

## MEMORANDUM

**SUBJECT:** Summary of AEO2017 Nuclear Workshop Meeting held on March 7, 2017

**DATE:** June 15, 2017

**TO:** Ian Mead Assistant Administrator for Energy Analysis  
Jim Diefenderfer  
Director,  
Office of Electricity, Coal, Nuclear, and Renewables Analysis  
  
Angelina LaRose  
Director,  
Office of Integrated and International Energy Analysis

**FROM:** Coal and Uranium Analysis Team & Electricity Analysis Team

**PRESENTERS:** Howard Gruenspecht, Michael Scott, Thad Huetteman, Laura Martin, Cara Marcy, Nick Domenico, Mark Holt, and Phillip Brown

**ATTENDEES:** 20 external, 17 EIA (see attached list)

### Workshop Overview

On March 7, 2017, EIA's Coal and Uranium Analysis Team hosted an Annual Energy Outlook 2017 (AEO2017) Nuclear Workshop to re-initiate efforts to conduct regular outreach with external nuclear industry stakeholders to help better inform EIA's nuclear projections. The one-day workshop was organized into two sessions, which followed an opening address by the Acting EIA Administrator, Dr. Howard Gruenspecht.

During the morning session, EIA staff discussed the National Energy Modeling System (NEMS), including the assumptions and modeling parameters used to produce the AEO2017 outlook. This discussion centered around four separate presentations:

- AEO2017 Nuclear Projections: Dr. Michael Scott, Coal and Uranium Analysis Team, EIA
- AEO2017 Electricity Projections: Thad Huetteman, Team Lead, Electricity Analysis, EIA
- Electricity Market Module Overview: Laura Martin, Electricity Analysis Team, EIA
- AEO2017 Renewable Energy Projections: Cara Marcy, Renewable Energy Analysis Team, EIA

During the afternoon session, invited stake holders discussed issues affecting the nuclear sector, including subsequent license renewal (SLR) and a review of recent activity concerning price subsidies and nuclear generating plant closures. This discussion centered around two separate presentations:

- Issues for Subsequent License Renewal Decision Makers – Licensing, Investments, and Market Risk: Nick Domenico, Z Inc. (contractor to EIA)

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- Review of Recent Market Activity - Price Subsidies and Recent Closings: Mark Holt and Phillip Brown, Congressional Research Service

### **Opening Address by the Acting EIA Administrator, Dr. Howard Gruenspecht**

The Acting Administrator summarized some of the current uncertainties related to the future of the domestic nuclear power market, including the increase in shale gas production and the growth of renewables. He explained EIA's task of modeling the complex interactions between these markets and their impact on EIA projections under Reference case and various side cases, where various economic, policy, and technology assumptions are modified to examine alternative scenarios.

The Acting Administrator highlighted the importance of the workshop for EIA. Workshops like these help EIA better model projected developments in the overall energy market, especially when the market conditions depart from historical conditions.

He noted that the current U.S. nuclear fleet is achieving high capacity factors and availability at a relatively low cost, and that nearly all reactors have received license renewals to operate for up to 60 years. However, all but the newest reactors will require a subsequent license renewal (SLR) within the 2030-50 timeframe to operate for up to 80 years. In previous AEO releases, EIA assumed all reactors would apply for and receive a SLR. But as EIA extends its projections to 2050 (from 2040), this assumption needs to be better characterized to properly reflect the fuel mix and capital investments requirements for long term operations. To that end, AEO2017 assumed generic retirements of approximately 25% of the existing fleet as reactors reach 60 years of commercial operations. EIA is continuing to evaluate the uncertainty associated with this modeling assumption, and is interested in stakeholder feedback on the issue. Near-term uncertainty also exists with respect to the impact of low-cost shale gas, low load growth, and growth in renewable electricity generation that contribute to a difficult revenue and investment environment for nuclear, both in the near and long term.

He also commented on the CO2 pricing assumptions in the AEO2017. Whereas BP, Exxon, and other forecasters do assume some price for CO2, EIA assumes existing laws and regulations. He pointed out that the AEO2017 Reference Case incorporated the Clean Power Plan (CPP) and that AEO2017 also included a No CPP side case.

