MONTANA ENERGY POLICY STUDY

ENVIRONMENTAL QUALITY COUNCIL

FINAL REPORT

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SENATE JOINT RESOLUTION 24
(March 3, 1973)

A JOINT RESOLUTION OF THE SENATE AND THE HOUSE OF REPRESENTATIVES OF THE STATE OF MONTANA DIRECTING THE ENVIRONMENTAL QUALITY COUNCIL TO UNDERTAKE A STUDY, MAKE RECOMMENDATIONS AND PROPOSE LEGISLATION CONCERNING THE DEVELOPMENT AND IMPLEMENTATION OF A STATE ENERGY POLICY AS IT RELATES TO A DEVELOPING NATIONAL ENERGY POLICY AND REQUESTING THE GOVERNOR TO DIRECT THE COAL TASK FORCE TO WORK WITH AND ADVISE THE ENVIRONMENTAL QUALITY COUNCIL.

WHEREAS, the legislative assembly recognizes a need for a state energy policy to contribute and respond to a federal energy policy, and

WHEREAS, a study of this need should carefully separate nationwide problems from those that are matters for action at the state level, and

WHEREAS, there is a need to consider the full range of possible energy sources, optimal efficiency, conservation of use, and administration and regulation of the energy industry, and

WHEREAS, the environmental quality council has received a private grant to make such a study as is described above, which is to relate to an ongoing national energy policy study financed and conducted by the source of the private grant, and

WHEREAS, section 69-6514 (f), R.C.M. 1947, makes it the duty of the executive director and staff of the environmental quality council to make and furnish such studies, reports thereon and recommendations with respect to matters of policy and legislation as the legislative assembly requests, and

WHEREAS, the governor, acting on the recommendation of the environmental quality council, created on August 2, 1972, an interagency task force on coal development to coordinate comprehensive planning incorporating consideration of the social, economic and environmental well-being of Montana people in present and future generations.

NOW, THEREFORE, BE IT RESOLVED BY THE SENATE AND THE HOUSE OF REPRESENTATIVES OF THE STATE OF MONTANA:

That the environmental quality council is hereby directed to undertake a thorough study, prepare a report, make recommendations and propose legislation concerning the development and implementation of a state energy policy as it relates to a developing national energy policy.

BE IT FURTHER RESOLVED, that the governor is requested to direct the coal task force to work with and advise the environmental quality council in conducting a state energy policy study.

BE IT FURTHER RESOLVED, that the avowed purpose of this resolution is to obtain a comprehensive energy policy, together with recommendations for necessary supply of energy in a manner consonant with the preservation of environmental values and the prudent use of the state's air, land, water and energy resources.

BE IT FURTHER RESOLVED, that copies of this resolution be delivered to the Honorable Thomas L. Judge, Governor of the State of Montana; to the Honorable Mike Mansfield and Lee Metcalf, United States Senators from the State of Montana, the Honorable John Melcher and Richard Shoup, Congressmen from the State of Montana and to the Honorable Rogers Morton, Secretary of Interior of the United States, to the presidential Counsellor for natural resources and to the Montana coal task force.

TABLE OF CONTENTS

TABLE OF CONTENTS (CONTINUED)

TABLE OF CONTENTS (CONTINUED)

PREFACE

The Environmental Quality Council's Montana Energy Policy Study is designed to provide data and policy recommendations to assist Montana legislators in developing a state energy policy. In this sense the Montana Energy Policy Study is an energy data handbook: it presents information on the current energy situation from a national as well as a state perspective and closely examines the assumptions behind past trends and future projections. This information was used to outline some policy options that would insure the state's energy supply future and at the same time, promote long-term economic stability and maintain environmental quality.

The first three parts of the study trace the causes of the crisis, examine current energy supply and demand data, analyze the major studies investigating the problem, and suggest some decisions Montanans ought to consider. Part I provides a basic overview, from both a national and state perspective, of the energy problem from a fuels resource standpoint. In this part data on petroleum, natural gas, electricity, coal, and uranium are presented and assessed. Part II concentrates on our energy futures. Here, the projections and policy scenarios outlines by the Federal Energy Administration's Project Independence and the Ford Foundation's Energy Policy Project are summarized and compared. A major section analyzes Montana's energy outlook and presents important information on uranium mining and milling, strip mining, coal liquefaction, energy conversion, energy transportation, and water resources. Part III examines alternative energy sources. In addition to analyzing the federal energy research and development (R&D) budget, this part summarizes current developments in the areas of solar energy, photosynthesis, wind power, and geothermal sources.

Readers of the Montana Energy Policy Study should be cautioned against dismissing the material in the appendixes. Appendix A on rate restructuring and Appendix C on the net energy concept present important new material that has important policy implications. Official summaries of the Project Independence final report and the Ford Foundation's Energy Policy Project final report are reprinted in Appendix F and Appendix G. A review of Montana state agency energy-related programs is contained in Appendix D. A convenient summary of Montana state laws relating to energy is the subject of Appendix E.

The material presented in Parts I, II, and III has been reviewed for both accuracy and adequacy. As such it constitutes an energy data source book, designed to assist legislators and citizens as they make the decisions that will determine Montana's energy future. However, the Introduction to the Montana Energy Policy Study presents the EQC staff's energy policy options for Montana. Based on premises contained in the Montana Environmental Policy Act, these recommendations are offered to stimulate discussion of how Montana can manage its own future in terms of the types and rates of growth associated with different kinds of future energy development.

The major finding of the study is that Montana must take certain steps immediately in order to protect its long-range agricultural base, its economic stability, and its environmental quality. Without these measures, the state's future will be determined by the federal government and energy conglomerates whose actions are based on expedience and may not coincide with what is best for the state of Montana.

In 1973, Montana produced over 12 percent of the nation's wheat, half of which was exported to other nations. With water as a critical limiting factor, a trade-off between agricultural production and energy production will be made. Can the nation afford to sacrifice the planned addition of over 150,000 acres of new irrigated land by 1985, needed to meet the food crisis, in order to help meet the energy crisis? Which is more important: to provide substantial amounts of food to the nation and the world or to provide the nation with only a small percent of its coal?

Acknowledgments

Many people contributed to the EQC Montana Energy Policy Study. Thanks is due Fletcher E. Newby, former EQC Executive Director, who initiated the study. Walter I. Enderlin, an environmental engineer now with Battelle Laboratories in Richland, Washington, was the original research coordinator of the study. William Tomlinson is responsible for assembling the material on alternative energy sources. Kenneth Porter and David Kinnard divided the task of surveying current state agency programs and compiling the list of current Montana statutes dealing with energy. Richard Bourke, EQC staff economist, assumed the major responsibility for checking and re-checking the data and assumptions. In addition, he wrote the appendixes dealing with rate restructuring, Montana fuel taxes, and the concept of net energy. Ronald Schleyer helped organize and edit the final report. Several members of the Montana Energy Advisory Council read earlier drafts, criticized sections and contributed their expertise. John Goers and Ted Clack of the Lt. Governor's staff saved us from numerous errors. Sharon Solomon of the Department of State Lands and James Posewitz of the Department of Fish and Game provided important additional material to the study. Likewise, the staff of the Energy Planning Division of the Department of Natural Resources and Conservation answered thousands of questions during a period in which they had little spare time. All these individuals and many more helped in the preparation of the report. However, full responsibility for the report rests with the EQC staff.

INTRODUCTION AND SUGGESTED POLICY

The "energy crisis" did not suddenly begin on October 17, 1973, when the Arab nations declared their oil export embargo. Nor did the "energy crisis" end when the embargo was lifted. The major explanation for the crisis is a single one: domestic energy consumption exceeds energy production. Because of its very low price in relation to other goods and services, domestic energy has been consumed rapidly.

A combination of conflicting policies lies at the core of the nation's current energy difficulties. Inconsistent and sometimes contradictory government policies compound the problem. Perhaps the clearest summary of the present energy problem is contained in the preliminary summary of the Ford Foundation's Energy Policy Project:*

On the consumption side:

(a) Rate structures for natural gas and electricity promote more consumption by offering large-volume users a significantly lower price per BTU than small users.

(b) Promotional advertising encourages the use of energy-consuming goods such as autos, air conditioners, home appliances, electric heating systems, color televisions, and petrochemical products (such as plastics, which require large amounts of energy to manufacture).

(c) Construction of the interstate highway system with the billions of dollars from the Highway Trust Fund brought a rapid increase in inter-city, high-speed auto travel.

(d) Subsidies to truck and air transporation draw freight away from rail transport. Public expenditures for roads and airports plus military development of what become commercial aircraft, are among these subsidies.

*Ford Foundation Energy Policy Project, Exploring Energy Choices: A Preliminary Report. (Washington, D.C. Ford Foundation Energy Policy Project, 1974), pp. 8-9.

(e) Passenger air fares dropped in comparison with bus and rail fares, and stimulated air traffic. While air fares increased 8 percent between 1950 and 1970, bus and rail fares increased 90 percent and 47 percent respectively.

(f) Investment tax incentives and steadily rising wage rates encourage industry to expand with energy-intensive capital equipment.

(g) The growth of suburbia, encouraged by federal income tax breaks and federally guaranteed loans for homeowners, has resulted in the soaring use of gasoline for commuting and other energy for the single-family homes that were built.

However, concurrent with all this, the policies of the federal government have operated to hold back energy production:

(a) The foreign tax credit, which permits oil companies to subtract the payments to host governments from their U.S. income taxes, became a greater incentive to oil production abroad--rather than at home--during the 1950s and 1960s. Ironically, while the import quota system was trying to boost domestic oil production, the foreign tax credit was effectively stimulating oil production abroad by U.S. oil companies.

(b) FPC regulation of natural gas prices and reductions in the oil and gas depletion allowances in 1969 from 27 1/2 percent to 22 percent were viewed by industry and others as a deterrent to development.

(c) Price controls imposed in 1971 on fuels (as well as on other goods and services) distorted normal marketplace actions to balance supply and demand.

(d) Offshore oil and gas lease sales were virtually halted after 1969 for a year and a half.

(e) The Coal Mine Health and Safety Act of 1969 resulted in lower productivity in underground coal mines.

(f) The National Environmental Policy Act of 1969, requiring detailed environmental impact assessments of major federal projects, caused delays in the Trans-Alaska Pipeline, offshore lease sales, and nuclear power plants, while government agencies learned to comply adequately with its requirements.

(g) The Clean Air Act of 1970 caused industrial and power plant operators to turn away from coal to natural gas and oil to meet the sulfur oxide emission standards as well as automobile manufacturers to build cars with reduced fuel economy to meet emission requirements.

It must be emphasized that those policies that acted to limit energy production were valid from a social, economic, and environmental perspective. Without them, both inflation and environmental deterioration would have been accelerated. The root cause of the present crisis lies less in limited production than in a set of misdirected policies, that fostered over-consumption of energy.

The Arab oil embargo focused attention on America's energy problems. A number of studies of the energy crisis have been completed, each recommending different policy options designed to help the nation determine what it wants its energy future to be. The Ford Foundation's Energy Policy Project and the Department of Interior's Project Independence have made careful assessments of the impacts associated with different energy policies, taking the economy and the environment into account.

The most exhaustive analysis of the energy problem was conducted by the Ford Foundation's Energy Policy Project over a two-and-a-half year period at a cost of $4 million*. Ford projects three energy futures, each with different mix of energy conservation and supply options. The Historical Growth scenario projects a future much like the past, in which policies would be enacted to maintain a high rate of growth in energy consumption. This option would require

*Ford Foundation Energy Policy Project, A Time To Choose: America's Energy Future. (Cambridge, Mass.: Ballinger Publishing Company, 1974).

maximum domestic energy production and dependence on oil imports. The second energy future is the Technical Fix alternative, in which energy consumption is decreased by increasing the efficiency of energy use. Such policies would allow the nation to maintain all the services which energy currently provides while decreasing the total amount consumed. This option allows the nation to be more selective in choosing energy supply options. The third scenario is called Zero Energy Growth and would require policies to match long-range energy growth with population increases. According to the Ford analysis, the adoption of such a policy would not reduce employment or cause serious economic dislocations. (Appendix G contains a full summary of the Ford Foundation's Energy Policy Project.)

The Federal Energy Administration's Project Independence Report* took a different approach. It began with a business-as-usual scenario which served as the base from which policy options designed to achieve energy independence were analyzed. From this, Project Independence explored three options for achieving zero oil imports: accelerated supply, conservation, and emergency programs. Accelerated supply requires the maximum amount of growth for each of the conventional fuel sources (oil, gas, coal, nuclear) as well as production of synthetic fuel supplies from coal and shale. The adoption of such a policy would produce acute shortages of capital, labor, and materials to say nothing of water resource depletion and high population and environmental impacts in those areas subject to development.

The FEA's conservation option was less extensively developed than the similar scenario produced by Ford's Energy Policy Project. Project Independence concluded that neither accelerated supply or conservation alone could achieve zero oil imports by 1985. Some combination of the two would be required. The emergency program contained methods to mitigate the effects of a short-term oil embargo. This

*Federal Energy Administration, Project Independence Report. (Washington, D.C.: Government Printing Office, November, 1974).

would require expanded oil storage facilities and emergency conservation measures. (A summary of the Project Independence Report is presented in Appendix F.)

In his State of the Union address on January 16, 1975, President Ford offered his program for securing national indpendence from all foreign fuels by 1985. The President's program asked the country to:

1. Reduce oil imports by one million barrels per day by the end of 1975, to be further reduced by two million barrels per day by the end of 1977 with total independence by 1985.
2. "Develop our energy technology and resources so the United States has the ability to supply a significant share of the energy needs of the free world by the end of the century."

Translated into actual plans, this means that the following have to be constructed by 1985, according to President Ford:

1. 200 major nuclear power plants
2. 250 major new coal mines
3. 150 major coal fired power plants
4. 30 major new oil refineries
5. 20 major new synthetic fuel plants
6. the drilling of many thousands of new oil wells

Such a program, if enacted, will demand much from Montana. In the absence of a declared state energy policy and programs designed to implement that policy, Montana can expect to have by 1985:

--a uranium enrichment plant to process fuel for a portion of the 200 new nuclear plants, with a 2,400-megawatt electrical plant to energize it.

--accelerated development of synthetic fuels plants, requiring more water than is available in the Yellowstone River Basin, if irrigated agriculture is allowed to grow as planned.

--Montana coal mines to be producing approximately 100 million tons of coal per year, or more than six times 1974 record high production. This level of accelerated development would be necessary under the President's program in spite of the fact that:

1. reclamation in Montana is not yet proven.
2. extensive damming of the free-flowing Yellowstone River, including Allenspur-type dams, would be required.
3. eastern Montana would become heavily industrialized.
4. the clean air and water of eastern Montana would be sacrificed.

President Ford outlined a specific program for achieving energy self-sufficiency by 1985. The legislative proposals sent to Congress already have met considerable resistance. The President and Congress do not see eye to eye on a number of key issues: the overall effect of the proposals on inflation, the oil import tax, the advisability of domestic gas rationing. According to many observers, it will be some months before the federal government decides upon a comprehensive energy policy for the nation.

This should not be interpreted to mean that Montana has a breathing spell to decide whether or how to respond to the emerging federal energy program. Montana cannot afford to wait. If Montana makes decisions now to determine its energy future, the federal government must respond explicitly to those decisions when deciding its own course of action. In the absence of a deliberate, coherent, and clear Montana energy policy, the federal government is likely to ignore Montana's desires in designing and implementing a national energy policy. Perhaps the greatest advantage of bold action now is that it would allow state government to attempt to define the optimum balance between the various and varied social, economic, and environmental goals for Montana. Without such action these decisions will be left to the federal government and the energy conglomerates, whose choices may not be in the best interests of the state and its citizens.

Montana already has an energy policy, although it is in a disjointed and contradictory, piecemeal form. Montana energy policies still encourage over-consumption. Production laws place a premium on efficiency in energy extraction and proper regulation. The Montana consumption policies* are:

a. a promotional pricing system (block rate structure) for residential and commerical electricity and gas customers which encourages large consumption.

b. lower overall cost for large industrial customers for gas and electricity. Also the overall price for natural gas, which is in short supply, is lower than for coal which is relatively plentiful.

c. limited conservation policies such as the 55 mile per hour highway speed limit that has weak penalties.

The policies and laws governing the energy producing industry of Montana are much broader and in some cases represent the most far-sighted legislation in the nation. These policies* are:

a. Reclamation laws--applying to coal and uranium mining and drilling for oil and gas--which emphasize return of land to productive use without inhibiting production. (Strip Mine Siting Act, Strip Mining and Reclamation Act, Oil and Gas Conservation Board.)

b. Discouragement of waste of energy in production, for oil, gas, and coal. (Oil and Gas Conservation Board and the Coal Conservation Act.)

c. Siting of utilities on the basis of public need and environmental compatibility. Provides for one-stop approval for utilities and shortens delays in application and filing for air, water pollution and other permits necessary to construct utility facilites. The siting law allows a facility to be judged in total, rather than in disjointed parts.

*A summary of the energy related laws of Montana can be found in Appendix E.

Since the 1974 legislative session there have been further policy declarations from the executive branch. Governor Thomas L. Judge has responded to a number of federal energy policy initiatives, including the Department of Interior's proposed Federal Coal Leasing Policy and the Federal Energy Administration's Project Independence. The Governor's reactions are summarized below.

Preliminary Position Statement, Federal Coal Leasing, April 1974

The Montana Energy Advisory Council, in response to the federal coal leasing program, prepared a preliminary position statement. In this statement, the governor stated the policy that Montana would agree to further federal coal leasing in the next five years only "if its combustion or conversion will take place near the nation's high energy demand areas." "This position," he said, "can be modified only if it can be clearly shown that mine-mouth industrialization is necessary to meet state needs." Governor Arthur A. Link of North Dakota followed Montana's policy lead and adopted a final position "consistent with Montana's Preliminary Statement of Position." Governor Judge toured Montana to receive a citizen response on the preliminary position paper. He reported that the response was highly favorable.

On the Project Independence Report, Governor Judge in a January 17, 1975 letter to Frank Zarb, administrator of Federal Energy Administration, outlined Montana's objections to President Ford's energy policy proposals. The governor made the following recomendation:

> The State of Montana recommends that the Administration and Congress consider more than one energy future in deriving a nation energy policy, particularly since the economic, social, environmental and technological results of that policy will be of great significance and long duration.
>
> Rather than committing the Nation to 200 major nuclear power plants, 250 major new coal mines, 150 major coal-fired power plants, 30 major new oil refineries, 20 major new synthetic fuel plants and the drilling of many thousands of new oil wells in the next ten years, the leaders of this Nation must consider a more balanced national approach.

> Especially in the arid West, where impacts of massive energy industrialization are little known and greatly feared, development of new facilities should proceed slowly until consequences are better understood.
>
> Every dollar spent in developing new fossil fuel sources and conversion or refining facilities should be matched by equal expenditures for conserving a limited fossil fuel base. Increased efficiency of energy conversion technology must be stressed as much as construction of new facilities which waste more of the "energy in." Means of actually cutting back on energy use in the industrial sector, transportation and homes are equally important as constructing hundreds of new facilities.
>
> Finally, if we are to resolve our energy crisis, the Nation must embark upon a comprehensive program of energy conservation. This program must critically examine many aspects of our current way of life and, very likely, must suggest some drastic changes in it. To do otherwise, we feel, is to repeat the mistakes of the past.

Governor Judge summarized his coal policies in a statement to Russell Train, Environmental Protection Agency administrator. Judge said:

> Montana has a long and proud legislative record of protecting its environment, and we will continue to protect our environment and our people. As long as we can share our mineral resources without undue cost to other values in the state, we will do so. But we do not intend to be sitting on spoils piles watching wasted rivers flow across farms and ranches destroyed for the sake of the nation's energy appetite. Farming, ranching, and outdoor recreation are economic mainstays of this state. They will be protected.*

Existing state energy policy is inadequate to assure Montana's future economic stability, agricultural growth and environmental quality. To make the state's policies sufficient to protect Montana's interests, action in two general areas is required. First, present subsidies which encourage inefficient use of energy must be eliminated. Concurrent with this action, the state should encourage the energy conservation efforts of residential, commercial, and industrial consumers so that energy demand is decreased even as services provided by energy are maintained. Second, the state must enact policies to guide future energy development and provide reasonable limits on energy conversion facilities.

*Reported in EPA-LOG, 1974, a newsletter of the Environmental Protection Agency, Denver, Colorado, (Special Edition, July 1974).

Recommendations for Federal Energy Policy

The state should assist the federal government in arriving at a reasonable national energy policy. The state should not be asked to suffer the negative impacts of massive energy development without simultaneous implementation of a comprehensive national conservation program. With such a program the state can be assured that its sacrifices are made to supply national energy needs rather than energy demands. Demand and need are not synonymous; through increased efficiency the nation can have the same energy services at reduced energy cost.

Here is an outline suggesting a worthwhile federal energy policy:

A. The nation, at a minimum, should adopt a goal of achieving an average energy growth rate of 2 percent per year through the year 2000 (This is the Ford Foundation's Technical Fix Scenario). This policy option would:

1. Result in lower per unit prices for energy than would some other policy options.
2. Retain and expand the individual services provided by energy while decreasing growth in aggregate energy demand.
3. Retain and expand economic stability and employment.
4. Provide greater flexibility in energy supply than other policy options.
5. Allow maintenance of environmental quality standards.

B. The goal of 2 percent annual energy growth could be reached by enacting such measures as:

1. Mandatory and gradually increasing standards for automobile fuel economy.
2. Incentives for efficient heating and cooling of buildings.
3. Revision of regulatory and tax structures to eliminate promotional energy rates and subsidies.
4. Direct government action to: a.) shift more energy research and development funds to conservation and technology, and promote the purchase of

goods and services representing the most advanced energy saving technologies.

Upon enactment of such a conservation policy, Montana should accept location of necessary energy facilities in-state, if certain criteria are met. The criteria would recognize that state government, because of its close relationship to the people, can more effectively guide the siting of energy facilities and mitigate their negative effects than the federal government.

C. The federal government should adopt the following criteria to assist it in deciding upon future energy supply options.

1. All regions of the nation shall bear the burden of supplying energy in proportion to their demand for that energy.

2. Federal regulation and legislation for supplying the nation's energy needs shall incorporate state energy policies.

3. States shall be integrally involved in all phases of federal energy planning within their respective borders.

4. States could control the siting of energy facilities within their borders.

5. Such proposals must result in the most favorable net energy delivery. (Montana coal burned in Illinois is less energy efficient than burning West Virginia underground or surface mined coal in Illinois.)

6. State air and water environmental quality standards shall be met.

7. The federal government shall provide funds to mitigate adverse environmental, social and economic impacts resulting from energy development.

8. Surface mining of minerals (uranium, coal) must take place only in areas where reclamation is proven.

9. Water availability for agricultural growth must not be limited by premature water appropriations for industrial uses. Agriculture should be given highest priority for future water appropriations.

Montana has specific energy problems upon which state government must act. The Environmental Quality Council presents the following policy considerations and potential options for discussion leading toward resolution of the state's energy problems.

ENERGY POLICY CONSIDERATIONS AND POTENTIAL OPTIONS*

ENERGY DEMAND--Electricity

Findings of Fact:

1. The existing pricing structure of electricity established by the Montana Public Service Commission gives a per unit of energy price discount to large users. This is a promotional pricing system that encourages consumption of electricity (pp. 59-60).

Suggested Policy:

The Public Service Commission should adopt a pricing structure that would encourage efficient allocation of Montana's limited resources and conserve energy. The pricing structure should reflect the full cost to society of producing each additional unit of energy (that is, the marginal cost), and should be phased in over a period of time.

Suggested Policy Implementation:

Temporary changes as follows should be made while certain studies are being conducted (see Appendix A, p. 190).

a. The existing declining block rate structure should be altered by increasing charges for "tail end" blocks, representing large users.

b. Rates for seasonal peak load period (winter) should be increased relative to seasonal non-peak periods. Certain studies are necessary to implement the marginal cost pricing structure suggested under Policy. The studies are as follows:

*Page numbers following findings of fact refer to supporting material in the body of the Montana Energy Policy Study.

a. Determine the customer service cost, demand cost (cost of additional generating capacity) and energy cost--all components of marginal cost--for each class of electricity consumer during peak and non-peak periods.

b. Begin testing to determine feasibility of time-of-day metering systems for all classes of customers (residential, commercial, and industrial).

c. Determine elasticities of demand (response to price changes) for each customer class for peak and non-peak periods.

Based on the findings of studies, the Public Service Commission could enact a rate structure which would conserve energy and ensure future energy supplies.

ENERGY DEMAND--Natural Gas

Findings of Fact:

1. Montana natural gas supplies are being and will be strained by the reduction and eventual cutoff of imports from Canada (p. 30).

2. The existing natural gas pricing system, based on declining blocks similar to those used in electricity pricing, reduces per unit cost to large consumers and encourages consumption (pp. 31-32).

3. Interruptible gas contracts (in which supplies can be cut off during times of short supply) makes industry most vulnerable to shutdown in the event of natural gas shortages (pp. 33-34).

Suggested Policy:

The Public Service Commission should adopt a pricing structure which will encourage efficient allocation of Montana's limited natural gas supplies. Avenues should be explored to encourage the shift by large consumers to other fuel sources (coal, for example).

Suggested Policy Implementation:

a. The existing declining block rate structure should be altered by increasing charges for "tail end" blocks, representing large users.

b. Studies should begin to determine the economic and technological feasibility of converting large natural gas users to the use of other fuels.

c. The price of natural gas should be allowed to rise to a level equal to the marginal cost (cost per unit supplied) of providing it under a deregulated production system.

ENERGY DEMAND--Conservation Assistance

Suggested Policy:

Because energy supplies will decrease, it is in the best long-term interests of Montana to encourage energy conservation by consumers. It is also in the interest of the state to help Montana industry overcome or avoid periods of short supply. Hence incentives are necessary to encourage residential and industrial consumers to conserve energy and to encourage industry to switch to more plentiful energy supplies, such as coal.

Suggested Policy Implementation:

a. Low interest loans should be made available to home and apartment owners to encourage installation of insulation, storm windows and other energy saving equipment. The conservation assistance should be limited to loans of (say) $500 per housing unit over a two-year period. Money for the program could come from state investments funds, some of which are now being invested out of state. The perhaps slight loss of interest revenue could be discounted by increased revenue from income taxes on contractors and suppliers of energy conservation equipment. The loans could be administered through commerical banks and loan institutions which would be doing a public service, recouping costs through loan service charges, and possibly deriving increased business.

b. Accelerated tax depreciation should be allowed for industrial and commerical consumers who install energy conservation equipment. This would allow the depreciation of property in less time and allow greater tax benefits initially--and more cash in hand--yet insure payment of the tax after the time of depreciation.

c. Industrial consumers switching to coal or electricity from natural gas could be allowed to sell bonds on the tax-free municipal bond market, as they are now allowed to do for installation of pollution control devices. Switching from gas to coal also would involve the need for pollution control technology so the bonds could be sold together. There also should be a definite time period to encourage rapid action.

ENERGY DEMAND--Petroleum

Findings of Fact:

1. The greatest portion of the growth in petroleum demand has been in the transportation sector (p. 18).

2. The 55 m.p.h. conservation speed limit, although it has weak penalties, has encouraged conservation of fuel (pp. 20-21).

Suggested Policy:

The state should at least match the conservation program which the federal government has enacted, one portion of which is the mandatory speed limit. The state also should encourage other forms of petroleum conservation.

ENERGY PRODUCTION--Uranium Mining

Findings of Fact:

1. Extensive uranium exploration is occurring in Montana. Although most of this exploration is still speculative, it is likely that in the future, uranium mining will occur here (pp. 75-78).

2. State laws already provide for some regulation of the uranium mining industry. However, under these laws, the regulations are inadequate or have not been promulated specifically for uranium. Some forms of uranium mining, in particular solution mining where acid solutions are injected into the deposit and then recovered along with uranium, is not covered at all even though it could have very harmful effects on water quality and land productivity (p. 82).

Suggested Policy:

The state should prepare to regulate the uranium industry in anticipation of actual development because of the potential hazards of improperly regulated uranium mining. Major reliance on present state law should occur in the short term with preparations being made to draft legislation for proper regulation of all forms of uranium mining by mid-1977.

Suggested Policy Implementation:

a. By resolution, the legislature should direct the relevant state agencies, the Department of State Lands and the Department of Health and Environmental Sciences (DHES), to draft or update rules or regulations concerning uranium mining and milling to safeguard environmental quality and worker safety. The resolution also should direct the two departments, along with the EQC, to jointly determine what new laws need to be enacted and what is required to safeguard the state's interest. They should be directed to report to the 1977 legislative session with their findings.

b. Also by resolution, the legislature should direct the DHES to upgrade its regulatory program so the state can take over the Atomic Energy Commission's regulatory functions in Montana.

ENERGY PRODUCTION--Uranium Enrichment

Findings of Fact:

1. Location of a uranium enrichment plant in Montana already has been proposed once, and another proposal, or application for a permit under the Utility Siting Act could come before 1980 (p. 83).

2. Uranium enrichment plans for Montana are primarily based upon the state's plentiful coal reserves which can potentially produce electricity to power the enrichment process (p. 83).

3. Siting of a uranium enrichment plant is already regulated under the Utility Siting Act although specific rules have not been promulgated (p. 84).

Suggested Policy:

The siting of an uranium enrichment plant could mean construction of the largest coal conversion plant complex in the state. Due to its large impact, any such plant should be regulated by the Department of Natural Resources and Conservation as any other coal conversion facility. If the siting choice is the state's--which it may not be due to federal jurisdiction--such a plant should be carefully investigated and if permitted, stringently regulated.

Suggested Policy Implementation:

By resolution the legislature should direct the Department of Natural Resources and Conservation to promulgate rules and regulations under the Utility Siting Act concerning uranium enrichment facilities. Also, the Department should be asked to report to the 1977 legislative session what further legislation is needed to properly regulate uranium enrichment facilities. The Department of Health and Environmental Sciences should scrutinize its rules and regulations to determine whether the existing authority and regulations are adequate.

ENERGY PRODUCTION--Petroleum and Natural Gas

Findings of Fact:

1. Petroleum and natural gas supplies from Canada are expected to be cut off in the 1980s (pp. 27 and 30).

2. Canadian natural gas accounts for much of what gas is consumed in Montana. Canadian oil accounts for approximately one-third of the oil refined in the state (p. 30).

3. Oil and gas production in Montana could offset decreases in oil and gas supplies caused by Canadian export reductions and cutoffs (pp. 22-23 and 34).

4. Synthetic fuels plants could meet Montana needs for oil and gas caused by Canadian export reductions and cutoffs (p. 148).

Suggested Policy:

The state government should attempt to insure future oil and gas supplies by encouraging the use of domestic energy sources. Incentives may be needed to increase oil and gas production. Federal action may have the needed effect. As a last resort, the state could authorize the construction of synthetic fuels plants for Montana needs.

Suggested Policy Implementation:

The legislature should ask the governor to direct the Montana Energy Advisory Council to evaluate the time table for Canadian gas and oil export reduction and cutoff. Methods of increasing gas and oil production then could be evaluated for efficacy in meeting in-state need. MEAC also could determine whether synthetic fuels plants will be needed to meet in-state demand for natural gas, and for crude oil to supply refineries.

ENERGY PRODUCTION--Coal Mining

Findings of Fact:

1. Reclamation of land where coal has been strip mined has not been proven in Montana (pp. 53-57).

2. Projected coal production by 1980 is to exceed 40 million tons a year based on present contracts even if no new mines are opened. If President Ford's energy program (as stated in his 1975 State of the Union message) is implemented, it would reach the accelerated development scenario of the Project Independence Report projection of 60 million tons a year. Even at 40 million tons production, 21 square miles of Montana would be strip mined by 1980, without assurance of reclamation based on today's technology (pp. 116-122).

3. Present reclamation laws are adequate to provide for reclamation if they are stringently enforced (p. 57).

Suggested Policy:

Until reclamation is assured, the state should adopt a conservative coal strip mining policy in its review of expansion plans of present mines and proposed opening of new mines.

Suggested Policy Implementation:

a. The legislature should direct the Department of State Lands to deny new mines under the Strip Mine Siting Act unless reclamation is certain. Also, the department should not be allowed to approve expansion of existing mines in areas where reclamation technology is untried or is failing to produce reasonable results.

b. By resolution or by its appropriation process, the legislature should encourage the Department of State Lands to undertake studies necessary to properly enforce the strip mine reclamation laws. (For example, to determine methods to quantify aesthetic significance so that as a criterion for judgment of a mining application, arguments based on aesthetics can be solidly supported in court.) Funding for these studies could be supplemented by federal or private grants.

ENERGY PRODUCTION--Coal Conversion

Findings of Fact:

1. Montana coal is needed to make up a low-sulfur coal deficit that Project Independence projects will exist until 1985 (pp. 123-124).

2. Mine site conversion of coal into electricity requires more energy and is more expensive to consumers than load center conversion (involving the argument of rail versus transmission line transportation of energy) (pp. 142-144).

3. Mine site conversion of coal into synthetic gas and oil requires approximately the same cost and energy as load center conversion but in a slurry pipeline less water is used (involving the argument of slurry pipeline and gasification versus gasification and gas pipeline systems) (pp. 144-146).

4. Projections for energy conversion plant construction in Montana indicate that there will be a severe conflict with water allocation plans in the Yellowstone Basin if irrigated agriculture expands at planned rates. If President Ford's energy program is implemented, there will be a shortage of water by 1985 (assuming short-term growth in irrigation in the basin) even if extensive damming and aqueduct systems are undertaken (pp. 132-139).

5. Slurry pipeline transportation systems are the most energy efficient and least expensive methods available for transportation of coal to out-of-state markets. Slurry pipeline transportation of coal would not require damming of the Yellowstone River. Nor would it interfere with planned growth of irrigated agriculture through 1985 (p. 147).

6. Slurry pipelines are not allowed under the Water Use Act for water allocations nor is the power of condemnation for rights of way available to slurry pipeline companies (p. 147).

7. The building of conversion plants in rural areas will cause severe strains on local social, health, business, and governmental systems. The construction phase entails a high growth period followed by a decline after construction is completed, all of which complicates planning and provision for private and public services (pp. 69-73 and 149-151).

8. Coal conversion plants located in eastern Montana would require that the present pristine air quality be significantly degraded (pp. 66-69).

Suggested Policy:

The state should preserve its land, air, water and human resources to provide for growth in a sustained economy (over 30 years at least). Load center conversion of coal to electricity costs less to the consumer and uses less energy for electrical production than in-state conversion. Load center conversion of coal to synthetic fuels does not cost significantly more or use significantly more energy than conversion in-state. Hence the state should allow in-state conversion of coal only for significant in-state energy demands--when the end product is for Montana residential, commercial and industrial use. Because coal is needed until 1985 to make up an immediate low-sulfur coal shortage and because high-sulfur coal will be suitable for conversion to clean synthetic fuels later, Montana coal should be exported as much as possible for electrical generation, which requires low-sulfur fuel to meet air quality standards.

Suggested Policy Implementation:

a. The Utility Siting Act should be amended to allow coal conversion plants in Montana only when the end product will be used primarily to meet Montana energy demand.

b. The Montana Water Use Act should be amended to include slurry pipeline transportation of coal as one of the beneficial uses of water under the act. Slurry pipelines should be regulated under the Utility Siting Act.

If state government were to enact the policies outlined in the Montana Energy Policy Study, or take similar actions, Montana would be on its way toward a comprehensive energy policy. However, it should be obvious that continual updating and further action will be needed to respond to the ever-changing energy picture. Neither these recommendations nor the study itself should be viewed as the end of Montana's evaluation and response to the "energy crisis": rather, as the first attempt of its scope in Montana history, it is a mere beginning.

I. THE ENERGY SITUATION (1950-1974)

NATIONAL PERSPECTIVE

National energy consumption increased consistently from the late 1950s to 1973. The annual rate of growth in energy consumption increased at ever greater rates in recent years of the period. From 1947 to 1973 energy demand grew at an average of 3.2 percent per year. Between 1965 and 1970 this annual rate of growth increased to 4.8 percent, rising again between 1972 and 1973 to a 4.9 percent average annual rate of growth (1,III-2).* Figure 1 on p. 2 shows the gross consumption of energy from 1947 through 1973, with annual average rates of growth given for selected years. Figure 1 on p. 2 summarizes how total energy demand has increased and also how this increase has accelerated especially since 1960.

The trend of increasing demand did not continue through 1974. Some energy indicators may serve to illustrate the general trend of demand changes. As part of total energy demand, for example, demand for electricity from 1970 to 1973 grew at an average annual rate of 6.9 percent (2,3). National electrical consumption for the first nine months of 1974 compared with the same period in 1973 shows a 1.3 percent decrease in demand (3,4). This is not only true for electricity, but also for petroleum, for which demand dropped almost 5 percent compared with 1973 (3,4). Natural gas consumption also dropped over the same period (3,4).

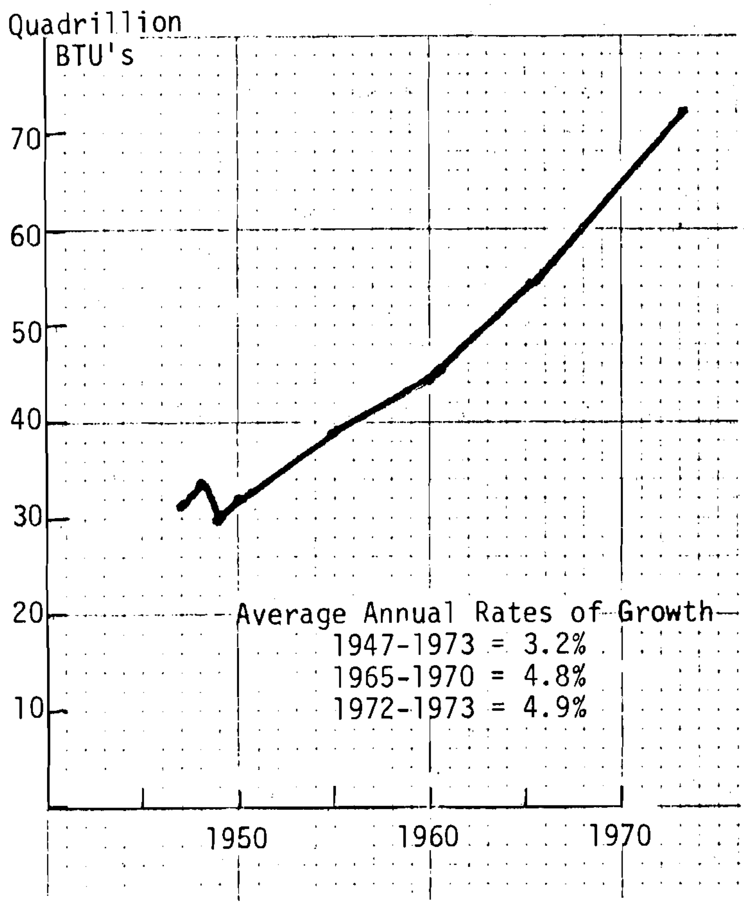
One of the greatest influences on increased energy consumption has been the general drop in price of energy relative to other goods. As the demand for energy continually increased at an accelerating rate, the relative cost for this energy continually decreased, also at an accelerating rate (4,80). Table 1 on p. 3 indicates the weighted price of energy for each five year period from 1950. These energy prices are weighted to account for changes in the cost of other goods and

*References to Parts I, II, and III begin on p. 175. In all cases, the first number refers to the item being referred to; a second number, where indicated, refers to the page number of the item being cited.

consumer buying power (4,81). Prices for energy did rise slightly throughout the 1960s and early 1970s; however, energy prices increased less than the price of other goods and services, hence the drop in the weighted price of energy.

FIGURE I

National Energy Consumption, 1947 - 1973
(with average annual rates of growth for selected years)



Source: U.S. Department of Interior, Northern Great Plains Resource Program. Interim Report, Sept., 1974.

TABLE I

National Energy Prices* - Weighted Value 1950 to June, 1973

(1960 = 100)

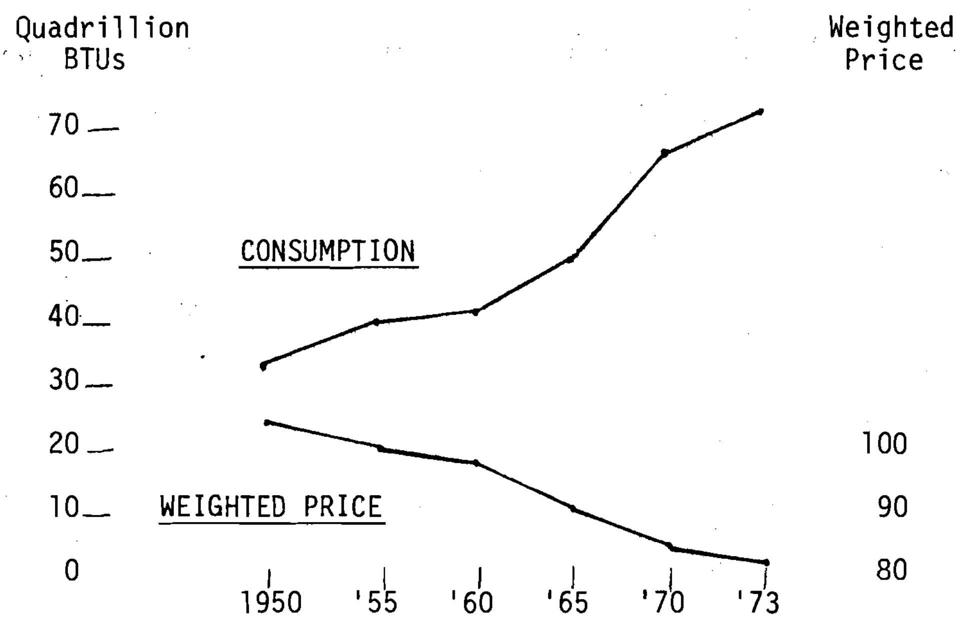
Year	1950	1955	1960	1965	1970	June, 1973
Weighted Value	107.2	103.9	100.0	93.5	85.4	80.7

*Energy Prices weighted according to Consumer Price Index

Source: A U.S. Energy Policy Primer, Edward J. Mitchell (1974).

FIGURE 2

National Energy Consumption Compared to Weighted Price
(for selected years)



Sources: Exploring Energy Choices, Energy Policy Project of the Ford Foundation, and A U.S. Energy Policy Primer, Edward J. Mitchell (1974).

Energy prices increases significantly in 1973. The rise in price was not unique in the nation's economy but was a part of accelerating general price levels (5.2). Increases in the price of fuels, however, especially petroleum, were much greater than the average increase in the general price level (5,2). In some areas of the nation, particularly the northeastern United States, prices rose substantially due to regional dependence upon imported oil which was in short supply. One characteristic of this price rise was the tendency for prices of larger users to increase relatively more than those of smaller users (5,2).

Energy demand strongly reacts to price changes. If the price decreases, as it has in the past, demand generally increases. Figure 2 on p. 3 shows this trend by comparing the increased consumption since 1950 and the decreasing price over the same period of time. Recent studies show that as energy prices rise, demand decreases. The degree to which demand is affected by prices is estimated by measures of price elasticity. Briefly, price elasticity can estimate how much the sale of a product will be affected by prices. In this case, it is the amount energy demand would fall in relation to an increase in price. Harvard economist Dale Jorgenson estimates that in response to each 10 percent increase in price, the long-term demand for energy will drop roughly 10 percent (6). In recent months, this elastic relationship has materialized as a drop in energy demand. As prices increased in late 1973 and early 1974 the demand dropped far below what historical growth rates would have predicted. Other factors, such as voluntary conservation measures, shortage of supplies of certain fuels and reduced industrial production also have affected energy consumption but price remains the greatest determinant of demand.

Production, Demand And The Shortfall Between Them

The domestic production of energy has grown substantially in the last 20 years. In fact, 1973 production was almost double the 1950 level (7,75). However, since the beginning of the 1970s energy production has increased only slightly (7,75). (See Figure 3 on p. 5 .) During the same time, the consumption of energy has

U.S. ENERGY PRODUCTION AND CONSUMPTION 1947-1973

FIGURE 3

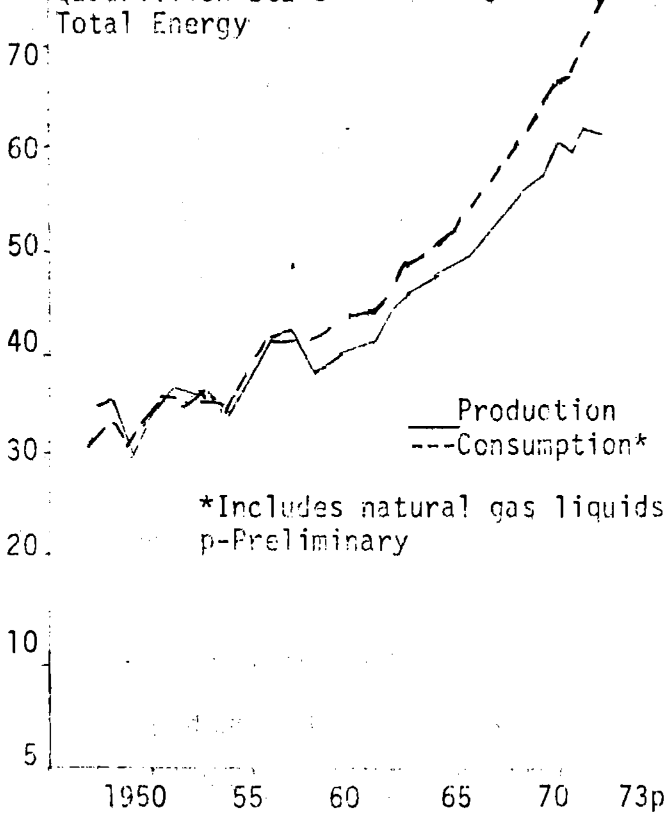


FIGURE 5

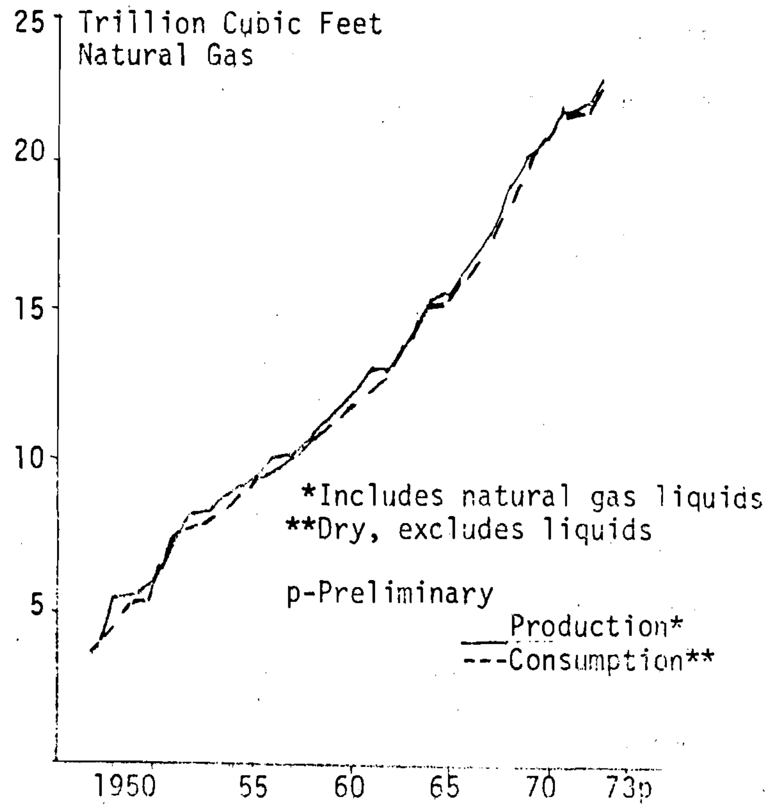


FIGURE 4

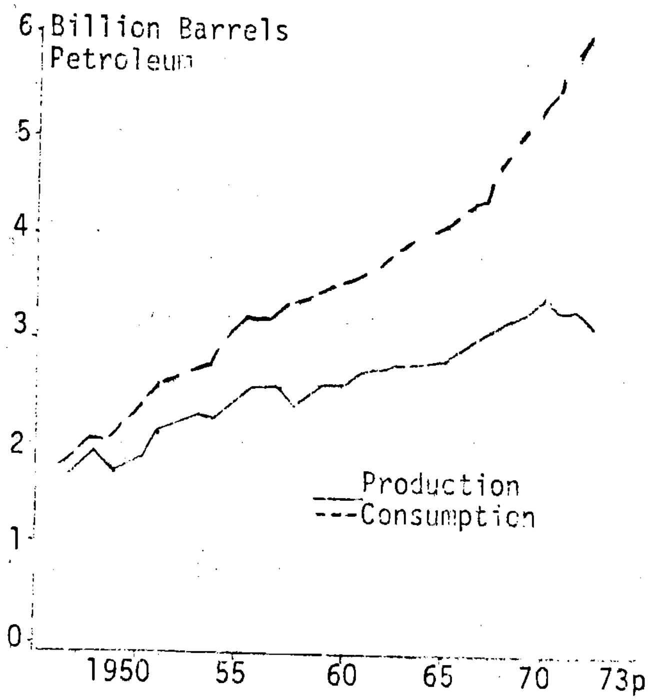
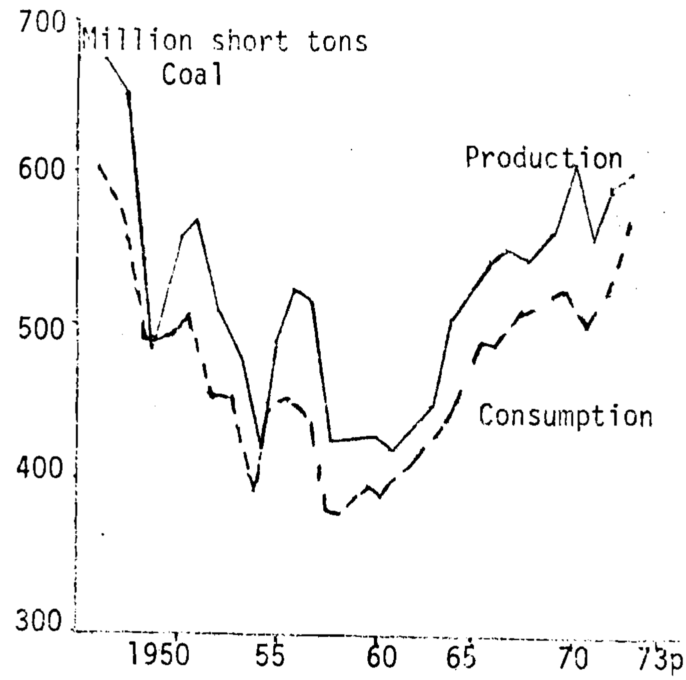


FIGURE 6



Source: Exploring Energy Choices, A Preliminary Report of the Ford Foundation's Energy Policy Project, p. 71.

increased dramatically--to the point where domestic demand has outstripped supplies by about 20 percent (7,75). This shortfall--the difference between domestic supply and demand--is mainly in petroleum. Imports of oil, which account for approximately 35 percent of total oil consumed, make up for this shortfall (7,6). On a national scale, there has been minimal importation of natural gas. In contrast, coal production in the United States has consistently been greater than domestic demand. Coal is the only national energy source which is exported more than it is imported (7,75).

PETROLEUM

The gap between domestic oil production and consumption is the largest part of the national energy shortfall. Since 1950 oil production grew consistently until 1970 when it started to level (7,74). (See Figure 4 on p. 5) Domestic oil production for the first 9 months of 1974 was 3 percent below 1973's production (3,4). During the late 1960s the nation's comfortable domestic oil position started to deteriorate, with major new oil discovered only in the North Slope of Alaska and some offshore fields. Toward the end of the 1960s, "production of older U.S. fields began to peak out, so new domestic wells served primarily as replacements for older wells, rather than supplies to meet growth" (7,6). Since 1970 oil imports have largely supplied the nation's oil growth needs. This reliance on imported oil has tripled since 1960, as Table 2 on p. 7 shows. Early indicators of 1974 imports show that oil imports dropped, due to the Arab oil embargo which continued into the early months of the year (3,8). Imports of crude oil since the end of the embargo (middle March) increased, rising substantially above the level of imports for pre-embargo 1973. Total oil imports for the first nine months of 1974, including the Arab oil embargo, were 3.2 percent larger than that of 1973 (3,9).

TABLE 2

National Energy Demand--Imports of Crude Oil and Refined Products 1960-1972

Year	Imports (thousands/ barrels day)	Imports % of Total Oil Demand
1960	1,815	18.1
1965	2,468	21.1
1970	3,419	22.8
1972	4,741	28.6
1973	6,100	35.0*

*preliminary-International Economic Report of the President, February 1974.

Source: U.S. Bureau of Mines; Independent Petroleum Association, "Summary of Statistics," Supply and Demand Outlook, December 1973.

NATURAL GAS

Natural gas production historically has remained relatively close to demand, with approximately 10 percent being imported (3,4). Historical natural gas production is recorded in Figure 5 on p. 5 . Production has generally risen with demand--with shortages occurring only since the early 1970s (7,7). Natural gas production through late 1974 ran substantially below production for previous years, while consumption only slightly decreased from 1973 levels (3,4). Shortages were felt at first by customers holding interruptable contracts, that is, contracts based on buying low-cost "surplus" supplies. Disruptions occurred when the supply was needed for firm contract holders, mostly residential and commercial customers, who paid higher prices.

> At first the interruptions were few, making interruptable contracts a remarkable bargain. But by the early 1970s, natural gas was in short supply. Interruptions became common, requiring customers to shift temporarily to other fuels, primarily oil. During the last few years even some "firm" contract customers have found their natural gas cut off at times of peak demand. In some areas new gas customers have been turned away entirely (7,7).

Natural gas prices have remained low due to the price controls on gas at the wellhead and in transmission pipelines; that is, regulated by the Federal Power

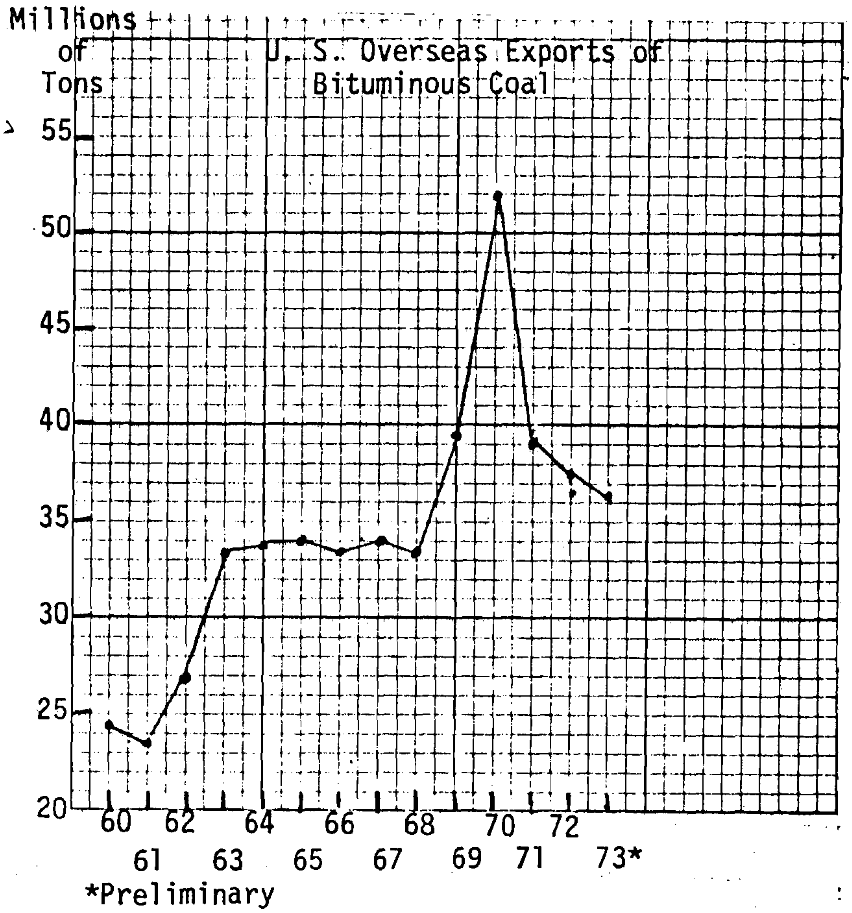
Commission. Intrastate wellhead prices of natural gas are not regulated and generally are higher than prices for gas sold across state lines. Many economists believe that current gas shortages would be eliminated by deregulating price.

COAL

Coal production continually has exceeded domestic consumption. In fact, coal has been exported overseas consistently since 1917 (8, 22). Total national production has varied as domestic markets changed. (See Figure 6 on p. 5.) After World War II, coal production was reduced drastically due to the shift from coal to other energy forms for use in railroad and homes. This market change led to a 36 percent decline in coal mine output between 1947 and 1962 (7, 74). Since the early 1960s coal production and consumption generally has risen, with the only major decline occurring in 1971. The change was caused by industries and utilities shifting from coal to cleaner burning fuels (natural gas, for example) in response to the standards of the Clean Air Act of 1970. Since then, consumption has shifted to coal with a lower sulfur content, and mining output is equivalent to the level that existed before the standards took effect.

Coal production was generally higher in early 1974 than 1973. The United Mine Workers holiday in August and the strike in November caused production to drop so total 1974 coal production was essentially the same as 1973 (9,1). The proportion of exported coal compared with domestic production has not changed significantly since 1960, despite wide variation in total tonnage (8). (See Figure 7 on p. 9.) Coal exports through September 1974 were 17 percent above 1973 levels, with most of the increase due to larger exports to Japan (10, 4). It appears from the 1974 consumption patterns that coal is plentiful. Since the oil embargo, however, a number of eastern utilities announced intention to switch from oil to coal, but reported that supplies were not available. These spot shortages stem from lack of railroad cars and delayed deliveries of mining equipment rather than shortages of coal itself.

Figure 7



% of coal exported	
1960	6.0
1965	6.7
1970	8.7
1973*	6.2

Source: 1974 Keystone Coal Industry Manual (McGraw-Hill)

ELECTRICITY

Electrical energy demand and production have grown over the last 20 years at an almost constant 7 percent per year (2,3). (See Figure 8, on p. 12.) Like most other energy sources in 1974, the rate of growth for electricity did not meet historical, 7 percent a year, growth projections. In fact 1974 consumption of electricity was 1.2 percent below 1973 (3,4). Due to the unexpected decline in demand and unavailability of capital, many utilities postponed or abandoned expansion plans for generating facilities. Robert S. Wail, vice-president of a New York investment counseling firm, put it this way late in 1974:

> For some months now--and lately it has been almost every day--individual utilities have been announcing cutbacks of deferrals in their plans to expand generating capacity. The great difficulty in raising money in today's capital markets is usually cited as the major reason, with the recent lack of growth in electricity consumption offered as a secondary consideration. Not only has there been no year-to-year gain in electricity production in 1974, but on a seasonally adjusted basis, weekly output has been running level for the last three months (11). [Emphasis added]

The postponed expansion of generation plans by utilities has occurred in the Pacific Northwest. Pacific Power and Light (a joint owner of the proposed Colstrip 3 & 4 complex) and Idaho Power Company have extended the construction schedule of their Jim Bridger plant in Wyoming because of the lack of expected growth in demand. Bob Moench, Pacific Power and Light vice president and division manager of Wyoming stated in December of 1974: "The actual load growth patterns experienced by Pacific and Idaho Power simply have not paralleled our projected forecasts. This makes such revisions in generating requirement schedules both possible and practical" (12).

The chief cause of national decreases in demand was the increase in electricity prices, relative to other commodities--the first increase to occur since 1950 (2, 5)." When the trend is price of electricity if compared to cost of living, the sharp increases in relative price are seen readily. Table 3 shows recent relationships between electricity prices, cost of living and growth figures.

TABLE 3

Year	A = Price of Electricity (% increase)	B = Cost of Living (% increase)	Difference (A - B =)	Rate of Growth of Electricity Demand (%)
1965-1973	+25	+33	-8	7
1973-1974 (8/73 - 6/74)	+21	+11	+10	-0.3

Source: Robert Wail, New York Times, Oct. 19, 1974; Monthly Energy Indicators, Federal Energy Administration, August 1974; compiled by EQC staff.

Because of the delayed response of demand to price increases, the first year's response to higher electrical prices is approximately 10 or 11 percent of the total anticipated decrease in demand. Within 7 to 8 years, half of the total response will be evident (13,703). So, by 1980 the full effect of recent price increases is expected to be felt.

FIGURE 8

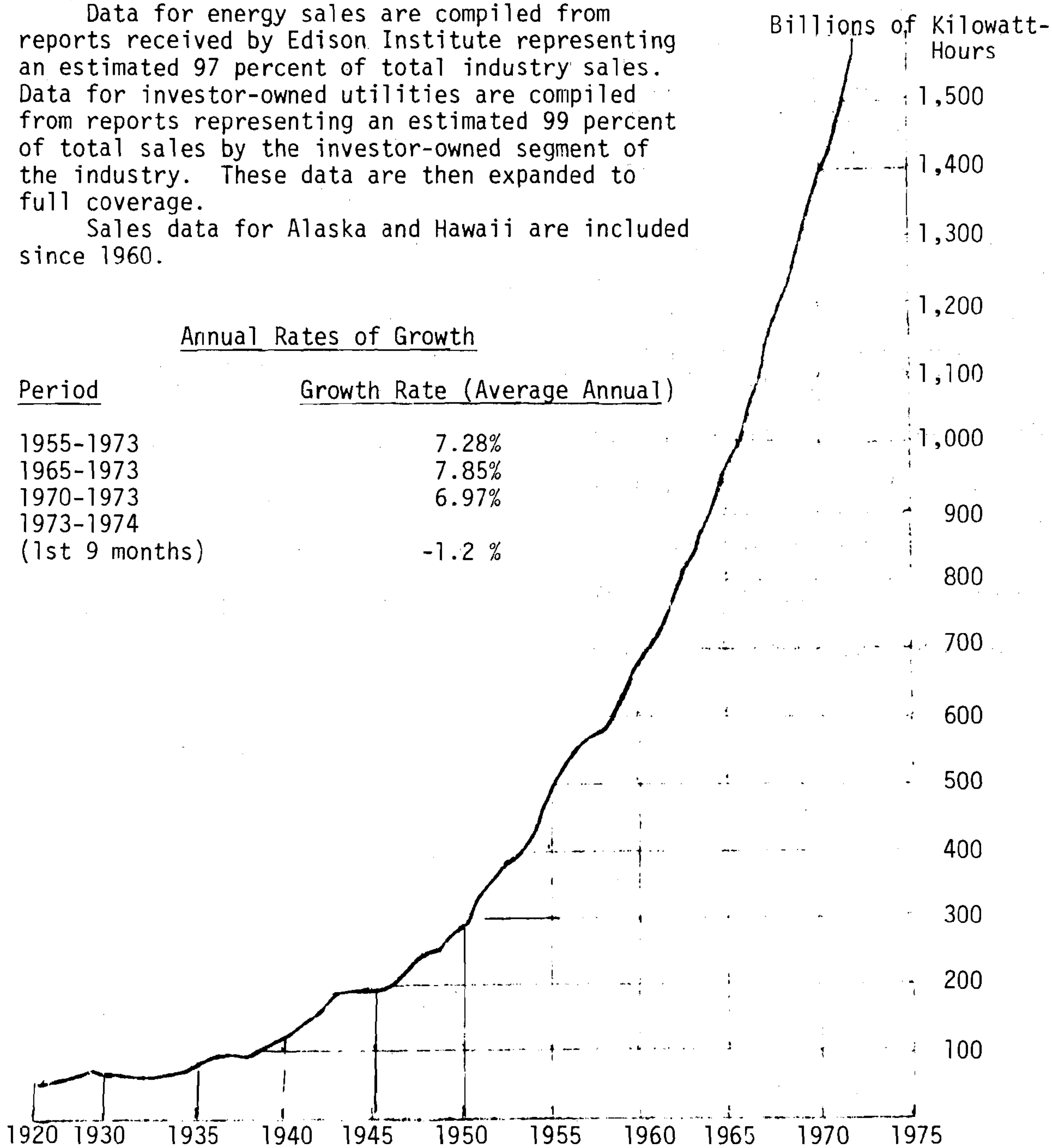
United States
Electricity Demand (Sales)

Data for energy sales are compiled from reports received by Edison Institute representing an estimated 97 percent of total industry sales. Data for investor-owned utilities are compiled from reports representing an estimated 99 percent of total sales by the investor-owned segment of the industry. These data are then expanded to full coverage.

Sales data for Alaska and Hawaii are included since 1960.

Annual Rates of Growth

Period	Growth Rate (Average Annual)
1955-1973	7.28%
1965-1973	7.85%
1970-1973	6.97%
1973-1974 (1st 9 months)	-1.2 %



Source: Edison Electric Institute Statistical Yearbook, 1972; Monthly Energy Review, Federal Energy Administration, November 1974.

MONTANA

Montana's energy position contrasts strongly with that of the nation as a whole. Nationally, energy exports exceed imports only for coal, but Montana exports to other parts of the nation more coal, oil and electricity than it consumes. Montana exports natural gas as well, but not enough to offset gas imports. Moreover, the growth of energy consumption in Montana is much less than the national average although the per capita consumption of energy in the state is much higher than the national average. Recent downward trends in energy consumption largely parallel those of the nation.

Montana Energy Consumption

Energy consumption in Montana from 1960 through 1971 grew at an average annual rate of 3.2 percent per year (Figure 9 on p. 14), much below the 4.5 percent average annual rate of increase experienced in the Montana-Wyoming-Dakota region and nationally during the same time period (14).

The state's per capita energy consumption (energy consumed per resident), has been substantially higher than the national average (Table 4 on p.14), a fact that can be attributed to Montana's large traveling distances and the many energy-intensive industries located in the state. The generally low price of energy in Montana also encourages consumption. Low energy prices can be credited to the accessibility of coal, natural gas, and petroleum produced in the region and the availability of cheap hydroelectricity.

The state's energy consumption growth pattern has changed in recent years. Natural gas consumption has dropped almost 3 percent since 1971(15). Electrical consumption has essentially stayed the same since 1972 (15). Gasoline demand dropped in 1974 (17). Trends of reduced energy consumption can be expected to

TABLE 4

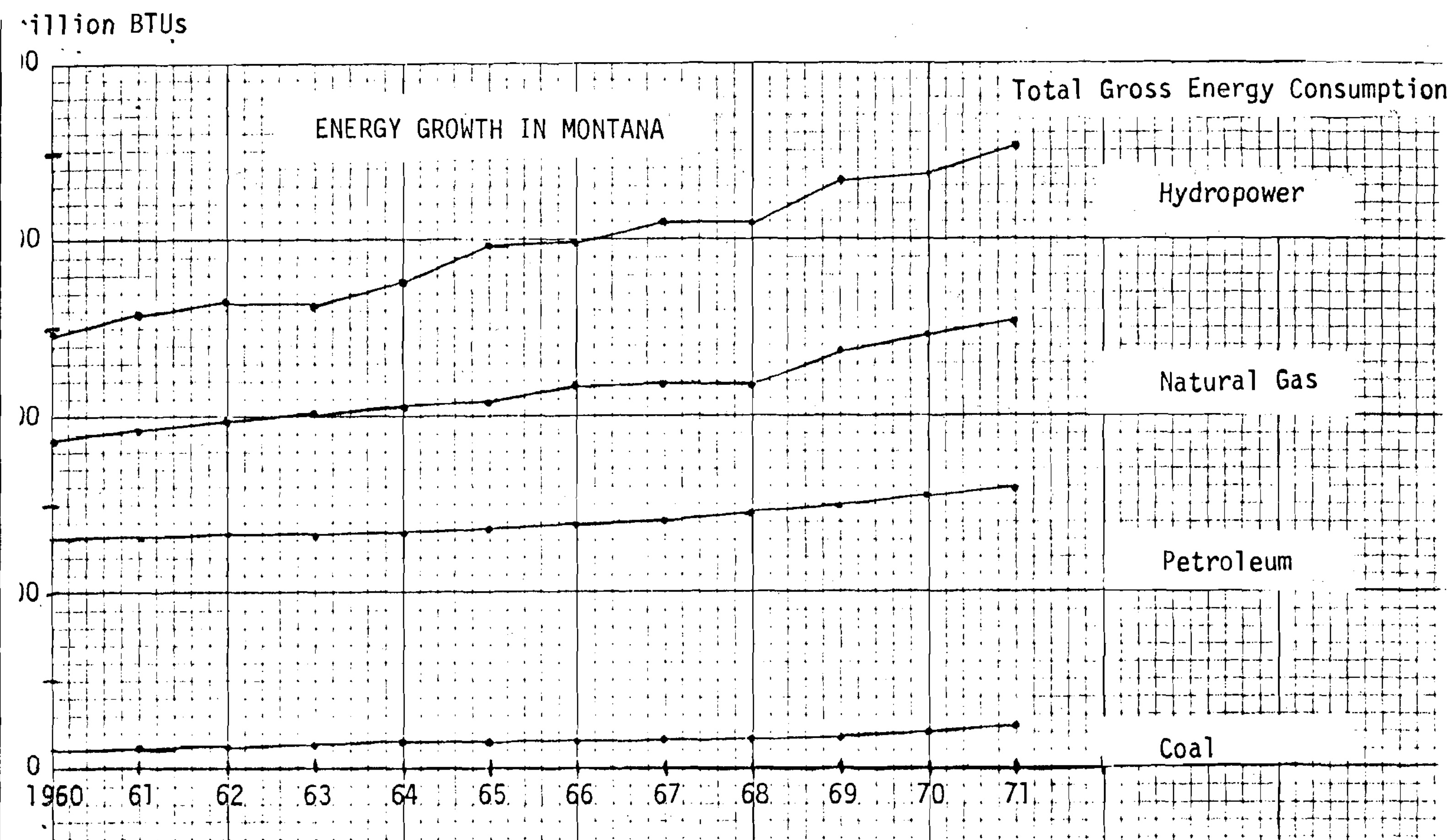
Per Capita Gross Energy Consumption
(in millions of BTUs)

Year	Montana	United States	Difference*
1960	369.9	246.8	123.1
1965	420.1	274.4	145.7
1971	498.4	333.3	165.1

*Montana per capita energy consumption minus U.S. per capita energy consumption.

