

WORLD COAL

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Allocating funds

Roger H. Bezdek and Robert M. Wendling, Management Information Services, Inc., US, ask, after half a century of Federal incentives for the coal industry, what do the numbers show and what do they mean?

The Federal Government has supported the development of US energy resources (including coal) in many diverse ways. Federal incentives for energy have included subsidies, regulation, R&D, tax incentives, market support, demonstration programmes, procurement mandates, information dissemination, technology transfer and other types of actions. This article will estimate and assess Federal incentives for the coal industry over the past half century.

Table 1 shows Management Information Services estimate that Federal energy incentives totalled US\$ 644 billion through to 2003 (2003 dollars). Of these incentives, coal received approximately US\$ 81 billion (13%). The company has classified these incentives within six generic categories. Table 1 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 and credits, etc. related to the Federal tax code.
- Disbursements - financial subsidies, such as grants.
- Government services - assistance provided by the Federal Government without charge.
- Market activity - Federal involvement in the marketplace.

Matrix analysis

A matrix analysis of Federal incentives 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. Table 1 illustrates the use of this classification

scheme to estimate Federal incentives for energy throughout 2003 (2003 dollars).

Identification of specific incentives for coal

The major Federal incentives for the coal industry can be summarised as follows. Table 2 shows the time periods over which the incentives costs were estimated.

Research and development

Throughout 2003 the coal industry received US\$ 27.3 billion in R&D funding. Most of this expenditure was Federal coal R&D monies. However, significant expenditures were also derived from pro-rated expenditures of selected US Geological Survey and Bureau of Mines programmes.

Regulation

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

Taxation

Throughout 2003 Management Information Services 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 US\$ 26.7 billion.

Disbursements

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

Government services

Federal support of ports and waterways (primarily through the US Army Corps of Engineers), was allocated and prorated to the

coal industry. This totalled US\$ 12.6 billion throughout 2003.

Market activity

Market incentives for the coal industry totalled US\$ 1.7 billion throughout 2003, through the activities of the Bureau of Land Management and other Federal agencies.

The distribution of Federal incentives for the coal industry

Management Information Services estimates that, as shown in Table 1, Federal energy incentives totalled US\$ 644.3 billion throughout 2003 (2003 dollars). The way in which the Federal Government has supported different types of energy differs markedly. Of the US\$ 644.3 billion in Federal energy incentives, approximately 13%, (US\$ 81 billion) was for coal. Specifically, as illustrated in Table 1 and Figure 1, incentives for the coal industry were distributed as follows:

- R&D expenditure was the most important. Of the US\$ 81 billion in Federal coal incentives, US\$ 27.3 billion (34%) was in R&D expenditure. This represented 23% of total Federal energy R&D spending over the period. Thus, while the coal industry received 13% of all Federal energy incentives, it received 23% of all Federal energy R&D funding over the past half century.
- The second most important form of Federal support for coal was tax incentives, which totalled US\$ 26.7 billion (33%). This represented 10% of all Federal energy tax incentives over the period.
- Government services represented the third most important form of Federal incentives for coal, and totalled US\$ 12.6 billion (16%), 28% of all Federal energy Government services incentives. Thus, while the coal industry received 13% of all Federal energy incentives,

Table 1. The total cost of Federal incentives for energy development throughout 2003 (billions of 2003 dollars)

	Nuclear	Hydro	Coal	Oil	Natural Gas	Solar	Geothermal	Total	Percent
Research and development	US\$ 60.6	US\$ 1.2	US\$ 27.3	US\$ 6.7	US\$ 5.6	US\$ 16.4	US\$ 2.9	US\$ 120.7	18.7
Regulation	US\$ 9.9	US\$ 4.1	US\$ 6.2	US\$ 106.1	US\$ 2.9	US\$ 0	US\$ 0	US\$ 129.2	20.1
Taxation	US\$ 0	US\$ 10.5	US\$ 26.7	US\$ 155.4	US\$ 75.6	US\$ 11.7	US\$ 1.4	US\$ 281.3	43.7
Disbursements	US\$ -8.3	US\$ 1.4	US\$ 6.4	US\$ 2.1	US\$ 0	US\$ 1.5	US\$ 0	US\$ 3.1	0.5
Government services	US\$ 1.2	US\$ 1.3	US\$ 12.6	US\$ 27.2	US\$ 1.3	US\$ 1.7	US\$ 0	US\$ 45.3	7.0
Market activity	US\$ 0	US\$ 54.1	US\$ 1.7	US\$ 4.5	US\$ 1.7	US\$ 1.3	US\$ 1.4	US\$ 64.7	10.0
Total	US\$ 63.4	US\$ 72.6	US\$ 80.9	US\$ 302	US\$ 87.1	US\$ 32.6	US\$ 5.7	US\$ 644.3	
Percent	9.8	11.3	12.6	46.9	13.5	5.1	0.9		100

Source: Management Information Services, Inc., 2006.

