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Direct Federal Financial Interventions and Subsidies in Energy in Fiscal Year 2016

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Preface

This report—an update based on Fiscal Year (FY) 2016 data—continues a series of U.S. Energy Information Administration (EIA) reports on federal direct financial interventions and subsidies into energy markets. Using a set of data sources and analytic procedures, EIA assigns within-scope U.S. tax and direct expenditures to a set of discrete energy system categories.

Contents

Contacts	ii
Preface	iii
Tables	v
Figures	vii
Overview and Key Findings	1
Overview	1
Subsidy types.....	1
Key findings.....	3
Textbox: Renewable-related subsidy trends	6
Limitations of this Report.....	13
Analytic Approach	14
Data availability, accuracy, and variation.....	16
Other energy subsidy studies.....	17
Tax Expenditures.....	19
Examples of energy-specific tax expenditures	21
Direct Expenditures, Including R&D.....	30
Textbox: Federal direct purchasing of designated energy products	31
Examples of energy-specific direct expenditure and R&D programs.....	35
Textbox: Research and development for general application.....	49

Tables

Table 1. Total energy subsidies and support and selected energy indicators, FY 2010, FY 2013, and FY 2016	2
Table 2. Measures of electricity net generation and growth (FY 2000 versus FY 2016)	5
Table 3. Quantified energy-specific subsidies and support by type, FY 2010, FY 2013, and FY 2016	9
Table 4. Quantified renewable-related energy-specific subsidies and support by type, FY 2010, FY 2013, and FY 2016.....	11
Table 5. Estimates of energy-specific tax expenditures, FY 2010, FY 2013, and FY 2016.....	19
Table 6. Estimates of coal-related energy-specific tax expenditures, FY 2010, FY 2013, and FY 2016	22
Table 7. Estimates of renewable-related energy-specific tax expenditures, FY 2010, FY 2013, and FY 2016	24
Table 8. Estimates of natural gas- and petroleum-related energy-specific tax expenditures, FY 2010, FY 2013, and FY 2016.....	25
Table 9. Estimates of nuclear-related energy-specific tax expenditures, FY 2010, FY 2013, and FY 2016.	26
Table 10. Estimates of conservation, efficiency, and end-use energy-specific tax expenditures, FY 2010, FY 2013, and FY 2016	27
Table 11. Estimates of electricity transmission-related energy-specific tax expenditure, FY 2010, FY 2013, and FY 2016.....	28
Table 12. Estimates of direct expenditures in energy, FY 2010, FY 2013, and FY 2016	32
Table 13. Estimates of research and development expenditures in energy, FY 2010, FY 2013, and FY 2016	34
Table 14. Estimates of coal-related energy-specific direct expenditures by department and program, FY 2010, FY 2013, and FY 2016	36
Table 15. Estimates of coal-related energy-specific research and development expenditures by department and program, FY 2010, FY 2013, and FY 2016	36
Table 16. Estimates of renewable-related energy-specific direct expenditures by department and program, FY 2010, FY 2013, and FY 2016.....	37
Table 17. Estimates of renewable-related energy-specific research and development expenditures by department and program, FY 2010, FY 2013, and FY 2016	39
Table 18. Estimates of natural gas- and petroleum-related energy-specific direct expenditures by department and program, FY 2010, FY 2013, and FY 2016	42
Table 19. Estimates of natural gas- and petroleum-related energy-specific research and development expenditures by department and program, FY 2010, FY 2013, and FY 2016	43
Table 20. Estimates of nuclear transformation-related energy-specific direct expenditures by department and program, FY 2010, FY 2013, and FY 2016	44
Table 21. Estimates of nuclear transformation-related energy-specific research and development expenditures by department and program, FY 2010, FY 2013, and FY 2016	44
Table 22. Estimates of conservation, efficiency, and end-use energy-specific direct expenditures by department and program, FY 2010, FY 2013, and FY 2016	46
Table 23. Estimates of conservation, efficiency, and end-use energy-specific research and development expenditures by department and program, FY 2010, FY 2013, and FY 2016	47

Table 24. Estimates of electricity transmission-related energy-specific direct expenditures by department and program, FY 2010, FY 2013, and FY 2016 48

Table 25. Estimates of electricity transmission-related energy-specific research and development expenditures by department and program, FY 2010, FY 2013, and FY 2016 48

Figures

Figure 1. U.S. Department of Energy budget authority and outlays (FY 1980-FY 2016)	4
Figure 2. Renewable-related energy subsidies	6
Figure 3. Renewable-related estimated tax expenditures.....	7
Figure 4. Renewable-related direct expenditures	7
Figure 5. Renewable-related research and development expenditures	8
Figure 6. Data sources used for energy-related subsidies	14
Figure 7. Relationship of data sources to EIA data processing	15
Figure 8. Direct expenditures by select programs, FY 2010, FY 2013, and FY 2016	30

Overview and Key Findings

Overview

This report—an update based on Fiscal Year (FY) 2016 data and earlier EIA reports on direct federal financial interventions and subsidies in energy markets—continues a series of U.S. Energy Information Administration (EIA) reports¹ that began in response to congressional requests. More recently, the Secretary of Energy requested updated information as part of the U.S. Department of Energy’s (DOE) Grid Resiliency Study.²

The scope of this EIA report is limited to direct federal financial interventions and subsidies, i.e., subsidies provided by the federal government, subsidies that provide a financial benefit with an identifiable federal budget impact, and subsidies that are specifically targeted at energy technologies and markets. State and local programs—although significant in a number of cases—have been excluded from EIA’s reporting. As a result, this report does not encompass all subsidies that affect energy markets and should therefore be viewed in context and in conjunction with related information from other sources (see discussion of *Other energy subsidy studies* in the *Analytic Approach* section).

Consistent with EIA’s independent role and mission, this report focuses on providing information to inform discussion rather than drawing conclusions or discussing policy issues related to energy subsidies. By using a comprehensive data acquisition and analysis process, EIA estimates how federal financial actions are distributed among a defined set of categories comprising the U.S. energy system.³ EIA has made only limited observations of the scale, trends, and relationships within the data and the report tables.

Table 1 summarizes total within-scope energy subsidies and selected U.S. energy system indicators.

Subsidy types

Federal financial interventions and subsidies included in this report fall into four categories:

- **Tax expenditure:** the amount of tax benefits or preferences received by taxpayers and forgone by the federal government
- **Direct expenditures** to recipients (i.e., both producers and consumers): the amount of grants, loans, or other financial assistance awards made directly to recipients
- **Research and development (R&D) support:** the amount of grants, loans, or other financial assistance awards made for R&D

¹ The first EIA study was undertaken at the request of Congress in Fiscal Year (FY) 1992, pursuant to language appearing in the House Appropriations Committee’s Report on the U.S. Energy Information Administration FY 1992 appropriations.

² U.S. Department of Energy, [Staff Report to the Secretary on Electricity Markets and Reliability](#), Washington, DC, August 2017.

³ EIA has requested further detailed data from the Internal Revenue Service as it pertains to the distribution of energy-related tax benefits.

- **DOE loan guarantees:** financial support authorized to be provided by DOE for innovative clean energy technologies that are typically unable to obtain conventional private financing because of their high technology risks.⁴

Table 1. Total energy subsidies and support and selected energy indicators, FY 2010, FY 2013, and FY 2016

trillion British thermal units or as specified

Indicators	FY 2010	FY 2013	FY 2016
Total Energy Subsidies and Support (million 2016 dollars)	37,992	29,335	14,983
U.S. Energy Consumption	96,850	98,655	96,788
U.S. Energy Production	73,695	81,151	84,833
U.S. Natural Gas (dry and liquids)	24,105	28,220	32,652
U.S. Crude Oil	11,512	15,370	18,797
U.S. Coal	21,657	20,223	14,807
U.S. Nuclear	8,318	8,099	8,352
U.S. Biomass	4,358	4,680	4,963
U.S. Hydroelectric	2,588	2,582	2,482
U.S. Wind	863	1,557	2,038
U.S. Solar	88	205	533
U.S. Geothermal	207	215	209

Note: Totals may not equal the sum of components due to independent rounding.

Sources: **Consumption:** EIA, *Monthly Energy Review*, February 2018, Table 1.3. **Production:** EIA, *Monthly Energy Review*, February 2018, Table 1.2. **Tax expenditure estimates:** Office of Management and Budget, *Analytical Perspectives, Budget of the U.S. Government*, FY 2012, 2015, and 2018. Joint Committee on Taxation, *Estimates of Federal Tax Expenditures for Fiscal Years 2010-2014*, JCS-3-10 (Washington, DC, December 2010), Table 1, Joint Committee on Taxation, *Estimates of Federal Tax Expenditures for Fiscal Years 2012-2017*, JCS-1-13 (Washington, DC, February 2013), Table 1, and Joint Committee on Taxation, *Estimates of Federal Tax Expenditures for Fiscal Years 2016-2020*, JCX-3-17 (Washington, DC, January 2017), Table 1. **Federal direct expenditure and R&D expenditure subsidies:** DOE: U.S. Department of Energy, Office of the Chief Financial Officer, *Base Financial Data*, FY 2010, FY 2013, and FY 2016; FY 2010 and FY 2013: U.S. General Services Administration, USASpending.gov - Government spending at your fingertips, <https://www.usaspending.gov/>, accessed October 22, 2014; FY 2016: U.S. Department of the Treasury, USASpending.gov, <https://www.usaspending.gov/>, accessed November 16, 2017. **Loan guarantee programs credit subsidy:** Computed from data from U.S. Department of Energy, Loan Program Office, <https://www.energy.gov/lpo/portfolio/portfolio-projects>, accessed January 20, 2015 and EIA, *Direct Federal Financial Interventions and Subsidies in Energy in Fiscal Year 2010, July 2011*, Table 29.

⁴ Section 1703 of Title XVII of the Energy Policy Act of 2005 authorizes the U.S. Department of Energy to support innovative clean energy technologies that are typically unable to obtain conventional private financing due to high technology risks. In addition, the technologies must avoid, reduce, or sequester air pollutants or anthropogenic emissions of greenhouse gases. The *Advanced Technology Vehicles Manufacturing (ATVM) Loan Program* was established in Section 136 of the Energy Independence and Security Act of 2007 to support the production of fuel-efficient, advanced technology vehicles and qualifying components in the United States. American Recovery and Reinvestment Act of 2009 amended Loan Guarantee Program's authorizing legislation, creating Section 1705.

Key findings

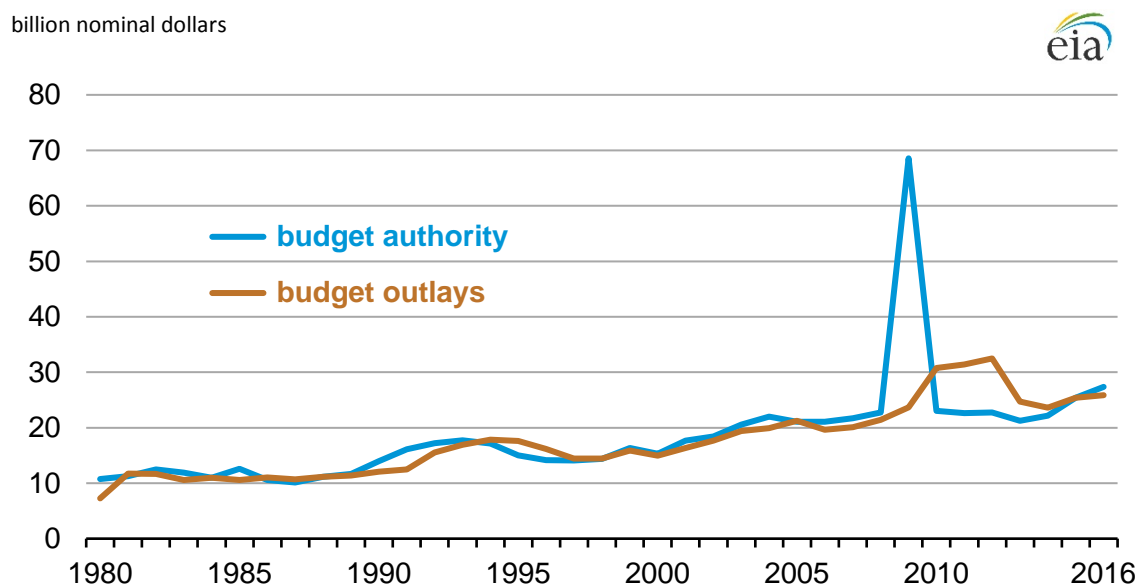
Table 3 and Table 4 summarize the allocation of federal direct financial interventions in U.S. energy markets by subsidy type. Several key findings stand out.

The scope and complexity of federal financial and award activities are very large and spread over a wide range of sources, recipients, and time frames. Despite a recent trend of decreasing federal activity, hundreds of distinct energy-related federal financial programs continue to pursue a wide range of goals using various methods. The time frames of these programs and activities can be very different, as in the case of tax provisions that allow taxpayers to decide which year to take a credit or to pay a deferred charge. Isolating the impacts of these programs, as well as characterizing the net impact of the whole set of actions on the U.S. energy system, is challenging.

Most current federal subsidies support developing renewable energy supplies (primarily biofuels, wind, and solar) and reducing energy consumption through energy efficiency. In FY 2016, nearly half (45%) of federal energy subsidies were associated with renewable energy, and 42% were associated with energy end uses. Table 4 shows a more detailed distribution of renewable energy-related federal support. The amount and distribution of renewable energy subsidies over time (see text box on *renewable-related subsidy trends*) have depended on congressional authorizations and the market competitiveness of renewable electricity technologies. Among renewable technologies, biofuels received the only incremental increase in FY 2016 subsidy support, driven by greater domestic biomass-based diesel production and foreign imports of these products that resulted in an approximately \$1 billion increase in tax credits from FY 2013 levels.

Energy end-use and conservation subsidies decreased from \$7.7 billion in FY 2013 to \$7.2 billion in FY 2016 (Table 3). The largest program in this combined category—the Low Income Home Energy Assistance Program (LIHEAP) operated through the U.S. Department of Health and Human Services (HHS)—maintained its funding levels at \$3.2 billion and \$3.4 billion in FY 2013 and FY 2016, respectively. The decrease in total subsidies and support for energy-related conservation and end-use programs between FY 2013 and FY 2016 was led by declines in direct expenditures, which decreased from \$4.2 billion to \$3.6 billion, respectively. Of the \$438 million decline in total federal support of conservation and end-use programs between FY 2013 and FY 2016, direct expenditures decreased \$597 million. The tax credit for energy efficiency improvements to existing homes (26 U.S.C. 25C) accounted for \$106 million of the decrease, and conversely, many tax expenditures (e.g., the credit for residential energy efficient property, 26 U.S.C. 25D) increased during the same period.

Since FY 2010, the scale of federal support has decreased as temporary measures expired, even as the U.S. energy system continues to grow. Federal activities within the scope of this study have been decreasing, in large part because of the expiration of provisions and programs authorized by the American Recovery and Reinvestment Act (ARRA or the Recovery Act) of 2009 (Figure 1). The Recovery Act provided energy funding that greatly increased DOE's previous energy program budgets but also required the rapid obligation of funds that would cover outlays over several years. The U.S. energy system, as a whole, continues to grow, with production activities growing more rapidly than energy consumption. As a result, the relative scale of federal activity within the overall context of the energy system has continued to decline since FY 2010.

Figure 1. U.S. Department of Energy budget authority and outlays (FY 1980-FY 2016)

Source: Office of Management and Budget, [Historical Tables, Tables 4.1 and 5.2](#), accessed February 23, 2018.

In FY 2016, tax code provisions were the largest source of direct federal financial interventions and subsidies in energy markets, following a period of higher federal direct expenditures resulting from ARRA programs and funding. The federal tax code—with 36 wide-ranging, energy-specific tax provisions (Table 5)—provided greater financial support to energy in FY 2016 than direct expenditures and R&D support. This reversal from FY 2013 is best captured by the temporary ARRA Section 1603-grant program to allow an investment tax credit (ITC)⁵ in lieu of the renewable energy production tax credit (PTC).⁶ In FY 2013, this ITC grant program pushed the direct expenditure category above estimated tax expenditures in absolute dollar terms.⁷ In FY 2016, the ITC grant program had largely ended, and tax expenditures (in total) regained their dominance, with tax provisions representing 59% of the total (Table 3).

No new DOE loan guarantees were issued in either FY 2013 or FY 2016. The subsidy cost of the loans issued in FY 2010 totaled \$1.7 billion. Because this cost is assessed at the time the loan is issued, there was no related subsidy cost for FY 2013 or FY 2016. The loan guarantees associated with the Vogtle nuclear project⁸ are included with FY 2010 subsidy costs. However, there were still outstanding debts in FY 2016 for loans issued in prior years. Although lending authority for the Section 1705 loan program had expired by 2013, budget authority remains for future lending on the Section 1703 loan program.

⁵ This report will reference only renewable electricity investment (i.e., energy investment credit) as the ITC.

⁶ This report will reference only renewable electricity production (i.e., energy production credit) as the PTC.

⁷ This categorical shift can be viewed as an accounting issue, with the subsidy still ultimately stemming from the tax code.

⁸ DOE, Loan Guarantee Office, website: <https://energy.gov/lpo/vogtle>, accessed February 20, 2018. On September 29, 2017, the U.S. Department of Energy offered conditional commitments for construction to the Vogtle project, website: <https://energy.gov/lpo/articles/vogtle-conditional-commitments-support-energy-infrastructure>, accessed February 27, 2018.

Electricity projects accounted for 25% of FY 2016 total R&D expenditures. This share is similar to the share in FY 2010 and FY 2013. Except for biofuels, virtually all non-fossil energy subsidies (renewable fuel and nuclear) were for electricity projects. In addition, most coal subsidies were electricity-related, even though they were often not denoted as such, because about 85% of coal consumption is used to generate electricity. The share of natural gas subsidies for electricity generation is more difficult to determine.