Source: Northern Great Plains Resource Program, Energy Work Group Report (unpublished, 1973).

FIGURE 9



Source: Northern Great Plains Resource Program, Energy Work Group Report (unpublished, 1973).

follow the national situation, except the impacts of regional changes in fuel supplies and prices and the effects of state government conservation policies.

The state relies about equally on oil, gas and hydroelectricity for energy (18,40). Less than 10 percent of the energy consumed in Montana is derived from coal. In Figure 10 on p. 16, these energy sources are listed. Different areas of use have varying reliance upon these different fuel sources. (See Table 5 below .) The transportation sector, for example, relies almost totally on oil. If oil supplies were totally cut off to Montana, the transportation sector would be hardest hit, followed by the household, commercial and industrial sectors.

TABLE 5

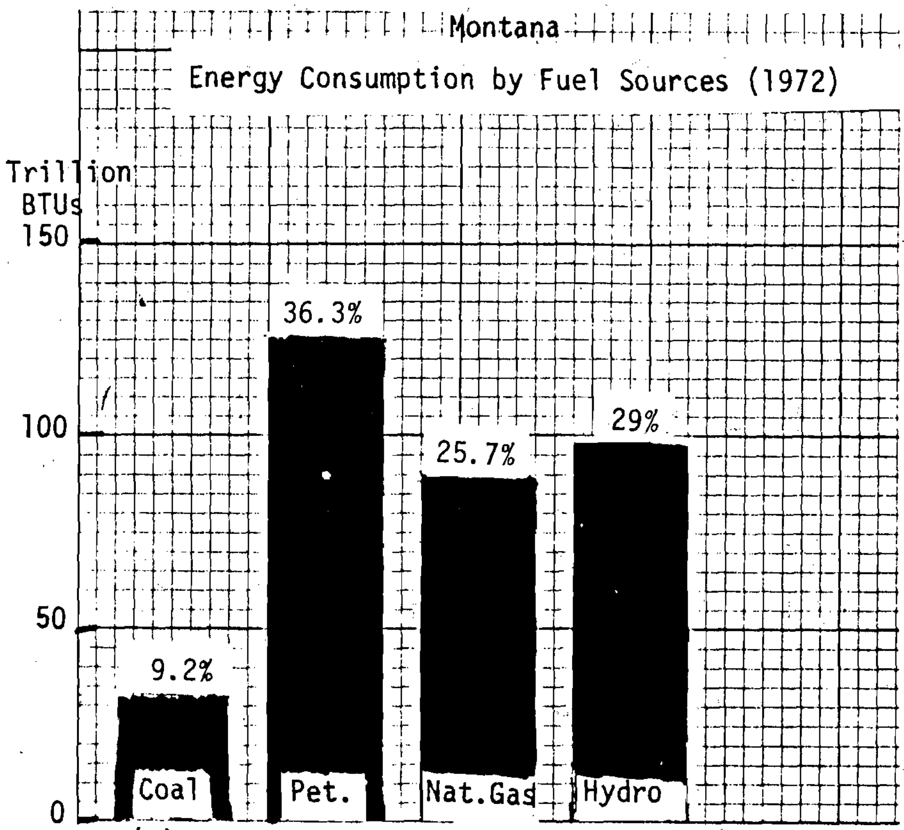
Energy Consumption of Sectors By Fuels

Sectors	Fuels (Energy Consumed by Sectors %) Coal	Oil	Nat. Gas	Hydro.	(% of Total Electricity Consumed)	(% of Total Energy Consumed-By Sector
Household-Commercial	8	34	58	0	34	21
Transportation	--	99	1	0	0.9	24
Industrial	9	36	56	0	65	21

Source: "Fuel and Energy Data, United States by States and Regions, 1972," Bureau of Mines Information IC 8647, 1974.

Since 1960, Montana has been a net exporter of petroleum and electricity. In the late 1960's Montana became a net exporter of coal (14). (See Figure 11, p. 17) Net exports greatly increased in 1971, because of increased coal and petroleum production. Petroleum production continually has outstripped consumption in the

FIGURE 10

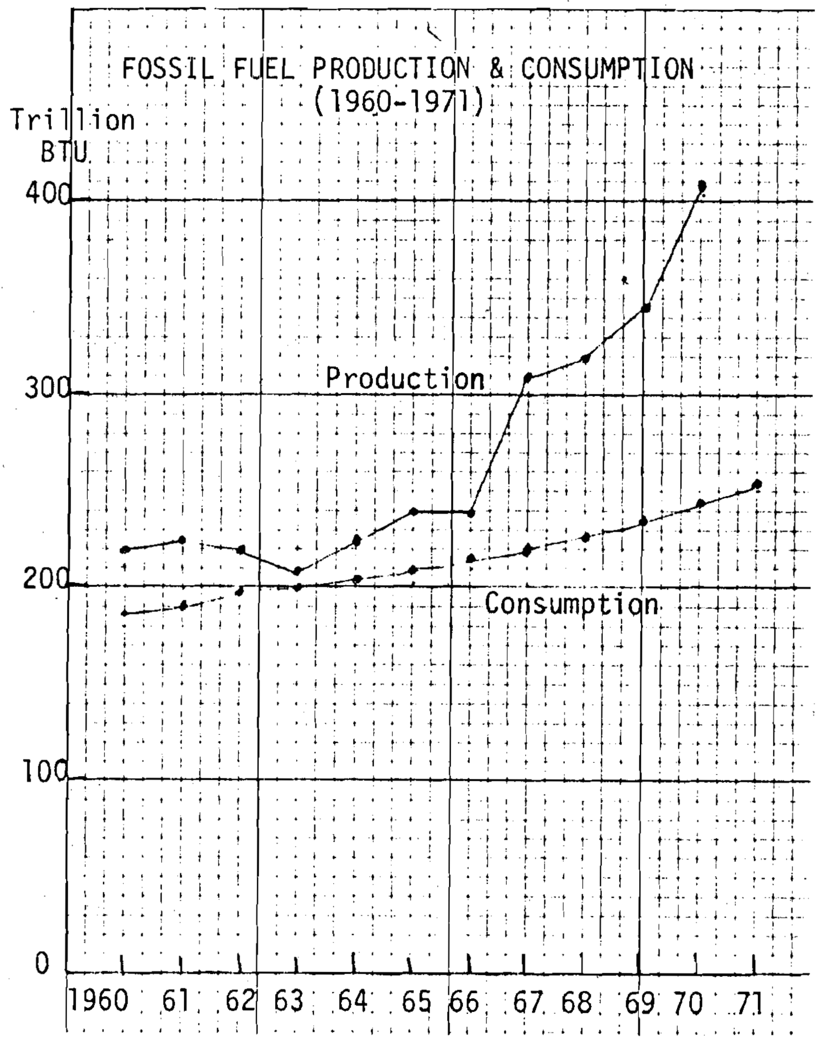


(%) Percent of total BTUs consumed.

Source: "Fuel and Energy Data, United States by States and Regions, 1972," Bureau of Mines Information Circular IC 8647, 1974.

FIGURE 11

Montana Energy Production and Consumption



Source: Northern Great Plains Resource Program, Energy Work Group Report (unpublished, 1973).

state (14). A significant rise in oil net exports occurred in 1968, but then fell to previous levels by 1971 as production decreased. Even with this decline in net exports, there is still much petroleum shipped from the state (14). Electric power exports continue primarily due to the quantities of federal hydroelectricity produced in Montana and sold interstate by the Bureau of Reclamation and Bonneville Power Administration. The state cannot totally tap federal electric production reserves because of restrictions in federal legislation under which the power plants (dams) were constructed.

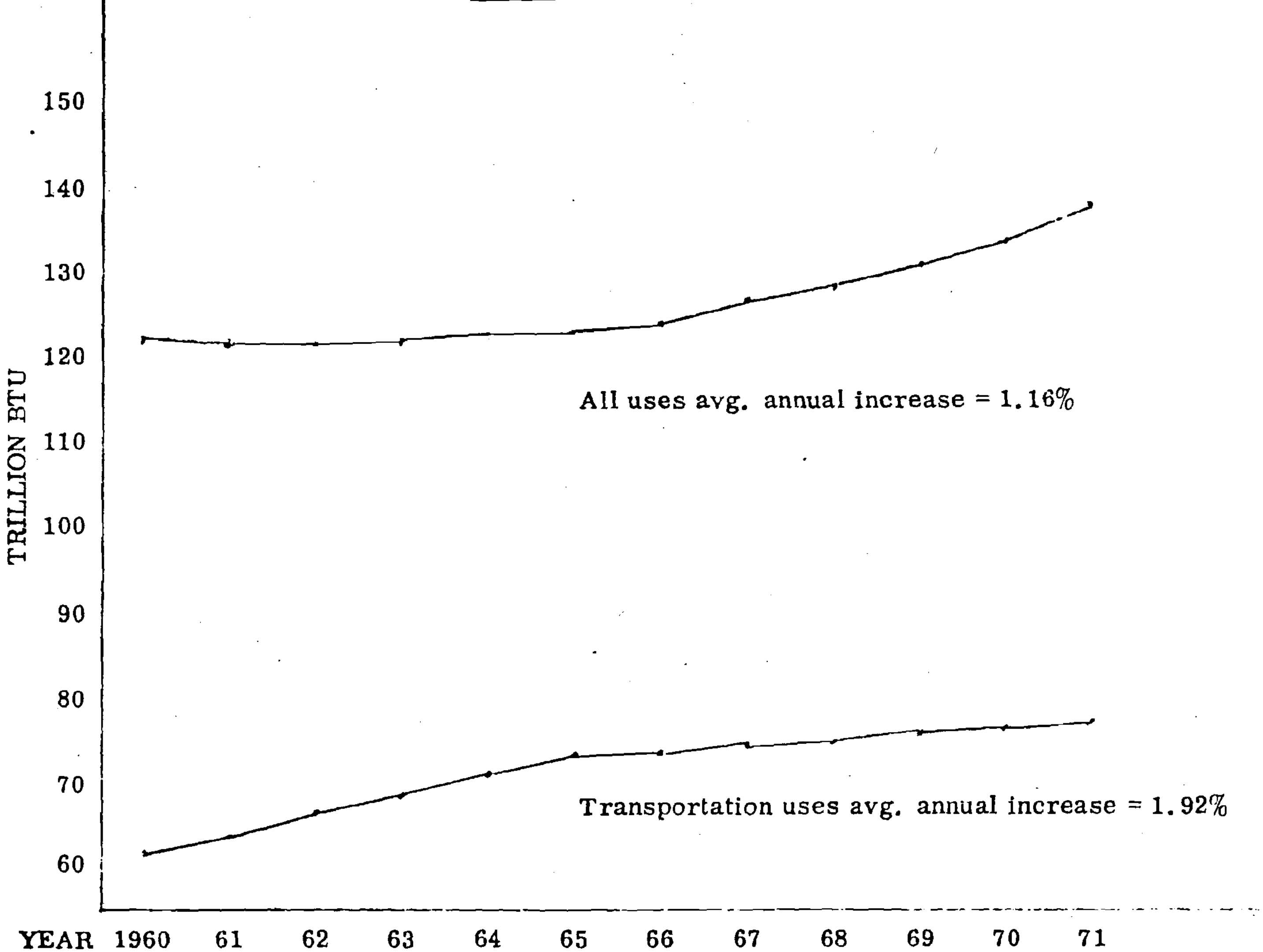
Natural gas is the only fuel for which imports exceed exports--most from Canada. Montana has exported gas in increasing amounts in recent years but not in sufficient quantities to offset imports (19). Exported gas is not now available for use by Montanans because corporate and federal government policies have allowed it to be shipped to the midwest without concern to the state's gas needs. Production of oil and coal has increased overall, while in-state demand has stabilized, so increases in net energy exports are likely to increase.

PETROLEUM

Demand for oil and its by-products in the state gradually increased from 1960 to 1972 (Figure 12 on p.19) at an average annual rate of 1.16 percent which is far below the national consumption growth for oil (14). The chief cause of this increase is due to the almost 2 percent annual growth rate for use of petroleum for transportation (20). Much of this growth is due to the shift away from efficient modes of transportation such as trains to less efficient cars and trucks. In addition, average energy efficiency (miles per gallon) of cars has decreased. Non-transportation uses of petroleum, for home heating or industrial fuel, has grown far more slowly--about one quarter percent (0.25%) per year (20). Decline in use of oil as a home heating fuel has offset most of the effects of increases in industrial use of oil for fuel and lubrication.

FIGURE 12

Montana Petroleum Consumption



Source: Northern Great Plains Resource Program, Draft Energy Workshop Report (unpublished, 1973) Department of Interior.

Although Montana petroleum consumption indicators have not been compiled since 1972, recent gasoline consumption figures can be used to show the general change in state petroleum consumption trends because gasoline is the largest single component of petroleum demand (20).

TABLE 6

Gasoline Consumption (1971-1974)

Year	Gasoline Consumption (million gallons)	Percent Change
1971	408.969	
		+6.3
1972	435.025	
		+5.9
1973	462.181	
1973 (1st 8 mos.)	313.228	
		-4.2
1974 (1st 8 mos.)	300.520	

Source: Montana Fuel Allocation Office, Federal Energy Administration. 1974 (unpublished).

Gasoline consumption increased between 1971-1973 at an average annual rate of about 6 percent (17). Gasoline demand in 1974 dropped by 4 percent over the same (8 month) period in 1973. Most of the difference between these two years took place after March, 1974, when the new 55 mile per hour speed limit took effect (17). Overall petroleum consumption probably declined by less than four percent.

Policies Affecting Petroleum Consumption

The chief state policy affecting demand for petroleum is the 55 mile per hour speed limit authorized by the 43rd Legislature in March, 1974 (21). This act, prompted by new federal highway regulations, requires lower speed limits to curb use of gasoline. The federal act required states to lower their speed limits in order to receive federal highway construction funds. The amendment passed by the legislature authorized the attorney general to set speed limits on highways in accordance with the federal regulations so that the state could receive federal money for roads. The act allows a $5 penalty for exceeding the speed limit up to prior speed limits. Violations do not become part of permanent driving records (22).

Although the penalties for violating this law are minor, the effect on gasoline consumption has been significant. Before the speed limit was imposed in March, 1974, gasoline demand was two percent below 1973 consumption levels (January and February 1974 compared to the same months in 1973)(17). (See Table 7 below .) Although prices rose substantially during the period, the decline in consumption could also be attributed to small shortages of gasoline supplies, and voluntary conservation efforts. After the speed limit went into effect in March, gasoline consumption dropped 4.6 percent (17) (March-August, 1974, compared to the same time in 1973). (See Table 7 below .) This difference could be attributed to traveling slower and making fewer trips in response to the new speed limit.

TABLE 7

Gasoline Consumption in Montana (Jan.-Aug.)

	1972	1973	72-73 Percent Change	1974	73-74 Percent Change
Jan. & Feb.	53.8	59.141	+9.9	57.7	-2.1
March - August	242.125	254.11	+4.9	242.71	-4.6

Source: Montana Fuel Allocation Office, Federal Energy Administration, 1974 (unpublished).

Petroleum Reserves

There are substantial oil reserves in Montana. In fact, some experts believe that much of the oil resource is yet undiscovered. The record high level of leasing in 1973 by energy corporations for oil and gas supports this belief (22, 1). Most of the inexpensively drilled and shallow oil traps have been explored (23). Since prices for oil have risen and will probably continue to rise somewhat in the future, there is an economic incentive to drill deeper. Total oil reserves, the total recoverable oil under current economic conditions, is over 334 million barrels (23). Oil-in-place, that is the amount known to be in the ground, is almost 4 billion barrels. It is expected that 30 percent of this oil will be recovered, totaling 1139.8 million barrels (Table 8 below) (23). These reserves would allow production at 1973 levels for 33 years, based on 1973's 34.6 million barrels per year and the estimate of 1139.8 million barrels in place.

TABLE 8

Montana Oil Reserves (million barrels)

		Extraction Method***	
	Total	Primary	Secondary
Reserves*	334		
Oil-In-Place**	3,932	779.510	360.29

*Reserves are limited to the amount of oil which can be produced under present economic conditions.
**Oil-in-place--known oil reserves.
***Amount able to be produced with existing extraction methods. Twenty-nine percent of the total oil-in-place.

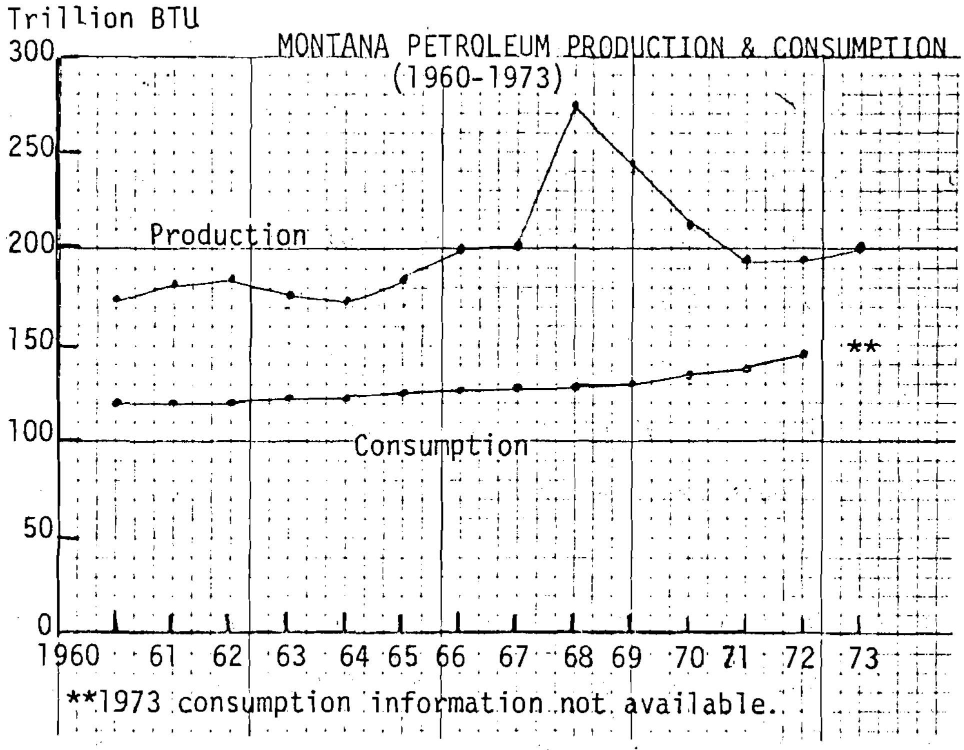
Source: "Oil and Gas Energy Resources of Montana," report to EQC by Gustav Stolz, August 1974.

From the total oil-in-place, approximately 20 percent will be extracted by conventional or primary methods. An additional 10 percent will be produced by secondary methods. Secondary oil recovery techniques are used when primary methods cannot produced more oil from a field. Secondary recovery means any fluid injection (in Montana, usually water) into an oil reservoir to augment naturally occurring pressure and increase the underground flow of oil toward the well allowing more complete recovery of oil reservoir. The Oil and Gas Conservation Board of the Department of Natural Resources reports that secondary recovery is being used in the state and was an important factor in increased 1973 and 1974 production levels (24).

Montana oil production has varied since 1960. (See Figure 13 on p.24.) Production increased to 48.5 million barrels in 1968 with the discovery of the Bell Creek field in Powder River County (21, 1). The high production level was not sustained and fell rapidly to earlier levels within two years. The slight increase in production in 1973 and 1974 is credited to increased production from old fields by secondary oil recovery techniques (21, 1). Oil production is expected to rise in the near future as high oil prices act to encourage recovery of more difficult to reach reserves and allow use of expensive secondary recovery methods.

The environmental impacts of oil production are associated with oil spills, burning of natural gas, disposal of water from drilling operations and the land use impacts of the well itself and access roads (25). The state has experienced relatively minor oil spills from producing wells. When a spill does occur, the producer tries to recover all the oil possible. The main incentive to recover spilled oil is the high prices of oil (25). Any oil not recovered is subsequently burned upon approval of the Oil and Gas Conservation Board of the Department of Natural Resources and Conservation. When natural gas is found in an oil well in amounts precluding its economic recovery it is sometimes burned or flared. Most of the gas which would have been flared in the past is now re-injected into the well in order to enhance the ultimate recovery of oil. The disposal of brines sometimes produced with oil, and disposal of solid waste from wells (drilling

FIGURE 13



Source: Northern Great Plains Resource Program, Energy Work Group Report, U. S. Bureau of Mines, Ethyl Corporation and American Petroleum Institute.

mud), are regulated by the Oil and Gas Conservation Board of Department of Natural Resources and Conservation (26). Abandoned oil wells also are regulated by the board. The board must require prevention of pollution of fresh water by oil, gas, salt or brackish water and the restoration of surface lands to their previous grade and productive capability upon abandonment of the well (26). Adverse hydrological effects from abandoned wells also must be prevented. If oil spills and brines are not properly disposed of, serious land and water pollution can result.

Policies Affecting Oil Production

It has been argued that the tax burden on oil well operators is too high and discourages oil production in Montana. The crux of this argument is that Montana taxes on oil are proportionately higher than those in other states. Jack Rehberg, Executive Director of the Rocky Mountain Oil and Gas Association, argues that:

> The tax structure under which oil production in Montana is taxed is discriminatory and the total tax burden is excessive. This direct adverse economic effort of excessive and discriminatory taxes on oil production in Montana has been a decided disadvantage in our state in attracting oil exploration risk capital.... Reasonable incentives and taxes must be encouraged and maintained to stimulate a continuous exploration program for oil in Montana (27).

Support for this argument lies in a comparison of oil taxes in Montana compared with those of other oil producing states in the region. As seen in Table 9 below, Montana oil taxes are higher than taxes in other Rocky Mountain states (28).

TABLE 9

Taxes on Oil Production in 1973
(Percent of Gross Value)

State	Tax as percent of gross value of oil produced
Montana	12.5
Wyoming	9.1
New Mexico	6.0
North Dakota	5.0
Colorado	4.4

Source: Fossil Fuel Taxation Committee, Montana Legislature, 1974.

The argument may have been valid when oil was being supplied from foreign sources at very low cost and domestic oil was relatively high priced. Oil prices and supplies from foreign sources were believed to be stable. However, the Arab nations' export embargo and the resulting price increases have invalidated this argument and made Montana oil more competitive. A comparison of approximate oil prices shows Montana's competitive relationship with imported oil. (See Table below.)

TABLE 10

Oil Prices (July, 1974)

Source	Price per barrel ($)	Difference from Montana oil prices ($)
Algeria **	13.53	+3.53
Saudi Arabia **	8.56	-1.44
Venezuela **	10.58	+ .58
Canada **	12.28	+2.28
United States (New oil)	10.00	
(Old oil)	5.00	
Montana* (New oil)	10.00	
(Old oil)	7.00	

*Includes taxes
**Cost at U. S. port of entry

Sources: Monthly Petroleum Reports, Federal Energy Administration, July 1974 and Oil and Gas Conservation Board of Montana, August 1974.

Algerian and Saudi Arabian supplies are very unstable. Canadian and Venezuelan oil supplies have been relatively stable. Canadian officials have announced that their oil exports will cease by 1983 (29). Montana oil is in a good economic position to compete on both the regional and national markets.

A major policy explicit in the authorizing legislation for the state's oil regulatory agency, the Oil and Gas Conservation Board of the Department of Natural Resources, is the prohibition of the waste of oil. The prohibited waste includes physical waste, inefficient extraction, and location of wells so as to cause a reduction of the ultimate recovery or storage of oil. The policy against the waste of oil, combined with the secondary oil recovery program appears to assure effective recovery of the oil resource.

OIL REFINERIES

There are nine oil refineries operating in the state; the three largest are located in the Billings-Laurel area. The total barrels of oil refined in Montana has been increasing for the last five years, with 1973 production over 20 percent more than that of 1969 (22, 4). The source of crude oil for these refineries comes from Canada and Wyoming as well as from in-state. Approximately 50 percent of the oil used in these refineries comes from Wyoming, 30 percent from Canada, with the remaining 20 percent from Montana (22, 1). The Canadian Energy Minister announced in late 1974 that his nation would reduce its oil exports starting in 1975, with a total phase out by 1983. Canadian exports to the United States totaled more than one million barrels per day (1 mmb/d) in 1973 and approximately 970,000 b/d in 1974 (29). Canadian exports as of January 1975 will be reduced to 800,000 b/d with a further reduction to 650,000 b/d by the middle of that year (29). Normally Canadian exports account for nearly one-fourth of the U. S. crude oil imports. The reduction and eventual cutoff of Canadian exports will put a strain on the supplies of oil needed to maintain refinery output levels. Approximately 15 million barrels of oil per year will be needed by Montana refineries to replace the Canadian supplies (22, 4). This curtailment of crude oil exports to Montana may serve as an incentive for energy corporations to explore and subsequently tap Montana oil reserves. Some believe that future increased production of oil in-state may well make up the shortfall of crude oil supplies for refineries.

NATURAL GAS

Natural gas is a convenient, clean burning, low-cost fuel. These characteristics have made it particularly useful for residential and industrial customers. Overall consumption for this fuel has grown, on the average, at 4.7 percent a year from 1960 to 1971 in Montana--slightly higher than the national growth rate (14). Most of this rise has been due to increased industrial use which has grown an average of 6.8 percent a year (14). Recently, growth has fallen off substantially; in fact, demand has decreased slightly. Since fiscal year 1973, consumption of dry natural gas, that is gas sold by utilities through pipelines, has declined by 2 percent contrary to national demand increases (15). Although there are many factors that affect consumption of natural gas, the substantial decline in use from earlier growth patterns somewhat reflects the impact of conservation measures.

Natural gas accounts for more than a quarter of the fossil fuel used in the state (18, 44). The industrial sector uses half of the gas consumed in the state. The residential and commerical sectors account for most of the remaining consumption (18, 44). (See Table 11 below.)

TABLE 11

Natural Gas Consumption in Montana (1972)

Sector	Percent of Total Use	Percent of Sector Which Uses Gas as a Fuel
Industrial	50	62.6
Household-Commercial	47	58
Utility (For electrical Production)	1.4	Less than 1%
Miscellaneous	1.4	Less than 1%

Source: "Fuel and Energy Data, United States by States and Regions, 1972," Bureau of Mines Information Circular IC 8647, 1974.

Of the two major gas suppliers, Montana-Dakota Utilities Company (MDU) and Montana Power Company (MPC), only MPC imports large quantities of gas from Canada. MDU buys its gas from regional producers in Wyoming, Montana and the Dakotas. MPC began importing gas from Canada in 1951 under an Albertan government permit issued for a defense production emergency, namely Anaconda Company's production of copper for the Korean War (30). In that same year, MPC formed two subsidiaries, Canadian-Montana Gas Company to develop gas reserves in southeastern Alberta and Canadian-Montana Pipe Line Company to build and operate a pipeline to ship the gas to Montana (30). In 1952, after the war, MPC continued to import natural gas, this time under five-year permits also granted by the Albertan government. Periodically, MPC increased its imports so that by 1973, 80 percent of its gas came from Canada (31).

Heavy reliance on Canadian gas could have been avoided. New gas deposits were found in Montana in the late 1960s. The opening of Tiger Ridge field is a good example. In 1966, the High Crest Oil Company, an independent oil and gas firm, discovered substantial reserves of gas in the Tiger Ridge field in Hill and Blaine counties (32). From drilling results in 1967 High Crest believed it could supply Montana Power Company with gas to offset Canadian imports. But Montana Power Company and the gas company could not agree on the extent of proven reserves or a price (32). When MPC applied to the Federal Power Commission (FPC) for authority to increase its natural gas imports from Canada by 20 million cubic feet a year, High Crest intervened (32). High Crest argued that it had sufficient supplies to meet MPC's request. Montana Power Company offered a price of 9 cents per thousand cubic feet (mcf) at the wellhead. High Crest asked for 15.5 cents. At the FPC hearings in early 1968, L. S. Stadler, in charge of MPC gas operations, expressed the corporate opinion: "We don't think High Crest has the reliability that the Canadian source has. The High Crest contract offer, we think, requests a full commitment for the near future, at least, of any MPC supply requirements" (33). MPC received permission to import additional supplies of gas and High Crest had to start looking for other customers. Sixteen months later in 1969 when High Crest was in sales negotiations with out-of-state gas companies, MPC again offered a gas purchase contract to High Crest and all other Montana gas producers (33). The offer provided for an initial price of 16 cents per mcf with an escalation of one cent per mcf at five-year intervals. Initial development loans also were offered. High Crest accepted an offer from Northern Natural Gas Company for a price of 15.5 cents per mcf with a $4 million interest free loan to develop its fields (33). At an FPC hearing on NNG's application to build a pipeline to ship the gas to its service area, Montana Power Company intervened. The MPC brief filed stated: "Montana Power has an urgent need for the Tiger Ridge gas for consumption in the state of Montana, in order to avoid almost total dependence on Canadian supplies" (33). The FPC ruled in favor of NNG's application, allowing transmission of the gas from Tiger Ridge and set the wellhead price for new gas connections at 23.5 cents per mcf (33).

It has been argued convincingly that the FPC's price regulations on natural gas sold interstate have stunted growth in the production of this fuel. Montana Power Company's 1969 offer was far below the federal price regulations and about the same as the out-of-state firms could offer. So at least in this situation, the federal price regulation did not affect the negotiations.

Since 1969, Canada has made major policy changes regarding natural gas exports. Canadian law now requires that exported gas be in surplus of Canadian requirements. The National Energy Board of Canada which has the authority to establish whether energy resources are indeed surplus, has cut back on exports to Montana. This decision was reached after the board discovered that Canada's 30-year reserve was deficient by over a trillion cubic feet. The policy change also has led to higher prices in Montana for natural gas and an uncertain future supply.

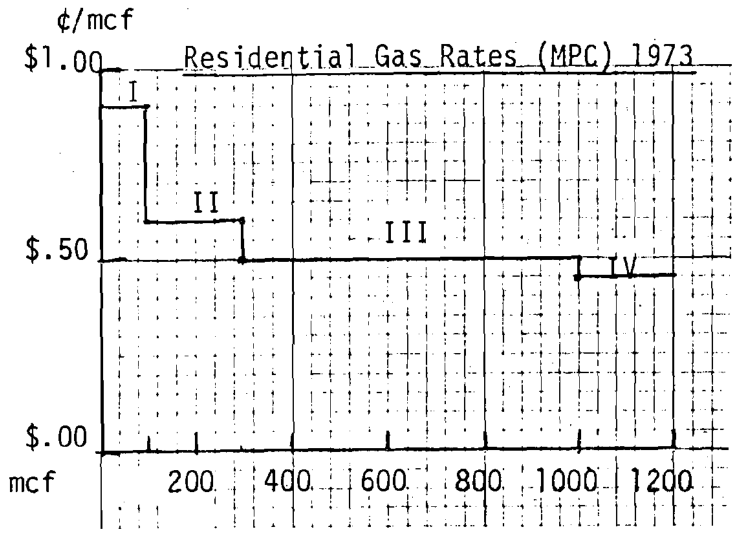
Policies Affecting Natural Gas Consumption

The consumer price of natural gas sold in Montana is regulated by the Montana Public Service Commission. The commission has the power to establish rate structures (the method used to determine price for various customers and quantities) as well as the selling price. The commission has established a block rate structure in which the price per unit of gas goes down as more is used. This practice, know as quantity discounting, hinges on the premise that average consumer cost declines as production increases--to reflect what are known as "economies of scale." Changes in the national economy and in the availability of natural gas have made the premise--and the practice of quantity discounting--highly questionable.

Montana Power Company's gas rates can be used as an example, since it services most of the state. For residential customers, the first 1,000 cubic feet (mcf) cost $2.97 a month (which happens to be the minimum monthly bill). For the next 99 mcf, the price is 88.1 cents per mcf. Use over 100 mcf receives a further price break, according to the rate structure (34). Figure 14 on p.32 illustrates the rate system. The average MPC residential customer uses approximately 15 mcf per month (an average based upon the total number of MPC residential gas customers divided by the total amount of gas sold in the residential sector (34). The actual average use may be somewhat higher because many homes do not use much gas. A 20 mcf monthly gas consumption figure can be assumed to be typical of the average residential use. The cost per mcf for this average household would be 98.1 cents. Industrial users holding interruptable contracts pay a much lower price per mcf. The highest-priced interruptable industrial contract charges 41.7 cents per mcf, half the cost charged to the average residential user (34). The lowest cost interruptable industrial contract is 35.5 cents per mcf, approximately a third of the charge to the average residential customer (34). (See Figure 15 on p. 32.) Industries holding interruptable

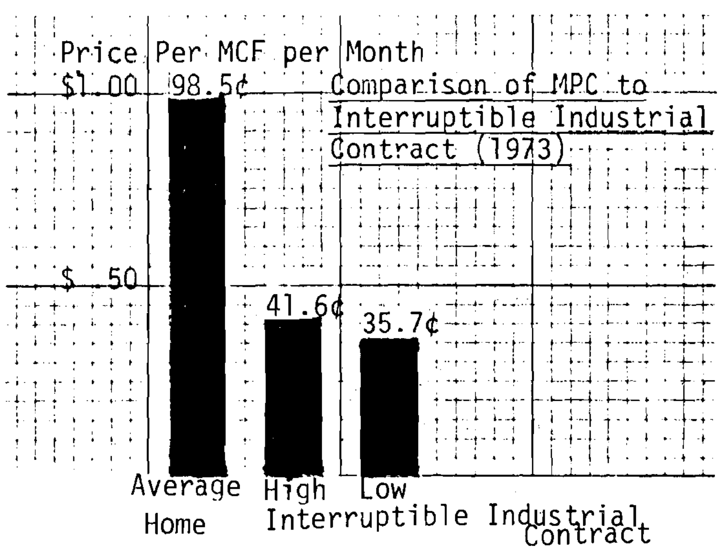
FIGURE 14

Montana Power Company



Source: Montana Public Service Commission

FIGURE 15



Source: Montana Public Service Commission contracts receive this price discount because of their large volume purchases and their acceptance of supply interruptions during peak demand periods.

The block rate structure offers an incentive to large volume residential and commercial users. Once the consumers of this sector become committed to natural gas as a fuel, they are hesitant to change to fuels in greater supply. Residential and small commercial users' demand is relatively inelastic, that is, as prices rise demand will only slightly be changed (35, 43). This reflects the inability to change equipment (stoves, water heaters, furnaces) until they are worn out and in some cases a personal predisposition toward gas. For example, a housewife who is used to cooking on a gas stove may be hesitant to switch to electricity. In the long run, increased prices to the residential and commercial sectors would tend to slow the growth of natural gas demand rather than cut it (35, 43).

Most industrial natural gas consumers have a different type of rate schedules or contracts which are called interruptable contracts. Interruptable contracts are based on the premise that there are excesses in supply and in order to keep pipelines filled, gas must be sold at lower prices during non-peak times. The holders of these contracts purchase large amounts of gas which can be interrupted if supplies are not adequate to meet demand. In many cases industrial users must shut down when gas supplies are not available or shift to other fuel sources such as oil or coal.

The industrial demand elasticity for gas, including gas for electric power generation, presents a somewhat different picture. In some areas of the nation, particularly on the East and West coasts, industrial gas demand is very elastic (changeable) (35, 43). For some industrial users, demand is very inelastic because of the inherent advantages natural gas offers to them in terms of the process used or air quality considerations. In aggregate, natural gas demand is somewhat inelastic for price increases up to 10 cents per mcf although not as inelastic as residential and small commercial demand (35, 43). If gas prices increase drastically relative to other fuels, the elasticity of demand ought to increase, so demand would decrease, especially in the industrial sector.

Natural Gas Production

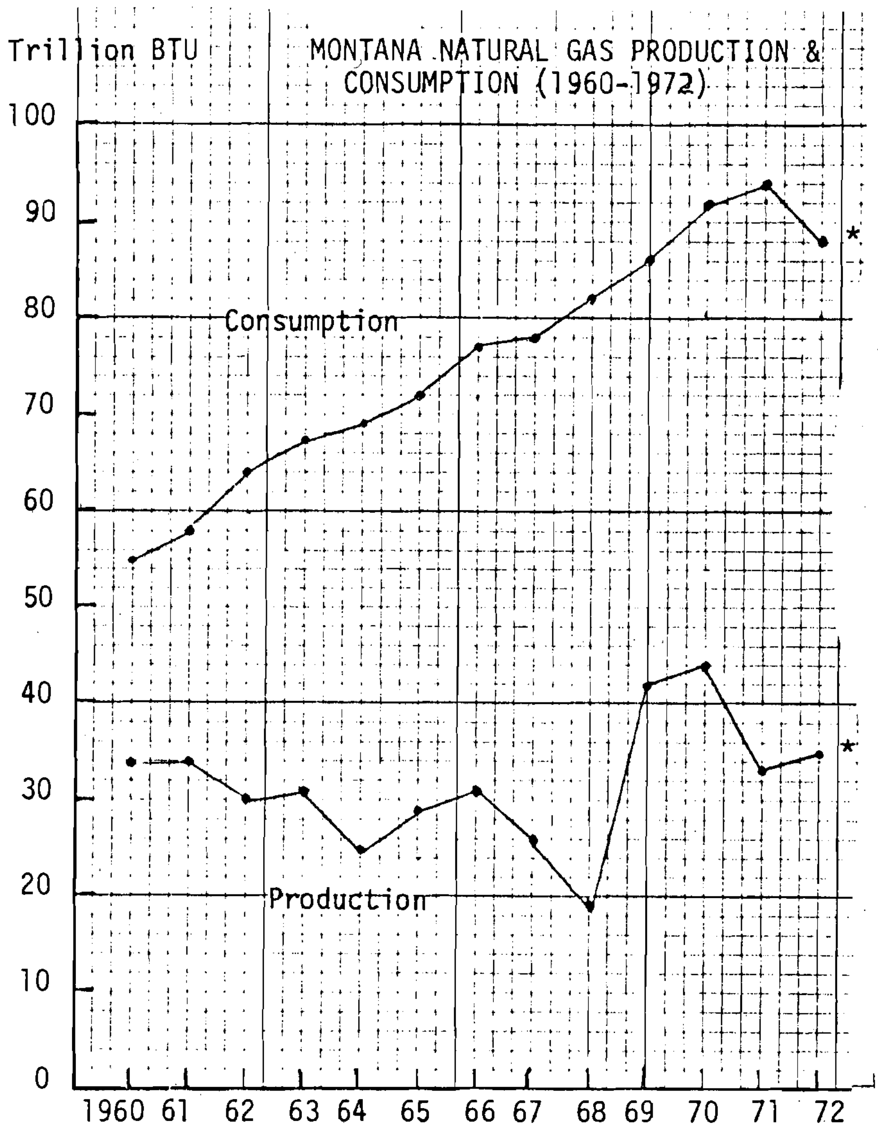
Even with uncertainty in imported natural gas supplies, continued production of gas in Montana can be expected. The doubling of production since 1971 included a 53 percent increase in calendar 1973, mainly from the addition of Tiger Ridge gas (northcentral Montana), where production started in late 1972 (22, 1). Production in the first nine months of 1974 (compared to the same 1973 period) was down 21 percent (36). In spite of the decline from 1973's record high production year, natural gas production was up 32 percent over 1972 (See Figure 16 on p.35).

Natural gas reserve estimates vary. An independent report produced for this study estimates natural gas reserves at 700 billion cubic feet, but 1974 reserve estimates of the U. S. Bureau of Mines and the Independent Petroleum Association of America show slightly over 1,000 billion cubic feet (23). At 1973 production levels the estimated reserves would last 12 to 18 years. However, natural gas reserves are based on economic conditions and existing technology. Federal Power Commission price ceilings on interstate natural gas sales have held prices arbitrarily low. With allowance of higher prices, reserve estimates probably would grow.

COAL

In-state coal consumption is relatively slight; coal accounts for only about 6 percent of total energy consumed (18, 44). Coal consumption varies among sectors, but reliance on coal as a fuel source is generally low. (See Table 12 on p. 36.) Coal consumption in Montana has varied greatly in the last decade. There was a substantial decline in consumption from 1963 to 1968; by

FIGURE 16



*Production figures do not include liquid natural gas. Consumption figures do.

Source: Northern Great Plains Resource Program, Energy Work Group Draft Report, 1973 (unpublished).

1971 consumption finally exceeded the 1962 level. Since 1971, consumption has grown slowly, usually less than two percent per year. (See Figure 17 on p.37.)

TABLE 12

Coal Consumption in Montana (1972)

Sector	Percent of Total Consumption	Percent of Sector Reliance upon Coal
Household-Commercial	18	5.1
Industrial	28	8.3
Transportation	0	0
Utility (for electrical generation)	55	17.0

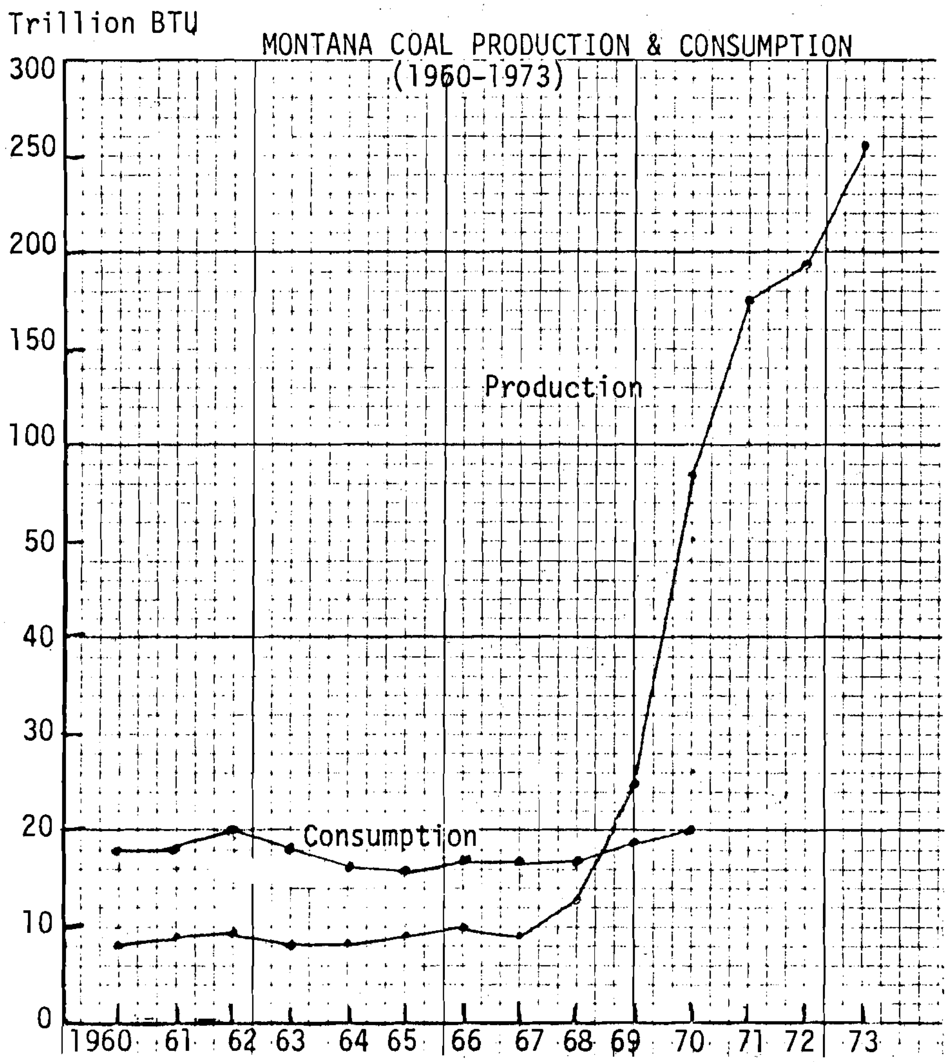
Source: "Fuel and Energy Data, United States By States and Regions, 1972," Bureau of Mines Information Circular IC 8647, 1974.

Montana has the largest demonstrated coal reserve base of any state in the nation (approximately 25 percent of the national total) with an estimated 107 billion tons of coal (37). Approximately 42 billion tons of the total reserve base could be surface mined under current economic and legal restrictions. The reserves consist of bituminous, subbituminous and lignite coal (37). The small bituminous coal deposits in Montana are not expected to be mined. Subbituminous, the largest category of coal in the state, has an average heat value of 8,500 BTU* per pound. Lignite has a lower average heat content--about 6,100 BTU per pound. Both subbituminous and lignite coal have significantly lower heat content than higher ranked eastern coal. For comparison, anthracite and bituminous coal have a heat content of 14,000 and 14,100 BTU per pound respectively. Montana subbituminous coal has 65 percent of the heat energy of eastern bituminous coal. Table 13 on p.38 breaks down the demonstrated coal resource base, according to type, potential mining method and percentage of the nation's total reserves.

Coal reserves by definition are based on economic and legal conditions. As prices for coal rise, it becomes economically feasible to mine formerly uneconomic

*British Thermal Unit: The heat required to raise the temperature of a pound of of water by one degree Fahrenheit.

FIGURE 17



Source: Northern Great Plains Resource Program, Draft Energy Work Group Report (unpublished) 1973, and Draft Summary Report, Sept., 1974.

deposits. As energy corporations are exploring for coal in areas where strippable coal reserves have not yet been identified, further deposits may be listed in coal reserves. For these reasons, the demonstrated coal reserve base should be regarded as conservative.

TABLE 13

Demonstrated Montana Coal Reserve Base*
(January 1974, million tons)

Type of Coal	Mining Method: Surface	Mining Method: Underground
Subbituminous	35,431	63,781
Lignite	7,131	Not economically mineable
Total	42,562	63,781
Percent of Total U. S. Reserve in Montana	31	21

*The demonstrated coal reserve for subbituminous coal includes seams 60 or more inches thick and less than 1,000 feet deep; for lignite, 60 or more inches thick and no deeper than 120 feet. Whenever coal reserve is mentioned in the coal section it refers to the demonstrated coal reserve unless otherwise noted.

Source: "Demonstrated Coal Reserve Base of the United States on January 1, 1974." Department of Interior, Bureau of Mines, June, 1974.

Although half of the coal in the nation on a tonnage basis is in the west, on a BTU basis, 55 percent of the coal is in the east (38). When Montana coal is compared on a BTU basis it accounts for slightly over 12 percent of the national coal reserves, rather than the 25 percent on a tonnage basis. This figure is derived by discounting the reserves on the basis of recovery and BTU content. Approximately 50 percent of the underground reserves and 90 percent of the surface reserves can be recovered with conventional mining methods. This decreases the total coal available to 70,196 million tons from the 107,727 million tons of reserves. Montana subbituminous and lignite coal has much less heat content (BTUs) than higher ranked eastern coal. When Montana coal reserves are discounted on the basis of recoverability and BTU content there are 1,227.897 quadrillion BTUs of coal in Montana. The national total coal BTUs is roughly 9,731 quadrillion (38). Montana coal is 12.6 percent of this national BTU total. Table 14 below shows the discounting of Montana reserves and the comparison to the national total.

TABLE 14

Montana Coal--Recoverable BTUs

Type of Coal	BTU Content (BTU/ Pound	Mining Method*	Total Reserves (millions tons)	Total Recoverable Reserves (millions tons) **	Total BTUs Available (Quadrillion BTUs)
Subbituminous	8500	Surface	35,431	31887.9	602.327 quads
		Underground	63,781	31890.5	542.138 quads
Lignite***	6100	Surface	-------	6417.9	83.4 quads
State Total				70196.3	1227.987 quads
National Total				433900.	9731.000 quads

*Surface--90 percent recovery rate with conventional methods.
Underground--50 percent recovery rate with conventional methods.
**Total BTUs available = total recoverable times the BTU content.
***Lignite underground reserves are not considered economically mineable.

Source: "Demonstrated coal reserve base of the United States on January 1, 1974," U.S. Department of the Interior, Bureau of Mines (June 1974) and Project Independence Report, Federal Energy Administration, November, 1974.

Most of the coal is found in eastern Montana. In fact, Department of the Interior coal resource figures cited above reflect mostly coal reserves which lie in eastern Montana. Here are coal reserves estimates listed for eastern Montana by counties (See Table 15 on p.40.) Not all of the mineable coal in the state lies in eastern Montana. In fact, the American Electric Power Company, one of the largest electric utilities in the nation has leased 4,500 acres of coal land in the Livingston-Trail Creek area of Park County (39).

The coal and the surface above it often are held by different owners, which presents conflicts. This situation resulted from the federal government retaining mineral rights to much of the land offered to homesteaders. In addition, the government gave Northern Pacific (now Burlington Northern) railroad the surface and mineral rights in large areas of Montana underlain by coal. When the railroads sold some of the land, they retained the mineral rights. Hence split ownership of coal land in Montana is more the rule than the exception in eastern Montana. In the Decker-Birney area*, for example, the federal government owns approximately 26 percent of the surface and 88 percent of the mineral rights. In contrast, 69 percent of the surface and only 7 percent of the mineral rights are privately held (40, 1).

TABLE 15

Coal Reserves by County

Subbituminous Reserves (Millions of Tons)	
Big Horn	38,355
Garfield	137
Musselshell	3,467
Rosebud	26,274
Treasure	1,304
Yellowstone	590
	70,127

Lignite Reserves (Millions of Tons)	
Carter	56
Daniels	3,965
Dawson	8,332
Fallon	1,622
Richland	8,068
Roosevelt	1,632
Valley	258
Wibaux	1,866
	25,799

Counties Containing Both Subbituminous And Lignite Reserves (Millions of Tons)

Custer	3,463
McCone	24,501
Powder River	28,074
Prairie	1,045
Total	57,083

Source: Coal Development Information Packet, Montana Energy Advisory Council, December, 1974.

Farther north in eastern Montana, in the McCone County area, most of the surface is owned by private, non-corporate interests. Only about six percent of the total is state school trust land; a lesser surface area is administered by the Bureau of Land Management. Except the state school lands, approximately

*The Decker-Birney area refers to a study area of the Forest Service and Bureau of Land Management bounded on the south by the Wyoming border, the east by the Crow Reservation, the north by the Northern Cheyenne Reservation and includes part of the Custer National Forest.

6 percent of the total, mineral rights are owned by Burlington Northern and the federal government in a checkerboard (every other square mile) pattern (41, 8).

There are at least 614,000 acres of coal mineral rights leased in Montana. Most of this coal has been leased from private owners (42) (See Table 16 below.)

TABLE 16

Coal Leasing in Montana

	Acres	Percent of Total
Indian	91,390	15
Federal Government (Non-Indian)	36,229	6
State School Lands	56,217	9
Private	430,397	70
Total	614,233	100

Source: Northern Great Plains Resource Council, Department of the Interior and Montana Department of State Lands.

Seven energy corporations hold more than 70 percent of the total leased acres in the state (42). (See Table 17 on p. 42.) Some of these energy corporations are joint ventures, such as the Decker Coal Company, which is owned by Pacific Power and Light Company, and Peter Kiewit Sons' Co. Other companies are subsidiaries of major corporations such as Sentry Royalty owned by Peabody Coal Company.

The most important chemical property of Montana coal is its relatively low sulfur content. Coal sulfur content in the eastern U. S. ranges from very low, 0.4 percent, to high, 3.0 percent or more. Montana coal is generally less than 1 percent sulfur (43, 13). This characteristic has become important because of sulfur emissions limitations of the 1970 Clean Air Act passed by Congress. In the administration of the Clean Air Act, the federal Environmental Protection Agency (EPA) established two levels of standards. First are the primary standards--those necessary to protect the public health--which were to be achieved by July 1, 1973. Secondary standards are those considered necessary to protect the public welfare in general and to prevent damage to materials, soils, vegetation and animal health in particular. Current plans call for their achievement by mid-1977. Sources existing at the time of the law's passage were allowed to operate under standards more lenient than new sources. The states retain authority to administer the Clean Air Act, provided they have a plan for the maintenance and enforcement of federal primary and secondary standards.

TABLE 17

Coal Leases Held by Major Energy Corporations
(in acres)

Lessee	BLM	State	Indian	Private	Total
Peabody Coal Co.*	4,306.55	3,837.68	16,035.05	3,965.00	28,144.28
Sentry Royalty Company	--	--	--	96,781.87	96,781.87
Western Energy Company (Subsidiary Montana Power Co)	7,173.45	2,551.77	--	75,011.99	84,737.21
HFC Oil Co.	--	--	--	67,632.08	67,632.08
Consolidated Coal Company	--	17,399.77	--	41,251.31	58,651.08
Westmoreland Resources	--	1,280.00	30,876.25	21,243.49	53,399.74
Shell Oil Co.	--	--	30,247.68	--	30,247.68
Decker Coal Co.**	13,610.31	2,568.51	--	--	16,178.82
Pacific Power & Light	3,066.76	640	--	--	3,706.76
Peter Kiewit Sons' Co.	--	2,639.69	--	--	2,639.69
Total					442,119.21

*Peabody wholly owns Sentry Royalty Company

**Pacific Power and Light and Peter Kiewit Sons' are co-partners of Decker Mining Co.

To achieve the ambient air quality standards (or more stringent standards as established by states), some states have chosen to limit sulfur dioxide emissions; others have placed direct limits on the sulfur content allowed in fuels. Still others have adopted only ambient (free air) standards, or standards stated in terms of pounds of sulfur dioxide per cubic foot of effluent.

The allowable sulfur content of fuels is directly related to the heat content. The higher the heat content, the higher percentage of sulfur which can be allowed and still meet air quality standards for new sources. For typical Montana coal (8500 BTUs per pound) and a new-source air quality standard of 1.2 pounds per million BTUs, the allowable coal sulfur content (without stack gas sulfur removal) is 0.5 percent (44). Table 18 on p.44 shows the relationship for any given standard, related to the heat content of the fuel burned and the amount of Montana coal that falls within these ranges.

Only 60 percent of Montana coal falls within the acceptable range for sulfur dioxide emissions for new sources (44). The EPA maintains that stack gas desulfurization is available and sufficiently reliable to warrant installation in fossil fuel power plants (1, III-10). With removal of sulfur dioxide from smokestack gases by desulfurization technology, high sulfur coal--abundantly available from mines in eastern U. S.--becomes suitable for use in power plants. Some utility companies, however, have disagreed with the EPA and maintain that current technology is too unreliable for use in their power plants. Their spokesmen say use of low-sulfur (western) coal is the only way feasible to meet air quality standards (1, III-10).

Another chemical characteristic of coal is ash content, which refers to the particulate matter resulting from the combustion of coal. The ash content of coal in the United States ranges from 2 percent to more than 30 percent by weight (44). Montana coal varies greatly within this range. Ash content does not generally correlate with coal location or other properties. Federal particulate standards for fossil-fuel fired steam generators limit emission to 0.1 pound per million BTU of heat input (44). The EPA has determined that the required level of control is feasible both technologically and economically. A relatively high level of particulate removal is necessary--regardless of ash content of the coal--to meet these air quality standards. Ash content is not a significant factor affecting demand for various competing kinds of coal (44).

TABLE 18

Montana Coal Meeting Various SO_2 Emission Standards (without desulfurization)

SO_2 Standard (lb/mmBTU)	Estimated strippable reserves meeting standard	Percent of Total
0.4	0	0
0.6	2,595	8.1
0.8	9,419	29.6
1.0	15,518	48.7
1.2*	19,211*	60.3*
1.5	23,888	75.0
1.8	25,768	80.9
2.0	26,234	82.3
3.0	26,935	84.5
		unknown sulfur content**

*Federal New Source Standards (state laws may be more stringent)
**Sulfur content unknown for remaining 15.5 percent of Montana coal.

Source: Markets for Montana Coal, unpublished report by Cameron Engineers (Denver) to Montana Bureau of Mines and Geology, 1974.

Most of the coal produced in Montana is from area strip mines. (Contour mining is not allowed here under the Strip Mining and Reclamation Act.) Area mining is used in flat or slightly rolling areas where coal seams are relatively flat (45). The design of the pit is governed by the equipment and desired level of production. Pits are made in a series of long, narrow strips; as the mining continues, the overburden from each strip is cast back into the open pit of the previous strip where coal has been removed and trucked off (45, 50). A series of gigantic parallel furrows are formed suggestive of a plowed field.

Coal production in Montana dramatically increased in the past five years; 1974 production was fifteen times greater than that in 1969. Montana coal production in 1973 was 2 percent of the national total. Figure 18 on p. 46 shows the increase in coal production since 1960. There are five strip mines presently operated in Montana, increased production from which caused the great expansion of production. (See Table 19.) Most of the coal is exported to midwestern utilities (41, 29).

TABLE 19

1974 Coal Production by Company
(million tons)

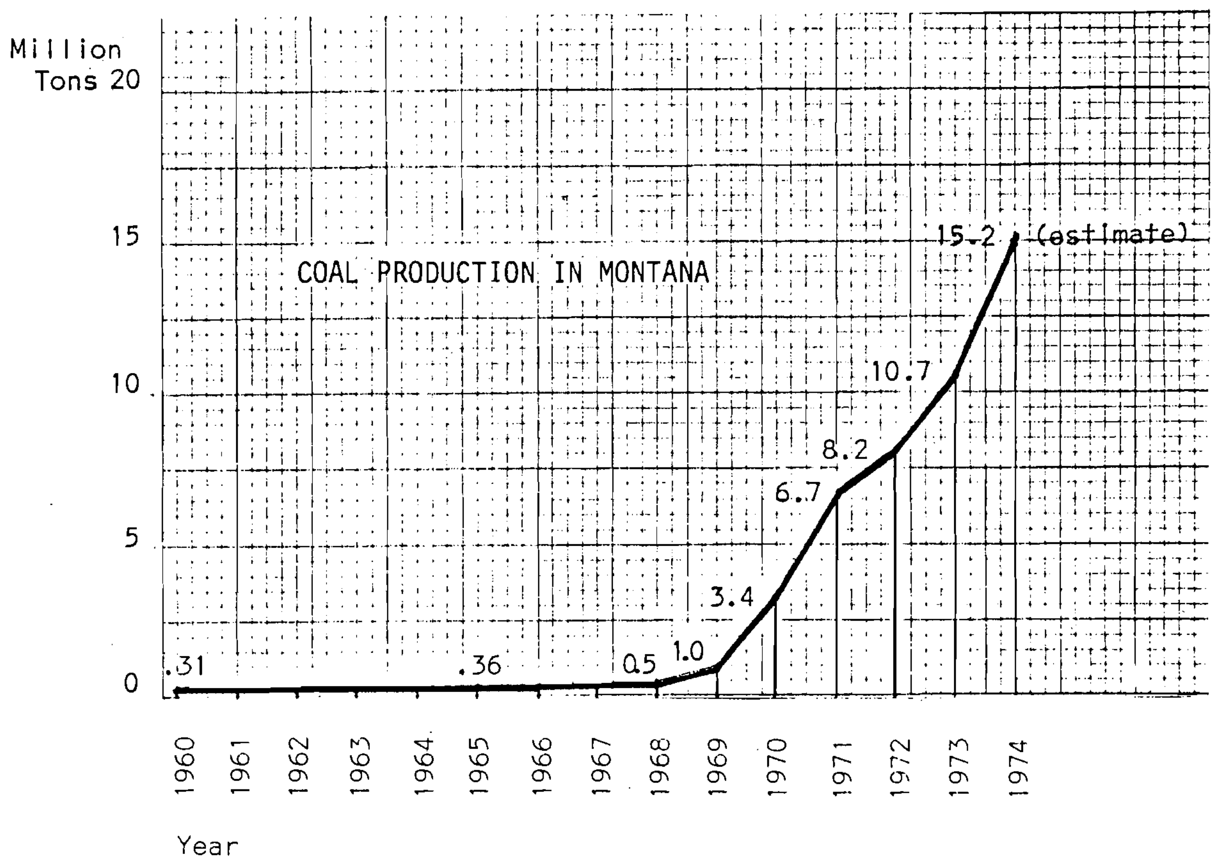
Decker	7.00
Western Energy	2.837
Knife River Coal Company	.32
Peabody	2.7
Westmoreland	1.5

Source: "Coal Development Information Packet," Montana Energy Advisory Council, December, 1974.

A recent Montana Energy Advisory Council survey found that operating mines could expand production by 9 million tons in an emergency. (See Table 20, p. 47.) The limiting factor for rapid expansion of production is the machinery required to strip overburden. Draglines are brought to major mine sites as needed to keep up with coal sales. Coal storage and loading equipment is generally constructed to accommodate long-term needs. If demand were to increase suddenly the four Montana mines reported the following capabilities:

<u>Decker Mining Company</u>: Could expand production by 2 million tons annually by stripping areas of shallow overburden with self-propelled scrapers. Essentially no additional production could be realized by adding more mine workers or production shifts (46).

FIGURE 18



Source: "Markets for Montana Coal," Cameron Engineers, Bureau of Mines Report, 1974 (unpublished); "Coal Development Information Packet," Montana Energy Advisory Council, December, 1974.

Western Energy Company: Could double production on short notice to an annual rate of 5 million tons per year. The erection of a new 60-yard dragline was scheduled for completion by late 1974. When operational this new dragline could add an additional 5 million tons per year mining capacity (46).

Westmoreland Resources:** Could expand production from 4 million tons annually to an annual rate of 6 million tons, on short notice (46).

Peabody Coal Company: By increasing the hours its coal loading tipple is operated, Peabody could increase its present production to five million tons annually.

TABLE 20

Ability of Montana Coal Mines to Expand Production in Emergencies*

Company	Amount Increase	Remarks
Decker Mining Co.	2 million tons/year	Would need to use self propelled scrapers to strip overburden--would cost more.
Western Energy	2.5 million tons/year	Can with existing equipment increase 2.5 mt/y. New dragline when operational can increase production by another 5 million tons per year.
Westmoreland	5 million tons/year	
Peabody Coal Company	2.5 million tons/year	
	9 million tons per year	

*Each of these expanded production levels by the mines would be reviewed by the state government for approval or disapproval. Rapid expansion would require modification of the yearly company mining plans submitted to the Department of State Lands.

**A joint venture of Morrison-Knudsen Construction Company, Inc., Kewanee Oil Company, Westmoreland Coal Company, Penn-Virginia Corporation.

Source: Montana Energy Advisory Council, Coal Company Survey (unpublished) 1974.

Fossil Fuels Cost Relationships

Cost relationships among fossil fuels are measured in the common denominator of cost per unit of heat or the cost per million BTUs. The cost relationships among competitive fuels have been changing recently. Cost of natural gas and fuel oil rose dramatically in late 1973 and in 1974, while coal costs have risen only slightly. This change in relative cost has given coal a price advantage over alternative fossil fuels. Table 21 below shows the cost of various fuels in areas where Montana coal now is marketed. The 1973 cost per million BTU figures are an average price over the year, hence they do not reflect totally the price increases in the last few months of that year. The cost of natural gas and fuel oil continued to rise in 1974, more than coal, so if anything, the price advantage of coal over the other fuels has increased.

TABLE 21

Comparative Cost of Fossil Fuels in Selected States
(cents per million BTUs)

State	Coal	(% increase)	Oil	(% increase)	Gas	(% increase)
Minnesota						
1971	38.2	8	77.3	14	29.0	33
1973	41.3		88.6		38.7	
Illinois						
1971	34.4	24	65.5	28	40.8	56
1973	43.3		84.0		63.7	
Iowa						
1971	37.0	14	81.1	34	31.8	30
1973	44.0		108.8		41.4	
Wisconsin						
1971	43.1	14	86.8	1	37.8	26
1973	49.1		87.7		47.7	
Michigan						
1971	41.8	16	69.3	18	51.3	27
1973	48.5		81.9		65.3	

Source: "Analysis of Fuel For Electrical Generation By The Electric Utility Industry Fuel Burned Under Boilers and By Internal Combustion Engines," Edison Electric Institute, July 1974.

Natural gas is coal's closest competitor in the utility market because it is inexpensive and relatively clean burning. In the early 1970s natural gas supplies were shut off to interruptible contract holders--such as utilities--during peak demand periods. New interruptible industrial contracts have been denied in many cases. As natural gas prices rise and reliability of supplies become more uncertain, natural gas will become less and less competitive against coal.

Not only has coal in general become an economically attractive fuel source, but Montana coal has become especially attractive in many areas of the nation. When compared to coal from other parts of the nation Montana coal has a price advantage in many markets (1, III-11). Coal from midwestern (Illinois, Indiana) and eastern (Pennsylvania and Appalachia) coal fields is generally high in sulfur. Under minimum air quality standards, emissions from this coal must be treated. The cost of treatment must be added to the price of using midwestern and eastern coal to make a valid coal cost comparison (1, III-11). Even when the price of transportation is added, Montana coal still undersells coal from midwestern or eastern fields (1, III-11). (See Table 22 on p. 50.)

Montana coal also has the price advantage in some market areas where sulfur content is not as much a factor, such as in generating plants built before 1971 and thereby under permissive air quality standards. Kentucky, Illinois and Montana coal all were sold to the same Wisconsin utility company. The Montana coal is the least expensive even ignoring the added cost of sulfur dioxide removal associated with high sulfur coal. (See Table 23 on p. 51.)

TABLE 22

Price of Montana Coal in Midwest Markets Compared to Prices of Midwest Coal

Origins, destinations and transport mode	Actual cost of transportation by unit trains, cents/10^6 Btu Average	1973 coal cost f.o.b. mine in origin state cents/10^6 Btu	Estimated average total cost of western coal delivered to state, cents/10^6 Btu	November 1973 actual price of midwestern coal purchased by steam-electric plants in state destinations cents/10^6 Btu	Difference in cents/10^6 Btu of Montana coal delivered compared to midwestern coal delivered	Cost of stack gas cleaning		Price advantage of Montana coal in cents/10^6 Btu delivered compare to midwestern coa delivered with emissions control
Montana to Minnesota (approx. 815 miles)	24.5	16.2	40.7	39.6	1.1 more +	15.7	=	18 less
Unit train		16.2	30.8	39.6	8.8 less +	15.7	=	28 less
Montana to Ill.-Ind. (approx. 1,270 miles)	49.2	16.2	65.4	46.4	19.0 more +	15.7	=	0.3 less
Unit train		16.2	39.1	46.4	7.3 less +	15.7	=	26.6 less

Source: Northern Great Plains Resource Program, Interim Summary Report, U. S. Department of Interior, Sept. 1974.

TABLE 23

Coal Used by Wisconsin Power and Light* (6/74)

State (Supplier)	BTU/Lbs.	Sulfur Content (%)	¢/million BTU**	lbs. of sulfur/million BTU
Illinois	10,260	4.4	119.5	4.2
	10,387	4.4	111.2	4.2
	10,260	2.9	94.7	2.82
Western Kentucky	10,913	3.5	88.8	3.2
Montana	8,535	0.2	82.1	.234

*short term contracts
**price at the plant

Source: Weekly Energy Report, Federal Energy Administration, Sept. 23, 1974.

