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Funding for Carbon Capture and Sequestration (CCS) at DOE: In Brief

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Introduction

Carbon capture and sequestration (or storage)—known as CCS—is a physical process that involves capturing man-made carbon dioxide (CO_2) at its source and storing it before its release to the atmosphere. CCS could reduce the amount of CO_2 emitted to the atmosphere from the continued use of fossil fuels at power plants and other large, industrial facilities. An integrated CCS system would include three main steps: (1) capturing CO_2 before it is emitted to the atmosphere and separating it from other gases; (2) purifying, compressing, and transporting the captured CO_2 to the sequestration site; and (3) injecting the CO_2 into subsurface geological reservoirs. Following its injection into a subsurface reservoir, the CO_2 would need to be monitored for leakage and to verify that it remains in the target geological reservoir. Once injection operations cease, a responsible party would need to take title to the injected CO_2 and ensure that it stays underground in perpetuity.

The U.S. Department of Energy (DOE) has pursued research and development (R&D) of aspects of the three main steps leading to an integrated CCS system since 1997.[1] Congress has long been interested in the future of CCS as a mitigation strategy for lowering global emissions of CO_2. Since FY2008, Congress has appropriated more than $7 billion for CCS activities at DOE.[2] Nearly half that funding, $3.4 billion, came from the American Recovery and Reinvestment Act (P.L. 111-5; enacted February 17, 2009; hereinafter referred to as the Recovery Act). Authority to expend Recovery Act funding expired at the end of FY2015.[3]

The large and rapid influx of funding for industrial-scale CCS projects from the Recovery Act was intended to accelerate development and demonstration of CCS in the United States. Along with the large financial boost to CCS research and development provided by the Recovery Act, Congress continued to appropriate additional funds annually to support other CCS activities. CCS-focused research and development has come to dominate the coal program area within DOE Fossil Energy Research and Development (FER&D) since the Recovery Act was enacted.

Table 1 and **Table 2** of this report show the funding for DOE CCS programs since 2010 under FER&D, including the Administration's FY2017 budget proposal. **Table 1** shows funding from FY2010 through FY2016, including Recovery Act funding. **Table 2** shows a comparison between FY2016 enacted funding and the FY2017 budget proposal, including proposed changes to the budget structure for FY2017.

DOE Carbon Capture and Sequestration Funding Since FY2010

In **Table 1**, Recovery Act programs are organized under the CCS Demonstrations category. CCS-related programs funded by annual appropriations—apart from the Recovery Act—are organized under the Coal CCS and Power Systems category. The remainder of Fossil Energy spending is organized under Other Fossil Energy R&D. DOE changed the program structure for coal after

[1] U.S. Department of Energy (DOE), National Energy Technology Laboratory, *Carbon Sequestration Program: Technology Program Plan*; *Enhancing the Success of Carbon Capture and Storage Technologies*, February 2011, p. 10, at http://www.netl.doe.gov/technologies/carbon_seq/refshelf/2011_Sequestration_Program_Plan.pdf.

[2] DOE annual budget justifications, FY2010 through FY2015.

[3] For more information about Recovery Act support for CCS, see CRS Report R44387, *Recovery Act Funding for DOE Carbon Capture and Sequestration (CCS) Projects*, by (name redacted)

FY2010, renaming and consolidating program areas. In **Table 1**, the Coal CCS and Power Systems bottom-line total is provided for FY2010, but the amounts for individual programs are not provided for that year because of the reorganization.

Recovery Act funding supported four main categories of activities: (1) FutureGen; (2) the Clean Coal Power Initiative (CCPI); (3) Industrial Carbon Capture and Storage (ICCS); and (4) Site Characterization, Training, and Program Direction. FutureGen, CCPI, and ICCS garnered the bulk of Recovery Act funds for CCS ($3.32 billion, or 98%). **Table 1** shows the Recovery Act funding amounts in one column for 2009, but those funds were available through FY2015. Zeroes in the columns for FY2010 through FY2016 indicate that no *new* Recovery Act funds were made available during those years. However, DOE continued to fund other CCS programs and activities with regular appropriations in each of those years, as shown by the rows in the table below Recovery Act programs.

