# A half century of US federal government energy incentives: value, distribution, and policy implications

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**Abstract:** This paper presents the most comprehensive estimates yet developed of US federal government energy subsidies and incentives over the past 50 years – $644 billion. It shows that the federal government has subsidised the energy industries – nuclear, coal, oil, natural gas, renewables – using different budget and off-budget funding techniques. It questions the common perception that federal energy subsidies in recent decades have favoured coal and nuclear energy at the expense of renewables. The authors conclude that federal subsidies and incentives can impact US energy and environmental policies for decades into the future, and that development of these policies must be informed by the findings reported here. In particular, there is an emerging consensus that expanded federal support for renewable energy is warranted. This support should be coupled with appropriate policies to ensure that, in the future, renewable technologies penetrate the market and make substantial contribution to the US energy mix.

**Keywords:** US energy policy; federal energy subsidies; energy incentives; US energy R&D spending; US energy budgets; nuclear energy subsidies; renewable energy subsidies; fossil energy subsidies; oil and gas tax incentives.

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## 1 Introduction: federal energy incentives policy

The Federal government has historically encouraged, promoted, and supported the development of domestic US energy resources in many diverse ways. Federal incentives for energy production have taken the form of direct subsidies, regulation, tax incentives, market support, demonstration programmes, research and development funding, procurement mandates, information generation and dissemination, technology transfer, directed purchases, and other types of actions.

We estimate that Federal incentives for energy development totalled $644 billion through 2003 (in 2003 dollars), and we classified these incentives within six generic categories – Table 1. This classification is useful because it not only shows the total Federal incentives for each energy source, but also illustrates the distribution of these incentives among the different policy options and support mechanisms:

- Research and development – Federal R&D funding
- Regulation – Federal regulations and mandates
- Taxation – special exemptions, allowances, deductions, credits, *etc.* related to the Federal tax code
- Disbursements – direct financial subsidies such as grants
- Government services – assistance provided by the Federal government without direct charge
- Market activity – direct Federal involvement in the marketplace.

**Table 1** The total cost of federal incentives for energy development through 2003 (Billions of 2003 dollars)

| | *Nuclear* | *Hydro* | *Coal* | *Oil* | *Natural gas* | *Renewables* | *Geothermal* | *Total* | *Percent* |
|---|---|---|---|---|---|---|---|---|---|
| Research and development | 60.6 | 1.2 | 27.3 | 6.7 | 5.6 | 16.4 | 2.9 | 120.7 | 18.7 |
| Regulation | 9.9 | 4.1 | 6.2 | 106.1 | 2.9 | 0 | 0 | 129.2 | 20.1 |
| Taxation | 0 | 10.5 | 26.7 | 155.4 | 75.6 | 11.7 | 1.4 | 281.3 | 43.7 |
| Disbursements | –8.3 | 1.4 | 6.4 | 2.1 | 0 | 1.5 | 0 | 3.1 | 0.5 |
| Government services | 1.2 | 1.3 | 12.6 | 27.2 | 1.3 | 1.7 | 0 | 45.3 | 7.0 |
| Market activity | 0 | 54.1 | 1.7 | 4.5 | 1.7 | 1.3 | 1.4 | 64.7 | 10.0 |
| *Total* | 63.4 | 72.6 | 80.9 | 302.0 | 87.1 | 32.6 | 5.7 | 644.3 | |
| Percent | 9.8 | 11.3 | 12.6 | 46.9 | 13.5 | 5.1 | 0.9 | | 100 |

*Source:* Management Information Services, Inc. (2006)

## 2 A brief summary of federal energy organisations

Until the early 1970s energy policy was a low priority for the Federal government, and responsibility for policy and funding was scattered throughout the government in the Atomic Energy Commission (AEC), the Department of the Interior, the Department of the Treasury, the State Department, and other agencies. This changed dramatically during 1973, as the Arab oil embargo and the ensuing increases in oil prices focused the nation's attention as never before on the 'energy crisis'.

Reacting to this crisis atmosphere, President Nixon established the Federal Energy Office (FEO) by Executive Order in December 1973 to coordinate policy and to administer the increasingly complex energy regulations and allocation mandates. The Federal Energy Administration Act of 1974 transferred FEO's responsibilities to the newly created Federal Energy Administration (FEA).

In 1974, Congress also greatly expanded the Federal government's role in energy R&D by creating the US Energy Research and Development Administration (ERDA) as the focus of the nation's energy research efforts. The rationale for the creation of ERDA was threefold:

1 There was a need for a single agency within which the government's greatly increased interest in and funding for energy R&D could be concentrated and centralised.

2 It was felt that even a 'reformed' AEC would be perceived as favouring nuclear energy over other options.

3 There was concern that the AEC's dual functions of regulating the nuclear energy industry as well as funding research and promoting the development of nuclear energy were incompatible.

In 1975, the AEC was abolished and its regulatory functions were transferred to the Nuclear Regulatory Commission (NRC), its energy research functions were transferred to ERDA, and many – but not all – of the energy research programmes scattered among different Federal agencies were transferred to ERDA. FEA continued to administer most energy regulations – primarily petroleum and natural gas price controls and allocations.

