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February 1980

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REVISED

AN ANALYSIS OF FEDERAL INCENTIVES USED TO STIMULATE ENERGY PRODUCTION

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FOREWORD

In March 1978, Battelle published "An Analysis of Federal Incentives Used to Stimulate Energy Production." Since that time, considerable discussion has centered around the analysis contained there. A two and a half day workshop was organized which brought together twenty-eight contributors to energy policy, representing a wide variety of professional skills and training. Insights gained from this discussion, coupled with additional interaction and research by the Battelle team, have been incorporated into the revised versions of "An Analysis of Federal Incentives Used to Stimulate Energy Production."

A number of significant changes were made for the first revision, published during December, 1978. A chapter was added which analyzes federal incentives to encourage public utility generation and transmission of electricity. This chapter was added primarily to identify the incentives provided by the Rural Electrification Administration (REA) since its incentives were considered to be beyond the scope of the hydro-energy chapter of the first document. The nuclear energy chapter was expanded to include estimates of the incentives provided the nuclear industry from government sponsored educational programs and the Naval Reactors Program.

The current revision brings the information up to date with the inclusion of 1978 incentive data to the various tables and the revision of dollar values previously in terms of constant 1977 dollars to constant 1978 dollars. These revisions maintain the accuracy, viability, and usefulness of "An Analysis of Federal Incentives Used to Stimulate Energy Production."

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AN ANALYSIS OF FEDERAL INCENTIVES USED TO STIMULATE ENERGY PRODUCTION

I. INTRODUCTION

The amount of solar energy that reaches the earth's surface every two weeks is equivalent to all of the known reserves of coal, gas, and oil.[1] Yet, the use of this energy source to generate electricity and heat and cool buildings is negligible. Debate over solar energy's share in the national energy budget has caused policymakers to speculate on the reasons for the large difference between present and potential use. The reasons appear to be buried in complex technical, economic, legal, institutional, and political interrelationships. The research presented here is intended to contribute to a clear understanding of that relationship and to enhance the design of solar energy policy.

PURPOSE OF THE RESEARCH

The purpose of the research presented in this report is to assist the Division of Conservation and Solar Applications, Department of Energy (DOE), in the study and recommendation of federal incentives for the development of solar energy. A federal incentive is any action that can be taken by the government to expand residential and commercial use of solar energy. The development of solar energy policy could be enhanced by identification, quantification, and analysis of federal incentives that have been used to simulate the development of other forms of energy. The text of this report identifies, quantifies and analyzes such incentives and relates them to current thought about solar energy.

A building contractor or prospective homeowner contemplating the purchase of solar energy equipment for heating and cooling can be expected to consider initial expense, interest rates, and the life of the system when choosing among competing energy sources. If the price of alternative sources of energy were set in a perfectly competitive market, price would be an impartial and efficient allocator of the nation's energy resources. Such is not the case. Historically the United State has created incentives to increase production of specific energy sources, resulting in an imperfectly competitive energy economy. A rational solar energy policy is therefore predicated on a knowledge of existing incentives that have been created to increase production of other forms of energy.

CURRENT THOUGHT ON SOLAR INCENTIVES

The oil embargo of 1973 stimulated concern over energy supplies. As policy makers sought U.S. self-sufficiency in energy production, the opportunities and advantages of utilizing solar energy were considered. One result of this concern was the development of a body of thought on the creation of federal incentives to increase the national use of solar energy.

Bezdek and Maycock point out that incentive programs designed to reduce the high initial cost of solar systems have received the most attention. Economic incentive programs, property and sales tax waivers, investment tax credits, and accelerated depreciation have all been proposed. Preliminary findings indicate that tax credits and low interest loans would have the most significant impact on solar market penetration. The most important non-economic incentive program was found to be the development of the critical solar/electrical utility interface.[2]

Butt is one of the strongest advocates for federal action to stimulate accelerated solar development. He argues that there is a need to redress existing distortions in the competitive energy marketplace. The individual, as a producer of solar energy, does not receive the competitive benefits of investment tax credits and depreciation allowances provided by present tax law to corporate producers of alternative energy sources. All producers of solar energy are competitively disadvantaged by lesislation and regulatory practices which restrict conventional energy prices to below marginal costs or market-clearing prices.[3,4]

Economic Feasibility

The National Plan for Energy Research, Development, and Demonstration states that the principal constraint on successful commercialization of solar systems is their inability to compete economically with conventional systems and fuels. Competitive use of solar systems depends on many technical and economic factors, including the unit cost for purchase and installation of available solar equipment, the climate and average available sun flux, the initial and operational cost of conventional heating and cooling systems, the availability of capital funds, and the cost of conventional energy.[5]

Bennington, Bohannon and Spewak state that solar water heating and solar space heating installed at an equivalent cost of $20/ft^2 of collector system could compete today with electric resistance systems throughout most of the United States. If the cost is reduced to $15/ft^2 solar systems become competitive with oil, hot water heating, and/or oil and electric heat pump space heating in many cities.[6] Lof, Tybout, Davis and others state that solar heating and cooling systems for residential buildings are nearly, but not quite, economically competitive with fossil fuel and electric systems.[7-9]

A TRW report states that total installed solar energy system costs, converted to a cost per unit area of collector and including all markups, generally range from about $20/ft^2 down to $13/ft^2 depending on system size and function. It further states that solar cooling of buildings using current lithium bromide gas adsorption refrigeration systems will not be cost competitive to any significant extent during this century. However, modest reductions in peak cycle temperature costs could reverse this situation.[10]

A Westinghouse Electric Corporation report states that solar heating systems can become competitive for residential use in the California region in 1975-80 and for commercial and institutional structures in several regions by 1980. Solar heating and cooling can become competitive in most regions of the country by 1985-90.[11]

Scott, Melicher and Sciglimpaglia found that solar heaters were once widely used for heating water in southern Florida. By the early 1950's, however, the solar industry was reduced to a few firms whose principal activity was the repair or replacement of water storage tanks. This decline in the solar industry resulted from the rapid decrease in electricity rates, an increase in the initial installation costs of solar systems, maintenance costs for solar systems, and the increasing size of firms in the building industry.[12]

Wilman showed that the present value of a 20-year stream of heating expenditures for an average home with a solar system was $12,907, as compared with $3,659 for oil and $2,582 for gas. Thus, the solar system is 3.5 times as expensive as alternative systems.[13]

In a residential case study that assumed a climate similar to Madison, Wisconsin, Ruegg found that incentives are required to make solar energy cost effective if #2 fuel oil is 38¢/gal or electricity if 1.5¢/kWh. A commercial case study also showed that solar incentives would be needed as alternative energy sources increased in price.[14]

These sources indicate the diversity of thought about the economic feasibility of solar energy. There is considerable difference of opinion about whether solar heating and cooling is or will be price competitive with other forms of energy in this century. This lack of consensus could be due to market imperfections resulting from weak institutional forces associated with a relatively new energy technology. Strengthening of institutions, in part, deals with legal protection of property rights and rules of transaction. Further insights can be gained from a review of the legal literature.

Legal Factors

Thought about the legal implications of solar energy development and use has focused on: 1) the right of solar users to unobstructed sunshine and 2) statutory, regulatory, and institutional restraints affecting financing, construction and marketing. Incentives associated with the latter would consist of changes in existing laws and regulations that take solar energy and associated technology into consideration. This would require alteration of existing institutional forces.

The Environmental Law Institute (ELI) reviewed the existing Sunrights Laws and identified new approaches that might be used to encourage development of solar energy systems. They concluded that establishing sunshine rights, solar zoning schemes and land use planning compatible with solar access, developing municipal regulations, and passing a basic policy statute could encourage solar energy development. Mandatory installation laws, both for construction and existing buildings, would probably survive a court challenge but could be unwise because of economic factors.

ELI states that property tax, mortgage and insurance laws should consider assessment of backup heating systems, define solar energy systems, determine whether solar systems are eligible for exemption, treat solar easements as they relate to assessments, and determine whether solar systems under construction are eligible for an exemption. If property taxes are assessed on real estate according to its income production, solar systems should either be exempted or given other, more appropriate incentives. Mortgage barriers affecting new solar energy systems include: 1) federal laws that regulate the size of new home loans granted by savings and loan institutions, 2) borrowers' underwriting criteria that do not consider the cost of heating and cooling homes when they assess a loan applicant's ability to pay, and 3) secondary market restraints on lending institutions attempting to sell their mortgages. Financing of retrofits of old homes is affected by the Home Owners Loan Act of 1933 (48 STAT. 128, 12 USC 1461 et seq., as amended), which allows federally chartered savings and loan companies to make first liens on residential properties. As a result, the person seeking retrofit financing must pay higher interest rates on homeowner improvement loans and personal installment loans, thus increasing the cost of the solar system.

ELI found no existing major legal barriers associated with the insuring of solar structures since solar systems are not explicitly excluded in the standard homeowner's insurance contract. Regulatory jurisdiction over solar heating and cooling is at the state level; the Federal Power Commission and other federal agencies apparently do not have jurisdiction. Utility involvement in the sale, financing, ownership or servicing of solar collectors for heating and cooling is a key policy question. Although there is strong opposition to public utility involvement in the marketing of solar energy, ELI believes public utilities could have a role in the public acceptance of solar energy.[15]

The American Bar Foundation identified five areas of legal concern:

Regulation of Building Materials and Design Through Building Codes. The two established procedures for devising building codes are "prescriptive standards," which designate specific building materials and how they are to be used, and "performance criteria," which describe the objectives the materials or design must attain. Architects and engineers prefer the latter procedure, keyed to function rather than design, because it allows more flexibility and reduces the financial burdens.

Financing and Marketing Arrangements. Barriers include property and sales taxes, insurance rates, mortgage and depreciation rates, and warranties on equipment. Incentives include tax credits and deductions and loan and interest rate guarantees.

Role of Public Utilities. The need for a backup energy source for solar units directly involves public utilities. A rate structure that is equitable both to the utilities and to the small user will have to be devised.

Land Use Planning. The immediate barriers local governments must face are the restraints that constitutionally can be imposed on the use of privately owned land. Newer procedures that favor the use of solar energy include comprehensive plans, transferable development rights, official mapping of solar districts, and planned unit development.

Access to Sunlight. The property owner has a right to receive light from directly above his property but no right to receive light across neighboring land.[16] Approaches to ensuring lateral light without purchasing the neighboring property include purchase of an easement that would prevent the adjacent landlord from obstructing lateral light, creation of solar zones and inclusion of open space requirements in comprehensive plans at the state and local level, and adoption of a policy that the encouragement of solar energy is of such community important that local governments use the right of eminent domain to acquire air space above critical parcels.[16]

The American Bar studies claim that although Congress has passed statutes encouraging the use of solar energy, there has been no coordinated federal effort. Constitutional protection of unobstructed solar sky space could be enacted, based upon commerce power, national defense and other constitutional grounds, to protect solar sky space. Fiscal incentives such as tax credits or deductions, loan guarantees, and loan insurance could be written into the federal tax system and other programs. Changes in patent policy could require compulsory licensing that would lead to more rapid development or use of solar energy systems. Quality standards and the federal certification of solar energy systems would deter negligent design or outright fraud in marketing systems. Regulatory action could alter the competitive positions of conventional energy sources and impose the full costs of exploration, production and use upon ultimate users. Jurisdictional issues over designing, constructing, installing and maintaining solar energy systems could be addressed to encourage labor organizations to support the use of solar energy. Planning and community development and other energy-related activities that receive federal assistance could be made conditional on state and local adoption of laws and regulations that encourage solar energy use.(16)

Bins sought to identify and abstract all state enactments in 1974 and 1975 that directly related to the improvement of prospects for solar energy development and application. Included were property tax incentives, income tax incentives, sales tax incentives, research and development, life-cycle cost analyses for new or remodeled state buildings, solar provisions in state building codes, access to incident solar energy, informational and promotional activities, state financing of buildings using solar energy, and an index of enactments by state.(17)

Miller suggests that solar advocates approach legislated remedies with caution since such legislation might be unnecessary and in fact might have an undesirable effect on solar energy growth. Where shading problems exist, the legislation should be drawn with the purpose of avoiding conflict in the courts. Such conflict could create the impression among the public that significant legal problems exist, which could inhibit investment in solar systems. Solar initiatives should be taken first in those areas where sun rights problems are minimal before tackling areas where the problem is real (e.g., high rise developments).[18]

Eisenstadt and Utton share Miller's concern about legal conflicts over the shading of solar collectors. They believe that allowing the zoning powers of local government to control solar rights would be a practical method for obtaining solar access, would speed public acceptance of solar power, and would avert delays in solar development that could arise as a result of a solar collector shading lawsuit.[19]

Institutional Forces

Hirshberg and Schoen indicate that, within the U.S. housing industry, technically feasible and economically competitive innovations often fail to achieve rapid acceptance. Some of these failures have stemmed from a lack of understanding of the institutional forces operating to deter innovative diffusion.[20] Several other investigators have recommended incentives for institutional change.[21-23] As a result of four public laws enacted during the 93rd Congress, a major National Solar Energy Program has been created.[24] The 94th Congress has submitted eight bills which deal with institutional changes.

Information Technology

According to Eberhard, the largest incentive to widespread use of solar energy may lie in information technology. Easily assessable, well defined and low-cost systems of information codification, translation and dissemination could aid in defining the market more perfectly.[21] H. R. 36 would establish an Energy Conservation Research and Development Corporation to conduct research and development in areas which offer substantial potential for solar space conditioning. H. R. 6860 would establish the Energy Conservation and Conversion Trust Fund which provides for funds to be spent for basic and applied research.

Development of Standards

Spokesmen for the building industry see a need for a set of industry-wide performance standards and tests for solar systems. Designs for the use of solar energy require more integration between the internal and external natural environment, between the skills of architects and the skills of engineers, and between solar systems and structural, mechanical, and enclosure systems of buildings than is generally found in the building industry.[21] Promulgation of performance design techniques for architects and engineers is part of a diffusion of information program. Further incentive would be created through the improvement and streamlining of procedures for testing, evaluation, and certification of solar technologies. Establishment of equipment quality and performance standards would increase consumer confidence in newly developed equipment.[22]

Warranties

Effective consumer protection depends on the rapid development and implementation of reasonable performance standards and testing mechanisms. These in turn depend on actual experience. Until this is available, warranties of materials and workmanship would reduce the level of uncertainty. The construction industry, with the encouragement of the Federal Government, could extend the normal warranty requirements for building construction from one to two years.

Construction Codes

The Federal Government could encourage the standardization of codes, local adoption of model codes, and education of code officials in the components and performance of solar systems.

Demonstration Programs

Prototype system development, reliability testing, and cost analysis could be carried out using government buildings. The Energy Research and Development Administration funded and the U.S. Department of Housing and Urban Development administered a 3-year program of time-phased demonstrations in various climates and geographic regions with active involvement of the housing industry.[25]

H. R. 8546 would require that buildings financed with federal funds incorporate solar energy systems. H. R. 62 would direct the architects of the Capitol to study the feasibility of using solar energy in certain House office buildings and for other purposes.

Electric Utilities

A more perfect market for solar energy could be created by eliminating the critical solar-electric utility interface. If utilities perceive that the use of solar systems will increase their peak-load requirements and decrease their base-load requirements, it can be anticipated that they will take protective action, such as charging unfavorable rates for solar installations. Federal regulatory agencies could induce an inversion of rates, thus removing penalties for the use by solar owners of small amounts of electrical auxiliary power. Higher electrical rates for peak demand periods could encourage use of solar storage facilities. Incentives could induce utilities to lease solar equipment to mitigate the impact of rate structures and transfer of initial costs.[23] However, Asbury and Mueller conclude that solar energy systems and conventional electric utility systems represent a poor technological match because both technologies are very capital intensive. The electric utility, because of the high fixed costs of generation, transmission, and distribution capacity, represents a poor backup for solar energy systems. On the other hand, the solar collection system, because it represents pure, high-cost capital and intermittent output, should not be considered as a part-load source of auxiliary energy for the utility.[26]

Federal Procurement

A report by Don Sowle Associates states that approximately 40 statutes, executive orders and government procurement regulations prescribe programs that impinge on the procurement process. Procurements often become more costly and time consuming because of the added requirements of the programs. Yet, the direct procurement of solar facilities by the Federal Government offers an additional incentive in market penetration.[23]

Incentives to Competing Energy Sources

Larson stated that a policy decision on any nonsolar energy source could alter the market for solar energy. Changes in national policies affecting exploration, leasing, and royalties could either encourage or discourage solar energy; a policy change that discouraged some form of rapid exploration and extraction could be expected to increase the market for solar energy. Price decontrol of natural gas could have a major impact on the solar market, as could Congressional action to raise the liability of the Price-Anderson risk limit. These examples illustrate the fact that all incentives to alternative present day depletable fuels can affect the future market for solar energy.[27] S. 311 would establish a tax on excess petroleum industry profits. S. 489 would amend the Clayton Act to preserve and promote competition among corporations in the production of oil, natural gas, coal, oil shale, bar sands, uranium, geothermal steam, and solar energy. S. 93 would increase the tax on gasoline. S. 1112 would establish a trust fund to develop solar energy, financed partially by a tax of 2¢/million Btu on all energy resources levied at the source of production or importation.

There is considerable evidence that institutional forces are being developed and strengthened to induce the adoption of innovative solar technology. Thought has been conceptualized as legislation. Legislation has, in some cases, been passed by the Congress. Federal programs have been initiated. But these institutional forces must be supplemented with cost reducing fiscal incentives in a climate of uncertain price competition.

Fiscal Policy

The two principal types of fiscal incentives for expanded residential and commercial uses of solar energy that are discussed in the literature are tax incentive programs and direct subsidy programs. Several investigators have listed and discussed appropriate fiscal incentives.[22,28,29] Others have commented on specific incentives. Twelve bills that would create fiscal incentives were introduced into the 94th Congress.

Income Tax Deduction

Senate Bill 28 would allow a $1,000 deduction in federal income tax liability for any taxable year for purchase of a solar system, or a tax credit equal to 25% of the allowable expense. H. R. 1697 would allow a tax deduction for the purchase and installation of solar heating and cooling equipment not to exceed 50% of the expenses paid. However, John M. Nicluss of the Department of the Treasury has stated that the Department's basic position is to resist the use of the tax system to provide incentives to specific sectors of the U.S. economy. Such incentives have been enacted over the opposition of the Treasury Department. In the view of the department, it is far more effective to provide subsidies through grants or means reflected directly in the Federal Budget.[30] Costello feels that allowing a federal income tax deduction for displacing fossil fuels with onsite solar energy is one of the most promising policy actions open to Congress.[31]

Income Tax Credit

House Bill 5959 would permit a 25% income tax credit for expenditures for solar heating and cooling equipment that do not exceed $8,000, or a 12.5% credit for expenditures over $8,000. H. R. 6860 would allow 40% of the first $1,000 and 20% of the second $1,000, for a maximum of $600, of the amount spent on solar energy equipment on the taxpayer's principal residence. S. 1379 would give a 25% credit, not to exceed $2,000, for solar energy equipment on new and existing residences. S. 168 would allow a 25% tax credit or deduction on sums up to $4,000 spent for solar energy equipment. Wilman concluded that a 20% marginal tax bracket homeowner would need a 69% tax credit to make solar heat competitive with oil and a 77% credit to make it competitive with gas.[13] This has resulted in the enactment of a deduction of 30% of the first $1,500 and 20% of the next $8,500 on a $10,000 solar installation.

Direct Subsidy

Cass stated that the general public favors government subsidies to encourage the use of solar energy.[32]

Low Interest Government Financing

Senate Bill 875 would grant 8-year loans to buyers of one to five-family homes with solar systems at the rate at which the Treasury can borrow money plus 0.5% of the administrative cost. S. 2163 would establish a solar energy loan administration to provide loans for the purchase of solar systems at a rate of 2% for up to 25 years. S. 2087 would allow low-interest loans to assist homeowners and builders in purchasing and installing solar heating. S. 622 would create low-interest loans and loan guarantee programs. Costello found that interest-free loans were the most potent policy alternative that he investigated.(31) Peterson found that interest rate subsidies could more than double solar energy use over the next decade in areas comparable to Denver, Colorado.(33)

Investment Tax Credit

The current 10% investment tax credit could be extended to the cost of solar installation. The effect would be to reduce the cost of the investment by the amount of the credit and therefore to increase the rate of return. Costello found that a 50% investment tax credit would make onsite solar energy less costly than all fossil fuel rivals. With a 50% investment tax credit on solar capital equipment, large onsite solar designs using storage and very little fossil fuel backup would be the most economically attractive alternative of those considered.(31)

Accelerated Depreciation

House Bill 6584 would permit either a 60-month amortization for federal income tax purposes of solar heating and cooling equipment placed in nonresidential structures or an investment tax credit for such equipment.

Mortgage Financing

House Rule 8524 would authorize loans by the Small Business Administration to homeowners and builders for solar heating or combined solar heating/ cooling equipment. The Federal Home Loan Bank Board could influence commercial banks' lending policies on mortgates. The Federal Housing Administration and Veterans' Administration could increase the maximum loan limits and the loan-to-value ratios. Barrett, Epstein, and Harr formulated a variety of lender-oriented incentive options to increase the availability of private mortgage financing for solar homes. Incentives aimed directly at purchasers were examined primarily as they might affect the willingness of lenders to make financing available or as they might complement lender-oriented incentives.[34]

Insurance Requirements

The Federal Government could reduce insurance costs by directly insuring buildings or reinsuring private insurance company policies, as is done in certain intercity areas susceptible to property loss because of civil disorder. The Federal Deposit Insurance Corporation offers a precedent. The Price-Anderson Act is an example under which the Federal Government agrees to idemnify the owner or limit losses in the event of catastrophic accidents at nuclear power plants.

Federal Compensation of State and Local Property and Sales Taxes

Ten states currently allow an exclusion of part or all of the value of a solar energy system for a period ranging from 5 years to the life of the system. Ruegg concluded that exemption from an assumed 3% effective property tax and depreciation writeoff against both state and federal taxable income over 5 years had the largest impact on owner cost of all the exemptions analyzed. However, none of the fiscal incentives analyzed would be sufficient to make a solar system cost-effective when applied alone.[14] Peterson concluded that sales tax exemptions would have little impact over the next decade in areas comparable to Denver.[33]

Tax Free Bonds

The Federal Government has established a precedent with the Tennessee Valley Authority and FNMA for the establishment of tax free bonds.

Thought about the use of fiscal policy to reduce the cost of solar energy is expansive. Significant legislation has been introduced in Congress but only one of the 19 bills introduced in the 94th Congress was enacted. A consensus has not yet been reached about priorities on specific fiscal incentives.

Conclusions

This review of current thought on solar incentives has formed the foundation for the research described in the following pages. The question of cost differentials between solar and conventional energy sources has been raised. Concern has been expressed about property rights and statutory, regulatory, and institutional restraints. Institutional changes have been discussed. Fiscal policies which could result in an economically viable solar industry have been reviewed. Future policy designed to increase the share of solar energy in the national energy budget will likely draw upon this body of thought. However, to do so without consideration of federal incentives that have been used to stimulate energy production in the past would very likely result in unguided thought, wasted resources, and lost federal expenditures. The achievement of industrial strength and domestic comfort has been, to some extent, the result of federal incentives to stimulate energy production. It is therefore necessary to review these incentives if efficient solar energy policy is to be established.

DEFINITION OF THE PROBLEM

It is hypothesized that the market for energy has been significantly distorted by the creation of federal incentives to stimulate energy production. If such distortions result in subsidized prices for energy, the result could favor existing energy sources with established markets. Policy decisions affecting solar energy development that are based on subsidized prices of competing energy sources could prevent realization of optimum national energy efficiency.

When price signals from the marketplace do not coincide with the goals and objectives of industry, consumer groups or public institutions, the perception is one of market failure. Using perceived market failure as justification, industry allocates resources to manipulate energy policy in order to gain greater profits. Consumer groups seek lower prices. Scientists and administrators of public institutions influence energy policy to maintain or expand their positions. Through economic, political, institutional and legal pressures these groups attempt to rectify perceived market failures.

Using economic theory to aid in problem definition, curve S_e (Figure 1) represents a supply curve for U.S. energy. The curve represents the range of energy quantities that would be marketed at various prices in the absence of federal incentives. The shape of the curve is primarily determined by the existence and location of known energy resources and the rate at which a stream of technology can transform these resources into power.

The market for energy exists at the intersection of S_e and the demand for energy, D_e. Changes in the demand and the resultant effect on price could be perceived as market failure. Using perceived market failure as justification, pressures are created to transfer some of the cost of energy production to the public sector. The result is an apparent supply curve that is different from the real supply curve.

Some of the real costs of energy production are borne by the Federal Government through the creation and administration of policy, programs and projects. The problem at hand is to identify those federal policies, programs and projects which have resulted in extra-market pressures to create an apparent supply curve for energy, represented by curve S_e' on Figure 1. To test the hypothesis that the market for energy has been significantly distorted by the creation of federal incentives to stimulate energy production, it is necessary to quantify the federal expenditures for these incentives. This is done by specifying that area in Figure 1 lying between curve S_e and S_e'.

APPROACH TO THE ANALYSIS

The analysis of economic, political, institutional and legal pressures applied by industry, consumer groups, and public institutions to transfer costs to the public sector is complex. Such analysis requires a detailed interdisciplinary procedural map to guide investigators through a maze of interrelating events. Such a map of procedures is presented in Chapter II as the theoretical basis for the analysis.

Thereafter, two approaches were taken simultaneously. Specialists in the study of government and public institutions took a broad perspective in identifying and measuring incentives created throughout the energy sector of the

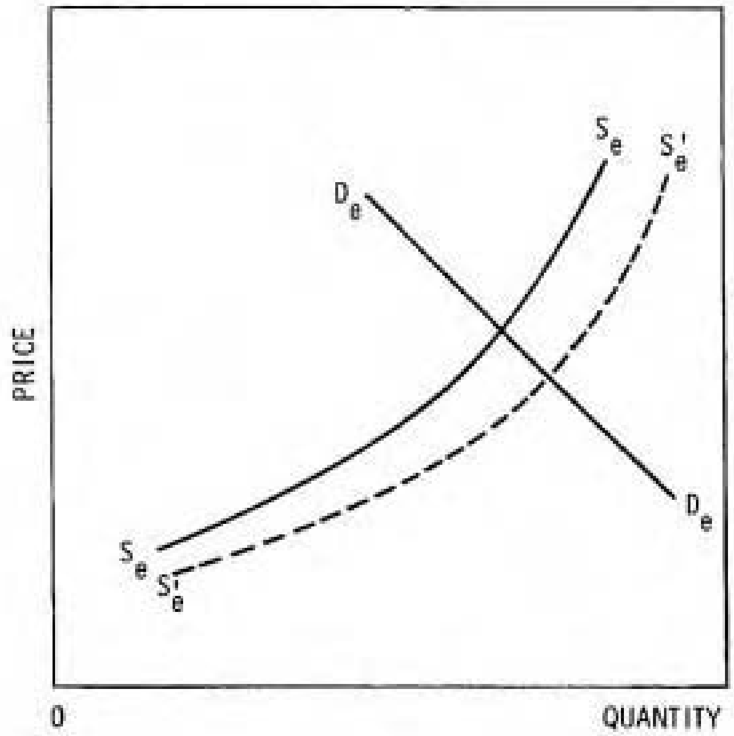

FIGURE 1. The Real and Apparent Market for Energy

economy, while engineers and micro-economists focused on incentives created along the trajectory of transformation from exploration and mining through transmission and waste disposal. The latter approach was oriented to the energy industries: hydro, nuclear, coal, gas, and oil. Electricity is one of the outputs of the energy industries. The indirect nature of this energy form precludes a complete analysis of electricity incentives to be incorporated into the analysis of the energy industries. Hence, an additional chapter analyzes the incentives to generation and transmission of electricity. The final chapter summarizes the empirical analysis presented in the preceding seven chapters and presents resulting insights as they relate to the development of incentives to encourage increased use of solar energy.

REFERENCES - CHAPTER I

1. E. W. Eaton, Solar Energy. Energy Research and Development Administration, Washington, D.C., 1976, p. 1.

2. R. H. Bezdek and P. D. Maycock, Incentives and Barriers to the Development of Solar Energy. Joint Conference of the American Section of the International Solar Energy Society and Solar Energy Society of Canada, Winnipeg, Canada, August 1976.

3. S. H. Butt, Incentives for Solar Heating and Cooling Justification, Effect and Cost. Solar Energy Industry Association, Washington, D.C.

4. S. H. Butt, Government Action to Stimulate Accelerated Solar Development. Solar Energy Industry Association, Washington, D.C., 1976.

5. A National Plan for Energy Research, Development, and Demonstration - Creating Energy Choices for the Future, ERDA 76-1, Energy Research and Development Administration, Washington, D.C., Vol 1, p. 63, 1976.

6. G. Bennington, M. Bohannon and P. Spewak, An Economic Analysis of Solar and Space Heating. ERDA Contract E (49-1)-3764, The Mitre Corporation for Division of Solar Energy, ERDA, Washington, D.C., 1976.

7. G. O. G. Lof and R. A. Tybout, "Cost of House Heating with Solar Energy." Solar Energy, Vo. 14, 1973.

8. E. S. Davis, "Project SAGE Phase O Report." California Institute of Technology Environmental Quality Lab Report No. 11, Pasadena, CA, 1974.

9. Solar Heating and Cooling of Buildings. NSF RAN-74-021A-21E, National Science Foundation, June 1974.

10. Solar Heating and Cooling of Buildings, Phase O. NSF-RAN-74-0234, TRW Systems Group, Redondo Beach, CA, May 1974.

11. Solar Heating and Cooling of Buildings, Phase O. Westinghouse Electric Corporation, Baltimore, MD, May 1974.

12. J. E. Scott, R. W. Melicher and D. M. Sciglimpaglia, Demand Analysis, Solar Heating and Cooling of Buildings, Solar Water Heating in South Florida: 1923-1974. National Science Foundation, Research Applied to National Needs (RANN), Washington, D.C., p. 53, 1974.

13. J. Wilman, Solar Heating. BTM-76-11, Department of Treasury, Washington, D.C., 1976.

14. R. T. Ruegg, Evaluation of Incentives for Solar Heating. NBSIR 76-1127, National Bureau of Standards, Department of Commerce, Washington, D.C., 1976.

15. A. S. Miller and G. P. Thompson, Research on Legal Barriers to the Utilization of Solar Energy for Heating and Cooling. Environmental Law Institute, Washington, ERDA Contract No. E. (49-18)-2528 EA-02-03 56-60-91, November 10, 1976. (The state utility regulation discussion draws heavily from a forthcoming book entitled Energy Efficiency in Industry: A Guide to Legal Barriers and Opportunities by Normal L. Dean.)

16. American Bar Foundation Legal Issues Related to Use of Solar Energy Systems. Draft report, American Bar Studies, Chicago, IL, August 1976.

17. Turning Toward the Sun, Vol. 1, Abstracts of State Legislative Enactments of 1974 and 1975 Regarding Solar Energy. National Conference of State Legislatures Renewable Energy Project, 1976.

18. A. S. Miller, Another Perspective on the Sunrights Issue. Environmental Law Institute, Washington, D.C., 1976.

19. M. W. Eisenstadt and A. E. Utton, "Solar Rights and Their Effect on Solar Heating and Cooling." National Resources Journal, Vol 363, 1976.

20. A. S. Hirshberg and R. Schoen, "Barrier to Widespread Utilization of Residential Solar Energy: The Prospects for Solar Energy in U.S. Housing Industry." Policy Sciences, December 1974.

21. J. P. Eberhard, Constraints and Incentives to the Widespread Utilization of Solar Heating and Cooling. AIA Research Corporation, Washington, D.C., 1976.

22. Residential Solar Heating and Cooling Constraints and Incentives, A Review of Literature. Prepared by Arthur D. Little, Inc., for the Division of Energy, Building Technology and Standards, Office of Policy Development and Research, Department of Housing and Urban Development, Washington, D.C., pp. 55-88, 1976.

23. A Federal Procurement Plan to Accelerate Use of Solar Energy. Don Sowle Associates, Inc., Arlington, VA, pp. 21-41, 1976.

24. National Program for Solar Heating and Cooling - Residential and Commercial Applications. ERDA-23A, Energy Research and Development Administration, Washington, D.C., 1976.

25. Residential Energy from the Sun, U.S. Department of Housing and Urban Development, Washington, D.C., 1975.

26. J. G. Asbury and R. O. Mueller, Solar Energy and Electric Utilities: Can They Interface? Argonne National Laboratory, Argonne, IL, 1976.

27. R. W. Larson, Policies Which Could Indirectly Influence Solar Development. Georgia Institute of Technology, Atlanta, GA, undated.

28. J. B. Margolin and G. C. Sponsler, Analysis of Financial and Economic Incentives for the Commercial Use of Solar Energy. Unpublished paper, George Washington University, Washington, D.C., 1975.

29. W. Ahern et al., Energy Alternatives for California: Paths to the Future. R-1793-CSA/RF, The Rand Corporation, Santa Monica, CA, p. 155, 1975.

30. Correspondence with J. M. Nicluss, Department of the Treasury, Washington, D.C., October 18, 1976.

31. D. Costello, Midwest Research Insitute Programs Dealing with Incentives and Barriers to the Commercialization of Solar Energy. Midwest Research Institute, Kansas City, MO, pp. 47-53, 1976.

32. R. C. Cass, Public Acceptance of Solar Heating and Cooling Systems for Buildings. University of Houston, Houston, TX, 1975.

33. C. H. Peterson, Simulation of the Impact of Financial Incentives on Solar Energy Utilization for Space Conditioning and Water Heating: 1985. Department of Economics, Utah State University, Logan, UT, 1976.

34. D. Barrett, P. Epstein and C. M. Haar, Financing the Solar Home: Understanding and Improving Mortgage Market Receptivity to Energy Conservation and Housing Innovation. Regional and Urban Planning Implementation, Inc., Cambridge, MA., pp. 171-172, 1976.

II. A THEORETICAL APPROACH TO ANALYZING INCENTIVES FOR ENERGY PRODUCTION

This chapter presents a theoretical approach for identifying and quantifying federal incentives for energy production. The approach draws heavily upon deductive reasoning from a body of logic, developed in various disciplines, for use in studying governmental actions. This approach forms the framework used to evaluate and select the information presented in subsequent chapters. It provides a rationale for interpreting the complex maze of actions and incentives that have affected energy production in the United States. Readers who are not interested in the constructs developed to guide the subsequent analysis to a complete treatment of the problem at hand may wish to move directly to the empirical chapters. Since the material presented in this chapter represents the development of thought necessary to complete the analysis in the subsequent chapters, it has been positioned here.

"POLICY" VERSUS "POLICIES"

This discussion would be easier if the Federal Government had always had an Energy Policy. However, policy, according to one dictionary, means "any course or plan of action, especially in governmental or business administration."(1) "Course of action" implies a degree of comprehensive forethought and consistency that has been missing from governmental actions concerning energy. Instead, the government has taken a variety of actions to serve a variety of purposes and these actions have had a variety of effects. Each action may have been preceded by forethought and may have been consistent with that forethought, but the collection of actions has not been. Therefore, the collection of energy-related actions is more a series of "policies" than a "Policy."

Of course, any collection of actions will have some net effect, which could be labeled a de facto Policy. In situtations where the net effect has been the same over a period of years, government observers tend to do so.

However, this is misleading because it dilutes the general understanding of the word Policy, which then becomes less meaningful to describe such a planned and consistent program, should one come into being.[2]

Boundaries of the Discussion

Discussing governmental actions in a field that lacks consistent Policy is difficult, since boundaries defining energy actions are unclear. All governmental actions probably have at least some indirect relevance to energy. If a consistent Policy did exist, the discussion could focus on those actions that were part of the planned and consistent program. For this analysis, however, boundaries must be somewhat arbitrarily defined.

First, this discussion will include only those actions taken by the Federal Government; relevant actions of state and local governments are not considered. Second, the discussion covers only those Federal Government actions in which major causes included an attempt to influence energy or major effects included some influence on energy. Within those limits, the discussion considers actions related to both production and consumption, although production receives the most emphasis. It also includes actions relating to both increases and decreases in energy consumption or production.

Energy production is defined as the transformation of natural resources into commonly used forms of energy such as heat, light, and electricity. By this definition, the shining of the sun or the running of a river are not examples of energy production, but the installation of solar panels or the construction of a hydroelectric dam are. Energy consumption is defined as the use of one of these common, "manufactured" forms of energy. Under this definition sunbathing is not energy consumption, but heating water by means of a solar panel is. In both definitions, the crucial ingredient is the application of technology and resources to change a natural resource into a useful energy form.

Determining Cause and Effect

The use of major causes or major effects of governmental action as boundaries for the discussion requires stipulating some methods for determining the major causes and effects of a governmental action.

Of the many methods (or "models") possible, this discussion will use four. We will call them "viewpoints" because this term suggests that any one observation of something as complicated as a governmental action will necessarily be incomplete. Each governmental action has many causes and effects, and no one viewpoint can include all of them. The term viewpoint also suggests that any one observation will be somewhat distorted, since it emphasizes some phenomena and downplays others. Use of more than one viewpoint is necessary to ensure that all the major phenomena have been adequately observed.

The four viewpoints used in this discussion come from four types of analysis: economic, political, organizational and legal. These particular four viewpoints have two major advantages. First, they are often used to study governmental actions (Table 1). The economic viewpoint, particularly in an extreme form that treates the entire government as an "economic man," has been the overwhelmingly dominant model in foreign policy analysis[3] and has been used a great deal in domestic policy analysis, particularly by economists such as Downs[4] and Schelling.[5] The political viewpoint, in various forms, has been used by such well-known political scientists as David B. Truman[6] and Richard E. Neustadt.[7] The organizational viewpoint, often called bureaucratic or institutional theory, has been a principal tool for governmental observers such as Michel Crozier[8] and Graham Allison.[3] The legal viewpoint, as the term is used in this discussion, is used by lawyers or for a legal audience, or even in other situations, as in de Tocqueville's DEMOCRACY IN AMERICA.[9]

The second advantage of these particular four viewpoints is that they vary along two parallel continua, so one can be sure of highlighting different phenomena in moving from one viewpoint to another. The first continuum is the interchangeability of the entities viewed, the ability to replace one entity in a given situation with another without changing the outcome. The four viewpoints are ranked in the following order with respect to interchangeability:

1. Economic
2. Political
3. Organizational
4. Legal.

In other words, entities in the economic viewpoint are most interchangeable; presumably each "economic entity" in the same situation would act the same. The actors (individuals, groups, and organizations) that make up the political viewpoint are less interchangeable; the components within the organizational viewpoint are even less so; and the authoritative bodies that act within the legal viewpoint are least interchangeable. The second continuum is the equality of influence among the entities involved. Once again, the viewpoints range in the same order. The economic viewpoint assumes the influence among entities is most equal; this factor decreases from the political to the organizational to the legal viewpoint, where authoritative bodies by definition can overrule their inferiors and can be overruled by their superiors.

The next four sections will describe each viewpoint in more detail, outlining the energy-related causes and effects highlighted by that viewpoint. Each description uses a reference example[10] (the Price-Anderson insurance provisions for nuclear facilities) to illustrate the type of information provided by that viewpoint.

THE ECONOMIC VIEWPOINT

In the economic viewpoint, producers make production decisions based on the prices of various levels of inputs, the technology available to transform those inputs into a common form of energy, and the price of various amounts of that energy form.[11] Consumers make decisions based on their desire for various goods and services that use energy and the price of those goods and services. The price of an energy-using item includes both the purchase price of the item and the price of the amount of energy required to use that item.

In a mixed economy, such as that of the United States, the government contains some share of the nation's producers and consumers. It also has the power to change conditions in the marketplace. In acting to change conditions in the marketplace, the Federal Government acts as a unitary and analytic decision-maker.[12] It uses a consistent set of objectives to evaluate a relatively complete set of alternative actions according to their relatively well-known outcomes. If the outcomes of an alternative are uncertain, the Federal Government weighs the value of an outcome by the estimated probability of its occurrence.[12]

Causes of Governmental Actions

For the economic viewpoint, the Federal Government takes action because it wants to change a market outcome, such as the relationship between production and price or between consumption and price. Production may be considered too high relative to price, as when certain energy production processes do not take into account the pollution they produce. Production may be thought too low relative to price, as when certain energy production processes do not take into account the contribution to national security they could make. Similarly, consumption could be too high relative to price, as when consumers fail to take into account the future or otherwise alternative uses that might be made of the energy or natural resource they are buying. In other cases, consumption could be too low relative to price, as when consumers fail to take into account some of the benefits that stem from use of a particular energy form such as the decreased use of another energy form.

Decisions made in the private sector of the economy may fail "to take into account public values" for a number of reasons:[13]

1. Externality: The decision may affect parties other than the one making the decision (e.g., widespread pollution may result).

2. Nonrivalry: One person's consumption of a good or service may not diminish the benefits available for other consumers. Each person has a tendency to wait for the other person to buy the goods. Such goods might be underproduced. Provision for national defense is an example.

3. Nonexcludability: Excluding the nonpayers from a good or service may be inefficient or impossible. Some goods or services, such as national defense, illustrate both nonrivalry and nonexcludability.

4. Uncertainty: A private decision concerning production or consumption may involve risks and the private decision-maker may have a different tolerance for risk than society (or a majority of its members) does. Use of a dangerous substance is a typical case.(14)

5. Delay: A decision concerning production or consumption may involve a delay between the decision and some of its effects and the decision-maker may have a different tolerance for delay than society does. An effort to preserve a resource for future generations is a typical case.

6. Merit: Many individuals may value a good or service less (or more) than society thinks they should. Education is usually positively valued and efforts are made to encourage its consumption. Alcohol, tobacco, and narcotics are usually negatively valued and efforts are made to discourage their consumption.

7. Inequity: An initial maldistribution of resources may lead to less consumption by those initially disadvantaged than society thinks is equitable. Efforts to provide food, clothing, and shelter for the needy illustrate this phenomenon.

8. Noncompetition: The relationship between the size of the most efficient firm and the size of the market may keep the market from being competitive, so that natural workings of the market do not produce the outcome society wants. Provision of telephone service illustrates this phenomenon.

9. Interdependence: Whether one individual will do something depends on his or her confidence that others will do the same. Enforcing child labor laws on all competitors so that no competitor gains an advantage by violating those laws illustrates this factor.

10. Transaction difficulties: The difficulty of achieving agreement among all the necessary parties through market bargaining may make individuals refuse to seek such agreement, although each would welcome an agreement imposed from outside the market. Uniform weights and measures, contract terms, and currencies all illustrate this factor.

More than one of these reasons may be present in a single situation. The case for government intervention is strongest in situations where several reasons are present. These reasons result in a perceivable disparity between the allocation of resources resulting from existing price signals and the goals of groups thought to articulate the preference of a broad segment of society.

Effects of Governmental Actions

In the economic viewpoint, governmental actions have three types of effects. A price change effected by the governmental action causes the price of a given level of energy use or an energy-using device to be higher or lower than it would be without the governmental action. A technological change effected by governmental action, such as scientific research, changes the amount of an energy form produced from a given level of inputs or the amount of an energy form used by a given type of device. A third type of change is a taste change where a governmental action such as advertising changes consumer desire for a given type of energy-using device.

Summary of the Economic Viewpoint

In summary, the economic viewpoint leads one to look for such causes of a governmental action as the failure of production processes or consumption decisions to take into account public values. It leads one to look for such effects of a governmental action as technical change, price change, or taste change. To use the Price-Anderson example, the insurance provisions were created because without them producers would not be willing to produce enough nuclear energy at any price to satisfy public goals like national security. The producers were less tolerant of risk than society could be and less interested in the effects on national security than society had to be. The effect of the provisions was to lower the price of insurance to the producer and to lower the cost of accidents if they did occur, thus lowering the costs of production to the producers. Consequently, the producer was not willing to produce more nuclear energy at any given price than he would have been without the action.

If the United States approached a laissez faire system of capitalism, the economic point of view could eliminate the empirical analysis of this report. Such is not the case. The ten reasons must be considered. In addition, they must be considered in unison with other points of view.

THE POLITICAL VIEWPOINT

In the political viewpoint on energy processes, individuals, groups, and organizational participants inside and outside of government bargain with each other to obtain government actions that will favor the goals they independently seek. The federal government is not a unitary actor outside the energy market. It is a collection of political groups that, together with nongovernmental groups, forms an energy bargaining arena. For example, producers of a particular form of energy may seek policies that will lead to greater profits. Consumer groups may seek lower prices. Environmentalists may seek less pollution. Groups concerned with national security may seek a national stockpile of energy resources. Because resources are scarce, not all groups will get everything they want. Since bargaining power in unequal, some groups will get more of what they want than others will. The Congress and the executive offices are crucial entities in the bargaining arenas because most federal actions start with statutes and appropriations from Congress and regulations and actions from the executive offices.

Causes of Governmental Actions

Governmental actions take place as a result of the bargaining game between political actors pushing for a given action and the actors resisting that action. The resulting action may closely resemble what one actor, or group of actors, wanted or it may be different from what any actor wanted. The result in analogous to a "resultant vector" in vector addition. Depending on the relative strengths of the initial vectors, the resultant may approximate one of the initial vectors or may take off in some entirely new direction.(3)

Predicting which actors are apt to get what they want is very difficult, but some factors seem to be reliably associated with success. One of the most important is intensity of preference; that is, how valuable a particular action would be to the groups seeking it, versus how damaging it would be to the groups opposing it. Groups may oppose a policy not only when they want an alternative action, but also when they want to use the resources involved for some other action (as in budget fights). For instance, producer groups seeking higher profits generally find that government actions are most valuable to them when some or all of the following conditions exist: 1) private cartelization is unfeasible or very costly, 2) the product has a relatively inelastic demand, 3) production requires a relatively high capital input, 4) constrained entry exists, and 5) the industry lacks high concentration. In addition, significant differences among the firms in a producer group may induce a desire on the part of each to participate because one firm cannot rely on another to represent a favorable position in the political bargaining.(15)

Another factor that seems reliably associated with success is the political power of the groups involved. Sources of political power have been extensively analyzed.(16) To summarize those analyses, sources of political power include official positions in the crucial arenas of Congress and the executive offices; access to those in official positions; resources like money, publicity and votes; and the skill to use the various resources well.(17)

Effects of Governmental Actions

In the political viewpoint, actions already effected can change the bargaining situation for the next potential action. On one hand, the groups most successful in obtaining favorable actions gain resources and other sources of political power that make them better able to obtain further favorable actions (although in some circumstances a group may emerge from a successful battle with its political power greatly reduced).(17) On the other hand, a successful group may be satisfied for a while, so its intensity of preference will temporarily be lowered. Alternatively, this group may have engaged in logrolling or other forms of trade in order to obtain the action, so will have to devote at least some of the new power to repay this debt, which may include supporting some action other than one they want. The general presumption is that the first effect predominates over the second, so the usual result is that success, after a possible delay, breeds more success unless some external event occurs. For example, oil producers may obtain favorable action until a senior senator well-disposed toward oil producers retires; then they are apt to succeed less well.

Summary of the Political Viewpoint

In summary, the political viewpoint leads one to look for such causes of an action as bargaining by groups with a high intensity of preference for that action and high political power. It leads analysts to look for changes in the political power of the successful groups, tempered by some decrease in intensity due to satisfaction and trades.

To use the Price-Anderson example, the insurance provisions were created because interests inside and outside of Congress (notably, the Joint Committee on Atomic Energy and the nuclear industry) had an intense interest in such provisions and the political power (positions, resources, and skill) to bargain for that result. Their effect was to increase the resources available to the groups obtaining them. The Joint Committee gained in prestige and the nuclear industry grew, so those groups were more likely to get what they wanted or protect themselves from what they did not want in the next round of bargaining.

THE ORGANIZATIONAL VIEWPOINT

In the organizational viewpoint of energy processes, various activities relevant to energy are conducted by a series of organizations. Each organization has certain characteristics, such as size, operating procedure, and structure, that determine how it will act in an energy production or consumption process. These organizations include firms that produce energy, firms that consume energy, public agencies that regulate energy, and other organizations, such as consumer and environmental groups, that seek a role in energy. The government itself is a collection of organizations.

Organizations in the government and the energy market do not make decisions in the way the economic viewpoint assumes the government does. Although the economic viewpoint assumes that the Federal Government and each consumer and producer are unitary, analytic decision-makers, the organizational viewpoint assumes that the Federal Government and many producers and consumers are multiple, cybernetic decision-makers.[12] In other words, the economic viewpoint assumes that decision-makers react to complicated decisions with uncertain outcomes by developing a consistent set of objectives, examining a relatively complete set of alternatives in light of those objectives, and explicitly discounting for uncertainty. The organizational viewpoint assumes that decision-makers react to complicated decisions with uncertain outcomes by applying set procedures. Such procedures do not begin until an explicit problem occurs, consider only a limited set of objectives one at a time, consider only a limited set of alternatives, take the first acceptable one, and use various methods to assume away uncertainty.

Cyert and March in THE BEHAVIOR THEORY OF THE FIRM[18] describe these search procedures. They state that one can analyze the organizational process of decision-making in terms of the variables that affect organizational goals, those that affect organizational expectations, and those that affect organizational choice.[18, p. 115]

Organizational Goals. Variables affecting the relative importance of goals include the composition of the organization, the division of labor in decision-making, and the specific problems facing the organization. Variables that affect the aspiration level on any goal include the organization's past goals, the organization's past performance, and the past performance of other "comparable" organizations.

Organizational Expectations. Variables that affect the intensity and success of search include the extent to which goals are achieved and the amount of organizational slack. Variables that affect the direction of search include the nature of the problem stimulating the search and the organizational component actually carrying out the search.

Organizational Choice. The key issues are the definition of the problem that requires a choice, the standard decision making rules applied, and the order in which alternatives are considered. Variables affecting those issues include the past experience of the organization with a given set of decision rules, the past record of slack, the organizational component actually carrying out the search, and the past experience in considering alternatives.

Organizational goals, expectations, and choice are knitted together by four phenomena: 1) quasi-resolution of conflict, 2) uncertainty avoidance, 3) problemistic search, and 4) organizational learning.[18,p.116-126]

1. Quasi-resolution of conflict. Organizations reduce conflict by dividing themselves into components and letting different components make decisions about different goals; by striving for no more than "acceptable" performance on each goal; and, when conflict still remains, by favoring one goal at one time and another the next time.

2. Uncertainty avoidance. Organizations avoid uncertainty by emphasizing short-run reaction to short-run feedback rather than trying to anticipate long-run events.

3. Problemistic research. Organizational search has three major characteristics. First, it is motivated--started by the discovery of a problem and stopped by the discovery of a solution. Second, it is simpleminded--using a simple model of causality until forced by failure to find a solution to use a more complex model. Organizations will search in the neighborhood of the problem and past activity before considering new areas. Third, search is biased--the actual conduct of the search is very dependent on the characteristics of the people in the organizational component conducting it.

4. Organizational learning. Organizations modify their behavior in the light of past experience. They may change goals, the parts of the environment to which they respond, or the rules they use in searching for solutions.

Figure 2 depicts the relationships of these concepts.[18]

One of the most important consequences of cybernetic decision-making is that different organizations may make different decisions, even though they face the same problems and have the same objectives.

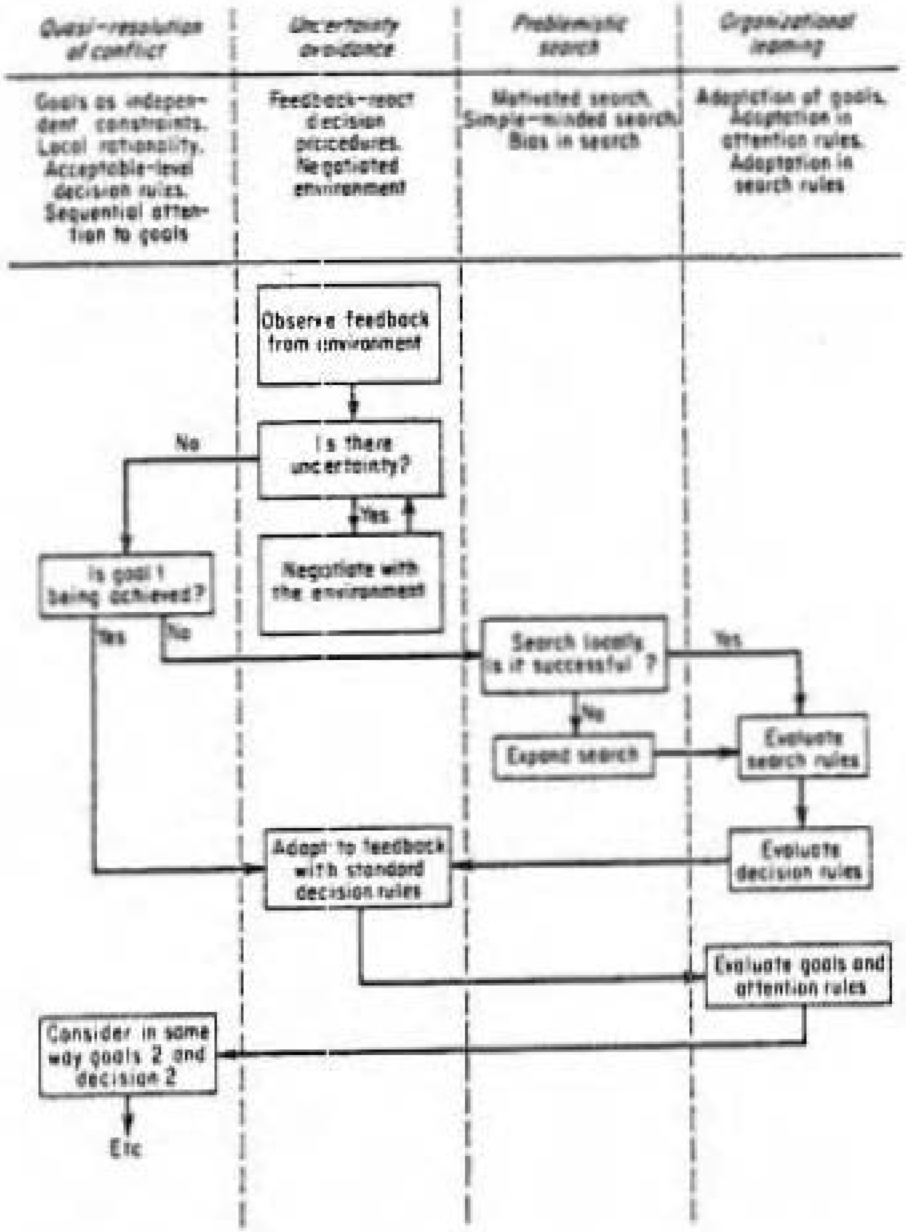

FIGURE 2. A Diagram of Organizational Decision Making

Causes of Governmental Action

In the organizational viewpoint, governmental actions take place when a governmental organization responds to a decision problem. The decision problem for the governmental organization may be created by events (such as a bitter winter) or by actions of organizations outside the government. The latter situation occurs when a nongovernmental organization's procedures for responding to a decision problem lead it to take actions that elicit a governmental response.

The kinds of actions that take place therefore depend on the characteristics of the organizations taking action. For instance, the existence of a governmental organization with a concern for the energy market makes actions affecting energy more likely than they would be if such organizations with such concern did not exist.

Many analysts have tried to outline the characteristics that affect organizational response, as shown in the organizational column of Table 1. Graham Allison says the crucial questions are:[3,p.257] How (with what procedures) does the organization generate information about a problem? How does the organization generate alternative responses? How does the organization implement the chosen response? Marc Roberts, in a recent summary of the organizational analysis literature,[19] suggests that the answers to crucial questions like these depend on the following factors:

1. Factors in the external environment, such as the amount of uncertainty and the amount of competition from other organizations.
2. Factors in the organization itself, such as its size, its structure, and its strategy (normal goals and normal activities).
3. Factors in the organization's personnel, such as their training and experience and their experiences with the organization's formal and informal means of selection, monitoring, and reward.

Effect of Governmental Actions

In the organizational viewpoint, governmental actions either change which organizations respond to a given decision problem or they change the

TABLE 1. Prominent Users of the Four Viewpoints

Viewpoints	Economic	Political	Organizational	Legal
Prominent Users[a]	von Neuman and Morgensterm (1947)	Lindblom (1954)	Bernard (1936)	de Tocqueville (1832)
		Dahl (1957)	Simon (1945)	Hart and Sacks (1956)
	Downs (1957)	Lipset (1960)	Parsons (1949)	Vose (1958)
	Boulding (1959)	Matthews (1960)	Whyte (1956)	Schneidhauser (1962)
	Schelling (1960)	Almond (1961)	March (1958)	Shapiro (1964)
	Baumol (1961)	Key (1961)		Grossman (1966)
	Snyder (1961)			Miller (1966)
	Rapoport (1965)	Lane (1962)	Deutsch (1966)	Tanenhaus (1966)
	Wohlstetter (1965)	Huntington (1968)	Argyris (1967)	Casper (1970)
	Gilpin (1968)	Lowi (1969)	Thompson (1967)	Danelski (1970)
	Axelrod (1970)	Seidman (1970)	Merton (1968)	Falk (1971)
	Quester (1970)	Fenno (1973)	Barnet (1972)	Surry (1971)
	Meadows et al (1972)		Halperin (1973)	
			Steinbruner (1974)	Willrich (1973)
	Knorr (1973)			
	Melman (1974)			

(a) See the references for this chapter for complete citations.

characteristics of the organizations that do respond. In either case, the changes are apt to produce new procedures for responding to a given type of decision problem.

As an example of the first case, a government antitrust or tax policy may influence whether of not oil companies become involved with other forms of energy. If they do become involved, they may have expertise and resources to use that other organizations would not. On the other hand, however, they may have reasons for de-emphasizing production that organizations without involvement in competing energy sources would not have. For an example of the second case, government regulations concerning a particular form of energy may require energy companies to hire new types of people and create new procedures for making energy decisions.

Summary of the Organizational Viewpoint

In summary, the organizational viewpoint leads one to look for such causes of a governmental action as organizational response to decision problems caused by events or the actions of other organizations; it leads one to look for such effects as changes in which organization does what. To use the Price-Anderson example, the insurance provisions were created because the appropriate organizations were in existence and had the appropriate characteristics to design and create them. The Atomic Energy Commission and the Joint Committee on Atomic Energy were available to design and help create the incentives, the large firms making up the nuclear industry were able to contribute substantial help, and each stood to gain substantially if the provisions came into being. The effects of the provisions were to allow and in some cases require large and otherwise powerful organizations such as the AEC and the nuclear firms to become even bigger and to work together (at least to the extent of helping to insure each other).

THE LEGAL VIEWPOINT

In the legal viewpoint of energy processes, parties establish and modify legal relationships among themselves and between themselves and things. The government, in this viewpoint, is a collection of authoritative bodies for establishing and modifying legal relationships. Moreover, the collection of bodies is arranged in a fairly definite hierarchy.

The relationships among parties include contracts between buyers and sellers and laws between the Federal Government and others. In energy, the relationships between parties and things include not only the ownership or leasing of natural resources but also patented or licensed operation of a production process, although some evidence exists that the Federal Government is more apt to support and protect ownership and use of resources than of manufacturing processes.[20]

Together, the relationships form a "great pyramid of legal order."[21] In roughly descending order, the pyramid consists of constitutions, constitutional interpretations, statutes, statutory interpretations, executive orders, administrative orders, administrative regulations, administrative interpretations, and a large collection of privately established relationships such as organizational charters and commercial contracts.

Causes of Governmental Actions

In the legal viewpoint actions take place because a body with the authority to make law does so, usually on the insistence of parties appearing before it. Courts hear cases and decide them. Congress hears testimony and passes statutes. The President issues executive orders. The various agencies issue regulations in response to requests by others. Even the buyer and seller, acting as a body, create "law" between them by writing and signing a contract because each wants to exchange something.

A major emphasis of the legal viewpoint is that each instance of this law-making has to follow certain procedures and fit within certain substantive boundaries set by the existing law with greater authority. The constitution sets the most authoritative bounds; statutes or court decisions come next, depending on the situation; and remaining legal actions must act within the bounds set by all of these. If they do not, a court may declare them null and void.

Effects of Governmental Actions

As reflected in the legal viewpoint, governmental actions have the effect of changing the permissible and actual relationships among parties and between parties and things. They determine what energy activities can take place and have a major influence on what energy activities will take place. For example, the U.S. does not allow private individuals to own "sun rights."[22] Thus private individuals have limited action in uses of the sun produce energy. For another example, statutes and regulations set out requirements for the leasing of federally-owned minerals, including who can lease them and what procedures potential and actual lessees must follow.[23] For still another example, taxes can determine what percentage of the revenue from selling a particular form of energy at a given price will go to the government and what percentage will thus be left to cover expenses and provide a profit to the producer.[23]

Summary of the Legal Viewpoint

In summary, the legal viewpoint leads one to look for such causes of a governmental action as a declaration of law by an authoritative body that has heard parties ask for that declaration. It leads one to look for such effects of the action as changes in relationships among parties and things.

To use the Price-Anderson example, the insurance provisions were created because certain parties were dissatisfied with the normal legal relationship between energy producers and accidents in the nuclear production process. Energy producers were liable, under many conditions, for much of the damage caused by those accidents. Congress agreed to change that relationship. The effect of the insurance provisions was to alter, through a statute, the relationships between energy producers and accidents. Under the new scheme, energy producers would have their liability limited. The government helped in meeting that liability, but in turn would have to give up some of the limits on the conditions of liability and would have to help pay for the liability insurance.

THE INTERRELATIONSHIPS AMONG THE FOUR VIEWPOINTS

Table 2 lists the causes and effects of governmental actions highlighted by each of the four viewpoints. Note that the viewpoints may complement each other. Any single governmental action may have some or all of these causes and some or all of these effects. For example, while the Price-Anderson insurance provisions changed the relationship between production and price, they also changed the political power of the groups involved, helped determine which organizations would be involved in nuclear energy, and changed the legal relationships between producers and the accidents stemming from their production processes.

TABLE 2. Causes and Effects of Governmental Actions

Viewpoint	Causes	Effects
Economic	Price signals that fail to reflect some social values	Technical and price changes
Political	Bargaining for actions by groups with high intensity of preference and high political power	Changes in the benefits and political power of the groups involved
Organizational	Activities to design, create and use actions by organizations with appropriate characteristics	Changes in which organizations are involved
Legal	A request by interested parties for an authoritative body to declare a change	Changes in the legal relationships among parties and between parties and things

Government actions such as those described as incentives to increased production of energy are often analyzed from a single point of view. The other viewpoints are subordinate, if used at all. For instance, changes in political power, organizational activity, and legal relationships might be treated as intermediate steps leading to a change in economic relationships.

Similarly, changes in economic relationships, organizational activity and legal relationships might be treated as intermediate steps leading to a change in political power. The latter approach is roughly the Marxian view of the world.[24]

TYPES OF POSSIBLE GOVERNMENTAL ACTIONS

The four viewpoints provide a method for choosing which governmental actions should be considered energy policies. The next step is to outline the types of actions the Federal Government could have taken. Then applying the four viewpoints, a determination can be made as to which actions should be considered energy policies. The list of energy policies guide the analysis of how and why the U.S. Government intervenes in the energy marketplace.

In order to aid analysis of existing situations by identifying existing actions, a categorization of governmental actions must meet the following criteria:

1. Generality. The categories should be relevant to most, if not all, situations apt to be subject to analysis or policy development.
2. Completeness. All the relevant categories should be included.
3. Concreteness. Each category and category label should, as much as possible, suggest the actions that are or could be within that category.
4. Lack of ambiguity. Actions should, as much as possible, clearly belong in one category rather than another.

The economic viewpoint suggests that a categorization of governmental actions might be based on the part of the production-consumption cycle affected by a given action. Such a categorization meets the criteria of generality and concreteness well and the criterion of lack of ambiguity fairly well, but fails to meet the criterion of completeness. Some actions do affect more than one part of the cycle, and other actions have their most direct effects outside the production-consumption cycle. Therefore, this categorization is only partially complete.

The political viewpoint leads to a categorization based on the political purpose served by the action. In fact, most previous attempts at categorization have been done by political scientists following this general idea. However, this type of categorization, while general and complete, is neither concrete nor unambiguous. Political purposes do not immediately suggest concrete actions and one action may serve many purposes.

Another categorization is based on the organizational viewpoint. That is, one could categorize governmental actions by the organization or organizational component that carries them out. This categorization is probably the most concrete of those suggested so far, but fails to meet the other criteria. It can be ambiguous because more than one organization may be involved in "carrying out" a given action. It fails to meet the criteria of generality and completeness because some actions may involve organizations not yet in existence. Therefore, this categorization is also incomplete. However, it does help in identifying existing actions, even though it fails to generate all the alternatives it should.

The legal viewpoint suggests a categorization based on the legal form of the governmental action, such as a constitutional amendment, a statute, or a regulation. The categorization that results is general and complete, but not concrete or unambiguous. The categories contain too many different actions and any one action may be created through the use of a number of legal forms.

Previous attempts to categorize governmental actions also failed to meet all the criteria. All of these attempts are general and complete, but are neither concrete nor unambiguous. In listing governmental actions, we considered the four criteria as well as reults of previous attempts. The list which resulted is arranged in a hierarchy of categories:

Creation or prohibition of organizations. An important and basic kind of governmental action is the creation of organizations that in turn carry out some of the following kinds of actions. This category includes both the creation of such organizations and the prohibition of them.

Taxation. Levying of a tax or the exemption or reduction of one that is levied in other similar situations.

Fees. Charges for the delivery of a government service or goods not directly related to the cost of providing that good or service.

Disbursements. Actions in which the Federal Government gives out money without receiving anything in return directly or immediately. The category includes promises to disburse under certain circumstances as well as actual disbursements.

Requirements. Demands made by government, backed up by criminal and civil sanctions.

Traditional government services. Assistance or benefit provided by the government to a nongovernmental entity or entities without direct charge. This category of assistance or benefit includes all the symbolic or tangible goods or services that are traditional to government and do not fall into other categories.

Nontraditional services. In addition to providing symbolic or tangible goods and services traditional to government, the government also provides other nontraditional services. Although the boundary between this category and the category of government services is somewhat ambiguous, the distinction is useful for the purposes of completeness and concreteness.

Market activity. Involvement in a market under conditions similar to those faced by nongovernmental producers and consumers.

The list of eight government actions is subdivided into categories to allow a complete screening of the actions of the Federal Government with respect to the creation of incentives. These categories are listed below.

Creation and Prohibition of Organizations

The government can create or prohibit organizations of the following types:

- Federal Government organizations
- Other governmental organizations
- Nongovernmental organizations.

These subcategories can be divided as follows:

Federal Government organizations[25]

1. Department or departmental agency
2. Agency within the Executive Office of the President
3. Independent agency
4. Foundation
5. Institution or institute
6. Claims commission
7. Regulatory commission
8. Conference
9. Government corporation
10. Interagency board
11. Advisory body
12. Joint executive-congressional committee
13. Intergovernmental organization
14. Semi-public organization (e.g., the Federal Reserve System)
15. Government-owned, contractor-operated facility
16. Contractor-owned, contractor-operated (but under government contract) facility
17. Congressional agency
18. Federal court.

Other government organizations. (The Federal Government can often exert a substantial influence over creation or prohibition even when it cannot directly create or prohibit.)

1. Regional compact
2. State government
3. Organization of substate governments
4. County government
5. Municipal government
6. Special purpose government (e.g., school district or sewer district).

Nongovernmental organizations

1. Economic (e.g., prohibition of cartels)
2. Other

Taxation

The following category division stems from that developed by the Musgraves, particularly their diagram of the production-consumption cycle (Figure 3).[13] The divisions are:

- Levied on part of the production-consumption cycle
- Levied outside the production-consumption cycle.

Within the production-consumption cycle[13]

1. Personal income tax
2. Consumer expenditure tax
3. Sales (general) or excise (specific) tax
4. Gross receipts tax
5. Value-added tax
6. Business payroll tax
7. Corporate income tax
8. Personal payroll tax
9. Retained earnings tax
10. Dividends tax.

Outside the production-consumption cycle[13,p.225]

1. Taxes on the holding of property
   - General purpose
   - Special purpose.
2. Taxes on the transfer of property
   - Gift taxes
   - Estate (death taxes)
   - Inheritance taxes
   - Capital gains taxes.

3. Taxes on the crossing of political boundaries
   - Import taxes
   - Use taxes (to compensate for the failure to collect sales or excise taxes because purchased outside jurisdiction)
   - Export taxes (the U.S. constitution prohibits their use in the United States).
4. Exemptions from the taxes of other jurisdictions.

