18

PNL-3422 Exc. Sum.
UC-59

An Analysis of the Results of Federal Incentives Used to Stimulate Energy Production

February 1981 Executive Summary

Prepared for the U.S. Department of Energy under Contract DE-AC06-76RLO 1830

**Pacific Northwest Laboratory
Operated for the U.S. Department of Energy
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PNL-3422

PACIFIC NORTHWEST LABORATORY
operated by
BATTELLE
for the
UNITED STATES DEPARTMENT OF ENERGY
Under Contract DE-AC06-76RLO 1830

Printed in the United States of America
Available from
National Technical Information Service
United States Department of Commerce
5285 Port Royal Road
Springfield, Virginia 22151

Price: Printed Copy $_______*; Microfiche $3.00

*Pages	NTIS Selling Price
001-025	$4.00
026-050	$4.50
051-075	$5.25
076-100	$6.00
101-125	$6.50
126-150	$7.25
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176-200	$9.00
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251-275	$10.75
276-300	$11.00

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AN ANALYSIS OF THE RESULTS OF FEDERAL INCENTIVES USED TO STIMULATE ENERGY PRODUCTION

An Executive Summary

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The intent of this study was to enhance the formulation of a national incentive policy for renewable resource utilization by examining past incentives for traditional energy forms. The research summarized here builds on an earlier analysis which estimated that in the years between 1918 and 1977 the Federal Government expended $217.4 billion (1977 dollars) for incentives to stimulate energy production. The energy types considered were nuclear, hydroelectricity, coal, oil, natural gas, and electricity. The present study shows that extra production induced by these incentives was at least 61 quadrillion Btu (quad). The research also estimated price changes and, in a nonquantitative manner, other effects.

AN ESTIMATE OF FEDERAL INCENTIVES

Federal incentives to stimulate energy production between 1918 and 1977 amounted to $217 billion, representing 33 distinct incentives, divided into six incentive types, as shown in Table 1.

The six categories are defined as follows:

1. Taxation is the exemption or reduction of a tax that is otherwise levied. This was used for gas and oil in the form of a percentage depletion allowance and the expensing of intangible drilling costs. A percentage depletion allowance was also used for coal. Many electric power suppliers exempted revenues, used liberalized depreciation, sold tax-free bonds, and received investment tax credits.

2. Disbursements are actions in which the Federal Government gives out money without receiving anything directly or immediately in return. This category included oil tanker subsidies and liability insurance for nuclear reactors.

TABLE 1. The Cost of Incentives Used to Stimulate Energy Production, 1918-1977 (Billions of 1977 Dollars)

	Nuclear	Hydro	Coal	Oil	Gas	Electricity	Total
Taxation		1.8	4.0	50.4	16.0	31.4	103.6
Disbursements				1.1			1.1
Requirements	1.1	(a)	0.7	41.9	(a)		43.7
Traditional Services			2.3	6.0		0.5	8.8
Nontraditional	15.1		2.7	1.5	0.3		19.6
Market Activity	1.8	13.5	(a)	0.4	0.1	24.7	40.6
Totals	18.0	15.3	9.7	101.3	16.5	56.6	217.4

(a) Less than $0.1 billion.

3. Requirements are demands made by government and backed by criminal and civil sanctions. These included federal energy price regulations, stripper well price incentives, and high yield on oil pipelines. Federal regulation of the natural gas industry, including wellhead price controls, was treated as requirement incentives for the gas industry. Coal mines had to meet health and safety requirements. Private dams were regulated. Safety requirements for nuclear reactors were set by the Atomic Energy Commission and the Nuclear Regulatory Commission.

4. Traditional governmental services are activities provided when private ownership or operation is not practical within the current political system. The maintenance of ports and waterways for oil and coal and the activities of the Rural Electrification Administration (REA) constituted traditional services.

5. Nontraditional governmental services are defined as activities provided when private ownership or operation is possible but not thought to be in the general public welfare. This incentive consisted of research and development and the collection of data by the Geological Survey, Bureau of Mines, and Department of Energy.

6. Market activities consist of direct governmental involvement in one or more steps of production, exchange, or consumption. Oil, gas, and coal leases from the Bureau of Land Management, federal purchases of uranium, the construction and operation of enrichment plants, the construction and operation of dams, and REA loans were classified as market activites.