Table 2. Measures of electricity net generation and growth (FY 2000 versus FY 2016)

Beneficiary	2000 Net Generation (billion kilowatt- hours)	2016 Net Generation (billion kilowatt- hours)	Share of 2000 Generation (percent)	Share of 2016 Generation (percent)	Annual Growth from 2000 to 2016 (percent)
Coal	1,931	1,208	51.4	29.6	(2.9)
Natural Gas and Petroleum Liquids	684	1,431	18.2	35.1	4.7
Nuclear	765	799	20.4	19.6	0.3
Other	13	21	0.3	0.5	3.1
Renewables	365	618	9.7	15.2	3.3
Biomass	59	63	1.6	1.5	0.4
Geothermal	15	16	0.4	0.4	0.5
Hydroelectric	286	268	7.6	6.6	(0.4)
Solar	1	51	0.0	1.2	31.8
Wind	5	220	0.1	5.4	26.3
Total	3,759	4,077	100.0	100.0	0.5

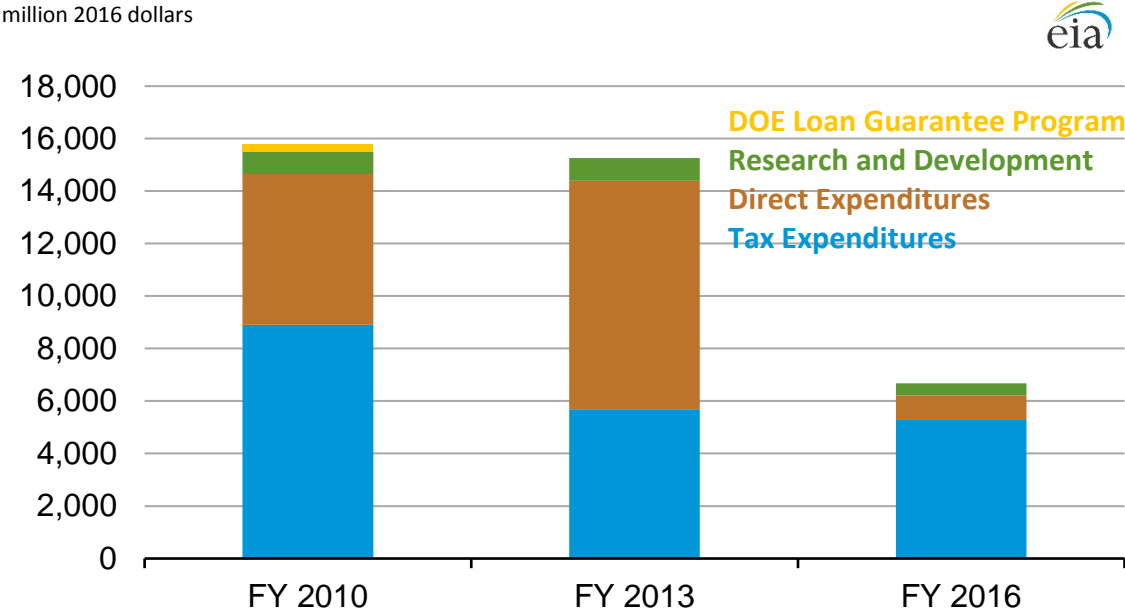
Notes: Totals may not equal sum of components due to independent rounding. A table value in brackets () denotes a negative value. Zero denotes rounding to zero value. *Other* includes net generation from hydroelectric pumped storage, other gases, batteries, chemicals, hydrogen, pitch, purchased steam, sulfur, and miscellaneous technologies. *Biomass* includes net generation from wood and waste. *Solar* includes distributed (small-scale) generation and utility-scale generation.

Sources: U.S. Energy Information Administration, *Monthly Energy Review*, February 2018, Table 10.6 (solar) and Table 7.2a (all other).

Textbox: Renewable-related subsidy trends

Renewable energy (including biofuels) comprised between 42% and 52% of total energy subsidies for each of the three fiscal years analyzed (Table 5). Total renewable-related subsidies were about \$15.5 billion for both FY 2010 and FY 2013, then dropped to \$6.7 billion in FY 2016 (Figure 2). Tax and direct expenditures combined accounted for about 93% of total renewable-related subsidies for each of the years analyzed. In FY 2016, tax expenditures alone accounted for 80% of total renewable energy subsidies. Direct expenditures decreased 90% from FY 2013 to FY 2016, largely as a result of the expiration of the Section 1603 grant program.

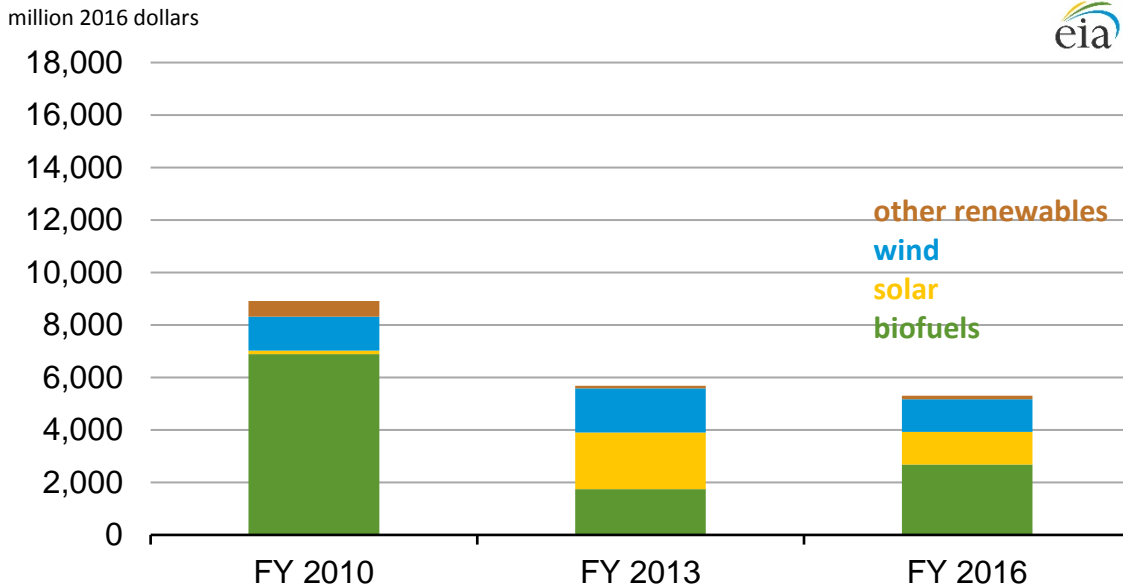
Figure 2. Renewable-related energy subsidies



Source: Table 4.

Renewable tax expenditures declined \$367 million between FY 2013 and FY 2016, due almost entirely to lower outlays for the PTC for electricity plants (Figure 3). In previous years, the Section 1603 grant program was designed to achieve the same goals as the PTC (during years when investors had little tax liability) and represented a large portion of renewable energy subsidies. Changes in biofuel tax expenditures from FY 2010 to FY 2016 reflect the 2011 expiration of the alcohol fuel excise tax exemption followed by increasing expenditures associated with the biodiesel mixture credit (referred to as the biodiesel production tax credit in Table 5).

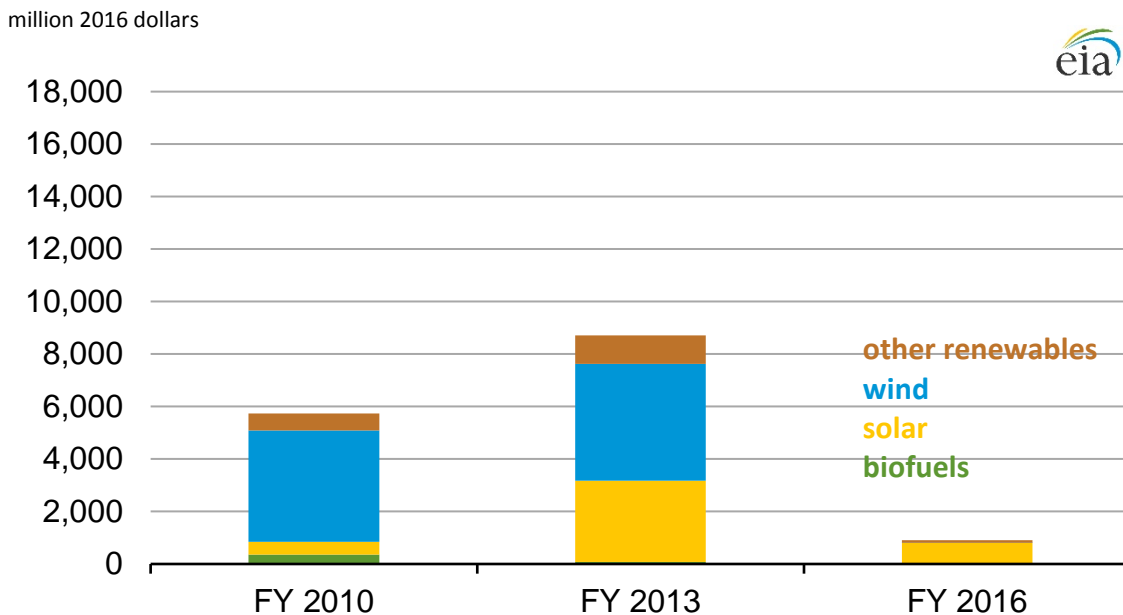
Figure 3. Renewable-related estimated tax expenditures



Source: Table 4.

Nearly all direct expenditures since FY 2010 for renewable-related energy have supported renewable electricity plant construction. Renewable-related direct expenditures were \$5.7 billion and \$8.7 billion in FY 2010 and FY 2013, respectively, which consisted mostly of payments in lieu of tax credits to construct wind plants (Figure 4). Solar and wind projects, when combined, received at least 82% of direct expenditures in each of the years analyzed.

Figure 4. Renewable-related direct expenditures

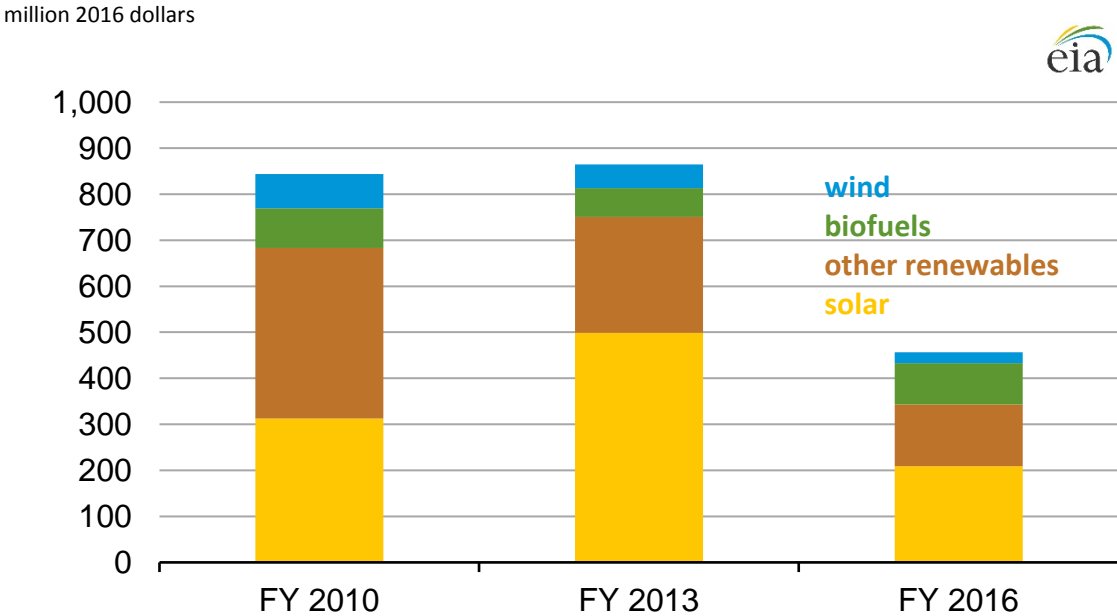


Source: Table 4.

Most direct expenditures between FY 2010 and FY 2016 were Section 1603 grants designed as alternatives to previous tax expenditure subsidies. The number of tax equity investors willing to make new investments after the 2008–09 recession decreased substantially, as few investors had tax liabilities to make the tax credits meaningful. To be eligible for the Section 1603 grant program, a project had to meet statutory requirements for starting construction and entering service. This provision resulted in substantial grant payouts continuing into FY 2010 and FY 2013. By FY 2016, however, grants had been paid to most eligible plants. The wide swings in investor demand for tax credits, coupled with direct expenditure program expiration dates, account for the large changes over the years analyzed.

Renewable energy research and development spending was about \$850 million for FY 2010 and FY 2013, then dropped to \$456 million for FY 2016 (Figure 5). Of the total renewable R&D subsidies, electricity projects accounted for more than 80% of each year’s subsidies, despite the large FY 2016 decrease in renewable-related R&D spending.

Figure 5. Renewable-related research and development expenditures



Source: Table 4.

Solar received the largest share of estimated renewable energy R&D funds for each of the years analyzed, ranging from 37% in FY 2010 to 58% in FY 2013. R&D spending dropped in FY 2016 for most renewable energy categories, with the exception of biofuels, which grew from \$62 million in FY 2013 to \$90 million in FY 2016.

Table 3. Quantified energy-specific subsidies and support by type, FY 2010, FY 2013, and FY 2016

million 2016 dollars, unless otherwise specified

Year and Support Type	Coal	Refined Coal	Natural Gas and Petroleum Liquids	Nuclear	Renewables	Electricity - Smart Grid and Transmission	Conservation	End Use	Total	Share of Total Subsidies and Support
2010										
Direct Expenditures	48	-	83	69	5,732	4	3,226	6,264	15,427	41%
Tax Expenditures	506	187	2,883	999	8,913	63	3,511	1,055	18,119	48%
Research and Development	320	-	10	177	844	566	704	97	2,718	7%
DOE Loan Guarantee Program	-	-	-	292	296	22	4	1,113	1,728	5%
Total	875	187	2,976	1,537	15,785	655	7,446	8,530	37,992	100%
Share of Total	2%	0%	8%	4%	42%	2%	20%	22%	100%	
2013										
Direct Expenditures	77	-	388	38	8,716	9	872	3,349	13,450	46%
Tax Expenditures	801	10	2,345	1,155	5,683	219	657	2,081	12,951	44%
Research and Development	216	-	64	197	864	887	517	189	2,934	10%
DOE Loan Guarantee Program	-	-	-	-	-	-	-	-	-	-
Total	1,094	10	2,796	1,390	15,264	1,115	2,046	5,619	29,335	100%
Share of Total	4%	0%	10%	5%	52%	4%	7%	19%	100%	
2016										
Direct Expenditures	19	-	111	40	909	11	234	3,391	4,716	31%
Tax Expenditures	906	-	(940)	160	5,316	160	560	2,653	8,816	59%
Research and Development	337	-	56	164	456	49	189	200	1,451	10%
DOE Loan Guarantee Program	-	-	-	-	-	-	-	-	-	-
Total	1,262	-	(773)	365	6,682	220	983	6,244	14,983	100%
Share of Total	8%	-	(5%)	2%	45%	1%	7%	42%	100%	

Notes: Totals may not equal sum of components due to independent rounding. Zero denotes rounding to zero value and a “-” symbol denotes a zero value. Energy-specific tax expenditures associated with renewables were allocated based on preliminary generation data. No hydropower generation was assumed to be eligible for production tax credits (PTC). It was assumed all investment tax credits were claimed by solar power plants. Municipal Solid Waste (MSW) and open-loop biomass generation estimates used to calculate PTCs were halved to represent the value of their PTC credit, relative to geothermal and wind. Generation estimates for 2016 were used to calculate credits associated with the PTC for wind plants that came online in 2006 and later.

Sources: **Tax expenditure estimates:** Office of Management and Budget, *Analytical Perspectives, Budget of the U.S. Government*, Fiscal Years 2012, 2015 and 2018. Joint Committee on Taxation, *Estimates of Federal Tax Expenditures for Fiscal Years 2016-2020*, JCX-3-17 (Washington, DC, January 2017), Table 1, *Estimates of Federal Tax Expenditures for Fiscal Years 2012-2017*, JCS-1-13 (Washington, DC, February 2013), Table 1, Joint Committee on Taxation, *Estimates of Federal Tax Expenditures for Fiscal Years 2010-2014*, JCS-3-10 (Washington, DC, December 2010), Table 1. **Federal direct expenditure and R&D expenditure subsidies:** DOE: U.S. Department of Energy, Office of the Chief Financial Officer, *Base Financial Data*, FY 2010, FY 2013, and FY 2016; FYs 2010 and 2013: U.S. General Services Administration, USASpending.gov - Government spending at your fingertips, <http://www.usaspending.gov/>, accessed October 22, 2014; FY 2016: U.S. Department of the Treasury, USASpending.gov, <http://www.usaspending.gov/>, accessed November 16, 2017. **Loan guarantee programs credit subsidy:** Computed from data from U.S. Department of Energy, Loan Program Office, <https://www.energy.gov/lpo/portfolio/portfolio-projects>, accessed January 20, 2015 and EIA, *Direct Federal Financial Interventions and Subsidies in Fiscal Year 2010*, Table 29.