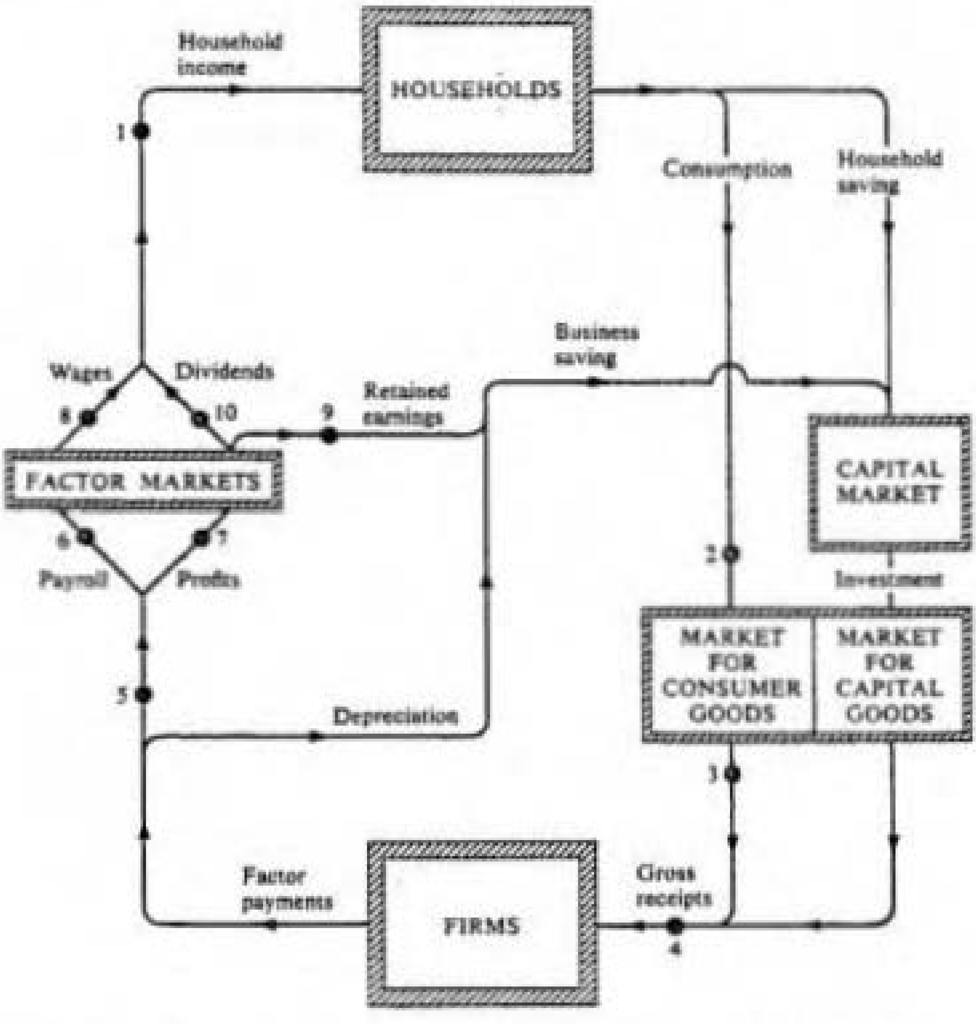

FIGURE 3. Types of Tax in Production-Consumption Cycle(13)

Within each of the subcategories above, either inside or outside the production-consumption cycle, are two further subdivisions. The first distinguishes between actions relating to the imposition of a tax and those relating to the failure to impose it. Failure to impose includes lower rates, delayed payments, and adjustments to the taxable base such as additional deductions and exemptions. Tax credits are also included and usually defined as direct adjustments to the amount of tax due.

Fees

The category of fees is not divided, primarily because the category is so little used. We noted that this category does not include prices charged for goods and services normally provided by nongovernmental organizations, even if the government is providing them.

Disbursements

We divided disbursements according to the recipient of the federal money.

Grants-in-aid. Adopting the definition of a grant-in-aid as "a grant of funds by a central government to a local government or agency for assistance in a civic undertaking,"[1] the Federal Government is the "central government," all other governments are the "local government or agency," and almost all purposes qualify as "civic undertakings."

Subsidy. Subsidy is defined as "pecuniary aid directly granted by government to an individual or private commercial enterprise deemed beneficial to the public."[1] The recipient can be any nongovernment organization, group, or individual, and the purpose of the grant is to support some activity the recipient is undertaking for himself or for others, but not for the Federal Government.

Transfer. Transfer is "a delivery of title or property from one person to another."[1] We consider the term to mean the delivery of money from the Federal Government to individuals as a consequence of the status of those individuals (as opposed to grants designed to support an activity).

Requirements

Requirements are divided according to their announced primary subject matter. The announcement is found in the judicial, legislative, or administrative preamble to the requirement being imposed. We identified the following subcategories.[26]

1. Economic
2. Safety
3. Environmental (including zoning)
4. Civil rights.

The economic subcategory is subdivided into price requirements, quantity requirements, quality requirements, and entry or exit requirements. All of the requirements can be further divided according to whether they require activities by nongovernmental entities, require disclosure of aspects of nongovernmental activities, or exempt entities from otherwise normal requirements. In addition, all the requirements can be once more subdivided into those enforced by civil sanctions, those enforced by criminal sanctions, and those enforced by both.

Traditional Government Services

This category is somewhat of a catch-all to insure that all "traditionally governmental" actions are included in the list. Another major reason for including it is to identify those actions whose major effects may not be relevant to the situation under discussion, but whose major effects may be very relevant. For instance, government provision of roads for transportation purposes may have important effects on the consumption of some energy forms.

We have somewhat incompletely divided the category by subject headings traditionally listed as primarily governmental responsibilities.

The U.S. constitution (especially Article I, Section 8) suggests the following services traditionally provided by government:

1. Coining and regulating money
2. Regulating interstate and foreign commerce (i.e., enforcing property rights and contractual obligations)
3. Regulating immigration
4. Regulating bankruptcy
5. Establishing weights and measures

6. Borrowing money
7. Defending the country, raising armies and declaring war
8. Providing a postal service
9. Providing "post roads" (highways)
10. Providing inland waterways.

A study of state and local government adds the following services as normally governmental:(27)

11. Education
12. Social services (counseling, adoption, and the like)
13. Health
14. Utilities
    - Water
    - Power (electricity)
    - Sewer
    - Garbage.
15. Recreation
16. Law enforcement
17. Fire protection.

The government also delivers less tangible goods and services. These include at least the following:

18. Legitimacy
19. Recognition
20. Acceptance
21. Agreement (nontangible support)
22. Interest
23. Involvement.

Nontraditional Services

As with traditional services, this category is something of a catch-all. Some of the most important actions in this category of services that are usually or often provided by nongovernmental organizations are:

1. Knowledge acquisition
   - Exploration
   - Basic research
   - Applied research
   - Development
   - Demonstration.
2. Knowledge dissemination (other than education)
3. Job placement
4. Transportation (e.g., buses and subways)
5. Professional services
   - Legal
   - Engineering
   - Scientific
   - Administrative.

Market Activity

In order to divide this category, we refer once again to the Musgraves' diagram of the production-consumption cycle and their discussion of phenomena outside of it.(13) The government can itself act as a market entity at each step in the cycle:

1. Government borrowing
2. Saving
3. Consumption (procurement) of consumer goods
4. Investment
5. Production of consumer products
6. Production of capital goods
7. Production of labor (training or manpower development)

8. Consumption of capital goods
9. Consumption of labor (employment)
10. Ownership of land and other natural resources
11. Transfer of land and other natural resources.

USE OF THE VIEWPOINTS AND THE TYPOLOGY TO IDENTIFY ENERGY ACTIONS

The next step in the process of identifying energy policies is to survey each category and subcategory to determine whether a major cause or effect pertaining to energy is part of any of the actions within that category. The results, of this survey, including concrete examples of these types of actions, appear in Chapter III.

REFERENCES - CHAPTER II

1. Funk and Wagnalls Standard College Dictionary. Funk and Wagnalls Company, New York, 1963.

2. R. I. Hofferbert, The Study of Public Policy. The Bobbs-Merrill Company, New York, 1974.

3. G. T. Allison, Essence of Decision. Little, Brown and Company, Boston, 1971.

4. A. Downs, An Economic Theory of Democracy. Harper and Row, New York, 1957.

5. T. C. Schelling, Aims and Influences. Yale University Press, New Haven, 1966.

6. D. B. Truman, The Governmental Process. Alfred A. Knopf, New York, 1951.

7. R. E. Neustadt, Presidential Power. Wiley and Sons, New York, 1960.

8. M. Crozier, Bureaucratic Phenomenon. University of Chicago Press, Chicago, 1964.

9. A. De Tocqueville, Democracy in America. Mayer, J. P. (ed.) and Lawrence, George (tr.), Doubleday Anchor Books, New York, 1969.

10. 42 USC 2210.

11. R. H. Campbell, (ed.), Adam Smith, An Inquiry Into the Nature and Causes of the Wealth of Nations. Glasgow Edition of the Works and Correspondence of Adam Smith, Oxford University Press, Oxford, 1976.

12. J. D. Steinbruner, The Cybernetic Theory of Decision. Princeton University Press, Princeton, NJ, 1974.

13. R. A. Musgrave and P. B. Musgrave, Public Finance in Theory and Practice, Second Edition. McGraw-Hill Book Company, San Francisco, CA, 1976.

14. R. Zeckhauser, "Uncertainty and the Need for Collective Action." In The Analysis and Evaluation of Public Expenditures: The PPB System, Joint Economic Committee, 91st Congress, 1st Session, Vol. 1, pp. 149-166, May 29, 1969.

15. R. A. Prosner, "Theories of Economic Regulation." The Bell Journal of Economic and Management Science 5:(2)335-357, 1974.

16. R. A. Dahl, Who Governs? Yale University Press, New Haven, CT, 1961.

17. M. Edelman, The Symbolic Uses of Politics. University of Illinois Press, Chicago, 1974.

18. R. Cyert and J. March, A Behavioral Theory of the Firm. Prentice-Hall, Englewood Cliffs, NJ, 1963.

19. M. Roberts, "A Rational Framework for Explaining the Behavior of Resource--Allocating Organizations." Discussion Paper No. 264, Harvard Institute of Economic Research, December 1972.

20. G. M. Brannon, Energy Taxes and Subsidies. Ballinger Publishers, Cambridge, MA, 1974.

21. H. Hart and A. Sacks, The Legal Process. Temporary edition, Harvard Law School, 1958.

22. A. S. Miller and G. P. Thompson, Research on Legal Barriers to the Utilization of Solar Energy for Heating and Cooling. Environmental Law Institute, Washington, ERDA Contract No. E (49-18)-2528 EA-02-03 57-60-91, November 10, 1976.

23. K. Marx, Das Capital, The Communist Manifesto and Other Writings. Modern Library, New York, 1932.

24. H. Seidman, Politics, Position, and Power. Oxford University Press, New York, 1970.

25. J. D. Lewis, "National Science and Technology Policy--Its Impact on Technological Change." Research Management, 20:13-16, January 1977.

26. M. C. Cummings, Jr. and D. Wise, Democracy Under Pressure. Harcourt Brace Janovich, Inc., San Francisco, CA, p. 583, 1974.

REFERENCES - TABLE 1

1. Almond, Gabriel A. The American People and Foreign Policy. New York: Harcourt, Brace, 1950.

2. Almond, Gabriel and Powell, G. Bringham. Comparative Politics: A Developmental Approach. Boston: Little, Brown, and Company, 1966.

3. Argyris, Chris. "Some Causes of Organizational Ineffectiveness Within the Department of State." Occasional Paper 2, Center for International System Research, Dept. of State. Washington, D.C.: R.S. Government Printing Office, 1967.

4. Axelrod, Robert. Conflict of Interest: A Theory of Divergent Goals with Applications to Politics. Chicago: Markham Publishing Co., 1970.

5. Axelrod, Robert. Framework for a General Theory of Cognition and Choice. Berkeley: Institute of International Studies, University of California, 1972.

6. Barnard, Chester I. The Functions of the Executive. Cambridge: Harvard University Press, 1938.

7. Barnet, Richard J. The Roots of War. New York: Atheneum, 1972.

8. Boulding, Kenneth E. Economic Factors Bearing Upon the Maintenance of Peace: A Report to the Committee on Research for Peace. New York: Institute for International Order, 1961.

9. Baumel, William. Economic Theory and Operations Research. Englewood Cliffs, NJ: Prentice-Hall, Inc., 1961.

10. Baumel, William. Welfare Economics and the Theory of the State, Cambridge, Mass.: Harvard University Press, 1965.

11. Casper, Jonathan. "Lawyers Before the Supreme Court: Civil Liberties and Civil Rights, 1957-1966." Standard Law Review 22 (1970).

12. Dahl, Robert Alan. Congress and Foreign Policy. New Haven, Conn.: Yale Institute of International Studies, 1949.

13. Danelski, David J., and Glendon Schubert (ed.). Comparative Judicial Behavior: Cross-Cultural Studies of Political Decision-Making in the East and West. New York: Oxford University Press, 1969.

14. Duetsch, Karl W. The Nerves of Government: Models of Political Communication and Control. New York: The Free Press, 1966.

15. Falk, Richard A. This Endangered Planet. New York. Vintage Books, 1972.

16. Fenno, Richard F., Jr. Congressmen in Committees. Boston: Little, Brown and Company, 1973.

17. Gilpin, Robert. "European Disunion and the Technological Gap." Public Interest (Winter 1968), pp. 43-54.

18. Gilpin, Robert. "Technological Strategies and National Purpose." Science 169, pp. 441-449.

19. Grossman, Joel B. "Social Backgrounds and Judicial Decision Making." 79 Harvard Law Review (1966), pp. 211-214.

20. Grossman, Joel B. and Richard S. Wells. Constitutional Law and Judicial Policy Making. New York: John Wiley and Sons, 1972.

21. Halperin, Morton H. and Arnold Kantor (eds.). Readings in American Foreign Policy. Boston: Little, Brown, and Co., 1973; esp. Halperin and Kantor's "The Bureaucratic Perspective: A Preliminary Framework."

22. Huntington, Samuel P. The Common Defense. New York: Columbia University Press (1961).

23. Key, V. O. Politics, Parties, and Pressure Groups. New York: Thomas Y. Crowell Company, 1942.

24. Knorr, Klaus Eugen. The American Trade Proposals. New Haven, CT: Yale Institute of Internation Studies, 1946.

25. Knorr, Klaus Eugen. A Critique of the Randal Commission Report on U.S. Foreign Economic Policy. Princeton, NJ: Center of International Studies, 1954.

26. Lane, Robert Edwards. Political Life: Why People Get Involved in Politics. Glencoe, ILL: Free Press, 1959.

27. Lindblom, Charles Edward. Bargaining: The Hidden Hand in Government. Santa Monica, CA: Rand Corp., 1955.

28. Lipset, Seymour Martin. Political Man: The Social Basis of Politics. Garden City, NY: Doubleday, 1960.

29. Lowi, Theodore. "American Business, Public Policy, Case Studies, and Political Theory." World Politics 16 (1964) pp. 677-715.

30. March, James and Herbert Simon. Organization. New York: Wiley and Sons, 1958.

31. Matthews, Donald. Senators and Their World. Chapel Hill, NC: University of North Carolina Press, 1960.

32. Meadows, Donella H., et al. The Limits to Growth. New York: Universe Books, 1972.

33. Melman, Seymour. Pentagon Capitalism: The Political Economy of War, 1st ed. New York: McGraw-Hill, 1970.

34. Melman, Seymour. The Permanent War Economy: American Capitalism in Decline. New York: Simon and Schuster, 1974.

35. Merton, Robert K. Social Theory and Social Structure. New York: The Free Press, 1968.

36. Miller, Arthur S. "Constitutional Revolution Consolidated: The Rise of the Positive State. 35 George Washington Law Review (December 1966), pp. 172-184.

37. Miller, Arthus S. The Supreme Court and American Capitalism. New York: Free Press, 1968.

38. Parsons, Talcott (ed.) and A. M. Henderson (trans.). Max Weber's The Theory of Social and Economic Organization. New York: Oxford University Press, 1947.

39. Quester, George H. Deterence Before Hiroshima: The Air Power Background of Modern Strategy. New York: Wiley and Sons, 1966.

40. Rapoport, Anatol. Fights, Games and Debates. Ann Arbor: University of Michigan Press, 1960.

41. Rapoport, Anatol. N-Person Game Theory: Concepts and Applications. Ann Arbor, MI: University of Michigan Press, Ann Arbor Science Library Series, 1966.

42. Schelling, Thomas C. International Economics. Boston: Allyn and Bacon, 1958.

43. Schmidhauser, John R. "State Decisis, Dissent, and the Background of the Justices of the Supreme Court of the United States." 14 University of Toronto Law Journal (1962), pp. 164-212.

44. Shapiro, Martin. Law and Politics in the Supreme Court. Glenco, IL: Free Press, 1964.

45. Shapiro, Martin. The Supreme Court and Administrative Agencies. New York: The Free Press, 1968.

46. Simon, Herbert A. Administrative Behavior: A Study of Decision-Making Processes in Administrative Organization. New York: The Macmillan Co., 1945.

47. Snyder, Glenn H. Deterrence and Defense: Toward a Theory of National Security. Princeton, NJ: Princeton University Press, 1961.

48. Surrey, Stanley S. Tax Incentives. Lexington, MA: D. E. Heath and Company, 1971.

49. Tanenhaus, Joseph. "The Cumulative Sealing of Judicial Decision." 79 Harvard Law Review (1966), 1583-1589.

50. Thompson, James D. Organizations in Action. New York: McGraw-Hill Book Company, 1967.

51. Von Neumann, J., and O. Morgerstern. Theory of Games and Economic Behavior. Princeton, NJ: Princeton University Press, 1947.

52. Vose, Clement. "Litigation as a Form of Pressure Group Activity." Annals of the American Academy of Political and Social Science, 1958.

53. Whyte, William H., Jr. The Organization Man. New York: Simon and Schuster, 1956.

54. Willrich, Mason, et al. Energy and World Politics. New York: The Free Press, 1975.

55. Willrich, Mason. Global Politics of Nuclear Energy. New York: Praeger Publishers, 1971.

56. Wohlstetter, Albert J. "Analysis and Design of Conflict Systems," in E. S. Quade (ed.), Analysis for Military Decision. Rand Corporation, 1964, p. 131.

III. GENERIC ANALYSIS OF ENERGY INCENTIVES

This chapter identifies actions (primarily domestic) that the federal government has taken concerning energy. As mentioned in the previous chapter, "concerning energy" means that either a major purpose or a major effect of the action involves energy. This analysis uses the typology of actions described in the previous chapter to identify actions, and the four viewpoints described there to determine whether an action concerns energy. The basic starting points for analysis are thus types of action. Later chapters analyze the actions according to energy form. Once identified, the actions are described and then quantified by our estimate of the FY 1978 cost of accomplishing them. The cost of conducting a government activity can have at least three components: (1) the money the government spends; (2) the money the government foregoes collecting (as in tax benefits); and (3) the money the government shifts from one party to another (as in shifts from consumers to producers brought about by price regulations). This chapter considers only the first component, the money the government spends. Other chapters extend the analysis to the second and third components.

IDENTIFICATION AND DESCRIPTION OF ENERGY ACTIONS (TABLE 3)

Energy actions are identified and described in Table 3. Some of the columns require further explanation.

Organizational Types (Column 3)

Chapter 2 describes the types of organizations that conduct energy actions. The significance of each organizational type is described in the following paragraphs.

Type 1: Departmental Agency

Almost every one of the 11 cabinet-level departments of the federal government contains an organization that conducts energy actions. Consequently, these departmental agencies house over half of the major federal actions in energy that we have identified. For example, the Bureau of Land Management (within the Department of the Interior) manages national resource lands and

TABLE 3. Identification and Description of Energy Actions

	Agency Name	Major Energy Related Purposes[a]	Organizational Type[b]	Congressional Committee Jurisdiction: Senate	Congressional Committee Jurisdiction: House	Major Energy Form[c] and Stage[d]	Major Type(s) of Action[e]	FY78 Outlays ($000)[f]
	1	2	3	4	5	6	7	8
1.	Rural Electrification Administration (Agriculture Department)	Rural electrification program to provide service to rural cooperatives and other rural establishments.	1	Agriculture, Nutrition, and Forestry	Agriculture; Government Operations	Electricity; Production	Market Activity	12,314
2.	REA Capital Investment Program (Agriculture Department)	Insured loans and loan guarantees for construction and operation of generating plants, electric transmission and distribution lines or systems.	1	Agriculture, Nutrition, and Forestry	Agriculture; Government Operations	Electricity; Production	Market Activity	736,306
3.	Forest Service (Agriculture Department)	Mineral leasing and mining activity, special use permits; Biomass Conv. R&D.	1	Agriculture, Nutrition, and Forestry	Agriculture; Government Operations	Electricity; Fossil; Other; Both	Nontraditional: (Knowledge Acquisition); Market Activity	26,256
4.	National Oceanic and Atmospheric Administration (Commerce Department)	Coastal zone management, energy impact formula grants, coastal energy impact fund.	1	Commerce, Science, and Transportation	Merchant Marine and Fisheries	All Forms; Production	Disbursements; Organizational Creation	6,283
5.	Maritime Administration (Commerce Department)	Construction and operating subsidies for U.S. ships and waterborne transportation systems.	1	Commerce, Science, and Transportation	Merchant Marine and Fisheries	Oil; Production	Disbursements	336,531
6.	National Bureau of Standards (Commerce Department)	Energy conservation and efficiency standards, energy conversion materials reliability energy storage systems, nuclear standards for fission power and thermonuclear reactions.	1	Commerce, Science, and Transportation	Science and Technology	All Forms; Both	Nontraditional: (Knowledge Acquisition, Dissemination)	8,770

TABLE 3. (contd)

Agency Name	Major Energy Related Purposes[a]	Organizational Type[b]	Congressional Committee Jurisdiction: Senate	Congressional Committee Jurisdiction: House	Major Energy Form[c] and Stage[d]	Major Type(s) of Action[e]	FY78 Outlays ($000)[f]
1	2	3	4	5	6	7	8
7. Corps of Engineers (Defense Department)	Major dam and reservoir construction and hydro-electric power generation, deep water ports construction.	1	Environment and Public Works	Public Works and Transportation Government Operations	Electricity; Oil; Production	Market Activity; Traditional	1,575,366
8. Atomic Energy Defense Activities (DOE)	Nuclear weapons effects research, nuclear weapons testing, and nuclear weapons stockpile management, naval reactor development.	1	Armed Services	Armed Services	Nuclear; Production	Traditional	442
9. National Institutes of Environmental Health Services (HEW)	Support of research into the potential adverse health and environmental side effects of the various energy technologies under development.	1	Human Resources Committees	Science and Technology	All Forms; Production	Nontraditional: (Knowledge Acquisition, Dissemination)	55,077
10. Housing and Community Research (HUD)	Implementation of Solar Heating and Cooling Demonstration Act of 1974, conservation research, development of more efficient energy and utility systems, energy efficient building standards, site planning, and design for solar energy (AIA solar design project), new town planning for boom town areas impacted by new energy resource production.	1	Banking, Housing, and Urban Affairs	Banking, Finance, and Urban Affairs	All but Other; Consumption	Nontraditional: (Knowledge Acquisition, Dissemination)	2,750
11. Bureau of Land Management (Interior Department)	Energy and minerals management including leasing and management of energy minerals, both onshore, and nonenergy minerals.	1	Energy and Natural Resources	Interior and Insular Affairs	Fossil; Nuclear; Other (geothermal); Production	Market Activity Requirements: (Economic);	81,880

TABLE 3. (contd)

Agency Name	Major Energy Related Purposes[a]	Organizational Type[b]	Congressional Committee Jurisdiction: Senate	Congressional Committee Jurisdiction: House	Major Energy Form[c] and Stage[d]	Major Type(s) of Action[e]	FY78 Outlays ($000)[f]
1	2	3	4	5	6	7	8
12. Bureau of Reclamation (Interior Department)	Hydroelectric power generation and transmission.	1	Energy and Natural Resources	Interior and Insular Affairs Government Operations	Electricity; Other; Production	Market Activity	438,199
13. Geological Survey (Interior Department)	Provides basic scientific data concerning water, land and mineral resources, and supervises the prospecting, development and production of minerals and mineral fuels on leased federal, Indial and OCS.	1	Energy and Natural Resources	Interior and Insular Affairs Government Operations	All but Solar; Production	Requirements: (Economic); Nontraditional: (Knowledge Acquisition, Dissemination)	182,376
14. Bureau of Mines (Interior Department)	Health and safety-related coal mining research.	1	Energy and Natural Resources	Interior and Insular Affairs Government Operations	Coal; Oil; Nuclear; Other; Production	Nontraditional: (Knowledge Acquisition, Dissemination)	73,219
15. Office of Surface Mining	Regulation of strip mines and reclamation programs.	1	Energy and Natural Resources	Interior and Insular Affairs	Coal; Production	Requirements (Environment)	4,961
16. Bureau of Indian Affairs (Interior Department)	Energy leasing, generation, and power.	1	Human Resources	Interior and Insular Affairs	Fossil; Other; Electricity; Production	Market Activity	20,212
17. Mine Safety and Health Administration	Coal mine, metal and nonmetal mine health and safety inspections along with education and training programs in safety motivation constitute the major thrust to activities.	1	Energy and Natural Resources	Interior and Insular Affairs Goverment Operations	Coal; Nuclear; Production	Requirements: (Safety)	35,061

TABLE 3. (contd)

Agency Name	Major Energy Related Purposes[a]	Organizational Type[b]	Congressional Committee Jurisdiction: Senate	Congressional Committee Jurisdiction: House	Major Energy Form[c] and Stage[d]	Major Type(s) of Action[e]	FY78 Outlays ($000)[f]
1	2	3	4	5	6	7	8
18. Alaska Power Administration Department of Energy[g]	Power opreations in Alaska including federal hydro-electric projects marketing.	1	Energy and Natural Resources	Interior and Insular Affairs Goverment Operations	Electricity; Production	Market Activity	2,110
19. Bonneville Power Administration Department of Energy[g]	Constructs, operates and maintains facilities to market electric power from 29 federal hydroelectric generating plants.	1	Energy and Natural Resources	Interstate and Foreign Commerce Government Operations	Electricity; Production	Market Activity	349,232
20. Southwestern Power Administration Department of Energy[g]	Transmission, substation and switching facilities to transmit power generated at Corps of Engineers hydroelectric projects in the Southwest.	1	Energy and Natural Resources	Interstate and Foreign Commerce Government Operations	Electricity; Production	Market Activity	21,249
21. Southeastern Power Administration Department of Energy[g]	The administration markets power generated at Corps of Engineers hydroelectric plants in a 10-state area of the Southeast.	1	Energy and Natural Resources	Interstate and Foreign Commerce Goverment Operations	Electricity; Production	Market Activity	5,572
22. OSHA (Labor Department)	Promulgates occupational safety and health standards, establishes regulations, enforces compliance with safety and health standards and regulations.	1	Human Resources	Education and Labor	All Forms: Production	Requirements: (Safety)	170,571
23. Employment Standards Administration Disabled Coal Miners' Benefits (Labor Department)	Compensation and medical treatment costs paid to those totally disabled due to pneumoconiosis.	1	Human Resources	Education and Labor	Coal; Production	Disbursements: (Subsidy)	112,678

TABLE 3. (contd)

Agency Name	Major Energy Related Purposes[a]	Orga-niza-tional Type[b]	Congressional Committee Jurisdiction: Senate	Congressional Committee Jurisdiction: House	Major Energy Form[c] and Stage[d]	Major Type(s) of Action[e]	FY78 Outlays ($000)[f]
1	2	3	4	5	6	7	8
24. Department of Justice Legal Activities	Land matters--use of federal and natural resources. Enforcement of antitrust.	1	Judiciary	Judiciary	Fossil; Other; Production	Requirements: (Economic)	1,327
25. Department of Justice Antitrust	Enforcement of antitrust.	1	Judiciary	Judiciary	All Forms; Both	Organizational Prohibition	5,061
26. Department of Transportation, Research and Special Programs, Transportation Systems Center, Off-shore Oil Compensation Fund	Pipeline R&D; R&D on increased energy efficiency, minimizing adverse impacts of energy constraints.	1	Commerce, Science, and Transportation	Public Works and Transportation Science and Technology	Oil; Consumption	Nontraditional: (Knowledge Acquisition)	54,598
27. IRS (Treasury Department)	Monitoring revenue policy vis-a-vis energy companies.	1	Finance	Ways & Means	All Forms; Both	Taxation	87,420
28. Department of Energy	Directs and conducts R&D on domestic energy sources, carries out nuclear energy functions related to national defense and fuel production and conducts basic research in the physical, biomedical and environmental sciences.	1	Energy and Natural Resources Government Affairs Judiciary Commerce, Science, and Transportation	Science and Technology Interior and Insular Affairs Government Operations Judiciary Interstate and Foreign Commerce	All Forms; Both	Nontraditional: (Knowledge Acquisition, Dissemination); Market Activity; Traditional; Requirements	4,893,115

TABLE 3. (contd)

Agency Name	Major Energy Related Purposes[a]	Organizational Type[b]	Congressional Committee Jurisdiction: Senate	Congressional Committee Jurisdiction: House	Major Energy Form[c] and Stage[d]	Major Type(s) of Action[e]	FY78 Outlays ($000)[f]
1	2	3	4	5	6	7	8
29. Council on Environmental Quality	Analysis and evaluation of environmental effects of energy activities.	2	Government Affairs	Government Operations	All Forms; Both	Requirements: (Environmental)	1,027
30. Office of Management and Budget	Supervision of government spending on energy and natural resources.	2	Government Affairs	Government Operations	All Forms; Both	Traditional	2,320
31. Appalachian Regional Development Program	Limited programs of grants to simulate energy-related enterprise; grants for the sealing and filling of voids in abandoned coal mines.	2	Environment and Public Works Government Affairs	Public Works Transportation Government Operations	Coal; Both	Disbursements: (Grants-in-Aid)	1,429
32. Environmental Protection Agency	Protection against radiation pollution energy-related environmental programs.	3	Environment and Public Works	Science and Technology Government Operations	All Forms; Both	Requirements: (Environmental); Nontraditional: (Knowledge Acquisition, Dissemination)	112,824
33. National Aeronautics and Space Administration	Activities giving improved data and technology for energy production and utilization are space applications, space research and technology, aeronautical research and technology applications, and supporting activities.	3	Commerce, Science, and Transportation	Science and Technology	All Forms; Both	Nontraditional: (Knowledge Acquisition, Dissemination)	145,377
34. Small Business Administration	Energy loans program.	3	Banking, Housing, and Urban Affairs	Small Business	Petroleum; Production	Disbursements: (Subsidy)	0

TABLE 3. (contd)

Agency Name	Major Energy Related Purposes[a]	Organizational Type[b]	Congressional Committee Jurisdiction: Senate	Congressional Committee Jurisdiction: House	Major Energy Form[c] and Stage[d]	Major Type(s) of Action[e]	FY78 Outlays ($000)[f]
1	2	3	4	5	6	7	8
35. National Transportation Safety Board	Pipeline surface accident and safety investigation, and certificate or license appeal.	3	Commerce, Science, and Transportation	Public Works and Transportation	Petroleum; Nuclear; Production	Requirements: (Safety)	1,852
36. Smithsonian Institute (Science Information Exchange)	SSIE plays an increasing role in support of a number of programs of national interest, such as energy, cancer and pesticides research.	5	Government Affairs	Government Operations Science and Technology	All Forms; Both	Nontraditional: (Knowledge Dissemination)	487
37. Nuclear Regulatory Commission	Licensing and regulatory functions, including antitrust, of nuclear facilities, primarily those for electric power generation.	7	Energy and Natural Resources Judiciary Government Affairs	Interstate and Foreign Commerce Judiciary Goverment Operations Interior and Insular Affairs	Nuclear Production	Requirements: (Economic, Safety, Environmental); Fees	287,699
38. Federal Trade Commission	Energy and product liability; enforcement of competition in energy industries.	7	Judiciary	Judiciary	All Forms; Both	Requirements: (Economic) Prohibition	6,420
39. ICC	Granting oprating authority to interstate carriers, regulating interstate shipping rates, and monitoring compliance with Interstate Commerce Act.	7	Commerce, Science, and Transportation	Interstate and Foreign Commerce	Coal; Oil; Production	Requirements	2,001
40. Securities and Exchange Commission	Public utilities holding company regulation.	7	Banking, Housing, and Urban Affairs	Banking, Finance and Urban Affairs	Electricity; Production	Requirements: (Economic)	747

TABLE 3. (contd)

Agency Name	Major Energy Related Purposes[a]	Organizational Type[b]	Congressional Committee Jurisdiction: Senate	Congressional Committee Jurisdiction: House	Major Energy Form[c] and Stage[d]	Major Type(s) of Action[e]	FY78 Outlays ($000)[f]
1	2	3	4	5	6	7	8
41. Tennessee Valley Authority[g]	Government owned corporation acting as wholesale supplier for 160 local municipal and cooperative electrical systems.	9	Energy and Natural Resources	Public Works and Transportation Government Operations	Coal; Natural Gas; Nuclear; Electricity; Production	Market Activity	3,866,583
42. The Joint Federal-State Land Use Planning Commission for Alaska	Created in 1971; resolves land-use matters between Federal, state, and local (Tribal) jurisdictions.	13	Energy and Natural Resources Environment and Public Works	Interior and Insular Affairs	Petroleum; Production	Requirements: (Economic)	622
43. Office of Technology Assessment	Impact assessments of new technology in energy production.	17	Commerce, Science, and Transportation	Science and Technology	All forms; Both	Nontraditional: (Knowledge Acquisition, Dissemination)	984
44. Congressional Budget Office	Budget priorities for energy.	17	Budget	Budget	All forms; Both	Nontraditional: (Knowledge Acquisition, Dissemination)	200
45. General Accounting Office	In 1976 through the Office of Special Programs, GAO conducted Energy Policy Conservation Act--verification examinations of energy-related information developed by private business concerns under circumstances of the Act. Economic and environmental impact of natural gas curtailments, report; uranium enrichment service pricing procedures, report.	17	Government Affairs	Government Operations	All forms; Both	Nontraditional: (Knowledge Acquisition, Dissemination)	5,739

TABLE 3. (contd)

Organizations Deleted Due to Formation of DOE

Petroleum Reserves	Federal Energy Administration
Defense Power Administration	National Science Foundation
General Services Administration	Federal Power Commission
Energy Research and Development Administration	

Notes for Table 3

a From the President's Budget for FY78 submitted to Congress, the Manual on Government Organization, or statutes.

b 1--Department of department agency
2--Agency within the Executive Office of the President
3--Independent agency
4--Foundation
5--Institution and institute
6--Claims commission
7--Regulatory commission
8--Conference
9--Government corporation
10--Interagency Board
11--Advisory body
12--Joint executive-congressional committee
13--Intergovernmental organization
14--Semi-public organizaton (e.g., the Federal Reserve System)
15--Government-owned, contractor-operated facility
16--Contractor-owned, contractor operated (but under government contract) facility
17--Congressional agency
18--Federal court

c Electricity is largely hydropower; Oil includes oil shale; Other Forms includes geothermal, biomass conversion, wind, thermal gradients, and others; Petroleum includes oil and natural gas; Fossil fuels consists of coal, oil, and natural gas.

d Production includes resource extraction, conversion and transmission; Consumption includes intermediate and end use as well as conservation. "Both" means production and consumption.

e Explained in Chapter II

f Appendix B gives background for these estimates.

g The outlays listed here do not represent outlays of tax dollars by the Federal government. These organizations are government controlled, but, all outlays come from revenues received through the sale of electricity to their customers.

their resources and "administrates the mineral resources connected with acquired lands and the submerged lands of the OCS." It has special responsibility for leases involving geothermal energy.

Type 2: Executive Office of the President

Several of the offices or councils within the Executive Office of the President conduct energy activities. For instance, the Council on Environmental Quality "provides an ongoing assessment of the nation's energy research and development from an environmental and conservation standpoint." CEQ performs this activity along with its broader role in monitoring the nation's environment. Other EOP offices with energy activities are the Energy Resources Council, the Office of Management and Budget, and the Appalachian Regional Development Program.

Type 3: Independent Agencies

Independent agencies are only independent of any executive department and not independent of the President or the executive branch. The Environmental Protection Agency (EPA) is an example of an independent agency. EPA is responsible for requirements programs to improve air and water quality, and for conducting or sponsoring needed research on pollution, its effects, and means of avoiding or cleaning up pollution. NASA, the General Services Administration, and the Small Business Administration are other examples of independent agencies.

Type 4: Foundations

Foundations have become a preferred organizational arrangement for making grants to local governments, universities, nonprofit organizations, or individual researchers, because decision-making is structured to allow for participation by experts representing the fields of specialization in which research funds are being allocated. No federal foundations currently have energy programs, since the only foundation previously having such a program, the National Science Foundation, has transferred its energy responsibilities to the DOE.

Type 5: Institutes

Institutes provide much the same decision-making framework as foundations, allowing for leaders in the fundamental sciences, medical sciences, and public affairs, and specialists in the field covered by the institute to voice approval over research contracts. The Smithsonian Institute's Social Science Information Exchange plays an increasing role in support of a number of programs of national interest, such as energy, cancer, and pesticides research. The Solar Energy Research Institute, part of DOE, is specifically concerned with R&D on various solar energy technologies.

Type 6: Claims Commissions

Some of the activities undertaken by the various claims commissions undoubtedly concern energy. However, the budgets for such commissions give no idea how to identify and quantify these activities. Since the amounts involved are apt to be relatively small, these organizations have been omitted from Table 3.

Type 7: Regulatory Commissions

The ICC has served as a model for regulatory commissions. Other organizations falling within the regulatory commission type are: the Nuclear Regulatory Commission, the Federal Trade Commission, and the Securities and Exchange Commission. Many of the regulatory commissions conduct energy-related activities. Within the Department of Energy, the Federal Energy Regulatory Commission is responsible for regulating interstate gas and electricity production, transmission, and sales activities. These responsibilities formerly belonged to the Federal Power Commission which merged into DOE. The Economic Regulatory Administration is responsible for the range of activities formerly belonging to the Federal Energy Administration, such as controlling energy prices, coping with energy emergencies, and promoting conservation and coal utilization.

Type 8: Conferences

No federal conferences untook activities directly related to energy.

Type 9: Government Corporations

Government corporations vary in their closeness to the Executive Branch, their decision-making structure (single-head or multi-head), and form of ownership (wholly owned by the government or mixed ownership). The only wholly government-owned energy related corporation is the Tennessee Valley Authority. Directorship of this corporation is vested in a board of three members appointed by the President with consent of the Senate.

Type 10: Interagency Boards, Councils, Committees

One energy-related example of an interagency board, council, or committee is the Federal Radiation Council. Such organizations do not appear in Table 3 because their costs are shared among the member organizations already included in the table.

Type 11: Advisory Boards

What the government basically wants from advisory committees is support. Advisory boards may be utilized to lend respectability to new or controversial programs such as poverty and foreign assistance. Several energy-related advisory bodies were created and funded by the Federal Energy Administration, including the list below:

Coal Industry Advisory Committee
Construction Advisory Committee
Consumer Affairs and Special Impact Advisory Committee
Electric Utilities Advisory Committee
Energy Forecasting Advisory Committee
Environmental Advisory Committee
Food Industry Advisory Committee
LP-Gas Industry Advisory Committee
Natural Gas Transmission and Distribution Advisory Committee
Northeast Advisory Committee
State Regulatory Advisory Committee
Retail Dealers Advisory Committee
Wholesale Petroleum Advisory Committee
Transportation Advisory Committee

The fate of these specific committees during the formation of DOE is unknown; DOE may have continued their existence, replaced them with other advisory bodies, or developed in-house capability in these areas.

Type 12: Joint Executive-Congressional Committees

No joint executive-congressional committees have been energy-related.

Type 13: Intergovernmental Organizations

There are two distinctive features of intergovernmental organizations: (1) there is no consistent approach to their establishment, and (2) they tend to have tenous futures when compared to government activities within federal, state, and local jurisdictions. The only energy-related example of this type is the joint Federal-State Land Use Planning Commission for Alaska created in 1971 with a termination date in 1979. Commission activity is coterminous with pipeline construction in Alaska and the pipeline is an important reason for the commission's establishment.

Type 14: Semi-public Organizations

No energy-related organization of this type existed in FY 1978, although several hvae been proposed, including one to expedite development of a coal-based synfuels industry.

Type 15: Government-Owned, Contractor-Operated Facility

Table 3 does not list the activities of GOCO facilities working under contract to the Department of Energy, because the DOE budget includes those activities. The GOCO facilities not listed for this reason include:

Argonne National Laboratory
Brookhaven National Laboratory
Holifield National Laboratory
Los Alamos Scientific Laboratory
Lawrence Berkeley Laboratory
Lawrence Livermore Laboratory
Pacific Northwest Laboratory
Sandia Laboratories

Type 16: Contractor-Owned, Contractor-Operated (Under Government Contract) Facilities

Table 3 does not list any COCO facilities, even though many conducted energy-related activities. First, so many conducted energy activities that listing them all would lengthen the table unduly. Second, since activities were conducted under contract, the budgets of the agencies which let the contracts include the money involved in these activities.

Type 17: Congressional Agencies

Congressional agencies are administrative agencies primarily responsible to and serving the legislative branch. The General Accounting Office is an example of a congressional agency with wide-ranging activities in overseeing government action, including verification examinations of energy-related information developed by private business concerns in relation to the Energy Policy and Conservation Act; reporting on topics such as economic and environmental impacts of natural gas curtailments; and uranium enrichment service pricing procedures. This organizational type also include the Congressional Budget Office and the Office of Technology Assessment.

Of course, Congress itself conducts many energy activities. However, these activities usually do not affect energy directly, but only thrugh some supplemental activities by other government organizations. In addition, identifying and assigning costs to the relevant congressional activities would be very difficult. Therefore, Table 3 does not contain estimates of the cost involved in energy activities conducted by Congress itself.

Type 18: Federal Courts

Table 3 omits federal courts for the same reasons it omits claims commissions and Congress. Organizations of these types usually work through other organizational types and the identification and quantification of relevant actions is very difficult.

Congressional Committee Jurisdiction (Columns 4 and 5)

All government action is subject to two review processes in Congress. One is substantive; the other is appropriations. Since all federal programs are reviewed by the Appropriations Committee or its subcommittees, our concern with committee jurisdiction is limited to those committees with a voice in formulating the substance of agency policy or programs in the energy field. Since committee jurisdictions have changed drastically since 1976, we identified the new committees that would have had jurisdiction in 1976 and consequently will probably have jurisdiction over similar actions in the future. Congressional committees are listed in Table 3 if their jurisdiction in a substantive area gives them responsibility for energy policy. Table 4 includes committees with other than substantive responsibility over energy policy.

There are fifteen standing committees in the Senate. Only four are excluded from our list for lack of any relevant substantive energy jurisdiction: Appropriations, Foreign Relations, Veterans Affairs and Rules. The Foreign Relations Committee is not included at this time because although the Foreign Relations Committee (the subcommittee on Arms Control, Oceans, and International Environment) does have jurisdiction over international aspects of nuclear energy and nuclear transfer policy, the thrust of our analysis is in the direction of assessing government actions affecting domestic energy production and consumption.

In the House there are 22 standing committees. Table 3 includes 14 committees with jurisdictional issues pertaining to energy policy. House committees included in Table 3 whose jurisdiction is not obviously energy-related are:

1. Government Operations - which oversees government purchases and could have a significant impact on government activity in the marketplace if energy efficiency became a strict measure in the procurements policy.

2. Small Business - which would oversee, if not the actual appropriations, at least the guidelines implementing and continuing the Energy Shortage Program.

Table 4 gives the jurisdiction of each committee included in Table 3, plus others.

Major Energy Form and Stage (Column 6)

This column lists only the major forms and stages, in terms of money and emphasis, involved with an organization's energy actions. Obviously, actions

TABLE 4. Federal Organizations by Major Type of Action

Congressional Committee	JURISDICTIONAL ISSUES
Senate:	
Agriculture, Forestry and Nutrition Committee	Rural development, rural electrification and watersheds
Appropriations Committee	Appropriation of the revenue for the support of the government
Armed Services Committee	• Military R&D • Aeronautical and space activities primarily associated with development of weapons systems or military operations • National security aspects of nuclear energy • Naval petroleum reserves, except those in Alaska
Banking, Housing, and Urban Affairs Committee	• Financial aid to commerce and industry • Public and private housing • Urban development and urban mass transit
Budget Committee	• Oversee Title III and IV of Congressional Budget Act • Budget outlays on continuing and proposed legislation • Request and evaluate continuing studies of tax expenditures • Review Congressional Budget Office conduct and its functions and duties
Commerce, Science and Transportation Committee	• Interstate commerce • Regulation of interstate common carriers, i.e., pipelines • Merchant Marine and navigation • Marine and ocean navigation including deep water ports • Science, engineering and technology research and deveopment and policy • Nonmilitary aeronautical and space sciences • Commerce on OCSL • Coastal zone management • All matters related to science and technology, ocean policy, transportation, communications and consumer affairs

TABLE 4. (contd)

Congressional Committee	JURISDICTIONAL ISSUES
Energy and Natural Resources Committee	• Energy policy • Energy regulation, conservation • Energy R&D • Solar energy systems • Nonmilitary development of nuclear energy • Naval petroleum reserves in Alaska • Oil and gas production and distribution • Extraction of minerals from ocean and OCSL • Energy related aspects of deep water ports • Hydro electric power, irrigation and reclamation • Coal production, distribution and utilization • Mineral extraction from public lands • Mining, mineral lands, mining claims and mineral conservation • Mining education and research • Subcommittee: study energy resources and development
Environment and Public Works Committee	• Environmental policy • Environmental R&D • Flood control and river-harbor improvements including environmental aspects of deep water ports • Public works on bridges and dams • Nonmilitary environmental regulation and control of nuclear energy • Tariffs, import quotas and material related thereto
Finance Committee	• Revenue measures generally • Counterpart to Ways and Means in House
Foreign Relations Committee	• Ocean and international environment and scientific affairs • International aspects of nuclear energy, including nuclear transfer policy
Governmental Affairs Committee	Organization and management of U.S. nuclear expert policy
Human Resources Committee	• Measures relating to education, labor, health, and publicy welfare • Indian land management and trust responsibilities

TABLE 4. (contd)

Congressional Committee	JURISDICTIONAL ISSUES
Judiciary Committee	• Patents, copyrights and trademarks • Interstate compacts generally • Goverment information
House:	
Agriculture Committee	Rural electrification
Armed Services Committee	• Naval ptroleum and oil shale reserves • Scientific R&D in support of Armed Services
Banking, Finance and Urban Affairs Committee	• Urban development • Public and private housing • Financial aid to commerce and industry (other than transportation)
Budget Committee	• Request and evaluate continuing studies on tax expenditures, to divise methods of coordinating tax expenditures, policies and programs with direct budget outlays • Review conduct of Congressional Budget Office • function and duties
Government Operations Committee	• Federal procurement • Intergovernmental operations
Interior and Insular	• Forfeiture of land grants and alien ownership including alien ownership of mineral rights • Insular possessions of U.S. except those affecting revenue and appropriations • Mineral land laws and claims and entries thereunder • Mineral resources of public land • Mining interests generally • Mining schools and experimental stations • Petroleum conservation on public lands and conservation of the radium supply in U.S. • Public lands in general including easements • Special oversight with respect to nonmilitary nuclear energy R&D including disposal of nuclear waste
International Relations Committee	• Export controls • International commodity agreements

TABLE 4. (contd)

Congressional Committee	JURISDICTIONAL ISSUES
Interstate and Foreign Commerce Committee	• Interstate and foreign commerce generaly • Interstate oil compacts and petroleum and natural gas, except on the public lands • Regulation of interstate transmissions of power, except the installations of connections between government water power projects • Securities and exchanges • Consumer affairs and protection
Judiciary Committee	• Interstate compact generally • Patents, copyrights, and trademarks • Protection of trade and commerce against unlawful restraints and monopolies
Labor and Education Committee	• Labor standards • Labor statistics • Welfare of miners
Merchant Marine and Fisheries Committee	• Oceanography and marine affairs - costal zone management • Fisheries and wildlife - research, restoration, refuges and conservation • Regulation of common carriers (except matters under jurisdiction of I.C.C.), Merchange Marine inspection • Registering and licensing of vessels
Public Works and Transportation Committee	• Flood control and improvement of rivers and harbors • Oil and other pollution of navigable waters • Public works for benefit of navigation - bridges and dams, except international • Water power • Transportation, including civil aviation except railroads • Roads and safety thereof • Water transportation regulatory agencies except (a) I.C.C. as relates to railroads (b) Federal Railroad Administration (c) Amtrak
Science and Technology Committee	• Astronautical R&D • Bureau of Standards • NASA • National Aeronautics and Space Council • NSF • Outer Space - exploration and control thereof

TABLE 4. (contd)

Congressional Committee	JURISDICTIONAL ISSUES
Science and Technology Committee (cont.)	• Scientific R&D • Environmental R&D • All energy R&D except nuclear R&D • National Weather Service • Special oversight function in all nonmilitary R&D
Small Business Committee	• Assistance and protection to small business including financial aid • Participation of small-business enterprises in Federal procurement and Government contracts • Special oversight function with respect to problems of small business • Solar and renewable energy source loan programs
Ways and Means Committee	• Reciprocal trade agreements • Revenue measures generally • Revenue measures relating to the insular possessions

Sources: Congressional Record - Senate, February 4, 1977, "Senate Resolution 4 cited as 'Committee System Reorganization Amendments of 1977,' Title I - Senate Committees; Jurisdictions and Sizes," pp. S2308-S2311.

Congressional Quarterly, Weekly Report, "Senate Committees," vol. 35, no. 5, pp. 157-188, January 29, 1977.

Rules of the House of Representatives, Revised June 16, 1975, 1st Session, 94th Congress.

House Resolution 5, January 4, 1977, 95th Congress, 1st Session.

Appendix to The Budget of the United States Government, Fiscal Year 1980, p. 376.

involving one form or stage may also affect other forms and stages; such secondary effects are not reflected in Table 3. In addition, we have not attempted to allocate outlays for combination forms among single forms.

Major Types of Action (Column 7)

As the column title implies, this column lists only the major types of action, in terms of money and emphasis, conducted by an agency.

Type 1: Organizational Creation and Prohibition

Congress and the President are the major organizations conducting this type of activity. We have not attempted to identify and quantify the purely congressional or purely presidential phase of any action because these phases are usually part of the creation of an action, not its conduct. Occasionally, however, Congress or the President delegate this type of activity to some other organization. The Federal Energy Administration created advisory bodies. None of the agencies is now involved in creating federal organizations and none prohibits them. Several agencies create nonfederal or private organizations, and several agencies prohibit some forms of private economic organizations.

Type 2: Taxation (including fees)

Taxation as such is used only by the Internal Revenue Service. Fees are a relatively minor type of government action and those subject to fees are usually business or utility interests who encounter fees as part of production costs. We have found only two cases of fees as major actions (the Bureau of Land Management and the Nuclear Regulatory Commission).

Type 3: Disbursements

Five organizations use grants-in-aid to support government action at the state or local community level. Subsidies were used in three cases, with the money going to small scale private enterprise. Few cases of government action appear to fit the subtype transfers.

Type 4: Requirements

Economic, safety, and environmental requirements are imposed by several different organizations.

Type 5: Traditional

Actions involving the traditional government services of interstate and foreign commerce, national defense, highways, and inland waterways have affected energy production and consumption.

Type 6: Nontraditional Services

The major subtypes in this category are knowledge acquisition and knowledge dissemination--usually lumped together as "research and development." The bulk of the activity is in acquisition, rather than dissemination. As studies of technology transfer have shown, the U.S. government has rarely done a great deal to disseminate the findings of its research.

Type 7: Market Activity

Market activity is a major type of action, within which the production of capital goods is the most frequent subtype of government action for agencies that we have cited. This subtype characterizes most activities within the REA, Corps of Engineers, APA, BPA, Southeastern and Southwestern Power Administrations, and the TVA. The education and training programs in mine safety motivation conducted by the Mining Safety and Health Administration fall within the subtype of production in labor.

The petroleum reserves in the Department of Energy, and the Bureau of Land Management engage in a different kind of government market activity, which we have termed transfer of natural resources. Transfer of natural resources is one way to describe action related to the stockpile of energy resources. For instance, the ownership of land and natural resources involves the BLM in leasing arrangements in parts of a 450 million-acre reserve of natural resources.

FY 1978 Outlays (Column 8)

Fiscal year expenditures in our chart are based on a review of the FY 1978 outlays reported by the federal government. How accurately the energy-related actions are identified and quantified depends upon the reporting procedures used in the budget to list spending by activities. Unfortunately, statements on fiscal expenditures often do not give precise figures for energy-related program activities. Although budgets are prepared by activities, there is widespread inconsistency in how specifically an agency labels its activities for the purpose of reporting program costs. Also, programs authorized by special funding are reported in a special section of the budget and often without an elaborate description of specific activities being funded. For instance, research on new energy uses, technology development, and conservation is often grouped with other environmental, transportation, and information exchange activities.

Where a precise account of program expenditures is unavailable, we have tried to estimate using a variety of data sources and procedures, the percentage of budget outlays going to energy action. Appendix B discusses these sources and procedures organization by organization.

In this update we have taken the formation of the Department of Energy and other recent organizational changes into account. Two organizations formerly concerned with energy have been dissolved: Federal Energy Administration and Federal Power Commission. Other organizations have transferred all of their major energy-related responsibilities to DOE: Defense Nuclear Agency, DOC Domestic and International Business Administration, National Science Foundation, and Naval Petroleum Reserves. Outer continental shelf activities are no longer a separate organizational component in Interior. Interior's Bureau of Mines is now restricted to safety and health related coal mining research, with other coal mining R&D programs transferred to DOE. The General Services Administration no longer lists energy conservation program expenditures in its budget.

ANALYSIS OF ENERGY ACTIONS

The following analysis of energy actions is oriented along the lines suggested by the columns of Table 3. The first part of the analysis ranks the individual agencies by size of outlay and develops a total figure for the number of separate agencies conducting energy-related activities in 1978 and the cost of conducting those activities in 1978. Later parts of the analysis break down those two total figures by various items of interest, including the type of organization (Column 3 of Table 3), committee jurisdiction (Columns 4 and 5), energy form (Column 6), energy stage (Column 6), and major type of activity (Column 7).

ENERGY-RELATED EXPENDITURES OF VARIOUS FEDERAL ORGANIZATIONS (TABLE 5)

In Table 5, federal organizations conducting energy-related activities are ranked according to their spending in FY 1978 for these activities. This table is based on columns 1 and 8 of Table 3.

As Table 5 shows, a total of 45 organizational components spent an estimated $13,685,245,000 conducting energy activities in FY 1978. Energy-related spending ranged from $4,893,115,000 spent under the authority of the Department of Energy to $0 spent by the Small Business Administration on established energy actions. The average amount spent per organization was $304,116,556.

Thirty-six percent of the total was spent by authority of DOE. TVA plus DOE spent 64% of the total. The Army Corps of Engineers, REA, TVA, and DOE accounted for 81% of total energy related spending. Since the formation of DOE and transfer of energy responsibilities from other agencies to DOE, energy spending has become more concentrated in fewer agencies. ERDA accounted for just 28% of the energy budget in FY77, while ERDA, TVA, the Army Corps of Engineers, and REA accounted for just 64% (Cone et al., 1978, p. 79).

TABLE 5. Energy-Related Outlays of Federal Organizations

Organization	FY78 Outlays ($000)
Department of Energy	$4,893,115
Tennessee Valley Authority [a]	3,866,581
Corps of Engineers	1,575,366
Rural Electrificaton Administration (Capital Investment)	736,306
Bureau of Reclamation	438,199
Bonneville Power Administration[a]	349,232
Maritime Administration	336,531
Nuclear Regulatory Commission	287,699
U.S. Geological Survey	182,376
National Aeronautics and Space Administration	145,377
Occupational Safety and Health Administration	120,571
Environmental Protection Agency	112,824
Employment Standards Administration[b]	112,678
Internal Revenue Service	87,420
Bureau of Land Management	81,880
Bureau of Mines	73,219
National Institutes of Environmental Health	55,077
Department of Transportation	54,598
Mining Safety and Health Administration	35,061
Forest Service	26,256
Southwestern Power Administration[a]	21,249
Bureau of Indian Affairs	20.212
Rural Electrification Administration	12,314
National Bureau of Standards	8,770
Federal Trade Commission	6,420
National Oceanic and Atmospheric Administration	6,283
General Accounting Office	5,739
Southeastern Power Administration[a]	5,572
Justice Antitrust Division	5,061
Office of Surface Mining	4,961

TABLE 5. (contd)

Organization	FY78 Outlays ($000)
Housing and Community Research	2,750
Office of Management and Budget	2,320
Alaska Power Administration[a]	2,110
Interstate Commerce Commission	2,001
National Transportation Safety Board	1,852
Appalachian Regional Development	1,429
Justice Legal Activities	1,327
Council on Environmental Quality	1,027
Office of Technology Assessment	984
Securities and Exchange Commission	747
Joint Federal-State Land-Use Planning Commission	622
Smithsonian Information Exchange	487
Atomic Energy Defense Activities (DOE)	442
Congressional Budget Office	200
Small Business Administration	0

(a) The outlays listed here do not represent outlays of tax dollars by the federal government. These organizations are government controlled, but all outlays come from revenues received through the sale of electricity to their customers.

(b) The outlays listed here come from a special excise tax on coal tonnage paid by coal producers and from reimbursements into the trust fund by mine operators. The funds are used to pay compensation, medical and survivor benefits to eligible miners and their survivors.

ENERGY-RELATED ORGANIZATIONS AND OUTLAYS BY PROFESSIONAL TYPE (TABLE 6)

Table 6 is based on columns 3 and 8 of Table 3. As Table 6 shows, departmental agencies allocated the most energy dollars ($9,248,936,000). Approximately 67% of the total outlay was spent by departmental agencies in FY78. Independent agencies spent about 1.9% of the total outlay, while regulatory commissions spent about 2.2%. One government corporation (TVA) spent 28%. The remainder of the FY 1978 outlay was spent by various organizations of four different organizational types. The major change from previous years is the growth in relative importance of departmental agencies. For example, in FY77, departmental agencies accounted for just 46% of the total outlay on energy, and independent agencies were the next most important organizational type with 33% of the outlays. These changes are due to the formation of the Department of Energy, which replaced major independent agencies (FEA and ERDA), and took over functions formerly belonging to several other agencies including functions in DOD, DOI, FPC, and NSF.

TABLE 6. Energy-Related Organizations and Outlays by Organizational Types

Organizational Type	FY78 Outlays ($000)
1. Departmental Agency	$9,248,936
2. Executive Office of the President	4,776
3. Independent Agency	260,053
4. Foundation	0
5. Institution	487
6. Claims Commission	0
7. Regulatory Commission	296,867
8. Conference	0
9. Government Corporation	3,866,581
10. Interagency Board	0
11. Advisory Body	0
12. Joint Executive--Congressional Committee	0
13. Intergovernmental Organization	622
14. Semipublic Organization	0
15. GOCO	*
16. COCO	*
17. Congressional Agency	6,923
18. Federal Court	*

ENERGY-RELATED ORGANIZATIONS AND OUTLAYS BY COMMITTEE JURISDICTION (TABLE 7)

Table 7 is based on columns 4, 5, and 8 of Table 3. Congressional committees listed in column 1 of Table 7 authorize energy-related programs based on their jurisdictional interests described in Table 4. Each committee's jurisdiction column gives the number of federal energy-related organizations each congressional committee oversees. The energy dollars in each committee's jurisdiction column represent the total outlays for the organizations under that committee's jurisdiction, based on energy-related spending in each organization as given in Tables 3 and 5.

In many cases more than one congressional committee has jurisdiction over a given organization. Where there is overlapping congressional authority, we added the "overlapped" organization to each committee's totals because we wanted to calculate a maximum energy jurisdiction for each committee. For example, the two REA programs are included in the totals of a number of organizations and outlays for both the Agriculture and Government Operations Committees. (Note that further analyses involving operations such as adding amounts together or computing percentages would not yield completely valid results.)

The jurisdiction of several committees is overstated by the inclusion of the entire Department of Energy budget. For example, the Judiciary Committees of the House and Senate are concerned only with the Federal Energy Regulatory Commission and the Economic Regulatory Administration, not the entire DOE. The Armed Services Committees are similarly concerned with only part of DOE, in this case the Atomic Energy Defense Activities.

In the Senate, 11 committees had jurisdiction over energy-related organizations. The Energy and Natural Resources Committee's jurisdiction was the largest; it included 14 organizations with a combined total of $10,241,876,000 in outlays. The Budget Committee's jurisdiction was the smallest; it included one organization with $200,000 in outlays. Jurisdiction averaged 4.1 organizations. The biggest jurisdiction (Energy and Natural Resources) included 31% of the energy-related organizations.

TABLE 7. Energy-Related Organizations and Outlays by Committee Jurisdiction

Senate Committees	Organizations in Each Committee's Jurisdiction	FY78 Outlays ($000)
Energy and Natural Resources	14	10,241,876
Commerce, Science, and Transportation	9	5,449,481
Government Affairs	7	5,191,816
Judiciary	4	4,909,059
Environment and Public Works	4	1,690,241
Agriculture, Nutrition, Forest	3	774,876
Human Resources	4	308,538
Finance	1	87,420
Banking, Housing, and Urban Affairs	3	3,497
Armed Services	1	442
Budget	1	200
House Committees		
Government Operations	21	12,628,481
Interior and Insular Affairs	11	6,019,454
Interstate and Foreign Commerce	6	5,556,867
Public Works and Transportation	5	5,499,826
Science and Technology	8	5,271,202
Judiciary	5	5,193,622
Agriculture	3	774,872
Merchant Marine and Fisheries	2	342,814
Education and Labor	2	233,249
Ways and Means	1	87,420
Banking, Finance, and Urban Affairs	2	3,497
Armed Services	1	442
Budget	1	200
Small business	1	0

In the House, 14 committees had jurisdiction over energy-related organizations. The Government Operations Committee's jurisdiction was the largest; it included 21 organizations with a combined total of $12,628,481,000 in outlays. The Budget Committee's substantive jurisdiction was the smallest; it included one organization with $200,000 in outlays. Jurisdiction averaged 3.2 organizations. The biggest jurisdiction included 24% of the energy-related organizations.

ENERGY-RELATED ORGANIZATIONS AND OUTLAYS BY ENERGY FORM (TABLES 8, 9, 10)

Tables 8, 9, and 10 are based on columns 6 and 8 of Table 3. Table 8 groups energy-related organizations and outlays by the energy form or combination of forms involved. Combinations are kept together to emphasize organizations that must spread their activities over a number of forms. Table 9 lists the names of the energy-related organizations in each group of Table 8.

Table 10 is a condensed version of Table 8, produced by estimating how organizations with outlays affecting more than one energy form allocated their outlays among forms in FY78.

For the purposes of Table 10, we have estimated an organization's allocations of energy-related outlays by energy form. Once again, we used a variety of data sources and procedures for making those estimates discussed in Appendix B and by organization.

Where additional data were not available, we first took note of DOE's breakdown of 1978 consumption by primary energy type.(1) That breakdown in quadrillion Btu was as follows:

Coal	14.087
Natural Gas	19.819
Oil	37.786
Hydroelectricity	3.147
Nuclear	2.977
Solar and Other	0.199
Total	78.014

It does not separate electricity, although many federal programs address it directly, even though it is not a "primary energy type" according to the DOE.

To include electricity as part of the breakdown, we calculated total electricity sales in Btu.[2] We then calculated the amount of electricity in Btu produced by each primary type. We assigned one-half of those Btu to electricity and one-half to the primary energy type, on the theory that interest in electricity from a specific form is really interest split between the specific form input and the electricity output. We did, however, assign all the hydroelectric Btu to electricity.

Electricity Btu thus equal:

100% of hydroelectricity	=	3.147
50% of coal-electricity	=	6.076
50% of oil-electricity	=	2.299
50% of natural gas electrictiy	=	1.899
50% of nuclear electricity	=	1.488
Total		14.909

We then subtracted the Btu we had allocated to electricity from the appropriate primary energy type to produce the following breakdown that includes electricity:

Electricity (from above)		14.909
Coal		
100% of its total consumption	14.087	
Minus 50% of coal-electricity	6.076	
Equals		8.011
Oil		
100% of its total consumption	37.786	
Minus 50% of oil-electrictiy	2.299	
Equals		35.487
Natural Gas		
100% of its total consumption	19.819	
Minus 50% of gas-electricity	1.899	
Equals		17.920
Nuclear		
100% of its total consumption	2.977	
Minus 50% of nuclear-electricity	1.488	
Equals		1.488
Solar and Other		0.199
TOTAL		78.014

Therefore we calculate the following percentages by energy form:

Electricity	19.1
Coal	10.3
Oil	45.5
Natural Gas	22.9
Nuclear	1.9
Solar	--
Other	0.3

We assumed that almost all of the "Solar and Other" consumption was "other," rather than "solar" (e.g., geothermal).

We allocated energy outlays to form by these percentages when we had no other data to suggest some other allocation.

When we knew a federal action had some influence on energy production or consumption, but energy-related spending was not disclosed in the cost of conducting an action, we used a percentage (12%) of total outlays as a fraction of spending likely to be energy-related. This 12% figure was used, because energy production is roughly 12% of national product. Energy production was calculated as 12% of total market activity by the following method.

The 1978 energy consumption figures on the previous page were multipled by the average price of that energy type in 1978.(3) These calculations are shown below:

	Quads Consumed	¢/Quad	Estimated Expenditure (billions)	Percent
Electricity (including nuclear)	16.397	$1,020.0 \times 10^9$	$167.249	68
Coal	8.011	97.8×10^9	7.835	3
Oil	35.487	154.5×10^9	54.827	22
Natural Gas	17.920	90.0×10^9	16.128	7
		TOTAL	$246.039	

Gross national product in 1978 was $2,127.6 billion; hence, Energy Expenditures divided by Gross National Product equaled 0.116 in 1978.

When considering both single and multiple energy forms, as in Tables 8 and 9, the number of organizations with actions involving a given energy form ranged from 16 for All Forms to 1 for several single forms. The number of organizations per form averaged 2.6. Approximately 36% of the organizations fell into one group (All Forms). The outlays involving a given energy form ranged from $5,451,675,000 for all forms to $2,001,000 for coal and oil. The outlays per form averaged $805,600,880. Approximately 40% ($5,451,675,000) of the outlays fall into one group (All Forms).

When considering single forms alone, as is done in Table 10, the outlays involving a given energy form ranged from $5,585,096,000 for Nuclear to $119,777,000 for Other. The outlays per form averaged $1,955,035,000. Approximately forty-one percent of the outlays fell into one group (Nuclear).

TABLE 8. Energy Related Organizations and Outlays by Energy Form (extended version)

Forms	Number of Organizations	FY78 Outlays ($000)
Single		
Electricity	7	$1,127,530
Nuclear	2	288,141
Coal	3	119,068
Oil	4	391,751
Multiple Forms		
All Forms	16	5,451,675
Petroleum and Nuclear	1	1,852
Fossil, Electricity, and Other	2	46,468
Fossil, Nuclear, and Other	1	81,880
Fossil and Other	1	1,327
Coal and Nuclear	1	35,061
Electricity and Other	1	438,199
Coal and Oil	1	2,001
Coal, Oil, Nuclear and Other	1	73,219
Coal, Natural Gas, Nuclear and Electricity	1	3,866,581
Electricity and Oil	1	1,575,366
All but Solar	1	182,376
All but Other	1	2,750

TABLE 9. Federal Organizations by Energy Form

Energy Form	Federal Organizations
Electricity	• Southeastern Power Administration • Alaska Power Administration • Southwestern Power Administration • Bonneville Power Administration • Rural Electrification Administration • Rural Electrification Administration - Capital Investment • Securities and Exchange Commission
Nuclear	• Nuclear Regulatory Commission • Atomic Energy Defense Activities
Coal	• Appalachian Regional Development • Employment Standards Administration • Office of Surface Mining
Oil	• Department of Transportation • Maritime Administration • Small Business Administration • Joint Federal-State Land-Use Planning Commission
MULTIPLE FORMS	
Fossil, Nuclear, and Other	• Bureau of Land Management
Fossil and Other	• Legal Activities - Justice Department
Coal and Nuclear	• Mine Safety and Health Admnistration
Electricity and other	• Bureau of Reclamation
Fossil, Electricity, and Other	• Forest Service • Bureau of Indian Affairs
Oil and Coal	• Interstate Commerce Commission
Coal, Natural Gas, Nuclear and Electricity	• Tennessee Valley Authority
All Forms	• Congressional Budget Office • Internal Revenue Service • Office of Management and Budget • Antitrust--Justice • Smithsonian (SSIE)

TABLE 9. (contd)

Energy Form	Federal Organizations
All Forms (continued)	• National Oceanic and Atmospheric Administration • Council on Environmental Quality • Office of Technology Assessment • Government Accounting Office • National Aeronautics and Space Administration • National Bureau of Standards • Environmental Protection Administration • Department of Energy • National Institute of Environmental Health • Federal Trade Commission • Occupational Safety and Health Administration
All but Solar	Geologic Survey
Petroleum and Nuclear	National Transportation Safety Board
Coal, Oil, Nuclear and Other	Bureau of Mines
Oil and Electricity	Corps of Engineers
All but Other	Housing and Community Research

TABLE 10. Energy Outlays by Energy Form (Condensed Version)

Energy Form	FY 1978 Outlays[a] ($000)	Percent of Total Outlays
Electricity	$4,034,844	29.5
Nuclear	5,585,096	40.8
Coal	1,630,365	11.9
Solar	371,412	2.7
Oil	1,646,805	12.0
Gas	296,946	2.2
Other	119,777	0.9

(a) These figures are derived from information presented in Appendix B.