Wyoming is Montana's closest competitor in the coal market. Coal from the two states has largely the same characteristics; production costs are similar too. Table 24 presents a cost summary in cents per million BTUs:

TABLE 24

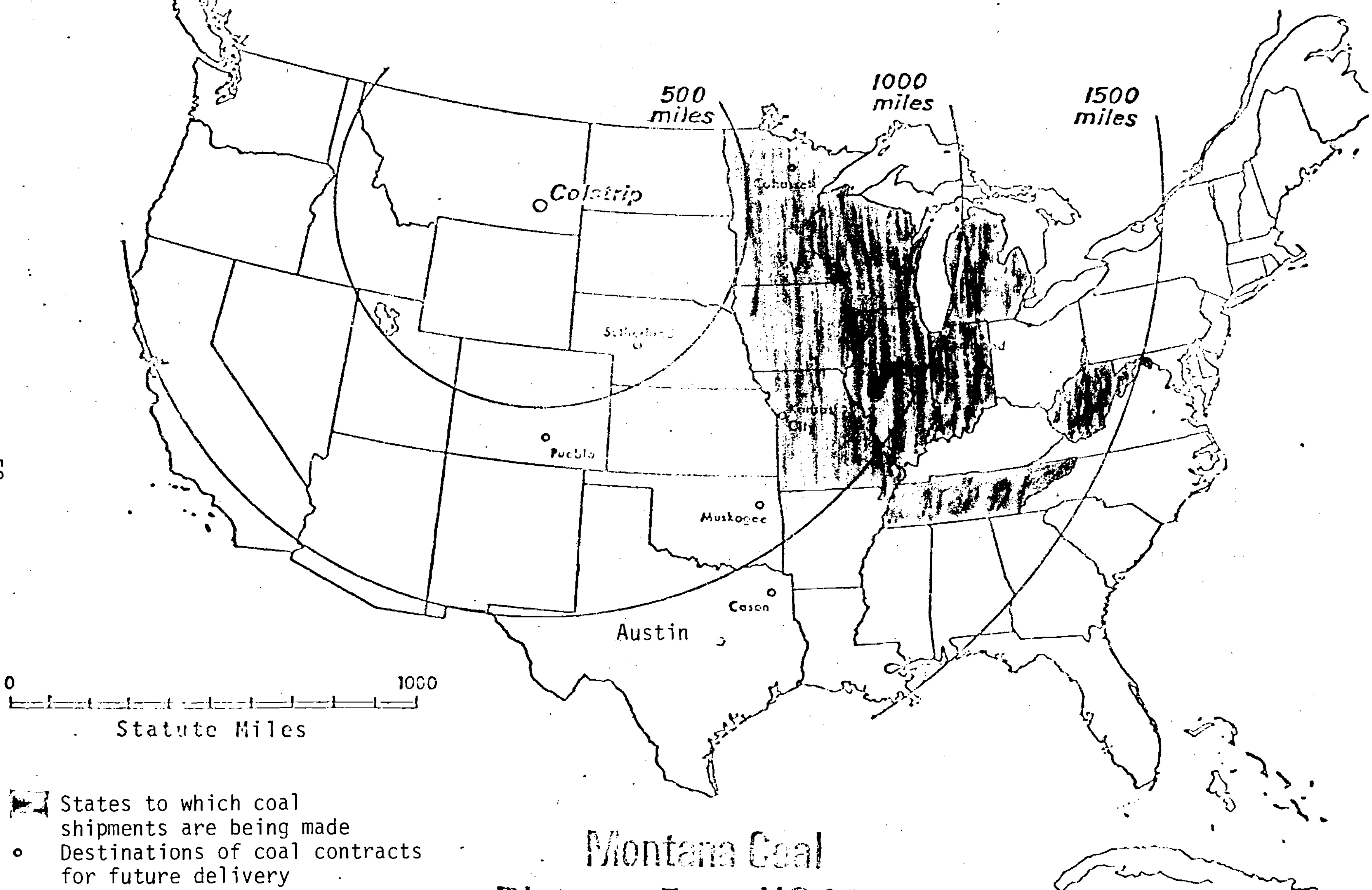
Origin-Destination	Actual cost of Transportation by unit		1973 coal f.o.b. price		Estimated average cost
Montana to Minnesota (approx. 815 miles)	24.5	+	16.2	=	40.7
Wyoming to Minnesota (approx. 1,100 miles)	31.3	+	16.2	=	52.8
Montana to Ill.-Ind. (approx. 1,270 miles)	49.2	+	16.2	=	65.4
Wyoming to Illinois (approx. 1,110 miles)	43.7	+	21.5	=	65.2

Source: Northern Great Plains Resource Program, Interim Report, Sept., 1974.

Wyoming coal has a cost advantage in transportation to markets in the southwest. Figure 19, p. 52 shows states as far east as West Virginia and Tennesee where Montana coal has been sold and the shipping distance. Demand for Montana coal is quite strong. Lt. Governor Bill Christiansen illustrated this point at a fossil fuel taxation hearing recently:

> There's a producer that has the capacity of about 6.5 million tons; who has 4 million tons subscribed for on a contract. He personally told me that coal consumers (electric utilities) were beating a path

FIGURE 19



States to which coal shipments are being made

o Destinations of coal contracts for future delivery

Montana Coal Distance From US Markets

Source: "Coal Traffic Annual 1974 Edition" National Coal Association-August, 1974
"Market Prospects for Montana Coal" Camaron Engineers, Inc., 1974

> to his door to buy the last 2 1/2 million tons of capacity for calendar 1975, and that it looked like he would not even have to go to competitive bidding. And that's a Montana producer (28).

Montana coal currently is transported by unit trains. Unit trains are used to transport a single commodity, in this case coal, and are assigned to specific destinations (48). Unit transportation is much less expensive than trains with multiple cargoes. It has been estimated that nationally, a third to a half of all coal transported by rail is moved by unit trains (48, 54). Table 25 shows selected Montana coal contracts with the number of railroad cars being used to transport the coal:

TABLE 25

Selected Coal Contracts

Company	Cars per week (100 Ton/Car)	Destination
Western Energy	263	St. Paul & Northtown, Minnesota
	580	Havanna & Hammond, Illinois
	125	Joliet, Indiana
	8	Other
Peabody	300	Cohasset, Minn.
Decker	500	Havanna, Illinois
Westmoreland	832 cars anticipated in 5 years	Minneapolis, Minnesota Dubuque, Iowa LaCrosse, Wisconsin Madison, Wisconsin

Source: Managing Our Energy Future, Upper Midwest Council, Minneapolis, August, 1974.

Reclamation

In 1974, more than 3,000 acres of land were permitted under the Montana Strip Mining and Reclamation Act for surface mining of coal. Of the total, 240 acres actually were displaced to recover coal (41, 53 - 54). Most of the land was disturbed only by facilities associated with mining such as roads and tipples. The total acreage actually stripped is likely to rise drastically in the future.

The extraction of coal by strip mining is potentially one of the most environmentally destructive methods of obtaining fuel for energy production now used in Montana. Strip mining disrupts wildlife habitat, withdraws land from agricultural production, and disrupts the quantity and quality of ground water at least temporarily and possibly permanently. Whether these effects are mitigated and the land returned to a productive use depends upon the extent of preplanning, the mining and reclamation plan, the soil, topography, rainfall and climatic conditions, and the institutional policies and state laws regarding reclamation, among many influences.

Any analysis of reclamation depends on how it is defined. Table 26 lists a number of rehabilitation objectives and the probability of success for each:

TABLE 26

Probability of Reaching Reclamation Objectives
(High, Moderate, Low, Zero)*

Reclamation Objective	Vegetative Zones		
	Sagebrush Foothills	Mixedgrass Plains	Ponderosa** Pine & Mountain Brush
National Sacrifice Areas (Abandon the Spoils)	H*	H	H
Shape Site to Avoid Aesthetic Insult	H	H	H
Shape Site and Expect Natural Vegetation to Stabilize the Environment	L	M	M
Establish Stable Vegetation by Using Best Technology	M	H	H
Approach Conditions and Values of Original Ecosystems	L	M	M
Complete Restoration of All Site Values	0	0	0

*H = High; M = Moderate; L = Low; 0 = Zero

**Most Montana land with strippable coal would fall in this group.

Source: Rehabilitation Potential of Western Coal Lands, National Academy of Sciences, 1974.

Reclamation, as defined in Montana, is a process that is begun the day a mine is anticipated and is not completed until the land is back in full-time productive use after mining. By law, mining is not allowed without the prospect of successful reclamation.

The reclamation process can be broken down into eleven steps:

1.	Inventory resources (wildlife, soils, overburden, vegetation, hydrology, exceptional areas)	Preplanning
2.	Analyze and decide on reclaimability (Issuance or non-issuance of permit)	
3.	Design mining and reclamation plan to meet provisions of law and problems of specific mine site	
4.	Stockpile topsoil	
5.	Remove overburden and sort	
6.	Remove coal	
7.	Replace sorted overburden and topsoil	
8.	Prepare overburden and topsoil	
9.	Seed or plant vegetation	
10.	Protect vegetation	
11.	Manage and use land	

Adequate reclamation has yet to be proven in Montana. The Montana Agricultural Experiment Station (MAES) has been carrying out experiments for several years on test plots at the Rosebud Mine.* These studies to date have demonstrated that with careful horicultural practices and management, certain species of introduced and indigenous plants can be established on some of the reclaimed strip-mined areas (49, 50). However, conclusive evidence that self-sustaining, permanent, diverse vegetative cover of predominantly native species is feasible has yet to be shown (50).

*The Rosebud Mine is Western Energy's (Montana Power Company subsidiary) mine at Colstrip in Rosebud County, Montana.

Wildlife habitat--the vegetation and topography needed by wildlife for food, shelter and breeding purposes--is destroyed by strip mining and the species thus disturbed are displaced or eliminated, at least until reclamation is successful (51). Very little direct research has been done on the restoration of wildlife habitat after mining. The few projects begun are not advanced enough to predict success in reclaiming wildlife habitat. Successful revegetation of strip-mined land does not guarantee that a habitat will be restored (51). Many factors, including the behavioral characteristics of the various species, figure in this.

It is likely that some food and cover requirements will be restored while some existing specific uses probably will not be. The dancing grounds utilized by prairie chickens in their annual courtship displays could become one example (51). Disturbance of key wildlife range areas and migration routes could cause other examples. Excepting these uses, impacts of strip mining probably will be confined to the immediate mine site area.

Strip mining can affect ground water quantity and quality by disrupting the coal beds that are natural aquifers (52). This situation has occurred at the Decker Mine in southeastern Montana. Before mining, the aquifer discharged about 40,000 gallons of water a day into the Tongue River. Since mining was begun this flow has been disrupted (52). Much of the flow now causes pools in the mining pits and must be pumped out. The pumping draws down water levels locally but induces lateral flows from all directions and vertical flow from below, producing a total mine effluent of about 400,000 gallons per day (52). The character of the discharge has been changed by mining. The effluent has high concentrations of sulfates and nitrates leached from pulverized coal, overburden and residues from ammonium nitrate explosives used in the mine (52). The water level is predicted to decline as the mining continues but at a decreasing rate (52). Wells very close to the final cut will become non-productive after mining stops. Nearby wells may regain their previous water levels after the mine closes but the water drawn from such wells could remain more mineralized than unaffected ground water supplies (52).

There are three major state laws which relate to coal production. The Strip Mine Siting Act provides that strip mines cannot be opened in areas which have certain special characteristics and cannot be reclaimed. The Strip Mining and Reclamation Act provides standards for reclamation, and recommends certain procedures for strip mining in order to enhance possibilities for reclamation (53). The Coal Conservation Act is intended to prevent the waste of coal in mining and requires that all marketable coal in a given area be mined at once (54).

The Strip Mining and Reclamation Act passed by the 1973 legislature does not really affect strip mine production because reclamation is an integral part of good mining procedures. The act requires that procedures be used to insure the best possible reclamation. It requires each mine operator to reclaim land as rapidly, completely and effectively as the most modern technology will allow. It also requires that reclamation provide a permanent vegetative cover capable of feeding wildlife and livestock and withstanding grazing pressure at least as well as vegetation that existed previously. Regeneration must take place under natural conditions including drought, heavy snowfall and strong winds and soil erosion must be prevented to the extent achieved before mining. So far, reclamation under these requirements has not been achieved in Montana.

The Strip Mine Siting Act, a sister to the Strip Mining and Reclamation Act, was passed by the 1974 legislature (55). It was designed to implement a section in the reclamation act which provided for denial of mining permits on unreclaimable land or on the grounds of special or unique area characteristics.

The Coal Conservation Act is to assure the wise use and to prevent the waste of coal from strip mines (54). Under this act the Department of State Lands has the authority to review strip mining plans and require that they assure the prevention of waste. The act requires that all marketable coal, strippable coal that is economically feasible to mine and is fit for sale in the usual course of trade, must be mined. Western Energy and Decker Mining companies have had their mining plans reviewed under this act and were found to be in compliance. (For a review of the Department of State Lands program and a summary of these laws, see Appendixes F and G respectively.)

ELECTRICITY

Consumption

From 1961 to 1973 electricity consumption in Montana grew at an average annual rate of 4.8 percent per year (16). Large industrial users had a much larger growth rate for the same period. Demand has virtually ceased growing since 1969. In fact, from 1969 to 1973 electrical consumption dropped an average of 1.5 percent per year (16). There were new consumers since 1969 but they failed to offset the decreasing demand of others. The general leveling of demand for the past five years may be indicative of a trend toward reduced rates of growth.

Electricity consumption varies among sectors with industrial users accounting for two-thirds of the total use (56). (See Table 27 on p. 59.) The large percentage of industrial users reflects Montana's concentration of energy intensive industries, such as aluminum refining, cement and copper reduction plants. The largest industrial consumer, the Anaconda Aluminum Company reduction plant near Columbia Falls, is supplied energy by the Bonneville Power Administration, and consumes about a third of all electricity used in Montana (56). Montana's many energy intensive industries are typical of the Pacific Northwest, where plentiful electricity supplied by hydroelectric facilities is relatively inexpensive.

Electricity demand does not remain constant throughout the year, or day. When demand is greatest is called peak load. Montana's peak load is in the winter, at mealtimes, with a smaller peak period in the summer about midday.

Utilities plan and build their generation capacity to meet the anticipated peak load period. Much of the time capacity greatly exceeds demand so utilities have electrical reserves. This surplus of power is sold to customers (mostly industries) who accept the risk of interruptible supply in order to receive a much lower price. During peak loading, if there is not enough capacity to supply full power in the entire system, interruptible contract holders must have their electricity shut off so that utilities can supply firm demand.

TABLE 27

Electrical Consumption by Sector (1973)

Sector	Portion of Total Consumed (%)
Residential	17
Small commercial and industrial	13
Large industrial and commercial	66

Source: Compiled by EQC Staff from Federal Power Commission reports of companies operating in Montana.

Policies Affecting Electricity Consumption

Price significantly affects consumption of electricity. Montana's Public Service Commission regulates the price of electricity sold by utilities to Montana consumers. The existing price structure for electricity established by the commission gives a discount to customers who use much electricity. This price structure encourages consumption. Moreover, industrial users receive much lower prices per unit than the residential or commercial users. Hence industrial users are encouraged to use processes which may cost less initially but require more electricity to operate in the long run. Table 28 on p.60 shows the three main classes of electricity consumers and their average charges for 1973. Montana Power Company's rates are shown here, but it should be noted that all electric utilities operating in the state offer similar price incentives for large consumers.

TABLE 28

Montana Power Company's Customers and Rates (1973)

Sector	Average Charges	Consumption of Total (%)	Contribution of Total Revenue (%)
Residential	2.45	24	37
Commercial	2.197	21	30.4
Industrial	.86	50	27.8

Source: Based on Federal Power Commission annual reports, Form 1, Account 460 on file with Montana Public Service Commission.

The residential sector contributes 37 percent of the total revenue received by Montana Power Company, yet it only uses 24 percent of the electricity. The industrial sector only contributes to 27.8 percent of the revenue yet it uses half of the electricity (56). A detailed discussion of electrical rates is presented in Appendix A, "Conservation Through Rate Restructuring."

Production

Electricity in Montana is generated from two basic sources: hydroelectric and fossil fuel steam generating facilities. (See Table 29 on p. 61.) Hydroelectricity accounts for approximately 84 percent of the total power produced in the state; steam power accounts for the rest (18). Hydroelectric plants, dams and turbine-generators themselves are nonpolluting, although the adverse environmental effects of a dam on a stream and its surroundings are massive. Fossil fueled plants emit pollutants that significantly affect air and water quality. Hydroelectric plants are also much less expensive than steam generation facilities per unit of electricity produced. It would seem that hydroelectricity is the preferred method of generation, but the sites for more such facilities in Montana are limited and in most cases would require damming of previously free flowing streams.

TABLE 29

Generation Facilities and Fuel Requirements

	Percent of Total Electrical Production	Percent of Production From Steam Generation Facilities
Hydroelectricity	84	---
Steam Generators	16	100
Oil	less than 1	less than 1
Gas	1	6
Coal	15	94

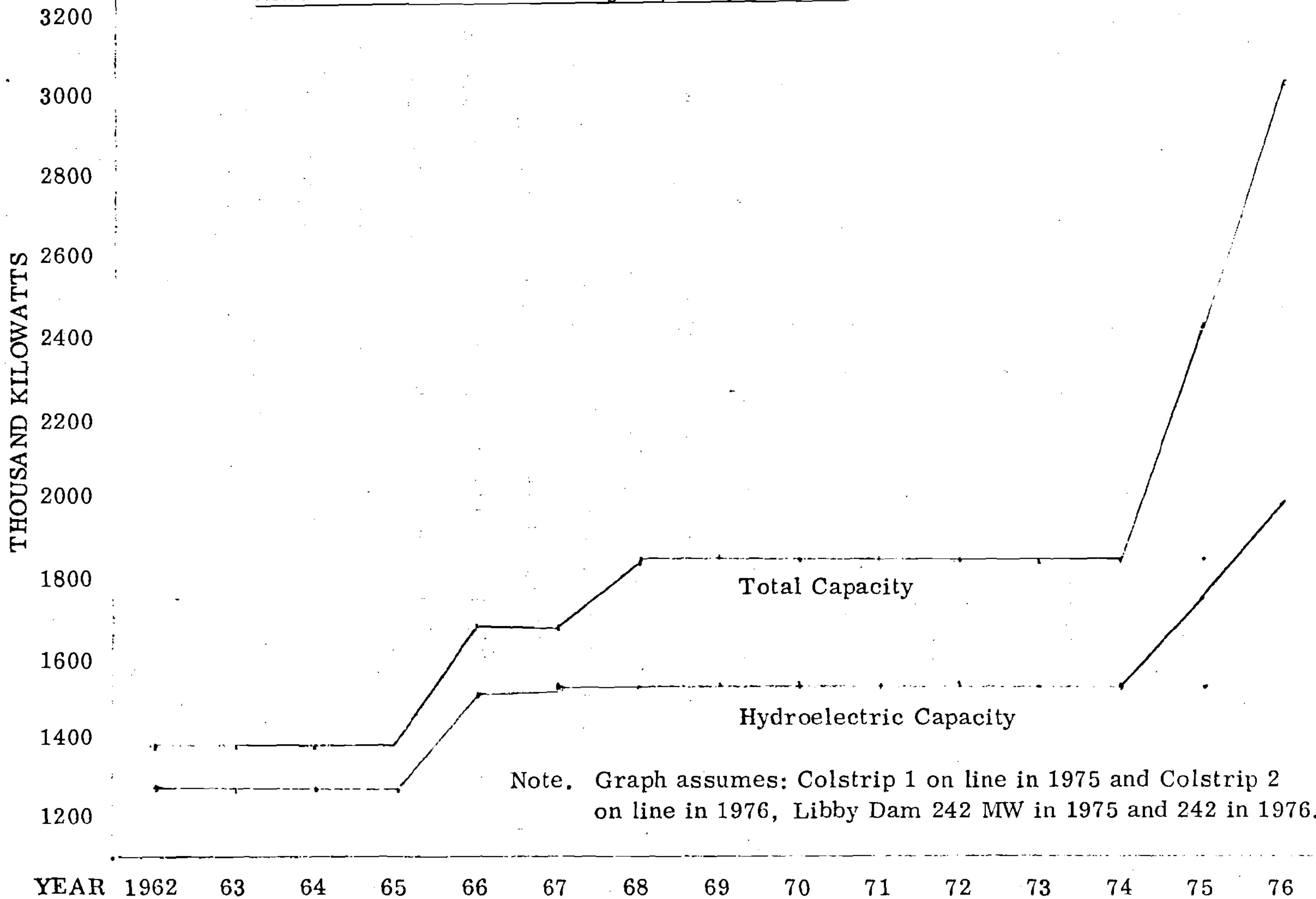
Source: "Fuel and Energy Data, 1972, United States by States and Regions," Bureau of Mines Information Circular IC 8647, 1974.

Although 84 percent of the electricity generated in Montana comes from hydroelectric sources, not all of it is available for in-state users. This is true for the federally sponsored dams under the Bureau of Reclamation, Army Corps of Engineers and the Bonneville Power Administration. The Bureau of Reclamation, which markets power from its own and the Army Corps of Engineers dams, sells power on a preferred basis: that is, certain customers such as Rural Electric Cooperatives (REA) and irrigation districts have first call on any power produced from these dams. Much of the electricity produced in Montana from these sources is already committed to out of state preferrred customers. An investor-owned utility, Washington Power and LightCompany, owns Noxon Dam; its hydroelectricity is totally committed for use in Spokane, Washington.

Fossil fuel steam generation facilities, which account for 16 percent of the total electricity production in Montana, use natural gas, oil and coal as fuels (18). In Montana, most of these plants rely primarily on coal as a fuel source, with lesser amounts of natural gas and fuel oil used respectively. In 1972, approximately 15 percent of the total electricity produced in Montana was generated in plants that use coal (18). About 1 percent of the electricity was produced from natural gas and less than 1 percent was generated from fuel oil (18).

FIGURE 20

Montana Electric Generating Capacity 1962-76

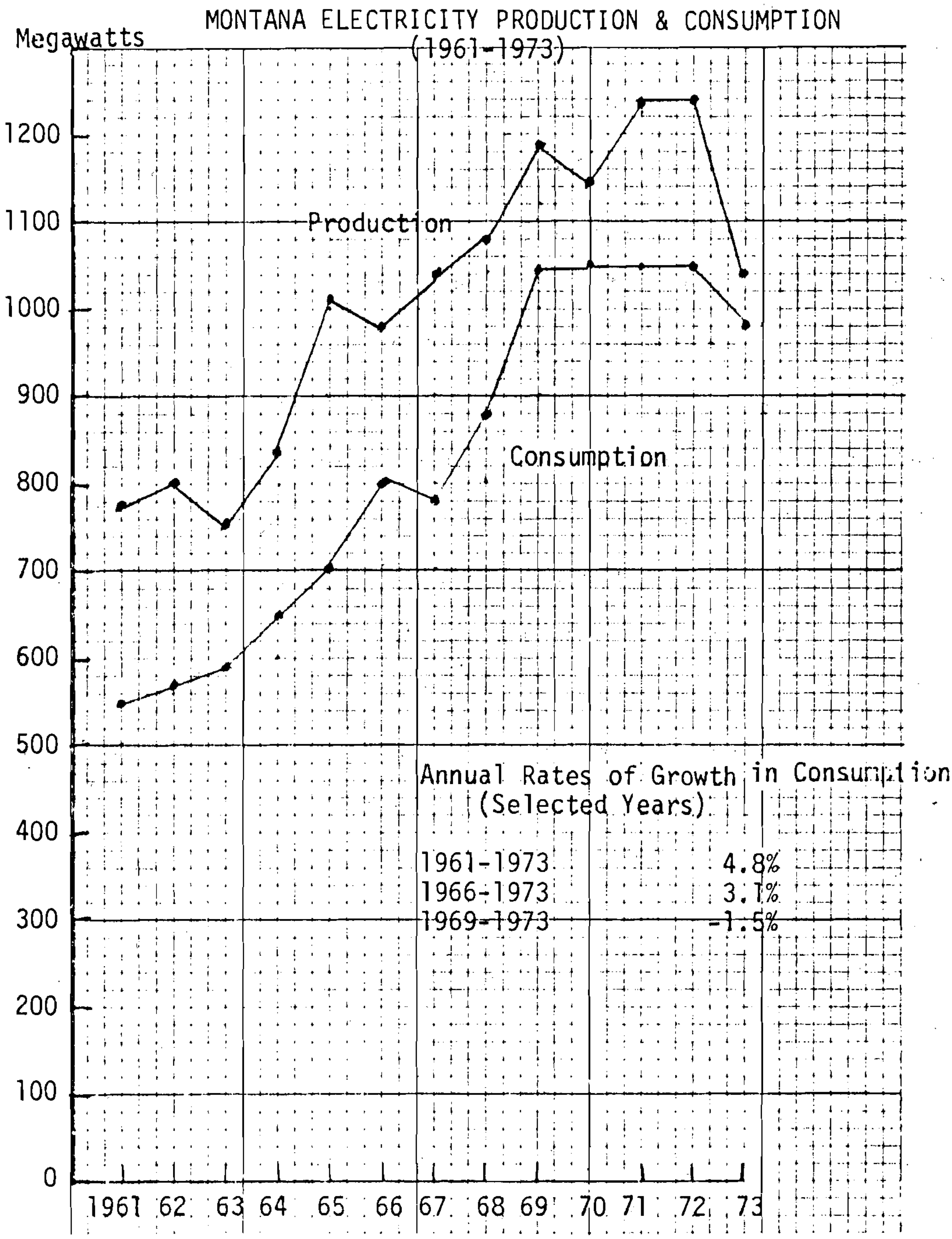


Source: Federal Power Commission, The 1970 National Power Survey, U. S. Government Printing Office, Dec. 1971.

The total electrical generation capacity in the state has not risen since 1968 (57). (See Figure 20 on p. 62.) Total capacity refers to the maximum amount of electricity a facility can generate operating at 100 percent efficiency. In 1975, the situation will change greatly with the operation of Montana Power Company's first Colstrip unit (350 megawatts) and the expansion of the hydropower facilities at Libby Dam (287 megawatts) (57). These additions will increase Montana's total capacity to 2400 megawatts. There will be a further increase in 1976, with the operation of Colstrip Unit No. 2. By 1976, even allowing for the expanded hydroelectric production at Libby Dam, hydroelectric power will account for only 66 percent of the total generation in the state.

Montana's electricity production from 1960 to 1973 continually exceeded the amount consumed in the state, which made Montana a net exporter of this energy source for those years (16). (See Figure 21 on p. 64.) The net exports decreased over the years as demand increased in the state. Production declined dramatically in 1973 because of a water shortage for hydroelectric dams. However, 1974 production was back to normal. Montana in 1975 will become a net exporter of electricity in amounts larger than ever before by the addition of the Colstrip generating plant, jointly owned by Montana Power Company and Puget Sound Power and Light. This plant will be larger than any other in the state. At least half of the electricity--the amount owned by Puget Sound Power and Light--will be exported from the state. Montana Power Company will have enough electricity available to export surplus amounts, further increasing net-exports. In anticipation of the large increase in electric power available to Montana, a series of advertisements were placed in the eastern and midwestern editions of the Wall Street Journal. "Project Energize," which the series is termed, emphasizes "cheap, abundant power" to encourage new industries to locate in Montana. These ads are correct; Montana will have power in excess of its demand, power that will be exported to the Northwest Power Pool. Montana has first call on this power,

FIGURE 21



Source: Draft Environmental Impact Statement on Colstrip Units 3 & 4, Montana Department of Natural Resources and Conservation, November, 1974.

so if new industrial facilities located in the state they would have adequate electrical energy supplies.

Montana utilities pool their power resources with other utilities in the region. For example, Montana Power Company has joined a number of power pools such as Pacific Northwest Coordination Agreement, Western Systems Coordinating Council, Associated Mountain Power Systems, and the Northwest Power Pool mentioned above (58). Through power pools utilities can share electric power during their somewhat different peak loads. For example, with a peak load in Montana at 7:00 p.m., utilities in the state's service area can acquire excess power out-of-state from utilities whose peak load does not occur until later due to time zone differences. This system of regional power pools allows for relatively efficient power distribution; however, this arrangement has not been extended to its fullest potential. Different regions of the nation have different seasonal peak load periods. For example, the northwest's seasonal peak load is in the winter, while the southwest United States' peak load occurs in the summer. If regional pool systems were expanded to a national grid system, excess electricity in some areas could be used in areas with peak loads. Such a grid system would require less excess generating capacity needed for peak load periods.

ENVIRONMENTAL EFFECTS OF ELECTRICAL GENERATION

Generation of hydroelectricity itself does not produce air or water pollution. The dam which is associated with the power plant, however, does alter natural ecosystems. Damming of a stream causes massive changes in aquatic habitat and leads to changes in species. Residents who live in the area of flooding, of course, are relocated. Major new dam sites in Montana would have to be on what are now free-flowing streams, thus destroying their native characteristics. Hydroelectricity is inexpensive today only because the dam builders do not take into consideration the cost to the human environment. One author sums up the environmental effects of hydroelectric power production:

> Few actions of which man is capable in a similar time and place can have such farreaching ecological effects--physically, biologically or socioeconomically--as a major hydroelectric dam (59).

Steam generation facilities fueled by coal emit substantial air and water pollution. There also are significant negative economic and social impacts connected with their construction, especially in rural areas, such as Colstrip in Rosebud County, where Montana Power Company and Puget Sound Power and Light's generating complex is. The Colstrip Units No. 1 and No. 2 represent Montana's first experience with mine-site power plant location in a rural area, so it will be used as an example of the environmental, social and economic impacts of such facilities.

Air Quality

Air pollutants from coal-fired generating plants are regulated under the federal Clean Air Act of 1970. There are two air quality standards under this act, primary and secondary. Primary air standards aim to protect human health by limiting the ambient (outside air) concentrations of various pollutants from emission sources (1, IV-67). Similarly, secondary ambient air standards are to protect public welfare, plant life, and animals with limits generally more stringent than primary standards. Standards for a given pollutant are set at permissible levels for given periods of time. Requirements for annual average permissible pollution for example, are more restrictive than the levels allowable for daily pollutant concentrations.

There is considerable controversy about the extent to which secondary standards protect crops, native vegetation, livestock, wildlife and the public welfare in general. Little data exist on the effects of long-term exposure to sulfur dioxide, and trace metals in particulates (dust). Still less is known about the effects of biological concentration of trace metals. Trace metals present in vegetation for example, can be concentrated in grazing and predatory animals.

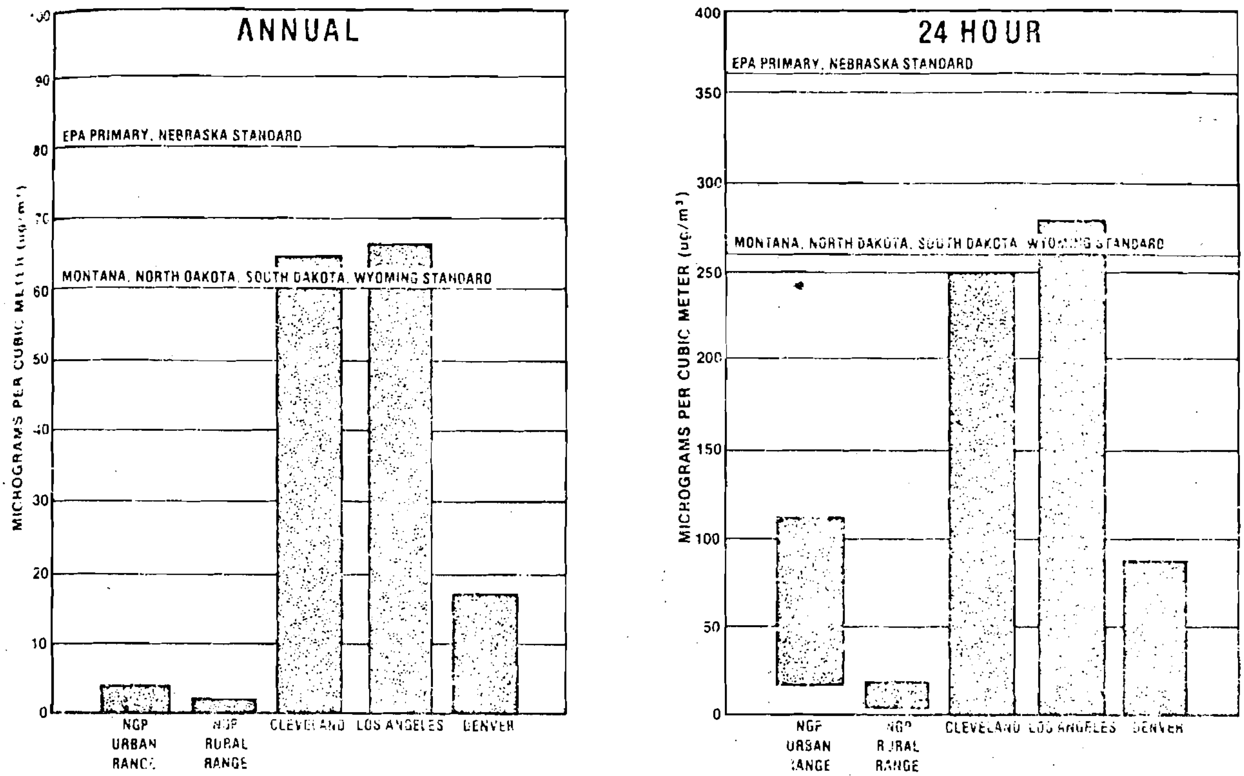
As illustrated in Figure 22 on p. 68, state and federal ambient sulfur dioxide standards are set at levels far above existing sulfur dioxide concentrations in the Northern Great Plains (1, IV-67). By depicting existing sulfur dioxide levels in selected urban areas, the graphs show that airborne sulfur dioxide concentrations in Montana could rise almost to levels now experienced in Cleveland and Los Angeles and still be in compliance with existing standards. With reference to sulfur dioxide, Montana air could be three times more polluted than Denver's and still meet standards (1, IV-69).

In a recent letter to the governors of the 50 states, EPA Administrator Russell Train explained:

> To allow for maximum state flexibility and discretion in assessing the air quality implications of major new sources of sulfur dioxide and particulates, the regulations establish a national procedural framework within which the states would act. Following public hearings each state would classify its presently clean areas into any one of three categories: (1) a preservation area, in which very limited growth in emissions and deterioration of air quality would be allowed (Class I). (2) a moderate emissions growth area, in which modest increases in emissions and deterioration of air quality could occur (Class II). (3) an intensive emissions growth area, in which emissions would be allowed to deteriorate air quality up to the national standards (Class III) (60).

Train noted that non-degradation provisions by themselves could limit future land use options in clean air areas. He conveyed a strong personal belief that "the federal government, including EPA, ought not to dictate local land use decisions" (60). Under court order to define non-degradation, EPA passed on to the states the job of determining, area by area, how much new industry is desired and what levels of air quality deterioration will be allowed to accommodate new facilities.

FIGURE 22
Sulfur Oxides-Ambient Air Quality Data and Standards



Source: Northern Great Plains Resource Program, Interim Summary Report, 1974

The EPA regulations would be concerned with sulfur dioxide and particulate emissions from 19 kinds of sources, including refineries, power plants and smelters. If the regulations adopted remain unchallenged in court, all air quality regions in the country will be given an initial Class II status.

According to the EPA, air in a Class II area could accommodate a coal-fired power plant of about 1000 megawatts capacity without exceeding permissible limits (60). Larger or additional generation units in the same area probably would be precluded in Class II areas. Colstrip Units No. 1 and No. 2 total 700 megawatts capacity; proposed Colstrip Units No. 3 and No. 4 total 1400 megawatts capacity for a grand total of 2100 megawatts capacity at on site. The Colstrip area probably would not be eligible for Class II status if Units No. 3 and No. 4 were allowed. The arbitrary Class II designation, however, is meant to be temporary; final classification would be up to the governors. After public hearing in the subject areas, the governors could reclassify areas as Class I, ensuring that existing air will remain undegraded (60). Alternatively, governors could reclassify areas as Class III and allow additional pollution to the level of primary ambient air standards. If governors were to take no action, Class II classifications allowing "moderate emissions growth" would stand.

Social and Economic Effects

Colstrip Units No. 1 and No. 2 are being built in a previously rural area, and have caused significant social and economic impacts on the residents of that area. The chief cause of these impacts is the drastic growth in population during construction which will be followed by a decline when construction is finished. Rosebud County must provide services such as schools, roads, and law enforcement for many temporary residents. The agriculturally based economy also is disrupted by uncertainty about future development and tax levels (61). All of these impacts cause severe demands upon the residents and county government in the Colstrip area. Colstrip area farmers and ranchers, many of whom must expand to stay competitive, are marking time in an attempt to determine whether buying more land and equipment will increase production profitably (61). Ranchers are reluctant to buy land for fear of not being able to use it; farmers are reluctant to buy additional equipment for similar reasons (61). Ranchers who want to move out are hesitant to sell land to the coal companies or land speculators, yet they cannot find other ranchers who want to buy (61).

Local businessmen also are very uncertain about their future. According to recent research, only financial institutions, and not even all of them, are making plans to cope with the changes of growth (62). Many businessmen in Forsyth are delaying expansion plans until the size of the potential market is known. There are also fears that with more development will come chain stores and competition that cannot be met (62). As a consequence of the all-round economic hesitation, goods and services in the Colstrip and Forsyth area are scarce and are priced higher than in other eastern Montana communities (62).

Detailed data on governmental expenditures to meet increased demand for public services have yet to be tallied thoroughly. However, interviews with officials in Rosebud County reveal a bleak picture. The drinking water system of Forsyth is being used to capacity, as is the sewage disposal system (63). The potable water supply in Colstrip was reported recently contaminated. Any increase in the capacity of the Forsyth systems is likely to come only at the local taxpayer's expense, although some federal assistance may be available (63). County officials also have reported that land use planning is slowing because of the limited funding available for a planning staff. Practically all of the land in the Forsyth area that is available for siting of mobile housing is being used for that purpose (63). The part-time county sanitarian for Rosebud County has predicted that serious public health problems are possible very soon. Rosebud County has one public health nurse. Interviews with Rosebud County's only public nurse have revealed that she is unable to perform all needed services and is barely able to keep up with school system responsibilities (63). The Montana Department of Health and Environmental Sciences has been providing intermittant services such as family planning. In addition, a $175,000 grant to build up local health services in rural eastern Montana has been awarded to the Department of Health and Environmental Sciences by the Old West Regional Commission.

Although the Rosebud County service area numerically has adequate hospital and long-term care facilities, they are in Forsyth, 35 miles from the site of Colstrip construction and mining. The only health care facilities available in Colstrip are two mobile houses, one located on the construction site and the other nearer to the housing area in Colstrip. The mobile units were provided by the Montana Power Company and are staffed by nurses who give first aid and provide elementary diagnosis and referral. The Rosebud County public health nurse and state health officials also use the mobile units. Rosebud County, typical of many rural Montana counties had a shortage of health manpower even before industrialization began.

The Rosebud County school system, especially at Colstrip, has been affected severely by industrialization. While some of the classroom crowding problems have been solved by a long-promised Montana Power Company donation of mobile housing for classrooms, crowding still exists. Several courses formerly offered have been dropped as luxury items, as the teaching staff struggles to meet increasing demands (61). Many have complained that the quality of education offered by the Colstrip school has declined. Newcomers to the area also complain about the lack of certain courses (61).

The incidence of crime in Rosebud County has skyrocketed. In 1972, arrests totaled 129 (7 felonies, 122 misdemeanors); in 1973, the figure rose to 835 arrests (13 felonies, 822 misdemeanors). Of the 1973 offenses known to police, more than half were theft; slightly over 15 percent were aggravated assault. The law enforcement budget has been increased four-fold in recent years and many residents are not yet satisfied with its adequacy.

The Highway Department reports that the roads in the coal development area of Rosebud County are being used far beyond what they were designed to handle. Montana Highway 315 connecting Interstate 94 with Colstrip has deteriorated greatly. Traffic increased from 50 vehicles per day a few years ago to 1,053 in 1973 and an estimated 2,500 in 1974. The cost of rebuilding the road is far beyond the budget capabilities of the county.

To meet rising demand for public services the county must raise new revenue. The county is to receive three cents a ton on coal mined in the county; however, the money is restricted to use in general fund and cannot be applied to schools or roads where the needs are most pressing. Table 30 compares the mill levies for the last two years and shows the large increase in taxes in Rosebud County:

TABLE 30

Mill Levies in Rosebud County

		72-73	73-74	Percent increase
Rosebud County				
	General Fund	12.42	16.31	31
	Road Fund	10.56	11.93*	13
Forsyth:	General Fund	24	48	100
	Schools			
	Angela 2	67.16	80.75	20
	Forsyth (C)4, (R)4	83.91	95.26	
	Rosebud 12	86.80	90.97	5
	Colstrip 19	62.78	79.71	27

*12 mills is the Road Fund legal limit

Source: State and Local Government Coordinator, Governor's Office, 1974.

In many cases the increased mill levies are not meeting needs adequately. For example, the quality of education at Colstrip school has deteriorated greatly in the opinion of longtime residents (61). One rancher reports that his fourth grader has had eight different teachers during the year as classes were split, children moved, and teachers reassigned.

The taxable value of Rosebud County increased $6.45 million from 1973 to 1974 but most of the increase was attributed to a 30 percent jump in the valuation of cattle (64). Only $1.68 million was attributed to the Colstrip energy complex (64). The plant, with an estimated value of $180 million, added only $1.68 million to Rosebud County's tax base (64).

The County Commissioners are aware that the tax base of the county will increase and Western Energy Company's projections indicate that sometime in the 1980s Rosebud County will have more money than it will be able to spend. But now there is no way to meet the needs with available funds and financing mechanisms.

Once Colstrip resident sums up the problem this way:

> Under the present laws in the state of Montana small rural communities, such as Colstrip was prior to the recent coal development, are going to be destroyed by the impact of coal development. Present laws make it possible for the coal development companies to shift the tax burdens of their impact on the farmers and ranchers in the area being developed. Not only will these older residents be forced to accept a deterioration of roads, schools, law enforcement, recreational facilities, environment and life style but they will be subjected to unbearable tax loads to provide social services for the employees of the Colstrip area...(64).

URANIUM

Although its true potential remains speculative, Montana's uranium ore resource may have an important future in the nation's growing nuclear power industry. The state's nuclear role may include becoming a major step in the complex nuclear fuel cycle, the enrichment process which is used to concentrate the energy of uranium for nuclear power plant fuel. Uranium enrichment facilities need not be near uranium deposits however; the primary requirement for a nuclear fuel plant is adequate power (about 2,500 megawatts) to drive the enrichment process. Montana, which has coal and therefore potential for large supplies of electric power, has high potential as an enrichment plant site.

In order to examine Montana's possible contribution to the nation's nuclear industry and the impact such an industry would have on the state, it must be determined first whether there is a potential here for a nuclear-related industry and what its adverse environmental effects might be. Montana agencies may have some authority to impose controls and in limited cases mitigate environmental problems.

The commercial production of uranium in Montana has been very small. The largest ore production recorded was less than 3,000 tons in 1958. In only two other years, 1960 and 1961, was production large enough to record. Most of Montana uranium has been mined in the Pryor Mountains of Carbon County. There has been no production of uranium in the state since 1966 (65).

Montana does have potential commercial reserves of uranium, although there are no maps available to the public for exact locations. A number of energy industries are actively exploring for uranium, especially in areas most likely to have uranium deposits--southeastern Montana in the Fort Union coal region and to a lesser extent, mountainous western portions of the state. Uranium's future in Montana is uncertain: "Production of uranium from Montana deposits remains more potential than actual. Although uranium production in the state is currently dormant, the discovery of commercially more important deposits is a continuing possibility" (66).

Uranium can be found associated with more than 50 mineral types, mostly rare. The main ores are uraninite, found in vein deposits, and secondary mineral deposits which are the weathered remains of uraninite. The vein ores are found in the mountainous areas of Montana, in particular, the northern half of the Boulder Batholith just south of Helena in Lewis and Clark and Jefferson Counties. Veined deposits also have been found in Granite, Madison, Mineral, Powell, Sanders, and Silver Bow Counties (66). The occurrence of the secondary minerals, located in sedimentary deposits, are generally in parts of eastern Montana, notably in Carter and Fallon Counties, and southwestern

Montana (66). The uranium deposits in Carter and Fallon Counties are a portion of uranium bearing lignite (low-grade coal) deposits which underlie much of North and South Dakota. In southwestern Montana there are uranium bearing lignites, shales and phosphorite deposits, whose exploitation might be possible someday, according to one source. "The amount of uranium disseminated in these sedimentary deposits is very small, but if the need were great enough or the improved treatment techniques developed, they could in the aggregate be the source of substantial amounts of uranium" (66).

Geological formations, drill patterns made by exploration, and leases all help identify possible commercially mineable areas, but none gives information about specific location or type of uranium reserves. Because it is more costly to engage in prospective activities than to hold leases, prospecting patterns are a better indicator of a corporation's interest in any given area. Based on the indicators of geologic formations and type of prospective activity, Sidney L. Groff of Montana Bureau of Mines speculates that Montana does have low-grade uranium reserves, which probably will be mined in the future (68). According to Groff, the state's reserves are not as great as those of Wyoming which are extensive and are now being mined (68).

Leasing and prospecting activities show that the uranium industry is interested in Montana uranium reserves. Of more than 85,000 acres of state school lands leased to energy corporations for uranium, about 80 percent are controlled by two companies, Mobil Oil and Utah International, Inc., in about equal shares (68). For county by county listing of total acres leased, see Table 31 on p. 76 . Prospecting permits are probably a better indicator of industry interest in the uranium potential of Montana. The Department of State Lands (DSL) has issued 28 prospecting permits for uranium in 17 counties (69). The prospecting permits represent 35 percent of the total permits issued by the department; the rest were issued for coal prospecting. This activity is believed to be speculative exploration to discover marketable deposits of uranium.

TABLE 31

Uranium Activity in Montana

County	Acres leased on school lands (4/74)	prospecting permits (7/23/74)
Beaverhead	4,490.32	0
Broadwater	2,480.00	1
Carbon	none	1
Carter	14,704.00	7
Cascade	310.00	0
Dawson	none	1
Deer Lodge	none	1
Fallon	none	1
Fergus	11,206.76	1
Golden Valley	none	1
Jefferson	21,000.00	1
Madison	16,608.00	2
Musselshell	1,480.00	5*
Petroleum	640.00	1
Sweet Grass	480.00	1
Silver Bow	none	1
Wibaux	none	1
Yellowstone	none	1
Total	85,665.00	23 by Department of State Lands 4 by Bureau of Land Management 27 total by state and federal p.p.

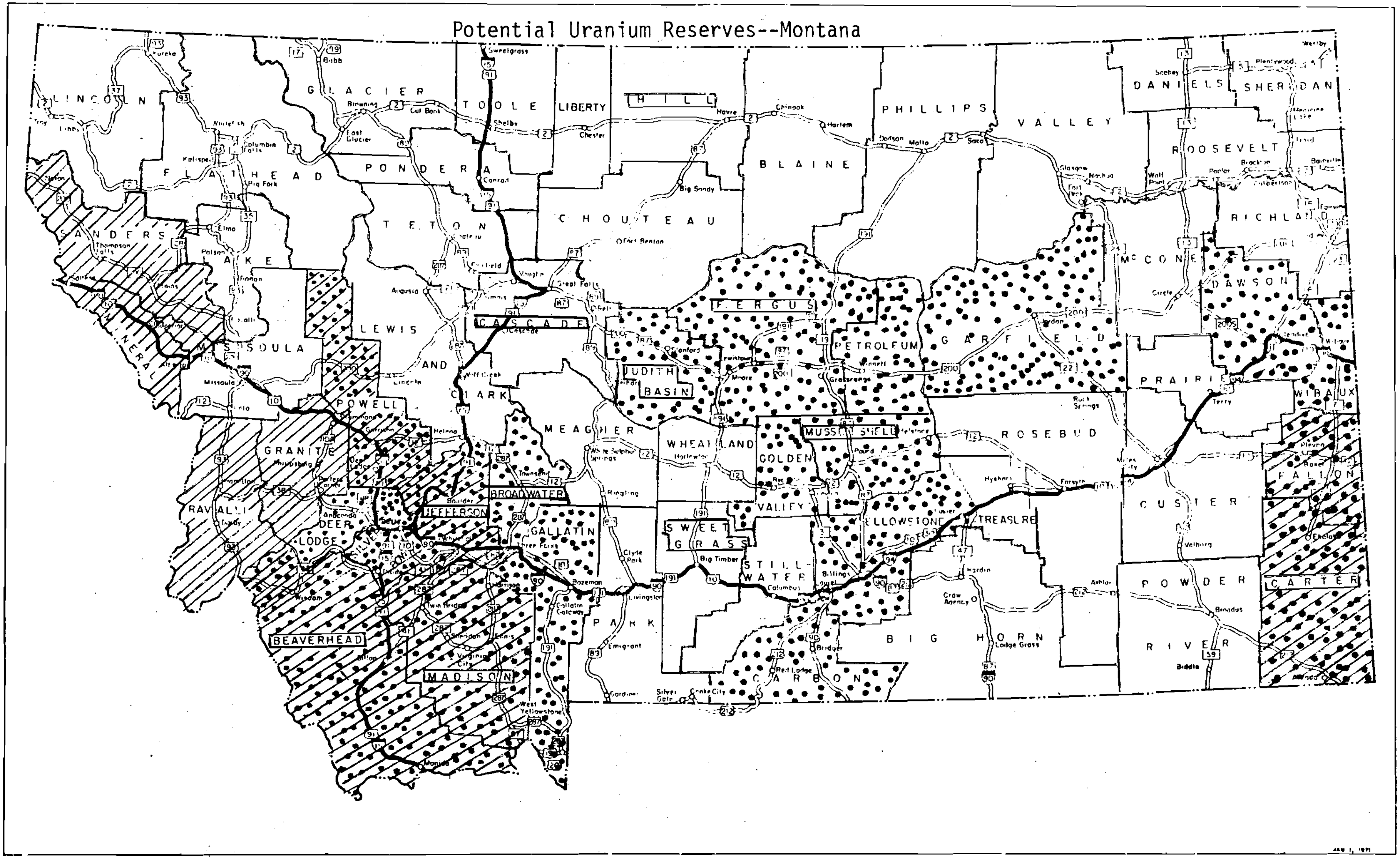
*(1 through State Lands Department and 4 through Bureau of Land Management)

Source: Leasing record and prospecting permits issued by Department of State Lands.

The geological formations and present uranium industry interest as shown by leasing of state lands and prospecting permits seem to indicate that uranium mining in Montana is a probability. Figure 23 on p. 78 shows known geological formations, prospecting permits issued and leases granted for uranium. This map shows only the probable location of uranium in the state. This is not to say that all of the counties indicated have uranium in commercial quantities or will have uranium mining. There are four counties with leasing, prospecting and geological formations known to contain uranium, namely Carter, Beaverhead, Madison, and Jefferson. Uranium mining occurring in the state, of course, will be a function of economics and demand for uranium in the nuclear industry.

Market conditions dictate whether specific deposits of uranium would be economically mineable. Market conditions for uranium are likely to change substantially in the next few years as the demand for uranium grows. America seems to be counting on nuclear power to solve many of her energy supply problems. The number of nuclear power plants expected to be built by 1980 is eight times the number in operation in 1972. Plant capacity in 1990 is expected to be 30 times that of 1972 (71). Demand for uranium ore is expected to jump five times by 1980, up from the 8,000 tons a year now consumed (71). The breeder reactor should greatly reduce the amount of newly mined uranium needed for nuclear plants, but is not expected to be available commercially until mid-1990. Unless other methods of extending the use of mined uranium are discovered, it may be necessary to use previously low-grade, uneconomical uranium ores, such as Montana's.

FIGURE 23



Prospecting Permits by County

County — State Leases by County

Deposits by County

Three methods are used to extract uranium; each of which might be applied to recovery of Montana's reserves. Two of the methods, open pit and underground mining, are conventional. Solution mining is semi-experimental. Open pit mining is used to extract ore which is relatively close to the surface, and resembles open pit mining of other minerals. Underground mining is used to recover deep reserves and may be used in conjunction with open pit mining. Solution mining can recover reserves at underground mining depths. In solution mining, an acidic solution injected through a well leaches the uranium deposits (72). The uranium-bearing liquid is then pumped from the deposit through production wells to a recovery plant which separates the uranium from the acidic solution. This waste solution is then discarded into tailing ponds (72). Solution mining was used in Shirley Basin, Wyoming from 1967 until 1971 when damage it was causing to an aquifer was discovered (72).

A facility usually located near open pit or underground mine sites is the uranium mill. Low-grade ore (mostly 0.1 to 2.0 percent uranium) moves from the mine to the mill where the uranium ore is separated from waste rock (73). The ore, crushed to the consistency of fine sand and mixed with water, is pumped into leaching tanks, where (according to ore type) an acidic or alkaline solution is added to dissolve the uranium. At the end of this process the uranium--called "yellowcake"--contains about .7 percent uranium (73). The solid waste products (tailings) are suspended in the liquors and then,

> pumped by slurry to tailing dumps located alongside the mill. The liquor ultimately evaporates or seeps into the ground or is allowed to flow into natural waterways at a controlled rate dictated by applicable regulations. The sand-like material remains and the radioactive daughter products of the uranium remain in the tailing piles. (73)

The amount of tailings from a particular mill depends upon the percent of uranium per ton of ore. The national average ore contains .25 percent uranium. Only about five pounds of uranium and 100 pounds of vanadium are removed from each ton processed; the balance (nearly 1,900 pounds) is heaped on a tailings pile as waste (73). If Montana's uranium reserves are of quality lower than the national average, which is probably the case, volume of waste tailings would be higher than average.

Environmental Effects

There are serious environmental problems associated with any open pit or underground mine; here the emphasis will be on environmental impacts specific to uranium mining.

The power of condemnation of surface rights for strip mining of coal has been taken from energy companies, but this option is still open for the strip mining of other minerals. Under current laws, a surface owner can have his land condemned to allow surface mining of uranium. Because there are social and environmental problems common to all surface mining disturbances, perhaps condemnation powers should be taken from uranium miners too, at least those who use surface mine methods.

Open pit and underground uranium mining both have problems associated with the disposition of overburden. One problem associated with surface or underground uranium mining is that radioactive material leached from tailings may enter nearby streams. Some sources say the problem can be controlled: "This hazard can be controlled by adequate monitoring, impoundment of water for critical periods, control of discharge, and by suitable design of tailings areas to prevent uncontrolled leaching" (73). Underground uranium mining poses a unique problem in that there are occupational hazards associated with working in a closed space with radioactive materials. A direct relationship has been established between occurrence of lung cancer in uranium miners who work underground and the level of radioactive by-products in the mine atmosphere. This problem can be alleviated by adequate ventilation and limiting the amount of time workers spend in the mine, it is said:

> The possibility of danger to workers in underground mines and their associated mills is due to radon emissions. This danger is one of the industrial or work environment, and it is unlikely that the situation will ever be encountered where there is damage to the natural environment outside the mine itself. The danger can be minimized by adequate ventilation within the mine and by rotation and scheduling the workers to control the time spent in the critical areas. Modern statistics of health injury to miners of radioactive ores show that with present understanding and management the awareness of the miners and mill workers themselves, risks from accumulated radiation are negligible in uranium mines today. (73)

Open pit mining does not share the ventilation problem. Although solution mining does not cause the surface disturbances of open pit mining and therefore would seem to be more environmentally attractive, groundwater quality may be affected by the acids used in solution mining. Ground subsidence is a possibility. There needs to be more research to control the adverse effects of solution mining.

Tailings from uranium mills and recovery plants are discarded in a slurry to ponds where the liquid must evaporate, seep into the ground or flow into natural waterways. The substance which remains is a sand-like material containing the radioactive by-products of uranium. If allowed to enter surface or groundwater resources, the tailings can contaminate water used for other purposes (73). Also, as the tailings dry, wind lifts radioactive particles into the air. To prevent water and air pollution from the long-lived radioactive contaminants, it is necessary to isolate the tailings pond from weathering factors for many years.

Controls on Uranium Mining and Milling

The controls on uranium mining and milling cover two areas: regulating the mining process and regulating radioactive pollution from uranium reserves and waste. Open pit mining of uranium is regulated by Department of State Lands under the Strip Mining and Reclamation Act which requires reclamation of disturbed land. Because the present regulations do not apply specifically to uranium mining, new regulations should be promulgated. Underground mining is not controlled except for its surface disturbances. The chief occupational hazards of underground uranium mining are regulated by Department of Health and Environmental Sciences (DHES) under the Radiation Control Act, which can require control devices. Threats to groundwater quality from solution mining can be controlled by the DHES under the Water Quality Act, although other problems may not. The regulations under the Water Quality Act are not promulgated specifically for solution mining.

The environmental effect of uranium mine and mill tailings also is regulated by DHES under the Radiation Control Act. However, existing regulations concerning tailings are inadequate. The regulations were written in 1971 before many new techniques for control of tailings were devised. Perhaps new regulations should include these techniques. The Atomic Energy Commission has regulative powers in the uranium milling process; however, the state can assume its function by becoming a so-called "agreement state." By assuming the AEC's standards, the state then assumes the AEC's regulatory authority. The 1969 legislature authorized the governor to "enter into agreement with the federal government providing for discounting the federal government responsibilities with respect to sources of ionizing radiation and the assumption of the state thereof." State regulation could be more strict than AEC regulations. It would require six months' preparation with added funding before the state's regulatory program could meet AEC standards for an "agreement state."

Uranium Enrichment Facilities

A uranium enrichment facility is one of the many processes associated with the nuclear fuel cycle and considered for location in Montana. The uranium enrichment process increases the proportion of fissionable isotope required for fuel in most nuclear power plants. There are only three uranium enrichment facilities operating in the U. S. The process, which increases the uranium-235 isotopic concentration from .7 to more than 2 percent, is not performed by private industry (71). However, future uranium enrichment plants probably will be built and operated by industry. Foreign demand for enriched uranium is increasing at a rapid rate. It is projected that 10 or 11 new enrichment plants will be built in the nation by the year 2000, totaling more than three times the present capacity (71).

Colstrip, Montana and Gillette, Wyoming were considered by a three-company consortium as possible sites for a uranium enrichment plant, mainly because of the large electric power requirements of such a facility (74). Although these companies have decided to locate elsewhere, Montana remains a prime site for future enrichment facilities due to the state's vast coal reserves with the possibility of mine mouth electrical conversion of these reserves (74).

The power requirements of an enrichment plant are massive, exceeding the total power output now planned at Colstrip (74). The enrichment plant itself would require approximately 22,000 acre-feet of cooling water annually (71). The facility also would require 500 to 600 acres of land during its 30 to 40-year operating life to accommodate waste from the process (71).

Environmental Impacts

Enrichment facilities pose a two-fold environmental impact. There are social and economic costs and benefits (associated with any large scale industrial development in a rural area) and there are possible problems associated with the disposal of waste from the enrichment process.

Constructing an enrichment plant requires three to four times the number of workers needed for a 2,500 megawatt generating plant and associated mine (71). In operation, the enrichment plant needs almost twice the number of employees compared to operating a 2,500 megawatt electrical generation facility (71). Both the enrichment plant and power facility (with mine) would be near one another since the environmental problems would be compounded. An enrichment facility would require 500 to 600 acres during its normal 30- to 40-year life span to allow waste disposal. Some of the radioactive by-products, for example, are valuable for other uses and may be temporarily stored in sealed containers on site for later use. Other liquid and solid chemical wastes are treated and diluted for release, burial on site, or packaged and shipped elsewhere (71). Some environmental problems may be mitigated by proper licensing and regulation by either state or federal government.

Uranium enrichment plants would be regulated by the Department of Natural Resources under the Utility Siting Act, and by the Department of Health and Environmental Sciences under the Radiation Control Act. Although the location of both the enrichment plant and its coal-fired power plant would be covered under the Utility Siting Act, it is not clear whether the two would be considered together or separately. There are no regulations under the Utility Siting Act pertaining specifically to enrichment plants, but there could be. The Radiation Control Act could control any radioactive pollution from the plant as well as waste disposal and occupational hazards if Montana were an "agreement state." Montana has not gained this status. Until it does, the Atomic Energy Commission has the main regulatory powers with the state Department of Health of maintaining a "watchdog" function over the AEC. The Western Interstate Nuclear Board has contacted the state of Montana over possible assumption of federal regulation by becoming an "agreement state."

II. THE ENERGY OUTLOOK

SUMMARY OF NATIONAL PROJECTIONS

Energy demand projections are available which give an approximation of future energy options in the United States. The projections used in this part of the study are the federal Project Independence Report, a so-called blueprint by the Federal Energy Administration; the Department of Interior's United States Energy Through the Year 2000, used in the Northern Great Plains Resource Program (NGPRP); and the Ford Foundation's Energy Policy Project scenarios. The three assessments of the future attempt to show what effect energy policies will have on energy demand and supply. They represent the most up-to-date thinking in the very inexact science of predicting the future. While they may be inaccurate, they are the best tools available. Uncertainties hinging on the possible inaccuracies of the projections are small in comparison to the problems certain to occur in the absence of state and national energy policy, which is very dependent on governmental action today.

Project Independence Report

Project Independence began in March, 1974 to evaluate the nation's energy problems and to provide a framework for future energy policy. Energy independence or self-sufficiency was declared federal policy by then-President Richard Nixon, during the Arab oil export embargo. The document developed by the Federal Energy Administration (FEA) does not make specific recommendations--rather it offers alternatives to lessen U.S. dependence on imported oil. Specific recommendations were made by President Gerald Ford in early 1975. First, it gives a business-as-usual case or the energy situation the nation would have without major policy changes. Alternative energy strategies are offered to accelerate growth in domestic supply, encourage energy conservation and demand management, and provide emergency programs to mitigate vulnerability of the nation in the event of renewed cutoffs. It analyzes the strengths and weaknesses of various energy alternatives in meeting the goal. Also it develops the policy needed to achieve the environmental and economic impact results of the alternative strategies. For summary of the document, see Appendix D, Project Independence Executive Summary, prepared by the FEA.

The business-as-usual case gives three future energy demand projections based on imported oil prices of $4, $7, and $11 a barrel in the world market (38,24). The differences in projected demand hinge on the effect energy prices have on demand--the result of price elasticity. Energy demand at $4 barrel for imported oil is projected to grow at 3.8 percent per year, much less than the 4 to 5 percent average annual energy growth experienced through the 1960s (38,26). Table 32 below shows projected energy demand in 1985 pegged to various imported oil prices:

TABLE 32

Project Independence Energy Demand, Base Case--1985

Price of imports		Total Demand	
	1972 (Actual)	Quads*	1985 estimated % Growth
$4	72.1	118.3	3.8
$7	72.1	109.6	3.2
		102.9	2.7

*Quads = Quadrillion BTUs or 1.0 x 10^{15} BTUs or 1,000,000,000,000,000 BTUs

Source: Project Independence Report, FEA, November 1974

The assumptions used in the business-as-usual case are that United States population will grow .96 percent annually and the Gross National Product will grow at 3.5 percent annually between 1973 and 1985. Other key assumptions about future federal energy policies in a business as usual case were:

1. Regulation of natural gas prices would not discourage production which would otherwise be economically justified; or deregulation of natural gas prices occurs.

2. Energy siting and price controls will be removed by the end of 1975. Current Clean Air Act will be modified to allow use of polluting fuels.

3. Current tax laws on depletion allowances, profits, and the like will remain unchanged.

4. Natural gas imports from Canada will be available at $1.20 per thousand cubic feet up to 2.1 trillion cubic feet annually; liquefied natural gas imports will be available at $2.00 per mcf.

5. The Trans-Alaskan Pipeline will be completed on schedule.

6. No major Pacific, Atlantic or Gulf of Alaska off-the-Continental-Shelf oil leasing is slated (38,25-26).

Some of these assumptions are very hopeful. For example, that Canadian natural gas imports even will be available, let alone at a $1.20 per mcf* The production schedule of the Trans-Alaskan Pipeline may well suffer more delays which could alter the 1985 energy picture.

Supply for this projected demand would vary according to the imported oil prices and conversion techniques used. Petroleum production would remain the same or decline between 1974 and 1977. At $7 a barrel world oil prices in 1985, production will rise slightly due to increased production from Alaska and Outer Continental Shelf (OCS) production (38,29). Production in the continental United States will decline by approximately half, but the deficit would be offset by increased production from Alaska from the OCS (38,29). At $11 world oil prices production would increase greatly beyond $7 price projections from the use of expensive secondary and tertiary recovery techniques in the continental U.S. (38,29). Coal production would increase significantly but would be limited by lack of

*mcf: thousand cubic feet.

markets. Use of coal for synthetic oil and gas (by coal gasification and liquefaction) would increase but would not affect national supplies of the commodities significantly (38,30). These advanced synthetic fuels technologies barely would be economical at $11 a barrel world oil prices in this scenario and by 1985 their contribution would yet be small.

Natural gas production increases are limited in this scenario and continued price regulation could result in significant declines. Nuclear power would be expected to grow from 4.5 to 30 percent of total electrical power generation, limiting some markets for coal (38,30). Much of the oil that would be needed in 1985 under business-as-usual projection would be imported. There would be more oil imported at $7 than $11 prices because energy demand would be less at $11 prices and imported oil could be replaced by domestic sources.

The first of the alternative energy supply strategies given is the one which would accelerate growth in U.S. energy supply to meet the demand. The main differences between business-as-usual and accelerated supply are in the proposed supply sources. Federal policies to lease the Atlantic and reopen the Pacific OCS oil fields and tap the Navy's Petroleum Reserves would increase domestic oil production dramatically. Petroleum production at $7 prices by 1985 could rise by 43 percent, and practically double at $11 prices although less would be needed to achieve zero imports (38,47). Shale oil production would contribute to the national oil supply although $11 prices would be needed for economic viability (38,49). Serious potential environmental and water supply problems would have to be overcome. Accelerating synthetic fuel production would require bypassing important research steps and thus may yield uneconomic or impractical technology by 1985 unless government price supports are instituted (38,50). Accelerating domestic energy production could be restrained by key problems, according to the FEA:

In the short-term, many shortages of materials, equipment and labor will persist.

By 1985, however, most critical shortages will be overcome sufficiently to meet the requirements of the Accelerated Supply scenario.

Availability of drilling rigs and fixed and mobile platforms will be a major constraint in reaching projected oil levels.

Financial and regulatory problems in the utility and railroad industries could hamper their ability to purchase needed facilities and equipment (38,50).

Water availability would be a problem in selected regions by 1985 under an accelerated supply strategy (38,50).

The FEA lists some important drawbacks of the accelerated supply scenario. It would:

1. Adversely affect environmentally clean areas.

2. Require massive regional development in areas which may not benefit from or need increased supply.

3. Gamble on as yet unproven reserves of oil and gas.

4. Be constrained by key materials and equipment shortages (38,50).

These problems would reduce the benefits of any massive acceleration of the United States energy supply between now and 1985.

The FEA document offers an energy conservation scenario in which current domestic oil deficits are eliminated by decreasing demand rather than increasing supply. They estimate that demand could be reduced to about a 2.0 percent per year growth between 1972 and 1985 (38,52). Energy demand first would be curbed by increased prices but achieving further reductions would require new energy conserving standards on products and buildings or subsidies and tax incentives. Major actions could include standards for efficient new cars, incentives to reduce total miles traveled, to improve heat efficiency in existing homes and offices, and minimum insulation standards for new homes and offices. It is estimated that such conservation efforts could reduce petroleum demand by 12 percent by 1985 (38,54). Electrical demand could be reduced 10 percent from the base, and accelerated supply scenarios (38,54). Demand management could reduce dependence on limited oil and gas supplies even further by switching from petroleum and natural gas consumption to coal or coal-fired electric power. Environmental problems and inability of the electric utility industry to finance massive increase in demand could limit the shift away from oil and gas (38,55). Also, an early (before 1985) shift to heavy domestic oil and gas use would have to be weighted against the necessity of increasing coal use for liquefaction and gasification in the post-1985 period to take up deficits in domestic oil and gas production (38,55).

The federal program for emergencies would consist of standby conservation programs and expanded oil storage. Standby conservation would be initiated within 60 to 90 days of any future embargo and could cut consumption significantly (38,56). Associated conservation programs would involve almost no cost when not needed and would require relatively small administrative and economic expenditure when implemented (38,56). The major component of the emergency program would be storage of sufficient oil to replace imports that were cut off. Storage would require $6.2 billion over 10 years (38,59). The United States' participation in the International Energy Program (IEP) would reduce the likelihood of a disruption in imports. It includes a formula for international allocation of oil supplies to avoid excessive bidding and divisive scramble for available oil (38,62). If the United States were to achieve the low import levels which are possible at high oil prices, and pursue aggressive strategies of accelerating supply and conservation, the IEP still would act against oil supply disruption but its importance to the United States would be diminished (38,62).

The implementation of any of these strategies, or a combination of any, would greatly affect domestic energy supply and demand by 1985. The net impacts are summarized in Table 33 below for the cases of $7 and $11 oil prices.

The FEA document makes several conclusions about the economic vulnerability of the United States in any of the strategies:

1. At $11 a barrel oil, the import problem would not be very serious, and an accelerated supply program could eliminate imports entirely.

2. Even at $7 oil, supply and conservation measures can bring imports down to pre-1974 levels.

3. Especially at $7, the strategies could produce a large reduction in U.S. demand for world petroleum which could be expected to reduce world oil prices (38,35).

TABLE 33

U.S. Energy Supply, Demand and Imports in 1985
(Project Independence)

	U.S. Energy Demand (quads)**	Domestic Energy Supply (quads)**	Imports* Oil (MMB/D)	Imports* Natural Gas (TCF)
At $7 World Oil Prices				
Base Case w/ and w/o Emergency Programs	109.1	84.2	12.4	
Accelerated Supply	109.6	92.6	8.5	0
Conservation	99.2	79.6	9.8	0
Accelerated Supply plus Conservation	99.7	88.5	5.6	0
At $11 World Oil Prices				
Base Case w/ and w/o Emergency Programs	102.9	96.3	3.3	0
Accelerated Supply	104.2	104.2	0	0
Conservation	94.2	91.8	1.2	0
Accelerated Supply plus Conservation	96.3	96.3	0	0

*1 MMB/D equals 2 quads
*1 TCF Natural Gas equals 1 quad
**1 quad equals 10^{15} BTUs

Source: Project Independence Report, Federal Energy Administration, November, 1974.