Some programs are directly focused on one or more of the three steps of CCS: capture, transportation, and storage. For example, the Carbon Capture program supports R&D on post-combustion, pre-combustion, and natural gas capture. The Carbon Storage program supports the regional carbon sequestration partnerships,[4] geological storage technologies, and other aspects of permanently sequestering CO_2 underground.

Also shown in **Table 1** are funding levels under Other Fossil Energy R&D. Activities in this category include programs pursuing fossil energy R&D and support activities. The largest activity is Program Direction ($114.2 million in FY2016), which provides DOE headquarters support and federal field and contractor support of the fossil energy R&D programs overall. These activities support CCS-related activities directly and indirectly. The next-largest activities are Natural Gas Technologies ($43 million in FY2016) and Unconventional Fossil ($20.3 million in FY2016), which support collaborative research to foster safe and prudent development of shale gas resources, the reduction of methane emissions from natural gas infrastructure, and research on gas hydrates.[5] The other activities listed in **Table 1**—Plant and Capital, Environmental Restoration, and Special Recruitment—total approximately $24.5 million for FY2016.

FY2017 Budget Request and Proposed Restructuring

Table 2 shows the FY2017 DOE budget proposal for Fossil Energy R&D and compares the proposal to the FY2016 enacted amount. On the left side of **Table 2**, enacted funding for FY2016 is shown in the current organizational structure. On the right side of **Table 2**, FY2016 enacted funding and FY2017 proposed funding are compared in the proposed restructuring scheme.[6] The total funding for Fossil Energy R&D is $632 million for FY2016 and $600 million for FY2017. (In FY2017, DOE proposes using $240 million of prior-year balances, plus $360 million, for a total request of $600 million.[7])

[4] In 2003, DOE created seven regional carbon sequestration partnerships (RCSPs), essentially consortia of public- and private-sector organizations grouped by geographic region across the United States and parts of Canada. See DOE, National Energy Technology Laboratory, "Storage Infrastructure," at http://www.netl.doe.gov/research/coal/carbon-storage/carbon-storage-infrastructure.

[5] DOE, FY2016 Congressional Budget Request, Volume 3, pp. 603-616.

[6] DOE, FY2017 Congressional Budget Request, Volume 3, *Fossil Energy Research and Development*, pp. 547-659, at http://www.energy.gov/sites/prod/files/2016/02/f29/FY2017BudgetVolume3_2.pdf.

[7] In its FY2017 budget justification, DOE proposes to use $240 million from Clean Coal Power Initiative projects that have not reached financial close. DOE, FY2017 Congressional Budget Request, p. 551.

Observations

The FY2017 budget request continues the trend of the past several years of shifting increasingly toward CCS-related activities and away from what were termed *coal* program areas in previous budgets. The term *coal* itself is omitted in the proposed restructuring of the FER&D accounts. DOE notes in its Highlights and Major Changes summary:

> In FY 2017, FER&D continues to focus on CCS and activities that increase the efficiency and availability of advanced power systems integrated with CCS. It is important to demonstrate that electric generation technology with CCS can be deployed at commercial scale while maintaining reliable, predictable and safe operations. Therefore, the FER&D portfolio includes several major integrated CCS demonstration projects encompassing different technological approaches and applications of CCS. A number of those projects have not yet reached financial close. DOE intends to deobligate $240 million from CCPI projects that have not yet reached financial close and repurpose these funds to support the FY 2017 R&D portfolio.[8]

Further, the budget request "proposes a restructuring of the account to support clarity in the Budget request, improve execution, and eliminate the categorization by fuel type that is no longer appropriate for this R&D portfolio."[9] The emphasis on developing CCS technologies would apply to coal and natural gas. Other changes indicate some consolidation of accounts, such as National Energy Technology Laboratory (NETL) research and operations and NETL infrastructure, and moving the Supercritical CO_2 Technology program—a separate program in the FY2016 structure—to a subprogram of Advanced Energy Systems under the proposed FY2017 structure (see the comparison in **Table 2**).