Table 4. Quantified renewable-related energy-specific subsidies and support by type, FY 2010, FY 2013, and FY 2016

million 2016 dollars, unless otherwise specified

Year and Support Type	Renewable Electric						Subtotal Renewable Electric	Biofuels	Total Renewables	Share of Total Renewables Subsidies
	Biomass	Geothermal	Hydroelectric	Solar	Wind	Other				
2010										
Direct Expenditures	185	67	63	481	4,241	330	5,369	363	5,732	36%
Tax Expenditures	575	1	19	132	1,297	-	2,023	6,890	8,913	56%
Research and Development	277	1	13	313	74	79	757	86	844	5%
DOE Loan Guarantee Program	-	13	-	190	94	-	297	-	296	2%
Total	1,037	83	95	1,116	5,705	410	8,446	7,340	15,785	100%
Share of Total Renewables	7%	1%	1%	7%	36%	3%	54%	46%	100%	
2013										
Direct Expenditures	346	325	205	3,094	4,454	218	8,642	75	8,716	57%
Tax Expenditures	48	32	18	2,164	1,682	-	3,944	1,740	5,683	37%
Research and Development	178	1	10	499	51	63	802	62	864	6%
DOE Loan Guarantee Program	-	-	-	-	-	-	-	-	-	-
Total	572	358	233	5,756	6,187	280	13,387	1,878	15,264	100%
Share of Total Renewables	4%	2%	2%	38%	41%	2%	88%	12%	100%	
2016										
Direct Expenditures	18	41	2	771	4	41	877	33	909	14%
Tax Expenditures	34	34	34	1,251	1,239	34	2,626	2,690	5,316	80%
Research and Development	27	10	2	209	24	95	367	90	456	7%
DOE Loan Guarantee Program	-	-	-	-	-	-	-	-	-	-
Total	79	86	38	2,231	1,266	169	3,869	2,813	6,682	100%
Share of Total Renewables	1%	1%	1%	33%	19%	3%	58%	42%	100%	

Notes: Totals may not equal sum of components due to independent rounding. Zero denotes rounding to zero value and a “-“ symbol denotes a zero value. Energy-specific tax expenditures associated with renewables were allocated based on preliminary generation data. No hydropower generation was assumed to be eligible for production tax credits (PTC). It was assumed all investment tax credits were claimed by solar power plants. Municipal Solid Waste (MSW) and open-loop biomass generation estimates used

to calculate PTCs were halved to represent the value of their PTC credit, relative to geothermal and wind. Generation estimates for 2016 were used to calculate credits associated with the PTC captured wind plants that came online in 2006 and later.

Sources: **Tax expenditure estimates:** Office of Management and Budget, *Analytical Perspectives, Budget of the U.S. Government*, Fiscal Years 2012, 2015 and 2018. Joint Committee on Taxation, *Estimates of Federal Tax Expenditures for Fiscal Years 2016-2020*, JCX-3-17 (Washington, DC, January 2017), Table 1, *Estimates of Federal Tax Expenditures for Fiscal Years 2012-2017*, JCS-1-13 (Washington, DC, February 2013), Table 1, Joint Committee on Taxation, *Estimates of Federal Tax Expenditures for Fiscal Years 2010-2014*, JCS-3-10 (Washington, DC, December 2010), Table 1, and, computed from data from U.S. Energy Information Administration (EIA), Form EIA-923, "Annual Electric Utility Data". **Federal direct expenditure and R&D expenditure subsidies:** U.S. General Services Administration, USASpending.gov - Government spending at your fingertips, <http://www.usaspending.gov/>, accessed October 22, 2014 and U.S. Department of the Treasury, USASpending.gov, accessed November 16, 2017. **Loan guarantee programs credit subsidy:** Computed from data from U.S. Department of Energy, Loan Program Office, <http://energy.gov/lpo/loan-programs-office>, accessed January 20, 2015 and EIA, *Direct Federal Financial Interventions and Subsidies in Fiscal Years 2010*, July 2011, Table 29.

Limitations of this Report

Both the scope and the measurement of direct federal financial interventions and subsidies in energy markets are subject to limitations. This section addresses limitations in scope first, followed by limitations in measurement.

This report is limited in scope to a defined set of federal activities. These activities must meet a certain set of criteria for inclusion. They must

- be provided by the federal government
- provide a financial benefit with an identifiable federal budget impact
- be specifically targeted at energy markets

This scope does not include a wide range of more indirect or shared governmental activities that can provide financial benefits to energy market participants. For example, providing security to general infrastructure or tax provisions that apply to wide sets of equipment (i.e., applicable to both energy-related and non-energy-related) are types of federal activities that are not considered within this report's scope. The definition used in this report also excludes activities performed by federal staff or contractors, which can include energy technology development and direct energy purchases. Examples of such activities are noted in later sections.

Measurement limitations are an important consideration in the assessment of federal financial activities. Even a seemingly simple notion like the mismatch of fiscal, calendar, and tax years can result in the need to calculate, estimate, or interpolate figures, or to make different interpretations of an annualized benefit. Some fiscal year appropriations are not committed in a given fiscal year, and some obligated funds may not reach the intended recipients in the same fiscal year, leading to variability in the apparent pattern of federal activities over time. EIA provides a series of single-year estimates, not a continuous annual series, making specific events and broader trends more difficult to distinguish (as it is possible for any particular year's figures to be affected by unique factors). Finally, the estimation methods used by EIA are revised as new data and improved methods become available. While efforts are made to maintain consistency, improved estimation techniques take precedence over complete consistency with past editions of this report. EIA's treatment of measurement issues is discussed further in the Analytic Approach section.

Analytic Approach

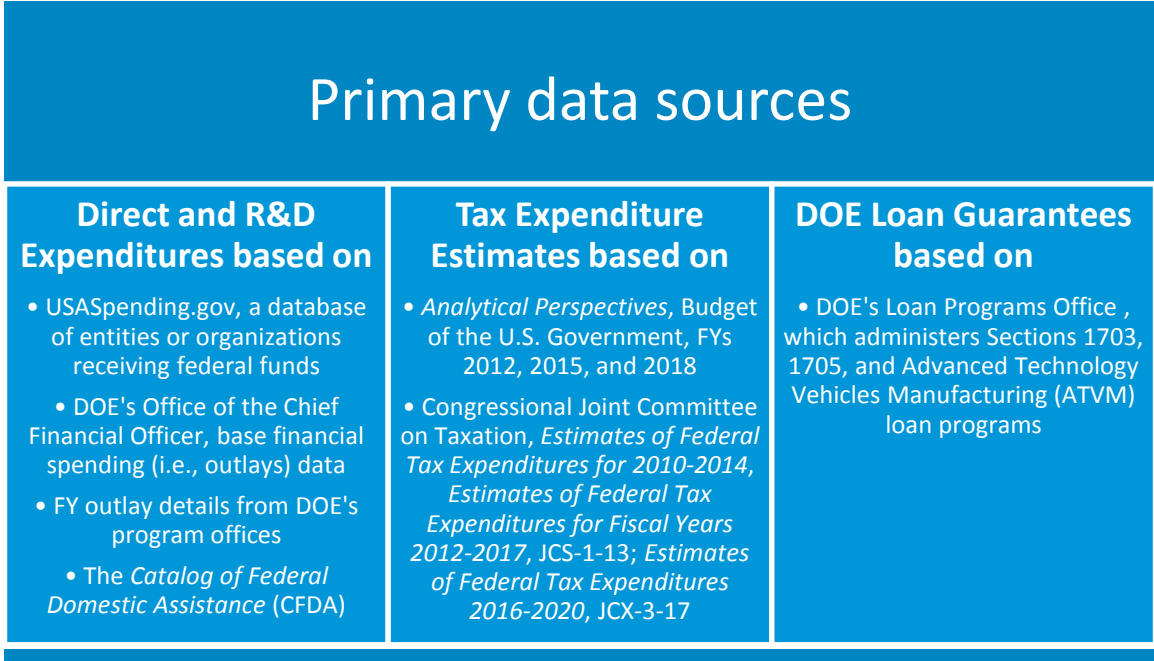
This report compiles direct federal financial interventions and subsidies in energy markets using federal government outlays (for DOE and the U.S. Department of the Treasury (the Treasury)), reported budget obligations (for all other federal departments), the estimated outlay equivalent value of tax expenditure estimates, and the subsidy value of DOE loan guarantees (Figure 6). The report then sorts or assigns all of the within-scope federal activities into one or more energy-specific categories within the U.S. energy system (biomass, coal, end use, etc.).

Goals. The primary goal of this report is to help people understand energy market interventions, specifically federal tax and direct expenditures that support various parts of the U.S. energy system. Consistent with this goal, EIA’s final report tables are as simple as possible, despite the complexity of the data and the necessary analytic procedures. As noted in the Overview section, EIA has limited its observations of the scale, trends, and relationships within the data and the report tables.

Previous EIA studies. Since 1992, EIA has periodically updated this report. Prior reports and supporting materials are available from the EIA website.⁹

Data sources. EIA relies on several official governmental data sources as initial report inputs. Distinct data sources are used for tax expenditures, direct expenditures, and research and development expenditures, as well as amounts for DOE-related financial spending activities (Figure 6).

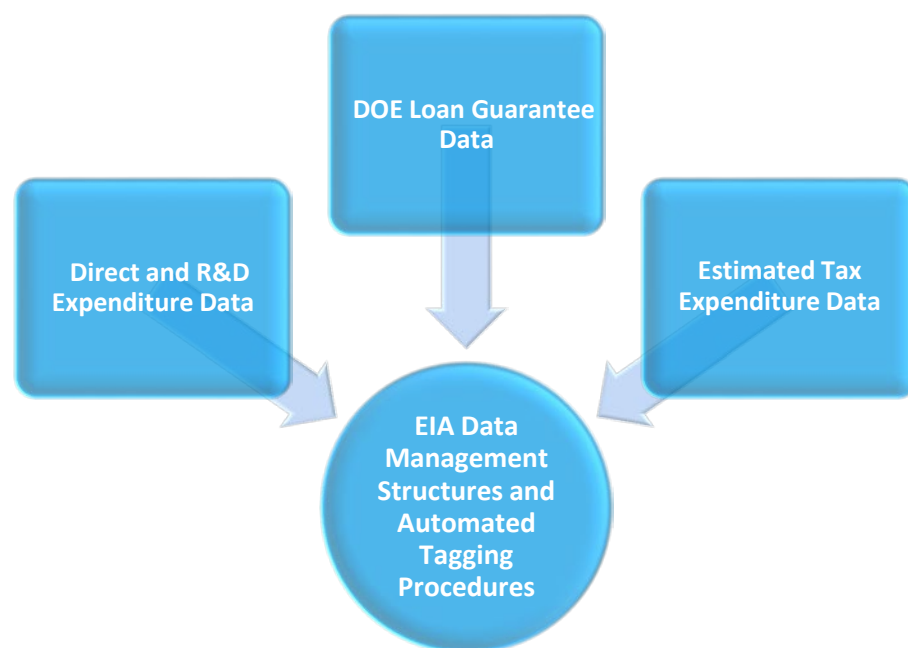
Figure 6. Data sources used for energy-related subsidies



⁹ U.S. Energy Information Administration, [Analysis and Projections: Subsidy](#), accessed February 16, 2018.

Budget terminology. Appropriations, obligations, and outlays are the primary phases of the U.S. government budget control system. Congress enacts appropriations that provide federal agencies and programs budget authority to make financial commitments (i.e., obligations) to spend funds. Obligations are legally binding agreements to purchase items or services, which is the budget phase captured in [USASpending.gov](https://www.usaspending.gov). Outlays are actual payments made by the federal government for services performed, and they offset or liquidate outstanding obligations.

Figure 7. Relationship of data sources to EIA data processing



EIA uses the definitions of tax expenditures incorporated in federal budget documents and the associated tax expenditures estimated by the Treasury that are itemized in various sections of the Budget of the U.S. Government, *Analytical Perspectives*. To a lesser extent, this report includes data estimates by the congressional Joint Committee on Taxation. Some tax expenditures that benefit the energy industry may also support non-energy related activities, such as the use of accelerated depreciation schedules; these provisions are not included. EIA included only tax provisions that are narrowly targeted to the energy sector and were quantified by the other federal sources discussed here.

For direct expenditures, including research and development, EIA developed automated data processing when assigning energy-specific beneficiaries. For FY 2016 data, automated tagging or classification of nearly three million federal budgetary transactions were custom-designed, which in turn provided automated pre-binning and aggregation of more than 20,000 transactions meeting specified criteria for subsequent review by EIA's subject-matter experts.¹⁰

Obligation data come from a comprehensive public database summarizing all federal budget obligations; this transaction data is made available through [USASpending.gov](https://www.usaspending.gov). In this report, as in the FY 2013 report

¹⁰ [USASpending.gov](https://www.usaspending.gov) is a database website owned by the U.S. Department of the Treasury that identifies entities or organizations receiving federal funds. It was created as part of the Federal Funding Accountability and Transparency Act (FFATA) of 2006.

update, direct expenditures and R&D expenditures for federal agencies other than DOE, Treasury, and the U.S. Department of Health and Human Services that administers LIHEAP come from [USASpending.gov](https://www.usaspending.gov). These data represented about 10% (or \$624 million) of the \$6.2 billion estimated as the combined direct and R&D expenditures in energy subsidies in FY 2016. This smaller subset of subsidies underwent more extensive automated data processing, whereas the remaining 90% (or \$5.6 billion) of the total was estimated directly from program office data sources listed in Figure 6.

Subsidy type exclusions. The definition of energy subsidy for this EIA report excludes federal staff and contractor actions. Some federal programs—such as National Laboratories—rely more extensively on contractor and staff work than others. As an example of a program with a large reliance on contracted work, the bulk of federal support to the nuclear energy industry is through direct federal program funding and not through grants and assistance awards. Funding is primarily through two organizations: the DOE and the Nuclear Regulatory Commission. The FY 2016 enacted appropriations for nuclear energy programs within DOE was \$986 million.¹¹ Based on DOE’s FY 2016 budget within the President’s FY 2018 budget request, most nuclear energy-specific spending would support nuclear energy technology research and development programs, including fuel cycle, nuclear energy enabling technologies, small modular reactor licensing support, and management and operations at Idaho National Laboratory. These activities are not considered energy subsidies for purposes of this report.

DOE’s direct expenditures and R&D expenditures are based on actual outlays, as provided by the Office of the Chief Financial Officer at DOE (Figure 6). Treasury’s direct expenditures are similarly based on outlays, as obtained from the Office of Management and Budget’s *Analytical Perspectives* report. As noted in earlier sections, appropriations, obligations, and outlays are the primary phases of the U.S. government budget control system.

Under steady-state conditions, where outlays follow obligations in a regular pattern and there are no sharp discontinuities in the former or the latter, obligation and outlay measures closely correspond. However, enactment of the Recovery Act of 2009, which included energy funding that dwarfed DOE’s previous energy program budgets and required the rapid obligation of funds to cover outlays over several years, makes it more appropriate to report DOE programs based on outlays, using information obtained from DOE’s Office of the Chief Financial Officer (Figure 1). This treatment is consistent with EIA’s FY 2013 subsidy report update.

Data availability, accuracy, and variation

For measuring subsidies and support, EIA serves as a data aggregator from non-EIA federal data sources and depends on those federal sources for data quality and control issues. Tax expenditure estimates data are in most cases specific and accurate, as tax provisions included in this report typically are targeted to specific energy-related activities and are accounted for on a tax-year basis by Treasury. As a result, EIA staff could isolate numerous tax provisions and the corresponding energy system categories. Estimation procedures, however, were needed for a subset of tax expenditure data because particular tax provision data that could be made available, such as the specific types of renewable energy reported when a credit is taken, are not processed or published at this time. Improvements in the reporting on

¹¹ U.S. Department of Energy, FY 2018 Department of Energy's Budget Request to Congress, [Nuclear Energy: Volume 3](#), page 531, accessed March 21, 2018.

these provisions would be beneficial. Such data are provided by taxpayers to the IRS when credits are claimed.

Each year Treasury estimates tax expenditures for the upcoming fiscal year budget. These appear in OMB's *Analytical Perspectives: Budget of the U.S. Government* report. Tax expenditure figures are estimates for historical FYs and forecasts for non-historical FYs. Prior-year tax expenditure estimates may be substantially revised. However, a particular year's revision will not necessarily affect all past estimates. The methodology Treasury uses to estimate tax expenditures is also subject to periodic modification, and these changes are not always applied to revisions of all historical tax expenditure data.

This report presents energy tax expenditure estimates for FYs 2010, 2013, and 2016. Sizable changes in the dollar value of particular expenditures over time often reflect changes in their utilization due to changes in the Internal Revenue Code (IRC), in key interpretations of the IRC, or in other relevant market and policy drivers. The historical data also reveal when particular energy programs were implemented and terminated, illustrating the magnitude of various tax policies affecting energy production and consumption over time. Although there are gaps in the data for some years, generalized trends in tax expenditures are still apparent. Some of the tax expenditure data presented in this report will be revised in the future, and some of the historical data presented here have not been fully revised.

Agencies are required to submit data files to USAspending.gov within 30 days after making an award or after making a modification or transaction to an award, except for the U.S. Department of Defense, which delays its submission by 90 days to protect operations. However, the timing of when specific records are displayed on USAspending.gov depends on when the agency submits files to the data source sites and the processing time required by that site. There could be a lag of one to three days before the files are processed and uploaded to USAspending.gov.

If an agency reports a modification or transaction to an award made in a previous fiscal year, the modification/transaction data are displayed in the fiscal year in which the modification/transaction was made, not in the fiscal year that the original award was made. EIA takes all fiscal year data as supplied regardless of these modifications.

Other energy subsidy studies

Debate continues over the scope, role, and effectiveness of energy policy measures, and several studies addressing energy subsidies appear each year from various sources and use different definitions and methods. Some examples within the past five years include: (1) Coady, Parry, Sears and Shang (2017), *How Large Are Global Fossil Fuel Subsidies?* in World Development; (2) National Renewable Energy Laboratory (2016), *Impacts of the Federal Tax Credit Extensions on Renewable Deployment and Power Sector Emissions*; (3) Department of the Treasury, *Progress Report on Fossil Fuels Subsidies to G20*; and (4) Institute for Energy Research (2013), *Estimating the State-Level Impact of Federal Wind Energy Subsidies*. Several of these reports and others in the literature seek to draw conclusions about policy issues related to energy subsidies.

This EIA report focuses on developing data to provide information that can be used by others to conduct their own analyses. Along with EIA, the Congressional Research Service (CRS), the Congressional Budget Office (CBO), and the Government Accountability Office (GAO) also issue occasional reports on the

scope and nature of federal energy subsidies that mainly or exclusively focus on data. Recent CRS, CBO, and GAO reports include: (1) CRS (2017), *The Value of Energy Tax Incentives for Different Types of Energy Resources: In Brief*¹²; (2) CRS (2015), *Energy Tax Incentives: Measuring Value Across Different Types of Energy Resources*¹³; (3) CBO (2017), *Federal Support for Developing, Producing, and Using Fuels and Energy Technologies*; (4) GAO (2013), *Energy: Federal Support for Renewable and Advanced Energy Technologies*; and (5) GAO (2014), *Energy Policy: Information on Federal and Other Factors Influencing U.S. Energy Production and Consumption from 2000 through 2013*.

