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MEMORANDUM FOR: Steve Nalley
Assistant Administrator for Energy Analysis

FROM: John Staub
Director, Petroleum, Natural Gas, and Biofuels Analysis

Subject: Summary of Oil and Gas Supply, Liquid Fuels Markets, and Natural Gas Markets Working Group Meeting held on June 5, 2019

This memorandum provides an overview of the presentation given during the first *Annual Energy Outlook* (AEO) 2019 Oil and Gas Supply, Liquid Fuels Markets, and Natural Gas Markets Working Group meeting and a summary of the resulting discussions that took place. The meeting had three parts. The first part covered the Oil and Natural Gas Supply Module (OGSM). The second part covered the Liquid Fuels Market Module (LFMM) and International Energy Model (IEM). The third part covered the Natural Gas Markets Module (NGMM). The presentation slides are available in separate documents on the U.S. Energy Information Administration's (EIA) website.

OGSM

In her presentation, Dana Van Wagener covered three main topics: results from AEO2019, changes to recent *Short-Term Energy Outlook* (STEO), and plans for the AEO2020. She highlighted the following points:

Results (AEO2019)

- U.S. crude oil and natural gas production are sensitive to resource availability and technological improvements.
- U.S. crude oil and natural gas production continues to be driven by growth in tight oil and shale gas supply.
- The Southwest region leads growth in U.S. crude oil production, and the East region leads growth in natural gas in the Reference case, similar to AEO2018.
- Bakken and Wolfcamp formations lead growth in tight oil production.
- Marcellus and Utica formations lead production of shale gas.
- The East and Southwest regions lead the production of natural gas plant liquids in the Reference case.

In addition, some comments were made that related to the latest forecasts in EIA's STEO:

- Stronger growth in crude oil production than in the October 2018 STEO
- Stronger growth in natural gas production than in the October 2018 STEO

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Model updates under consideration (AEO2020)

- Update estimated ultimate recovery (EUR) for tight and shale wells
 - Expand play areas as needed
 - Determine target zone for wells in the Permian Basin
- Incorporate 45Q federal tax credits for carbon capture and sequestration.
- Update Alaska and Lower 48 offshore announced discoveries.

Discussion

The following discussion focused on questions about the Reference case projection for natural gas production from the Marcellus and how technological improvement is incorporated into the model.

Results (AEO2019)

The first question was about the Reference case projection for natural gas production from the Marcellus formation: how certain is this projection, which is quite “bullish?” EIA provided an overview of the methodology, which starts with well-level decline curve analysis and is layered over large geographic areas, which implies significant resources. EIA also noted a large amount of uncertainty around the technically recovered resource (TRR) estimates, which change as drilling progresses and as well-level production data provide more information about the formations. This uncertainty launched a discussion about how much the TRR increased during the past decade and how the estimates continue to increase with technology and logistics optimization improvements. EIA explained how the TRR estimates cited in the [AEO2019 Assumptions report](#), Tables 1-4, are a snapshot in time. This fact led to the question: could the model generate the TRR estimates throughout the projection period? Currently, the model cannot track these estimates in a reasonable amount of model run time, which is a topic for possible model improvement in the future.

A second round of questions and discussion focused on how technology improvement is modeled. The participant who runs the National Energy Modeling System (NEMS) asked if technology improvement is modeled in the shale plays. This person noticed a difference between the technology improvement factors in the conventional versus tight plays. EIA discussed the percentage rates of technology improvement assumed in the different phases of the lifecycle of a play—an initial percentage, a ramp-up phase (learning by doing), and a percentage once development is established. More detail is provided in the *Assumptions to the Annual Energy Outlook 2019: Oil and Gas Supply Module*. Another participant asked whether technology improvement is modeled at the play level. EIA responded that technology improvement is modeled at the county-level, except in areas where more granular resource information is available in which case it is modeled at more granular-level.

LFMM and IEM

James Preciado gave the next presentation. He began by showing the updated crude oil price path for AEO2020. He described the primary supply and demand side factors, such as higher domestic

production and lower demand growth in the Organization for Economic Cooperation and Development (OECD), that drove the AEO2020 crude oil price path to be lower than the AEO2019 forecast.

