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Implementation of Partial-Capture Power Plants in NEMS

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Disclaimer

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Exhibits

Acronyms and Abbreviations

AEO	Annual Energy Outlook
CC	Carbon capture
CCS	Carbon capture and storage
CO_2	Carbon dioxide
CPSNPP	Carbon Pollution Standard for New Power Plants
CTL	Coal to Liquids Power Plant
DOE	Department of Energy
ECP	Electricity Capacity Planning
EFD	Electricity Fuel Dispatch
EOR	Enhanced oil recovery
EPA	Environmental Protection Agency
ESPA	Energy Sector Planning and Analysis
EPSA	Office of Energy Policy and Systems Analysis
FE	Fossil energy
GAMS	General Algebraic Modeling System
GW	Gigawatt
IGCC	Integrated gasification combined cycle
IS	IGCC with sequestration
kWh	Kilowatt-hour
LCOE	Levelized cost of electricity
mmBtu	Million British thermal units
NEMS	National Energy Modeling System
NETL	National Energy Technology Laboratory
NG	Natural gas
NGCC	Natural gas combined cycle
O&M	Operation and maintenance
P-CCS	Partial-capture CCS
PTC/ITC	Production and investment tax credit
PV	Photovoltaic
QER	Quadrennial Energy Review
SERC	SERC Reliability Corporation
tonne	Metric ton (1,000 kg)
U.S.	United States

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1 Introduction

The Environmental Protection Agency (EPA) has finalized a new set of regulations, known as the Carbon Pollution Standard for New Power Plants (CPSNPP). This new set of regulations, promulgated under Section 111(b) of the Clean Air Act, imposes, for the first time, CO_2 emission limits on new construction coal-fired power plants. One compliance path that a new coal-fired power plant can take is the addition of carbon capture and storage (CCS) equipment. Under the CPSNPP, the percentage of carbon capture required is far less than what is required from a coal-fired full-capture CCS ("full-capture") power plant.

Currently, the National Energy Modeling System (NEMS) only allows two categories of capture at coal power plants: uncontrolled and controlled CO_2 emissions. These two options for new coal-fired power plants do not reflect the current possible array of options that the industry may now consider.

The object of this activity is to add a new coal plant, with the ability to incorporate carbon capture, slot into NEMS. This new slot will enable the simultaneous assessment of new coal plants with different rates of capture. The runs made under this activity were assembled for the purpose of testing the new plant linkages and drivers for the dispatch of coal power plants with capture. This study should not be taken as an assessment as to the commercial suitability of plants with partial carbon capture.

2 Exercise of NEMS with New Coal-Fired P-CCS Power Plant Modifications

Once the modifications to accommodate partial capture (P-CCS) in NEMS were complete, several scenarios were developed and run to verify the efficacy of the modifications and to reveal the conditions under which P-CCS power plants might deploy.

The scenarios were developed by modifying the "EPSA Side Case," a scenario developed using a version of the Energy Information Administration's (EIA's) National Energy Modeling System (NEMS). Since the EPSA Side Case was needed for this and other EPSA reports in advance of the completion of EIA's Annual Energy Outlook (AEO) 2016, it uses data from EIA's AEO 2015 Reference Case, the most recent AEO available at the time. However, since AEO 2015 did not include some significant policy and technology developments that occurred during 2015, the EPSA Side Case was designed to reflect these changes.

The EPSA Side Case scenario was constructed using EPSA-NEMs,[a] a version of the same integrated energy system model used by EIA. The EPSA Side Case input assumptions were based mainly on the final release of the 2015 Annual Energy Outlook (AEO 2015), with a few updates that reflect current technology cost and performance estimates, policies, and measures, including the Clean Power Plan and tax credits. The EPSA Side Case achieves the broad emissions reductions required by the Clean Power Plan. While states will ultimately decide how

[a] The version of the National Energy Modeling System (NEMS) used for the QER Side Case has been run by OnLocation, Inc., with input assumptions by EPSA. It uses a version of NEMS that differs from the one used by the U.S. Energy Information Administration (EIA), the model is referred to as EPSA-NEMS.

to comply with the Clean Power Plan, the Side Case assumes that states choose the mass-based state goal approach with new source complement and assumes national emission trading among the states, but does not model the Clean Energy Incentive Program because it is not yet finalized. The EPSA Side Case also includes the tax credit extensions for solar and wind passed in December 2015. In addition, cost and performance estimates for utility-scale solar and wind have been updated to reflect recent market trends and projections, and are consistent with what was ultimately used in AEO 2016. Carbon capture and storage (CCS) cost and performance estimates have also been updated to be consistent with the latest published information from the National Energy Technologies Laboratory.

As with the AEO, the ESPA Side Case provides one possible scenario of energy sector demand, generation, and emissions from present day to 2040, and it does not include future policies that might be passed or unforeseen technological progress or breakthroughs. EPSA-NEMS also constructed an "EPSA Base Case" scenario, not referenced in this report, which is based primarily on the input assumptions of the AEO 2015 High Oil and Natural Gas Resource Case. Projected electricity demand values forecast by the EPSA Base Case and Side Case are very close to each other (within 3% by 2040). However, the values forecast by the EPSA Base Case are closer to those that that were ultimately included in the AEO 2016 Reference Case.

Initially five scenarios were defined by NETL to be used in this exercise. Exhibit 2-1 outlines the specific assumptions for each scenario.

Exhibit 2-1 Scenario-specific assumptions

Scenario	Scenario-specific Assumptions
Scenario 1	• 3% risk premium on coal technologies including partial capture; excludes full-capture CCS
Scenario 2	• No 3% risk premium on coal technologies
Scenario 3	• No 3% risk premium on coal technologies • No new full-capture coal CCS technology
Scenario 4	• No 3% risk premium on coal technologies • Low oil and gas resource case (higher natural gas prices) • High macro-economic growth case (higher electricity demand) • Nuclear builds not allowed in wholesale competitive markets • Unplanned new nuclear builds delayed until 2027
Scenario 5	• No 3% risk premium on coal technologies • No new full-capture coal CCS technology • Low oil and gas resource case (higher natural gas prices) • High macro-economic growth case (higher electricity demand) • Nuclear builds not allowed in wholesale competitive markets • Unplanned new nuclear builds delayed until 2027
Scenario 6	• No 3% risk premium on coal technologies

	• Low oil and gas resource case (higher natural gas prices) • High macro-economic growth case (higher electricity demand) • Nuclear builds not allowed in wholesale competitive markets • Unplanned new nuclear builds delayed until 2027 • No new full-capture coal CCS technology • Reduced costs for new partial capture coal plants by: ○ 16% for capital costs ○ 8% for fixed O&M costs ○ 8% for variable O&M costs

Because no deployment was observed in the first five scenarios due to the lower cost option provided by renewables, a levelized cost of electricity (LCOE) analysis of P-CCS and the competing technologies was performed to determine the cost (including capital and operation and maintenance (O&M) costs) at which P-CCS could be competitive. A sixth scenario was then designed that lowered the cost of P-CCS to allow it to be more competitive with other technologies and better elucidate the threshold at which P-CCS will deploy. This final scenario shares the common assumptions with the previous four (and is most similar to Scenario 5), but encourages P-CCS builds by removing competition from full-capture and reducing capital and operating costs of the P-CCS technology. Exhibit 2-1 also describes the assumptions for Scenario 6.