ENERGY-RELATED ORGANIZATIONS AND OUTLAYS BY ENERGY STAGE (TABLES 11, 12, 13)

Table 11 is also based on columns 6 and 9 of Table 3. This table groups energy-related organizations and outlays by energy stage rather than form. Tables 12 and 13 are based on a combination of Tables 11 and 9. Table 12 groups organizations by both energy form (using single and multiple forms) and energy stage, while Table 13 does likewise for energy outlays.

Table 12 shows that the number of organizations involved with a given form/stage combination ranged from 13 for All Forms/Both to zero for many combinations. The number of organizations per form/stage combination averaged 0.83. Approximately 44% of the organizations fell into two form/stage combinations (All Forms/Both or Electricity/Production). About 62% of the organizations are involved at the production stage, 33% at both production and consumption stages, and just 4% at the consumption stage only.

Table 13 shows that outlays involved with a given form/stage combination ranged from $5,269,744,000 for All Forms/Both to zero for many combinations. Outlays per form/stage combination averaged $285,316,970. Approximately 38% of the outlays fell into one form/stage combination (All Forms/Both).

TABLE 11. Energy-Related Organizations and Outlays by Energy Stage

Energy Stage	Number of Organizations	FY78 Outlays ($000)
Production	28	8,330,468
Consumption	2	57,348
Both	15	5,297,429

TABLE 12. Energy-Related Organizations by Energy Form and Energy Stage

Energy Form	ENERGY STAGE Production	Consumption	Both
Single Forms			
Electricity	7	0	0
Nuclear	2	0	0
Coal	2	0	1
Oil	1	1	0
Multiple Forms			
All Forms	3	0	13
Petroleum	2	0	0
Petroleum and Electricity	1	0	0
Petroleum and Nuclear	1	0	0
Fossil, Electricity, and Other	1	0	1
Fossil, Nuclear, and Other	1	0	0
Fossil, and Other	1		
Coal and Nuclear	1	0	0
Electricity and Other	1	0	0
Coal and Oil	1	0	0
Coal, Oil, Nuclear and Other	1	0	0
Coal, Natural Gas, Nuclear and Electricity	1	0	0
All but Solar	1	0	0
All but Other	0	1	0

TABLE 13. FY 1978 Energy Outlays by Energy Form and Energy Stage ($000)

Energy Form	ENERGY STAGE Production	Consumption	Both
Single Forms			
Electricity	1,127,490	0	0
Nuclear	288,141	0	0
Coal	117,639	0	1,429
Oil	336,531	54,598	0
Multiple Forms			
All Forms	181,931	0	5,269,744
Petroleum	662	0	0
Petroleum and Electricity	1,575,366	0	0
Petroleum and Nuclear	1,852	0	0
Fossil, Electricity and Other	20,212	0	26,256
Coal and Nuclear	35,061	0	0
Electricity and Other	438,199	0	0
Coal and Oil	2,001	0	0
Fossil, Nuclear, and Other	81,880	0	0
Fossil and Other	1,327	0	0
Coal, Oil, Nuclear and Other	73,219	0	0
Coal, Natural Gas, Nuclear and Electricity	3,866,581	0	0
All but Solar	182,376	0	0
All but Other	0	2,750	0

ENERGY-RELATED ORGANIZATIONS AND OUTLAYS BY MAJOR TYPE OF ACTION (Tables 14, 15, 16)

Table 14 is based on columns 7 and 8 of Table 3. If an organization emphasized more than one type of action, it is counted only for the action we judge it to have emphasized most. We did not attempt to group multiple types (as in Table 8) or to estimate intraorganizational allocations (as in Table 10). Table 15 identifies the organizations we assigned to each type of activity.

Tables 14 and 15 show that the number of organizations giving most emphasis to a particular type of action ranged from 13 for requirements to one for Taxation. The number of organizations per type averaged 6.43. The total outlays of organizations emphasizing a given type of action ranged from $7,109,021,000 for Market Activity to $2,762,000 for Traditional Services. Approximately 52% of the outlays were made by organizations emphasizing Market Activity.

TABLE 14. Energy-Related Organizations and Outlays by Major Type of Action

Major Type of Action	Number of Organizations Emphasizing This Type of Action	FY78 Outlays ($000)
Creation or Prohibition of Organizations	1	5,061
Taxation	1	87,420
Disbursements	5	456,921
Requirements	13	757,488
Traditional Services	2	2,762
Nontraditional Services	12	5,266,572
Market Activity	11	7,109,021

TABLE 15. Federal Organizations by Major Type of Action

Major Type of Action	Federal Organizations
Organizational Creation or Prohibition	• Antitrust--Justice Department
Taxation	• Internal Revenue Service
Disbursements	• Employment Standards Administration • Appalachian Regional Development Program • Small Business Administration • Maritime Administration • National Oceanic and Atmospheric
Administration	
Requirements	• Occupational Safety and Health Administration • Federal Trade Commission • U.S. Geological Survey • Nuclear Regulatory Commission • Legal Activities--Justice Department • Council on Environmental Quality • Environmental Protection Agency • Securities and Exchange Commission • Joint Federal-State Land-Use Planning Commission • Interstate Commerce Commission • National Transportation Safety Board • Mine Safety and Health Administration • Office of Surface Mining
Traditional Services	• Office of Management and Budget • Atomic Energy Defense Activities
Nontraditional Services	• Congressional Budget Office • Office of Technology Assessment • National Aeronautics and Space Administration • General Accounting Office • Smithsonian (SSIE) • National Bureau of Standards • Department of Energy • Department of Transportation • Housing and Community Research--(HUD) • National Institute of Environmental Health • Bureau of Mines • Forest Service

TABLE 15. (contd)

Major Type of Action	Federal Organizations
Market Activity	• Southwestern Power Administration • Alaska Power Administration • Southeastern Power Administration • Bonneville Power Administration • Rural Electrification Administration • Rural Electrification Administration Capital Investment • Bureau of Reclamation • Bureau of Indian Affairs • Tennessee Valley Authority • Corps of Engineers • Bureau of Land Management

Table 16, which combines Tables 8 and 14, shows the relationship between energy form and major type of activity. It shows that the number of organizations involved with a given form/type combination ranged from 8 for Nontraditional Services/All Forms to one for many combinations. The number of organizations per form/type combination averaged 1.6. Nontraditional Services/All Forms and Market Activity/Electricity together account for 31% of the Form/Organization combinations.

Table 16 also shows that the outlays involved with a given form/type combination ranged fom $5,109,749,000 for Nontraditional Services/All Forms to $442,000 for Traditional Services/Nuclear. The outlays per form/type combination averaged $489,114,820. Approximately 37% of the outlays fell into one form/type combination (Nontraditional Services/All Forms). Four form/type combinations together have 85% of the outlays (Nontraditional Services/All Forms, Market Activity/Electricity, Market Activity/Oil and Electricity, and Market Activity/Electricity, Coal, Natural Gas and Nuclear).

TABLE 16. Energy-Related Organizations and Outlays by Action Type and Energy Form

Major Type of Action	Energy Form	Number of Organizations	FY78 Outlays ($000)
Creation and Prohibition of Organizations:	All Forms	1	5,061
Taxation:	All Forms	1	87,420
Disbursements:	Coal	2	114,107
	Oil	1	336,531
	All Forms	1	6,283
Requirements:	Nuclear	1	287,699
	All Forms	4	240,842
	Petroleum	1	622
	Electricity	1	747
	Coal	1	4,961
	Coal and Nuclear	1	35,061
	Oil and Coal	1	2,001
	Petroleum and Nuclear	1	1,852
	Fossil and Other	1	1,327
	All but Solar	1	182,376
Traditional Services:	Nuclear	1	442
	All Forms	1	2,320
Nontraditional Services:	Oil	1	54,598
	All Forms	8	5,109,749
	Coal, Oil, Nuclear and Other	1	73,219
	Electricity, Fossil, and Other	1	26,256
	All but Other	1	2,750
Market Activity:	Electricity	6	1,126,783
	Fossil, Electricity and Other	1	20,212
	Electricity and Other	1	438,199
	Oil and Electricity	1	1,575,366
	Coal, Natural Gas, Nuclear & Electricity	1	3,866,581
	Fossil, Nuclear, and Other	1	81,880

CONCLUSIONS

The preceding analysis is summarized in Table 17, where each organization is listed only once under one of the major types of actions. Although an organization may have conducted more than one major type of action, this table places all spending in the major type of action most frequently conducted by that organization. The first conclusion is that energy actions occurred in at least 45 different organizations in FY1978. The biggest single energy program is the Department of Energy. Energy spending as a percentage of government spending was only about 3%[4] while energy expenditures as a percentage of gross national product was about 12%. Over the past three years, the federal government has not spent a higher percentage of its budget on energy, even though the nation has spent a higher percentage of its gross national product on energy.

The government appeared to be trying a number of approaches, with greater emphasis on some. Heavy use was made of departments and relatively little use of independent agencies in the wake of the creation of the Department of Energy. Independent agencies were more heavily relied on prior to the creation of DOE (e.g., ERDA and FEA). Congressional supervision was spread among a number of committees, but was very heavy in a few. Some energy forms received much more attention than others. For instance, over the three years we have been performing this analysis, the percentage of federal spending devoted to electricity directly has dropped significantly, while the percentage devoted to nuclear energy has increased significantly. Energy production received much more attention than energy consumption. Research and market activities were used much more than organizational creation or disbursements.

Variations in incentives interacted in a number of ways. Some energy forms were addressed much more at one stage than another. Also, certain energy forms were addressed much more by one type of action than others. This unevenness in the application of incentives suggests that some opportunities may have been missed. Indeed, critics of federal actions toward energy have pointed to a number of them. Perhaps most frequently mentioned are: (1) the attention paid to production and the lack of attention to consumption and (2) the lack of attention paid to some very promising new technologies.

TABLE 17. An Estimate of the Cost of Generic Incentives Used to Stimulate Energy Production FY 1978 (Thousand $)

Energy Form	Creation and Prohibition of Organizations	Taxation	Disbursements	Requirements	Traditional Services	Nontraditional Services	Market Activity	TOTAL	Percent
Electricity	967	16,697	1,200	47,000	443	58,111	3,910,426	4,034,844	29.5
Nuclear	96	1,661	119	293,158	486	3,302,943	1,986,633	5,585,096	40.8
Coal	521	9,004	114,754	66,084	239	769,654	670,109	1,630,365	11.9
Solar	0	0	0	0	0	371,412	0	371,412	2.7
Oil	2,303	39,776	339,390	233,560	1,056	541,035	489,685	1,646,805	12.0
Natural Gas	1,159	20,019	1,439	116,959	531	105,080	51,759	296,946	2.2
Other	15	263	19	727	7	118,337	409	119,777	0.9
Total	5,061	87,420	456,921	757,488	2,762	5,266,572	7,109,021[a]	13,685,245	
Percent	0.04	0.64	3.34	5.53	0.02	38.48	51.95		100.0

(a) This value includes expenditures of $4,244,744,000 by the Tennessee Valley Authority and the Bonneville, Southwestern, Alaska, and Southeastern power administrations whose budgets are financed from operating revenues and not Federal Government funds.

Data summarized in Table 17 show that solar energy has received a very small part of the Federal Government's energy attention. However, the percentage of energy spending devoted to solar has increased from roughly one percent to roughly three percent. The data also suggest that the Federal Government has undertaken a large variety of actions with respect to other forms of energy. As a consequence, any expanded attention to solar energy could draw on a large number of existing options. The following chapters examine many of these federal actions toward other energy forms in much greater detail and over longer periods.

One additional conclusion emerges from a comparison of the results of this update with our previous analysis of federal spending on energy (Cone, et al., December 1978). First, consumer spending on electricity has increased relative to other energy forms. According to our calculations, electricity has increased from 16 to 19% of energy consumption or 21% if nuclear is included. As a percentage of purchases of energy, electricity (including hydropower and nuclear) absorbs 68%. The Federal Government devoted a roughly comparable percentage of its spending (70.4%) to nuclear plus electricity.

REFERENCES - CHAPTER III

1. Department of Energy, Energy Information Administration, Quarterly Report to Congress, Fourth Quarter, 1978. April 1979.

2. Quarterly Report, p. 50.

3. Coal, oil, and natural gas prices from Energy Information Administration, Annual Report to Congress, 1978, Volume 2, p. 13; electricity prices from Volume 3, p. 269 of the same Report (calculated by linear interpolation between historical 1978 value and projected 1985 value). The price obtained by interpolation from the Report equals 34.7 mills/kwh. Since 1 kwh = 3,412 Btu's, this is equivalent to the price of 1.019¢ x 10^{12} per quadrillion Btu's shown in the table above.

4. Total government spending in FY 1978 was $502 billion, (1980 Budget, p. 4) while energy expenditures totaled about $13.7 billion (this chapter).

IV. NUCLEAR ENERGY INCENTIVES

One of the hallmarks of commercial nuclear power is the high degree of federal participation in its development and regulation. In this chapter, we estimate the magnitude of federal support that has been directed toward making nuclear power in all its forms (including fission and fusion) into commercial energy resources. This support has been manifested in a number of ways: subsidies, use of facilities, sponsorship of R&D directly applicable to commercial nuclear power, education, transfer of technology from weapons, space and military applications, and legislation. Although not all of this support is monetary, where practical we have quantified it in 1978 dollars.

It is relatively simple to measure research and development costs, but much more difficult to estimate federal support derived from facilities constructed for weapons or military programs (e.g., the uranium enrichment plants) but now used largely for commercial nuclear power. Various approaches to this problem have produced a range of estimates. Even more difficult to measure are legislative actions which have facilitated, and in fact been vital to, commercial nuclear power. In this category is the liability protection (Price-Anderson Act) provided the industry. In such cases we simply describe the scope of federal support without attempting to quantify it. Other contributions to commercial power have been interwoven with political and foreign policy considerations that were beyond the scope of this project. Finally, it is impossible to quantify the contribution that derives from simply proving that a concept works, e.g., nuclear power, or from training people which become the nucleus of a new industry.

Secondary data used in this analysis were obtained from authorizing legislation for the Department of Energy (formerly Atomic Energy Commission and Energy Research and Development Administration), various General Accounting Office (GAO) reports, and other literature sources.

BACKGROUND

The development of nuclear energy required unique institutional arrangements, in which both government and private industry operated in ways very different from their conventional roles. The government's role in the development of nuclear power has been that of a participant in the creation and evolution of a commercial alternative to the power systems traditionally devised and manufactured by private industry.

The U.S. Government recognized at the beginning that although nuclear power had great potential benefits to the nation as an energy source, success was uncertain and long-range. Its development required large financial resources and greater risks than private industry alone was willing to take. Through government leadership, an arrangement was established with industry to provide a framework to develop nuclear power. The policies and practices formulated and implemented by the government have been effective in developing nuclear power within the traditional industry framework.

In 1970, there were 13 nuclear power plants in operation, representing only 2% of the total U.S. utility generating capacity.(1) At present, the U.S. has 70 reactors with operating licenses and about 126 powerplants are either under construction or planned.(2) Nuclear plants currently account for about 13.0% of total utility generating capacity,(2) with estimates of about 21% by 1985.(4)

From the beginning the development of commercial nuclear power derived from manpower, facilities, technology and contracting policies which had their genesis in World War II. The technology grew out of military applications of atomic power, namely the weapons and naval reactors program. Originally, the energy source was controlled by the Federal Government under conditions of secrecy.

The Atomic Energy Act of 1946 created the basis for commercial development of nuclear power. The act transferred the atomic energy program from military to civilian control. The "Declaration of Policy" stated:(5)

> It is hereby declared to be the policy of the people of the U.S. that, subject at all times to the paramount objective of assuring the common defense and security, the development and utilization of atomic energy shall, so far as practical, be directed toward

improving the public welfare, increasing the standard of living, strengthening free competition in private enterprise, and promoting world peace.

The Atomic Energy Commission's original charter, as stated by law, was to develop the utilization of fission energy.[5,p.261] The 1946 Act established two governmental bodies to control and develop nuclear power: the AEC in the Executive Branch and the Joint Committee on Atomic Energy (JCAE) in the Congress. Two bodies were established because it was believed that a single administrator should not control all nuclear activities.[5,p.24] Concurrent with, and to some degree as a result of, AEC contracting arrangements and development programs, a third party emerged, the industrial suppliers. Up to the end of 1974, this three-member group remained a stable coalition working together toward the goal of developing nuclear power. However, the control of nuclear power remained primarily within the government's jurisdiction.

Two other major pieces of federal legislation have been instrumental in the trend away from the federal monopoly of nuclear power - the AEC laws of 1-954 and 1964. Major modifications occurred with the passage of the AEC Act of 1954.[6] This new act paved the way for industrial participation in nuclear power development.

Among other changes, this law called for the declassification of much information that had been previously restricted. It established procedures by which private interests could obtain classified data needed for nuclear power development. Most significant of all was the end to the government's monopoly on reactor ownership. For the first time, private industry was permitted to own and operate nuclear reactors, including those for the generation of electricity.[6,p.196] The AEC was still denied authority to build reactors for purposes unrelated to research and development, such as the business of generating or selling power.

However, through the 1954 Act the government still retained ownership of all fissionable material. Private operators could obtain such material only on lease from the Federal Government. Likewise, any fissionable material generated within a privately owned reactor was also government property.[17]

With both a policy and a legal platform established, the AEC was in a position to encourage the evolution and growth of the nuclear power industry. Because of the financial risk involved, a framework of government-industry cooperation was developed for financing early nuclear power plants. This first took the form of the Power Demonstration Reactor Program (PDRP), initiated in 1955. Three rounds of demonstration plants were built under this program, in which the AEC offered financial incentives to cooperating utilities to help build competitive nuclear plants. Research and development technology, waiver of fuel use charges, fuel fabrication and the training of operators[8] were among the terms offered under the PDRP.

Although the 1954 Act permitted the private ownership of nuclear reactors, the fuel needed for the reactors was available only on lease from the Federal Government and the product plutonium was to be sold back at a fixed price. In 1964, legislation permitting private ownership of fissionable material was passed. Full private ownership was reached in steps over a period of years.[7,p.100] Therefore, during its infancy, the commercial nuclear power industry had a set price for fuel and a guaranteed supply and market for its product, plutonium.

INCENTIVES

The AEC's basic goal was to transfer the federally developed nuclear reactor and fuel cycle technology to a self-sustaining private industry. Roadblocks to private commercialization were removed when necessary support and incentives were provided to create an independent nuclear supply industry and encourage utilities to build nuclear plants. As stated by the Commission:

> At present, atomic energy is a government-owned industry. This departure from the normal pattern of industrial enterprise in the country was not taken capriciously or with intent to alter our institutions. It was deemed necessary to cope with the unique and unfamiliar characteristics of atomic energy and because its products then went almost entirely into our military arsenals. Continuance of complete government dominance into the period of major practical applications, involving as it would a basic change in the

fundamental roles of government and of private individuals and firms, could produce a change in our society as significant in its way as any that might accure from the technical novelty of nuclear power.

In order that the principal effect of realizing nuclear power may be to confirm and strengthen rather than to change our economic institutions and our way of life, we believe that nuclear power should be produced and distributed by the private and public power systems and not by the Commission.[9]

To a large extent this goal has been reached. Currently, all steps in the fuel cycle, except enrichment and waste management, are handled by industry. Table 18 explains the steps in the nuclear fuel cycle. An estimated $21 billion has been spent since 1950 by the Federal Government to develop commercial nuclear power. These costs (in 1978 dollars) can be assigned as follows:

• Research and development activities	$17.2 billion
• Liability insurance	not quantifiable
• Uranium mining industry	not quantifiable
• Enrichment plants	$2.1 billion
• Regulation activities	$1.65 billion
• Waste management	included under R&D
Total	$20.95 billion

Within the scope of this project, some incentives could not be quantified. These incentives are discussed in the following sections.

RESEARCH AND DEVELOPMENT ACTIVITIES

From the beginning, the development of nuclear reactors of all types has rested on a broad program of basic technology supported by the AEC. Research and development programs were carried out largely by national laboratories, industrial concerns and private and public institutions under contracts administered by the AEC field offices and by industrial firms with their own

TABLE 18. Steps in the Nuclear Fuel Cycle[a]

Step	Description	Institution Involved
Mining	Underground and surface mining of ore.	Independent mining companies. Large resource companies.
Milling	Mechanical and chemical refined ore to "yellow cake." Usually done near mine.	Mining and chemical companies.
UF_6 production	Conversion of "yellow cake" to gas for enrichment	Chemical companies and resource companies.
Enrichment	Concentration of natural uranium content of ^{235}U at 0.7% to between 2% and 4%. Current technology being upgraded and new techniques being tested. Gaseous diffusion plant with capacity of 9 million separative work units (SWU) requires about 2,500 MWe electric plant to operate at full capacity.	Federal Government. Private ownership being encouraged.
Fuel fabrication	Conversion of enriched UF_6 gas to solid and assemble in fuel pins and elements.	Nuclear steam system suppliers, large resource companies, others.
Utility power plant	Converts energy in uranium to electricity	Investor-owned, public and federally owned utilities.
Waste fuel	"Burned" up fuel bundles which no longer sustain the power output of the reactor. Has concentration of about 1% ^{235}U plus about 0.6% plutonium "bred" in the reactor.	Public utilities and federally owned utilities.
Fuel reprocessing	Recovery of usable uranium and plutonium from waste.	Chemical and nuclear service companies.
Waste management	Problem is high-level waste whether recycling proceeds or not. Problem is safe waste management essentially forever because of the level of radiation and the long life of the radioactive isotope.	Federal Government

(a) Adopted from The Nuclear Power Controversy, The American Assembly, Columbia University, Prentice-Hall, Englewood Cliffs, NJ, 1976.

funding. To develop commercial reactors, AEC's program had two main thrusts: 1) to develop basic R&D, and 2) to build demonstration plants in partnership with industry.

The Controller's Office of DOE (ERDA) analyzed funds spent on the development of commercial nuclear power from 1950 through 1978. These figures are presented in Tables 19 and 20. The total contribution to commercial nuclear power was comprised of contributions or partial contributions from one or more of the following programs:

- Nuclear materials
- Laser fusion
- Controlled thermonuclear reaction (magnetic fusion)
- Civilian reactor development (fission)
- Advanced isotope separations
- Waste management
- Reactor safety research
- Resource assessment
- Reactor safety facilities.

These programs are comprised of operating, equipment and construction funds. In the DOE analysis, the major program contribution to civilian nuclear power was the Civilian Reactor Development Program (CRDP). Approximately 81% of the R&D funds allocated to commercial nuclear power by DOE from 1950 to 1978 have been spent through CRDP.[2] The remaining 19% has been spent through other program categories. The bulk of the DOE support has been in the form of research and development dollars.

Developmental fission reactors and the early cooperative power reactor projects were also supported through the CRDP program. The portion of costs assumed by the AEC for the demonstration projects was about 20% of the total costs incurred, with industry contributing the remaining 80%.[8]

More recently, the Liquid Metal Fast Breeder Reactor (LMFBR) program has received most of the funds of the CRDP. The GAO reports that from 1948 through fiscal year 1978, $4.4 billion has been spent on R&D for the breeder reactor.[2]

TABLE 19. Research and Development Expenditures for the Nuclear Power Program 1950-1974 (in Millions of Dollars)

Year	Nuclear Materials	Laser Fusion	CTR Magnetic Fusion	Civilian Reactor Dev. Fission	Plowshare	Advanced Iso. Separations	Waste Management	Reactor Safety Research	Resource Assessment	Total Current $	Total 1978 $
1950	3.3			3.9						7.2	19.5
1951	3.7		0.3	11.3						14.8	37.2
1952	4.1		0.4	15.8						20.3	49.9
1953	4.3		0.4	19.1						23.8	58.0
1954	5.1		1.8	31.6						38.5	93.4
1955	5.1		6.1	45.9						57.1	139.1
1956	6.0		7.4	69.2						82.6	198.7
1957	7.4		11.6	116.8						135.8	314.0
1958	8.3		28.8	128.0						165.1	372.5
1959	8.1		28.9	162.5						199.5	446.5
1960	8.1		33.7	219.0						260.8	574.5
1961	1.0		30.0	231.2						267.2	571.9
1962	8.7		24.8	217.7						251.2	541.0
1963	9.6	0.2	25.5	218.1	1.0					254.4	542.1
1964	9.8	1.1	22.6	200.8	1.2					235.2	494.6
1965	9.0	1.3	23.1	204.6	0.7					238.7	493.6
1966	9.0	1.2	23.1	198.6	1.7					231.6	465.5
1967	7.6	1.4	23.9	201.2	4.8					238.9	444.0
1968	7.6	1.3	26.5	248.6	2.3					286.4	537.0
1969	9.3	2.1	29.7	234.1	3.4					278.6	499.9
1970	12.4	3.2	34.3	231.0	5.8					286.9	482.0
1971	19.3	9.2	32.2	265.6	6.8					333.1	536.6
1972	23.4	17.0	33.1	324.0	7.0					404.5	630.6
1973	35.5	26.8	39.3	341.2		0.8	3.6	41.0		488.2	716.7
1974	83.0	43.3	57.2	431.9	—	3.7	12.0	48.0	2.9	659.0	871.9
Totals	305.1	138.1	564.9	4,389.7	34.7	4.5	15.6	89.0	2.9	5,454.0	10,190.6

Source: Nuclear Energy Branch Office of the Controller ERDA (now DOE)

TABLE 20. Research and Development Expenditures for the Nuclear Power Program 1975-1978 (in Millions of Dollars)

	Year					
	1975	1976	1976 TQ	1977	1978	Total
Magnetic Fusion	95.0	139.0	50.0	211.0	277.0	772.0
Breeder Reactor Systems	523.0	496.0	136.0	654.0	766.0	2,575.0
Converter Reactor Systems	34.0	45.0	22.0	67.0	96.0	264.0
Commercial Nuclear Waste	25.0	33.0	18.0	115.0	123.0	314.0
Spent Nuclear Fuel					5.0	5.0
Advanced Nuclear Systems	34.0	39.0	12.0	42.0	61.0	188.0
Light Water Reactor Facilities	___	___	___	20.0	27.0	47.0
Total in current $	711.0	752.0	238.0	1,109	1,355	4,165.0
Total in 1978 $	861.7	861.8	272.7	1,194.4	1,355	4,545.6

Source: Nuclear Energy Branch Office of the Controller DOE.

Using the ERDA and DOE data, we calculate that $14.7 billion (1978 dollars) has been spent on commercial nuclear power through 1978. The percentage of the DOE budget allocated for the development of commercial nuclear power has increased over time. In the early 1950s, only 1-2% of the budget was apportioned by the Atomic Energy Commission to commercial nuclear power R&D. Approximately 17% of the 1978 DOE funds were spent on commercial nuclear power.[2]

The DOE figures include R&D contributions only from programs directly supportive of nuclear power as an electricity generation source. Enrichment R&D, along with the R&D of supporting technology (waste management, reactor safety research) are included, but not contributions from Biology and Environmental Science, Education Information and Training, or program management costs.

In analyzing other program categories for possible contributions to commercial nuclear power, we used the following assumptions:

1) We assumed that overall the military and space nuclear programs (other than submarine propulsion) did not contribute technological information to the commercial nuclear power program, the submarine propulsion program is the major military contributor.

2) For jointly funded facilities and capital equipment where the commercial aspects of programs were less than 50% of the total funds, we assumed that they would have been provided for the noncommercial sector.

There is no simple way to verify assumption 1. In the early years of atomic energy the weapons program developed many aspects of the emerging commercial nuclear power program. Methods of handling radioactive materials, neutron diffusion codes, critical experiment technology, and other information were largely applicable to the commercial program. The commercial program developed around an alternative fuel form (uranium oxide rather than uranium metal), cladding material, pressure member (vessel rather than tube), moderator (light water rather than graphite or heavy water), and reactor components. Technology from these developments became available to the weapons program. Fuel reprocessing technology, as presently conceived for commercial nuclear power, is based on weapons program-developed processes, but it is not clear at this time that these processes will become commercial. Waste management technology is being developed for both applications.

Out of the military reactor program grew the pressurized water reactor technology. But again fuel forms differ, reactor components are substantially larger and of different designs for the commercial market. Compactness and long-life are much more important to military applications. Further, much of the military technology remains classified while most of the commercial technology is reported in the open literature and thus is available for military application. On balance, then, it seemed that assumption 1 was warranted. The nuclear submarine propulsion program made significant technological and personnel contributions in the 1950s. While much of the program was classified, the transfer of people from the naval Program to industry carried both the expertise and technology into the industry PWR programs. Important technical areas from the Naval Program include zirconium technology, reactor control (including nuclear constants and codes), piping and pressure vessel design. The money contribution from the submarine propulsion R&D programs was taken at 50% of the total in 1950, declining linearly to 0% in 1959. The resultant contribution of the nuclear submarine program is $0.14 billion ($1978).

With these assumptions we did not include any contributions from the weapons, naval reactors other than a portion of submarine R&D, or space nuclear programs. However, several other categories of funds, such as Biology and Medicine, Physical Research, Program Management, and Education and Training provided support to both the commercial sector as well as the weapons and military sections. Including a proportional share of these costs increases the amount of Federal money invested from $14.7 to $17.2 billion, as shown in Tables 19, 20, and 21.

Table 21 is based on the following reasoning. The Biomedical and Environmental Program focuses on health studies of humans who have been exposed accidentally, occupationally, or therapeutically to radiation. Research is

TABLE 21. Mixed Program Contributions to Civilian Nuclear Power (1978 Dollars in Millions)

Biology and Medicine	$418
Nuclear Submarine Propulsion Research	140
Education and Training	141
Physical Research	1,300
Program Management	553
Total	$2,552

conducted in the basic areas of biological studies, health studies, environmental studies, waste management, physical and analytical studies, heart devices and some other minor areas. Most of this work done before 1965 supported the weapons program. Therefore, only the years since 1965 have been apportioned for the tabulation in Table 21. We assumed the contributon from biology and medicine to civilian power development to be in the same proportion as the civilian power program to the fiscal year AEC (or ERDA or DOE) budget. Applying that percentage results in approximately $418 million (1978 $) from 1965 through 1978.

From examination of the educational and training budget it appeared that about one-third of the programs contributed to or directly supported the development of commercial nuclear power. This contribution totaled $141 million (1978 $).

Currently the physical research program is funded in three categories: nuclear physics, high energy physics, and basic energy sciences. The nuclear physics program supports research in the areas of medium energy physics, heavy ion physics, and nuclear theory. The high energy physics research has been directed toward understanding energy and matter in their most basic forms. The justification for this effort is broadly based. It ranges from a crucial frontier role in the effort of man to understand the universe, through the possiblity of important discoveries for meeting the longer range needs of society, to technological contributions to present energy problems. The basic energy sciences program is comprised of four subprograms: nuclear sciences; materials sciences; molecular, mathematical, and geo-sciences; and advanced energy projects. The objective is to develop scientific understanding of physical phenomena basic to all applications. The program is designed to develop new experimental and theoretical insights, new concepts, improved instrumentation, and other innovations in the key areas for continued progress in energy research, development, and demonstration.

Programs of this nature appear to support future technologies more than present technologies (e.g., fusion more than fission). Since these future technologies have not yet emerged, the connection between the research and the technology is often very obscure. Still, it was the "physical research" of the early twentieth century that laid the foundation for the commercial nuclear industry of today. This rationale led us to take a ratio of the Physical Research budget in the same proportion as the civilian power program is to the fiscal year AEC (or ERDA or DOE) budget. Thus, an additional $1300 million (1978 $) could be included from 1950 through 1978.

Program management or administrative costs can be allocated with similar reasoning. That is, in any one year the portion of program management allocated to nuclear power should be the same percentage of the total amount spent in that area. Thus, an additional $553 million (1978 $) could be included from 1950 through 1978.

Between 1948 and 1978, the Federal Government contributed to the development of nuclear power, without direct charge, $17.2 billion (1978 dollars) in the area of knowledge acquisition, dissemination and professional services. Therefore, this incentive has been classified as nontraditional service.

Approximately $14.7 billion of this figure comes from DOE's calculation of the contribution to commercial power development. An additional $2.5 billion was included from the Biology and Medicine, the Physical Research, Education and Training, and Program Management categories; an amount was also included from the submarine nuclear programs noted.

LIABILITY INSURANCE

We could not locate in the literature a total quantification of the value of the liability insurance provided to the commercial nuclear power program by the Price-Anderson Act. This act was quite clearly an important government action that encouraged nuclear power development.

The 1954 Atomic Energy Act allowed for private ownership and operation of nuclear reactors. This raised the question of liability in the case of an accident, especially a catastrophic accident. At this time the competitive position of nuclear power had not been established and industry did not know when it would become profitable. The suppliers and the operators of nuclear facilities were not willing to take on the additional financial risk of a catastrophic accident which could conceivably bankrupt the companies involved.[5,p.124] To meet this need, the Price-Anderson Act, enacted in 1957, was designed to financially protect the public and AEC licensees and contractors against excessive risks associated with the use of nuclear power.

Although the exact magnitude of a "catastrophic" accident was never specified in the 1957 hearings, industry spokesmen visualized the possibility of liability substantially in excess of $500 million.[11] The private insurance industry would not provide this amount of insurance, first because they had no experience with the risks of nuclear reactors, and second, because the potential liability was many orders of magnitude beyond the capacity of the insurance industry.[11]

Utilities and equipment suppliers publicly expressed their reluctance to risk their solvency, all the assets of their stockholders, and the very existence of their companies on the remote possibility of a major nuclear catastrophe that was insurable to only a limited extent. Following are some comments made by industry spokesmen in the 1955-1957 era about this subject.

> At this time we do not see any sound basis on which we can risk solvency on the possibility, remote as it may be, of a major nuclear catastrophe. (William Gale, Chairman, Commonwealth Edison Co.)[12]

Obviously we cannot risk the financial stability of our company for a relatively small project . . . We cannot exclude the possibility that a great enough fool aided by a great enough conspiracy of circumstances, would bring about an accident exceeding available insurance. (Charles H. Weaver, V.P., Westinghouse Electric Co.)[13]

We have been very reluctant, categorically, to state that we will not proceed unless an indemnity bill is passed by Congress . . .

Eventually, however, there comes a time for a frank statement on the position of the General Electric Company . . . At present, I see no alternative but to recommend that work on the Dresden station be halted as soon as practicable after the end of this session of Congress in case appropriate legislation has not been passed by that time. (Francis K. McCune, V.P., General Electric Co.)[14]

AEC and the Joint Committee on Atomic Energy (JCAE) solved the problem using an indemnification approach rather than government insurance. The reason for indemnification was explained by the JCAE as follows:

A system of indemnification is established rather than an insurance system, since there is no way to establish any actuarial basis for the full protection required. The chance that a reactor will run away is too small and the foreseeable possible damages of the reactor are too great to allow the accumulation of a fund which would be adequate. If this unlikely event were to occur, the contributions of the companies protected are likely to be too small by far to protect the public so Federal action is going to be required anyway. If the payments are made large enough to insure that there is an adequate fund available, the operation of the reactors will be made even more uneconomic. On the other hand, if, as the Joint Committee anticipates, there never will be any call on the fund for payments, the funds will have been accumulated to no purpose.

Committee not to treat this as an insurance problem but to treat it as an indemnification problem. there seems to be no real need for establishing all the technical mechanisms of an insurance fund in this situation.(5,p.125)

Thus, while private industry was saying that it needed the protection before it could proceed with any further commercialization, the government recognized that the cost of insurance would be an economic burden that would raise reactor costs. By stating that it would not require full insurance, the JCAE indicated that an indirect government subsidy to the reactor development program was intended. If no accident ever occurred, the approach would essentially cost the government nothing.

The provisions of the act covered firms involved with the chemical processing, fuel fabrication plants, firms providing transportation between plants, R&D reactors, and commercial reactors. The purpose of the fee was to cover administration costs, as illustrated by this comment from JCAE:

> The fee for indemnification is not set by the Commission. The Commission is not seeking to go into the insurance business. It is not trying to establish an actuarily sound fund, and it is not trying to get into the rate-making business. The legislation calls for a minimal fee to cover administrative costs of this program. (5,p.131)

Provisions of the original 1957 Price-Anderson Act were effective for ten years. Since 1957 the act has limited the amount of liability protection to $560 million even though the possibility exists that damages could exceed this amount. It provided government indemnity in the amount of $500 million for each nuclear incident above the maximum private liability insurance available in 1957--$60 million. The act, as amended in 1965, extended the government indemnity for ten additional years. The government also provided for a "no-fault"-type clause, meaning that proof of negligence of the reactor owner was not required before the injured party could be compensated.[15]

The Price-Anderson Extension Act, amended in 1975, will phase out the government's indemnification of commercial reactors, although nonprofit and R&D reactors will remain covered to the $560 million liability limit. Private insurance companies are currently providing $125 million of insurance. Essentially, the plan consists of a deferred or retrospective premium, which is payable by the utilities only if there is an incident. Therefore, a layer of "pool insurance" is created, in addition to the amount provided by the private insurance companies. This layer will increase as the number of reactors increases until the pool is able to provide the total difference between $560 million (total liability limit) and the primary insurance layer, phasing out the government. The Nuclear Regulatory Commission, now administering the Price-Anderson Act, has set the retrospective premium at $5 million per reactor per incident, with a limit of $10 million per facility maximum payment for any calendar year.[16]

Since its enactment in 1957, there has been much discussion about whether, and to what extent, Price-Anderson indemnification has been a subsidy for nuclear energy. In analyzing this question, two items to consider are 1) the Price-Anderson Act removed a stumbling block to the development of nuclear power and 2) the cost of potential liability was not borne by the nuclear industry, so the apparent economic competitiveness of nuclear power with other energy sources may be misleading. The act authorized NRC (or its predecessors) to collect fees, beginning in 1957, in return for the indemnity. The fee is $30 per year per thousand kilowatts of thermal energy authorized by the reactor's license.[a] By August 1, 1977, almost $10 million in indemnity fees had been collected. Only minor claims have been made against the government for indemnity liability.

Without Price-Anderson, the utilities would have to purchase liability insurance. They would also have to estimate a cost for the uncertainty that a potential loss might exceed the liability limits available on the private market. These costs would be passed on to the consumer in higher electricity

[a] the annual fee for a 1000 MWe power plant would be about $90,000.

prices. The price of nuclear power would therefore increase and the utilities would have to decide whether nuclear power would be competitive and profitable in relation to other energy sources.

GAO estimated a portion of the subsidy inherent in the Price-Anderson Act in a report issued in 1976. They computed the annual indemnity subsidy to be no more than $145,480 for a utility with one 1,000 MWe reactor at a site and no more than $114,350 for a utility with two 1,000 MWe reactors at a site. This subsidy was calculated as shown in Table 22.(17)

TABLE 22. The Value of Government Indemnity to the Nuclear Power Plant Owner(17)

		Additional Annual Cost of Liability Insurance if Available		Annual Indemnity Fee		Annual Subsidy
One Reactor Rated at 1,000 MWe	less	$348,000(a) 112,520(a)		$90,000		
		$235,480	-	$90,000	=	$145,480
Two reactors, each rated at 1,000 MWe	less	$435,000(a) 140,650(c)		$180,000		
		$294,350	-	$180,000	=	$114,350

(a) Computation based on current premium per $1 million of atomic energy insurance.
(b) The present value of the two-thirds insurance rebate ($232,000) after 10 years, discounted at the average rate of return on investment for appropriate electric utilities from 1970 through 1973 (7.5%).
(c) The present value of the two-thirds insurance rebate ($290,000) after 10 years, discounted at the average rate of return on investment for appropriate electric utilities from 1970 through 1973 (7.5%).

To multiply these annual figures for reactors by the years each has been in operation would be one way to obtain an approximation of the subsidy for commercial nuclear reactors. However, this figure would represent only a small percentage of the broad coverage which has been provided for fuel fabrication plants, nuclear equipment suppliers, etc. covered under the Price-Anderson Act. This incentive has been classified as a disbursement since that category includes promises to disburse under certain circumstances.

The Price-Anderson Act has existed since 1957 but only a small amount has been disbursed to pay claims. We could not find in the literature any estimate of the total subsidy for protection from liability that has been provided to participants in the commercial nuclear power industry. However, it is quite clear that the Price-Anderson Act removed a crucial stumbling block in the development of commercial nuclear power.

INCENTIVES TO THE URANIUM INDUSTRY

The uranium industry has been influenced to a greater extent by government policy than has any other natural resource industry.[18] The uranium production industry in the U.S. developed and grew in the late 1950s as the result of stimulation by the U.S. weapons program. Until 1966, the Federal Government was the only buyer for the industry's product. The government set prices, bought and owned all uranium as soon as it was mined. The AEC significantly influenced the size and structure of the industry by its procurement policies. Even today the uranium industry is highly dependent on government policy decisions in such areas as enrichment and the export-import of uranium.

Although the initial stimulus for uranium mining was to provide material for the military, later government policies supported the mines and mills until private demand for the ore as fuel for commercial nuclear power plants developed.

The incentives used to encourage the uranium industry were:

- AEC procurement policies
- restriction on import of foreign ore
- enrichment policies
- tax policies

Procurement Policies

Prior to the mid-1940s the only commercial use for uranium was as a coloring agent in the ceramic industry. The U.S. needs for the war effort were supplied from a mine in the Belgian Congo, another small mine in Canada, and a few scattered deposits in the U.S. In 1947, the AEC was formed and plans for a much expanded nuclear weapons program unfolded. Domestic reserves were then estimated at 2000 tons of U_3O_8.[19]

Recognizing these reserves and U.S. dependence on foreign ore, the AEC set out to establish a program that would provide sufficient uranium for both weapons production and research needs. Histories of the AEC's procurement program are availale from several literature sources and also from Circulars 1-8 issued by the AEC.

To stimulate production and exploration, the AEC program offered domestic producers long-term contracts with attractive incentives:[18,p.71-73]

1) a ten-year guaranteed minimum price for certain high-grade uranium ore

2) a $10,000 bonus for the discovery and production of high-grade uranim ore

3) a guaranteed three-year minimum price for ores from the Colorado Plateau.

The government also carried out an extensive domestic exploration program between 1948 and 1955 for the benefit of the uranium industry. These activities were conducted by private concerns under contract to AEC, by the U.S. Geological Survey, by the U.S. Bureau of Mines, and by AEC's geological staff. In addition, the AEC constructed and operated ore-buying stations (later phased out) and built numerous access roads to remote mine areas.[5,p.161]

Production of U_3O_8 increased dramatically between 1948 and 1958. A total of 261,000 mineable tons of contained U_3O_8 were discovered in this period.[19] The stimulation policies were so effective the AEC was forced to modify them in 1958-1962 to avoid accumulation of excessive stock pile.[18,p.7.2-7.3]

> . . . In April 1958, the AEC issued a release announcing that uranium reserves developed after Novemer 1, 1957, would not be eligible for purchase in the pre-1962 period.
>
> . . . In November 1958, the AEC issued a release substantially modifying its 1956 announcement regarding the 1962 to 1966 procurement

program. Under the new announcement, only uranium reserves developed prior to November 1958 are eligible for the 1962 to 1966 purchase program. The purchase price of \$8.00/lb of U_3O_8 was retained.

> . . . In November 1962, the Commission announced the "stretchout" purchase program. Companies which elected to participate in the program could defer to 1967 and 1968 a portion of the uranium which otherwise would be sold to the AEC between 1963 and 1966. The 1967-1968 price was also \$8.00/lb of U_3O_8. In return for the deferral, the Commission agreed to purchase in 1969 and 1970 an amount of uranium equivalent to that deferred to 1967 and 1968 at a computed price not to exceed \$6.70.lb of U_3O_8.

The effect of the government incentives to expand uranium production is reflected in uranium drilling activity. Historically, drilling activity has been correlated with additions to reserves and both were correlated with early AEC procurement policy. Surface drilling steadily increased through 1957 while the principal incentive programs were in effect (Figure 4). Drilling activity then steadily decreased through 1965. From 1966 to 1969, drilling activity increased again on the basis of a sharp increase in new orders for nuclear power plants. Drilling declined between 1970 and 1972 largely because of delays experienced in nuclear power plants coming on-line.

However, since the anticipated market demand by the utilities did not materialize as early as AEC had expected, a "stretchout program" was implemented. As noted by Dawson in Nuclear Power: Development & Management of a Technology:(5,p.162-163)

> . . . In anticipation of a transition from a government-controlled market to a commercial market, and to provide a basis for long-range planning by the mining and milling companies, the AEC announced a

new procurement program for the period April 1, 1962, through December 13, 1966; this program provided a guaranteed market, subject to certain conditions; such as quality, for domestic uranium concentrates . . .

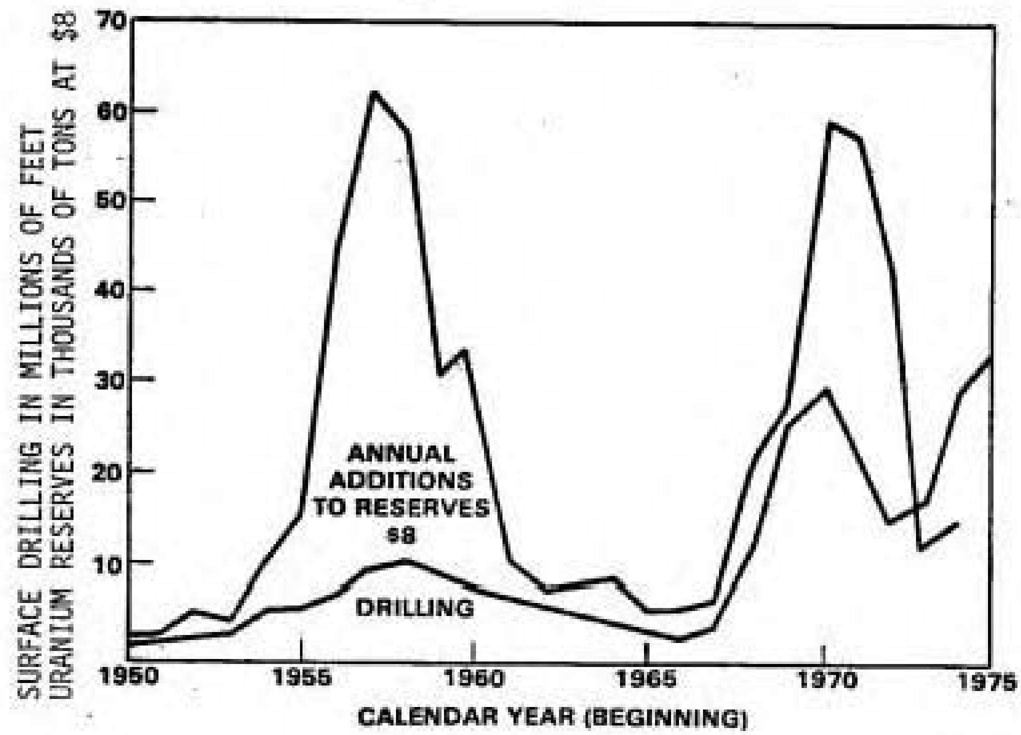

FIGURE 4. Annual Surface Drilling and Reserve Additions (AEC Data)

It was evident to the AEC in 1962 that by 1966, which was the termination date of the AEC's purchase program, the commercial market for uranium would not be sufficient to absorb the production from the uranium industry. With the objective of maintaining a viable industry, the AEC announced a stretchout program on November 17, 1962. The program was to run from December 31, 1966, to December 31, 1970.

The new program consisted of deferral of a portion of the material then contracted for delivery to the AEC before 1967. The deferred material would be purchased by the AEC during the period from January 1, 1967, through December 31, 1968, at prices previously established. An additional quantity equal to the deferred quantity would be purchased from January 1, 1969, to December 31, 1970. The fixed price would be 85% of production cost plus \$1.60/lb of U_3O_8, with a maximum of \$6.70/lb.

From 1948 to 1970 the AEC's total purchase of uranium (tons of U_3O_8) had been 315,900 tons, from the following sources:[5,p.163]

Domestic	174,500 tons (55%)
Canada	73,800 tons (24%)
Overseas	67,600 tons (21%)
Total	315,900 tons

In 1971, the AEC terminated the uranium purchase program after purchasing \$2.9 billion of uranium from domestic sellers at an average price per pound of U_3O_8 of \$8.52. The domestic uranium-producing industry was then dependent on the commercial market.

The long-term procurement contracts had attracted sellers by assuring that their productive capacity would be utilized at predictable levels and prices. AEC's major problem was adjusting incentives to yield the desired production. When it became apparent that the original incentives were resulting in the accumulation of too much uranium, AEC was forced into the position of allocating its future uranium purchases among the many sellers that had responded to its incentive program. This situation was analyzed by a Battelle Memorial Institute study for the National Science Foundation.[18,p.7.5, 7.6]

> The allocation program proved to be difficult to administer and generated many complex legal problems. For example, the AEC allocated its maximum uranium purchase obligations on the basis of resources contained in all properties in which a producer owned mineral rights. An operator controlling more than one property generally had his properties grouped together into a property unit and was free to produce his allocation from the reserves within the property unit which offered the lowest production cost. Problems subsequently arose when ownership changed and operators added or transferred property containing uranium reserves. An operator then controlling

two property units, for example, would have to produce his quota from each separate unit even though efficiency might dictate production from only one unit. In some instances the AEC alleviated this problem by permitting consolidation of property units. Another problem was the difficulty in determining whether claimed reserves could actually be mined at a profit. Some holders of allocations did not produce because it was uneconomic to do so.

The stretchout program created additional problems. During the 1962-1968 period, the AEC purchased uranium at a flat price of \$8.00/lb of U_3O_8. This flat price facilitated payment but had the effect of benefiting producers with low production costs and hurting those with high costs. The price paid during 1969 and 1970 was based on 85% of average allowable production costs between 1963 and 1968 but could not exceed \$6.70/lb of U_3O_8. The average price paid was less than \$6.70/lb of U_3O_8. The determination of average allowable production costs generated many difficult problems and required detailed provisions in the stretchout contracts.

Restriction on Import of Foreign Ore

After terminating the uranium purchase program one benevolent policy to the uranium industry remained--the restriction on the import of foreign uranium ore. Passage of the "Private Ownership of Special Nuclear Materials Act" in 1964 placed a prohibition against importing foreign uranium for use in domestic nuclear power plants. Section 161 of the 1964 Act states:

> And provided further, that the Commission, to the extent necessary to assure the maintenance of a viable domestic uranium industry, shall not offer such services for source or special nuclear materials of foreign origin intended for use in a utilization facility within or under the jurisdiction of the United states. The Commission shall establish criteria in writing setting forth the terms and conditions under which services provided under this subsection shall be made available including the extend to which such services will be made available for source or special nuclear material of foreign origin intended for use in a utilization facility within or

under the jurisdiction of the United States: Provided, that before the Commission established such Criteria, the proposed Criteria shall be submitted to the Joint Committee, and a period of forty-five days shall elapse while Congress is in session (in computing the forty-five days there shall be excluded the days in which either House is not in session of adjournment for more than three days unless the Joint Committee by resolution in writing waives the conditions of, or all of any portion of, such forty-five day period).[19]

By this provision, the domestic uranium industry was protected from competition from the cheaper foreign uranium. In 1975, the policy was changed to phase out the restriction on the use of foreign uranium in domestic plants, according to the following schedule shown in Table 23.[20,p.308]

TABLE 23. Percent of Foreign-Origin Uranium Ore Permitted for Use in U.S. Plants

1977	Up to 10% of Uranium Furnished for Enrichment may be of Foreign Origin when used in a Domestic Plant
1978	15%
1979	20%
1980	30%
1981	40%
1982	60%
1983	80%
1984	No Restrictions

We did not attempt to quantify the subsidy to the uranium industry created by the ban on the use of foreign ores in domestic reactors. While the cost of uranium to the ultimate user (the utilities) might have been higher, still the utilities benefited from the development of an assured domestic source of supply. The protection from foreign competition in conjunction with AEC procurement policies has provided an environment which fostered the growth of the U.S. uranium industry.

Enrichment Policies

After taking into account government needs for uranium, in 1971 the AEC estimated it had 50,000 tons (100 million pounds) of surplus U_3O_8 on hand.(21,p.190) Although the uranium production industry and some buyers argued that the national stockpile should be retained as insurance against any future surge in demand, the AEC announced its intention to dispose of the stockpile. To dispose of this stockpile with minimum disruption to the market, in 1972 the government adopted its "split tails plan" of disposal.

This plan is technically complicated in that it involves the method of operating the gaseous diffusion enrichment complex. Enrichment policy is a complicated factor involving many economic trade-offs. The demand for uranium is somewhat inelastic because the total cost of producing electric power from a nuclear power plant is relatively insensitive to the price of uranium. In simple terms under the "split tails" plan, the AEC (DOE) requires its customers for enrichment services to supply only approximately 80% of the natural uranium required to produce the enriched uranium that is delivered and to pay about 25% more for enrichment services than is actually delivered. The remaining 20% of the raw material requirement is taken from the stockpile. As a consequence, the stockpile will be reduced over a period of 7 or 8 years by sale to a variety of enrichment customers.(21,p.191) According to a special topical report by the Nuclear Exchange Corporation, while this approach minimized market disruption, split tails did reduce uranium demand by 20%.(22)

As a result of a review of the literature and discussions with persons knowledgeable with enrichment plant costs, we found that the sale of the stockpile could result in a gain or loss to the government, depending on one's viewpoint. Much of the periodical literature maintains that the sale is a subsidy. However, an analysis of the split tails plan found government record-keeping to be such that the current selling price of the uranium is equal to or greater than the average government purchase price (although a handling charge is not allowed for). In addition, the depleted uranium tails are stored and maintained by DOE and can be reprocessed. The "tails" are valued at zero by DOE.

Government ownership of one step of the nuclear fuel cycle allows for a federal influence on the uranium mining industry. In this particular situation, the benefits to the uranium industry have been basically two:(23,p.12,13)

- the market was not depressed, even though at over-capacity, and
- artificial pricing was avoided.

The uranium industry has also been affected by DOE's long-term fixed commitment enrichment contracts, which provided for delivery of and payment for fixed quantities of SWU for delivery up to 18 years into the future.[22,p.4] It is Nuexco's view that the move to fixed commitment SWU contracts initiated the price[a] move of uranium from $5.95/lb in August 1971 to $41/lb in September 1976.[22,p.1,10] Current prices for U_3O_8 are about $45/lb. Hence, the Federal Government still exerts a strong influence on the uranium industry through its control of the enrichment process.

Tax Policies

The best known tax provision affecting the energy industry is percentage depletion. The percentage depletion rate for uranium is 22%.[25] Brannon, in Tax Incentives, states that the uranium market has been so influenced by other government policies that the tax effect is minor; therefore, no attempt was made to quantify it.

In summary, the many incentives given to the uranium industry do not lend themselves to quantification. The Federal Government has participated in the marketplace as a purchaser of uranium, has placed restrictions on foreign ore to protect the young U.S. industry, has allowed tax incentives, and has exerted an influence on the uranium industry through its control of the enrichment process.

FEDERAL INVESTMENT IN ENRICHMENT PLANTS

Uranium enrichment involves separating the two principal isotopes of uranium found in nature--uranium-235 and uranium-238--to increase the percentage of the fissionable uranium-235. The work done to separate these isotopes is called separative work, and the product achieved is called enriched uranium.

(a) Price refers to the Nuexco exchange value for immediate delivery.

Between 1943 and 1956 the U.S. built for national defense purposes three uranium enrichment facilities--at Oak Ridge, Tennessee; Paducah, Kentucky; and Portsmouth, Ohio--at a cost of approximatly $2.4 billion. (Cost in 1978 dollars would be $6.2 billion.) The Oak Ridge plant was built during World War II and the latter two, during the Korean War. These plants are owned by the government and are operated by private firms under cost-plus-fixed-fee management contracts. An additional $250 million in R&D and capital improvements has been invested in the three plants during their life, but not capitalized. The government has continued to own the technology, which is classified because it is vital to the production of nuclear weapons.

With the passage of time, the dominant market for enriched uranium has shifted from that of a highly enriched product for defense purposes to a lower enrichment material for commercial nuclear power fuel. Most domestic and foreign commercial nuclear power reactors use slightly enriched uranium as fuel. Uranium products of higher enrichment are used for weapons, in military reactors, and for fuel in HTGR and specialized reactors.

DOE's three enrichment plants are the major source of enriched uranium in the free world. These facilities, at today's maximum production capacity, can annually service the equivalent of about 200 power plants with a generating capacity of 1,000 MWe each. The U.S. not only provides enrichment services to the domestic reactors but has more than 95% of the present noncommunist enrichment capacity.(24) DOE supplies enrichment services to both domestic and foreign customers under three major types of contracts: 1) requirements contracts, under which DOE agrees to supply all of the enriched uranium required to fuel a specific nuclear reactor; 2) long-term, fixed-committment contracts, under which DOE agrees to provide fixed amounts of enriched uranium for a certain time period; and 3) conditional contracts, under which DOE agrees to provide enriched uranium if certain enriching capacity currently under contract is freed. Table 24 shows the distribution of contracts as of September 15, 1978.

About one-third of the capacity of the plants was used in 1969.(26,p.43) Government requirements in the future for defense purposes are projected to be only 10% of the capacity of these plants.(26,p.26) To quote Dr. Glenn Seabor in 1969 hearings before the JCAE:

TABLE 24. DOE Uranium Enrichment Contracts as of September 15, 1978 (in Gigawatts)

Type of Contract	Domestic	Foreign	Total
Requirements	75	25	100
Long-term, Fixed Commitment	127	84	211
Conditional	0	1	1
Total	202	110	312

> . . . Thus, the future market projected for the existing U.S. uranium enriching capacity is primarily for civilian nuclear power, both within the United States and abroad, . . . and the requirements for uranium enriching services to produce the fuel for nuclear power plants are growing rapidly.[26,p.26]

With the aforementioned shift in the market for enrichment services toward industry, the Atomic Industrial Forum, the Atomic Energy Commission, the JCAE of the Congress, and others have over the past 10 years studied the future ownership and management of the uranium enrichment facilities.[27] Since 1971, the executive branch has followed policies and programs to encourage private industry--rather than the Federal Government--to build the next increments of uranium enrichment capacity. Regardless of the technology involved (centrifuge, laser, or gasous diffusion), an enrichment facility requires a large amount of capital to construct and operate. The estimated cost (in 1975 dollars) to construct one economically sized gaseous diffusion plant is $3.3 billion.[28] To help private industry enter this market, a classified information access program was initiated. Industry has made several proposals to build enrichment plants, but as of mid-1977, none has announced its intention to build one. It is beyond the scope of this report to describe the political ramifications of the enrichment issue.

With continued growth in electricity generated by nuclear plants, the eventual need for new enrichment capacity is clear, but the timing and magnitude of that need are not. As an interim solution to meet this demand, a program for improving and uprating enrichment capacity was initiated in the early

1970s. Total capacity will be increased by 59%.[27] Through mid-1978, $1.5 billion has been spent.[29] The entire additional enrichment capacity is for domestic and foreign nuclear power plants.

Foreign Implications

For many years the AEC, and now DOE has felt that it is in the interest of the U.S. to act as a supplier of enriched uranium abroad. This policy was reviewed in a (6/24/69) letter to Chet Holifield, then Chairman of the JCAE, from Glenn Seaborg, Chairmain of the AEC:

> National Security aspects . . . in particular the national policy of seeking to avoid the proliferation of nuclear weapons . . . The availability of enriched uranium from the U.S. on attractive terms reduces the incentive for other countries to develop their own enriching capability . . . the availability of enriched uranium from the United States . . . has helped in the development of the Non-Proliferation Treaty.
>
> Secondly, . . . by supplying enriched uranium we encourage the development of strong and mutually beneficial economic ties between ourselves and the user . . .
>
> Finally, there are important economic benefits attendant upon the sale of enriched uranium aboard. U.S. enriched uranium prices, while they do not include a profit from a private financing viewpoint . . . they thus provide a net cash benefit to the U.S. Treasury and help in the amortization of facilities initially built for defense purposes.[21,p.48,49]

Thus, the U.S. involvement in supplying other countries with enriched uranium has played an important role in the foreign policy of the U.S. by improving our balance of payments position and by helping to limit the spread of nuclear weapons. Sales of enrichment services have also been used as leverage to obtain safeguards and nonproliferation guarantees.[27,p.28]

No attempt has been made to quantify the effects of guaranteed government subsidies and fuel supplies on foreign LWR sales. However, had the diffusion plants not existed, the development of commercial nuclear power in the United States would probably have been along the lines of natural uranium fueled reactors, such as the Canadian heavy water reactors or the British graphite reactors. The existence of diffusion plants permitted a more competitive type of reactor to be built, the light water reactor.

Enrichment Services

The DOE pricing policy for uranium enriching services has been based on recovering the government's cost for providing the services. As such it does not provide for insurance costs, federal, state or local taxes, or a provision for return on equity. With the advent of possible private ownership of new enrichment facilities, concern has been expressed over the expected difference in federal and private service costs. Too large a difference, it was thought, would discourage private involvement.

In 1975, the GAO analyzed federal enrichment services and the following material is derived from this report.[30]

The Private Ownership of Special Nuclear Materials Act of 1964 (Public Law 88-489) authorized AEC to offer, beginning in January 1969, services for enriching privately owned uranium. The act also provided that AEC set forth the terms and conditions under which enriching services would be made available, including the requirement that prices be established on the basis of providing reasonable compensation to the Government.

The act was amended by P.L. 91-560 on December 19, 1970, to state that prices would be established on a basis of recovery of the Government's cost over a reasonable period. On May 9, 1973, AEC established a new type of enrichment contract--fixed commitment. Under fixed-commitment contracts, customers must specify delivery leadtime of at least 8 years for initial delivery and 10 years for subsequent deliveries and make a substantial down payment. Before this type of contract was established, AEC offered requirements contracts in which AEC agreed to provide the enrichment services for a stated nuclear reactor on an "as needed" basis, up to a limit, with only 120 days' advance notice.

The establishment of fixed-commitment contracts created a dual pricing structure--one price for requirements contracts and a lower price for fixed-commitment contracts. AEC justified this difference by pointing to its experience with requirements contract holders that have shown that actual sales have fallen short of projected sales. In June 1975 the Administrator of ERDA forwarded to the Congress draft legislation which would revise the pricing criteria for enriching uranium used to fuel nuclear power plants. The proposed legislation would amend the Atomic Energy Act of 1954, as amended, to 1) obtain fair value for enriching service, and 2) eliminate or reduce the differential between the Government's charges for enriching services and those of potential domestic private enrichment projects. The price for a separate work unit under the new basis would include charges in lieu of insurance and federal, state, and local taxes plus a factor to cover economic risks.

The proposed legislation will increase enrichment prices from $53.35 per separative work unit to about $76.00. The $22.65 difference is roughly equivalent to the Federal subsidy[a] for enrichment services.

This subsidy represents a benefit to the nuclear power industry because the price charged by the Government to enrich uranium has not included profit, taxes, and insurance. If a taxpaying, profit-maximizing company were selling these enrichment services to the nuclear power industry, these items would be included in the price.

Table 25 shows the quantity of enriched uranium sold by the government in terms of separative work units and revenues received through fiscal year 1978.

TABLE 25. Separative Work Units and Revenue from Enriched Uranium Sold Through 1978 (in Millions)

	Separative Work Units	Revenues
Domestic	21,468	635,874
Foreign	21,858	695,397
Total	43,326	$1,331,271

The information in Table 25 illustrates the complexity of determining federal incentives to commercial nuclear power for enrichment services. Several approaches have been suggested. One approach is to assume the GAO's estimate

(a) Defined to include direct or indirect payments, economic concessions, and privileges or benefits provided to any enterprise by the Government to promote its policy.

of federal subsidy for enrichment services ($22.65 per SWU), assume that the ratio of subsidy to cost remained constant, and with the total domestic revenues given in Table 25, calculate a subsidy. Such a calculation yields a subsidy of $556.3 million (in 1978 dollars) for the domestic enrichment services. The availability of enrichment services at a lower-than-world price for foreign nations could be an important consideration in their buying U.S. reactor plants, and might be looked upon as a subsidy to commercial nuclear power. The objectives of such sales, as previously discussed, seem to embrace aspects other than simply developing commercial nuclear power. A more detailed analysis of this aspect is beyond the scope of this project.

An alternative point of view might be that it is inappropriate for the government to charge for services on the same basis as private industry. The enrichment plants were built for military purposes, have served their purpose and, therefore, only out-of-pocket expenses should be considered a subsidy to the unrelated commercial nuclear power industry.

Perhaps another way to estimate the subsidy is to speculate on how the industry might have developed had there been no federally owned enrichment plants. Two cases might establish the upper bound of a potential subsidy. First, the electrical output of all commercial nuclear power plants might have been generated by fossil fuel (coal, oil, or gas) plants if the nuclear industry had not evolved. During 1977, the cost of producing electrical power by nuclear plants was 16% less than for coal plants[31] and considerably less than for oil and gas fired plants. Secondly, the U.S. nuclear industry might have evolved arond natural uranium fueled reactors. Typically capital costs for these reactors are about 10% higher than for LWRs. At the present time the U.S. investment in operating LWRs is about $15-25 billion. Ten percent of that amount is $1.5-2.5 billion. One might consider some fraction of this figure to be a subsidy to commercial nuclear power. As noted before, the total cost of the enrichment facilities is $6.2 billion in 1978 dollars. Therefore, the maximum subsidy could be the total cost of these plants. However, the majority of their production has been for military applications, and only a small percentage has been devoted so far to commercial nuclear power production.

One might wish to look at the value of the net investment not yet repaid. The cash flow received from sales of enrichment services (both foreign and domestic) has included a provision for depreciation, which averages about 33 years life but is actually figured on the capacity used. The net book value of the enrichment plants as of June 30, 1971, was $1.13 billion. Hence, the unrecovered costs were $1.8 billion in 1978 dollars. This figure does not indicate the percentage of total capacity used for commercial nuclear power compared to military needs, but rather the recovered costs through sales of enrichment services. Actual production for military needs is classified, but the commercial nuclear program has only used its services since 1965 and most predominantly since 1968.

The existence of the enrichment plants influenced the type of reactor that was commercialized in the U.S. Because of the plants' military origins, however, it is difficult to defend one particular dollar amount as an incentive. Depending on the approach used to analyze the situation, the incentive could be considered as much as the total cost of the enrichment facilities. We have selected $2.1 billion (1978$) as the incentive on the basis of the $0.6 billion GAO estimated subsidy of the difference between commercial and government prices plus the $1.5 billion outlay (not yet recovered) for increasing the enrichment capacity for commercial purposes. Since 1965, the Federal Government has been supplying utilities with enriched uranium and therefore this subsidy is classified as a market activity.

FEDERAL REGULATION OF THE NUCLEAR INDUSTRY

Since AEC's establishment by Congress through the Atomic Energy Act of 1946, the responsibility both for protecting the health and safety of the public with regard to use of nuclear energy and for regulating the control of nuclear materials has rested with that body and its successor, DOE. Atomic energy is unique in requiring maximum regulation of every aspect, from the mining of the ore to the waste product. This is partly so because of the dual uses to which these materials, processes, and products may be put--both peaceful and warlike applications. During the period when all nuclear materials were owned by the government, control was relatively simple. Since the passage of the 1964 Private Ownership Act, the task has become increasingly difficult.

As the construction and operation of nuclear power stations increased, the AEC devoted an increasing share of its resources to regulating the industrial uses of atomic energy. In 1965, regulatory activities were only 0.2% of the AEC budget, whereas in 1974 they were 2.1%. In 1975, the Energy Reorganization Act separated the developmental and promotional functions of nuclear power from the regulatory functions. The act created the Nuclear Regulatory Commission (NRC), whose purpose was to regulate the design, construction and operation of central station nuclear power plants and associated facilities. NRC plays a major role in the regulation of all phases of the commercial fuel cycle except mining, which is controlled by individual states, and enrichment, which is regulated by DOE.[6,p.449]

As stated in the AEC budget requests, the basic purpose of the regulatory program is:

> . . . to carry out the Commission's statutory responsibilities for assuring that the possession, use and disposal of radioactive facilities be conducted in a manner consistent with public health and safety and the common defense and security, and with proper regard for environmental quality.[33]

The regulatory system encompasses three functions:

- rulemaking, or the issuance of requirements of generalized applicability
- licensing, including review of necessary prerequisite conditions for license
- coordination of policy, enforcement of determinations, and administration of the agency itself.[5,p.175]

These standards are codified and published as Title 10 of the U.S. Code of Federal Regulations.[5,p.176]

Regulatory responsibilities are defined in three pieces of legislation:[33]

1) Atomic energy Act of 1954, as amended

2) National Environmental Policy Act of 1969 (NEPA)

3) Federal Water Pollution Control Act, as amended by the Water Quality Improvement Act of 1970.