Taken together, the extensive literature on subsidies provides examples of how differing definitions and methods can yield a wide range of estimates and interpretations.

¹² CRS Report R44852, *The Value of Energy Tax Incentives for Different Types of Energy Resources: In Brief*, May 18, 2017, by Molly F. Sherlock.

¹³ CRS Report R41953, *Energy Tax Incentives: Measuring Value Across Different Types of Energy Resources*, March 19, 2015, by Molly F. Sherlock and Jeffrey M. Stupak.

Tax Expenditures

In FY 2016, EIA estimates that U.S. federal energy-related tax expenditures were \$8.8 billion, or 59% of the total subsidies and support identified in this report. This total is substantially lower than the \$13.0 billion, or 44% share, in FY 2013. This decrease reflects, in large part, shifts in subsidies for renewable energy production over this period, including the installation of renewable energy production equipment on residential property. In addition, changes to tax expenditure estimates for oil- and natural gas-related activities for FY 2016 result in aggregate revenue inflows to Treasury, rather than subsidies to those industries (see Table).

Of the FY 2016 total tax expenditures (\$8.8 billion) that subsidize or otherwise support activities of energy producers or consumers, \$5.3 billion (60%) was for tax provisions that support renewable energy sources. End-use technologies represent the next largest source at \$3.2 billion (36%), with coal being the next largest at \$906 million (10%).

In preparing detailed data on energy-related tax expenditures (Table 5), EIA relied on the definitions of tax expenditures incorporated in the federal budget and the associated tax expenditures estimated by Treasury. To a lesser extent, this section includes data estimates by the congressional Joint Committee on Taxation (JCT). Tax expenditures arise from provisions in federal tax laws including credits, deductions, deferrals, preferential rates, and exemptions (exclusions). Items in the budget identified as tax expenditures by Treasury on occasion differ from those determined to be tax expenditures by the JCT. Historical tax expenditure data used in this report are taken from a number of government sources. For FY 2016, Treasury is the primary provider of estimates for tax expenditures, supplemented by data provided by the JCT.

Table 5. Estimates of energy-specific tax expenditures, FY 2010, FY 2013, and FY 2016

million 2016 dollars

Tax Provision	FY 2010	FY 2013	FY 2016
Biodiesel Producer Tax Credit ^a (26 U.S.C. 6426)	539	1,667	2,650
Credit for Residential Energy Efficient Property (26 U.S.C. 25D)	242	1,000	1,450
Energy Production Credit (26 U.S.C. 45)	1,695	1,740	1,400
Energy Investment Credit (26 U.S.C. 48)	143	2,032	1,190
Alternative Fuel and Fuel Mixture Credit (26 U.S.C. 6426 and 6427e)	197	365	590
Tax Credit and Deduction for Clean-Burning Vehicles (26 U.S.C. 30, 30B, 30C, and 30D)	275	281	480
Exclusion from Income of Conservation Subsidies Provided by Public Utilities (26 U.S.C. 136)	242	354	430
Excess of Percentage over Cost Depletion (26 U.S.C. 611-613A and 291)	1,079	552	410
Amortization of Certain Pollution Control Facilities (26 U.S.C. 169)	110	417	500
Credit for Energy Efficiency Improvements to Existing Homes (26 U.S.C. 25C)	3,511	636	530
Credit for Construction of New Energy Efficient Homes (26 U.S.C. 45L)	22	156	210
Credit for Investment in Clean Coal Facilities (26 U.S.C. 48A, 48B)	264	188	160
Nuclear Decommissioning (26 U.S.C. 468A)	991	1,146	160
Capital Gains Treatment of Royalties on Coal (26 U.S.C. 631(c))	55	94	150
Natural Gas Distribution Pipelines being Treated as 15-Year Property (26 U.S.C. 168(e)(C)(iv))	132	104	140

Table 5. Estimates of energy-specific tax expenditures, FY 2010, FY 2013, and FY 2016 (cont.)

million 2016 dollars

Tax Provision	FY 2010	FY 2013	FY 2016
Transmission Property Treated as Fifteen-Year Property (26 U.S.C. 168(e))	110	208	100
Allowance for the Deduction of Certain Energy Efficient Commercial Building Property(26 U.S.C. 179D)	66	73	80
Credit for Holding Clean Renewable Energy Bonds ^b (26 U.S.C. 54A and 54C)	77	73	70
Amortize All Geological and Geophysical Expenditures over 2 Years (26 U.S.C. 167(h))	165	104	70
Exception from Passive Loss Limitation for Working Interests in Oil and Gas Properties (26 U.S.C. 469)	33	21	60
Deferral of Gain from Disposition of Transmission Property to Implement FERC Restructuring Policy (26 U.S.C. 451(i))	(55)	-	60
Qualified Energy Conservation Bonds ^c (26 U.S.C. 54D)	-	21	30
Partial Expensing for Advanced Mine Safety Equipment (26 U.S.C. 179E)	3	28	24
Biodiesel and Small Agri-Biodiesel Producer Tax Credits (26 U.S.C. 6426)	22	21	30
Exclusion of Special Benefits for Disabled Coal Miners (26 U.S.C. 104, 30 U.S.C. 922)	43	31	30
Alcohol Fuel Credits (26 U.S.C. 6426)	77	42	10
Advanced Energy Manufacturing Facility Investment Tax Credit (26 U.S.C. 48C)	198	219	10
Expensing of Exploration and Development Costs (26 U.S.C. 263(c) and 291)	440	573	(450)
Temporary 50-Percent Expensing for Equipment used in the Refining of Liquid Fuels(26 U.S.C. 179C)	837	625	(1,760)
Alternative Fuel Production Credit (26 U.S.C. 45K)	187	10	-
Alcohol Fuel Exemption ^a (26 U.S.C. 6426)	6,252	10	-
Credit for Production from Advanced Nuclear Power Facilities (26 U.S.C. 45J(a))	-	-	-
Credit for Energy Efficient Appliances (26 U.S.C. 45M)	165	156	-
Mine Rescue Training Credit (26 U.S.C. 45N)	-	1	2
Expensing of Capital Goods with Respect to Complying with EPA Sulfur Regulations (26 U.S.C. 179B)	-	-	-
5-Year Net Operating Loss Carryover for Electric Transmission Equipment (26 U.S.C. 172)	-	-	-
Total	18,119	12,951	8,816

Notes: Totals may not equal sum due to independent rounding. Zero denotes rounding to zero value and a “-” symbol denotes a zero value. The advanced energy manufacturing facility investment tax credit or sometimes called advanced energy property credit was allocated by fuel and technology using data appearing in: <https://energy.gov/articles/energy-department-announces-150-million-tax-credits-invest-us-clean-energy-manufacturing> (Phase II of Section 48C) and IRC Section 48C Certifications at <https://www.irs.gov/businesses/irc-section-48c-certifications>, accessed March 20, 2018.

Sources: **Tax expenditure estimates:** Office of Management and Budget, *Analytical Perspectives, Budget of the U.S. Government*, Fiscal Years 2012, 2015 and 2018. Joint Committee on Taxation, *Estimates of Federal Tax Expenditures for Fiscal Years 2016-2020*, JCX-3-17 (Washington, DC, January 2017), Table 1, Joint Committee on Taxation, *Estimates of Federal Tax Expenditures for Fiscal Years 2012-2017*, JCS-1-13 (Washington, DC, February 2013), Table 1, Joint Committee on Taxation, *Estimates of Federal Tax Expenditures for Fiscal Years 2010-2014*, JCS-3-10 (Washington, DC, December 2010).

^aThe alcohol fuel exemption (VEETC) is essentially the excise tax exemption equivalent to the alcohol fuel credits. The biodiesel producer tax credit is the excise tax exemption to the biodiesel and small agri-biodiesel producer tax credits. These are both listed as footnotes to OMB, *Analytical Perspectives*, tables which includes energy tax expenditures.

^bIn addition, the provision has an outlay effect of \$10 million, \$40 million, and \$30 million in FY 2010, 2013, and 2016, respectively.

^cIn addition, the provision has an outlay effect of \$30 million, \$50 million, \$40 million in FY 2010, 2013, and 2016, respectively.

In many cases, the level of energy production or investment determines the potential value of the tax expenditure for qualified taxpayers. However, the value of the tax expenditure received by eligible taxpayers may not equal the potential value of the expenditure based upon production or investment. One factor that mitigates against the eligible taxpayer receiving the full value of the tax expenditure is the alternative minimum tax (AMT), a separately calculated tax that eliminates many deductions and credits for which many tax expenditures are not exempt. Another mitigating factor is that the tax expenditure, in many cases, may not be received in the year in which the investment or production took place, but may, by law, be carried back or forward a number of tax years. Finally, most of the energy-related tax credits discussed in this report are not refundable; that is, the credit may not be claimed in excess of a taxpayer's tax liability (i.e., the credit cannot cause their tax burden to go negative). Therefore, a taxpayer with insufficient gross tax burden may be unable to fully claim a credit.

Treasury does not provide estimates of *de minimis* tax expenditures, i.e., \$5 million or less. Therefore, the impact of such tax expenditures is not reported in either OMB budget documents or tabulations in this report.

Examples of energy-specific tax expenditures

The following examples illustrate the kinds of specific tax provisions associated with various categories of energy-related beneficiaries.

Coal. Table shows coal-related U.S. tax expenditures with an estimated value of \$906 million in FY 2016, down from an estimated \$811 million in FY 2013.

- **Amortization of Pollution Control Equipment (26 U.S.C. 169).** EAct 2005, Section 1309 modified Section 169 of the IRC, which permitted a 60-month amortization of qualifying pollution control facilities used in connection with plants placed in service before January 1, 1976. For plants placed in service after 1975, the EAct 2005 modification provides that a taxpayer can recover the cost of any certified pollution control facility (but not a water pollution-control facility) over a period of 84 months for one placed in service after April 11, 2005, and used in connection with an electric generation plant or other property that is primarily coal-fired. The pre-existing 60-month amortization period remains in effect for any newly constructed certified air pollution control facility added at a plant in operation prior to January 1, 1976. The JCT estimated the value of this expenditure to be \$417 million for FY 2013 and \$500 million for FY 2016.
- **Credit for Investment in Clean Coal Facilities (26 U.S.C. 48A and 48B).** This credit has an estimated value of \$188 million in FY 2013 and \$160 million in FY 2016. Section 1307 of the EAct 2005 provided for a 20% credit to advanced coal projects using integrated gasification combined-cycle (IGCC) technology and a 15% credit to other advanced coal technologies. This legislation allocated \$800 million tax credits towards electricity-related IGCC projects and \$500 million towards other advanced coal technologies. An additional \$350 million was applied to

coal gasification technologies for industrial use with an allowable tax credit of 20%. The Energy Improvement and Extension Act of 2008 (Public Law 111-343) authorized an additional \$1.5 billion in tax credits for advanced coal and gasification projects, and it increased the investment tax credit for qualifying advanced coal and gasification projects to 30%.

Table 6. Estimates of coal-related energy-specific tax expenditures, FY 2010, FY 2013, and FY 2016

million 2016 dollars

Tax Provision	FY 2010	FY 2013	FY 2016
Amortization of Certain Pollution Control Facilities	110	417	500
Credit for Investment in Clean Coal Facilities	264	188	160
Capital Gains Treatment of Royalties on Coal	55	94	150
Energy Production Credit	30	42	40
Exclusion of Special Benefits for Disabled Coal Miners	43	31	30
Partial Expensing for Advanced Mine Safety Equipment	3	28	24
Mine Rescue Training Credit	-	1	2
Advanced Energy Manufacturing Facility Investment Tax Credit	1	1	0
Subtotal Coal Tax Expenditures	506	801	906
Alternative Fuel Production Credit (Synthetic coal, coke and coke oven gas, and Steel Industry fuel)	187	10	-
Total	693	811	906

Notes: Totals may not equal sum due to independent rounding. Zero denotes rounding to zero value and a “-” symbol denotes a zero value. The advanced energy manufacturing facility investment tax credit or sometimes called advanced energy property credit was allocated by fuel using data appearing in: <https://energy.gov/articles/energy-department-announces-150-million-tax-credits-invest-us-clean-energy-manufacturing> (Phase II of Section 48C) and IRC Section 48C Certifications at <https://www.irs.gov/businesses/irc-section-48c-certifications>, accessed March 20, 2018.

Sources: **Tax expenditure estimates:** Office of Management and Budget, *Analytical Perspectives, Budget of the U.S. Government*, Fiscal Years 2012, 2015 and 2018. Joint Committee on Taxation, *Estimates of Federal Tax Expenditures for Fiscal Years 2016-2020*, JCX-3-17 (Washington, DC, January 2017), Table 1, Joint Committee on Taxation, *Estimates of Federal Tax Expenditures for Fiscal Years 2012-2017*, JCS-1-13 (Washington, DC, February 2013), Table 1, and Joint Committee on Taxation, *Estimates of Federal Tax Expenditures for Fiscal Years 2010-2014*, JCS-3-10 (Washington, DC, December 2010), Table 1.

Renewable energy including biofuels. In FY 2013, 44% of energy-related U.S. tax expenditures were for renewable fuels. At \$5.7 billion, renewable-related tax expenditures in FY 2013 were down 36% from \$8.9 billion in FY 2010 (see Table). Ethanol and biodiesel both provide sizable volumes of the U.S. liquid fuels supply, and their market penetration has increased as the result of several policies that have resulted in significant income and excise tax expenditures. The excise tax policies had large fiscal impacts for the biodiesel industry. The biggest change for renewable energy since FY 2010 was attributed to the expiration of the alcohol fuel tax exemption, which received \$6.3 billion in FY 2010 but has since decreased to zero. The biodiesel mixture credit increased from \$1.7 billion in FY 2013 to \$2.7 billion in FY 2016 as a result of greater domestic biomass-based diesel production and foreign imports of these products. Examples of renewable-related tax provisions include

- **Biodiesel Mixture Credit (26 U.S.C. 6426).** A tax credit was created by the American Jobs Creation Act of 2004 and later amended and extended various times. The biodiesel mixture credit—often referred to as the biodiesel blenders tax credit—had expired in previous years but Congress restored the credits retroactively. Qualified taxpayers may claim the biodiesel mixture credit, at \$1.00 per gallon, when the applicable amount of biodiesel or renewable diesel is blended with petroleum diesel for sale or use in a trade or business. The credit is applied against the federal sales tax for diesel fuel imposed by 26 U.S.C. Section 4081. Biodiesel and renewable diesel blending activity was supported by EPA’s Renewable Fuels Standard, which mandates the incorporation of biofuels into the nation’s fuel supply, with biomass-based diesel final volume requirements in 2015 and 2016 of 1.73 and 1.90 billion gallons, respectively. Largely because of the renewable fuel standard (RFS), the fiscal impact increased from \$1.7 billion in FY 2013 to \$2.7 billion in FY 2016. The biodiesel mixture tax credit expired at the end of 2016 but was retroactively applied to 2017 as part of the Bipartisan Budget Act of 2018.
- **Production Tax Credit (26 U.S.C. 45)** The PTC is frequently referred to as the *Section 45 credit* for its applicable provision in the IRC.^{14,15} It provides an inflation-adjusted tax credit worth 2.4 cents per kilowatthour (kWh) in 2016 to qualifying electricity production from wind energy facilities. It also provides a *half-value* credit of 1.2 cents per kWh for qualifying electricity production from closed-loop biomass, geothermal, solar, open-loop biomass, incremental hydroelectric, marine, tidal, and certain other waste energy facilities not claiming the Investment Tax Credit. The production tax credit for renewable resources is reported to have totaled \$1.4 billion in FY 2016 versus \$1.7 billion in FY 2013. Wind power was the primary beneficiary of this credit in FY 2016, which includes facilities built from 2006 through 2016. With enactment of ARRA, wind energy also became eligible for the investment tax credit (ITC). Because of the ability to exclusively claim one of these three subsidies during the FY 2010 and FY 2016 timeframe and because of the different temporal impacts of these provisions, it is not possible to accurately determine how much wind (or other similarly affected renewables) claimed the PTC or ITC for either year. EIA has generally assumed that wind energy projects will prefer the PTC over the ITC, and so assumed that those projects not taking the Section 1603 grant received the PTC instead.
- **The Energy Investment Tax Credit (26 U.S.C. 48).** The ITC, also referred to as the *Section 48 credit*, is the sole federal tax credit currently available to commercial solar facilities. It is also available as an alternative to the PTC discussed above. Originally established in the 1970s at a

¹⁴ In the FY 2007 version of this report, the PTC was reported aggregated with the ITC as the “New Technology Credit”, to be consistent with OMB reporting. However, current reporting separates these two business credits. EIA’s FY 2010, FY 2013, and current report presents the PTC and ITC separately.

¹⁵ Note that Section 45 of the Internal Revenue Code now contains several provisions that are accounted for elsewhere in this report. This report will reference only the renewable electricity production as the PTC.

value of 10%, the Energy Policy Act of 2005 (EPACT 05) temporarily increased the ITC value to 30% of capital costs and modified the expiration date for projects entering service by the end of 2019 and then ramped down to a value of 10% of capital cost for projects entering service by the end of 2022 and continued at the 10% level in perpetuity. The ITC is also known as a *business credit* and does not apply to projects owned by individuals. The credit for residential energy efficient property, also worth 30% of investment costs, was subsequently established for individual (residential) owners of solar and other end-use equipment. This latter credit reverted to zero at the end of 2016. ARRA expanded the scope of the ITC to include most renewable electricity technologies. However, EIA estimates that most of the more than \$2.0 billion FY 2013 ITC tax expenditures went to solar and other end-use equipment and that other eligible renewables claimed either the PTC or the Section 1603 grant. This represents a 14-fold increase in expenditures for the ITC between FY 2010 and FY 2013.