3 Power Plant Cost and Performance Assumptions

The cost and performance assumptions for coal plants used in this study are based on the Coal Baseline studies work done by NETL. The reports can be found at http://www.netl.doe.gov/research/energy-analysis/search-publications/vuesearch?search=netl&id=18&value=FE%20Plants%20C%26P%20Vol%201.

Specifically, the power plants in the runs were defined using the following Baseline cases:

> Pulverized Coal - Cost and Performance Baseline for Fossil Energy Plants Volume 1a: Bituminous Coal (PC) and Natural Gas to Electricity Revision 3, July 6, 2015 (DOE/NETL-2015/1723) - Case B12A
>
> Integrated Gasification Combined Cycle - Cost and Performance Baseline for Fossil Energy Plants Volume 1b: Bituminous Coal (IGCC) to Electricity Revision 2b – Year Dollar Update, July 31, 2015 (DOE/NETL-2015/1727) - Case B1A
>
> Pulverized Coal with Full Sequestration (90% Capture) - Cost and Performance Baseline for Fossil Energy Plants Volume 1a: Bituminous Coal (PC) and Natural Gas to Electricity Revision 3, July 6, 2015 (DOE/NETL-2015/1723) - Case B12B
>
> Pulverized Coal with Partial Sequestration (22% Capture) - Cost and Performance Baseline for Fossil Energy Plants Supplement: Sensitivity to CO_2 Capture Rate in Coal-Fired Power Plants, June 22, 2015 (DOE/NETL-2015/1720) - Case 22% Capture, 1,300 lb CO_2/MWh-gross

The cost and performance parameters were implemented by modifying the ecpdatx.xml file in NEMS. Initial Capital, Variable Operating & Maintenance (VOM), Fixed Operating & Maintenance (FOM) costs were set based on the referenced Baseline cases. Improvements on the plant capital costs are endogenously calculated by NEMS using a learning-by-doing algorithm. The learning function parameters for the above described plants were mostly left as originally set by EIA; the partial capture plant only required an adjustment in the weight of its plant components. The heat rate for power plants were also set based on the NETL baseline studies; a trajectory for the plant heat rates was determined using analyst judgement using as a guide the original heat rate curves provided by EIA. In the case of FOM and VOM costs NEMS maintains the same level of real costs for all years, so no time dependent adjustments were necessary. Finally, ancillary costs for the operation of environmental control devices were de-activated since they were already taken into consideration within the FOM and VOM costs taken from the Baseline Studies.

4 Results

Among the six scenarios, the overall capacity mix (Exhibit 4-1) and generation mix (Exhibit 4-2) are similar among the first three scenarios. Scenarios 4, 5, and 6 differ from the first three, but are roughly the same when compared to each other. The higher macro-economic growth assumption in the latter three scenarios prompts greater growth in capacity and generation.

Exhibit 4-1 Total Electricity Capacity Mix

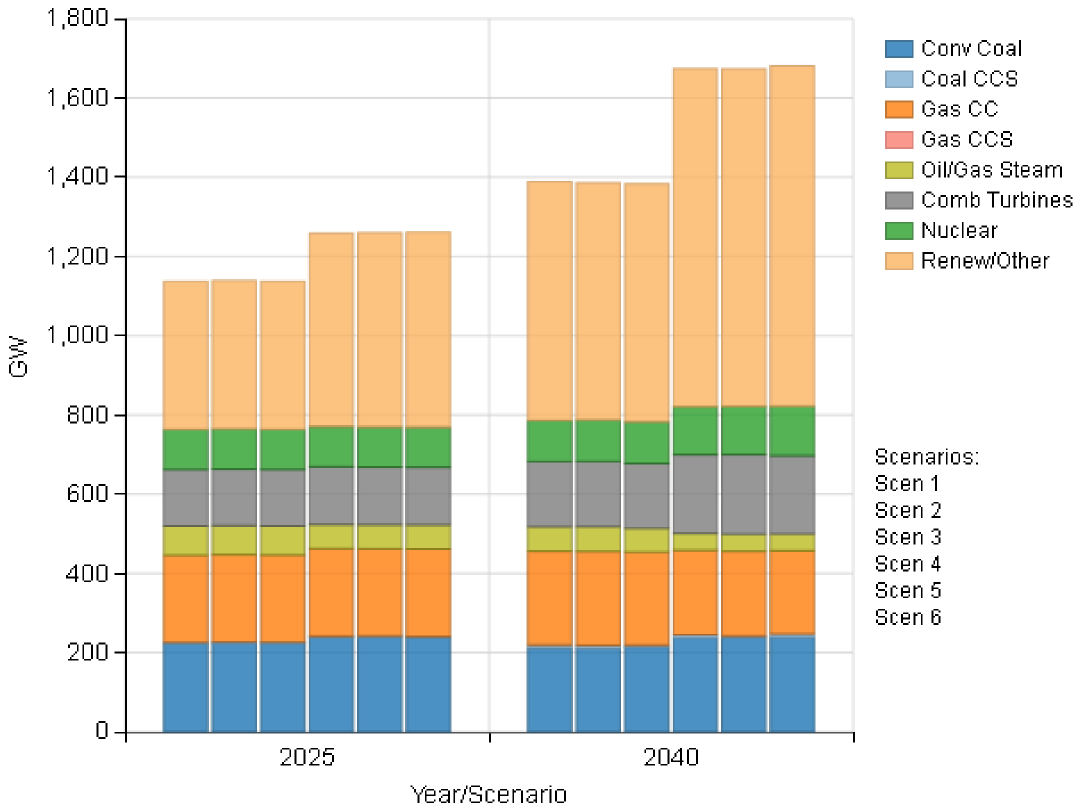
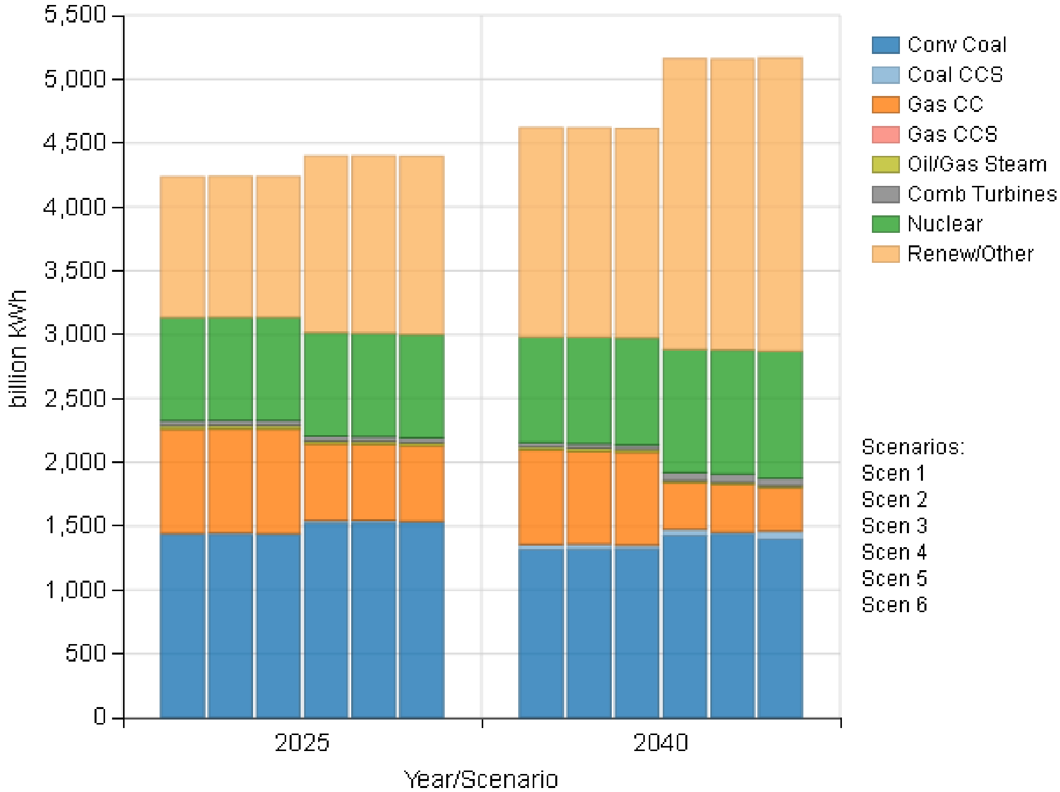
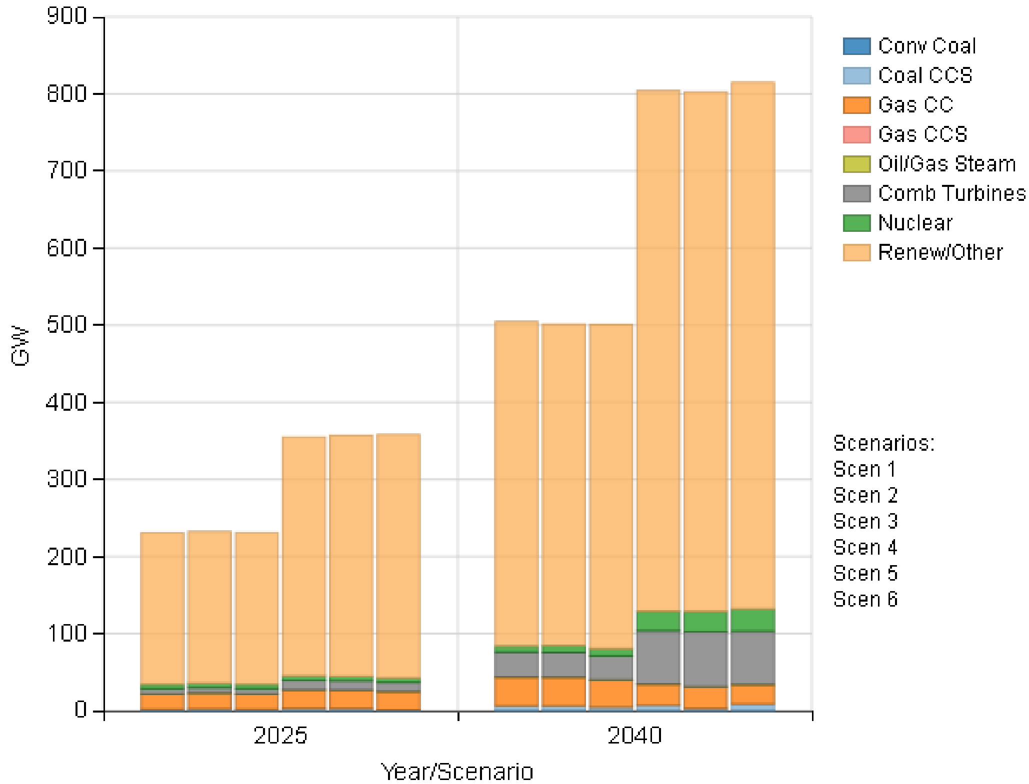