During 1976 and 1977 Presidents Ford and Carter both recommended the creation of a centralised Cabinet-level energy department, and in 1978 the energy bureaucracy was again reorganised. ERDA and FEA became part of the newly formed Department of Energy (DOE), while the Nuclear Regulatory Commission remained an independent agency. The Federal Power Commission, which had been an independent agency since its inception, became the semiautonomous Federal Energy Regulatory Commission (FERC) within DOE.

In the early 1980s, the Reagan Administration proposed abolishing DOE and in the FY 1983 budget proposed transferring the energy R&D budget to an 'Energy Research and Technology Administration' to be created within the Commerce Department. However, this proposal was not implemented, and the Federal energy bureaucracy has remained relatively intact since 1978.

## 3 Generic federal energy incentives

Federal energy incentives can be best understood by examining relevant examples within each category pertaining to specific energy sources – Table 2 shows the time periods over which the incentives were estimated and Figure 1 shows the distribution of incentives among the generic categories.[1]

**Table 2** Dates from which energy incentives cost estimates were derived

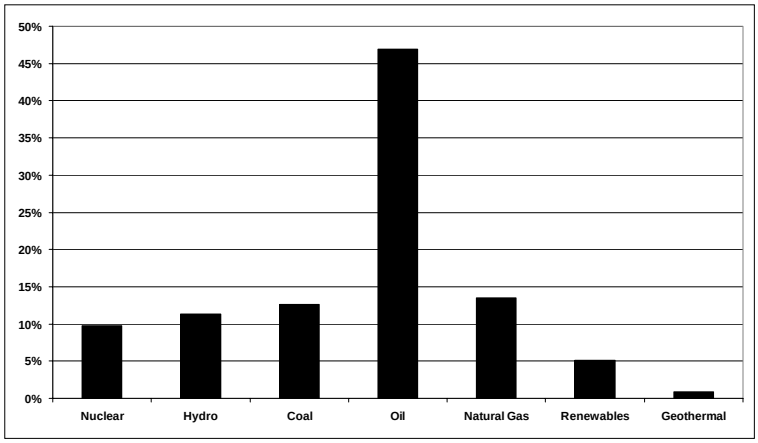
| *Incentive category and matrix designation* | *Year* |
|---|---|
| Nuclear energy | |
| Research and Development Activities (R&D) | 1950 |
| Regulation of Commercial Nuclear Energy (Regulation) | 1960 |
| Waste Management and Disposal (Disbursements) | 1982 |
| Enrichment Plants (Market Activity) | 1943 |
| Liability Insurance (Disbursements) | 1957 |
| The Uranium Mining Industry (Market Activity) | 1971 |
| Nuclear Waste Fund (Disbursements) | 1982 |
| All other federal support activities (Government Services) | 1950 |
| Coal | |
| Research and Development (R&D) | 1950 |
| US Geologic Survey (R&D) | 1950 |
| Bureau of Land Management (Market Activity) | 1950 |
| Percentage Depletion Allowance (Taxation) | 1950 |
| Mine Health and Safety (Regulation) | 1950 |
| Bureau of Mines (R&D) | 1964 |
| Black Lung Disability Trust Fund (Disbursements) | 1977 |
| Abandoned Mine Reclamation Fund (Disbursements) | 1977 |
| Transportation, Ports, and Waterways (Government Services) | 1950 |
| Oil | |
| Research and Development Activities (R&D) | 1951 |
| US Geologic Survey (R&D) | 1950 |
| Bureau of Land Management (Market Activity) | 1950 |
| Bureau of Mines (R&D) | 1964 |
| Percentage Depletion Allowance (Taxation) | 1950 |
| Maintenance of Ports and Waterways (Regulation) | 1950 |
| Stripper Well Price Incentives (Regulation) | 1944–1945; 1974–1981 |
| Regulation (Regulation) | 1974 |
| Intangible Drilling Expenses (Taxation) | 1950 |
| High Rate of Return for Oil Pipelines (Regulation) | 1921–1951 |
| Leaking Underground Storage Tank Trust Fund (Disbursements) | 1987 |
| Oil Spill Liability Fund (Disbursements) | 1989 |
| Pipeline Safety Fund (Disbursements) | 1979 |
| Subsidies for Oil Tankers (Disbursements) | 1970 |