During Dr. Gruenspecht's introduction, one participant inquired about regions in the Electricity Market Module (EMM); a map of the [EMM regions](#) is available on the EIA website.

## **SESSION A**

### **EIA Perspective on Nuclear Power and the AEO2017 Electricity Sector Outlook**

Dr. Michael Scott provided an overview of EIA's perspective of the nuclear power market, including the major issues that are driving plant operations. These issues include rising operation and maintenance (O&M) costs, flat demand, historically low prices in deregulated markets, increasing electricity production from renewables, and developing state price support for nuclear power. The challenge for EIA relates to modeling how these factors impact major capital investment decisions, including those to seek subsequent license renewals or build new reactors. The importance of the workshop was emphasized since EIA has limited access to nuclear industry data and future investment decisions cannot

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be properly represented without an understanding of the strategies being developed to deal with these market challenges. Thad Huetteman provided a description of the NEMS Electricity Market Module (EMM) and how the market variables are represented.

Several attendees asked questions about how state renewable portfolio standards (RPS) are modeled. EIA staff indicated that only actual mandates, not state goals, are assumed, with accommodations for special carve outs and alternative compliance mechanisms. Attendees were also interested in how different power markets were represented and to what level of fidelity. The effect of the CPP on the production profiles was discussed and illustrated the strong impact natural gas and renewables had on coal use and to a lesser effect on nuclear use.

One participant inquired about assumptions regarding electric vehicles. EIA clarified that a 10-year turnover rate for vehicles is assumed and that vehicle choices are otherwise economically driven in the model. One participant inquired about capital cost comparisons and EIA staff indicated that the latest capital cost study would be available shortly. Another participant inquired about how advanced reactor costs come down over time. EIA staff explained how learning curves are implemented in the EMM and mentioned the original research and development conducted on the issue, which are available upon request from EIA.

### **Electricity Market Module (EMM) Overview**

Laura Martin provided an overview of how the NEMS EMM works. In particular, participants were interested in how the EMM treats competition with respect to regulated and deregulated nuclear power markets, the granularity of the market model, and renewable portfolio standards (RPS) and other carve-outs or forms of support for renewables. There was also interest in the cost profiles used in NEMS to represent the nuclear fleet, including the profile going forward out to 2050. EIA staff stated that nuclear fuel costs are projected in AEO2017 to go up in real dollars. The nuclear fuel cost projections for each AEO are developed from an Energy Research Institute report on projected uranium prices. The current EMM fuel costs are comparable to high-level Electric Utility Cost Group fuel cost estimates.

### **Overview of renewable technologies in the National Energy Modeling System (NEMS)**

Cara Marcy discussed how renewable energy resources are represented in the Electricity Market Module (EMM). The renewable energy presentation spurred discussion from the participants concerning cost estimates for renewable power and how these may differ from the Nuclear Energy Institute's estimates. EIA noted that the input capital costs assumptions for AEO2017 were updated using an independent report based on as-installed system costs. EIA also references external reports published by independent research laboratories such as DOE's Lawrence Berkeley National Laboratory to keep abreast of market changes. Ms. Marcy also noted that future costs in the model are projected to decline based on a learning algorithm and are dependent on the deployment of the technology.

Tax credits for renewables were also discussed, in reference to their inclusion in the EIA model. Participants inquired as to the cost of the credits, by technology or dollar amount or by year. EIA stated

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that details of the renewable tax credit assumptions were described in the Legislation and Regulations section of AEO2016.

Renewable Portfolio Standards (RPS) were discussed, with respect to the degree by which the standards set the decision-making within the model. EIA staff responded that RPS are modeled as constraints in the EMM, and that while the standards do appear to have some influence, overall they tend to set the minimum bound to which renewable technologies are deployed and that generally the economics are favorable enough that renewable generation well exceeds RPS requirements.

One participant inquired about whether EIA “backcasts” against reality. EIA responded that the projections have a “current” policy focus and are not subject to backcasting, but retrospective analyses are published on an annual basis. In addition, last year [EIA published a report](#) that focused on specifically on historical renewable projections and the impacts of policy on the model results.