Exhibit 4-2 Total Year Electricity Generation



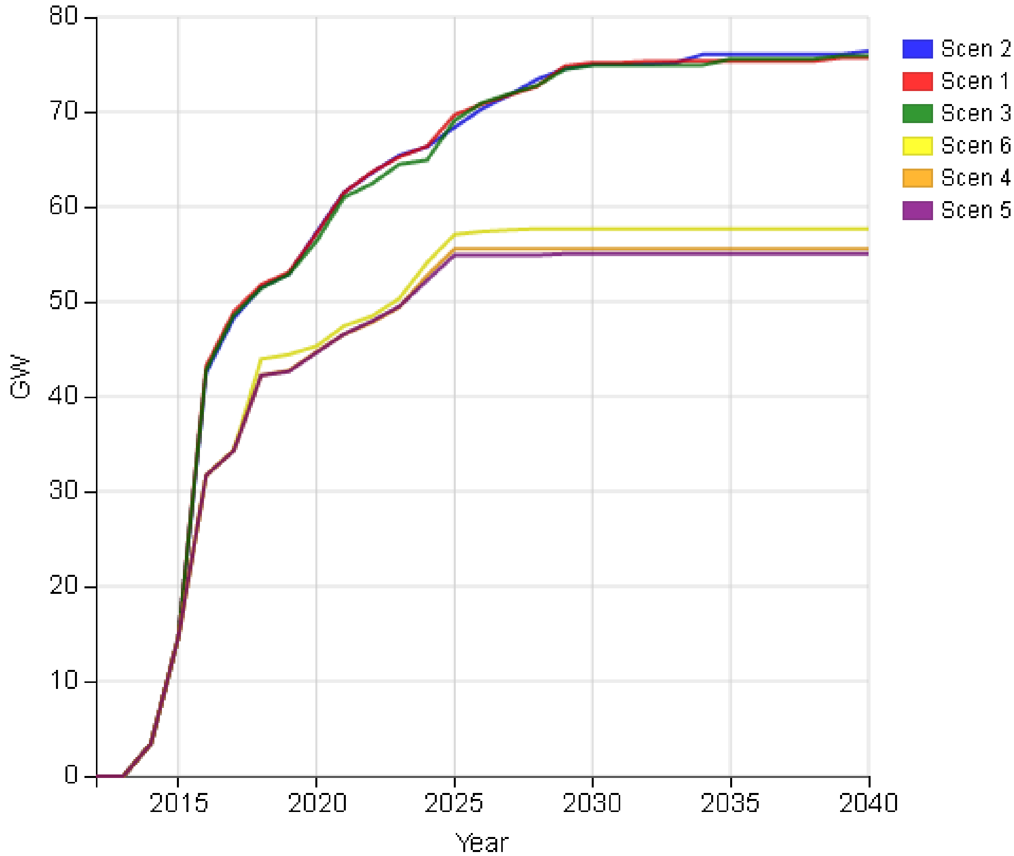
The capacity additions in each of the six scenarios is dominated by renewable generation (Exhibit 4-3), the majority of which is PV and wind power along with combustion turbines to support the growth intermittent power. There is some, but a lesser amount of natural gas combined cycle (NGCC) and nuclear capacity added. The shift away from gas (due to higher gas prices) in scenarios 4, 5, and 6, results in slightly more nuclear additions than in the other three scenarios, which are mainly added in Florida and the SERC Reliability Corporation (SERC) region.