**Table 2** Dates from which energy incentives cost estimates were derived (continued)

| *Incentive category and matrix designation* | *Year* |
|---|---|
| Natural gas | |
| Research and Development Activities (R&D) | 1951 |
| Regulation (Regulation) | 1938 |
| Wellhead Price Controls (Regulation) | 1955 |
| US Geologic Survey (R&D) | 1950 |
| Bureau of Land Management (Market Activity) | 1950 |
| Pipeline Safety Fund (Disbursements) | 1979 |
| Section 29 Tax Credits (Taxation) | 1980 |
| Intangible Drilling Expenses (Taxation) | 1950 |
| Hydroelectric energy | |
| Research and Development Activities (R&D) | 1950 |
| Construction and Operation of Federal Dams (Market Activity) | 1933 |
| Exemption of Power Revenues from Federal Taxation (Taxation) | 1938 |
| Low Interest Loans (Market Activity) | 1933 |
| Federal Regulation (Regulation) | 1971 |
| Construction and Operation of Federal Transmission Systems (Market Activity) | 1936 |
| Renewables (solar energy) | |
| Research and Development Activities (R&D) | 1950 |
| Tax Credits and Deductions (Taxation) | 1978 |
| Federal Programmes and Disbursements (Disbursements) | 1976 |
| Market Activities and Demonstration Programmes (Market Activity) | 1976 |
| Renewable Energy Production Incentive (Disbursements) | 1993 |
| Commodity Credit Corporation Programmes (Government Services) | 2001 |
| All Other Federal Support Activities (Government Services) | 1973 |
| Geothermal energy | |
| Research and Development Activities (R&D) | 1950 |
| Tax Credits and Deductions (Taxation) | 1978 |
| Market Activities and Demonstration Programmes (Market Activity) | 1976 |

*Source:* Management Information Services, Inc. (2006)

**Figure 1** Distribution of federal energy incentives among energy sources




*Source:* Management Information Services, Inc. (2006)

### *3.1 Research and development*

Federal support of energy research and development programmes began during the 1950s. However, Federal support of energy R&D became a major national priority after the first 'energy crisis' of 1973–1974. Due to the 1973 Arab oil embargo and the resulting rapid increases in oil prices, energy R&D changed from being a peripheral Federal interest to a major concern:

- In the summer of 1973, energy was a non-issue in the USA; less than a year later it was the most important issue.
- Prior to 1973, funding on energy R&D was minimal and unfocused; for many years after 1973 Federal spending for energy R&D programmes and research projects grew rapidly and expanded dramatically.

Of the $644 billion in total Federal incentives, research and development funding comprised about 18.7% – $120.7 billion. These R&D funds were not distributed evenly among technologies, and from Table 1 it is clear that three energy technologies – nuclear energy, coal, and renewable energy – have received 86% of all R&D support. In terms of R&D funding, 1976 was a watershed year, as this was the first year in which the new 'reformed' Federal energy organisations were fully in-place and the first year in which Federal energy R&D priorities became clearly established:

- As noted, most Federal energy R&D funding, representing 86% of the total spent since 1950, went to three electricity-generating energy sources: Nuclear, coal, and renewables.
- Prior to 1976, the primary focus of Federal research and development funding was nuclear energy. This funding concentrated on commercialisation of light water reactors and development of liquid metal fast breeder reactors judged necessary by industry and governments around the world to assure long-term supply of nuclear fuel.
- In 1976, coincidental with the reorganisation of the AEC into the NRC and ERDA, a major change in R&D priorities and funding occurred.
- R&D expenditures for all three electricity generating energy sources expanded greatly after 1975, but this increase was especially marked for coal and renewables – between 1976 and 2003 the Federal government spent six times as much on coal R&D as it had the previous quarter century, and more than ten times as much on renewables R&D.
- Most recently, major new energy R&D initiatives have been implemented and proposed that are related to climate change, fuel cells, and hydrogen. These have been primarily targeted toward renewables and coal.

### *3.2 Regulation*

Federal mandates and regulatory actions have been an important part of energy policy, accounting for $129.2 billion (20.1%) of energy incentives. There are essentially two types of regulatory actions the Federal government can undertake to promote energy development:

1 exemption from Federal regulations

2 payment by the Federal government of the costs of regulating the technology.

An example of the former type of regulatory incentive relates to the oil industry. This industry has benefited from:

- The exemption from price controls (during their existence) of oil produced from 'stripper wells'.
- The two-tier price control system, which was enacted as an incentive for the production of 'new' oil.
- The higher than average rate of return allowed on oil pipelines.

An example of the latter type of regulatory incentive relates to nuclear energy, and through 2003 the Federal government expended $9.9 billion on regulating the nuclear energy industry. These expenditures include the cost of administering the AEC and the NRC and are net of the regulatory user fees paid by utilities. Federal payments for regulating the nuclear energy industry were phased out during the 1980s, and since 1991 the industry has been paying for the costs of regulation.

### *3.3 Taxation*

Tax policy has been, by far, the most widely used incentive mechanism, accounting for $281 billion (43.7%) of all Federal incentives. One example of this policy relates to the oil and gas industries, which have utilised the percentage depletion and intangible drilling provisions of the Federal tax code as an incentive for exploration and development. Federal tax credits and deductions have also been utilised to encourage the use of renewable energy.

### *3.4 Disbursements*

Direct Federal grants and subsidies have played only a small role in energy policy, accounting for only $3.1 billion (0.5%) of incentive costs. An example of Federal disbursement subsidies has been, for the oil industry, subsidies for the construction and operating costs of oil tankers. Federal disbursements for nuclear energy are shown as negative because through 2003 the Nuclear Waste Trust Fund had accumulated a $14 billion surplus.

