Proposed Scenarios for Evaluation of the Future Benefits of DOE R&D

FE-EERE Scenarios Working Group
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DEFINITIONS

Scenario *– an abbreviated description of a set of key conditions regarding environmental and energy parameters*

Case *– a unique setup of the National Energy Modeling System (NEMS) code, including all initial and boundary conditions placed on NEMS, and a corresponding setup of any other analytic tools*

Reference Case *– a specific recognized Energy Information Administration (EIA) Reference Case forecast*

Baseline Case *– a NEMS forecast assuming that certain U.S. Department of Energy (DOE) research and development (R&D) is not implemented (an "A" case in previous FE nomenclature)*

Program Case *– a NEMS forecast assuming that DOE R&D is implemented (a "B" case in previous FE nomenclature)*

INTRODUCTION

The objective of this document is to develop a suite of scenarios for the DOE FE and DOE Energy Efficiency and Renewable Energy (EERE) Offices to consider, and ultimately execute and present to the National Academy of Sciences (NAS) as it evaluates the future benefits estimation methods for DOE technologies. The FE-EERE Scenarios Working Group has developed three scenarios:

- ***A Reference Scenario***
- ***A Carbon Cap-&-Trade Scenario***
- ***A High Fuel Price Scenario***

The DOE FE will formally request that the authors of the NEMS, EIA, setup NEMS code to model these three scenarios. Analysts from the FE's NETL and from EERE's contractors, LBNL in consultation with OnLocation, will work closely with the EIA to develop NEMS cases that provide sensible conditions while minimizing the work required by the EIA.[1]

[1] The NEMS is a large, complex code consisting of more than 300,000 lines of Fortran written by many analysts.

The EIA will make the customized NEMS code available to analysts at the NETL and LBNL. The NETL and the LBNL together with OnLocation will then work separately to estimate program benefits using separate NEMS[2] Baseline and Program Cases under each Scenario, and in keeping with their usual respective estimation methods. The NEMS forecast will extend through the year 2025 and will use the full NEMS model, including macroeconomic feedback. Working separately, the NETL for FE and the LBNL together with the Brookhaven National Laboratory (BNL) for EERE will also generate additional forecasts from 2025 to 2050, according to their normal practice.

SCENARIOS

The Reference Case Scenario

For this study, the EIA's Reference Case as of April 9, 2004 will be used.[3] This is an updated version of the EIA's AEO 2004 Reference Case, and represents a business-as-usual scenario. Regulations and policies in place as of September 2003 remain in place throughout the forecast horizon. In future years, the EIA's AEO Reference Case could be used for this Scenario. The two NEMS cases described below will be built upon this Reference Case.

The Carbon Cap-&-Trade Scenario

The carbon cap is implemented through a simple cap-and-trade regime and will cover all energy sectors.[4] This Working Group was asked to implement a "fairly extreme" carbon cap. To meet this request, U.S. carbon emissions will be reduced by approximately 500 million metric tons of elemental carbon equivalent per year (mmtce) by the year 2017. After 2017, this cap is held constant through 2050, which is equivalent to stabilizing U.S. carbon emissions at about 1996 levels (approximately 1470 mmtce).[5]

Because carbon banking tends to make the numerical solution of NEMS more difficult, banking will not be considered initially, rather carbon emissions will be reduced gradually starting in 2010. The carbon cap may be adjusted slightly if needed to achieve a well-behaved numerical simulation and interesting levels of market penetrations of FE and EERE technologies. Builds of nuclear plants will be held to Reference Case levels. Any necessary changes to the above conditions will be determined by joint discussions between NETL, LBNL, EE, and FE.

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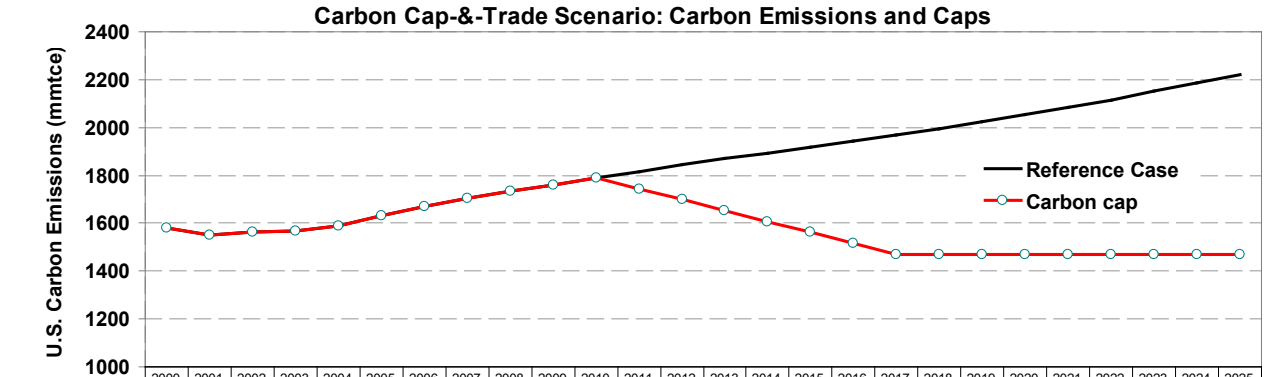
[2] The LBNL will modify and rename the NEMS code according to their needs.