Exhibit 4-3 Capacity additions



The significant amount of renewable capacity added in scenarios 4, 5, and 6 (over 800 GW) results in over compliance with the CPSNPP, thus relieving the pressure to retire coal-fired power plants. Scenarios 4, 5, and 6 retire nearly 20 GW fewer of coal capacity than the first three scenarios (Exhibit 4-4).

Exhibit 4-4 Cumulative coal capacity retirements



4.1 Impact on Electrical Capacity and Generation

While there are differences in the capacity mix among the scenarios to comply with the CPSNPP, the vast majority of difference in new capacity deployments occurs in low (NGCC) or no carbon technologies (renewable, and to a lesser extent, nuclear) power plants. Capacity with carbon capture comprises, at most, between 8 and 9 GW in these scenarios, with a set-in demonstration plant comprising 1 GW of that amount. In scenarios 1 – 5, where CCS retrofits for coal plants are allowed, those that are economical are implemented. In Scenario 6, where only P-CCS is allowed, no P-CCS is built until 2035, when natural gas prices are $8.82/mmBtu and the technology was artificially set to be cost competitive by implementing a 16% and 8% reduction in capital and O&M cost respectively. The reduction in capital and O&M costs was calculated by examining the gap in the resulting LCOEs between P-CCS and the photovoltaic (PV) power plant type. PV plants were selected as comparison basis due to their high deployment levels in previous runs and LCOE value proximity to P-CCS.

Without regard to P-CCS, the scenario results fall into two general outcome categories: those with no new coal CCS penetration (scenarios 1, 2, 3, and 5) and those with some new coal CCS penetration (scenarios 4 and 6). The high macro-economic and low natural gas resource assumptions in scenarios 4 and 6 result in higher natural gas prices (Exhibit 4-5), which cause a shift away from NGCC power plants and towards coal-fired power plants with CCS. In 2022, when power plants must comply with mass-based CO_2 standard, the price of natural gas for power plants is $6.32/mmBtu. This is sufficiently high to allow coal plants with CCS (in this case, retrofits) to become an economic alternative to NGCC power plants. As natural gas prices increase over time to $7.55 in 2025 and over $10.00 by 2040, more coal with CCS is introduced into the capacity mix. In the near term, the higher natural gas price results in higher average electricity prices (Exhibit 4-6), until load can be shifted to more low carbon, non-gas-dependent technologies such as coal with CCS and renewables. Ultimately, the combined effect of higher natural gas prices and the disallowance of full-capture in Scenario 6 prompts a significant reduction in the amount of CO_2 captured from power plants (Exhibit 4-7), despite having the greatest capacity of power plants with capture technology by 2040 (Exhibit 4-8). This dichotomy is the result of a shift of power generation from full capture to partial capture sources; that is, the reduction on the capture levels outweigh the build of capacity when full capture plants are artificially disallowed.