PURPOSE

The purpose of the analysis summarized here was to estimate the results of these 33 incentives in terms of their effects on energy price and quantity as well as on nonquantifiable values such as federal-state relations, competition, and capital formation. The findings are reported so that the dialog can continue to incorporate the lessons from past incentives to the production of energy from traditional sources into a federal renewable resource energy policy. They are reported as a budget to serve as a point of departure for future debate centering on the cost of specific federal actions over relatively short periods.

METHOD

There are five general methods of estimating the results of federal actions: mathematical modeling, analogy, inspection, engineering costs, and expert opinion. Models of the energy sector of the economy were found to be simplistic or too expensive to adapt and use. Analogy with other well-understood actions was not useful because the cases under consideration were not sufficiently similar. Inspection, consisting of a comparison of energy production before and after the incentive, was used as a starting point. The engineering approach was used to calculate how changes in technology and the costs of specific inputs affected energy prices and quantities. The opinions of experts knowledgeable about specific actions were sought through interviews, questionnaires, and analysis of public statements.

ANALYSIS BY INCENTIVE TYPE

A generic analysis focused on the results of the applicable incentives during 1976-77. The expert opinion approach was used, employing opinions of those active in the policy-making process. These came from interviews and public statements as recorded in contemporary newspaper accounts or congressional hearings.

Thirteen impact types were analyzed for each incentive type. These included energy produced per dollar, timing and predictability of response, ease and flexibility of administration, and dispersion and visibility of the results. Each incentive ranked high in some characteristics and low in others, giving credence to the importance of having a balance of incentives when designing a strategy. Each incentive type varied as much in its impacts as the incentive types varied from each other.

The following are some general findings about the incentives:

- Disbursements produce relatively predictable results and are easy to control and terminate. They require technological skill to administer.
- Tax incentives were found to produce relatively quick responses and were relatively easy to adopt and modify. They could affect a large number of people with low public visibility.
- Market activities have a high energy impact per dollar. Predictability and speed of response for the government as a consumer are high. The government as a consumer is more easily administered than the government as a producer.
- Services, both traditional and nontraditional, produce responses relatively slowly and have a low energy impact per dollar. They are easy to administer.

- Requirements produce relatively quick responses and are relatively predictable. They are easy to initiate but difficult to administer.

If the government has confidence in a particular solar technology and wants quick response, it should provide tax incentives and buy that type of equipment. If the government wishes a high impact per dollar, it should both invest in the production of energy from solar resources and consume that form of energy. If it wants predictable outcomes, it should disburse funds, consume solar energy, and require the use of it. A highly visible solar program would result if the government entered into the production of energy from solar resources.

NUCLEAR ENERGY

To estimate the results of federal incentives to the nuclear industry, responses were analyzed from 48 persons involved in significant ways in the early development of nuclear power. Their opinions varied on the effectiveness of funding and types of incentives, but general agreement prevailed that there was substantial capability and willingness in industry to commercialize nuclear power with technology that had been developed by the mid-fifties even without incentives. Positive federal support in the form of legislation, general encouragement, and supportive attitudes was considered an important (and to some, sufficient) incentive to commercialize nuclear power. Indeed, about one-third of the responses indicated that the U.S. economic system provided the necessary incentives for industrial growth without being heavily dependent on federal incentives. Some responders commented on the importance of liability insurance and incentives to the uranium mining and milling industry. Some were quite outspoken that regulations have had an adverse effect on the numbers of nuclear plants built or planned, on foreign policy matters, and on a number of organizational and legal factors.

Through 1977, light-water reactors in the U.S. generated about 3.35 quad of energy. Based on the responses from the energy industry survey and supporting analyses, federal incentives were estimated to have increased nuclear energy production by slightly more than one quad. This was achieved through the expenditure of about $6.3 billion on light-water reactors. A total $18 billion was spent on all nuclear activities.

Important to the development of nuclear power was a congressional constituency epitomized by the Joint Committee on Atomic Energy, which helped overcome legislative roadblocks to commercial development. This activity suggested that legislative requirements to facilitate solar adoption be identified early so that appropriate implementation actions can be instigated in a timely fashion. It was also noted that the Power Reactor Demonstration Program could serve as a model to accelerate the use of solar-electric generation by utilities.

HYDROELECTRICITY

The Federal Government manages 145 hydroelectric facilities that account for 51% of the net hydroelectric generation. Another 164 federally subsidized, municipal, state, and utility-district facilities produce an additional 24%. A total $15.33 billion of incentives to hydroelectricity production was made available from 1933 to 1977.