Table 2. Dates from which Federal incentives for the coal industry were derived

Incentive Category and Matrix Designation	Year
Research and Development (R&D)	1950
United States 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

Source: Management Information Services, Inc., 2006.

Table 3. Summary of Federal research and development expenditure for coal, 1950 - 1975 (millions of 2003 dollars)

Year	Expenditures (US\$)	Year	Expenditures (US\$)
1950	79	1964	98
1951	74	1965	90
1952	74	1966	100
1953	73	1967	117
1954	58	1968	142
1955	48	1969	129
1956	52	1970	153
1957	57	1971	256
1958	68	1972	371
1959	66	1973	554
1960	79	1974	769
1961	93	1975	1049
1962	92		

Source: Management Information Services, Inc., 2006.

it received 28% of all Federal energy Government services incentives over the past half century.

- Federal disbursements totalled US\$ 6.4 billion and regulatory incentives totalled US\$ 6.2 billion, each representing approximately 8% of Federal coal industry incentives.
- Market incentives totalled US\$ 1.7 billion, 2% of Federal coal incentives.

and safety, coal utilisation and pollution control. This research was conducted at the Bureau of Mines (BOM) of the Department of the Interior, the Environmental Protection Agency and ERDA/DOE.

From the 1940s through to 1996 (when it was abolished) BOM conducted extensive R&D pertaining to coal mining, preparation and utilisation. This research included mining methods and systems, mechanisation of

operations, coal cleaning processes and factors to increase the productivity of mines. BOM made field and laboratory examinations and analyses of the chemical constituents of coal and developed improved coal treatment technologies to upgrade the quality of coal by reducing the amount of ash, sulphur and other coal constituents.

Extensive coal-related environmental research is underway within Federal agencies, including scrubbers, fluidised bed combustion, solvent refining and other processes. This includes expenditure by the EPA, in addition to those expended by BOM and the DOE, for research to mitigate the environmental impact of coal utilisation.

In addition to R&D on coal combustion techniques, the DOE has engaged in extensive research on coal gasification, coal liquefaction, pulverised coal combustion, carbon sequestration and solvent refining. Research has also been conducted by the DOE on the preparation of coal to reduce impurities, including sulphur, as an alternative to post-combustion abatement.

The coal research programme

Federal coal R&D includes a wide variety of technologies for promoting the use of coal. The programme conducts the research that is necessary to strengthen the scientific and engineering technology base. It funds generic and technology based R&D and environmental research and supports experimental facilities, pilot plants and test facilities. The programme supports long-term, high risk R&D at universities, national labs and private firms.

Recent budgets focused on the super clean and efficient systems needed for the electric power market under stringent environmental requirements and on reducing the cost of coal-to-liquids, primarily transport fuels from coal. Research is being conducted to control and dispose of CO₂ emissions and to reduce sulphur, nitrous oxides and toxic air emissions from coal-fired power plants.

Federal R&D expenditures for coal

Background

Coal currently provides over half of the US nation's electricity and nearly a quarter of its total energy supply. The Federal Government has funded a substantial coal research programme over the past five decades, including R&D for coal production, R&D on resource assessment, mining techniques, mining health

Table 4. Federal R&D expenditure for coal by major programme: financial year 1976 - 1997 (millions of constant 2003 dollars)