### *3.5 Government services*

This category refers to all services traditionally and historically provided by the Federal government without direct charge, and totalled $45.3 billion through 2003, representing 7% of total incentives. Relevant examples pertain to the oil industry and the coal industry.

The policy of the US government is to provide ports and inland waterways as free public highways. In ports that handle relatively large ships, the oil tankers represent the reason for deepening channels. They are usually the deepest draft vessels that use the port and a larger-than-proportional amount of total dredging costs are allocable to them. We estimated the expenditures for Federal navigation programmes and allocated

these costs as a petroleum subsidy according to the ratio of petroleum and petroleum products carried to all waterborne trade. Analogously, to estimate the incentives for coal production from Federal expenditures for ports and waterways, the costs for all improvements were multiplied by coal's share of the tons of total waterborne commerce.

### *3.6 Market activity*

Federal energy incentives consisting of direct Federal government involvement in marketplace activities totalled $64.7 billion through 2003 – 10% of all energy incentives. Most of this effort was expended on behalf of hydroelectric power, and, to a much lesser extent, on behalf of the oil industry.

Market intervention incentives for hydroelectric energy include the prorated costs of Federal construction and operation of dams and transmission facilities. These costs are prorated because, beginning in the 1930s, Federal dams and water resource projects have been multi-purpose. The results of these investments include flood control, navigation, recreation, regional development, and other benefits in addition to hydroelectric power. It is thus necessary to estimate that portion of the net investment in construction and operation of dams allocated to power development and the relevant transmission facilities.

Market activity incentives for the oil industry refer to the relevant planning, leasing, resource management, and related activities of the Bureau of Land Management of the Department of the Interior.

### *3.7 Matrix analysis*

A matrix analysis of Federal incentives for energy development was constructed, with the columns listing the energy sources and the rows listing the generic incentive categories. This matrix presentation is useful in comparing and contrasting Federal incentives for energy technologies. As noted, Table 1 illustrates the use of this classification scheme to estimate Federal incentives for energy development through 2003. Table 2 shows the time periods over which the incentives costs were estimated.

## 4 Generic federal incentives for energy

The incentives discussed below are the major ones that have been used by the Federal government to stimulate energy development, and Figure 1 shows the distribution of incentives among the energy sources.

### *4.1 Commercial nuclear energy*

Through 2003, Federal incentives for nuclear energy totalled $63.4 billion – 9.8% of Federal energy incentives.

### 4.1.1 Research and development

Federal R&D expenditures for nuclear energy, expended primarily by the Atomic Energy Commission, the Energy Research and Development Administration, and the Department of Energy, totalled $60.6 billion through 2003.

### 4.1.2 Regulation

Through 2003 the Federal government expended $9.9 billion on regulating the nuclear energy industry. These expenditures include the cost of administering the NRC/AEC and are net of the regulatory user fees paid by utilities.

### 4.1.3 Taxation

There have been no tax incentives specifically designed to subsidise nuclear energy.[2]

### 4.1.4 Disbursements

There initially were Federal disbursements for nuclear energy for waste management and disposal – these funds are included under R&D monies. However, under the Nuclear Waste Policy Act of 1982 nuclear utilities are assessed the costs of developing a high level waste depository for spent fuel from nuclear plants. Through 2003 this fund had accumulated $14 billion more than had been disbursed.

Through 2003, the Federal government has expended approximately $5.7 billion for environmental restoration related to commercial nuclear energy. Thus, Federal disbursements for nuclear energy net to – $8.3 billion.

### 4.1.5 Government services

Federal support activities related to nuclear energy development exist in about 45 Departments and Agencies other than DOE and NRC, but the expenditures are very small compared to the funds spent by DOE and NRC. We estimated that through 2003 the total for all other Federal incentives and support activities was about $1.2 billion.

### 4.1.6 Market activity

There has been no direct Federal government involvement in market activity with respect to commercial nuclear energy.

## 4.2 Coal

Through 2003, Federal incentives for coal totalled $80.9 billion – 12.6% of Federal energy incentives.

### 4.2.1 Research and development

Through 2003 the coal industry received $27.3 billion in R&D funding. Most of these expenditures were Federal coal R&D monies. However, significant expenditures were also derived from pro-rated expenditures of selected US Geological Survey (USGS) and Bureau of Mines (BOM) programmes.

### *4.2.2 Regulation*

Federal expenditures for regulating mine health and safety and other aspects of the coal industry totalled $6.2 billion through 2003.

### *4.2.3 Taxation*

Through 2003, we estimated that the percentage depletion allowance for coal, the expensing of exploration and development costs, capital gains treatment of royalties on coal, and exclusion of interest on energy facility bonds resulted in a tax subsidy of $26.7 billion.

### *4.2.4 Disbursements*

As of 2003, the Black Lung Disability Trust Fund had a positive balance of $1.5 billion, and the Abandoned Mine Reclamation Fund had a negative balance of $7.9 billion, resulting in net Federal disbursements for the coal industry of approximately $6.4 billion.