It was estimated that market activities have resulted in the production of 12.86 quad since 1933, calculated from the fossil fuel equivalent of hydroelectricity. The price of power was reduced by 29.2¢ per million Btu. The $1.77 billion exemption of federal power revenues from taxes is estimated to have decreased the price of hydroelectric power by 8.4¢ per million Btu.

Regional development resulted from controlling floodwaters, from providing year-round water supplies to agricultural and municipal users, from opening up inland navigational routes, as well as providing dependable, abundant, and affordable electrical energy. The largest impacts came in the form of increased capital formation, modification of public and private relations, demographic factors, increased employment and productivity, and definite changes in the quantity and price of hydroelectricity. More moderate impacts occurred for such factors as the competitive structure of the industry, the balance of payments, the regulatory burden, the quality of life, and sectoral changes.

The Federal Government could stimulate the centralized production of solar energy by creating incentives to locate sites where solar potential is highest. It could then set a high long-range return on investment and finance construction. To accelerate repayment, the revenues from such a facility could be tax free.

COAL

Federal incentives for coal amounted to about $10 billion. It was estimated that the Mine Health and Safety Act of 1969 resulted in a 10¢ per million Btu increase in price and had a negative impact on productivity. The coal depletion allowance has had a negligible impact on coal output; yet without it the price of coal would have been approximately 1.3¢ per million Btu higher. Governmental construction, operation, and maintenance of ports and waterways helped lower the market price of coal by about 1/2¢ per million Btu while having a negligible impact on coal output. Governmental research and development activities, data gathering activities, and federal coal leasing policies have not yet had a significant impact on the price and output of coal.

The analysis of coal incentives led to the conclusion that for small, under-capitalized firms an investment tax credit that pays cash if there is no tax liability has a greater impact than accelerated depreciation. This happens because these firms in their early years have large investments to make and little taxable earnings to be offset by depreciation. Research and development sponsored by the government can help firms too small to do the work for themselves or can help the industry as a whole in cases where a private developer cannot get sufficient competitive advantage from innovation to justify the effort.

OIL

Federal incentives to stimulate oil production have amounted to over $100 billion. It was estimated that 26.6 quad of increased production resulted from the expensing of intangible drilling costs and the percentage depletion allowance. These taxation incentives held the price of oil down by 21.3¢ per million Btu. Stripper well and new oil pricing allowances accounted for almost $42 billion of the incentives and stimulated approximately 2.3 quad of increased production. The higher price for new oil and stripper well oil did, however, cause refiner acquisition costs to increase by approximately 11.6¢ per million Btu.

Oil transportation incentives, data gathering, federal leasing policies, and federal research and development activities had negligible impacts on price and output. On the other hand, promoting orderly oil markets by encouraging the Interstate Oil Compact Commission and passing the Connally Hot Oil Act was found to have had an unquantifiable but highly significant impact on price and output.

In addition to the conclusions already mentioned for coal incentives, oil incentives point out that those large, capital-intensive parts of solar energy technology that are constructed by large established firms will profit from both investment tax credits and accelerated depreciation. These opportunities include ocean thermal energy conversion and utility solar thermal and photovoltaic electricity generation.

NATURAL GAS

The total value of federal incentives provided for natural gas production was $16.5 billion. The percentage depletion allowance and expensing of intangible drilling costs increased output by 6.6 quad and held the price down by 10.8¢ per million Btu. The pricing of interstate gas above the level of intrastate gas before 1970 promoted an estimated 6.4 quad of production by encouraging market development. In 1977 prices were 12.5¢ per million Btu lower than they would have been in the absence of controls. As natural gas supply changed from surplus to shortage, wellhead price controls began to reduce production.

Some federal leasing policies have encouraged natural gas production, and others have discouraged it. Prices have been increased by the royalty bonus system of lease bidding. Data-gathering activities have had negligible impacts on natural gas price and output. Regulatory activities of the Federal Power Commission (FPC), now the Federal Energy Regulatory Commission (FERC), other than wellhead price controls, had an unquantifiable effect on the price and output of natural gas.

In the natural gas industry, as in the oil industry, tax incentives led to increased production. Tax credits and accelerated depreciation can lead to increased solar energy usage in large capital-intensive systems. A review of natural gas incentives suggests that government programs that develop the confidence in the stability of supply and in safety can be effective in stimulating production as well as consumption. Just as programs to assure domestic supply, to develop appliances, and to promote safety encouraged natural gas adoption and potential suppliers, the demonstration of the economic feasibility, dissemination of information, and development of efficient and reliable equipment will increase the adoption of solar energy. Codes, licensing, and equipment rating are examples of steps that would help to develop confidence in solar energy usage.