Two areas of concentration for AEO2020 were covered in detail: potential revisions to U.S. crude oil export levels and updated representation of biofuels (mainly ethanol and biodiesel). Anticipated data updates were also described. The presentation highlighted the following points:

- U.S. crude oil exports rose considerably during the past few years, and that trend has continued in the first half of 2019.
- The U.S. biofuel market is changing, with low feedstock prices contributing to sustained low biofuel prices and U.S. exports of biofuels.

Results (AEO2019)

- Projections for the crude oil price path in AEO2020 will be lower than the AEO2019 forecast.
- Projections for U.S. crude oil exports remained relatively flat, near 2018 levels, in AEO2019, in contrast to the rapid growth shown in *Petroleum Supply Monthly* data.
- Projections for U.S. wholesale prices for ethanol increased sharply in the short and medium term in AEO2019. However, actual ethanol prices have remained relatively low.

Model updates under consideration (AEO2020)

- Assumptions related to international supply and demand curves will be revisited to make sure the international market for U.S. light crude oil and condensate is properly represented in AEO2020.
- Information from the new Global Hydrocarbon Supply Model (GHySMo) in EIA's *International Energy Outlook* (IEO) 2019 could provide additional information and help calibrate the IEM and U.S. exports of crude oil.
- Information from EIA's agricultural model (POLYSYS) may more accurately represent corn and soy oil feedstock quantities and prices in LFMM.
- International representation of ethanol markets could be updated to better reflect recent trends in U.S. imports and exports of ethanol.

Several other small, planned updates to the LFMM and IEM were also presented.

- Updated pipeline capacity from the Permian basin to the U.S. Gulf Coast
- A new methodology to estimate distribution cost markups for gasoline, diesel, and jet fuel prices
- Revised state taxes for gasoline, diesel, and jet fuel
- Updated refinery fuel use of natural gas, still gas, and petroleum coke to more accurately match historical results
- Representation of the latest Renewable Fuel Standard (RFS) rulemaking from the U.S. Environmental Protection Agency (EPA) and any changes to E15 (gasoline that contains about 15% ethanol by volume) penetration rates because of the new E15 waiver rule
- Continued monitoring of petroleum product markets and the effects of the new sulfur standards on marine fuel being implemented by the International Maritime Organization (IMO) in 2020

Discussion

The discussion clarified points raised during the presentation. No comments were given about the proposed model updates to the LFMM and IEM, and no other suggestions for future model development were offered.

A participant asked how the IMO 2020 sulfur regulation was represented within the framework of NEMS. EIA explained that the transportation model represents domestic marine fuel demand and the portion of international marine fuel demand that is bunkered in the United States. LFMM supplies the prices to the transportation model, and, based on those prices, decisions are made on investment and compliance with the regulation. The IEM then makes assumptions on the rest of the international marine fuel market that is bunkered outside the United States, with changes in those volumes represented through U.S. imports and exports of crude oil and petroleum products.

A participant asked about the new E15 waiver from EPA and whether it will affect EIA's ethanol consumption projection. EIA explained that E15 penetration rates are an assumption in the model and that the new rule will be analyzed to see if any changes to EIA's assumptions are necessary. These model changes will be done in conjunction with the other biofuel updates.

A participant asked, specifically, which economies were contributing to reduced global demand for petroleum products and leading to lower crude oil prices in the projection. EIA explained that the OECD was the primary area where demand was slowing because of faster adoption of fuel efficiency standards, biofuels, and electric vehicles and lower GDP growth assumptions. Assumptions for non-OECD liquid fuel consumption growth were actually slightly higher compared with AEO2019, but these increases were not enough to offset the declines in the OECD.

NGMM

Katie Dyl presented both results from AEO2019 and plans for AEO2020, as well as some preliminary updated assumptions in order to obtain stakeholder feedback.

Results (AEO2019)

- U.S. natural gas production growth exceeds that of natural gas consumption, leading to a rise in U.S. natural gas exports in most cases.
- U.S. natural gas spot prices at the Henry Hub do not exceed \$5 per million British thermal units (MMBtu) in the Reference case; natural gas prices are most sensitive to the resource and technology assumptions used. The lowest price (\$3.50/MMBtu in 2050) appears in the High Resource and Technology case, and the highest price (more than \$8/MMBtu in 2050) appears in the Low Resource and Technology case.
- Industrial and electric power sectors drive U.S. natural gas consumption growth.
- LNG exports account for most of U.S. natural gas export growth after 2020 because the *second wave* of LNG export projects is expected to reach final investment decision (FID) and come online.
- The level of LNG exports in all cases is extremely sensitive to the underlying assumptions used and varies widely across side cases.