### *4.2.5 Government services*

Federal support of ports and waterways (primarily through the US Army Corps of Engineers), allocated and prorated to the coal industry, totalled $12.6 billion through 2003.

### *4.2.6 Market activity*

Market activity incentives for the coal industry totalled $1.7 billion through 2003, through the activities of the Bureau of Land Management (BLM) and other Federal agencies.

## *4.3 Oil*

Through 2003, Federal incentives for oil totalled $302.1 billion – 46.9% of Federal energy incentives.

### *4.3.1 Research and development*

Through 2003, Federal R&D incentives for the oil industry totalled $6.7 billion. These resulted from:

- federal R&D expenditures for the oil industry
- the pro-rated costs of selected USGS and BOM programmes.

### *4.3.2 Regulation*

Incentive costs under this category totalled $106.1 billion through 2003. These resulted from:

- the exemption from price controls (during their existence) of oil produced from ‘stripper wells’

- the two-tier price control system, which was enacted as an incentive for the production of 'new' oil
- the costs of oil industry regulation
- the higher than average rate of return allowed on oil pipelines.

### *4.3.3 Taxation*

We estimate that through 2003 tax incentives for the oil industry totalled $155.4 billion. These tax expenditures resulted primarily from the percentage depletion allowance and from deducting as a current expense 'intangible drilling and development costs'.

### *4.3.4 Disbursements*

Through 2003 the Federal government disbursed approximately $5.2 billion to the oil industry, primarily through subsidies for construction and operating costs of oil tankers. However, as of 2003, the combined balances in the Leaking Underground Storage Tank Trust Fund and the Oil Spill Liability Fund totalled $3.1 billion. Thus, the net Federal disbursements for the oil industry totalled $2.1 billion through 2003.

### *4.3.5 Government services*

Government services incentives ($27.2 billion) resulted primarily from the pro-rated cost of maintaining ports and inland waterways, and, to a lesser extent, from the support of numerous Federal agencies through 2003.

### *4.3.6 Market activity*

Market activity incentives for the oil industry refer to the planning, leasing, resource management, and related activities of the BLM. We estimated that the pro-rated costs of these totalled $4.5 billion through 1997.

## *4.4 Natural gas*

Through 2003, Federal incentives for natural gas totalled $87.1 billion – 13.5% of Federal energy incentives.

### *4.4.1 Research and development*

Through 2003, Federal R&D funds for the natural gas industry totalled $5.6 billion. These resulted from Federal R&D expenditures for the gas industry and the pro-rated costs of selected USGS and BOM programmes.

### *4.4.2 Regulation*

Incentive costs under this category totalled $2.9 billion through 2003. These resulted from the net effects of the costs of Federal regulation and the net effects of wellhead price controls (which historically have served at some times as an incentive and at other times as a disincentive for natural gas production).

### *4.4.3 Taxation*

We estimate that through 2003 tax incentives for the natural gas industry totalled $75.6 billion. These tax expenditures resulted primarily from:

- the percentage depletion allowance and from deducting as a current expense 'intangible drilling and development costs' – both allocated on the basis of well head values
- the alternative fuel production credit.

### *4.4.4 Disbursements*

Federal government disbursements to the natural gas industry were negligible.

### *4.4.5 Government services*

Traditional services incentives ($1.3 billion) resulted primarily from miscellaneous services provided by the Federal government to the industry through 2003.

### *4.4.6 Market activity*

Market activity incentives for the natural gas industry refer to the planning, leasing, resource management, and related activities of the BLM. We estimated that the pro-rated costs of these totalled $1.7 billion through 2003.

## *4.5 Hydroelectric energy*

Through 2003, Federal incentives for hydroelectric energy totalled $72.6 billion 11.3% of Federal energy incentives.

### *4.5.1 Research and development*

Through 2003, Federal R&D expenditures for hydroelectric energy in the Department of Energy, its predecessors, and the Corps of Engineers totalled approximately $1.2 billion.

### *4.5.2 Regulation*

Expenditures for the regulation of hydroelectric energy through FERC and other regulatory agencies totalled approximately $4.1 billion through 2003.

### *4.5.3 Taxation*

We estimate that through 2003 that the exemption of power revenues from Federal taxes resulted in a tax expenditure subsidy for the development of hydroelectric energy of $10.5 billion.

### 4.5.4 Disbursements

Through 2003 the Federal government disbursed $1.4 billion for hydroelectric energy development.

### 4.5.5 Government services

Traditional services through the support of numerous Federal agencies resulted in a subsidy for hydroelectric energy of $1.3 billion through 1997.

### 4.5.6 Market activity

Market activity incentives for hydroelectric energy include Federal construction and operation of dams and transmission facilities – estimated as the portion of the net investment in construction and operation of dams allocated to power development and the relevant transmission facilities – and the net expenditures of the power marketing administrations. These incentives totalled $54.1 billion through 2003.

## 4.6 Renewables

Through 2003, Federal incentives for renewables (solar, wind, biomass, and photovoltaics) totalled $32.6 billion – 5.1% of the Federal energy incentives.