ELECTRICITY

Federal incentives to electricity distribution, transmission, and generation were about $57.9 billion, about one-third of which went to REA. REA loans increased electrical energy production by 4.97 quad by promoting the distribution of electricity in areas not otherwise apt to be served. The cost savings attributable to low-interest REA loans promoted a $1.92 per million Btu reduction in the price of electricity, calculated on the fuel used for generation. Traditional services and requirements had a negligible impact on electricity transmission and distribution, although the imposition of antitrust review, environmental analysis, and the like may have significant impacts in the future. Taxation incentives in the form of investment tax credits and liberalized depreciation for privately owned utilities and tax exemptions for publicly owned utilities were estimated to have held down the price of electricity by approximately 34¢ per million Btu. In addition, certain rapidly increasing federal incentives have offset rapidly increasing costs so that recent prices have remained relatively constant.

Subtle accounting changes such as those allowed electric utilities by the Internal Revenue Service, the Securities and Exchange Commission, and FERC could make substantial changes in the renewable energy market. For instance, very accelerated depreciation or expensing of solar equipment would offset its long payback period. The redirection of the REA could provide an incentive to energy self-sufficiency for some segments of agriculture.

APPLICATION OF THE RESULTS

The findings presented above serve as a point of departure for an incentive strategy to encourage the use of renewable resources. Such a strategy must initially address: (1) total expenditures, (2) choice of incentives, and (3) timing. The findings serve as data to focus debate on these three issues.

Total Expenditures

The $217.4 billion of federal incentives divided by the 61 quad of induced energy gives $3.57 per million Btu induced energy. Of the 33 incentives identified, 7 were found to have a quantifiable effect on the quantity of energy produced. Eleven were found to have a quantifiable effect on the price of energy.

The concept of parity was used to estimate the minimum level of expenditures for the future. Parity was defined as an equivalence between federal incentives to renewable energy resources and federal incentives to traditional energy sources. To calculate the level of incentives required to achieve parity, a weighted average incentive in dollars per million Btu for traditional energy forms was developed. Based on the analysis of federal incentives for energy production and the use of this parity index, an average incentive of 27¢ per million Btu for all renewable energy resources would be required to achieve parity with traditional energy resources.

Of course, renewable energy may involve different technologies and institutions than do traditional forms of energy. Also, energy forms or activities are not moral categories, entitled to equal treatment on the grounds of justice. Indeed, the argument for many solar activities is that they deserve more than equal treatment because they serve social values such as national security and environmental quality better than traditional forms of energy. Nonetheless, parity is a useful starting point because it provides a minimum estimate of needed expenditures. The burden of persuasion ought to be placed on the person who argues that the government can effectively stimulate renewable energy at far less cost than was needed or used to stimulate other forms. He or she should explain why renewable technologies are so much more amenable to stimulation or why the government is now so much more efficient.

Calculating the level of national commitment requires an assumption about the growth of the renewable energy industry. The natural gas industry increased annual production by 17 quad during the 20-year period from 1950 to 1970. Assuming a similar 20-year growth curve for the renewable energy industry, a total increase in production of 152 quad would be necessary to achieve an annual production level of 18 quad by the year 2000. Applying the criterion of parity, an incentive of 27¢ per million Btu times 152 quad would result in a total federal expenditure, from 1980 to 1999, of $41 billion (1977 dollars).

Choice of Incentives

Of the 61 quad of increased energy production attributable to incentives as a whole, the share attributable to each incentive type is as follows:

- taxation--33 quad, or 55% (mainly in oil production)
- market activity--18 quad, or 29% (in electricity and hydroelectricity)
- requirements--9 quad, or 14% (in oil and natural gas)
- nontraditional services (research and development)--1.17 quad, or 2% (nuclear power)
- disbursements--unquantifiable
- traditional services--negligible.

Taxation incentives, the most pervasive incentive, generally had the greatest overall downward pressure on energy prices. The downward pressure on prices that resulted from market activity was large but limited to hydroelectricity and electricity. It was found that requirements could have positive or negative pressure on energy prices, depending on how they were structured. The price results of alternative incentives do not suggest any changes in the distribution of incentives proposed above because those incentives with the largest production impacts also had the most significant price impacts.