Northern Great Plains Resource Program

The Northern Great Plains Resource Program (NGPRP) did not generate its own energy projections, but relied on a Department of Interior report, United States Energy Through the Year 2000, written by Walter B. Dupree, Jr. and James A. West, in 1972 (1,III-2). The NGPRP, a cooperative program between western states and the Department of Interior and the Environmental Protection Agency, has best assessed the impacts of future coal production and energy conversion in the Northern Great Plains. The projections established by the Interior report are typical of earlier energy projections, in their optimistic assumptions about growth of the Gross National Product--generally they see high rates of energy growth.

The Department of Interior's projection of energy consumption established a 3.7 percent average annual growth for energy from 1971 through 1985 (75,20). (See Table 34.) In 1980, it predicts an annual energy consumption of 96 quadrillion BTUs and by 1985, 116.8 quadrillion BTUs (75,20). It assumes the Gross National Product to grow at 4.3 percent annually between 1972 and 1980 and 4.0 percent thereafter (75,17). (There was no real growth in the economy during 1974 but forecasts indicate slow recovery to rates similar to the Interior assumptions.) Nationally, population would grow at 1 percent a year (current population growth is estimated at 0.7 percent a year (75,19). Supply limitations were taken into account explicitly. The report states that it is a consumption forecast, not an energy demand forecast. No energy conservation policies were taken into account (75,1).

Until 1980, the extra supplies needed to fulfill this would come from increased oil imports or from domestic conventional sources that may become available through discovery of new reserves. The share of each of these sources (oil, gas, coal and nuclear) would be dependent on governmental policies, environmental constraints and economic conditions during the period (75,11). Beyond 1980 supplemental supplies also could come from shale oil, coal liquefaction and tar sands (75,11). Their contribution also would be dependent on commercial development of new technologies. Nuclear power is to expand five times its 1973 production level by 2000 (75,11). The only other domestic energy source expected to make significant new contributions is coal. Its production is expected to double in the next three decades. Domestic supplies of petroleum and natural gas generally are expected to be limited, with total oil production expected to decline and natural gas production to stabilize (75,11).

TABLE 34

NGPRP Projected Energy Growth

	1980	1985	% Growth (average annual compounded)
Energy Consumption*	96.0	116.8	3.7
Gross National Product**	1102	1343	4.3 (before 1980) 4.0 after
Population***	229.4	243.3	1

*quadrillion BTUs

**billions of 1958 dollars

***millions

Source: U.S. Energy Through the Year 2000, Dupree and West, Department of Interior, 1972.

Energy Policy Project of the Ford Foundation

The Energy Policy Project, a $4 million two-year study financed by the Ford Foundation is the most complete private energy study ever undertaken. The project provides three major energy demand projections: scenarios based on Historical Growth, Technical Fix and Zero Energy Growth (ZEG). Historical Growth is largely a projection of energy demand based on past trends and policies. The Technical Fix scenario is energy growth that could be expected with present energy prices and specific energy conservation policies. The third projection, ZEG, is what could be achieved with an ambitious national effort of energy conservation. The ZEG scenario assumes per capita energy consumption will increase by about 10 percent between 1975 and 1985, then level off (75, 16). The conservation programs would be phased in throughout the following decades, without causing major disruptions in the energy economy. Energy consumption would grow after 1985 at the same rate as population thus achieving Zero Energy Growth relative to population (75,16). Zero Energy Growth would not mean no economic growth; it would allow for sustained economic growth.

The Historical Growth scenario would require that the energy trends of the 1950s and 1960s reestablish themselves and remain beyond the year 2000. It provides for an average annual rate of energy growth of 3.4 percent (75,20). For the situation actually to occur, oil prices would have to drop to $7 to $8 per barrel and other energy prices remain stable (75,27). Electrical power prices would have to start dropping again, a trend that generally ceased in 1968 (75,27).

In the Historical Growth scenario, there would be energy by the year 2000 to heat and air condition every household in the nation (75,20). Energy also would be abundant enough to run a water heater, cooking stove, freezer, dish-washer, a large frost-free freezer in every household (75,21). Approximately a third of homes would be all electric (75,21). There could be 138 million large powerful cars, or better than a car for every two people. In 1970 there were

2.3 people per car (75,21). The average fuel efficiency of automobiles under this scenario would be about 11.4 miles per gallon compared to 1970's average of 13.6 mpg (75,21). By 2000, each person would consume two times the energy consumed individually in 1973 (75,23).

Accelerated development of all energy sources would be necessary to provide the energy needed in the scenario. There would have to be substantial growth in the nuclear and coal industries (75,26). Also required would be the discovery and production of marginal--and costly--energy supplies. High prices would cause a decline in demand, so governmental price ceilings and subsidies would be needed to maintain the 3.4 percent annual growth rate (75,28). Self-sufficiency, that is an absence of oil and gas imports, is not possible by 1985 in this scenario (75,32). Self-sufficiency would require rapid expansion of nuclear power, now limited by uranium enrichment capacity and shortage of skilled labor. Coal also would play a very important role. The inefficiency of converting raw energy to usable forms becomes increasingly important in the scenario of continued growth (75,32).

Growth in energy consumption by individuals and industry in any scenario would require an even higher percentage growth in fuel production because of production losses (75,33). The losses would grow larger as natural oil and gas were replaced by synthetic fuels and electric power--both supported by inefficient conversion processes. As marginal fuel sources came into play, higher and higher energies would be required to extract fuel from the ground, to build the plants to convert it to usable form, and to provide the water supply and other required support facilities (75,33). The net energy available to consumers will be reduced. (See Appendix C for an explanation and application of the "net energy" concept.)

In the Technical Fix scenario the same high energy services (heating, cooling, number of cars) would be offered, but the nation would adopt specific policies to decrease the energy needed to supply these services (75,46). Average annual rate of growth approximately half the rate of the Historical Growth scenario would be allowed, or average annual growth of 1.9 percent (75,46). This growth rate could be achieved either by specific governmental energy conservation policies or through greatly increased energy prices. The project report states:

> We believe that if the nation adopts energy conservation as a goal, and adopts the set of policies that we recommend, we can achieve the level of savings in the Technical Fix scenario, and by so doing alleviate concerns about supply, environment and foreign policy without appreciable energy price increases (75,72).

The country gains considerable flexibility in putting together a combination of energy supplies under the Technical Fix (75,75). It is important to emphasize that sustaining even the low rate of growth in this scenario would require substantial additional energy supplies and expansion of a number of sources. It would be possible, however, to forego development of some major energy sources or, alternately, to meet demand by expanding various sources at about half the rate required in the Historical Growth scenario (75,76).

Zero Energy Growth is what the nation could achieve with vigorous energy conservation policies and prices slightly higher than today. It is predicted that ZEG, that is no further increases in per capita energy consumption, would occur after 1985 (75,82). Energy growth would approximate the rate seen in the Technical Fix scenario, but after 1985 it would level, and increase only with population (75,82). The move toward ZEG would be done carefully and over a long period. Policies would uncouple energy and economic growth. The economy would be changed somewhat, but the Gross National Product essentially would be the same as in the two other scenarios. The project report explains:

> In our Zero Energy Growth (ZEG) future there would be greater emphasis on services--education, health care, day care, cultural activities, urban amenities such as parks--which generally require much less energy

per dollar than heavy industrial activities or primary metals processing, whose growth would be deemphasized. Although production of materials would be much greater in 2000 than it is today, production of material "things" would be somewhat lower by 2000 in ZEG than in the Historical Growth or Technical Fix scenarios. This does not mean that people would lack the valued material amenities of the higher energy growth scenarios. Rather, in ZEG there would be a premium placed on durability and quality of consumer goods, so that production each year could be lower. Also, materials substitutions would be encouraged. As a prime example, throw-away cans and bottles would be discouraged in favor of reusable containers (75,82).

The energy supplies strategy for ZEG is not scaled down from supply schedules in other growth scenarios (75,105). A decision to level off energy consumption in a decade might stem in part from a desire to avoid development problems that cause very serious environmental problems, problems now commonly associated with expansion of nuclear power, development of offshore oil production, oil shale and western coal strip mining (75,105). Alternative energy sources furnish a high percentage of ZEG energy supplies. Alternative sources would include solar power, wind, conversion of organic waste--energy sources which are both renewable and environmentally clean (75,106). In many cases, the alternative energy sources are now economically and technically available.

The Gross National Product and employment under all three scenarios would be largely the same (75,90). By 1985, the Gross National Product would be slightly less in the Technical Fix and Zero Energy Growth Scenarios than the Historical Growth, but employment would be slightly higher--reflecting the movement toward a service-oriented economy (75,90). (See Figure 24 on p. 98.)

Comparison of National Energy Projections

Three national energy scenarios propose meeting domestic energy demand without governmental conservation policies. They are Dupree's and West's United States Energy Through the Year 2000 (Interior); the Energy Policy Project's Historical

FIGURE 24

Economic Comparison of the Three Energy Policy Project Projections

Gross national product: Historical Growth, Technical Fix, and ZEG

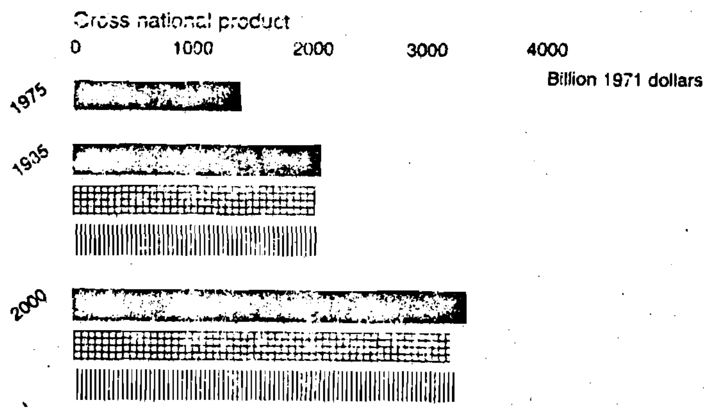


Figure 15–Employment: HG, TF, and ZEG

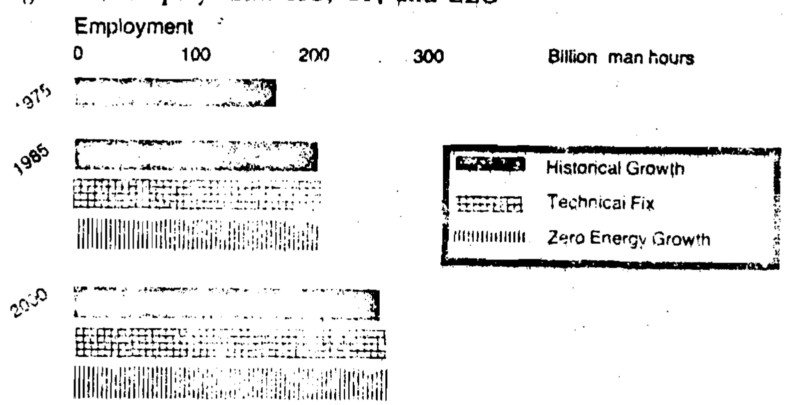
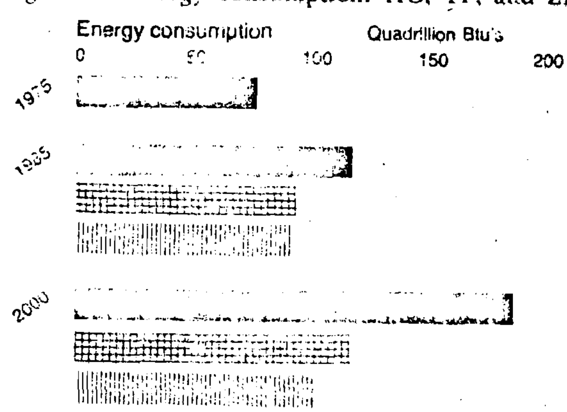


Figure 16–Energy consumption: HG, TF, and ZEG



Sources: Energy Policy Project and Data Resources, Inc.

Source: Energy Policy Project of the Ford Foundation

Growth scenario (Ford) and the Federal Energy Administration's (FEA) Project Independence business-as-usual (BAU) case. The projections range from 2.7 percent to 3.8 percent average annual rate of growth. (See Table 35.) Ford's historical growth and Interior's forecasted growth essentially are the same. The FEA took into account the elasticity of oil in response to price increases; Ford determined that to achieve historical growth, oil prices would have to be $7 to $8 a barrel (75,24) (1971 dollars). The FEA explains its approach: "The FEA forecast of energy consumption in the BAU [business-as-usual] case is very sensitive to the assumed price for world oil. As effective world oil prices drop, domestic demand will increase. Conversely, world oil prices higher than $11 per barrel will further dampen demand " (38,26). However demand reduction between a $4 price increase to the $11, is much greater than from $11 up because consumers have only limited freedom to shift to other sources of fuel.

TABLE 35

Comparison of Forecasts of Energy Demand

(Quadrillion BTUs)

	1972	1985	% Change 1972-1985	Compound Annual Rate of Growth % 1972-1985
FEA ($11/BBL Import Price)	72.1	102.9	43	2.7
FEA ($7/BBL Import Price)	72.1	109.1	51	3.2
Interior	72.1	116.6	62	3.8
Ford: Historical Growth	72.1	116.1	60	3.7

Source: Project Independence Report, Federal Energy Administration November 1974.

Energy consumption by sector also is largely the same between projections. The FEA projected total use in the household and commercial sectors at 9 percent lower than the Interior forecast primarily because of a decrease in oil consumption at higher prices. (At the time of the Interior projection, oil was selling at $4.) The only difference between the Historical Growth scenario and the others is in Ford's industrial demands picture which shows a decrease in energy used in transportation. (See Table 36.)

TABLE 36

Shifts in Energy Demand by Sector

(Quadrillion BTUs)

End-Use Sector	1972 Actual Quads	%	FEA $11/BBL Quads	%	1985 Estim. FEA $7/BBL Quads	%	Interior Quad	%	Historical Quad	%
Household & Commercial	18.1	31	25.9	32	25.9	32	27.7	31	38.0	32
Industrial	23.1	38	29.0	38	30.4	38	34.9	39	52.1	44.7
Transportation	18.1	31	22.0	29	24.6	30	27.1	30	26.0	22.3
Total Gross Fuel Consumption	72.1		102.9		109.1		116.6		116.1	

Source: Project Independence Report, FEA; U.S. Energy Through the Year 2000, Department of Interior; A Time to Choose, Ford Energy Policy Project.

The projections have very different projections of energy supply among gas, oil, nuclear and hydroelectric energy sources. (See Table 37 on p.101.) The Interior estimate relies most heavily on oil and the least for coal for other than synthetic natural gas production (74,40). The FEA estimates have the most nearly equal mix among the sources of fuel (38,46). Ford's Historical Growth scenario uses three different supply forecasts: domestic oil and gas, high nuclear and high import mixes. The differences among the three are basically in apportionment of reliance on nuclear and oil fuels. The high import mix has oil requirements similar to the Interior forecast. Ford's high nuclear mix also is similar to the Interior nuclear projection.

TABLE 37

Fuel Mix for Selected Projections (1985)

(% of total fuel required)

	Coal	Synthetic Gas	Oil	No Gas	Nuclear	Hydro & Geo-thermal	Total (%)
Interior	18.4	1.7	43.7	24.3	10.0	3.7	100
Ford: Hist. Growth							
a. Domes. Oil & Gas	21.5	1.7	38.7	25.8	8.6	3.4	100
b. High Nuclear	19.8	1.7	38.7	25.8	10.3	3.4	100
c. High Import	17.3	0.8	42.6	23.4	8.6	3.4	100
FEA (BAU) $ 7	20.5*	--	36.7	24.7	12.9	5.0	100
$11	22.9*	--	34.7	24.6	12.5	5.1	100

0.0 - highest percentage of reliance among forecast.

*Includes minimal synthetic gas and oil production.

Source: Project Independence Report, FEA; U.S. Energy Through the Year 2000, Department of Interior and A Time to Choose, Ford's Energy Policy Project.

The environmental impact of acquiring an energy supply is largely agreed between Ford and the FEA. To produce enough oil and gas, offshore and frontier areas (Alaska) would have to be opened for development. Widespread development of western coal would be needed to supply fuel requirements. Synthetic production of gas and oil from coal, even though a small portion of the total energy budget, would require large amounts of water from areas where it is scarce. The FEA made estimates for air and water pollution that would be expected in the supply scenario. Results show in Table 38. The reason that air pollution would be higher at $11 than $7 world oil prices is that more coal conversion would be needed in the $11 projection.

TABLE 38

Environmental Comparisons 1972-1985
(Project Independence)

Pollutant Category	1972 Level	1985 Level	
		$7	$11
Water Pollution:			
Dissolved solids (tons/day)	37,000	5,200	5,800
Suspended solids (tons/day)	7,600	240	300
Thermal discharges (billion Btu/day)	19,500	24,000	24,000
Air Pollution:			
Particulates (tons/day)	1,800	2,200	2,300
Nitrogen Oxides (tons/day)	38,000	41,800	46,700
Sulfur Oxides (tons/day)	58,900	47,100	53,700
Hydrocarbons (tons/day)	33,200	18,800	18,800
Carbon Monoxide (tons/day)	7,900	1,000	1,400

Source: Project Independence Report, Federal Energy Administration, November, 1974.

A major constraint in supply projections is that there would be a shortage of clean fuels, especially low-sulfur coal (38,305). The constraint probably would require amendment of the federal Clean Air Act of 1970. There also would be significant manpower and equipment shortages for production of oil, gas and coal in the nation. Nuclear growth would be hampered by the lack of uranium enrichment facilities. Other problems with nuclear power generation include radioactive pollution of the environment, safety and reliability problems (shutdown time now averages 20 to 40 percent of total operating time). These problems would have to be mitigated before nuclear growth could occur.

Imports

Even with generally increased domestic production, the United States under any of the projections would have to import significant amounts of oil, which could again be used as a political and economic weapon against the United States. The amount of oil that would be imported varies from a low of 6.4 percent of total energy demand in the FEA $11 oil price projection, to a high of 22.7 percent of total demand in its $7 oil price projection. (See Table 39.) The FEA projections did not take into account the goal of self-sufficiency because this projection was designed to approximate the nation's situation if no major energy policies were enacted.

TABLE 39

Oil Imports (1985)

(Quadrillion BTUs)

Forecast	oil	natural gas	oil import as % of total demand
Ford--Historical Growth			
Domestic Oil & Gas	10	1	8.6
High Nuclear	10	1	8.6
High Imports	22	4	18.5
FEA-- $7 oil price	24.8	0	22.7
$11 oil price	6.6	0	6.4
Interior	7.55	5.88	6.5

Source: Project Independence Report, Federal Energy Administration; U.S. Energy Through the Year 2000, Department of Interior; Ford Foundation's A Time to Choose.

ACCELERATED SUPPLY

One way to eliminate oil imports would be to accelerate production of domestic energy supplies. This strategy was presented in the FEA's accelerated development energy option. Even with accelerated development of energy supplies the only case in which supply could meet demand was in its $11 oil price projection (38,39). In order to stimulate supply in excess of that available in the FEA's business-as-usual case it would be necessary to:

1. Standardize and expedite licensing to increase nuclear capacity 15 percent by 1985.

2. Open Navy Petroleum Reserves to full-scale commercial development.

3. Begin significant new leasing, exploration and development of the Pacific, Gulf of Alaska and Atlantic outer continental shelf oil fields.

4. Build additional oil and gas pipelines from Alaska to the lower 48 states and construct major new domestic pipelines.

5. Increase federal leasing and take action to eliminate environmental and water constraints to allow additional oil shale production.

6. Take action to assure supplies of critical materials and equipment to meet expected production levels, particularly for oil and gas (38,46).

With these new policies, the increased production could be achieved by 1985, according to Table 40.

TABLE 40

Domestic Fuel Consumption by Source, 1985 (FEA)

(Quadrillion BTUs)

		$7 Oil					
Fuel Source	1972 Actual	Base Case	Acc. Supply	% Change	Base Case	Acc. Supply	% Change
Coal	12.5	19.9	17.7	-11.0	22.9	20.7	- 9.6
Oil	22.4	23.1	30.5	+32.0	31.3	38.0	+21.4
Gas	22.1	23.9	24.7	+ 3.3	24.8	25.5	+ 2.8
Hydro & Geo	2.9	4.8	4.8	0	4.8	4.8	0
Nuclear	0.6	12.5	14.7	+17.6	12.5	14.7	+17.6
Synthetics		-	0		-	0.4	
Imports	11.7	24.8	17.1	-31.0	6.5	0	-100.0
TOTALS	72.1	109.1	109.6	+ 0.4	102.9	104.2	+ 1.2

Source: Project Independence Report, Federal Energy Administration, November 1974.

The increase in oil production would come from additional oil supplies tapped from Alaskan and offshore fields. The accelerated development strategy coal production actually would decline from 1,085 million tons per year in the business-as-usual projection to 998 million tons per year (38,48). This would be the result of accelerated development of nuclear power and reduced use for power generation. Nuclear expansion would have no impact on imported oil; rather it would reduce the growth of new coal-fired generation capacity. The FEA presents several environmental impacts in accelerated development that differ from the business-as-usual case. They are:

1. Reduced air pollution impact from coal due to increasing nuclear power and oil development.

2. Reduction of oil spills because Outer Continental Shelf drilling results in fewer spills than imports by tanker.

3. More solid waste from increased production of oil shale.

4. Significant disruption of virgin frontier areas in the West for coal and in Alaska and the Atlantic and Pacific OCS for oil (38,40).

Energy Demand With Conservation

Energy conservation could eliminate the need for oil imports and still allow the benefits of the energy powered services that contribute to a comfortable standard of living. The object of a conservation policy would be to increase the efficiency of energy use and thereby lessen demand. Four projections offer a conservation strategy, two each in the FEA's Project Independence Report and the Ford Foundation's Energy Policy Project. (See Table 41 below.) The projections differ chiefly in the policies hypothesized for enaction and the price of world oil.

TABLE 41

Demand With Conservation Policies (1985)

	Quads*	Reduction in Demand from non-conservation case (%)
FEA: $7 oil	99.2	9 (from BAU $7 oil projection)
$11 oil	94.2	8.4 (from BAU $11 projection)
Ford: Tech Fix	95	18 (from Historical Growth)
ZEG	93	19.8 (from Historical Growth)

*Quadrillion BTUs.

Source: Project Independence Report, 1974, and A Time To Choose, 1974, Ford Foundation.

TABLE 42

FEA Energy Conservation
(Savings in Quadrillion BTUs)

Conservation Actions	$7 Oil 1977	$7 Oil 1980	$7 Oil 1985	$11 Oil 1977	$11 Oil 1980	$11 Oil 1985
Transportation						
Establish a mandatory 20 mpg auto efficiency standard	0.38	1.05	2.68	0.26	0.67	1.88
Enact legislation and establish programs that would substantially increase the use of public transit and discourage the inefficient use of automobiles, such as a gasoline conservation fee	1.04	1.12	1.61	0.84	0.89	1.22
Total Transportation Sector 1/	1.42	2.17	4.29	1.10	1.56	3.10
Residential and Commercial 2/						
Subsidy such as a 25% tax credit for retrofit of existing homes, expiring in 1980	0.28	0.45	0.76	0.29	0.47	0.82
Subsidy such as a 15% investment credit for energy reduction investments in existing commercial buildings, expiring in 1980	0.15	0.17	0.20	0.15	0.17	0.21
National thermal efficiency standards for new residential & commercial buildings	0.28	0.54	1.04	0.27	0.51	0.97
Mandatory lighting standards for commercial buildings	0.19	0.25	0.37	0.19	0.24	0.33
Appliance efficiency standards	0.07	0.25	0.65	0.05	0.19	0.47
Total Residential & Commercial Sector	0.97	1.66	3.02	0.95	1.58	2.80
Industrial						
Aggressive conservation programs assisted by R&D for increased efficiency in industrial processes	0.25	0.62	1.22	0.35	0.90	1.50
Total Net Savings 1/	2.64	4.45	8.53	2.40	4.04	7.40
Utilities 3/						
Demonstrations in support of adding energy conservation standards to the Federal Power Act	0.11	0.50	1.01	0.09	0.47	0.91

1/ Savings not entirely additive since auto disincentives would induce some increased new car efficiency.

2/ The gross savings would be higher since losses due to generation and distribution of electricity would be included.

3/ Savings in electrical generation result from decreasing the fossil fuel input required to generate the electricity demand in the three end-user sectors.

Source: Project Independence Report, Federal Energy Administration, 1974.

The FEA offers identical conservation policies for both the $7 and $11 world oil scenarios (See Table 42 on p. 106). The policies would include a mandatory 20-miles a gallon auto efficiency standard, mass transit systems in urban areas, increased insulation in homes and commercial buildings and conservation standards added to the Federal Power Act (38,52). Some conservation actions would have to be done on the state and local level. Assessment rates for state and local property taxes for homes with energy saving innovations could be reduced; energy conservation innovations could be exempted from state and local sales taxes and deductions from gross taxable income could be allowed for homeowners installing energy saving equipment. There is much potential for energy conservation in the policies developed by utility regulation commissions in each state. The FEA found that peak electrical load pricing (one of several rate restructuring aspects discussed in Appendix A), and increased distribution of energy among utility power pools could save significant amounts of energy (38,152).

An added benefit of the conservation strategy of the FEA is that the price of energy would be less with this strategy than with any scenario of demand without conservation (38,179). The reason for the low prices is that energy supply and demand would become nearly equal (38,179). Table 43 below shows the projected reduction in average prices for all sectors by fuel.

TABLE 43

1985 Price Changes in Energy Due to Accelerated Conservation at $11 Imported Crude Oil
(Standard Units)

Fuel	Base Case Price	Conservation Price	% Change
Electricity	24.51	24.30	-0.9
Gasoline	10.56	9.73	-7.9
Distillate	11.81	11.64	-1.4
Residual	10.70	10.41	-2.7
Natural Gas	1.02	0.89	-12.75
Coal (Hi BTU)	16.59	15.59	-6.0

Source: Project Independence Report, Federal Energy Administration, 1974.

Ford's Technical Fix and Zero Energy Growth scenarios both are conservation oriented. However, the ZEG is the most long-ranged approach offered to date. Zero Energy Growth admits that increasing energy demand cannot be satisfied forever, and submits that the nation should begin now to reduce demand. The Technical Fix is very similar to FEA's $11 project, in policies offered and in results. The conservation policies for the Technical Fix scenario are summarized below.

TECHNICAL FIX CONSERVATION POLICIES

Residential and Commercial

1. Consumer education: Giving the consumer information when buying on how much energy appliances and equipment use. A truth in energy law would require labeling of appliances to reveal energy consumption. State and local real estate laws would require disclosure of energy costs to buyers and renters (75,53).

2. Replacing promotional utility rates: Existing rates in electricity and to a lesser extent natural gas, now encourage consumption. Such rates fail to reflect the added true cost of extra units of energy (See Appendix A). Utility rates would be restructured to eliminate this defect and provide price incentives for conservation (75,54).

3. The upgrading of building codes: Energy saving technology would be encouraged for new buildings. Incentives for owners of existing buildings would be devised to encourage use of insulation and other fuel saving technology (75,55).

Transportation

1. A 20-mile per gallon fuel efficiency for cars by the year 1985. A purchase tax would increase as the average efficiency decreased. A tax credit would be allowed for cars with high fuel economy (75,57).

2. Change of Interstate Commerce Commission regulations to encourage competition by railroads with other forms of transportation (75,59).

3. Rail passenger service for short hauls (up to 400 miles) would be improved to a standard comparable to that found in other advanced industrial countries (75,60).

4. The Civil Aeronautics Board would be asked to consider energy and economic impacts on airlines of higher fuel costs as a factor in scheduling flight speeds and frequency with the objective of improving load factors wherever possible (75,61).

Industrial

1. Develop and use efficient production processes in paper, steel, aluminum, plastics and cement manufacturing (75,67).

2. Group industries to allow efficient use of waste heat among otherwise divergent industrial activities (75,66).

3. Recycle aluminum and other high-energy materials (75,68).

Zero Energy Growth

In addition to the energy conservation policies proposed by the Technical Fix for Residential and Commerical, Transportation and Industrial sectors, Zero Energy Growth energy conservation policies would:

1. Impose an energy sales tax to allow gradual purchase of energy saving equipment. The tax would be designed to raise the price of energy-intensive goods and services relative to non-energy intensive activities and so would use traditional market mechanisms to reduce energy consumption. Additional policies would attempt to eliminate impact on low income consumers. A reduction of federal taxes or increases in federal payments for low income citizens could be a part of the energy sales tax. Alternatively, an energy stamp program, much like a food stamp program, could be designed (75,95).

2. Expand urban mass transit systems and develop bikeways systems (75,96).

3. <u>Eliminate depletion allowances</u> on virgin minerals. End freight rates that discriminate against hauling of recycle scrap. This would encourage recycling of materials (steel, aluminum) which requires less energy than original processing (75,96).

4. <u>Eliminate the aluminum can</u> in favor of recyclable glass bottles (75,96).

Reduced energy demand under conservation policies would permit flexibility in energy supply. With the added flexibility, environmental considerations could be given fair treatment. In Ford's Technical Fix and ZEG projections, there would not be need for offshore oil development in the Gulf of Alaska, Atlantic or Pacific outer continental shelves. Coal production could be limited to underground mines. Strip mining would be only where reclamation is feasible, specifically in the midwest and eastern United States. Growth of nuclear power would be curtailed pending solution of its serious environmental problems. The FEA conservation approach, like Ford's, also has environmental advantages. Water and air pollution under FEA's conservation strategy would be much less than in either the business-as-usual (base case) or accelerated development cases (See Table 44 on p. 111) (38,40).

The major advantage of conservation is its extension of the life of national energy sources. The FEA's look at the effects of energy alternatives shows business-as-usual leading to peak oil and gas production in the mid-1980s (38,432). The deficit would be taken up by oil and gas synthesized from coal and shale oil. Coal and synthetic fuel production would have to grow 6 percent a year. Coal production by 2010 would reach 3.5 billion tons per year (38,432). This production level rapidly would deplete the nation's coal reserves. If coal production stays at 1972 production levels, however the United States would have at least 800 years' coal supply (38,432). At 1985 coal production levels in the FEA's accelerated development case, the nation would have 12 years' coal supply based on today's proven reserves. The major short-term problem with expanding energy supply is in oil production. If the nation accelerated oil and gas production in the next decade, it could reduce imports quickly but this benefit probably would come at the expense of a large oil and gas deficit in the early 21st century. (See Figure 25 on p. 112.) (38,435)

TABLE 44

Environmental Impacts of FEA Energy Strategies
(Selected Indicators)

		1985 at $11 Oil Imports Alternate Energy Strategies		
Air Pollution	1972	Base Case	Accelerated Supply	Conservation
Particulates (tons/day)	1,800	2,200	2,300	1,800
NO_X (tons/day)	30,000	46,800	43,000	38,400
SO_X (tons/day)	58,900	53,700	48,800	41,500
Water Pollution				
Disolved Solids (tons/day)	37,000	5,800	5,500	5,000
Suspended solids	7,600	300	260	210
Solid Waste				
1000 tons/day	900	1,100	2,300	900
Land Disruption 1,000 acres	19,800	26,700	21,800	17,900

Source: Project Independence Report, Federal Energy Administration, Nov. 1974.

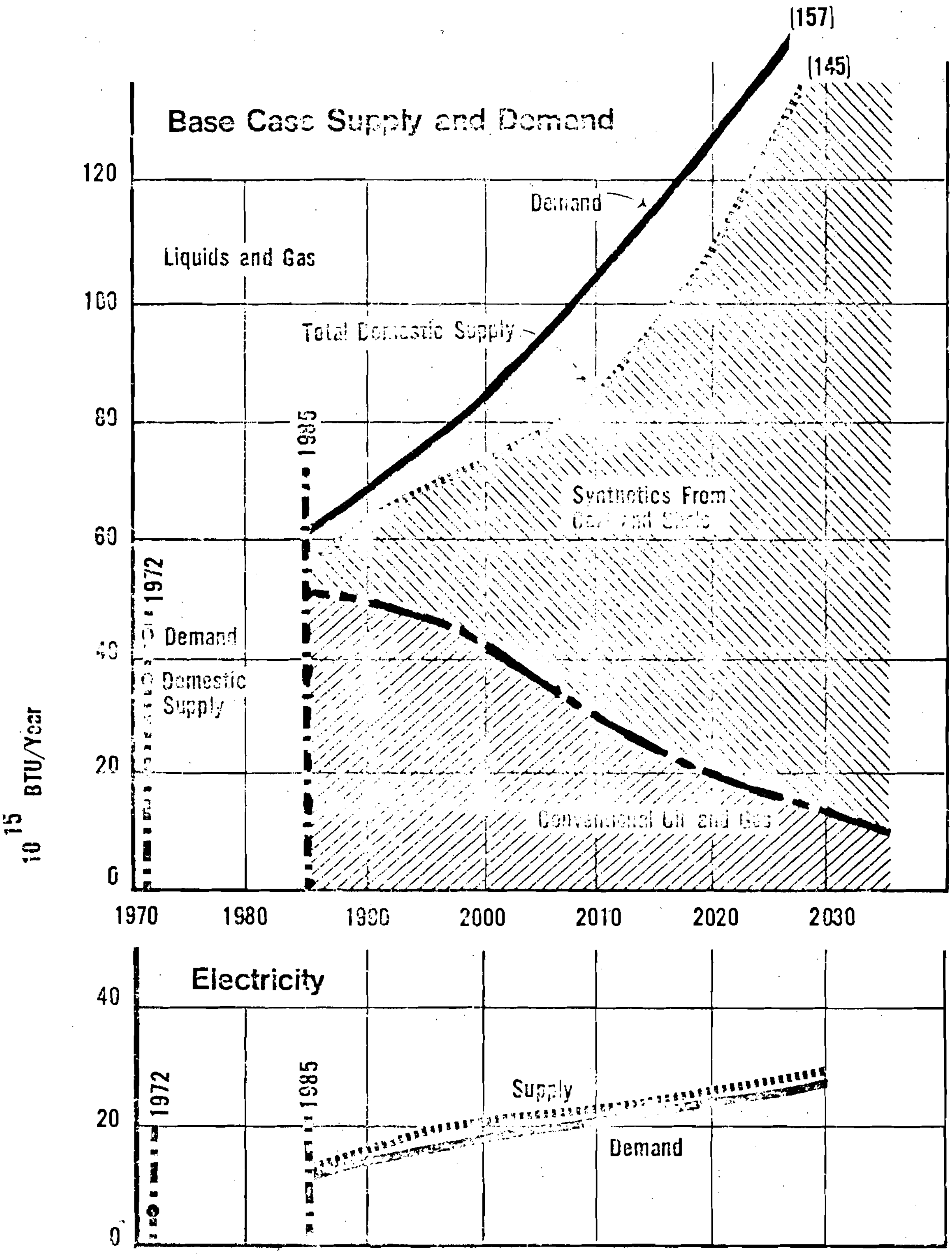
The FEA found basic trends in its long-term analysis (beyond 1985):

1. Oil and gas will become increasingly scarce;

2. Shale oil and synthetic fuels from coal, while having a limited impact in the near-term, will be needed to make up for the long-term deficits. In any case, such fuels may determine the price of natural oil and gas late in the century;

3. Conservation, especially when combined with shift to electric power, will become imperative in the long run.

FIGURE 25



Source: Project Independence Report, 1974, Federal Energy Administration.

4. Increased reliance on electric power will be necessary, implying dependence on nuclear power or other new sources as well as improved fossil fuel conversion technology (38,435).

MONTANA ENERGY OUTLOOK

Montana's energy future is tied very much to federal energy policies. For example, if the federal government moves toward accelerating supply rather than energy conservation, the pressure to build synthetic fuel plants will be increased, thus limiting the water available for irrigated agriculture. However, with an effective national conservation policy, the need for synthetic fuel plants in Montana in the next 10 years is questionable. Also, if growth in the nuclear industry is encouraged, uranium mining and enrichment plants in Montana may become more attractive. Energy-related industrialization will introduce many severe conflicts over resource allocation and preservation. The water resources of southeastern Montana cannot provide enough water for both planned irrigation and coal conversion even with extensive damming. Preservation of the state's land, water and air as well as economic and social resources may not be compatible with extensive energy development.

The state also has serious problems in the supplies of oil and natural gas. The Canadian government decision to cut off exports of natural gas and oil severely affects Montana and the entire Upper Midwest region. Natural gas accounts for 58 percent and 63 percent respectively of the total fuel used in the industrial sectors in Montana (18). Through present rate structures, large industrial users will feel the greatest impact of natural gas shortages and in some cases will have to shut down because of the lack of fuel. Canadian oil shipped to the U.S. is to be reduced January 1975, with cutoff to be achieved by 1983 (29). Approximately one-third of the crude oil supplied to Montana's refineries comes from Canada (22). The prospect of meeting these natural gas and oil shortfalls by increased in-state production is promising. If adequate supplies are not found in Montana or in neighboring states, large-scale conversion of coal into synthetic oil and gas for in-state use may become necessary.

Future of Montana Uranium Production

The construction of uranium enrichment facilities in Montana is not specifically related to development of in-state uranium reserves. The major resources necessary are energy sources capable of supporting the electrical energy requirements of an uranium enrichment plant. Given the goals of Project Independence, this would require the construction of a typical enrichment facility (with a capacity of 8.75 million Separative Work Units a year) at the rate of one every 18 months until 1980 (38,113). This amount of new production would be sufficient to meet domestic and foreign requirements until 1983 (38,113). As more enrichment plants are built, the number of places which have the needed energy sources to produce the electricity decreases. If the growth in enrichment capacity follows the Project Independence predicted trend the state will become a more and more likely site for such plants.

New technology such as reprocessing usable uranium in "spent" nuclear fuel could reduce the demand for new uranium by 15 percent and enriched uranium by 20 percent (38,114). These type of plants are not being built, however, in sufficient quantities to meet 1985 requirements (38,114). The major constraints to expanded nuclear industrial development as seen by the FEA, are as follows:

--Uranium resources and exploratory activities.*
--Uranium mining and milling capacity.**
--Uranium enrichment capacity.**
--Spent fuel reprocessing capacity.
--Uncertainties about the schedule for on-line nuclear generating capacity (38,114).

*Occurring in Montana
**Has been proposed for Montana

If the price of uranium increases as expected and nuclear power plants are constructed on schedule, the state may well see proposals for uranium mining and enrichment between now and 1980.

It is still uncertain what role the state will play in the growth of the nuclear industry. The Project Independence, Ford Energy Policy Project, and Department of Interior projections on growth in nuclear generating capacity range from almost none to 10 times present capacity by 1980 (38,114). Many nuclear plants scheduled to begin construction or be in operation this year have been set back because of technological difficulties, lack of expected demand for electricity, and insufficient capital. The future of this source of electrical generation is very uncertain. The siting of a nuclear power electrical generating plant in Montana is unlikely because of excess in electrical generating capacity for in-state use and the abundant coal reserves available for future electrical conversion.

The Project Independence Report asserts that the nation will not have enough uranium production in the United States unless exploration and mine-mill facility construction is accelerated in the near future. If the nuclear power generation plants do grow at expected rates, much higher cost uranium ore will have to be used. The Project Independence Report states:

> The source of nuclear electric generating plant fuel is uranium ore. Uranium ores, like all mineable natural resources, are depletable and of finite size. The Atomic Energy Commission estimates that the United States has 520,000 tons of uranium reserves producible at a cost of $15/lb. or less and an additional 1,000,000 tons of potential resources at this cost (38,113).

Montana probably has some uranium reserves which can be mined at a cost of $15 per pound or twice the 1972 price of uranium ore. One option offered by Project Independence to stimulate the uranium mining industry is a program of financial incentives and greater access to exploration on public lands If the uranium mining industry were granted incentives, the probability of recovery of the state's uranium reserves would increase (38,114).

Coal

Coal development in Montana may take many forms. It could be mined, exported from the state, burned and processed to yield electricity, or converted to synthetic natural gas or oil. There are three major projections concerning coal in Montana, one by the Montana Energy Advisory Council (MEAC) based on existing contracts; a Northern Great Plains Resource Program forecast based on national demand as determined in the Interior report by Dupree and West, United States Energy Through the Year 2000, and Project Independence projections. Projections on coal conversion into electricity and synthetic fuels in Montana have been compiled in the Northern Great Plains Resource Program's scenarios and by Project Independence. Each coal development projection is based on the need for products yielded by the converted coal. As seen in the preceeding discussion on demand and conservation policies, demand for synthesized fuels may not materialize, depending on the results of federal and state policies.

STRIP MINING

Montana coal mining companies have long-term coal contracts through 1980 that require more than three times 1974 production rates. Based on these contracts and the opening of a new mine by Shell Oil Company in 1977, the total production in 1980 will exceed 50 million tons annually (41,28). This projection, made by MEAC, is based on known long-range (20- to 30-year) coal contracts as of 1974. Strip mining procedures needed to yield contracted amounts would have to be periodically approved by the Department of State Lands under the Strip Mining and Reclamation Act (41,28). The MEAC projection shows the amount of coal which can be expected to be mined, with the opening of one new mine, and serves as a base estimate below which production probably will not fall. MEAC projections estimate coal production according to use. Most of the coal scheduled to be produced by both 1975 and 1980 is to be exported to other states for conversion (41, 29). (See Table 45 below and Table 48 on page 120.)

TABLE 45

Coal Production by Coal Use (1975, 1980)
(million tons)

Year	Electrical Generation in Montana		Coal for Export	
1975	0.32	Knife River for Sidney Plant	4.33	Western Energy Co.
	0.50	Western Energy for Corette plant - Billings	8.25	Decker Coal Co.
	0.40	Western Energy for Colstrip No. 1 (coming on line)	4.00	Westmoreland
			3.00	Peabody
	1.22	million tons	19.58	tons
	1975 TOTAL: 20.8 million tons			
1980	0.32	Knife River Coal Co.	10.00	Western Energy (min.)
	0.50	Corette Plant	13.90	Decker Coal
	3.00	Colstrip No. 1 and No. 2 (Western Energy)	3.00	Peabody
	5.60	Colstrip No. 3 and No. 4 (Western Energy)	6.50	Westmoreland
			8.00	Shell Oil Mine (expected)
	9.42	million tons	41.40	million tons
	1980 TOTAL: 50.8 million tons			

Source: Coal Development Information Packet, Montana Energy Advisory Council, December 1974.

The Northern Great Plains Resource Program, a joint effort among the states of Montana, Wyoming, the Dakotas and three federal agencies (Interior and Agriculture Departments, Environmental Protection Agency), also presents projections on coal development in Montana. It offers three coal development profiles (CDPs): base, intermediate and extensive. The three profiles are based on varying forecasts of the need for energy:

CDP 1: Coal production and energy conversion facilities are adequate to meet Northern Great Plains regional demands and to supply existing sales contracts (base energy forecast).

CDP 2: The most probable forecast based on current demand trends.

CDP 3: An extensive development forecast showing possible effects of serious national shortfalls in imported oil and natural gas and delays in provision of nuclear generating capacity (1, III-23).

The forecasts were based on U.S. Department of Interior national demand projections in United States Energy Through the Year 2000. The CDPs developed in early 1973 already appear out-of-date. Table 46 below shows regional CDPs compared to an actual industry expectation. The industry expectation is based on the best estimates of individual companies for export, power generation and synthetic gas production. The 143 million tons a year current industry expectation exceeds CDPs 1 and 2 and indicates there has been more interest in developing Northern Plains coal than anticipated (1, III-27).

TABLE 46

Northern Great Plains Coal Production Rates, 1980
(million tons a year)

CDP 1 Estimate	91
CDP 2 Estimate	107
Actual Industry Expectation	143
CDP 3 Estimate	160

Source: Northern Great Plains Resource Program, Interim Summary Report, 1974.

The coal development profiles for coal production in Montana range from 34 million tons in the CDP 1 to 64 million tons in CDP 3 by 1980 (1, III-26). The MEAC contracts survey found that industry has promised 50 million a year by 1980 (41, 28). This production level falls between CDP 2 and CDP 3. The CDP 1, or base energy forecast, does not seem to be very realistic. (See Table 47.)

TABLE 47

NGPRP Montana Coal Production Projections
(million tons a year)

Year	CDP 1 (base energy)	CDP 2 (intermediate)	MEAC*	CDP 3 (extensive development)
1975	20	20	20.8	20
1980	34	41	50	64
1985	39	75	--	153
2000	58	133	--	393

*MEAC estimates for coal contracts after 1980 are not available.

Source: Northern Great Plains Resource Program, Draft Report, 1974 and Coal Development Information Packet, Montana Energy Advisory Council, 1974.

Project Independence has two coal production estimates for Montana: business-as-usual and accelerated development. The business-as-usual estimate is much lower than the amount of coal already contracted. The accelerated development case is approximately 60 million tons a year by 1980, or 10 million tons more than the coal already contracted for that year*(76). It seems reasonable to assume that the accelerated development case may occur, if another mine is opened or existing mines are successful in selling additional coal in the next five years. A number of new coal contracts presently are being negotiated which may increase the contracted coal amount to the level of the accelerated development scenario. Figure 26 on p. 122, Montana Coal Production Estimates, compares the projections of MEAC, Northern Great Plains Resource Program and Project Independence.

By 1980, Montana coal miners will be strip mining at least a square mile a year, without any new contracts beyond what MEAC has estimated. The cumulative total, from 1968 to 1980, will be over 21 square miles. The receptiveness of

*President Ford's State of the Union message (January 16, 1975) on energy goals indicated that accelerated development of the nation's coal resource is planned.

TABLE 48

Projected Montana Coal Production
From Coal Sales Contracts, By Year
(Data Gathered October 14-18, 1974 by MEAC)

Existing Mines (contracted production)		1974	1975	1976	1977	1978	1979	1980
Peabody	1/	2,700,000	3,000,000	3,000,000	3,000,000	3,000,000	3,000,000	3,000,000
Western Energy	2/	2,837,000	5,230,000	10,430,000	13,500,00	14,900,000	17,700,000	19,100,000
Knife River	3/	320,000	320,000	320,000	320,000	320,000	320,000	320,000
Decker	4/	7,000,000	8,250,000	10,900,000	10,900,000	14,500,000	12,100,000	13,900,000
Westmoreland	5/	1,500,000	4,000,000	4,000,000	6,500,000	6,500,000	6,500,000	6,500,000
Subtotals		14,357,000	20,800,000	28,650,000	34,220,000	39,220,000	39,620,000	42,820,000
New Mines (planned production)								
Shell Oil	6/				2,000,000	4,000,000	6,000,000	8,000,000
TOTALS		14,357,000	20,800,000	28,650,000	36,220,000	43,220,000	45,620,000	50,820,000

1/ The Peabody figures are estimates obtained from corporate headquarters, St. Louis, Missouri. Another major sales contract for their Big Sky Mine near Colstrip is being negotiated.

2/ Projections for Western Energy's Big Sky Mine at Colstrip include coal consumed at Colstrip Units No. 1 and No. 2 for 1975 and beyond. For 1978-1980, they include coal that would be furnished to Colstrip Units No. 3 and No. 4. If Units No. 3 and No. 4 are not approved by the state, a projected 13,500,000 tons would be mined each year. Yearly totals would drop accordingly.

3/ Knife River Coal's mine at Savage, Montana, produces lignite exclusively for the 50 megawatt Lewis and Clark steam plant near Sidney. The mine's annual production for the last eight years averaged just over 321,000 tons.

4/ Projected production for the Decker Coal Mine north of the Town of Decker drops from 1978 to 1979, reflecting a short-term contract that expires in 1978. It is very likely that future coal sales contracts will bring 1979 and 1980 projections to 1978 levels.

5/ Westmoreland Resources has not yet negotiated a contract or contracts that would boost projections for its Sarpy Creek Mine to 6,500,000 tons in 1977. The company recently provided two unit train test shipments to domestic utilities, and MEAC believes that coal sales at the elevated level can be reasonably anticipated.

6/ The Shell oil mine will begin producing in 1977 at 2 million tons a year; by 1980 production is planned to reach 8 million tons per year. It was assumed to increase production [illegible] 2 million tons per year until the desired 1980 production level was reached.

the land to reclamation attempts, and effects of mining on aquifers, have yet to be determined. Table 49 below gives the number of acres mined each year and the cumulative total since 1968. Also this table includes only the five existing mines and does not include new mines, such as Shell's, scheduled for production between 1974 and 1980.

TABLE 49

	1968-1973	1974	1975	1976	1977	1978	1979	1980
Acres per year		213	343	506	613	690	733	790
Cumulative (acres)	690	903	1459	2521	4196	6561	9659	13547
Cumulative (sq.miles)	1.0	1.4	2.2	3.9	6.5	10.2	15.1	21.16

Source: Compiled by EQC staff, based upon Coal Development Information Packet, Montana Energy Advisory Council, 1974.

The acreage given in this table includes only the acres actually strip mined, not all the land used by a strip mine for associated facilities, which account for approximately 100 to 150 acres per mine.

Montana coal is economically attractive for two reasons: it is inexpensive and relatively clean burning. Future cost estimates by the Coal Program Support Report for the FEA's Project Independence study show Northern Plains coal to be consistantly lower priced than coal from other parts of the nation. (See Table 50 below.)

TABLE 50

Comparative Cost of Coal (*FEA)

	1977	1980	1985	1990
Northern Plains	3.60	3.92	3.90	4.06
Appalachia	8.08	8.06	8.19	8.29
Midwest	5.54	5.89	5.78	5.81

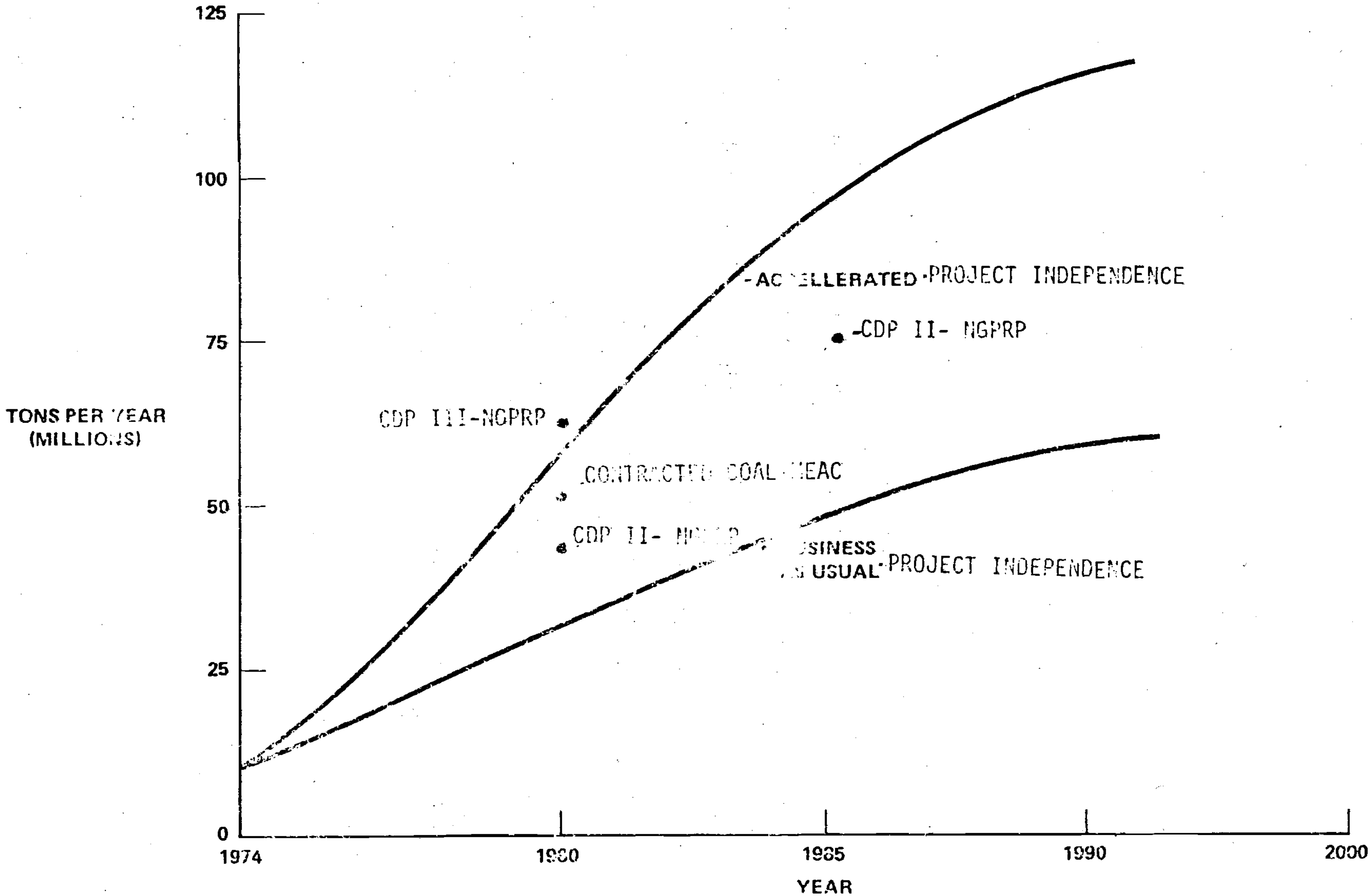
*Lowest acceptable price in dollars per ton.

Source: Project Independence Report, Federal Energy Administration, Nov. 1974.

FIGURE 26

MONTANA COAL PRODUCTION ESTIMATES

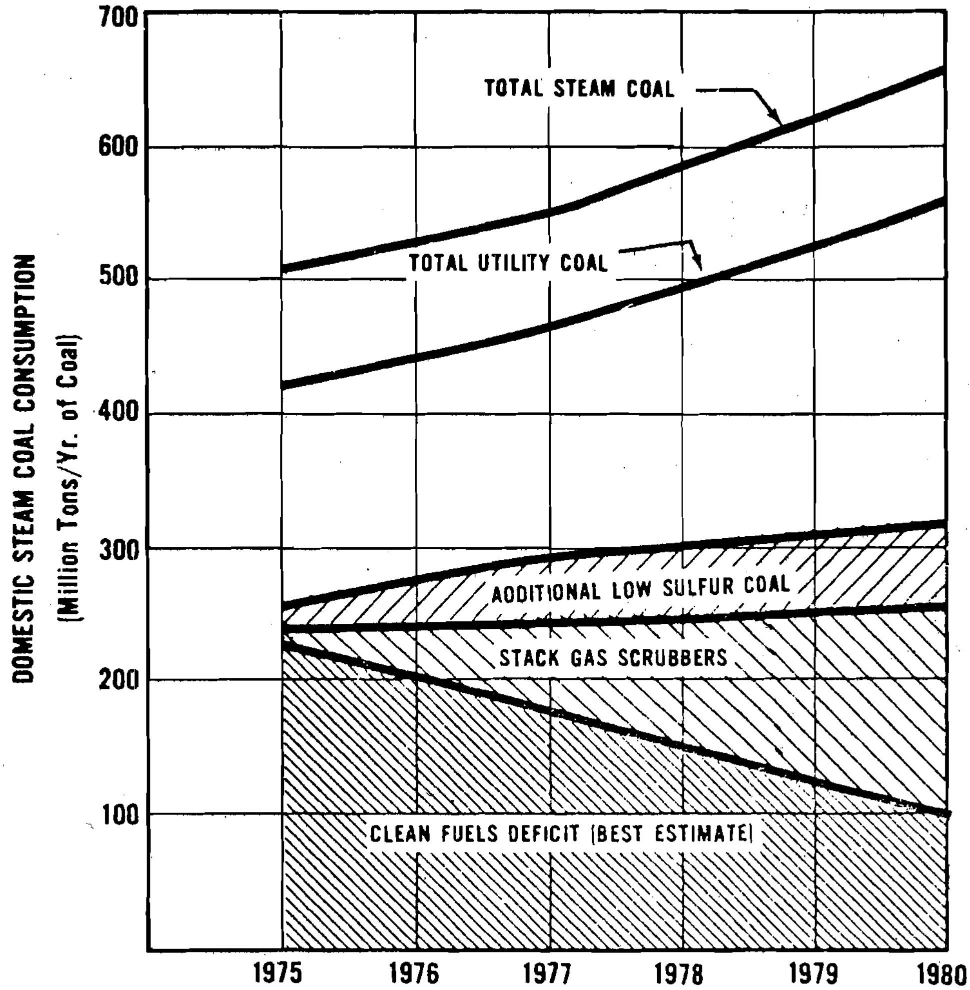
(Project Independence)



Source: Montana Coal Development, November 12, 1974, TRW Systems Group, Los Angeles.
Compiled by EQC staff.

FIGURE 27

CLEAN FUEL DEFICIT RELATIVE TO DOMESTIC STEAM COAL PRODUCTION



Source: Project Independence Report, November 1974, Federal Energy Administration.

The FEA also estimates that there will be a shortage of low-sulfur fuels, even allowing for expansion in desulfurization technology. In the estimates, using conservative estimates of low-sulfur coal production and application of desulfurization technology, there is projected clean fuels deficit of 225 million tons in 1975 and 100 million tons in 1980 (38, 306). Expanded low-sulfur coal production, and use of desulfurization technology for smokestacks, will be needed to make up the deficit, according to the FEA. (See Figure 27 on p.123.) The FEA expects the deficit to disappear by 1985 by expanded low-sulfur coal production, widespread use of smokestack scrubbers and perhaps changes in air quality laws (38, 309). In the short term (to 1985), Montana coal is expected to keep its advantage hinging on sulfur content. After 1985, its low price is expected to make it competitive.

There are at least three kinds of coal conversion plants that could be constructed in Montana. These are coal-fired steam generating facilities, gasification plants and liquefaction plants. Table 51 on p.125 identifies some potential developments. Colstrip Units 1 and 2 are under construction and the Montana Board of Natural Resources is currently reviewing plans for Colstrip 3 and 4 through the permit process established by the Utility Siting Act. After 1985 synthetic fuel plants may be developed extensively to supplement natural oil and gas supplies.

Table 52 on p.126 shows the employment, water, and coal use statistics for the plants. It should be noted that these statistics are preliminary. The complete analysis is available in the Department of Natural Resources' Environmental Impact Statement on Colstrip Units No. 3 and 4, released November 25, 1974.

TABLE 51 – Facilities Under Construction, Applied for or Publicly Proposed

Facility	Location	Capacity	Status
Colstrip I and II	Colstrip, Rosebud County	330 megawatts capacity each (330 megawatts equal 330,000 kilowatts).	Under construction by Bechtel Corporation for Montana Power (50%) and Puget Sound Power and Light (50%). Colstrip I due on line September 1975. Colstrip II due on line September 1976.
Colstrip III and IV	Colstrip, Rosebud County	700 megawatts capacity each.	Montana Power (30%), Puget Sound (25%), Portland Gas and Electric (20%), Washington Water Power (15%) and Pacific Power and Light (10%) have an application to construct pending before the Energy Planning Division, Montana Department of Natural Resources and Conservation. Final decision is made by the Board of Natural Resources. The Department's final environmental impact statement and recommendations will be before the Board on or before January 31, 1975.
Burlington Northern Synthetic Fuels Plant	Northwest of Circle, McCone County. Dreyer Brothers ranch - now wholly owned by Burlington Northern.	Daily production: 1,000 to 3,000 tons ammonia; 2,500 to 5,000 tons methanal-methyl fuel; 10,000 to 30,000 barrels synthetic diesel fuel; 12,000 to 32,000 acre feet of water; and 5 to 13 million tons of lignite would be consumed annually.	Dreyer Brothers Inc. (a BN subsidiary) has applied to the Dept. of Natural Resources and Conservation for rights to 67,000 acre feet of water annually from Fort Peck Reservoir for industrial and irrigation use. Construction for segments of the industrial complex could start within the following time frames: ammonia - 2 years; methyl fuel - 3 to 5 years; and synthetic diesel fuel - 5 years. No construction decisions have been made -- BN proceeding with feasibility studies. It is uncertain whether the facilities would be subject to the Montana Utility Siting Act.
Northern Natural Gas -- Cities Service Gas Company gasification complex (Reference 10, Table 3-8)	Southeast Montana or Northwest Wyoming.	Four "standard" synthetic natural gas (SNG) plants, 250 million cubic feet per day capacity each -- complex to use a total of 108,500 tons of coal per day.	Northern Natural and Cities Service plan to construct four 250 million feet per day coal gasification plants. Peabody Coal has agreed to supply 800 million tons of coal and the gas companies are negotiating for another like amount. Through 1975, 10 to 11 million dollars will be spent on initial development; construction could start in 1976-77 with operation in 1979 or 1980. Peabody's reserves lie within the NE portion of the Northern Cheyenne Reservation and their validity is in doubt.
Colorado Interstate Gas -- Westmoreland Coal Company (Reference 10, Table 3-8)	Southeast Montana.	One "standard" SNG plant using 25,000 tons of coal per day.	Colorado Interstate has an option on 300 million tons of coal and 10,000 acre feet per year of water to be supplied by Westmoreland for development of a gasification project. Status of feasibility studies unknown.

Source: Coal Development Information Packet, Montana Energy Advisory Council, December 1974

TABLE 52

Impact Data Projections
For Colstrip Project (Plants I, II, III and IV)

Plant Requirements

Employment	160 employees
Water	39,000 acre feet per year
Acreage	700 acres plus plant complex, surge pond and ash pond

Coal Requirements

Tons per year	Approximately 9 million tons per year (varies with load factor)
Total mine employment	500 employees
Acreage (total)	11,000 acres

Population Impact (not including construction force)

Total service personnel	160 employees
Total project employment	820 employees
Secondary jobs	2,214 employees
Total new employment	3,034 employees
Total population increase	3,499 employees*

(Note: Montana's Energy Planning Division will release definitive data on the Colstrip project within a few weeks. The data presented herein should be regarded as sketchy and preliminary.)

*2.8 multiplier-statewide ratio of population to jobs in 1970.

Source: Coal Development Information Packet, Montana Energy Advisory Council December 1974.

Future generating plants may not necessarily follow the pattern or size given in the Colstrip data. A probable standard would be a 1,000 megawatt plant, used in the Northern Great Plains Resource Program projections. The same statistics are given in Table 53 on p. 127 for a hypothetical plant in southeastern Montana.

The technology for synthesizing oil and gas from coal has been available for a long time. Beginning in the late 19th century and continuing through World War II gas manufactured from coal was available commercially in the United States (38, 135). The U.S. undertook a major effort to synthesize fuels from coal

TABLE 53

Hypothetical 1,000 Megawatt Power Plant

Plant Requirements	
Employment	165 employees
Water	18,000 acre feet per year
Acreage	500 acres
Coal Requirements	
Tons per year	3,800,000 tons
Reserve requirements	166,000,000 tons
Employment	100 employees
Acreage (current)	519 acres
Acreage (total)	2,728 acres
Plant Emissions (limited listing)	
Sulfur	10,260 lbs./hr.
Nitrous oxides	7,180 lbs./hr.
Water vapor	6,333,000 lbs./hr.
Particulate	400 lbs./hr.
Population Impact	
Project employment	265 employees
Secondary jobs	450 employees
Total new employment	715 employees
Total population increase	2,100 people

(Note: The population impact data are for a power plant in operation. The numbers do not reflect the large work force necessary to construct the plant.)

Source: Coal Development Information Packet, Montana Energy Advisory Council, December 1974.

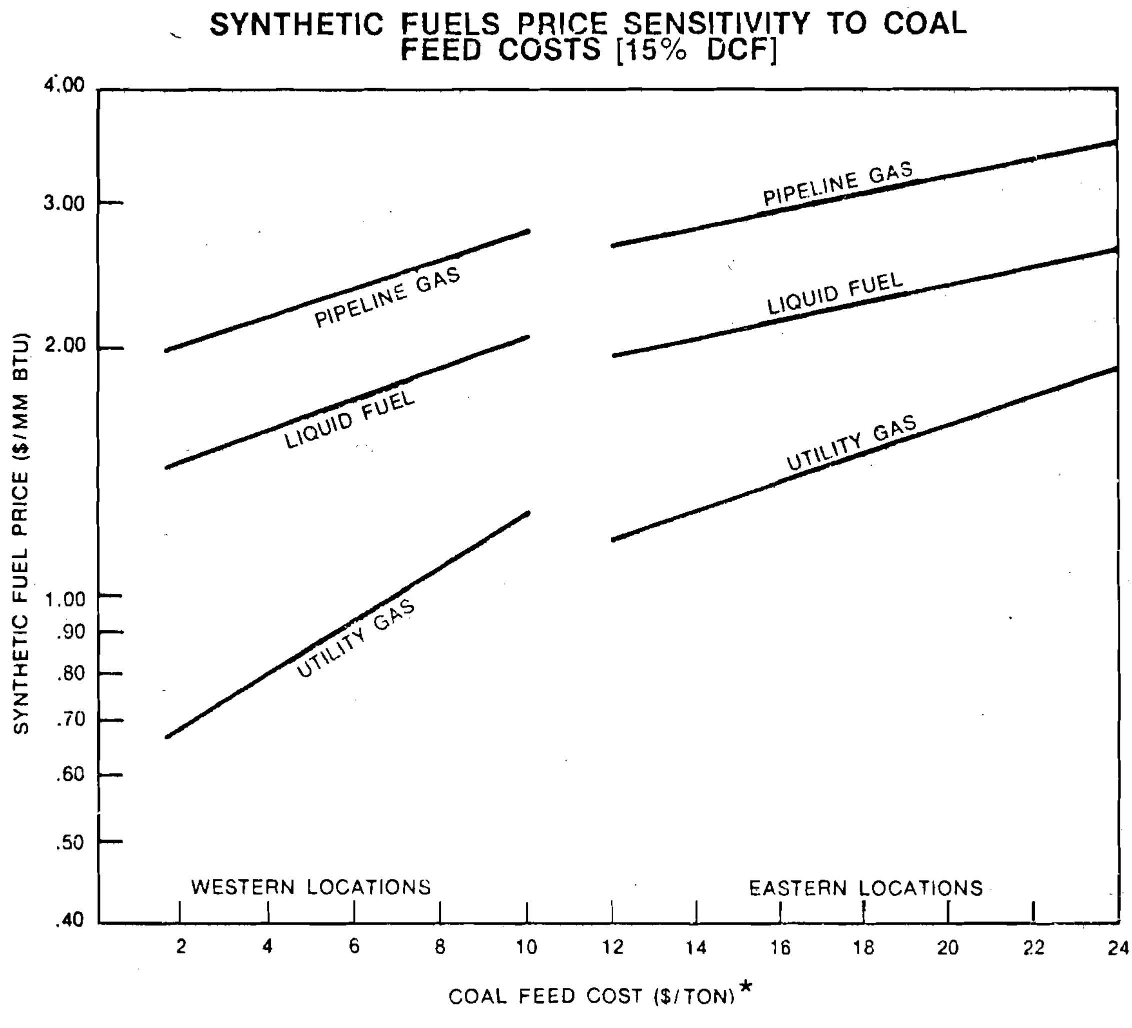
in the late 1940s and early 1950s, but abandoned it for economic reasons. There are several coal conversion processes presently under development in the U.S. One is the Lurgi process invented in Germany in the 1930s to gasify non-coking coal using oxygen and steam. It produces a low-BTU gas that can be converted to electricity or used for industrial heating at or near the production site (38, 135). Several high-BTU processes have reached the pilot-plant level. The Hygas, synthane, Bi-gas, and CO_2 Acceptor coal gasification processes are being sponsored at least in part by federal research and development funds (38, 135). High-BTU gas can be used in pipelines for shipment to demand regions. There are no commercial synthetic plants currently in operation in the United States, and with several possible development routes available production potential is variable. Coal for most processes need not have any special characteristics. The federal government could discourage the construction of new technology plants and focus on the existing, but more expensive, Lurgi gasification technology (38, 135). In this case, economic considerations would preclude substantial synthetic fuel production before 1985 (38, 135). Or the federal government could subsidize the construction of plants using existing technology and undertak an accelerated program to develop advanced approaches. A major limitation here would be the necessary lead times for demonstration and construction.

Coal liquefaction technology also is being developed by the federal government and industry. A solvent-refined coal pilot plant now is being built by the government. Industry has been active in the process development and laboratory work. Some products of the process can be used as fuel oil. Naphtha produced can be used as a petrochemical feedstock. There are no liquefaction plants of commercial size in operation in the United States.

The major barrier to production of synthetic fuels from coal has been cost. Synthetic high-BTU gas (pipeline gas) costs of $2.00 or more per million BTUs make it generally non-competitive with natural gas (38, 139). At crude oil price levels of $11 a barrel, liquid fuels produced from coal costing less than $19 a ton are less expensive than natural petroleum products (38, 139). Figure 28 on p. 129 shows the cost for high-BTU pipeline gas, liquids and low-BTU gas for a range of coal costs from eastern and western locations.