Area of expenditure	Expenditure for each financial year (US\$)											
	1976	1976tq	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
US Department of Energy	926	238	1243	1433	1593	1639	1521	854	406	343	367	356
Control technology and coal preparation	-	-	-	-	-	-	-	44	48	43	57	50
Advanced research and technology development	99	25	116	124	105	127	95	100	62	64	64	51
Coal liquifaction	276	72	294	275	471	449	633	408	65	48	41	50
Combustion systems	130	39	148	168	135	157	116	73	41	30	48	44
Heat engines	-	-	-	-	133	132	86	27	9	11	19	19
Magnetohydrodynamics	95	25	106	178	137	170	153	50	50	50	49	43
Surface coal gasification	219	44	379	522	366	357	207	95	66	62	51	63
Underground coal gasification	-	-	-	-	34	21	19	14	10	10	12	7
Mining research and development	-	-	137	153	174	141	82	20	-	-	-	-
Advanced environmental control technology	-	-	-	-	16	50	95	-	-	-	-	-
Programme direction and management support	-	-	-	-	23	25	23	21	54	27	27	30
Miscellaneous	107	33	61	12	-	10	10	-	-	-	-	-
US Environmental Protection Agency	199	64	318	295	304	325	322	154	89	104	133	129
US Department of the Interior, Bureau of Mines	188	44	217	233	178	141	110	84	66	92	70	60
Total coal energy R&D (US\$)	1314	348	1777	1960	2076	2104	1952	1090	561	541	570	545

Source: Management Information Services Inc., 2006.

Table 5. Federal coal R&D: financial year 1998 - 2000 (millions of constant 2003 dollars)

Area of expenditure	Expenditure for each financial year (US\$)		
	1998	1999	2000
US Department of Energy	203	224	225
Advanced electric power systems	79	95	85
Advanced pulverised coal technology	18	16	2
Indirectly fired cycle	5	8	7
Gasification combined cycle	24	35	37
Pressurised fluid bed	20	16	13
Advanced research and environmental	14	21	25
Advanced clean fuel research	18	17	21
Coal preparation	5	5	4
Coal liquefaction	7	10	7
Steelmaking feedstock	4	-	7
Advanced research and environmental	1	2	2
Advanced research and technology development	20	22	24
Fuel cells	44	48	48
Miscellaneous R&D	7	7	6
Programme direction and management support	34	36	40
US Environmental Protection Agency Coal R&D	123	127	107
Total Federal Coal R&D	326	351	333

Source: US Department of Energy, US Environmental Protection Agency and Management Information Services Inc., 2006.

The major programme components since 1976 include the following:

- Gasification combined cycle.
- Pressurised fluid bed.
- Fuel cells.
- Carbon capture and sequestration.
- Transportation fuels and chemicals.
- Control technology and coal preparation.
- Advanced research and technology development.
- Coal liquefaction.
- Combustion systems.
- Heat engines.
- Magnetohydrodynamics.
- Underground and surface coal gasification.
- Mining R&D.
- Advanced environmental control technology.
- Coal research at EPA and BOM.

Federal coal R&D expenditures

Federal coal research programmes between 1950 and 1975 were conducted within the BOM and EPA. These expenditures are shown in Table 3, which illustrates that over a 26 year period the Federal Government invested US\$ 4.8 billion (2003 dollars) in coal R&D. Coal R&D was relatively constant in real terms during the 1950s, increased gradually between 1960 and 1968, and then increased more than eight-fold between 1969 and 1975.

Tables 4, 5 and 6 show the detailed Federal coal R&D programmes that were undertaken at DOE, BOM and EPA over the period 1976 - 2003. Over this period, coal R&D expenditure totalled US\$ 22.4 billion. This increased rapidly from 1976 through to 1980, reaching an all-time high of US\$ 2.1 billion in 1980. Expenditure decreased slightly to US\$ 1.95 billion in 1981 and then decreased drastically, falling by nearly 75% to US\$ 540 million by 1984. Thereafter, coal R&D expenditure remained relatively constant until 1990, and then decreased gradually thereafter, declining to US\$ 253 million in 1997, at which time it was, in real terms, only 12% of the 1980 total. However, by 2003, coal R&D funding had increased to US\$ 575 million, the highest level in two decades.

Conclusion

Focusing on the period 1976 - 2003 the following conclusions can be drawn, which are illustrated in Figure 2:

- The largest share of R&D funds was allocated to environment related coal research programmes at the EPA, which spent US\$ 4.4 billion, 20% of the total. When combined with the environmental research programmes within the DOE, environmental research accounted for 25% of the coal R&D budget.
- Coal liquefaction received the second largest share of the coal R&D budget, at 16% (US\$ 3.5 billion).
- R&D expenditure for surface coal gasification totalled US\$ 2.7 billion, 12% of the total.
- The research programme at the BOM, which consisted of a variety of coal-related research programmes, spent US\$ 2.1 billion over this period, 9% of the total.
- Research spending on combustion systems totalled US\$ 2.3 billion (10% of the total), and spending on