Battery storage was mentioned as an emerging consideration for the models, and EIA noted that it currently plans to add storage into NEMS for in AEO2018. In addition, advances in energy storage may show an offset in curtailments for wind and solar.

Aging of renewable generation equipment is addressed via cost adders. Renewables have minimal maintenance costs and, as a young industry (particularly solar), there is not much historical data on retirements.

Attendees asked many questions about the growth of renewables and how their impacts on grid congestion were modeled. EIA discussed an ongoing project to develop an enhanced model structure to capture the intermittency aspect of renewable technologies through an 864-hourly model which accounts for minimum generation constraints for non-flexible technologies such as coal and nuclear and the resulting excess generation from non-dispatchable technologies such as wind and solar. Elements of this structure were in place for AEO2017, with older algorithms capturing many aspects of intermittency also in use.

## **SESSION B**

### **Analysis of Subsequent License Renewal (SLR) for Nuclear Power Plants**

Nick Domenico gave a presentation on work being performed by Z Inc. under contract with EIA to review some of the key issues affecting the modeling of SLR decisions. The project is intended to improve the quality of SLR modeling in NEMS by deriving a long-term qualitative vulnerability measure as an input into the model.

One participant expressed interest in a methodology for including revenues in the decision-making, noting that revenues could be the single most significant driving factor influencing the decision to pursue SLR.

Another participant added that plant-by-plant evaluations should also be included in the model, but technology and regulatory decisions should be kept separate from economic risk calculations on the grounds of the potential to confound causality. EIA staff responded that although technology and

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regulation are addressed along with cost in the current model, cost has been “set aside” due to lack of data in some cases – but it will ultimately be included in the model.

A participant noted that revenue is a key variable in plant decision-making and given the current presence of rating bodies already in the “market,” advised caution regarding how the ranking of reactors by the likelihood of pursuing a SLR may be perceived by others. The participant also further argued that regulating bodies in the nuclear sphere may have existing positions on plant rankings that could conflict with EIA rankings.

EIA noted that it must review risk rating in some form, as risk can influence the operational cost. It was suggested that further discussions between NEI and EIA will take place on this subject.

A participant suggested that additional data sources should be explored. DOE’s opinion regarding SLR to 80-years of plant operation is generally viable, whereas EIA assumes a 25% reduction in capacity as the result of unpursued SLRs. He added that NEI has published figures for a non-SLR specific nuclear capacity decline of 15%.

After the Workshop another participant followed up with email further discussing SLR – “First, when it comes to wholesale markets, EIA could do some sort of analysis like what Congressional Research Service or Idaho National Labs did looking into the future. For example, if EIA’s day-ahead power prices from 2030-2032 are say \$40/MWh in a certain region and a three-year cost average over the same time frame for a nuclear plant is say \$44/MWh (single-unit all-in cost), EIA could assume the plant will close no matter where they are with the license (could be year of operation 20 or 50). EIA could do this on a three-year average, a five-year average, base it off capacity market rules, etc. Just be clear on the assumptions. It’s obviously impossible to predict the value judgments of nuclear companies in the future beyond say the next few years. In the near term forecasts, it is recommended that EIA continue analyzing public statements and strategies stated by nuclear operating companies in public settings. So if a company says they will be out of wholesale markets by day X and their plants don’t have policy support and/or a buyer, EIA probably has cover to go ahead and close those plants in NEMS. Although this is constantly evolving, this is the best source of information any of us have got.”

“Second, when it comes to regulated markets, it’s obviously very difficult to model value judgments by governmental entities. However, EIA could analyze the fact that the cost of new natural gas combined-cycle (NGCC) or new NGCC plus a certain set of renewables may be cost-effective compared to the cost of operating nuclear plants plus the periodic lifecycle costs (which EIA already has assumptions for). Or, if load growth is decreasing or distributed solar becomes really big, there may not be a need to continue operating the nuclear plant (or other generation for that matter). These are possibly all things that NEMS can be utilized for. Once the timeframes that IRPs will analyze start making assumptions for nukes, that’ll also help influence your assumptions for the model.”