### 4.6.1 Research and development

Through 2003, Federal R&D incentives for renewable energy totalled $16.4 billion. These resulted primarily from Federal R&D expenditures by the Energy Research and Development Administration and the Department of Energy.

### 4.6.2 Regulation

Federal incentive costs for renewable energy under this category were negligible.

### 4.6.3 Taxation

We estimate that through 2003 tax incentives for renewable energy totalled $11.7 billion. These tax expenditures resulted primarily from targeted, exclusive Federal tax credits and deductions for renewable energy applications for individuals and businesses, beginning in 1978 – including the alcohol fuel credit and the partial exemption from the excise tax for alcohol fuels.

### 4.6.4 Disbursements

Federal government disbursements to encourage renewable energy utilisation through various Federal programmes, including the Renewable Energy Production Incentive, totalled $1.5 billion.

### *4.6.5 Government services*

Government services incentives of $1.7 billion resulted primarily from miscellaneous services provided by various Federal agencies, including the Commodity Credit Corporation, to encourage renewable energy development.

### *4.6.6 Market activity*

Market activity incentives for renewable energy include commercialisation programmes, demonstration projects, and outreach programmes, and totalled $1.3 billion through 2003.

## *4.7 Generic incentives for geothermal energy*

Through 2003, Federal incentives for geothermal energy totalled $5.7 billion – 0.9% of the Federal incentives for energy development.

### *4.7.1 Research and development*

Through 2003, Federal R&D spending for geothermal energy totalled $2.9 billion. These resulted primarily from Federal R&D expenditures by the Energy Research and Development Administration and the Department of Energy.

### *4.7.2 Regulation*

Federal incentive costs for geothermal energy under this category were negligible.

### *4.7.3 Taxation*

We estimate that through 2003, targeted tax expenditure incentives for geothermal energy totalled $1.4 billion.

### *4.7.4 Disbursements*

Federal government disbursements to encourage geothermal energy were negligible.

### *4.7.5 Government services*

Government services incentives for geothermal energy were negligible.

### *4.7.6 Market activity*

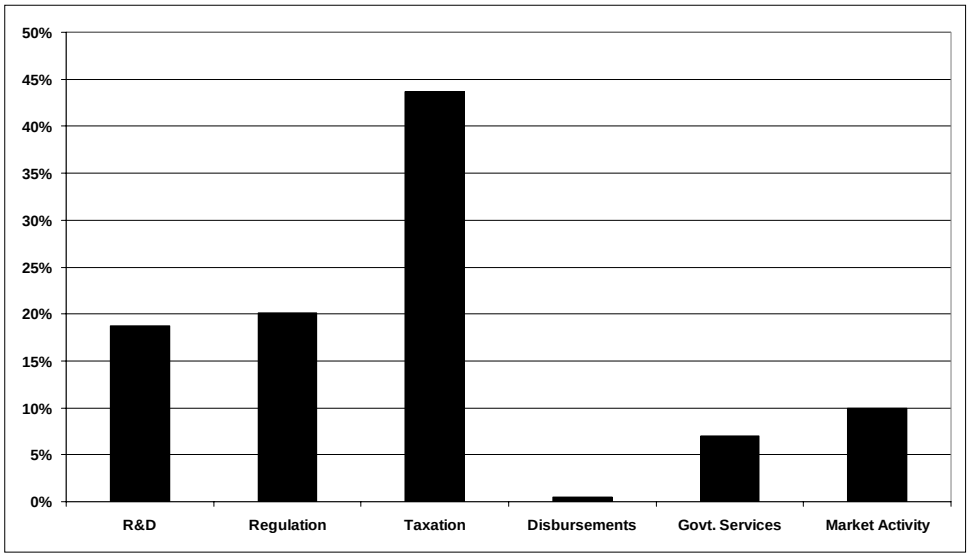
Market activity incentives for geothermal energy include commercialisation programmes and demonstration projects, and totalled approximately $1.4 billion through 2003.

# 5 Findings and implications

We disaggregated Federal energy subsidies and incentives into six categories: R&D, Regulation, Taxation, Disbursements, Government Services, and Market Activity and estimated Federal support within each category for each energy source over the past five decades – Table 1 and Figures 1 and 2. We found that the distribution of these subsidies

was highly skewed, with subsidies for the oil industry comprising nearly half of all Federal support – $302 billion (47%) out of a total of $644 billion energy subsidies. Thus, the conventional wisdom that the oil industry has been the major beneficiary of Federal financial largess is essentially correct.