Congressional Action

The Senate Appropriations Committee reported S. 2804, the Energy and Water Development and Related Agencies Appropriations Act, 2017, on April 14, 2016, and recommended $632 million for FER&D, the same amount as the FY2016 enacted amount. The committee did not accept the proposed restructuring of most of the FER&D accounts but did support the proposed reorganization of the NETL budget structure. **Table 2** includes a column to the left of the bold vertical bar showing the FY2017 committee funding recommendations for programs under the existing structure and a column to the right of the bold vertical bar showing the FY2017 committee funding under the proposed restructuring of the NETL accounts. Funding levels recommended by the committee for FY2017 are either identical or roughly similar to FY2016 levels for most of the programs shown in **Table 2**. The restructured NETL accounts are not directly comparable, but the overall funding recommendation for FER&D of $632 million is identical to the FY2016 enacted amount, suggesting that the NETL activities would be funded similarly in FY2017.

[8] DOE, FY2017 Congressional Budget Request, Volume 3, p. 553.

[9] Ibid.

Table 1. Funding for DOE Fossil Energy Research, Development, and Demonstration Program Areas

(FY2010 through FY2016, including Recovery Act)

Fossil Energy R&D Coal Program Areas	Program/Activity	Recovery Act	FY2010 ($1,000)	FY2011 ($1,000)	FY2012. ($1,000)	FY2013 ($1,000)	FY2014 ($1,000)	FY2015 ($1,000)	FY2016 ($1,000)
Carbon Capture and Storage (CCS) Demonstrations	**FutureGen 2.0**	$1 billion	0	0	0	0	0	0	0
	Clean Coal Power Initiative (CCPI)	$800 million	0	0	0	0	0	0	0
	Industrial Carbon Capture and Storage Projects (ICCS)	$1.52 billion	0	0	0	0	0	0	0
	Site Characterization, Training, Program Direction	$80 million	0	0	0	0	0	0	0
Coal CCS and Power Systems	**Carbon Capture**	—	—	58,703	66,986	63,725	92,000	88,000	101,000
	Carbon Storage	—	—	120,912	112,208	106,745	108,766	100,000	106,000
	Advanced Energy Systems	—	—	168,627	97,169	92,438	99,500	103,000	105,000
	Cross Cutting Research	—	—	41,446	47,946	45,618	41,925	49,000	50,000
	Supercritical CO_2 Technology	—	—	—	—	—	—	10,000	15,000
	NETL Coal Research and Development	—	—	—	35,011	33,338	50,011	50,000	53,000

Fossil Energy R&D Coal Program Areas	Program/Activity	Recovery Act	FY2010 ($1,000)	FY2011 ($1,000)	FY2012. ($1,000)	FY2013 ($1,000)	FY2014 ($1,000)	FY2015 ($1,000)	FY2016 ($1,000)
Subtotal Coal		**$3.4 billion**	**393,485**	**389,688**	**359,320**	**341,864**	**392,202**	**400,000**	**430,000**
Other Fossil Energy R&D	**Natural Gas Technologies**	—	17,364	0	14,575	13,865	20,600	25,121	43,000
	Unconventional Fossil	—	19,474	0	4,859	4,621	15,000	4,500	20,321
	Program Direction	—	158,000	164,725	119,929	114,201	120,000	119,000	114,202
	Plant and Capital	—	20,000	19,960	16,794	15,982	16,032	15,782	15,782
	Environmental Restoration	—	10,000	9,980	7,897	7,515	5,897	5,897	7,995
	Special Recruitment	—	700	699	700	667	700	700	700
	Coop R&D		4,868	—	—	—	—	—	—
	Congressionally Directed Projects		35,879	—	—	—	—	—	—
Subtotal Other Fossil R&D		**—**	**266,285**	**195,364**	**164,754**	**156,851**	**178,229**	**171,000**	**202,000**
Rescissions/Use of Prior-Year Balances				(151,000)	(187,000)				
Total Fossil Energy R&D		**$3.4 billion**	**659,770**	**434,052**	**337,074**	**498,715**	**570,431**	**571,000**	**632,000**

Sources: U.S. Department of Energy (DOE) annual budget Justifications for FY2010 through FY2016.