Table 7. Estimates of renewable-related energy-specific tax expenditures, FY 2010, FY 2013, and FY 2016

million 2016 dollars

Tax Provision	FY 2010	FY 2013	FY 2016
Biodiesel Producer Tax Credit ^a	539	1,667	2,650
Energy Production Credit	1,665	1,699	1,360
Energy Investment Credit	143	2,032	1,190
Credit for Holding Clean Renewable Energy Bonds ^b	77	73	70
Biodiesel and Small Agri-Biodiesel Producer Tax Credits	22	21	30
Alcohol Fuel Credits	77	42	10
Advanced Energy Manufacturing Facility Investment Tax Credit	138	139	6
Alternative Fuel Production Credit ^c	-	-	-
Alcohol Fuel Exemption ^a	6,252	10	-
Total	8,913	5,683	5,316

Notes: Totals may not equal sum due to independent rounding. Zero denotes rounding to zero value and a “-” symbol denotes a zero value. The credit for business installation of qualified fuel cells and microturbine power plants is part of the energy investment tax credit (Section 48 of the internal revenue code). The advanced energy manufacturing facility investment tax credit or sometimes called advanced energy property credit was allocated by fuel using data appearing in: <https://energy.gov/articles/energy-department-announces-150-million-tax-credits-invest-us-clean-energy-manufacturing> (Phase II of Section 48C) and IRC Section 48C Certifications at <https://www.irs.gov/businesses/irc-section-48c-certifications>, accessed March 20, 2018.

Sources: **Tax expenditure estimates:** Office of Management and Budget, *Analytical Perspectives, Budget of the U.S. Government*, Fiscal Years 2018, 2015 and 2012. Joint Committee on Taxation, *Estimates of Federal Tax Expenditures for Fiscal Years 2016-2020*, JCX-3-17 (Washington, DC, January 2017), Table 1, Joint Committee on Taxation, *Estimates of Federal Tax Expenditures for Fiscal Years 2012-2017*, JCS-1-13 (Washington, DC, February 2013), Table 1, and Joint Committee on Taxation, *Estimates of Federal Tax Expenditures for Fiscal Years 2010-2014*, JCS-3-10 (Washington, DC, December 2010), Table 1.

^aThe alcohol fuel exemption (VEETC) is essentially the excise tax exemption equivalent to the alcohol fuel credits. The biodiesel producer tax credit is the excise tax exemption to the biodiesel and small agri-biodiesel producer tax credits. These are both listed as footnotes in OMB’s *Analytical Perspectives* tax expenditure tables, which includes energy tax expenditures.

^bIn addition, the provision has an outlay effect of \$10 million, \$40 million, and \$30 million in FY 2010, FY 2013, and FY 2016, respectively.

^cThe alternative fuel production credit in FY 2010 and FY 2013 went primarily to coal.

Natural gas and petroleum. Natural gas and petroleum-related U.S. tax expenditures decreased from \$2.3 billion in FY 2013 to an estimated revenue inflow (versus a positive tax expenditure) of \$940 million in FY 2016 thus in aggregate becoming a set of revenue-generating tax provisions to the government in that fiscal year (Table).

- **The Temporary 50-Percent Expensing of Equipment Used in the Refining of Liquid Fuels (26 U.S.C. 179C)** Established under the Energy Policy Act of 2005, Section 1323, this provision is available for qualified refinery property used for processing liquid fuel from crude oil or qualified fuels and allows for an accelerated recovery of the cost of certain refinery investment under Section 179C of the IRC by allowing a partial expensing of the cost. It is estimated to have reached \$625 million in FY 2013 to become a generating revenue item for the federal government with an estimated revenue of \$1.8 billion in FY 2016.
- **The Expensing of Exploration and Development Costs (26 U.S.C. 263(c) and 291)** This provision allows energy producers, principally oil and natural gas producers, to expense exploration and development (E&D) expenditures (to include certain intangible drilling and development costs) rather than capitalize and depreciate them over time. The FY 2013 tax expenditure is estimated at \$573 million. In FY 2016, this sector generated an estimated \$450 million in revenues to the federal government.

Table 8. Estimates of natural gas- and petroleum-related energy-specific tax expenditures, FY 2010, FY 2013, and FY 2016

million 2016 dollars

Tax Provision	FY 2010	FY 2013	FY 2016
Alternative Fuel and Fuel Mixture Credit	197	365	590
Excess of Percentage over Cost Depletion	1,079	552	410
Natural Gas Distribution Pipelines being Treated as 15-Year Property	132	104	140
Amortize All Geological and Geophysical Expenditures over 2 Years	165	104	70
Exception from Passive Loss Limitation for Working Interests in Oil and Gas Properties	33	21	60
Expensing of Exploration and Development Costs	440	573	(450)
Temporary 50-Percent Expensing for Equipment used in the Refining of Liquid Fuels	837	625	(1,760)
Expensing of Capital Goods with Respect to Complying with EPA Sulfur Regulations	-	-	-
Total	2,883	2,345	(940)

Notes: Totals may not equal sum due to independent rounding. Zero denotes rounding to zero value and a “-” symbol denotes a zero value. A portion of the tax expenditures, but indeterminate amount, of the Excess of Percentage over Cost Depletion and the Expensing of exploration and Development Costs goes to coal.

Sources: **Tax expenditure estimates:** Office of Management and Budget, *Analytical Perspectives, Budget of the U.S. Government*, Fiscal Years 2012, 2015 and 2018. Joint Committee on Taxation, *Estimates of Federal Tax Expenditures for Fiscal Years 2016-2020*, JCX-3-17 (Washington, DC, January 2017), Table 1, Joint Committee on Taxation, *Estimates of Federal Tax*

Expenditures for Fiscal Years 2012-2017, JCS-1-13 (Washington, DC, February 2013), Table 1, Joint Committee on Taxation, *Estimates of Federal Tax Expenditures for Fiscal Years 2010-2014*, JCS-3-10 (Washington, DC, December 2010)

Nuclear. The estimated expenditures for nuclear-related tax provisions fell from \$1.2 billion in FY 2013 to \$160 million in FY 2016 (Table). Nearly all of this decrease stems from the tax treatment of qualified and nonqualified nuclear decommissioning trust funds. Because these particular revisions to the Internal Revenue Code were not itemized by OMB for FY 2010 and FY 2013, EIA relied on the estimates of the value of these tax expenditures prepared by the JCT. A small portion of the advanced energy property tax credit was also directed to nuclear facilities. An example of these provisions is below:

- **The Modification to Special Rules for Nuclear Decommissioning Costs (26 U.S.C. 468A).** Section 1310 of EPAAct2005 changed the IRS rules for qualified nuclear decommissioning trust funds by repealing the cost of service requirement for contributions to a qualified decommissioning trust fund created under IRC Section 468A. This change permitted full present value funding of a qualified nuclear decommissioning fund and the transfer of pre-1984 decommissioning funds held in nonqualified trusts. The provision also required that nuclear plant owners obtain a new schedule of ruling amounts from the IRS upon renewal of a plant’s operating license by the NRC. In FY 2016, EIA estimates the value of this tax expenditure was \$160 million versus \$1.2 billion in FY 2013. Modification of section 468A of the IRC was done to eliminate an impediment to nuclear plant sales arising from the structural change in the electric utility industry.

Table 9. Estimates of nuclear-related energy-specific tax expenditures, FY 2010, FY 2013, and FY 2016

million 2016 dollars

Tax Provision	FY 2010	FY 2013	FY 2016
Nuclear Decommissioning	991	1,146	160
Advanced Energy Manufacturing Facility Investment Tax Credit	9	9	0
Credit for Production from Advanced Nuclear Power Facilities	-	-	-
Total	999	1,155	160

Notes: Totals may not equal sum due to independent rounding. Zero denotes rounding to zero value and a “-” symbol denotes a zero value. The advanced energy manufacturing facility investment tax credit or sometimes called advanced energy property credit was allocated by fuel using data appearing in: <https://energy.gov/articles/energy-department-announces-150-million-tax-credits-invest-us-clean-energy-manufacturing> (Phase II of Section 48C) and IRC Section 48C Certifications at <https://www.irs.gov/businesses/irc-section-48c-certifications>, accessed March 20, 2018.

Sources: **Tax expenditure estimates:** Office of Management and Budget, *Analytical Perspectives, Budget of the U.S. Government*, Fiscal Years 2012, 2015 and 2018. Joint Committee on Taxation, *Estimates of Federal Tax Expenditures for Fiscal Years 2016-2020*, JCX-3-17 (Washington, DC, January 2017), Table 1, Joint Committee on Taxation, *Estimates of Federal Tax Expenditures for Fiscal Years 2012-2017*, JCS-1-13 (Washington, DC, February 2013), Table 1, and Joint Committee on Taxation, *Estimates of Federal Tax Expenditures for Fiscal Years 2010-2014*, JCS-3-10 (Washington, DC, December 2010), Table 1.

Efficiency and conservation. The nine energy efficiency- and conservation-related tax provisions have collectively increased from \$2.7 billion in FY 2013 to \$3.2 billion in FY 2016, with the tax credit for

residential energy efficient property accounting for an expenditure increase of \$0.5 billion (Table). Examples of these provisions include

- Credit for Residential Energy Efficient Property (26 U.S.C. 25D).** EIA estimates that this credit had a value of \$1.5 billion in FY 2016 and \$1.0 billion in FY 2013. Section 1335 of EAct2005 established a 30% personal tax credit, not to exceed \$2,000, for the purchase of solar electric and solar water heating property. A 30% tax credit up to \$500 per 0.5 kilowatt (kW) of capacity is also available for fuel cells. The fuel cell provision of EAct2005 was due to expire at the end of 2007. It was extended through the end of calendar year 2008 by Section 206 of the Tax Relief and Health Care Act of 2006 (Public Law 109-432). Section 106 of EIEA2007 removed the cap on the tax credit for purchase of residential solar photovoltaic installations and extended the credit to December 31, 2016. Section 104 of EIEA extended the credit to include small wind properties (under 100 kilowatts) through December 31, 2016; and, Section 105 extended the tax credit to include geothermal heat pumps through December 31, 2016. Finally, Section 1122 of ARRA removed some of the previous maximum amounts and allowed a credit equal to 30% of the cost of qualified property.
- Credit for Energy Efficiency Improvements to Existing Homes (26 U.S.C 25C).** This credit was established in EAct2005, Section 1333, and it is estimated at a value of \$530 million in FY 2016, down from an estimated \$636 million in FY 2013 with most of this decrease traceable to the higher credit amounts made available due to ARRA. This credit applies to windows, furnaces, boilers, furnace fans, and building envelope components, such as exterior doors and any metal roof that has appropriate pigmented coatings.

Table 10. Estimates of conservation, efficiency, and end-use energy-specific tax expenditures, FY 2010, FY 2013, and FY 2016

million 2016 dollars

Tax Provision	FY 2010	FY 2013	FY 2016
Credit for Residential Energy Efficient Property	242	1,000	1,450
Credit for Energy Efficiency Improvements to Existing Homes	3,511	636	530
Tax Credit and Deduction for Clean-Burning Vehicles	275	281	480
Exclusion from Income of Conservation Subsidies Provided by Public Utilities	242	354	430
Credit for Construction of New Energy Efficient Homes	22	156	210
Allowance for the Deduction of Certain Energy Efficient Commercial Building Property	66	73	80
Qualified Energy Conservation Bonds	-	21	30
Advanced Energy Manufacturing Facility Investment Tax Credit	43	59	3
Credit for Energy Efficient Appliances	165	156	-
Total	4,567	2,737	3,213

Notes: Totals may not equal sum due to independent rounding. Zero denotes rounding to zero value and a “-” symbol denotes a zero value. The advanced energy manufacturing facility investment tax credit or sometimes called advanced energy property credit was allocated by fuel using data appearing in: <https://energy.gov/articles/energy-department->

[announces-150-million-tax-credits-invest-us-clean-energy-manufacturing](#) (Phase II of Section 48C) and IRC Section 48C Certifications at <https://www.irs.gov/businesses/irc-section-48c-certifications>, accessed March 20, 2018.

Sources: **Tax expenditure estimates:** Office of Management and Budget, *Analytical Perspectives, Budget of the U.S. Government*, Fiscal Years 2012, 2015 and 2018. Joint Committee on Taxation, *Estimates of Federal Tax Expenditures for Fiscal Years 2016-2020*, JCX-3-17 (Washington, DC, January 2017), Table 1, Joint Committee on Taxation, *Estimates of Federal Tax Expenditures for Fiscal Years 2012-2017*, JCS-1-13 (Washington, DC, February 2013), Table 1, and Joint Committee on Taxation, *Estimates of Federal Tax Expenditures for Fiscal Years 2010-2014*, JCS-3-10 (Washington, DC, December 2010), Table 1.

Electricity transmission and grid network. Transmission-related tax expenditures fell from \$219 million in FY 2013 to \$160 million in FY 2016 (Table). This decrease is largely a result of the decrease in estimated expenditures from transmission property treated as 15-year property, which fell by more than half from FY 2013 to FY 2016. Examples of these provisions include

- The Transmission Property Treated as 15-year Property (26 U.S.C. 168(e)).** This permanent provision was set forth in Section 1308 of EPAct2005 and modified Section 168 of the IRC by shortening the recovery period for specified assets from 20 to 15 years. To be eligible, an asset must be used in the transmission of electricity following sale of the property or related land improvements. Specifically, this applies to Section 1245 property, (i.e., personal property and real property subject to depreciation or amortization) used in the transmission of electricity that is energized at 69 kilovolts or more. The provision applies to transmission facilities placed in service by the taxpayer after April 11, 2005, but excludes any transmission facilities for which the taxpayer or related party had entered into a binding construction contract for or initiated self-construction on or before April 11, 2005. This tax provision is permanent, under current statutes.¹⁶ For FY 2016, the estimated value of accelerating the standard recovery period by five years is \$100 million, down from \$208 million in FY 2013.

Table 11. Estimates of electricity transmission-related energy-specific tax expenditure, FY 2010, FY 2013, and FY 2016

million 2016 dollars

Tax Provision	FY 2010	FY 2013	FY 2016
Transmission Property Treated as Fifteen-Year Property	110	208	100
Deferral of Gain from Disposition of Transmission Property to Implement FERC Restructuring Policy	(55)	-	60
Advanced Energy Manufacturing Facility Investment Tax Credit	8	11	0
5-Year Net Operating Loss Carryover for Electric Transmission Equipment	-	-	-
Total	63	219	160

Note: Totals may not equal sum due to independent rounding. Zero denotes rounding to zero value and a “-” symbol denotes a zero value. The advanced energy manufacturing facility investment tax credit or sometimes called advanced energy property credit was allocated by fuel using data appearing in: <https://energy.gov/articles/energy-department-announces->

¹⁶ Joint Committee on Taxation, *Report to the House Committee on Ways and Means on Present Law and Suggestions for Reform, Tax Reform Working Groups submissions*, JCS-3-13, May 6, 2013.

[150-million-tax-credits-invest-us-clean-energy-manufacturing](https://www.irs.gov/businesses/irc-section-48c-certifications) (Phase II of Section 48C) and IRC Section 48C Certifications at <https://www.irs.gov/businesses/irc-section-48c-certifications>, accessed March 20, 2018.

Sources: **Tax expenditure estimates:** Office of Management and Budget, *Analytical Perspectives, Budget of the U.S. Government*, Fiscal Years 2018, 2015 and 2012. Joint Committee on Taxation, *Estimates of Federal Tax Expenditures for Fiscal Years 2016-2020*, JCX-3-17 (Washington, DC, January 2017), Table 1, Joint Committee on Taxation, *Estimates of Federal Tax Expenditures for Fiscal Years 2012-2017*, JCS-1-13 (Washington, DC, February 2013), Table 1, and Joint Committee on Taxation, *Estimates of Federal Tax Expenditures for Fiscal Years 2010-2014*, JCS-3-10 (Washington, DC, December 2010), Table 1.

Direct Expenditures, Including R&D

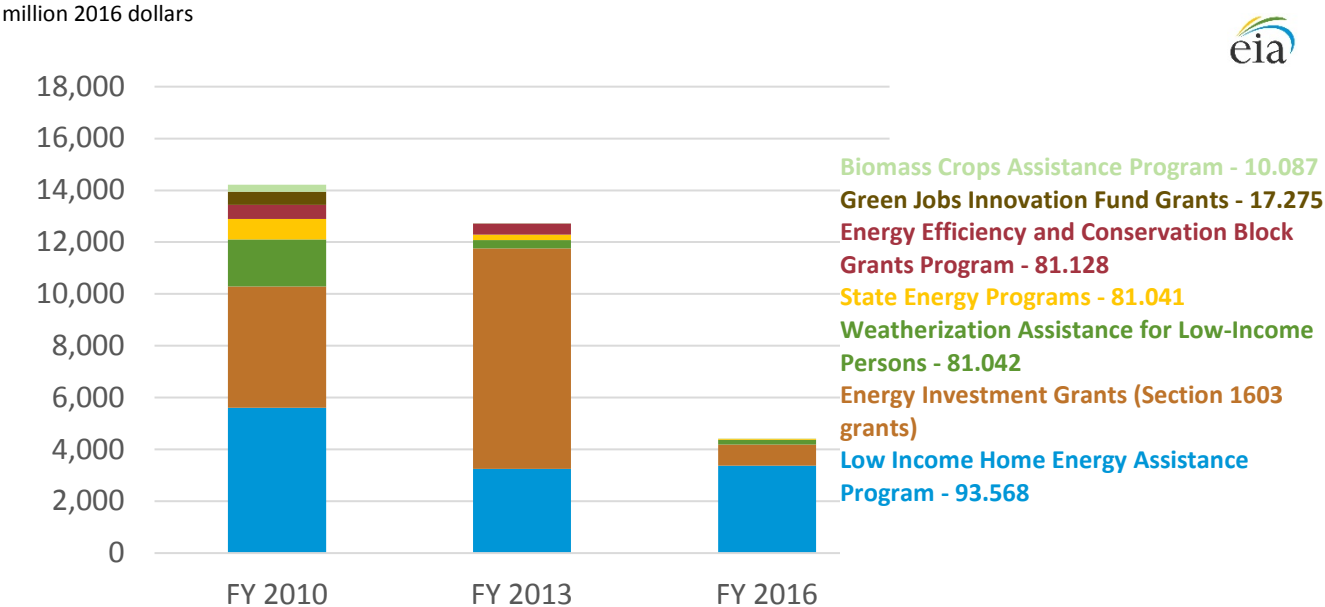
Direct expenditures, in contrast to tax expenditures, involve the transfer of congressionally appropriated funds to recipients by federal agencies. The enormous volume and diversity of federal direct expenditures makes it very difficult to assign energy-related activities to specific aspects of the energy system. As discussed in the Analytic Approach section, EIA has developed several powerful methods of obtaining and processing federal expenditure data; the resulting estimates in this section are nonetheless subject to scope and measurement issues.