Model updates under consideration (AEO2020)

- Update LNG export-related assumptions
 - Include additional facilities that are under construction/have reached FID (~4 billion cubic feet per day)
 - Review updates to various cost and assumptions around time to build and number of trains to build in a given year
- Improve econometric estimations for delivered end-use prices to include population shifts and heating and cooling degree days (HDD/CDD) by census division
- Change regional mapping between NGMM and the Electricity Market Module (EMM) after its new regional definitions are incorporated into the NEMS

The working group reviewed initial LNG export-related assumptions and provided feedback. It also discussed how the NGMM-EMM regional changes were expected to improve some of the convergence issues that have been experienced in previous AEOs.

Discussion

The discussion did not focus on AEO2019 results; rather, participants asked many questions about general modeling methods and the LNG export updates and assumptions presented for AEO2020.

One participant asked how natural gas pipeline infrastructure was modeled (this discussion also came up during the OGSM presentation earlier in the meeting). EIA replied that it had an assumed cost to building additional pipeline infrastructure at the state-to-state level; however, in general, the costs are low enough such that if the pipeline infrastructure is needed to satisfy growing demand, it will be built. The NGMM does not incorporate significant regulatory costs or burdens or refuse to allow new pipeline builds. Staff commented that it would be a fair comment/criticism that EIA may be underestimating some of these costs/time required to build new pipelines; however, participants agreed that there was not necessarily a good alternative to account for some of these costs.

Several questions were related to LNG export levels and assumptions. One participant pointed out that the list of planned LNG export projects EIA intend to add into the AEO2020 seemed low. He believed that twice as many projects were likely going forward and that they totaled as much as 20 billion cubic feet per day (Bcf/d). He noted that the various deals signed by some of the proposed projects make it clear that the projects have agreements in place to move forward. EIA responded that several other subject matter experts within EIA agreed that LNG export capacity could total 20 Bcf/d in the United States given the current planned projects. However, the Reference case only includes FID or projects under construction when assuming particular projects will be built. The model then builds additional projects if the economics are positive. EIA agreed that LNG exports in AEO2020 would likely be higher than what was projected in AEO2019.

Finally, another participant asked about monthly demand and storage with respect to LNG exports and the facilities. EIA explained that these factors are not currently built into the NGMM; however, it has considered making an assumption about different monthly maximum utilization levels for LNG export facilities (which would be possible given that the NGMM solves by month).

Attendees*Guests (in person)*

John Powell	DOE
Gabby Intihar	DOE
Ray Boswell	NETL
Jose Benitez	Deloitte

Registered Guests (WebEx/phone)

Geoffrey Brand	API
Joann Zhou	Argonne National Lab
Brad Barnds	Arrowhead
Ben Schlesinger	BSA Energy
Walter Weathersby	BTU Consulting
Ning Lin	Bureau of Economic Geology (BEG)
Mark Shuster	Bureau of Economic Geology (BEG)
Martin Linn	Deloitte
Greg Leveille	DOE
Tim Reinhardt	DOE
Tom White	DOE
Michael Schaal	Energy Ventures Analysis Inc.
Jai Gopal	GPS EC PROJ DTBA
Robert Schultz	Leenalabs
Yelena Dandurova	Leidos
Donald Remson	NETL
Frances Wood	OnLocation Inc.
Sharon Showalter	OnLocation Inc.
Hannah Kolus	Rhodium Group
Hannah Pitt	Rhodium Group
Dave Hughes	Post Carbon Institute
Leticia Phillips	UNICA- Brazilian Sugarcane Industry Association
Mariana Zechin	UNICA- Brazilian Sugarcane Industry Association
Steven B. Yates	U.S. ACE PCXIN
Cory Forgrave	U.S. Office of Natural Resources Revenue
Emil Attansasi	USGS
Eugene Kim	Wood Mackenzie

EIA participants (in person)

Kathryn Dyl (presenter)
James Preciado (presenter)

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Meg Coleman
John Staub
Elizabeth May
Adrian Geagla
Mindi Farber-DeAnda

EIA participants (WebEx/phone)

Angelina LaRose
Dana van Wagener (presenter)
David Manowitz
Manussawee Sukunta
Samantha Calkins
Steve Hanson