Synthetic fuel technology can produce a clean burning fuel from a "dirty" one. In the conversion process the sulfur content of the feed coal can be

FIGURE 28



*Assuming no coal transportation cost, mine mouth conversion

Source: Project Independence Report, Federal Energy Administration, November 1974.

removed, so it is possible to make high-sulfur coal environmentally acceptable. Coal conversion in general is a heavy user of energy and efficiencies are not as great as in direct coal use. The conversion efficiency of a coal burning steam generation plant is about 33 percent; gasification and liquefaction is approximately 60 percent efficient. Potential environmental impacts are not yet fully defined, but some land, water and atmospheric pollution is involved. Approximately 4.9 tons of particulates and 8.7 tons of sulfur oxides per day would be produced from coal gasification plants using the Lurgi process (38, 210). A coal liquefaction plant producing the equivalent number of BTUs in oil would generate half the pollutants of a gasification plant, but oil would generate more pollution than gas when burned (38, 210).

Synthetic gas prices seem to indicate it is not economical to build a gasification plant. Low prices in the natural gas industry basically caused by federal price regulation make coal gasification projects economically unfeasible. The Federal Power Commission regulates the price of gas sold interstate. The price for the gas is based on the cost of production plus a fair rate of return. The selling price is being held arbitrarily low, thus stimulating demand and lowering the amount of economic reserves. At the 1972 prices, there were approximately 257 trillion cubic feet of gas in the United States which could be economically produced.

Synthetic natural gas costs approximately $1.86 to $2.87 per thousand cubic feet (4, 24). The U.S. Geological Survey estimates the total undiscovered gas reserves at 2,100 trillion cubic feet (4, 24). Exxon Corporation estimates that 1,200 trillion cubic feet of gas could be recovered at a cost of 70 cents per thousand cubic feet or less (4, 24). These reserves are 4.5 times what could be recovered under the 1972 prices. At existing rates of consumption, there is enough natural gas at the 70 cent price to yield a 50-year natural gas supply.

At higher prices demand could fall (4, 24).

Gasification plants are being considered now because there is economic incentive for public utilities to engage in capital intensive activities. Edward J. Mitchell, a consultant for the Ford Energy Policy Project, uses a gasification project to illustrate this situation in his book, U.S. Energy Policy: A Primer. A joint project between the Michigan-Wisconsin Pipeline Company and the Peoples' Natural Gas Company of Chicago to convert North Dakota coal to synthetic gas and to transport it to Michigan consumers is used as an example:

> The delivered cost of the gas in Michigan would be $1.75 per thousand cubic feet, or roughly three and one-half times the current cost of gas in the state to the companies. Unquestionably there is a gap between supply and demand for gas in Michigan. But the gap is at a price less than a third of the cost of the gas to be delivered.
>
> Is there a gap to be filled at a price three and a half times current prices? Almost certainly not. Then how can the project succeed? Simply because the high-priced synthetic gas will be "rolled-in" with the cheap natural gas and a moderate average price will result.
>
> But why do the pipelines want the project? Because it will increase the rate base and thus the profits of the companies, something that does not happen when higher natural gas prices are passed on to the consumer (4, 25).

In Mitchell's analysis two governmental policies could eliminate the need for any gasification plants in the coming years. One would be simply eliminate the Federal Power Commission's price regulations on gas sold interstate. The second would involve changing the way utility profits are calculated by eliminating the temptation to expand profits through capital intensive expansion of the rate base.

Without shortage of natural gas or a tripling of natural gas prices sold interstate, synthetic natural gas could not possibly be a factor in the interstate market. However, if there is no conservation, a shortage is likely. Supplemental supplies would include natural gas synthesized from coal, liquefied natural gas, gas from the North Slope of Alaska and Mackenzie Delta of Canada, and liquid synthetic natural gas. Table 54 on p.135 offers a cost comparison of supplemental natural gas supplies. The strongest market for Montana synthetic natural gas is in the Dakotas, Nebraska, Minnesota and Iowa. However it would be lower priced than gas from Alberta and from the North Slope of Alaska too. After 1985, natural gas demand without conservation in the FEA's estimation will be sufficiently high to warrant the development of all supplemental fuel supplies.

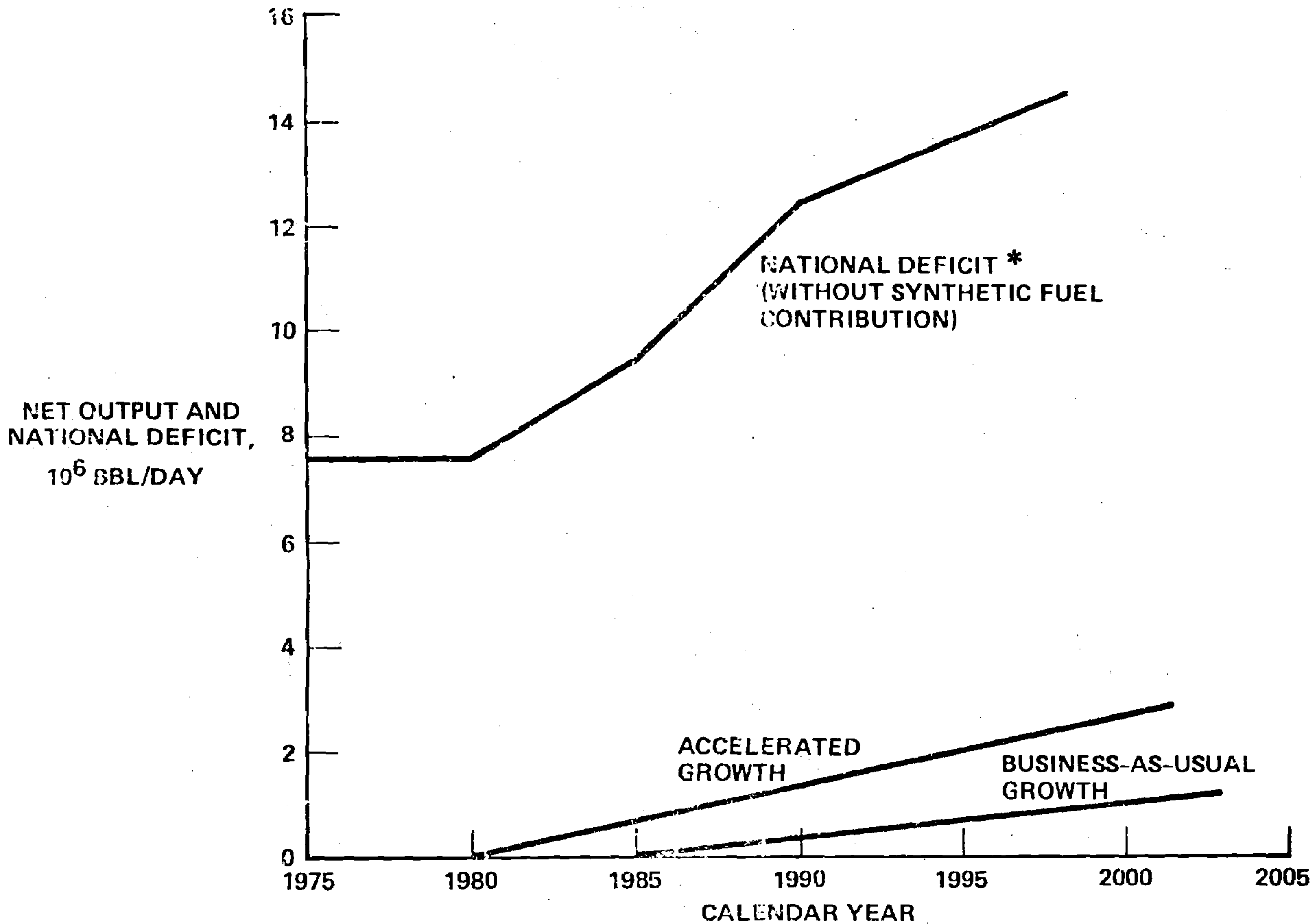
Project Independence has two scenarios for synthetic fuel production in Montana. The business-as-usual case assumes no change in the government's pre-embargo policies, no relaxation or postponement of environmental standards and no incentives. The accelerated development case assumes substantial relaxation or other modification of environmental standards, incentives such as price supports, priority allowances, accelerated research funding and construction*. Montana synthetic oil and gas production would begin in 1985 with marginal growth in synthetic oil under the business-as-usual assumptions and faster growth under accelerated development (76). (See Figures 29 and 30 on pp. 133-134.) In accelerated growth, Montana production of synthetic oil and gas would begin in 1980 with much larger rates of growth for both oil and gas (76).

A major supplementary resource needed for coal conversion facilities is water. In the steam generation process, it is a coolant. In gasification and liquefaction it is a source of hydrogen. In eastern Montana, in the Yellowstone River Basin, there are competing uses for water, mostly for irrigated agriculture. Land in the Yellowstone River Basin has been irrigated increasingly beyond estimates of both federal and state agencies. According to private plans more land will be irrigated in the future (77). This brings the Montana citizenry to a crucial choice: which shall be benefited by governmental policies,

*President Ford's energy program (as stated in the 1975 State of the Union Message) includes accelerated development of the synthetic fuels industry and the incentives stated above.

FIGURE 29

PROJECTED BUSINESS-AS-USUAL AND ACCELERATED GROWTH CURVES FOR MONTANA SYNTHETIC LIQUID FUELS

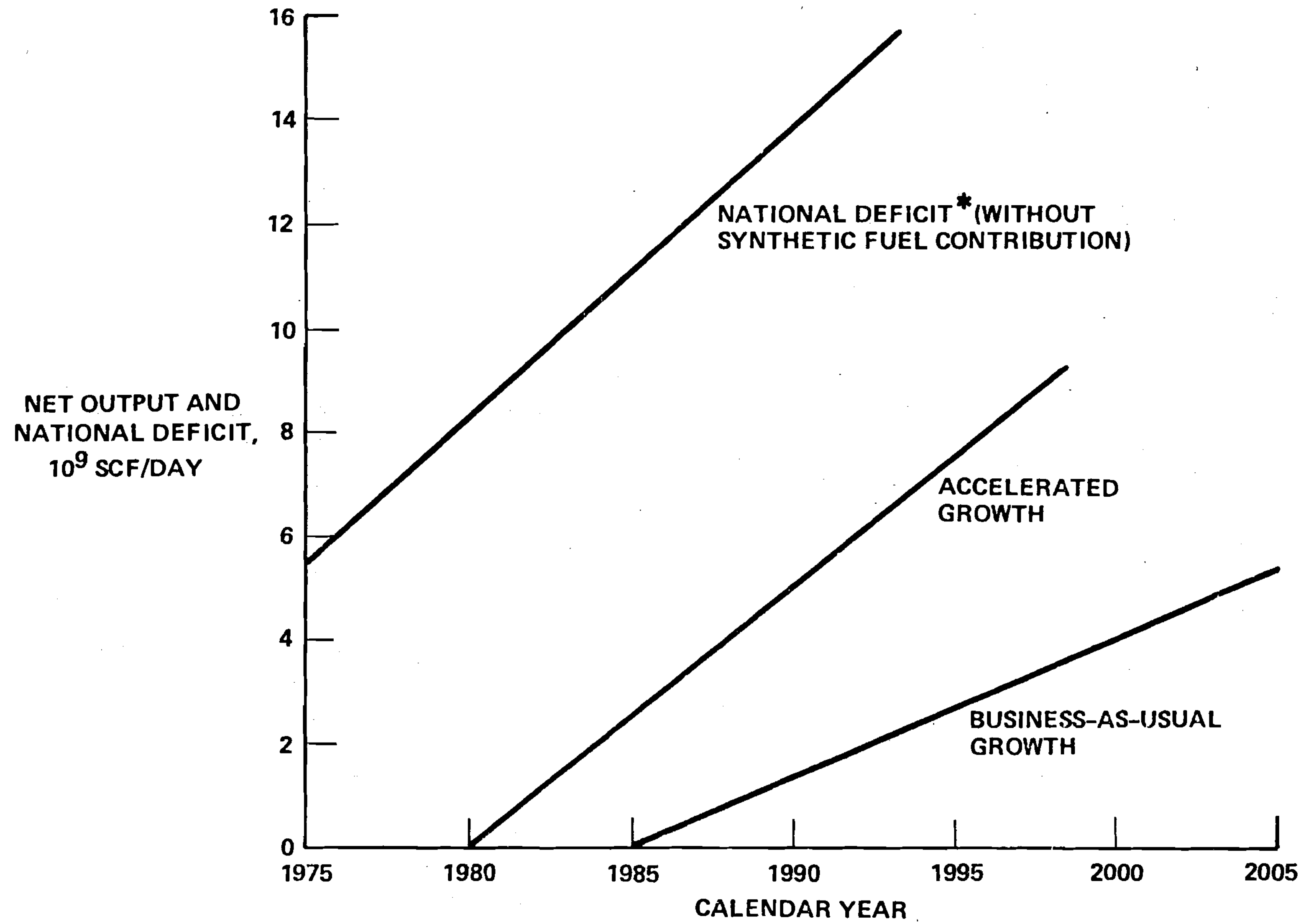


* BASED ON DEPARTMENT OF INTERIOR ESTIMATES

Source: TRW System Group, Montana Coal Development, November 1974.

FIGURE 30

PROJECTED BUSINESS-AS-USUAL AND ACCELERATED GROWTH CURVES FOR MONTANA SYNTHETIC PIPELINE GAS



* BASED ON DEPARTMENT OF INTERIOR ESTIMATES

Source: TRW Systems Group, Coal Development in Montana, November 1974.

TABLE 54

Competitive supplementary gaseous fuels
(Source: Branch of Natural Gas, Division of Fossil Fuels, USBM)

Market area	Fuel	Wholesale price $/million Btu (1972 dollars)
North and South Dakota, Nebraska, Minnesota, Iowa	CSNG* (Western)	1.10–1.27
	CSNG (Eastern)	1.24–1.40
	LNG†	1.35
	NSG‡	0.86–1.05
	North Slope** (into U.S. West)	1.37
	North Slope (into U.S. Central)	1.16
	Alberta Gas	0.97
Montana, Wyoming, Colorado, Utah	CSNG (Western)	0.91–1.08
	CSNG (Eastern)	1.34–1.50
	NSG	0.67–0.86
	North Slope (into U.S. West)	1.07
	Alberta Gas	0.67
California, Nevada, Arizona	CSNG (Western)	1.04–1.21
	CSNG (Eastern)	1.52–1.68
	LNG	1.47
	NSG	0.80–0.99
	North Slope (into U.S. West)	0.90
	Alberta Gas	0.50
	Alaska LNG	1.25
Washington, Oregon, Idaho	CSNG (Western)	0.96–1.13
	CSNG (Eastern)	1.26–1.42
	LSNG§	1.40
	LSNG	1.47
	NSG	0.73–0.92
	North Slope (into U.S. West)	0.87
	Alberta Gas	0.47
	Alaska LNG	1.22

*Coal Synthetic Natural Gas.
†Liquified Natural Gas.
‡Nuclear Stimulated Natural Gas.
**Gas from Alaskan North Slope and Canadian Mackenzie Delta.
§Liquid Synthetic Natural Gas.

Source: Northern Great Plains Resource Program, Interim Summary Report, 1974 agriculture or energy development?

The Project Independence base development scenario predicts that water allocations for synthetic gas production will be 146,000 acre feet a year by 1985. The accelerated development scenario predicts water requirements for gasification will be 876,000 acre feet per year by 1985. (See Figure 31 on p. 137 .)

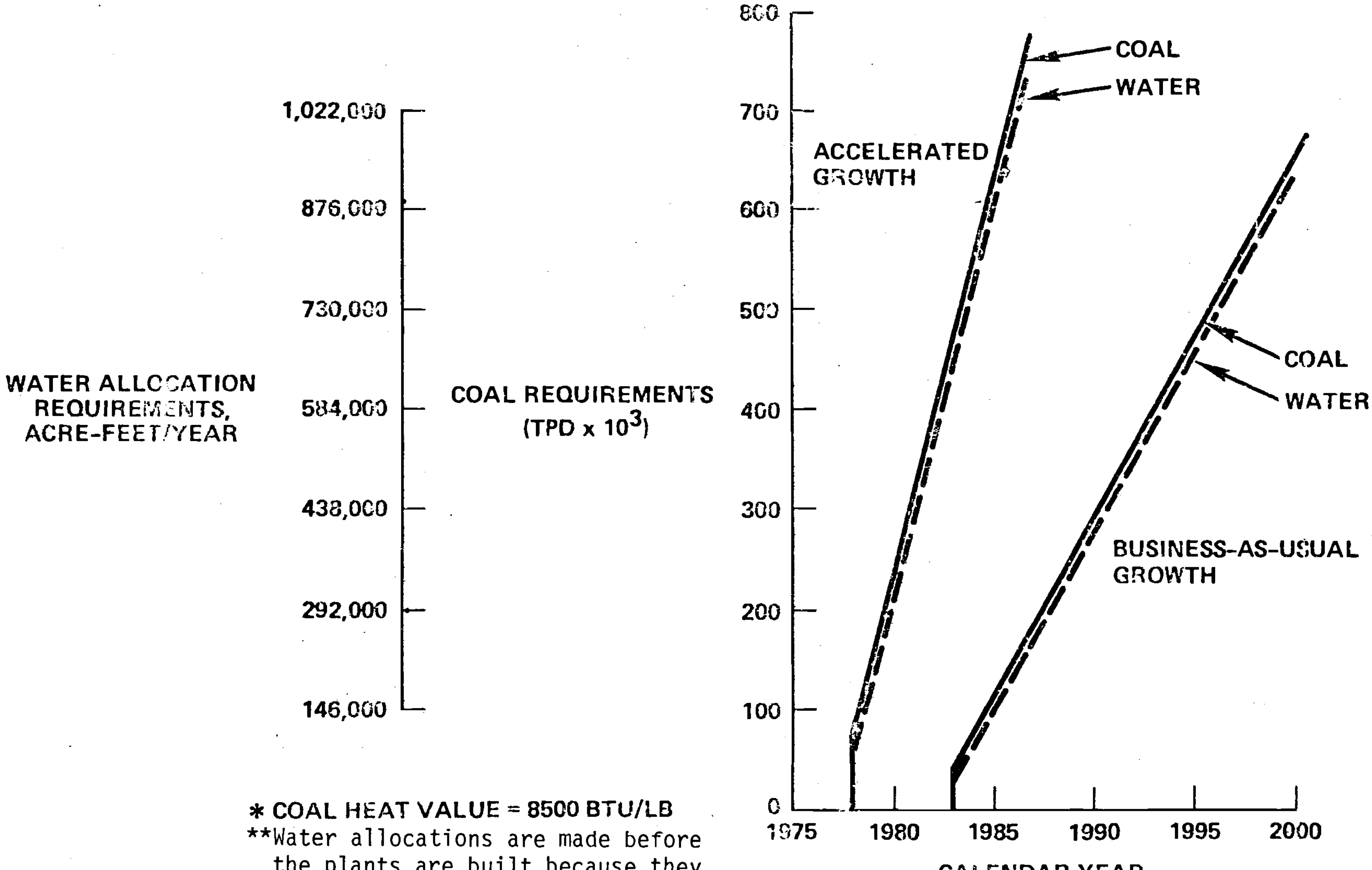
The Bureau of Reclamation has already contracted approximately 258,000 acre feet of water from Yellowtail Reservoir for use in Montana. Depending on federal policies concerning natural gas and synthetic fuels production, the water requirements may fall somewhere among the three.

Demand for irrigation water in the Yellowstone Basin has been on the increase. According to a Soil Conservation Service survey, 19,750 acres of land was newly irrigated within the last three years (77). An additional 36,840 acres of land is expected to be irrigated within the next two years (77). Another 126,900 acres of land is planned for irrigation between 1976 and 1985, bringing the total new irrigation by 1985 to 193,490 acres (77). Most of the land will be irrigated by sprinkler systems. Sprinklers are approximately 70 percent efficient in use of water compared to 50 percent efficiency in flood systems (78). Applying the most recent cropping patterns (1972) reveals a per acre diversion requirement of three acre feet per year for the sprinkler systems and five acre feet per year for flood systems (78). Much of this water is not consumed by the crops and returns to the stream.

Table 55 on p. 138 lists the total water allocated in the Yellowstone Basin for coal gasification and/or planned irrigation development in Montana. It stresses allocations rather than consumption because coal gasification plants need to have water resources assured before construction begins and some irrigation water would be returned downstream by return flow. It has been assumed that all

FIGURE 31

GROWTH OF COAL* MINE OUTPUT REQUIREMENTS AND WATER ALLOCATIONS** ON BUSINESS-AS-USUAL AND ACCELERATED BASES FOR GASIFICATION PLANTS



* COAL HEAT VALUE = 8500 BTU/LB

**Water allocations are made before the plants are built because they must have their resource requirements assured before operation.

Source: TRW Systems Group, Coal Development In Montana, November 1974.

TABLE 55

Yellowstone Water Allocations (1985)

Energy Development (Project Independence Projections)

Irrigation Planned	None*		Business As Usual (145.0 AF)		Accelerated Development (876.0 AF)	
None	0	A damming not required	146,000		876,000	
1973-1975 (36,840 acres)						
Highest**	110,520		256,520		986,520	
Base***	184,200		330,200	B damming and aquaducts	1,060,200	C not sufficien water supplie
Through 1985 (193,490 acres) (cumulative						
Highest**	580,470		726,470		1,456,470	
Base***	967,450		1,113,450		1,843,450	

Water Available

A = 500,000-600,000 AF ≐ Maximum amount of water available to Montana without storage and without instream flow during periods of low flow. (50-60 percent of total Yellowstone water available)

B = 1,000,000-1,200,000 AF = Maximum amount of water available to Montana and Wyoming with extensive storage and aquaduct system. (50-60 percent of total Yellowstone water available)

C = Not enough water available with maximum damming, if instream flow is maintained.

*Hypothetical case of no development.
**Highest efficiency--using sprinkler irrigation system assuming 1972 cropping pattern requires 3.0 acre feet per acre per year diversion requirement.
***Base efficiency--using flood irrigation system of moderate efficiency assuming 1972 cropping patterns require 5.0 acre feet per year diversion requirement.

Sources: Energy projections--Project Independence, Department of Interior estimates (1974).
Irrigation planned--Department of Natural Resources Soil Conservation Service Survey (1974).
Water available--Northern Great Plains Resource Program--Water Work Group Report (Dec. 1974).
Allocation to Montana, interpreted from "Montana-Wyoming Aquaducts Study," Department of Interior (1972).

gasification in Montana would occur in the Yellowstone River Basin in these two 1985 Project Independence scenarios. The water requirements for each level of development are listed. These requirements are segregated into three categories, A, B, and C, according to the level of storage dams or in-stream flow values which would be required. For example, in category A, water could be allocated to all planned irrigation development (at base efficiency) Through 1985, without storage dams or to coal gasification at the BAU (Business-As-Usual) level and allow for only irrigation (also at base efficiency) somewhere between the 1974-1976 and Through 1985 level. In category B, water could be allocated up to BAU energy and Through 1985 (at base efficiency) levels of development. Category B requires extensive damming and includes an aquaduct system for delivery. In no case could available water meet 1985 AD (Accelerated Development) and Through 1985 irrigated agriculture demands (at either efficiency), even with storage dams and aquaduct systems. The Yellowstone River Compact requires Montana to share water with Wyoming. Montana's allocation is approximately 50 to 60 percent of total water available. Using the same assumptions and not allowing for irrigation beyond 1985, the Business-As-Usual scenario by 1985 would surpass water availability.

In addition to the shortage of water for coal conversion in Montana to be used for out-of-state consumption, there are advantages to load-center conversion in terms of cost and energy use. It takes less energy and costs less to ship coal by rail than it does to ship equivalent amounts of coal in the form of electricity to the load-center. For synthetic fuels, specifically gasification, a transportation system of shipping coal by slurry pipelines to a gasification plant, is a technically feasible alternative to in-state gasification. It would be better for the nation as well as Montana, to convert coal at the load center rather than at the mine mouth, given these considerations.

The Montana Department of Natural Resources' analysis of the costs, to the customer, of shipping coal west to Hot Springs, Montana compared to shipping the power equivalent via Extra High Voltage (EHV) transmission lines clearly points out the cost advantage of coal shipment by rail. Rail costs were 0.95 cents per ton mile (ptm) for shipping 8,500 BTU coal with a power equivalent equal to that delivered via EHV lines, assuming 1,390 megawatts of peak power delivered and an average 80 percent load factor (16, 44). The comparable costs for the EHV transmission were between 1.08 cents ptm and 1.2 cents ptm, depending upon assumptions regarding the investment total and interest rates (16, 45). Total savings to the customer over the 37-year expected life of the project of shipping coal by rail averaged out at between $2.8 million per year and $13.7 million per year, depending upon assumptions (16, 101-125).

Other estimates of the cost of transporting coal energy as electricity through EHV lines fall in a similar range. The Northern Great Plains Resource Program Draft Report cites the 1970 National Power Survey which uses cost estimates of .94 cents ptm to 1.25 cents ptm, assuming a single 500 kilovolt line (1, III-15). These figures were computed by applying an inflation factor of 1.45 to the 1970 data, which actually reflects 1969 costs (79).

This same Northern Great Plains Resource Program report also presents cost data for rail shipments of Northern Great Plains coal. Actual rail tariffs for an 815-mile shipment of Montana coal, adjusted to 1974 prices by a factor of 1.07 applied to the 1973 data, and a 1270-mile shipment are .58 cents ptm and .75 cents ptm respectively (1, III-15). Other data from this study show the cost of rail shipment to range between .62 cents and .77 cents ptm (1, III-12). These figures show rail shipment of coal energy to be roughly 25 percent to 50 percent cheaper than high voltage transmission line shipment of the power equivalent of the coal energy. Actual data of more recent rail tariffs show a similar cost range. A shipment of Montana coal to Havana, Illinois cost .61 cents ptm (79); the cost estimate in a recently signed contract to ship coal from southeastern Montana to a power plant near Austin, Texas was nearer .7 cents ptm (80).

Expenses of transporting energy can be reduced more by using slurry pipelines to transport coal instead of unit trains. Data generated in mid-1974 by Bechtel, Inc. indicate the following average costs for a 1,000-mile slurry pipeline: .565 cents ptm for a 10 million tons per year shipment; .476 cents ptm for 15 million tons per year; and .4 cents ptm for 20 million tons per year (81). Coal slurry estimates given in the Northern Great Plains report indicated similar ranges between .32 cents ptm and .6 cents ptm, depending upon distance (1, III-12). Transportation of coal by barge is also less costly than rail transportation, approximately .36 cents ptm. There is a proposal to have the Army Corps of Engineers study the building of a barge canal from Fort Benton, Montana to Omaha, Nebraska along the Missouri River.

Further comparison of rail and slurry costs would have to consider the cost escalation factor, that is how rapidly are these cost estimates expected to increase over time. Projections show pipeline tariff escalation rates of 3.8 percent per year implying a doubling in cost every 19 years. This is significantly lower than the recent escalation rates for railroads of about 7 percent per year, or a doubling every 10 years, due to the capital intensive nature of pipelines as opposed to the high percent of variable costs associated with rail transport (81).

To summarize, costs to the ultimate energy consumer can be significantly reduced by generating electrical power at the load center rather than at the mine mouth. Slurry pipelines appear to offer the greatest cost savings, particularly over the long run. From a cost viewpoint slurry pipelines coupled with barge transport is the optimum transport system.

Energy Use (Net Energy)

Different forms of transportation require different amounts of energy from proposed energy shipment processes. In this context net energy is defined as that amount of energy in BTUs which enters the shipment phase minus the amount of BTUs lost during shipment, or the amount of usable BTUs delivered at the end of shipment. Minimizing energy losses during shipment will obviously conserve finite energy supplies, thus preserving future energy options.

A comparison was made of energy use for four transport modes: Extra High Voltage (EHV) transmission, rail, barge, and slurry pipeline. The comparison assumed an annual movement of 7 million tons of coal, or its power equivalent.

Energy use in rail transport was analyzed using three data sources. Data generated by H. E. Risser, cited by Michael Rieber of the Center for Advanced Computation at the University of Illinois, shows that 394×10^9 BTUs are consumed per 100 miles per year of rail transport (82, 32). Another document from the Center for Advanced Computation, by Anthony Sebald, shows an average actual energy use of 447×10^9 BTUs per 100 miles per year (83). Using diesel fuel consumption figures for a round trip unit train shipment of coal west from Colstrip, Montana to the Spokane, Washington area, developed by Malinda Schaill at the University of Montana, the energy consumption is 656×10^9 BTUs per 100 miles per year for 6 million tons annually, or about 760×10^9 BTUs for 7 million tons (79). It is assumed that this figure should be halved, to 380×10^9 BTUs, to be comparable to the above fuel consumption estimates, as they no doubt refer to a one-way trip. Variance in these final figures is probably due to different diesel engine efficiencies over various routes and at different elevations.

According to Sebald, barge transport is approximately 23 percent less efficient than rail, on a per mile basis (83).

The only figure for energy consumption of slurry pipelines is given by Bechtel, Inc., 160 X 10^9 BTUs per year per 100 miles at a 7 million tons a year (81). This is about 2.5 times more efficient than rail transport according to the rail energy consumption figures.

Energy loss during EHV transmission is significantly higher than energy consumed during either rail, barge, or slurry transport. The Energy Planning Division of the Department of Natural Resources, in its background work for the Colstrip Units 3 and 4 Draft Environmental Impact Statement, has estimated energy losses, for this particular transmission line of 1.25 percent per 100 miles (85). Voltage booster stations keep this figure constant over the entire length of the line. The Department indicates that this is a conservative figure and less efficient lines could experience 2 and 3 percent losses per 100 miles.

The power equivalent of a 7 million ton coal movement is roughly 1,630 peak megawatts (mw). This translates to 1,300 average delivered mw at an 80 percent load factor. Power loss of 1.25 percent for 1,300 mw is about 16 mw-hours per 100 miles. At 10.2 million BTUs per mw-hour this is equal to an energy loss of 160 X 10^6 BTUs per mw-hour or 1,400 X 10^9 BTUs per year per 100 miles. This amounts to 3 to 3.5 times the BTUs consumed during rail transport, roughly twice the BTUs consumed during barge transport and nine times the energy consumed during slurry transport. Supporting information on energy consumption is presented in Figure 32 on p. 145 which appeared in a May, 1974 publication by Bechtel, Inc.

In summary, then, slurry transport of 7 million tons of coal would consume 1,240 X 10^9 BTUs less energy per 100 miles than its power equivalent being transported over EHV lines (81). Slurry saves about 240 X 10^9 BTUs per 100 miles over rail, rail consumes about 1,000 X 10^9 BTUs less energy than EHV transmission (81).

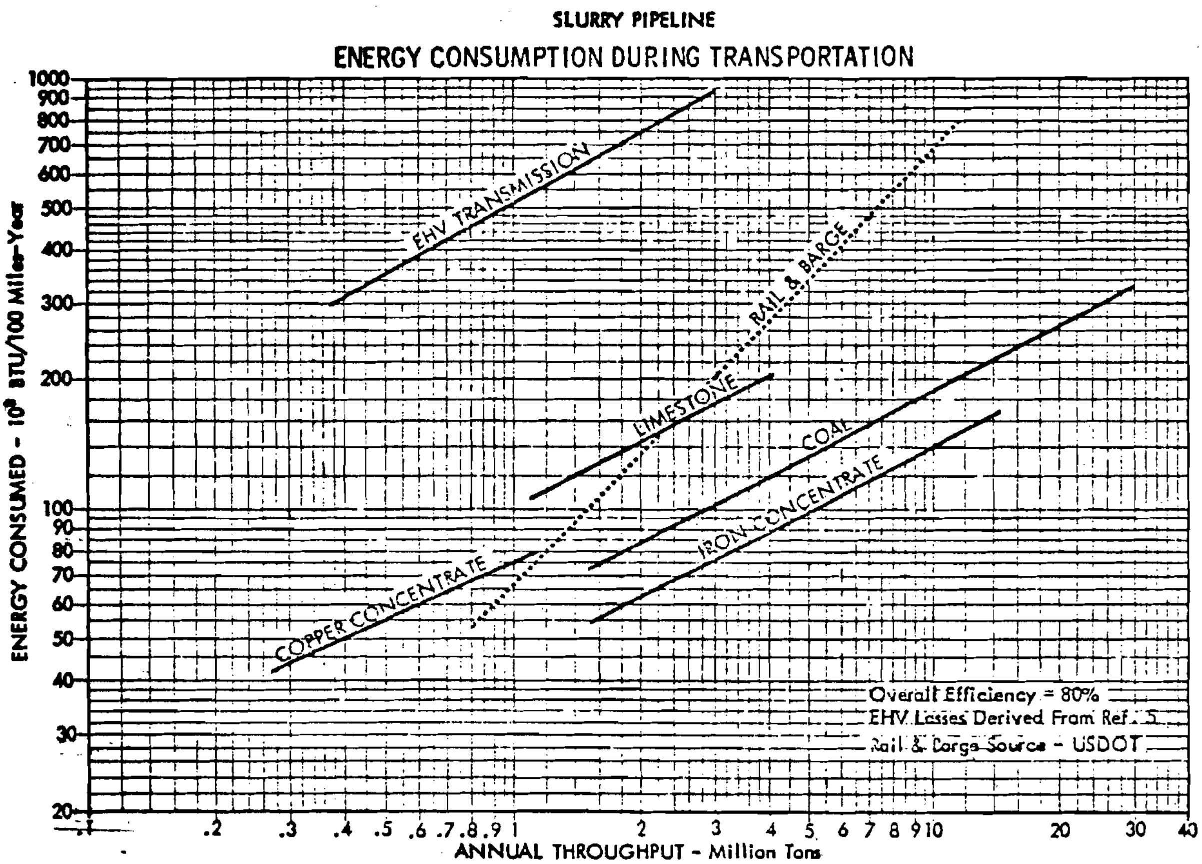
These figures would be multiplied by a factor of 5 if a distance of 500 miles were being analyzed, or, for example, 15 if 500 miles and a 21 million ton shipment were being considered. Rail shipment would save, in the latter case, 15 X 10^{12} BTUs over EHV lines or the BTU equivalent of 833,000 tons of 8,500 BTU per lb. Montana coal. Slurry shipment as opposed to rail would save an additional 3.6 X 10^{12} BTUs, or 200,000 tons of 8,500 BTU per lb. coal.

Net energy analysis leads to the conclusion that load center electrical power generation is preferable to mine mouth generation in that it requires the least amount of energy for delivering the same amount of BTUs to the ultimate destination. Our nation's energy, then, can be best conserved by a policy supporting load center power generation.

Coal gasification is expected to make a large contribution to gas supplies in post-1985 United States. By that time, desulfurization technology is expected to be competitive in costs with use of low sulfur-fuels in order to meet air quality standards. Montana coal would be free then for in-state coal gasification. However, the agricultural water demand conflict probably will ramain. Unless the water could be withdrawn or withheld from agricultural uses gasification could not use Montana water. Slurry pipeline transportation technology offers a solution for this dilemma. Most second-generation gasification processes (other than Lurgi) are designed for pulverized coal. Coal transported in a slurry pipeline must be pulverized before it is shipped, so the slurry processed can fit with the needs of the gasification plant (85).

A slurry pipeline to gasification plant system located at the load center has several advantages over a mine site plant (85). The environmental effects are felt at the area where the synthetic gas is used. There is much less water needed at the mine site in order to transport by slurry pipeline. Construction costs at either location are about the same (85). To illustrate, two coal

FIGURE 32



Source: Economics of Slurry Pipeline Systems, Bechtel, Inc., May, 1974.

gasification cases are presented: at the mine site, and at the load center. Table 56 on this page compares the impacts of mine site gasification and slurry pipe to load center gasification complexes.

TABLE 56

	Gasification at Mine Site (gas pipeline)	Gasification at Load Center (slurry pipeline)
Impact at minesite		
Electricity required (megawatts)	30	60
Water Use (mmgpd)*	300	12
People	3,000	400
Impact at Load Center		
Electricity required (mw)	nil	280
Water (mmgpd)	nil	30
People	mil	2,600

*Million gallons a day

Source: "Slurry Pipelines--Energy Movers of the Future," Wasp and Thompson, Bechtel, Inc., 1973.

If there is a trade-off of water use for gasification or slurry pipeline-gasification systems, then the latter would be preferred, assuming the state was committed to preservation of eastern Montana water. Pressure to build gasification plants in Montana will become increasingly greater after 1985. At that time, when the gasification--slurry pipeline trade-off is realized, then the water allocation question between the two systems should be reexamined. Also, by allowing the use of slurry pipelines for coal transporation at that time, Montana could have water for agricultural and recreational development without foreclosing future options for coal mining.

The Montana Water Use Act does not allow the use of slurry pipeline for transportation of coal. The Water Use Act states that water for slurry pipelines is not considered a beneficial use. This precludes use of Montana Water and right of condemnation to secure right-of-way for slurry pipelines. However, much less water-efficient coal conversion processes are allowed to use Montana water. This gives an advantage to in-state conversion of coal for out-of-state use rather than allowing the most efficient and least costly form of transportation to be used which could hamper the need for mine-mouth conversion. Table 57 on this page shows the water requirements of a thermal generation, synthetic gas and coal slurry per million tons delivered. Coal slurry, which could transport coal in a price range required for gasification, delivers the most energy using the least amount of Montana water.

TABLE 57

Water Requirements
(Gallons of water per million BTUs delivered)

Thermal (Steam) generation	100
Synthetic Gas	30
Coal Slurry	12

Source: Bechtel, Inc., November 1973.

The United States Senate toward the end of the 1974 session passed a bill which would allow slurry pipeline companies to condemn land for rights-of-way. It did not pass the House of Representatives. If this power were given to the pipeline companies by the federal government, it would to some extent supersede the Montana law. Such corporations could condemn land under the federal law and use water from federal water storage projects (i.e., Yellowtail Dam--Bureau of Reclamation) and ship Montana coal with this system. At this time, there is no law regulating the siting or building of a slurry pipeline under Montana law.

A number of specific coal conversion plants have been applied for under the Utility Siting Act or publicly announced. They range from the contested application for Units 3 and 4 at Colstrip to a gasification plant proposed by Burlington Northern Railroad to produce fertilizer and later, diesel fuel. Table 51 on p. 125 listed the applied for and announced coal conversion facilities.

If these plants are built, it is expected their energy products would be consumed outside Montana.

The MHD Research Institute*has negotiated a $90,000 contract with the Federal Energy Administration for a feasibility study of using Glasgow Air Force Base as an energy park (86). An energy park is one method of eliminating siting problems by locating multiple energy conversion or processing facilities in one area. It is supposed to speed the siting process. A gasification plant and some type of nuclear facility are being considered. The water needed for the facilities in the park, if built, would presumably come from Fort Peck Reservoir (86). Since the facility would be located on federal land (Department of Defense) and would be using federal water (Bureau of Reclamation) the state's Utility Siting Act may not apply.

The state may need synthetic fuels in order to ensure its own energy supplies. If Montana oil and gas production follows the trend of declining production after 1985, as projected by the Federal Energy Administration, Montana may need supplemental supplies of oil and gas made from coal. Canadian imports of crude oil account for 15 million barrels per year of the supplies refined in the state (22). If increased production does make up the shortfall of Canadian export cutoffs between now and 1985, after that point a liquefaction plant may have to be built to supply the refineries. If no adequate natural crude oil supplies can be located in-state or out-of-state, a liquefaction plant may have to be built sooner. One syncrude plant with a 65,000 bbl/day capacity operating at 70 percent efficiency would produce approximately 16 million barrels of oil per year, or enough to supply the refineries' supplemental needs (76). Montana relies upon imports of Canadian natural gas of more than 50,000 mmcf per year (19). One gasification plant, producing 250 mmcf per day, operating at 70 percent efficiency would produce approximately 63,000 mmcf per year--14,000 mmcf in excess of the Montana shortfall.

* Magnetohydrodymnamics Research Institute, formed in Butte in late 1974 under a federal grant to carry out research in energy conversion and development.

Montana may be asked to site a number of synthetic fuel plants, a uranium plant and further steam generation plants. Most of the pressure will probably come after 1980, with dramatically increasing pressure occurring from 1985 on. However, Montana can adopt policies which could decrease this pressure and only build facilities for in-state use. For purposes of providing a baseline, development level, Montana could expect at a minimum by 1985 steam generation facilities totalling 1,200 mw, one gasification plant and one liquefaction plant, both for Montana use, and a uranium enrichment plant. This level of development, just from the conversion plants and not including people operating mines, would bring 15,000 new people to eastern Montana. (See Table 58 on p. 150.) Analysis of the socio-economic impacts produced by this level of conversion development, must be tempered with the knowledge that this is a minimum level of development, and much larger levels are projected for Montana. In fact, President Ford's energy program includes a much larger coal conversion industry in Montana, although there are other policy options available which could meet the energy self-sufficiency goal.

Conversion facilities constructed in rural areas can cause significant social and economic impacts on the residents of that region. The chief cause of these impacts is the population increase generated by the construction and operation phases of the plants. Table 58 on p. 150 gives some indication of the employment and population impacts associated with steam generation, gasification, liquefaction, and uranium enrichment facilities.

From this table it is evident that substantial population impacts will result from the construction and operation of coal conversion facilities. For example, the addition of Colstrip 3 and 4 plus two gasification and liquefaction facilities will result in an aggregate permanent population increase of over 17,000 people in eastern Montana. If the construction phases coincided, the peak population increase

TABLE 58

Impacts Per Plant

	Steam Generation*	Gasification**	Liquefaction**	Uranium Enrichment
Plant Size	1,200 mw	250 mcfd	65,000 bbls/day	8,750 mtswu/yr. plus 2,500 mw power plant
Construction*** (at peak)				
Direct	2,260	2,190	2,200	5,200
Indirect	3,300	3,200	3,200	8,840
Total	5,560	5,390	5,400	14,040
Population Increase	11,120	10,780	10,800	28,080
Operating****				
Direct	103	625	750	1,050
Indirect	175	1,063	1,275	1,785
Total	278	1,688	2,025	2,835
Population Increase	612	3,714	4,455	6,237

*700 mw being constructed. If only one plant of the proposed Colstrip 3 and 4 project were built (700 mw apiece) their total would represent 1,400 mw.

**Largely for Montana Consumption.

***One direct construction job will generate 1.46 indirect jobs. Each job will add about 2 persons to the population.

****One direct operating job will generate 1.7 indirect jobs. Each job will add 2.2 persons to the population.

Source: Coal Development Information Packet, Montana Energy Advisory Council, 1974. Draft Environmental Impact Statement for Colstrip 3 and 4, 1974. Water Use and Coal Development in Eastern Montana, Paul Polzin, University of Montana, 1974; Northern Great Plains Resource Program, Interim Summary Report, 1974. Montana Coal Development TRW Systems Group, 1974. Uranium Enrichment: Guidelines for Assessment and Planning, Western Interstate Nuclear Board, 1973.

could be over 56,000 people. The addition of one uranium enrichment facility to this scenario would increase permanent population figures to over 23,000 people, and the construction population estimate to 84,000 people.

The school and housing demands of the newcomers must also be considered. For every increase of 10,000 people it is estimated that 2,500 school age children will require school space and teachers. Assuming the need for additional facilities and a capital cost of $4,000-$4,500 per pupil, this means a requirement of $10 to $11 million in school construction costs (87). If current bonding capacity is at the maximum (in Montana this is set at 5 percent of the county's assessed valuation), the issuance of a $10 million bond will require an additional $200 million in increased assessed valuation. A rural county will be hard pressed to meet this requirement.

Meeting the additional housing needs of the increased population presents other problems. Estimates of these vary; however an average figure is roughly 1 domicile (either a house or trailer) for every 2.5-3.5 additional people (87). It has been estimated that one-fifth of these domiciles will be houses, the rest trailers. Thus, 10,000 additional people will require about 2,300-3,200 trailers and 500-800 houses in a given community. Meeting this need will severely strain local home building industries in those small rural towns where the housing will be needed. It will also drive up rent.

Other sociological and cultural impacts that can be expected are: disruption of the agricultural sector of the economy due to uncertainty about future development, water availability, and taxes; higher general price levels caused by local demand outstripping supply and business hesitation regarding expansion; labor shortages for small businessmen and ranchers; inadequate health care facilities and water supply and sewage disposal systems; increased crime rates; road and highway deterioration; school overcrowding and an attendant decrease in educational quality.

III. ALTERNATIVE ENERGY SOURCES

INTRODUCTION

Every fuel the United States now uses is limited--petroleum, natural gas, uranium and coal. The federal Project Independence Report states that domestic oil and gas production will peak about the mid-1980s. The resulting deficiency in liquid fuels could be taken up by synthetic oil and gas made from coal and oil shale. According to Project Independence, the deficiency of oil and gas "could eventually be limited if coal and synthetic fuel production were to grow at 6 percent per year. This would rapidly deplete our coal resources and exhaust available water supplies in the shale areas as well as place very serious burdens on the environment unless there were some technological breakthroughs" (38, 122). Nuclear energy has been offered as a virtually inexhaustible energy resource. However, even with a doubling of current uranium prices to $15 a ton, estimated reserves of 1.5 million tons would be exhausted by 1988, assuming the mining industry could expand fast enough to meet demands. The nuclear breeder reactor, or fusion technology--neither requiring as much uranium--are not expected to be ready until the mid-1990s, about five years too late. Even if nuclear power were inexhaustible, which it is not, it can produce electricity only, not fluid fuels such as natural gas, gasoline, and fuel oil.

The United States needs to have fossil fuels well into the future, for many things other than fuel: plastics, fertilizers and many types of modern drugs are derived from fossil fuels. There are a number of technologies, some developed, others needing new technology for full development, which are renewable and relatively non-polluting. Among the new technologies are solar and wind power and the use of various wastes as energy sources. The methods and processes for exploitation of these sources are available now in some form: solar heating is economically and technologically feasible today. The government's Project Independence Report assesses these energy forms in this way:

> The two largestsources of solar energy through 1985--solar heating and cooling and wind electric systems--are not very dependent on new technology (38, 143).
>
> Solar heating and cooling, which is already being commercialized, is projected to be competitive with conventional systems at a cost of $2.50 per million BTUs of space heat (38, 143).
>
> Wind energy systems, for example, should be economically viable within a few years. If the aerodynamic technology developed over the last 30 years were applied, the system costs could be dramatically reduced and market applications would be greatly increased (38, 143).
>
> Bioconversion of fuels [urban and agricultural waste] includes both near term and long term applications. Recycling of urban and agricultural wastes is now providing energy in some areas, while large biomass forms, both terrestial and marine are longer-range prospects (38, 142).
>
> The economic viability for these different applications will occur in different stages, but cost reductions will depend more on market volume than on technological breakthroughs. Indeed, economic viability for much of the dispersed market could be achieved by 1980 without any technological breakthroughs (38, 142).

The federal government is moving very slowly toward development of alternative long-range fuel sources. A comparison of the federal research and development budget for energy shows the present priorities. (See Table 59 on p.155 .)

The emphasis now in federal energy research and development budgets is in nuclear and coal technology. Because industrial research is geared toward development of projects with short-term payoffs, federal assistance is usually required for development of long-range energy supplies and technology with reasonable environmental compatibility. Federal grants have been awarded for research on conversion of coal to oil and gas but these are not renewable fuels, merely synthetically produced forms of existing nonrenewable fuels. Research and development funds for solar energy research planned for 1975 are a relatively modest improvement over earlier budgets. The improvement represents some change in the government's attitude toward development of truly long-range, environmentally sound energy sources.

TABLE 59

Energy Research and Development Budget
(In millions of dollars and percent of total R & D budget)

	Fiscal Year 1973	Percent of Total	Fiscal Year 1974	Percent of Total	Fiscal Year 1975	Percent of Total
Oil, Gas & Shale	18.7	2.7	19.1	1.5	41.8	2
Coal	85.1	12.6	164.4	13.	415.5	18
Nuclear Fission	406.5	60.4	530.5	41.78	724.7	31
Nuclear Fusion	39.7	6	57.0	4.4	102.3	4.4
Solar	4.00	0.5	13.8	1.	50	2.
Totals	672.2	100*	1269.6	100*	2302	100*

*Only approximately because conservation and environmental control research and development programs are not included.

Source: Project Independence Report, Federal Energy Administration, Nov. 1974.

Montana need not wait for the federal government to act before moving toward long-range energy supplies, however. Some alternative energy sources are very practical in Montana today, especially the use of agricultural and wood products wastes, and conversion of wind power to electricity. The state government could, for example, provide tax incentives to encourage installation of the new technologies. Already, alternative energy research projects are underway in the Montana University System under research grants that could be supplemented by the state government. In addition, Montana state officials could, perhaps by legislative resolution, encourage the federal government's movement toward long-range solutions to critical energy supply problems.

Harnessing the Sun

Solar energy can be used directly in the generation of electricity and for space heating and cooling. William R. Cherry of the National Aeronautics and Space Administration's Goddard Space Flight Center estimates that "by the year 2020 solar energy could provide 60 quadrillion BTUs of energy" (11), or approximately the energy from all sources used in the United States in 1968. Achieving this huge solar energy capacity would require no major scientific breakthroughs to be economically competitive (88, 65).

Centralized solar generators--the solar equivalent of the massive power plants existing today--have received considerable attention in recent years. Although major engineering studies for solar power complexes are preliminary, results indicate that capital costs would be close to costs of present energy sources, assuming fruitful research and development.

The low maintenance costs, potentially slight environmental impact, free fuel, and secure supply should weigh heavily to offset any remaining capital cost advantage of current technologies. One argument frequently raised against centralized solar conversion is that each plant would require vast amounts of land. Although it is true that centralized facilities would occupy large areas, the land occupied would be less than that disturbed by prolonged coal strip mining and unlike the stripped land, would be continuously available for certain other uses. Decentralized solar conversion, usually in the form of equipment attached to individual buildings, requires little additional space because most solar generating equipment could be sited on rooftops and in spaces already occupied by residential or commercial structures.

SOLAR ELECTRICITY

Electric power generation based on solar energy occurs in two basic phases: 1) conversion from sunlight, to heat, to steam, to mechanical power, and ultimately to electric energy; and 2) direct conversion of sunlight to electricity by solar cells or thermocouples. The first process requires arrays of solar collectors covering relatively large expanses, the concentration of the solar radiation to liberate heat, the production of steam, and finally production of electricity by a steam turbine-generator.

The brightest prospect for direct conversion of sunlight involves the refinement and use of solar cells. This system to harness light energy from the sun works through the reaction of sunlight and silicon crystals in solar cells. Electricity liberated in the reaction is available directly. The brighter the sun the more power produced by the cells (89, 24). Although solar cells have been very expensive to date, promising new ways are being explored to reduce the cost of solar cells. Researchers at Tyco Laboratories, Inc., of Waltham, Massachusetts estimate that solar panels might be sold at less than $400 per kilowatt (peak power in full sunlight), or roughly the equivalent of electric power produced conventionally with oil at today's prices (90, 1,360). By mounting solar cell arrays on roofs or walls of buildings (eliminating the need for additional land), and combining solar cells with solar collectors for space heating and hot water, an efficient and economical system could be designed. Cost estimates of power delivered to the consumer indicate that a two kilowatt rooftop panel costing $1,000 and delivering an average of 10 kilowatt-hours a day would pay for itself in about six years at east coast electric rates (90, 1,360).

Estimates vary greatly on the contribution to national supply which solar based electrical generation will make in the remainder of the century. According to testimony given by Barry Commoner at an Atomic Energy Commission hearing, solar energy could contribute 21 percent of the electric power needed by the year 2000 at an economically competitive cost (91, 651). Dr. Commoner's figures were based on AEC information. Others estimate that from 1 to 30 percent of the total electrical production in the nation could be from solar energy by either direct conversion or steam generation by the year 2000 (91, 385)(89, 23).

One other option for direct solar electrical generation entails the placement of a space station in synchronous orbit around the earth. The station would carry arrays of solar cells and beam the electrical output to earth by microwave. The space station system has the twin advantages of continuous operation and high efficiency. Despite some estimates that a substantial amount of the total national energy consumption in the year 2000 could be met with the satellite system, there are ponderous potential environmental and social difficulties inherent in the idea (92, 385).

SOLAR HEATING AND COOLING

Current federal energy policies call for increased electrification in homes to reduce demand for oil and natural gas. Space and water heating by electricity is inefficient and wasteful. This is so even though solar cells covering the roof of an average house could produce enough energy to supply household needs with enough left over to charge an electric car (89, 24). It is even more efficient to control the temperature of a building by collecting and storing the sun's heat directly. It is said that solar heating systems could reduce use of oil and gas by 30 to 70 percent (89, 24). Approximately

25 percent of present national energy consumption is used for space heating and cooling (93, 10). The Solar Energy Report of Federal Council on Science and Technology estimates that by 2020, 40 to 50 percent of the heating for buildings in the U.S. could be supplied by solar energy. If solar energy were used, it is estimated that solar energy could supply up to 75 percent of heating energy if combined with thermal energy storage sufficient for one day's needs (92, 384).

Specific solar devices probably would be competitive with conventional methods in many other areas if supported by modest research and development efforts. In fact, there is good reason to believe that diffuse solar technology already may be competitive with conventional methods anywhere in the latitude of the United States (94, 38, 50). Economic studies indicate that solar heating is less expensive than electrical heating anywhere in the U.S., but is not competitive with gas or oil in most places (95, 268). Development of solar air conditioning systems, however, could change the competitive picture. It is estimated that it costs $312 a year for fuel to heat and cool the average house. The fuel costs would pay for a $3000 solar heating and cooling system mortgaged over 15 years. Pitted against rising gas and oil prices the solar powered system will become even more economical. No fundamental reason exists that works against the use of direct solar energy for domestic use.

Domestic solar water heaters are now available in Florida, where they provide energy for water heating at rates lower than costs for commercial electric power, and at levels not more than twice the cost of natural gas (92, 384). The figures are for equipment largely manufactured by hand and are expected to fall sharply with mass production.

Solar energy can be used for hot water production by installing collectors on the roofs of buildings. The collectors are simply constructed. A black surface absorbs the sunlight and the resulting heat is collected under glass using the principle of a greenhouse. The collector is insulated on the sides and back to prevent heat losses. Water, air, or some other fluid is passed through the collector to be heated up to 200 degrees Fahrenheit or more. The hot fluid is then stored to provide energy when it is needed.

An examination of Montana climatic conditions indicates that using sunlight for space heating would be worthwhile. The roof of a small house receives about five times more solar energy on its roof than would be needed to heat it for an average year (96). The rate of incoming solar radiation does not remain constant throughout the year, however, but varies more than five-fold from season to season. Peak demand in Montana coincides with the low point in receipt of solar energy. But even during January, when heating requirements are greatest, the solar energy from a 35 by 70-foot collection surface is enough to heat an average house in an average month (96).

Detailed determination of the rate of incoming solar energy is required from locations representative of the entire state. The only measurements now available were taken in Great Falls and Glasgow, making it difficult to predict solar energy system performance for other areas of Montana having different climatic conditions.

Some applications of solar powered space heating are being developed in Montana. A number of new systems are planned. The Sam Anderson home in Bozeman incorporates six solar panels, produced by the Graemar Company in Australia. Mr. Anderson expects to heat 70 to 80 percent of his domestic water with the panels costing $120 each (97, 8). Officials are considering using a solar panel to heat a new school's swimming pool in Three Forks. In Wyoming, the federal government is financing a tourist center designed for solar heating and cooling (98).

PHOTOSYNTHESIS AS AN ENERGY SOURCE

Photosynthesis, the process by which green plants acquire solar energy and use it to build their structure from the elements of the environment, is a potentially vast and renewable liquid fuel source of energy. Plant tissues thus formed can be converted through fermentation to alcohol, a very clean burning fuel. One of the possible alcohol products from the fermentation process, methanol, can be added to or substituted for oil. A simple adjustment of carburetion can allow the addition of methanol to gasoline for automobile use, for example. A reduction of air pollutants from the burned mixture is only one of the benefits.

Waste as Energy

U.S. urban populations generate more than 136 million tons of solid waste (household and commercial trash) annually that can be used as a fuel (99, 210). Heat content of the combustible portion (about 75 percent of the total) is equivalent to about 228 million barrels of oil (99, 210), or about 10 percent of annual U.S. oil imports. Used entirely for the production of electricity, the heat energy of trash could produce about 11 percent of the electric energy from conventional steam generation in 1970 (99, 210). It should be noted that both volume and potential heat content value of refuse are increasing, thus raising its energy value. Since 1960 Germany has built 20 refuse burners, which together dispose of the refuse of about 18 percent of the country's population and generate electricity (100, 62).

According to the Department of Health and Environmental Sciences, approximately 150 to 180 tons per day of refuse are collected in Great Falls and in Billings (101). Figures for Helena are about 80 to 90 tons a day (101).

If 75 percent of the waste is combustible (100, 62), and if the heating value of trash is at 5500 BTU per pound (102, I-9), about 1.2 to 1.5 billion BTUs would be available annually by burning the trash in cities the size of Billings or Great Falls. Probably only the state's large urban areas (Missoula, Billings, Great Falls) would find it practical to build a trash-fueled power supply but applicability might be increased if a mix of other fuels were available too.

One report (103) details a conversion concept involving wood wastes and municipal wastes. The preliminary technical and economic evaluation of the proposed concept is encouraging. Power costs in the range of present Montana electrical prices are indicated, including recovery of transportation costs to a centrally located plant site. In a study of the use of hogged fuel (wood wastes) for the heating and electric generation at the University of Oregon, annual net savings in fuel cost were found to be enough to recover initially high capital costs in two years. In western Montana it appears practical, for example, to use urban and wood wastes together.

It appears that existing technology could be used to generate steam in Montana at costs highly competitive with natural gas with little resulting air pollution (104, 35, 36). An advantage of wood wastes and urban refuse is that they contain negligible sulfur. The major components of the exhaust gases would be carbon dioxide, nitrogen, oxygen, and water vapor.

Another report, prepared by C. C. Gordon, and others at the Environmental Studies Laboratory, University of Montana, concluded that:

> use for the wood wastes of the wood products industry and the forested areas of Montana could occur now with much less of a biological impact than is and will be occurring in the Rocky Mountain area when the coal-fired utility plants go on line...When the wood waste products collected at the industry sites as well as from the forests are burnt in large boilers (200-400 megawatts) for energy conversion, the problems of air pollution emissions and abatement control will be immensely reduced over that of coal-fired boilers of equal size. First, the amounts of

known phototoxic emissions (i.e., SO_2 and NO_x) from wood fired boilers are extremely small compared to coal-fired boilers. Second, costs for abatement equipment for capturing particulates and gaseous emissions from wood waste boilers is only a small fraction of what it has cost those few utility companies which have installed adequate air pollution abatement equipment for coal-fired generators (105, 28).

Use of wood and urban waste as a fuel for generating electricity thus appears to have good potential for western Montana, particularly in the Missoula area.

On the basis of information collected for the Hoerner Waldorf Corporation, some 2,536,000 units of dry wood were estimated to be readily available in Missoula on a sustainable basis for approximately 20 years (106, 27). (See Table 60 below.)

TABLE 60

Wood Waste Residues Available to the Hoerner Waldorf Corporation

Supply Source	Thousand BTUs Chips	Sawdust	Total
UNUSED PRIMARY MFG. RESIDUES			
Area of Influence	1,047*	359**	1,406
Less: Committed Usage	636	31	667
Net Surplus	441	323	739
ROUNDWOOD WASTE RESIDUES			
Logging slash wood waste residues	485	33	518
Dead wood waste residues***	1,220	60	1,280
Total Roundwood	1,705	93	1,798
Less: HWC Chipping	1		1
Net Surplus	1,704	93	1,797
Total Wood Waste Available:	2,115	421	2,536
	---thousands short tons---		
Potential Yield of Kraft Pulp	1,218	242	1,460

*1971 capacity unchanged although there will be a chip volume increase
**1971 capacity reduced by approximately 41 percent
***annual supply for 20 years from present source

Source: Environmental Impact Statement on the Proposed Expansion of Hoerner Waldorf's Missoula Pulp and Paper Mill, Department of Health and Environmental Sciences, Helena, Montana, November 6, 1974.

The dead wood residues portion of the accounting is less than 15 percent of the total dead standing and downed wood waste in Bitterroot and Lolo National Forests. Each unit of dry wood is approximately 2,400 pounds. Hence, some 6 billion pounds of dry wood chips could be available in the Missoula area. If the wood waste were converted into electricity, it could supply a substantial amount of the electrical needs for Montana.

PRODUCTION OF METHANE

Methane production is another potential energy option for Montana. Livestock, human, and wood wastes can be converted to methane gas, the primary component of natural gas. The technology and skills necessary to convert biological waste to methane are now available so, development of this source of energy could be almost immediate.

Methane gas has been generated by decomposition of feedlot wastes and municipal sewage. Methane also has been produced from lumber mill waste. The product, referred to as "wood gas," was used in Europe during the World War II (97, 5).

It should be possible to interest feedlot operators in methane conversion because it offers a profit from an otherwise bothersome problem. Manure from the lot could be fed easily into a large digester resulting in the production of large quantities of so-called bio-gas (a mixture of methane, carbon dioxide, hydrogen sulfide, and other gases in trace amounts) which can be used to generate electricity and heat buildings in much the same way natural gas is used.

Calculations based on the number of cattle in Montana feedlots in 1973 show that nearly a trillion BTUs of bio-gas could have been generated if all livestock waste had been fed through a methane converter (107). Actual net energy contributions associated with the methane converter program are substantial because the converter's by-product is an excellent fertilizer, which can be used to reduce the demand for natural gas used in synthetic fertilizer production.

In Greely, Colorado, Bio-Gas of Colorado is building a methane converter scheduled to begin production in early 1975. It will be the first industry-sized methane converter anywhere, converting about 1,650 tons of manure a day into 5.25 million cubic feet of natural gas (Methane), equivalent to peak winter gas needs of a city of 50,000 (108, 7).

It also may be possible to build methane generators and connect them to municipal sewage treatment plants. In fact, some existing treatment plants use self-generated methane to energize the sewage treatment process. Based on 1970 population figures, 13.5 million BTUs a day are available in every Montana town with a population over 1,000, or a total of 1.83 trillion BTUs of bio-gas in Montana every year (109).

Limited development of bio-gas has begun in Montana. Al Rutan, of Billings, has constructed a small methane converter in his home (97, 2). A small corporation, Biofuels, has been started in Noxon. George Oberst, of Biofuels, has begun consultation with several potential customers for methane digesters (97, 2).

At Montana State University, the Animals Sciences Department is studying the methane conversion process as a way to reduce odor and water pollution problems at feedlots. Current research concerns waste from swine. The thrust of research is to develop a process economically suitable for operators of small livestock businesses.

The Power of Wind

Windmills in Montana harnessed the energy of moving air long before the Rural Electrification Association brought electricity to rural areas.

Wind system researcher Forrest Stoddard, an associate of William Heronemus of the University of Massachusetts, is quoted by the Billings-based Alternative Energy Resources Organization (AERO), as stating, "We at the University of Massachusetts propose that you in Montana get started on a statewide program, looking at small, intermediate and large-scale wind power schemes. Your results should give you operational electricity within 36 months" (97, 2). Recent estimates indicate that the total wind generating capacity for the Great Plains could equal the nearly 200,000 megawatts of nuclear plant installed capacity (110, 192).

The National Aeronautics and Space Administration predicts that windmills could supply between 5 and 10 percent of the nation's electrical power demand by the year 2000 (111, 1,056). Professor Heronemus believes that with an accelerated national effort, windmills could be generating 1.5 trillion kilowatt-hours by the year 2000, nearly as much as existing electrical generation (111, 1,056).

An ideal windmill could extract as much as 59 percent of the energy of the wind passing through the area swept by its blades. Windmills with good aerodynamic design generate approximately 75 percent of the theoretical maximum. Alternative schemes such as the Tracked Vehicle Airfoil Concept, explored by Ralph Power and Harry Townes at Montana State University, offer possibilities of up to 80 percent energy conversion (112).

Windmills can be used to supplement a large power system, or to provide base power, which necessitates storing energy for delivery when the wind dies. Wind generators could be added to any system with storage capabilities, such as pumped-storage or a conventional dam and hydroelectric plant. In addition, wind generators could supply power to any grid and the storage could be considered to be the fuel that runs the conventional generating plant. The possible applications for large-scale use of wind-powered generators should be determined. This determination should include wind analysis, economic analysis and a further examination of the need for and problems of power storage capabilities.

In assessing the potential for wind-based generation in Montana, careful consideration must be given to wind speeds. Wind speed data are contingent on the exact location of the site of measurement, with shifts of only short distances making major differences in wind speed and duration. However, for a rough estimate of favorable areas, climatological data--wind speed measurements from across the state--published by the U. S. Weather Bureau can be used.

More than 10,000 kilowatt-hours could be generated per year in Great Falls with a small wind generator having a 3 meter propeller and a 70 percent mechanical efficiency. Based on estimates received for average household electrical consumption of 12,000 to 14,000 kilowatt-hours (113)(114), including a hot water heater, such a wind generation system could contribute significantly to reducing residential electric demand, particularly if the hot water heating load were offset by solar powered heating.

Hugo Schmidt, physics professor at Montana State University, supervised the construction of an electricity-producing windmill during the summer of 1974. The windmill, with four blades eight feet in diameter, generated 200 watts in an 18 mile per hour wind current. Material construction costs for the system included $200 in materials--mostly using junked automobile parts (97, 8).

Geothermal Energy

Geothermal means literally "earth heat." This heat results from the slow decay of radioactive elements and from frictional forces. With our present technology drilling depths of 7.5 kilometers have been achieved and someday may reach two or three times that depth. However, the depths from which we may economically extract the earth's heat seems unlikely to exceed 10 kilometers (115, 95,121).

The average amount of heat which flows to the surface is very small and would have to be concentrated considerably to be considered as an energy source. There are, however, areas in which molten rock is, or has been, much closer to the surface. It is the areas in which natural heat is concentrated close to the surface that economic energy exploitation may be possible. In this context, geothermal heat is similar to minerals or petroleum in that it becomes economically exploitable when found in sufficient concentrations.

GEOTHERMAL ENERGY IN MONTANA

A potential geothermal energy site was discovered near Marysville in 1966 by Professor David Blackwell (Geology Department, Southern Methodist University) while he was conducting heat flow surveys in the Rockies. The area has one of the highest geothermal gradients on the continent. Battelle Pacific Northwest Laboratories is conducting a three year study on the area under National Science Foundation funding. Another high heat gradient has been found at Butte. In addition, there are a number of hot springs in western Montana and hot groundwater is found in some eastern Montana wells.

A 12,763-acre area in Montana near Yellowstone Park is classified as a known geothermal resource area (116, 18). More than 3.8 million additional acres are classified as prospective geothermal sites (116, 18).

Montana has the basic requirements for geothermal energy (117). Much of the state has evidence of Tertiary volcanic intrusive activity. The western part of the state is faulted, the mountains in that area are fault block mountains and the state has high-volume aquifers.

The following are potential geothermal areas: (117)

1. Upper Yellowstone River Valley--this area has thermal springs. Some (e.g. Chico) have been used for recreation facilities. Hot water escapes through faults probably from Tertiary intrusive body in the Beartooth Mountains or perhaps from volcanic activity in the Crazy Mountains.

2. Mocassin-Judith Mountain Area--Big Warm Springs, a large thermal spring, is on the north side of South Mocassin Mountains. Geothermally heated water comes through faults in the loccolithic Tertiary intrusions of the area.

3. Little Rocky Mountain Area--This area has several warm springs coming out of limestone of faults from Tertiary intrusive masses which comprise the core of the mountains.

4. White Sulphur Springs Area--A major fault is thought to be under the city of White Sulphur Springs and might be the pathway for heat from Castle Mountain intrusive body or other nearby cooling body.

5. Boulder Batholith Area--Several thermal springs surface along fault lines in this area.

6. Idaho Batholith Area--The eastern part of this area lies in Montana and is a source of dry geothermal heat.

7. Beaverhead Area--This area, south of the Boulder and Idaho batholiths has thermal springs. Drilling for uranium has revealed warm water beneath Big Hole Valley.

8. Snowcrest-Gravelly Range Area--This area west of Yellowstone Park has a heat source probably from deep igneous intrusions.

9. Madison Group Area--Hot water wells.

GEOTHERMAL SYSTEMS

Different geothermal areas vary according to geological and hydrological characteristics present at each site. The type of system present determines the type of extraction and production techniques, and to a lesser degree the type of exploration methods which are used in the development of the field. The system variation is based largely upon the method in which heat energy is transferred at exploitable depths.

Dry Rock Systems

Conduction is the dominant means of heat transfer through solids and therefore the earth's crust. In a largely dry rock conduction system, temperature generally increases continously with depth to the interface of the Moho* Differences in heat flowing through dry rock in various areas of the world arise as a function of the depth of the heat source, the thermal conductivity of the crustal rock, and

*Mohorovicic discontinuity: a boundary line between the earth's crust and hot mantle said to exist between 3 and 25 miles below sea level.

the thermal gradient. At present there are no dry hot rock systems being exploited, although the technology is currently being developed, as will be discussed later.

Fluid Systems

Convection is the other primary heat transfer mode present in the earth's crust. This occurs when fluids are heated and rise as a result of thermal expansion and low specific gravity. Cooling fluids or cool ground waters replenish the cycle of circulation which is driven by heat furnished at the base of the system. In a convection system the temperatures tend to be greater in the upper portions than in the lower parts due to the nature of the system. There are two basic types of water convection systems which differ according to the physical state of the water.