This section follows the outline of the previous section, but adds information on agency-specific activities to the energy-specific discussions.

Table 12 shows the most comprehensive picture of the direct expenditure amounts estimated for each part of the energy system. As described in the Analytic Approach section, the Catalog of Federal Direct Assistance (CFDA) is the primary source for program information as well as CFDA coding for both agency and program designations.

Renewable energy facility construction (the Energy Investment Grant) and low-income energy assistance (LIHEAP, energy efficiency block grants, and weatherization) have dominated direct expenditures for energy over the three FY periods displayed in this report. Direct expenditures in these two areas accounted for nearly 67% of the FY 2010 total, with their percentage rising to 89% in FY 2016 (see Figure 8). Of more than 35 direct expenditure programs in Table 12, 7 programs accounted for between 92% and 95% of the total direct expenditures over the three FY time periods of interest in this report.

Figure 8. Direct expenditures by select programs, FY 2010, FY 2013, and FY 2016



Source: Table 12.

Tables in this section summarize the energy-specific categories with respect to the total set of direct expenditures in Table 12 and also sort by the 15 energy-specific categories.

Textbox: Federal direct purchasing of designated energy products

A set of overlapping federal programs aimed at direct acquisition of renewable, sustainable, resilient, or other designated energy resources has seen rapid growth in recent years. Driven in part by statute and Executive Orders, these programs allow or require federal organizations to use certain energy resource acquisition procedures, sometimes on a pooled or regional basis.

The definition of direct federal financial interventions (or subsidies) used in this report would generally only include federal energy purchases that add incremental cost and are intended to provide market support for the purchased resource. Because federal acquisition programs pursue a wide variety of goals—both operational and policy-related—such a determination is often difficult to make. To date, EIA has not included federal energy acquisition programs in the report tables or summaries.

Without determining what portion of these activities might be considered subsidies or market interventions, data from federal programs, both Defense and non-Defense, indicate the magnitude of direct energy acquisition activities in FY 2016.

Defense. The Department of Defense FY 2016 [Operational Energy Annual Report](#) includes accounting for more than \$46 billion in Defense-related energy purchasing in FY 2016. Of this, slightly more than \$1.8 billion is considered to be Operational Energy Initiatives that encompass a wide variety of activities. Research and development, field testing, pilot deployments, energy-reducing measures, and purchases of specific fuels (typically renewable energy sources) are all included.

Non-Defense. The Federal Energy Management Program (FEMP) and the General Services Administration (GSA) are responsible for most non-defense federal energy acquisition activities. Much of this activity is related to the March 2015 Executive Order on federal facility sustainability planning, which is summarized in a DOE [progress report](#).

Table 12. Estimates of direct expenditures in energy, FY 2010, FY 2013, and FY 2016

million 2016 dollars

Department and Program - CFDA Number	FY 2010	FY 2013	FY 2016
U.S. Department of Agriculture	364	139	97
Rural Energy for America Program - 10.868	55	45	35
Biofuel Infrastructure Partnership - 10.117	-	-	15
Bioenergy Program for Advanced Biofuels - 10.867	21	49	14
Biomass Crop Assistance Program - 10.087	269	9	10
Denali Commission Program - 90.100	-	16	8
Assistance to High Energy Cost Rural Communities - 10.859	8	14	6
Sun Grant Program - 10.320	2	2	5
Wood Utilization Assistance - 10.674	5	3	3
Biodiesel (Biodiesel Fuel Education Program) - 10.306	1	(0)	1
Biorefinery Assistance - 10.865	-	-	-
State Bulk Fuel Revolving Fund Grants - 10.857	1	-	-
Forest Biomass for Energy - 10.686	-	-	-
Repowering Assistance - 10.866	2	-	-
Community Wood Energy Program - 10.685	-	-	-
U.S. Department of Energy	3,577	1,421	304
Weatherization Assistance for Low-Income Persons - 81.042	1,818	313	182
State Energy Program - 81.041	784	212	46
Energy Efficiency and Renewable Energy Information Dissemination, Outreach, Training and Technical Analysis/Assistance - 81.117	42	47	31
Epidemiology and Other Health Studies Financial Assistance Program - 81.108	1	13	14
Expand and Extend Clean Coal Power Initiative - 81.131	46	52	11
State Energy Program Special Projects - 81.119	9	11	7
Nuclear Waste Disposal Siting - 81.065	9	5	6
Transport of Transuranic Wastes to the Waste Isolation Pilot Plant: States and Tribal Concerns, Proposed Solutions - 81.106	40	5	4
Industrial Carbon Capture and Storage (CCS) Application - 81.134	62	298	3
Carbon Capture and Storage-FutureGen 2.0 - 81.130	-	24	1
State Heating Oil and Propane Program - 81.138	-	0	0
Energy Efficiency and Renewable Energy Technology Deployment, Demonstration and Commercialization - 81.129	3	1	-
National Industrial Competitiveness through Energy, Environment, and Economics - 81.105	0	-	-
Geologic Sequestration Site Characterization - 81.132	-	-	-
Energy Efficiency and Conservation Block Grant Program (EECBG) - 81.128	549	436	-
Energy Efficient Appliance Rebate Program (EEARP) - 81.127	214	(0)	-
Office of Scientific and Technical Information - 81.064	-	-	-
Regional Biomass Energy Programs - 81.079	1	1	-
Inventions and Innovations - 81.036	0	2	-
U.S. Department of Health and Human Services	5,614	3,247	3,368
Low Income Home Energy Assistance - 93.568	5,614	3,247	3,368

Table 12. Estimates of direct expenditures in energy, FY 2010, FY 2013, and FY 2016 (cont.)

million 2016 dollars

Department and Program - CFDA Number	FY 2010	FY 2013	FY 2016
U.S. Department of Housing and Urban Development	259	-	(2)
Assisted Housing Stability and Energy and Green Retrofit Investments Program - 14.318	259	-	-
Multifamily Energy Innovation Fund - 14.319	-	-	(2)
U.S. Department of Labor	499	(2)	(0)
Green Jobs Innovation Fund Grants - 17.275	499	(2)	(0)
U.S. Department of State	-	-	-
Bureau of Western Hemisphere Affairs (WHA) Grant Programs (including Energy and Climate Partnership for the Americas) - 19.750	-	-	-
U.S. Department of the Interior	12	9	28
Federal Oil and Gas Royalty Management State and Tribal Coordination - 15.427	-	-	12
Science and Technology Projects Related to Coal Mining and Reclamation - 15.255	-	(0)	7
BOEM Environmental Studies Program - 15.423	0	4	5
Minerals and Mining on Indian Lands - 15.038	10	3	3
Louisiana State University (LSU) Coastal Marine Institute CMI - 15.422	1	1	1
Energy Cooperatives to Support the National Coal Resources Data System (NCRDS) - 15.819	0	0	0
Tribal Energy Development Capacity Grants - 15.148	-	-	-
U.S. Department of Transportation	272	88	42
Pipeline Safety Program State Base Grant - 20.700	43	46	40
PHMSA Pipeline Safety Program One Call Grant - 20.721	1	1	1
Air Emissions and Energy Initiative - 20.817	-	1	0
Railroad Research and Development - 20.313	-	-	-
Capital Assistance Program for Reducing Energy Consumption and Greenhouse Gas Emissions - 20.523	216	15	-
Clean Fuels - 20.519	12	24	-
U.S. Department of the Treasury	4,678	8,514	820
Energy Investment Grant; Outlay Equivalent for Clean Renewable Energy Bonds; Outlay Equivalent for Qualified Energy Conservation Bonds	4,678	8,514	820
U.S. Environmental Protection Agency	134	18	45
National Clean Diesel Emissions Reduction Program - 66.039	101	14	33
State Clean Diesel Grant Program - 66.040	32	5	12
Nuclear Regulatory Commission	19	16	16
U.S. Nuclear Regulatory Commission Scholarship and Fellowship Program - 77.008	12	15	15
U.S. Nuclear Regulatory Commission Minority Serving Institutions Program (MISP) - 77.007	2	1	1
U.S. Nuclear Regulatory Commission Nuclear Education Grant Program - 77.006	6	-	(0)
Total	15,427	13,450	4,716

Notes: Totals may not equal sum due to independent rounding. Zero denotes rounding to zero value and a “-” symbol denotes a zero value. Appropriations made in either FY 2010, FY 2013, or FY 2016 federal agency budgets may be obligated and fund programs in subsequent fiscal years. Energy investment grants are commonly referred to as Section 1603 grants administered by the U.S. Department of the Treasury.

Sources: U.S. Department of Energy, Office of the Chief Financial Officer, *Base Financial Data*, FY 2010, FY 2013, and FY 2016; U.S. Department of the Treasury, Bureau of the Fiscal Service, *USASpending.gov*, website: <https://www.usaspending.gov/>, accessed December 1, 2014 (FY 2010 and FY 2013) and accessed November 16, 2017 (FY 2016); and, U.S. General Services Administration, *2014 Catalog of Federal Domestic Assistance*, (Washington, DC, October 2014) https://www.cfda.gov/downloads/CFDA_2014.pdf, accessed December 1, 2014 and *2017 Catalog of Federal Domestic Assistance*, (Washington, DC, October 2017) https://www.cfda.gov/downloads/CFDA_2017.pdf, accessed December 1, 2017.

Table 13. Estimates of research and development expenditures in energy, FY 2010, FY 2013, and FY 2016

million 2016 dollars

Department and Program - CFDA Number	FY 2010	FY 2013	FY 2016
U.S. Department of Agriculture	34	4	11
Biomass Research and Development Initiative Competitive Grants Program (BRDI) - 10.312	32	(2)	7
Agricultural Research Basic and Applied Research - 10.001	2	6	5
U.S. Department of Defense	22	5	52
Basic Scientific Research - 12.431	7	4	46
Basic, Applied, and Advanced Research in Science and Engineering - 12.630	6	1	7
Research and Technology Development - 12.910	8	0	0
U.S. Department of Energy	2,244	2,284	1,051
Fossil Energy Research and Development - 81.089	321	218	377
Renewable Energy Research and Development - 81.087	610	501	184
Advanced Research and Projects Agency - Energy Financial Assistance Program - 81.135	29	149	184
Conservation Research and Development - 81.086	587	454	151
Nuclear Energy Research, Development and Demonstration - 81.121	174	133	137
Electricity Delivery and Energy Reliability, Research, Development and Analysis - 81.122	518	824	15
University Coal Research - 81.057	2	2	2
Geologic Sequestration Training and Research Grant Program - 81.133	3	4	-
U.S. Department of the Interior	1	0	2
Safety and Environmental Enforcement Research and Data Collection for Offshore Energy and Mineral Activities - 15.441	-	-	2
Offshore Research Technology Center (OTRC) Texas Engineering Experiment Station (TEES) - 15.425	-	-	-
Marine Gas Hydrate Research Activities - 15.428	1	0	(0)
U.S. Department of Transportation	6	16	2
PHMSA Pipeline Safety Research and Development Other Transaction Agreements - 20.723	6	16	2
Biobased Transportation Research - 20.761	0	-	-
Hydrogen Storage Research and Development - 20.764	-	-	-
U.S. Environmental Protection Agency	3	3	2
Surveys, Studies, Research, Investigations, Demonstrations, and Special Purpose Activities Relating to the Clean Air Act - 66.034	3	3	2

Table 13. Estimates of research and development expenditures in energy, FY 2010, FY 2013, and FY 2016 (cont.)

million 2016 dollars

Department and Program - CFDA Number	FY 2010	FY 2013	FY 2016
National Science Foundation	407	621	328
Mathematical and Physical Sciences - 47.049	268	475	243
Engineering Grants - 47.041	138	146	86
Nuclear Regulatory Commission	2	0	2
U.S. Nuclear Regulatory Commission Office of Research Financial Assistance Program - 77.009	2	0	2
Total	2,718	2,934	1,451

Notes: Totals may not equal sum due to independent rounding. Zero denotes rounding to zero value and a “-” symbol denotes a zero value. Appropriations made in either FY 2010, FY 2013, or FY 2016 federal agency budgets may be obligated and fund programs in subsequent fiscal years. DOE and totals exclude DOE’s Office of Science, Office of Science Financial Assistance Program.

Sources: U.S. Department of Energy, Office of the Chief Financial Officer, *Base Financial Data*, FY 2010, FY 2013, and FY 2016; Department of the Treasury, Bureau of the Fiscal Service, *USASpending.gov - Government spending at your fingertips*; website: <https://www.usaspending.gov/>, accessed December 1, 2014 (FY 2010 and FY 2013) and accessed November 16, 2017 (FY 2016); and, U.S. General Services Administration, *2014 Catalog of Federal Domestic Assistance*, (Washington, DC, October 2014) https://www.cfda.gov/downloads/CFDA_2014.pdf, accessed December 1, 2014 and *2017 Catalog of Federal Domestic Assistance*, (Washington, DC, October 2017) https://www.cfda.gov/downloads/CFDA_2017.pdf, accessed December 1, 2017.

Examples of energy-specific direct expenditure and R&D programs

Coal. Direct expenditures for coal-related programs decreased from \$77 million in FY 2013 to \$19 million in FY 2016, while R&D spending rose from \$216 million in FY 2013 to \$337 million in FY 2016. Table and Table show detailed coal-related program outlays. Examples of coal-related federal activities include

- Carbon Capture and Sequestration (CCS).** DOE’s Fossil Energy Research and Development program portfolio includes CCS technology research. Coal-centered CCS focuses on post-combustion capture of carbon dioxide (CO₂) from existing plants and industrial sources. Sequestration research aims to provide reliable and safe permanent storage of CO₂ gas to mitigate carbon emission for fossil fuel sources. In 2016, DOE’s R&D expenditures also supported the FutureGen 2.0 project, an oxy-fuel retrofit of a recently idled 65-year-old facility in Illinois. FutureGen 2.0 was a DOE CCS demonstration project, combining all three aspects of CCS technology: capturing and separating CO₂ from other gases, compressing and transporting CO₂ to the sequestration site, and injecting CO₂ in geologic formations for permanent storage.
- University Coal Research (UCR).** UCR supports hands-on research experience to future generations of scientists and engineers. Since the program’s inception in 1980, more than \$100 million has been provided and more than 1,700 students have acquired experience in understanding the science and technology of coal. UCR projects include a number of diverse coal-based studies. In FY 2016, UCR supported projects researching high-tech sensors and

controls, water management and flue gas desulfurization, and the use of high-performance materials in steam turbines.

Table 14. Estimates of coal-related energy-specific direct expenditures by department and program, FY 2010, FY 2013, and FY 2016

million 2016 dollars

Department and Program - CFDA Number	FY 2010	FY 2013	FY 2016
U.S. Department of Energy	46	77	12
Expand and Extend Clean Coal Power Initiative - 81.131	46	52	11
Carbon Capture and Storage-FutureGen 2.0 - 81.130	-	24	1
U.S. Department of the Interior	2	1	7
Science and Technology Projects Related to Coal Mining and Reclamation - 15.255	-	(0)	7
Minerals and Mining on Indian Lands - 15.038	1	0	0
Energy Cooperatives to Support the National Coal Resources Data System (NCRDS) - 15.819	0	0	0
Total	48	77	19

Notes: Totals may not equal sum due to independent rounding. Zero denotes rounding to zero value and a “-“symbol denotes a zero value. Appropriations made in either FY 2010, FY 2013, or FY 2016 federal agency budgets may be obligated and fund programs in subsequent fiscal years.

Sources: U.S. Department of Energy, Office of the Chief Financial Officer, *Base Financial Data*, FY 2010, FY 2013, and FY 2016; Department of the Treasury, Bureau of the Fiscal Service, *USASpending.gov - Government spending at your fingertips*; website: <https://www.usaspending.gov/>, accessed December 1, 2014 (FY 2010 and FY 2013) and accessed November 16, 2017 (FY 2016); and, U.S. General Services Administration, *2014 Catalog of Federal Domestic Assistance*, (Washington, DC, October 2014) https://www.cfda.gov/downloads/CFDA_2014.pdf, accessed December 1, 2014 and *2017 Catalog of Federal Domestic Assistance*, (Washington, DC, October 2017) https://www.cfda.gov/downloads/CFDA_2017.pdf, accessed December 1, 2017.

Table 15. Estimates of coal-related energy-specific research and development expenditures by department and program, FY 2010, FY 2013, and FY 2016

million 2016 dollars

Department and Program - CFDA Number	FY 2010	FY 2013	FY 2016
U.S. Department of Energy	320	211	335
Fossil Energy Research and Development - 81.089	318	207	333
University Coal Research - 81.057	2	2	2
Advanced Research and Projects Agency - Energy Financial Assistance Program - 81.135	1	2	-
National Science Foundation	-	5	2
Mathematical and Physical Sciences - 47.049	-	5	2
Total	320	216	337

Notes: Totals may not equal sum due to independent rounding. Zero denotes rounding to zero value and a “-“symbol denotes a zero value. Appropriations made in either FY 2010, FY 2013, or FY 2016 federal agency budgets may be obligated and fund programs in subsequent fiscal years. DOE and totals exclude DOE’s Office of Science, Office of Science Financial Assistance Program.

Sources: U.S. Department of Energy, Office of the Chief Financial Officer, *Base Financial Data*, FY 2010, FY 2013, and FY 2016; Department of the Treasury, Bureau of the Fiscal Service, *USASpending.gov - Government spending at your fingertips*; website: <https://www.usaspending.gov/>, accessed December 1, 2014 (FY 2010 and FY 2013) and accessed November 16,

2017 (FY 2016); and, U.S. General Services Administration, *2014 Catalog of Federal Domestic Assistance*, (Washington, DC, October 2014) https://www.cfda.gov/downloads/CFDA_2014.pdf, accessed December 1, 2014 and *2017 Catalog of Federal Domestic Assistance*, (Washington, DC, October 2017) https://www.cfda.gov/downloads/CFDA_2017.pdf, accessed December 1, 2017.