Exhibit 4-5 Power sector natural gas price

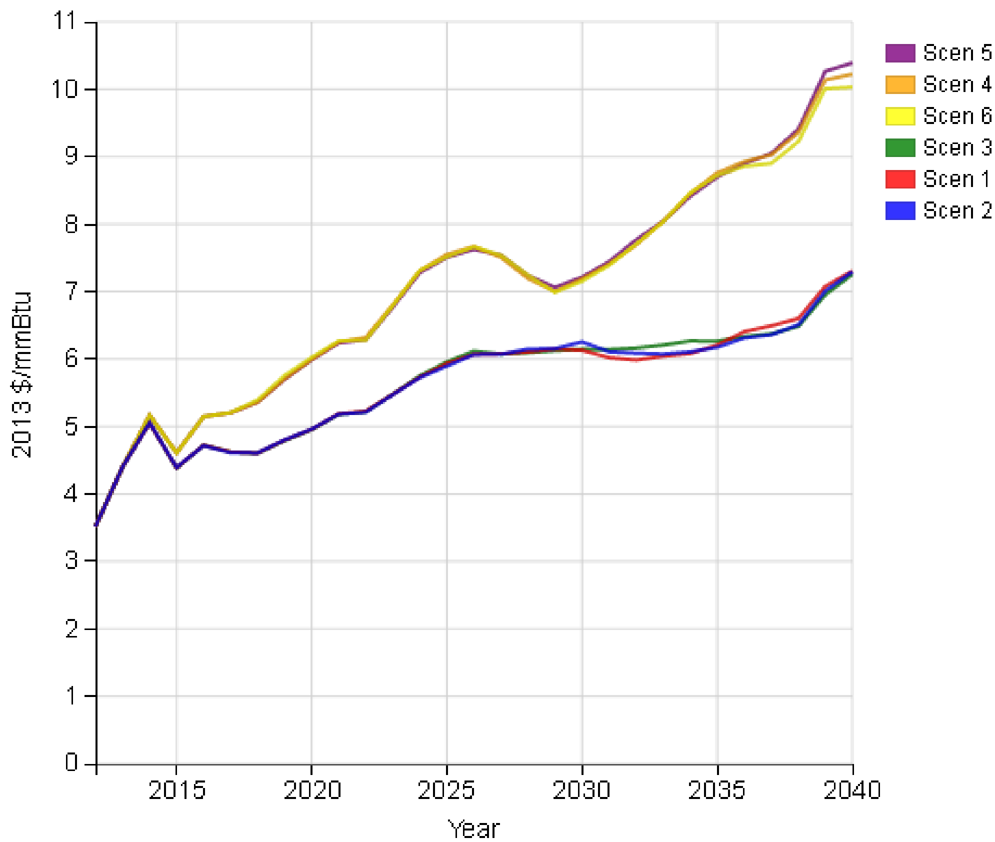


Exhibit 4-6 Average electricity price

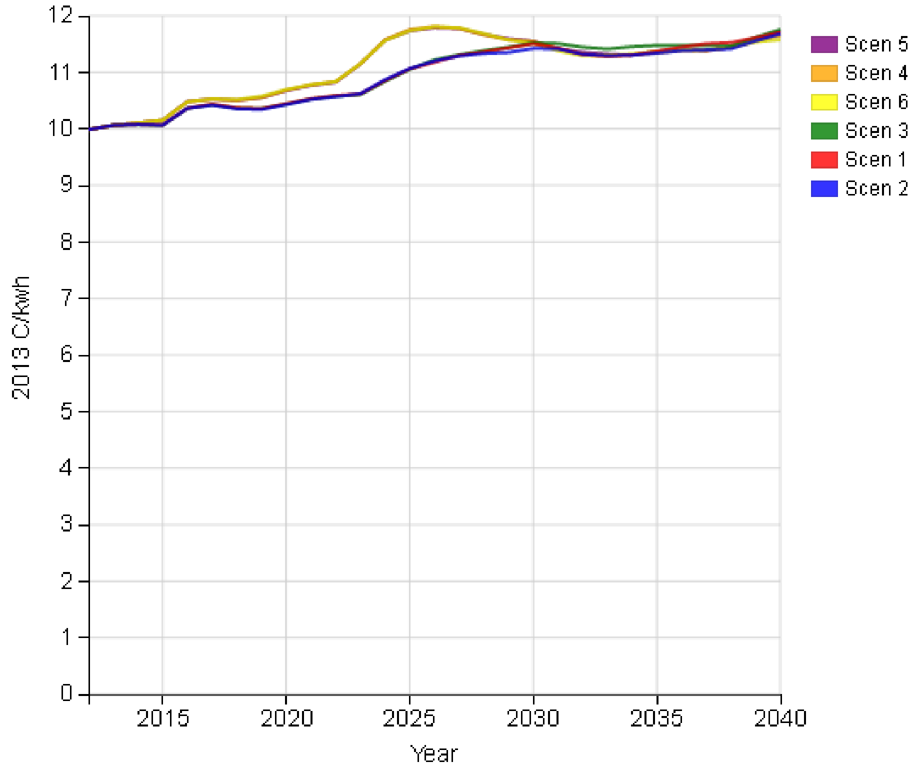


Exhibit 4-7 CO_2 captured at power plants

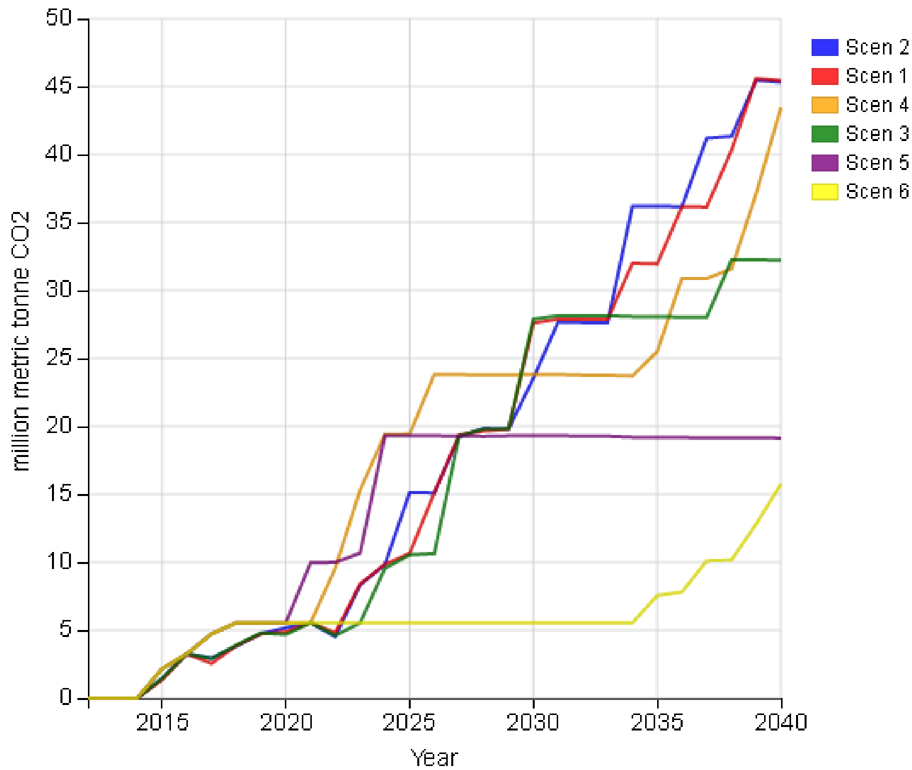
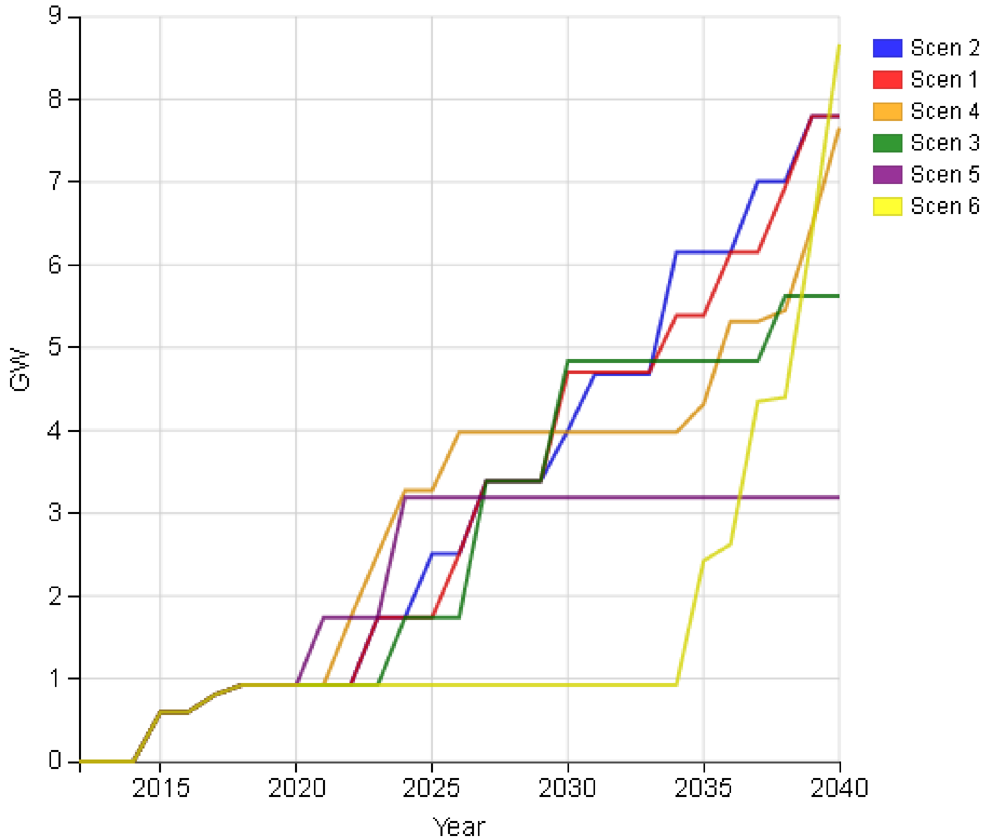