Notes: Recovery Act = American Recovery and Reinvestment Act (P.L. 111-5); R&D = research and development; NETL = National Energy Technology Laboratory. On February 3, 2015, DOE announced that it was suspending the FutureGen program. Funding in nominal dollars.

Table 2. Comparing Funding for DOE Fossil Energy R&D in FY2016 with the FY2017 Request and Proposed Restructuring and the Senate FY2017 Appropriations Bill

Fossil Energy R&D Coal Program Areas (FY2016)	Program/Activity (FY2016)	FY2016 Enacted ($1,000)	Senate FY2017 Approps Bill ($1,000)	Fossil Energy R&D (Request to restructure accounts for FY2017)	Program/Activity (Request to restructure accounts for FY2017)	FY2016 Enacted ($1,000)	FY2017 Request ($1,000)	Senate FY2017 Approps Bill[a] ($1,000)
Coal CCS and Power Systems (FY2016)	**Carbon Capture**	101,000	101,000	**CCS and Advanced Power Systems (Restructured for FY2017)**	**Carbon Capture**	131,000	170,352	—
	Carbon Storage	106,000	106,000		**Carbon Storage**	106,000	90,875	—
	Advanced Energy Systems	105,000	105,000		**Advanced Energy Systems**	90,000	47,800	—
	Cross Cutting Research	50,000	50,000		**Crosscutting Research and Analysis**	50,700	59,350	—
	Supercritical CO_2 Technology (STEP)	15,000	15,000					
	NETL Coal Research and Development	53,000	—					
Subtotal Coal CCS and Power Systems (FY2016)		**430,000**	**377,000**	**Subtotal CCS and Advanced Power Systems**		**377,700**	**368,377**	
Other Fossil Energy R&D (FY2016)	**Natural Gas Technologies**	43,000	46,000	**Other Fossil Energy R&D (Restructured for FY2017)**	**Fuel Supply Impact Mitigation**	43,000	26,500	—
	Unconventional Fossil	20,321	23,245		**Unconventional Fossil**	20,321	0	—

Fossil Energy R&D Coal Program Areas (FY2016)	Program/Activity (FY2016)	FY2016 Enacted ($1,000)	Senate FY2017 Approps Bill ($1,000)	Fossil Energy R&D (Request to restructure accounts for FY2017)	Program/Activity (Request to restructure accounts for FY2017)	FY2016 Enacted ($1,000)	FY2017 Request ($1,000)	Senate FY2017 Approps Bill[a] ($1,000)
	Program Direction	114,202	60,000		**Program Direction**	60,045	60,998	—
	Plant and Capital	15,782	—		**NETL Research and Operations**	91,984	76,070	73,000
	Environmental Restoration	7,995	—		**NETL Infrastructure**	38,950	68,055	52,055
	Special Recruitment	700	700					
Subtotal Other Fossil Energy R&D		**202,000**	**129,945**	**Subtotal Other Fossil Energy R&D**		**254,300**	**231,623**	**125,055**
Rescissions/Use of Prior-Year Balances		0	0	Use of Prior-Year Balances		0	(240,000)	0
Total Fossil Energy R&D		**632,000**	**632,000**	**Total Fossil Energy R&D**		**632,000**	**360,000**	**632,000**

Source: Department of Energy, FY2017 Congressional Budget Request, Volume 3, *Fossil Energy Research and Development*, pp. 547-659, at http://www.energy.gov/sites/prod/files/2016/02/f29/FY2017BudgetVolume3_2.pdf.

Notes: The Senate Appropriations Committee rejected the proposal to restructure Coal CCS and Power Systems accounts and several other Fossil Energy R&D accounts but accepted the proposal to restructure National Energy Technology Laboratory (NETL) accounts. This table shows amounts for both in the Senate FY2017 Approps Bill column, and it shows the same total amount on the bottom line. Dashes are shown where the Senate FY2017 Approps Bill did not specify funding. The STEP program, listed parenthetically in the FY2016 budget structure with the Supercritical CO_2 Technology program, stands for Supercritical Transformational Electric Power.

a. This column indicates that the Senate Appropriations Committee did not agree to the restructured accounting in the FY2017 budget proposal except for the proposed reorganization of the NETL budget structure.

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