An amendment to the Atomic Energy Act passed in December of 1970 added the regulatory function of reviewing the antitrust aspects of license applications for all commercial or industrial nuclear facilities.[33]

Early siting problems and conflicts centered almost entirely on the safety of proposed reactors. In the early 1970s, however, the environmental issue became a major concern in siting considerations. The Calvert Cliffs decision by the Federal Court of Appeals on July 23, 1971, affected all new license applications and over 110 reactors which were already under licensing review, under construction, or in operation. The effect of the court's decision was to make the AEC directly responsible for evaluating and assessing the total environmental impact (chemical, thermal, and radiological) of nuclear reactors.[33,p.746]

Atomic energy is unique in requiring maximum regulation of every aspect, from the mining of the ore to treatment of the waste product. When the AEC was reorganized into ERDA and NRC, NRC was given regulatory responsibility for the storage and disposal of high-level wastes at ERDA facilities in addition to the regulation of waste materials in the commercial sector.[4,p.541] Before 1960 most regulatory activities were for defense reasons. From 1960 to 1978, the Federal Government directly spent $1.65 billion (see Table 26) for regulation of the commercial nuclear power industry. More than half of the total spent for regulatory activities was spent after 1975, reflecting the increase in the number of plants and the pressure from special interest groups. In keeping with the overall approach of this report, federal funds spent on regulatory activities, in this case $1.65 billion, have been included as an incentive. Regulation costs have been categorized as a requirement, since fees not paid are backed by penalties.

WASTE MANAGEMENT

As nuclear fuel is consumed in the process of producing electricity, fission products are produced. These waste products effectively slow the nuclear reaction in the power plant and therefore must be removed. Each year about one-third of the fuel load is removed and fresh fuel is loaded into the reactor. The "spent" fuel elements still contain usable uranium isotopes. Figure 5 illustrates the options available for reusing spent fuel. The fuel cycle has to be ended either by reprocessing and permanent waste management or by no reprocessing and permanent waste management.

TABLE 26. AEC and NRC Regulatory Costs (Millions of $)

Year	Amount	Amount 1978 $
1960	3.1	6.8
1961	3.4	7.4
1962	3.6	7.8
1963	4.0	8.5
1964	21.0	44.2
1965	23.6	48.8
1966	26.5	53.3
1967	34.0	66.4
1968	39.7	74.4
1969	43.0	76.5
1970	49.0	82.3
1971	51.5	83.0
1972	69.5	108.4
1973	47.5	69.7
1974	55.2	73.0
1975	94.3	114.3
1976	164.8	188.9
1976 TQ	56.2	64.4
1977	213.6	230.1
1978	240.2	240.2
Total in 1978 dollars		1,648.4

Source: "Nuclear Power Costs and Subsidies," General Accounting Office, EMD-79-52 June 13, 1979 p. 28

The economics of reprocessing, as well as related safety considerations, are in dispute. Currently no spent fuel reprocessing plant is in operation in the U.S. and those under construction are unlikely to start up in the foreseeable future.[34] While the disposal of radioactive waste has long been recognized as a key issue affecting public acceptance of nuclear power, basic decisions regarding the form in which waste should be stored and locations of storage facilities have not yet been made.

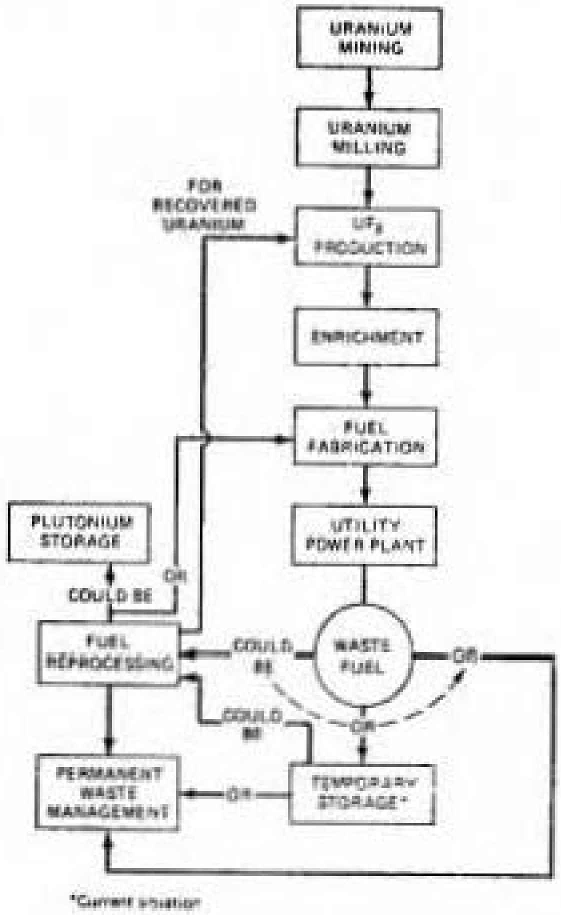

FIGURE 5. Nuclear Fuel Cycle - Options for Waste Fuel

The front end of the fuel cycle--uranium mining and enrichment--was developed on a large scale in the 1940s and 1950s to meet the demands of the nuclear weapons program.(34,p.100) As weapon production declined, there was ample capacity to service the growing needs of the commercial power program. As for the back-end of the fuel cycle--spent fuel reprocessing, plutonium fabrication and waste storage--all had been treated rather casually as part of government programs, according to Fritz F. Hermann, Chief Council for G.E.'s Power Generation group. The general assumption was that the private sector would proceed to build whatever fuel cycle capacity was necessary when required for the growth of nuclear power. It fitted the "conventional economic wisdom of both government and industry leaders and it did not require the appropriation of government funds."(34,p.100)

Prior to 1971, the responsibility for direction of long-term radioactive waste management was vested in the AEC under several programs. In 1971 these were consolidated into a new AEC division in order to place greater emphasis on waste management and to improve the integration of relevant activities.(35,p.74) In 1975, both ERDA and NRC were given responsibilities for waste management.

The Office of Nuclear Regulatory Research in NRC is now responsible, in addition, for research to support NRC's regulatory functions. NRC was specifically created to have an independent capability for developing and analyzing technical information related to reactor safety, safeguards, and environmental protection in support of licensing and regulatory processes.

> NRC's research was to be solely confirmatory, by establishing the validity of safety principles that support the regulated technologies; ERDA was to be responsible for developmental or promotional research. NRC was to use the facilities and expertise available through ERDA, other Federal agencies, and private contractors to carry out its analytical and experimental research program.(36)

Until the last few years only small sums were spent on waste management problems. The problem of waste has always been there, but the need to resolve it was not the focus of public pressure until recently.

An analysis of past AEC budgets shows periods when budgets for waste management R&D were negligible. Most of the nuclear waste now in storage dates from the weapons program. Therefore, only the funds associated with the management of, or R&D relating to, waste management should be included as an incentive to civilian nuclear power, as the other funds in the AEC (ERDA) budget have been for containment and surveillance of nuclear waste from the weapons program.

In the 1977 International Atomic Energy Agency Study on Regional Nuclear Fuel Cycle Centers, over 70% of the total capital cost of waste management is attributed to the solidification plant for high-level waste and the cost of disposal in a geological formation.[37] Furthermore, the economic decision regarding fuel recycle versus long-term storage of spent fuel would depend strongly on the size of the regional fuel cycle center, the price of uranium, and the economic conditions under which the recycle storage facilities would be financed.[37,p.51] To analyze future costs of waste management is beyond the scope of this project, but preliminary estimates of storage and disposal costs indiate that they should add less than 1 mill per kilowatt hour to nuclear power costs, which are now about 40 mills per kilowatt hour to the consumer.[39]

Since the development of commercial nuclear power began, funds have been spent for research and development on nuclear wastes, both military and commercial. These expenditures were accounted for under the incentive, Research and Development Activities. Recent public pressures have resulted in an increase in the R&D waste managemet budget from $81 million in 1976 to $180 million in 1978. Of the $180 million, $123 million is for R&D. Over 70% is for research on commercial waste management. These R&D funds have been accounted for in Table 19.

CONCLUSIONS

The Federal Government believed that attaining economically competitive nuclear power was a goal of national importance. It was thought that the uncertain future of our fossil fuel reserves and the pressure toward higher cost power due to increased fuel costs made the development of a new source of energy an essential goal. The uncertainty of return on investment and the risk involved necessitated government involvement if nuclear power was to become commercially viable.[38] However, it was also firmly believed that as nuclear power became competitive it should be integrated into established institutions in the U.S. and that it should be produced by the existing utility systems.

Although development of an economically competitive energy source was the basic goal, the history of nuclear energy policy cannot easily be divorced from matters of national security and foreign policy. The entanglement of these policies began with original use of fission by the U.S. Government. From the beginning the development of commercial nuclear power drived from manpower, facilities, technology and contracting policies started during World War II. Originally the use of the atom as an energy source as well as for national defense purposes was controlled by the government under conditions of secrecy. Policies concerning international trade and the nonproliferation of weapons have played important roles in the development of commercial nuclear power.

Through July 1978, nuclear power had cumulatively produced 1121×10^9 kWh or 3.83×10^{15} Btu_e. Nuclear power accounted for 13.0% of the total utility generating capacity in 1978. Over the past 30 years, we estimate that $21 billion have been spent by the Federal Government to assist the development of commercial nuclear power. Table 27 presents these figures. The total

TABLE 27. An Estimate of the Cost of Incentives to Stimulate Civilian Nuclear Power Production (in Billions of 1978 Dollars)

	Taxation	Disbursements	Requirements	Traditional Services	Nontraditional Services	Market Activity
Research and Development					17.2	
Liability Insurance		(a)				
Uranium Industry						(a)
Enrichment Plant						2.1
Regulation			1.65			
Waste Management					(b)	
Total	0	(a)	1.65	0	17.2	2.1

Total $20.95 Billion

(a) Not able to quantify
(b) Included in R&D costs

does not take into account several nonquantifiable incentives. Neither legislative actions (such as the Price-Anderson Act), which removed the liability roadblock, nor several policies (such as long-term uranium procurement) which were initiated for military programs but created or subsidized the industry for the commercial nuclear power industry are included. Commercial nuclear power provides an example of a partnership between government and industry aimed at developing an alternative energy source.

REFERENCES - CHAPTER IV

1. R. M. Murray, Jr., "The Economics of Electric Power Generation 1975-2000." The Nuclear Power Controversy, The American Assembly, Columbia University, Prentice-Hall, Englewood Cliffs, NJ, p. 62, 1976.

2. "Nuclear Power Costs and Subsidies", General Accounting Office, EMD-79-52, June 13, 1979.

3. Atomic Industrial Forum, Inc. INFO 117, Washington, DC, April 1978.

4. ERDA Authorizing Legislation Fiscal Year 1977 Hearings, Part 1: Volume I, p. 24, January 21, 1976.

5. F. G. Dawson, Nuclear Power: Development and Management of a Technology. University of Washington Press, Seattle, WA, p. 19, 1976.

6. W. H. Zinn and F. K. Pittman, Nuclear Power, U.S.A. McGraw-Hill Book Co., NY, p. 9, 1964.

7. Resources for the Future, Inc., U.S. Energy Policies: An Agenda for Research. Johns Hopkins, Baltimore, MD, p. 100, 1968.

8. Atomic Energy Commission, 1974 Financial Report, pp. 9-11.

9. Congress of the United States, Hearings before the Joint Committee on Atomic Energy. 83rd Congress, 2nd Session, S 3323 and H.R. 8862, p. 574, 1954.

10. Considerations for Commercializing the Liquid Metal Fast Breeder Reactor. U.S. General Accounting Office, EMD-77-5, p. 1, November 29, 1976.

11. H. Green, "Nuclear Power: Risk, Liability, and Idemnity." Michigan Law Review, Vol 71, p. 483.

12. Testimony of William Gale, Hearings Before the Joint Committee on Atomic Energy on Government Indemnity for Private Licenses and AEC Contractors Against Reactor Hazards. 84th Congress, 2nd Session, Washington, D.C.: U.S. Government Printing Office, p. 240, 1956.

13. Testimony of Charles H. Weaver, 1956 Indemnity Hearings.

14. Testimony of Francis K. McCune, Hearings Before the Joint Committee on Atomic Energy on Governmental Indemnity and Reactor Safety. 85th Congress, 1st Session, Washington, D.C.: U.S. Government Printing Office, p. 148, 1957.

15. Public Law 89-210, Stat. 855, 1965.

16. "NRC Sets Insurance Premium at $5 Million." Nuclear Industry, 24(2):23, February 1977.

17. "Selected Aspects of Nuclear Power Plant Reliability and Economics." U.S. GAO Report B-164105, RED-76-7, Appendix I, pp. 18-19, August 15, 1975.

18. J. B. Burnham, Assessment of Uranium and Thorium Resources in the United States and the Effect of Policy Alternatives. Report to National Science Foundation, Battelle, Pacific Northwest Laboratories, Richland, WA, p. 71, December 1974.

19. American Mining Congress Statement on Uranium Imports Submitted to the Chairman of the Atomic Energy Commission, Appendix II, June 15, 1973.

20. U.S. Atomic Energy Commission, Annual Report to Congress, p. 104, 1970.

21. Hearings before JCAE, "Development, Growth and State of Nuclear Industry." p. 308, February 5 and 6, 1974.

22. "Significant Events in the Uranium Market, 1969-1976." Nuclear Exchange Corporation, p. 2, October 15, 1976.

23. "New Master Policy for Fuel Supply." Nuclear Industry 19 (3):11-18, March, 1972.

24. Uranium Enrichment: Alternatives for Meeting the Nation's Needs and Their Implications for the Federal Budget. Background Paper No. 7, Congressional Budget Office, p. 2, May 18, 1976.

25. G. M. Brannon, Energy Taxes and Subsidies. Ballinger Publishing Co., 1974.

26. "Future Ownership of the AEC's Gaseous Diffusion Plants," Hearings before JCAE, p. 43, 1969.

27. See the following sources:

    Private Ownership and Operation of Uranium-Enrichment Facilities, Atomic Industrial Forum, Inc., June 1968.

    Selected Background Information on Uranium Enriching, AEC. ORO-688, March 1969.

    AEC Gaseous Diffusion Plant Operations, ORO-685, February 1968.

    Summary Report by AEC Staff of Future Ownership and Management of Uranium Facilities in the U.S., March 1969.

Report to the JCAE Congress of the United States, Possible Transfer of the AEC's Gaseous Diffusion Plants to Private Ownership, by the Comptroller General of the U.S., May 20, 1969.

28. "Evaluation of the Administration's Proposal for Government Assistance to Private Uranium Enrichment Groups." U.S. General Accounting Office (RED-76-36), p. 32, October 31, 1975.

29. ERDA Authorizing Legislation FY-1977, Hearings before JCAE, Part I: Volume I, pp. 127, 129, January 21, 1976.

30. "Comments on Proposed Legislation to Change Basis for Government Charge for Uranium Enrichment Services." U.S. General Accounting Office, RED-76-30, September 22, 1975.

31. "Federal Government Incentives to Coal and Nuclear Energy", Congressional Research Service, Committee Print 96-IFC20, G.P.O., May 1979.

32. AEC Gaseous Diffusion Plant Operations, AEC, ORO-684, p. 9, January 1972.

33. AEC Authorizing Legislation FY-1973, Hearings before the JCAE, Part I, p. 743, 1973.

34. "How Can We Get the Nuclear Job Done?" Nuclear Power Controversy.

35. U.S. Atomic Energy Commission, Annual Report to Congress, p. 75, 1971.

36. "Development of Interagency Relationships in the Regulation of Nuclear Materials and Facilities." U.S. GAO, RED-76-72, p. 3, March 10, 1976.

37. Regional Nuclear Fuel Cycle Centers, Vol I: Summary 1977 Report of the IAEA Study Project, IAEA, Vienna, p. 23, 1977.

38. J. L. Morrison, "Federal Support of Domestic Atomic Power Development - The Policy Issues." 12 Vanderbuilt Law Review, p. 195, 1958.

39. "DOE Announces New Spent Nuclear Fuel Policy," RLO-77-33, October 18, 1977.

V HYDRO-ENERGY INCENTIVES

The Federal Government constructs, operates and regulates hydroelectric facilities and markets the electricity. Federal projects now account for 28% of the major hydroelectric plants, 44% of the installed hydroelectric capacity and 47% of the net hydroelectric generation.[1] Many of the first major projects funded by the government were justified to improve navigational facilities, control floods and develop water resources for agriculture, industry and municipalities. Hydroelectric power generation was a secondary consideration. In recent years hydroelectric power generation has become the main justification for new dams. For example, many of the projects now contemplated involve the development of pumped storage facilities to meet peak power requirements. This chapter presents a discussion of those factors that are involved in the construction of dams, the marketing of power and the regulation of facilities. Alternative methods of quantifying the costs of incentives are described in detail.

CONSTRUCTION

The construction of all federal dams is supervised by the Army Corps of engineers, the Bureau of Reclamation or the Tennessee Valley Authority. These organizations are involved with site selection and dam design. However, the construction may be performed by subcontractors. The federal incentive provided by the direct participation of these organizations is included in the cost of the projects. This information is presented in the section on "Marketing of Hydroelectric Power."

Army Corps of Engineers

The Corps of Engineers began its substantial involvement in civilian projects in 1824 when the Congress assigned the Corps the task of clearing snags and sandbars from the Ohio and Mississippi Rivers. This initial assignment gradually expanded to a general responsibility for navigation improvements. In 1917 Congress added the responsibility for flood control. Multipurpose dams were constructed to meet these needs and hence the Corps also became involved in the operation of hydroelectric facilities. Today the Corps operates over 70 hydroelectric facilities throughout the country.

Bureau of Reclamation

The Reclamation Act of 1902 authorized the Secretary of the Interior to locate, construct, operate, and maintain works for the storage, diversion, and development of waters for the reclamation of arid and semiarid lands in 17 western states and Hawaii. The reclamation Service was established and in 1923 the name was changed to the Bureau of Reclamation.

Bureau of Reclamation projects, through a multiple-purpose concept, provide some or all of the following: municipal and industrial water supply, hydroelectric power generation and transmission, irrigation water service, water quality improvement, fish and wildlife enhancement, outdoor recreation, flood control, navigation, river regulation and control, and related uses. All funds are appropriated by Congress. Through contractual agreements with project beneficiaries, the Bureau arranges for repayment to the government of reimbursable project construction, operation, and maintenance costs.

Tennessee Valley Authority

The Tennessee Valley Authority (TVA) is a government corporation created by an act of Congress in 1933. All functions of the Authority are vested in its Board of Directors, who are appointed by the President with the consent of the Senate.

A system of dams built by TVA on the Tennessee River and its larger tributaries provides flood regulation on the Tennessee and contributes to regulation of the lower Ohio and Mississippi Rivers. The system maintains a continuous 9-ft draft navigation channel for the length of the 650-mile Tennessee River main stream from Paducah, Kentucky, to Knoxville, Tennessee. The dams harness the power of the rivers to produce electricity. They also provide other benefits, including recreational facilities. The electric power program is required to be financially self-supporting but other programs are financed primarily by Congressional appropriations.

TVA operates the river control system, and investigates the need for and feasibility of additional river control projects. It gives assistance to state and local governments in reducing local flood problems. It also works with cooperating agencies to encourage full and effective use of navigable waterways by industry and commerce.

Projects now under construction by TVA include nuclear power plants, a pumped-storage hydroelectric project, and multi-use reservoirs.

MARKETING

The Federal Government markets electric power through the Bureau of Reclamation, the Tennessee Valley Authority, and five power administrations. The Bureau of Reclamation and TVA have the authority to construct and operate their own power facilities. The five power administrations are the Bonneville, Western, Southwestern, Southeastern, and Alaska. These administrations sell electricity produced at dams that are constructed and operated by the Army Corps of Engineers and/or the Bureau of Reclamation. These power administrations, combined with the hydroelectric facilities in their regions, are called Federal Power Programs or Federal Power Systems.

The Flood Control Act of 1944 requires the Department of Interior to sell power generated at reservoir projects operated by the Army Corps of Engineers. The rates must pay for the cost of producing and transmitting the energy plus amortization of capital investment over a reasonable period. The Federal Energy Regulatory Commission must approve the rate. Public bodies and cooperatives are preferred customers.

The Bureau of Reclamation constructs and operates many large projects. However, some of these projects have been transferred to the power administrations. When a project is transferred, the Bureau of Reclamation continues to operate it but the power administration assumes reponsibility for marketing the power and repaying the cost of the project.

When a hydroelectric project is completed, the costs are allocated to the various functions of the project: flood control, navigation, recreation, power generation, etc. Some of the costs, such as for navigation, flood control, fish and wildlife, and recreation, do not have to be repaid. The costs associated with commercial power production and irrigation water supply must be repaid with interest. Some of the costs allocated to irrigation are paid by commercial power revenues. In the Federal Columbia River Power System 82.4%

of the total costs must also repay more than 2/3 of the costs allocated to the Bonneville Power Administration (BPA) irrigation system.

The costs allocated to power can be differentiated from the costs allocated to navigation, irrigation and other purposes. But, it is difficult to justify the allocation of all the transmission costs as an incentive only to hydropower. The transmission systems built by the Alaska Power Administration (APA), Southwestern Power Administration (SWPA) and the Bureau of Reclamation are solely incentives to hydropower. However, the transmission systems built by the BPA and TVA are used by thermal electric plants also. This problem was dealt with by separating the transmission costs from the generation costs where possible and treating the transmission costs as a subsidy to electric power in general.

Bonneville Power Administration

The Bonneville Power Administration (BPA) was created in 1937. Through a regional interconnecting transmission system, it markets electric power and energy from federal hydroelectric projects in the Pacific Northwest constructed and operated by the Corps of Engineers or the Bureau of Reclamation. Through interregional connections, it sells and exchanges surplus power to other regions.

By Act of Congress approved October 18, 1974, the Bonneville Power Administration now has the authority, in lieu of appropriations, to use its revenues or to sell revenue bonds to the U.S. Treasury in order to construct, operate, and maintain its transmission system.

Data on the federal investment in hydropower generation and transmission facilities are presented in Appendix E, Table E-11.(2) These figures include the interest accrued on the federal investment. The fluctuations in values are brought about by changes in yearly rainfall, political conditions, and the cost allocation to power. A heavy yearly rainfall can mean more power sold and larger revenues. A change in the political clim-te can mean shifts in the Federal Government's spending on hydropower. Also, the cost of a project that is allocated to power can change once the project is completed. Cost allocations are tentative when the project is on the drawing board and can be changed as the project nears completion.

By the end of FY-1978 the net federal investment in the Federal Columbia River Power System was $6.66 billion. As a result of this investment there are 28 projects with a capacity of 16,441,780 kW in operation. Improvements and one additional project with a capacity of 3,439,400 kW are under construction. The total generation of the Federal Columbia River Power system from inception to September 30, 1978 was 1,359.10 billion kWh.

Southwestern Power Administration

The Southwestern Power Administration (SWPA) was created by the Secretary of the Interior in 1943. It administers the scale of electric power generated at certain projects constructed and operated by the Army Corps of engineers in the states of Kansas, Missouri, Oklahoma, Arkansas, Texas and Louisiana.

Chronological data on the federal investment in hydropower generation and transmission is reported in Appendix E, Table E-12.[3] These data include investments in the completed facilities but not the interest or repayment on projects under construction. The total federal investment is slightly higher than the number reported here.

By the end of FY-1978 the net federal investment in the Southwestern Federal Power system was $1.31 billion. The Southwestern Federal Power System has 21 projects with a capacity of 1,916,700 kW in operation and 2 projects with a capacity of 218,000 kW under construction. The total generation of the Southwestern Federal Power System hydroelectric projects from inception to September 30, 1978 was 82.27 billion kWh.

Southeastern Power Administration

The Southeastern Power Administration (SEPA) was created by the Secretary of the Interior in 1950 to carry out functions assigned to the Secretary by the Flood Control Act of 1944. It administers the sale of electric power from dams operated by the U.S. Army Corps of Engineers in the states of West Virginia, Virginia, North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, Tennessee, and Kentucky. The SEPA does not own, construct or maintain any transmission facilities. Therefore, Table E-13 in Appendix E presents data on hydroelectric generation only.[4]

By the end of FY-1978 the net federal investment in the Southeastern Federal Power Program (SEFPP) was $1.77 billion. The SEFPP has 21 projects with a capacity of 2,712,375 kW in operation and one project with a capacity of 300,000 kW under construction. The total generation of the SEFPP Hydroelectric projects from inception to September 30, 1978, was 131.6 billion kWh.

Alaska Power Administration

The Alaska Power Administration (APA) was created by the Secreatry of the Interior in 1967 to carry out functions assigned to the Secretary related to water and power planning and power operations in Alaska, including among others the Eklutna Project Act; the Snettisham Project authorization in the Flood Control Act of 1962; and the power marketing provision of the Flood Control Act of 1944.

The Administration 1) plans water, power, and related resources development and utilization in cooperation with other state, local, and federal entities; and 2) provides operation, maintenance, and power marketing for federal hydroelectric projects.

The power operations and marketing functions involve the Eklutna and Snettisham hydroelectric projects, including related transmission systems serving the Anchorage and Juneau areas, respectively. The cost data on the hydroelectric generation and transmission facilities are reported in Appendix E, Table E-14.(5)

By the end of FY-1978 the net federal investment in the Alaska Federal Power Program (AFPP) hydroelectric projects was $172.89 million. The AFPP has two projects with a capacity of 77,200 kW in operation and a project with a capacity of 27,000 kW under construction. The total generation of the AFPP from inception to September 30, 1978, was estimated to be 3.97 billion kWh.

Tennessee Valley Authority

The Tennessee Valley Authority (TVA) is the wholesale power supplier for 160 local municipal and cooperative electric systems serving 2.6 million customers in parts of seven states. It supplies power to several federal installations and industries whose power requirements are large or unusual. Power to meet these demands is supplied from 29 dams, 12 coal-fired power plants, 1 nuclear power plant, and 4 gas turbine installations operated by TVA; 8 U.S.

Corps of Engineers dams in the Cumberland Valley; and 12 Aluminum Company of America dams whose operation is coordinated with the TVA system.

Chronological data on the federal (TVA) investment in hydropower generation and transmission facilities are reported in Appendix E, Table E-15.[6] These data are reported because they were readily available, deal only with hydropower, and the total Federal Government investment in the TVA's hydropower facilities could not be accurately obtained from the financial statements. The assets do not include the interest or repayment of the federal investment. In all cases encountered the investment of the Federal Government is larger than the assets. Therefore, the use of the assets leads to a low estimate of the federal incentive to the TVA's hydropower facilities. The fluctuations in the data are due to changes in the annual rainfall, the policies of the government, the economic situation, and the accounting procedure used to audit the TVA.

By the end of FY-1978 the net federal investment in the Tennessee Valley Authority hydroelectric projects was $2.00 billion. The TVA has 30 projects with a capacity of 3,269,910 kW in operation and a pumped storage unit with a capacity of 1,530,000 kW under construction. The total generation of the TVA hydroelectric projects from inception to September 30, 1978 was 487.0 billion kWh.

Western Area Power Administration

The Western Area Power Administration (WAPA) was established on December 21, 1977, with headquarters in Denver, to serve the electric power needs of an estimated 5 million retail customers in 15 western states.

The new power administration is responsible for the federal power marketing functions transferred from the Department of the Interior's Bureau of Reclamation to DOE On October 1, 1977, under the provisions of the Department of Energy Organization Act (91 Stat. 578; 42 U.S.C. 7152). These marketing functions involve the sale and distribution of power produced at existing federal hydroelectric generation facilities in the 15 states. In addition, the responsibility for construction, operation, and maintenance of transmission lines and attendent facilities was transferred to DOE. The 14 states to be served by WAPA are California, Arizona, Nevada, Montana, North Dakota, South Dakota, Iowa, Colorado, Wyoming, Minnesota, Texas, New Mexico, Utah, and Nebraska.

It is anticipated that the WAPA will not be completely operational until 1981. Currently the WAPA is coordinating its assigned activities with the Bureau of Reclamation. Until the WAPA is fully operational, the data on the hydropower facilities in the WAPA region will be reported in the Bureau of Reclamation section below.

Bureau of Reclamation

The Bureau of Reclamation produces power from the projects in its six regions. The regions are: the Lower Missouri, the Upper Missouri, the Lower Colorado, the Upper Colorado, the Central Valley and the Rio Grande. The general criteria for repayment of the projects with power revenues are:

1. Projected annual revenues must be sufficient to meet all costs in the year they occur except investment and replacement costs, and current year's interest that cannot be met from current revenues.
2. Each increment of investment suballocated to commercial power must be paid, with interest, within 50 years after the related facility is placed in service. Replacements must be repaid within the estimated service life of the equipment.
3. Irrigation and waterfowl conservation aid must also be repaid within 50 years after the major project addition.

Chronological data on the federal investment in hydropower generation and transmission facilities is reported in Appendix E, Table E-16.[7-11] These data include repayment of the interest, operation and maintenance and replacement expenses. Because the generation and transmission costs were not separable, they are reported as a total figure.

By the end of FY-1977 the net federal investment in hydroelectric projects from which the Bureau of Reclamation markets the power was $2.59 billion. The total installed capacity of these projects is 6,882,500 kW. The total gross generation of these projects from inception to September 30, 1977 was 437.00 billion kWh. This gross generation figure includes only plants that are still operating. Due to transfer of responsibility to WAPA, 1978 data was not available at the time of this printing. Consequently, 1977 data was reapplied to 1978 for estimation purposes.

The Federal Power Marketing Agencies provide a market activity incentive to hydro-energy by marketing the power produced at federal dams. The BPA and TVA also transmit and wheel power produced by private utilities. The transmission and wheeling of power by the BPA and TVA constitutes a market activity incentive to both hydro-energy and electric energy. The costs associated with the administrative functions of power marketing and wheeling are very small compared to the dam and powerline construction costs.

REGULATION OF HYDROELECTRIC FACILITIES

The Federal Energy Regulatory Commission (FERC) regulates the interstate aspects of the electric power and natural gas industries. It is an independent agency operating under the Federal Power Act originally enacted as the Federal Water Power Act of 1920 and subsequently amended by Title II of the Public Utility Act of 1935 and the Natural Gas Act of 1938. Additional responsibilities have been assigned by subsequent legislation and executive order.

Concerning hydroelectricity, the Federal Energy Regulatory Commission issues permits and licenses for nonfederal hydroelectric power projects; regulates the rates and other aspects of interstate wholesale transactions in electric power; issues certificates; conducts continuing investigations of the electric power industries and their relationships to national programs and objectives, including conservation and efficient utilization of resources; requires maximum protection of the environment in the construction of new hydroelectric projects and transmission lines consistent with the nation's needs for adequate and reliable electric power; and allocates resources consistent with the public interest under the Federal Power Act. In addition, the FERC prescribes and enforces a uniform system of accounts for regulated electric utilities.

The FERC publishes river basin appraisals for use in licensing projects. It also reviews plans for dams proposed by other federal agencies and makes recommendations concerning facilities for the development of hydroelectric power. The Commission reviews rates for the sale of electric power from certain federal hydroelectric projects. In addition, it participates with other agencies in coordinating development and utilization of the nation's water and related land resources. Expenditures since 1971 for regulation of hydroelectric power are listed in Table 28.[12]

ANALYTICAL METHOD

In this chapter benefit is defined as electrical energy produced in kilowatt hours (kWh). Five definitions of costs of incentive were considered and represented in Appendix D. Two definitions were selected:

1. The portion of the net investment in construction and operation of the dam allocated to power development and the exemption of power revenues from federal income taxes. This definition includes return on the investment from power revenues and covers costs of construction, operation, maintenance, management and regulation.

2. The low interest rates of federal appropriations and the exemption of power revenues from federal income taxes. This definition is based on the difference between federal and private industry costs for the dams.

For definition #1, plant investment, generation and capacity data were used to estimate the chronological listing of federal incentives shown in Table 28. All amounts are in 1978 dollars. This table was obtained using the calculational procedures in Appendix D and by summing Tables E-11 through E-15 in Appendix E.

The total cumulative net federal investment in hydroelectric generation facilities by the end of FY-1978 was $14.52 billion; the total installed capacity of these facilities is 31,300,456 kW. The total cumulative generation was 2,500.94 billion kWh.

The total cumulative net federal investment in electricity transmission facilities has been $6.22 billion. These transmission facilities are used by other electricity generating sources as well as hydro. It is beyond the scope of this research to proportion this expenditure over the appropriate energy sources so this investment is identified here as a subsidy to electric energy and the dollar amount is incorporated into the electricity chapter.

The method used to estimate the income tax exemption incentive is as follows:

REFERENCES - CHAPTER V

1. Federal Power Commission, Hydroelectric Plant Construction Cost and Annual Production Expenses, 16th Annual Supplement, 1972.

2. U.S. Department of the Interior, Bonneville Power Administration, Annual Reports, 1945-1947, 1951-1952, 1955-1959, and 1961-1976.

3. U.S. Department of the Interior, Southwestern Power Administration, Annual Reports, 1973-1975.

4. U.S. Department of the Interior, Southeastern Power Administration, Annual Reports, 1970-1972, 1974.

5. U.S. Department of the Interior, Alaska Power Administration, Annual Reports, 1969-1970, 1973, 1974-1976.

6. Comptroller General of the United States General Accounting Office, Report to the Congress, Examination of Financial Statements of the Tennessee Valley Authority for the Fiscal Years 1947, 1948 ... 1976.

7. U.S. Department of the Interior, Bureau of Reclamation, Mid-Pacific Region, Central Valley Project, California, Tentative Power Rate Adjustment Study, August 1975.

8. U.S. Department of the Interior, Bureau of Reclamation, Southwest Region, Rio Grande Project, New Mexico, Tentative Power Rate Adjustment, September 1975.

9. U.S. Department of the Interior, Bureau of Reclamation, Lower Colorado Region, Parker-Davis Project Power Repayment Study Brochure for Fiscal Year 1974, July 1975.

10. U.S. Department of the Interior, Bureau of Reclamation, Upper Colorado Region, Colorado River Project and Participating Projects Tentative Power Rate Adjustment, September 1975.

11. U.S. Department of the Interior, Bureau of Reclamation, Eastern and Western Division, Customer Brochure, Proposed Power Rate Adjustment, September 1975.

12. Executive Office of the President of the United States, Office of Management and Budget, The Budget of the United States Government, 1967 through 1972.

13. Historical Statistics of the Electric Utility Industry Through 1970. Edison Electric Institute, New York, NY 10016, Tables 54 and 57.

14. Statistical Year Book of the Electric Utility Industry for 1975. Edison Electric Institute, New York, NY 10016, Tables 545 and 575, October 1976.

15. Statistical Year Book of the Electric Utility Industry for 1976. Edison Electric Institute, New York, NY 10016.

VI. COAL ENERGY INCENTIVES

The U.S. Department of Energy publication, Monthly Energy Review"[1] indicates that 74% of U.S. coal production is used by utility companies for power generation, 24% is used by industry, and the balance of current coal production is consumed by household or commercial users. In 1978 these users consumed 10,372; 3,433 and 265 trillion Btu, respectively. The major federal incentives to coal production and utilization are for capital expenditures and depletion allowances. This chapter presents a brief review of the federal incentives applicable to leasing, mining and R&D, and regulations and laws which have served as incentives for the development of U.S. coal resources.

RESEARCH AND DEVELOPMENT

As shown in Table 32, about $3.4 billion (1978 dollars) of direct federal funds were spent for coal R&D programs from 1950 to 1978. This includes expenditures by the Environmental Protection Agency for research to mitigate the environmental impact of using high-sulfur coal as a fuel, especially for electricity generation.

Mining Methods and Techniques

Because for many years the coal industry operated at a deficit (or at relatively low earnings as compared to other major industries in the United States), and because of the industry's lack of highly specialized laboratories and skills in the multiple disciplines needed for effective research little research was done by the coal industry except as directed to local problems. Recently, however, through Bituminous Coal Research, Inc., now affiliated with the National Coal Association, the coal industry has initiated and participated in considerable research on various coal processes. In addition, several of the large coal and coal owning oil companies have been active in mining and conversion research.

The Bureau of Mines has carried on numerous studies pertaining to coal mining, preparation, and utilization, including coking coal characteristics. These studies included mining methods and systems, mechanization of operations,

TABLE 32. Federal R&D Expenditures for Coal Industry (in Millions of Dollars)

R&D Program	50[k]	51[k]	52[k]	53[k]	54[k]	55[k]	56[k]	57[k]	58[k]	59[k]	60[f]	61	62	63[g]	64
Mineral Resources Research Related to Coal (BUMINES)[b]	10.0[l]	10.0[l]	10.0[l]	10.4	8.6	6.9	9.1	10.6	11.3	11.3	11.8	15.0	17.6	13.8	12.0
Mining Technology Research Related to Coal (BUMINES)[d]															
Office of Coal Research (Interior)													1.8	1.6	2.4
Coal Utilization (ERDA)[c] (DOE)[m]															
Health and Safety Research (BUMINES)[a]											0.8	0.9	1.2	1.5	1.6
Mined Area Protection															
(Sect Interior)[e]															
Environmental Research															
Environmental Protection Agency															
Total (current $)	10.0	10.0	10.0	10.4	8.5	6.8	8.3	9.1	10.4	11.3	12.6	16.9	15.6	16.9	14.0
Total (1978 $)	27.1	25.1	24.6	25.4	20.3	16.8	19.9	21.1	23.9	25.1	27.6	34.7	33.7	35.9	33.7
Total 1950-78	$3,301.3														

R&D Program	65	66	67	68	69[h]	70	71	72	73	74	75	76[i]	77[i]	78
Mineral Resources Research Related to Coal (BUMINES)[b]				15.9										
Mining Technology Research Related to Coal (BUMINES)[d]					3.7	4.0	4.5	2.9	3.2	8.5	25.3	37.1	35.8	49.1
Office of Coal Research (Interior)	3.2	4.0	5.0	5.9										
Coal Utilization (ERDA)[c] (DOE)[m]					15.2	12.6	25.3	34.3	39.8	60.9	228.7	417.4	354.5	555.0
Health and Safety Research (BUMINES)[a]	2.0	2.1	1.9	2.1	7.2	10.9	20.8	22.3	20.3	30.7	31.9	34.9	35.2	37.1
Mined Area Protection											3.0	25.0		
(Sect Interior)[e]				5	6	10	9.8	10.0	13.4	16.6	42.4	22.3	15.6	17.9
Environmental Research														
Environmental Protection Agency														
Total (current $)	17.8	19.5	22.6	28.8	27.1	33.5	60.3	92.5	87.1	123.6	338.3	531.7	441.1	659.9
Total (1978 $)	36.8	39.2	44.2	63.8	49.2	65.1	97.3	146.4	128.1	163.6	401.7	609.9	475.0	659.9

(a) The major emphasis of health and safety research for mining is on coal. 100% of expenditures were allocated to the coal industry.
(b) Mineral resources research by BUMINES was related to other minerals or to mining in general as well as to coal. 50% of the expenditures in this category were allocated to coal.
(c) ERDA was not created until 1975, but the most recent reference reassigned work within OCR and other coal related research which was incorporated into ERDA to this category.
(d) Mining technology research within BUMINES is not related to any specific ore. 50% of the expenditures in this area was allocated to coal.
(e) The major emphasis on mined area protection is related to coal. 100% of the expenditures in this area was allocated to coal.
(f) Data for 1960 through 1962 were taken from "An Analysis of Federal R&D Funding by Budget Function, 1960-1972", NSF 71-25.
(g) Data for 1963 through 1968 were taken from "An Analysis of Federal R&D Funding by Budget Function 1963-1973," 72-313.
(h) Data for 1969 through 1976 were taken from "An Analysis of Federal R&D Funding by Budget Function, 1969-1976." NSF 75-330.
(i) Data for 1975 and 1976 were estimated in August 1975.
(j) SOx abatement research. Includes minor amounts for refinery SOx control.
(k) 1950-59 estimated using NSF's "Federal Funds for R&D and other Scientific Activities for 1953-1960" and the percentage of the Bureau of Mines total obligations spent toward coal related research for 1960.
(l) Estimated based on 1953 number.
(m) Reported as part of DOE for 1978; see Ref. 1.

coal cleaning processes, and factors to increase the productivity of mines, plus experiments in longwall mining, the use of diamond drills, and the development of roof bolting. For many years the Bureau has made field and laboratory examinations and analyses of the chemical constituents of coal on a mine-by-mine basis and has regularly published reports on them.

In addition, by 1985, the Bureau of Mines will have completed major demonstrations in the eastern, central and southwestern sections of the country to establish the economic efficacy of integrated extraction-reclamation systems. Also, the Bureau currently is developing improved coal treatment technologies to upgrade the quality of coal by reducing the amount of ash, sulfur, and other coal constituents.[2]

Utilization

The only major growth market for coal is the electric utility industry. In 1978, 69% of total coal production was used for power generation. Excluding coal exports, consumption by utilities represents over 74% of U.S. coal consumption.[1] On the basis of coal equivalents, coal supplies approximately 60% of the fossil fuels consumed for power generation as compared to about 22% for oil.[1] In other areas of current coal utilization, approximately 25% of production is used for making coke at home and abroad; there is now considerable competition among electric utilities for low sulfur, high-Btu coals.

Among the factors limiting the use of coal are environmental regulations, particularly air pollution standards, which prescribe limits on the sulfur content of usable coal. This is a serious problem for the electric utility industry. This problem is increased by the high cost, and in some cases questionable effectiveness, of stack gas scrubbers and other desulfurization processes for reducing coal combustion pollutants.

Extensive research is under way to provide viable antipollutant processes, including different types of scrubbers, fluidized bed combustion, solvent refining, and other processes. To encourage the installation of flue gas desulfurization equipment, it has been suggested that until these processes become high performance, proven techniques, consideration be given to classifying them under the Internal Revenue Code to permit the rapid write-off of their capital costs.[4]

A prime incentive for the development of western coal mining is the need for low-sulfur coals to meet air quality standards in the East. The practical problems in the development of western coal mining are the leasing of public lands, the appreciably lower Btu values of western coals compared to eastern coals, high transportation costs, and the impact of successful development of economically and technically viable flue gas desulfurization processes.

Just as the sulfur content of coal has become an increasingly important factor in the production and utilization of coal, so are relative heating values (Btu) of coals, both in their direct relation to SO_2 regulations and their costs. Generally coals of high Btu value command the highest prices.

Another factor that influences coal use is the price of competing fuels. Partial or complete deregulation of natural gas prices would be a strong deterrent to the continued use of natural gas for power generation and thus would be an added incentive for increased use of coal.

Considerable research has been done by both the Federal Government and industry on the preparation of coal to reduce impurities, including sulfur, as an alternative to post-combustion abatement.

Research on new uses of coal, including low-rank coals such as lignite, has been carried on for many years by the Bureau of Mines. During the Kennedy Administration the Office of Coal Research was established to develop new processes for the utilization of coal, including research, development, and demonstration. With the establishment of ERDA, the Office of Coal Research and coal utilization activities of the Bureau of Mines were transferred out of the Department of the Interior. These activities are now part of DOE.

Through the efforts of the U.S. Bureau of Mines, synthetic fuel developments achieved in Germany during World War II were evaluated in a program at Louisiana, Missouri. German Lurgi hydrogeneration units were evaluated using U.S. coals. Only minor economic use was made of the information developed at that time but it has provided useful background for the present synfuels program.

Because of the total lack of information relative to the feasibility of underground coal gasification, the U.S. Bureau of Mines developed a field scale test and methodological evaluation at Gorgas, Alabama, in 1948. More recent tests have been performed in Wyoming by DOE. To date, however, no commercial installations have resulted from this research.

One of the major forces underlying many coal research programs (as well as those involving other energy sources) is the large utility market, which is continually expanding to meet increasing requirements for electric power. This research is motivated by our inadequate domestic supplies of oil and natural gas and our increasing dependence on high-cost foreign oil, plus all the attendant adverse implications. In addition to research and development on coal combustion techniques, DOE is engaged in extensive and vitally needed research on coal gasification, coal liquefaction, and solvent refining. These programs are positive secondary incentives for coal production.

Research and development for coal production and utilization is a non-traditional service of government. The total presented for the period was developed from published expenditures of the appropriate government agencies and includes R&D on resource assessment, mining techniques, mining health and safety, coal utilization, and sulfur dioxide pollution abatement. Expenditures were about $3.4 billion (in 1978 dollars) for the period 1950-1978.

EXPLORATION

Among the basic incentives to coal production has been the comprehensive data assembled by the U.S. Geological Survey through exploration and geologic inference and supplemented by information from the Bureau of Mines and federally supported state agencies on coal resources and reserves.

Although the U.S. coal resources are huge,[a] they have neither been as fully explored nor as finely categorized as now appears necessary in consideration of the drastic reassessments of energy resource availabilities made in recent years, and the "quality of fuels" factors recently made more important

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[a] Approximately 1.7 trillion tons each of "identified" and "unidentified" (or postulated) resources, according to estimates of the U.S. Geological Survey, presented in Reference 12.

by environmental considerations. Until processes are developed that will permit the use of coal that otherwise may be considered environmentally unacceptable, these factors will effectively "reduce" the coal resource base. Coal in its solid state must continue to play a vital role in national energy supply, notwithstanding the develoment of large-scale alternate sources of energy, including the development of synthetic oil and gas from coal and oil shale, of nuclear power, solar power, and a variety of other energy sources which heretofore have not been considered of consequence.

Whereas coal "resources" refer to the totality of existing coal, practicalities of commercial availability require us to consider as readily-available "reserves" only those coals that are mineable under current economic and technological conditions. This narrows the coal reserve base to approximately 438 billion tons.[12] These coals are categorized by rank (bituminous, subbituminous, lignite, anthracite) and by their amenability to "underground" mining or "surface" mining (68% and 32% of total reserves for the country as a whole, respectively, although the percentages differ in various sections of the nation). Also, primarily because of safety requirements and geologic conditions, generally only about 50% of underground reserves can be recovered in mining, whereas surface mining recovery ranges up to 90%. It is expected that new technology will increase the percent recovery in underground mining.

Among other important delineations for coal are geographic and quality differences. Most coal reserves are west of the Mississippi River; many are on federal and Indian lands where leases are required for operation, and generally they are far from concentrations of industry and commerce.

Although about 65% of total coal resources are estimated to contain 1.0% or less sulfur by weight and almost half contain 0.7% or less sulfur, most coals of these qualities are located in the West.[4] Western coals have average heating (Btu) values well below those of "Eastern" coals. Generally, they are less costly to produce, as most Western production is surface mined; but, for eastern markets, they have high transportation cost. Water availability can be a constraining factor in both the production and use of coal, particularly in the West.

Eastern coal land is mostly privately owned and is relatively near the large industrial and commercial markets of the United States (electric utilities, coke plants, exports) for which transportation facilities have been well developed. Approximately 49% of coal production in the east is from underground mines (51% from surface mines).(13) These coals generally have appreciably higher Btu values than Western coals. (The heating values of coal shipped to market range from approximately 7,000 Btu/lb for Texas lignite to 14,000 Btu/lb for coking coal from southern Appalachia.)

Most Eastern coal is of medium-to-high sulfur content except that from southern Appalachia, which produces the highest quality (low sulfur) coals for metallurgical purposes (the production of coke for steel mills) and for other purposes that require low-sulfur coal. Because of the higher sulfur content of much of the coal near industrial centers, considerable effort is being concentrated on the development of stack gas scrubbers and other antipollutant processes to make these coals more environmentally acceptable.

Federally supported exploration and examination of coal inventories have provided, and will continue to provide, valuable incentives for the development, production, and utilization of the nation's coal energy resources. At the same time, they will form a basis for comparing coal resources with the volume and quality of other domestic energy resource availabilities in the nation's overall energy structure and with foreign sources of supply.

The principal government agency involved in collecting, analyzing, and disseminating information on coal resources is the Geological Survey of the Department of Interior. For example, recently the U.S. Geological Survey published a detailed study, "Resources and Land Information Demonstration Program," pertaining to coal-bearing areas in the Intermountain West (including the Power River Basin), related water resources, and other valuable information. Map folios were also prepared. These offer valuable guidance in the development of these area.

The expenditures by the Geological Survey for all geological and mineral surveys (descried in Chapter VII) amounted to $1,262 million in 1978 dollars for the period 1950-1978. If the 10.3% of the energy consumed during 1978 which is attributed to coal (using the figures from Chapter III) can be applied to all funds expended since 1950, coal-related work amounted to $130 million (1978 dollars).

Tax Rules Applicable to Exploration

In 1976 the holding period of 6 months was extended to 9 months as a result of Section 1402 b(1)(I) of the Tax Reform Act of 1976, which amended Section 631 of the Code. In 1968, the U.S. Treasury estimated that for that fiscal year the revenue cost of this incentive was $5 million.[5]

Federal expenditures for exploration are defined in 25 USC 617 (a) as those"...paid or incurred during the taxable year for the purpose of ascertaining the existence, location, extent, or quality of any deposit of ore or other mineral..., and paid or incurred before the beginning of the development stage of the mine..." This statute does not apply to oil and gas exploration costs.

Prior to 1951, exploration expenditures were not covered in the Revenue Act even though it was generally accepted that such expenditures were capital in nature.[6,p.1570] In that year, changes were made in the act allowing a specific deduction of such costs up to $75,000, or an alternative method by which the taxpayer could elect to defer amounts up to that sum not deducted in the current year and deduct the amount ratably as the minerals were discovered or sold. This was intended to encourage small mine operators.[6,p.1571] The law was further amended in 1954, when the dollar limitation was increased to $100,000 per year or $400,000 in 4 years, and in 1960, when the 4-year limitation was removed. In 1966, the Congress, in an attempt to stimulate increased domestic mining activity due to the need for a domestic, rather than a foreign source of essential minerals, removed the monetary limit on amounts that could be deducted currently. However, the law introduced the principle of recapture to be applied when the mine was sold or reached the producing stage. If, however, the taxpayer opted to be subject to a $400,000 limitation, he could avoid the effects of recapture.[6,p.1572]

In 1969, the exploration expenditure statute was amended to its present form. For expenditures incurred after December 31, 1969, the law has provided no provision for deduction of costs without one of two forms of recapture. The rules for recapture were analyzed in a review of incentives for natural resources by Frank M. Burke, Jr., when he stated"

> A taxpayer under the first rule of recapture (which applies if the second method discussed below is not elected), is not allowed any deduction for depletion with respect to a property until the otherwise allowable depletion for such property equals "adjusted exploration expenditures" with respect to such property. The term "adjusted exploration expenditures" means the excess of 1) the total exploration costs deducted by the taxpayer in all taxable years which would have otherwise been capitalized as basis of the property, over 2) the amount by which allowable depletion for that property has been reduced, for all taxable years, because exploration costs were deducted, rather than capitalized. A taxpayer may elect the second method of recapture which requires inclusion in gross income of an amount equal to the "adjusted exploration expenditures" with respect to all properties or mines reaching the producing stage during the taxable year. If the taxpayer elects this alternative, he will be allowed his full depletion deduction for the year. The amount included in gross income is added to the taxpayer's depletable basis. The first method, of course, may allow the taxpayer to spread the recapture over several years, whereas the second method requires inclusion of the entire amount in one taxable year.
>
> Generally, if a mining property is disposed of, the lesser of the adjusted exploration expenditures with respect to the property or the excess of the amount realized over the adjusted basis of the property, is treated as ordinary income. In the case of a disposition other than a sale, exchange, or involuntary conversion, the fair market value of the property is used in place of the amount realized.[6,p.1572]

The net effect of the 1969 changes prohibits the taxpayer from benefiting from both the current deduction of exploration costs and from depletion of the property when it reaches the production state, or from capital gains when the property is sold.[7]

Thus far, it has been difficult to quantify the number of tax dollars lost as a result of this incentive. However, the deduction for such costs in nonmetallic mining were termed "trivial for tax returns filed in 1960.[7]

Leasing and Development of Federal Coal Lands in the West

As the Federal Government owns over 60% of western coal reserves,[4] most of which are of low-sulfur content, it can directly influence the ability of the United States to meet its energy production goals, both qualitatively and quantitatively. Because of the lead times necessary for capital formation, market acquisition, mine development, and the blocking up of reserves to support large, long-term coal consumers, any undue deferment of leasing under conditions sufficient to attract development automatically could be a constraint to the achievement of production goals for the 1980s.

Although 51.5% of the demonstrated coal reserve base is west of the Mississippi River and is predominantly low-sulfur coal, 1978 production in the West was only 28% of total U.S. production.[13]

Although leasing schedules for federal coal lands have not yet been established, proposed amendments to the Federal Coal Leasing Act of 1975 generally are designed as incentives to the leasing and development of these lands. The amendments establish criteria for leasing that are favorable to investors, including the recapture of costs; deferred bonus payments; the treatment of royalties and other tax incentives; the protection of proprietary data; and other administrative and operational measures. Such incentives are effective because private industry is reluctant to spend large sums for geological and hydrological data collection unless proprietary data can be protected. The cost of paying royalties on coal mining leases can be a significant factor in lease investment speculations. The IRS at present has a tax regulation which grants significant tax deductions to investors paying advance royalties on coal leases. Taxation of royalties at regular tax rates led owners to ask for larger royalties. Such royalties could be treated as capital gains if cost depletion were used, which could lower the effect of coal leases on increased production. Deduction of costs for mine development instead of capitalization also would encourage mine operators.

Public Law 94-377 (S-391) of August 4, 1976, amended the Federal Coal Leasing Amendments Act of 1975. Among the changes which encouraged leasing and development are the following provisions: Section 2, "No less than 50 per centum of the total acreage offered for lease by the Secretary in any one year shall be lease under a system of deferred bonus payments;" Section 5(d) (1), "The Secretary, upon determining the maximum economic recovery of the coal deposit or deposits served thereby may approve the consolidation of coal leases into a logical mining unit. A logical mining unit is an area of land in which the coal resources can be developed in an efficient, economical, and orderly manner as a unit with due regard to conservation of coal reserves and their resources;" Section 8A (a), "The Secretary is authorized and directed to conduct a comprehensive exploratory program designed to obtain sufficient data and information to evaluate the extent, location, and potential for developing the known recoverable coal resources within the coal lands subject to this Act. This program shall be designed to obtain the resources information necessary for determining whether commercial quantities of coal are present and the geographical extent of the coal fields--;" Section 8A (b), "The Secretary shall maintain a confidentiality of all proprietary data or information purchased from commercial sources while not under contract with the U.S. Government until after the areas involved have been leased."

These amendment statements offer direct incentives to large private coal developers to extend their operations on new or contiguous coal reserves.

Section 26 USC 161 (a) defines "development expenditure" deductions as those"... paid or incurred during the taxable year for the development of a mine or other natural deposit (other than an oil or gas well) if paid or incurred after the existence of ores or minerals in commercially marketable quantities has been disclosed."

Prior to 1951, this type of expenditure in excess of net receipts from ores or minerals had to be capitalized while the mine was in the development stage and to be recovered through depletion when the mine became productive. Since this tax treatment inhibited mining industry expansion, and since the Senate Finance Committee was concerned about the shortage of many essential metals and minerals necessary to the defense effort, the Congress provided for development costs to be treated either as a current deduction or as a deferred expense to be deducted ratably as the units of ores or minerals were sold.(6,p.1573)

In 1954, the current Section 616 of the Code was enacted. It continued the option to deduct currently or defer such expenditures. Although the expenditures are not defined in the statute, the Internal Revenue Service has ruled that it includes all costs resulting directly from the process of making the mineral accessible by the driving of shafts, tunnels, and similar processes or activities.(6,p.1579)

Since development expenditures are not subject to recapture as are exploration expenditures under Section 617, taxpayers are anxious to have their interest classified as being in the development stage.(6) The general rule governing whether a mine is in the development or exploration stage is that the taxpayer's action must indicate a definite intention and commitment to develop the property before the advancement from exploration to development can be established. This intention should be manifested after the existence of commercially marketable quantities of ores or other minerals has been established.(9)

In 1960, development expenses totaling about $13 million were deducted against $2 billion of gross income from mineral properties. In the most important of the industries covered by the deduction, bituminous coal, the ratio of development expense to gross income was 0.3%.(3)

Section 26 USC 631 (c) provides a gain/loss incentive to iron and coal royalty recipients. Before 1951, the recipients of bonuses, advances, and royalties in coal leasing transactions were required to treat the amounts received as ordinary income, subject to percentage depletion. The Senate Finance Committee in that year decided that the recipients of coal royalties were entitled to tax relief and Section 117 (c) (2) of the Internal Revenue Code of 1939 was enacted, the predecessor to Section 631 (c).(6,p.1570) The effect of this incentive provision has been explained as follows:(6,p.1570)

> This provision states that where the owner of coal assigns rights to exploit such coal, retaining an economic interest, such owner may treat the present and future proceeds from assignment of the interest, to the extend such proceeds exceed his adjusted depletion

basis (plus any deductions disallowed for the taxable year by virtue of Section 272 of the Internal Revenue Code of 1954) as gain from disposition of an asset used in a trade or business. Therefore, provided the owner has held his interest in the coal for more than 6 months when the coal is mined, the resulting gain is treated as Section 1231 gain. Bonuses received in connection with the grant of the lease qualify under Section 631 (c) to the extent attributable to coal held more than 6 months. An owner qualifying under Section 631 (c) is not entitled to depletion on the receipts under the contract. Section 631 (c) does not apply to income realized by the owner as a co-adventurer, partner or principal in the actual mining of such coal.

In the Internal Revenue Code of 1954, Section 631 (c) was expanded to include iron ore except to the extent iron ore is disposed of to certain related partners. Thus, under present law, the recipients of iron ore and coal royalties are afforded more favorable tax treatment than most other mineral royalty recipients.

The holding period of 6 months was extended to 9 months in 1977 and one year thereafter as a result of Section 1402 b(1) (I) of the Tax Reform Act of 1976. That section amended Section 631 of the Code.

In 1968, the U.S. Treasury estimated that for that fiscal year the revenue cost of this incentive was $5 million.[5]

Leasing of coal on federal lands, which are almost entirely west of the Mississippi, is handled by the Bureau of Land Management of the Department of the Interior. In Chapter VII, it is estimated that BLM has spent $672.4 million (1978 dollars) on fossil fuel resource management and leasing activities. From 1950 to 1978 approximately 3% of the value of fossil fuel produced from federal leases was from coal.[1] Using this as a measure of the incentive, $20.2 million (1978 dollars) can be attributed to the coal leasing costs incurred by BLM.

Development of Coal in the East

Coal mining east of the Mississippi River, which accounts for about 76% of total coal production, is almost wholly on privately-owned lands. Most mines have been developed to supply the open market, although some are owned and operated by large consumers such as steel companies and electric utilities. Of the approximately 6,000 mines in the East in 1975, 37% (2,245) were underground mines, producing 52% of production. The 3,750 surface mines (63% of the total) produced 48% of Eastern output.(3)

Southern Appalachia (Alabama, Virginia, and portions of West Virginia and Kentucky) has the largest low-sulfur coal reserves in the East, although Pennsylvania and Illinois also have sizeable reserves in the lower ranges of sulfur content. The remaining coals in both northern and southern Appalachia contain medium-to-high sulfur contents, which is the primary reason for intensive research activities for the development of viable stack gas scrubbers, fluidized bed combustion, and other antipollution processes.

As in the West, most production in the East is from large mines. In 1975, for the country as a whole, over 55% of production came from only 4.6% (284) of the mines; 71% of production came from less than 10% of the mines.(3)

As distinguished from the past, when many coal mines were developed with minimal thought to competitive markets for coal, oil, and natural gas, large mines today are not developed without firm consumer commitments for at least a major portion of their intended production.

Exploration incentives consist of taxation and traditional services. Special tax rules are designed to encourage small coal mine operators by giving special deductions, which amount to only a few million dollars per year. The principal type of incentive is the nontraditional service provided by the U.S. Geological Survey in supplying information which, for the period 1950-1978 amounted to $130 million. A market activity service was provided by the Bureau of Land Management in awarding and Supervising coal mining leases (for 1950-1978 $20.2 million). The figures were calculated from budget figures for agencies and the share of their activity that is coal-related. The total for the exploration area is thus $150.2 million for the period 1950-1978.

MINING

There are many complexities involved in broadening the role of coal resources in the nation's energy structure. These include various mining and associated administrative and operational considerations, including past, present, and possible future incentives, both direct and indirect, some of which are discussed below.

Depletion Allowance

Coal is a "wasting asset," that is, the value of capital invested in mines is decreased as coal reserves are extracted. Originally calculated on the basis of the value of reserves and the value of annual production, the coal depletion allowance is calculated today as a percentage of the value of production at the minemouth.

The percentage depletion allowance is 10%, which is substantially less than the 22% for oil and gas. The maximum allowance is 50% of the income from the property. Because of the low price of coal in 1960, the effective percentage was reported as 4%. With higher prices for coal in recent years, 5-6% now seems reasonable.(7) For this analysis, 4% was used from 1950 to 1974 and 6% thereafter. A 48% tax rate was applicable from 1954 to 1977. Prior to that the rate was 52%. In 1978, the rate was reduced to 46%.

The total revenue equivalent of the percentage depletion allowance is shown in Table 33. The total from 1950-1978 is about $4.7 billion 1978 dollars. During this period about 26 billion tons of coal were produced, equivalent to roughly 624 quadrillion Btu. The incentive amounted to $0.011 per million Btu.

Minimum Price Controls--Stabilization

Historically, among the most important federal incentives for coal production were the provisions of the National Recovery Act and Bituminous Coal Acts of 1935 and 1937. Although the first two were held unconstitutional because of the inclusion of labor provisions, under the National Bituminous Coal Act of 1937 minimum price schedules for coal were successfully established and upheld by the courts. These measures were a direct outgrowth of the Great Depression. Their fundamental purpose was to prevent unrestrained price

TABLE 33. Revenue Equivalent of Percent Depletion Allowance for Coal

	Value of Production				
	Million Current $			Million 1978 $	
Year	Lignite and Bituminous	Anthracite	Total	Total	Revenue Equivalent of Percent Depletion
1978	16,214	272	16,486[b]	16,486	430
1977	15,149	232	15,381[a]	16,565	457
1976	13,300	211	13,511	16,497	455
1975	12,500	202	12,702	16,414	456
1974	9,504	147	9,651	12,774	343
1973	5,050	90	5,140	7,552	143
1972	4,562	85	4,647	7,254	136
1971	3,901	103	4,004	6,458	122
1970	3,772	105	3,877	6,519	124
1969	2,797	94	2,891	5,150	97
1968	2,546	97	2,643	4,960	94
1967	2,555	96	2,651	5,185	99
1966	2,421	101	2,522	5,075	96
1965	2,276	122	2,398	4,962	94
1964	2,166	149	2,315	4,872	93
1963	2,013	154	2,167	4,620	87
1962	1,892	134	2,026	4,374	81
1961	1,845	140	1,985	4,332	82
1960	1,950	147	2,097	4,622	87
1959	1,966	172	2,138	4,789	90
1958	1,996	188	2,184	4,933	93
1957	2,504	228	2,732	6,339	121
1956	2,412	237	2,649	6,366	121
1955	2,092	206	2,298	5,603	107
1967	2,504	228	2,732	6,339	121
1956	2,412	237	2,649	6,366	121
1955	2,092	206	2,298	5,603	107
1954	1,770	248	2,018	4,903	93
1953	2,248	299	2,547	6,216	117
1952	2,289	380	2,669	6,562	124
1951	2,626	406	2,032	7,619	144
1950	2,500	392	2,892	7,839	148
TOTAL				$213,840	$4,736

(a) Assumed $22/ton for lignite and bituminous and $37.5/ton for antracite coal.
(b) Assumed $24.80/ton for lignite and bituminous and $47.25/ton for antracite coal.

Sources: Minerals Yearbook, U.S. Dept. of Interior, Bureau of Mines, various issues. Monthly Energy Review, Dept. of Energy, Energy Information Administration, July, 1979. Budget of the U.S. Government, years 1976-1980, Special Analyses section, "Tax Expenditures" chapter.

cutting and consequent overproduction and bankruptcies in the coal industry through the estabishment of "minimum prices." In effect, the purpose was to prevent large segments of the coal industry from selling coal below their costs of production in vain attempts to recoup their losses by gaining new customers at the lower prices, which inevitably continued their downward spiral.

Stated briefly, the minimum prices were based on weighted average costs for designated districts and minimum price areas into which the country was divided on the basis of meaningful characteristics related to production, transportation, and prices. Among the many factors considered were coal qualities, sizes, uses for which sold, transportation rates to common market areas, and other matters related to coal values.

The establishment and administration of federally regulated minimum prices involved lengthy and complex procedures, including requirements for the submittal of cost data from individual producers and support data from sales agents, distributors, transportation media, and others. The validity of such control measures was challenged all the way to the Supreme Court, where they were upheld. Although the law and the minimum prices resulted in significant stabilization of the coal industry and in the development of a great body of administrative law, their full effectiveness was never realized because of the United States' entry into World War II. As a result of the war, the need changed from minimum prices to maximum permissible prices, set by the Office of Price Administration.

Data Collection

An important factor in the development of price stabilization policy was the collection and analysis of coal production and price data. This task was assigned to the Bureau of Mines. For the period 1964-1978 the cost of data collection and analysis by BOM for all minerals is presented in Table 34 based on the Appendix to the Budget. For 1964-71, data were published on the amounts attributed to bituminous and anthracite coal and "petroleum." The petroleum fraction has been assigned 2/3 to oil and 1/3 to natural gas. Since no breakdown after 1971 is available, estimates must be used. It was assumed that the percentage breakdown for 1971 applies to later years. This yields a cost estimate of $56.2 million (1978 dollars) for coal data collection and analysis for

TABLE 34. Cost of Data Collection and Analysis, All Minerals--Bureau of Mines

Year	Current $ (Thousands)	Fraction Coal	Fraction Oil and Gas	1978 $ (Thousands) Coal	Oil[a]	Gas[a]
1978	13,017	0.23[b]	0.12[b]	2,994	1,041	521
1977	12,554	0.23[b]	0.12[b]	3,109	1,087	535
TQ 1976	3,431	0.23[b]	0.12[b]	905	317	156
1976	15,417	0.23[b]	0.12[b]	4,066	1,413	707
1975	11,621	0.23[b]	0.12[b]	3,244	1,129	564
1974	11,384	0.23[b]	0.12[b]	3,465	1,204	602
1973	9,598	0.23[b]	0.12[b]	3,353	1,165	583
1972	8,104	0.23[b]	0.12[b]	2,910	1,011	506
1971	10,752	0.23	0.12	3,988	1,387	694
1970	10,219	0.23	0.12	3,953	1,374	687
1969	9,189	0.24	0.13	3,929	1,417	709
1968	8,885	0.26	0.12	4,335	1,449	667
1967	7,506	0.24	0.11	3,524	1,077	645
1966	7,875	0.25	0.10	3,984	1,055	528
1965	7,540	0.27	0.11	4,213	1,144	572
1964	7,266	0.28	0.11	4,282	1,122	561
TOTAL				56,253	18,392	9,129

(a) Assumes 2/3 of "petroleum" cost for oil, 1/3 for gas.
(b) Estimated.

the entire period 1964-1978.(The data collection activity was transferred to DOE at the start of FY 1978).

Health and Safety

The Bureau of Mines and coal producing states have had active programs in health and safety for many years. They culminated in the Federal Mine Health and Safety Act of 1969, which mostly extended governmental authority in this area and imposed new restrictions and responsibilities on the coal industry, some of which are burdensome. Administration of the act is now the responsibility of the Mining Enforcement and Safety Administration (MESA), part of the Department of the Interior until March 8, 1978. As a result of the Mine Safety and Health Amendments Act of 1977, this activity is now the Mine Safety and Health Administration in the Department of Labor. The cost of administering mine health and safety programs, 1950-1978, is given in Table 35. For the period 1972-1978, data exist for the cost of inspections of coal mines and for metal and non-metallic mineral mines. The ratio was used to apportion training programs and administrative costs. For the earlier period it was assumed that 0.85 of the total cost was coal industry-related. Thus, coal mine health and safety, excluding R&D, is estimated as $798.9 million (1978 dollars). (Whether this is a positive incentive, negative incentive, or merely an increased cost of doing business is a matter of opinion; since it was not intended as an incentive for coal production, its impacts on mine productivity and mining costs are secondary effects.)

As an incentive to the industry to invest in certain coal mine safety equipment, in 1964 Congress enacted four provisions to make 5-year amortization available. Among them was 26 USC 187, which extended rapid amortization to coal mine operators. This provision was repealed, however, by Section 1901 of the Tax Reform Act of 1976.