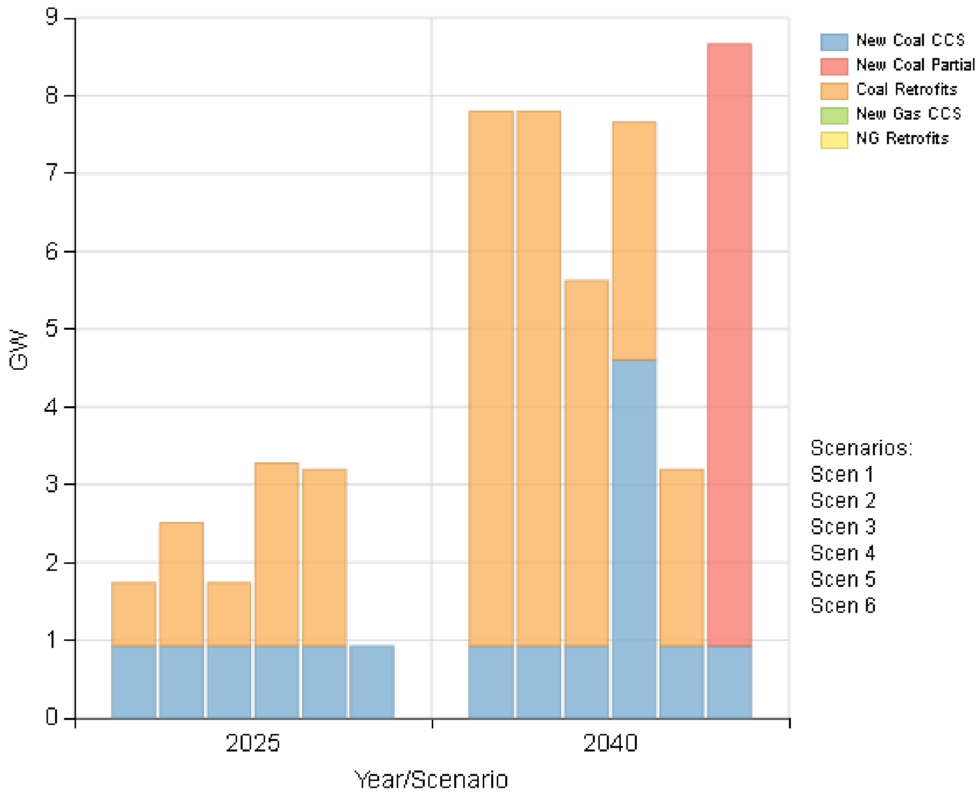
Exhibit 4-8 Total capacity with CO_2 capture



4.2 P-CCS Deployment

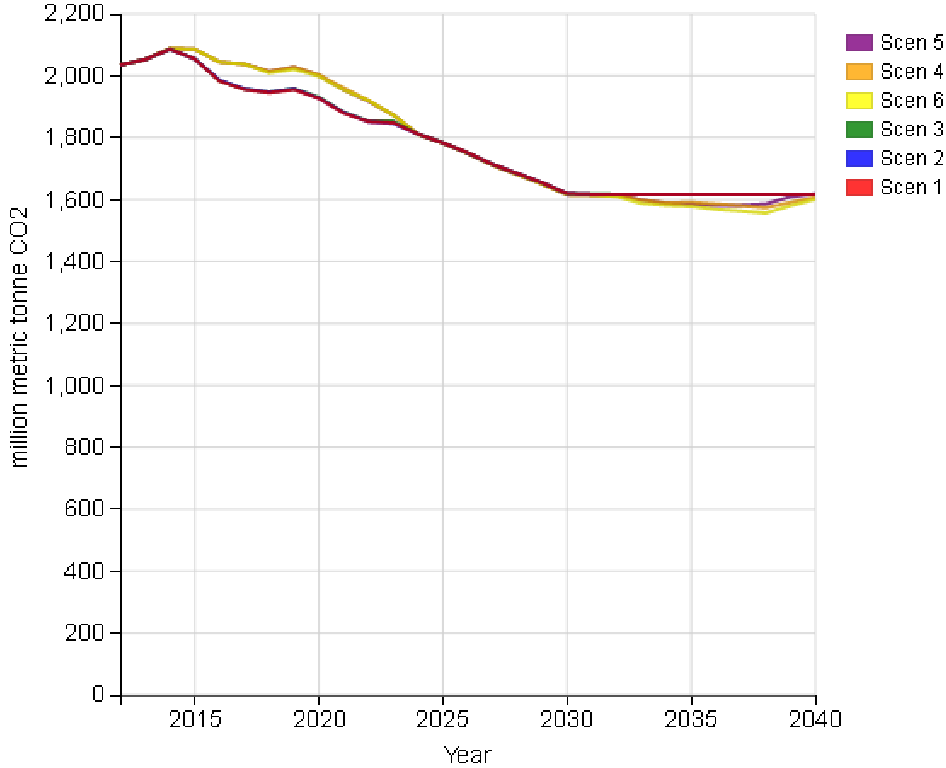
The model was exercised using the six scenarios described in Section 2, only one of which (Scenario 6, for which full capture plants were not allowed) deployed new P-CCS power plants. In the first five scenarios, P-CCS is not cost competitive with other technologies and is not selected. Scenario 4 deploys more new full-capture, but no P-CCS. In this scenario, full-capture is chosen over P-CCS due to the value added from greater amounts of captured CO_2 that can realize economic benefits through the supply of CO_2 for enhanced oil recovery (EOR). Even in Scenario 5, where full-capture is disallowed (but is otherwise the same as Scenario 4), P-CCS is not deployed, because of the foregone value of the additional CO_2 capture combined with higher CCS costs than included in Scenario 6. Scenario 6, where P-CCS costs are reduced and full-capture is disallowed, new P-CCS technology is finally deployed (Exhibit 4-9), displacing retrofits as the economic choice for coal plant CO_2 capture. Because compliance with CPSNPP begins in 2022 and because electricity demand grows throughout the model time horizon, gains in capacity with CO_2 capture are realized after 2022 and increase through 2040 as demand increases, as Exhibit 4-9 illustrates in its contrast of 2025 and 2040 levels of generating capacity with CO_2 capture.

Exhibit 4-9 Capacity with CO_2 capture



Because the power sector must comply with the CPSNPP in this version of NEMS, CO_2 emissions from the power sector are roughly the same in all six scenarios, though after 2030, scenarios 4 and 5 actually over-comply slightly (Exhibit 4-10).

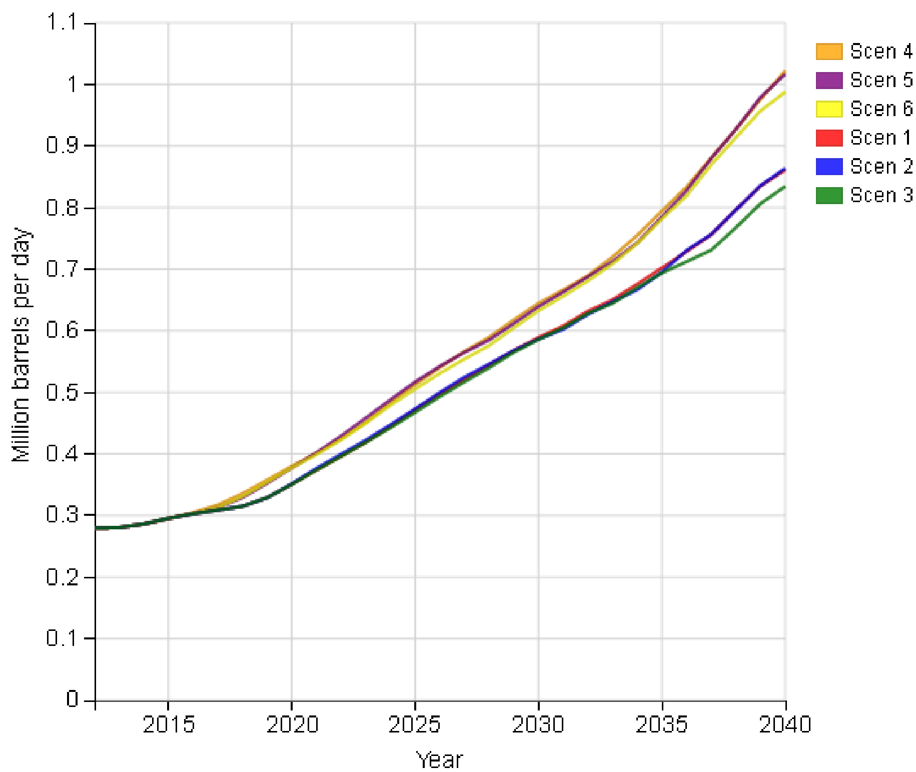
Exhibit 4-10 CO_2 emissions from the power sector