If dollars are to be allocated among incentive types by the pattern suggested by the estimated results of past incentives to traditional energy production, 55% of the federal investment to stimulate renewable energy production would be in the form of taxation incentives; 29% of the federal investment would be in the form of market activities; 14% would be in the form of requirements; and 2% would be for research and development.

Timing

The historical spending pattern for incentives also serves as a point of departure in designing an incentive strategy for renewable energy resources. During the period 1950-1969 the expenditure for incentives for traditional energy sources was $102.5 billion (1977 dollars). Taxation incentives generally rose steadily during that time. Requirements rose sharply during the late fifties and leveled. Service rose more rapidly than the others. Market activities fluctuated widely with three distinct peaks and three valleys. Allocating the sum by five-year periods, it was found that 19% of this was expended from 1950 to 1954, 23% from 1955 to 1959, 28% from 1960 to 1964, and 28% during the remaining five years. For the development of renewable and solar energy in the period 1980-1999, similar percentages for five-year periods are reasonable.

CONCLUSIONS

The Federal Government has provided incentives amounting to $217.4 billion (1977 dollars) to promote the national goals of equity and a better life for the American people. Therefore, much of the result of this expenditure cannot be measured in terms of quantities of energy. But there are lessons that can guide the development of a federal renewable resource energy policy in a way that will transform the tensions among the goals of economic efficiency, national self-sufficiency, environmental quality, and political equity into a creative force to satisfy our needs for work, warmth, and light.

A federal renewable resource energy policy based on historical incentives to traditional sources of energy suggests the level of expenditure would be at least $41 billion (1977 dollars) during the period 1980-1999. Though this level of commitment can be justified on the basis of equity with nonrenewable energy, it must also be justified on the basis of national goals. The difficulty of measuring the results of expenditures for incentives in terms of energy quantity and price makes developing a measure of national commitment transcend the total expenditure. The impact of the Joint Committee on Atomic Energy, which helped overcome legislative roadblocks to commercial development of nuclear power, is not reflected as a budget item. The economic growth of both the Columbia Basin and the Tennessee Valley is greater than the energy quantity and price results of the Bonneville Power Administration and the Tennessee Valley Authority expenditures. Thus, to be consistent with historical precedent, the expenditure of at least $41 billion must be justified in terms of goals that are broader than the achievement of 18 quad of renewable energy use in the year 2000.

If the measurable results of historical incentives form the basis of determining the mix of incentives, then a federal renewable resource energy policy would focus primarily on tax incentives and the purchase of utilizing equipment. Requirements such as equipment standards, zoning for access to sunlight, and solar mandating would receive less attention. Nontraditional services, primarily research and development, would be funded at less than a billion dollars.

The timing of expenditures for incentives to induce the use of renewable energy resources would be about $1.54 billion per year during the 1980-1984 period. During the 1995-1999 period it would increase to about $2.46 billion per year. New incentives would be added on top of old ones as time passed. However, because total renewable energy production will be much larger toward the end of the twenty-year period, the incentive cost per million Btu will decline over time.

Were the budget for a national renewable energy resource policy based on past incentive policies, it would appear as in Table 2. The use of past policies to achieve future goals may or may not prove to be

TABLE 2. A Point of Departure for Preparing a Federal Incentives Budget for Renewable Energy (Billions of 1977 Dollars)

	Time Period					
Incentive Type	1980-1984	1985-1989	1990-1994	1995-1999	Totals	Percentage of Total
Taxation	4.30	5.19	6.33	6.78	22.6	55
Requirements	1.09	1.30	1.61	1.70	5.7	14
Nontraditional Services	0.15	0.18	0.22	0.25	0.8	2
Market Activity	2.26	2.73	3.34	3.57	11.9	29
TOTAL	7.80	9.40	11.50	12.30	41.0	
Percentage of TOTAL	19	23	28	30		100

successful. There is no guarantee that the future application of historical policies will affect future decisions as they did in the past. Nevertheless, past actions do set precedents and their estimated results provide useful input for the determination of future policies. The budget in this table is intended to serve as a point of departure for future debate. The application of precedent to current and future conditions is useful because many organizational activities persist in the face of radically different conditions. The procedures, resources, and thoughts of the past and present frame the problem and shape the alternatives available in the future. Consequently, this budget allows the debate to center on the cost of specific actions over relatively short periods of time. So centered, the debate should promote a fruitful exchange of ideas based on the lessons of the past.

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