Hot Water Systems

Hot water systems are characterized by water in the liquid state, although it may be at pressures greater than hydrostatic. In a major convection system water serves as the medium by which heat is transferred as it moves from a relatively deep geothermal heat source to the surface or near surface. Cool ground waters seep into the perimeters of the geothermal system due to their higher density in relation to warmer heated water. The pressure exerted by cooler waters on less dense heated waters may result in artesian hot springs. If the aquifer, a porous water carrying layer of rock, which lies on top of the heat source is covered by an impermeable caprock, the water may be at temperatures which exceed boiling at atmospheric pressure. This liquid water, under high pressure, may partially flash to steam once the pressure is released either by drilling or by natural faulting in the caprock layer. All of the water does not flash to steam, and thus droplets are carried up with the steam; this is often called a "wet steam" system.

Vapor Dominated Systems

A small percentage of the world's geothermal resources are to be found in the form of vapor dominated systems. At present the only large known systems of this type are found at the Geysers field in California and the Lardello field in Italy. Since they produce superheated steam with no associated liquid, they are often called "dry steam" systems. This steam is generally thought to originate from boiling water in a deep geothermal reservoir with a high temperature heat source and a low water recharge rate. The water reservoir has overlying rock which is highly porous and permeable and allows the steam to exist as the continuous pressure controlling phase with pressures below hydrostatic. As the steam rises in the geothermal system it loses its heat to surrounding rock and eventually condenses near the surface in most vapor systems. This condensed liquid, if not lost to the surface, drains downward on the perimeter of the system to deeper water-saturated rock on the perimeters of the heat source and serves as a recharge source for the system.

GEO-EXPLORATION

Geophysical exploration for geothermal energy has been largely adapted from standard geophysical practices, although alterations and various innovations have been found necessary to provide for the uniqueness of geothermal resources. Preliminary exploration selection is based upon a number of previously known geologic factors. The presence of geysers, fumaroles, mud volcanoes, or thermal springs are obvious indicators of geothermal activity. Areas with volcanism of late Tertiary or Quaternary age may also indicate possible near surface heat sources, especially if caldera, cones, or volcanic vents are present. Information available from other activities such as deep mining, well drilling for petroleum, etc. may also provide information pertaining to the possible presence of geothermal anomalies.

Drilling

There are two phases of drilling which can occur in the development of a geothermal field, test drilling and field development drilling.

Test wells are located on the basis of preliminary geophysical exploration. These wells provide subsurface geologic data, information as to the physical and chemical characteristics of the geothermal fluid or rock, help define local productive zones, and help determine the extent and productiveness of the field.

Although the drilling of geothermal wells is very similar to petroleum drilling, geothermal fields present some problems not encountered in petroleum fields. The heat and abrasiveness found in geothermal formations are extremely hard on subsurface equipment. This includes drill bits, valves, cements, casing, etc. Much of the conventional equipment will not stand up to the physical characteristics found in geothermal systems.

The future development of geothermal systems which have characteristics that economically prohibit the use of present drilling technology due to physical limitations is dependent upon the development of low cost drilling. Presently, the cost of drilling increases very rapidly with depth. Utilization of geothermal energy at depths greater than three kilometers (km) is not now economic (117, 17). The development of low cost drilling to depths of greater than three kilometers would permit much greater utilization of the heat energy stored in the outer 10 kilometers of the earth's crust.

Plutonic or hard metamorphic rock also limits the use of present drilling technology due to extreme wear on subsurface equipment. High temperatures associated with geothermal systems are also very hard on drilling tools. As a result, costs may be prohibitive to development in geothermal systems with these geologic characteristics.

The Los Alamos Scientific Laboratory has recently been developing drills which bore through rock by progressive melting rather than by chipping and abrading. This borer is electrically or automatically heated to melt through rock. As it moves, the molten rock hardens and forms an obsidian-like casing which is fused to surrounding rock. There is no debris to remove from the hole and it would not be necessary to install casing as the glass liner serves that purpose. High temperature rock improves the performance of the drill, unlike conventional equipment performance which is impeded by high temperatures.

A two inch prototype has been developed which consists of a molybdenum shell, a tungsten tip, and a graphite heating element which uses a three kilowatt power source. Melting rates have been slow, 60 feet per day. However, calculations show that larger drills should have much higher melting rates as well as increased energy consumption efficiency.

Conversion and Use

The type of technology used in the development of any particular geothermal system is determined largely by the type of system present (e.g. vapor dominated, liquid dominated, dry hot-rocks), and by the chemical and physical characteristics of the steam, liquid, rock present in that system. In general, increasing technological difficulty is encountered with the development of vapor dominated systems, liquid dominated systems, and hot dry-rock systems, respectively.

The technology for the development and exploitation of vapor dominated systems, and superheated liquid dominated systems with low chemical content is readily available. However, the technology for the production of power from low enthalpy hot waters and geothermal waters of high chemical content is in a pre-pilot plant stage of development. The technology for the use of hot dry-rock systems is in the early planning and experimental stage.

Power generation from geothermal energy sources differs from fossil and nuclear electrical generation in several aspects. Geothermal plants do not require hotboxes, boilers, or furnaces, or mining of fuels. However, because geothermal steam or water cannot be transported over large distances, geothermal plants are "mine mouth" plants (the generation facilities sited at the location of the geothermal field).

Environmental Impacts

Geothermal energy has environmental advantages over conventional energy sources. It is not a source of air pollution or radiation hazard, or require that large amounts of land be disturbed (other than for transmission lines or pipelines and the plant itself). However, it does have some environmental drawbacks. Effluent can pollute surface and ground water unless fluids are reinjected into deep reservoirs. Potential thermal pollution problems can also be avoided by reinjection. Other potential problems include noise, objectionable gases, visual impact, and subsidence due to fluid withdrawal (118).

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APPENDIX A

CONSERVATION THROUGH RATE RESTRUCTURING

The Montana Public Service Commission operates under statutes that at least in part give it power over prices and rate structures of Montana utilities. Utility regulators normally have considered it their primary duty to assure the governed utilities a profit adequate to generate a fair rate of return and sufficient to allow the utilities to compete in money markets. So long as prices could be kept low, rate structures and levels were not examined provided that they generated revenue sufficient to achieve the agreed-upon rate of return.

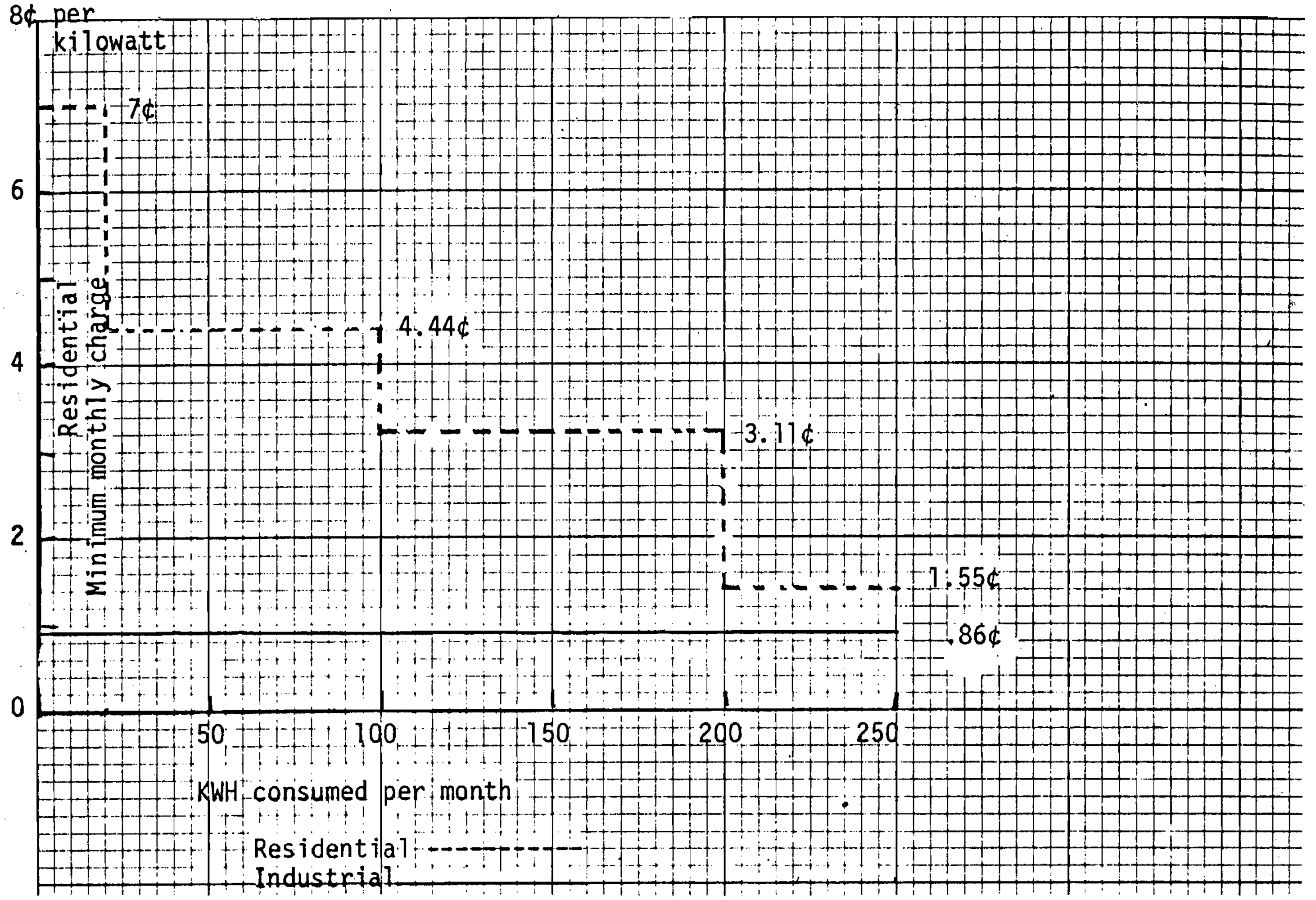
Today, however, the importance of energy conservation has raised a number of questions about this traditional approach to regulation. Dwindling energy resources and rapidly increasing private and social costs of new generating facilities point to the vital public interest in seeing that utility rates are set in the best long-term interest of the consuming public as well as the regulated utility industry.

Marginal cost pricing, defined as the reasonably expected additional cost that would be incurred in producing an additional unit of a product or good, has been long recognized as a prerequisite for efficient use of resources and markets. This concept is becoming recognized as the necessary foundation for any utility rate structure that will best serve the interests of the public and the industry. A recent rate hearing of Madison Gas and Electric Co. before the Wisconsin Public Service Commission illustrates this trend: "There was reasonably general agreement among all parties that the first principle enumerated (rates should promote efficient allocation of resources, thus discouraging wasteful use of energy) implies that rates should properly reflect the marginal cost of providing service to a given customer" (1).*

*References to Appendix A are found on page 192.

Figure A

Montana Power Company Residential Rate Schedule 1972
(declining block rate system)



Source: Data derived from Federal Power Commission Report #1, Account 400 for Montana Power Company, 1973.

The commission said marginal cost pricing in utility rates would accurately reflect the cost to society of producing each additional unit of energy. The findings of the Wisconsin Public Service Commission concluded that, in the context of the electric power industry, the long-run incremental (marginal) cost, defined as the cost of capacity and output that can be expected to be added to a utility system over a period of several years, is the overriding factor to be considered in marginal cost pricing and utility rates (1).

At the present time, Montana utilities are governed by rate structures that allow users to pay reduced rates for increased use. This is called the "declining block rate" system. An example of this "declining block rate" system is the residential electric rate schedule of Montana Power Company shown in Figure A: 7 cents per kilowatt-hour (kwh) for the first kwh (minimum charge -- $1.40); 4.44 cents per kwh for the next 80 kwh; 3.11 cents per kwh for the next 100 kwh; and 1.55 cents per kwh for all additional consumption (2). Montana Power's commercial schedule is based upon a similar declining block rate system (2). Individual contracts are signed with large industrial customers to deliver energy at rates substantially below prevailing rates for other classes of customers (3).

Initially, the declining block rate schedules were designed to encourage the use of electricity and hence provide increased revenue and demand for additional generating capacity. Until the mid-1960s the electric power industry was experiencing declining costs: in such circumstances new generating capacity had the effect of delivering electricity at a lower average cost than would existing equipment, thus lowering the average cost to all users.

Today the electric power industry is faced with much higher costs for additional capacity caused by the rising costs of labor, equipment and fuels. High costs of money, slowdowns in technological advancement and expenses necessary to protect public health and the environment also have driven up prices. The fact that costs for additional (incremental) capacity significantly exceed those for facilities already in place (embedded) will seriously affect planning for utility expansion. "By the end of 1976," according to one estimate, "the embedded cost of kilowatt [kw] of capacity will be on the order of $425/kw. Incremental capacity will cost on the order of $650 if the recently experienced rates of inflation at 7% per year continue for the next few years" (4). In Montana, 80 percent of the embedded generating capacity is low-cost hydroelectric power. Hence the difference between embedded and incremental costs is accentuated in the Montana Power system. A recent Montana Power advertisement stated that the overall cost for new generating plants today is twice what it was six years ago. A rate structure that in effect tells users that increased consumption lowers their average cost is misleading, uneconomic and obviously not based on a marginal cost concept.

The existing declining block rate system also fails to offer customer incentives to minimize the long run costs of service because it does not differentiate between on and off-peak service. Power generating equipment, transmission and distribution networks all are built to exceed maximum system demand by a small amount. Montana Power's daily peak loads occur around supper time; yearly peak loads are in January. The 1974 yearly peak load estimate is 953 megawatts; the average load of 645 megawatts requires two-thirds of this capacity (6). The cost of building generating capacity to meet this predicted peak requirement accounts for roughly 50 percent of what users pay for electricity (7). When rates do not differentiate between peak and non-peak service they do nothing to encourage off-peak usage and thus improve the system load factor. Shifting consumption away from peak usage would reduce required generating capacity and lower the long-run costs of service.

Table A shows Montana Power's three main classes of electricity consumers and their average rates for 1973.

TABLE A: Montana Power Company Customers and Rates (1973)*

Class	Average Charges (cents/kwh)	Consumption of total electricity sold (percent)	Contribution to total revenue (percent)
Residential	2.45	24	37.7
Commercial	2.197	21	30.4
Industrial	.86	50	27.8

*Montana utilities all have similar rate structures.

Source: Data derived from Federal Power Commission Report #1, Account 400 for Montana Power Company, 1973.

All this raises questions about the wisdom of quantity discounts and pricing the bulk of power used below long-run incremental costs. Such a policy results in a misallocation of resources, unneeded capacity, and subsidizes those customers contributing the most to peak power demands but who are paying the least.

A more useful way to analyze the "long-range incremental costs" (LRIC) would be to divide them into three distinct components:

1. <u>Customer cost</u>: Includes meter reading, billing, connection costs, and that part of distribution cost that has been designated as varying only with the number of customers.

2. <u>Demand cost</u>: Includes generation, transmission and distribution capacity costs that vary with total kilowatt demand. These are future costs of anticipated plant additions adjusted to the current price level for rate setting purposes. These costs do not vary with the number of customers but equal the aggregate cost of the capacity commitments made by the utility when providing service to customers.

3. Energy cost: Includes operating and maintenance costs associated with supplying a given number of kilowatt-hours of energy. These costs vary directly with the amount of energy consumed.

Service at peak and off-peak times will have different LRIC due to varying demand costs. The expenses associated with supplying 950 megawatts will be higher than those for 650 megawatts. The customers using peak power should pay for the capacity needed to meet their demands; those using off-peak power should not be expected to contribute to capacity costs.

A step toward a full peak-load pricing system might be the creation of a winter-summer differential rate so that the summer users of a winter peaking utility, such as Montana Power, are not charged for the additional capacity required for January customers. Also, it should be remembered that even during the coldest winter months the utility is not operating at peak load constantly. Full peak-load pricing must ultimately take the form of time-of-day metering in which rates would vary with the time of day. Supper time rates would reflect a higher demand charge than mid-morning rates. Some argue, in fact, that peak load pricing cannot have much effect until carried to the extent of time-of-day metering. "Indeed," said an intervenor in the Madison Gas and Electric case, "this is most logical for while it is unlikely that consumption patterns can be shifted seasonally, substantial opportunities exist for time-of-day shifts particularly in the industrial sector" (8). Time-of-day metering is really required to shift daily usage patterns and improve average local factors.

Recent evidence indicates that time-of-day meters are now technologically and economically feasible, particularly for large volume users. Such meters cost about $30 each (8). Certain industrial and commercial users in Montana may already be equipped with recording type meters which can be adapted to time-of-day metering.

Strict adherence to a rate structure based on LRIC will, during a period of increasing prices, yield utility earnings greater than immediate revenue requirements because rates will be based on future utility costs which will be higher than the utility's current costs. In other words, the utility would be receiving revenue based on costs above those currently experienced. Deviations may be required from a strict LRIC-based rate structure until demand levels off, so that LRIC approximates current costs, or until inflation decreases.

Any alteration in the rate structure should be based on the electricity user's elasticity of demand. Elasticity of demand indicates numerically how much the sale of a product, in this case electric energy, might shift in response to a hypothetical change in price. While the elasticity of demand for electricity in Montana is unknown, recent studies have indicated that the long-run elasticity for residential users is between -1.0 and -1.2, indicating that a 10 percent increase in price would result in a 10 to 12 percent decrease in use. For industrial users the coefficient of elasticity is between -1.5 and -1.8; indicating that a 10 percent increase in price would result in a 15 to 18 percent decrease in use. Elasticities for commercial users are estimated to fall between those for residential and industrial use (10).

Excess revenues generated during times of increasing costs should be offset by reducing rates charged to the inelastic consumers, those who would increase their demand <u>least</u> in reaction to a price drop. For electric power consumption this would be the residential class, since it is less price-sensitive than the other classes. Pricing below LRIC level for the residential class to curtail excess revenues would create the least increase in demand, thereby minimizing system costs.

Even if revenue requirements are in balance under the marginal cost pricing system, an understanding of demand elasticities is desirable as the following testimony given before the Wisconsin Public Service Commission points out:

> But all [LRIC] cost estimates are approximations, and the practical ratemaker may want to recognize that fact by leaving a margin between the rate and the calculated LRIC in the case of demand elastic services, again, so as to not stimulate uneconomic usage. There is, of course, the danger that by so doing he will be unduly discouraging elastic demand uses... Again, however, the practical ratemaker might well wish to know enough about demand elasticities to choose consciously between running the risk of over stimulation or running the risk of undue discouragement (8).

Recommendations

The foregoing analysis is based on the assumption that any policy for conserving electricity must be accompanied by a rate structure related to true cost. The Montana Public Service Commission should take steps to adopt a pricing structure truly based upon marginal costs of service, defined here as "the long range incremental cost (LRIC), or the cost of capacity and output which can reasonably be expected to be added in the next several years. A rate structure based upon these costs would encourage efficient energy use as user received realistic economic "signals" of the true cost of energy.

Toward this objective, the Montana Public Service Commission, in conjunction with Montana utilities, should initiate studies to resolve the following issues:

1. Make a determination of the three cost components (customer, demand, and energy) of the Long-Run Incremental Costs associated with each separate class of customers for peak as well as off-peak periods.

2. Initiate feasibility testing for time-of-day metering for residential and small commercial users.

3. Study and determine elasticities of demand for each customer class during peak and off-peak periods.

The new rate structures produced by the application of the study results would no doubt be "flatter" than the declining block rates currently charged to residential and commercial customers, and probably somewhat higher, on the average, for industrial users. Customer costs (one component of LRIC) would be recouped in a fixed monthly charge. Demand charges would be levied according to time-of-use and energy charges would vary only with kilowatts of power consumed.

Such research will take time, but there are certain rate changes which could be implemented immediately and result in some savings:

1. Differential rates, yielding aggregate revenue similar to that currently being generated, should be charged for winter and summer usage. Under the existing rate system the same rates are charged for January and July.

2. Time-of-day meters should be installed, or currently used recording devices adapted, for large volume users.

3. Rate flattening should begin by raising the charges for "tail end" blocks of usage and lowering the charges in initial blocks so that the total revenue generated remains the same.

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9. a. Science, "Electricity Demand Growth and the Energy Crisis," Chapman, Trell, and Mount, Nov. 17, 1972.

   b. "Electricity Demand in the US; An Econometric Analysis," T. J. Tyrell, Oak Ridge National Laboratory, 1973.

   c. "Demand for Electric Power in the U.S.," R. Halvorson, paper presented to the Econometric Society, New York, Dec. 1973.

APPENDIX B

MONTANA'S FUEL PRODUCTION TAXATION SYSTEM

Seven primary taxes are levied on the production of oil, coal, and natural gas in Montana:

1. Net Proceeds Tax (oil, coal, and gas)
2. Resource Indemnity Trust Tax (oil, coal, and gas)
3. Corporation License (Income) Tax (oil, coal, and gas)
4. Oil Producers' License Tax
5. Strip Coal Mine License Tax
6. Natural Gas Distributors' License Tax
7. Oil and Gas Conservation License Tax

In addition, there are locally levied personal property taxes on equipment and real estate and, in some cases, a right of entry property tax. The additional taxes are explained in more detail later in this Appendix. The following brief explanation will serve to show that the current tax system lacks simplicity in design and consistency among the three fuels.

Taxes on oil, coal, and natural gas are paid at different times during the year. The Net Proceeds Tax is payable semi-annually, November 30 and May 30, for the production period ending the previous March 31. The Resource Indemnity Trust Tax is payable by March 31 for the calendar year's production. The Strip Coal Mine License Tax, Oil and Gas Conservation License Tax, Natural Gas Distributors' License Tax, and the Oil Producers' License Tax all are paid quarterly for the previous calendar year's production.

Coal taxes in Montana are based on gross value (Resource Indemnity Trust Tax), gross value minus deductibles (Net Proceeds Tax), and physical production and BTU content (Strip Coal Mine License Tax).

Oil producers pay net proceeds and resource indemnity taxes, a tax based on gross value of the oil that varies with quarterly production per well (Oil Producers' License Tax), and a tax based on production but varying according to daily production rate (Oil and Gas Conservation License Tax).

Natural gas producers pay the resource indemnity, net proceeds, and gas conservation taxes, and a tax based on the value of the gas they distribute (Natural Gas Distributors' License Tax).

Peculiarly, the Natural Gas Distributors' License Tax applies only to natural gas which is distributed to consumers within Montana. It does not apply to gas produced within the state and distributed directly to out-of-state customers (1)* Table 1 on p.195 shows the major taxes, excluding the Corporation License Tax and local property and equipment taxes, and the revenue raised for each of the three fuels for calendar year 1973.

Net Proceeds Tax

The Net Proceeds Tax is a major revenue producer for those counties which produce fossil fuels. This tax is essentially a property tax levied against the income of the fuel producer. Allowable deductions from gross income include royalties and the costs of production, including reclamation.

For the local jurisdiction that levies it, the nature of the tax is its worst failing: unpredictably hinging on the earnings, profits, and costs of what usually is the dominant corporate taxpayer in a jurisdiction, the proceeds tax cannot be depended on from year to year either by government or the more numerous citizen taxpayers, who must adjust their payments to compensate for the irregular yields produced by the Net Proceeds Tax.

By law, mining companies are allowed to deduct expenses incurred in reclamation efforts. This expense varies from year to year and the deduction

*References to Appendix B can be found on page 213.

Table 1--Oil, Coal and Natural Gas Taxes*

Oil Production Taxes (1973)

Production (Barrels)	Gross Value (1) Wellhead ($)	Net Proceeds Taxes ($)	Resource Indemnity Tax ($)	Oil Producers License Tax ($)	Oil & Gas Conservation Tax ($)	Net Proceeds Royalty Taxes ($)	Total ($)
34,583,851	133,452,664	10,316,810 (61%)	667,264 (4%)	3,418,551 (20%)	188,985 (1%)	2,265,564 (14%)	16,857,174 (100%)

Coal Production Taxes (1973)

Production (Tons)	Gross Value (2) Minehead ($)	Net Proceeds Taxes ($)	Resource Indemnity Trust Tax ($)	Strip Coal Mines License Tax ($)	Net Proceeds Royalty Taxes ($)	Total ($)
10,729,019	30,242,696	848,929 (24%)	109,203 (3%)	2,422,076 (67%)	231,061 (6%)	3,611,269 (100%)

Gas Production Taxes

Production (Thousand cubic feet)	Gross Value (3) Wellhead ($)	Net Proceeds Tax ($)	Resource Indemnity Trust Tax ($)	Gas Distributors License Tax ($)	Oil & Gas Conservation Tax ($)	Net Proceeds Royalty Taxes ($)	Total ($)
55,276,037	8,958,656	809,047 (69%)	44,793 (4%)	158,990 (13%)	12,512 (1%)	155,421 (13%)	1,180,763 (100%)

*All data supplied by Alan Taylor, Econometrician, Montana Department of Revenue.
1. At average price of $3.86 per barrel
2. At average price of $2.82 per ton.
3. At average price of 16.2 cents per thousand cubic feet.

Source: Compiled by EQC staff.

of land reclamation costs can substantially reduce local tax receipts as Table 2 (2) shows:

TABLE 2

Peabody Coal Company Taxes in
Rosebud County School District No. 19 (1973)

	Without Reclamation Deduction	With Reclamation Deduction
Taxable Net Proceeds	$640,655	$191,188
Taxes Owing	86,258	25,742

Source: Derived from Coal Development Information Packet, Montana Energy Advisory Council, December 1974.

In estimating its reclamation costs at $449,467 ($640,655 minus $191,188), Peabody Coal was saying that reclamation cost $12,500 an acre during the year. Burlington-Northern Railroad, which is trying to reclaim old spoils banks in the same county, and Western Energy, which is attempting concurrent reclamation and mining nearby, both indicate reclamation costs of about $700 an acre (2).

Royalty payments on coal are deductible also, and in 1973 varied from 8.2 cents a ton (Knife River Coal Company) to 41.4 cents a ton (Decker Coal Company) (2).

Much of Montana's strip-mined coal is being sold to parent companies by a subsidiary division. The law currently allows profits of the subsidiary to be included among deductible mining costs for the parent company. This has the effect of reducing local tax collections.

The unpredictable size of tax collection under the Net Proceeds Tax also affects county budgeting officers. The proceeds vary widely among operating mining companies.

Western Energy (owned by Montana Power Company), reported a drop in net proceeds per ton from 82 cents to 38 cents in the last five years. Knife River Coal Company reported a drop from 91 to 53 cents in net proceeds during the same period. Peabody's 1973 net proceeds calculation was 9.7 cents a ton; Decker's was $1.64 (2).

In a general sense, the practice of connecting property taxes and corporate earnings is inherently inequitable because individual area taxpayers will see their mill levies rise in unprofitable years. During a year with particularly high land reclamation costs, for example, a coal company would get a tax break. Surrounding farmers and ranchers, though, would suffer the opposite. Silver Bow County levies responded to this kind of pressure in 1962, 1963, 1967, 1968, and 1971--years when Anaconda Company had deficit earnings (3).

Strip Coal Mines License Tax

Data on Table 1 on p. 195 show that the revenue produced by the Strip Coal Mines License Tax accounts for two-thirds of the coal-related state and local tax receipts in 1973. This tax is basically a severance tax levied against the volume of production, at a rate that increases as a function of the BTU rating. Because tax receipts under this system do not change with coal market values, Table 3 shows how, during a period of rising coal prices, the tax revenue as a percent of gross value will drop substantially.

TABLE 3

Relationship Between Coal Price and Tax Revenue

Present Tax Rate (8500 BTUs)	Price Per Ton	Tax as a Percent of Gross Value
34¢/ton	$2	17
"	$3	11.3
"	$4	8.5
"	$7	4.8

Source: Compiled by the EQC staff.

Although the $7 per ton figure may seem high, Decker Coal recently signed a 25-year contract to deliver coal at a $7 a ton mine head price with the Austin, Texas, City Council (4).

Even though BTU content represents the energy value inherent in the coal, it has little effect on the price of coal relative to other fossil fuels because end uses are incompatible among the three major fuels and because the fuels vary in scarcity. Any two kinds of coal of comparable heating quality also may differ in price due to differences in shipping distances, and different costs of extraction.

Natural Gas Distributors' License Tax

The Natural Gas Distributors' License Tax is levied against distributors of natural gas on gas distributed to consumers in Montana. Table 1 on p.195 shows that this is the most important state-levied tax on natural gas, surpassed only in revenue producing capability by the locally levied Net Proceeds Tax.

The Natural Gas Distributors' License Tax has two major shortcomings: 1) it is a tax on physical quantity distributed, so revenue produced will not keep pace with rising market values for natural gas, and 2) gas produced within the state for export out-of-state escapes taxation altogether.

Table 4 below shows the revenue producing problems inherent in this tax during the period of rising gas prices.

TABLE 4

Operation of the Natural Gas Distributors' License Tax

Present Tax Rate (cents) per 1000 cubic feet	Price per 1000 cubic feet (cents)	Tax as a percent of gross value
.575	16.2	3.5
"	30	1.9
"	42	1.4
"	55	1.0

Source: Compiled by EQC staff.

Although the average price of natural gas per 1000 cubic feet in Montana during the calendar year 1973 was 16.2 cents, the regulated interstate sales price for "new" (gas produced from wells beginning operation after January 1, 1973) has been raised recently from 21 cents per 1000 cubic feet to 42 cents.

Recently some gas sold intrastate has had a wellhead price of 50 to 55 cents per 1000 cubic feet (5). If all gas prices were deregulated, a position for which there is a growing body of public support, wellhead prices regardless of destination would approach 50 to 60 cents per 1000 cubic feet. If this were the case the current tax would be entirely inadequate for the purpose of raising revenue.

By not taxing the production of gas sold out-of-state, Montana is losing revenue associated with the extraction of a very valuable fuel as well as encouraging resource waste. A tax on fuel production could encourage efficient management by producers and discourage consumers from wasting available energy. All natural gas produced in Montana should be taxed similarly regardless of the ultimate destination.

The Tax on Montana's Fuels--A Question of Rates

The current fossil fuel tax system, and resultant taxation rates, is depicted in Table 5. Two comparisons are made of oil, coal and natural gas taxes; taxes as a percent of gross value and taxes per million BTUs. Column five shows coal taxes are highest as a percentage of gross value but oil bears the highest burden on an energy (BTU) basis. It is difficult to determine the overall equity in this system because the physical properties and end markets differ for the three fuels. Coal is in demand primarily to produce electricity, oil for gasoline and other by-products, and natural gas for residential and industrial uses. Energy values also fail to translate into comparable money values: $5 worth of Montana coal (at $4.50 per ton) contains 20 million BTUs; $5 worth of oil (at $5.25 per barrel) contains 5.5 million BTUs, and $5 worth of gas (at 40 cents per 1000 cubic feet) contains 13.25 million BTUs.

To determine what the tax relationship should be between the fuels we should first address the question: What can a fuel production tax accomplish?

Table 5 --Fuel Production Taxes and Taxation Rates

	Production (1)	BTUs (trillions) (2)	Gross Value (3)	Taxes Paid (4)	Tax expressed as percentage of Gross Value	Tax per Million BTUs (cents) (5)
OIL (barrels)	34,583,851	200,586	133,452,664	16,857,174	12.6	8.4
COAL (tons)	10,729,019	192,908	30,242,696	3,661,269	11.9 (16.9) (5)	1.9 (2.7) (5)
GAS (thousand cubic feet)	55,276,037	58,593	8,958,696	1,180,763	13.2	2.0

1. From Table A

2. Assuming 5.8 million BTUs per barrel (oil), 17.98 million BTUs per ton (coal), and 1.06 million BTUs per 1000 cubic feet (gas).

3. From Table A: $3.86/barrel (oil), $2.82/ton (coal), 16.2¢/1000 cubic feet (gas).

4. From Table A

5. These are the currently effective rates resulting from the higher Strip Coal Mines License Tax which went into effect during the middle of calendar year (July 1) 1973.

Source: Compiled by the EQC Staff.

The answer is, many things. It can enable the state to share in the profits generated by fuel extraction, and to use the tax receipts to alleviate adverse local impacts caused by extraction. Fossil fuels are a finite resource and a tax also can raise general purpose revenue to compensate the public for the loss of their valuable resources. A severance tax based on value can encourage conservation of fuels if the added tax cost is passed on to the buyer. If the tax is passed along in the form of higher prices, resource buyers may well be encouraged to use the resources more efficiently. If the tax-induced higher prices are passed along to the ultimate consumer, reduced energy consumption may well result. A tax sufficiently high actually may discourage extraction of some of the resource, assuming other (less taxed) sources of supply are available, thereby leaving fuels in the ground for future energy needs.

How can Montana's fuel production tax system assist the state in meeting its tax and energy policy objectives? It must be assumed there is concensus that energy conservation is desirable and that future energy options must be preserved by encouraging non-wasteful extraction practices. It must further be assumed that the public wants to realize tax revenues consistent with the market value of energy resources--that is, a severance tax based on gross value is assumed to be preferable to one based on physical quantity.

The question remains, what should the actual tax rates be on the three fossil fuels that would be consistent with the assumptions regarding energy and tax policy. A case can be made that the current tax rates, particularly in view of rising fuel prices, have encouraged neither efficiency in extraction nor conservation in end use. It also can be assumed that current tax costs are not enough to discourage production of these fuels. Simply put, the demand appears to be such that producers are assured of prices adequate for fair profit. Oil currently gets about $7 per barrel compared with an average of $3.83 in 1973; coal has been sold for $7 per ton compared with average of $2.82

per ton in 1973; intrastate natural gas has been sold for 50 cents per 1000 cubic feet compared with a 1973 average of 16.2 cents for all contracts. Such prices increases indicate a strong demand for Montana fuels.

If the current tax rates, 12.6, 13.2 and 16.9 percent of gross value for oil, gas, and coal respectively, are not affecting demand for and use of Montana fuels then what taxes rates might? A precise answer to this question is beyond the scope of this analysis but it is probable that tax levels could be raised without dampening demand for the resources, thereby moving toward a tax policy explicitly supporting the assumptions concerning energy policy.

Recommendations

A. A single severance tax on the production of oil, coal, and natural gas.

The Net Proceeds Tax, Resource Indemnity Trust Tax, Strip Coal Mine License Tax, Natural Gas Distributors' License Tax, and Oil and Gas Conservation Tax should be combined into a single severance tax levied on the gross value of the fuel. Royalties would be treated as they are now for oil and gas producers; that is, the producer is responsible for the royalty taxes and then deducts them from his royalty payments.

The advantages of this tax system are many:

1. The mechanics of the system are similar for the three fuels recognizing the interrelatedness of finite energy sources.

2. Administration would be simplified and streamlined.

3. Producers' time spent calculating and paying taxes would be shortened.

4. A more stable and predictable tax flow would be created.

5. Flexibility in distributing receipts to impacted areas would be ensured.

It is further suggested that the rate of taxation be increased to assist in encouraging energy conservation and resource preservation. It is in Montana's interest to preserve her finite fuels for two reasons: 1) their value will increase the longer they are left in the ground, at least until alternative energy sources are developed, and 2) the longer a supply of fossil fuels can be assured the better energy challenges of the future will be met.

Theoretically, taxes set high enough could slow down the fuel production process in Montana to the extent the taxes reduced profit margins. However, here only small increases in oil and gas taxes are advocated--from 12.6 and 13.2 percent of gross value respectively to 15 percent for both. At $5.25 a barrel for oil the tax increase would be 12.6 cents a barrel; at 40 cents per 1000 cubic feet for gas the tax would be an additional .72 cents per 1000 cubic feet. Because of national deficiencies in these fuels and escalating prices, tax increases of this magnitude are not unreasonable and would not create hardships for producers.

Montana coal has more potential competition than oil or gas. However, Montana coal is being priced far below competitive coal, even when the cost of stack gas cleaning is added to high sulfur coal. At a price of $4.50 per ton in a midwest market, Montana coal enjoys a price advantage over midwest coal of 8 cents per million BTUs when shipped by rail, and about 18 cents per million BTUs if shipped by slurry (6). Transportation routes also give Montana coal a price advantage when sales are in the upper midwest. Even though transportation costs would appear to give Wyoming coal a price advantage when sold in the south, Montana coal has been sold at $7 per ton in Texas. This indicates that the resource availability may well be the dominant factor in today's coal market.

Because of Montana coal's price advantages and the nature of the coal market, an escalation in the effective overall tax rate to 25 percent (from 16.9 percent) is recommended. The increase, about 2.1 cents per million BTUs, would equal only 1.8 to 3.5 percent of the price of coal at the destination depending on the selling price*--hardly enough to harm Montana coal's current price advantage. If supply capability is indeed the prime factor in coal buying decisions, small price increases may be totally irrelevant anyway.

A single severance tax of 15 percent on oil and gas and 25 percent on coal could earmark revenue for the purposes associated with the current Resource Indemnity Trust Tax and Oil and Gas Conservation Tax.

Eliminating the Net Proceeds Tax would reduce both local taxable valuations and tax receipts. Reductions in local tax receipts could be offset by returning state tax receipts to the counties by allocating a flat percent of the tax, or proportions of different receipt levels, to the local jurisdiction. Reductions in taxable valuations, however, can affect school bonding capacities and bond repayment schedules. Additional legislation may be needed to address this problem.

A single state-levied tax also would introduce desirable flexibility into the process of delivering revenues to the geographical areas where they may be needed to alleviate public costs associated with resource extraction. Today, specific local jurisdictions receive tax benefits even when impacts of extraction are not limited to a school district or even a county. The proposed system would allow adjacent political jurisdictions to receive some revenue when they are affected by energy development taking place nearby.

B. <u>Revisions of Net Proceeds Tax, Oil Producers' License Tax, Strip Coal Mine License Tax, Natural Gas Distributors' Tax.</u>

This second alternative would leave the existing taxes intact but would revise three of them as follows:

1. The Net Proceeds Tax would remain locally assessed and collected but

*2.1 cents is 3.5 percent of cost of coal selling at 60 cents per million BTUs and 1.8 percent if the selling price is $1.12 per million BTUs.

would be changed to a Gross Proceeds Tax. Gross Proceeds would be defined as the gross value, wellhead or minehead, with no deductibles. Tax burdens would remain the same as under the current system and the percent of gross value subject to tax should reflect this policy. This will mean, particularly in the case of coal, that initially some individual tax burdens will rise and some will fall. The advantages of this tax change would be that local communities' tax base and revenue raising capability would remain unchanged, producers would be taxed equally (because deductions would be eliminated), computation and administration would be simplified, and more predictability could be built into the taxing process.

2. The Oil Producers' License Tax would be increased from 2.1 percent and 2.65 percent of gross value to 4.5 percent and 5 percent. This would effectively increase the total oil tax to roughly 15 percent of gross value.

3. The Strip Coal Mine License Tax would be levied against gross value instead of gross tonnage and BTU content. The current rate varies between 4.5 percent of gross value, for low-BTU coal, to 16.9 percent for 8000-9000 BTU coal (7). The average effective rate of 12.6 percent of gross value should be increased by 8 percent to 20.6 percent of gross value so that the overall tax burden approaches 25 percent of gross value.

4. The Natural Gas Distributors' License Tax would be changed to a severance tax levied against the gross value of production of Montana's natural gas. Thus it would become the gas equivalent of the Strip Coal Mine License Tax and Oil Producers' License Tax. An increase in the current effective rate of 1.8 percent to 3.6 percent gross value would increase the total tax burden on gas approximately 15 percent--on par with oil.

Taxation and Energy Conversion Facilities

Certainly one of the most important issues of energy taxation is whether state and local communities are receiving taxes adequate, in both quantity and timing of tax receipts, to compensate Montanans for the loss of their finite resources and the disruption of their environment and society by impacts associated with energy development. The proposal to tie energy extraction taxes to gross value is the first step in linking energy taxes to the market value of the resource. The second step should be a close examination of locally incurred social, economic, and environmental costs associated with energy development compared with projected tax receipts. If the former exceeds the latter in either absolute quantity or at any particular phase of development, tax levels should be adjusted upward or additional forms of taxation should be explored.

Although a long-run, local fiscal analysis would be difficult to make with accuracy because of the unpredictability of public costs, early research indicates that there is a high probability of short-run fiscal deficit in local communities impacted by energy conversion development. A joint Bureau of Reclamation and Montana State University study regarding social and municipal service needs and cost-revenue calculations in certain counties where major coal development is expected addressed these issues. Specifically referring to Rosebud and Bighorn counties, the study stated:

> If (governmental) cost increases were modest they could be absorbed against the prospect of future state and county tax income, but if the costs are as great as present projections suggest, the traditional methods of state and local finance will not be able to bear the short-term burden without unreasonable sacrifice (8).

Bill Gillin of Colstrip summed up the current Rosebud County tax situation in his testimony at the Federal Coal Leasing Hearings in Billings, August 14, 1974. The following are relevant excerpts:

The Colstrip schools had adequate facilities to absorb the impact caused by the reopening of the mines in 1968 but the influx of people since the beginning of the mine-mouth generating facilities (here) has been so great as to overwhelm the Colstrip schools. Last year it was even necessary to hold classes in the shower rooms and such important classes as Physics and foreign languages had to be dropped...

My daughter, a fourth grader in the 1973-'74 school year...had a total of eight teachers due to splitting classes, moving from building to building and other factors brought on by the turmoil resulting from the great influx of students. Experiences such as this certainly aren't conductive to good education and is not fair to either of the students such as my daughter or to the children of the mining families or the construction workers....

The irony of all this is that the ranchers of the Colstrip district have not only seen their school, one of the best in Montana, rapidly deteriorate but have seen their tax burden expand with alarming rapidity. The general fund budget of the Colstrip schools, high school and elementary, has gone from $399,413.00 in 1973-1974 to ($976,914.00 for the 1974-5 school year. The total mill levy for the Colstrip district has increased from 114.2 mills in 1972 to 129.2 for 1974, an increase of 13 percent in just two years.)* We have been assured and reassured that once all this development is done all our tax worries will be over, but each year they become more serious.

The promises of Montana Power's officials concerning the taxable valuation is becoming ever harder to believe compared with the tax records of Rosebud County. Last year the increase valuation of cattle in Rosebud County set by the Department of Revenue actually exceeded the increase taxable valuation of all the coal development in the Colstrip area. This year the Department of Revenue increased the valuation of cattle 30 percent and it nearly again exceeded the increase taxable valuation of all the coal development in the Colstrip area. Other increases in taxable valuation in the county far exceeded that of the Colstrip development. The total increase in taxable valuation in Rosebud County increased from $20,181,496 in 1973 to $26,650,000 for 1974. Of this taxable valuation increase of $6,468,504.00, the Colstrip development contributed only $1,688,545 or a total of 26 percent. These figures are incredible when one considers that these developments are the largest industrial investments in Montana, two plants are under construction and one is to be producing in 1975. The investment in these two plants is supposed to exceed $180 million yet they have only added $1,688,545 to Rosebud County's tax base this year.

The impact they have caused is devastating to schools, roads, law enforcement, and recreational facilities in our county. For an example on roads, Montana 315 between Colstrip and Interstate 94 carried an average load of 50 vehicles and the State Highway Department projected a total of 2,500 vehicles a day by this summer and I'm sure it has reached or exceeded it by now. We have had a nearly four-fold increase in the law enforcement budget in Rosebud County in two years, the recreational facilities are inadequate for such increased population, Mr. Lippert, our area sanitarian, has warned

*parenthetical material refers to updated figures made available since testimony was taken.

of serious health hazards because of the proliferation of trailer courts and inadequate sewage facilities. The city of Forsyth is facing very serious problems in both sewage disposal and water systems. Both Forsyth and Rosebud are experiencing rapid increases in school enrollment.

Under the present laws in the state of Montana small rural communities such as Colstrip were prior to the recent coal development are going to be destroyed by the impact of coal development. Present laws make it possible for the coal development companies to shift the tax burdens of their impact on the farmers and ranchers in the area being developed. Not only will these older residents be forced to accept a deterioration of roads, schools, law enforcement, recreational facilities, environment and life style but they will be subjected to unbearable tax loads to provide social services for the employees of the Colstrip area and if the hard lessons to be learned there are not heeded, every small rural community where this type of development occur will suffer the same fate....

The following recommendations of alternatives would allow for the impacted communities to receive tax revenues early in the development process:

A. Prepaid Property and Equipment Taxes. Local governments and school districts could estimate future property tax receipts for three to five years in advance and require prepaid corporate taxes. Receipts for these advance payments could be turned over in lieu of cash as the actual taxes come due. The disadvantage of this proposal is that it does not allow for additional tax revenue, it only alters the timing of receipts. A further problem will arise if the future tax receipts in three to five years are so low as to be entirely inadequate.

B. Development Impact Tax. This would be a state-levied tax against energy conversion facilities or, generally, large industrial plants. Ideally the tax would be based on the projected financial needs of the impacted local communities, which would be determined jointly by the locality and the state. Essentially a revenue deficit would be estimated, being the difference between forecast public expenditures and receipts due the community from the development of the energy facility.

The tax would be levied before construction to enable the community to pay for its projected public responsibilities. The receipts could be timed to coincide with the public expenditures and the moneys could be drawn upon as needed. Funds not spent within six or eight years would revert back to the company.

The Development Impact Tax is preferable to the prepaid property tax because it effectively internalizes the social costs incurred by the local community to the firm responsible for the conversion facility. This alternative also does not require disruption of property tax receipts.

Summary of Current Fuel Production Taxes

I. Net Proceeds Tax

A. Imposed on mining, oil and gas well operators, and owners of royalty interests.

B. Taxes valuation of annual net proceeds and royalty interests of firm.

C. Net proceeds is the gross dollar value of product taken from a mine minus the cost of extracting and selling that product. These costs include:

1. All royalties due to owners of royalty interests. In the case of oil and gas the operators also pay the taxes due from the royalty owners and deduct these taxes from their gross royalty payments. Owners of coal royalties pay their royalty taxes directly.

2. All mining labor, machinery, and supplies.

3. The costs of improvements, repairs and betterment of the property (reclamation).

D. Rate: subject to county-wide millage and state mill levy on property (100 percent of assessed value).

E. Distribution to state and county as all other tax revenue from property taxation (90 percent county, 10 percent state).

F. Reference: Title 84, Chap. 62 R.C.M. 1947.

G. Payment Schedule:

1. Production statements due March 31 yearly.

2. Net proceeds valuations computed and transmitted to assessors by July 1.

3. Tax levies fixed by county commissioners on second Monday in August.

4. Taxes computed by assessors by September 15.

5. One-half taxes payable by November 30 and one-half payable May 31 following.

II. Resource Indemnity Trust Tax

A. Imposed on nonrenewable resource extracting industries.

B. Taxes gross (market) value of annual product.

C. Rate: $25 plus 0.5 percent of gross value of annual product in excess of $5,000.

D. Distributed to resource indemnity trust account for environmental improvement.

E. Reference: Title 84, Chap. 70 R.C.M. 1947.

F. Payable by March 31 following calendar year production.

III. Corporation License Tax (Income Tax)

A. Applied to all corporations in Montana.

B. Taxes annual net income from business in the state.

C. Rate: 6.75 percent of annual net income derived in Montana--minimum $50.

D. Distribution:

1. General Fund: 64 percent.

2. Long-range building program: 11 percent.

3. State school equalization fund: 25 percent.

E. Net income is defined in section 84-1502 R.C.M. 1947 much as defined in internal revenue code.

F. Reference: Title 84, Chap. 15 R.C.M. 1947.

G. Payable on 15th day of 5th month following close of taxable year.

IV. <u>Oil Producers' License Tax</u>

A. Imposed on oil producers.

B. Taxes total gross (market) value of net output.

C. Rate: 2.1 percent of total gross value of product up to 450 barrels per producing well in the calendar quarter. Rises to 2.65 percent of total gross value of product in excess of 450 barrels per producing well in the calendar quarter. Output used in connection with production not taxed.

D. Distribution: General Fund.

E. Reference: Title 84, Chap. 22 R.C.M. 1947.

F. Payable quarterly within 60 days of end of calendar quarter.

V. <u>Strip Coal Mine License Tax</u>

A. Imposed on strip mine coal producers.

B. Taxes net physical production by ton.

C. Rates: (cents per ton of coal with the listed heating values per pound.)

1. 12 cents up to 7,000 BTU.

2. 22 cents over 7,000 up to 8,000 BTU.

3. 34 cents over 8,000 up to 9,000 BTU.

4. 40 cents over 9,000 BTU.

D. Distribution: three cents per ton to county General Fund, balance to state General Fund.

E. Reference: Title 84, Chap. 13 R.C.M. 1947.

F. Payable quarterly within 30 days of end of calendar quarter.

VI. <u>Natural Gas Distributors' License Tax</u>

A. Imposed on distributors, not necessarily producers, of natural gas.

B. Taxes the value of natural gas distributed to consumers in Montana for use within or outside the state.

C. Rate: 0.575 cents per 1,000 cubic feet.

D. Distribution: General Fund.

E. Reference: Title 84, Chap. 21 R.C.M. 1947.

F. Payable quarterly within 30 days of end of calendar quarter.

VII. Oil and Gas Conservation License Tax

A. Imposed on operators and producers of oil and gas to defray the expenses of the oil and gas conservation commission.

B. Taxes the production of oil by barrels and gas by cubic foot.

C. Rates:

Oil

1. On leases with wells producing fewer than 25 barrels per day, up to three-eights cents per barrel.

2. On leases with wells producing more than 25 barrels per day, not more than three-fourths cents per barrel.

Natural Gas

1. On gas marketed for less than 15 cents per 1000 cubic feet, not more than 2.5 mills per 10,000 cubic feet.

2. On gas marketed for 15 cents or more per 1000 cubic feet, up to 5 mills per 10,000 cubic feet.

(Assessments set by oil and gas commission in accordance with its own needs. In addition, a variable fee is charged for drilling permits depending on depth of test well or core hole.)

D. Distribution: Earmarked revenue fund for oil and gas conservation commission. If commission is dissolved, money remaining in this fund reverts to general fund.

E. Reference: Title 60, Chap. 1 R.C.M. 1974.

F. Tax payable quarterly within 30 days of end of calendar quarter.

VIII. Personal Property Tax on Equipment and Real Estate

A. Taxes owners of industrial equipment and real estate.

B. Machinery, equipment and real estate assessed at 40 percent of market value. The taxable value is 30 percent of assessed value.

C. Rate hinges on county and state mill levies.

D. Distribution: 90 percent to the county and 10 percent to the state.

(An important exemption is "new industrial property," which is taxable for the first three years of operation only at 7 percent of its assessed value, not 30 percent.)

IX. "Right of Entry" Property Tax

A. Taxes owners of mineral wealth for their "right to enter land for digging, prospecting, or exploration."

B. Mills are levied on taxable value, here set at 100 percent of assessed value, which can be the price the owner paid for the land but historically has been 25 to 50 cents an acre (9).

C. Distribution: Similar to other property taxes.

References Cited

1. Title 84, Sec. 2101-2110, R.C.M. 1947.

2. Testimony presented by Lt. Gov. Bill Christiansen at the Montana Legislature Subcommittee on Fossil Fuel Taxation hearing, Billings, July, 1974.

3. Property Tax Administration and Assessment Practices in Montana, Subcommittee on Intergovernmental Relations, Committee on Government Operation, U. S. Senate, October, 1972.

4. Independent Record, (Helena, Montana), week of October 21, 1974.

5. Dissent of Robert McTaggart, Montana Public Service Commission Docket #6221, September 20, 1974.

6. Northern Great Plains Resource Program, Draft Report, September, 1974.

7. Testimony presented by Alan Taylor, Dept. of Revenue, at November, 1974 meeting of Subcommittee on Fossil Fuel Taxation, Helena, Montana.

8. Anne Williams, et al., Draft Interim Summary of Recommendations Projecting Social and Municipal Service Needs and Cost and Revenue Calculations in Six Counties Where Major Coal Development is Anticipated, Bureau of Reclamation and Montana State University, April, 1974, (mimeographed, unpublished).

9. Conversation with Frank Moze, Department of Revenue, August, 1974.

APPENDIX C

THE NET ENERGY CONCEPT AND THE EAST-WEST COAL SHIFT

Since the inception of the energy "crisis" national policy makers have become increasingly convinced that the answer to our future energy needs lies with surface-mined western coal. Arguments often advanced to support this reasoning cite the tremendous reserves of economically recoverable western coal, the fact that it is relatively clean when burned, and that it will meet air quality standards. Another fairly obvious, although mainly unstated, reason for energy companies' interest in western coal is that its exploitation generally yields high profits, since the mining is capital-intensive, thick seams lie close to the surface, and the federal government owns the mineral right that can be purchased at low cost. Analysis also shows that even with high transportation costs western coal still enjoys a price advantage in the midwest where it is burned. Because coal transportation costs can be passed on to consumers, utilities also stand to profit handsomely by burning western coal.

However, a factor critical to the long-term success of any national energy policy has been ignored totally. This is the concept of net energy. Simply stated, net energy is the energy liberated by an activity minus the energy expended in all steps comprising the activity (1).* Used in this sense, it becomes important to determine the net energy available as a result of stripping western coal and comparing those results with the net energy available from other coal. The question becomes: Given certain future energy needs what energy policy will result in meeting these BTU requirements at the least BTU cost?

For coal mining and conversion, net energy can be defined as the usable energy left after deducting from the gross energy of the extracted coal the

*References to Appendix C can be found on page 222.

energy consumed during strip mining and coal crushing, in transporting the coal to the burn site, and in reclaiming the mined land.

The principal architect of net energy analysis is Dr. Howard T. Odum of the University of Florida. He has made the following observations about the net energy concept:

> The true value of energy to society is the net energy, which is that amount remaining after the energy costs of getting and concentrating that energy are subtracted.
>
> Many forms of energy are low grade because they have to be concentrated, dug from deep in the earth or pumped from far at sea. Much energy has to be used directly and indirectly to support the machinery, people, supply systems, etc., to deliver the energy. If it takes 10 units of energy to bring 10 units of energy to the point of use, then there is no net energy gain. Right now we dig further and further, deeper and deeper, and go for energies that are more and more dilute in the rocks. Sunlight is also a dilute energy that requires work to harness.
>
> We are still expanding our rate of consumption of gross energy, but since we are feeding a higher and higher percentage back into the energy seeking process, we are decreasing our percentage of net energy production. Many of our proposed alternative energy sources would take more energy feedback than required of present processes.
>
> Many calculations of energy reserves, which are supposed to offer years of supply, are as gross energy rather than net energy and thus may be of much shorter duration than often stated.
>
> Suppose for every 10 units of some quality of oil shale proposed as an energy source there were required 9 units of energy to mine, process, concentrate, transport, and meet environmental requirements. Such a reserve would deliver 1/10 as much net energy and last 1/10 as long as was calculated. Leaders should demand of our estimators of energy reserves that they make their energy calculations in units of net energy. The net reserves of fossil fuels are mainly unknown but they are much smaller than the gross reserves which have been the basis of public discussions and decisions that imply that growth can continue (2).

The net energy available from 1 million tons of Montana coal compared to that available from a similar quantity of West Virginia strip-mined and underground mined coal can be estimated. One method for computing net energy is being developed by Thomas Ballentine, a graduate assistant under Dr. Odum.

Ballentine's system involves five steps (3):

1. Calculate BTUs produced.

2. Estimate BTUs consumed in the extraction process.

3. Estimate BTUs consumed during transportation to the burn site.

4. Estimate BTUs consumed in land reclamation activity.

5. Calculate the ratio 1/2 + 3 + 4 (BTUs produced divided by BTUs consumed) to indicate the number of BTUs made available per each BTU consumed.

Table A shows the amount of gross BTUs produced from 1 million tons of eastern and western coal.

Table A--BTUs Produced from 1 Million Tons of West Virginia and Montana Strip-Mined Coal

Mine Location	BTUs Per Pound	BTUs per 1 Million Tons
West Virginia (Surface and Underground)	13,200	26.4×10^{12}*
Montana	8,500	17×10^{12}

Source: Adopted from data contained in Ballentine's proposal (3).

Table B shows the energy consumed during the various phases involved in producing and transporting the coal to the burn site and reclaiming the land. The BTUs consumed during the production phase were calculated by using the conversion factor 67,456 BTUs per dollar (4). Transportation is assumed to be by rail to a common burn site in Illinois. The $1200 per acre reclamation cost in Montana is an average figure based on 1973 reported data (5). West Virginia reclamation costs were assumed to be half those of Montana. As can be seen from the last column of Table B, more energy is consumed getting Montana coal to market than for either surface or underground mined eastern coal, principally because of the energy consumed during transportation.

Table C totals the energy delivered and consumed, shows the ratio of

*10^{12} equals one trillion, hence the scientific notation 26.4×10^{12} equals 26.4 trillion.

BTUs gained per each BTU consumed (36.1:1 for eastern surface mined, 32.8:1 for eastern underground mined, and 19.6:1 for Montana coal), and finally shows the amount of BTUs consumed to deliver the BTU equivalent of given amounts of Montana coal to an Illinois burn site for eastern and western coal. Delivering 50 million tons of Montana coal consumes 19.9×10^{12} more BTUs than would be consumed in delivering the BTU equivalent of eastern strip mined coal. 19.9×10^{12} BTUs is equivalent to 1.17 million tons of 8500-BTU per pound Montana coal.

Restating this conclusion another way, 85 percent more BTUs will be consumed in delivering Montana coal to an Illinois burn site than a BTU equivalent of strip-mined West Virginia coal. The figure is 68 percent when comparing Montana coal to underground mined West Virginia coal.

This net energy analysis leads to the following conclusion: finite energy supplies can be conserved, thereby preserving future energy options, by fully utilizing eastern coal to meet the energy needs of the eastern half of the country before strip mining Fort Union reserves for the same markets. The conclusion is strengthened further because the analysis merely assumes successful reclamation in the west. Should rehabilitation of western coal lands be less than successful, additional energy will be required if these land can be returned to productivity.

The analysis does not take into account the environmental costs of strip mining. One very serious potential cost already mentioned is that the Fort Union land may be unreclaimable. Strip mining in the west also will disturb underground aquifers, to an extent not yet determined.

Finally, it should be noted that the analysis here is based on only 1 million tons of coal. Large scale strip mining of Montana coal will require an additional energy investment over that required for large scale mining of eastern coal, namely upgrading existing, and perhaps creating new rail facilities for transporting coal.

Extending the Analysis

Markets for Montana coal would be restricted greatly if the entire energy cost of mining, transportation and reclamation (not just availability, and profit) were taken into account in sales of coal. Montana coal sold in Illinois and Texas in lieu of West Virginia coal represents a huge waste of energy. Conversely, net energy benefits are substantial in the sale of Illinois coal in Texas and Illinois. Many other combinations of mine sites and power plants can be analyzed in terms of net energy yield.

Table B--BTUs Consumed to Extract, Transport, and Reclaim Land For 1 Million Tons of West Virginia and Montana Coal (1)

Mine Location	Production Costs		Transportation	Acres	Acres	BTUs Consumed	BTUs
	$\$/10^6$ Tons	BTUs Consumed Per 10^6 Tons (5)	BTUs Consumed Per 10^6 Tons (6)	Disturbed Per 10^6 Tons	Disturbed x 3 (7)	For Reclamation (9)	Consumed Total
West Virginia							
--Surface	$\$4.80 \times 10^6$ (2)	32.4×10^{10}	30.8×10^{10}	809 (7)	2427	9.8×10^{10}	73×10^{10}
--Underground	$\$7.35 \times 10^6$ (3)	49.6×10^{10}	30.8×10^{10} (600 miles)	-0-	-0-	-0- (@$600/ac.)	80.4×10^{10}
Montana	$\$1.77 \times 10^6$ (4)	11.9×10^{10}	74.5×10^{10}	20 (8)	60	5×10^{10} (@ $1200/ac.)	86.9×10^{10}

1. Based on methodology contained in Ballentine (3).

2. Bureau of Mines Information Circular 8535 (1973 dollars).

3. Bureau of Mines Information Circular 8632 (1973).

4. 1973 average production costs from Net Proceeds Tax Returns.

5. 67,456 BTUs/$1.

6. Based on consumption of 360×10^9 BTUs/7mm tons/100 miles (or 51.4×10^9 BTU per 1 million tons per 100 miles) and rail distance to common burn site (Havanna, Illinois).

7. Surface Mining, U.S. Senate Hearings before subcommittee on minerals, materials, and fuels, Feb. 24, 1972.

8. Assuming 1644 tons delivered per acre foot and 30-foot seams (Lt. Governor's coal fact sheet).

9. 67.456 BTUs/$1.

Table C--BTUs Produced and Consumed per 1 Million Tons of Coal And Net Energy Analysis of Delivering Coal Tonnages From Montana and West Virginia

Mine Location	BTUs Produced Per 1 MM Tons	BTUs Consumed Per 1 MM Tons	Ratio- BTUs Produced / BTUs Consumed	BTUs Consumed To Deliver Equivalent of		
				5 Million Tons of MT Coal	20 Million Tons of MT Coal	50 Million Tons of MT Coal
West Virginia						
--Surface	26.4×10^{12}	73×10^{10}	36.2/1	2.35×10^{12}	9.4×10^{12}	23.5×10^{12}
--Underground	26.4×10^{12}	80.4×10^{10}	32.8/1	2.59×10^{12}	10.4×10^{12}	26×10^{12}
Montana	17×10^{12}	86.9×10^{10}	19.6/1	4.34×10^{12}	17.36×10^{12}	43.4×10^{12}

Note:

The difference in BTUs consumed at 50 million tons is 19.9×10^{12} BTUs. This is the BTU equivalent of 1.17 million tons of Montana coal. This is really the amount of Montana coal wasted per 50 million tons delivered, revealed by the calculation of net energy yields between West Virginia and Montana coal.

Source: Table B, Appendix C. Basic methodology supplied by Ballentine (3).

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1. Odum, Howard T., Environmental, Power and Society. (New York: Wiley, 1971).

2. Odum, Howard T. "Energy, Ecology, and Economics," AMBIO (Royal Swedish Academy of Sciences), Vol. 2, No. 6 (1973).

3. Ballentine, Thomas. "A Net Energy Analysis of Surface Mining, Electrical Power Production, and Coal Gasification." A research proposal prepared for masters degree program, Environmental Engineering Sciences, University of Florida, Gainesville, May 1974 (Mimeographed).

4. Herendeen, R.A., "An Energy Input-Output Matrix for the U.S., 1963: Users Guide," CAC Doucment No. 69, Center for Advanced Computation, University of Illinois, March 4, 1973.

5. a. Testimony presented by Lt. Governor Bill Christiansen at the Montana legislature Subcommittee on Fossil Fuel Taxation hearings, Billings, July, 1974.

   b. Northern Great Plains Resource Program, Draft Report, September, 1974.

APPENDIX D

REVIEW OF ENERGY RELATED PROGRAMS OF MONTANA STATE AGENCIES

An important responsibility of the staff of the Environmental Quality Council is "to review and appraise the various programs and activities of state agencies" (Sec. 69-6514 (b)) in the context of evaluating their overall compliance with the policies established in the Montana Environmental Policy Act. This section focuses upon those agency programs that in some way deal with the use and management of an energy resource or have some bearing upon the development of a coherent state energy policy. Major programs and policies of the Montana Department of State Lands, the Public Service Commission, the Department of Natural Resources and Conservation, and the Department of Health and Environmental Sciences are reviewed from the perspective of highlighting material that will be of use in developing a state energy policy.

Department of State Lands

By the Enabling Act of 1889, Congress granted two sections of land in every township within the state to Montana for support of the common schools. To this land the act and other subsequent acts granted acreage for additional educational and institutional purposes. The proceeds from the sale of these lands and the income from their use are placed in a permanent fund and must remain forever inviolate.

Originally created by the 1889 Constitution, the Board of Land Commissioners has the authority to "direct, control, lease, exchange and sell school lands which have been or may be granted for the support and benefit of the various state educational institutions" (1972 Constitution, Art. X Sec. 4). Under executive reorganization the Department of State Lands was established by Title 82A, Chapter 11, R.C.M., 1947. Its authority and responsibilities are set forth in Title 81.

The major laws administered by the department affecting energy matters are those regulating leasing of state lands and mining and reclamation of all lands in the state with the exception of Indian reservations. The intent of the leasing laws is apparently to ensure the financial return to the school fund for the use of state lands. The department administers the leasing of state lands for the production of coal (Title 81, Chap. 5), oil and gas (Title 81, Chap. 17), metals, including uranium and thorium (Title 81, Chap. 6), non-metaliferous minerals including oil shale (Title 81, Chap. 7), geothermal resources (Title 81, Chap. 26), and hydroelectric power sites (Title 81, Chap. 18). These laws provide for leases, rentals and royalties for various uses of state lands.

The department has a "no lease" policy at present for coal on state lands. Prospecting on lands already leased is being permitted but no coal leases are being issued. There are four reasons for this department policy. First is the doubtfulness of reclamation; there is no proof that reclamation is always feasible everywhere. Second is the low price of Montana coal. Third, the department wishes to assess the amount of coal actually on state lands before resuming leasing. A fourth reason has to do with the timing of federal coal land leases surrounding and touching state lands. It is argued that simultaneous leasing by the state and the federal government will produce a higher price than if the state leases before or after.

The department is responsible for promulgating rules and administering the following mining and reclamation acts: the Montana Strip Mining and Reclamation Act (Title 50, Ch. 10), the hard rock mining act for the reclamation of mining lands (Title 50, Ch. 12), the Strip Mined Coal Conservation

Act (Title 50, Ch. 14), and the Strip Mine Siting Act (Title 50, Ch. 16). The 1972 Montana Constitution requires that "All lands disturbed by the taking of natural resources shall be reclaimed. The legislature shall provide effective requirements and standards for the reclamation of lands disturbed" (Art. IX, Sec. 2). The legislature intended the mining and reclamation acts to fulfill the constitutional provision. State regulation of mining activities is secured by provisions of these acts requiring those wanting to engage in mining activities to submit development and reclamation plans as a precursor to obtaining a permit from the department.

The department now has a Reclamation Division of 15 persons who make approximately 1,830 inspections a year concerning about 1,200 different mines and permits. The division opened an office in Billing in December, 1974. The office should save time and travel and also make it possible to do more inspections in the Colstrip area. According to the division chief, C. C. McCall, not all the coal mines have complied with the reclamation act. He said the miners try but are slow to achieve reclamation standards. There have been no willful violations of the reclamation law proven. What problems there are seem to stem from operators' unfamiliarity with reclamation laws. He said a serious problem is getting coal companies to plan ahead, which is crucial for meaningful reclamation.

Some serious problems related to the administration of laws dealing with strip mining, reclamation and conservation have been inadequately considered in department decisions; for example, a permit for continued mining at Decker and an application for a new mining permit at Sarpy Creek were both approved by the department although serious environmental questions existed. The Environmental Impact Statement (EIS) prepared for the Decker permit stated, "Since there are now abundant concentrations of saline-alkali salts at Decker the problem of revegetating the graded and retopsoiled spoils becomes more pressing. Drought and saline-alkali tolerant species must be utilized in revegetation processes. It has not yet been proven that adaptable species exist or can be used. Even tolerant species tested have had a very low success ratio" (p. 2). According to the Strip Mining and Reclamation Act, the department "shall not approve the application for...strip mining permit where the area of land described includes land having...[characteristics of] ecological fragility, in the sense that the land, once adversely affected, could not return to its former ecological role in the reasonable foreseeable future" (Sec. 50-1042(2)(b)). The EIS prepared for the Decker permit also omitted mentioning the effect on ground water created by cutting and removing the coal seam aquifer. Such a practice has been shown to lower the level of groundwater and introduce soil contaminants which affect water quality. The removal of a coal seam aquifer is thought to produce the effect of a dam on the flow of underground water. The impact of the dam effect will be compounded as more mines disturb water bearing coal seams. The consequences of strip mining on the availability and quality of water are known to be serious but research and experience has not been able to show how extensive.

Another problem for the reclamation division has been the enforcement of the Strip Mined Coal Conservation Act. For example, the original plan for Western Energy's Colstrip mine contended that the McKay seam (the second seam from the surface) lacked marketability in the usual course of trade. The Decker Coal Company similarly maintained that the D-2 (second from the surface) seam of its mine was not strippable economically because of the seam's depth and other engineering and equipment problems. The Department of State Land's review of Western Energy's economic study stated that "the 'unmarketability' contention does not appear realistic." Even with much prodding by the department, Western Energy still was unable to find a market for the McKay seam. The permit was issued when it was proven to the department's satisfaction that the McKay seam was unmarketable. A spokesman summarized the problem by saying there is better quality coal available at cheaper prices. Decker was allowed to skip the second seam because their contention could not be disproved without a very extensive economic analysis of the company's operation. The department's economic review stated, "The company officials appear to be generally receptive to the idea of mining the D-2 seam coal, but not at the expense of causing a massive disruption in their current mining plan. The one year approval by the Department of Lands on the Decker permit largely reflects these realities."

