October 7, 2016

MEMORANDUM FOR: Ian Mead
Assistant Administrator for Energy Analysis

Jim Diefenderfer
Office Director
Office of Electricity, Coal, Nuclear, and Renewables Analysis

Paul Holtberg
Team Leader
Analysis Integration Team

FROM: Chris Namovicz
Team Leader for Renewable Electricity Analysis Team

SUBJECT: Summary of AEO2017 Electricity, Coal, Nuclear, and Renewables 2nd Working Group Meeting held on October 3, 2016

PRESENTERS: Chris Namovicz, Thad Huetteman, Greg Adams

ATTENDEES: 16 EIA, 76 external (list provided following meeting summary)

This working group meeting was the second of two for the upcoming Annual Energy Outlook (AEO2017). Presentation topics included a discussion of key updates to electricity, coal, nuclear and renewables model assumptions.

Renewables

EIA reviewed the most significant modeling changes for renewables technologies that have been completed – including better regional breakouts of solar costs and updated solar performance assumptions. DG modeling and solar curtailment algorithm updates are to be completed by mid-October. Energy storage modeling has been postponed until AEO2018.

A participant asked what extent EIA had looked at updating wind learning. EIA clarified that because AEO2017 will be a shorter version, learning assumptions were not significantly revised. Consistent with

history, wind capital costs experience a low decline rate. However, wind does receive additional learning through capacity factors which leads to an opportunity for significant cost reduction.

A participant wondered if this was the case even without PV curtailment? EIA noted that PV curtailment will contribute even more.

A participant asked what renewables subsidies EIA is assuming. EIA staff explained the renewable subsidies that are current legislation are modeled (i.e., the production tax credit (PTC) and investment tax credit (ITC)). The ITC phases out from 30% reaching 10% by 2022. In addition, many states also have renewable portfolio standards (RPS), but in the model, these are consolidated into larger regions. New for AEO2017, the Internal Revenue Service (IRS) rule for wind designating a four year construction profile has been incorporated even though the model assumes a three year construction lead time. Many in the industry state that it takes only six months to 2 years to construct a wind facility. Preliminary results show wind builds shifted out one year (compared to AEO2016) due to the May 2016 IRS ruling. Wind builds subside after the PTC expires in 2022, but pick back up post-2035.

A participant commented that the relative contribution of wind-to-solar feels 'off'. Especially because solar costs today are slightly more expensive. Maybe for AEO2018, EIA could look at the forecast for cost reduction assumptions and compare regional deployment?" EIA responded that we are trying to get a better handle on this with PV curtailment modeling work currently underway. Also, the near-term PTC-expiration drives the front-loading of wind builds. Additionally, distributed solar generation is included in these results. The model does not include the Levelized Avoided Cost of Electricity (LACE). Solar is broadly available and has more room to grow – that is, it has more mid-day value (when wind doesn't).

Another phone participant inquired if there was a technological lifetime assumption for wind and whether or not wind retirements would be expected as we approach 2050. EIA noted that there is not a technological lifetime assumption for wind. There is not much historical experience with wind plants after 30 years of operation. In looking at wind plants from the 1980's, some have retired, some have repowered, and some have replaced equipment. At this point, there's no reason to believe that there will be mass retirements of wind plants after 30 years of operation. The implicit model assumption is that it is cheaper to maintain infrastructure than build new facilities. EIA plans to evaluate the impacts of aging generating resources in the future.

A participant asked if there are any assumptions about energy storage. EIA informed the group that more detailed modeling of energy storage has been delayed until AEO2018. Currently, the AEO represents pumped storage as it currently operates (generally charging at night when electricity is cheaper, and running during the day). However, EIA does not currently model pumped storage as a capacity expansion option for this AEO.

A participant posed two questions "With huge renewables expansion is there a transmission assumption associated with that?" and "As market share grows in wind-oriented areas, are you assuming that transmission assumption goes away?" EIA clarified that transmission cost assumptions are included

along with wind builds. EIA is also looking to apply the higher-resolution PV-curtailment algorithm to wind for AEO2018.

Another participant wondered if LACE was used for solar expansion. EIA noted that LACE was derived from the model results.
Another participant inquired as to how solar capacity expansion was calculated. EIA described that the solar capacity expansion was determined using linear programming.