### **Financial Challenges of Operating U.S. Nuclear Power Plants**

Mark Holt and Phillip Brown with the Congressional Research Service (CRS) presented evidence from their paper, “Review of Recent Market Activity - Price Subsidies and Recent Closings”, highlighting the financial challenges of operating nuclear plants in the current market. Key takeaways showed that shutdown decisions were not only financial, but in most cases a combination of things, including political

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factors. This is evident when observing the sample - units operating in negative cost areas are not congruent with those “at risk” for shutting down. Plants sampled were in deregulated areas only and did not include capital costs due to significant data limitations. O&M costs were estimated as an industry average.

One participant added that value judgements by plants are also relevant, but very difficult to model. Another participant concurred, and noted they also attempt to capture political, economic, environmental, and employment factors. A discussion occurred related to whether federal policies would be necessary to support existing nuclear in regulated markets. Participants noted that although not necessarily needed, fairness could be an issue, but prudence issues could be an issue and SLR would be hard to consider for regulated concerns. Participants noted that economics were the main driver behind Fort Calhoun’s closure. For Indian Point, the retirement decision was driven by political and safety concerns rather than economics. In comparison, employment, grid reliability, and emissions considerations were major factors supporting the continued operation of reactors in upstate New York.

Participants agreed that fixed O&M costs were not representative, and integral for a meaningful analysis. EIA also uses a single value, though EIA staff recognized that this is in reality a range of costs. Next steps for EIA staff would be to reach out to partners and cooperatively discuss how to accurately capture this range in the model.

EIA added that current policies are modeled as much as possible. While CRS may be at liberty to suggest policy recommendations, EIA, as a policy neutral statistical and analytical agency is not. DOE indicated that a nuclear cost gap study has been commissioned, and DOE will coordinate with CRS once an additional round of results are available.

### **Industry/Industry Representatives/Consultants**

#### **In Person**

Ahn	Alan	Global America Business Institute
Brown	Phil	Congressional Research Service
Davis	Ed	The Pegasus Group
Gadomski	Christopher	Bloomberg New Energy Finance
Grecheck	Eugene	Grecheck Consulting LLC
Holt	Mark	Congressional Research Service
Nakano	Jane	CSIS Energy & National Security Program
Purdie	Michael	Nuclear Energy Institute
Roth	Michael	Carnegie Mellon

#### **WebEx**

Dittmer	Kent	Energy Northwest
Harding	Margaret	NECG Affiliate
Kaydak	Andrew	NECG Affiliate / Kadak Associates, Inc.
Kee	Ed	Nuclear Economic Consulting Group (NECG)
Venkatesh	Boddu	ICF International

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Young Garry G. Entergy Nuclear

### **EIA Staff**

Adams	Greg	U.S. Energy Information Administration
Angel	Stacy	U.S. Energy Information Administration
Bowers	Richard	U.S. Energy Information Administration
Bowman	Michelle	U.S. Energy Information Administration
Diefenderfer	Jim	U.S. Energy Information Administration
Domenico (Contractor)	Nick	U.S. Energy Information Administration
Dubin	Kenneth	U.S. Energy Information Administration
Gospodarczyk	Marta	U.S. Energy Information Administration
Huetteman	Thaddeus	U.S. Energy Information Administration
Jell	Scott	U.S. Energy Information Administration
Jones	Jeff	U.S. Energy Information Administration
LaRose	Angelina	U.S. Energy Information Administration
Manzogol	Nilay	U.S. Energy Information Administration
Marcy	Cara	U.S. Energy Information Administration
Martin	Laura	U.S. Energy Information Administration
Mead	Ian	U.S. Energy Information Administration
Namovicz	Christopher	U.S. Energy Information Administration
Scott	Mike	U.S. Energy Information Administration
Sukunta	Manussawee	U.S. Energy Information Administration

### **Other Government**

Bergman	Aaron	US DOE: Office of Policy and International Affairs
Hagen	Ron	U.S. Department of Energy
Kelly	John	U.S. Department of Energy
Schoeberlein	David	US DOE: Office of Policy and International Affairs
Williams	Bradley	U.S. Department of Energy

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