Area of expenditure	Expenditure for each financial year (US\$)		
	FY 2001	FY 2002	FY 2003
US Department of Energy	409	485	483
Clean coal power initiative	—	149	146
Central systems	207	96	92
Innovations for existing plants	21	23	22
Advanced systems			
Integrated gasification combined cycle	43	43	43
Pressurised fluidised bed	12	11	10
Turbines	32	18	17
Power plant improvement initiative	99	—	—
Sequestration	20	32	39
Fuels			
Transportation fuels and chemicals	8	26	21
Solid fuels and feedstocks	4	5	6
Advanced fuels research	5	4	3
Steelmaking	7	—	—
Advanced research			
Coal utilisation science	6	6	9
Materials	7	7	9
Technology crosscut	13	11	11
Other advanced research	4	6	3
Fuel cells	55	58	59
Miscellaneous R&D	10	15	14
Programme direction and management support	61	69	70
US Environmental Protection Agency Coal R&D	101	101	92
Total Federal Coal R&D (US\$)	510	586	575

Source: US Department of Energy, US Environmental Protection Agency and Management Services Inc., 2006.

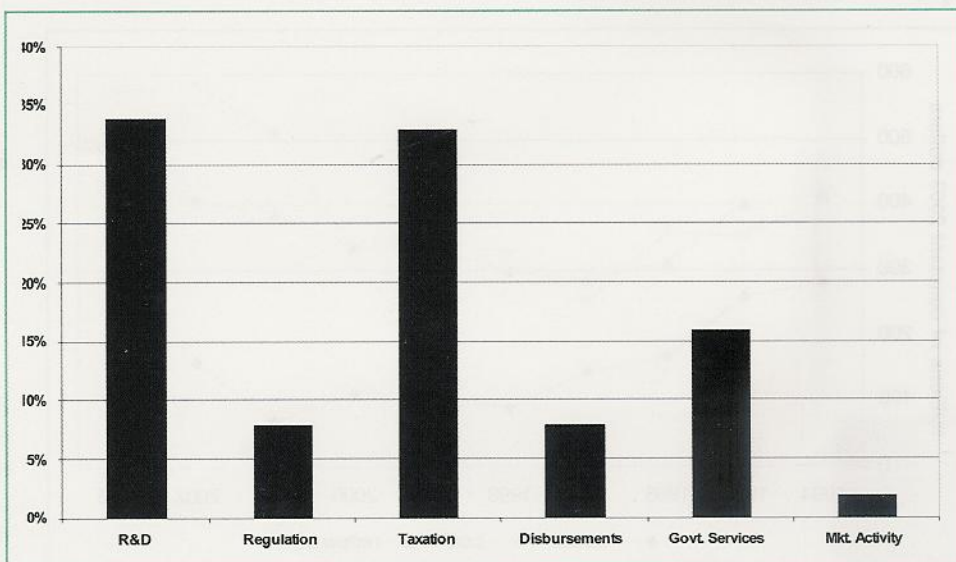


Figure 1. The distribution of Federal incentives for the coal industry.

Magneto-hydrodynamics totalled US\$ 1.4 billion (6%).

- Federal coal R&D spending in 1997 was, in real terms, the lowest since 1971, but by 2003 it had increased to more than double the 1997 level.

Analysis of Federal energy R&D budget data over the past four decades shows the following:

- Most Federal energy R&D funding, representing 86% of the total spent since 1950, went to three energy sources: coal,

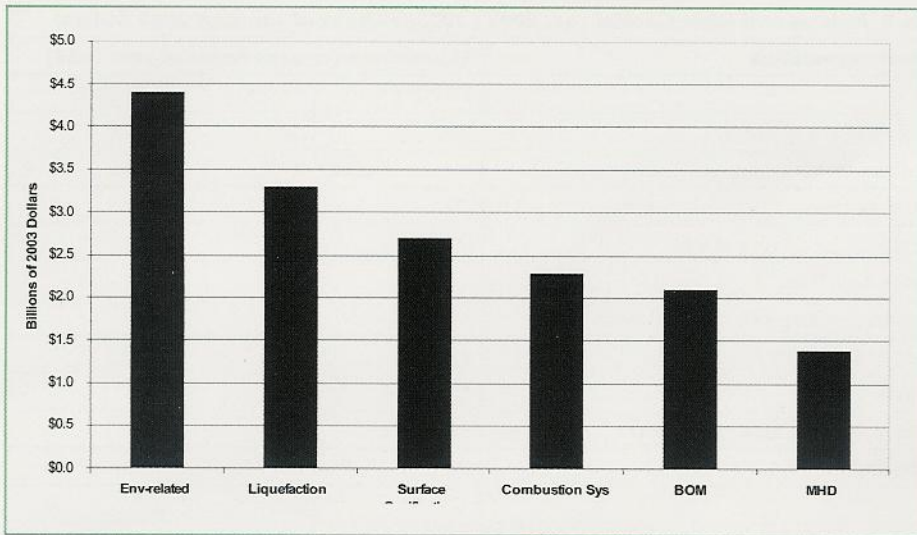


Figure 2. Federal coal R&D expenditure 1976 - 2003.