Natural Gas Prices

EIA clarified that natural gas price is a model result, not an assumption. AEO2017 prices increase post-2040 perhaps because of a supply-demand issue. EIA doesn't expect final results to be significantly different from the preliminary results presented at this meeting.

Electricity Sales

EIA stated that post-2040 electricity sales in AEO2017 generally follow the same trajectory and growth rate as the sales for AEO2016 prior to 2040.

A participant on the phone asked if electricity sales included an offset from distributed generation. EIA clarified that sales do not include self-generated electricity.

A participant wondered why the slope of electricity sales was faster after 2035. EIA explained that sector growth overtakes any additional savings after 2035 because future efficiency standards aren't reflected yet. Current efficiency standards are only being modeled for the near term (through 2035); we only model federal equipment efficiency standards that are currently in effect or set to go into effect on a specific date. Standards are generally specified for 6-year interval, and the latest standards that we implement in our technology menus are in 2023. Beyond specific standards, we do assume that there is some efficiency improvement and/or cost reduction based on research and development trends through the projection. In addition, we assume improvements to building heating and cooling shell efficiency with the continuing adoption of more recent building energy codes.

Electricity Generation Mix

A phone participant asked if EIA could talk about the oscillation between coal and gas share. EIA explained that gas prices and the Clean Power Plan (CPP) are driving fuel economics. As gas prices rise, coal recovers early in the projection, but when the CPP takes effect, gas generation surpasses coal.

Another participant inquired why renewable and natural gas generation increase faster than the decrease in nuclear generation. EIA clarified that it is caused from a combination of demand increasing as well as decreasing nuclear generation. More renewable and gas generation occurs partly as a replacement to nuclear generation but the increase in demand also contributes to the incremental growth in these fuels sources. It is important to distinguish between the capacity additions and the resulting generation when discussing the growth of renewables and gas.

Nuclear

A participant asked if nuclear retirements are evenly spread. EIA noted that most 60-year licenses expire around 2030. The capacity decrement is applied evenly across all plants modeled as generic derates and tied to license expiration dates to address the uncertainty of reactors achieving a subsequent license renewal from approximately 2030 onward, with most of the retirements occurring by 2040.

A phone participant wondered how solar could replace retiring baseload nuclear capacity. EIA explained the preliminary results show solar *and* natural gas capacity come online as nuclear plants retire (less natural gas capacity is needed relative to solar, since natural gas generation has a higher capacity factor). The low natural gas prices allow for more gas additions, but these plants are also used more intensively. In addition, because of the modification to the model that allows coal plant's heat rate to change based on operating mode, coal plants may be fully utilized. The capacity factor for solar is much lower than for the other sources of generation. Though the model builds the capacity, there is not necessarily a commensurate increase in generation. The model is not generating electricity from solar in a 1:1 relationship with the generation lost from nuclear.

A participant asked how EIA accounts for the mismatch between regions where the nuclear retirements occur and the regions where solar resources exist, stating that the locations where nuclear is threatened are not necessarily the places with the best solar resources. EIA clarified that solar economics are driven by demand that ample solar resources exist. Also, seasonal regional resource availability is accounted for in the model. Each region has solar potential and if the economics support solar it can be built.

Another participant inquired if there were plans to make nuclear uprates endogenous. EIA stated that nuclear uprates are linked to specific regulatory actions and are specific to particular nuclear units. There are plans to develop an adjunct feeder model that may, in the future, drive retirements endogenously.

Coal

A participant wondered why CO2 emissions are lower but there are not as many coal retirements. EIA noted that the dip in CO2 emissions came from a combination of lower capacity factors coupled with updated heat rates for coal plants.

A phone participant asked if age was a factor when determining the retirement of coal plants. EIA clarified that age was not a factor and that model retirements were strictly based on economics

Another phone participant wanted more detail on the new heat rate operation mode such as, "Is ambient temperature included?" and "Do you make any distinction between the type of coal used (e.g. lignite or subbituminous)" EIA explained that there are six separate heat rate adjustments that can be made in each season based on six different operating modes: Max generation on 3 segments, Max generation on 2 segments, Load following (cycling) on 3 segments, Load following (cycling) on 2 segments, Minimum generation (max spinning reserve) on 3 segments, Minimum generation (max spinning reserve on 2 segments. Also, effects of the change in ambient temperature among seasons are reflected in the heat rate adjustments. However, the methodology does not explicitly take coal type into consideration.