The Public Service Commission

The Public Service Commission is responsible for regulating rates and services of railroads, motor carriers, pipelines and utility companies under its jurisdiction. Its major goal, as stated in its 1973 Annual Report to the Governor, is to assure safe and adequate services for the consumer at just and reasonable rates. The authorizing legislation (Title 70, Ch. 1, R.C.M. 1947) gives the PSC authority to supervise, regulate, and control all public utilities--including municipally owned ones--that furnish water, electricity, gas, power, telephone or telegraph service. Such control covers all aspects of state utility regulation except those covered by the Utility Siting Act. The PSC's vast regulatory powers could play a substantial role in developing an energy policy for Montana. Sec. 70-105 requires "every public utility...to furnish reasonably adequate service and facilities." This section permits the PSC to exercise the control over utility facilities necessary to serve the public interest.

The legislature has given the PSC authority to regulate the rates, fares, and services of the railroads (Title 72, Ch. 1), common carriers of petroleum and petroleum products by pipeline (Title 8, Ch. 2), and all classes of motor carriers with the exception of school buses and highway construction equipment (Title 8, Ch. 1).

Because railroads are a much less energy-intensive mode of transportation than either air or motor vehicles, the significance of the PSC for energy policy is obvious. The role that the PSC ultimately could play to encourage energy saving modes of transportation and adopt incentives to encourage transportation of recyclable materials is yet undecided. But regulation of the transportation industry has a definite effect on energy use.

Included in the Motor Carrier Act is the requirement that all classes of motor carriers obtain certificates declaring that public convenience and necessity require such operations (Sec. 8-108-110). In the past, the decision of the PSC in granting such certificates has been based generally only on direct public needs, ignoring any consideration of the effects service has on energy utilization. One energy saving policy would be for the PSC to promote two-way hauling of motor freight.

Robert McTaggart, former PSC commissioner, says rates can be used effectively to control both consumer prices and energy resource conservation. According to former commissioner Ernest Steel the PSC's relationship to conservation and the environment is no different than the average citizen's. Steel said the PSC's first concern has been protection of the consumer but he added that utilities must provide satisfactory service and protect investors.

Until now, conservation and consumer costs appear to have been largely ignored by the PSC. In his dissent against a recent natural gas rate hike (Sept. 20, 1974) McTaggart said it "was and still is my feeling that rate structures must be a part of any rate case and should preferably be at a separate and subsequent hearing...the majority of this commission merely adopted...[the power company's] recommendations without question. In the adoption of said recommendations this Commission failed to undertake any analysis of why and where vital costs will be borne."

The PSC, like many federal and state regulatory agencies, has tended to be an agent of the industries it is supposed to regulate. In the past several years, however, the legislature has taken steps apparently to correct or at least alleviate this problem. The 1973 legislature, for example, enacted the Consumer Counsel Act (Title 70, Ch. 7, R.C.M. 1947). This act provides for the creation of a four-member Legislative Consumer Committee to appoint and advise a consumer counsel. The powers and duties of the counsel (a lawyer) are laid out in Sec. 70-707; for example, the consumer counsel:

(1) may appear at public hearings conducted by the commission, as the representative of the consuming public, ...and shall have all the rights and powers of any party in interest appearing before the commission regarding examination and cross-examination of witnesses, presentation of evidence and other matters;

(2) may institute proceedings before the commission against regulated companies;

(3) may institute, intervene in, or otherwise participate in appropriate proceedings in the state and federal courts and administrative agencies in the name of the utility and transportation consuming public of the state of Montana or substantial elements thereof.

In effect, the legislature provided for a consumer advocate to represent the best interests of the public in PSC proceedings.

In 1974, the legislature again responded to the needs of the public by enacting a bill that reorganized the PSC. The law amended Sec. 70-101 R.C.M. 1947 to provide that the commission be expanded to five members instead of three and that the five members be elected from five public service commission districts established across the state. The legislature intended that the new commissioners be responsive to the public they directly represent in each district.

The Public Service Commission has enough statutory authority to make it an influential policy maker in energy matters. There has been a lack of such policy declaration in the past; yet, the newly organized commission may be different. Despite calls by federal energy officials for automatic rate hikes when the utilities ask for them, a PSC that is responsible to the consuming public, energy resources, and the environment, could be of great assistance in providing Montana with a rational, long-range, energy policy.

Department of Natural Resources and Conservation

The Department of Natural Resources and Conservation (DNR&C) has significant influence on energy policy and use in Montana. Three DNR&C divisions have the primary responsibility for energy-related regulations. They are the Energy Planning Division, Oil and Gas Conservation Division, and the Water Resources Division.

The Energy Planning Division administers the Montana Utility Siting Act of 1973 (Sec. 70-801). This act gives the division the authority to require and review long range planning by certain utilities and to give approval to energy generation and conversion plant sites and associated facilities. Fees are assessed for environmental investigations. The act also requires preconstruction certification of such facilities. The department prepares a recommendation using an environmental impact statement process and format. Final decisions on most energy-related facilities are made by the Board of Natural Resources. Because of the scope and power of the Utility Siting Act, the Energy Planning Division plays an important role in deciding on the balance of energy needs and environmental protection in Montana.

Interpretation appears to be one of the most severe problems with the act. Most court cases involving the Utility Siting Act hinge on interpretation and definition of crucial portions of the law. Cases have been taken into court to determine what constitutes a "transmission line" under a certain circumstance or what is "construction" for the purpose of the grandfather clause.

Another, and possibly more serious, problem may involve determination of "need." The act does not precisely or specifically define need or spell out what is meant by "public need." It would not be surprising, especially considering the controversial generating facilities in the Colstrip area, to see one or more court cases concerning the definition of "environmental compatibility and public need."

One apparent major oversight of the act is its failure to include natural gas pipelines in the definition of energy facility. The impacts of natural gas pipelines on the environment may be as significant, if not more so, as a power transmission line.

Fees under the act vary according to the size of the proposed facility. Allowable fees appear substantial enough for the department to do an adequate environmental impact statement and meet all the investigatory requirements of the act.

The division has completed two major environmental impact statements to date. The first was on the water supply system and other associated facilities of Colstrip Units No. 1 and No. 2. The second was on a 230-kilovolt Colstrip-Broadview transmission project. The transmission line review is one of the best examples so far of a systematic, interdisciplinary approach to decision making. The corridor for the transmission project selected by the Energy Planning Division did not coincide with the one preferred by the applicant (Montana Power Company, et al.). The difference between the two corridors, as explained in the environmental impact statement, is "the extent to which they create new linear patterns. A totally new corridor across farms and undissected landscape is created by route A [preferred by the applicant]. In contrast, corridor F [DNR's preferred route] takes advantage of existing corridors over a sizable portion of the route. Although this may not be without some drawbacks, it certainly is less limiting on future land use."

Another issue that developed in the department's review of the Colstrip-Broadview transmission line involved the construction of the support towers. The department requested the Board of Natural Resources and Conservation to approve its preferred corridor and to delay decision on the towers until the decision on generating Units No. 3 and No. 4 was made. The applicant intends to build towers to handle the projected 500-kv output of the proposed Units No. 3 and No. 4. Because the application for Units No. 3 and No. 4 was made before the application for the transmission line, the board did not have to decide on the transmission line until the decision for the generators is made. In spite of this and against the recommendations of the department, the board approved the proposed transmission towers. The draft EIS on the two proposed 700-megawatt plants at Colstrip was released in November, 1974.

The department's final EIS on the proposed facilities at Colstrip was issued in January 1975. It recommended that the permit be denied. Board action in the department's recommendation will take place sometime in February or March.

Despite the fact that portions of the act will no doubt be litigated and that the 1975 legislature will be asked to limit, modify, and expand the act, the Energy Planning Division is perhaps the only state agency that has a broad-range resource planning capability. In important respects, it alone has the skills and methodology that are required to analyze the full range of impacts associated with large-scale industrial development.

The Oil and Gas Conservation Division, second of the three DNR&C agencies most involved in energy matters, has made its greatest impact in the energy field by developing and encouraging secondary oil recovery techniques. Montana production of oil increased 2 percent from 1972 to 1973; the division, in its

1973 annual review, attributed the increase to secondary recovery.

Title 60, Ch. 1 provides the basic law for the Oil and Gas Conservation Division with respect to energy conservation. The division grants permits for oil and gas drilling under this title. It also prohibits the waste of oil and gas in the extraction process. Steps have been taken to maximize the recovery of gas from wells with high oil-to-gas ratios where the natural gas previously was wasted.

The Water Resources Division is the third of DNR&C's agencies active in energy. The two major laws administered by the division are the Montana Water Resources Act (Title 89, Ch. 1) and the Montana Water Use Act (Title 89 Ch. 8). The Water Resources Act gives the division responsibility for developing a state water use plan. The Water Use Act was designed to determine the existing water rights in the state, to centralize the records of all existing water rights, and to adjudicate those rights in local district courts. These two acts have great significance in the development of energy within the state and the region. The determination of water rights and the data provided by both studies should play a profound part in the future energy related decisions of the state.

The water law of western states, including Montana, has operated under the "appropriation rights doctrine" where the beneficial use (as defined by each state) of water is the basis, the measure, and the limit of the water right. The first beneficial appropriation in time is first in right. Appropriations are for a specified rate of diversion or amount of storage. The appropriation right is obtained and sustained only by actual and continuous beneficial use. Failure to make beneficial use of an appropriation can result in its loss.

With the implementation of the Water Use Act, water rights will be accorded certainty for the first time in Montana's history. The statewide inventory process is time consuming and complicated by demands on water for possible energy use. The immediate concern of the Department of Natural Resources and Conservation, many of the ranchers and farmers of the area, and recreational users is protection of existing rights. Problems concerning competition for use and the validity of existing rights are compounded during low flow periods. The lack of any coordinated or standardized records has been a major complication in the determination of water rights in Montana.

The conflict between the national goal of energy self-sufficiency and the future of Montana's resources should be of paramount concern to Montana's citizens. Many recent federal programs and policies are in direct opposition to those of Montana. One example is the policy of making federally controlled water available to corporate industrial lessees at the same time federal coal is being leased; another is leasing of federal coal lands without the demonstration of substantial need. Such actions can be seen as further erosions in citizen control of the future of Montana and the Montana way of life, to say nothing of the conflict with local and state planning efforts now underway.

Central to the issue of energy development in the state is the suspension of new water appropriations in the Yellowstone River Basin that went into effect March, 1974 (Sec. 89-8-103). This three-year moratorium was enacted to give the state time to study the implications of energy and coal development in the Yellowstone River Basin. The moratorium suspends for the three-year period the granting of any new water permits of substantial size. According to the Water Resources Division, only a fraction of the necessary studies in the Yellowstone Basin under the Water Use Act will be completed at the end of the moratorium.

Of the major drainages in the Yellowstone River Basin scheduled for water rights determination, only the Powder River Basin is expected to be adjudicated by the end of the moratorium. The drainages which will not be finished include the Tongue River, Rosebud Creek, Armells Creek, Sarpy Creek, the Big Horn River, and the Clarks Fork of the Yellowstone River Basin.

The Powder River Basin was chosen as the lead basin for several reasons: it is an area with sparse population, little irrigation, no Indian water rights, and in an important coal development area. The Water Rights Division is still developing its methodology. Division officials fully expect to have to change their approach once they get the experience of working with district courts in determining water rights.

In 1950 the Yellowstone River Compact (Sec. 89-903) was signed by the states of Montana, North Dakota, and Wyoming and ratified by the Montana legislature in 1951. All existing water rights in the Yellowstone River Basin and the right to supplemental waters to satisfy existing rights were continued. The remaining waters were apportioned to the states according to fixed percentages as found in the compact for each individual drainage of the Yellowstone River covered by the compact. The agreement has remained largely ineffectual because water rights existing as of the date of the compact were never determined, hence the correct apportionment of waters to the states could not be determined. The lack of a systemized water rights determination in the state has made the adjudication of water rights very complicated and confusing.

The question of the Indian water rights expands these troubles. Indian water rights is a complicated legal question and appears to be predicated on treaty relationships with the federal government. Just as the states have little or no control over federal waters so it is with Indian waters. One of the most heated issues surrounding the Indian water rights question is how much water they own. Speaking for many Indians, an intertribal agency has proclaimed rights to all waters arising on, flowing through or underlying the various reservations. Their argument is strong, but opponents question the quantity of water available and how much belongs to the Indians.

In a legal memorandum prepared for the Montana Attorney General's office in July, 1974, the Department of Natural Resources and Conservation made the following conclusions:

1. Reservation Indians have a reserved water right in the waters arising on, flowing through or underlying the various reservations. A pro-rata share of the reserved right is an appurtenance to allotted reservation land, regardless of the owner.

2. This right is not subject to regulation or control by the state.

3. This right is not subject to regulation or control even when exercised on allotted lands owned by a non-Indian.

4. The state may regulate those waters which arise on, flow through underlie the lands of an Indian reservation and which are surplus to the Indians' reserved right. Persons wishing to obtain rights in such surplus waters should apply for state permits.

5. The state may join the United States in a water rights determination proceeding in order to assert the Indians' reserved right. (It should be noted that DNR&C's conclusions are not an official position of the state of Montana, but they do present well-researched legal reasoning on the subject.)

The determination of Indian water rights will have important implications on the availability of water for both energy and irrigation development in the future. How much water is available, and who controls it could make a considerable difference in the energy development and therefore the life of the region.

Department of Health and Environmental Sciences

All of the energy-related regulations and programs of the Department of Health and Environmental Sciences are the responsibility of the Environmental Sciences Division. The most important laws affecting energy policy fall into two categories, air quality and water quality. The laws governing these two areas do not affect energy use directly but they govern the facilities that generate and use energy.

The laws dealing most directly with air pollution control are the Clean Air Act of Montana (Title 69, Ch. 39) and the federal Clean Air Act Amendments of 1970. The state law gives broad control and regulatory authority to the Board of Health and the department. Montana's air quality laws and standards are among the most stringent in the nation, and they appear to be fairly well enforced, although several large corporations hold variances.

The federal Clean Air Act places the responsibility for enforcement on the states. Montana's laws were interpreted by her Attorney General as providing sufficient authority to the department to accomplish the purposes of the federal act. It required the states to prepare a plan to attain air quality at least equivalent to national standards as well as retain air quality that is presently better than the standards. The so-called implementation plan must include procedures to prevent projects that would violate the regulations.

The Montana plan, which has been approved by the Board of Health, has been mired in a number of procedural and court complications since the beginning of 1972. Officially, the plan has been disapproved by the federal government. The plan is still considered to have the force of law in Montana. Here is its policy statement:

> it is hereby declared to be the policy that ambient air whose existing quality is better than the established standards, will be maintained at that high quality unless it has been affirmatively demonstrated to the Department of Health and Environmental Sciences of the State of Montana that a change is justifiable as a result of necessary economic and social development vital to the state (p. 6, Implementation Plan for Control of Air Pollution in Montana, Department of Health and Environmental Sciences, revised June 30, 1972).

Similar prohibitions in the federal Clean Air Act led to a court suit against the Environmental Protection Agency, whose general regulations were said to be insufficient to prevent "significant deterioration" of regional air quality. The Supreme Court agreed and ordered the EPA to prepare specific regulations. A draft proposal released in August, 1974, essentially would allow degradation of a state's clean air up to national secondary standards with and only with the approval of the individual state. Hence the EPA would relegate responsibility for prevention of significant air quality deterioration to the states. Court challenge to the EPA's non-degradation proposal has been announced.

In November, 1974, the Montana Board of Health expressed a desire to move ahead on the non-degradation clause in the Montana Implementation Plan, apparently in an effort to build a structure for land use management based on air quality.

Two issues emerge concerning the Montana non-degradation policy. First, the definition of "significant" deterioration is largely a subjective one. Second is the question of necessity in any justification for allowing deterioration of air quality.

The Montana Water Pollution Control Program prepared in response to EPA requirements has been effective in pollution control and abatement. After the enactment of Montana's first water pollution control law in 1955, water quality standards, classifications of stream use, and minimum requirements for waste water treatment were created for nearly every stream in the state. After the enactment of the federal Water Quality Act in 1965 the state began what a major rewrite of the 1955 standards that appears in the water pollution control act of 1967 (Title 69, Chs. 48 and 49). The 1971 legislature added a non-degradation clause at Sec. 69-4804.2.

In addition to its regular functions of regulating water pollution and water supplies in the state, the Environmental Sciences Division is preparing for three water system studies for which it has received grants. The first study concerns the impact of Yellowstone River water withdrawals on water quality. The study is funded by the Old West Regional Commission and is directly related to eastern Montana coal development. An EPA grant is for study of effects of waste on the Yellowstone River near Billings. The study eventually will help control the wastes of individual polluters. The waste level of the Yellowstone may well be the limiting factor of industrial development considering available water pollution control technology and its costs.

A grant has also been made under Sec. 208 of the federal Water Control Act for area-wide water quality planning. The planning is to be done for the entire coal development area, essentially from Billings to Miles City. The division is to develop policies within the planning area that will result in long-term enhancement of water quality. The Environmental Sciences Division believes the policy making to be a form of land use decision making for industrial development and energy generation.

APPENDIX E

SUMMARY OF STATE LAWS RELATING TO ENERGY

DEPARTMENT OF STATE LANDS

Sources of authority:

Montana Constitution, Art. IX (Environment and Natural Resources), Sec. 2 (Reclamation): "All lands disturbed by the taking of natural resources shall be reclaimed. The legislature shall provide effective requirements and standards for the reclamation of lands disturbed;" and Art. X (Education and Public Lands), Sec. 4 (Board of Land Commissioners):

> The governor, superintendent of public instruction, auditor, secretary of state, and attorney general constitute the board of land commissioners. It has the authority to direct, control, lease, exchange and sell school lands and lands which have been or may be granted for the support and benefit of the various state education institutions, under such regulations and restrictions as may be provided by law.

The Strip Mining and Reclamation Act of 1973 (Sec. 50-1034 *et seq.*, R.C.M., 1947), which declares it to be the policy of the state:

> --to protect its environmental life-support system from degradation,
> --to prevent unreasonable degradation of its natural resources,
> --to restore, enhance, and preserve its scenic, historic, archeologic, scientific, cultural, and recreational sites, [and]
> --to demand effective reclamation of all lands disturbed by the taking of natural resources (Sec. 50-1035).

The act requires an annual permit to be issued by the Department of State Lands for strip mines and prospecting (Sec. 50-1039-1041). A comprehensive reclamation plan is required to be submitted to the department as part of the application process. The law also requires an adequate performance bond be given to the department to insure the effective reclamation of the land. The minerals specifically covered by the act are coal and uranium. The act absolutely forbids strip mining of lands with unique or unusual characteristics. There are four specific grounds for refusal or conditional approval of a permit for mining under Sec. 50-1042:

1. The department shall not approve the application for a strip mine if on the basis of the application, on site inspection, and the evaluation of the operation by the department it is determined that the requirements of the act will not be observed.

2. The department shall not approve an application if the area includes land having "special, exceptional, critical, or unique characteristics" or would have adverse affects on such land. These characteristics are defined as:

(a) biological productivity, the loss of which would jeopardize certain species of wildlife or domestic stock; or

(b) ecological fragility, in the sense that the land, once adversely affected, could not return to its former ecological role in the reasonable foreseeable future; or

(c) ecological importance, in the sense that the particular land has such strong influence on the total ecosystem of which it is a part that even temporary effects felt by it could precipitate a system-wide reaction of unpredictable scope or dimensions; or

(d) scenic, historic, archeologic, topographic, geologic, ethnologic, scientific, cultural, or recreational significance. In applying this subsection, particular attention should be paid to the inadequate preservation previously accorded Plains Indian history and culture.

3. If overburden of some particular nature has historically proven to be a problem for landslides or various forms of water pollution the department shall delete that area from the application.

4. If the operation shall constitute a hazard to a personal dwelling or public property the permit shall not be allowed until such portions are deleted from the prospecting or strip mining application.

The civil penalties for violation of the act require a fine of not less than $100 nor more than $1000 for the violation and the same for every day the violation continues. A willful violation is a misdemeanor and carries a fine of not less than $500 nor more than $5000 for each violation. Each day that a violation takes place is a separate offense (Sec. 50-1056).

The Strip Mined Coal Conservation Act of 1973 (Sec. 50-1401 et seq., R.C.M., 1947): This law provides the Department of State Lands with the authority to review strip mine plans and to disapprove those plans on the basis of waste or non-conservation of marketable coal. The department may require the revision or disapproval of mining plans (Sec. 50-1405). The law provides for the issuance of a two year permit and civil penalties of not less than $100 nor more than $1000 for each offense, and the same amounts apply for each day the violation continues. An operator not complying with the terms of an approved strip mining plan is liable to civil penalty of not less than $1,000 nor more than $10,000.

The Strip Mine Siting Act of 1974 (Sec. 50-1601 et seq., R.C.M., 1947): This act provides control over the location of new strip mines and all strip mine preparatory work. The law states, "It is the policy of this state to provide adequate remedies for the protection of the environmental life-support system from degradation and provide adequate remedies to prevent unreasonable depletion and degradation of natural resources." The stated purpose of the act is to satisfy the requirement of Art. IX, Sec. 2 of the Montana Constitution and to ensure that adequate information is available on the proposed mining areas such that adequate plans can be formulated to accommodate those areas (Sec. 50-1602). Under the act no preparatory work is allowed on a mine site until a permit is issued. Grounds for refusal of a permit include inconsistency of the mining plan with the act's policies and purposes; inconsistency with the envrionmental criteria of Sec. 50-1042; or failure of the reclamation plan to meet requirements of the Strip Mining and Reclamation Act (Sec. 50-1608).

The act provides civil penalties similar to Sec. 50-1056 plus provisions for willful violations with a fine of not less than $500 or more than $5,000 for every day on which a violation occurs (Sec. 50-1611).

Coal Mining Leases and Permits (Sec. 81-501 et seq., R.C.M., 1947): The Board of Land Commissioners is given the authority to lease state lands or land on which the state owns the mineral rights to allow mining of coal, The mining, handling and marketing must prevent as far as possible all waste of coal and the mining must be carried out to avoid making subsequent mining more difficult or expensive. A violation is grounds for the forfeiture of the lease. The maximum term for a lease is 20 years although the lease may be renewed upon the board's discretion (Sec. 81-502). Royalties for coal are set at a minimum of 12.5 cents per ton (Sec. 81-503). The board is granted broad authority to prescribe additional rules and regulations that it finds necessary and proper relating to the leasing of state land for coal mining purposes (Sec. 81-507). The board is authorized to grant one year permits to private residents and school districts to mine up to 30 tons of coal in a year for their individual use. The resident pays a $5 royalty and the schools pay 12.5 cents per ton for anything over 30 tons (Sec. 81-509).

Prospecting Permits and Mining Leases (metalliferous) (Sec. 81-601 et seq., R.C.M., 1947): The Board of Land Commissioners may lease state lands including the beds of navigable streams and bodies of water to allow mining metalliferous minerals or gems (Sec. 81-602). "Metalliferous" is defined as gold, silver, lead, zinc, copper, platinum, iron and all other metallic minerals. Uranium is included in this definition (Sec. 81-601). The board may issue prospecting permits without a lease. Prospectors may apply for leases but the board is not required to grant them (Sec. 81-601.1). If a coal, oil or gas lease is in effect, no metalliferous leases shall be issued unless they are issued to the holder of the coal lease or with the coal lessee's written consent (Sec. 81-610).

Disposal of Oil and Gas on State Lands (Sec. 81-1701 et seq., R.C.M., 1947): The Board of Land Commissioners is authorized to lease state lands in which the state holds the oil and gas rights. The lessee must exercise caution to prevent the waste of either resource and violations are grounds for forfeiture of the lease (Sec. 81-1701). The term of the lease is 10 years and renewable for as long thereafter as oil and gas are producible (Sec. 81-1702). The state has the power to terminate the lease if, after the second year, drilling has not begun (Sec. 81-1702.2). The board is empowered to permit the underground storage of natural gas but the lessee is required to take reasonable precautions to prevent waste, injury or destruction to oil or gas deposits (Sec. 81-1725).

Hydroelectric Power Sites on State Lands (Sec. 81-1801 et seq., R.C.M., 1947): This act provides for the lease or licensing of power sites on state lands but makes it unlawful to sell such state-owned sites (Sec. 81-1802). The board is empowered to place such restrictions and regulations in the lease as it may find necessary to protect the interest of the state and its people (Sec. 81-1806). The term of such leases shall not exceed 50 years (Sec. 81-1803). The board is allowed to cooperate with the federal government in the joint development of a power site (Sec. 81-1804).

Lease of Geothermal Resources (Sec. 81-2601 et. seq., R.C.M., 1947): This act gives the board the authority to lease state land for geothermal exploration and development (Sec. 81-2601). The lease will be for a primary term of 10 years and for as long thereafter as the development is productive providing the conditions and terms have been fully performed (Sec. 81-2604). The royalties for the lease are to be $1 per acre and/or not less than 10 percent of the market value of the steam and not more than 5 percent of any by-product derived from production (Sec. 81-2605).

PUBLIC SERVICE COMMISSION (PSC)

Sources of authority:

Montana Constitution, Art. XIII (General Provisions), Sec. 2 (Consumer Counsel):

> The legislature shall provide for an office of consumer counsel which shall have the duty of representing consumer interests in hearings before the public service commission or any other successor agency. The legislature shall provide for the funding of the office of consumer counsel by a special tax on the net income or gross revenues of regulated companies.

Public Service Commission--Regulation of Public Utilities (Sec. 70-101 et seq., R.C.M., 1947): This legislation gives the PSC the authority to supervise, regulate, and control all public utilities, including municipally owned utilities, furnishing water, electricity, gas, power, telephone or telegraph service.

The Consumer Counsel Act (Sec. 70-701 et seq., R.C.M., 1947): The Consumer Counsel Committee was created by the legislature to comply with Art. XIII, Sec. 2 of the Montana Constitution. The committee consists of two members of the state senate and two members of the house with one membership from each house of the legislature allotted to each party (Sec. 70-703). The Consumer Counsel Committee appoints a counsel. He is required to have a bachelor's degree and a major or minor in accounting or allied fields. He also must be admitted to practice law in Montana Courts and the U.S. District Court (Sec. 70-705). The counsel may obtain a staff to help with his duties and to fulfill the purposes of the act; the staff will be funded according to the usual appropriation procedures (Sec. 70-706). The act allows the counsel to represent the consuming public and gives the counsel the right and powers of any party in interest. He can institute proceedings before the PSC against regulated companies and may examine under oath during any commission proceedings any officer, manager, or employee or any regulated company and may examine their records. The act also allows the counsel to participate in behalf of the consuming public in both the state and federal courts. The counsel is required to issue an annual report and such other interim reports as he deems advisable (Sec. 70-707). The counsel is given the power to subpoena witnesses to appear before the PSC (Sec. 70-708). The PSC is required to serve notice of all commission meetings to the counsel and is required also to advise the public of the availability of the consumer counsel in all forms of public notices for hearings before the PSC (Secs. 70-710-711).

Railroads-Regulation by Public Service Commission (Sec. 72-101.1 *et seq.*, R.C.M., 1947): This act states the definitions and terms under which the railroads in Montana are allowed to act. This statute allows the PSC to fix the rates, schedules and classifications of the railroads (Sec. 72-116). The PSC has the power to compel railroad companies to provide adequate accommodations and service for the public (Sec. 72-123).

Motor Carriers-License and Regulation by the Public Service Commission (Sec. 8-101 *et seq.*, R.C.M., 1947): The PSC has the duty, power, and authority to supervise, regulate and fix the rates of motor carriers (Secs. 8-103-104.1). All records of the motor carriers are open to the PSC and an annual report is required to be filed (Sec. 8-113).

Pipeline Carriers of Oil-Regulation (Sec. 8-201.1 *et seq.*, R.C.M., 1947): Common carriers (pipelines) of petroleum products are determined by this act to be a public interest and are subject to state regulation (Sec. 8-202). The PSC was given the power to establish and enforce rates of charges and regulation for the gathering, transportation, loading, and delivering of petroleum products (Sec. 8-214). The PSC is given the power to regulate the construction of pipelines and at the same time the utility is given the right of eminent domain (Sec. 8-203).

DEPARTMENT OF NATURAL RESOURCES AND CONSERVATION

Sources of authority:

Montana Constitution, Art. IX (Environment and Natural Resources), Sec. 1 (Protection and Improvement):

> (1) The state and each person shall maintain and improve a clean and healthful environment in Montana for present and future generations.
>
> (2) The legislature shall provide for the administration and enforcement of this duty.
>
> (3) The legislature shall provide adequate remedies for the protection of the environmental life-support system from degradation and provide adequate remedies to prevent unreasonable depletion and degradation of natural resources;

and Art. IX (Environment and Natural Resources), Sec. 3 (Water Rights):

> (1) All existing rights to the use of any waters for any useful or beneficial purpose are hereby recognized and confirmed.
>
> (2) The use of all water that is now or may hereafter be appropriated for sale, rent, distribution, or other beneficial use, the right-of-way over the lands of others for all ditches, drains, flumes, canals, and aqueducts necessarily used in connection therewith, and the sites for reservoirs necessary for collecting and storing water shall be held to be a public use.
>
> (3) All surface, underground, flood, and atmospheric waters within the boundaries of the state are the property of the state for the use of its people and are subject to appropriation for beneficial uses as provided by law.
>
> (4) The legislature shall provide for the administration, control, and regulation of water rights and shall establish a system of centralized records, in addition to the present system of local records.

Conservation of Oil and Gas (Sec. 60-124 et seq., R.C.M., 1947): The Board of Oil and Gas Conservation (Sec. 82A-1508) is given the power to investigate and determine whether any waste exists in the operation of oil or gas wells. The board is given broad power to investigate and prevent the loss or pollution of hydrocarbons and pollution of water by oil or salt water. The board also has control over reclaiming disturbed surface lands. The prevention of waste is one of the board's primary goals. One form of conservation written into the law is pooling or unit operation of oil and gas fields. The proper spacing of producing wells is required for efficient operation and greater oil recovery (Secs. 60-129-131.12). The law also requires the approval of a plan to restore the well site before any new drilling permits are issued (Sec. 60-149).

Montana Utility Siting Act (Sec. 70-801 et seq., R.C.M., 1947): This act states that no person shall build a utility facility in the state unless he has first obtained a certificate of environmental compatability and public need from the Department of Natural Resources and Conservation (Sec. 70-804). The act requires a filing fee from each applicant according to the size of the facility. The fee is to cover the cost of the necessary studies, investigations and publications and other associated costs of the department in carrying out its responsibilities under the act (Sec. 70-806). The department has 600 days following the receipt of an application to make a report to the Board of Natural Resources and Conservation. It has the authority to grant or deny the application. Annual long-range plans from each utility are to be furnished to the department; the act specifies the information to be included in the plan. The act also requires that all electric transmission lines carrying 34.5 kilovolts (kv) or more (except 69 kv lines or less above ground less than 10 miles, or 161 kv lines or less underground less than 5 miles in length or 161 kv lines or less, 30 miles in length or less) shall be covered by the act and will require a permit. Lines which carry gas or liquid hydrocarbons from gasification or liquefaction plants also are covered under the act (Sec. 70-802).

Montana Water Resources Act (Sec. 89-101.1, et seq., R.C.M., 1947): This act makes a statement of necessity and policy relating to water resources. The general welfare requires that water resources of the state be put to optimum beneficial use and not wasted. The public policy is to promote conservation, development and beneficial use of the state's water resources to secure maximum economic and social prosperity for its citizens. The state, through the Department of Natural Resources and Conservation, will coordinate that development and use to effect full utilization, conservation, and protection of its water resources. The section lists domestic, industrial, agricultural, and other beneficial uses plus public recreational purposes and conservation of wildlife and aquatic life. The act also states that public interest requires the construction, operation and maintenance of water works systems. To achieve its objectives and protect the waters of Montana from diversion to other areas of the nation, the act provides for a coordinated multiple use water resource plan (Sec. 89-101.2). The act requires the department: to prepare a continuing comprehensive inventory of water resources; to formulate the multiple use plan; to submit portions of the plan to each general session of the legislature; to prepare a ground water inventory as a separate component of the comprehensive inventory and to publish the inventories and water plans (Sec. 89-132.1). The chapter provides the Board and Department of Natural Resources and Conservation with the necessary authority to coordinate and develop the state's water resources according to the plan.

Montana Water Use Act (Sec. 89-865 *et seq.*, R.C.M., 1947): This act provides a system for the appropriation and use of surface and groundwater. It also provides a procedure for the determination and confirmation of existing water rights. The act specifically states that the use of water for slurry to export coal from Montana is not a beneficial use (Sec. 89-867).

Moratorium on Yellowstone River Basin Appropriations (Sec. 89-8-103 *et seq.*, R.C.M., 1947): This act suspends for a period of three years any action on applications for permits to appropriate surface water for either or both of the following uses:

(a) a reservoir with a total planned capacity of fourteen thousand (14,000) acre feet or more, or

(b) for a flow rate greater than twenty (20) cubic feet of water per second (89-8-104).

Actions also may be suspended when, consistent with the Montana Administrative Procedures Act, the department determines the cumulative impact of those applications, if granted, would be contrary to the policies and purposes of the act (Sec. 89-8-106). The term "application" also includes an application for approval to change the purpose (e.g., agricultural to industrial) of a water use.

Yellowstone River Compact (Sec. 89-906 *et seq.*, R.C.M., 1947): The Yellowstone River Compact was designed to define the water rights of each state in the compact: Montana, North Dakota and Wyoming. It gave each state the water rights to those appropriations made before January 1, 1950. Remaining water was appropriated by each state according to a formula of percentages for each drainage in the basin.

DEPARTMENT OF HEALTH AND ENVIRONMENTAL SCIENCES (DHES)

Sources of Authority:

Control of Ionizing Radiation (Sec. 69-5804 *et seq.*, R.C.M., 1947): The purpose of this act is to establish and maintain for the state of Montana a single, effective system of regulating sources of ionizing radiation. This act was designed to be compatible with existing federal programs, and as much as possible, consistent with similar programs of other states. Secondly, the act was designed to allow the development and subsequent utilization of sources of ionizing radiation for peaceful purposes. The Board of Health was designated as the state radiation control agency, and was empowered to take such measures as it deemed necessary to carry out the provisions of this act.

This act specifically requires that the Department of Health and Environmental Sciences provide for the licensing of "persons to receive, possess, or transfer radioactive materials and devices or equipment utilizing such materials" (Sec. 69-5806). Certain exemptions are provided by statute, but beyond those it is unlawful for any person to: "use, manufacture, produce, or knowingly transport, transfer, receive, acquire, own or possess any source of ionizing radiation unless such person, is licensed by or registered with the department" (Sec. 69-5813). Violationsof this section are misdemeanors and punishable by a fine ranging between $100 and $1,000, or by imprisonment between 30 and 90 days, or both. The department was given, within its jurisdiction, the power of inspection. Records of all relevant information relating to the use of possession of ionizing radiation, are required by the Department of Health.

The governor, on behalf of the state, may enter into agreements with the federal government concerning state assumption of federal responsibilities with respect to sources of ionizing radiation. Similarly, the Board of Health may enter into agreements with the federal government, other states or interstate agencies concerning cooperative inspections or other actions to control sources of ionizing radiation. Through this process the department can assume many of the regulatory activities presently held by the Atomic Energy Commission.

<u>Water Pollution</u> (Sec. 69-4801, <u>et</u> <u>seq</u>., R.C.M., 1947): The water pollution policy of the state is to conserve water by protecting, maintaining and improving the quality and potability of water for beneficial uses including public water supplies, wildlife, fish and aquatic life, agriculture, industry and recreation. The act provides for a comprehensive program for the prevention, abatement, and control of water pollution.

Pollution is defined as:

> contamination, or other alteration of the physical, chemical, or biological properties of any state waters, which exceeds that permitted by Montana water quality standards, including, but not limited to, standards relating to change in temperature, taste, color, turbidity, or odor, or discharge of any liquid, gaseous, solid, radioactive, or other substance into any state water which will or is likely to create a nuisance or render the waters harmful, detrimental or injurious to public health, recreation, safety, welfare, livestock, wild animals, birds, fish, or other wildlife (Sec. 69-4802).

The Department of Health and Environmental Sciences is responsible for the administration of the act and may use its personnel and those of local departments as necessary. The act makes pollution unlawful and requires current permits to be obtained before discharging any wastes (Sec. 69-4806).

The act directs the Board of Health and Environmental Sciences to classify all waters in accordance with their present and future most beneficial uses and to formulate standards of water purity giving consideration to the economics of waste treatment and prevention and to review these classifications and standards from time to time. The board also is required to maintain the high quality of state waters where it exists unless it has been affirmatively demonstrated to the board that a change is justifiable as a result of necessary economic or social development and will not preclude present and anticipated use of these waters. New projects or developments are required to provide the degree of waste water treatment necessary to maintain existing water quality. The board is to determine the rules and procedures of the department's administration. The department must issue, suspend, revoke, modify, or deny permits to discharge wastes into state waters, consistent with rules made by the board. The department also is given authority to examine and approve or disapprove plans for permits, to collect and furnish information and conduct research relating for the prevention and control of water pollution. The department may issue orders requiring a polluter to clean up any material he may have accidentally or purposefully deposited in or near state waters.

Clean Air Act of Montana (Sec. 69-3904, *et seq.*, R.C.M., 1947): This act makes it the policy of the state to achieve and maintain levels of air quality that will protect human health and safety and to the greatest degree practicable, prevent injury to plant and animal life, and property, foster the convenience and comfort of the people, promote the economic and social development of this state and facilitate the enjoyment of the natural attractions of this state. The act encourages the support of local and regional air pollution control programs and provides a coordinated statewide program of air pollution prevention, abatement, and control.

The act defines air contaminants as "dust, fumes, mist, smoke, or other particulate matter, vapor, gas, odorous substances, or any combination thereof." Air pollution means "the presence in the outdoor atmosphere of one or more air contaminants in a quantity and for a duration which is or tends to be injurious to human health or welfare, animal or plant life, or property, or would unreasonably interfere with the enjoyment of life, property, or the conduct of business" (Sec. 69-3906).

The Board of Health has the power to adopt, amend, and repeal rules implementing and consistent with the act, hold hearings, issue orders necessary to effect the purposes of the act, require access to emissions records, and establish ambient air quality standards for the state (Sec. 69-3909).

Among other things the Department of Health and Environmental Sciences must enforce the orders of the board, and prepare and develop a comprehensive plan for the prevention, abatement, and control of air pollution in the state. The department also must encourage local government units to handle air pollution problems and can pay up to 30 percent of the total cost of local programs (Sec. 69-3909.1).

The department may enter and inspect at any reasonable time the property and premises where an air contaminant source is located to ascertain the state of compliance with the Clean Air Act. At his request, the owner, or operator of the premises must receive a report setting forth all the facts found which relate to his compliance status.

The enforcement provisions of the act provide for notice to violators and the ability to order corrective steps. Hearings are to be held. Instead of this first provision the department may require alleged violators to appear before the board for a hearing to answer charges or the department may prescribe the penalties as outlined in Sec. 69-3921 (Sec. 69-3914). The act also gives the department authority to handle emergency situations.

APPENDIX F

PROJECT INDEPENDENCE EXECUTIVE SUMMARY*

Introduction

-- The report is an evaluation of the Nation's energy problem.

° It assesses the "base case" situation through 1985, if current policies prevail.
° It evaluates the impacts and implications of a wide range of major energy policy alternatives.

-- The FEA study is not a "blueprint" for reaching zero imports by 1980, nor does it make specific policy recommendations.

-- Rather than evaluate hundreds of alternative actions, the study contrasts the broad strategic options available to the U.S.

° Increasing domestic supply
° Conserving and managing energy demand
° Establishing standby emergency programs

-- The strategies are evaluated in terms of their impact on:

° Development of alternative energy sources
° Vulnerability to import disruptions
° Economic growth, inflation and unemployment
° Environmental effects
° Regional and social impacts

-- The strategies are only illustrative, and in reality, a national energy policy will probably contain elements from each.

-- The study provides the analytical and factual basis for focusing debate on the difficult choices and tradeoffs, and selecting a national energy policy.

-- Domestic energy demand has been growing at 4-5 percent per year.

-- The U.S. was self-sufficient in energy through about 1950, but our situation has deteriorated rapidly since then.

° Coal production is still at 1940 levels
° Crude oil production has been declining since 1970
° Natural gas consumption has been exceeding new discoveries since 1968

-- Our dependence on foreign oil has grown to 35 percent of domestic petroleum consumption in 1973 (see Figure 1).

-- The world oil market is dominated by several Middle East countries.

° They have 60 percent of world reserves (see Figure 2)
° They product 70 percent of world oil exports (see Figure 3)

*Appendix F reprints in full the Project Independence Executive Summary found in the Federal Energy Administration's <u>Project Independence Report</u> (Washington, D.C., November, 1974), pp. 1-15.

Figure 1

U.S. ENERGY PRODUCTION AND CONSUMPTION
1947-1973

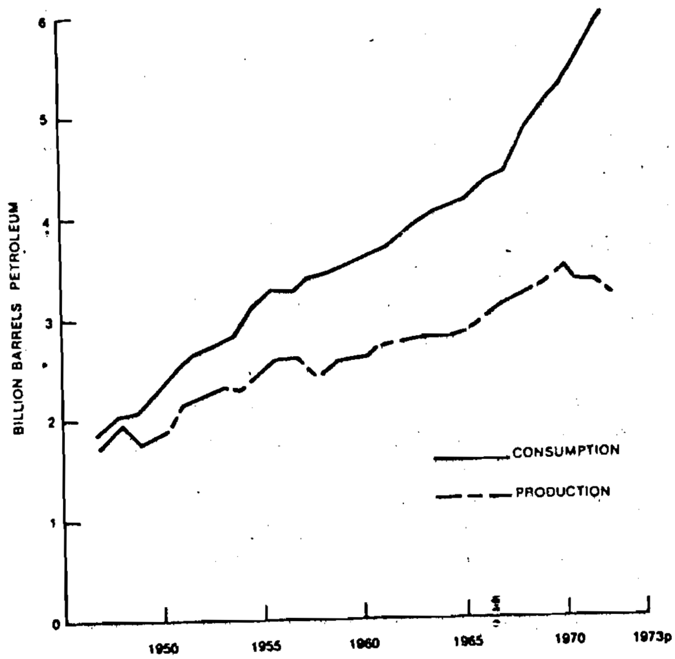


Figure 2

1973 CRUDE PETROLEUM RESERVES FOR MAJOR PRODUCING AREAS

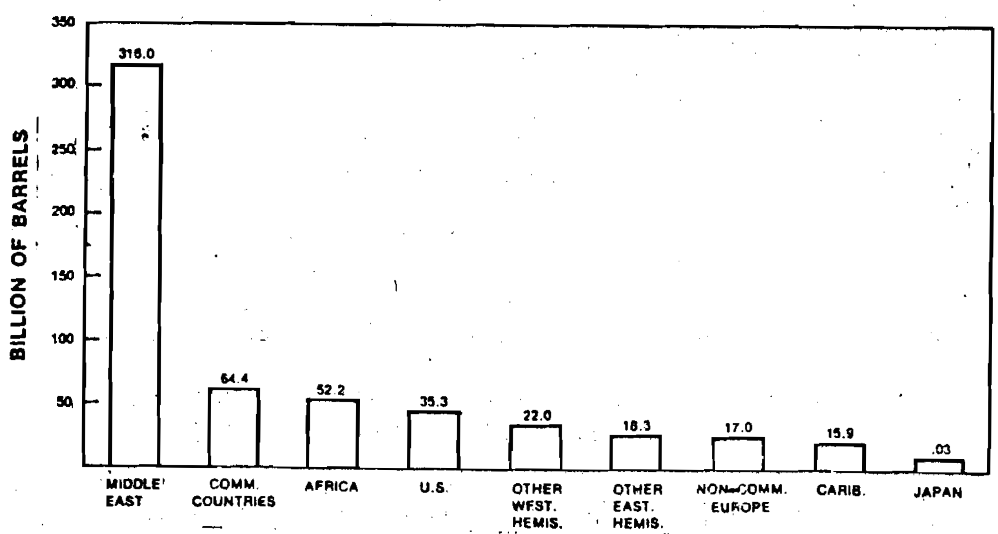
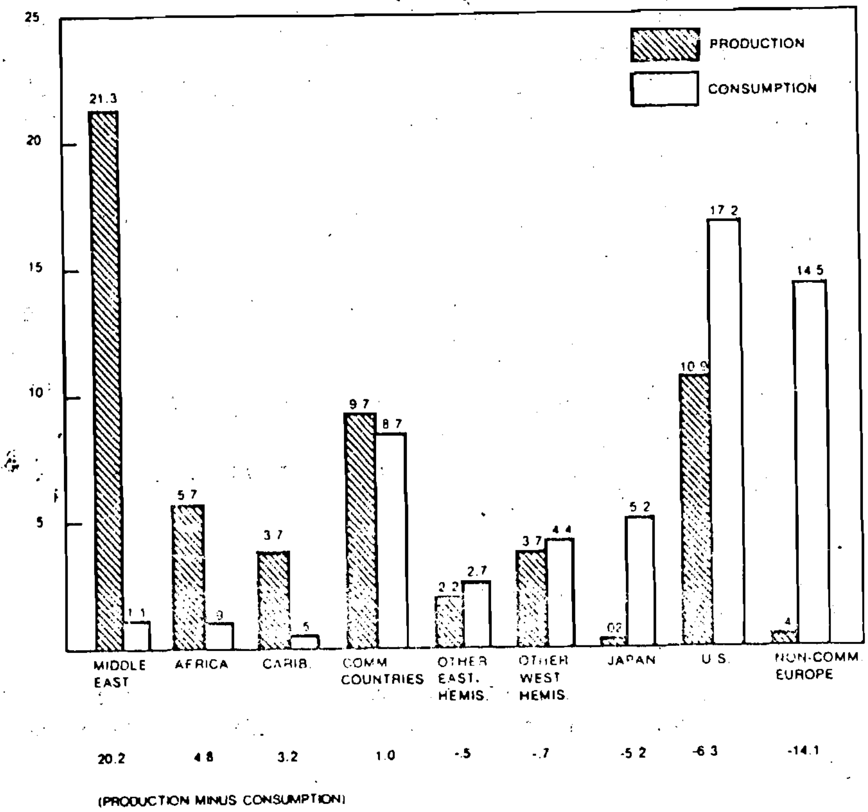


Figure 3

1973 CRUDE PETROLEUM PRODUCTION AND PETROLEUM PRODUCT CONSUMPTION FOR MAJOR PRODUCING AND CONSUMING AREAS (MB/D)



-- The 1973 embargo demonstrated our domestic vulnerability to insecure imports.

- The embargo affected 14 percent of U.S. petroleum consumption.
- Its economic impact was a $10-20 billion drop in GNP
- 500,000 additional people were unemployed at its peak.

World Oil Assessment

-- The world oil price will largely determine U.S. energy prices and, in turn, affect both United States supply possibilities and rate of energy growth.

-- World oil prices are highly uncertain and could decline to about $7 per barrel (FOB U.S.) and might fall somewhat lower.

- World supply/demand can be brought into balance at $7, but would require significant OPEC production cutbacks from the expected doubling of their capacity by 1985.
- OPEC has already cut back production 10 percent in four months to eliminate the estimated 2-3 million barrel per day (MMBD) world surplus.

-- Major OPEC cutbacks would be required to sustain $11 world oil prices.

- In the short term, prices can be supported by moderate production cutbacks.
- Much of the expected increase over 1973 OPEC production levels must be foregone by 1985 to support $11 prices.
- Decisions by major oil exporters will be more policical than economic because greater revenues are not needed by the key suppliers to support their economic growth.

-- Foreign sources of oil have a significant probability of being insecure in the 1974-1985 time frame.

-- The resolution of pressing international financial, economic and political problems will ultimately determine world oil prices and security of supply.

- The study contrasts differences in the United States' situation based on a $7 and on an $11 world oil price.
- The study also estimates potential levels of world oil disruptions and their impact on the U.S.

DOMESTIC ENERGY THROUGH 1985: THE BASE CASE

-- If major policy initiatives are not implemented, the U.S. energy picture will be substantially different from pre-1974 trends, and is described below.

Energy Demand

-- At $11 world oil prices, domestic energy demand will grow at substantially lower rates than it has in the past.

- Total demand will grow at a rate of 2.7 percent per year between 1972 and 1985, compared to 4-5 percent during 1960-1970,
- 1985 demand will be about 103 quadrillion Btu's (quads) as contrasted with most other forecasts in the 115-125 quads range,
- Electric demand will also be below its recent high growth rates,
- Petroleum demand will be about constant between 1974 and 1977 and only grow at about 1-2 percent per year thereafter.

-- At $7 prices, total energy demand will grow at 3.2 percent through 1985, and petroleum consumption will be about 5 million barrels per day (MMBD) higher than at $11 levels by 1985.

Energy Supply

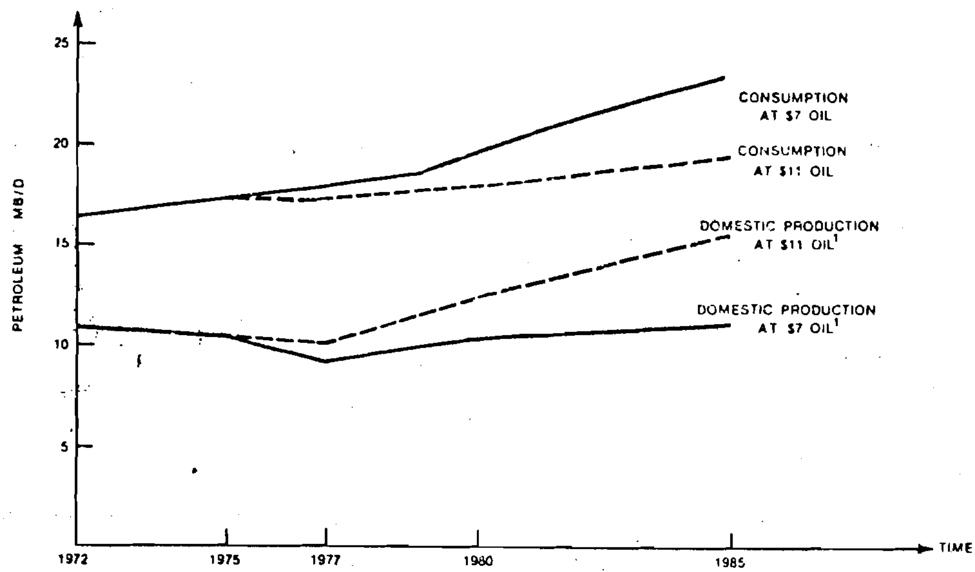
-- Petroleum production is severely constrained in the short run and greatly affected by world oil prices in the long run (Figure 4).

- Between 1974 and 1977, there is little that can prevent domestic production from declining or at best remaining constant.
- By 1985, at $7 world oil prices, production will rise to 8.9 MMBD from from the current 8.6 MMBD. "Lower 48" production will decline from 8.2 MMBD to 4.2 MMBD, but is offset by Alaskan and Outer Continental Shelf (OCS) production.

° If oil prices remain at $11, production could reach 12.8 million barrels per day by 1985. This further increase comes mainly from the use of more expensive secondary and tertiary recovery in the lower 48 States.

Figure 4

EFFECTS OF $7 VS $11 FOREIGN OIL



[1] INCLUDES NGL

-- Coal production will increase significantly, but is limited by lack of markets.

° By 1985, coal use will be between 1.0 and 1.1 billion tons per year depending on world oil prices.
° Production could be expanded greatly by 1985, but lower electric growth, increasing nuclear capacity and environmental restrictions limit this increase.

-- Potential increases in natural gas production are limited, but continued regulation could result in significant declines.

° Continued regulation at today's price will reduce production to 15.2 TCF by 1985, or 38 percent below the deregulated case.
° With deregulation of gas, production will rise from 22.4 trillion cubic feet (TCF) in 1972 to 24.6 TCF by 1985. Alaska production will be 1.6 TCF of this total.

-- Nuclear power is expected to grow from 4.5 percent to 30 percent of total electric power generation.

- This forecast is lower than many others due to continued schedule deferments, construction delays and operating problems.

-- Synthetic fuels will not play a major role between now and 1985.

- At $7 they are marginally economic.
- At $11 they are economic, but given first commercial operation in the late 1970's, their contribution by 1985 is small.
- Research and development (R&D) on these technologies is important if they are to replace a growing liquid and gaseous fuels gap which may develop after 1985.

-- Shale oil could reach 250,000 B/D by 1985 at $11 prices, but would be lower if expectations for $7 prices prevail.

-- Geothermal, solar and other advanced technologies are large potential sources, but will not contribute to our energy requirements until after 1985.

- R&D is needed so that these important sources, which can have less environmental impact than current sources and are renewable (do not deplete existing reserves), can be useful beyond 1985.

Constraints and Barriers

-- Even achieving the Base Case will require actions to alleviate potentially serious barriers.

- Rather than stimulating coal use, current Clean Air Act requirements could, by mid-1975, preclude 225 million tons of coal now used in utilities.
- The financial situation of the electric utility industry is particularly critical, and inadequate rates of return will not only reduce their internal funds, but hamper their ability to attract debt or equity financing.
- Current manpower, equipment, and materials shortages are likely to persist in the short-term and inhibit production increases.
- Continued problems with growth in the nuclear industry are possible, unless reliability problems, future shortages of enrichment capacity, and the waste disposal problem are resolved.

Oil Imports and Domestic Vulnerability

-- Oil imports will remain level or rise in the next few years, no matter what long-term actions we take.

-- Our domestic vulnerability to future disruptions is dependent on world oil prices.

- At $7 oil and no new domestic policy actions, imports will reach 12.3 MMBD in 1985, of which 6.2 MMBD are susceptible to disruption. A one year embargo could cost the economy $205 billion.
- At $11, imports will decline to 3.3 MMBD by 1985, and only 1.2 MMBD

are susceptible to disruption, at a cost of $40 billion for a one year embargo.

Economic and Environmental Assessment

-- Higher energy prices are likely in any event, but $11 world oil will magnify these price trends and have several major effects.

° $11 oil prices, as opposed to $7, will reduce U.S. economic growth from 3.7 percent to 3.2 percent.
° Dollar outflows for petroleum imports will be higher in the near term for $11 than for $7, but by 1980 the situation will be reversed.
° At $11 oil prices, large regional price disparities exist with eastern oil-dependent regions at the high end of the spectrum.
° At $7 prices, these disparities narrow and the northeast is no longer the highest cost region.
° Because energy costs as a percentage of total consumption are higher for lower income groups, higher energy costs will impact the poor more heavily.

-- Energy production through 1985 will have mixed environmental impacts.

° Most sources of water pollution should be below 1972 levels, due to the federal water pollution standards.
° Emission controls will lessen the air pollution impact of increased energy use, but some regions will still be affected significantly.
° Surface mining will continue to increase and problems of secondary economic development in the west and Alaska are likely.

ALTERNATIVE ENERGY STRATEGIES

-- U.S. options to reduce vulnerability fall into three distinct categories. While each have significant impact, a national energy policy will probably combine elements from each.

Accelerating Domestic Supply

-- Federal policies to lease the Atlantic OCS, reopen the Pacific OCS and tap the Naval Petroleum Reserves can dramatically increase domestic oil production.

° At $7 prices, domestic production by 1985 could rise from 8.9 MMBD to 12.8 MMBD.
° At $11 prices, production could reach as high as 17 MMBD, although less is needed to achieve zero imports (Figure 5).

-- Shale oil production could reach one MMBD in 1985.

° Prices close to $11 would be needed for economic viability.
° Potential water and environmental constraints would have to be overcome.

-- Accelerating nuclear power plant construction does not reduce imports much; in general, it replaces new coal-fired power plants.

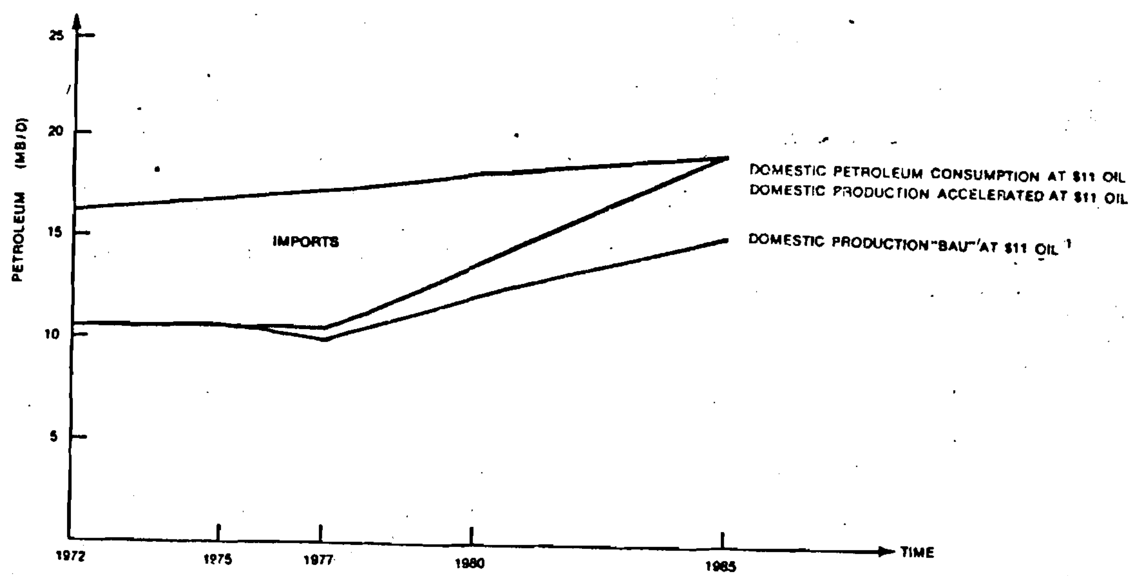
-- Accelerating synthetic fuel production would require by-passing key research steps and may not be cost-effective or practical in the 1985 time frame.

-- Accelerating domestic energy production could be inhabited by several key constraints:

- ° In the short-term, many shortages of materials, equipment, and labor will persist.
- ° By 1985, however, most critical shortages will be overcome sufficiently to meet the requirements of the accelerated supply scenario.
- ° Availability of drilling rigs and fixed and mobile platforms will be a major constraint in reaching the projected oil levels.
- ° Financial and regulatory problems in the utility and railroad industries could hamper their ability to purchase needed facilities and equipment.
- ° Water availability will be a problem in selected regions by 1985.

Figure 5

EFFECT OF DOMESTIC PRODUCTION ON PETROLEUM IMPORTS



1 INCLUDES NGL's AND OIL SHALE

<u>Energy Conservation and Demand Management</u>

-- Energy conservation actions can reduce demand growth to about 2.0 percent per year between 1972 and 1985.

- ° To achieve reductions beyond those induced by price could require new standards on products and buildings, and/or subsidies and incentives.
- ° Major actions could include standards for more efficient new autos, incentives to reduce miles traveled, incentives for improved thermal efficiency in existing homes and offices and minimum thermal standards for new homes and offices.

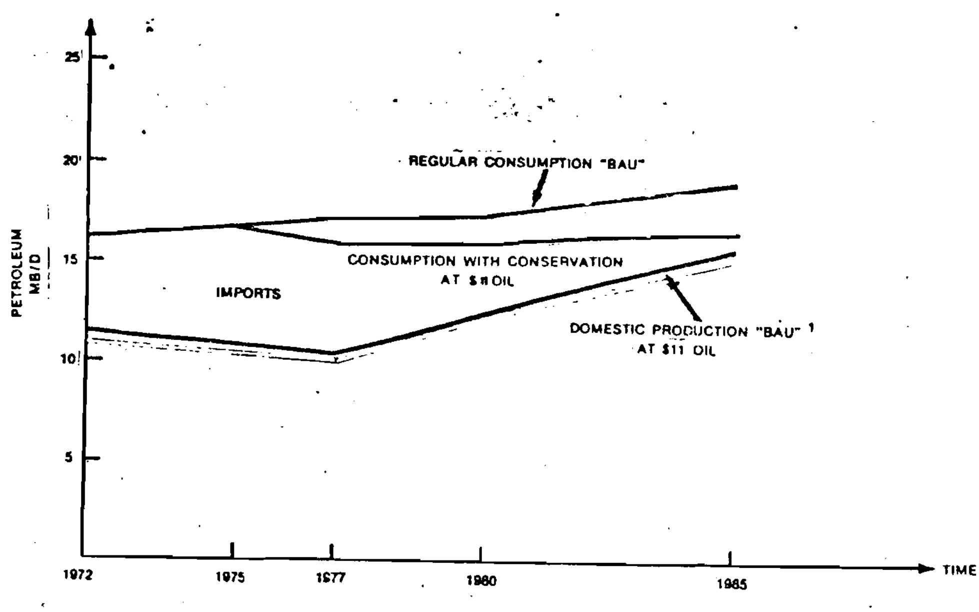
- Petroleum demand could be reduced by 2.2 MMBD by 1985 (Figure 6).
- Electricity consumption could be reduced from 12.3 quads to about 11.0 quads in 1985, compared with 5.4 in 1972.

--Demand management can further reduce dependence on limited oil and gas supplies by actions that involve switching from petroleum and natural gas consumption to coal or coal-fired electric power.

- Switching existing power plants and industrial users, prohibiting new oil or gas-fired power plants and encouraging electric space heating is most important at lower oil prices, and can substitute 400 million tons of coal per year for 2.5 MMBD of petroleum and 2.5 TCF per year of natural gas.
- Implementation may be limited by environmental restrictions and financial inability of the electric utility industry to support a large electrification strategy.
- Electrification to increase coal use in the pre-1985 period must be weighed against the possibility of increasing coal use by liquefication and gasification in the post-1985 period.

Figure 6

CONSERVATION MANAGEMENT



1 INCLUDES NGL

Emergency Programs

-- Standby conservation or curtailment measures can reduce vulnerability.

° Depending on the level of demand in 1985, curtailment measures in response to an embargo can cut consumption by 1-3 MMBD.
° At higher world oil prices curtailment is less effective because there is less "fat" in energy consumption.
° They involve almost no cost when not needed and relatively small administrative costs and some economic impact when implemented.
° They can be instituted in 60-90 days.

-- Emergency storage is cost-effective in reducing the impact of an embargo (Figure 7).

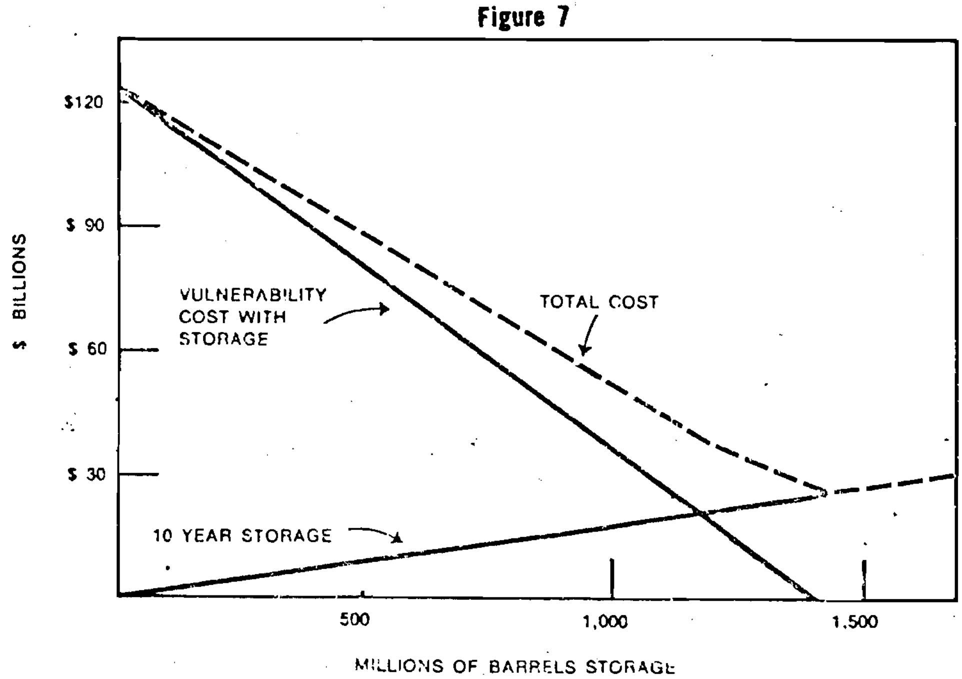
° Storage to insure against a one MMBD cutoff for one year would cost $6.3 billion over ten years.
° A one MMBD interruption of oil supply for one year during that period could cost the economy $30-40 billion.
° This cost effectiveness holds for any level of insecure imports, and applies if there is a one-in-five chance of one disruption in ten years.

-- The International Energy Program (IEP) developed in Brussels will foster consumer nation cooperation and reduce the United States' economic impact of a supply disruption during the next several years.

° It can reduce the likelihood of an import disruption.
° It includes a formula for allocating shortages which avoids excessive bidding and divisive scramble for oil by the participants during the most vulnerable period of the next few years. If, in the 1980s, the United States achieves the low import levels which are possible at high oil prices and by pursuing aggressive strategies of accelerating supply and conservation, the IEP would still act as a deterrent to an interruption, but its utility in protecting the U.S. against the economic impact of supply disruptions would be diminished.

COSTS OF VULNERABILITY AS A FUNCTION OF STOCKPILE SIZE

Figure 7



COMPARISON OF ALTERNATIVE ENERGY STRATEGIES

Import Vulnerability

-- Domestic supply and demand actions can greatly reduce U.S. vulnerability to import disruptions by 1985.

  - At $7 per barrel oil with all supply and demand actions implemented, 3 MMBD could still be subject to cutoff.
  - At $11, either all the demand actions or only a portion of the supply strategy would completely eliminate our vulnerability.

-- Domestic supply and demand strategies are cheaper in economic terms than imported oil or any other emergency option.

  - At either $7 or $11, they have a lower present resource cost than imports, and reduce insecure imports.

-- After domestic actions, standby demand curtailment is most effective in reducing vulnerability.

-- Demand curtailment and storage can be designed to buffer against large levels of insecure imports.

Economic and Regional Impacts

-- Accelerating domestic supply or reducing demand will mean lower energy costs for the Nation and higher economic growth.

-- Reduced energy costs will benefit lower income groups.

-- Increased domestic supply may result in wider regional price disparities than if no action is taken.

-- The economy can absorb the increased financial costs of reducing vulnerability.

-- Both supply and demand actions will have economic impacts, regionally and in key sectors of the economy

Environmental Impacts

-- The conservation strategy has the lowest environmental impact.

-- A demand management strategy which substitutes coal for oil and gas will result in the greatest increase in environmental impact over the base case.

-- The accelerated supply strategy has mixed environmental impacts.

  - Air pollution is lower due to more nuclear plants and increased oil and gas production.
  - Solid waste is up dramatically due to increased shale oil production.
  - Many virgin resource areas will be disturbed for the first time.

MAJOR UNCERTAINTIES

-- The degree to which price will dampen demand

- ° If demand is much less sensitive to price than is assumed, we will be much more vulnerable in 1977 and in 1985 at higher world oil prices.
- ° Mandatory energy conservation measures or diversification and acceleration of supply hedge against this uncertainty.

-- The ultimate production potential of frontier oil areas

- ° Literally all the new oil production forecast comes from frontier areas in Alaska and the Atlantic OCS, or from improved tertiary recovery techniques.
- ° If the frontier areas do not prove productive:

  - 1985 domestic production could decline to 5 MMBD at $7 oil prices;
  - at $11 and with accelerated supply actions, total production could still not exceed about 11 MMBD.

- ° Synthetic fuels, switching from petroleum and gas to coal and mandatory conservation may be necessary if frontier areas are not lucrative.

-- Time required to implement domestic measures

- ° While lead times were taken into account, other factors could delay achievement.
- ° Federal inaction or local opposition.
- ° Materials and equipment constraints.
- ° Delays in private investment decisions due to price uncertainty.

POLICY IMPLICATIONS

-- Although $11 world oil prices make achievement of self-sufficiency easier, the United States is still better off economically with lower world oil prices. The implementation of a limited number of major supply or demand actions could make us self-sufficient. By 1985, we could be at zero imports at $11, and down to 5.6 MMBD of imports at $7 prices.

- ° Not all of these actions may be warranted, but they indicate we have significant flexibility when one considers:

  - some projected imports in 1985 are from secure sources.
  - some insecure imports can be insured against.
  - not all of the supply and demand actions must be implemented to achieve the desired result.

-- While we cannot delay all action, we can pick from those that make the most economic, environmental and regional sense.

-- Accelerating domestic supply, while economic, has some important drawbacks.

- ° It will adversely affect environmentally clean areas.
- ° It requires massive regional development in areas which may not benefit from or need increased supply,
- ° It is a gamble on as yet unproved reserves of oil and gas.
- ° It may well be constrained by key materials and equipment shortages.

-- Implementing a conservation strategy has positive environmental effects and alleviates constraint problems, but:

- ° It requires intervention and regulation in previously free market areas.
- ° It results in increased nonmarket costs due to more limited individual choice and changed lifestyles

-- While cost effective, there are several important ramifications to a storage program.

- ° It will take a few years to implement and our vulnerability will be greatest during that period.
- ° It requires more imports now, which will act to sustain cartel prices. in the near term.
- ° We could suffer major capital losses -- $4 billion for each one billion barrels stored if the world oil price drops from $11 to $7.

-- Our actions to increase domestic self-sufficiency could have an appreciable impact on world oil price.

- ° U.S. reduction in imports can make even $7 hard for OPEC to maintain.
- ° World oil price reductions could jeopardize domestic energy investments and could require price quarantees or other supports.

