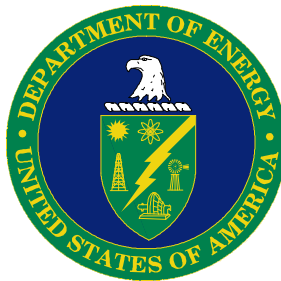




**Strategic Center for Coal
Annual Operating Plan (AOP)
Fiscal Year 2013
Carbon Storage Technology Area**

Oct 14, 2013

Revision History			
Date	Version	Description	Author
Oct 14, 2013	1.1	Document was approved	Traci Rodosta
Oct 14, 2013	1.1	Document submitted for approval	Traci Rodosta
Dec 04, 2012	1.0	Initial document created	Traci Rodosta



Carbon Storage	Beginning Year Active Project Count 101	Prior Year Uncosted (\$K) \$206,714	FY2013 Budget (\$K) \$95,477	Total Available Funds (\$K) \$302,191
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See M-1 Dashboard for a full listing of active Carbon Storage projects and their respective FY2013 project milestones.

1.0 Scope

1.1 Business Case / Overview

The Strategic Center for Coal's (SCC's) Annual Operating Plans (AOPs) are annual planning documents prepared in coordination with Headquarters, Office of Fossil Energy (FEHQ) and used to ensure RD&D work being performed supports the Department's Mission, Strategic Objectives, Annual Performance Measures, and Quarterly GPRA targets. AOP's are completed on an annual cycle.

Development of the next fiscal year's set of AOP's typically starts just prior to the new government fiscal year but continues throughout the year as the budget goes through its phases, beginning with the President's Congressional Budget Request, the House Mark-up, Senate Mark-up, and concluding with a Final Enacted Appropriation.

Planning functions are accomplished in conjunction with Technology Managers and supporting crosscutting teams at NETL, as well as with the participation of Senior FEHQ Program Managers. Planning is done in parallel with, and is supportive of, the Department's Annual Appropriations and Budget Process. SCC's Project Management Divisions support and input the annual planning and budgeting process in accordance with their respective technology areas of responsibility. Thorough up-front planning includes an assessment of past progress made toward achieving prior-year Coal Research Program cost and performance milestones, and an analysis of various alternatives available to achieve current-year Annual Performance Measures.

The AOP links planned research within a technology area to Key Activities (or Key Elements) identified in final enacted appropriations. An AOP is created for each of the Coal Research Program Technology Area/Budget Lines. The AOP, in combination with its companion Program Implementation Plan (PIP) and Spend Plan, link the distribution of appropriated funds with alternative investment opportunities, including the issuance of Funding Opportunity Announcements (FOAs) targeted at the creation of new research, the contributions of private sector and university performers, and of the Department's National Laboratories including NETL (via FWP's). The PIP, an attachment which is also prepared annually and accompanies the AOP, is comprised of a "Mortgage List" that distributes available annual funding to active projects, new awards and planned competitions.

For Fiscal Year 2013, SCC's planning and implementation responsibilities include the following Technology Area/Budget Lines:

- Carbon Storage
- Carbon Capture

- Advanced Energy Systems (Gasification Systems, Advanced Combustion Systems, Hydrogen Turbines; Coal and Coal and Biomass to Liquids, and Solid Oxide Fuel Cells)
- Crosscutting Research
- Clean Coal Power Initiative

Each AOP document will show consistency with all other AOP documents by following the same document table of contents, outline, and connection to mission, program goals, and performance measures.

Clean Coal Research Program	
FUELS AND POWER SYSTEMS	
Carbon Capture	
Carbon Storage	
Advanced Energy Systems	
Advanced Combustion Systems	
Gasification Systems	
Hydrogen Turbines	
Coal and Coal Biomass to Liquids	
Solid Oxide Fuel Cells	
Crosscutting Research	
Plant Optimization Technologies	
Coal Utilization Science	
Energy Analyses	
University Training and Research	
International Activities	
CCS DEMONSTRATIONS	

Figure 1: FY 2013 Technology Area/Budget Lines

1.2 Definitions, Acronyms, and Abbreviations

Following are acronyms and abbreviations that will be used throughout this document:

AOP – Annual Operating Plan

BSI – Business Systems Integration
CDP – Congressionally Directed Project
DOE – Department of Energy
FE – Office of Fossil Energy
GPRA – Government Performance Results Act
HQ – Headquarters
IGCC – Integrated Gasification Combined Cycle
IPD – Integrated Program/Project Database
MYPP – Multi-year Program Plan
NATCARB – National Carbon Sequestration Database and Geographic Information System
RUA – Regional University Alliance
SCC – Strategic Center for Coal
Technology area and program area are synonymous in this document.
TM – technology manager
Annual Performance Measure and Annual Target are used synonymously between the AOP and the GPRA Milestones.