4.3 Impact on Enhanced Oil Recovery

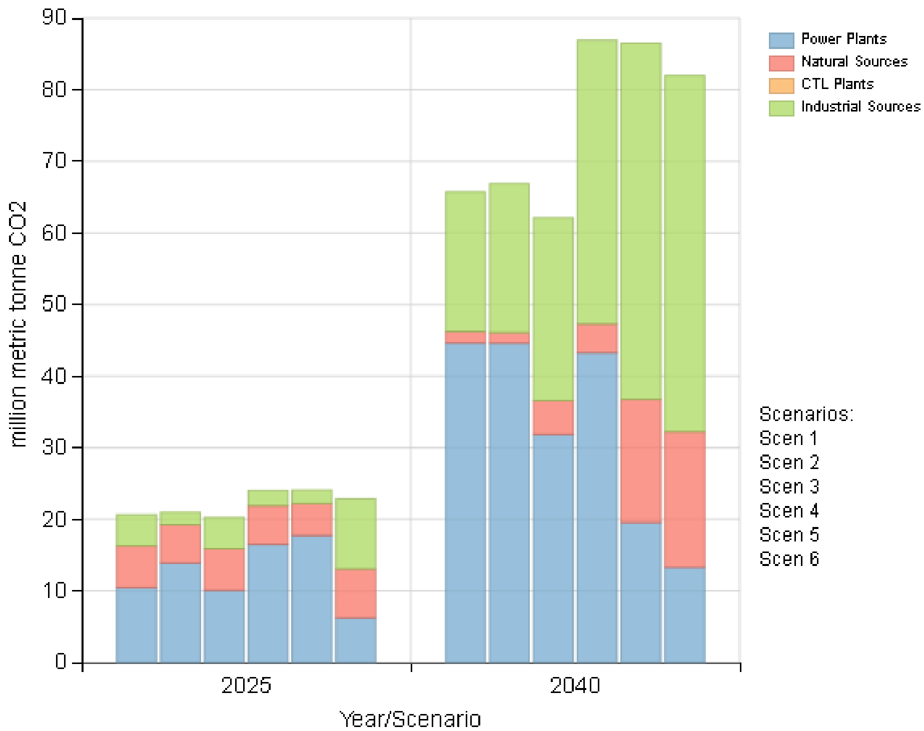
EOR injects CO_2 into an oil reservoir to assist in the extraction of residual oil deposit. CO_2, especially when priced low enough, becomes a valuable commodity in oil production. For power plants that capture their CO_2, EOR provides a viable and potentially economically rewarding way to dispose of their CO_2, while complying with emission standards. In NEMS, CO_2 used for EOR may be purchased from natural or industrial sources or power plants, each of which is associated with distinct volumes and prices. The macro-economic assumptions drive the amount of oil produced in each of the six scenarios. Scenarios 4, 5, and 6, with higher macro-economic growth also have higher and similar amounts of oil production. The other three scenarios have lower oil production, but are also similar in volume to each other (Exhibit 4-11).

Exhibit 4-11 CO_2 enhanced oil recovery



When full-capture is excluded, as in scenarios 3, 5, and 6, CO_2 purchased from power plants is slightly lower due to the lower over-all volumes of CO_2 available for purchase from power plants. Scenarios 4, 5, and 6 reveal a higher demand for CO_2 due to the higher macro-economic growth. In these scenarios most, if not all, of the CO_2 captured from power plants is purchased for EOR due to its lower cost when compared with industrial sources. However, the amount of CO_2 purchased from power plants is significantly lower in scenarios 5 and 6 than the other scenarios, simply due to the smaller volume captured (only thirty percent from P-CCS power plants, as opposed to 90 percent in full-capture power plants) (Exhibit 4-12).

Exhibit 4-12 CO_2 purchased for enhanced oil recovery



5 Conclusions

Although P-CCS technology has been successfully introduced into the NEMS model, our runs indicate that it will need to become more cost competitive with other power sources in order to achieve any significant levels of deployment. Some of its most significant competition comes from natural gas-fired power plants, renewable, and full-capture power plants. Without notable benefit from building a new P-CCS power plant instead of a full-capture power plant, the model will always choose the full-capture power plant due to the added benefit of CO_2 that can be purchased by CO_2 EOR operations. To achieve deployment of P-CCS, cost and/or performance benefits of that technology over other low- or no-carbon options will need to be employed.

Appendix A: Approach

The integration of new partial-capture carbon capture and storage (P-CCS) power plants into the National Energy Modeling System (NEMS) required modifications to the *includes, input,* and *source code* files, and reporting functions of NEMS. A version of NEMS based on the Annual Energy Outlook (AEO) 2015 code, modified to include a representation of the CPSNPP, was used as a basis for this exercise. These modifications are consistent with the Quadrennial Energy Review (QER) Base case version of the NEMS-Office of Energy Policy and Systems Analysis (EPSA) model and include:

- National power sector mass-based CO_2 standard that begins in 2022 and covers all fossil generation except existing combustion turbines. The standard reflects the Clean Power Plan targets with new source complement
- Modified technology assumptions for wind and solar photovoltaics (PV) based on preliminary technology costs from the AEO 2016, which are lower than the AEO 2015 costs
- Fossil Energy (FE)/NETL baseline assumptions or all coal technologies
- Renewable production and investment (PTC/ITC) tax credit extensions approved by Congress in December 2015
- End-use utility-sponsored rebates for select residential and commercial lighting and appliances

Modifications were made to this version of NEMS following the plan laid out in the Activity Methodology Plan (delivered by Energy Sector Planning and Analysis (ESPA) to the National Energy Technology Laboratory (NETL) on January 29, 2016) to ensure a methodical and systematic approach. Once NEMS was modified to include P-CCS technologies, it was exercised to verify the functionality of the modifications. In order to inspect the functioning of and reporting from the model, it was necessary to ensure P-CCS deployment by halving capital and operating costs, even though this would be a highly unlikely event in reality. The modified NEMS model did deploy P-CCS in this scenario and the model's function and reporting were validated.

While integrating P-CCS into NEMS required modification to the *includes*, *input*, and *source code* files (see Exhibit A-1), the majority of the modifications involved the expansion of the existing structures to incorporate the new technology rather than the introduction of new logic or mathematical calculations. Generally speaking, wherever a 90 percent carbon capture technology exists in the model, a parallel accommodation was made for the P-CCS technology. The approach taken to perform these modifications is presented in the following subsections, according to the types of files that were changed, specifically the *includes*, *input*, and *source code* files (which include both the Fortran, ".f" and General Algebraic Modeling System (GAMS), ".gms" code).