Renewable energy including biofuels. Renewable energy direct expenditures have varied considerably, dropping to \$909 million in FY 2016 from \$8.7 billion in FY 2013. In each fiscal year, however, the overwhelming share of renewable energy direct expenditures came from an ARRA modification of two tax expenditure provisions previously discussed:

- The PTC, where the support amount is based on electricity generation from eligible new renewable electricity facilities
- Two tax credit bonds, the clean renewable energy bond (CREB) and the qualified energy conservation bond (QECB) for public-sector renewable projects

Table 16. Estimates of renewable-related energy-specific direct expenditures by department and program, FY 2010, FY 2013, and FY 2016

million 2016 dollars

Department and Program - CFDA Number	FY 2010	FY 2013	FY 2016
U.S. Department of Agriculture	322	95	82
Rural Energy for America Program - 10.868	19	25	32
Biofuel Infrastructure Partnership - 10.117	-	-	15
Bioenergy Program for Advanced Biofuels - 10.867	21	49	14
Biomass Crop Assistance Program - 10.087	269	9	10
Sun Grant Program - 10.320	2	2	5
Wood Utilization Assistance - 10.674	5	3	3
Assistance to High Energy Cost Rural Communities - 10.859	4	5	2
Biodiesel (Biodiesel Fuel Education Program) - 10.306	1	(0)	1
Repowering Assistance - 10.866	2	-	-
Denali Commission Program - 90.100	-	1	-
Forest Biomass for Energy - 10.686	-	-	-
Biorefinery Assistance - 10.865	-	-	-
Community Wood Energy Program - 10.685	-	-	-
U.S. Department of Energy	288	98	4
Energy Efficiency and Renewable Energy Information Dissemination, Outreach, Training and Technical Analysis/Assistance - 81.117	23	25	2
State Energy Program - 81.041	262	71	1
Regional Biomass Energy Programs - 81.079	1	1	-
Office of Scientific and Technical Information - 81.064	-	-	-
Energy Efficiency and Renewable Energy Technology Deployment, Demonstration and Commercialization - 81.129	2	0	-
Industrial Carbon Capture and Storage (CCS) Application - 81.134	1	-	-
Inventions and Innovations - 81.036	0	1	-

Table 16. Estimates of renewable-related energy-specific direct expenditures by department and program, FY 2010, FY 2013, and FY 2016 (cont.)

million 2016 dollars

Department and Program - CFDA Number	FY 2010	FY 2013	FY 2016
U.S. Department of Labor	437	(2)	(0)
Green Jobs Innovation Fund Grants - 17.275	437	(2)	(0)
U.S. Department of the Interior	3	2	3
Minerals and Mining on Indian Lands - 15.038	3	1	3
BOEM Environmental Studies Program - 15.423	-	0	1
Tribal Energy Development Capacity Grants - 15.148	-	-	-
U.S. Department of Transportation	4	10	0
Air Emissions and Energy Initiative - 20.817	-	1	0
Clean Fuels - 20.519	4	8	-
U.S. Department of the Treasury	4,678	8,514	820
Energy Investment Grant; Outlay Equivalent for Clean Renewable Energy Bonds; Outlay Equivalent for Qualified Energy Conservation Bonds	4,678	8,514	820
U.S. Environmental Protection Agency	-	-	0
State Clean Diesel Grant Program - 66.040	-	-	0
Total	5,732	8,716	909

Notes: Totals may not equal sum due to independent rounding. Zero denotes rounding to zero value and a “-“symbol denotes a zero value. Appropriations made in either FY 2010, FY 2013, or FY 2016 federal agency budgets may be obligated and fund programs in subsequent fiscal years.

Sources: U.S. Department of Energy, Office of the Chief Financial Officer, *Base Financial Data*, FY 2010, FY 2013, and FY 2016; Department of the Treasury, Bureau of the Fiscal Service, *USASpending.gov*, website: <https://www.usaspending.gov/>, accessed December 1, 2014 (FY 2010 and FY 2013) and accessed November 16, 2017 (FY 2016); and, U.S. General Services Administration, *2014 Catalog of Federal Domestic Assistance*, (Washington, DC, October 2014) https://www.cfda.gov/downloads/CFDA_2014.pdf, accessed December 1, 2014 and *2017 Catalog of Federal Domestic Assistance*, (Washington, DC, October 2017) https://www.cfda.gov/downloads/CFDA_2017.pdf, accessed December 1, 2017.

Congress created direct expenditure programs related to each of these after the 2008 recession. At that time, few companies interested in constructing projects that would qualify for the PTC, CREBs, or QECBs had sufficient tax liability to offset those programs’ tax credits.¹⁷ To maintain support for building new renewable energy facilities, Congress created direct payment programs that entities could opt for in lieu of the tax credits. It is important to note that Treasury does not regard these two direct expenditure programs as *domestic financial assistance*, so they do not appear in the CFDA. Each program is discussed below:

- **Energy investment grants (Section 1603 of Public Law 111-5)** Congress created Energy Investment Grants as an alternative support program to the PTC. The program was created as a part of ARRA, which authorized Treasury to provide grants up to 30% of PTC-eligible facility

¹⁷ Many firms during and after the 2008-09 recession were making little or no profit, so they owed little or no tax. Under such conditions, a firm’s eligible PTC tax credit exceeded its total tax liability, greatly limiting the amount of the tax credit it could claim.

construction costs.¹⁸ Taking a grant instead of the PTC eliminates dependence on tax liability considerations. Because the grants are largely tied to PTC-eligible facilities, direct expenditures for Section 1603 grants have declined sharply between FY 2013 and FY 2016 as the PTC or 1603 grant deadline expired for some types of renewable energy-producing facilities. Energy investment grants fell sharply from previous years. No additional projects are expected to receive the Section 1603 grants.

- **Payments in lieu of tax credits for CREBs and QECBs (Public Law 111-147).** In March 2010, Congress enacted [Public Law 111-147 \(Section 301\)](#), permitting new CREB and QECB issuers (in the public sector) to make an irrevocable election to receive a direct payment—a refundable tax credit—from Treasury. The amount is equivalent to, and in lieu of, the amount of the non-refundable tax credit that would otherwise be provided to the bondholder.¹⁹ New CREBs are those issued after March 18, 2010, the enactment date of the law. In April 2010, the Internal Revenue Service issued [Notice 2010-35](#) that provides guidance on the direct payment option.²⁰ As a result of the Tax Cuts and Jobs Act being signed into law on December 22, 2017, new CREBs have been eliminated effective January 1, 2018.

Table 17. Estimates of renewable-related energy-specific research and development expenditures by department and program, FY 2010, FY 2013, and FY 2016

million 2016 dollars

Department and Program - CFDA Number	FY 2010	FY 2013	FY 2016
U.S. Department of Agriculture	34	4	8
Biomass Research and Development Initiative Competitive Grants Program (BRDI) - 10.312	32	(2)	7
Agricultural Research Basic and Applied Research - 10.001	2	6	1
U.S. Department of Defense	22	5	2
Basic Scientific Research - 12.431	7	4	2
Research and Technology Development - 12.910	8	0	0
Basic, Applied, and Advanced Research in Science and Engineering - 12.630	6	1	-
U.S. Department of Energy	551	488	233
Renewable Energy Research and Development - 81.087	542	445	166
Advanced Research and Projects Agency - Energy Financial Assistance Program - 81.135	9	43	60
Fossil Energy Research and Development - 81.089	-	-	6
Department of Transportation	0	-	-
Biobased Transportation Research - 20.761	0	-	-

¹⁸ In addition to PTC-eligible facilities, certain energy efficiency investments (e.g., LED lighting) are also eligible for the grants.

¹⁹ For more details, see the [Database for State Incentives for Renewables and Efficiency \(DSIRE\)](#). DSIRE also includes information on federal and state renewable energy incentive programs.

²⁰ Public Law 111-147 also created direct expenditure provisions for other Tax Credit Bonds.

Table 17. Estimates of renewable-related energy-specific research and development expenditures by department and program, FY 2010, FY 2013, and FY 2016 (cont.)

million 2016 dollars

Department and Program - CFDA Number	FY 2010	FY 2013	FY 2016
U.S. Environmental Protection Agency	0	0	-
Surveys, Studies, Research, Investigations, Demonstrations, and Special Purpose Activities Relating to the Clean Air Act - 66.034	0	0	-
National Science Foundation	237	367	214
Mathematical and Physical Sciences - 47.049	156	276	169
Engineering Grants - 47.041	81	90	45
Total	844	864	456

Notes: Totals may not equal sum due to independent rounding. Zero denotes rounding to zero value and a “-” symbol denotes a zero value. Appropriations made in either FY 2010, FY 2013, or FY 2016 federal agency budgets may be obligated and fund programs in subsequent fiscal years. DOE and totals exclude DOE’s Office of Science, Office of Science Financial Assistance Program.

Sources: U.S. Department of Energy, Office of the Chief Financial Officer, *Base Financial Data*, FY 2010, FY 2013, and FY 2016; U.S. Department of the Treasury, Bureau of the Fiscal Service, *USASpending.gov - Government spending at your fingertips*; website: <https://www.usaspending.gov/>, accessed December 1, 2014 (FY 2010 and FY 2013) and accessed November 16, 2017 (FY 2016); and, U.S. General Services Administration, *2014 Catalog of Federal Domestic Assistance*, (Washington, DC, October 2014) https://www.cfda.gov/downloads/CFDA_2014.pdf, accessed December 1, 2014 and *2017 Catalog of Federal Domestic Assistance*, (Washington, DC, October 2017) https://www.cfda.gov/downloads/CFDA_2017.pdf, accessed December 1, 2017.

Renewable energy R&D. More than 90% of federal renewable energy R&D support came from DOE and the National Science Foundation (NSF) in all fiscal years.

Federal spending on renewable energy R&D dropped by nearly 50% between FY 2013 and FY 2016. A \$255 million reduction in DOE's principal renewable energy R&D program, although spending increased on early-stage research by DOE's Advanced Research Projects Agency.

The principal NSF program funding renewable energy R&D in FY 2016 was the physical sciences.

Physical science grants tend to address research at earlier stages than engineering grants (see *Textbox: Research and development for general application* at the end of this section). More than 70% of physical science grants went to solar energy research with virtually all of the remainder for *other renewable energy* (e.g., fuel cells). Engineering grants, which totaled slightly more than one-fifth of physical science grants, also principally funded solar energy research (56%).

Major federal R&D programs for renewable energy are discussed below:

- **Renewable Energy Research and Development (81.087).** This R&D program is DOE’s largest renewable-related R&D program (note that DOE’s Office of Science programs are being treated as non-specific, as discussed in *Textbox: Research and development for general application* at the end of this section) and administers grants in the areas of solar, biomass, hydrogen fuel cells

and infrastructure, wind and hydropower, and geothermal.²¹ Projects in fuel areas except for biomass are exclusively related to electricity generation. Biomass projects also include biofuels research and related fuel-vehicle research. The largest category of award recipients in FY 2016 was colleges and universities, which received more than one-third of all awards. Solar and wind have received most of the grant money for electricity projects over the years with solar receiving the largest share in FY 2016.

- **Energy Efficiency and Renewable Energy Information Dissemination, Outreach, Training and Technical Analysis/Assistance (81.117).** This program is the longest-running direct assistance energy program, established by the Energy Reorganization Act of 1974 ([Public Law 93-438](#)). As its name suggests, this program funds both energy efficiency and renewable energy projects. Within renewable energy, the program has a broad focus, including all forms of renewable energy use and production. Specifically, it provides financial assistance for information dissemination, outreach, training, and related technical analysis designed to encourage increased use of renewable and alternative energy and accelerate the adoption of new technologies to increase the use of renewable and alternative energy through the competitive solicitation of applications. More than half of FY 2016 awards supported Industrial Assessment Centers (IACs), whose primary goal is to train the next generation of energy engineers. IACs also offer feasibility studies to qualified plants to significantly improve their energy efficiency and promote renewable energy. This program also supports the [Database for State Incentives on Renewable Energy](#) (DSIRE),²² a website containing comprehensive information about incentives for renewable energy.
- **National Science Foundation (47.041 and 47.049).** NSF implements two research programs that include sizable grant awards for energy research. Engineering grants provide engineering knowledge, education, and knowledge transfer to the broader population. However, only a fraction of engineering energy-related awards are oriented to specific fuel areas covered in this report. The most common renewable fuel studied in FY 2016 engineering grants was solar energy. Renewable projects range from basic engineering theory to studying engineering improvements for commercial projects and processes. The other major NSF energy project covers mathematics and physical sciences.

Petroleum and natural gas. Table shows petroleum and natural gas-related federal direct expenditures while Table shows associated R&D outlays. Petroleum and natural gas-related direct expenditures, including R&D, would have been fairly stable except for the \$298 million entry in FY 2013 for the Industrial Carbon Capture and Storage program from the Department of Energy. In FY 2016, the National

²¹ Hydropower includes conventional hydropower as well as ocean energy (e.g., wave, tidal, etc.).

²² DSIRE also includes information about Federal renewable energy incentives.

Clean Diesel Emissions Reduction Program increased to \$33 million from \$14 million in FY 2013. Other elements in this area, in aggregate, saw funding decrease slightly from FY 2013 (\$140 million) to FY 2016 (\$134 million). One example of an oil and natural gas-related direct expenditure program is

- The Bureau of Ocean Energy Management (BOEM) Environmental Studies Program (ESP).** The mission of the ESP is to enable the Department of the Interior (DOI) to perform its environmental stewardship duties by producing scientific research aimed at safer ocean-based energy production. The ESP is a [strategic planning program](#) and plans annual activities through a [Study Development Plan](#). The National Academy of Sciences Committee on Offshore Science and Assessment (COSA) advises ESP on the scientific and technical aspects of the proposed study efforts. According to BOEM, the ESP budget is balanced annually and tracked to its ultimate use. When a study is complete, BOEM measures success and accountability with an OMB tool – the Environmental Studies Program Assessment Tool.

Table 18. Estimates of natural gas- and petroleum-related energy-specific direct expenditures by department and program, FY 2010, FY 2013, and FY 2016

million 2016 dollars

Department and Program - CFDA Number	FY 2010	FY 2013	FY 2016
U.S. Department of Agriculture	1	11	6
Denali Commission Program - 90.100	-	11	6
State Bulk Fuel Revolving Fund Grants - 10.857	1	-	-
U.S. Department of Energy	-	298	3
Industrial Carbon Capture and Storage (CCS) Application - 81.134	-	298	3
State Heating Oil and Propane Program - 81.138	-	0	0
Geologic Sequestration Site Characterization - 81.132	-	-	-
Inventions and Innovations - 81.036	-	-	-
U.S. Department of the Interior	2	5	17
Federal Oil and Gas Royalty Management State and Tribal Coordination - 15.427	-	-	12
BOEM Environmental Studies Program - 15.423	0	4	4
Louisiana State University (LSU) Coastal Marine Institute CMI - 15.422	1	1	1
Minerals and Mining on Indian Lands - 15.038	-	-	0
U.S. Department of Transportation	48	55	42
Pipeline Safety Program State Base Grant - 20.700	43	46	40
PHMSA Pipeline Safety Program One Call Grant - 20.721	1	1	1
Clean Fuels - 20.519	4	8	-
U.S. Environmental Protection Agency	32	18	44
National Clean Diesel Emissions Reduction Program - 66.039	-	14	33
State Clean Diesel Grant Program - 66.040	32	5	12
Total	83	388	111

Notes: Totals may not equal sum due to independent rounding. Zero denotes rounding to zero value and a “-“symbol denotes a zero value. Appropriations made in either FY 2010, FY 2013, or FY 2016 federal agency budgets may be obligated and fund programs in subsequent fiscal years.

Sources: U.S. Department of Energy, Office of the Chief Financial Officer, *Base Financial Data*, FY 2010, FY 2013, and FY 2016; Department of the Treasury, Bureau of the Fiscal Service, *USASpending.gov - Government spending at your fingertips*; website: <https://www.usaspending.gov/>, accessed December 1, 2014 (FY 2010 and FY 2013) and accessed November 16, 2017 (FY 2016); and, U.S. General Services Administration, *2014 Catalog of Federal Domestic Assistance*, (Washington, DC, October 2014) https://www.cfda.gov/downloads/CFDA_2014.pdf, accessed December 1, 2014 and *2017 Catalog of Federal Domestic Assistance*, (Washington, DC, October 2017) https://www.cfda.gov/downloads/CFDA_2017.pdf, accessed December 1, 2017.

Table 19. Estimates of natural gas- and petroleum-related energy-specific research and development expenditures by department and program, FY 2010, FY 2013, and FY 2016

million 2016 dollars

Department and Program - CFDA Number	FY 2010	FY 2013	FY 2016
U.S. Department of Defense	-	-	1
Basic Scientific Research - 12.431	-	-	1
Basic, Applied, and Advanced Research in Science and Engineering - 12.630	-	-	0
U.S. Department of Energy	3	22	42
Fossil Energy Research and Development - 81.089	3	11	38
Conservation Research and Development - 81.086	-	-	5
Geologic Sequestration Training and Research Grant Program - 81.133	-	4	-
Advanced Research and Projects Agency - Energy Financial Assistance Program - 81.135	0	8	-
U.S. Department of the Interior	1	0	2
Safety and Environmental Enforcement Research and Data Collection for Offshore Energy and Mineral Activities - 15.441	-	-	2
Offshore Research Technology Center (OTRC) Texas Engineering Experiment Station (TEES) - 15.425	-	-	-
Marine Gas Hydrate Research Activities - 15.428	1	0	(0)
U.S. Department of Transportation	6	16	2
PHMSA Pipeline Safety Research and Development Other Transaction Agreements - 20.723	6	16	2
National Science Foundation	-	25	8
Engineering Grants - 47.041	-	-	6
Mathematical and Physical Sciences - 47.049	-	25	2
Total	10	64	56

Notes: Totals may not equal sum due to independent rounding. Zero denotes rounding to zero value and a “-“symbol denotes a zero value. Appropriations made in either FY 2010, FY 2013, or FY 2016 federal agency budgets may be obligated and fund programs in subsequent fiscal years. DOE and totals exclude DOE’s Office of Science, Office of Science Financial Assistance Program.