1.3 References

(February 2012) Department of Energy, FY 2013 Congressional, Budget Request
(April 18, 2012) House/ENERGY AND WATER DEVELOPMENT APPROPRIATIONS BILL, 2013
(April 26, 2012) Senate/ENERGY AND WATER DEVELOPMENT APPROPRIATIONS BILL, 2013
(October 31, 2012) GPRA-OMB, Coal Power FY13 Annual Performance Measures and GPRA Milestones

1.4 Detailed Process Maps

Figure 2: The Overall Process Map for High Level AOP and GPRA Milestones is a high-level process diagram describing the flow of information around the AOP. Currently, all of these processes are manual inputs. It is anticipated that with follow on work additional capabilities shall allow linkages with this new AOP system, the Multi-year Program Plan (MYPP), and the strategic plans, therefore having multiple years of information stored in one area.

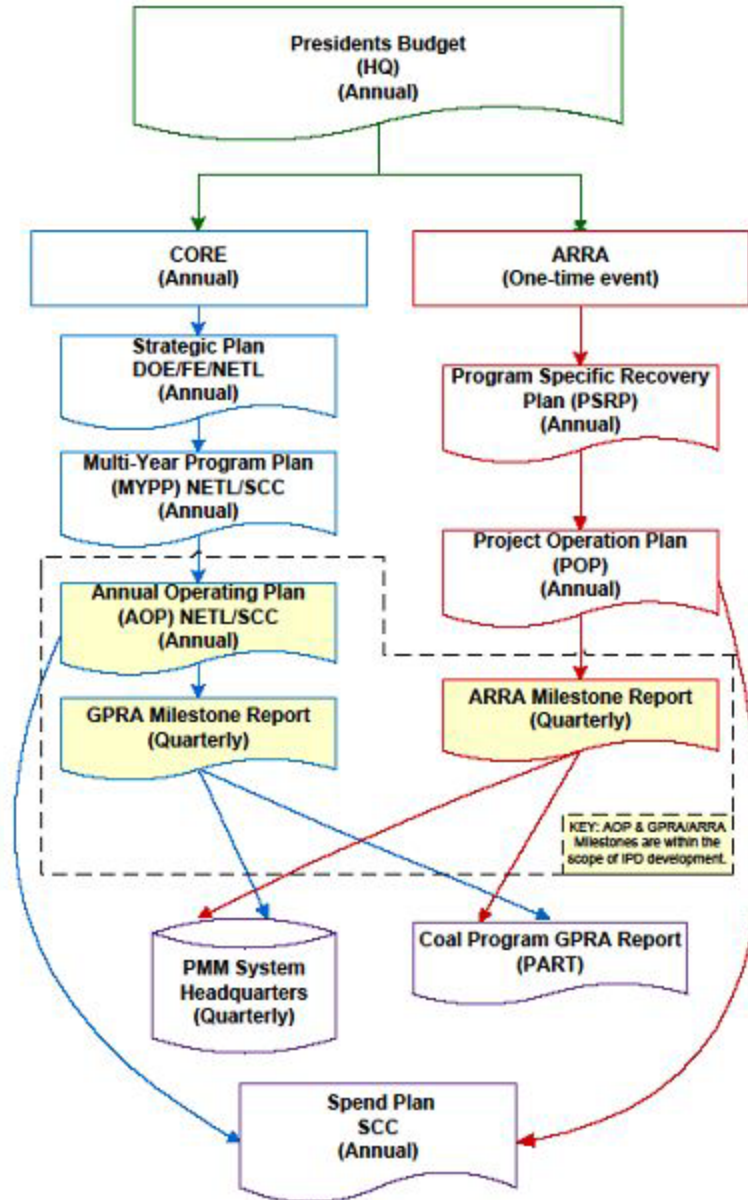


Figure 2: Overall Process Map for High Level AOP and GPRA Milestones

Figure 3 below is a detailed process diagram describing the key elements of an AOP, along with its associated Program Implementation Plan (PIP) and M-1 Dashboard Quarterly Project Milestone information. It describes the current flow of the AOP document and the linkage between the AOP, PIP and M-1 dashboard.