Attendees

Webex	In person	Last Name	First Name	Organization
	☑	Adams	Greg	EIA
	☑	Boedecker	Erin	EIA
	☑	Bowman	Michelle	EIA
	☑	Conti	John	EIA
	☑	Daniels	David	EIA
		Diefenderfer	James	EIA
	☑	Donohoo-Vallett	Paul	DOE
	☑	Gulen	Gurcan	beg.utexas
	☑	Hodge	Tyler	EIA
	☑	Huetteman	Thaddeus	EIA
	☑	Jell	Scott	EIA
	☑	Johnson	Elias	EIA
	☑	Kearney	Diane	EIA
	☑	Khair	Lauren	NRECA
	☑	Macy	Cara	EIA

	☑	Marmon	Greg	woodmac
	☑	Mayes	Fred	EIA
	☑	Mead	Ian	EIA
	☑	Peterson	David	EIA
	☑	Purdie	Mike	NEI
	☑	Slater-Thompson	Nancy	EIA
☑		Alfaro	Jose	alphanr
☑		Angielski	Shannon	VNF
☑		Arguello	Ed	CSU
☑		Augustine	Chad	NREL
☑		Baca	Justin	SEIA
☑		Blumenfeld	Andy	archcoal
☑		Bowles	Mark C	Entergy
☑		Bowles	Mark	SBC global
☑		Bratvold	Delma	leidos
☑		Brewer	John	NETL
☑		Caravaggio	Michael	EPRI
☑		Clausen	Scott	ACORE
☑		Cole	Wesley	NREL
☑		Digiantommaso	Jen	OCFO
☑		Dougherty	Ryan	Geothermal Exchange Organization
☑		Evans	Carolyn	nscorp
☑		Eyster	Jerry	GE
☑		Fix	John	leidos
☑		Goggin	Michael	AWEA
☑		Gresham	Lee	brattle
☑		Hanson	Don	ANL
☑		Harrison	Keith	southernco
☑		Hensley	John	AWEA
☑		Herndon	Whitney	Rhodium
☑		Hewson	Tom	evainc
☑		Holmes	Mike	undeerc
☑		Kislear	Jordan	DOE
☑		Kwon	Augustine	EIA
☑		Leff	Michael	Con Edison
☑		Lewandowski	Dave	OneEnergyWind
☑		Luckow	Patrick	Synapse
☑		Lundgren	Carl	DOL
☑		Mai	Trieu	NREL
☑		Manzagol	Nilay	EIA

☑		Nethercutt	Elliott	NERC
☑		Nichols	Christopher	NETL
☑		Nowak	Seth	ACEEE
☑		Park	Brian	EIA
☑		Peters	Jamie	UP
☑		Pierce	Paul	USGS
☑		Reyes	Jorge	dep.nj
☑		Roberts	Ricky	EPRI
☑		Roche	Madelyn	NRECA
☑		Rosner	David	DOE
☑		Salmi	Chris	dep.nj
☑		Satsangi	Ann	DOE
☑		Sattler	Sandra	UCS
☑		Schmalzer	David	ANL
☑		Serpil	Kayin	EPA
☑		Shawn	Rumery	SEIA
☑		Shenk	Brian	USACE
☑		Showalter	Sharon	On Location
☑		Smith	Alexander	FERC
☑		Somerday	Michele	firstenergycorp
☑		Stansky	Michael	firstenergycorp
☑		Steinberg	Helen	GE
☑		Steinberger	Kevin	NRDC
☑		Stevens	Bill	EPA
☑		Strohfus	Mark	grenergy
☑		Sutton	Jim	GE
☑		Theis	Joel	NETL
☑		Tsai	Chenhao	beg.utexas
☑		Tucker	Russell	NRECA
☑		Tusing	Rich	DOE
☑		Venkatesh	Boddu	ICFI
☑		Walsh	Ken	leidos
☑		White	Larry	MHPowerSystems
☑		Wise	James	dep.nj
☑		Wiser	Ryan	LBL
☑		Wos	Thomas	tristategt
☑		Wright	Evelyn	SEE
☑		Wyes	Tesfaye	OCFO
☑		Zelek	Charles	NETL
☑		Zhao	Song	leidos

☑		Zummo	Paul	publicpower