[3] This case represents an updated version of the NEMS AEO 2004 Reference case, and is the version described in the EIA's report "Analysis of S. 1844, the Clear Skies Act of 2003; S. 843, the Clean Air Planning Act of 2003; and S. 366, the Clean Power Act of 2003" available at http://www.eia.doe.gov/oiaf/servicerpt/csa/pdf/sroiaf(2004)05.pdf This NEMS run is named INbase.d040904n.

[4] No international offsets will be employed. Market rules, such as grandfathering and lower plant-size limits, will be avoided unless required to obtain a plausible forecast.

[5] Total carbon dioxide emissions from the energy sector in 1996 are estimated at 1463 mmtce, and total U.S. emissions at 1496 mmtce. EIA, *Emissions Greenhouse Gases in the United States 1996*, *http://www.eia.doe.gov/oiaf/1605/gg97rpt/list.html*.



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Reference Case	1580	1550	1563	1566	1589	1633	1670	1705	1734	1760	1790	1816	1844	1870	1894	1917	1943	1970	1996	2026	2055	2082	2115	2152	2185	2221
Carbon cap	1580	1550	1563	1566	1589	1633	1670	1705	1734	1760	1790	1744	1699	1653	1607	1561	1516	1470	1470	1470	1470	1470	1470	1470	1470	1470

High Fuel Price Scenario

The supply of natural gas and oil are restricted to cause significantly higher fuel prices. The natural gas supply will be restricted enough to cause natural gas prices to reach $5.00[6] by 2015, $5.50 by 2025, and $7.50 by 2050. Techniques to restrict natural gas supplies are listed in Appendix A. Oil prices will be set according to the method used in the EIA's AEO High World Oil Price Case and will meet the following conditions: oil prices will be $33[7] by 2010, $34 by 2015, $35 by 2025, and $45 by 2050.

TIME REQUIRED FOR THIS STUDY

Three scenarios have been proposed. For each scenario, at least three NEMS runs will be required: the scenario case as received from the EIA, a corresponding Baseline Case (without DOE R&D), and the program Case (with DOE R&D). At least ten NEMS runs will be required. This should take two to three weeks to complete, if no problems arise. Before these runs can be completed, the EIA must create the NEMS code to model the three scenarios and test it to ensure that the numerical solution is well-behaved, and that other conditions have not been violated, e.g. markets are operating in legitimate segments of supply curves. The EIA will have to estimate the time required to setup these cases, but given past experience with the EIA, it will take two to four weeks to setup and deliver the code. All together, final results should be available to the NAS in one to two months after this work is started by the EIA, although preliminary results may be available for FE and EERE staff earlier.

[6] Natural gas prices are in terms of the wellhead price in year 2002 dollars per thousand standard cubic feet.
[7] Average refiner acquisition cost for imported crude oil in year 2002 dollars per 42 U.S. gallon barrel.

APPENDIX A

The natural gas price trajectory achieved in this scenario is more important than the means by which the natural gas supply is restricted; however, to present a sensible forecast, the following supply restrictions will be used:

- Construction of an Alaska natural gas pipeline is assumed to be delayed such that it will not be in operation before 2025.
- Western Canadian Sedimentary Basin gas supplies (both conventional and coalbed methane) are reduced by 25 percent relative to the Reference Case assumptions.
- Once initially on line, the Mackenzie Delta pipeline in Canada is not allowed to expand again.
- No new LNG facilities are allowed on U.S. shores (under the other scenarios, LNG facilities are allowed on the Atlantic and Gulf Coasts).
- Non-U.S. LNG facilities are not allowed to expand again once built (this results in about 1/2 the capacity as assumed under Reference Case conditions). This applies to planned facilities in the Bahamas and Baja California.
- The existing four U.S. LNG facilities (Cove Point, Elba Island, Lake Charles, and Everett-DistriGas) are only allowed to expand 1/2 as much as allowed under Reference Case conditions.
- Beyond 2050, Arctic and LNG gas supplies are restricted until the price target is met.

Other constraints will be added until the price target in 2025 is met. These constraints are listed below in the order that they will be added by EIA consistent with EIA's need to achieve a well-behaved numerical simulation and agreement with NETL and LBNL.

1. Eliminate new LNG terminals (only one available, Region 10, "Planned Facility").
2. Delay Mackenzie Delta development.
3. Restrict supply from Canada conventional western sedimentary basin (WSB) and unconventional bases.
4. Cut LNG terminal maximum capacity utilizations by up to 50%.
5. Increase LNG supply prices.
6. Set Mexico Supply/Demand Flag to Base Case.
7. Set Oil/Gas Price Expectancy Flags to Low Case.