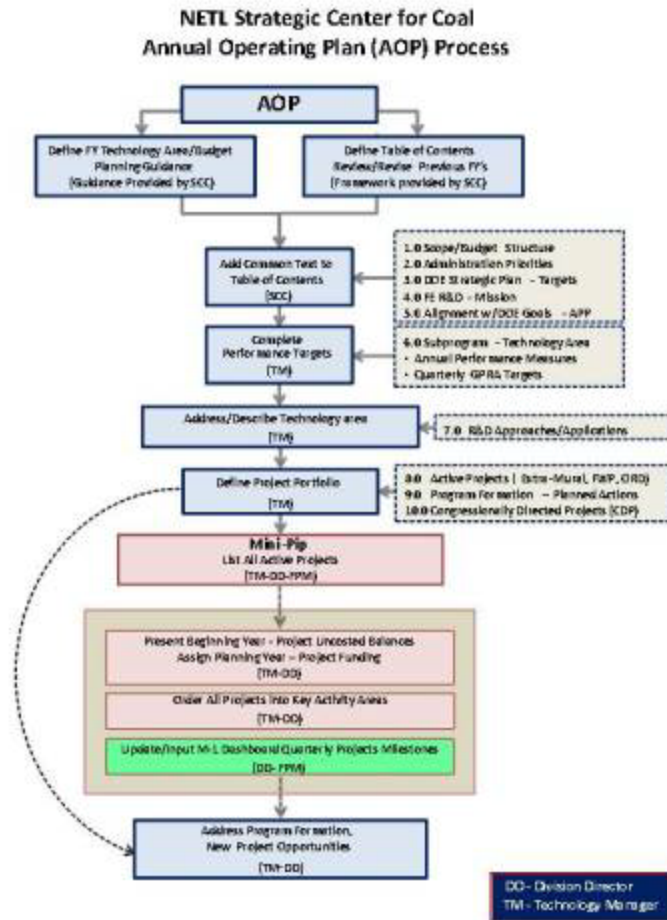


Figure 3: Detailed Process Map for AOP

2.0 Administration Priorities

Presidential Goal - Catalyze the timely, material, and efficient transformation of the nation’s energy system and secure U.S. leadership in clean energy technologies.

Presidential Energy Targets

- Reduce energy-related greenhouse gas emissions by 17% by 2020 and 83% by 2050, from a 2005 baseline.
- By 2035, 80% of America’s electricity will come from clean energy sources.

3.0 DOE Strategic Plan - Hierarchy of Relevant Goals, Targets, and Mission

Mission - The mission of the Department of Energy is to ensure America’s security and prosperity by addressing its energy, environmental, and nuclear challenges through

transformative science and technology solutions.

Secretarial Priorities

- **Clean, Secure Energy:** Develop and deploy clean, safe, low carbon energy supplies.
- **Climate Change:** Provide science and technology inputs needed for global climate change negotiations; develop and deploy technology solutions, both domestically and globally.

Goals

- Catalyze the timely, material, and efficient transformation of the nation's energy system and secure U.S. leadership in clean energy technologies.
- Maintain a vibrant U.S. effort in science and engineering as a cornerstone of our economic prosperity, with clear leadership in strategic areas.

Targets

- Sustain a world-leading technical work force
- Deploy the technologies we have
 - Demonstrate and deploy clean energy technologies
 - Enable prudent development of our natural resources
- Discover the new solutions the Nation needs
 - Accelerate energy innovation through precompetitive research and development
 - Facilitate technology transfer to industry
 - Establish technology test beds and demonstrations
 - Leverage partnerships to expand our impact
- Deliver new technologies to advance our mission
 - Lead computational sciences and high-performance computing
- Use Energy Frontier Research Centers where key scientific barriers to energy breakthroughs have been identified. We believe we can clear these roadblocks faster by linking together small groups of researchers across departments, schools and institutions.
- Use ARPA-E, a new funding organization within the Department, to hunt for new technologies rather than the creation of new scientific knowledge or the incremental improvement of existing technologies.

4.0 Fossil Energy Research and Development

Mission – The Office of Fossil Energy advances technologies related to the reliable, efficient, affordable, and environmentally sound use of fossil fuels which are essential to our Nation’s security and economic prosperity. FE programs create public benefits by: (1) managing and performing energy-related research that reduces market barriers to the environmentally sound use of fossil fuels; (2) partnering with industry and others to advance fossil energy technologies toward commercialization; and (3) supporting the development of information and policy options that benefit the public.