The statute provided that a taxpayer could elect a 5-year amortization, in lieu of the depreciation deduction allowed by 26 USC 167, for certified coal mine safety equipment (i.e., electric mine-face equipment) required by the Federal Coal Mine Health and Safety Act, as certified by the Secretary of the Interior and placed in service prior to January 1, 1976.[10]

TABLE 35. Expenditures on Mine Health and Safety Excluding R&D

Year	Thousands of $ Total	Fraction of All Inspection Funds for Coal Mines	Current $ Total for Coal (Thousands)	Total 1978 $ for Coal (Thousands)
1978	108,361	0.71	76,936	76,936
1977	98,271	0.76	74,686	80,437
TQ 1976	22,765	0.75	17,074	19,584
1976	83,066	0.77	64,275	73,724
1975	77,882	0.79	61,523	74,660
1974	56,735	0.82	46,361	61,365
1973	54,009	0.84	45,532	66,901
1972	47,209	0.84	39,773	62,089
1971	29,384	0.85[a]	24,976	40,280
1970	13,903	0.85[a]	11,818	19,872
1969	8,856	0.85[a]	7,528	13,409
1968	8,114	0.85[a]	6,897	12,941
1967	7,443	0.85[a]	6,327	12,373
1966	7,092	0.85[a]	6,028	12,127
1965	6,861	0.85[a]	5,832	12,068
1964	6,604	0.85[a]	5,613	11,815
1963	8,201[b]	0.85[a]	6,971[b]	14,858[b]
1962	7,154[b]	0.85[a]	6,081[b]	13,118[b]
1961	6,782[a]	0.85[a]	5,765	12,579
1960	5,985	0.85[a]	5,087	11,209
1959	6,063[a]	0.85[a]	5,154[a]	11,540
1958	5,659	0.85[a]	4,810	10,858
1957	4,893	0.85[a]	4,159	9,643
1956	4,861	0.85[a]	4,132	9,924
1955	5,031[b]	0.85[a]	4,276	10,421
1954	4,821[b]	0.85[a]	4,098	9,953
1953	4,270[b]	0.85[a]	3,630	8,859
1952	4,058[b]	0.85[a]	3,449	8,480
1951	3,805[a,b]	0.85[a]	3,234[a]	8,126
1950	3,782[b]	0.85[a]	3,215	8,715
TOTAL				798,864

(a) Estimated.
(b) Includes some R&D and facility development costs.

This equipment is designed to prevent sparking of coal mine equipment. When sparking occurs in a coal mine with a sufficient concentration of methane gas, ignition and explosion can result. The provision was passed to ease the cost burden on operators of so-called nongassy mines who were required to install safe electrical mine equipment under the act.[10,p.7484] When the investment credit was reenacted in 1971, the Congress provided that rapid amortization and the investment tax credit could not both be used for the same investment. The taxpayer was required to make an election.[10,p.7482]

In 1974, when Congress extended the effect of the 1969 law for an additional year, it estimated that the four amortization statutes would result in a tax revenue loss of $5 million in 1975. However, no breakout was given for this particular incentive. That same projection showed declines of $4 million, $3 million, $2 million, and $1 million in succeeding years.[10,p.7484]

Training Programs

As modern coal mining requires skilled manpower to operate the sophisticated equipment now used in coal extraction, handling, and treatment, there is a serious need for programs to train miners. Such programs need to be promoted and supported through the cooperation of government, industry, and educational institutions in or near those communities which will benefit most from the employment of such skilled workers.

Similarly, there is an inadequate supply of mining engineers, for when training programs should be established, including the cross-training of engineers from other disciplines.

Production and Productivity

Incentives for the development of small mines are discussed in a preceeding section, "Development of Coal in the East."

In 1977, coal production reached an all-time high of 695 million tons.[1] Production of 660 million tons[1] was lower during 1978 because of the coal strike. The value of production has also increased significantly, from $3.9 billion in 1971 (522 million tons) to $16.5 billion in 1978 assuming $24.80 per ton for bituminous and lignite coal and $42.25 per ton for anthracite coal.

In recent years, major production has shifted from underground to surface mining (39% and 61%) respectively, in 1978.[12]

However, productivity has declined significantly for both underground and surface mining in recent years. This is a reversal of the earlier long-term trends toward increased industry productivity which resulted largely from continuing mechanization of mining operations. The primary reasons for this decrease have been the addition of nonproductive workers required under the Health and Safety Act, unprecedented absenteeism and strikes in the industry, and other factors. Declining productivity has an adverse influence on mining costs and prices.

With emphasis being placed on the need for increased coal production, the industry is concerned about the impact of environmental restrictions. These restrictions will cause shifts in patterns of production, both geographically and technologically, in land leasing regulations, and in other related areas, including oil import levels and prices and future policies on natural gas. The coal industry is watching closely requirements under the National Energy Act of 1978 (specifically the Power Plant and Industrial Fuel Use Act), that apply to the conversion of electric power plants from oil and gas to coal, as well as the results of research and development programs associated with these conversion efforts.

Powerplant and Industrial Fuel Use Act

The Powerplant and Industrial Fuel Use Act (PIFUA) is one of the five major components of the National Energy Act of 1978. PIFUA contains three major provisions: (1) new electric powerplants cannot be constructed with the capacity if using natural gas or petroleum as their primary fuels, (2) existing electric plants are prohibited from using natural gas after January 1, 1990, and are in the interim prohibited from increasing their proportional use of natural gas above historic levels, and (3) boilers for new major fuel burning installations (generally a single unit using 100 MM Btu/hr heat input or an aggregation using 250 MM Btu/hr) are prohibited from using natural gas or petroleum as their primary energy source. Other significant provisions include a prohibition on the use of natural gas for decorative outdoor lighting and the availability of financial assistance to states substantially impacted by the development resulting from increased coal and uranium mining. The Department of Energy is given the authority to grant exemptions from major provisions of the Act.

The purposes of PIFUA are to reduce oil imports and to stimulate the use of coal and other plentiful substitute fuels to save dwindling domestic supplies of oil and gas. The fuel that is likely to receive the greatest benefit is coal. The Department of Energy has estimated that coal use will be increased fom 9.6 percent to 11.6 percent as a result of the Act.[(14)] total energy consumption is not expected to change significantly. PIFUA has been included as an incentive for coal production because that is one of the purposes stated by Congress and it is one of the expected results. Since the Act was signed only in November 1978, the costs are probably small and are not included.

Small Operators

It is not economical or operationally feasible for large mining organizations to extract many of the smaller, noncontiguous coal deposits. And, until recently there was only a moderate incentive for small mining operators, who have flexibility of structure, capabilities, and mobility, to work these somewhat isolated resource areas. Except for Pennsylvania, most small mines are in the southern coal fields (Kentucky, Tennessee, Virginia, and West Virginia), many of them in areas of low-sulfur, high-Btu coal reserves.

Collectively, small and medium-sized mines contribute significantly in providing energy for the nation's economy. They are especially important in emergencies when, due to their greater flexibility for interruptible operation, they can readily increase or decrease their production in response to sudden changes in demand. This was amply demonstrated following the oil embargo and subsequent energy crisis when increased production was largely from small- to medium-sized mines, since coal from larger mines was committed to long-term contracts. With the assistance of federal loan guarantees to the smaller underground mines under the Energy Policy and Conservation Act of 1975, the potentials for significantly increased production to meet expanding energy requirements would be excellent.

The increased demand for coal to bolster the decreasing supply and increased cost of other direct fired fuel resources such as oil and gas has led to the opening of new underground coal mines, particularly deposits that will yield low-sulfur coal. The Energy Policy and Conservation Act of 1975, provides, in part, for financial assistance in the form of loan guarantees to small coal producers. Small producers are defined as those with gross revenues of $50 million or less, or production of 1 million tons of coal or less, in the calendar year preceding the year in which they apply for a loan guarantee. The guaranteed loan cannot exceed 80% of the loan required, or $30 million. The aggregate permitted under this section is not to exceed $750 million.

The principal incentive for coal mining has been the tax incentive provided by allowing a percentage deduction, as opposed to the cost depletion allowance. From 1950-1978 this amounted to $4.7 billion, calculated by using an estimated realized fraction of the maximum value (10%) times the value of production. Enforcement of mine health and safety regulations by the Department of Labor, which cost $798.9 million for the period 1950-1978 is a "requirements" type of action. Budget expenditures were multiplied by the estimated fraction of activities involving coal to give the total. Data collection and dissemination by the Bureau of Mines is nontraditional service, with a cost of $56.2 million for the period 1967-1978. Loan guarantees for small mine operators, a small cost, constitute a market activity.

RECLAMATION

Aside from its effects on air quality, the major environmental impact of coal production is surface disturbance during strip mining. As strip mining increases in both the East and West, the establishment of reclamation standards that are economically feasible as well as environmentally acceptable is a matter of great concern to the coal industry as well as to environmentalists and the public. Of principal interest is the return of the land to its original contour or as nearly so as possible, or to equal or more productive use, without unduly restricting coal production.

The degree of land disturbance depends upon the land and water reclamation measures taken by coal operators prior to, during, and after stripping. Considerable advances have been made by the coal industry in such reclamation efforts as rehabilitation of farmlands, reforestation, development of recreational activities including lakes and wildlife refuges, and restoration of aesthetic values. Even in relatively arid regions of the West, land reclamation is possible with good management practices.(1)

Although many states have enacted legislation to control land reclamation and rehabilitation, there is considerable lack of uniformity in the controls and in their effectiveness and in proposed federal reclamation measures. Federal regulations can have a significant impact on the ability of the coal industry to meet the expectations that have been set for it. The Surface Mining Control and Reclamation Act of 1977 resulted in establishing the Office of Surface Mining Reclamation and Enforcement in the Department of the Interior. Total expenses through 1978 were $3.2 million (1978 dollars).

TRANSPORTATION

During the opening of the U.S. frontier, the need for major railroad development was apparent. The vast distances involved made railroads essential. Their development required such large investments of capital that it would not have been possible to achieve the needed growth without a subsidy. This was provided by the Federal Government in the form of land grants to railroad companies, which were used for rights of way and to finance construction. Approximately 94.5 million acres of railroad land grants have been made since the land grant program was initiated in 1950. Reducing the required investments by the railroads permitted lower rail tariffs.

In addition to further direct benefits to the railroads from the mining and utilization of coal for their locomotives, the development of railroads throughout the country was a major incentive in support of the development of coal mines to meet the growing nation's industrial needs for energy. This in turn, generated millions of tons of traffic, and corresponding revenues to the railroads.

Today an uninterrupted flow of coal is totally dependent upon adequate, efficient transportation systems. Except for the assembly of coal in silos or other facilities for unit trains, coal to be shipped by rail usually is not stockpiled at the mines because of the added expense involved in relifting. Accordingly, if mines do not receive the required number of empty railroad cars for their daily loading of coal output, they do not work or production is curtailed until cars become available. On a lesser scale, the same principle generally holds true for shipments by truck and barge.

In 1975, approximately 65% of coal shipments were by rail, 12% by truck, and 11% by waterways. Approximately 11% of coal production was used by plants at or near the mines and 1% was used for other local purposes, including power and heat at the mines and coal for employees.[3]

Generally it is considered that with shorter lead times needed for the production of new transportation equipment than for the development and construction of new mines and large coal consuming plants, the problem of transportation availability will be minimal. Many problems will be involved, however, which require planning and coordination. Attention must be given to track and roadbed rehabilitation and construction. Long-term markets must be anticipated or assured to warrant the long-term investments that will be required by the railroads unless federal or other financial incentives evolve. Changing patterns of utilization and coal production can have significant effects on the extent to which the transportation industry feels secure in maintaining or expanding coal movement capabilities. Potentials for substantially increased movements of low-sulfur coal from the West to eastern markets pose difficult questions with regard to future adequacy of transportation facilities, including both railroads and coal slurry pipelines. In this respect, successful research and development of viable antipolltant processes, such as stack gas scrubbers and fluidized bed combustion, would permit the continuing use in the East of its medium and high-sulfur coals and thus preclude shipments of significant quantities of low-sulfur coals from the West to eastern markets--particularly since western coals generally have appreciably lower heating values than eastern coals.

Similarly, transportation factors are important in the consideration of the conversion of electric utility plants to coal from oil and natural gas. In many instances where "reconversion" to coal is considered, coal receiving and storage facilities are no longer available. Many coal-carrying vessels (coast-wise colliers and barges) used previously for waterborne movement either have been diverted to other uses or otherwise taken out of service. Many of the former coal piers and docks have been abandoned, dismantled, or allowed to decay. Until recent years, 16-20% of U.S. waterborne commerce consisted of coal. However, recently this has decreased to approximately 12% as shown in Table 36.

The incentives to coal production from federal expenditures for ports and waterways have been estimated in Table 36. The costs for all improvements have been multiplied by coal's share in tons of total waterborne commerce, giving a total subsidy of $2.6 billion (1978 dollars). Obviously, some ports carry little coal but others (Hampton Roads, Baltimore, Mobile) have large coal exports, primarily metallurgical coal.

Coal slurry pipelines and extra high-voltage (EHV) transmission of coal produced power over longer distances are other considerations that must be addressed when considering overall national transportation needs and policies in relation to substantial increases in coal production and utilization.

Transportation rates are an important component of the cost of enrgy delivered to consumers. Overall rail freight charges for coal shipments increased from $3.70 to $5.23 per ton between 1971 and 1975.[3] Types of shipments are factors involed in the setting of railroad rates, such as the development and approval of unit trains for the direct shipment of coal from mines to consumers' plants and other "volume" rates as approved by the Interstate Commerce Commission. Other important controls, particularly in times of emergencies, include changes in railroad car demurrage rates or the amount of free time permitted for unloading so that coal cars may be returned to active service more quickly.

Federal support of ports and waterways has been a traditional government activity, with expenditures chiefly by the Army Corps of Engineers. The

TABLE 36. Domestic and Foreign Waterborne Shipments[a]

Year	Total Shipments (Million Tons)	Coal[b] (Million Tons)	Percent Total Shipments	Expenditures (Million $)[c]	Subsidy (Millions of Current $)[d]	Subsidy (Millions of 1978 $)
1978	--	--	12.2[e]	766.8	93.5	93.5
1977	1,908	234.7	12.3	698.2	85.9	92.5
TQ 1976	--	--	12.5	174.0	21.8	25.0
1976	1,835[f]	229.4	12.5	613.7	76.7	88.0
1975	1,695	219.0	12.9	551.2	71.1	86.3
1974	1,747	208.5	11.9	497.5	59.2	78.5
1973	1,762	197.7	11.2	461.0	51.6	75.8
1972	1,617	204.9	12.7	420.2	53.4	83.4
1971	1,513	196.9	13.0	392.5	51.0	82.3
1970	1,532	225.4	14.7	348.0	51.2	109.1
1969	1,449	209.3	14.4	392.0	56.4	100.5
1968	1,396	206.9	14.8	380.0	56.2	105.4
1967	1,337	214.2	16.0	377.1	60.3	117.9
1966	1,334	211.3	15.8	400.2	63.2	126.9
1965	1,273	207.1	16.3	386.4	63.0	130.4
1964	1,238	204.1	16.5	326.2	53.8	113.2
1963	1,174	191.5	16.3	321.7	52.4	111.7
1962	1,129	176.3	15.6	301.7	47.1	101.7
1961	1,062	162.4	15.3	292.3	44.7	97.6
1960	1,100	168.9	15.4	278.6	42.9	94.7
1959	1,052	167.4	15.9	257.3	40.9	91.7
1958	1,006	117.1	17.6	218.2	38.4	86.7
1957	1,131	228.4	20.2	189.4	38.3	88.9
1956	1,092	219.3	20.1	143.0	28.7	68.9
1955	1,016	190.2	18.7	109.5	20.5	50.0
1954	866	143.4	16.6	93.3	15.5	37.6
1953			18.0[e]	98.0	17.6	43.1
1952			18.0[e]	100.2	18.0	44.4
1951			18.0[e]	152.7	27.5	69.1
1950			18.0[e]	152.7	27.5	74.5
TOTAL						$2,569.3

(a) From Waterborne Commerce of the U.S.--Corps of Engineers
(b) Excluding coal briquettes, coke briquettes, and coke.
(c) From "The Budge of the U.S. Government," Fiscal Year 1954 through 1978.
(d) The subsidy is calculated as the product of total expenditure and the proportion of total waterborne trade that is coal.
(e) Estimates from previous or later years.
(f) For calendar year 1976.

portion ascribed to coal on the basis of the fraction of tonnage represented by coal amounted to $2.6 billion from 1950 to 1978. Federal support of railroads in the late 1800s has been omitted because it occurred so long ago. Highway support, a minor factor for coal, is largely balanced by user charges through taxes and has been omitted.

WASTE DISPOSAL

Whereas wastes at mines and preparation plants generally are solid (rock, slate, etc.), acid water and sludge "wastes" at consumer plants include fly ash, particulates, sulfur dioxide, and where stack gas scrubbers and some other antipollution processes are used, considerable amounts of sludge. Sludge formed in the process of scrubbing is difficult to dispose of and nearly doubles the bulk of waste from a power station.

Although the air quality emission standards for effluents from coal combustion established under State Implementation Plans (SIPs) and the EPA are designed to reduce pollution, in the absence of adequate supplies of low-sulfur coal and desulfurization processes it is virtually impossible for users of high-sulfur eastern coals to meet the standards.

The sociopolitical attitudes prevalent in parts of the Intermountain West have been strongly opposed to western low-sulfur coal utilization in the area, particularly when the power generated is transferred out of the region. However, there is less apparent opposition to shipping western coal to eastern and midwestern markets. As a consequence, the emission standards have led to increasing production of western coals for sale in the East, to the encouragement of intense mining of low-sulfur eastern coal, and to research and development of antipollution processes that will permit the use of large reserves of high-sulfur eastern coals that cannot otherwise meet the standards. Western consumption of western coals is expected to double within the next 10 years. Under the Clean Air Act Amendments (CAAA) of 1977, EPA revised the rules for electric power plants started after September 19, 1978, to require removal of specified fractions of the SO_2 in the flue gas depending on the sulfur content of the coal. This requires the use of scrubbers in all new electric plants and destroys much of the advantage that western coal formerly had. The intention of the requirements in addition to reducing pollution, is to prevent further job losses in high sulfur coal areas such as Ohio. A secondary effect is to favor nuclear over coal in areas where it is the cheapest fuel when all new coal plants must have a scrubber. Since these regulations did not apply in 1977, and are being implemented in 1978, no cost has been included.

CONCLUSIONS

Although coal was the United States' most important fuel until the end of World War II, it has not received much in the way of federal incentive, compared with other energy forms. The loss of two large markets, steam locomotives and space heating, produced a decline in the industry, slowed only by the rapid growth of the electricity generation market. Only recently did coal production reach its high of a generation ago. The incentives for nuclear energy can all be considered as disincentives for coal but have not been included in the following tabulation. Coal development has not been a vital factor in U.S. economic wealth recently and its developers have not had the political clout of the oil and gas industry. All of these factors explain why coal incentives have been smaller than those for other energy forms.

The principal coal incentives and their magnitude in 1978 dollars are as shown in Table 37. The total of about $12 billion is due principally to the depletion allowance (taxation), 40%, research (non-traditional service), 31%, and ports and waterways costs (traditional services) 22%.

The federal regulations affecting the control and disposal of waste products of coal use were not intended to encourage or discourage the production of coal as such. It was a secondary effect and the costs have not been tabulated. The Amendments to the Clean Air Act passed in 1977 (CAAA) require new specifications for New Source Performance Standards for electric power plants so the use of western coal in the Midwest will be discouraged, but few federal costs of the Amendments have been incurred yet.

TABLE 37. Summary of Incentives to Coal by Type (in Millions of 1978 Dollars)

Incentive Area	Taxation	Disbursement	Requirements	Traditional Services	Nontrad. Services	Market Activity	Total
Research and development					3,364		
Exploration							
Geological Survey					130		
Bureau of Land Management						20	
Mining							
Depletion allowance	4,736						
Mine health and safety			799				
Bureau of Mines data					56		
Mine Reclamation			3				
Transportation, ports and waterways				2,569			
TOTAL	4,736		802	2,569	3,550	20	11,677

REFERENCES - CHAPTER VI

1. U.S. Department of Energy, Monthly Energy Review, DOE/EIA-03517, (79), July 1979.

2. A National Plan for Energy Research, Development and Demonstration; Creating Energy Choices for the Future. Volume I, U.S. Energy Research and Development Administration, 1976.

3. Coal-Bituminous and Lignite in 1975. U.S. Department of the Interior, Bureau of Mines, Division of Fuels Data and Division of Coal, February 10, 1975.

4. "Coal Task Force Report, Project Independence Blueprint." Federal Energy Administration - U.S. Department of the Interior, November 1974.

5. S. M. Surrey, "Tax Incentives as a Device for Implementing Government Policy: A Comparison with Direct Government Expenditures." Harvard Law Review, Harvard University, 83:708-9, 1970.

6. F. M. Burke, Jr., "Incentives to Develop Natural Resources: Factors Affecting Industries Involved in Natural Resource Exploitations; Oil and Gas; Hard Materials; Timber." 33rd Annual N.Y.U. Institute on Federal Taxation, 1975.

7. G. M. Brannon, "Existing Tax Differential and Subsidies Relating to the Energy Industries." Studies in Energy Tax Policy, (a Report to the Energy Policy Project of the Ford Foundation). Ballinger Publishing Company, Cambridge, MA, 1975, p. 12.

8. "Bituminous Coal and Lignite Distribution, Calendar Year 1975." U.S. Department of the Interior, Bureau of Mines, Division of Fuels Data, April 12, 1976.

9. J. J. Mikelonis, "Coming to Grips with the Perplexities of Coal Mine Taxation." Coal Age, 81:93, 1976.

10. "Taxation and Tariff." U.S. Code Congressional and Administrative News, Senate Report No. 1357, West Publishing Company, St. Paul, MN, Vol 7483, 1974.

11. National Academy of Sciences, "Rehabilitation Potential of Western Coal Lands." A report to the Energy Policy Project of the Ford Foundation, Ballinger Publishing Company, Cambridge, MA, 1974.

12. 1978 Keystone Coal Industry Manual, p. 658 pp. 693-696.

13. Energy Data Reports, Weekly Coal Report No. 69, January 26, 1979, Table 5.

14. Analysis of Proposed U.S. Department of Energy Regulations: Implementing the Power Plant and Industrial Fuel Use Act, U.S. DOE, Energy Information Administration, November 1978, Table S-2.

[redacted]

VII. OIL ENERGY INCENTIVES

There are two major areas of oil energy incentives:

1) exploration and production, including the search and recovery of crude oil and natural gas, as well as the transportation of crude oil, and

2) refining and product transportation, including the conversion of petroleum to products, and distribution to both wholesale and retail customers.

Incentives to natural gas production and recovery are included in the first (exploration and production) classification, because most natural gas is produced by oil companies. However, natural gas transmission and distribution, discussed in Chapter VIII, are controlled by a different type of company, encompassing different needs for incentives.

RESEARCH

Table 38 shows the federal funds spent for R&D in the petroleum industry during the period 1950 through 1978. The total for that period is $1287.2 million (1978 dollars). The various changes in orgnizations within the Federal Government and the continual overlap of agency interests make it difficult to identify the beneficiaries of R&D budget components. Even within the same publication series, such as the NSF series on "Research and Development in Industry" and an "Analysis of Federal R&D Funding by Function," there are inconsistencies from year to year. When such inconsistencies were found, the data used in the table were taken from the most recent sources. These expenditures constitute a nontraditional government service.

OIL AND GAS EXPLORATION AND PRODUCTION

Exploration and production are the first steps in making petroleum resources available for use by consumers. Since exploration and production do not necessarily involve crossing state boundaries, many aspects of this phase of oil company operations are matters of state, rather than federal, concern. Any such activities on federal lands, however, including the outer continental shelf, are under federal control. Perhaps the most important federal

[redacted]

TABLE 38. Federal R&D Expenditures Related to the Petroleum Industry (in Millions of Dollars)

Fiscal Year	Petroleum and Natural Gas Research (DOE)	Control of Pollution from Spillage Waste (Coast Guard)	Seabed Assessment (NSF)[e]	Energy Related Environmental Control Program (EPA)[f]	Federal Funded R&D for the Petroleum Industry	Totals (Current $)	Totals (1978 $)[g]
1978[d]	110.2	6.1	5.9	8.0	--	130.2	130.2
1977	66.7	6.0	2.6	6.8		82.1	88.4
1976	38.4	5.5	2.4	3.6		49.9	57.2
1975	37.9	5.4	2.3	5.4		51.0	61.8
1974	11.2	8.1	2.6	1.2		23.1	30.6
1973[c]	6.5	7.8	2.2			16.5	24.2
1972			2.8		15	17.8	27.8
1971			4.0		17	21.0	33.8
1970					22	22	37.1
1969					10	10	17.8
1968					34	34	63.8
1967					16	16	31.3
1966					18	18	36.3
1965					48	48	99.3
1964					61	61	128.4
1963[b]					21	21	44.7
1962					20	20	43.1
1961					19	19	41.6
1960					20	20	44.0
1959					27	27	60.4
1958					12	12	27.0
1957[a]					11	11	25.5
1956[h]					5.1	5.1	12.3
1955[i]					8.2	8.2	20.0
1954[i]					8.2	8.2	19.9
1953[h]					8.2	8.2	20.0
1952[i]					8.2	8.2	20.1
1951[i]					8.2	8.2	22.2
TOTAL							1,287.2

(a) Data for FY-1957 through FY-1962 are from API "Petroleum Facts and Figures. 1971 Edition" which used data from NSF "Research and Development in Industry, 1967."
(b) Data from FY-1963 through FY-1972 are from NSF "Research and Development in Industry, 1972."
(c) Data from FY-1973 through FY-1979 are from NSF "Analysis of Federal R&D Funding by Function, 1979.
(d) Data for 1978 is an estimate contained in NSF "Analysis of Federal R&D Funding by Function, 1979."
(e) The emphasis of under-sea mineral studies is on petroleum. Seventy five percent of the program costs were allocated to the petroleum industry.
(f) Petroleum receives minor emphasis in this program. Based on an examination of the 1976 program, 6.7 percent of the total program was allocated to the petroleum industry.
(g) The Bureau of Labor Statistics' Consumer Price Index was used to convert to 1978 dollars.
(h) Data from API "Petroleum Facts and Figures, 1959."
(i) Estimates using 1953 actual figures.

incentives are those that allow state conservation controls to apply to oil sold in interstate commerce. Although the costs to the Federal Government of these incentives have been small, the incentives have been very significant to the oil companies.

Geological Survey Data

The principal government source of geological information for use in exploration (principally onshore) is the U.S. Geological Survey of the Department of Interior. Table 39 gives the expenditures for all geologic and mineral resource surveys. In 1978, 45.5% of the energy consumed was in the form of oil (Chapter III). Applying the same percentage for the period 1950-1978 gives a total of $574.2 million (1978 dollars). Similarly, natural gas is 22.9% of the total, or $289 million.

Oil Leasing Policy

When leasing federal lands for oil and gas exploration and production has been contemplated, the normal progression has been for the Bureau of Land Management to nominate blocks for lease. Other government agencies have then requested withdrawals for various reasons such as national defense, high environmental risk, etc. Although there have been some experiments with leasing methods, most bidding is on the basis of an advance royalty bonus payment in addition to the usual production royalty. Because large companies can raise extra money for the bonus payments more easily than can small companies, there are constraints on joint bidding by large companies. The bids are reviewed and those considered inadequate are rejected. Appropriate environmental impact statements, including archeological surveys and baseline biota surveys, are required as part of the leasing process. To date the offshore leasing process has gone rather slowly, a disincentive in general.

The overall effect of advance royalty bonuses has been to give the government extra revenue early in the trajectory leading from exploration to production. Net cost to the government is therefore nonexistent, since the extra interest earned is greater than the costs of administration. The procedure probably favors large companies that can accept the risk of failure and is a disincentive to small companies. No quantitative assessment of the effect on overall production can be made.

TABLE 39. Geological and Mineral Resource Surveys--Direct Expenditures by the Geological Survey (Thousands of Dollars)

	Current $	1978 $
1978	112,708	112,708
1977	96,870	104,329
TQ	24,893	28,552
1976	102,203	117,227
1975	76,268	92,553
1974	43,340	57,366
1973	39,030	57,347
1972	33,066	51,618
1971	30,998	49,990
1970	30,610	51,471
1969	29,639	52,796
1968	28,789	54,022
1967	23,417	45,789
1966	17,709	35,628
1965	17,527	36,267
1964	16,388	34,493
1963	14,974[a]	31,916
1962	13,560[a]	29,252
1961	12,350[a]	26,948
1960	11,417	25,158
1959	10,975[a]	24,574
1958	10,676	24,100
1957	10,767	24,966
1956	5,718	13,733
1955	5,346	13,030
1954	6,333	15,381
1953	5,901	14,402
1952	5,763	14,170
1951	4,420[a]	11,106
1950	4,071	11,036
TOTAL		1,261,928

[a] Estimated

Bureau of Land Management

The Bureau of Land Management plans the use and leasing of federal lands, including the outer continental shelf. In addition, it has responsibility for other activities related to planning and resource management. The costs for these activities for all fossil fuels are shown in Table 40. Since about 74% of the value of fossil fuels produced on leased federal land in 1974 was from oil,[1] and 23% from natural gas, these percentages have been used to calculate the cost of the incentive. Thus, $497.6 million can be attributed to oil leasing and $154.7 million to natural gas (1978 dollars).

Interstate Oil Compact Act--1935

The production of oil in the 1920s and early 1930s involved physical and economic waste, as described in the discussion of the Connally Hot Oil Act. (which follows). This waste was a matter of concern for both the producing states and the Federal Government. However, proposals to solve the problem created a controversy over states, rights versus the power of the Federal Government to regulate interstate commerce and to improve economic conditions in general.[2,3]

The oil production code (Section 9c) of the National Industrial Recovery Act (NIRA) of 1933 gave the Federal Government authority to establish and enforce conservation. When the courts ruled Section 9c invalid, Congress debated instituting new laws to establish federal control again, but the proposed legislation was successfully opposed by the oil companies and producer states. As an alternative to federal regulation, the American Petroleum Institute and the Governor of Oklahoma promoted the formation of an association of producer states to coordinate conservation laws, regulations, and enforcement. By mid-1935, six states had ratified this compact. President Roosevelt then recommended to Congress that a law be passed to give federal blessing to the compact. The Act of Congress stated that eliminating physical waste was the goal; in this way Congress avoided the criticism that passage of the law was tantamount to price fixing. Oklahoma, Texas, and several other principal producing states evolved a series of regulations that, with the Hot Oil Act, brought most of the U.S. oil industry under control.

TABLE 40. Expenditures by the Bureau of Land Management for Fossil Fuel Activities (thousands of Dollars)

Year	Leasing and Disposal	Resource Management	Energy and Mineral Resource Management	Total Fossil Fuel and Share of Leasing	Total in 1978 $
1978	28,548	--	81,880	82,821[b]	82,821
1977	40,452		109,568	112,515[b]	121,179
TQ	9,766		12,236	16,502[b]	18,928
1976	31,341		37,413	51,566[b]	59,147
1975	28,233		33,018	45,938[b]	55,747
1974		70,192[g]		28,077[h]	37,164
1973		60,842[g]		21,295[h]	31,289
1972		57,119[g]		17,136[h]	26,751
1971		52,715[g]		13,179[h]	21,254
1970	7,483	41,456		9,788[f]	16,476
1969	6,427	37,028		8,691[f]	15,481
1968	6,125	35,968		8,419[f]	15,797
1967	5,268	37,384	4,399[e]	7,250[b]	14,178
1966	5,100	34,253	4,253[e]	7,015[b]	14,113
1965	5,497	30,766	4,426[e]	7,442[b]	15,399
1964	4,922[d]	27,547[d]	3,963[d](e)	6,664[b]	14,026
1963		40,218		9,729[c]	20,737
1962		32,969		7,967[c]	17,206
1961	8,239[a]			6,179[b]	13,483
1960	7,140			5,355[b]	11,800
1959	6,713[a]			5,035[b]	11,274
1958	5,720			4,290[b]	9,684
1957	5,014			3,760[b]	8,718
1956	3,469			2,602[b]	6,249
1955	2,435			1,876[b]	4,450
1954	1,933			1,450[b]	3,522
1953	605			454[b]	1,108
1952	537			403[b]	991
1951	884[a]			663[b]	1,666
1950	876			657[b]	1,772
TOTAL					672,410

(a) Estimated.
(b) 0.75 of columns 1 plus 3.
(c) 0.24 of column 2 (same ratio as in 1964).
(d) Estimated from proportions in 1965 and total of $32,469,000.
(e) Land classification and mineral examination.
(f) 0.2 of columns 1 plus 2.
(g) Includes leasing.
(h) Column 2 times 0.25 in 1971, 0.3 in 1972, 0.35 in 1973, 0.40 in 1974.

As a result of this legislation, the short-term effect of increased consumer prices has been balanced by the long-term price reduction due to better overall recovery. The cost of this incentive to the Federal Treasury, the consumer, and the industry has been too small to tabulate.

Information Gathering

As part of the plan to stabilize the oil industry under the NIRA, the Bureau of Mines was instructed to gather information on prices and volumes of oil produced. Details on the overall costs of collecting data on all fossil fuel production are presented in Chapter VI. The costs for oil data gathering for the period 1964-78 amounted to \$18.4 million (1978). For natural gas it amounted to \$9.1 million. (This breakdown is based on the assumption that 2/3 can be attributed to oil and 1/3 to natural gas; see Chapter III.)

Connally Hot Oil Act--1935

Oil-field practice at the time of the discovery of the East Texas Field in 1930 was characterized by close-spaced drilling and maximum production from each lease. This resulted from operation under the doctrine of capture, which said the owner of a well was entitled to whatever it produced, even if it drained oil from part of the stratum under a neighboring lease.(2)

This rapid production resulted in both physical and economic waste. The reservoir pressures dropped rapidly, decreasing the amount of oil that could be ultimately produced. In addition, resources were wasted drilling and servicing unneeded wells.

By the end of 1931, there were about 4,000 wells in the East Texas Field with an overall production of almost 1 million bbl/day, or about 40% of total U.S. requirements at that time. As a result of this overproduction, the price of crude oil dropped from \$1.10/bbl to as little as \$0.10/bbl. By January 1932 about 600 oil fields were closed down as the price was below recovery costs. Martial law was established in the East Texas Field to enforce a proration plan (limiting each well's production to less than its maximum output) but the plan was declared invalid by a federal court.(3)

As a result of this chaotic situation, a variety of oil conservation laws were passed in the producing states. The Federal Government also developed conservation regulations for leases on federal lands. (Since production on federal lands has been only about 3% of the U.S. total, costs associated with these regulations are not included in our figures.) The heart of the conservation system was prorationing; the amount of production allowed could be related to the number of wells, the acreage leased, or the "maximum efficient rate" (MER) for each well. In recent times, the last approach has been used, granting an "allowable" of a certain percentage of the MER, set on the basis of expected sales.

In spite of the state laws, great difficulties were experienced in preventing production of oil in excess of the allowable ("hot oil"). In 1934, 20% of all oil from the East Texas Field was produced illegally and by the end of the year, there were 17,650 wells to police. State laws and regulations were revised follwing court tests until a fairly enforceable scheme evolved for control inside the states. A defect in the conservation system was that the sales orders could be written up out of state. Thus, the movement could be considered interstate commerce and therefore beyond state control.

To avoid this defect in the state conservation programs, President Roosevent in 1933 issued a decree banning sales of hot oil in interstate and foreign commerce. As part of the National Industrial Recovery Act (1933) a code for petroleum production was developed which specificially banned interstate and foreign shipment of "hot oil". In 1935, a series of court decisions invalidated the whole production code. To avoid a return to chaos, Congress passed the Connally Act on February 22, 1935, authorizing the Interior Department to develop regulations to stop interstate and foreign shipment of "hot oil."

The cost of this program has been quite small, consisting of administrative and legal costs. More importantly, the Interstate Oil Compact and the Connally Hot Oil Act permitted the development of an orderly and stable oil industry, rather than the boom-and-bust conditions that had characterized the industry.

Stripper Well Incentives--1944, 1973

Stripper oil wells are wells on producing properties with an average output per well of no more than 10 barrels per day. Thus, some individual wells may produce more than 10 barrels daily, while other low producers on the same property bring the average down to 10 or less. These wells are generally in fields which were once highly productive but have declined over time. Stripper production plays an important role in maintaining reserves and the productive capacity of the nation's oil supply. In 1978, stripper wells accounted for 14.03 percent of total U.S. oil production. Because stripper wells have high operating costs, they are only marginally economical. They have been partially or wholly exempt from prorationing by the states.

During World War II when there were price controls on oil production, special subsidies were paid to stripper well operators. From August 1, 1944, to November 30, 1945, about \$65 million was paid to operators; 177 million bbl of oil were produced under this program, amounting to about \$0.36/bbl subsidy (\$1.36 in 1978 dollars).

Following the 1973 OPEC price increase, the Emergency Petroleum Allocation Act of 1973 was enacted. This fixed the price of oil from existing wells at a level that averaged about \$5 a barrel (see Table 41). As an incentive to stripper well operators, prices for stripper oil were not controlled. Stripper oil thus commanded a price \$5 to \$8 more than "old" oil. The Energy Policy and Conservation Act, effective February 1976, rolled back the price of stripper oil to \$11.53 under rules designed to make the average price of domestic oil \$7.66. Under the Energy Conservation and Production Act, effective September 1976, all price controls on stripper oil were lifted. The incentive for stripper oil has been calculated as shown in Table 42; it amounts to \$16.84 billion for the years 1974-1978.

Note that this analysis takes as a baseline the controlled price for old oil and considers the higher price for stripper oil as an incentive. If one took the world price set by OPEC as the baseline, the low price for old oil would represent a disincentive. History indicates that, at the time, the officials involved considered that they were providing an incentive for stripper oil.

Incentives for New Oil Production--1973

The Emergency Petroleum Allocation Act was enacted in late 1973 during a time of severe shortages of crude oil and refined products. The principal

TABLE 41. Incentives Under Oil Price Controls

Year	Average Domestic Production (Bbl/day)	Percent of Production: Old Oil	New Oil	Stripper Oil	Released Oil	Alaska North Slope	Naval Petroleum Reserve	Average Price ($/Bbl): Old Oil	New & Released Oil	Stripper Oil	Alaskan North Slope	Naval Petroleum Reserve
1974	8,774,000	63	15	13	9			5.03	10.13	10.13		
1974	8,375,000	62	16	13	8			5.03	12.03	12.03		
1976												
Jan.	8,211,000	54	21	15	10			5.02	12.99	12.99		
		Lower Tier Oil	Upper Tier Oil					Lower Tier Oil	Upper Tier Oil			
Feb.-Aug	8,134,000	57	29[a]	14				5.12	11.53	11.53		
Sept.-Dec.	8,070,000	51	36[a]	13				5.17	11.63	13.29		
1977												
Jan.-June	8,001,000	49.3[a]	37.1[b]	13.5[b]				5.16[b]	11.12[b]	13.29[b]		
July-Dec.	8,357,000	42.8[b]	35.2[b]	13.1[b]		7.9[b]	0.97[b]	5.21[b]	11.32[b]	13.87[b]	6.48[b]	12.33[b]
1978	8,701,000	37.5	34.4	14.0		13.0	1.10	5.46	12.15	13.95	5.22	12.85

Source: Monthly Energy Review, Federal Energy Administration, May 1975, June 1977, August 1978, July 1979.
(a) Excludes stripper oil.
(b) Arithmetic average of monthly figures.

TABLE 42. Value of Incentives (Billion $)

	Current Dollars				1978 Dollars	
	Stripper Oil	New Oil, Upper Tier Oil, Released Oil	Alaskan North Slope Oil	Naval Petroleum Reserves	Stripper Oil	New, Released, Alaska North Slope, and Naval Petroleum Reserves
1974	2.12	3.92			2.81	5.18
1975	2.78	5.13			3.37	6.21
1976						
Jan.	0.30	0.63			0.34	0.72
Feb.-Aug.	1.55	3.22			1.78	3.69
Sept.-Dec.	1.04	2.29			1.20	2.63
1977						
Jan.-June	1.58	3.25			1.70	3.50
July-Dec.	1.74	3.31	0.15	0.11	1.87	3.84
1978	3.77	7.31	-	0.26	3.77	7.57
TOTAL					16.84	33.34

aims of the act were to meet the nation's priority needs; to distribute the available production equitably and at equitable prices; and to accomplish these objectives in ways that would preserve the competitive viability of the "independent"[a] segments of the industry.

Regulations under this act established a "two tier" pricing system which imposed a price ceiling on the classification of crude oil designated as "old oil" (oil from properties producing at, or less than, their 1972 production levels), while allowing new and stripper oil to sell at the market prices. As an extra incentive for increased production from old fields, an additional amount of old oil, designated "released oil," was allowed to be sold at the new oil prices.

The Energy Policy and Conservation Act, effective February 1976, sought to roll back the average price of domestic crude oil to \$7.66/bbl. To this end, old oil, designated lower tier oil, was to be priced at the May 15, 1973 price plus \$1.35/bbl. New and stripper oil ("upper tier oil") were set at the September 30, 1975 new oil price less \$1.32/bbl. The "released oil" program was dropped. Provisions for adjusting for inflation were included but due to miscalculation caused by lack of data, the prices set have not achieved the desired average prices and there have been "freezes" on the inflationary adjustments and even a rollback of the "upper tier" price.

The Energy Conservation and Production Act, effective September 1976, exempted stripper oil from price controls but imputed the upper tier price to it in calculating the average domestic price. For entitlement purposes, it is considered imported oil. The same rules have been applied to oil from Alaska's North Slope.

The two tier price-control system was intended by the officials in charge to be an incentive for oil exploration and production. However, the roll back of new oil prices and inclusion of new oil in the entitlement program since February 1976 has served as a mild incentive to the purchase of imported oil

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(a) "Independent" originally referred to individuals and companies other than those of the "Standard Oil Trust." In present terminology, independent usually excludes "major" oil companies, the top 25 or so companies in terms of revenues, virtually all of which have exploration, production, refining, and marketing operations.

since the importer takes none of the risks of exploration and field development directly and in addition gets an entitlement credit that equalizes the prices. Thus, a buyer of upper tier oil in December 1976 paid an average of $11.64/bbl. Imports averaged $13.71/bbl with an entitlement credit of $2.10 to give a net cost of $11.61. (This assumes the average grades of domestic and imported crude oil are equivalent and that the buyer does not exceed the national average domestic oil supply ratio.) However, starting in mid-1977 the value of the entitlement decreased while the average cost of imports rose eliminating the small incentive to imports. The value of the incentives for new oil from 1974-78 amounted to $33.34 billion as shown in Table 42.

Entitlement Program

Under price controls, profit per gallon of product was controlled and each refiner had to base his selling price on the amount paid for crude. The refiner with contracts for or ownership of large amounts of price-controlled domestic crude would have been forced to undersell his competitor, who used exclusively imported oil, by up to 20 cents per gallon. Differences this large would have disturbed local markets, created problems with refinery and transportation schedules, created large regional price differences and caused great discrepancies in company cash flows and profits. To avoid these problems, FEA instituted a system that allocated the price-controlled oil among all refiners. (This program is currently administered by the Economic Regulatory Administration, DOE). Refiners with access to a larger amount of price-controlled oil than the national average are required to pay for the excess by purchasing "entitlements" from refiners with less price-controlled oil. The crude oil entitlement benefit for imported crude has varied from $1.27 in December, 1978 to a high of about $3.10 in late 1975.(4) Due to the large amount of imported residual fuel oil priced at the OPEC level and used in the Atlantic Coast states, the entitlement program also was extended to imports of residual oil from Caribbean refiners. In addition, small refiners obtain special privileges under the entitlement rules. Starting in May, 1979, a temporary program providing a $5 per barrel credit for the importation of middle distillates was established.

The entitlement program has not acted as an incentive for production but it has stabilized the market. By stabilizing the volumes sold by each company and controlling the profit per barrel refined, DOE (previously FEA) has spread overall profitability over the entire industry. The cost of this is the administrative cost for FEA, and DOE, covered elsewhere.

Economic Regulatory Administration

The Economic Regulatory Administration (DOE) and its predecessors, the Federal Energy Administration and the Federal Energy Office, have primarly been concerned with developng and administering policy in the area of petroleum supply and demand. This includes price controls on crude oil and products, allocation of crude, allocation of products, and switching of gas and oil burning utilities and industrial plants to coal. The National Strategic Oil Reserve, established with the idea of maintaining at least a 90-day supply of oil in domestic storage facilities is an incentive to the consumer of oil, but not the domestic producer of oil. Nevertheless, these costs are included in the expenditure considered here for years prior to FY 1978. Those in FY 1978 are in the next section. The costs of administering the petroleum related functions of FEA (and its successor, ERA) are included in this chapter. The costs were $51.8 million in 1974, $87.3 million in 1975, $121.2 million in 1976, $42.7 million in the 1976 transition quarter, $153.1 million in 1977, and $447.6 million in 1978. The total in 1978 dollars is $974.8 million.

Strategic Petroleum Reserve

The cost of the Strategic Oil Reserve in 1978 was $733.5 million. This figure includes only actual outlays, as opposed to the total appropriation, since actual crude oil purchases fell far below the planned level.[a] This was the first year that a significant amount of money was spent on this program. In former years, it was included in the budget for FEA/ERA. Although the Strategic Oil Reserve is really an incentive for consumption, it does indirectly provide a production incentive and thus has been included here.

[a] This is different from all other sections, where the authorization figure is used. However, in this case, the difference between authorization and outlays is substantial, with no guarantee that expenditures will ever reach the planned level.

Intantigle Drilling Expenses--1918-1978

Section 26 USC 263(c) established this incentive for the oil and gas industry. Since 1918, the industry has been given the option of deducting as a current expense any "intangible drilling and development costs."[4] The main result of this incentive is that the oil and gas industry uses the deduction to reduce income taxes on unrelated income and thereby to pay a lower proportion of taxes on their overall income.[5,p.52] Intangible drilling expenses include the amounts paid for labor, fuel, repairs, hauling, and supplies which are used in drilling oil or gas wells, clearing of ground in preparation for drilling, and the intangible costs of constructing derricks, tanks, pipelines, and other structures and equipment necessary for the drilling and preparation of the wells for production. Without the statutory authority to deduct these expenses, they would in the case of successful wells be added to the taxpayer's basis and recovered through depletion and depreciation as in the case of tangible property, e.g., derricks. In the case of dry holes, the costs are deducted at the time the hole is completed.[5] The purpose of the incentive was to encourage oil and gas producers to bring in more wells and thus increase production. In 1971, the treasury estimated the tax benefit due to quick expensing of such costs to be $340 million.[6] The estimate derived in this study is presented at the end of the following section.

Percentage Depletion--1926-1978

The need for depletion as a special tax incentive for the oil and gas industry was recognized in the Revenue Act of 1913, which established cost depletion (now 26 USC 611, 612) as the method of computing the depletion deduction. In the Revenue acts of 1916, 1918, 1921, and 1924 refinements were made in the law and finally, in 1926, the Revenue act introduced the new concept of percentage depletion and established a 27.5% depletion rate for oil and gas. Under this concept, the stated percentage was applied to the gross income from a property for a taxable year to determine the amount of the percentage depletion deduction for such year. Such deduction was limited to 50% of the net income from the property computed without allowance for depletion. The law also provided that the annual depletion deduction could not be less than cost depletion as computed for such property.[7] An essential difference between cost depletion and percentage depletion is that the former is similar to depreciation and tied more to the initial cost of the asset, whereas the latter takes into consideration an amount equal to the gross value of production from that asset. The chief advantage of percentage depletion is that it avoids making the uncertain estimate of the total production likely from the field. At the time it was instituted, the federal corporate tax rate was 15% and cost and percentage depletion gave about the same recovery of capital in the wasting asset. As the federal tax rate rose, the advantage of percentage depletion rose. Similarly when OPEC raised the price of oil in 1973, the percentage depletion incentive became very large, prompting Congress to change the law.

There are varying estimates as to the actual cost of percentage, as compared with cost depletion, to the U.S. Treasury. For fiscal year 1968, a Treasury analysis showed an incentive expenditure of 1,300 million dollars.[8] In 1971, another estimate, after changes in the Tax Code in 1969, identified a total tax cost of the excess of percentage over cost depletion for all minerals of $985 million.[9] That same estimate referred to an annual revenue loss in 1937 from percentage depletion to cost depletion of $75 million; in 1950, $400 to $500 million; in 1953, more than $700 million; and, in 1960, a revenue loss of $2.5 billion. It also noted that the House estimated that changes in the 1969 Tax Reform Act would increase revenues to the government from changing percentage depletion by $425 million in 1970 and $410 million in 1971. Those changes reduced the percentage depletion allowance from 27.5% to 22% and reduced eligibility.

The percentage depletion rate was 27.5% of the wellhead value from 1926 to 1969 and subsequently 22%, with severe restrictions on firm size starting in 1975.[10-17][a] The depletion percentage deduction is limited to not more than 50% of total income from the property. Since 1969, there has also

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[a] In 1981 the depletion allowance will be 20 percent, in 1982, 18 percent, in 1983, 16 percent and 1984 and thereafter 15 percent. The allowable depeltable quantity is being lowered in steps from 2000 barrels per day in 1975 to 1000 barrels per day in 1980, (including the oil equivalent of gas specified in the Act).

been a minimum tax rate. The allowance is available not only to the operator of the field but also the royalty holder. Thus, the depletion deduction can apply to incomes taxed at rates of up to 46% starting in 1978 (48% from 1954-77 and 52% prior to 1954) for corporations and 70% for individuals. Comparing percentage values developed by Brannon[10] with dollar estimates reported by the Library of Congress[11] and assuming an incremental tax rate of 48%, for the period 1970-74 the 22% allowance is effectively only 15% after adjusting for the 50% rule, the minimum tax, and the cost depletion alternative. For the period 1975-78, the allowance applies only to small operators[12] or an estimated 30% of the total oil production. The gas production allowance applies only to gas regulated in price or sold under fixed price contract. It was assumed that all gas met these criteria. For 1950 to 1969, the 27.5% allowance was taken to be effectively 19% when corrected for the 50% rule and the cost depletion alternative.

Starting with the 1976 Budget of the U.S. Government, the Treasury Department has made estimates of the loss in tax revenue due to special treatment of certain types of income. The estimates[13] for the percentage depletion allowance (instead of cost depletion) and expensing of intangible drilling costs (instead of capitalization) have been used in this study for the period beginning in 1974, the first year they are available. The figures include both corporate tax losses and individual income tax losses, with a marginal tax rate of up to 70 percent applying to the latter. The total amount of these incentives was apportioned among coal, oil, and gas according to total value of production. These calculations were confirmed by conversation with the Treasury Department. For years prior to 1974, the corporate tax rate was used to calculate the income equivalent of the depletion allowance and expensing of intangibles. This assumes that the average marginal personal income tax of investors in oil properties and royalty holders was the same as the corporate rate.

The benefit of the depletion allowance does not accrue entirely to the oil company operating the field. The royalty holder and operator apply the allowance to their share of the wellhead value. In addition, the increased value of drilling rights to the operator make him more willing to pay a higher royalty. Under the competitive situation existing today, the price of the crude can be reduced and the operator can still get his desired return because of the allowance. Some of the benefit is passed on to the consumer and some is passed back to the royalty owner, which could be the Federal Government. Brannon estimates that 40% of the value of the depletion allowance ends up as increased royalties, 10% as after-tax profit for the operator, and 50% as price reduction.(14) Thus, 50% is a direct incentive to the producer and lessor and 50% is an indiret incentive to production, due to increased demand resulting from lower prices. The costs reported here do not correct for tax losses recaptured by the government in the form of higher royalties on government lands.

The value to the operator of considering intangible drilling expenses as an expense rather than a capital investment subject to depreciation is equivalent to receiving a tax-free loan from the government. Its value is related to the amount of drilling in any given year. For this study, it has been approximated as 6% of the wellhead value of production.(10)

Since 1950, allowances have amounted to $50.3 billion for depletion and $20.1 billion for the treatment of intangibles (Table 43). During this time, 76.8 billion bbl of oil and 444 trillion cubic feet of gas were produced, a total of 919 quadrillion Btu. On the basis of wellhead value that is subject to the incentive, $40.0 billion is allocated to oil depletion allowance, and $15.4 billion to oil intangible expenses allowance. The total incentive is 12.4 cents/million Btu of oil.

Recapture of Intangible Expenses on Disposition of Oil and Gas-Producing Property

In Studies in Energy Tax Policy, edited by Brannon,(10) it was noted that with equipment investments, the tax law takes the position that on sale any gain to the extent of prior depreciation deductions is to be treated as ordinary income on sale and taxed at ordinary income tax rates rather than at capital gains rates. However, Brannon pointed out that for natural resources involved in energy production, there is no corresponding penalty on the sale of natural resource property. As a result, if the taxpayer invests a certain amount in intangible drilling expenses, takes the deduction, and then sells

TABLE 43. Revenue Equivalent of Percentage Depletion Allowance and Intangible Drilling Expensing (Oil and Gas)

	Wellhead Value of Domestic Production Million Current $			1978 $	Revenue Equivalent Million 1978 $ Depletion Allowance		Intangible Drilling Expensing	
	Oil	Gas	Total	Total	Oil	Gas	Oil	Gas
1978	28,583	18,045	46,628	46,628	422	266	852	538
1977	25,584	15,820	41,404	44,592	431	266	685	424
1976	24,275	11,566	35,921	38,686	463	220	622	296
1975	23,409	8,949	32,358	34,849	1,031	394	445	207
1974	21,997	6,566	28,563	30,762	1,844	551	856	255
1973	13,058	4,894	18,952	20,411	1,458	547	588	220
1972	11,706	4,181	15,887	17,110	1,315	470	530	190
1971	11,693	4,086	15,779	16,994	1,358	474	547	191
1970	11,174	3,746	14,920	16,069	1,353	453	545	182
1969	10,427	3,456	13,883	14,952	1,338	443	538	179
1968	9,725	3,169	12,894	13,887	1,661	542	529	172
1967	9,376	2,899	12,275	13,220	1,668	516	531	165
1966	8,726	2,703	11,429	12,309	1,597	495	509	157
1965	8,158	2,495	10,653	11,473	1,537	470	489	150
1964	8,017	2,388	10,405	11,206	1,535	458	490	145
1963	7,967	2,328	10,295	11,088	1,547	451	492	144
1962	7,774	2,145	9,919	10,683	1,527	421	486	135
1961	7,566	1,996	9,562	10,298	1,503	396	492	126
1960	7,420	1,790	9,210	9,919	1,488	360	474	114
1959	7,473	1,557	9,030	9,725	1,523	318	485	101
1958	7,380	1,317	8,940	9,628	1,516	270	482	86
1957	8,079	1,202	9,281	9,996	1,705	254	543	81
1956	7,297	1,084	8,381	9,026	1,596	237	508	75
1955	6,870	978	7,848	8,452	1,524	218	486	69
1954	6,425	883	7,308	7,871	1,421	195	451	62
1953	6,327	775	7,102	7,649	1,525	187	481	59
1952	5,785	624	6,409	6,902	1,405	152	445	48
1951	5,690	543	6,233	6,713	1,413	135	446	43
1950	4,963	409	5,372	5,786	1,329	110	420	34
TOTAL 1950-1978					40,033	10,269	15,449	4,648

the property after the prescribed holding period for the same amount of profit in excess of the original cost of the land, the gain is treated entirely as capital gains and not as ordinary income.[10,p.23]

This failure to provide for recapture in the natural resource area provides an incentive to the oil and gas industry. Recapture, on the other hand, was introduced into the statute governing the treatment of hard mineral exploration cost.[15]

The Tax Reform Act of 1976 added Section 1254 to the Tax Code, providing that amounts deducted for intangible drilling expenses on productive wells are to be recaptured upon the disposition of the oil or gas property. Section 1254 declares that those amounts are to be treated as ordinary income to the extent they exceed the amounts that would be allowed if the intangible drilling expenses were capitalized and amortized over the useful life of the well. The law affects costs paid or incurred after December 31, 1975.[5,p 1228]

It was estimated by the House that tax revenues from this source would increase by $5 million in 1976, $10 million in 1977, and $75 million by 1981.[5,p 90] This is a negative incentive if the previous arrangement is treated as the baseline, or is neutral if recapture as existed in hard mineral exploration is treated as the baseline. These costs have not been included in the final tabulation.

<u>Western Hemisphere Trade Corporations</u>

Section 26 USC 921 defines Western Hemisphere Trade Corporations and 26 USC 922, the method by which a special tax credit for such corporations is computed. Although referred to in Section 922 as a special deduction, the net effect of this incentive is to reduce the applicable corporate income tax rate to as much as 14 percentage points below the applicable rate for other domestic corporations.

To qualify under Section 921, the domestic corporation must do all its business within the Western Hemisphere and must be predominantly engaged in the active conduct of a trade or business outside the United States.

These credit provisions were enacted in 1942 during a period of high wartime taxes in the United States and generally low taxes in other Western Hemisphere countries. They were aimed at ensuring that U.S. corporations would not operate at a disadvantage in competing with foreign corporations. Their purpose was to increase U.S. corporate activity in the hemisphere and retain U.S. ownership of foreign investments which, if placed in the control of foreign corporations, might eventually pass over to foreign interests.[5,p 818]

The Tax Reform Act of 1976, Section 1052, repeals the Western Hemisphere Trade Corporation deduction after 1979 and provides a credit beginning at 11% in 1976 and scaling down to zero after 1979. Among the reasons given for phasing out this incentive are that foreign income should be taxed at the same rate as domestic income; that DISC provisions 25 USC 992 (a) are a more appropriate incentive; and that other Western Hemisphere countries have raised their tax rates since the enactment of this provision, thus giving little tax benefit to companies that qualify for the credit.[5,p 818] DISC provisions cited have little application to the energy industry as a whole because of amendments contained in the Tax Reduction Act of 1975.

In fiscal year 1968, the U.S. Treasury estimated the revenue cost of this incentive to be $50 million.[8] The Senate and House disagreed on the amount of the increase in corporate taxes this amendment would produce during the phaseout period but both agree that the total tax savings, by 1980-81, will be $50 million.[5,pp 260,819] This incentive was used by the petroleum industry but has not been an incentive for domestic production; in fact, it may have been a disincentive.

Foreign Tax Credits

Section 26 USC 901 contains the statutory source for foreign tax credits, subject to the limitations contained in Section 904, and the special rules for oil and gas, enacted in 1975 and contained in Section 907 (a) and (b) of the Code. The special rules limited the amount of the credit available to the oil and gas industry on income from foreign sources. Furthermore, changes pertaining to the tax credit were made in the Tax Reform Act of 1976.

The purpose of the foreign tax credit was to prevent double taxation of U.S. corporate income derived from foreign sources. It has been suggested that the rules were interpreted in a liberal manner so as to subsidize the Saudi Arabian Government and thus avoid the cancellation of ARAMCO's concession in that country. The theory of subsidization and the foreign policy implications of the tax credit are discussed in a Forbes article,(16) which noted that in a single year, ARAMCO's U.S. income taxes dropped $44 million, to $6 million, while the Saudi Government increased its take from $44 million to $110 million through a 50% tax on ARAMCO's oil profits.

The effect of the foreign tax credit law prior to the 1975 changes has been described as follows:

> Under present law, a domestic taxpayer having foreign income pays tax on that income to the country of the business activity and, to avoid double taxation, the taxpayer is given a dollar-for-dollar tax credit against the United States tax. The United States has a limitation on the foreign taxes that can be credited in any 1 year against United States income tax. In general, limitation on the foreign tax credit is calculated on a "per country" or an "overall" limitation. Under the overall limitation, the credit for foreign taxes may not exceed the proportion of U.S. tax on the corporation's worldwide income in the ratio of its foreign source income to its worldwide income. The results of this limitation is to allocate the tentative U.S. tax on the taxpayer's worldwide income on a pro rata basis between U.S. source income and foreign source income. The same formula is also used by the "per country" limitation, but the formula is applied separately to the income from each foreign country. Under this limitation, the credit for taxes paid to each individual country may not exceed the proportion of the U.S. taxes on worldwide income which the income from any particular country is of worldwide income. The result under the "per country" limitation is that the total tax credit limit is the sum of the limits of each country. The effect of the "overall limitation" is to permit averaging of the taxes on income from different countries with the result that taxes in high rate tax countries can be used to reduce United States tax

on income earned in low rate countries. Because of this, most corporations, except those having heavy losses in a particular country, use the "overall limitation." Since most companies in the oil business incur large losses from drilling and development operations, they have elected to use the "per country" limitation.[7,pp 1589-90]

The 1975 changes accomplished the following:

- reduced the amount of foreign taxes attributable to oil and gas income which are available for the credit by reference to stipulated percentages applied to "foreign oil and gas extraction income"
- limited the availability of future foreign tax credits to foreign oil-related income and provided that such credits may not be used to offset foreign income from other sources
- required that the overall limitation be used to compute the foreign tax credits attributable to foreign oil-related income
- restricted foreign oil-related tax credit carry-forwards arising in years prior to 1975 to foreign oil-related income
- limited available credits where losses attributable to foreign oil operations are incurred.[17]

The Tax Reform Act of 1976 contains amendments further affecting the treatment of foreign source income. Included is an overall limitation for all foreign source income other than oil and gas covered in the amendments of the 1975 Act. However, Section 1031 of the 1976 Act amending 26 USC 904 delays the effective date for mining companies, because certain mining ventures were begun with substantial investments of capital under the assumption that foreign tax credit could be computed under the per country limitation. Therefore, the law contains transitional rules.[5,p 226] Section 1035 of the Tax Reform Act of 1976 further revises Section 907. Under this act, the foreign tax credit on extraction income allowable as a credit is limited, for taxable years after 1976, to 48% of that income on an overall basis. Special rules for production-sharing contracts and carryover and carryback of disallowed tax credits in any taxable year are also included.[5,p 1272]

The foreign tax credit is the major influence on foreign source income. It has been said, prior to the 1975 and 1976 amendments, that in the foreign petroleum industry, so many foreign tax credits were available from producing countries that U.S. Integrated petroleum operations would pay essentially no tax on foreign income, even if no other tax preferences were allowed.[10,p 214] A study published in 1975[10,pp 220-228] concluded that the tax credits were of much greater value to the petroleum industry in reducing tax payments than any other types of foreign investment. The study also showed that the total value of foreign tax credits used to reduce U.S. taxable income was \$815.39 million in 1962, \$1,001.85 million in 1964, \$1,029.05 million in 1965, \$1,131 million in 1966, and \$1,609.36 million in 1968.

The amendments in the 1975 and 1976 Tax Reform Acts have substantially reduced the application of the tax credit provisions to reduce domestic income taxes. For instance, it is projected that the adoption of Section 1035 will produce additional revenues to the Treasury of \$23 million in 1978 and \$50 million in 1979, 1980, and 1981.[5,p 1375]

Foreign tax credits, even though intended to avoid double taxation, are nevertheless a disincentive to domestic production. However, since the U.S. market was protected by quotas from 1959-73, the impact of the credit for foreign tax credits on domestic production was small.[a] It may have influenced the levels of investment at home and abroad, which in turn influenced the discovery of reserves and ultimately production. The impact on the U.S. consumer was also small since, prior to 1973, most of the foreign oil was marketed in Europe and Japan. (Since 1973, with the exception of the impact of Alaskan oil on California's heavy oil production, there has been a ready market for all domestic oil production.)

Oil Import Quotas--1959-1973

In the late 1940s it appeared that the United States was "running out of oil." The government was concerned and initiated R&D on coal conversion and oil shale development. The oil industry increased its drilling efforts and

[a] It could be argued, on the other hand, that generous foreign tax credits allowed international oil companies to subsidize domestic operations. However, there is no evidence for this point of view.

production rose from 5.4 million bbl/day in 1950 to 7.2 million bbl/day in 1956, an increase of 33%. Reserves increased 20% in spite of the increased production. During the same period imports of crude oil and petroleum products increased from 850 thousand bbl/day to 1.4 million/day, an increase of 65%.

The industry became concerned that a flood of low cost imports would take over a large share of the U.S market. Imports from Venezuela had always been a factor in the U.S. market, in spite of a tariff applied in 1932, but the production cost was not out of line with U.S. costs. What concerned U.S. oil producers was the tripling of reserves in the Middle East, the very low cost of production there, and the abundance of tankers.

After closing of the Suez Canal in 1956, the U.S. Government became concerned about dependence on foreign oil. The following year a voluntary reduction in crude imports was requested in the name of national security. Crude imports stabilized but imports of refined products and residual oil tripled. In 1959 the Mandatory Oil Import Control Program was proclaimed by President Eisenhower. Quotas were established for each section of the country. On the West Coast, imports were limited to the deficit between domestic supply and demand. East of the Rockies, imports of crude and distillate products were initially set at 12.2% of total demand. With domestic oil at a higher price than imports, the refineries were designed or redesigned to make as much gasoline and other distillate products as possible from each barrel, decreasing the availability of residual fuel oil. To prevent shortages and high prices on the East Coast, residual oil was declared exempt from the quota program.

The quotas for crude oil imports were allocated among refiners, using historical operating data and a sliding scale that favored small refiners. The inland refiners were allowed to sell their quota privilege to coastal refiners, "tickets" being worth roughly $1/bbl. Thus, the immediate impact was to support the U.S. oil price and to aid small and inland refiners while avoiding increases in electricity costs on the East Coast. Later provisions allowed asphalt imports outside the quota, aided industrial development by allowing some products from Puerto Rico and the Virgin Islands in a special quota, gave preference in quotas to oil coming overland from Canada and Mexico and allowed low sulfur crude burned in place of high sulfur residual oil to be classified as residual oil. In April of 1973, this program was cancelled due to high U.S. demand and increased costs of foreign crude.

The cost of the program to the government was small since military procurement overseas was not affeced. The cost to the industry was mixed. Crude oil costs to refiners were equalized through the quota system. Domestic crude oil producers received higher prices than would have been obtainable with uncontrolled imports, tax bases of major crude oil producing states were maintained, and consumer prices were higher prior to the embargo, but the extra reserves developed as a result of the incentive helped to reduce the impact of the Arab oil embargos of 1967 and 1973.

Oil exploration and production incentives amounted to $108.5 billion for the period 1950-1978. Of this, $55.5 billion was for tax items; namely, the expensing of intangible drilling costs and the use of the percentage depletion allowance. Extra income of $50.2 billion from higher allowed prices in 1974-1978 was assigned to requirements, even though the funds were received from the marketplace. Regulatory activities of the Economic Regulatory Administration and its predecessors, the FEA and FEO, and the Strategic Oil Reserve cost $1.71 billion for the period 1974-1978 and were categorized as requirements. Nontraditional services, the oil activities of the Geological Survey and the Bureau of Mines, amounted to $592 million from 1950 to 1978. The oil leasing activities of the Bureau of Land Management, $498 million for 1950-1978, are considered market activities. Costs were determined by estimates of taxes foregone, increased value of sales, or expenditures for government agencies, as appropriate.

PETROLEUM REFINING AND TRANSPORTATION

Since the focus of this study is production, the "downstream" activities of refining and transportation are important for their role in developing the markets for petroleum products and thus indirectly encouraging production. The real profitability in the petroleum industry until recently was in production, not refining and marketing petroleum. The major oil companies used a strategy of expanding their markets as rapidly as possible as a way of increasing their sales of crude oil. Anything that increased sales allowed them to produce more, either domestically or abroad.

Oil Pipeline Rates--1921-1951

During the 1920s, the pipeline companies were reluctant to expand. The volume of oil in a given field was not always predictable and there was danger that a field might become exhausted before the pipeline constructed to serve the field had been amortized. To continue expansion of the pipeline system, the Interstate Commerce Commission (ICC) permitted the pipeline companies to set tariffs to produce a higher rate of return than was allowed for most public utilities.[2,p 356-360] This provided an incentive for pipeline expansion that was equivalent to the difference between the actual rate of return and what would have normally been allowed. This incentive, which is tabulated for the years 1921-1951 in Table 44, affected the distribution stage of the energy system.

Cost of Oil Pipeline Regulation--1950-1978

Until October, 1977, the Interstate Commerce Commission (ICC) regulated pipeline companies; since then, regulation has been by the Federal Energy Regulatory Commission (FERC), part of DOE. Since the cost of this regulation is borne by the taxpayer, it can be considered a subsidy. The total outlay for all ICC operations was $58.7 million in 1977. This total is about four times the cost 20 years earlier,[18] or twice as much when measured in constant dollars.

Only a small portion of the ICC activitities were related to pipelines. In 1975, less than 1% of the tariffs received and cases handled involved pipelines.[19] Activities of FERC regulating oil pipelines cost $3.1 million in 1978. This amount is small compared to other subsidies and these costs were therefore not included.

Maintenance of Inland Waterways--1950-1978

The policy of the U.S. is to provide inland waterways as free public highways. The U.S. Army Corp of Engineers constructs and maintains inland waterways, which are available to the petroleum industry at no cost.

TABLE 44. Pipeline Company Return on Investment
(Millions of Dollars)

Year	Capitalization	Net Income[a]	Income at 10% Return[b]	Incentive Return[c]	Incentive Return in 1978 $
1921	337.1	34.4	33.7	0.7	2.5
1922	471.7	58.6	47.2	11.4	44.4
1923	497.1	62.6	49.7	12.9	49.3
1924	496.2	72.2	49.6	22.6	86.4
1925	346.0	88.5	34.6	53.9	200.9
1926	342.4	80.4	34.2	56.2	207.4
1927	387.9	93.2	38.8	54.4	205.6
1928	388.5	117.2	38.9	78.3	298.5
1929	428.4	142.2	42.8	99.4	379.0
1930	458.1	123.7	45.8	77.9	304.7
1931	473.5	120.7	43.4	77.3	331.5
1932	368.5	112.4	36.9	75.5	361.1
1933	359.8	105.9	36.0	69.9	352.3
1934	347.8	84.1	34.8	49.3	240.4
1935	346.3	78.2	34.8	43.6	207.5
1936	308.5	91.7	30.9	60.8	286.5
1937	322.8	102.7	32.3	70.4	320.1
1938	294.6	92.7	29.5	63.2	292.8
1939	310.0	80.8	31.0	49.8	234.1
1940	294.7	79.9	29.5	50.4	234.7
1941	292.5	79.5	29.3	50.2	222.6
1942	301.2	56.8	30.1	26.7	107.1
1943	297.1	61.3	29.7	31.6	119.3
1944	282.6	65.7	28.3	37.4	138.8
1945	301.2	65.9	30.1	35.8	129.9
1946	297.8	56.1	29.8	26.3	88.0
1947	339.3	53.1	33.9	19.2	56.1
1948	439.2	56.7	43.9	12.8	34.8
1949	548.6	57.7	54.9	2.8	7.6
1950	660.3	81.3	66.0	15.3	41.6
1951	759.3	82.0	75.9	6.1	15.4
TOTAL					5,600.9

(a) From API Petroleum Facts and Figures, 1971.
(b) Calculated - 10% of capitalization.
(c) Calculated - Net income minus income at 10% return.