Sources: U.S. Department of Energy, Office of the Chief Financial Officer, *Base Financial Data*, FY 2010, FY 2013, and FY 2016; Department of the Treasury, Bureau of the Fiscal Service, *USASpending.gov - Government spending at your fingertips*; website: <https://www.usaspending.gov/>, accessed December 1, 2014 (FY 2010 and FY 2013) and accessed November 16, 2017 (FY 2016); and, U.S. General Services Administration, *2014 Catalog of Federal Domestic Assistance*, (Washington, DC, October 2014) https://www.cfda.gov/downloads/CFDA_2014.pdf, accessed December 1, 2014 and *2017 Catalog of Federal Domestic Assistance*, (Washington, DC, October 2017) https://www.cfda.gov/downloads/CFDA_2017.pdf, accessed December 1, 2017.

Nuclear. Nuclear direct expenditures, inclusive of R&D, have decreased from \$235 million in FY 2013 to \$204 million in FY 2016. These activities are dominated by DOE program efforts. Unlike most kinds of federal energy assistance, nuclear support is higher in R&D than in direct expenditures. Note that some DOE R&D is not categorized by energy system category, as discussed in the *Textbox: Research and development for general application* at the end of this section; some of this basic R&D is also presumably used by the nuclear energy industry, as well as by others.

Table 20. Estimates of nuclear transformation-related energy-specific direct expenditures by department and program, FY 2010, FY 2013, and FY 2016

million 2016 dollars

Department and Program - CFDA Number	FY 2010	FY 2013	FY 2016
U.S. Department of Energy	50	23	25
Epidemiology and Other Health Studies Financial Assistance Program - 81.108	1	13	14
Nuclear Waste Disposal Siting - 81.065	9	5	6
Transport of Transuranic Wastes to the Waste Isolation Pilot Plant: States and Tribal Concerns, Proposed Solutions - 81.106	40	5	4
Nuclear Regulatory Commission	19	16	16
U.S. Nuclear Regulatory Commission Scholarship and Fellowship Program - 77.008	12	15	15
U.S. Nuclear Regulatory Commission Minority Serving Institutions Program (MISP) - 77.007	2	1	1
U.S. Nuclear Regulatory Commission Nuclear Education Grant Program - 77.006	6	-	(0)
Total	69	38	40

Notes: Totals may not equal sum due to independent rounding. Zero denotes rounding to zero value and a “-“symbol denotes a zero value. Appropriations made in either FY 2010, FY 2013, or FY 2016 federal agency budgets may be obligated and fund programs in subsequent fiscal years.

Sources: U.S. Department of Energy, Office of the Chief Financial Officer, *Base Financial Data*, FY 2010, FY 2013, and FY 2016; Department of the Treasury, Bureau of the Fiscal Service, *USASpending.gov - Government spending at your fingertips*; website: <https://www.usaspending.gov/>, accessed December 1, 2014 (FY 2010 and FY 2013) and accessed November 16, 2017 (FY 2016); and, U.S. General Services Administration, *2014 Catalog of Federal Domestic Assistance*, (Washington, DC, October 2014) https://www.cfda.gov/downloads/CFDA_2014.pdf, accessed December 1, 2014 and *2017 Catalog of Federal Domestic Assistance*, (Washington, DC, October 2017) https://www.cfda.gov/downloads/CFDA_2017.pdf, accessed December 1, 2017.

Table 21. Estimates of nuclear transformation-related energy-specific research and development expenditures by department and program, FY 2010, FY 2013, and FY 2016

million 2016 dollars

Department and Program - CFDA Number	FY 2010	FY 2013	FY 2016
U.S. Department of Energy	174	133	137
Nuclear Energy Research, Development and Demonstration - 81.121	174	133	137
National Science Foundation	1	64	25
Mathematical and Physical Sciences - 47.049	1	64	25
Engineering Grants - 47.041	0	0	1

Table 21. Estimates of nuclear transformation-related energy-specific research and development expenditures by department and program, FY 2010, FY 2013, and FY 2016 (cont.)

million 2016 dollars

Department and Program - CFDA Number	FY 2010	FY 2013	FY 2016
Nuclear Regulatory Commission	2	0	2
U.S. Nuclear Regulatory Commission Office of Research Financial Assistance Program - 77.009	2	0	2
Total	177	197	164

Notes: Totals may not equal sum due to independent rounding. Zero denotes rounding to zero value and a “-” symbol denotes a zero value. Appropriations made in either FY 2010, FY 2013, or FY 2016 federal agency budgets may be obligated and fund programs in subsequent fiscal years. DOE and totals exclude DOE’s Office of Science, Office of Science Financial Assistance Program.

Sources: U.S. Department of Energy, Office of the Chief Financial Officer, *Base Financial Data*, FY 2010, FY 2013, and FY 2016; Department of the Treasury, Bureau of the Fiscal Service, *USASpending.gov - Government spending at your fingertips*; website: <https://www.usaspending.gov/>, accessed December 1, 2014 (FY 2010 and FY 2013) and accessed November 16, 2017 (FY 2016); and, U.S. General Services Administration, *2014 Catalog of Federal Domestic Assistance*, (Washington, DC, October 2014) https://www.cfda.gov/downloads/CFDA_2014.pdf, accessed December 1, 2014 and *2017 Catalog of Federal Domestic Assistance*, (Washington, DC, October 2017) https://www.cfda.gov/downloads/CFDA_2017.pdf, accessed December 1, 2017.

Energy efficiency, conservation and end use. Taken together, support for end use-related activities decreased from \$4.9 billion in FY 2013 to \$4.0 billion in FY 2016 (see Table 22 for direct expenditures and Table 23 for R&D). The Low Income Home Energy Assistance Program administered by the HHS, funded at \$3.4 billion, accounted for almost 85% of the FY 2016 total. R&D program expenditures in these areas totaled \$389 million, with most of this support originating at DOE.

- The Low Income Home Energy Assistance Program (LIHEAP).** HHS administers the LIHEAP program, largely through state energy offices. This program provides direct payments and technical assistance to individual consumers, households, and multi-family building owners and tenants. Although a portion of LIHEAP support is used directly for energy consumption and could be considered a subsidy for consumption, the program is designed to free-up low-income consumer funds for other critical needs (rather than simply increasing energy services) and to provide information and assistance for energy conservation, weatherization, and other efficiency-enhancing measures. [LIHEAP funding](#) levels were \$3.2 billion in FY 2013 and \$3.4 billion in FY 2016.

Table 22. Estimates of conservation, efficiency, and end-use energy-specific direct expenditures by department and program, FY 2010, FY 2013, and FY 2016

million 2016 dollars

Department and Program - CFDA Number	FY 2010	FY 2013	FY 2016
U.S. Department of Agriculture	36	25	6
Denali Commission Program - 90.100	-	4	3
Rural Energy for America Program - 10.868	36	19	2
Assistance to High Energy Cost Rural Communities - 10.859	0	1	0
Sun Grant Program - 10.320	0	0	-
U.S. Department of Energy	3,193	925	254
Weatherization Assistance for Low-Income Persons - 81.042	1,818	313	182
State Energy Program - 81.041	522	141	44
Energy Efficiency and Renewable Energy Information Dissemination, Outreach, Training and Technical Analysis/Assistance - 81.117	19	22	21
State Energy Program Special Projects - 81.119	9	11	7
National Industrial Competitiveness through Energy, Environment, and Economics - 81.105	0	-	-
Energy Efficiency and Renewable Energy Technology Deployment, Demonstration and Commercialization - 81.129	1	0	-
Office of Scientific and Technical Information - 81.064	-	-	-
Energy Efficient Appliance Rebate Program (EEARP) - 81.127	214	(0)	-
Inventions and Innovations - 81.036	0	1	-
Geologic Sequestration Site Characterization - 81.132	-	-	-
Energy Efficiency and Conservation Block Grant Program (EECBG) - 81.128	549	436	-
Industrial Carbon Capture and Storage (CCS) Application - 81.134	61	-	-
U.S. Department of Health and Human Services	5,614	3,247	3,368
Low Income Home Energy Assistance - 93.568	5,614	3,247	3,368
U.S. Department of Housing and Urban Development	259	-	(2)
Assisted Housing Stability and Energy and Green Retrofit Investments Program - 14.318	259	-	-
Multifamily Energy Innovation Fund - 14.319	-	-	(2)
U.S. Department of Labor	62	(0)	(0)
Green Jobs Innovation Fund Grants - 17.275	62	(0)	(0)
U.S. Department of the Interior	6	2	0
Minerals and Mining on Indian Lands - 15.038	6	2	0
Tribal Energy Development Capacity Grants - 15.148	-	-	-
U.S. Department of Transportation	220	23	-
Clean Fuels - 20.519	4	8	-
Capital Assistance Program for Reducing Energy Consumption and Greenhouse Gas Emissions - 20.523	216	15	-
U.S. Environmental Protection Agency	101	-	-
National Clean Diesel Emissions Reduction Program - 66.039	101	-	-
Total	9,491	4,222	3,625

Notes: Totals may not equal sum due to independent rounding. Zero denotes rounding to zero value and a “-“symbol denotes a zero value. Appropriations made in either FY 2010, FY 2013, or FY 2016 federal agency budgets may be obligated and fund programs in subsequent fiscal years.

Sources: U.S. Department of Energy, Office of the Chief Financial Officer, *Base Financial Data*, FY 2010, FY 2013, and FY 2016; Department of the Treasury, Bureau of the Fiscal Service, *USASpending.gov - Government spending at your fingertips*; website: <https://www.usaspending.gov/>, accessed December 1, 2014 (FY 2010 and FY 2013) and accessed November 16, 2017 (FY 2016); and, U.S. General Services Administration, *2014 Catalog of Federal Domestic Assistance*, (Washington, DC, October 2014) https://www.cfda.gov/downloads/CFDA_2014.pdf, accessed December 1, 2014 and *2017 Catalog of Federal Domestic Assistance*, (Washington, DC, October 2017) https://www.cfda.gov/downloads/CFDA_2017.pdf, accessed December 1, 2017.

Table 23. Estimates of conservation, efficiency, and end-use energy-specific research and development expenditures by department and program, FY 2010, FY 2013, and FY 2016

million 2016 dollars

Department and Program - CFDA Number	FY 2010	FY 2013	FY 2016
U.S. Department of Agriculture	-	-	3
Agricultural Research Basic and Applied Research - 10.001	-	-	3
U.S. Department of Defense	-	-	49
Basic Scientific Research - 12.431	-	-	43
Basic, Applied, and Advanced Research in Science and Engineering - 12.630	-	-	6
U.S. Department of Energy	643	569	280
Conservation Research and Development - 81.086	587	454	147
Advanced Research and Projects Agency - Energy Financial Assistance Program - 81.135	18	87	116
Renewable Energy Research and Development - 81.087	34	28	18
Geologic Sequestration Training and Research Grant Program - 81.133	3	-	-
U.S. Department of Transportation	-	-	-
Hydrogen Storage Research and Development - 20.764	-	-	-
U.S. Environmental Protection Agency	3	2	2
Surveys, Studies, Research, Investigations, Demonstrations, and Special Purpose Activities Relating to the Clean Air Act - 66.034	3	2	2
National Science Foundation	156	135	54
Mathematical and Physical Sciences - 47.049	103	84	35
Engineering Grants - 47.041	53	51	18
Total	801	706	389

Notes: Totals may not equal sum due to independent rounding. Zero denotes rounding to zero value and a “-“symbol denotes a zero value. Appropriations made in either FY 2010, FY 2013, or FY 2016 federal agency budgets may be obligated and fund programs in subsequent fiscal years. DOE and totals exclude DOE’s Office of Science, Office of Science Financial Assistance Program.

Sources: U.S. Department of Energy, Office of the Chief Financial Officer, *Base Financial Data*, FY 2010, FY 2013, and FY 2016; Department of the Treasury, Bureau of the Fiscal Service, *USASpending.gov - Government spending at your fingertips*; website: <https://www.usaspending.gov/>, accessed December 1, 2014 (FY 2010 and FY 2013) and accessed November 16, 2017 (FY 2016); and, U.S. General Services Administration, *2014 Catalog of Federal Domestic Assistance*, (Washington, DC, October 2014) https://www.cfda.gov/downloads/CFDA_2014.pdf, accessed December 1, 2014 and *2017 Catalog of Federal Domestic Assistance*, (Washington, DC, October 2017) https://www.cfda.gov/downloads/CFDA_2017.pdf, accessed December 1, 2017.

Electricity transmission and grid network. Support for transmission grid-related programs was dominated by the DOE's Electricity Delivery and Energy Reliability Research, Development and Analysis program. This program accounted for 92% of total expenditures in this category. The program was expanded under ARRA and fell from \$824 million in FY 2013 to \$15 million in FY 2016 as ARRA funding authorities expired.

Table 24. Estimates of electricity transmission-related energy-specific direct expenditures by department and program, FY 2010, FY 2013, and FY 2016

million 2016 dollars

Department and Program - CFDA Number	FY 2010	FY 2013	FY 2016
U.S. Department of Agriculture	4	9	4
Assistance to High Energy Cost Rural Communities - 10.859	4	9	4
U.S. Department of Energy	-	-	8
Energy Efficiency and Renewable Energy Information Dissemination, Outreach, Training and Technical Analysis/Assistance - 81.117	-	-	8
U.S. Department of the Interior	-	-	0
Minerals and Mining on Indian Lands - 15.038	-	-	0
Tribal Energy Development Capacity Grants - 15.148	-	-	-
Total	4	9	11

Notes: Totals may not equal sum due to independent rounding. Zero denotes rounding to zero value and a “-“symbol denotes a zero value. Appropriations made in either FY 2010, FY 2013, or FY 2016 federal agency budgets may be obligated and fund programs in subsequent fiscal years.

Sources: U.S. Department of Energy, Office of the Chief Financial Officer, *Base Financial Data*, FY 2010, FY 2013, and FY 2016; Department of the Treasury, Bureau of the Fiscal Service, *USASpending.gov - Government spending at your fingertips*; website: <https://www.usaspending.gov/>, accessed December 1, 2014 (FY 2010 and FY 2013) and accessed November 16, 2017 (FY 2016); and, U.S. General Services Administration, *2014 Catalog of Federal Domestic Assistance*, (Washington, DC, October 2014) https://www.cfda.gov/downloads/CFDA_2014.pdf, accessed December 1, 2014 and *2017 Catalog of Federal Domestic Assistance*, (Washington, DC, October 2017) https://www.cfda.gov/downloads/CFDA_2017.pdf, accessed December 1, 2017.

Table 25. Estimates of electricity transmission-related energy-specific research and development expenditures by department and program, FY 2010, FY 2013, and FY 2016

million 2016 dollars

Department and Program - CFDA Number	FY 2010	FY 2013	FY 2016
U.S. Department of Defense	-	-	0
Basic, Applied, and Advanced Research in Science and Engineering - 12.630	-	-	0
U.S. Department of Energy	553	862	24
Electricity Delivery and Energy Reliability, Research, Development and Analysis - 81.122	518	824	15
Advanced Research and Projects Agency - Energy Financial Assistance Program - 81.135	1	10	8
Renewable Energy Research and Development - 81.087	34	28	-
National Science Foundation	13	25	25
Engineering Grants - 47.041	4	4	15
Mathematical and Physical Sciences - 47.049	8	21	9
Total	566	887	49

Notes: Totals may not equal sum due to independent rounding. Zero denotes rounding to zero value and a “-“symbol denotes a zero value. Appropriations made in either FY 2010, FY 2013, or FY 2016 federal agency budgets may be obligated and fund programs in subsequent fiscal years. DOE and totals exclude DOE’s Office of Science, Office of Science Financial Assistance Program.

Sources: U.S. Department of Energy, Office of the Chief Financial Officer, *Base Financial Data*, FY 2010, FY 2013, and FY 2016; Department of the Treasury, Bureau of the Fiscal Service, *USASpending.gov - Government spending at your fingertips*; website: <https://www.usaspending.gov/>, accessed December 1, 2014 (FY 2010 and FY 2013) and accessed November 16, 2017 (FY 2016); and, U.S. General Services Administration, *2014 Catalog of Federal Domestic Assistance*, (Washington, DC, October 2014) https://www.cfda.gov/downloads/CFDA_2014.pdf, accessed December 1, 2014 and *2017 Catalog of Federal Domestic Assistance*, (Washington, DC, October 2017) https://www.cfda.gov/downloads/CFDA_2017.pdf, accessed December 1, 2017.

Textbox: Research and development for general application

Research and development (R&D) in this report is treated as applying to specific parts of the U.S. energy system based on the research topics, program descriptions, and other available information, including information from the programs themselves in some cases.

R&D is broadly characterized as either basic or applied, or sometimes as upstream or downstream R&D investment, with upstream referring to basic research. R&D investment is more generally applicable to a wider variety of activities, both energy-related and non-energy-related, when the activity is aimed at basic or upstream technological improvement.

Basic R&D activities are not intended to support specific kinds of energy; instead they support advances in broadly applicable technologies such as high-speed computing or basic science such as physics. This concept is true of certain Department of Energy programs, notably those of the DOE’s Office of Science (SC) under CFDA 81.049, the Office of Science Financial Assistance Program. EIA did not include these activities as line items in the direct expenditure and R&D expenditure tables for this report. With total FY 2016 outlays reported at \$1.2 billion, the specific DOE financial programs and FY 2016 outlays in this category include the following:

- Office of Advanced Scientific Computing Research at \$39 million
- Office of Basic Energy Sciences at \$303 million
- Office of Biological & Environmental Research at \$130 million
- Office of Fusion Energy Sciences at \$168 million
- Office of High-Energy Physics at \$117 million
- Office of Nuclear Physics at \$181 million
- various small business research and technology transfer DOE programs at \$214 million