5.0 Clean Coal Research Program - Alignment with the Department's Goals and Agency Performance Plan

Mission - The mission of FE’s Clean Coal Research Program (CCRP) is to develop advanced clean and affordable coal-based Carbon Capture, Utilization, and Storage (CCUS) technologies to realize 90 percent carbon capture at electricity costs competitive with all other base load technologies, including advanced nuclear, advanced Natural Gas Combined Cycle (NGCC), and non-hydro renewable systems. These R&D efforts are targeting technology improvements that can deliver advanced coal plants with greatly reduced carbon footprints.

Strategic Goal - *Catalyze the timely, material, and efficient transformation of the nation’s energy systems and secure U.S. leadership in clean energy technologies.*

Strategic Objectives

- Deploy the technologies we have
- Discover the new solutions the Nation needs
- Deliver new technologies to advance our mission

Strategy

- Accelerate energy innovation through precompetitive research and development
- Demonstrate and deploy clean energy technologies
- Facilitate technology transfer to industry
- Establish technology test beds and demonstrations
- Leverage partnerships to expand our impact

Long-term Performance Goals

Carbon Capture and Advanced Energy Systems

- By 2020 - Complete R&D on 2nd Generation coal-based CCUS technologies that target 90% CO₂ capture and reduce today’s cost (including compression, but excluding transport and storage) from ~\$61/tonne to \$40/tonne or less.

- By 2030 – Complete R&D on transformational coal-based advanced energy systems that target 90% CO₂ capture and reduce cost (including compression, but excluding transport and storage) to less than \$10/tonne.

Carbon Storage – Achieve 99% monitoring and mass balance closure for tracking CO₂ in order to safely, permanently, and economically store large volumes in uneconomic underground formations.

CCUS Demonstrations - Bring at least 5 commercial-scale carbon capture and storage demonstrations online by 2016.

6.0 Subprogram/Technology Area

Carbon Storage

The Carbon Storage Program supports the following FY2013 Performance Measures:

GPRA Annual Performance Measure for Carbon Storage

Inject 4.0 million metric tons of CO₂ cumulatively at large-volume field test sites since 2009 to demonstrate the formations capacity to sequester carbon by developing technologies that can safely and economically store carbon dioxide from coal-based energy systems.

Q1 - Update at least one Best Practice Manual (BPM) from lessons learned from field tests and the Core R&D program.

Q2 - Initiate injection of CO₂ at one large scale field project.

Q3 - Initiate injection of CO₂ at one large scale field project.

Q4 - Inject at least 4.0 M metric tons of CO₂ at large volume field tests cumulatively since 2009.

Program Implementation

The Carbon Storage Program also supports the development of best practices for utilization and storage that will benefit projects implementing CCUS on a commercial scale, such as in the Clean Coal Power Initiative (CCPI) and Industrial Carbon Storage Programs. In general, DOE-applied research is being leveraged with both field and laboratory testing to assess the technical and economic viability of CCUS as a greenhouse gas (GHG) mitigation option. DOE has established the following plan to ensure that the goal of developing these technologies is met:

- Manage Core R&D activities within specific Technology Areas where challenges are identified and investigated further to develop enabling technologies for both utilization and long-term saline injection.
- Utilize the Regional Carbon Sequestration Partnership (RCSP) Technology Area to develop future infrastructure, as well as validate and field test technologies through all small and large scale carbon storage and utilization projects in different depositional systems leading to commercialization.
- The Focus Area for Carbon Sequestration Science Technology Area is a strategic effort funded by the Carbon Storage Program to engage the NETL Office of Research and Development (ORD) to work with the extramural research teams. This coordination enables DOE research and program managers to look across similar activities, quickly fill critical gaps in research, and archive results in a corporate database
- Work with NETL's Office of Program Planning and Analyses (OPPA) to determine the benefits of research and establish a systems approach to confirm that technologies are capable of meeting Carbon Storage Program goals.

7.0 R&D Approaches

NETL's Carbon Storage Program is developing a technology portfolio of safe, cost-effective, storage, and mitigation technologies that will enable commercial deployment beginning in 2020 to validate storage in utilization operations (i.e. enhanced oil recovery) and for long-term storage in saline formations by 2030. NETL's primary Carbon Storage R&D objectives are improving the understanding of factors affecting CO₂ storage permanence, capacity, and safety in geologic formations, and terrestrial ecosystems.