In supporting the waterways there was no direct intent to subsidize the petroleum industry, but a major part of the movement on inland waterways is petroleum and petroleum products (approximately 45 $\times 10^9$ ton-miles in 1973). The cost of construction, maintenance, and operation of the waterways was about 0.1 cent/ton-mile during 1973.[20] The second-order subsidy for 1973 was, therefore, about $45 million. This provides an incentive for the distribution stage of the energy system.

A longer-range approach to estimating the size of this subsidy is described under maintenance of Coastal Ports below.

Maintenance of Coastal Ports--1950-1978

The policy of providing waterways as free public highways applies also to coastal Great Lakes ports. In the same way there is a second order subsidy to the petroleum industry's use of the ports and channels. In ports that handle relatively large tankers, the tankers present the reason for deepening channels since tankers are usually the deepest draft vessels that use the port. Therefore, a larger-than-proportional amount of total dredging costs are in effect a second-order subsidy to the distribution stage of the oil energy system.

Federal funds for support of navigation in both coastal ports and inland waterways are provided through the U.S. Army Corps of Engineers. However, only a part of the commerce using these waters involves petroleum products. Table 45 lists the expenditures for navigation programs within the Corps of Engineers and allocates those costs as a petroleum subsidy according to the ratio of the tonnage of petroleum and petroleum products carried to all water-borne trade. The subsidy totals $6.9 billion for the period 1950 through 1978. At 390 million Btu/ton, this is an incentive of 0.13 cents million Btu.

The Jones Act of 1915--1915-1978

Foreign ships are able to provide services at lower cost than ships sailing under the U.S. flag. The wages paid to U.S. sailors and shipbuilders account for the difference. However, it is in the interest of the U.S. to maintain a functioning merchant fleet that would be available in wartime or other emergencies. Therefore, the Jones Act was passed in 1915 to insure the

TABLE 45. U.S. Army Corps of Engineers Expenditures for Navigation Projects[a] (in Millions of Dollars)

Fiscal Year	Petroleum Product Movements, Millions Short Tons[f]	Petroleum as[d] a Portion of Total Water-Borne Trade	Current Dollars: Expenditure[c]	Current Dollars: Petroleum Industry[e] Subsidy	1978 Dollars: Petroleum[f] Industry Subsidy
1978		0.50[b]	800.6	400.3	400.3
1977	936.8	0.491	698.3	342.9	369.3
TQ		0.459	174.0	79.9	91.6
1976	842.3	0.459	613.7	281.7	323.1
1975	741.4	0.437	551.2	240.9	292.2
1974	738.6	0.423	497.5	210.4	278.5
1973	759.8	0.431	461.0	198.7	291.9
1972	681.8	0.422	420.2	177.3	276.7
1971	687.0	0.421	392.5	165.2	266.1
1970	605.2	0.395	348.0	137.5	231.1
1969	568.0	0.331	392.0	129.6	230.7
1968	535.4	0.384	380.0	145.9	273.8
1967	505.1	0.378	377.1	142.5	278.5
1966	488.4	0.366	400.2	146.5	294.6
1965	473.5	0.372	386.4	143.7	297.3
1964	461.4	0.372	362.2[b]	121.3	255.2
1963	470.3	0.401	321.7[b]	129.0	275.0
1962	458.7	0.406	301.7	122.5	264.3
1961	443.9	0.418	292.3	122.2	266.7
1960	440.0	0.400	278.6	111.4	245.4
1959	429.5	0.408	257.3	105.0	235.1
1958	414.0	0.412	218.2	89.9	202.9
1957	419.3	0.371	189.4	70.3	163.1
1956	406.0	0.371	143.0	53.1	127.5
1955	378.0	0.372	109.5	40.3	99.2
1954	360.3	0.404	93.3	37.7	91.5
1953	359.5	0.389	98.0	31.1	92.9
1952	357.6	0.403	100.2	40.4	99.2
1951		0.388[b]	152.7	59.2	148.7
1950		0.388[b]	152.7	59.2	160.5
Total 1950-1978					6,922.9

(a) Navigation projects include (1) navigation studies, (2) construction of channels and harbors, (3) construction of locks and dams, (4) operation and maintenance of channels and harbors, and (5) operation and maintenance of locks and dams.
(b) Estimated.
(c) From the "Budget of the United States Government," Fiscal Year 1952 through Fiscal Year 1979.
(d) From API Petroleum Facts and Figures, 1971, Page 295; Waterborne Commerce of the United States Corps of Engineers, National Summaries 1968-75.
(e) The subsidy is calculated as the product of total expenditure and the proportion of total waterborne trade that is petroleum and petroleum products.
(f) Calendar year.

continued existence of a U.S. Merchant fleet. The act specifies that only U.S. flag ships could be used for transport movements between U.S. ports.

This act increases the cost of shipments of petroleum between U.S. ports. It is a disincentive for the transportation sector of the oil industry.

Deepwater Ports Act of 1974

The cost of shipping petroleum is directly related to the size of the tanker. No existing U.S. ports are able to handle the supertankers that can provide the lowest-cost transport. To promote the development of suitable ports and at the same time protect the environment, a Deepwater Ports Act (PL 93-627) was passed in 1974 to provide for licensing of deepwater ports. The act provided funds for developing design guidelines to assist with required environmental impact statements. The act also designated the ports as common carriers and, in addition, established a liability trust fund.

The incentives provided by this act can be evaluated in terms of the appropriation to implement the act. The incentive contributes to the distribution stage of the energy system.

There is another aspect of the act that might be considered an incentive. The liability trust fund is to be built by a charge per barrel of oil moved through the port. This fund will grow to a maximum amount, after which charges will not be collected until the fund is reduced by claims. Maximum liabilities are established at $150/dwt or $20,000,000, whichever is less. This fund could be considered an incentive if the cost is less than would be expected for the same insurance provided by a private insurer, if the damages resulting from an occurrence would be greater than the maximum liability, and if there are different economic advantages to supertankers of different sizes. Until experience is obtained, the net cost of these factors cannot be determined.

The Deepwater Ports Act authorized an appropriation of $2.5 million per year for administration of the act. If this entire amount were considered a subsidy to the petroleum industry, this would total $11.8 million for FY-1975-FY-1978 expressed in 1978 dollars.

Deepwater ports off the Gulf or Atlantic coasts will tend to discourage domestic production since they will make the importation of foreign crude cheaper. They will favor domestic refining, however, since very large crude carriers are too large for economical shipments of refined products from abroad.

Trans-Alaska Pipeline Authorization Act

The discovery of oil on the Alaskan North Slope provided an opportunity to reduce U.S. dependence on foreign oil. The transportation of the crude oil to refineries could be accomplished most efficiently using a pipeline across Alaska. Initial attempts at obtaining permission to construct a pipeline became bogged down in court cases concerning the environmental impact statements. The Trans-Alaska Pipeline Authorization Act (PL 93-153) specified steps to be taken for environmental protection and the requirements for environmental impact statements. In addition, the act established a liability trust fund.

The federal funds appropriated to administer the act could be considered a direct subsidy to the distribution stage of the energy system. The liability trust fund will be built from charges on pipeline throughput. Consideration of this government-operated insurance system as an incentive is similar to that for the Deepwater Ports Act, except that the Trans-Alaska Pipeline Authorization Act does limit liability.

Merchant Marine Act of 1970

The costs of construction and operation of U.S. flag ships are higher than for foreign ships. This makes U.S. ships less competitive and tends to interfere with the continued strength and growth of the U.S. Merchant fleet. A strong fleet is needed for national security reasons. In addition there is pressure from the maritime unions and the shipping industry to provide incentives to U.S. shipping.

The Merchant Marine Act of 1970 provided ship construction and operating subsidies for U.S. flag operators. Contracts to build 28 tankers under this program had been established as of October 1973. In addition, loans can be guaranteed under the Federl Shippers Mortgage Insurance Program (title XI).[21] This is a second-order subsidy to the transportation sector of the oil industry.

The ship construction and operating subsidies made available by the Merchant Marine Act of 1970 have been used for passenger ships, general cargo ships, and other specialized transports, as well as tankers. Therefore, it was necessary to estimate the portion of the total outlay used by the petroleum industry. The source of this data was the Appendix to the Budget of the U.S. Government for FY-1972 through 1978. The budgets for the Maritime Administration in the Department of commerce provided actual outlays for FY-1970 through 1975 and an estimated outlay for 1976. In addition, the amounts programmed for construction for different types of ships were provided in the budgets for FY-1973 through 1975. This breakdown was used to estimate the proportion of total construction subsidy to allocate to the petroleum industry. The budgets for FY-1975 through FY-1978 differentiated between operating subsidies for bulk cargo ships and general cargo ships. This helped allocate operating subsidies to petroleum. It was assumed that 50% of the bulk cargo operating subsidy went to tankers, (25% in 1976 when grain trade with U.S.S.R. was included in the data). The calculations of the estimated subsidy are shown in Table 46. The total subsidy for the period 1970 through 1978 was $1,300.8 million in 1978 dollars.

It should be noted that this is an incentive in that the cost of U.S. ships would be higher if the subsidy did not exist. The cost of foreign flag vessels is still lower and in the absence of the Jones Act preference foreign vessels would replace U.S. vessels, even with the subsidy. This subsidy is an incentive to domestic refining and utilization but not to domestic production, since the subsidized ships are not normally allowed to ply between domestic ports and thus cannot move crude oil from Alaska to the West Coast, although a six-month permission for use of subsidized tankers to carry oil from Alaska was granted.

World War II Pipeline Construction

Early during World War II, German U-boats sank many tankers carrying oil from the Gulf ports to the East Coast ports, creating a need for crude oil to

TABLE 46. Subsidies from the Merchant Marine Act of 1970
(Millions of Dollars)

	Current Dollars					
FY	Ship Construction Outlay	Ship Construction Tankers[a]	Operating Subsidy	Operating Subsidy Tankers	Total Subsidy Tankers	1978 Dollars Total Subsidy
1970	89.3	50.0	205.7	8.2[c]	58.2	97.8
1971	139.2	78.0	286.0	11.4[c]	89.4	144.2
1972	143.3	80.2	235.7	9.4[c]	89.6	139.8
1973	185.9	104.1	226.7	16.2[b]	120.3	176.7
1974	200.3	112.1	257.9	6.4[b]	118.5	156.8
1975	240.8	134.8	243.2	6.4[b]	141.2	171.4
1976	202.7	113.5	301.1	12.9[d]	126.4	145.0
TQ	42.0	23.5	85.3	2.0[d]	25.5	29.2
1977	219.4	117.3	343.9	12.7[b]	130.0	140.0
1978	156.7	87.8	303.2	12.1[c]	99.9	99.9
TOTAL						1,300.8

(a) Based on 56% of the programmed construction for tankers
(b) 50% of the indicated portion of the operating subsidy for bulk carriers.
(c) Based on 8% of the total operating subsidy for bulk carriers and 50% of that amount for tankers.
(d) 33% of the indicated portion of the operating subsidy for bulk carriers.

be shipped overland to the refineries in the East in order to supply the military needs. The Federal Government constructed a 24-in. pipeline from the Texas oil fields to refineries in Illinois during 1942. During 1943 the Federal Government constructed a 20-in. pipeline from Texas to Illinois and then extended it to New Jersey. These were called the Big Inch and Little Big Inch pipelines. An additional 31 pipeline projects were completed during World War II. The U.S. Investment in these pipelines was approximately $161.5 million.[2]

The pipelines were intended to provide for wartime needs, but after the war the Big Inch and Little Big Inch pipelines were converted to natural gas transmission, with the Little Big Inch later being converted to an oil product pipeline. Since the pipelines were sold to private interest at less than replacement cost, this provided a subsidy to the transportation stage of the oil and industries.

1973 Program to Encourage Energy Resource Development

In 1973, it was not advantageous for oil companies to expand their refinery capacity within the United States as there were import quotas which restricted access to expanded sources of crude oil. In April 1973 the restrictions on imports were suspended, an import license-fee schedule was established which imposed relatively higher fees for gasoline and residual fuel oils than for crude ($0.63/bbl versus $0.21). In addition, U.S. refiners could obtain duty-free quotas for imported crude equal to 75% of new refinery capacity for a period of 5 years.[22]

This was a first-order incentive for the refining stage of the energy system.

Federal Support of Highway Construction--1916-1978

Starting with the Federal-Aid Road Act of 1916 and extending through the 90% financing of the Interstate Highway System, the Federal Government has supported highway construction.[2,p 183-184] This has made automobile and truck travel easier, more economical, and safer and has thus stimulated oil consumption, especially gasoline. Asphalt for paving also was in greater demand. The need for gasoline and diesel fuel, in turn, has stimulated demand for domestic and foreign crude oil and has resulted in increased domestic production. This effect has been so indirect that it is not quantified here.

Subsequent to the 1973-1974 oil embargo Congress enacted a national 55 mile per hour speed limit. This, plus state energy conservation programs which discourage driving, can be considered disincentives to the use of petroleum.

Waste Disposal and Environmental Problems

The petroleum-producing industry faces several types of waste disposal and environmental problems: first in getting approval for siting of exploration and production activities (for example, meeting the requirements of the National Environmental Policy Act); second, regulations affect drilling, operation, and ultimate abandonment; finally, there are regulations that affect transportation, refining, marketing, and ultimate utilization. The impact can be delays, out-of-pocket costs, and increased energy consumption. A recent study analyzing 80 existing and potential federal and state regulations (many of the latter required by federal acts) estimated that their cost was about \$600 million in 1965 and rose to about \$6 billion in 1976.[23] Any reduction of demand caused by this impact would reduce imports, not domestic production. However, some production has been lost, particularly in the Bakersfield, California area. There some boilers that used to generate steam for injection to enhance oil recovery have been shut down because of sulfur dioxide emission regulations. In the fields classified as old oil, the cost of scrubbers is too high relative to the value of the oil and the fields were shut down. The recent decontrol of heavy oil prices may solve this problem. Extra energy required for pollution abatement in the oil industry during 1976 was estimated at 500 trillion Btu, close to 83 million bbl of oil.[23]

These figures do not include the extra cost and gasoline consumption brought about by emission controls on cars.

Environmental regulations are enforced by the Geologic Survey for drilling rigs and platforms on the Outer Continental Shelf, by the Coast Guard for all water-related transportation situations, and by EPA for all non-transportation water cases and all federal air cases on land and in state waters. In addition, the states also enforce rules and regulations, some of which have been developed at federal insistence. Since the regulations were not designed as direct incentives for production, the enforcement cost is not included here.

In the petroleum refining and transportation category, there are three separate major incentives, all connected with transportation. High yields allowed to encourage oil pipelines are considered a requirement. The value of the incentive, $5.6 billion, was calculated from the difference between the actual yield and a baseline 10% for the period 1921-1951. Funds spent to maintain ports and waterways, $6.9 billion from 1950 to 1978 are assigned to traditional services. Direct construction and operating subsidies for tankers, a disbursement, amounted to $1.3 billion during the period 1970-1978. Total incentives for the petroleum refining and transportation category are $13.8 billion.

CONCLUSIONS

Petroleum used for nontransportation-related residential and commercial purposes in 1978 amounted to 6.4 quadrillion Btu, about 22% of the energy used for this purpose. For industrial uses it constituted 26% and 97% for transportation. In addition, oil provided about 17% of the energy used for electricity generation.

The chief incentives and their costs are shown in Table 47. The costs of environmental controls are not included here since their intent was neither to encourage or discourage production.

TABLE 47. Summary of Oil Incentives by Type (in Millions of 1978 Dollars)

Incentive Area	Taxation	Disbursement	Requirements	Traditional Services	Nontrad. Services	Market Activity	Total
Research and Development					1,287		
Oil Exploration and Production							
Geological Survey-data					574		
Bureau of Land Management-leasing						498	
Bureau of Mines-data					18		
Stripper well price incentives			16,840				
Incentives for new oil			33,340				
Economic Regulatory Administration[a]			1,708				
Intangible drilling expensing	15,449						
Percentage depletion allowance	40,033						
Petroleum Refining and Transportation							
High yield on pipelines			5,601				
Maintenance of ports and waterways				6,923			
Subsidies for tankers		1,301					
Total	55,482	1,301	57,489	6,923	1,879	498	123,572

(a) Includes Strategic Oil Reserve.

REFERENCES - CHAPTER VII

1. W. Dupre, H. Enzer, S. Miller, and D. Hillieo, Energy Perspectives 2, U.S. Department of the Interior, 1975.

2. H. F. Williamson, et al., The American Petroleum Industry, The Age of Energy 1899-1959. Northwestern University Press, 1963, pp. 535-566.

3. J. A. Clark, Three Stars for the Colonel, The Biography of Ernest O. Thompson, Father of Petroleum Conservation. Random House, New York, 1954, pp. 101-117.

4. Monthly Energy Review, Federal Energy Administration and Energy Information Administration, DOE, various issues through July, 1979.

5. "Tax Reform Act of 1976," U.S. Code Congressional and Administrative News. Vol. 9A, West Publishing Company, St. Paul, MN, 1976.

6. R. B. Mancke, "Tax Incentives." The Failure of U.S. Energy Policy, Columbia University Press, New York, 1974, p. 79.

7. F. M. Burke, Jr., "Incentives to Develop Natural Resources: Factors Affecting Industries Involved in Natural Resource Exploitation; Oil and Gas; Hard Minerals; Timber." 33rd Annual N.Y.U. Institute on Federal Taxation, 1975.

8. S. M. Surrey, "Tax Incentives as a Device for Implementing Government Policy: A Comparison with Direct Government Expenditures." Harvard Law Review, Harvard University 83:708-709, 1970.

9. J. H. Shows, "The Oil and Gas Industry and Its Present Tax Treatment." Mississippi Law Journal, University of Mississippi 45:1140-41, 1974.

10. G. M. Brannon, "Existing Tax Differentials and Subsidies Relating to the Energy Industries." Studies in Energy Tax Policy, Ed Ballinger, 1974.

11. "An Analysis of the Federal Tax Treatment of Oil and Gas and Some Policy Alternatives." Senate Committee on Interior and Insular Affairs, Serial No. 93-29 (92-64), 1974.

12. L. McDonald, "U.S. Depletion Policy: Some Changes and Likely Effects." Energy Policy 4(1):56-62, 1976.

13. Budget of the United States Government, Special Analysis, 1976-1980.

14. G. M. Brannon, Energy Taxes and Subsidies. Ballinger, 1974, p. 41.

15. 26 USC 617.

16. J. Cook, "Taking the 'AM' out of ARAMCO." Forbes 118:38, 1976.

17. R. C. Bennett, "Tax Legislation Affecting the Petroleum Industry." Proceedings of the 21st Annual Rocky Mountain Mineral Law Institute, Southwestern Legal Foundation 25:346, 1976.

18. Budget of the U.S. Government, 1957 and 1977.

19. Interstate Commerce Commission 89th Annual Report to Congress.

20. L. A. Shabman, "User Charges for Inland Waterways: A Review of Issues in Policy and Economic Impact." Bulletin 91, Virginia Water Resources Research Center, Blacksburg, VA, 1976.

21. Oil and Gas Journal, October 15, 1973, p. 58.

22. Oil and Gas Journal, April 23, 1973, p. 20.

23. W. J. Sheppard, et al., "The Economic Impact of Environmental Regulations on the Petroleum Industry--Phase II Study." American Petroleum Institute Publication 4281, 1976.

VIII. NATURAL GAS ENERGY INCENTIVES

This chapter deals principally with the federal incentives applicable to the transmission and distribution of natural gas from the gathering point to the consumer. Incentives for production that are closely related to oil production, such as percentage depletion, were described in Chapter VII. This chapter focuses on the incentives affecting the pipeline companies and the residential consumer. As discussed below, the largest incentive, wellhead price control of natural gas, is now a negative incentive for the producer. Most of the federal incentives in this area of service can be ascribed to the organization and workings of a single federal agency, the Federal Energy Regulatory Commission (FERC)and its predecessor, the Federal Power Commission (FPC); hence, we have analyzed its expenditures in regulating natural gas.

Federal incentives are described in the following sections in terms of the relevant historical and economic conditions prevailing at the time the incentive was implemented. Following the initial section on R&D, the sections are roughly arranged in a sequence from exploration and production to the final sale to the consumer.

RESEARCH AND DEVELOPMENT

While federal expenditures for research and development of processes for the production, transmission, and utilization of synthetic natural gas are considered to be a direct incentive for the increased utilization of coal, they can also be considered to be indirect federal aid to the natural gas transmission companies. These companies can expect to profit from the government's research programs on synthetic fuels that they can transport and sell to their distributing companies. Research costs for coal gasification were included in Chapter VI, Coal Energy Incentives. The research dollars spent by the federl government to increase oil production can reasonably be expected to increase gas production, since gas is often found with oil. The cost of this research was analyzed in Chapter VII, Oil Energy Incentives.

To compensate for the fact that gas reserves are being used faster than new discoveries are being made, the gas industry feels that its technology base must be significantly expanded.[1] To accomplish this, the nation's natural gas distribution and transmission companies have joined together to form the Gas Research Institute (GRI). GRI is modeled after the Electric Power Research Institute (EPRI) and is funded by a charge passed on to consumers. EPRI is eligible to receive R&D funds from its members, who pass the cost on to the consumer. The FERC annually reviews the GRI research program and budget and authorizes advance payments by the pipeline companies in support of the approved program. Federal authorization of such R&D institutes constitute an incentive for increased production and consumption of natural gas at the expense of the consumer, not the taxpayer. Although the federal government's efforts to increase gas production by nuclear explosions could be considered as a direct incentive to the increased production of natural gas, in this study programs such as Plowshare are considered a direct incentive to stimulate the use of nuclear energy and are counted in Chapter IV, Nuclear Energy Incentives.

EXPLORATION

In recent years, the natural gas pipeline companies have acknowledged their continuing dependence on oil and gas exploration companies. Since exploration and drilling is a capital intensive business characterized by high costs and risks, the natural gas pipeline companies adopted a policy of advancing gas payments to drilling and exploration companies. This was intended to stimulate exploration and assist them in developing sites where large quantities of gas are expected to be found. This can be interpreted as an indirect incentive for an eventual increase in supply and consumption of natural gas. The FERC has now discontinued this policy except for payments up to 30 days in advance of delivery. The cost of this incentive is related to the interest on advance payments, which was an indirect price increase. This incentive was small and is not quantified in this study.

PRODUCTION

Wellhead Price Controls

In 1954, in the case of Phillips Petroleum versus the State of Wisconsin, et al., the U.S. Supreme Court ruled that producers of natural gas were subject to the same price regulations as companies transmitting and distributing natural gas. The Court ruled that

> "Regulation of the sales in interstate commerce for resale made by a so-called independent natural gas producer is not essentially different from regulation of such sales when made by an affiliate of an interstate pipeline company. In both cases, the rates charged may have a direct and substantial effect on the price paid by the ultimate consumers. Protection of consumers against exploitation at the hands of natural gas companies was the primary aim of the Natural Gas Act."(2)

The intent of the Court appears to be clear; consumers were to be protected from the possibility of rapidly rising fuel bills once they were committed to a natural gas system. It is felt that this assurance to the consumer has resulted in increased consumer confidence and ultimately in increased consumption of natural gas. However, this incentive for the consumer became a disincentive for exploration and production once the gas surplus turned to a shortage.

Prior to about 1967, there was a surplus of natural gas, and average prices of gas sold intrastate and to interstate pipelines were essentially the same, with slightly higher prices for interstate gas.(2) Intrastate prices for new gas began to increase slightly over interstate prices starting in 1969, with dramatic increases from 1972 to the present. Gas production peaked in 1973, decreased an average of 6% per year through 1975, and has decreased an average of 0.7% in recent years. This decrease, coincident with the effects of the oil embargo, contributed to the greatly increased prices of intrastate gas and declining purchases by interstate pipelines. In 1975, the FPC took action to increase interstate prices; however, interstate pipeline sales were still declining in that year because of lower amounts of gas discovered.

Regulation of interstate prices is considered as a subsidy or incentive for the use of natural gas. However, it has been a disincentive to new natural gas production since 1969. Because of outstanding contracts, it did not show up as a disincentive in the average figures until 1974. The following analysis estimates the amount of this incentive through 1978.

Table 48 was constructed from available statistics starting with 1955, the first year the Supreme Court decision had much effect. This analysis assumes that all interstate gas could be sold at intrastate prices, and that the difference between interstate and intrastate prices can be considered the incentive for promoting production of natural gas. This price difference multiplied by total interstate pipeline sales per year gives an estimate of the total amount of "subsidy," which was corrected for inflation. From 1955 to 1973 there was a net incentive to the producer, but during the period 1974-78 it was a net disincentive. Holding the wellhead price below the intrastate level has been a net saving for the consumer who is getting service. It has meant a net cost to those denied service because of a lack of gas.

The cost of wellhead price controls was assigned to the requirements category. In the early days of natural gas it was calculated from the higher price received by selling to the interstate market times the volume. In recent years the average interstate price has lagged behind that of intrastate gas, producing a negative incentive. The total net incentive has amounted to a negative $1,048 million for the period 1955-1978.

Natural Gas Policy Act

A substantial direct incentive to producers is the relaxation and eventual removal of wellhead price controls on natural gas as provided in the Natural Gas Policy Act. The Act classifies natural gas into several categories, based primarily upon the cost of production. Each category is allowed a certain maximum price escalated each month by a prescribed formula which includes the rate of inflation. As a result of this new pricing mechanism, wellhead prices have been allowed to rise much higher than under the previous system. This amounts to a reduction in a production disincentive, or a net incentive for production. Because the Act did not

TABLE 48. Data for Estimating Amount of Subsidy for Promotion of Natural Gas Use by Interstate Pipeline Price Regulation

	A	B	C	C	D	E	F	G
Year	Millions of ft3(a)	Average Wellhead Price ¢/Mcf(a)	Total Interstate Pipeline Sales of Domestic Gas(b) ft3 x 106	Average Sales Price to Interstate Transmission Co.,(b) ¢/Mcf	Average Estimated Price Intrastate Gas ¢/Mcf	Average New Price on Intrastate Market,(c) ¢/Mcf	Difference Between Interstate and Intrastate Prices ¢/Mcf	Incentive (Col C X Col G) Converted to Millions of 1978 $
1955	9,406,361	10.4	5,526,917(d)	10.7(d)	10.0		0.7	94
1956	10,081,922	10.8	6,163,439(d)	11.3(d)	10.0		1.3	148
1957	10,680,258	11.3	6,945,323(d)	12.0(d)	10.2		1.8	279
1958	11,030,248	11.9	6,860,565(d)	13.0(d)	10.1		2.9	448
1959	12,046,115	12.9	7,319,952(d)	14.3(d)	10.5		3.7	625
1960	12,771,038	14.0	7,967,501	15.5	11.5		4.0	703
1961	13,254,025	15.1	8,143,381	16.3	13.2		3.1	550
1962	13,876,622	15.5	8,592,450	16.5	13.9		2.6	481
1963	14,746,663	15.8	9,037,534	16.6	14.5		2.1	405
1964	15,462,143	15.4	9,648,297	16.6	13.4		2.9	595
1965	16,039,753	15.6	9,892,833	16.7	13.8		2.9	595
1966	17,206,628	15.7	10,688,480	16.7	14.1		2.6	559
1967	18,171,325	16.0	11,396,734	17.0	14.3		2.7	617
1968	19,322,400	16.4	12,214,721	17.2	15.0	17.1	2.1	528
1969	20,698,240	16.7	13,200,674	17.5	15.3	18.3	2.2	517
1970	21,920,642	17.1	13,671,951	17.9	15.8	19.8	2.1	481
1971	22,493,012	18.2	13,716,271	19.1	16.8	24.1	2.3	509
1972	22,531,698	18.6	13,804,001	20.6	5.4	47.1	5.2	1,120
1973	22,647,549	21.6	13,355,036	22.6	20.6	100.0	2.0	392
1974	21,600,522	30.4	12,615,924	26.9	35.3	130.0	-8.4	-1,402
1975	20,108,661	44.5	11,566,075	36.2	55.7	133.5	-19.5	-2,736
1976	19,952,438	58.0	11,388,608	48.1	71.2		-23.1	-3,018
1977	20,025,000	79.0	10,920,649	69.5	90.4	179.0	-20.9	-2,458
1978	19,636,000	91.9	11,141,065	84.1	102.1		-10.2	-1,136
Total 1955-1978								-1,048

(a) U.S. Bureau of Mines, National Gas Annual, Gas Facts, 1966 and 1976 data. Mineral Yearboo, 1953 and 1955 and Mineral Industry Surve, December 1977. Monthly Energy review, July 1979.

(b) Data from "Sales by Producers of Natural Gas to Interstate Pipeline Companies, 1977, FPC, Table A, p. VII; 1973, 1974, 1976 from FPC News, March 11, 1976, Item 22794; 1977, 1978 from unpublished EIA data.

(c) Various references were used to determine average intrastate gas prices for Column F, as follows:
- National Energy Outlook, FEA, February 1976 (FEA-N-75/713)
- Oil and Gas Journal, August 24, 1970, p. 47; November 27, 1972, p. 40; December 3, 1973, p. 24; November 4, 1974, p. 29; November 3, 1975, p. 20; November 7, 1975, p. 37; November 24, 1975, p. 31; December 22, 1975, p. 19; November 29, 1976, pp. 29, 34, 35, 37; December 13, 1976, pp. 30, 34, 47.
- A Preliminary Evaluation of the Cost of Natural Gas Regulation, FPC, Intra-Agency Task Force, January 1975, pp. 21, 22.

(d) Natural Gas Survey, Vol. 3, 1973, Federal Power Commission, pp. 153 to 164.

become effective until December, 1978, however, and because of widespread confusion about the various provisions, it had minimal impact in 1978. Furthermore, any positive impact upon interstate gas supplies was to some extent counterbalanced by the extension of price controls to gas production dedicated to intrastate markets. The overall impact of NPGA on natural gas production in 1978 is considered to be too small to be measured.

Roll-In Pricing of Supplementary Gas Supplies

The FPC has traditionally had a policy of requiring "rolled-in" rates on pipeline sales. Under this policy the costs of newly acquired gas supplies are averaged in with the existing gas supply costs and recovered through a single rate structure applicable to all customers of a given class, both old and new.[3] The averaging of prices takes place at all levels (i.e., producer to pipeline company, pipeline company to distribution company, distribution company to consumer), with the result that the price paid by the new consumer does not completely reflect the incremental price of the new production. Rolled-in pricing encourages pipelines and distributors to sell gas at less than the incremental value of producing and transporting it, resulting in a higher demand for natural gas than would be the case if new purchasers had to pay prices based only on the actual cost of producing and distributing new gas. This is a direct incentive for natural gas production, use and production of synthetic natural gas, and importation of liquified natural gas (LNG). (Even with wellhead price controls, the impact on domestic producers also has been favorable since wellhead prices have been allowed to rise).[a] This incentive could not be quantified since elasticities of demand for existing and new customers were not available.

The NGPA requires incremental pricing of certain categories of high cost natural gas for use in industrial boilers, and ultimately for other industrial uses as well. Once the incremental price of natural gas rises to the level of a substitute fuel (either No. 2 fuel oil or No. 6 fuel oil), then additional cost increases are rolled into the rates of other customers. Most of these

[a] In some recent cases, incremental pricing of imported LNG has been adopted by the Commission, however, it has not yet been applied to domestically produced gas.

provisions, which are yet to be finalized, will take effect in November 1979, with others to follow at a later date. Thus incremental pricing had no impact through 1978, the period of this study.

Industry Purchases of Intrastate Gas Transmitted in Interstate Pipelines

Due to the shortage of natural gas in recent years, in 1975 the FPC relaxed its policy of prohibiting transportation of intrastate gas in interstate pipelines in order to make more gas available to industrial users during periods of low supply. FERC Order 533 authorizes interstate pipelines to transport gas purchased intrastate by high-priority industrial users.[4] Title III of the NGPA allows FERC to authorize interstate pipelines to transport gas on the behalf of intrastate pipelines or local distribution companies, or to authorize intrastate pipelines to transport gas on behalf of the others. The authorization may be for a two year period with a two year extension.

This policy acts as a direct incentive for the utilization of natural gas in that industrial users in nonproducing states are able to receive gas through the interstate pipeline system. It is also an incentive for producers of gas not committed to the interstate system.

Interstate Pipeline Purchase of Intrastate Gas

FERC procedure 2.68 allows interstate pipeline companies and distribution companies to buy gas from intrastate gas companies (not producers) at unregulated prices for 60 day periods, subject to FERC approval. This acts as an incentive to production (or avoids the disincentive of wellhead price control), but the volumes sold have been small and hence the incentive is not quantified here. The NGPA allows the President to authorize such purchases for up to four months under a declared emergency. This provision has not yet been utilized.

TRANSMISSION

Natural Gas Act of 1938

The gas industry began marketing manufactured gas in this country in 1816. The first corporation organized to distribute natural gas was in

Fredonia, New York, in 1858. However, the technology to transport natural gas economically and efficiently from the producing southwest states to large parts of the country was not developed until the late 1920s.

The gas industry was the second industry to be designated a public utility, after the water supply industry. A public utility is an industry that furnishes what are generally considered to be essential services to large parts of the population. The definition and concept of a public utility was derived from early common law of England. Early English courts regulated certain occupations "affected with a public interest," requiring that they

- serve all who apply within the franchise area
- serve the maximum requirements of a customer
- provide safe and adequate service
- prevent unjust discrimination
- charge a reasonable price for service rendered.

As the natural gas industry required the investment of large sums of capital over an extended period, it was natural for the gas companies to evolve as large monopolies, each able to serve wide geographic areas without the influence of competition from other gas transmission companies. Two or more such utilities serving the same area would result in costly and unnecessary duplication of facilities.

By defining an industry as a "public utility," benefits are realized by both the utility and the population served. The principal obligations of a company as a public utility are: to serve all who request service if it can be reasonably supplied, to serve its customers without unreasonable discrimination, to set rates which have been judged reasonable by regulatory authorities and have customer acceptance, and to maintain adequate and safe facilities. In return, the companies designated as public utilities are compensated with the following benefits: the opportunity to earn a fair return upon the value of its property used and useful in public service, franchise rights in its area of operation, exercise of eminent domain, and use of public ways.[2]

The natural gas companies were initially regulated by state and local agencies. However, with technological advances in pipeline materials and joining, pipeline companies experienced tremendous growth between 1926 and 1932, expanding rapidly into the interstate market. By the early 1930s, concerns were raised that no regulatory body had influence over gas produced in one state and transported by a company for resale in another state.[a] In 1938, the Natural Gas Act was passed, giving the FPC regulatory powers over transmission companies operating in interstate markets.

Essentially, the Federal Government allows the interstate natural gas transmission companies to operate in a monopolistic manner. Because of the tremendous amounts of money which must be spent on equipment and plants when establishing gas transmission lines, it is beneficial to the company to be assured of a market. The FPC requires the company to obtain a "certificate of convenience and necessity" before it grants authority to that company to build and operate a new natural gas pipeline facility, to extend an existing natural gas facility, or to sell gas in interstate commerce.[5] The natural gas transmission company is responsible for investigating the demand for its product over a specified period of time, usually 20 years, and to demonstrate that it can provide this level of service over the same time frame. The customers are therefore assured that once they are hooked in to that company's pipeline, they will receive the amount of gas that has been predicted to be needed within a certain period. Thus, by government regulation of price and supply, the consumer's confidence in gas supply is kept high while prices are held low, resulting in increased use of natural gas.

In return for the services rendered to the public by public utilities, the utilties are generally granted the right of eminent domain or use of public right of way. The Natural Gas Act of 1938 extended this right to natural gas transmission companies by providing that any holder of a certification of public convenience and necessity may acquire right-of-way and/or other property required by exercising the right of eminent domain.

[a] These concerns arose over the waste of gas, the desire of consumers for cheap gas, the monopolistic control of pipelines by producers and gas utility holding companies, and discriminatory rates charged distribution companies.

This right may be exercised in federal district courts or in state courts. This right has obviously increased the consumption and utilization of natural gas by greatly reducing the time and expense that would have to be spent in negotiating for land rights with private or individual land owners.

The utility status granted to interstate transmission companies as a result of the Natural Gas Act was a boon to producers since the pipelines could be capitalized at a high debt-to-equity ratio by issuance of new stocks and bonds and did not produce a drain on the cash flow of the oil companies, large and small, that were the producers. At the time there was surplus production capacity and by facilitating access to markets, production from both oil fields and nonassociated gas fields was encouraged. This is one of the principal reasons that the cost of the FERC's gas regulation activities can be counted as an incentive.

Overall Estimate of the Cost of Gas Regulatory Agencies

The principal federal incentives to the natural gas transmission and distribution companies have occurred through the establishment and actions of the FPC and FERC. The passage of the Natural Gas Act in 1938 charged the FPC with regulating the interstate aspects of the natural gas industries. Additional responsibilities of the commission are the regulation of the interstate transmission of electrical power and oil pipelines.

The amount of money spent by the Federal Government for this incentive to the natural gas transmission and distribution companies, was estimated from the Appendix to the Federal Budget. Costs estimated in this manner included the costs of administration, personnel, and equipment that were involved in regulation of the natural gas transmission and distribution industries by the commission. The money allocated to the FPC for this purpose was recorded for each year from 1949 to 1977, and to FERC for 1978. From 1938 to 1948, the allocation of FPC funds for gas regulation (as opposed to electrical regulation) was not recorded in the Appendix to the Federal Budget. Discussion with FERC indicated that a further breakdown for those years was not available. An estimated 20% of these costs, however, were assumed in light of the trends in funding for the two functions in later years.

Table 49 lists the amount appropriated to the FPC (and FERC) for regulation of the natural gas transmission and distribution companies in constant 1978 dollars. (Note that regulation of producers is considered a negative incentive starting in 1969.)

Pipeline Safety Programs

The Department of Transportation has the responsibility for carrying out the natural gas pipeline safety program authorized under the Natural Gas Pipeline Safety Act of 1968. The minimum safety standards for natural gas pipelines were also established by this act. Through charging a federal agency with this reponsibility the Federal Government has, in effect, provided a direct incentive for the natural gas transmission and distribution companies by helping to provide the personnel, equipment, and activities required to carry out a natural gas pipeline safety program. The cost of this incentive has not been large and therefore is not included. (In 1976, the Materials Transportation Bureau of DOT spent $1.86 million altogether and the National Transportation Safety Board, an independent agency, spent $2.39 million investigating surface accidents and license appeals for fuels and nonfuels.)

The incentives in the transmission of natural gas are dominated by the costs of administering the industry by the Federal Energy Regulatory Commission. The costs of pipeline tariff administration were considered as positive in all years. However, the costs for regulation of interstate producers were considered negative starting in the year new contract prices were lower than those for intrastate gas. The total net incentive for the period 1938-1978 amounts to $248 million.

UTILIZATION

Regulation of Imported Liquefied Natural Gas

The policy of the government on the regulation of LNG seems presently to be in a state of flux and definition. The first major proceeding before the FPC involving proposals for long-term LNG imports and construction of substantial terminal, regasification, and transportation facilities was Distrigas Corporation, Opinion No. 613, issued in March, 1972.(4) This

TABLE 49. Estimated Net Incentive Due to FERC Regulations of the Natural Gas Pipelines and Interstate Producers

Fiscal Year	Regulation of Interstate Producers	Regulation of Pipelines	Net Incentives[a] 1978 $
1978	-6,970,000	14,034,000	7,064,000
1977	-6,114,000	12,311,000	6,674,000
TQ	-1,412,000	2,842,000	1,540,000
1976	-5,033,000	10,133,000	5,493,000
1975	-4,983,000	10,535,000	7,463,000
1974	-4,017,000	7,757,000	7,058,000
1973	-3,527,000	6,575,000	7,043,000
1972	-3,974,000	5,843,000	4,816,000
1971	-3,977,000	5,068,000	3,263,000
1970	-3,825,000	4,659,000	2,512,000
1969	-3,244,000	4,319,000	3,041,000
1968			13,396,000
1967			14,663,000
1966			14,059,000
1965			14,404,000
1964			13,921,000
1963			13,238,000
1962			10,912,000
1961			10,108,000
1960			8,824,000
1959			8,080,000
1958			6,672,000
1957			6,083,000
1956			5,699,000
1955			5,290,000
1954			4,841,000
1953			4,400,000
1952			3,891,000
1951			3,891,000
1950			3,925,000
1949			3,234,000
1938 to 1948			22,359,000
Total			248,341,000

Source: Appendix to the Budget of the United States Government.

(a) 1969-78 the cost of regulation of interstate producers was taken as a negative incentive. The final incentive also includes cost of regulation of pipelines, other gas programs, and a pro rata share of general expenses, from Appendices to the Federal Budget.

opinion involved the regulation of imported LNG to be used solely in intrastate markets where the primary use was anticipated to be peak-sharing in electric generation. The FPC ruled not to regulate such gas, stating,

> We are, in effect, inviting venture capital into the development of LNG import projects and, to the extent that these projects are intrastate in nature, we are expressing our intention not to regulate them. We are firmly of the opinion that the exemption of these projects from the federal regulatory umbrella will make them more attractive to private investors and lead to more gas at a lower price to the consumer, and effect this result sooner than if we controlled every detail and decision related thereto.

However, the FPC decided to regulate LNG which would be imported for interstate transmission and sale and intended for base load purposes in a proceeding brought by El Paso-Columbia Corporation. In this proceeding, the FPC not only decided to regulate LNG crossing state borders, but stated that the LNG would have to be incrementally priced by pipeline purchasers. This ruling has recently been reversed, allowing roll-in pricing.

With the establishment of the Department of Energy in 1977, the regulation of imported natural gas was divided between FERC and the Economic Regulatory Administration (ERA). Authority for siting of facilities and pricing to customers remains with FERC. All other issues, including certification to import and the price paid for the gas, are within the province of ERA. At this point, it appears that cost of the gas is the major determinant of whether or not an import certificate will be granted. In approving tariffs, FERC has recently tended to favor some degree of incremental pricing to those customers who stand to receive the greatest benefit from the gas. These policies will become better defined as additional decisions are handed down.

The status of imports of LNG is neither an incentive or disincentive for production since LNG is more expensive than domestic production at unregulated prices.

Priorities Established on Gas Purchased and Transmitted in Interstate Systems

A recent ruling by the FPC in response to the current shortages of natural gas overrode all the contracts previously established between producers, transmission companies, and distributing companies. FPC ruled in Order 467 in January, 1973, that natural gas should be directed on a priority basis for purposes of home heating and consumption. Commercial establishments were given a higher priority than industrial companies. The NGPA provides the President with additional allocation authority to be used in an emergency situation.

While prioritizing consumer groups for allocating the supply of natural gas does not increase the amount produced or utilized, it does increase and stabilize the amount of natural gas available for home heating and other uses. It can therefore be considered to be a direct federal incentive toward that end.

The Clean Air Act of 1970

The Clean Air Act Amendments passed in 1970 effectively limited the amounts of pollutants that could be released into the environment from various processes. Many power plants and industrial users had been burning coal or other low-cost, high pollutant-potential fuels; however, due to enactment of these amendments, many plants converted to use of gas as a clean, efficient fuel. Passage of these amendments can therefore be considered as indirect federal incentive to industries to use natural gas, thereby increasing the production and utilization of this fuel. The effect has been small due to the curtailments of industrial use and the passage of the Act cited immediately below.

The Energy Supply and Environmental Coordination Act of 1974

DOE is mandated to prohibit coal burning electric generating plants from switching to gas or oil, which it does through issuing "prohibition orders." DOE can issue prohibition orders or forbid the use of oil or gas in power plants now using it if a switch to coal is feasible in terms of plant design.

This law, of course, is intended to be a disincentive for natural gas utilization but has no impact on production since gas is in short supply. (Recently, DOE has encouraged the opposite, namely, replacing imported fuel oil used in power plants with natural gas.)

WASTE DISPOSAL

Althogh the natural gas industry does not have the severe waste disposal requirements of the nuclear and coal industries, it does have a few due to the presence of poisonous and corrosive hydrogen sulfide in certain natural gas supplies. This so-called sour gas is found primarily in Texas, Florida, Alabama, Mississippi, New Mexico, and Wyoming. To reduce corrosion problems, the hydrogen sulfide is scrubbed from the gas by an amine or caustic solution. Amine scrubbing is the primary process used today. The amine is regenerated by heating it to drive off hydrogen sulfide as a concentrated gas stream. Because of its poisonous nature, the released hydrogen sulfide is either flared or converted to elemental sulfur in a Claus or similar sulfur recovery plant. Since flaring releases sulfur dioxide to the atmosphere, pollution regulations place strict limits on flaring. The regulations are part of State Implementation Plants (SIP) filed under the requirements of the Clean Air Act as amended in 1970. The SIP requirements are designed to bring each state's ambient air quality into line with the state's standards, which must meet or exceed the federal ambient standards. Each state has a slightly different approach but in practice flaring is forbidden when the sulfur input is 2 to 5 tons per day, depending on the state. (Flaring is forbidden in Florida.) Since a Claus plant of 20 long tons per day is economical because of the value of the recovered sulfur, the penalty of these regulations on producers is small.

Florida, Oklahoma, and New Mexico have regulations requiring that new Claus plants be desinged to abate about 99% of the potential SO_2. This is to be compared with the 94 to 96% reduction obtained in the standard 2 or 3 stage Claus plants. In practice this doubles the plant cost but increases the sulfur recovered by only a few percent. The incremental cost for the tail gas cleanup is a disincentive for gas production, but, since only one plant has been built using this technology, the costs have not been calculated.

The Federal Government has the authority to control emissions from new sources in all states. To date, New Source Performance Standards have not been issued.

Federal environmental regulations of gas production such as appropriate disposal of drilling mud, limits on discharge of oily water coproduced, and abandonment procedures, are discussed in Chapter VII, Oil Energy Incentives.

CONCLUSIONS

Natural gas is a major source of U.S. energy supplies. In 1978, the residential and commercial sectors consumed 7.68 quadrillion Btu, or 38.8% of the total 19.80 quadrillion Btu's of natural gas consumption. The consumption by other sectors was; industrial, 8.28 quads (41.8%); transportation, 0.54 quads (2.7%); and electric utilities, 3.30 quads (16.7%).

The principal incentives related to natural gas transmission and production are 1) a fraction of the cost of running the Federal Power Commission, approximately $248 million since 1938, and 2) the incentive to the producer selling interstate natural gas due to wellhead price controls, which amounted to a negative $1,048 million from 1955-1978. (Since 1969 the wellhead controls have been a disincentive to the producer. Because of the effect of outstanding intrastate contracts at lower prices than interstate contracts, on average, the wellhead price controls did not become a net disincentive until 1974.) The expenditures shown in Table 50 can be considered as incentives provided by the Federal Government to the development of the natural gas industry.

TABLE 50. *Summary of Natural Gas Incentives by Type (in Millions of 1978 Dollars)*

Incentive Area	Taxation	Disbursement	Requirements	Traditional Services	Nontrad. Services	Market Activity	Total
From Oil Chapter							
Geological Survey-data					289		
Bureau of Land Management leasing						155	
Bureau of Mines-data					9		
Intangible drilling expensing	4,648						
Percentage depletion allowance	10,269						
Wellhead Price Controls			-1,048				
Federal Power Commission Regulation			248				
Total	14,917	0	-800	0	298	155	14,570

REFERENCES - CHAPTER VIII

1. O. J. Bowen, "Gas Research Institute Formed by Natural Gas Industry." American Gas Association Research and Engineering Quarterly Review, Volume 2, No. 3, November 1976.

2. National Gas Survey. Volume II, Federal Power Commission, Washington, D.C., 1973.

3. Gas Rate Fundamentals. American Gas Association, Rate Committee, 420 Lexington Avenue, New York, 17, NY, 1960.

4. S. G. Breyer and P. O. Macovoy, Energy Regulation by the Federal Power Commission. The Brookings Institution, Washington, D.C., 1974.

5. Staff analysis prepared at the request of Henry M. Jackson, Chairman, Committee on Interior and Insular Affairs, United States Senate, "Natural Gas Policy Issues and Options," Serial No. 93-20 (12-55), 1973.

6. A Preliminary Evaluation of the Cost of Natural Gas Deregulation. FPC Intra-Agency Task Force, p. 21, January 1975.

7. U.S. Department of Energy, "Monthly Energy Review," July 1979.

IX. ELECTRICITY

INTRODUCTION

In this chapter, electricity is analyzed as one of six energy forms. It is distinguished from other energy forms (oil, natural gas, nuclear, coal, hydropower, other (geothermal), and solar), because electricity refers to the electric current supplied as a public utility for lighting, heating, etc. Public utilities and electricity go hand in hand, or as Gerald Brannon says:

> "By public utilities in the energy field we mean principally companies concerned with the generation and distribution of electricity or with the distribution of natural gas. Practically speaking, these firms are not concerned with the availability of resources but with marketing energy. It will be helpful to think of the generation of electricity as simply a technique for marketing the energy content of coal, oil, and uranium. (The hydro-generation of electricity is a very small element of the total energy picture.)"[1]

This chapter will analyze federal incentives to encourage public utility generation and transmission of electricity. Federal actions taken to support electricity are primarily those actions which encourage the transmission of electric power. In cases where another energy form is used to supply electricity for transmission, federal actions to encourage public utility construction of facilities to convert various energy forms into electricity are included as actions whose primary purposes are to assist in the distribution of electric power.

ORGANIZATIONS

Thirteen major federal energy-related organizations have some involvement with public utility distribution of electricity as an energy form. Major energy-related actions toward electricity are conducted by the following twelve organizations.

Department of Agriculture (DOA)

- The Rural Electrification Administration (REA)

Department of Energy (DOE)

- The Alaska Power Administration (APA)
- The Bonneville Power Administration (BPA)
- The Southeastern Power Administration (SEPA)
- The Southwestern Power Administration (SWPA)
- The Western Area Power Administration (WAPA)
- The Economic Regulatory Administration (ERA)
- The Federal Energy Regulatory Commission (FERC)
- The Energy Information Administration (EIA)

Department of the Treasurey (DoT)

- The Internal Revenue Service (IRS)

Independent Organizations

- The Securities and Exchange Commission (SEC)
- The Tennessee Valley Authority (TVA)

The organizations that have had the largest direct impact on the dollar incentive figures presented in this chapter are the REA, TVA, BPA, SWPA, and FERC. The actions of the SEC and IRS in administering tax and investment incentives constitute the largest indirect impacts.

TYPES OF ACTIONS

Energy-related actions toward electricity and estimates of their costs to the Federal Government will be described according to the types of actions used by these organizations. There are nine distinct types of actions identified in the theoretical chapter, but not all of them are used as major actions to encourage the distribution of electricity. The types of federal actions affecting the electric energy market are:

exhortation	organizational creation and prohibition
taxation	traditional government services
requirements	market activity.

There is no example for exhortation as a major energy-related action, although this is an important minor action sometimes used in conjunction with other examples of major actions. For example, during the 1930's both REA and TVA conducted extensive public relations campaigns with the goal of demonstrating the advantages of residential and agricultural uses of electricity for those residing in rural areas and small towns. This spending for publicity or the use of exhortation was part of operations and maintenance expenditures and small in comparison to the cost of supporting power generating facilities and transmission equipment for the distribution of electric power. Hence, exhortation was a minor action conducted along with the major action of market activity. The remainder of this chapter will describe only those types of actions which have been used to encourage the distribution of electricity. Estimates of costs to the federal government for actions conducted to encourage use of electricity will be described by each type of action.

Expenditures for Electricity as an Energy Form

An analysis of the federal expenditures for electric power requires a careful separation of the costs to the Federal Government to develop hydropower resources and other costs to support the distribution of electricity. The method used will distinguish between two major types of utility companies. One type is the investor owned private utility. Another type is the government sponsored utility which exists in several different organizational forms.

Types of utilities:

A. Private investor owned utility

B. Government sponsored utility

1. Federal power authorities
2. State power authorities

3. Municipally owned electric utilities
4. Electric co-operatives.

Investor owned utilities distribute about 77% of all electricity used in the U.S., while government sponsored utilities distribute the remaining 23%. The distinction between type of utility is important because government sponsored utilities receive special treatment by the Federal Government not extended to investor owned utilities. This is particularly true in the area of taxation.

The method of analysis emphasizes federal actions directed at public utilities which encourage growth in the availability of electricity to consumers. Emphasis is placed as public utilities, because the distribution of electricity has traditionally been the principal concern of public utilities.

TAXATION

For the utility industry, there are special features of the federal taxation type of action which affects investor owned and government sponsored utilities differently. These special features are:

1. Investment tax credits
2. Liberalized depreciation which allows for:
    a. accelerated depreciation on plant and equipment
    b. tax deferrals on capital expenses
3. Absence of tax on the income of publicly owned utilities.

When first enacted by the Internal Revenue Act of 1962, the investment tax credit allowed electric utility companies a credit against federal income tax of 3% of investment in qualified property. This investment tax credit provision of the 1962 Act was suspended October, 1966, but reinstated effective March, 1967. It was repealed in April, 1969 for property constructed or acquired after that date, but it was restored in the Revenue Act of 1971 as the Job Development Investment Credit. The Act of 1971 increased the 3% credit to 4%. The credit applies to the construction, reconstruction, or erection of qualifying property completed after August, 1971. This credit was revised again in the "Tax Reduction Act of 1975" by increasing the investment tax credit allowable for electric utilities from 4% to 10%.

The use of investment tax credits by investor-owned utilities is summarized in Table 51 according to the method of accounting employed, 1) flow through or 2) deferred. The amounts listed by the flow through method of accounting indicts savings passed on to the customer. The amounts by deffered accounting do not result in a rate reduction from savings realized through use of investment tax credit. No suitable method was formed to convert the data to 1978 dollars, so the current dollar figures listed in Table 51 are low by a factor of roughly 1.2 to 1.5.

TABLE 51. Summary of Investment Tax Credits Generated and Utilized During the Years 1962 through 1976 by Method of Accounting. (Current Dollars)[2]

Method of Accounting	Credits Generated	Credits Utilized Amount	Credits Utilized Percent	Number of Companies
Flow-through	860,124,000	718,393,000	23	68
Deferred	3,451,585,000	3,060,622,000	77	177
Not stated	9,070,000	61,000		4
Total	4,370,816,000	3,779,676,000	100	249

For purposes of estimating amount of savings to investor-owned utilities from federal tax credits "generated" savings from tax credit will be used since this column refers to the amount likely to be utilized, considering that the provision for applying credits not currently used can be transferred to expenses either back three years or forward seven years. Hence, the tax credit incentive amounts to $4,370.82 million current dollars.

Liberalized Depreciations

Since 1954 the utility industry has had the option of using liberalized depreciation in computing their tax liability. They can choose to adopt accelerated depreciation for writing off expenses which is approximately twice the rate of depreciation that is possible when using the straight line method of depreciating expenses. For accounting purposes, however, utilities maintain records on the actual depreciation which is 50 percent of the accelerated depreciation. Thus, additional deductions from the use of accelerated depreciation are reported as deferred taxes. If the assumption that future plant maintain records on the actual depreciation which is 50 percent of the accelerated depreciation. Thus, additional deductions from the use of accelerated depreciation are reported as deferred taxes. If the assumption that future plant investment will continue to grow, these deferred taxes are perpetually retained by utilities. Under conditions of growth, it is unlikely that deferred taxes will be paid out as taxes. In a few cases, utility investment during the depression of the 1930's has been analyzed to determine what would happen to deferred taxes during a severe economic slump. The results of this analysis showed that the gross plant of New England Telephone and Telegraph continued to grow throughout the depression, with the exception of two years. Of course, more studies would have to be done to conclusively show that deferred taxes would not be affected during a severe economic slump. Assuming a healthy economy, the following description of deferred tax is accurate.

> It is true that for a single unit of plant subject to liberalized depreciation for tax purposes, any lower income taxes resulting from higher depreciation deductions in the early years of life would be offset by higher income taxes in the later years of life. However, in the case of a total utility property, annual depreciation charges for tax purposes under the liberalized methods will never be lower than the straight-line charges in later years as long as dollars of additions are at least equal to dollars of retirements. Therefore, for a growing utility, or even a static utility, the tax reductions from liberalized depreciation result not in tax deferrals, but in permanent tax savings.[3]

Thus, for purposes of this report tax deferrals will be considered a tax savings and an incentive encouraging growth in the distribution of electricity.

The incentive provided by liberalized depreciation is tabulated in Table 52 and amounts to $14,094.7 million 1978 dollars.

Absence of Federal Tax on the Income of Publicly Owned Utilities

So far, this description of taxation has concerned only the investor-owned utilities. Government-sponsored utilities are exempt from paying federal

TABLE 52. Incentive Provided to Class A and B Privately Owned Utilities by Deferred Income Tax Due to Liberalized Depreciation[2]

Year	Deferred Income Taxes[a] (Million of 1978 Dollars)
1978	NA
1977	2636.620 (P)
1976	1869.874
1975	1475.670
1974	1297.944
1973	829.587
1972	611.636
1971	395.448
1970	267.791
1969	251.072
1968	226.542
1967	194.937
1966	180.725
1965	189.917
1964	216.922
1963	305.214
1962	362.503
1961	402.051
1960	452.316
1959	490.582
1958	513.742
1957	479.740
1956	443.384
TOTAL	14,094.72

(a) The use of liberalized depreciation started in 1953 but data on the tax deferred was not split out until 1956.
(P) Preliminary

income tax. This exempt status is a significant inducement for the growth of government-sponsored utilities. In the last thirty years federal taxes paid by private investor-owned utilities has averaged 11% of operating revenue.[4,5] Savings in operating revenue of this magnitude should clearly place the government-sponsored utility at a competitive advantage over the investor-owned utility and encourage growth in the direction of government-sponsored utilities.

The accounting of the tax savings to government sponsored utilities is in three parts. The parts correspond to the following government sponsored utility types:

- Federal Power Authorities (APA, BPA, SEPA, SWPA, WAPA, and TVA)
- State Power Authorities and Municipally Owned Electric Utilities
- Electric Cooperatives (REA).

Each of these utility types has a different organizational structure and each is treated somewhat differently by the Federal Government. However, none of these utilities pay federal taxes. The net effect of this absence of federal tax is a lower energy price to the consumer. It does not matter what portions of the electric energy generation, transmission, conditioning, distribution and marketing cycle the government sponsored utility is involved in. If the same functions were performed by a private investor-owned utility they would be taxed and the cost of electric energy to the consumer would be higher.

The income tax exemption incentive provided to the Federal Power Administrations and the TVA amounts to $1,970.0 + $1,626.5 million 1978 dollars. The first figure ($1,970.0 million) is directly associated with hydro-energy and in included in the total of the hydro-energy chapter. The second figure ($1,626.5 million) is the tax exemption incentive for the TVA's non-hydropower energy sources. The basic data for these figures are included in Appendix C. The calculational method used is described in detail in the hydro-energy chapter. The TVA is the only Federal Power Authority that has extensive fossil fuel and nuclear electric generation plants. The tax incentive to this portion of the Federal Power Authorities is tabulated in Table 53.

The income tax exemption incentive provided to State Power Authorities and Municipal Utilities amounts to $8,215.91 million 1978 dollars. This figure is based upon a calculation of tax per million killowatt hours paid by investor-owned utilities from 1937 to 1978. This tax per million killowatt hours for each year was multiplied by annual amounts of electricity made available for distribution by State Power Authorities and Municipal Utilities reported in million killowatt hours. The resulting figure in the last column of Table 54

TABLE 53. Incentive Provided to the Tennessee Valley Authority by the Exemption of Federal Tax[(a)]

Year	Estimated Incentive Provided by Tax Exemption (Millions of 1978 Dollars)
1978	133.32
1977	142.38
TQ 1976	33.90
1976	109.67
1975	70.13
1974	44.84
1973	54.03
1972	48.35
1971	49.91
1970	47.74
1969	62.02
1968	65.63
1967	64.68
1966	69.91
1965	58.90
1964	64.47
1963	63.25
1962	54.28
1961	59.90
1960	59.89
1959	46.72
1958	38.39
1957	44.66
1956	48.49
1955	41.93
1954	24.60
1953	14.95
1952	8.15
1951	1.35
TOTAL	1,626.46

(a) This table includes only the non-hydropower portion of the TVA revenues as the hydropower portion is presented in the Hydro-Energy Chapter.

TABLE 54. Incentive Provided to State Power Authorities and Municipal Utilities by the Exemption of Federal Taxes

Fiscal Year	Federal Taxes Paid by Investor Owned Utilities (Millions of 1978 Dollars)	Annual Electrical Supply by Investor Owned Utilities (Millions of Kilowatt Hours)	Tax Rate (1978 Dollars per Million Kilowatt Hours)	Annual Electrical Supply by Government Sponsored Utilities (Million Kilowatt Hours)	Tax Savings of Government Sponsored Utilities (Million 1978 Dollars)
1978	N/A	1,556,761	480.716[e]	190,073	91.37[e]
1977	859.426	1,603,795	480.716	184,455	88.671
1976	996.417	1,557,006	376.99	178,024	67.114
1975	997.256	1,487,030	670.680	174,221	116.846
1974	701.926	1,442,114	486.734	170,657	83.065
1973	1,065.312	1,448,860	735.275	160,514	118.022
1972	1,386.935	1,356,677	1,022.290	152,300	155.696
1971	1,535.016	1,248,596	1,229.373	142,304	176.025
1970	1,876.758	1,183,190	1,587.675	139,207	221.063
1969	2,819.850	1,102,162	2,558.473	139,267	356.290
1968	3,103.959	1,019,313	3,046.150	125,156	371.429
1967	2,951.687	928,439	3,179.196	111,138	353.329
1966	3,119.342	880,837	3,541.337	99,271	351.522
1965	3,078.785	809,474	3,803.442	91,976	349.[illegible]
1964	3,125.835	756,183	4,133.706	89,937	371.[illegible]
1963	3,008.470	701,253	4,290.113	84,251	361.477
1962	3,011.873	653,070	4,496.472	79,459	357.386
1961	2,784.855	606,737	4,589.007	69,738	320.090
1960	2,607.944	578,400	4,507.334	57,467	259.023
1959	2,472.346	544,734	4,542.808	52,316	237.661
1958	2,175.454	496,402	4,382.440	40,837	178.966
1957	2,317.004	480,943	4,609.707	38,360	176.828
1956	2,300.038	459,015	5,010.410	37,529	188.061
1955	2,563.265	420,069	6,161.689	34,061	209.874
1954	2,221.453	370,970	5,988.229	30,436	182.258
1953	2,119.399	354,772	5,956.998	26,432	169.369
1952	1,949.984	322,126	6,053.401	23,080	139.715
1951	1,678.228	302,049	5,559.900	23,444	130.346
1950	1,332.630	266,860	4,993.746	20,906	104.409
1949	1,027.442	233,317	4,364.601	19,122	83.460
1948	984.435	228,231	3,875.175	18,444	71.473
1947	2,106.565	208,306	10,129.767	17,352	175.772
1946	2,025.567	181,090	12,814.440	15,198	194.758
1945	2,588.289	180,926	13,279.204	13,560	193.986
1944	2,716.487	186,550	14,041.263	13,473	197.261
1943	2,818.778	180,248	15,638.309	13,027	203.720
1942	2,758.953	158,062	17,455.981	10,933	193.846
1941	2,515.846	144,289	17,659.994	8,705	171.390
1940	2,084.086	125,411	16,618.043	7,843	130.336
1939	1,829.014	115,078	15,893.605	7,068	112.655
1938	1,697.805	104,090	16,262.889	6,693	108.848
1937	1,589.640	110,464	14,390.560	6,606	95.065
TOTAL					8,215.908

(e) Estimated.

represents the amount government-sponsored utilities would have paid out in taxes each year if they had been taxed at the same rate as investor-owned utilities.[9] Information on total federal taxes paid was not available for 1978 at the time of printing so, the 1977 tax is used as an estimate for 1978.

The income tax exemption incentive provided to the cooperatives that borrow from the REA amounts to $6,110.40 million 1978 dollars. This figure is presented in Table 55 and was calculated using the method described in the hydro chapter.

Interest Subsidy from Tax-Exempt Bonds

Government sponsored utilities can issue tax exempt municipal bonds. With a tax exempt status, these bonds can be offered for sale at a lower interest rate than a taxable utility bond. Through contacts with industry spokesmen we have estimated that the interest rate difference between taxable and tax free bonds has averaged about 2.25%. This 2.25% savings associated with the ability to support long-term debt by bond issues selling for a lower interest rate again results in the underpricing of electric energy. Complete data was not available at the time of printing, however figures for 1964 through 1974 are presented in Table 56. The estimated subsidy amounts to $2,441.28 million 1978 dollars.

MARKET ACTIVITY

The Federal Government constructs, operates and maintains electricity transmission systems and provides loans and loan guarantees for electricity generation, transmission and distribution systems. The federal involvement in the development of electricity began during the Roosevelt administration. The creation of the Tennessee Valley Authority (TVA), Rural Electrification Administration (REA), and the Bonneville Power Administrtion (BPA) were the first major actions of the Federal Government in the electrical energy market. The primary motivation for the electricity involvement of the BPA and TVA (ignoring the dam's multipurpose uses) was to stimulate industry and provide jobs. The primary motivation behind the creation of the REA was to slow the migration of people from the farms to the cities. At this time in history, the late 1930's

TABLE 55. Incentive Provided to REA Cooperatives by the Exemption of Federal Taxes

Year	Gross Operating Revenue of REA Borrowers (Millions 1978$)	Federal Tax Rate for Investor Owned Utilities	Tax Savings of REA Borrowers (Millions 1978$)
1978	7038.70	0.07	492.709
1977	5471.35	0.07	382.994
TQ 1976	1036.061	0.065	72.023
1976	4077.228	0.065	283.443
1975	3605.082	0.060	230.109
1974	3064.949	0.048	154.533
1973	2808.980	0.062	185.668
1972	2622.709	0.061	170.380
1971	2389.489	0.062	157.946
1970	2201.022	0.07	165.665
1969	2080.294	0.098	226.018
1968	1987.729	0.111	248.185
1967	1910.032	0.108	231.261
1966	1833.186	0.116	240.552
1965	1750.935	0.117	232.004
1964	1688.041	0.125	241.144
1963	1589.275	0.130	237.473
1962	1504.666	0.132	228.817
1961	1421.048	0.134	219.882
1960	1355.785	0.138	217.050
1959	1288.133	0.107	154.350
1958	1185.168	0.100	131.688
1957	1136.259	0.104	131.892
1956	1105.393	0.111	138.018
1955(e)	1027.363	0.120	140.096
1954	930.438	0.117	123.290
1953(e)	840.974	0.125	120.136
1952	752.285	0.129	111.416
1951(e)	672.402	0.117	89.098
1950	621.490	0.095	65.241
1949	514.155	0.079	44.097
1948(e)	404.440	0.072	31.382
1947	323.008	0.079	27.711
1946(e)	304.124	0.091	30.446
1945	259.177	0.107	31.059
1944(e)	233.339	0.116	30.618
1943	205.154	0.126	29.579
1942(e)	179.025	0.113	22.802
1941	155.243	0.195	37.605
TOTAL			6,110.40

(e) Estimated values.

TABLE 56. Tax-Free Bond Subsidy Provided to Publicly Owned Class A and Class B Electric Utilities(6)

Year	Long-Term Debt (Millions of Current Dollars)	Estimate of the Subsidy Provided by the 2.25% Average Difference in Bond Rates (Millions of 1978 Dollars)
1974	9,436.525	280.928
1973	7,828.203	258.647
1972	7,481.868	262.609
1971	6,363.388	230.595
1970	5,997.883	226.793
1969	5,455.858	218.547
1968	5,132.667	216.582
1967	4,578.430	201.291
1966	4,112.683	185.994
1965	3,919.311	182.374
1964	3,739.715	177.008
TOTAL		2,441.279

the cities had many modern conveniences like electricity and flush toilets. The electrical needs of the cities were served by private utilities. The rural areas were ignored by the utilities because there weren't enough customers to justify an electric distribution system. The REA was created to provide the financing necessary to develop an electrical distribution system for rural areas.

The REA was established by Executive Order of the President as an emergency relief program on May 11, 1935. Statutory authority was provided by the Rural Electrification Act of 1936. The Act established REA as a lending agency with responsibility for developing a program for rural electrification. On October 28, 1949, an amendment to the Rural Electrification Act authorized REA to make loans to improve and extend telephone service in rural areas. In 1971, the Act was amended to authorize the establishment of a Rural Telephone Bank to provide supplemental financing for telephone systems. And in 1973, authority to guarantee loans made by non-REA lenders was authorized by an amendment to the Act. This amendment also increased the standard interest rate for REA loans to 5 percent, but continued the 2 percent interest rate for borrowers meeting special statutory criteria.