-- Any domestic energy policy must be designed to resolve uncertainties and minimize the risk of not anticipating world oil prices correctly.

- ° Policy programs should include actions to reduce domestic uncertainty, such as exploring the frontier areas.
- ° Policies may be needed to avoid or defer major investments or actions, if they involve significant costs of being wrong, until world uncertainty is reduced.
- ° A flexible and dynamic approach must be balanced against the need for a stable long term policy which encourages domestic energy investment.

APPENDIX G

SUMMARY OF THE FORD FOUNDATION'S ENERGY POLICY PROJECT FINAL REPORT*

By cutting the growth rate in energy consumption, the United States can balance its energy budget, safeguard the environment and protect the independence of its foreign policy. This is the principal finding of the two-year study of national energy issues by the Energy Policy Project, sponsored by the Ford Foundation.

The Project's final report, A Time To Choose, concludes that the nation should trim energy growth from the 4.5 per cent of the last eight years to about 2 per cent a year, and can do so without adversely affecting the economy or the amenities of our way of life. Neither jobs, nor growth rate in incomes, nor household comforts will suffer if the nation's energy growth rate is slowed by more efficient use of energy. And a decade from now, with further efficiences and with the shifts in the pattern of economic growth to less energy-intensive activities, energy growth can level off to zero.

The Energy Policy Project was established and financed by the Ford Foundation and carried out by an independent staff of economists, engineers, scientists, writers and lawyers. Besides their own research and analysis, the staff drew on some two dozen specially commissioned studies. The Project had a 20-member Advisory Board of leaders from business, citizen groups and the academic world, and its comments are published as a part of the report.

To achieve major energy savings, the Project says, the nation must adopt a consistent, integrated energy conservation policy. In fact, no matter what energy course the nation chooses, a sense of direction is essential. The Project warns that "if the indifference and neglect that helped to create the energy gap continue, the U.S. could drift into a serious long lasting, energy-environment crisis."

To conserve energy, deliberate government actions are necessary to supplement market forces. Higher fuel prices alone will not induce builders, for example, to put insulation in new buildings, nor impel automobile manufacturers to put their best efforts into improved gasoline mileage in new cars. And only government can make some of the most fundamental decisions affecting energy. Leasing policy for publicly-owned resources is one example; the direction that federally-funded energy research and development should take is another. Whether the nation opts for slower growth or for a continuation of the rapid growth of the past, coherent government action is needed.

The greatest opportunities for improving energy efficiency lie in industry, in heating and cooling buildings, and in the American automobile, the Project finds. It makes four main policy recommendations for achieving slower energy growth:

*This summary is freely adapted from the summary prepared by the staff of the Energy Policy Project of the Ford Foundation. The full recommendations are contained in Chapter 13 of the final report, A Time To Choose: America's Energy Future (New York: Ballinger, 1974).

*Adopt minimum fuel economy performance standards for new cars, so as to achieve an average fuel economy of at least 20 miles per gallon by 1985.

*Encourage more efficient space heating and cooling. This includes making credit easily available for energy-saving investments in existing buildings; setting higher FHA standards for insulation and heating and cooling systems; upgrading building codes and providing technical assistance to builders.

*Shape government programs to encourage technological innovation for saving energy. This includes shifting federal research and development funding toward energy conservation technology and stressing government purchases of energy-conserving equipment--thriftier cars, tighter buildings, recycled materials and the like.

*Set prices to reflect the full costs of producing energy--this is especially important in encouraging energy-saving in industry. This means eliminating energy industry subsidies; abolishing promotional discounts for big electricity users; levying pollution taxes to supplement pollution control regulation; and building oil stockpiles financed by tariffs on imported oil.

Even at a 2 per cent annual growth rate, energy supplies will need to be 28 per cent larger in 1985 than in 1973. Yet the slow-down from present growth rates would mean that from now until 1985 the nation could meet energy demand without resorting to developments that threaten grave environmental damage or serious foreign policy risks.

Until 1985, new supplies could come from new discoveries of oil and gas onshore plus offshore production in the Gulf of Mexico; secondary and tertiary recovery from existing oil and gas wells; coal from deep mines and surface mines where the land can be reclaimed, and electric power plants which are already in some stage of construction. It would not be necessary yet to embark on large scale development of Western coal and shale where reclamation is chancy or impossible. Nor would massive new commitments to nuclear power, increased oil imports, or offshort oil development in presently undisturbed areas (Atlantic, Pacific and Gulf of Alaska) be required.

After 1985, development of some of these controversial sources would be necessary to support 2 per cent growth. Yet the nation could still afford to be more selective than if historical rates of growth were to continue. In the post-1985 period, given adequate research and development, conventional fuels could be supplemented by cleaner, more renewable energy sources--solar and geothermal energy, solid and organic wastes, and maybe, in time, nuclear fusion.

The Project analyzes the nation's energy choices by examining three different versions of possible energy futures for the U.S. through the year 2000. These three alternate futures, or scenarios, are based upon differing assumptions about how fast energy consumption will grow. They are not predictions, but are examples chosen from the infinite variety of real possibilities, to illustrate the broad range of energy futures that are open to the nation, and to explore the implications of different growth rates.

The rates of growth selected range from a high of 3.4 per cent a year in the Historical Growth future, to a growth rate that slows and then levels off to zero by 1990 for the Zero Energy Growth scenario. The Technical Fix scenario has a yearly energy growth rate of 1.9 per cent.

Under Historical Growth, the annual energy growth of 3.4 per cent (the average for 1950 to 1970) leads to an energy consumption level of 187 quadrillion BTUs* in the year 2000, which is two and half times that of 1973. Supplying energy demand at this level would mean "very aggressive development of all available energy sources." There would be "little scope to pick and choose among sources of supply, no matter what economic, foreign policy, or environmental problems they might raise."

The Project concludes that "though it is physically possible, even from domestic sources alone, to fuel the Historical Growth rate during the later years of the century," such a course would be exceedingly difficult and probably would require "a large scale government commitment" in the form of energy industry subsidies and market guarantees. "We do not believe that the government policies and action necessary to make it happen are desirable," says the Project.

In the Technical Fix scenario, energy use reaches 124 quadrillion BTUs by 2000, about one-third less than with Historical Growth. This scenario includes sufficient energy for full employment and steady growth in GNP and personal incomes. It also includes energy enough to heat and aircondition every home in the country, and to provide for water heating, a cooking stove, a freezer, a dishwasher, a color television and a big frost-free regrigerator in every household in the United States.

The slower growth rate in the Technical Fix permits much more flexibility in energy supply and a more relaxed pace of development. The nation could postpone for a decade any large increase in oil imports, and could also go slow on developing the domestic energy sources that threaten serious environmental damage: nuclear power; western coal and shale from land which cannot be reclaimed; and offshore oil and gas from areas which are not yet exploited.

Continued growth at the 2 per cent rate after 1985 would require development of at least two of these troublesome sources; but the nation could still ban growth in those that it considers most undesirable. For example, it would be possible to keep imports below today's level and still stop strip mining for coal in the arid West. Alternatively, the nation could halt new construction of nuclear plans and also preserve the Atlantic and Pacific Coasts from off-shore drilling and development. Or all these sources could be developed at a slower rate. Rapid growth in the burning of coal, for instance, could be postponed until better controls for air pollutants that are hazardous to human health are in place.

The Technical Fix scenario details how energy can be saved through technology which is available today, or soon will be. It describes improvements for cars and buildings, and emphasizes processes which save fuel in industry, especially the production of electricity and industrial steam together. The Project stresses that it takes a great deal of energy to make energy. The energy needed to produce and process energy accounts for more than half the difference in consumption between Technical Fix and Historical Growth for the year 2000.

In the Technical Fix scenario, there would be less investment in new coal mines and oil refineries and power plants and more investment in energy-saving technologies than Historical Growth. The result would be a net saving in capital investment requirements of some $300 billion over the next 25 years. The energy industry would need only about 20 per cent of the total capital

*British Thermal Unit--English system measure of heat energy.

funds for the U.S. (which is near the current share) instead of the 30 per cent that Historical Growth would require.

For all these reasons, the Project recommends the immediate implementation of the government policies to save energy and slow growth to a 2 per cent annual increase.

The Project also investigated the possibility of zero energy growth after 1985. In the ZEG scenario, energy use would stabilize at 100 quadrillion BTUs, or about one-third more than in 1973. The nation would therefore need to find enough supplies every year to meet a very large demand.

ZEG, with a slightly smaller GNP than that of Historical Growth, would still provide for as much economic growth as Technical Fix, and actually provides more jobs. Its main difference from the other scenarios lies in a small but distinct shift in economic growth away from energy-intensive industries toward economic activities that require less energy.

The Project finds that a shift to ZEG could well be feasible over 10 or 15 years, might be desirable to improve the quality of life, and might even be essential in response to environmental concerns or resource constraints. Under ZEG certain sectors of the economy would continue to grow--for instance, services such as health care, recreation and communications. Other areas, especially energy-intensive manufacturing, would be larger than today, but their growth would level off. A tax on energy could enlist market forces to encourage this shift by making energy more expensive. The resulting revenues could be used to spur growth in such services that would improve the quality of life.

Because of the long lead time necessary for energy decisions, the Project urgently recommends that an intensive study of the desirability of moving to zero growth begin now.

The issue of social equity is addressed. The Project reports that poor people typically spend about 15 per cent of their incomes for gas, electricity, and gasoline, while the well-to-do spend about 4 per cent. Further, most of the spending of the poor for energy is for bare necessities. Hence, for the poor to be forced to cut back because of higher energy prices or whatever the reason would cause real hardship.

Yet energy conservation does offer help to low-income people as well as to all other consumers. The measures the Project recommends for saving energy in homes, appliances and cars help to save money on energy bills. The Project also recommends a system of "energy stamps," emergency grants, or fuel allocations to help lower income people cope with fuel shortages and sharp price increases. The Project recognizes, however, that the fundamental answers to the energy distribution problem lie in solutions to the larger problem of poverty itself.

The Project also examines the relationship of energy to employment and economic growth. It concludes that although sudden unexpected energy shortages can cause severe unemployment, planned long-term conservation efforts will not affect growth in either output, incomes or jobs. These findings are based upon technical studies of energy-saving possibilities which were made by the Project itself, by Project-sponsored groups and by independent investigators. An econometric analysis of the impacts of energy savings on GNP and employment, done by Data Resources, Inc., for the Project, buttresses these findings.

In its analysis of U. S. energy policy in the world context, the Project concludes that the dramatic prices increases in the world oil market over the past four years are more than a temporary aberration. The Project suggests that there has been "a fundamental power realignment in the internation community." It adds:

> To put it bluntly, the major oil-rich nations, which formerly were weak and therefore did not need to be reckoned with politically, are now world powers by virtue of the financial reserves they have accumulated and the control they exercise over the oil artery to the industrialized West.

The Project counsels conciliation rather than confrontation between oil importing nations and the exporters, with both sides seeking agreement on areas of mutual interest -- such as prices and security of supply, aid to poor countries financial stability -- through systematic, multilateral government-to-government bargaining.

Energy conservation is found to be the most effective unilateral tool available to the U.S. for coping with energy-related foreign policy problems-- inflation, vulnerability to oil cutoff and strained relations with Japan and Europe as well as the Middle Eastern nations. The Project also cautions that nuclear materials can easily be diverted from the nuclear power industry to make weapons, and urges that nuclear exporting nations agree not to export nuclear fuels or equipment to the strife-torn Middle East, or to other areas as yet untouched by nuclear power.

The Project's environmental analysis finds that air pollution is the most immediate hazard to human health from the use of energy, and warns that "available scientific evidence indicates that there is no basis for relaxing present air quality standards." It calls for an urgent program for control of small particles, which are largely uncontrolled today, and may be the most dangerous of all emissions from fossil fuels. Regulations, pollution taxes and curtailed growth through energy conservation are recommended as the means for pursuing air quality standards.

The Project recognizes nuclear fission as a potentially large source of energy which avoids the air pollution of burning fossil fuels, as well as their land use and global climatic difficulties. But it also notes in detail the primary unresolved problems of nuclear power: reactor safety; theft or diversion of nuclear materials for violent purposes; and the ultimate disposal of nuclear wastes. The ability of human institutions to deal with these new problems is unproven.

The report points out that adoption of the Project's overall conservation program would permit a much slower rate of nuclear power development than is now planned. This slower growth would allow time to gain better understanding of nuclear power problems, before irrevocable expansion takes place.

Finally, the report calls attention to the problems of developing coal and shale in the West, and of offshore oil in undeveloped areas. These problems include water supply, disruption of land use values, and regionwide demographic and economic upheavals, as well as specific problems on site of land restoration, air pollution and so on. The final choice as to which supply options are environmentally best cannot be settled by scientific evidence alone, but depends on value judgements. Political decisions that depend on citizens' access to information will determine which options are chosen.

Judging by traditional tests of industry structure, the U.S. oil industry does not at present exercise decisive monopoly power over the market, nor does the energy industry as a whole constitute a monopoly; but there are signs of diminished competition in some areas. Changes in government leasing policies, in tax laws and in anti-trust enforcement are necessary to improve the industry's competitive performance.

A more fundamental problem is the disproportionate influence of the energy industry on government decisions. The Project notes that the energy industry, especially the oil industry, "possesses a unique combination of political advantages which has enabled it to exert considerable influence on public policy." The Project urges that "citizens must develop countervailing power at all levels of government" and that "economic and political power must be uncoupled so that the economically powerful can no longer run the government to achieve the policies that suit them best regardless of whether those policies suit the rest of the people."

Among the "countervailing" measures recommended by the Project is "a strong campaign finance law that would reduce the political power at present exercised by the big contributors." In addition, the Project urges that consumers take an active interest in the energy policy issues at the ballot box where their views can be most effective.

As for the regulated public utilities which supply electricity, the Project proposes an end to pricing which promotes growth through discounts for big users. It recommends a new method of pricing electricity that charges more for electricity use at peak time.

In addition, the Project suggests that state utility regulation be supplemented by broader regional commissions. It also proposes a reform to separate the distribution of electricity from its generation and transmission. The Project notes that electric utilities are now planning for an expansion of their capacity which is "substantially greater" than needed to supply electricity if consistent, integrated energy conservation policies are pursued by the nation.

Public ownership of more than half the United States' remaining energy fuels in the ground illustrates the necessary involvement of government decision-making in energy policy. Government decisisons on the sale and use of these energy assets "will be a critical force in determining patterns of future energy development," the Project notes.

Past Interior Department resource management policies have not adequately protected the public interest, according to the Project. "There is no assurance that the resources are being developed at a time and price which correspond to the national needs: vast amounts have been released with a grossly inadequate return to the public treasury; and the environment has been poorly served."

So much federal coal has already been transferred to private hands--at little or no cost, and the inadequate provision to restore the land--that the Project sees no present need for further coal leasing, even assuming historical rates of energy growth. Over 22 billion tons of coal are now under lease, and little of this has been developed.

The federal government has also launched a program to lease 10 million acres a year of offshore oil and gas lands "with poor understanding of the extent of oil and gas to be sold," or of the effects of the massive leasing on the environment and on public revenues.

The Project concludes that the public interest can best be served by truly competitive leasing under a reformed resource assessment, planning and regulatory system.

Present energy research and development efforts--public and private--are concentrated in a very few supply-oriented technologies, the Project reports. "The nation is ignoring energy conservation technologies, neglecting environmental R & D, and failing even to achieve very much diversity in energy supply."

The Project calls for a major new R & D thrust for energy conservation, environmental protection, and for renewable energy sources such as solar energy.

It recommends that government energy R & D programs explore promising, ideas, perform basic research, and advance tehcnology, but phase out its commitment in the demonstration phase. Before any funding for a demonstration project takes place, the health, safety and environmental problems of the new technology should be assessed by an independent body, and the whole project should be aired before Congress and the public. If the project is to proceed, government participation should be limited to one-quarter of the estimated cost, unless if offers environmental or other public purpose advantages for which there is no commercial incentive.

The Project applies this principle to the nuclear breeder reactor program, and calls the breeder program "an outstanding example of the neglect of public participation as well as independent assessment, and of failure to protect the public treasury." The "open-ended" commitment to the breeder should be stopped, and the whole program scrutinized by the National Academy of Sciences to assess the state of breeder reactor technology, including its health, safety and environmental problems. If a public decision is then made to go on with the breeder, government funding should follow the same ground rules for demonstration projects in general.

The Energy Policy Project suggests that Congress debate and enact legislation declaring that energy conservation is "a matter of highest national priority" and establish conservation goals for the nation. A target for the long-term growth rate in energy consumption should be set at 2 per cent a year, and reviewed annually by Congress. The Project also recommends the establishment of an Energy Policy Council to coordinate the effort and take the actions necessary to implement the goal.

APPENDIX H

MOBIL OIL'S 'TOWARD A NATIONAL ENERGY POLICY'

The Montana Energy Policy Study has relied heavily on the data contained in the Federal Energy Administration's Project Independence Report (November 1974) and the Northern Great Plains Resource Program's Draft Report (September 1974). These two documents incorporate most of what is known or believed about such factors as national energy supply and demand projections as well as more specific analysis of the resource base and impacts associated with the exploitation of the coal in the Fort Union region.

These data form the building blocks from which any attempt to devise an energy policy must begin. It is important to acknowledge that people using the same data can arrive at different conclusions. In order to provide some additional perspective to the Montana Energy Policy Study prepared by EQC, Appendix H includes a series of newspaper advertisements that represent the views of Mobil Oil. Many other items that might be said to reflect the attitudes of the so-called "business community" could have been selected. A good statement representing this view is contained in Achieving Energy Independence, published by the Committee for Economic Development (477 Madison Avenue, New York 10022). However, the EQC staff felt the attempts by Mobil Oil in its series "Toward A National Energy Policy" presented a strong case that those arguing for less growth, more conservation, and greater reliance on "non-polluting" energy sources had to confront.

Mobil's first effort to contribute to the growing concern over the energy crisis and the policy vacuum in Washington appeared as a full-page ad in the New York Times on November 17, 1974. It was entitled "An Energy Manifesto" and it made the following points:

- The nation's objective for the coming decade should be substantially greater energy self-sufficiency. This means increasing domestic production of conventional crude oil, natural gas, and coal. The resources are there. They must be developed.
- A return to a free market for oil and natural gas should be a near-term goal. This is the most immediate step our country can take to bring about greater energy self-sufficiency; there is no effective substitute for having incentives at the right level. We know of no better mechanism for fine-tuning incentives than the marketplace. If higher energy costs bear too hard on the poor, this can be ameliorated through tax relief or other means. But arbitrary and misguided controls that delay the development of additional supplies will only exacerbate the under-employment and other problems of the poor.
- Timetables on environmental objectives must be related to energy needs and other national priorities. There is no irreconcilable conflict between additional energy supplies and a cleaner environment.
- For the long term--by 1990 or thereabouts--we should aim for some surplus in domestic energy supplies, as the best guarantee of reasonable prices.
- To help minimize dependence on foreign oil, we must conserve energy by eliminating wasteful use of it. But we should distinguish between cutting out fat and cutting into muscle. To retain the muscle--i.e., to maintain a dynamic economy and to create more jobs--we will need more energy.
- The price of "new" natural gas should be decontrolled, to provide an economic incentive for accelerated exploration for this fuel and to discourage wasteful use of it. This can and should be done now.

- The Atlantic and Pacific sectors of our outer continental shelf should be opened up for exploration on an orderly, continuing basis. Obviously, we won't know how much oil and gas is there until we drill. But we clearly should avail ourselves of the opportunity to find whatever additions to our national reserves may be located in those areas. Environmental controls on drilling should continue to be strict, but excessive restrictions and litigation should not be allowed to hold up projects to provide additional energy.
- U. S. companies should be encouraged to search for oil and natural gas throughout the world, for the maximum diversification of foreign sources of supply. Those supplies are going to be required in the period before we can achieve a surplus. Our government should continue to give U. S. companies the same tax treatment that other major countries accord their companies operating abroad.
- Deepwater terminals enabling the largest tankers to deliver foreign oil to the U. S. should be built without delay, for environmental reasons as well as to provide the lowest transportation costs for the large volumes of oil we will have to import for at least the next decade.
- Provision should be made for security stockpiling of oil to help tide us over if another supply disruption occurs.
- Public transportation should be improved through the development of a comprehensive National Master Transportation Program that would take into account all of the nation's transportation needs and would provide enough money to do an adequate job nationwide.
- Goals and scheduled programs should be set for commercial development of alternate energy sources--primarily coal in liquid or gaseous form, nuclear and solar energy, and possibly oil from shale--so they can carry an important share of the energy load as soon as possible.

On December 29, 1974, Mobil ran a second full-page ad in which it summarized its major recommendations.

- Government has an important and affirmative role to play in national energy policy: reconciling conflicting interests, balancing various national needs, formulating policies, setting objectives, establishing appropriate incentives for the private sector to achieve those objectives, monitoring progress, and providing leadership.
- The ultimate objective of a national energy policy should be to ensure the economic and strategic security of U. S. energy supplies so that we can disentangle energy problems from international political problems.
- To help minimize our dependence on foreign oil, we should aim to eliminate all waste in the use of energy and should initiate long-term programs to achieve more-efficent use of energy. But we must realize that these alone cannot do the whole job; we must develop additional energy supplies concurrently. To maintain a dynamic economy, we will need more energy, not less, even if demand grows at a slower rate.
- The national objective for the coming decade should be a substantial increase in domestic production of the readiest energy sources: conventional crude oil, natural gas, coal, and nuclear power.
- A return to a free market for oil and natural gas should be a near-term goal. Price controls, quotas, and allocations <u>en</u>courage wasteful use, <u>dis</u>courage development of additional supplies, and build in distortions. A free market will provide more efficient distribution immediately and, over a period of time, will bring out adequate supply at competitive prices.
- Removing federal price controls from newly discovered natural gas would provide incentive for intensified exploration and would discourage wasteful use of this valuable fuel.

- Public transportation should be adequately funded, based on the development of a comprehensive master plan that would take into account all of the nation's transportation needs. It should enable us to move more people and more goods with less energy.
- We should relax limitations on sulfur emissions to the extent that we can do so and still meet primary air-quality standards designed to protect public health. This would make more U. S. coal usable and would lower the cost of heavy residual fuel, most of which has to be imported.
- Timetables on environmental objectives should be related to the country's energy needs and other priorities. There is no insuperable conflict between a cleaner environment and additional energy supplies--energy that will, in fact, be needed to continue to clean up the environment. We need a balanced approach.
- We should begin to open the Atlantic, Pacific, and Alaskan sectors of our outer continental shelf for exploration. Although we won't know how much oil and gas can be found and recovered until we drill, we must avail ourselves of the opportunity to find whatever new reserves may exist in these areas. Environmental controls on drilling should continue to be strict, but excessive restrictions should not be able to block projects to produce more domestic energy and minimize our dependence on other countries.
- Deepwater receiving terminals to enable supertankers to deliver oil to the U. S. should be built without delay for safer and more efficient handling of imported oil, on which the U. S. will be heavily dependent for years to come.
- We should develop a U. S.-flag fleet to transport significant volumes of our oil imports.

- We should provide security stockpiling of oil for use in the event of another supply disruption.
- Specific goals and timetables should be set for development of alternate energy sources--primarily liquefied and gasified coal, shale oil, and nuclear and solar energy--so they can play an important role in energy supplies as soon as possible.
- For the long term--around 1990 or later--we should aim for a surplus of domestic energy supplies from all sources.

Between the two dates, Mobil ran eight smaller ads that presented its case in more detail. On January 26, 1975, Mobil offered its thinking on conservation. These articles are reprinted here as they appeared in the New York Times.

Toward a National Energy Policy

New York Times, November 24, 1974 (Sun)

1. SETTING THE OBJECTIVES

A week ago we published an "energy manifesto" in this newspaper, listing what seemed to us to be the priorities for a national energy policy. We took this step, not because we have all the answers—nobody does—but because we believe we can make a useful contribution to an informed national debate.

Today we want to discuss the basic question of *how much* energy the United States will need.

The U.S. now consumes about 17 million barrels of oil, and 63 billion cubic feet of natural gas, a day. Oil and natural gas (plus liquids extracted from natural gas) make up about 77% of our total energy consumption.

But only a little over three-fifths of the oil we use is produced within the United States. This means some 6 million barrels a day of oil—nearly 40% of what we use—must be imported. While the U.S. still produces almost all the natural gas it uses, oil imports have been rising as domestic production has declined.

A key objective of national energy policy must be to reduce this dependence on foreign oil. Political considerations and the costs of that oil make this imperative. The costs are driving the U.S. balance of payments increasingly into the red, jeopardizing the international monetary system, and causing the transfer of basic wealth and strength away from the United States.

There are several ways to reduce dependence on foreign oil. We can use less. We can produce more of our own. And we can increase the production of coal from the truly huge domestic reserves of it.

Curiously, many people are urging the first approach—using less—as the *complete* answer. We think this is a prescription for disaster. While we can and should cut out waste, we are going to need more energy—not less—in the years ahead. Disproportionately large conservation efforts that inhibit expansion of supplies will tend to lock the nation into a posture of zero economic growth, probably producing widespread economic dislocation, large-scale unemployment, and a general lowering of living standards.

In particular, a policy of no economic growth—or very low growth—penalizes the poor. Economic growth and hence living standards depend critically on abundant energy supplies, and millions of Americans have not yet achieved adequate living standards. With our population still growing, as it is, a no-growth economy would mean less and less for everyone.

We also need more energy to protect, and expand on, the environmental gains we have made. As one instance, emission controls on automobiles added 4 *billion* gallons to our national gasoline consumption in 1973. We could use less gasoline if we had an adequate system of public transportation. But that's years away. By the same token, improved gasoline mileage built into new cars can exert real impact on gasoline consumption only over a period of several years.

Since cutting out waste is only part of the answer, we need to produce in this country enough of the energy we use to enable us to disentangle energy questions from those of international politics. No great power can be comfortable as long as it is excessively dependent on other countries for essential raw materials. A vigorous U.S. domestic energy program would make a major contribution to the development of an orderly international economy with a free flow of goods, services, and investment.

So, for the next decade at least, the focus must be on cutting out waste *and* developing additional energy supplies. In the near term—for at least the next 20 years—this means mainly oil, natural gas, coal, and nuclear power. By how many percentage points should we improve our energy self-sufficiency? We don't know. Because to answer that question we have to know how much oil and natural gas is available to supplement the vast U.S. coal reserves. And we won't know that until we drill a great many more wells, onshore and offshore.

For the long term, our aim should be a surplus of energy of all kinds. We will never be able to predict to the last decimal what the aggregate of individual needs will be. Prudence argues that we should err on the side of a moderate surplus. A surplus will enable us to continue cleaning up our environment and will facilitate responsible economic growth. It will avert or alleviate foreign dependence and related problems. It will give us more discretion in whatever we as a nation want to do.

So our objectives are clear. Eliminate waste. Increase domestic production of crude oil, natural gas, coal, and nuclear power. Aim for a moderate long-range energy surplus.

Toward a National Energy Policy

New York Times, November 24, 1974 (Sun)

2. WHAT WENT WRONG?

Mobil believes the nation's energy goal can be simply stated: In the coming decade, to produce a larger proportion of the energy we use; in the longer term, to achieve a reasonable energy surplus. Since nobody can forecast exactly how much energy the U.S. will need, it will be prudent to end up with too much rather than not enough.

But before we talk about surpluses, or even improved self-sufficiency, we have to ask: Why the present crisis? What went wrong?

The questions are necessary, because a nation should be able to learn from its past mistakes.

- Mistake #1 is 20 years old. In 1954 the U.S. imposed price controls on natural gas shipped across state lines. In its eagerness to protect the consumer, the government focused on low prices for the short term. It gave short shrift to the consumer's long-term stake in security and adequacy of supply. The artificially depressed price of natural gas has produced today's shortage of natural gas, by stimulating demand while reducing the incentive to look for new supplies. Even under the best conditions, this shortage will be with us for years, and it will probably get a good deal worse before it gets any better.
- Mistake #2 was the failure in past years to allow oil companies to press the search for oil and gas fully enough on the U.S. outer continental shelf. Reaction to the Santa Barbara spill caused too many people to lose their perspective. We must work to prevent spills and at the same time move ahead to try to assure adequate supplies.
  Britain will be self-sufficient in oil about 1980, because it has actively promoted exploration under the seas around it, while the U.S. still puts "off limits" signs on thousands of square miles of outer continental shelf waters.
- Mistake #3 was the failure to permit construction of the Alaska pipeline to begin much earlier. The pipeline raised legitimate questions about the environment. But scare tactics led to overreaction. Result: the line—designed to safeguard both terrain and wildlife on the basis of probably the most detailed ecological analysis ever made—was unnecessarily stalled in the courts and in Congress when it should have been pumping oil into the American economy.
- Mistake #4 was the nation's snail's-pace development of other energy sources. Construction of atomic power plants has been delayed for a variety of reasons. Coal—our country's most abundant energy source—was clobbered from all sides. It couldn't compete with the artificially low prices imposed on natural gas (which in turn held down the price of another competitor, home heating oil), nor could it compete with low-cost foreign oil in the Fifties and Sixties. Finally, a lot of coal was made unusable by tight limitations on sulfur content.
  Ironically, too, the *expectation* of cheap atomic energy discouraged investments in new coal mines—so that the country got the worst of both worlds. There were and are legitimate environmental concerns with both atomic energy and coal. But the nation has let itself be steered away from the basic question: "How much energy do we need, how soon, and at what economic and other cost?"
- Mistake #5 was the naive belief by many that we could rely indefinitely on getting all the foreign oil we wanted at the price we wanted to pay for it—so that we could continue to waste energy and avoid correcting mistakes #1, 2, 3, and 4.

It could have been worse, of course. Remember the people who wanted to make the U.S. even more dependent on foreign oil, while assuring you that "national petroleum security" was a fiction devised by oil barons to keep domestic petroleum prices up? Remember the people who said not to worry about balance-of-payments problems, because these always righted themselves? And the instant tax experts eager to make sweeping changes, with little concern for the consequences? Fortunately, we didn't go all the way down any of those primrose paths.

Even so, for at least another 10 years, the U.S. is going to be heavily dependent on imported oil (coming increasingly from the Middle East), because of the long lead times that are unavoidable both in conserving energy on a large scale and in developing additional supplies.

To make a substantial reduction in energy use will require large investments by industry, new building standards for structures of all sorts, large numbers of low-horsepower cars replacing higher-horsepower cars year after year, the development of adequate public transportation systems, and other efforts.

It will take years, and very substantial investments, to discover and develop a new offshore oil field, or to get a new coal mine into operation or a nuclear power plant built.

Remember this when anyone tells you we can wait 10 years to even initiate any major effort.

Next week: "Alternate energy sources"

Toward a National Energy Policy

New York Times, December 1, 1974 (Sun)

3. ALTERNATE ENERGY SOURCES

Last week in this newspaper, we pointed out the need for additional energy supplies to enable the U.S. to disentangle energy questions from those of international politics. Eventually this may involve tapping some fairly exotic sources.

But alternate energy sources are *not* a *near*-term alternative to conventional crude oil, natural gas, and coal.

In fact, it is the near term that is troublesome. In the *longer* term we can develop the United States' strong natural resource base enough to become self-sufficient in energy and even to achieve a reasonable surplus.

It is all a matter of timing. Timing and billions of dollars.

Since lead times in energy are unavoidably long, we as a nation must start planning now. This planning has to comprehend three broad, overlapping time frames.

Time frame 1: For about the next 10 to 15 years, we have no feasible alternative to continued reliance on crude oil and natural gas for most of our energy, with an increasing need for imports in the years just ahead. We therefore have to push ahead with exploration worldwide, including the U.S. offshore, to find and develop additional reserves.

Simultaneously we must make greater use of the very large U.S. deposits of coal, our most abundant fossil fuel. Coal can replace a good deal of imported oil without abandonment of air-quality standards and without irresponsible strip-mining.

Coal is in short supply today. To mine substantially greater quantities will require very large investments, a lot of critical materials, a good deal more skilled labor, and the years of lead time needed to marshal and apply these ingredients. Continued research on ways to reduce sulfur emissions will have to proceed simultaneously.

Toward the mid-1980s nuclear power should begin to play a significant role in generating electricity and freeing up oil and natural gas for other uses. There remain some environmental problems, but lead times could probably be cut in half by setting generally applicable siting, safety, and environmental standards, instead of negotiating such factors separately for each site.

This first time frame is so critical to our country's economic security that, even with maximum conservation, we have almost no options in our choice of large-scale energy sources.

Time frame 2: Beginning around 1985 to 1990, we will probably see heavy and growing stress on synthetic oil and gas, known in the trade as syncrude and syngas. At this juncture it seems probable, for a number of reasons, that coal will eventually become a more important source of synthetic fuels than shale.

There is more coal than shale available for mining at relatively low cost. And we won't need to mine and handle as much coal to produce a given quantity of syncrude or syngas, since a ton of coal will yield two to three times as much of these synthetic fuels as a ton of shale will.

In time frame 2 there also will be continued growth in nuclear power. And somewhere down the road we expect a new type of reactor—the nuclear "breeder," which would make nonfissionable material fissionable—to enlarge the supply of nuclear fuel.

Time frame 3: Sometime after the year 2000, fusion and solar energy can probably begin to contribute importantly to energy supply. At a minimum, this will require major scientific and technological advances. Probably nothing less than fundamental breakthroughs—which, by their nature, can't be predicted or counted on—can arrest the trend to higher energy costs.

Solar power seems to be everybody's favorite, because sunlight is an enormous, dependable energy source and poses no pollution problems (though the apparatus involved, spread over a good deal of ground, will unavoidably pose some environmental problems, at least in the esthetic sense). There are indications that we could be using solar cooling in 10 to 15 years. Local solar power generators to produce electricity for residential use may begin to be commercial in the next decade. But really large-scale use of solar energy before the end of this century is unlikely.

If the U.S. is to realize the bright promise implicit in these alternative energy sources, we must undertake continuing, long-term research and development work on a very large scale, and we must start now. Otherwise there will be few if any major scientific and technological advances, and almost certainly no fundamental breakthroughs.

But we have to ask ourselves:

How much are we willing to pay to become essentially independent of other countries with respect to energy supplies?

We cannot duck this question. Energy prices must cover prospective costs, including the cost of capital. In the last analysis it is the rate of return on capital in the privately owned energy industries that will determine whether the job gets done.

No company is going to be able or willing to borrow and invest on the scale that will be required unless the prospective rate of return on such investment—the ratio of earnings to assets—is adequately attractive.

Toward a National Energy Policy

New York Times, December 1, 1974 (Sun)

4. What about the offshore?

Now we want to tackle the question of drilling for oil and natural gas under the oceans around our coasts. Specifically, we are talking about the Atlantic and Pacific outer continental shelf areas of the U.S., where no leasing or drilling in federal waters is presently taking place.

The U.S. supply-and-demand outlook for energy is pertinent to any discussion of the importance of these offshore areas.

Conventional oil and natural gas, which today furnish over three-quarters of the energy Americans use, will still be furnishing about two-thirds of our energy by 1985. This projection takes into account a substantial rise in the production of coal and nuclear power and a little production of synthetic gas and oil.

Today Americans are consuming oil and natural gas at the rate of 28 million barrels a day of "oil equivalents." That figure (and that term) includes the nearly 17 million barrels a day of oil we use plus our natural gas consumption translated into oil equivalents on the basis of heat value, or British thermal units.

We produce 21 million of these 28 million barrels a day of oil equivalents, leaving a gap of 7 million barrels a day of oil equivalents to be imported.

By 1985 U.S. demand (even after conservation efforts) may be about 35 million barrels a day—around 25% higher than today's 28 million. But the production of oil and gas from presently proved reserves will drop by 1985 from the present 21 million barrels a day of oil equivalents to around 9 million barrels daily. *This will leave a gap of about 26 million barrels a day of oil equivalents—far more than today's total U.S. oil and natural gas production—to be made up by imports and by oil and gas from reserves still to be found and proved.*

Of all the remaining areas in the United States, the offshore appears to us to be the most promising and to offer the largest potential for significant new oil and natural gas discoveries.

How large?

You can get a lot of answers to that question —all of them tentative and all of them carefully qualified.

Even with extensive geological and geophysical data, estimates of still-undiscovered offshore reserves are highly subjective and therefore vary widely. What it comes down to is that there is simply no way of knowing how much oil and gas exists in a given area until that area is drilled extensively.

But if we want to work toward a secure domestic energy supply, we clearly must avail ourselves of the opportunity to find whatever additions to our national reserves may be located in undrilled offshore areas.

We have some pretty reliable information about the lead times involved. The elapsed time from the first U.S. government announcement of a proposed offshore lease sale to actual production—assuming you find oil or gas in commercial quantities—ranges from about four years to more than 10 years even in such familiar waters as the Gulf of Mexico. In new areas such as the Atlantic offshore, lead times could lengthen substantially.

All of which underscores the urgency of action *now* to begin opening the Atlantic and Pacific sectors of our outer continental shelf for exploration on an orderly, continuing basis.

Since we want to disentangle U.S. energy questions from those of international politics ...since alternate sources cannot exert major impact on our energy supplies for more than another decade...since even a strong program of energy conservation will show substantial results only over a period of several years... and since all energy poses some environmental risks, the simple truth is that for at least the next 15 to 20 years we are going to need all the environmentally acceptable domestic energy we can produce, from all sources.

Oil companies have drilled about 19,000 wells in U.S. offshore waters, and produced some 7 billion barrels of oil and 33 trillion cubic feet of gas offshore, over the past quarter-century—with only four spills that caused serious pollution. All were cleaned up quickly. There is no indication that any of the four caused lasting damage to the environment—not even the sensationalized Santa Barbara spill in 1969.

We believe the choice is clear: more offshore oil and gas, or greater dependence on high-cost, politically insecure oil. We believe, too, that most Americans understand this and comprehend that all of life requires reasonable compromises and trade-offs. In our view the combination of modern technology and human concern is adequate to the task of protecting our physical environment.

Next week: "Decontrol 'new' natural gas."

For free copies of this entire series, write to: Mobil, Room 645X, 150 East 42nd Street, New York, N.Y. 10017. We will mail them right after the last in the series.

Toward a National Energy Policy

New York Times, December 8, 1974 (Sun)

5. Decontrol "new" natural gas

Earlier in this ongoing discussion of national energy policy, we pointed out some mistakes our country has made with respect to energy supplies.

As the result of one of the biggest of those mistakes, natural gas—which furnishes about 30% of the energy used in the United States—is being rationed in much of the country.

Utility companies are having to turn away new customers who want this clean-burning fuel.

Some factories that use natural gas may be having to close for days at a time again this winter.

Some schools will probably have to close off and on, just as last year.

Reason: Domestic production of natural gas is declining and is nowhere near being able to meet demand. Proved reserves of natural gas (excluding gas on the North Slope of Alaska, which is years away from market) have dropped every year since 1967. Our consumption has been outstripping additions to reserves—a situation which obviously cannot continue indefinitely.

Yet geologists are convinced, on the basis of pretty solid evidence, that there are very substantial quantities of domestic natural gas still to be discovered.

Why this anomaly? Why such famine amid potential plenty?

Partly because most of the U.S. offshore areas are off limits to exploration for oil and natural gas, but mainly because the consumer has been "protected" into a shortage, through misguided government regulation. A shortage that is already severe and will worsen before it improves. A man-made shortage—made largely in Washington, D.C.

Twenty years ago the Federal Power Commission began regulating the wellhead prices of natural gas destined for interstate commerce—that is, the price paid to the producer for this gas. The FPC set the price so low that demand was artificially stimulated and wasteful use encouraged—while the same low prices reduced the economic incentive and the funds available to explore for additional supplies.

This is a foolproof way to produce a shortage. It has worked, with a vengeance. It will take years to find and develop and produce enough natural gas to begin to remedy the shortage, even if the outer continental shelf along the Atlantic and Pacific coasts is opened for exploration.

Our government's regulation has helped to create a market for expensive gas from such countries as Algeria and possibly the Soviet Union. The U.S. has approved the importation of liquefied natural gas from overseas that will cost several times as much delivered to New York harbor as domestic gas delivered here.

The arbitrarily low price our government has put on natural gas has had other fully predictable results.

Coal simply could not compete with such underpriced gas, so coal production languished. It will take years and very large capital investments and a lot of skilled labor to increase the production of low-sulfur coal substantially.

Another result: Utilities, unable to get adequate supplies of natural gas or of coal low enough in sulfur content to meet clean-air standards, made a massive switch to heating oil. This tightened supplies of heating oil and increased imports.

Look at what has happened in New England. Since it could not get enough natural gas, this region has come to rely on heavy residual fuel—nearly all imported, mostly from Venezuela. Since this fuel is made from foreign oil, utility companies and other users in New England are having to pay very high prices for it today.

The *Washington Post*, which calls the government's policy on natural gas "a monument to the influence of senators and congressmen from the urban states," said in an editorial more than a year ago:

> "...the federal government's misguided effort to hold down the price of natural gas is going to cost the residential consumer a lot of money...Because the FPC holds the price of natural gas too low, there is a shortage, and because there is a shortage, we must buy a synthetic substitute that costs three times as much. Who is saving money for whom?...The solution is to deregulate the price of natural gas at the well."

Congress can and must begin reversing this situation. Costs of natural gas to the consumer would rise as new, higher-priced gas supplies are added, but the rise would be restrained by the fact that "old" gas will stay at essentially the same price. Decontrol of "new" gas is a major step toward improving the U.S. energy base.

Toward a National Energy Policy

New York Times, December 8, 1974 (Sun)

6. Some essential facilities

So far in this series we have talked about the need to produce more domestic oil and natural gas (onshore and offshore) and more domestic coal, among other things. But the discovery and development of new reserves (especially offshore) and the opening of large new mines take years.

There are, however, things we can be doing now. Today we want to talk about these:

(1) Deepwater terminals and U.S.-flag ships. Worldwide, most crude oil carried across the oceans is transported in Very Large Crude Carriers, vessels of 160,000 deadweight tons or more—VLCCs for short. More than 60 ports around the world can accommodate these vessels. But *no* U.S. port can come anywhere near taking them, although they carry oil at a much lower cost per barrel than smaller vessels do, which obviously benefits the consumer.

Fortunately, modern technology makes it possible to build unloading terminals for these vessels offshore. This can obviate the need to build new ports in the traditional sense when this involves dredging harbors and disturbing marine life. Instead, oil from a large tanker can be pumped into a sea terminal (we call it a single-point mooring) and thence through a submarine pipeline to a storage tank on shore.

This solution would be environmentally preferable to the present alternatives—bringing oil to the U.S. in smaller tankers (so that we need more of them, with the result that harbors are clogged with vessels and the chance of a collision increases), or transferring the crude oil from a large tanker to smaller tankers at sea (an expensive operation). The sea terminals would normally be almost invisible from land in most cases, and so would the VLCCs using them.

Construction of deepwater terminals obviously will do nothing to reduce our dependence on foreign oil. They *will* make it possible to handle oil imports more efficiently and more safely than we can with the present antiquated facilities. There is no reason federal legislation to permit construction of these terminals should not be enacted now.

Because of balance-of-payments considerations and the need for security of supply, we should develop a U.S.-flag tanker fleet to transport significant volumes of our oil imports.

(2) Security storage. Japan and the countries of Western Europe have long followed a policy of keeping substantial security stockpiles of oil in storage, available for an emergency. Today the United States is increasingly dependent on imported oil. We must have our own stored oil supplies to tide us over in the event of another supply disruption.

This raises a lot of questions: How much oil does the country need to store? Enough to bridge the gap between production and consumption for one month? Two months? Longer? Where should the oil be stored? In salt domes? Abandoned mines? How much will it cost? Who will pay?

Industry, government, and others should be seeking answers to these questions. A proper storage program will help us limit our dependence on foreign oil until we achieve our goal of a national energy surplus. (If you wonder why oil companies don't go ahead with such a program on their own, the answer is that it would be far too expensive. It could cost billions of dollars.)

(3) Public transportation. We've said it before, and we'll say it again: the nation needs to get moving with a National Master Transportation Program. We must stop dealing with highway construction, railroad needs, urban transit, airport improvement, and maritime requirements in separate pieces of legislation with separate funding (when they are dealt with at all).

Congress should appropriate directly enough money to do what needs doing. This approach could provide the flexibility to meet the changing pattern of our transportation needs. And it could allow us to move more people and goods with less energy.

The time to begin is now.

Next week: "The need for balance."

For free copies of this entire series, write to: Mobil, Room 645X, 150 East 42nd Street, New York, N.Y. 10017. We will mail them right after the last in the series.

Toward a National Energy Policy

New York Times, December 15, 1974 (Sun)

7. The need for balance

Today Americans are more aware of the importance of clean air and water than at any time in our history. Also, we have made a good deal of measurable progress in this direction in the past decade. Much of the credit for achieving these positive results must go to those people called environmentalists. Without their urgings, we would not be as far along as we are. They can be justly proud of many of their successes.

But let us review some of the less fortunate results of environmental activities:

—Delaying the start of construction of the Alaskan pipeline for nearly five years means the U.S. will in the meantime have to import well over a billion barrels of oil that would otherwise have come from the North Slope. At today's high cost of foreign oil, this will create a drain of some $15 billion on the U.S. balance of payments. That's an extra $15 billion of the American people's money handed over to oil-exporting countries. Not to mention the increase of billions of dollars in the cost of the pipeline.

—The use of coal, our country's most abundant energy source, is being restricted severely in many areas by unnecessarily tight and inflexible limitations on sulfur content. This has forced large users to switch to low-sulfur heavy fuel, nearly all of which has to be imported—at very high costs.

—Construction and operation of nuclear power plants, which could have taken up some of the slack caused by insufficient domestic supplies of low-sulfur fuel oil and of natural gas, have been delayed.

—Legislation spurred by environmentalist lobbying has greatly increased U.S. gasoline consumption—by 6 billion gallons in 1974 alone—through emission-control systems installed on automobiles. Over the next three to four years the efficiency of automobile engines will drop still further, to meet that legislation's needlessly strict future standards within an arbitrarily short period of time.

—Every one of these actions placed an additional burden on oil supplies. At the same time, environmental pressures have delayed much of the increased offshore drilling that might provide some of the additional natural gas and oil the U.S. needs as a direct result of environmentalists' actions. This has made the U.S. just that much more dependent on other countries for high-cost, politically sensitive oil.

Another environmental achievement is the requirement that federal agencies prepare comprehensive documents known as environmental impact statements before they can proceed with offshore lease sales or grant permits for construction projects of any real size. Among other things, these statements have to discuss alternatives to the proposed action. Environmental impact statements do provide needed safeguards but have too often been used as an obstructionist tool for delaying energy projects.

Perhaps what the United States needs now is social and economic impact statements that would detail the social and economic consequences of *not* going ahead with any given project—for instance, the number and types of jobs that will *not* be created... the number of young people who will be *unable* to attend college if their parents are denied such jobs... the impact on the environment of insufficient supplies of energy to continue cleaning up our air and water... the increased dependence on foreign countries for oil... and the effects of this on the U.S. dollar, the international monetary system, and our country's economic and political security.

An adequate and secure supply of energy is not a discretionary item for our country. We have to strike a rational and workable balance between environmental risks and economic risks.

It seems to us that our country's failure to attain this balance reflects a normal human tendency of people to go too far (and too fast) in any given direction. We believe that, important as a cleaner environment is to all of us, it requires common-sense trade-offs. We believe timetables often can and must be made flexible even while one holds firmly to objectives. And we are convinced of the need to assess very carefully the economic and social costs to our fellow citizens of any proposed course of action.

Is all this to say that those of us in business have consistently been on the side of the angels, while the environmentalists have been on the other side? Of course not. People in business can be as wrong-headed as anyone. Certainly too many of us in business were slow to become fully aware of what had to be done to ensure cleaner air and water.

The problem is that over the past decade the pendulum has swung too far in one direction. Now, to mix a metaphor, we think it's time to balance the scales.

Toward a National Energy Policy

New York Times, December 15, 1974 (Sun)

8. Coal: the ugly duckling

The United States faces an immediate conflict between the issues of energy security and environmental concern.

Increased use of coal now could help minimize the dangerously heavy U.S. dependence on politically sensitive, high-cost foreign oil, with the pressure that this puts on our balance of payments. Not to mention the problems another oil embargo could create for us.

The U.S. has recoverable reserves of coal estimated at more than 800 times present annual production. Coal accounts for more than 90% of U.S. fossil-fuel resources but provides less than a fifth of our current energy supply. The problem is that severe limitations on sulfur content, at all levels of government, have made much of the country's coal unusable.

We can make much more U.S. coal usable, and still meet primary air-quality standards designed to protect public health, by relaxing various of the sulfur limitations now in effect. And we could take another step forward by allowing utilities and other large users in certain locations to burn coal under still less-severe sulfur limitations on days when atmospheric conditions and prevailing winds make it safe to do so.

Controls of this sort could be more rational than the stringent and inflexible controls we have now, and still protect public health. We need common-sense trade-offs to arrive at some happy medium midway between extremists on either side of this issue, because it is essential that coal begin to furnish a larger share of our energy.

Over the years coal has lost many of its traditional markets to oil and natural gas—both of them cleaner, more convenient, and (especially in the case of artificially underpriced gas) less expensive. In some places, nuclear power has displaced coal.

Now, with domestic oil production insufficient, with imported oil quadrupled in price, with a shortage of domestic natural gas, and with delays in nuclear power plant construction, the stage would seem to be set for a comeback by coal.

The comeback, however, is running into roadblocks. Existing limitations on sulfur content will become still more severe in 1975, when more stringent regulations take effect. These provisions can create a serious energy crunch. We should face up to this now.

Rapidly rising costs in coal-mining are an additional roadblock.

Mining substantially greater quantities of coal will require not only appropriate actions by the federal government, but also large capital investments in coal-mining. The machinery and equipment industries also will have to expand. New railroad lines to new coal-mining areas will have to be built, as will thousands of additional locomotives and railroad cars, plus barges and pipelines (to move coal in the form of slurry). Like most things in the energy business, all this will take not only money, but time as well.

Another important reason to begin expanding coal-production facilities now is that in the 1980s coal is expected to become a prime source of synthetic natural gas and synthetic oil (syngas and syncrude) on an increasing scale. By the year 2000, we will probably have little or no choice, since the Free World supply of conventional oil and natural gas is expected to fall far short of demand by then.

Syngas is relatively advanced technologically. A few plants to produce it are under construction now, and others are on the drawing boards. Syncrude production, however, requires substantial additional technological development before commercial plants will be feasible.

Large-scale production of these synthetic fuels will require the creation of a new industry, probably accompanied by new towns. Plants close to commercial size will have to be built and operated for extended periods to prove out the technology and to provide more precise information on costs. This will take years and a great deal of money. A plant capable of producing 100,000 barrels a day of synthetic oil—less than 1% of U.S. consumption today—is projected to cost $1 billion.

Involving as it will long-term commitments of so much money, this new industry will among other things require the prospect of an adequate return on investment and assurances by our government that oil-exporting countries will not be permitted to destroy new U.S. energy industries through manipulation of crude oil prices.

One central fact should be clear about coal, as about our other energy sources, actual or potential: We as a nation cannot rationally begin to assure intelligent utilization of our domestic energy resources in the absence of a comprehensive national energy policy.

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New York Times, January 26, 1975 (Sun)

Conservation alone is not enough: the past

Some people maintain the United States should delay developing additional energy supplies. They would rely entirely on conservation to eliminate our dependence on foreign oil—a dependence that now amounts to over 37% of the nearly 17 million barrels a day of oil we Americans consume.

The past is not an infallible guide to the future, but it can often be very instructive. Let's look at what happened to oil supply and demand in the U.S. over the past 10 years.

As Chart 1 shows, consumption increased 51% from 1964 through 1974—an average of 4.2% a year. U.S. oil production, however, increased only 20% in this period. The gap between the oil we use and the oil we produce therefore widened during this decade, to more than 6 million barrels a day.

This widening of the gap took place despite the fact that oil companies' capital and exploration outlays just to find and develop oil and natural gas in this country exceeded $60 billion in the 10 years through 1974. An average of more than $17 million a day, 365 days a year, for 10 consecutive years. Even so, the gap widened.

Suppose oil companies had not made that massive effort. Suppose they had just stopped drilling and consequently had not found and proved any additional domestic reserves. Suppose they had, instead, just produced oil from the reserves that had been proved by 1964. What would have happened?

U.S. OIL
CONSUMPTION AND SUPPLY

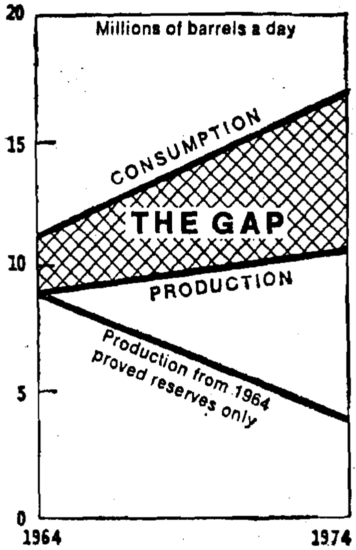

CHART 1

As you can see from Chart 1, U.S. oil production would have declined between 1964 and 1974. The reason is that it takes a succession of major discoveries just to maintain a country's production, much less to increase it, because once an oil field reaches its peak production, it thereafter produces at an ever-decreasing rate until it finally peters out. Compared with many fields in other countries, U.S. fields are quite old, and most of them are producing less and less oil each year. No oil field containing as much as a billion barrels has been found in the "lower 48" states of the U.S. since before World War II.

So, if no additional oil reserves had been proved up in this country between 1964 and 1974, production would have dropped by about 5 million barrels a day in that period. The gap between the oil we use and the oil we produce would have widened even further, to about 13 million barrels a day—over 75% of our total consumption.

If we had filled this gap of 13 million barrels a day with imports, the U.S. would now be running a crushing balance-of-payments drain of over $50 billion a year for oil alone. If we had tried to close the gap by drastic cuts in consumption, our economy would now probably be in far worse condition than it is.

Hard choices, those. Because when you talk about such massive cutbacks in energy supplies, you are talking about breadlines and human suffering. Very low economic growth at a time when our population is still increasing, even if at a slower rate, means a general lowering of living standards. Let nobody kid you about this.

And let nobody persuade you that conservation alone could have kept our need for oil from growing during these past ten years. Conservation alone is not enough. We must continue to develop additional supplies of energy while at the same time we work to eliminate waste in our use of it.

In the space to the right, we take a look at the United States' future need for oil in light of what the past has taught us.

New York Times, January 26, 1975 (Sun)

Conservation alone is not enough: the future

Some of the people who would like to reduce the United States' dependence on foreign oil argue that the answer to the problem of energy supplies is to slow our country's economic growth drastically and thereby reduce our consumption of energy.

These people say we should not develop the United States' strong energy resource base until we see what a decade or more of intensive conservation can do to reduce demand. Then, they say, we can determine whether there is a need for additional supplies of energy.

We think this argument is not only specious, but dangerous.

Look at Chart 2.

As we point out in the adjoining space, in commenting on the "historical" half of the chart, the 1974 gap of about 6 million barrels a day between U.S. oil consumption and production would have been about 13 million barrels a day if a no-growth domestic energy policy had prevailed from 1964 on. Or, alternatively, the U.S. would have had to slash consumption to a point that would in all probability have created enormous economic and social disorder.

What about the future? How much oil will we Americans be using by 1984, and what can we learn from the recent past?

As you can see from Chart 2, U.S. oil consumption would rise by a little over half between 1974 and 1984 if it continued to increase at the "historical growth rate" of the preceding 10 years—4.2% a year.

U.S. OIL CONSUMPTION AND SUPPLY

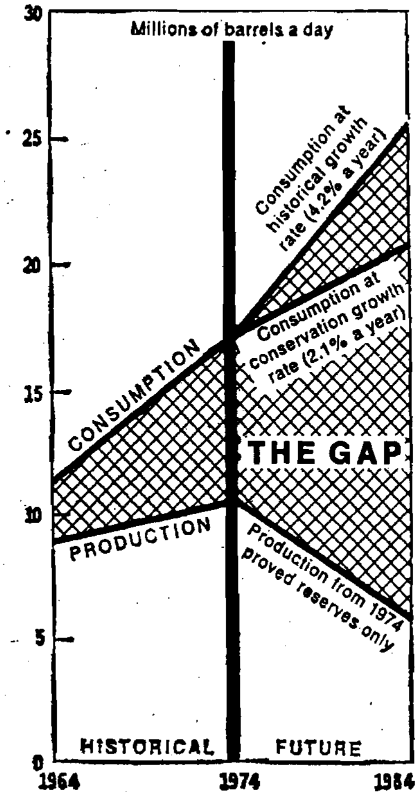

CHART 2

If this happened, our oil consumption in 1984 would be 8.5 million barrels a day higher than last year.

If, however, consumption increases only half this fast—at what might be called a "conservation growth rate" of 2.1% a year—it still will be 3.8 million barrels a day higher than it was last year. (We have discussed in earlier ads the adverse economic and social consequences of an inadequate growth rate.)

Now look at how much oil the U.S. will be able to produce in 1984 from presently proved domestic reserves (including those on the North Slope of Alaska): just about half as much as today.

What all this tells us is that conservation alone cannot do the whole job. We must proceed to develop substantially greater domestic energy supplies. If we do not, America will be forced either to increase its already heavy dependence on oil imports or to cut energy consumption in ways that will create great economic and social turmoil.

Today about 37% of the oil we use is imported. Under even the best of circumstances, it will be difficult to reduce that percentage very much in the decade ahead.

To come anywhere near holding our own, we must continue and intensify efforts to eliminate waste in the use of energy, including the waste required by overly severe environmental restrictions. It is clear, however, that conservation alone cannot do it all.

We therefore must also proceed immediately to develop the United States' strong energy resource base. For at least the next 10 to 15 years, this means primarily conventional crude oil, natural gas, coal, and nuclear power.

The long lead times that are unavoidable in the energy industries mean we cannot delay initiating the development of additional U.S. energy supplies.

Think where we'd be if we had held off on development over the past 10 years.

APPENDIX I

EQC STAFF SUMMARY OF 'COAL EXTRACTION R & D PROGRAM'

In preparing the Montana Energy Policy Study, the EQC staff culled a voluminous amount of resource material. Occasionally this process yielded a newsworthy item as when the EQC staff prepared and released a summary of a suppressed U.S. Department of Interior report on coal development in the West. That summary was first reported in a short article in the EQC News, Vol. 2, No. 2 (July 29, 1974). It is reprinted below.

MONTANA AS "NATIONAL SACRIFICE AREA" MAY BE NO JOKE

Montana cannot make national energy policy; however, the state can try to influence the federal government when it makes its policy. How the state can influence the federal government and what effects federal policies can have upon the state will be examined in the EQC's energy policy study. In passing Senate Joint Resolution 24, the 1973 Legislature directed the Environmental Quality Council to undertake the preparation of a state energy policy that will recommend an energy policy which will "insure a reliable and adequate supply of energy in a manner consonant with preservation of environmental values and the prudent use of the state's air, land, water and energy resources." There are many hard questions with respect to Montana's future agricultural growth, sustained economic development and maintenance of environmental quality which must be answered by the decision makers as well as the people of the state. The EQC's Energy Policy Study has been designed to be a tool to assist legislators in deciding where Montana wants to go in the coming decades. The study will be available in November.

Working closely with the Montana Energy Advisory Council (MEAC), coordinated by Lt. Gov. Christiansen, EQC has attempted to uncover a federal energy policy. Discussion dismissing a federal energy policy that will turn Montana into a "national sacrifice area" should take a look at a report on "Coal Extraction R and D Program" by the Coal Extraction Task Force of the Department of Interior (December, 1973).

Maximum reliance upon surface mined coal to meet long-term energy demand, "would exhaust the current surface mine reserves in the West by 1996", according to the Task Force report. This reliance upon surface mined coal, termed as "strategy 1" in the report, "would cause rapid regional changes and exhaust a very high portion of reported surface reserves in both the east and the west by 2000."

> Surface mine development related to "strategy 1 would cause an initial rapid transition which may be followed by rapid downturn." "This focus (upon surface mined coal) has received much attention because: (1) Western lignites and subbituminous coals are low in sulfurs, (2) mine development is more rapid, (3) productivity is higher, (4) costs are less (than underground mined coal)." The Task Force which authored the report also found that reliance upon surface mined coal would not be dependable to meet the major portion of future energy demands.
>
> This report gives some indication of the effect federal policies may make in the future of Montana. If "strategy 1" were implemented, which seems to be the present federal policy trend, the, according to the report, Montana would have a 22 year "boom-bust" energy development cycle with little long-range activity or new mines opening after this period. The EQC does not believe that a reliance on a short-term "boom-bust" economy is in the state's best economic or environmental interest. The state does have a responsibility to the nation to help solve the energy crisis but it also has a similar responsibility to provide the nation and the world with agricultural products which are also in continually increasing demand. The state should not rely upon the federal government's energy decisions to determine Montana's future because what is convenient for the federal government is not necessarily what is good for Montana.

It is interesting to note that the last two sentences of the EQC News article were quoted as evidence of the West's growing resistance to Washington policy dictates in a report on regional growth issues prepared for the U.S. Congress. (See A National Public Works Investment Policy, background papers prepared for the Committee on Public Works of the U.S. House of Representatives, Committee Print 93-49, November 1974.)

The full EQC summary of the U.S. Department of Interior's Coal Extraction Task Force Coal Extraction R&D Program (rev. December 27, 1973) is reproduced below.

Summary of: Coal Extraction R&D Program by Coal Extraction Task Force,
U.S. Department of Interior, 12/11/73 as revised 12/27/73

Prepared by: Tom Frizzell, EQC Research Analyst

ABSTRACT

The report makes certain projections based upon:

a. the amount of energy needed by the U.S. 1975-2000 (i.e. 1985 energy demand equals 124.9 x 10^{15} BTU, based upon National Petroleum Council projections with an assumed 4.2 percent rise in energy demand per year)

b. the amount of fuels available to meet this projected demand (hydropower, nuclear, oil, gas, coal, and natural gas)

The task force then develops two coal extraction strategies to meet coal's projected role in energy production. These strategies are:

STRATEGY 1. reliance mainly upon western surface mined coal with modest production from eastern surface mined coal. There would be little growth in underground mining in either region.

STRATEGY 2. balances the increased production between regions and mining methods. Initially, there would be increased surface mine development but after 1980 there would be greater reliance upon underground development in both the east and the west.

The conclusion of the report is: "Strategy 1 would exhaust the current surface mine reserves in the West by 1996; an additional 5.74 billion tons of coal will need to be added to reserves to support production from 1997 to 2000. It would also consume about 10 billion tons of surface coal in the East, 67 percent of the current reported reserves." (from page 15 of the report)

ASSUMPTIONS upon which the report was based

1. Coal Resource Base -- Assume present coal reserve data are sufficiently accurate to determine initial program direction.

2. Coal Use and the Environment -- Assume stack gas cleanup technology, improved coal preparation processes, and/or relaxed air quality standards will result in all coals being equally acceptable from a user standpoint.

3. Transportation/Distribution Systems -- Assume that these systems are available to effectively handle the coal being produced.

4. Legislative Actions -- Assume that legislative or judicial actions will not remove a prohibitively large fraction of our coal resources from the exploitable resource base and will resolve such questions as the ownership of methane within coalbeds.

5. Policy -- Assume that the industry structure to which the R&D program is addressed will remain substantially as it now exists and that the R&D effort will be supported fully by policy decisions to facilitate implementation as results become available.

6. Program Continuity -- Assume that assuring energy options is of sufficient concern that coal mining R&D efforts with high benefits will be continued to fruition.

7. Coal Production -- Assume that coal production estimates used for this initial effort are sufficiently accurate for the purpose of this exercise.

These assumptions are quoted directly from the report. (pages 3-4)

COAL RESERVES

"Data developed by the Geological Survey and Bureau of Mines indicate that the Nation's recoverable reserves totaled about 193 billion tons. The resource base is much larger (some 3 trillion tons) and much of this will be converted to reserves with additional investigation." (page 4) (See Table 1, page 7 of this summary)

ENERGY PROJECTIONS

To obtain an estimate of coal demand the Task Force used the following rationale. The rate of increased energy demand was assumed constant at 4.2 percent per year, which corresponds to the median increase used by the National Petroleum Council (NPC). The NPC's average values of energy available from other sources were then deducted from the resulting total and coal was assumed to satisfy this demand.

Total U.S. energy consumption by 1985		124.9×10^{15} BTU's
Subtract:	hydropower	3.3×10^{15}
	nuclear	18.7×10^{15}
	domestic oil and gas	51.4×10^{15}
	oil and gas imports - 1970 level	8.4×10^{15}
Equals	Coal Demand for 1985 *	43.1×10^{15}

To meet this demand for coal in 1985 it will require increasing coal production by about 12 percent per year and a doubling of coal production by 1980.

*this amount of coal is roughly equivalent to 2 billion tons of coal or 3.3 x 1972 production.

COAL EXTRACTION STRATEGIES

Strategy 1 - "is maximum reliance on surface mining to achieve the stated (2 billion tons per year, 1985) objective." This focus has received much attention because:

1. western lignites and subbituminous coals are low in sulfurs...;
2. mine development is more rapid...;
3. productivity is higher...;
4. production costs are less...;
5. less trained labor is required...

On the other hand:

1. western coals may still not meet the air quality standards;
2. lignite has about half the heat value of bituminous coal, is high in ash and may cause feed problems in plants;
3. transport of this coal to the east (location of users) places heavy demands on the railroad systems and diesel fuel, which is already in short supply;
4. western lands are more difficult to reclaim.

"Strategy 1 assumes that production from the western surface reserves will expand from 50 million tons in 1972 to 1.440 billion tons by 1985; an annual production level to be maintained through 2000. Surface mine production in the East is assumed to grow modestly from 250 million tons in 1972 to 380 million tons by 1985." Underground production from the West is not initiated and production from underground mines in the East is not expanded.

Strategy 2 - "balances the increased production between regions and mining methods." Increased surface mine development is initially required to meet the production goals, but this strategy would reduce the dependence on surface mining after 1980 by increasing underground development. Underground mine development in the East is assumed to double to 600 million tons by 1985 and after 1985 relatively large increments are made by underground coal development in the West. By 2000, some 200 million tons are assumed to be available from underground mining. Production from surface mines in the East would be steadily reduced after 1985. (quotes from pages 9-10)

IMPACT OF ALTERNATIVE COAL EXTRACTION STRATEGIES (See Table 2)

"Strategy 1 would exhaust the current surface mine reserves in the West by 1996; an additional 5.74 billion tons of coal will need to be added to reserves to support production from 1997 to 2000. It would also consume about 10 billion tons of surface coal in the East, 67 percent of the current reported reserves."

Strategy 1 would cause rapid regional changes and exhaust a very high portion of reported surface reserves in both the East and West by the year 2000, threatening rapid decline in surface mine development after the turn of the century. Thus, strategy 1 would cause an initial rapid transition which may be followed by rapid downturn. "Strategy 1 cannot be depended upon to maintain a production output of 43.1×10^{15} Btu's from 1986 to 2000. For these reasons, we find strategy 1 to be unacceptable." (page 15)

Strategy 2 would require about 21 billion tons of surface coal in the West (82 percent of reserves) and 9 billion in the East (60 percent of the reserves). Greatly accelerated development of underground reserves would still leave 93 billion tons in the East and 41 billion tons in the West by 2000." (page 15)

The full text of Coal Extraction R&D Program by the Coal Extraction Task Force, U.S. Department of the Interior can be found in Energy Research Program, U.S. Department of the Interior, 3/19/74, Superintendent of Public Documents No. 2400-00794, G.P.O.; for $3.00.

TABLE I: U.S. COAL RESERVES* (in millions of tons; location, type, and mining method)

	BITUMINOUS			SUBBITUMINOUS			LIGNITE			ANTHRACITE		
	surface	underground	total	surface	underground	total	surface	underground	total	surface	underground	total
West	700	11,500	12,200	19,900	15,000	34,900	5,700	16,300	22,000	----	10	10
Mid-Continent	5,800	45,200	51,00	----	----	----	1,300	2,100	3,400	----	30	30
Appalachia	4,700	58,100	62,800	----	----	----	----	----	----	3,200	3,130	6,330

*As of 1/1/72; to a depth of 1,ooo feet.

Source: Coal Reserve Data from report (page 5); U.S. Geological Survey and Bureau of Mines.

Table 2 -- Impact of Alternative Production Schedules on Reported Reserves 1/

	West		East		Total
	Surface	Underground	Surface	Underground	
Strategy #1					
Reserves (1972)	26,300	42,810	15,000	108,560	192,670
Production (1972-2000)	32,040	0	10,110	8,700	50,850
Reserves (2000)	-5,740 2/	42,810	4,890	99,860	141,820
Strategy #2					
Reserves (1972)	26,300	42,810	15,000	108,560	192,670
Production (1972-2000)	21,390	2,114	8,910	15,340	47,754
Reserves (2000)	4,910	40,696	6.090	93,220	144,916

1/ Reserves detailed in Table 1.

2/ Current reserves exhausted by 1996. Assumes 5,740 million tons will be added to reserves to support production from 1997 through 2000.

Source: Table 3 from the Task Force report.