Once these objectives are met, new and existing power plants and fuel processing facilities around the world have the potential to be retrofitted with CO₂ capture technologies. The Carbon Storage Program includes five Technology Areas for technology development. The first three areas represent the Core Research and Development (Core R&D), while the fourth and fifth areas are Regional Carbon Sequestration Partnerships (Infrastructure), and the Focus Area for Carbon Sequestration Science. Figure 4 illustrates the Carbon Storage Program research and key technology areas.

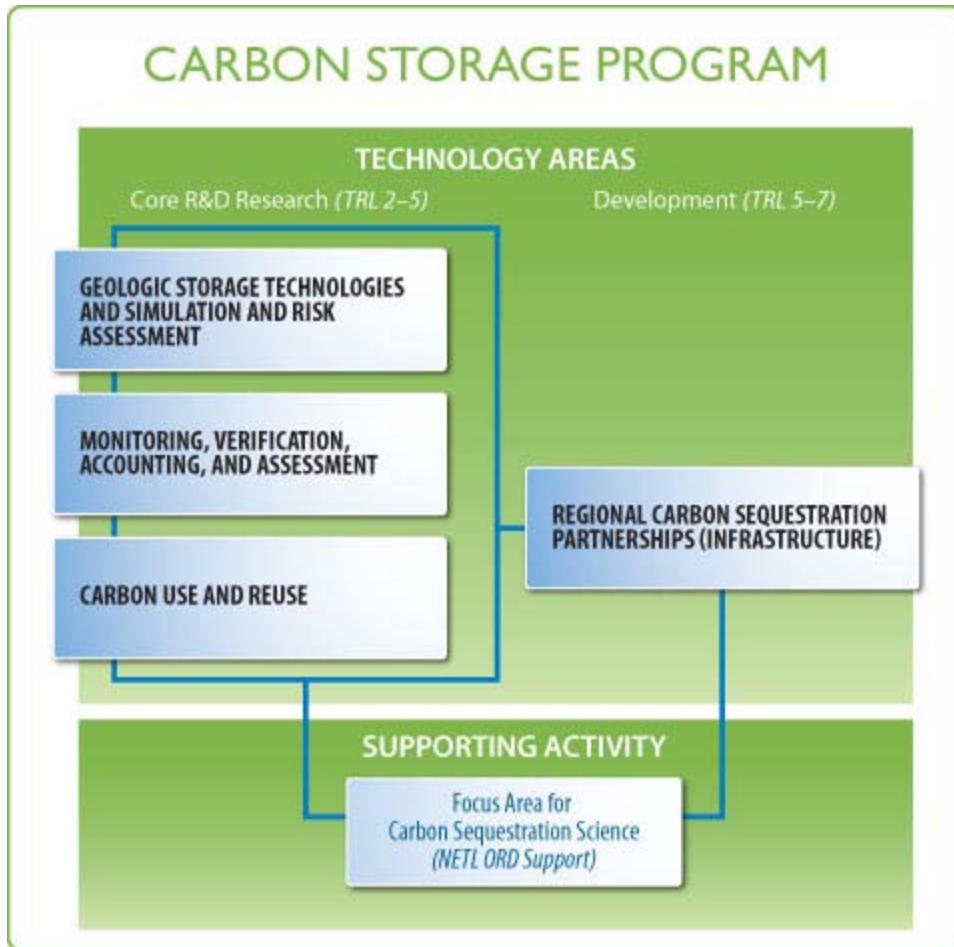


Figure 4 - Carbon Storage Program Structure

CORE R&D

Core R&D is driven by industry's technology needs and segregates those needs into technology areas to more efficiently obtain solutions that can then be tested and deployed in the field. The Core R&D Element contains three focus areas for applied research and carbon storage technology development: (1) Geologic Storage Technologies and Simulation and Risk Assessment, (2) Monitoring, Verification, Accounting (MVA) and Assessment, and (3) Carbon Use and Reuse.

Regional Carbon Sequestration Partnerships (Infrastructure for CCUS)

Early in the Carbon Storage Program's development, the Department determined that addressing CO₂ mitigation from power and other industrial sources regionally would be the most effective way to address differences in geology, climate, population density, infrastructure (human capital), and socioeconomic issues throughout the United States.

To support the development of regional infrastructure for CCUS throughout the United States, this element consists of several efforts, including:

- National efforts to characterize storage formations and reduce uncertainty associated with storage resource estimates.