**Figure 2** Distribution of federal energy incentives among generic incentive categories




*Source:* Management Information Services, Inc. (2006)

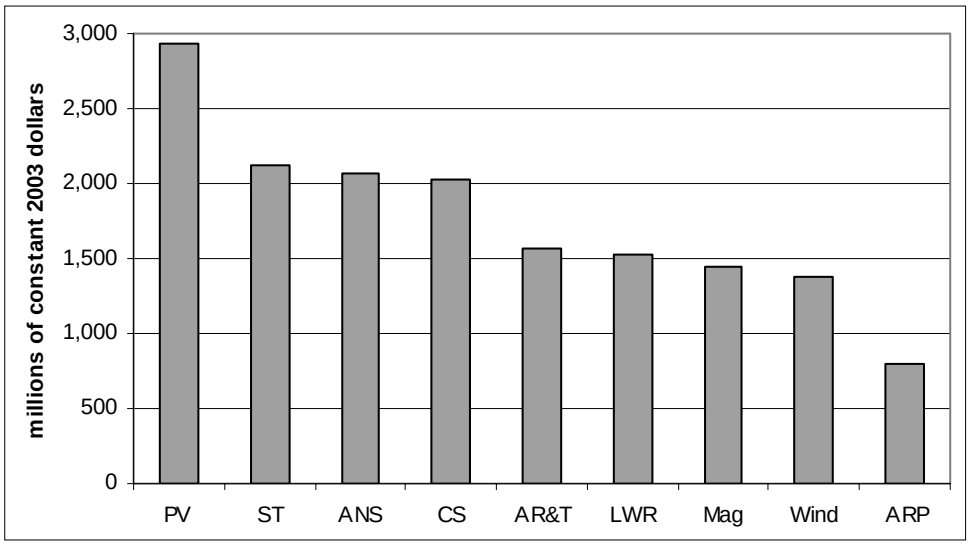
On the other hand, we found that the general perception that renewable energy sources have been historically short-changed at the expense of other energy sources is open to debate. Renewable energy (solar, hydro, and geothermal) received the second largest subsidy – $111 billion (17%), compared to $63 billion for nuclear energy, $81 billion for coal, and $87 billion for natural gas.

Another important finding is that 65% – $410 billion – of Federal energy funding was 'off-budget'. These funds were never proposed by the President or directly appropriated by the Congress. Rather, they consisted of foregone tax revenues, regulatory actions, and other off-budget provisions. There is thus ample precedent for using regulations and tax incentives to address critical energy and environmental issues, including energy security, oil import dependence, and climate change – as is currently being widely proposed.

We also found that, over the three decades since the 'energy crisis' of the 1970s, critically important Federal R&D support has tended to favour specific solar and renewable energy technologies rather than nuclear and fossil fuel technologies. As illustrated in Figure 3, Photovoltaics and Solar Thermal Energy Systems have received more R&D funding than any fossil or nuclear technology.

The subsidy mechanisms vary markedly both in total and in importance among energy sources. Figure 2 shows that tax incentives have been, by far, the most prominent Federal subsidy and accounted for 44% of all Federal support. Most of this support was in the form of tax incentives for oil and natural gas. Regulation was the second most important subsidy source, and R&D expenditures were the third most important type of Federal subsidy.

**Figure 3** Federal research and development expenditures for selected nuclear, coal, and renewables technologies, 1976–2003




Notes: PV: Photovoltaics (renewables); ST: Solar Thermal (Renewables); ANS: Advanced Nuclear Systems (Nuclear); CS: Combustion Systems (Coal); AR&T: Advanced Research and Technology (Coal); LWR: Light Water Reactor (Nuclear); Mag: Magnetohydrodynamics (Coal); Wind: Wind Energy Systems (renewables); ARP: Advanced Radioisotope Power Systems (Nuclear).

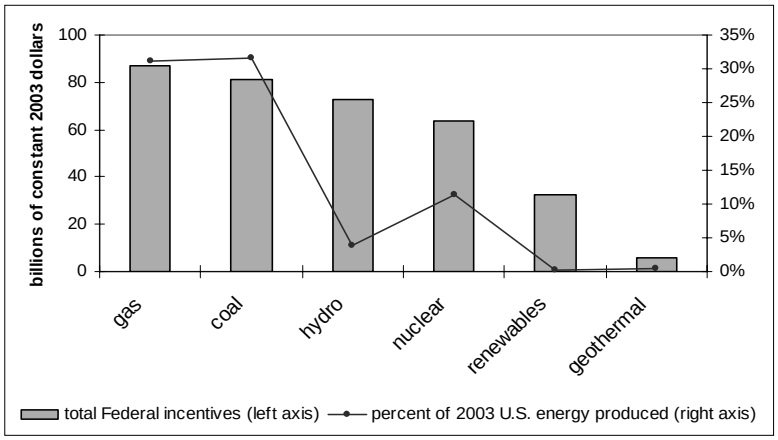
*Source:* Management Information Services, Inc. (2006)

The rows of Table 1 illustrate what mechanisms the Federal government has chosen to utilise to subsidise different energy sources:

- Federal R&D funds were of primary importance to nuclear, solar, and geothermal energy.
- For natural gas, tax incentives comprised 87% of Federal subsidies.
- For hydroelectric power, Federal market activities comprised 75% of Federal subsidies.
- For coal, tax incentives and R&D support each provided about 33% of the subsidies.

These subsidies – and energy and environmental policies and proposals based on similar types of incentives – must be assessed in perspective, for the energy sources make dramatically different contributions to the US energy mix. As illustrated in Figure 4, there is considerable disparity in the level of the incentives received by the different energy sources and their current contributions to the US energy mix.