REA has made long-term, interest-bearing loans, and guaranteed loans made by others, to 1,000 electric and 900 telephone systems located in the rural areas of the United States. These borrowers serve about 8.0 million electric consumers and 3.5 million telephone subscribers, located in 47 states, the Virgin Islands and Puerto Rico. REA loans to finance electric and telephone facilities bear interest at either a standard rate of 5 percent or a special rate of 2 percent interest in accordance with criteria set forth in the Act. REA also makes loans in conjunction with other lenders; and may guarantee the repayment of loans from non-REA financing sources.

Electric Loans

REA electric loans are made to non-profit and cooperative associations, public bodies, and other electric utilities. These loans finance the construction and operation of distribution lines or systems, generating plants and transmission lines to provide initial and continued adequate electric service to persons in rural areas. About 99 percent of the REA-financed electric systems are cooperatives, owned and controlled by their consumer members.

REA-financed distribution systems typically buy their power wholesale from existing suppliers and deliver it at retail to their consumers. REA generation and transmission loans are made only where no adequate or dependable source of power is available or where the rates offered by existing power sources would result in a significantly higher cost of power to the consumers than the cost from facilities to be financed by REA.

Loan Guarantees

REA also guarantees loans to facilitate the obtaining of financing for large-scale electric and telephone facilities from non-REA sources. Guarantees are considered if such loans could have been made by REA under the ACT, and may be made concurrently with an REA loan. Guaranteed loans bear interest at a rate agreed upon by the borrower and the lender, and may be obtained from any legally organized lending agency qualified to make, hold, and service the loan.

In 1974, REA entered into an agreement with the Federal Financing Bank, whereby FFB agreed to purchase obligations guaranteed by the REA Administrator. Interest rates on FFB loans are determined at the time each advance of funds is made and are based upon the cost of money to the FFB. REA acts as agent for the FFB, and performs all loan servicing functions as authorized by the Act creating FFB. Borrower's dealings are with REA and all policies and procedures of REA are applicable to a guaranteed loan.

Interest Rates

Most REA loans bear interest at the standard rate of five percent. A special two percent rate is available for electric and telephone borrowers which have experienced extenuating circumstances or extreme hardship, or which meet criteria set forth in the law. These include electric systems with an average consumer density of two or fewer per mile or an adjusted plant revenue ratio of 9.0 or more. Plant revenue ratio is the total cost of distribution and general plant divided by the annual gross revenue after excluding the cost of power.

A Revolving Fund for Loan Capital

A Rural Electrification and Telephone Revolving Fund in the U.S. Treasury is the source of REA loan funds. This fund is replenished through collections on outstanding and future REA loans and from the sale of borrower's notes to the Secretary of the Treasury or the money market. Repayment of notes sold is insured by REA. Limitations on the amounts authorized for loans in any one year may be imposed by the Congress.

Loans are repaid by the systems REA finances over a 35-year period. Success of this program may be demonstrated in the fact that these borrowers repay their government loans promptly, often ahead of schedule. Of the 12.9 billion loaned through September 30, 1978, less than 1/1,000th of one percent has been lost through foreclosures or failure.

Technical Assistance

REA helps develop the resouces and ability of borrowers to meet their own affairs effectively, and achieve as soon as possible the internal strength and soundness to assure their success. As borrowers develop adequate internal strength and financial soundness, the need for REA assistance diminishes.

REA is headquartered in Washington, DC and has no field offices. A staff of engineering, accounting and management specialists, operating from their private residences, is located through the United States to provide direct assistance to borrowers.

Throughout its history the REA has made loans for the consumption as well as distribution of electricity. An accounting of the loans granted by the REA for distribution lines and facilities, transmission and generation facilities, and consumer facilities is presented in Table 57. The amount of the principal and the interest that has been repaid is presented in Table 58. The net annual outstanding REA loans is calculated in Table 59 to facilitate calculation of the cumulative outstanding balance. The incentive provided to electricity production by the REA can be defined as the total amount of money outstanding in loans or the difference in the cost of capital paid by REA borrowers and private utilities. These definitions of incentives are similar to those in the hydro-energy chapter. The total amount of REA loans outstanding at the end of the 1978 fiscal year was $18.95 billion (1978). To estimate the incentive provided by low interest loans the net cumulative dollar amount of outstanding REA loans in 1978 dollars was multiplied by the difference between the weighted average yields on newly issued electric and gas utility bonds and the composite interest rates on the total long term financing for all REA electric borrowers for each year between 1936 and 1978. These data and results are presented in Table 60. The estimated incentive using this definition is $9.6 billion (1978). Administrative costs of operating the REA have amounted to $524.3 million (1978). Administrative cost data is presented in Table 61.

Federal Power Administrations and the TVA

The TVA and most of the Federal Power Administrations construct and operate transmission facilities to accompany their generation stations. A

TABLE 57. REA Loans Granted in the Electrification Program by Purpose (Millions of 1978 Dollars Per Year)[7]

Year	Loans for Distribution Lines and Facilities	Loans for Transmission Operation Facilities	Loans for Consumer Facilities
1978	298.82	688.800	
1977	128.659	785.283	
1976(a)	57.068	148.730	
1976	185.275	674.466	
1975	302.688	545.809	
1974	369.190	471.825	
1973	390.168	517.516	
1972	280.203	403.678	
1971	271.180	312.902	
1970	191.679	388.068	0.083
1969	353.939	259.248	0.831
1968	234.600	403.622	0.327
1967	158.134	344.814	0.293
1966	515.095	516.853	0.381
1965	473.852	311.163	0.940
1964	512.484	449.976	0.431
1963	390.839	331.254	4.779
1962	335.179	224.008	4.812
1961	331.517	262.858	4.573
1960	196.065	284.554	4.429
1959	145.134	244.866	6.997
1958	194.867	341.602	8.995
1957	278.673	405.941	12.304
1956	147.129	297.632	11.157
1955	70.508	311.461	5.957
1954	70.274	310.436	5.937
1953	42.993	298.113	5.759
1952	150.973	251.758	4.111
1951	128.575	416.266	12.433
1950	369.971	642.281	5.014
1949	232.729	994.946	1.296
1948	108.404	739.344	1.050
1947	96.839	635.973	1.776
1946	102.717	737.642	2.279
1945	25.755	211.380	2.785
1944	11.192	106.025	1.537
1943	6.398	19.250	0.356
1942	112.822	238.857	13.485
1941	24.877	410.144	8.480
1940	2.643	182.188	8.966
1939	16.374	626.212	11.384
1938	5.164	125.026	5.319
1937	6.756	197.527	0.426
1936	0.131	65.386	
TOTAL	8350.23	17,134.596	159.717

(a) 1976 Fiscal Year Transition Quarter

NOTE: Table may not add exactly due to rounding.

TABLE 58. Repayment of REA Loans (Millions of 1978 Dollars Per Year)[7]

Year	Principal Due and Paid	Interest Due and Paid	Advance Payments
1978	315.988	278.694	-14.957
1977	234.836	206.817	-15.286
1976[a]	52.469	47.899	-8.691
1976	215.992	187.014	-25.870
1975	241.168	169.474	-53.795
1974	240.652	149.625	-64.916
1973	263.597	152.460	-72.399
1972	265.472	152.497	-36.858
1971	262.408	147.346	-37.930
1970	249.331	144.321	-10.680
1969	247.327	145.645	-5.808
1968	245.674	146.182	67.906
1967	246.795	145.616	64.232
1966	245.738	141.603	15.061
1965	258.804	140.120	25.898
1964	239.099	136.082	78.405
1963	250.395	131.709	64.353
1962	229.414	124.223	35.522
1961	202.073	115.327	19.634
1960	192.880	107.853	30.768
1959	185.045	100.975	39.817
1958	173.240	95.630	44.586
1957	164.261	91.328	30.227
1956	164.571	88.550	31.308
1955	141.491	77.934	31.757
1954	112.470	63.371	31.652
1953	95.965	49.064	21.616
1952	84.255	43.295	35.370
1951	65.733	37.010	26.549
1950	61.938	36.935	9.993
1949	61.324	34.417	0.943
1948	60.281	25.699	2.525
1947	40.257	26.073	0.139
1946	35.430	32.190	2.146
1945	29.988	32.853	8.946
1944	51.111	42.618	15.368
1943	11.911	43.799	27.400
1942	1.757	31.078	8.824
1941	14.720	13.810	12.342
1940	9.976	10.911	1.942
TOTAL	6,265.84	3,937.28	437.02

(a) 1976 Fiscal Year Transition Quarter
NOTE: Table may not add exactly due to rounding.

TABLE 59. Net Annual REA Loans Outstanding (Millions of 1978 Dollars Per Year)(7)

Year	Total REA Loans Granted for the Electric Program	Total Payments to Principal on REA Loans	Total Principal Outstanding on REA Loans
1978	984.701	301.031	683.670
1977	913.943	219.550	694.393
TQ 1976	205.795	43.778	162.017
1975	848.497	187.373	661.123
1974	841.015	175.736	665.278
1973	907.684	191.198	716.486
1972	683.881	228.614	455.267
1971	583.272	224.477	358.794
1970	579.830	238.652	341.178
1969	614.018	241.519	372.499
1968	656.516	313.580	342.936
1967	503.241	311.027	192.213
1966	1,032.329	260.799	771.530
1965	781.955	284.703	501.252
1964	962.890	317.504	645.386
1963	726.872	314.748	412.124
1962	564.000	264.935	299.064
1961	598.948	221.706	377.242
1960	485.048	223.647	261.401
1959	396.997	224.863	172.134
1958	545.464	217.825	327.639
1957	696.918	194.488	502.430
1956	455.918	195.879	260.039
1955	387.926	173.248	214.677
1954	386.648	144.121	242.526
1953	346.865	204.784	229.284
1952	406.842	119.625	287.218
1951	557.274	92.282	464.993
1950	1,017.266	71.931	945.336
1949	1,228.971	62.267	1,166.704
1948	848.798	57.757	791.042
1947	734.588	40.118	694.470
1946	842.638	37.576	805.062
1945	239.920	38.935	200.985
1944	118.432	66.479	51.953
1943	26.005	39.311	-13.306
1942	365.164	10.581	354.584
1941	443.501	27.062	416.439
1940	193.797	11.918	181.879
1939	653.970	0.0	653.970
1938	135.510	0.0	135.510
1937	204.690	0.0	204.690
1936	65.518	0.0	65.518

TABLE 60. Total Net Cumulative Outstanding REA Loans for the Electric Program (Millions of 1978 Dollars)(7)

Year	Total Net Cumulative Outstanding REA Loans for the Electric Program	Weighted Average of Yields on Newly Issued Domestic Electric and Gas Utility Bonds (%)	Composite Interest Rates on Total Long Term Financing for All REA Electric Borrowers (%)	Estimated Cost of Incentives Provided by Low Interest REA Loans
1978	18,946.31	8.50	7.14	257.67
1977	18,262.64	8.50	7.14	248.37
TQ 1976	17,564.97	2.23	1.75	84.33
1976	17,405.89	8.92	6.86	358.57
1975	16,736.01	9.97	7.17	468.61
1974	16,074.63	9.59	7.02	413.12
1973	15,409.10	7.91	4.34	550.11
1972	14,692.34	7.50	3.65	565.65
1971	14,236.90	7.72	2.19	787.30
1970	13,877.95	8.79	2.00	942.31
1969	123,536.65	7.98	2.00	809.49
1968	13,164.01	6.80	2.00	631.88
1967	12,820.94	6.07	2.00	521.82
1966	12,628.65	5.53	2.00	445.79
1965	11,856.82	5.61	2.00	428.03
1964	11,355.38	4.55	2.00	289.56
1963	10,709.74	4.40	2.00	257.04
1962	10,297.46	4.40	2.00	247.14
1961	9,998.78	4.72	2.00	271.95
1960	9,620.89	4.72	2.00	261.69
1959	9,359.39	4.92	2.00	273.30
1958	9,187.19	4.18	2.00	200.28
1957	8,859.42	4.80	2.00	248.07
1956	8,356.80	3.86	2.00	155.43
1955	8,096.66	3.30	2.00	105.26
1954	7,881.90	3.11	2.00	87.48
1953	7,639.28	3.75	2.00	133.69
1952	7,409.91	3.36	2.00	100.77
1951	7,122.58	3.25	2.00	89.04
1950	6,657.40	2.86	2.00	57.25
1949	5,711.71	3.06	2.00	60.55
1948	4,544.55	3.07	2.00	48.63
1947	3,753.17	2.79	2.00	29.65
1946	3,058.46	2.74	2.00	22.63
1945	2,253.09	2.87	2.00	19.60
1944	2,052.03	2.97	2.67	6.16
1943	2,000.05	3.26	2.59	13.40
1942	2,013.37	3.35	2.48	17.51
1941	1,658.64	3.15	2.46	11.45
1940	1,242.05	3.09	2.69	4.96
1939	1,060.10	3.45	2.73	7.64
1938	405.88	3.49	2.88	2.48
1937	270.32	3.56	2.77	2.13
1936	65.55	3.56	3.00	0.37
TOTAL				9,571.94

TABLE 61. REA Administrative Funds Obligated to the Program (Millions of 1978 Dollars)(7)

Year	Administrative Funds Obligated	Year	Administrative Funds Obligated
1978	12.045	1955	10.341
1977	12.138	1954	10.940
1976(a)	3.152	1953	13.968
1976	12.441	1952	16.307
1975	11.923	1951	17.743
1974	11.644	1950	18.134
1973	11.462	1949	16.195
1972	13.584	1948	13.064
1971	13.170	1947	13.444
1970	13.258	1946	14.940
1969	13.288	1945	12.694
1968	13.180	1944	9.456
1967	12.985	1943	12.078
1966	12.894	1942	15.429
1965	13.129	1941	14.184
1964	12.454	1940	12.615
1963	11.377	1939	9.870
1962	11.472	1938	6.820
1961	10.779	1937	4.546
1960	10.394	1936	3.154
1959	10.639		
1958	10.251		
1957	9.900		
1956	10.440	TOTAL	524.344

(a) 1976 Fiscal Year Transition Quarter
* Estimated Data
NOTE: Table may not add exactly due to rounding.

description of these organizations and an analysis of their expenditures for transmission systems is presented in the hydro-energy chapter. The cumulative amount of loans outstanding at the end of 1978 was $6.2 billion (1978). These data are presented in the hydro-energy chapter in Table 28.

CONCLUSIONS

The directly quantifiable federal incentives to electricity distribution transmission and generation (excluding incentives already identified for hydro and nuclear energy) were found to be $64.5 or $51.4 billion 1978 dollars. The two costs represent two different viewpoints on how an incentive is defined. In either case these figures represent a conservative minimum estimate of the incentives to electricity. Most of the quantifiable incentives identified constitute market activity and taxation actions by the Federal Government. The total amount of federal money outstanding is designated as incentive definition number 1 and the interest rate incentive is designated as definition number 2. The results are summarized in Table 62.

TABLE 62. Federal Incentives Used to Stimulate the Development of Electric Energy (Millions of 1978 Dollars)

Incentive Area	Taxation	Traditional Services	Market Activity
Investment Tax Credits	4,370.8[a]		
Liberalized Depreciation	14,094.2		
Tax Exemption:			
- Federal Power	1,970.0[b]		
authorities	1,626.5		
- State Power Authorities and Municipal Utilities	8,215.9		
- Cooperatives	6,110.4		
Tax Free Bonds	2,441.3		
REA Loans			18,946.3(1)[c] 9,571.9(2)
REA Administration		524.3	
Electricity Transmission			6,224.7(1)[c,d] 2,447.1(2)
Subtotal	38,829.1	524.3	25,171.0(1) 12,019.0(2)
TOTAL	64,524.4(1) 51,372.4(2)		

(a) Current dollars.
(b) Included in hydro-energy chapter total and shown here only for completeness
(c) Definitions 1 and 2 represent different viewpoints and do not add or indicate a range.
(d) Transferred from the hydro-energy chapter.

REFERENCES - CHAPTER IX

1. Brannon, Gerald M., Energy Taxes and Subsidies, Energy Policy Project of the Ford Foundation, Ballinger, 1975.

2. Statistics of Privately Owned Electric Utilities in the U.S., Federal Power Commission, Government Printing Office, 1971, 1975, 1976, 1977, 1978.

3. Glassman, Gerald J. "Objections to Taking Liberalized Depreciation" Public Utilities Fortnightly, March 31, 1966, pp 34.

4. Historical Statistics of the Electric Utility Industry, Edison Electric Institute, New York, NY, 1971.

5. Statistical Year Book of the Electric Utility Industry, Edison Electric Institute, New York, NY, October 1977.

6. Moody's, A Nationwide Survey of Public Utility Progress, 1975, pp 22.

7. U.S. Department of Agriculture, Rural Electrification Administration, Report of the Administrator, years 1936 through 1977.

8. U.S. Department of Agriculture, Rural Electrification Administration, REA Loans and Loan Guarantees for Rural Electric and Telephone Service, October 1976.

9. In calculating this figure it has been assumed that the level of electricity supplied by the government sponsored utilities would not have changes even if they did have to pay Federal taxes. It is possible that the level of output may have been lower if the utilities had to pay the tax. The assumption was felt to be justified, however, due to the price inelasticity of demand for electricity.

X. CONCLUSIONS WITH RESPECT TO SOLAR ENERGY POLICY

Debate over solar energy's future role and its share in the national energy budget has caused policy makers to speculate on the reasons for the large difference between present and potential use of solar energy. With an understanding of the forces that have shaped the existing energy budget, policy makers may better guide the efficient exploitation of America's energy resources. The problem at hand is to identify the magnitude of the forces created by the Federal Government that have resulted in the increased energy production of coal, gas, oil, nuclear, and hydro power. With knowledge about what has been done to create incentives to increase production of traditional energy sources, policy makers can determine how to increase the share of solar energy used to generate electricity and heat and cool buildings.

THEORETICAL APPROACH

To identify incentives that resulted in the apparent secular supply curve for energy, we categorized government actions based on economic, political, institutional, and legal pressures. A typology was developed by considering economic, political, organizational and legal viewpoints. This typology resulted in the following eight categories:

1) Creation or prohibition of organizations that carry out actions.
2) Exemption from taxation, or reduction of existing taxes.
3) Collection of fees for the delivery of a governmental service or good not directly related to the cost of providing that good or service.
4) Disbursements in which the Federal Government distributes money without requiring anything in return.
5) Governmental requirements backed by criminal or civil sanction.
6) Traditional government services provided through a nongovernmental entity without direct change (i.e., regulating interstate and foreign commerce and providing inland waterways).
7) Nontraditional government services such as exploration, research, development and demonstration of new technology.

8) Market activity under conditions similar to those faced by nongovernmental producers or consumers.

Following the establishment of this typology, the problem became one of assigning values for expenditures or receipts foregone to each of these eight categories according to the five energy types. Two approaches were taken simultaneously. Specialists in the study of government and public institutions took a broad perspective in identifying and measuring incentives created throughout the energy sector of the economy. Engineers and micro-economists focused on incentives created along the trajectory of transformation from exploration and mining through transmission and waste disposal.

GENERIC INCENTIVES

The typology of federal actions developed in the theoretical framework was first applied broadly to identify incentives funded by federal institutions during fiscal year 1978. Forty-five organizational components spent an estimated $13.7 billion conducting energy related activities. Organizations that emphasized market activity spent 52% of all major federal energy-related expenditures. Exploration, research, development, and demonstration accounted for 38.5% expended by 12 organizations. Organizations whose primary action involves requirements backed by criminal and civil sanctions spent 5.5% of all energy-related expenditures. Only one organization was involved in altering the tax structure. The largest single energy program was the Department of Energy. Twenty-nine percent of the expenditures were directly related to incentives involving electricity, and most of this was for market activities. The remaining 71% was divided among six energy sources: nuclear, coal, solar, oil, other (primarily goethermal), and natural gas. The solar energy industry received 2.7% of the incentives directed specifically to energy producing industries in 1978.

NUCLEAR INCENTIVES

The national objective to create an economically viable nuclear energy source has been interrelated with matters of national security and foreign relations. Perhaps because of these interrelationships, over 80% of the cost of incentives was in the form of nontraditional services. These nontraditional services were primarily applied to knowledge acquisition in the area of the perceived potential for nuclear power. Creating incentives using nontraditional services gave the government firm control over specific factors of nuclear energy production that could have been contrary to the national interest, such as weapons development and environmental contamination.

Incentives for nuclear power are estimated to have cost the Federal Government $21.0 billion over the past 30 years. This is approximately 8.3% of the total estimated cost of all incentives useds to stimulate energy production.

The total costs of incentives to the nuclear industry do not take into account several nonquantifiable incentives. Neither the cost of the Price-Anderson Act (a legislative action which removed the liability insurance roadblock), nor the federal uranium policies are included because no way was found to quantify them.

HYDRO INCENTIVES

The Federal Government constructs, operates, and regulates hydroelectric facilities and markets electricity. Many major projects were originally funded by the government to improve navigational facilities, control floods, and develop water resources for agriculture, industry, and municipalities. Historically, hydroelectric power generation was a secondary consideration. As the former objectives have been largely accomplished, the primary justification for new dams has become power generation.

In the development of hydropower, the government has acted primarily as a market entity at each step of the production-consumption cycle, from ownership of the primary facilities of production through delivery to the consumer. Two alternative procedures were used in quantifying these incentives. First, return on investment from power revenues and costs of construction, operation, maintenance, management, and regulation of dams that could be allocated to power development were calculated. Second, the subsidies provided by the low interest rates of federal appropriations and the exemption of power revenues from income taxes were calculated on the basis of the differences between federal and private industry costs. Using the first definition, it was estimated that the costs of incentives were $16.9 billion for hydroelectric generation. With the second definition, it was estimated that the costs of the incentives were $8.9 billion for production. Hydro power has received 6.7% of the total estimated cost of incentives used to stimulate energy production.

COAL INCENTIVES

More energy has been produced from coal than any other energy source. Loss of the steam locomotive and space heating market produced a decline in the industry that was slowed and then reversed by the rapid growth of the electricity generation market. Only recently has production reached the level of a generation ago. Presently, 74% of U.S. coal production that is not exported is used by utility companies for power generation. Industrial production accounts for the use of 24% and the remaining 2% is consumed by household or commercial enterprises.

The depletion allowance, which amounted to $4.7 billion between 1950 and 1978, has been the single largest incentive to increased coal production. Traditional services, including facilities to aid the water-borne movement of coal, amounted to $2.6 billion between 1950 and 1978. The nontraditional services of research, exploration, development, and safety accounted for $3.6 billion of incentives.

Though much of the energy produced in the U.S. over the last 25 years came from coal, the estimated costs of incentives used to stimulate coal production were lower than those for the four other energy sources. An estimated $11.7 billion has been expended for incentives to the coal industry, or 4.6% of the total cost of incentives.

OIL INCENTIVES

Technical consideration necessitated dividing incentives to increase oil production into two categories: 1) *exploration and production* and 2) *refining* and distribution. Exploration and production included the search for and recovery of both crude oil and natural gas. Thus, incentives to the exploration and production of one of these energy sources acted as an incentive to the other. However, refining and distribution were limited to petroleum conversion.

Some of the largest incentives to the petroleum industry were the reduction of existing taxes through intangible drilling expensing and the percentage depletion allowance. These two incentives amounted to $55.5 billion. Another large category was requirements, in which the Federal Government makes demands which are backed up by criminal and civil sanctions. These requirements included stripper well price incentives, incentives for new oil, and requirements of the Economic Regulatory Administration. The estimated value of requirements through 1978 was $57.5 billion. Traditional services such as the maintenance of ports and waterways to handle oil tankers counted for $6.9 billion. Research and development and data from the Geological Survey and the Bureau of Mines accounted for $1.9 billion of incentives. Market activity and disbursements accounted for an insignificant percentage of the total cost of incentives to oil.

Among the six sources of energy analyzed, oil accounted for the highest cost of incentives. Forty-nine percent of the cost of incentives, or $123.6 billion, could be attributed to the production of oil.

NATURAL GAS INCENTIVES

Most of the incentives to the natural gas industry were in the form of exemptions or reductions of existing taxes. Intangible drilling expensing and the percentage depletion allowance accounted for $14.9 billion of the federal expenditure for incentives to natural gas. Requirements in the form of wellhead price controls was a disincentive to the natural gas industry of $0.8 billion. Nontraditional services which included data from the Bureau of Mines and the Geological Survey, and market activity accounted for $0.45 billion.

Between 1950 and 1977, incentives to the natural gas industry due to Federal Government actions were $14.6 billion. This was 5.8% of the cost of incentives to the six major energy sources.

ELECTRICITY INCENTIVES

The Rural Electrification Administration provides incentives to encourage public utility generation and transmission of electricity. During FY-1978 this organization spent $0.75 billion for 5.5% of the total energy-related outlays for FY-1978.

To estimate the value of incentives, the analysis distinguished between the investor owned private utilities and the government sponsored utilities. Emphasis was placed on public utilities since the distribution of electricity has traditionally been the principle concern of public utilities.

The same two alternative procedures used to estimate hydro incentives were applied to the calculation of electricity incentives. Using the first definition (federal investment money outstanding), it was estimated that the cost of incentives were $64.5 billion. With the second definition (interest rate incentive), the costs of incentives were estimated at $51.4 billion. Most of these incentives to electricity generation and transmission constitute market activity and taxation actions by the Federal Government.

The total cost of incentives for electricity was the second largest category, accounting for 25.6% of the total energy incentives provided by the Federal Government to the six major energy sources.

POSSIBLE SOLAR INCENTIVES

Following the indentification, quantification and analysis of federal incentives which have been used to stimulate energy production, each author identified one or more incentives that could effectively increase solar energy production.

Accelerated Depreciation

Currently, the Internal Revenue Service regulates the number of years over which certain items of equipment can be depreciated. Congress could direct the IRS to publish shorter-than-normal depreciation schedules for all forms of solar equipment. Shorter schedules would mean that more depreciation expense can be deducted in each year, and businesses would pay less tax if they were using solar equipment. This incentive would be somewhat analogous to the oil incentive that allows oil companies to deduct all the intangible expenses conducted with an oil well as they occur, rather than spreading expenses over the projected life of the well. The cost of this incentive would be the reduction in the amount of taxes otherwise collected and is estimated to be $5 billion over the next 10 years.

Direct Subsidies

The Federal Government could pay specific institutions, such as schools, to install solar equipment. Because of the political activity of such institutions, this incentive could become fairly powerful. The estimated 10-year cost of the incentive is $1 to $5 billion.

Low Interest Loans

A major barrier to investment in solar heating and cooling systems is their high initial cost. The cost and availability of financing for installation of solar systems is important to the acceptance of solar energy for heating and cooling homes. Low interest loans could be made available to individuals or neighborhoods for individual or central solar collecting units and associated heating distribution systems. Low interest loan programs would reduce down payment requirements and lower monthly repayments to owners, providing the greatest benefit to low and middle income groups. The REA low interest loans provide a precedent for this policy. The estimated cost of this incentive would be $1 to $5 billion over the next 10 years.

Value-Added Tax

Currently, businesses deduct the cost of all fuels purchased in calculating their income tax. If each incremental dollar earned is taxed at 48% by the Federal Government, then effectively the government pays about half the cost of all fuel utilized. Conversely, the business that installs solar units realizes only 52¢ of each dollar as after-tax-profit. A value-added tax is assessed on the value added by production. It covers labor costs, interest, rents, indirect taxes and profits. It is calculated by substracting the cost of raw material, semi-finished inputs, utilities, depletion and appreciation from the return from sales. The tax rate is typically 10% to 15% of the value added. This means a dollar in fuel purchases saved would be 85¢ to 90¢ in retained value added. If depreciation were defined as part of the value added, a more detailed analysis would be required because of the capital-intensive nature of solar energy. Since the value-added tax has been termed a federal sales tax, there could be some controversy with respect to infringement on state's rights. Since the tax generally penalizes imports and rewards exports by not taxing exports, it could cause some disruption in the petroleum market.

Tax-Free Industrial Bonds

In an incentive analogous to the tax free bonds available for the purchase of pollution equipment, public and private organizations would be able to purchase solar equipment with the proceeds from the sale of tax-free industrial bonds issued by municipalities. This income is tax free and the principal must be used for specified purposes. It is estimated that the cost of this incentive would be $5 billion over the next 3 years.

Government Liability Insurance for Solar Technology

The Price-Anderson Act, under which the Federal Government agreed to indemnify and limit losses in the event of a catastrophic accident at a nuclear power plant, offers a precedent for a similar incentive for solar energy. One of the barriers to the adoption of solar technology is the economic risk and uncertainty associated with a new technology. The risks involved are not known due to the lack of actuarial data on solar equipment breakage, durability and maintenance. An insurance or indemnity incentive, whereby the Federal Government assumes the risk, could provide the assurance needed by specific solar energy technologies to enable them to penetrate the market. It is estimated that the cost of this incentive would be less than $1 billion over the next 10 years.

Special Gas Priorities

One of solar energy's perceived limitations is its interruptability due to cloud cover. An incentive could be created by allowing existing gas users who adopt solar energy to have higher priorities to receive limited supplies of gas during times of scarcity. The greatest problem with this incentive is policing, accounting, and verification.

Redirection of the Rural Electrification Administration

The Rural Electrification Administration could provide grants and low-interest loans for the construction of medium-scale solar thermal, electric, photovoltaic and wind energy conversion facilities. The operation and function of the REA could remain unchanged, but it would be directed to fund projects using solar resources. It is estimated that such an incentive would cost over $5 billion in 10 years.

Formation of a Solar TVA

A large government corporation could be created to produce energy and stimulate the economy of the southern "sunbelt" states. The Federal Government owns vast areas of arid land in New Mexico, Texas and Arizona which could be used for large solar thermal electric and/or photovoltaic facilities. It is estimated that this project would cost more than $10 billion over 10 years.

Federal Construction of Large Solar Facilities

Using this incentive, the National Aeronautics and Space Administration, U.S. Army Corps of Engineers, and Bureau of Reclamation could be commissioned to design, build and operate large solar projects such as land and ocean biomass, solar thermal electric, ocean thermal energy conversion and photovoltaic facilities. These projects could be funded by low interest loans. The power and products produced would be marketed by the existing Bonneville, Alaska, Southwest, and Southeast Power Administrations. This program would have a major effect on the current electric energy marketing infrastructure. It is estimated that this program would cost over $10 billion during a period of time to exceed the next 10 years.

Bonus for Innovative Uses of Solar Energy

This incentive program is patterned after the uranium prospecting bonus program of the 1940-1950s, in which prospectors who located significant uranium deposits received bonuses of $10,000. The bonus approach would be applied to a wide range of solar energy uses, including passive designs for homes, offices, commercial buildings, and factories and the use of solar water heating in building applications, housing developments and shopping centers. In addition, solar electric applications to reduce electric demand during peak power periods could also be included. The possibilities of the bonus approach for ingenuity and specific applications is almost endless. The amount of the bonus could vary with the application, and administration of the bonus system could be delegated to individual states. Each state could set up its own incentive program to meet its own energy situation and industrial base. Considerable public involvement could be structured into the program. The public education and public relations aspects of the program would be considerable. The moving force of this program could be expected to arise at the grass roots level, in part in response to the possibility of recognition and a bonus. The program could be administered throughout state and local political subdividions based on their own perceived energy needs. It is estimated that bonuses would range from $10,000 to $100,000. If each state awarded between 10 and 100 bonuses, the annual cost of the program would range between $1 million and $100 million per year.

Manhattan Project for Solar Energy

This incentive would be baseds on a perceived national need for the utilization of solar energy on a crash/large-scale basis. Regional entities fashioned after the TVA or existing regional utilities would be the recipient of federal funds for installing solar base energy systems on a large scale. The electricity would be marketed through existing distribution channels. This approach would severely impinge on the present structures for producing, financing and regulating electrical energy. The precedent for this approach is the Tennessee Valley Authority and the Bonneville Power Administration. The estimated cost is more than $10 billion over a period in excess of 10 years.

Power Plant Demonstration Program

This incentive would be patterned after the Atomic Energy Commission's Power Reactor Demonstration Program (PRDP). Utilities would build small, often first-of-a-kind collectors and the Federal Government would agree to assume certain costs and responsibilities over and above what an equivalent generating capacity would require. This incentive accomplishes several objectives. It would facilitate deployment of solar power plants, of interest to utilities. It would transfer technology to the user. It would give hands-on experience of solar plant development to the utilities. Utilities could be asked to submit proposals for installing solar systems in their grids. Cost differentials could be assumed by the Federal Government. Assuming 20 large capacity demonstration plants, the cost is estimated to be less than $1 billion within 10 years.

CONCLUSION

Since as early as 1918, the Federal Government has expended $252 billion for incentives to stimulate energy production. These expenditures are presented in Table 63 by energy source and incentive type. A precedent therefore exists for the Federal Government to spend or forego large sums to increase energy production. Insights useful in the development of solar policy can be drawn by considering the information in Table 63 against a background of technical, economic, legal, institutional and political interrelationships.

Considering the sums of the columns of Table 63 it can be seen that oil received the largest share of incentive funds. Possible reasons are 1) a large percentage of the population enters the oil market, at the gasoline pumps, each week; 2) oil has been commonly assumed to be difficult to find and in relatively limited supply; and 3) oil is perceived by the average citizen as necessary for a desirable lifestyle. The great value placed on oil by the public makes legislators sensitive to an assured supply.

The second largest share of federal incentives went to the promotion of electricity generation and transmission. Reasons for this expenditure may have been the desirability of an inexpensive and readily available source of power for the public. The Rural Electrification Administration was created to provide the financing necessary to develop an electrical distribution system for all areas of the country.

Coal received the smallest percentage of incentives. The reasons may be: 1) coal has supplied energy over the longest period of time; 2) it is thought

TABLE 63. An Estimate of the Cost Incentives Used to Stimulate Energy Production (in Billions of 1978 Dollars)

	Nuclear	Hydro	Coal	Oil	Gas	Electricity	Total	Percent of Total Incentives
Taxation		2.0	4.74	55.48	14.92	38.83	115.97	46.0
Disbursement			-	1.30	-		1.30	0.5
Requirements	1.7	0.04	0.80	57.49	-0.80		59.23	23.5
Traditional Services			2.57	6.92	-	0.52	10.01	4.0
Nontraditional Services	17.2		3.55	1.88	0.30		22.93	9.1
Market Activity	2.1	14.86[a]	0.02	0.50	0.15	25.17[a]	42.80	17.0
Totals	21.0	16.90	11.68	123.57	14.57	64.52	252.24	100
Percent of Total Incentives	8.3	6.7	4.6	49.0	5.8	25.6	100	

(a) This value based on incentive definition 1 (federal money outstanding). See respective chapters for a discussion of the alternative definition.

to be available in abundant quantities; and 3) coal is perceived as an inconvenient and dirty fuel. It therefore commands less political popularity.

Incentives for gas, nuclear, and hydro power have received intermediate amounts of funding. Production of gas is strongly related to the production of oil and the creation of incentives to increase oil production is correlated to that for gas. Incentives to the nuclear industry could result from 1) a strong puritan ethic which valued the making of something useful out of an investment conceived for destruction, and 2) a recognized need for new power sources. This was manifested as a dream of the future and articulated by the Joint Committee on Atomic Energy. The driving forces behind federal expenditures for hydropower were largely social, as part of the taming of a raw land with flood control, irrigation and recreational facilities.

Considering the sum of the rows of Table 63, it can be seen that 46% of the total cost of incentives could be categorized as the action of levying a tax or the exemption or reduction of an existing one. Taxation is relatively easy to administer, has an immediate financial impact on those affected, is flexible, and is expedient. Approximately 0.5% of the cost of incentives was in the form of disbursements for which the Federal Government received no direct or indirect good or service in return. Requirements, such as price controls accounted for 23.5% of the incentives. The Federal Government allocated 9.1% of the money expended to create incentives for energy production through nontraditional services such as exploration, research, development, and demonstration. Though popular in promise, nontraditional services are not as flexible as taxation and requirements. One reason for this is the limit to the size of the research community, which cannot be readily expanded. Seventeen percent of the total expenditure for incentives to increse energy production involved government market activities such as TVA. Traditional government services accounted for only 4% of the total. These, too, are inflexible.

Creation or prohibition or organizations, and collection of fees have not been emphasized as incentives to increase energy production. Such incentives are often unpopular. When they are potentially feasible, as in the case of creating the TVA, they must be acted upon quickly.

The analysis indicates two apparent rationales for incentives: 1) promotion of a new technology during its early stages, and 2) payment of the difference between the value of an activity to the private sector and its value to the public sector. The support of nuclear energy represents an example of the first justification. Examples of the second are rural electrification (REA), economic development (TVA), flood control (dams), and price controls (oil, gas, and coal). If solar policy were developoed according to these rationales, two-thirds of the action would focus on taxation and requirements. It would appear that these incentives should affect the technical elements of solar energy production for which consumers most often enter the marketplace.

During the course of the analysis, incentives were identified which did not have a quantifiable cost to the American taxpayer. Examples of these are the Price-Anderson liability indemnification for nuclear power, the Connally Hot Oil Act, the Interstate Oil Compact Commission, and the Natural Gas Act of 1938. An analysis of the results of such incentives in which the Federal Government assumes responsibility and risk could lend considerable insight to the formulation of a strategy for solar development.

In conclusion, a precedent exists for utilizing federal incentives to increase energy production. Design of national energy policy which considers the results of federal investment in incentives to increase energy production could be an efficient basis upon which to integrate current and impending technology, existing energy stocks, and consumer requirements and preferences. The conclusions of micro-economic solar energy feasibility studies could be inconsequential without a comprehensive understanding of the costs <u>and</u> results of incentives to increse energy production. This is so because of the disparity in rationale between the Federal Government and the private sector. The Federal Government need not predicate national policy on short term, micro-economic analysis. As confirmed by this study, federal justification is predicated on long-term goals met with the aid of new technology and supported by social values of the nation. If it is socially desirable and technologically feasible to increase solar energy's share in the national energy budget, the paramount policy question is one of selecting an incentive strategy and determining the government's level of investment in it.

APPENDIX A

TABLE OF CURRENT AND CONSTANT DOLLAR FACTORS

APPENDIX A

TABLE OF CURRENT AND CONSTANT DOLLAR FACTORS

From the time of the creation of the Tennessee Valley Authority and the National Recovery Administration minimum coal price schedules in 1933 to the present, the purchasing power of the dollar has decreased by more than 75%. A comparison of federal expenditures over time must be made in constant dollars. Table A-1 presents the consumer price index for urban wage earners and clerical workers and the factor used to adjust current dollar values to 1978 dollars.

TABLE A-1. Annual Average Consumer Price Index and Conversion Factor to 1978 Dollars

Year	CPI	1978 Factor
1913	29.7	6.579
1914	30.1	6.492
1915	30.4	6.428
1916	32.7	5.976
1917	38.4	5.089
1918	45.1	4.333
1919	51.8	3.772
1920	60.0	3.257
1921	53.6	3.646
1922	50.2	3.892
1923	51.1	3.824
1924	51.2	3.816
1925	52.5	3.722
1926	53.0	3.687
1927	52.0	3.758
1928	51.3	3.809
1929	51.3	3.809
1930	50.0	3.908
1931	45.6	4.285
1932	40.9	4.778
1933	38.8	5.036
1934	40.1	4.873
1935	41.1	4.754
1936	41.5	4.708
1937	43.0	4.544
1938	42.2	4.630
1939	41.6	4.697
1940	42.0	4.652
1941	44.1	4.431
1942	48.8	4.004
1943	51.8	3.772
1944	52.7	3.708
1945	53.9	3.625
1946	58.5	3.340
1947	66.9	2.921
1948	72.1	2.710
1949	71.4	2.737
1950	72.1	2.710
1951	77.8	2.512
1952	79.5	2.458

TABLE A-1. (contd)

Year	CPI	1978 Factor
1953	80.1	2.439
1954	80.5	2.427
1955	80.2	2.436
1956	81.4	2.400
1957	84.3	2.318
1958	86.6	2.256
1959	87.3	2.238
1960	88.7	2.203
1961	89.6	2.181
1962	90.6	2.157
1963	91.7	2.131
1964	92.9	2.103
1965	94.5	2.068
1966	97.2	2.010
1967	100.0	1.954
1968	104.2	1.875
1969	109.8	1.780
1970	116.3	1.680
1971	121.3	1.611
1972	125.3	1.559
1973	133.1	1.468
1974	147.7	1.323
1975	161.2	1.212
1976	170.5	1.146
1977	181.5	1.077
1978	195.4	1.000

APPENDIX B

DETAILS OF CHAPTER THREE SPENDING ESTIMATES

APPENDIX B

The following pages give details about the estimates of FY-1978 energy-related spending used in Chapter III. The discussions correspond to each row of Table 3 in Chapter III. Sources for material in this appendix are noted. The notation "Appendix, p. _____" referes to the Budget of the United States, 1980: Appendix. In cases where this source provided insufficient detail, the agency's research department was contacted by telephone. The name of the agency analyst providing data is given for these cases.

APPENDIX TO CHAPTER THREE

Row	Organization (Source)	Budget Lines Items (Energy Form)	FY 1978 Outlays (000's)
Row 1	Rural Electrification Administration (Appendix, p. 157)	Administration of Rural Electrification Program (Electricity)	12,314

The administrative budget pays for the cost of monitoring REA cooperative relations. The generation, transmission, and distribution cooperatives are the primary customers of REA. They supply and sell power primarily to those local communities organized into rural electric cooperatives. For every one REA affiliated cooperative, there are approximately ten investor-owned utilities nationally. Through the REA-cooperative arrangement, about 8 million meters (as of FY 1976) are supplied with electricity, representing 25 to 28 million people utilizing REA financed generation, transmission, or distribution facilities.

Row 2	REA Capital Investment (Appendix, p. 113)	Loans	736,306
		Guarantees	2,309,118
		TOTAL (Electricity)	3,045,424

Only the actual loan outlays are included in Table 3.

Row 3	Forest Service (Appendix, p. 207)	Total	26,256
		Minerals management	11,500
		Minerals leases and permits:	
		Forest lands	10,942
		Grass lands	3,814

Minerals leasing takes in several energy forms: coal, oil, natural gas, and geothermal. When breaking down expenditures to distinct energy forms, Forest Service officials told us to assume Forest Service expenses per energy form to be similar to those for the Bureau of Land Management. This process yields the following estimates:

Distribution by energy type:	
56% Oil	14,703
29% Natural gas	7,614
12% Coal	3,151
3% Other	788

Row 4	National Oceanic and Atmospheric Administration (Appendix, pp. 243-253)	Program development grants	16,566
		Program administration grants	9,110
		Energy impact formula grants	2,407

Within the objectives category of Program and Performance Justification Goals and Objectives, energy is one of three program areas. Energy-related objectives are "to provide grants to state and local governmental units to assist these units in responding to the development and production of Outer Continental Shelf (OCS) oil and gas along their coastal zones." Although no specific line item expenditure is shown for energy before FY-1977, energy-related activities were important to the coastal zone management program in FY-1976, FY-1977, and FY-1978. Since energy is one of several stated objectives, one-fifth of NOAA coastal zone management spending for line items cited above were considered as supporting energy-related activities. By our procedure for allocating per energy form by consumption (see Chapter III), we have FY-1978 obligations broken down as:

Percent energy-related (20%)	6,283
Distribution by consumption percentages	
Electricity	1,200
Coal	647
Oil	2,859
Natural gas	1,439
Nuclear	119
Other	19

Row 5	Maritime Administration (Appendix, pp. 260-266)	Ship construction subsidy: 156,657 x 0.5	78,329
		Lines and bulk carrier operating costs: 284,709 x 0.5	142,355
		Research and Development	
		Development of waterborne transport systems: 6,325	2,530
		Use of waterborne transport systems: 7,160	2,864
		13,485 x 0.4	
		Construction loan mortgage guarantees	110,453
		TOTAL, all oil	336,531

Total outlays were based on 50% of ship construction subsidy and bulk carrier operating subsidy, 40% of development of waterborne transportation systems and use of waterborne transportation systems, and all construction loan and mortgage guarantees for tankers and oil drilling and drill service. The 50% figure is the proportion of oil tankers to all bulk carriers receiving funds. The 40% is the proportion of oil-related waterborne traffic by weight to all waterborne traffic.

Row	Organization (Source)	Budget Lines Items (Energy Form)	FY 1978 Outlays (000's)
Row 6	National Bureau of Standards (Appendix, p. 254)	Scientific and technical research: 73,081 x 0.12	8,770

Energy represents about 12% of national income. Therefore, we have assumed that NBS activity related to energy will resemble the proportion of all energy expenditures to national income.

Distribution to energy types using consumption percentages:	
Electricity	1,675
Coal	903
Oil	3,990
Natural gas	2,008
Nuclear	167
Other	27

Row	Organization (Source)	Budget Lines Items (Energy Form)	FY 1978 Outlays (000's)
Row 7	Corp of Engineers (Appendix, pp. 347-360)	Navigation structures: 20,294 x 0.4 (Oil)	8,117
		Navigation, transportation and rehabilitation: 457,471 x 0.4 (Oil)	182,988
		Power construction (Electricity)	986,275
		Navigation operations: 614,622 x 0.4 (Oil)	245,849
		Power outlays (electricity)	152,137
		TOTAL FY 78 OUTLAYS	
		Oil	436,954
		Electricity	1,138,412
		TOTAL	1,575,366

Navigation projects aid in using waterways to transport energy (dredging harbors to accommodate oil supertankers) and, where they make waterways accessible to shipping, increased use of energy in the shipping industry. Multiple-purpose power projects are multiple-purpose Corps projects that include the installation of new or additional power sources (hydroelectric). Navigation projects would effect oil consumption. The multiple-purpose projects contribute to increased production of hydroelectric power. All navigation cited above benefits oil and all power projects are electricity. Our navigation amount is 40% of total expenses for navigation because oil is about 40% of waterborne trade.

Row	Organization (Source)	Budget Lines Items (Energy Form)	FY 1978 Outlays (000's)
Row 8	Atomic Energy Defense Activities, DOE (Appendix, p. 371)	FY 78 Outlays (Nuclear): 442,144 x 0.10	442

According to DNA sources, an estimate that 10% of this military R&D activity would have civilian application is difficult to substantiate but reasonable as a rough estimate. Some areas where results of military R&D could have civilian applications are: simulated electromagnetic radiation, radiation studies performed at the Radio-Biological Institute, DNA's experience with clean-up of radioactive waste, and other special applications of technology in the fusion area on a special request basis.

Row	Organization (Source)	Budget Lines Items (Energy Form)	FY 1978 Outlays (000's)
Row 9	National Institute for Environmental Health Studies (Appendix, p. 415)		

NIEH research activities are supported by direct appropriations under Section 301, 311, and 472 of the Public Health Service Act. NIEH appropriations for FY-1978 support research on potentially hazardous by-products associated with various energy technologies.

Distribution by energy form using consumption data:	
Electricity	10,519
Coal	5,673
Oil	25,060
Natural gas	12,613
Nuclear	1,046
Other	166
Total	55,077

Row	Organization (Source)	Budget Lines Items (Energy Form)	FY 1978 Outlays (000's)
Row 10	Housing and Community Research (R. C. Jones, HUD)	Solar demonstration projects	2,750
Row 11	Bureau of Land Management (Appendix, p. 537)	Energy and minerals management	81,880

The assumption for distribution to oil and gas is taken from our report, based on the 1978 ratio of oil, gas, nuclear, and other energy consumption.

Energy type shares:	
64.4% oil =	52,731
32.4% gas =	26,529
2.7% nuclear =	2,211
0.5% other =	409

Row	Organization (Source)	Budget Lines Items (Energy Form)	FY 1978 Outlays (000's)
Row 12	Bureau of Reclamation (Appendix, p. 547)	Loan program	27,753
		Construction and rehabilitation	324,151
		Operation and maintenance	86,295
		TOTAL (All Electricity)	438,199

APPENDIX TO CHAPTER THREE (contd)

Row	Organization (Source)	Budget Lines Items (Energy Form)	FY 1978 Outlays (000's)
Row 13	U.S. Geological Survey (Appendix, p. 582)	Alaska Pipeline investigation	237
		Mineral resource surveys	112,708
		Conservation of lands and minerals	69,431
		TOTAL	182,376

The assumption for distribution between oil and gas is taken from our previous report [PNL-2410], and is based on 1978 oil and gas consumption data.

Distribution shares: 2/3 Oil = $121,584; 1/3 Gas = $60,792

Row 14	Bureau of Mines (Appendix, p. 590)	Mining research	46,438
		Mining environmental research	6,416
		Mined land demonstrations	2,888
		Data collection and analysis	13,017
		Mineral land assessments	4,467
		TOTAL (All Coal)	73,219
Row 15	Office of Surface Mining	State regulatory program grants	2
		Federal regulatory program grants	2,706
		Mineral institutes	8
		Abandoned mines reclamation fund	2,245
		TOTAL (All Coal)	4,961
Row 16	Bureau of Indian Affairs (Appendix, pp. 600-1)	Minerals, mining, irrigation, and power	10,164
		Alaska Native Fund--power systems	10,048
		TOTAL (Electricity)	20,212
Row 17	Mining Health and Safety Administration (formerly Mine Enforcement and Safety Administration) (Appendix, p. 657)	Coal health and safety inspections (Coal)	24,936
		Metal and non-metal (% uranium from PNL-2410): 8,740 x 0.02 (Nuclear)	175
		Education and training: $ 4,091	
		Technical support: 6,067	
		Program administration: 1,976	
		$12,134	
		% of above for coal = 0.77	9,343
		% of above for nuclear = 0.05	607
			35,061

All of the assumptions for distribution of expenditures by energy form are the same as those used in our previous report [PNL-2410]. The PNL-2410 assumptions are based on MESA's (MSHA's predecessor agency) FY-1978 Budget Justification.

		TOTAL: Coal	34,279
		Nuclear	782
			35,061
Row 18	Alaska Power Administration (Appendix, p. 387)	Entire agency (Electricity)	2,110
Row 19	Bonneville Power Administration (Appendix, p. 388)	Entire agency (Electricity)	149,232
Row 20	Southwestern Power Administration (Appendix, p. 389)	Entire agency (Electricity)	21,249
Row 21	Southeastern Power Administration (Appendix, p. 390)	Entire agency (Electricity)	5,572
Row 22	Occupational Health and Safety Administration (Appendix, p. 655)	Entire program: $150,714; Proportion energy-related from PNL-2410 = 0.8	120,571

Mining and transportation and public utilities are two industrial sectors reports in OSHA employment injury incidence rates. In 1974 and 1976, these two categories were the third highest in injuries per 100 full-time workers. A higher percentage than energy production's share of GNI [80% instead of 12%] was used to calculate energy-related spending. The average injury incidence rate was 9.1; the actual rate in mining was 11.0, and in transportation and public utilities, 9.4.

Distribution to energy type by consumptions shares:	
Electricity	23,029
Coal	12,419
Oil	54,860
Natural gas	27,611
Nuclear	2,291
Other	361

Row	Organization (Source)	Budget Lines Items (Energy Form)	FY 1978 Outlays (000's)
Row 23	Employment Standards Administration (Appendix, p. 665)	Black Lung Disability Trust Fund, payments for disabled miners (Coal)	112,678
Row 24	Justice-Legal Activities (Appendix, p. 618)	Legal opinions: $1,349,000	
		% energy-related from PNL-2410 x 0.2	270
		Land, natural resources, and Indian matters: $8,811	
		% energy-related equals 0.12	1,057
		TOTAL	1,327

The general litigation division spends about 20% of personnel time on energy-related matters. Included in these expenditures are attorney's time, secretarial assistance, travel expenses, and expenses for hiring expert witnesses. Energy-related spending amounted to $1,372,000 in 1977 and paid for cases, for example, related to coal strip mining, offshore development of oil resources, and oil shale on federal lands. In addition, the allocation for legal activities related to "land, natural resources, and Indian matters" were included at 12% of total, based upon the level of energy-related activities in the economy as a whole. Land, natural resources, and Indian affairs were then divided by energy consumption levels.

		Distribution by energy forms using consumption shares:	
		Electricity	253
		Coal	137
		Oil	604
		Natural gas	304
		Nuclear	25
		Other	4
Row 25	Justice-Antitrust Division (Appendix, p. 620)	Total Budget: $42,175,000	
		% of energy-related equals 0.12	5,061

The total antitrust budget equals $42,175. Energy accounts for 12% of the economy, so we used 12% of the antitrust budget. We allocated this estimate by our standard energy consumption figures.

		Distribution by energy forms using FEA consumption shares:	
		Electricity	967
		Coal	521
		Oil	2,303
		Natural Gas	1,159
		Nuclear	96
		Other	15
Row 26	Department of Transportation		

Non-Highway Systems, Fuels and Lubricants, Operational Improvements, Highway Activities--these budget categories are no longer listed. The functions or line items listed in PNL-2410 are now listed under the following DOT budget categories.

	Research and Special Programs	Research and development (pipeline safety, inter- and multi-modal systems)	153
	Consolidated Working Fund, Transportation Systems Center (Appendix, pp. 888, 741)	Responsible for R&D or increased efficiency, improved safety, lessened environmental impacts, minimizing adverse impact of energy constraints	54,445
	Offshore Oil Compensation Fund (Appendix, pp. 698, 741, 742)		0
		TOTAL (All Oil)	54,598
Row 27	Internal Revenue Service (Appendix, p. 771)	Compliance: $728,051	
		% energy-related = 0.12	87,420

For total figures, we took 12% of the IRS budget on compliance, because energy accounts for about 12% of the U.S. economy. Only IRS spending for compliance was used, because these expenditures are mostly directed at proper use of tax liability provisions. We allocated IRS expenditures by energy consumption.

		Distribution by energy forms using consumption figures:	
		Electricity	18,697
		Coal	9,004
		Oil	35,776
		Natural gas	20,019
		Nuclear	1,661
		Other	263
Row 28	Department of Energy (Appendix, pp. 369-386)	General science and research operations (Nuclear)	
		Life sciences: $41,292 x 0.62	25,601
		High energy physics: $186, 360 x 0.62	22,363
		Nuclear physics: $66,240 x 0.62	41,068
		General science and research capital (Nuclear)	
		Life sciences: $ 1,985	
		High energy physics: 68,807	
		Nuclear physics: 12,274	
		$83,066 x 0.62	51,501

Because weapons research was 38% of the allocated ERDA budget, we took 62% of the following categories: life sciences research and biomedical; high energy physics, and nuclear physics.

Row	Organization (Source)	Budget Lines Items (Energy Form)			FY 1978 Outlays (000's)
	Department of Energy, continued	Energy supply R&D	Ops.	Capital	
		Solar applications	101,700	2,200	103,900
		Solar technology	173,660	6,464	180,124
		Biomass and other	15,290	10	15,300
		Nuclear fission	892,386	198,581	1,090,967
		Magnetic fusion	194,496	79,830	274,326
		Geothermal	79,615	1,136	80,751
		Hydropower	8,329	-	8,329
		Environmental	224,333	21,849	246,182
		Supporting research	147,547	17,400	164,947
		Multi-sector	66,175	3,862	70,037
	Uranium enrichment		793,078	475,754	1,268,832
	Fossil energy R&D	Coal	552,959	2,835	555,794
		Petroleum	71,954	-	71,954
		Gas	20,407	-	20,407
	Energy production, demonstration, and distribution	Coal			447
		Oil Shale			492
		Oil and gas			58
		Solar			21,630
		Multi-resource			42
	Conservation				221,758
		Petroleum reserves			234,325
		EIA			46,486
		ERA			78,894
		FERC, regulation of: Hydro			7,584
		Multi-resource			8,310
		Gas			19,293
		Oil			3,064
	Geothermal resources development fund				401

DOE DISTRIBUTION TOTALS

		Percent	Specific Budget Items	Multisector Budget Allocated as Percent of Specific Energy Forms
Electricity		0.342	13,873	16,736
	Coal	13.712	556,281	670,871
	Oil	7.628	309,343	373,164
	Natural gas	0.978	39,700	47,857
	Nuclear	67.415	2,734,658	3,298,827
	Solar	7.534	305,644	368,662
	Other	2.386	96,944	116,899
Total, specific		100.000	4,056,403	
Multisector			836,712	
TOTAL			4,893,115	4,893,115

Row	Organization (Source)	Budget Lines Items (Energy Form)	FY 1978 Outlays (000's)
Row 29	Council on Environmental Quality (Appendix, p. 68)	Environmental policy development and program evaluation: $2,854 % energy-related = 0.36	1,027

Lacking specific data, we assumed that CEQ expenditures on energy would be in proportion to EPA spending on energy relative to total EPA research and development spending, or $117,824 divided by $327,246 = 0.36.

Distribution to energy forms by consumption data:	
Electricity	195
Coal	106
Oil	467
Natural gas	236
Nuclear	20
Other	3

Row	Organization (Source)	Budget Lines Items (Energy Form)	FY 1978 Outlays (000's)
Row 30	Office of Management and Budget (Appendix, p. 77)	Natural resources, energy, and science: $3,227 % for energy = 0.72	2,320

The percentage for energy was calculated as the federal energy function outlays divided by federal natural resources and sciences function outlays: 1980 Budget, Part 1, pp. 115, 127.

Electricity	443
Coal	239
Oil	1,036
Natural gas	531
Nuclear	64
Other	7

APPENDIX TO CHAPTER THREE (contd)

Row	Organization (Source)	Budget Lines Items (Energy Form)	FY 1978 Outlays (000's)
Row 31	Appalachian Regional Development Program	All (Coal)	1,428
Row 32	Environmental Protection Agency (re K. Pettit, Budget Operations Office)	Energy	112,824
		Distribution to energy forms by consumption percentages:	
		Electricity	21,549
		Coal	11,621
		Oil	51,334
		Natural gas	25,837
		Nuclear	2,144
		Other	339
Row 33	National Aeronautics and Space Administration (Appendix, p. 819)	Energy technology applications	145,377
		Distribution to energy sources by consumption percentages:	
		Electricity	27,767
		Coal	14,974
		Oil	66,147
		Natural gas	33,291
		Nuclear	2,762
		Other	436
Row 34	Small Business Administration (Appendix, p. 378)	Energy loan program--no expenditures during FY-1978	0
Row 35	National Transportation Safety Board (Appendix, p. 948)	Policy and support: 1,756 Accident investigations: 7,594 Administrative law judges: 620	
		Proportion energy-related from PNL-2410:	
		Policy and support = 0.26	492
		Accident investigation = 1/6	1,257
		Administrative law judges = 1/6	103
	TOTALS		1,852

This is one-sixth of the total expense for three safety board activities since "evaluation safeguards involved in the transportation of hazardous material" is one of six broad mandates. Oil, natural gas, and nuclear are the three energy forms considered hazardous materials in transport.

Approximately 72% of the Board's active program involves aviation. Therefore, we assume 72% of policy and support involves aviation. We took the remainder of policy and support plus 1/6 of other two items to get total energy-related spending.

		Distribution to energy forms from PNL-2410:	
		Oil = 0.61	1,129
		Natural gas = 0.35	648
		Nuclear = 0.04	75
Row 36	Smithsonian SSIE (Appendix, p. 987-8)	All: $2,435 Proportion energy-related = 0.2	487

Total energy-related spending is 20% of total budget, allocated evenly because of the extent of cross-effects in basic research. This 20% figure is derived from several broad topics of special interest to SSIE, one of which is energy.

		Distribution to energy sources by consumption percentages:	
		Electricity	93
		Coal	50
		Oil	222
		Natural gas	112
		Nuclear	9
		Other	1
Row 37	Nuclear Regulatory Commission (Appendix, pp. 950-951)	All (Nuclear)	287,699
Row 38	Federal Trade Commission	Maintaining competition--consumer protection: 53,507 x 0.12	6,420

Lacking more specific information, we assumed that FTC's energy related spending would be in proportion to energy's contribution to GNP; i.e., 12% of FTC's total budget for maintaining competition and consumer protection.

		Distribution to energy types by consumption percentages:	
		Electricity	1,226
		Coal	661
		Oil	2,921
		Natural gas	1,470
		Nuclear	122
		Other	20

Row	Organization (Source)	Budget Lines Items (Energy Form)	FY 1978 Outlays (000's)
Row 39	Interstate Commerce Commission (Appendix, p. 927)	All: $69,722	

These are ICC energy-related program activities. It is possible to estimate their share of the entire ICC FY-1977 outlay as approximately 3% or $2,060,501. Energy forms affected by ICC activities are coal and oil. Unfortunately, there is no way to allocate ICC budget by these energy forms based on actual ICC resources spent per energy form. Our guesses are:

		Proportion energy-related = 0.03	2,001
		Coal = 95%	1,900
		Oil = 5%	101
Row 40	Securities and Exchange Commission (Appendix, p. 973)	Public utility holding company regulation (Electricity)	747
Row 41	Tennessee Valley Authority (Appendix, pp. 1000-1003)	Operating costs	
		National Energy Demonstration Program: $4,286	
		Power Program: Power Supply and Use: 2,014,115	
		Total $2,018,401	
		One half of these operating costs were distributed to energy types using percentage of electrical generation provided by the energy types (calculated from TVA Annual Report Schedule C, p. 1); the remaining one half of the costs were attributed to electricity.	
		Hydro = 0.176	177,619
		Coal = 0.664	670,109
		Nuclear = 0.135	136,242
		Natural gas = 0.025	25,230
		Total 1.000	1,009,200
		Electricity	1,009,201
		Capital Cost	
		Power Program: Power Supply and Use: $1,848,180 (Nuclear)	
		TVA Totals:	
		Electricity	1,186,820
		Coal	670,109
		Natural gas	25,230
		Nuclear	1,984,422
		Total	3,866,581
Row 42	Joint Federal-State Land Use Planning Commission for Alaska (Appendix, pp. 991-2)	All	622

Expenditures were split 90% for oil and 10% for gas because gas pipeline activity is still in the planning stages.

		Distribution to energy sources from PNL-2410:	
		Oil = 0.9	560
		Natural gas = 0.1	62
Row 43	Office of Technology Assessment (Appendix, pp. 48-9)	Total budget: $8,204 x 0.12	984

Lacking more specific data, we assumed that OTA's energy-related activities would be in proportion to energy's contribution to GNP; i.e, 12% of OTA's total budget is assumed to be energy-related.

		Distribution to energy type using consumption percentages:	
		Electricity	188
		Coal	101
		Oil	448
		Natural gas	225
		Nuclear	19
		Other	3
Row 44	Congressional Budget Office (RE: CBO analyst K. Weiss)	Five staff persons at $40,000 per year	200
		Distribution to energy type using consumption percentages:	
		Electricity	38
		Coal	21
		Oil	91
		Natural gas	46
		Nuclear	4
		Other	0

Row 45	General Accounting Office (Appendix, p. 42)	Energy and Minerals Division	5,738
		Distribution by energy type using consumption percentages:	
		Electricity	1,098
		Coal	581
		Oil	2,612
		Natural gas	1,314
		Nuclear	109
		Other	17

Organizations Merged into DOE

Petroleum Reserves: The Naval Petroleum Reserves were transferred to the Department of Energy by P.L. 95-91 and Executive Order 12009 effective October 1, 1977. In addition, exploration and development of an Alaskan petroleum reserve is underway and a strategic petroleum reserve program has been established. Total outlays for all of these programs are reported below in DOE section.

Defense Power Administration: Emergency preparedness--part of DOE Budget Line Item "Energy Information, Policy, and Regulation."

General Services Administration: No energy activities listed.

National Science Foundation: Energy activities dismantled and responsibility shifted to ERDA, now DOE.

Federal Energy Administration

Federal Power Commission

Energy Research and Development Administration

APPENDIX C

DATA USED TO QUANTIFY FEDERAL LOW INTEREST RATE AND INCOME TAX INCENTIVES

APPENDIX C

This appendix contains a listing of the interest rates charged by the Federal Government on the appropriations allocated to hydro-energy development. The yearly gross operating revenues received by the federal power marketing agencies are also tabulated.

BONNEVILLE POWER ADMINISTRATION

Rates of interest applied to the unamortized federal investment for each generating project and for each year's investment in the transmission system, as shown below, have been set either by law, by administrative order pursuant to law, or by administrative policies. The rates have not necessarily been designed to recover the interest costs to the U.S. Treasury to finance the investment.

GENERATING PROJECTS

	%		%
Albeni Falls	2-1/2	John Day	2-1/2
Boise	3	Libby	3-1/8
Bonneville	2-1/2	Little Goose	2-1/2
Bonneville Second Power House and Peaking Modifications	3-1/4	Lookout Point-Dexter	2-1/2
		Lost Creek	3-1/8
Chief Joseph	2-1/2	Lower Granite	2-1/2
Chief Joseph Additional Units	3-1/4	Lower Monumental	2-1/2
Columbia Basin	3	McNary	2-1/2
Columbia Basin Third Power Plant	3-1/8	Minidoka	3
Cougar	2-1/2	Palisades	3
Detroit-Big Cliff	2-1/2	Teton	3.342
Dworshak	2-5/8	The Dalles	2-1/2
Green Peter-Foster	2-1/2	The Dalles Additional Units	3-1/8
Hills Creek	2-1/2	Yakima - Rosa Division	3
Hungry Horse	3	Yakima - Kennewick Division	2-1/2
Ice Harbor	2-1/2		

TRANSMISSION FACILITIES

Through Fiscal Year 1963	2-1/2
Fiscal Year 1964	2-7/8
Fiscal Year 1965	3
Fiscal Years 1966 through 1968	3-1/8
Fiscal Years 1969 and 1970	3-1/4
Fiscal Year 1971	4-7/8
Fiscal Year 1972	5-3/8
Fiscal Year 1973	5-7/8

SOUTHWESTERN POWER ADMINISTRATION

An interest rate of 2-1/2% is applied to the unpaid federal investment for the majority of the Corps hydroelectric projects. The projects which use a higher rate than 2-1/2% are as follows: Broken Bow, DeGray and Stockton - 2-5/8%, Harry S. Truman - 3%, and Clarence Cannon - 3-1/8%. Interest rates applied to the unpaid federal investment by SPA in transmission facilities are as follows:

Fiscal Year	%
Through 1963	2-1/2
1964	2-7/8
1965	3
1966 through 1968	3-1/8
1969 - 1970	3-1/4
1971	4-7/8
1972	5-3/8
1973	5-7/8
1974	5-1/2
1975	5-5/8

SOUTHEASTERN POWER ADMINISTRATION

An interest rate of 2.5% was used for all interest computations made for projects in operation as of June 30, 1969. A rate of 2.625% was used for both J. Percy Priest and Millers Ferry projects which became operational during fiscal year 1970, and for Cordell Hull in fiscal year 1974. The interest rates applicable to the projects under construction as of June 30, 1974, are as follows:

Carters	2-5/8%	Laurel River	3%
Jones Bluff	2-5/8%	West Point	3%

The interest rates have been set by law or by administrative policies pursuant to law. They have not necessarily been designed to recover the interest costs to the U.S. Treasury to finance the investment.

ALASKA POWER ADMINISTRATION

Authorizing legislation for Snettisham and Eklutna Projects requires that 3% and 2-1/2% interest rates, respectively, be applied to the net investment of the U.S. Government. This legislation does not permit modification of the interest rate to reflect the actual cost to the U.S. Treasury at the time of construction.

TENNESSEE VALLEY AUTHORITY

Section 15d and the TVA Act authorizes TVA to issue bonds, notes, and other evidences of indebtedness up to a total of $15 billion outstanding at any one time to assist to financing its power program. Debt service on these obligations, which is payable solely from TVA's net power proceeds, has precedence over the payment to the U.S. Treasury. Issues outstanding on June 30, 1978, consist of the following:

Long-Term Debt %					(Thousands)
4.40	1960	Series A,	due	November 15, 1985	$ 50,000
4-5/8	1961	Series A,	due	July 1, 1986	50,000
4-1/2	1962	Series A,	due	February 1, 1987	45,000
5.70	1967	Series A,	due	May 15, 1992	70,000
6-3/8	1967	Series B,	due	November 1, 1992	60,000
8-1/4	1969	Series B,	due	October 15, 1994	100,000
9	1970	Series A,	due	March 15, 1995	100,000
9-1/4	1970	Series B,	due	June 15, 1995	50,000
7.30	1971	Series B,	due	October 1, 1996	150,000
7	1972	Series A,	due	January 1, 1996	150,000
7.35	1972	Series B,	due	May 1, 1997	150,000
7.35	1972	Series C,	due	July 1, 1997	150,000
7.40	1972	Series D,	due	October 1, 1997	150,000
7.35	1973	Series A,	due	January 1, 1998	100,000
7.35	1973	Series B,	due	April 1, 1998	150,000
7-3/4	1973	Series C,	due	July 1, 1998	150,000
7.70	1973	Series D,	due	October 1, 1998	100,000
8.05	1974	Series A,	due	January 1, 1999	100,000
8.10	1974	Series B,	due	April 1, 1979	100,000
8.50	1974	Series C,	due	October 31, 1979 (FFB)	300,000
8.05	1975	Series A,	due	January 31, 1990 (FFB)	200,000
8.70	1975	Series B,	due	March 31, 2000 (FFB)	100,000
8.35	1975	Series C,	due	May 31, 1988 (FFB)	200,000
8.47	1975	Series D,	due	July 31, 2000 (FFB)	200,000
8.485	1975	Series E,	due	October 31, 2000 (FFB)	300,000
8.175	1976	Series A,	due	February 28, 2001 (FFB)	300,000
7.97	1976	Series B,	due	November 30, 2001 (FFB)	400,000
7.625	1976	Series C,	due	January 31, 2002 (FFB)	200,000
7.975	1977	Series A,	due	February 28, 2002 (FFB)	300,000
7.935	1977	Series B,	due	May 31, 2002 (FFB)	400,000
8.0	1977	Series C,	due	October 31, 2002 (FFB)	400,000
8.375	1978	Series A,	due	January 31, 2003 (FFB)	400,000
	TOTAL LONG-TERM DEBT				5,425,000

Short-Term Debt	
U.S. Treasury	150,000
Federal Financing Bank (FFB)	1,520,000
Long-Term Debt Due April 1, 1979	100,000
TOTAL SHORT-TERM DEBT	1,770,000
TOTAL DEBT	$7,195,000

These interest rates did not apply when the dams were built. The interest rates on the hydro projects were on the order of 1.875% and 3%.