- Development of small- and large-scale CO₂ injection field projects in different classes of geologic formations, which include the efforts of the RCSPs and other field projects.
- Development of geologic storage Best Practice Manuals to communicate lessons learned from field projects to industry, regulators, and the public.
- Development of human capital, stakeholder networking, regulatory policy, carbon mitigation plans, and public outreach and education throughout the United States.

FOCUS AREA FOR CARBON SEQUESTRATION SCIENCE

The Carbon Storage Program is funding the NETL ORD to be a strategic partner that supports the program efforts to evaluate the breadth of the research program, integrate their research with existing projects, archive all CCUS research data, and support knowledge sharing among related research teams. The ORD also has the capability to quickly adapt its research to the priorities of the Carbon Storage Program to fill critical gaps. Their efforts span all of the key technologies, including the research and development activities.

The future of the ORD research effort will continue to adapt as the Carbon Storage Program supports the research and development of the advanced technologies identified in this chapter. Technologies developed by ORD that have commercial viability will be licensed to industry through cooperative research and development agreements.

8.0 Active Projects

Core R&D (Geologic Storage, MVA, Carbon Use and Reuse)

Extramural –There are a total of 54 active carbon storage projects in 2013 throughout the 3 focus areas in the Core R&D initiative. There are also 22 FWPs with 9 National Laboratories directly associated with these Core R&D projects that support the implementation of their cooperative agreements. These projects are at the laboratory/bench-scale/prototype (TRL level <6). Two (2) are at the field pilot scale supporting geologic characterization and injection into a coal seam and monitoring at the Weyburn field in Canada (TRL 6-7). **Targeted FWPs DOE National Laboratories** – The program supports 7 National Laboratories working on 18 major tasks in support of the Carbon Storage Core R&D Program. All of these 18 tasks are at the laboratory/bench-scale/prototype (TRL level <5).

Regional Carbon Sequestration Partnerships Initiative – Infrastructure for CCS

Extramural - There are 12 active Regional Carbon Sequestration Partnership/Injection projects in FY2013. There are a total of 8 field projects through the Regional Carbon Sequestration Partnerships that are characterizing geologic formations and injecting up to 1MMT of CO₂. (TRL 6-7). Six of the projects are working to develop 1MMT injections into key storage formations throughout the United States and Canada. One of the projects is dedicated to the characterization of the regional geology to determine the

storage opportunities for future CCUS projects. Five (5) national laboratories are supporting these projects through 11 FWP's focused on contributing to the modeling and monitoring being conducted at the field projects sites. Three (3) projects awarded in FY11 are working to develop small scale injection projects in key depositional systems not adequately tested to date (TRL 5). Three of the large-scale and all of the small-scale projects are evaluating storage opportunities while evaluating the utilization of CO₂ for enhanced oil recovery.

Focus Area for Carbon Sequestration Science

The specific objective of the ORD-RUA Carbon Storage FWP is to develop a better understanding and application of that knowledge in the development of simulation codes, monitoring technologies, and strategies for carbon utilization and storage projects. The proposed research (funding \$6 MM) includes five technical tasks: Flow Properties of Reservoirs and Seals; Fundamental Processes and; Estimates of Storage; Verifying Storage Performance; and Geospatial Data Resources. This is the second year of a three-year FWP. The work being done this year will focus on developing simulations and code to refine models, refine estimates for capacity, and deploy the Energy Data Exchange database to house all data from field projects on storage. The Technology Readiness Level of technologies being developed in FY2012 will be between 2 and 4. The plan is to mature some of the technologies, codes, and databases to TRL 4-5 in 2013 and 2014.

9.0 Program Formation - Planned Actions

There will be one Funding Opportunity Announcement (FOA) for the Carbon Storage Program in FY2013 for the Core R&D program which will look to fund projects that develop technologies to the Monitoring, Verification, Accounting (MVA) and Assessment of CO₂ stored during CCUS operations.

10.0 Congressionally Directed Projects

There are two Congressionally Directed Projects (CDPs) managed under the Carbon Storage Program in FY2013.

- 1.) FE0000397 - Zero Emissions Research and Technology (ZERT) II-Investigating Fundamental Scientific Issues Affecting the Long-Term Geologic Storage of Carbon Dioxide (Montana State University). The end date for this project is 8/3/2014.
- 2.) NT0006642 - Shallow Carbon Sequestration Demonstration Project (City Utilities of Springfield, Inc.). The end date for this project is 9/30/2013.

There are no new CDPs in this fiscal year budget.