legislators, government and public interest representatives who formulate policy. Policy makers need to be informed fully both of the potentialities of peat as an energy source and the technical problems associated with its development. Several ways of improving scientist-policy maker dialogue are suggested, i.e., by lecture, seminar, conference, conducted tour and informal discussion. The professional of recommendation 6.5 e) would play a leading role in establishing and maintaining open lines of communication.

## 6.5 Information Collection and Dissemination

The most effective way to mitigate the effect of, lessen or even remove in part the credibility gap referred to in §5 is by the collection and dissemination of accurate, factual information. For peat, the following are recommended:

a) Educational programs for policy makers and interested laymen:

   These could take the form of day-long seminars given at several towns throughout the state or short courses extending over a period of several weeks. The actual program could be tailored to fit the particular needs and schedules of the participants.

b) Central data source for peat information:

   A central data source for the location of peat information should be established in the state. This data source would include computer tapes and microfiche as well as hard copy. The existing Renewable Energy Environment (TREE) Collection at the University of Minnesota is already a substantial store of information on alternative energy sources, their utilization, development and institutional problems. It is recommended that it be extended and expanded to become a central data source for peat energy as well.

c) On-going analysis of DNR's peat resource data: There is a need for a thorough on-going analysis of the data on our peat resource now being collected by DNR. The data itself and analysis made on it should be freely available for dissemination to all interested parties.

d) On-going program to monitor, collect and disseminate European peat development: Several European countries use peat extensively as an energy source for space and district heating and electrical generation. These countries have also successfully reclaimed their peat lands after harvest and the results of their experience is generally known. The State of Minnesota should set up an on-going program to monitor, collect and disseminate this information.

e) Appointment of a peat professional to the MEA staff: The Minnesota Energy Agency should appoint a half-time professional to work specifically on the peat alternative. This person would be required to work closely with the state's scientists and industry and also be involved specifically with recommendations 6.4 c), 6.5 a) and 6.5 d) above.

# APPENDIX I

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