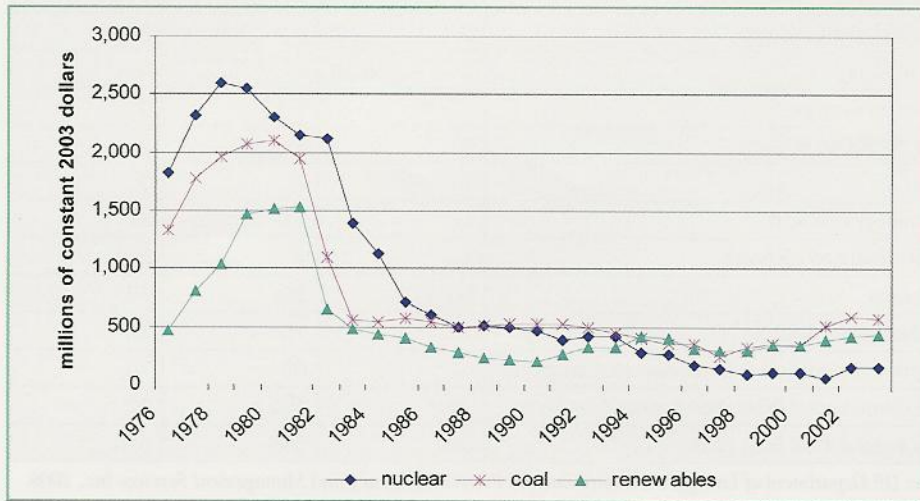


Figure 3. Federal R&D expenditure 1976 - 2003.

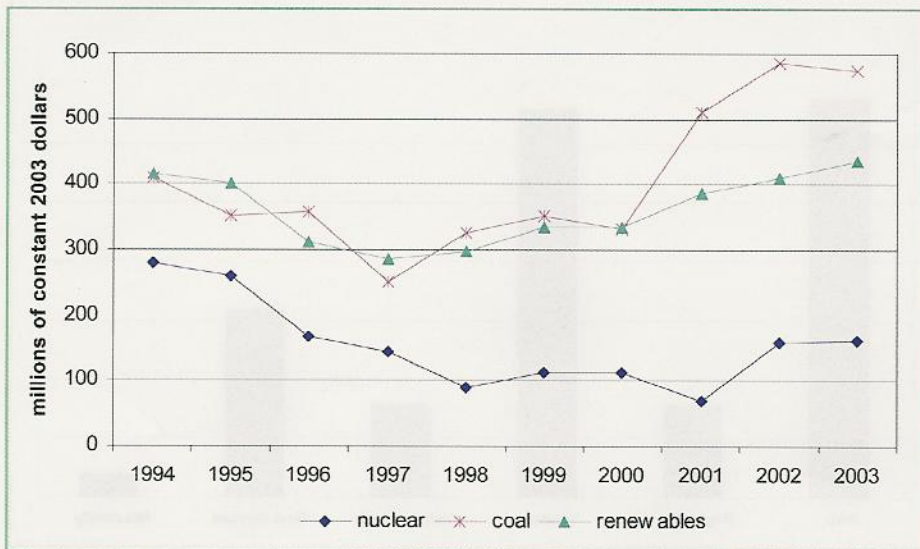


Figure 4. Federal research and development expenditure 1994 - 2003.

- nuclear, and renewables (excluding hydroelectricity and geothermal energy) (Table 1).
- Prior to 1976, the primary focus of Federal R&D funding was nuclear energy. This funding concentrated on

- commercialisation of light water reactors and the development of breeder reactors.
- In 1976, following the reorganisation of the AEC into the NRC and ERDA, a major change in R&D priorities and funding occurred.