**Figure 4** Federal energy incentives through 2003, compared to US 2003 energy production

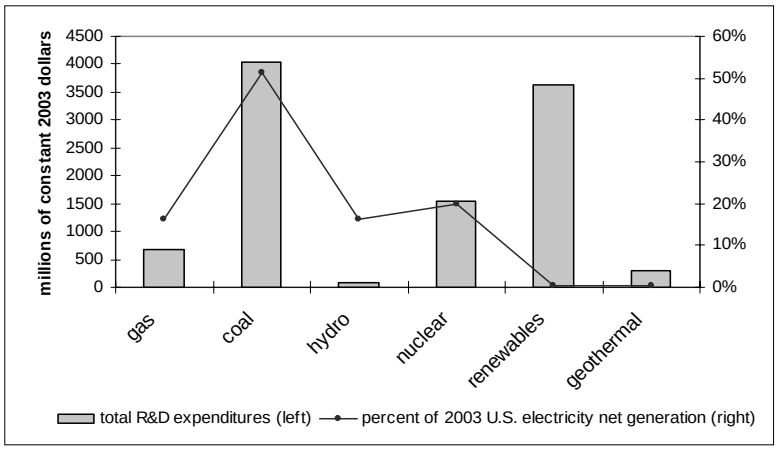



*Source:* Management Information Services, Inc. (2006)

In particular, recent (1994–2003) Federal R&D expenditures bear little relevance to these contributions (Figure 5):

- Coal provides about one-third of US energy requirements, generates over half of the nation's electricity, and received $3.9 billion in R&D funds.
- Natural gas provides 25% of US energy, generated 10% of the nation's electricity, and received $800 million in R&D monies.
- Nuclear energy provides 10% of US energy, generates 20% of the nation's electricity, and received $1.6 billion in R&D support.
- Photovoltaics, solar thermal systems, wind, and other solar/renewable technologies (excluding hydro) produce little energy or electricity, but received $3.7 billion in R&D funds.

**Figure 5** Federal research and development expenditures, 1994–2003, compared to US 2003 electricity production




*Source:* Management Information Services, Inc. (2006)

Major findings that emerge from our research include:

- The Federal government has subsidised the energy sector primarily (nearly two-thirds) through 'off-budget' monies that were not part of the Federal budget.
- The general perception that the oil industry has been the major beneficiary of Federal subsidies is correct, with this source receiving nearly half of all subsidy support.
- The perception that renewable energy has been short-changed at the expense of other energy sources is not correct: Federal subsidies for renewable energy (including hydroelectric power) totalled $111 billion, compared to $87 billion for natural gas and less for each coal and nuclear.
- Evaluated against the contributions being made by different energy sources to US energy supply, oil has received roughly its proportionate share of energy subsidies, nuclear energy, natural gas, and coal may have been under-subsidised, and renewables – especially solar energy – may have received a disproportionately large share of Federal energy incentives.
- With respect to recent R&D the disparity may be even greater: Coal and nuclear technologies have been underfunded, while solar technologies such as photovoltaics, solar thermal, and wind have been well funded.
- Forecasts through 2030 indicate that, absent a major change in US energy policy, the contributions of renewables to energy and electricity production will remain small, and federal incentives for these technologies will produce a minimal return on investment.

Federal subsidies and incentives can impact US energy policy, environmental policy, and global warming abatement policies for decades into the future, and the debate over energy policy, energy incentives, and federal energy R&D programmes must be informed by the findings reported here. In particular, there appears to be an emerging consensus that continued and expanded federal support for renewable energy technologies – including R&D, tax incentives, regulatory programmes, *etc.* – is warranted. This support should be coupled with appropriate policies to ensure that, in the future, renewable technologies penetrate the market and make substantial contribution to the US energy mix. Absent this, federal incentives will not generate an adequate return on the funds expended.

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## Notes

1 Our analysis spans more than five decades (1950–2003), during which the general price level in the USA increased more than sixfold. Further, price increases were not distributed uniformly over the period, with the most severe inflation occurring in the early 1950s, the 1970s, and early 1980s. Thus, the only meaningful way to compare and analyse Federal energy incentives over this period is to use constant dollar data, and all the estimates given here are stated in constant 2003 dollars. We derived the constant 2003 dollar data (2003 = 1.00), using the GDP deflators to convert current dollar data into 2003 base year estimates.

2 See the discussion in Roger H. Bezdek and Robert M. Wendling (1991) 'Costs and results of federal incentives for commercial nuclear energy', *Energy Systems and Policy*, Vol. 15, pp.269–293; and US Energy Information Administration, *Federal Financial Interventions and Subsidies in Energy Markets in 1999*, September 1999. The Tax Reform Act of 1986 included a 15 year accelerated depreciation period for nuclear power plants. However, under the reference tax law standard used by the Department of the Treasury, the Office of Management and Budget, and the Joint Committee on Taxation of the US Congress to estimate tax expenditures, the system of deprecation allowances provided by this Act is the reference tax law baseline for investments. Thus, there are no specific tax expenditures for nuclear from accelerated depreciation.