Exhibit A-1 NEMS files modified to accommodate P-CCS technology

Includes		
cdsparms	ecpcntl	ftable
coalemm	emablk	udatout
control	emmparm	uecpout
Input		
clparam.txt	efpcntl.txt	layin.xls
cmmdbdef.txt	eintlrn.txt	layout.txt
dict.txt	emmcntl.txt	plntdaf.daf
ecpdatx.xml	emmdbdef.txt	pltdata.txt
Source Code		
coalcsds.f	main.f	uecp.f
ctsprep.gms	prepplt.f	uefd.f
ftab.f	renew.f	util.f
intercv.f	udat.f	

A.1 Modification of *Includes* Files

The P-CCS technology needed to be introduced into nine of the *includes* files. In the emmparm file, the Electricity Capacity Planning (ECP) Technology List was expanded to include the P-CCS variable (ECP$DSP=48) as were the Electricity Fuel Dispatch (EFD) Technology List (EFD$DSP=33) and the Fuel Type List (EFD$NFL=55, which includes 36 coal types). Similarly, the coal type list in the cdsparms (nutsec=36), coalemm (nclut1=36) and emablk (nclpr2=36) files were expanded to include P-CCS technology. Finally, the ecpcntl, emmparm, ftable, udatout, uecpout, control, cdsparms, coalemm, and emablk files were updated to include the P-CCS (designated as "PQ") type, reporting and other variables. Exhibit A-2 summarizes the changes made to the *includes* files and the names of the affected variables.

Exhibit A-2 Summary of changes to *includes* files

***Includes* File**	**Changes to ECP types**	**Changes to EFD Types**	**Changes to Fuel Types**
cdsparms			nutsec=36
coalemm			nclut1=36
control	UIPQ, UICPQ		
ecpcntl	WIPQ		
emablk			nclpr2=36
emmparm	Ecp$dsp=48	Efd$dsp=33	Efd$nfl=55 (includes 36 coal types)
ftable	Added lines to table 59		
udatout	Added 5 new reporting variables (UCAPPQU, UCAPPQN, URETPQU, UGENPQ, UGENSC)		
uecpout	Added 3 new reporting variables (UADDPQU, UADDPQN, UPPQCCST)		

A.2 Modification of *Input* Files

A total of twelve *input* files were modified to include the P-CCS technology. The *input* files are the means through which NETL's cost and performance specifications for P-CCS are introduced to NEMS (ecpdatx.xml, emmcntl.txt). In addition, changes to the *input* files are also made to update the dictionary file (dict.txt) and reporting (layin.xls, layout.xls), as well as other files that track characteristics of the power plants. Exhibit A-3 summarizes the changes made to the *input* files.

Exhibit A-3 Summary of changes to *input* files

***Input* File**	**Changes to ECP types**	**Changes to EFD Types**	**Changes to Fuel Types**
clparam.txt			Inserted PQ fuel into 3 tables
cmmdbdef.txt			Inserted PQ fuel into 3 tables
dict.txt	ecpcap=60, ecpdsp=48, UCAPPQU, UCAPPQN, URETPQU, UGENSC, UGENPQ, UADDPQU, UADDPQN, UPPQCC		nutsec=36
ecpdatx.xml	Inserted PQ into all of the tables		
efpcntl.txt	Inserted PQ into table		
eintlrn.txt	Inserted PQ into all of the tables		
emmcntl.txt	NW_Coal=9, PQ added to 'FUEL PARM', PQ added to 'CO_2 STD PL', PQ added to 'ECP-EFD Fuelcode map', PQ added to 'ECP Tech', PQ added to 'ECP$PLT v1', PQ added to 'ECP$PLT v2', PQ added to 'HG EMF Info', PQ added to 'RET GRPS', PQ added to 'UPXTRA'	CPQ added to 'EFD PLT CD', CPQ added to 'GPS ALLOC', CPQ added to 'HRATE Targets', CPQ added to 'HR Profile', CPQ added to 'OandM targets', CPQ added to 'UOM profile', CPQ added to 'OM in MRGPRC'	UNFUELS=55, PQ added to 'Fuel Parm' (efd$nfl/55), PQ added to 'ACI RQ Info' (36/nclut1)
emmdbdef.txt	Inserted PQ into table		
layin.xls	Lines added to table 59		
layout.txt	Lines added to table 59		
plntdaf.daf	Reran common block changes		
Pltdata.txt		Added CPQ	

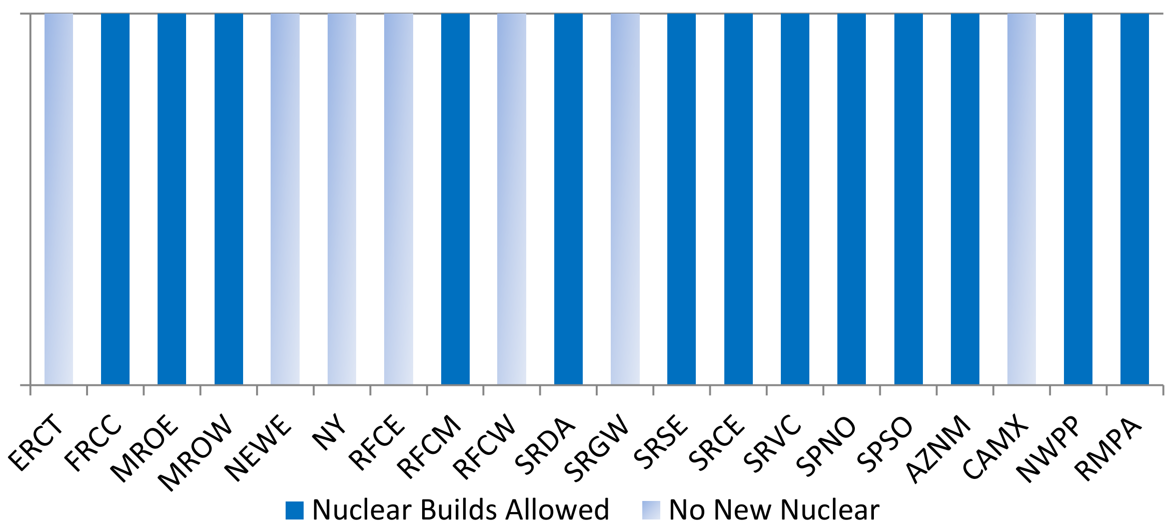
A.3 Modification of *Source Code* Files

The source code was modified to recognize P-CCS as a new and distinct technology. Generally speaking, wherever a 90 percent carbon capture technology exists in the model, a parallel accommodation was made for the P-CCS technology. Modifications were made to uefd.f, uecp.f, util.f, udat.f, renew.f, intercv.f, main.f, prepplt.f, and ctsprep.gms files to introduce new P-CCS technology (in addition to integrated gasification combine cycle (IGCC) with sequestration (IS) technology) everywhere and in a parallel fashion to where IS technology occurs. In addition, the coalcds.f code was modified to introduce a new coal fuel type. Finally, the ftab.f was changed to enable the separate reporting of P-CCS.

Appendix B: Regional Restrictions for Nuclear Builds

Scenarios 4, 5, and 6 in this exercise assume new nuclear builds are not permitted in regions with wholesale electricity markets. Exhibit B-1 indicates in which electricity regions new nuclear power plant builds are restricted.

Exhibit B-1 Regional restrictions for nuclear builds



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