- R&D expenditure for all three energy sources expanded greatly after 1975, but this increase was especially marked for coal and renewables. Between 1976 and 2003 the Federal Government spent nearly five times as much on coal R&D as it had over the previous quarter century and nearly ten times as much on renewables R&D (Figure 3).
- R&D expenditure for all three technologies peaked between 1979 and 1981 and then declined dramatically. This decline continued through the late 1990s (Figure 3).
- Over the past decade Federal R&D priorities shifted and by 2003 R&D expenditure for coal was 33% larger than for renewables and nearly four times as large as for nuclear energy. In 2003, Federal R&D expenditure for renewables was nearly three times as large as for nuclear energy (Figure 4).

In terms of support for electric generation technologies, cumulative R&D expenditure between 1976 and 2003 favoured coal and renewables technologies (Figure 5).

- In the nuclear energy programme, US\$ 1.5 billion was spent on light water reactors and US\$ 2.1 billion was spent on advanced nuclear systems, for a total of US\$ 3.6 billion.
- In the coal programme, US\$ 1.6 billion was spent on advanced research and technology development, US\$ 2.0 billion was spent on combustion systems, and US\$ 1.4 billion was spent on Magnetohydrodynamics, for a total of US\$ 5.0 billion.
- In the renewables programme, US\$ 2.9 billion was spent on photovoltaic systems, US\$ 2.1 billion was spent on solar thermal systems and US\$ 1.4 billion was spent on wind systems, for a total of US\$ 6.4 billion.

To place these findings in perspective, the three energy sources currently provide 71% of the nation's electricity and 43% of the nation's total energy consumption. Coal provides 51% of US electricity and 32% of energy consumption. Nuclear energy provides 20% of US electricity and 11% of energy consumption. Renewables (excluding hydroelectricity and geothermal energy) provide 0.3% of US electricity and 0.2% of energy consumption.

The major conclusions derived here include the following:

- The common perception that Federal R&D policies in recent decades have favoured fossil and nuclear energy at the

expense of renewables is not correct. In fact, nearly the opposite is true.

- Over the past decade, Federal R&D priorities have shifted in favour of renewables. By 2003 the renewable R&D budget was 75% the size of the coal R&D budget and nearly three times the size of the nuclear energy R&D budget.
- Thus far, the return to the US on the large sums spent on renewables R&D has been small. However, coal currently provides 51% of US electricity and 32% of energy consumption. Nuclear energy provides 20% of US electricity and 11% of energy consumption. Renewables (excluding hydro) produce a negligible portion of either US energy or electricity.
- This situation is unlikely to change for the foreseeable future. Forecasts of the US energy mix in 2030 indicate that coal will remain the major source of electric power generation and that the contributions of renewables to energy and electricity production will, unless there are major changes in US energy policy, remain small. ■

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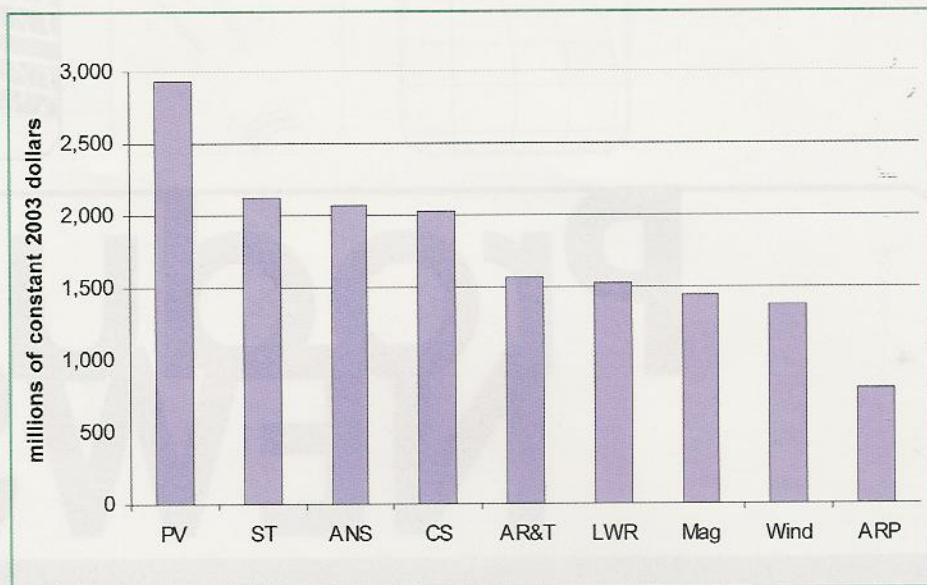


Figure 5. Federal research and development expenditure for selected nuclear, coal and renewables technologies, 1976 - 2003.

Legend: 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).

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