BUREAU OF RECLAMATION

The current interest rate to be applied to unpaid balances for all new project replacements and additions, except as otherwise provided by law, is the rate determined as of the first fiscal year in which funds are first appropriated to initiate construction with such investments. Such interest rate is determined each fiscal year in accordance with Departmental Manual, Part 730.3, and reflects the current cost of money to the U.S. Treasury. This reflection of current cost of money more nearly approaches actual cost.

Fiscal Year	%
Through 1969	3
1970	4-7/8
1971	5-3/8
1972	5-7/8
1973	5-1/2
1974	5-5/8
1975	6-1/8

Some completed projects have interest rates that do not correspond to these and further information is available in references 7 through 11.

TABLE C-1. Yearly Gross Operating Revenues Received by the Central Valley Project of the Bureau of Reclamation(7)

Year	Yearly Gross Operating Revenues (In Current Dollars)
1978	54,837,100
1977	54,837,100
TQ 1976	12,663,604[a]
1976	46,471,730
1975	37,378,380
1974	42,335,865
1973	32,816,122
1972	30,351,072
1971	28,204,300
1970	24,265,646
1969	25,019,856
1968	23,494,428
1967	22,575,615
1966	21,465,884
1965	20,451,194
1964	16,077,744
1963	13,053,937
1962	11,715,467
1961	11,749,648
1960	10,656,985
1959	11,887,770
1958	12,950,098
1957	11,278,231
1956	9,988,677
1955	8,352,119
1954	9,437,192
1953	8,825,170
1952	9,982,292
1951	10,530,461
1950	9,331,153
1949	7,312,574
1948	3,858,493
1947	3,530,897
1946	3,753,224
1945	1,918,386

(a) Estimate

TABLE C-2. Yearly Gross Operating Revenues Received by the Rio Grande Project of the Bureau of Reclamation[8]

Year	Yearly Gross Operating Revenues (In Current Dollars)
1978	1,390,921[a]
1977	1,390,921[a]
TQ 1976	337,251[a]
1976	1,307,088
1975	1,241,460
1974	1,111,792
1973	3,328,096
1972	681,918
1971	700,634
1970	687,024
1969	709,845
1968	673,380
1967	718,752
1966	641,391
1965	342,991
1964	327,907
1963	433,279
1962	479,675
1961	467,912
1960	547,058
1959	637,238
1958	560,340
1957	477,575
1956	612,886
1955	736,070
1954	959,280
1953	1,041,617
1952	778,005
1951	509,289
1950	493,580
1949	478,532
1948	363,460
1947	403,531
1946	450,177
1945	419,215
1944	490,727
1943	464,914
1942	377,950
1941	356,772

(a) Estimate

TABLE C-3. Yearly Gross Operating Revenues Received by the Parker-Davis Project of the Bureau of Reclamation[9]

Year	Yearly Gross Operating Revenues (In Current Dollars)
1978	10,135,000[a]
1977	10,135,000[a]
TQ 1976	2,476,000[a]
1976	9,674,000
1975	9,930,000
1974	9,749,000
1973	7,715,000
1972	7,718,000
1971	7,555,000
1970	7,609,000
1969	7,434,000
1968	7,468,000
1967	7,399,000
1966	7,208,000
1965	7,160,000
1964	7,401,000
1963	6,802,000
1962	6,172,000
1961	6,524,000
1960	6,623,000
1959	7,103,000
1958	7,688,000
1957	5,784,000
1956	6,033,000
1955	6,941,000
1954	6,487,000
1953	6,429,000
1952	6,098,000
1951	2,564,000
1950	2,468,000
1949	2,978,000
1948	3,058,000
1947	1,819,000
1946	1,797,000
1945	2,039,000
1944	2,018,000
1943	438,000

(a) Estimate

TABLE C-4. Yearly Gross Operating Revenues Received by the Colorado River Storage Project of the Bureau of Reclamation[10]

Year	Yearly Gross Operating Revenues (In Current Dollars)
1978	46,500,000[a]
1977	46,500,000[a]
TQ 1976	11,300,000[a]
1976	43,489,000
1975	43,225,000
1974	41,386,000
1973	37,755,000
1972	32,906,000
1971	30,029,000
1970	26,939,000
1969	21,851,000
1968	20,549,000
1967	15,937,000
1966	12,405,000
1965	6,809,000
1964	502,000

(a) Estimate

TABLE C-5. Yearly Gross Operating Revenues Received by the Pick-Sloan Missouri Basin Program of the Bureau of Reclamation[11]

Year	Yearly Gross Operating Revenues (In Current Dollars)
1978	84,912,000[a]
1977	84,912,000
TQ 1976	22,121,000
1976	92,052,640
1975	87,883,360
1974	84,752,905
1973	75,926,400
1972	81,476,861
1971	75,286,588
1970	67,757,201
1969	60,471,540
1968	56,163,293
1967	48,934,452
1966	45,555,123
1965	38,498,293
1964	33,945,191
1963	29,903,437
1962	27,283,525
1961	25,237,450
1960	22,263,696
1959	21,686,893
1958	21,383,943
1957	18,605,674
1956	14,583,175
1955	11,464,055
1954	8,201,212
1953	6,404,964
1952	2,371,956
1951	1,403,546
1950	4,032,802

(a) Estimate

TABLE C-6. Yearly Gross Operating Revenues Received by the Alaska Power Administration

Year	Yearly Gross Operating Revenues (In Current Dollars)
1978	3,010,516
1977	2,869,263
TQ 1976	1,580,885
1976	1,163,309
1975	1,660,097
1974	919,902
1973	1,355,254
1972	1,506,222
1971	1,207,613
1970	1,470,968
1969	1,575,060
1968	1,715,504
1967	1,654,771
1966	1,389,022
1965	1,734,278
1964	1,384,952
1963	1,470,626
1962	1,748,146
1961	1,774,203
1960	1,680,362
1959	1,648,364
1958	1,585,594
1957	1,405,713
1956	1,238,737
1955	285,089

TABLE C-7. Yearly Gross Operating Revenues Received by the Southwestern Power Administration

Year	Yearly Gross Operating Revenues (In Current Dollars)
1978	50,123,612
1977	51,029,254
TQ 1976	13,131,000
1976	64,864,120
1975	60,157,097
1974	54,454,162
1973	41,721,200
1972	41,761,285
1971	40,307,019
1970	34,510,980
1969	35,126,930
1968	32,782,240
1967	29,134,658
1966	27,390,400
1965	21,383,570
1964	18,520,997
1963	18,099,494
1962	16,092,842
1961	14,833,860
1960	15,013,104
1959	14,533,902
1958	13,335,325
1957	8,757,608
1956	8,169,043
1955	4,076,634
1954	5,042,484
1953	2,830,020
1952	2,630,689
1951	2,279,759
1950	2,036,941
1949	1,661,134
1948	1,361,529
1947	1,456,219
1946	1,254,989
1945	635,485
1944	8,510

TABLE C-8. Estimation of the Yearly Hydroelectric Energy Sales Revenue Received by the Tennessee Valley Authority

Year	Total Hydroelectric Energy Generation (Megawatt-hours)	Total Electricty (Megawatt-hours)	Total Sales Electricity (Millions of Current Dollars)	Estimated Sales of Hydroelectricity (Millions of Current Dollars)
1978	20,694,134	117,369,780	2,312.308	407.696
1977	14,318,000	134,356,900	1,966.700	209.600
TQ 1976	3,744,600	31,323,800	483.100	57.800
1976	19,196,749	108,718,451	1,670.934	295.042
1975	22,960,116	106,433,186	1,155.567	249.174
1974	23,536,367	106,144,729	863.643	191.503
1973	24,457,795	103,472,613	729.031	172.321
1972	21,292,572	92,090,406	622.591	145.531
1971	17,282,409	90,647,648	579.322	110.450
1970	16,539,659	90,722,358	461.478	84.132
1969	14,987,958	86,373,931	388.100	67.344
1968	20,833,209	84,720,109	371.667	91.395
1967	17,742,106	82,086,648	348.767	75.382
1966	14,139,513	77,106,323	324.589	59.523
1965	18,802,143	69,960,826	294.084	75.149
1964	16,832,311	68,449,814	284.468	69.953
1963	16,326,752	63,817,908	266.972	68.300
1962	20,454,628	60,321,174	250.457	84.929
1961	16,890,223	60,101,242	246.837	69.368
1960	17,458,764	59,342,582	240.650	70.800
1959	14,998,194	57,163,470	236.197	61.972
1958	19,319,189	56,717,714	232.217	79.096
1957	16,730,713	57,038,606	234.872	68.893
1956	14,411,512	53,845,388	220.903	59.124
1955	13,719,163	42,044,954	187.361	61.135
1954	12,815,444	30,058,772	133.370	56.840
1953	13,933,290	23,678,681	104.285	61.365
1952	15,394,493	20,177,163	94.467	72.075
1951	15,567,941	16,522,037	69.826	65.794
1950	16,521,642	14,165,592	57.259	57.259
1949	13,285,649	13,614,194	57.619	56.229
1948	11,618,704	12,244,859	48.435	45.958
1947	13,667,126	11,587,386	43.811	43.811
1946	11,997,324	9,058,797	34.908	34.908
1945	10,188,553	10,314,746	38.959	38.482
1944	8,424,935	9,110,371	35.200	32.552
1943	7,944,451	8,336,066	31.514	29.655
1942	4,332,501	5,983,369	25.214	18.215
1941	4,523,714	4,974,066	21.052	19.146
1940	3,214,149	3,629,678	15.210	13.469
1939	1,731,147	1,618,287	5.445	5.445
1933-1938	2,365,849	2,379,572	6.645	6.607
TOTAL	605,075,691	2,156,723,195	15,795.984	3,647.4

TABLE C-9. Yearly Gross Operating Revenues Received by the Bonneville Power Administration

Year	Yearly Gross Operating Revenues (In Current Dollars)
1978	267,473,836
1977	223,592,000
TQ 1976	75,508,000
1976	292,222,000
1975	234,417,000
1974	182,053,000
1973	174,494,000
1972	172,950,000
1971	152,728,000
1970	144,769,000
1969	134,318,000
1968	114,675,000
1967	110,164,000
1966	100,461,000
1965	87,285,000
1964	82,851,000
1963	77,704,000
1962	74,483,000
1961	69,702,000
1960	70,998,000
1959	68,474,000
1958	66,575,000
1957	66,271,000
1956	60,834,000
1955	51,978,000
1954	45,217,000
1953	38,949,000
1952	40,180,000
1951	36,189,000
1950	31,198,000
1949	27,821,000
1948	24,514,000
1947	21,891,000
1946	19,884,000
1945	22,990,000
1944	20,893,000
1943	11,265,000
1942	1,983,000
1941	1,874,000
1940	805,000

TABLE C-10. Yearly Gross Operating Revenues Received by the Southeastern Power Administration

Year	Yearly Gross Operating Revenues (In Current Dollars)
1978	53,926,000
1977	43,339,000
TQ 1976	10,949,000
1976	47,907,957
1975	43,390,043
1974	41,365,020
1973	40,054,858
1972	37,852,084
1971	34,239,264
1970	26,166,442
1969	24,406,271
1968	31,709,992
1967	29,325,588
1966	24,725,688
1965	27,456,737
1964	24,699,532
1963	22,559,269
1962	23,211,812
1961	19,711,260
1960	20,650,669
1959	14,863,864
1958	19,006,632
1957	13,644,212
1956	11,444,558
1955	9,783,105
1954	7,931,023
1953	4,948,589
1952	5,276,936
1951	2,458,470
1950	1,033,881
1949	295,000

APPENDIX D

DEFINITION OF HYDRO-ENERGY INCENTIVES AND DESCRIPTION OF PROCEDURES USED TO CALCULATE THE MONETARY VALUE OF THE INCENTIVES

APPENDIX D

DEFINITIONS

The following definitions of incentive were used for this project:

1. The portion of the net investment in construction and operation of the dam allocated to power development and exemption from federal income taxes.
2. Low interest rates on federal appropriations and the exemption from federal income taxes.

The basic arguments for and against using definition #1 are as follows:

Arguments for definition 1:

- It is the total net amount of money that the Federal Government has spent developing hydropower.
- If federal funding had not been available, the construction of most of these projects would have been set back 10 to 30 years waiting for private industry.

Arguments against definition 1:

- The federal funds are being repaid with interest and therefore are not an incentive.

In order to answer this dilemma, definition #2 was created. Definition #2 attempts to determine what the difference in cost of developing hydro-energy would have been if it had been done by the private sector instead of the Federal Government.

Three other definitions were considered and rejected.

3. Federal expenditures to encourage private development of hydroelectric facilities

This definition was rejected becuse the only federal interaction with privately-owned dams is regulation by the Federal Power Commission. Also, the cost of this regulation must be repaid by the owners of the dams.

4. The gross on net investment in the construction and operation of dams

This definition is deficient because it would include money spent for other purposes (flood control, navigation, fish ladders, etc.) and would account for the return on investment.

5. The portion of the gross investment in construction and operation of the dam allocated to power development

This definition was rejected because it does not account for the return on the investment.

CALCULATION PROCEDURES FOR DETERMINING NET INVESTMENTS IN HYDRO-ENERGY FACILITIES

This section describes the method used to estimate the missing data.

The data in Table D-1 were obtained by manipulating the information in the financial statements of the BPA's Annual Reports. The net federal investment in generation and transmission combined is found in the "Statement of Assets and Liabilities" under the "Proprietary Capital" heading. The split between transmission and generation money was made using data from the "Amount and Allocation of Plant Investment" schedule. The dollar amount allocated to transmission facilities in the "Total Commercial Power' column was divided by the total of that column and multiplied by the net federal investment to obtain the net federal investment in transmission. The federal investment in generation was obtained by subtracting the transmission dollars from the total.

The data in Table D-11 were calculated using the data in Table D-1. The calculation was made in the following manner: the Net Federal Investment in Hydroelectric Generation or Transmission per Year of Year N = The Net Cumulative Investment of Year N - the Net Cumulative Investment of Year N-1. The net federal investment hydroelectric generation and transmission per year is then multiplied by the proper index to represent the money in 1978 dollars. The breakdown of dollars per year between 1937 and 1945 was not known, so the following approximation was used. The net cumulative investment in 1945 was divided by the number of years between 1937 and 1945 and then multiplied by the 1978 dollar index for each year.

Similar methods were used to estimate the dollars per year figures for the other administrations but there were some differences. The BPA was the only one that required an approximate split between generation and transmission. The TVA data is in the form of net assets and not net investment.

ALTERNATIVE CALCULATION PROCEDURES CONSIDERED TO CALCULATE THE FEDERAL INCENTIVES TO HYDROPOWER DEVELOPMENT

This section presents several alternate calculation procedures for determining the federal incentives to hydropower development provided by low interest federal appropriations and exemption from federal income taxes.

The cumulative net federal investment (C_t) can be obtained by summing up the net federal investment in hydropower each year (A_t) from Table 28. Both A_t and C_t are in millions of 1978 dollars. These values (A_t and C_t) are a summation of the four following cash flows:

- Investment inflow in the form of federal appropriations.
- Revenue from power sales.
- Repayment of principal and interest.
- Operation and Maintenance expenses.

This assumes that the cumulative net federal investment (C_t) is essentially the outstanding unpaid balance. The interest subsidy is then calculated by multiplying the difference in the federal and private interest rates by C_t and summing over t. The resulting subsidy figure is only current to 1978, that is, it doesn't consider the difference in future interest payments on money obtained prior to 1978. It is in other words an estimate of the subsidy to date.

This can be written:

$$U_1 = \sum_{t=1933}^{1978} \left[C_t \, i'_t - C_t \, i_t\right]$$

where

U_1 = The total subsidy provided to hydropower development by the low interest federal appropriations.

C_t = The cumulative net federal investment in hydropower from inception to year t. in \$$10^6$ 1978.

i'_t = The weighted average cost of capital in the private utility sector in year t.

i_t = The federal interest rate in year t. in %

$_t$ = Subscript time indicator.

A second method treats the net federal investment each year (A_t) as a new loan taken out that year. It is assumed that the loans will be repaid with equal period payments for n periods. The appropriations must be repaid within 50 years. However, the federal agencies usually repay the higher interest loans within 25 years. It is assumed that n is 40 years. The subsidy is then calculated by the formula given previously. The resulting subsidy figure includes the future interest subsidy on all funds through 1978.

This can be written:

$$P_t = A_t \left[\frac{i_t \left(1 + i_t\right)^n}{\left(1 + i_t\right)^n - 1}\right]$$

$$P'_t = A_t \left[\frac{i'_t \left(1 + i'_t\right)^n}{\left(1 + i'_t\right)^n - 1}\right]$$

Total payment on year t's loan in $n P_t$

$$U_2 = \sum_{t=1933}^{1978} n(P'_t - P_t)$$

where

P_t or P'_t = The end of period payment in a uniform series continuing for the coming n periods, the entire series equal to A_t at interest rate i_t or i'_t.

A_t = The net federal investment in hydropower in year t. in $\$10^6$ 1978/year.

n = The number of interest periods.

The third method uses the total yearly revenues of all federal hydropower marketing agencies (R_t) and the average percentage of private utility revenues that went to federal income tax (E_t). The formula is not a straight percentage because the tax would have to be supported by larger revenues. Therefore the total yearly revenues (R_t) are treated as that which is left over after taxes. This subsidy figure is current to September 30, 1978. The subsidy and R_t are in current dollars and the 1978 dollar factor (F_t) corrects them to 1978 dollars.

This can be written:

$$X = \sum_{t=1937}^{1978} \frac{E_t \cdot R_t \cdot F_t}{1 - E_t}$$

where

F_t = The 1978 dollar factor (from Appendix A)

R_t = The total yearly gross operating revenues collected from inception to September 30, 1978 by federal agencies (in 10^6 current dollars).

E_t = The average percentage of revenues that utilities have paid in Federal taxes each year from 1937 to 1978 (in %).

The fourth method uses the total cumulative federal hydroelectric generation (M), the 1933 to 1978 average cost per kWh that private utilities charged ($\overline{D}$) and the total cumulative federal revenues (R). The reasoning for this calculation is as follows: The only basic differences between private utilities and the federal power marketing agencies are that the private utilities pay federal taxes, have a higher cost of capital and use more thermal-electric generating plants. If you assume that the federal taxes and higher cost of capital have a much greater effect than the fact that the private plants are mostly thermal-electric instead of hydroelectric then the difference between the revenue charged by the government and the revenue that would have been charged by the private utilities in a fair estimate of the subsidy to hydropower.

This can be written:

$$X_4 + U_4 = M \overline{D} - R$$

where

M = the total cumulative federal hydroelectric energy production from inception to September 30, 1978, in kWh

$\overline{D}$ = the average revenue per kilowatt hour that private utilities have charged from 1933 to 1978.

APPENDIX E

NET FEDERAL INVESTMENTS IN HYDRO-ENERGY FACILITIES: DATA AND RESULTS

APPENDIX E

In this appendix. Tables E-1 through E-10 contain the data used to estimate the net federal investment in hydro-energy; Tables E-11 through E-16 present the results obtained when the missing number calculation (from Appendix D) and dollar conversion factors were applied to this data.

TABLE E-1. Cumulative Net Federal Investment in the Federal Columbia River Power System Hydroelectric Generation and Electricity Transmission Facilities[a]

Fiscal Year 1978	Hydroelectric Generation $\$10^5$	Electricity Transmission $\$10^5$
1978	37,616.4	17,314.4
1977	34,905.7	16,069.4
TQ 1976	32,793.4	15,503.2
1976	32,295.4	15,267.8
1975	30,564.3	14,408.4
1974	28,356.7	13,391.9
1973	26,359.6	12,527.1
1972	24,419.8	11,605.1
1971	21,894.6	10,594.0
1970	19,860.7	9,782.1
1969	18,660.8	8,961.2
1968	17,001.1	7,970.5
1967	15,457.6	6,795.6
1966	14,197.6	5,884.6
1965	12,752.6	5,282.6
1964	12,617.0	4,942.8
1963	12,145.9	4,614.1
1962	10,647.0	4.369.2
1961	9,825.7	4.161.1
1960	9,749.7	4,110.6
1959	9,362.3	4,414.1
1958	9,366.5	4.202.7
1957	9.303.1	3,980.6
1956	7,864.0	3,338.9
1955	6,518.6	3,269.0
1954	5,943.4	3,058.8
1953	3,045.2	2,739.6
1952	2,228.5	1,880.0
1951	2,120.5	1,563.8
1950	2,207.8	1,222.0
1949	2,047.4	1,035.2
1948	1,897.4	839.5
1947	1,807.8	795.2
1946	1,796.7	732.8
1945	1,787.1	756.1

(a) Current Dollars - no adjustment has been made for inflation.

TABLE E-2. Cumulative Net Federal Investment in the Completed Hydroelectric Generation and Electricity Transmission Facilities of the Southwestern Federal Power System[a]

Fiscal Year 1978	Hydroelectric Generation Facilities in $\$10^5$	Electricity[b] Transmission Facilities in $\$10^5$
1978	6,721.8	617.4
1977	6,101.1	613.4
TQ 1976	6,091.1	608.6
1976	6,089.6	609.0
1975	6,078.5	587.2
1974	6,066.7	586.8
1973	5,390.7	571.2
1972	5,038.5	561.2
1971	4,376.0	514.7
1970	4,260.7	513.7
1969	4,125.0	461.9
1968	4,114.0	422.0
1967	3,789.9	414.6
1966	3,753.2	349.8
1965	3,333.3	343.0
1964	2,474.9	309.3

(a) Current Dollars - no adjustment has been made for inflation.

(b) The electricity transmission facilities of the Southwestern Federal Power System are used solely to transmit the power generated by the power system's hydroelectric facilities.

TABLE E-3. Cumulative Net Federal Investment in the Southeastern Federal Power Program Hydroelectric Generation Facilities[a]

Fiscal Year 1978	Net Federal Investment in Generation Facilities $\$10^5$
1978	7,729.0
1977	7,303.0
TQ 1976	6,673.8
1976	6,922.7[b]
1975	7,669.4
1974	7,526.5
1973	7,276.9
1972	6,816.4
1971	6,605.4
1970	6,283.3
1969	6,119.0
1968	5,940.0
1967	5,773.2
1966	5,578.8

(a) Current Dollars - no adjustment has been made for inflation.
(b) Estimate.

TABLE E-4. Data From Which the Estimates of the Net Federal Investment per Year in the Alaska Federal Power Program Were Made[a]

Fiscal Year	Cumulative Net Investment in the Snettisham Project $\$10^5$	Cumulative Net Investment in the Eklutna Project $\$10^5$
1977	814.4	205.9
TQ 1976	795.9	212.7
1976	790.0	212.3
1975		222.0
1974		221.9
1973		221.7
1972	(Start up)	225.1
1971		230.3
1970		231.8
1969		235.2
1968		242.1
1967		248.5
1966		263.1
1965		257.1
1964		262.4
1963		265.9
1962	(Construction begun)	274.3
1961		282.9
1960		285.5
1959		290.7
1958		294.9
1957		298.9
1956		301.8
1955		Start up 302.6
1954		
1953		
1952		
1951		
1950		(Construction begun)

(a) These data have not been corrected for inflation.

TABLE E-5. Cumulative Net Assets of the Tennessee Valley Authority Hydroelectric Generation and Electricity Transmission Facilities[a]

Fiscal Year	Assets in Hydropower Plants ($\$10^5$)	Assets in Transmission Facilities ($\$10^5$)
1978	5,682.8	13,714.4
1977	5,670.7	34,450.8
TQ 1976	5,654.5	12,922.5
1976	5,560.4	12,790.4
1975	5,571.6	
1974	5,556.1	
1973	5,551.7	
1972	5,555.2	
1971	5,419.9	
1970	5,410.6	
1969	5,385.3	
1968	5,366.2	
1967	5,198.3	
1966	5,218.4	
1965	5,217.8	
1964	5,023.6	
1963	4,975.0	
1962	4,810.9	
1961	4,626.0	
1960	4,619.8	
1959	4,616.3	
1958	4,616.5	
1957	4,620.9	3,908.0
1956	4,617.3	3,653.0
1955	4,547.3	3,358.9
1954	3,800.2	2,566.8
1953	3,661.7	2,191.4
1952	3,345.1	1.750.2
1951	3,317.6	1,389.4
1950	3,168.2	1.270.3
1949	2,927.2	1,142.4
1948	2,849.1	973.4
1947	2,864.0	847.9

(a) Current Dollars - no adjustment has been made for inflation.

TABLE E-6. Cumulative Net Federal Investment in the Bureau of Reclamation's Upper Colorado Region that Must be Repaid with Commerical Power Revenues[a]

Fiscal Year 1978	Net Federal Investment In Generation and Transmission Facilities ($10^5)
1978	N/A
1977	4,351.5
TQ 1976	4,063.8
1976	3,956.3
1975	4,076.9
1974	4,201.0
1973	4,280.1
1972	4,401.9
1971	4,482.2
1970	4,071.1
1969	4,118.2
1968	4,056.1
1967	3,628.4
1966	3,491.3
1965	2,486.2
1964	567.4

(a) Current Dollars - no adjustment has been made for inflation.

TABLE E-7. Cumulative Net Federal Investment in the Bureau of Reclamation's Lower Colorado Region that Must be Repaid with Commercial Power Revenues[a]

Fiscal Year 1978	Net Federal Investment In Generation and Transmission Facilities ($$10^6$)
1978	N/A
1977	555.7[b]
TQ 1976	576.3
1976	579.4
1975	599.1
1974	603.2
1973	625.7
1972	623.3
1971	635.9
1970	642.1
1969	628.1
1968	637.2
1967	652.6
1966	673.9
1965	685.4
1964	694.4
1963	722.3
1962	821.3
1961	865.9
1960	872.2
1959	884.1
1958	901.1
1957	919.0
1956	926.5
1955	909.9
1954	906.6
1953	888.9
1952	868.8
1951	845.8
1950	123.6
1949	97.6
1948	99.5
1947	92.2
1946	64.2
1945	69.2
1944	75.2
1943	81.4
1942	80.8

(a) Current Dollars - no adjustment has been made for inflation

(b) Estimate.

TABLE E-8. Cumulative Net Federal Investment in the Bureau of Reclamation's Upper and Lower Missouri Region that Must be Repaid with Commerical Power Revenues[a]

Fiscal Year 1978	Net Federal Investment In Generation and Transmission Facilities ($$10^5$)
1978	N/A
1977	7,301.0
TQ 1976	7,360.1
1976	7,359.0
1975	7,653.3
1974	7,914.7
1973	7,847.2
1972	8,067.7
1971	8,146.7
1970	8,287.2
1969	8,507.8
1968	8,599.5
1967	8,613.9
1966	8,273.8
1965	7,703.4
1964	6,973.6
1963	6,786.9
1962	5,773.4
1961	5,139.0
1960	4,215.0
1959	3,979.1
1958	3,965.8
1957	3,583.1
1956	3,402.3
1955	2,000.3
1954	1,110.3
1953	513.5
1952	283.9
1951	138.7
1950	54.7

(a) Current Dollars - no adjustment has been made for inflation.
(b) Estimate.

TABLE E-9. Cumulative Net Federal Investment in the Bureau of Reclamation's Central Valley Project that Must be Repaid with Commercial Power Revenues[(a)]

Fiscal Year 1978	Net Federal Investment In Generation and Transmission Facilities ($$10^5$)
1978	N/A
1977	762.2
TQ 1976	762.2
1976	762.2
1975	644.9
1974	421.8
1973	340.7
1972	143.9
1971	176.6
1970	213.3
1969	583.3
1968	699.8
1967	1,217.5
1966	1,401.4
1965	1,577.5
1964	1,766.6
1963	1,308.2
1962	413.3
1961	548.1
1960	499.2
1959	542.2
1958	602.5
1957	676.9
1956	733.3
1955	441.9
1954	341.4
1953	365.6
1952	400.4
1951	305.5
1950	298.7
1949	197.7
1948	156.1
1947	94.1
1946	119.7
1945	145.2
1944	137.1

(a) Current Dollars - no adjustment has been made for inflation

TABLE E-10. Cumulative Net Federal Investment in the Bureau of Reclamation's Rio Grande Project that Must be Repaid with Commercial Power Revenues[a]

Fiscal Year 1978	Net Federal Investment In Generation and Transmission Facilities ($$10^5$)
1978	N/A
1977	104.6
TQ 1976	104.6
1976	104.6
1975	104.6
1974	104.6
1973	104.6
1972	104.6
1971	129.6
1970	117.5
1969	112.7
1968	109.4
1967	106.4
1966	103.9
1965	102.7
1964	99.3
1963	96.3
1962	104.7
1961	102.9
1060	106.6
1059	99.2
1958	98.1
1957	97.4
1956	90.7
1955	88.3
1954	78.3
1953	75.5
1952	63.7
1951	50.3
1950	46.2
1949	42.8
1948	36.0
1947	33.5
1946	31.3
1945	30.1
1944	31.7
1943	33.2
1942	35.3
1941	32.7
1940	28.3

(a) Current Dollars - no adjustment has been made for inflation

TABLE E-11. Net Federal Investment in the Federal Columbia River Power System Hydroelectric Generation and Electricity Transmission Facilities per Year (in Million 1978 Dollars)

Year	Hydroelectric Generation	Electricity Transmission
1978	271.07	124.50
1977	227.34	60.92
TQ 1976	57.07	26.98
1976	198.37	98.49
1975	267.60	123.21
1974	264.12	113.56
1973	285.34	135.35
1972	393.78	157.66
1971	327.73	130.78
1970	201.59	137.93
1969	295.37	176.30
1968	289.43	220.32
1967	246.09	178.01
1966	290.48	121.02
1965	28.05	70.26
1964	99.08	69.14
1963	319.40	94.82
1962	177.10	44.88
1961	16.57	11.01
1960	85.37	-66.86
1959	-0.96	47.32
1958	14.33	50.11
1957	333.55	148.74
1956	322.95	16.78
1955	140.11	51.29
1954	703.46	77.48
1953	199.22	209.68
1952	26.54	77.74
1951	-19.92	85.02
1950	43.47	50.62
1949	41.05	53.55
1948	24.31	11.98
1947	3.24	18.26
1946	3.21	-7.82
1945	71.99[a]	30.45
1944	73.63[a]	31.15
1943	74.91[a]	31.69
1942	79.52[a]	33.64
1941	87.99[a]	37.22
1940	92.39[a]	39.08
1939	93.28[a]	39.46
1938	91.96[a]	38.90
1937	90.25[a]	38.17
TOTAL	6,660.29	3,114.20

(a) Estimated data; see Appendix D.

TABLE E-12. Net Federal Investment in the Southwestern Federal Power System Hydroelectric Generation and Electricity Transmission Facilities per Year (in Million 1978 Dollars)

Year	Hydroelectric Generation	Electricity Transmission
1978	0.33	0.40
1977	1.08	0.58
TQ 1976	0.17	-0.05
1976	38.46[a]	--
1975	1.43	0.05
1974	89.43	2.06
1973	51.76	1.47
1972	103.31	7.25
1971	18.58	0.16
1970	22.79	8.70
1969	1.96	7.11
1968	60.77	1.39
1967	7.17	12.66
1966	84.41	1.36
1965	177.49	6.97
1964	23.66	2.97
1963	23.97	3.00
1962	24.26	3.04
1961	24.54	3.07
1960	24.79	3.11
1959	25.18	3.15
1958	25.35	3.19
1957	26.07	3.27
1956	27.00	3.38
1955	27.41	3.44
1954	27.31	3.43
1953	27.45	3.44
1952	27.65	3.46
1951	28.26	3.54
1950	30.48	3.82
1949	30.78	3.86
1948	30.48	3.82
1947	32.86	4.11
1946	37.58	4.71
1945	40.79	5.11
1944	41.71	5.23
1943	42.44	5.32
TOTAL	1,309.22	144.01

(a) Estimated data; see Appendix D.

TABLE E-13. Net Federal Investment in the Southeastern Federal Power Program Hydroelectric Generation Facilities per Year (in Million 1978 Dollars)

Year	Hydroelectric Generation
1978	42.60
1977	67.71
TQ 1976	-28.52
1976	-79.53
1975	17.32
1974	33.02
1973	67.60
1972	32.90
1971	51.89
1970	27.61
1969	31.86
1968	31.27
1967	37.99
1966	48.77[a]
1965	50.16
1964	51.03[a]
1963	51.70[a]
1962	52.33[a]
1961	52.90[a]
1960	53.44[a]
1959	54.30[a]
1958	54.74[a]
1957	56.23[a]
1956	58.24[a]
1955	59.11[a]
1954	58.88[a]
1953	59.18[a]
1952	59.63[a]
1951	60.93[a]
1950	65.75[a]
1949	66.39[a]
1948	65.75[a]
1947	70.86[a]
1946	81.03[a]
1945	87.94[a]
1944	89.95[a]
TOTAL	1,771.47

(a) Estimated data; see Appendix D.

TABLE E-14. Net Federal Investment in the Alaska Power Administration Federal Power Program Hydroelectric Generation and Transmission Facilities Per Year (In Million 1978 Dollars)

Year	Hydroelectric Generation and Transmission Investment
1978	1.06
1977	1.26
TQ 1976	0.72
1976	4.93[a]
1975	5.25[a]
1974	6.99[a]
1973	7.23[a]
1972	7.40[a]
1971	8.24[a]
1970	8.27[a]
1969	8.15[a]
1968	8.68[a]
1967	7.44[a]
1966	11.79[a]
1965	9.79[a]
1964	10.34[a]
1963	9.43[a]
1962	9.50[a]
1961	-0.56
1960	-1.15
1959	-0.94
1958	-0.83
1957	-0.68
1956	-0.19
1955	12.29[a]
1954	12.24[a]
1953	12.31[a]
1952	-12.40[a]
1951	12.66[a]
1950	13.67[a]
TOTAL	172.89

(a) Estimated data; see Appendix D.

TABLE E-15. Net Federal Investment in the Tennessee Valley Authority Hydroelectric Generation and Electricity Transmission Facilities per Year (in Million 1978 Dollars)

Year	Hydroelectric Generation	Electricity Transmission
1978	1.21	26.36
1977	1.74	56.85
TQ 1976	0.01	15.14
1976	9.02	53.58[a]
1975	1.88	56.67[a]
1974	0.58	61.85[a]
1973	-0.52	68.63[a]
1972	21.10	72.90[a]
1971	1.50	75.30[a]
1970	4.25	78.55[a]
1969	4.55	83.19[a]
1968	31.48	87.67[a]
1967	-3.91	91.35[a]
1966	0.13	93.98[a]
1965	40.18	96.67[a]
1964	51.07	98.33[a]
1963	34.99	99.61[a]
1962	39.88	100.83[a]
1961	1.35	101.95[a]
1960	0.77	102.98[a]
1959	0	104.63[a]
1958	0.07	105.48[a]
1957	0.84	56.78
1956	16.80	70.57
1955	182.00	192.95
1954	33.61	91.27
1953	77.23	107.58
1952	6.78	88.72
1951	37.52	29.89
1950	65.31	34.69
1949	106.81	46.25
1948	21.17	33.88
1947	55.75[a]	16.50[a]
1946	63.76[a]	18.87[a]
1945	69.21[a]	20.48[a]
1944	70.78[a]	20.95[a]
1943	72.00[a]	21.32[a]
1942	76.44[a]	22.62[a]
1941	84.57[a]	25.03[a]
1940	88.82[a]	26.29[a]
1939	89.66[a]	26.54[a]
1938	88.39[a]	26.16[a]
1937	86.74[a]	25.67[a]
1936	89.88[a]	26.60[a]
1935	90.75[a]	26.86[a]
1934	93.02[a]	27.53[a]
1933	96.14[a]	28.46[a]
TOTAL	2,006.53	2,844.94

(a) Estimated data; see Appendix D.

TABLE E-16. Net Federal Investment/Year in the Hydroelectric Power Projects from Which the Bureau of Reclamation Markets the Power (in Million 1978 Dollars)

Year	Hydroelectric Generation and Transmission Investment
1978	22.38[a]
1977	22.38
TQ 1976	11.36
1976	-488.72
1975	20.19
1974	6.22
1973	-21.01
1972	-35.81
1971	38.65
1970	-103.98
1969	-27.05
1968	-21.90
1967	73.94
1966	292.72
1965	507.32
1964	249.72
1963	379.85
1962	102.40
1961	211.30
1960	40.18
1959	-14.06
1958	65.68
1957	28.64
1956	411.10
1955	244.58
1954	143.93
1953	55.33
1952	67.97
1951	205.27
1950	50.16
1949	12.73
1948	19.45
1947	1.36
1946	9.76
1945	0.13
1944	47.97
1943	0.57
1942	-33.43
1941	1.95
TOTAL	2,597.38

(a) Estimated

BIBLIOGRAPHY

BIBLIOGRAPHY

Department of the Treasury Staff Analysis of the Preliminary Federal Trade Commission, "Staff Report on Its Investigation of the Petroleum Industry", July 2, 1973, Serial No. 93-18 (92-53).

A Staff Analysis Prepared at the Request of Henry M. Jackson, Chairman, Committee on Interior and Insular Affairs, United States Senate, "Natural Gas Policy Issues and Options", Serial No. 93-20 (12-55), 1973.

Congressional Hearings, First Session on Enforcement Policies and Activities of the Federal Energy Administration, "FEA Enforcement Policies", Serial No. 94-21, 1975.

"Energy Conservation and Oil Policy Act of 1975 with Minority, Supplemental, and Additional Views".

U.S. Senate, "Energy Conservation and Conversion Act of 1975: Hearings Before the Committee on Finance", 1975.

Hearing Before the Subcommittee on National Parks and Recreation of the Committee on Interior and Insular Affairs, "To Prohibit Certain Incompatible Activities within Any Area of the National Park System", Serial No. 94-35, 1975.

House of Representatives Report No. 94-1428, "Providing for the Regulation of Mining Activity Within, and Repealing the Application of Mining Laws to Areas of the National Park System, and for Other Purposes", 1976.

Hearings Before the Subcommittee on Energy and Power of the Committee on Interstate and Foreign Commerce, House of Representatives, "Presidential Energy Program", Serial No. 94-20, 1975.

Prepared for the Subcommittee on Energy of the Committee on Science and Astronautics, U.S. House of Representatives, "Energy Policy and Resource Management", Serial R, 1974.

Oversight Hearings Before the Subcommittee on Mines and Mining of the Committee on Interior and Insular Affairs, House of Representatives, "Oversight on Federal Coal Leasing", Serial No. 94-53, 1976.

12, 13. Hearings Before the Committee on Interior and Insular Affairs, United States Senate, "Oil and Gas Imports Issues, Parts 1, 2, and 3", Serial No. 93-3 (92-38) 1973.

Hearings Before the Subcommittee on Antitrust and Monopoly of the Committee on the Judiciary, U.S. Senate, "Governmental Intervention in the Market Mechanism; the Petroleum Industry, Part 1, Economists' Views", 1969.

Printed at the Request of Henry M. Jackson, Chairman, Committee on Interior and Insular Affairs, U.S. Senate, "Presidential Energy Statements", Serial No. 93-23 (92-58), 1973.

Prepared by the Office of Economic Stabilization, Department of the Treasury, "Historical Working Papers on the Economic Stabilization Program, Part II, August 15, 1971 to April 30, 1974."

Report to the Congress by the Comptroller General of the United States, "An Evaluation of Proposed Federal Assistance for Financing Commercialization of Emerging Energy Technologies", 1976.

Report to the Congress by the Comptroller General of the United States, "Role of Federal Coal Resources in Meeting National Energy Goals Needs to be Determined and the Leasi g Process Improved", 1976.

The Mitre Corporation, "Legislation and Regulation of Utility Corridors and Power Plant Siting", February, 1975.

Department of the Interior, "Mining and Minerals Policy, Annual Report of the Secretary of the Interior Under the Mining and Mineral Policy Act of 1970", July, 1976.

Porter, S. P., "Petroleum Accounting Practices", McGraw Hill Book Company, 1965.

Murphy, John J., Ed., "Energy and Public Policy--1972", the Conference Board, Inc., New York, NY.

The American Petroleum Institute, "Energy, Profits, Supply, and Taxation", 1974.

Nelson, W. L., "Joint-Product Costing--Methods Accountants Suggest", The Oil and Gas Journal, May 5, 1975, p. 246.

Nelson, W. L., "Joint-Product Costing: 1973 Manufacturing Cost of Products", The Oil and Gas Journal, June 2, 1975, p. 123.

Nelson, W. L., "Joint-Product Costing--Calculating Value by Alternate Uses", The Oil and Gas Journal, June 23, 1975, p. 94.

Williamson, Harold F., Andreano, Ralph L., Daum, Arnold R., Klose, and Gilbert C., The American Petroleum Industry--The Age of Energy 1899-1959, Northwestern University Press, 1963.

Cameron, Virginia S., Ed., Volume 11, Exploration and Economics of the Petroleum Industry, Matthew Bender, NY, 1973.

Prepared for the Interdepartmental Energy Study by the Energy Study Group Under the Direction of Ali Bulent Cambel, "Energy R&D and National Progress", 1964.

United States Congress, Office of Technology Assessment, "An Analysis of the ERDA Plan and Program", October, 1975.

Deonigi, D. E., J. H. Broehl, T. J. Foley, and S. A. Rao, "Capital Requirements and Capital Formation for Various Assumed U.S. Energy Supply Patterns", A Battelle Energy Program Report, Research Completed January 15, 1975, Report Printed June, 1976.

Breslin, John J., and Richard J. Anderson, "Observations on the Surface Mining of Coal", A Battelle Energy Program Report, March 15, 1974.

Energy Research and Development Administration, Report to the Senate Committee on Public Works by the Comptroller General of the United States, May 5, 1976.

Department of Housing and Urban Development, Office of Community Planning and Development, "Rapid Growth from Energy Projects--Ideas for State and Local Action", 1976.

Federal Energy Administration, "National Energy Outlook", February, 1976.

U.S. Department of the Interior, Bonneville Power Administration, Annual Reports, 1945-1947, 1951-1952, 1955-1959, and 1961-1976.

U.S. Department of the Interior, Southwestern Power Administration, Annual Reports, 1973-1975.

U.S. Department of the Interior, Southwestern Power Administration, Annual Reports, 1970-1972, 1974.

U.S. Department of the Interior, Alaska Power Administration, Annual Reports, 1969-1970, 1973.

U.S. Department of the Interior, Alaska Power Administration, Alaska Electric Power Statistics 1960-1965, Fourth Edition, July, 1976.

Comptroller General of the United States General Accounting Office, Report to the Congress, Examination of Financial Statements of the Tennessee Valley Authority for Fiscal Years 1947, 1948 ... 1976.

U.S. Department of the Interior, Bureau of Reclamation, Federal Reclamation Projects, Water and Land Resource Accomplishments, 1976, Statistical Appendix II - Finances and Physical Features, Statistical Appendix III - Project Data.

Federal Power Commission, Statistics of Publicly Owned Electric Utilities in the United States, 1971, 1973, 1974.

Federal Power Commission, Hydroelectric Plant Construction Cost and Annual Production Expenses, 16th Annual Supplement, 1972.

A Policy Background Paper Prepared at the Request of Henry M. Jackson, Chairman, Committee on Interior and Insular Affairs, United States Senate, "Toward A Rational Policy for Oil and Gas Imports", Serial No. 92-34 (1973) 25 pp.

Prepared at the Request of Henry M. Jackson, Chairman, Committee on Interior and Insular Affairs, United States Senate, "Federal Charters for Energy Corporations--Selected Materials", Serial No. 93-37 (92-720((1974) 144 pp.

Hearing Before the Committee on Interior and Insular Affairs, United States Senate, "The National Coal Conversion Act and the National Crude Oil Refinery, Serial No. 93-27 (92-62) (December 10, 1973) 250 pp.

Hearing Before the Subcommittee on Energy of the Committee on Science and Astronautics, U.S. House of Representatives, No. 10 (May 15, 1973) 48 pp.

Hearings Before the Committee on Commerce, United States Senate, "Consumer Energy Act of 1974", Serial No. 93-63, Part 3 (1974) pp. 903-1353.

Hearings Before the Subcommittee on Public Lands of the Committee on Interior and Insular Affairs, House of Representatives, "Oil and Natural Gas Pipeline Rights-of-Way, Part I", Serial No. 93-12 (1973) pp. 577.

Hearings Before the Subcommittee on Public Lands of the Committee on Interior and Insular Affairs, House of Representatives, "Oil and Natural Gas Pipeline Rights-of-Way, Part II", Serial No. 93-12 (1973) pp. 579-1180.

Hearings Before the Subcommittee on Public Lands of the Committee on Interior and Insular Affairs, House of Representatives, "Oil and Natural Gas Pipeline Rights-of-Way, Part III", Serial No. 93-12 (1973) pp. 1181-1740.

Bosselman, Fred P., "The Control of Surface Mining: An Exercise in Creative Federalism", Natural Resources Journal, 9, (2), pp. 138-165, (1969).

Charles River Associates Incorporated, Report Prepared for the Appalachian Regional Commission, Washington, D.C., "The Economic Impact of Public Policy on the Appalachian Coal Industry and the Regional Economy, Volume II-Impact of Environmental and Other Policies on the Appalachian Coal Industry", (January, 1973), 495 pp.

Energy and the Need for Tax Incentives, Texaco Inc., New York (1972) 7 pp.

Breland, James E., "Cost Impact of the Federal Coal Mine Health and Safety Act of 1969", presented at the 1973 Fall Meeting of Society of Mining Engineers, Pittsburgh, Pennsylvania (September, 1973).

Ellison, Jr., Samuel P., Ed., Bureau of Economic Geology, The University of Texas at Austin, Austin, Texas, "Toward A National Policy on Energy Resources and Mineral Plant Foods," (1973) 128 pp.

National Science Foundation, Surveys of Science Resources Series, "An Analysis of Federal R&D Funding by Function", (1974) 69 pp.

Hearings Before the Subcommittee on Energy of the Committee on Finance, United States Senate, "Fiscal Policy and the Energy Crisis", Part 3 of 4, (1974) pp. 901-1329.

Hearings Before the Subcommittee on Energy of the Committee on Finance, United States Senate, "Fiscal Policy and the Energy Crisis", Part 4 of 4, (1974) pp. 1331-1896.

Prepared at the Request of Henry M. Jackson, Chairman, Committee on Interior and Insular Affairs, United States Senate, "An Analysis of the Federal Tax Treatment of Oil and Gas and Some Policy Alternatives", Serial No. 93-29 (92-64) (1974) 58 pp.

Hearings Before the Committee on Interior and Insular Affairs, United States Senate, "Coal Policy Issues", Part 1, Serial No. 93-12 (92-47), (1973) 700 pp.

Hearings Before the Committee on Interior and Insular Affairs, United States Senate, "Coal Policy Issues", Part 2, Serial No. 93-12 (92-47), (1973) pp 703-1272.

A Report Prepared for the Committee on Finance by the U.S. Tariff Commission, "World Oil Developments and U.S. Oil Import Policies", (1973) 146 pp.

Report by Senator Abraham Ribicoff to the Committee on Government Operations, United States Senate, Sam J. Ervin, Jr., Chairman, "Petropolitics and the American Energy Shortage", (1973) 13 pp.

Hearings Before the Committee on Interior and Insular Affairs, United States Senate, "Trends in Oil and Gas Exploration", Part 1, Serial No. 92-33, (1972) 540 pp.

Hearings Before the Committee on Interior and Insular Affairs, United States Senate, "Oversight--Mandatory Petroleum Allocation Programs", Part 1, Serial No. 93-35 (92-70), (1974) 197 pp.

Hearings Before the Committee on Interior and Insular Affairs, United States Senate, "Oversight--Mandatory Petroleum Allocation Programs", Appendix, Serial No. 93-35 (92-70), (1974) 194 pp.

Brannon, Gerard M., A Report to the Energy Policy Project of the Ford Foundation, Energy Taxes and Subsidies, Ballinger Publishing Company, Cambridge, Massachusetts, (1974) 174 pp. (2 copies available)

Hass, Jerome E., Edward J. Mitchell, Bernell K. Stone, assistance by David H. Downes, A Report to the Energy Policy Project of the Ford Foundation, Financing the Energy Industry, Ballinger Publishing Company, Cambridge, Massachusetts, (1974) 138 pp.

Hearings Before the Subcommittee on Administrative Practice and Procedure of the Committee on the Judiciary, United States Senate, "Federal Energy Administration: Enforcement of Petroleum Price Regulations", (1975) 324 pp. (FEA Policy on Natural Gas Liquids)

Report for the Use of the Committee on Interior and Insular Affairs of the U.S. House of Representatives, "Current Mineral Laws of the United States", (1976) 109 pp.

Hearings Before the Committee on Interior and Insular Affairs, House of Representatives, "Coal Slurry Pipeline Legislation", Serial No. 94-8, (1975) 1253 pp.

Hearings Before the Subcommittee on Science, Research, and Development of the Committee on Science and Astronautics, U.S. House of Representatives, "Utilization of Federal Laboratories", (No. 6) (1968) 457 pp.

Hearings Before the Committee on Interior and Insular Affairs, United States Senate, "Strategic Petroleum Reserves", Serial No. 93-11 (92-46), (1973) 472 pp.

<u>Economics of the Mineral Industries</u>, Edward H. Robie, Ed., Second Edition; The Maple Press Company, York, Pennsylvania (1964), 787 pp.

<u>An Appraisal of the Petroleum Industry of the United States</u>, United States Department of the Interior, (1965).

<u>United States Petroleum Through 1980</u>, United States Department of the Interior (1968), 92 pp.

<u>Directory of Federal Agencies Engaged in Energy-Related Activities</u>, Federal Energy Administration, Washington, D.C., (1975) 80 pp.

Final Report Prepared for the United States Energy Research and Development Administration, "Commercialization of New Energy Technologies", from Booz, Allen Applied Research Division, Booz, Allen & Hamilton, Inc., Bethesda, Maryland 20014, (July, 1976) 21 pp.

Appendix B--Case Study 2: Local Energy Supply, Conservation, and Control Systems, Prepared for the United States Energy Research and Development Administration, "Commercialization of New Energy Technologies", from Booz, Allen Applied Research Division, Booz, Allen & Hamilton, Inc., (July, 1976).

Congressional Record--Senate, March 30, 1976, (S 4562).

Feldman, Stephen, and Bruce Anderson, "Non-Conventional Incentives for the Adoption of Solar Energy Design: Peak-Load Pricing and Off-Peak Solar Energy Construction for Commercial and Residential Buildings", Interim Report #3, (July, 1976) 99 pp.

Hearings Before the Committee on Interior and Insular Affairs, United States Senate, "Financial Requirements of the Nation's Energy Industries", Serial No. 93-5 (92-40), (1973) 449 pp.

Parker, Glen Lawhon, The Coal Industry, A Study in Social Control, American Council on Public Affairs, Washington, D.C., (1940), 198 pp.

A Study Prepared for the Use of the Subcommittee on Economic Progress of the Joint Economic Committee, Congress of the United States, Peach, N.W., "The Energy Outlook for the 1980's", (1973) 39 pp.

U.S. Energy Policies, An Agenda for Research, Resources for the Future, Inc., The Johns Hopkins Press, Baltimore, Maryland (1968) 152 pp.

Balancing Supply and Demand for Energy in the United States, Rocky Mountain Petroleum Economics Institute, University of Denver (1972) 161 pp.

"Extraction of Energy Fuels" Prepared for the Bureau of Mines, From Extraction of Energy Fuels Panel for the Committee on Energy R&D Goals, Federal Council for Science and Technology, Washington, D.C., (1972).

Final Task Force Report, "Federal Energy Administration Project Independence Blueprint", Prepared by the Interagency Task Force on Natural Gas Under Direction of Federal Power Commission (1974).

Schurr, Sam H., Energy Research Needs, Resources for the Future, Inc., (1971).

Proceedings of the United Nations Inter-regional Seminar on Techniques of Petroleum Development, "Techniques of Petroleum Development", United Nations, New York (1965) 345 pp.

Ray, Dixy Lee, "The Nation's Energy Future", United States Atomic Energy Commission (1973) WASH-1281, 171 pp.

Energy R&D Present and Future, Thomas F. P. Sullivan, ed., 1st Annual Energy R&D Conference, Sponsored by Pollution Engineering Magazine, Power Engineering Magazine, Research/Development Magazine, Government Institutes, Inc., Washington, D.C., (1974).

Regulation of the Natural Gas Producing Industry, Brown, Keith C., Ed., Resources for the Future, Inc., Washington, D.C., (1972) 260 pp.

"Why A Natural Gas Shortage?--20 Years of Confusion and Chao", American Petroleum Institute, 1801 K Street, N.W., Washington, D.C., 20036.

Hawkins, Clark A., The Field Price Regulation of Natural Gas, Florida State University Press, Tallahassee, Florida (1960) 267 pp.

Factors Affecting U.S. Petroleum Refining, A Summary, Prepared by the National Petroleum Council's Committee on Factors Affecting U.S. Petroleum Refining (1973) 67 pp.

Regulation of the Natural Gas Producing Industry, Edited by Keith C. Brown, Resources for the Future, Inc., (1970), 260 pp.

Lovejoy, Wallace F., and Homan, Paul T., Economic Aspects of Oil Conservation Regulation, The John Hopkins Press, Baltimore (1967), 295 pp.

McDonald, Stephen L., Petroleum Conservation in the United States, An Economic Analysis, The John Hopkins Press, Baltimore and London (1971), 279 pp.

Schurr, Sam H., and Bruce C. Netschert, Energy in the American Economy, 1850-1975, The Johns Hopkins Press, Baltimore (1960), 774 pp.

Federal Economic Policy, 1945-1965, A Publication of Congressional Quarterly Service, Washington, D.C., 94 pp. (Chronology of Economic Legislation 1945-1965).

Fainsod, Merle, Gordon, Lincoln, and Joseph C. Palamountain, Jr., Government and the American Economy, Third Edition, W. W. Norton & Company, Inc., New York (1959), 996 pp. (Part 3 Government as Regulator in the Public Interest, Part 4 the Promotion and Regulation of Competition (Coal, Oil, Gas Regulation)).

Mitchell, Edward J., U.S. Energy Policy: A Primer, American Enterprise Institute for Public Policy Research, Washington, D.C., (1974), 103 pp.

Gas Rate Fundamentals, American Gas Association, Rate Committee, 420 Lexington Avenue, New York 17, New York (1960) 357 pp.

Report of the Committee on Interior and Insular Affairs, House of Representatives together with Additional, Dissenting, and Separate Views, "Surface Mining Control and Reclamation Act of 1976", House Report No. 94-896 (1976), 161 pp.

Prepared for the Subcommittee on Science, Research, and Technology of the Committee on Science and Technology, U.S. House of Representatives, "Science Policy, A Working Glossary" (Third Edition-1976), Serial X, 146 pp.

Melkus, Rolf A., "Toward A Rational Future Energy Policy", Natural Resources Journal, 14, pp. 239-256, (1974).

Hutchison, V. Vern, Selected List of Bureau of Mines Publications on Petroleum and Natural Gas, 1961-1970, United States Department, Bureau of Mines, Washington, D.C, 163 pp.

Ely, Northcutt, Summary of Mining and Petroleum Laws of the World (In Five Parts)--1. Western Hemisphere, United States Department of the Interior, Bureau of Mines, Washington, D.C., 159 pp.

Assessment of the Impact of Air Quality Requirements on Coal in 1975, 1977, and 1980, Prepared in the Division of Fossil Fuels, Mineral Supply, U.S. Department of the Interior, Bureau of Mines, Washington, D.C., (1974) 235 pp.

Symposium on Coal and Public Policies, Sponsored by the University of Tennessee and Oak Ridge National Laboratory, Center for Business and Economic Research, College of Business Administration/The University of Tennessee, Knoxville (1972) 170 pp.

McDonald, Stephen L., Federal Tax Treatment of Income from Oil and Gas, The Brookings Institution, Washington, D.C., (1963) 163 pp.

A Study of Conservation of Oil and Gas in the United States, Published and Distributed by Interstate Oil Compact Commission, Oklahoma City, Oklahoma (1964) 230 pp.

Proceedings--First International Conference on LNG (Liquefied Natural Gas), Sponsored by Institute of Gas Technology, Edited by Jack W. White and Arthur E. S. Neumann, Institute of Gas Technology, Chicago, Illinois (1968).

Petroleum Transportation Handbook, Edited by Harold Sill Bell, McGraw-Hill Book Company, Inc., New York (1963).

Breyer, Stephen G., and Paul W. Macavoy, Energy Regulation by the Federal Power Commission, The Brookings Institution, Washington, D.C., (1974) 163 pp.

Energy: Today's Choices, Tomorrow's Opportunities, World Future Society, Washington, D.C., 298 pp. (Tax Reform and Taxation of Oil Companies.)

A Statement by the Research and Policy Committee of the Committee for Economic Development, "International Economic Consequences of High-Priced Energy", Committee for Economic Development, New York (1975) 116 pp.

National Gas Survey, Volume I, The Commission Report, Federal Power Commission (1975), 387 pp.

National Gas Survey, Volume II, Federal Power Commission (1973), 662 pp. (Task Force Report of the Supply Technical Advisory Task - Regulation and Legislation to the Supply Technical Advisory Committee.)

National Gas Survey, Volume III, Federal Power Commission (1973), 460 pp. (Transmission - Technical Advisory Task Force - Report; Transmission Regulations and Legislation.)

Exploration and Economics of the Petroleum Industry, (8), Virginia S. Cameron, Editor, Matthew Bender, New York (1970), 312 pp. (Current Governmental Policies with Respect to the U.S. Petroleum Industry; Regulatory Response to Changes in Supply-Demand Relationships; Petroleum Policies Controlling Future Supplies)

Exploration and Economics of the Petroleum Industry, (9), Virginia S. Cameron, Editor, Matthew Bender, New York (1971), 271 pp. (Oil, Energy, and the Public Interest; Impact of the 1969 Tax Reform Act on Petroleum Operations; FPC Rate-Making Policies and Their Effects on Availability of Gas Supplies and Capital)

Exploration and Economics of the Petroleum Industry, (10), Virginia S. Cameron, Editor, Matthew Bender, New York (1972), 255 pp. (National Security and the Incentive System; Impact of Governmental Policies on Petroleum Supplies; U.S. Energy Policies and Economic Progress.)

Exploration and Economics of the Petroleum Industry, (12), Virginia S. Cameron, Editor, Matthew Bender, New York (1974), 267 pp. (The American Consumer's Stake in the Law of the Sea; Subsea Petroleum Resources in Relation to Proposed National-International Jurisdiction Boundaries and Imminent Energy Problems; Effects of the Mineral Leasing Act of 1920, As Amended, on the Trans-Alaska Pipeline.)

Exploration and Economics of the Petroleum Industry, (13), Virginia S. Cameron, Editor, Matthew Bender, New York (1975), 191 pp. (The Coal and Oil Shale Research Programs of the U.S.G.S.)

Hahn, Albert V., The Petrochemical Industry, Market and Economics, McGraw-Hill Book Company, New York (1970), 620 pp.

Working Paper on Factors Affecting the Future of the Coal Industry in the United States, prepared for the Battelle Energy Program, Battelle Memorial Institute, Columbus, Ohio (1973).

Report of the Task Force on Energy of the Subcommittee on Science, Research, and Development of the Committee on Science and Astronautics U.S. House of Representatives Energy Research and Development, December, 1972, Serial EE.

Impact of New Technology of the U.S. Petroleum Industry, 1946-1965, National Petroleum Council, Washington, D.C., (1967) 341 pp.

American Mining Congress Statement on Uranium Imports, Submitted to the Chairman of the Atomic Energy Commission, June 15, 1973.

Atomic Energy Commission Financial Statement of January 18, 1975.

1975 Financial Report, ERDA 76-3, U.S. ERDA, 1975.

1965 Financial Report, U.S. Atomic Energy Commission, 1965.

1959 Financial Report, U.S. Atomic Energy Commission, 1959.

1974 Financial Report, The U.S. Atomic Energy Commission, 1974.

AEC Authorizing Legislation Fiscal Year 1973, Hearings before the Joint Committee on Atomic Energy, Part I, 1972.

AEC Authorizing Legislation Fiscal Year 1974, Hearings before the Joint Committee on Atomic Energy, Part I, 1973.

ERDA Authorizing Legislation Fiscal Year 1977, Hearings before the Joint Committee on Atomic Energy, Part I, Vol. II, 1976.

ERDA Authorizing Legislation Fiscal Year 1977, Part I, Vol. I, 1976.

AEC Authorizing Legislation Fiscal Year 1972, Part I, 1971.

AEC Authorizing Legislation Fiscal Year 1971, Hearings before the Joint Committee on Atomic Energy, Part I, 1970.

ERDA Authorizing Legislation Fiscal Year 1976, Hearings before the Joint Committee on Atomic Energy, Part I, Vol. II, 1975.

AEC Authorizing Legislation Fiscal Year 1975, Hearings before the Joint Committee on Atomic Energy, Part I, 1974.

Brannon, Gerad M., Energy Taxes and Subsidies, Ballinger Publishing Company, 1974.

Burnett, Tobias W. T., "The Human Cost of Regulatory Delays", Nuclear Technology, Vol. 33, Mid-April 1977, p. 203-211.

Burnham, John B., Assessment of Uranium and Thorium Resources in the United States and the Effect of Policy Alternatives, Report to National Science Foundation, Battelle Pacific Northwest Laboratories, Richland, Washington 99352.

HR 8631: To Amend and Extend the Price-Anderson Act, Hearings before the Joint Committee on Atomic Energy, September 23 and 24, 1975.

Butler, Richard H., "Liability Insurance for the Nuclear Energy Hazard," Casualty Actorial Society Proceedings, Vol. XLVI, pp. 23-57, 1959.

"Delays Beset Radwaste Program", Nuclear Industry, October 1976, p. 3-6.

Development, Growth, and State of the Nuclear Industry, Hearings before the Joint Committee on Atomic Energy, February 5 and 6, 1974.

Dawson, Frank G., Nuclear Power: Development and Management of a Technology, University of Washington Press, Seattle & London, 1976.

U.S. GAO, B 159687, RED-76-30, Comments on Proposed Legislation to Change Basis for Government Charge for Uranium Enrichment Services - ERDA, September 22, 1975.

U.S. GAO, Report EMD-77-5, Considerations for Commercializing the LMFBR, November 29, 1976.

U.S. GAO, Report RED-76-36, B 159687, Evaluation of the Administration's Proposal for Government Assistance to Private Uranium Enrichment Groups.

U.G. GAO, Report EMD-76-10, B 178205, An Evaluation of Proposed Federal Assistance for Financing Commercialization of Emerging Energy Technologies, August 24, 1976.

"ERDA Acts on Waste Storage", Nuclear Industry, February, 1976, pp. 6-8.

Future Ownership of the AEC's Gaseous Diffusion Plants, Hearings before the Joint Committee on Atomic Energy, July 8 and 9, August 5, 7, 8 and 19, 1969.

Green, Harold, "Nuclear Power: Risk, Liability & Indemnity," Michigan Law Review, Vol. 71, pp. 478-506, 1973.

Green, Harold, "The Strange Case of Nuclear Power", 17 Fed. B.J. 100 (1957).

Green, Harold and Alan Rosenthal, Government of the Atom, Atherton Press, New York, 1963.

Green, Harold and Alan Rosenthal, The Joint Committee on Atomic Energy: A Study in Fusion of Government Power, The George Washington University, Washington, D.C., 1961.

How the Federal Government Participates in Activities Affecting the Energy Resources of the U.S., GAO Report B-173205, April 6, 1973.

Katler, R. J., Energy Supply and Government Policy, Cornell University Press, 1976.

"Low-Level Waste Debate Grows", Nuclear Industry, September, 1976, p. 22-24.

U.S. GAO, Report B 178205, EMD-77-8, Letter Report to Dr. Seamans, Review of ERDA Solar Energy R&D, November 30, 1976.

U.S. GAO, Report B 164105, RED-75-352, The Liquid Metal Fast Breeder Reactor Program--Past, Present and Future, April 18, 1975.

Marrone, Joseph, "Nuclear Liability--A Brief History Reflecting the Success of Nuclear Safety," Nuclear Safety, Vol. 12, No. 4.

McClure, Richard D., "A Review of Nuclear Energy Insurance," Casualty Actuarial Society Proceedings, Vol. LV, 1968, pp. 255-294.

Morrison, James L., "Federal Support of Domestic Atomic Power Development--The Policy Issues," 12 Vanderbuilt Law Review, pp. 195-222, 1958.

The Nuclear Industry, 1974, WASH. 1174-74, Office of Industry Relations, ERDA, 1974.

Nuclear News, August 1976, Vol. 19, No. 10, pp. 74-79.

The Nuclear Power Controversy, The American Assembly, Columbia University, Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 1976.

Nuclear Regulatory Commission Authorizing Legislation, Fiscal Year 1977, Hearings Before the Joint Committee on Atomic Energy, January 19, February 17, and March 19, 1976.

Nucleonics Week, Vol. 17, No. 40, September 30, 1976, p. 14.

Proposed Changes in AEC Contract Arrangements for Uranium Enriching Services, Hearings before the Joint Committee on Atomic Energy, March 7, 8, 26 and April 18, 1973.

Regional Nuclear Fuel Cycle Centres, Vol. I: Summary: 1977 Report of the IAEA Study Project, IAEA, Vienna, 1977.

Regional Nuclear Fuel Cycle Centres, Vol. II: Basic Studies: 1977 Report of the IAEA Study Project International Atomic Energy Agency, Vienna, 1977.

Reactor Safety Study, An Assessment of Accident Risks in U.S. Commerical Nuclear Power Plants, U.S. NRC, Wash, 1400 (NUREG-75-014) (Rasmussen Study), October 1975.

Rochein, Gene I., "Nuclear Waste Disposal: Two Social Criteria, Science (AAAS), Fol. 195, No. 4273, January 1977, pp. 23-31.

U.S. GAO, Report B 164105, RED-76-7, Selected Aspects of Nuclear Powerplant Reliability and Economics, August 15, 1975.

U.S. Energy Policies: An Agenda for Research, Resources for the Future, Inc. John Hopkins Press, Baltimore, Maryland, 1968.

Zinn, W. H. and F. K. Pittman, Nuclear Power, U.S.A., McGraw-Hill, New York, 1964.

Uranium Enrichment: Alternatives for Meeting the Nation's Needs and Their Implications for the Federal Budget, Background Paper No. 7, May 18, 1976, Congressional Budget Office, U.S. Congress.

"Creation of Licensing Criteria Accelerators", B.N. Naft, Electrical World, March 15, 1977, pp. 76-78.

Code of Federal Regulations Title 10, Part 170 - Fees and Facilities and Materials Licenses.

U.S. Congress JCAE, "Comments of Reactor Designers and Industrial Representatives on the Proposed Expanded Civilian Nuclear Power Program, December 1958.

Hodgetts, J. E., Administering the Atom for Peace, Atherton Press, 1964.

U.S. Congress JCAE, "Development of Scientific, Engineering, and other Professional Manpower (with Emphasis on the Role of the Federal Government)," May 1957.

U.S. Department of Health, Education and Welfare, "Careers in Atomic Energy", Pamphlet No. 119, 1957.

Nuclear Exchange Corporation, "Significant Events in the Uranium Market, 1969-1976", October 15, 1976.

U.S. GAO, "U.S. Financial Assistance in the Development of Foreign and Nuclear Energy Programs", ID-75-63, May 28, 1975.

U.S. GAO, "Allocation of Uranium Enrichment Services to Fuel Foreign and Domestic Nuclear Reactors", ID-75-45, March 4, 1975.

U.S. GAO, "Assessment of U.S. and International Controls Over the Peaceful Uses of Nuclear Energy", ID-76-60, September 14, 1976.

U.S. GAO, "Proposed Revisions to the Criteria and Contracts for Uranium Enrichment Services", B 159687, March 5, 1973.

U.S. GAO, "Comments on Selected Aspects of the Administration's Proposal for Government Assistance to Private Uranium Enrichment Groups", RED-76-110, May 10, 1976.

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