AEO2018 Electricity Sector Working Group Policy Assumptions and Key Model Updates

For
EIA Electricity Working Group
August 10, 2017

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Topics for AEO2018 Electric Sector Working Group

- What to look for in AEO2018
- AEO2018 Reference Case- treatment of current laws and regulations
- Changes in modeling- enhancements to NEMS Electricity Market Module (EMM)
- Changes in electric generating capacity
- Analytic agenda for longer term EMM enhancements
- AEO2018 Release schedule

What to look for in AEO2018

- AEO2017 extended results through 2050 in the AEO data browser to help solicit feedback from stakeholders
  - AEO2018 will be the first year time the 2040-2050 results will be highlighted in the presentation of AEO results
  - Please pay particular attention to the trends during that period and let us know if you have any feedback you would like us to consider
- AEO2018 will be presented in the same flip-book format as used for AEO2017
  - Regular cycle that will feature several Issues in Focus articles, an expanded set of side cases, and write ups of key legislation and regulations
  - Whether or not the EPA's Clean Power Plan (CPP) is included in the Reference case is still under consideration, but side cases with and without the CPP will be developed as for AEO2017

What to look for in AEO2018 *(cont'.)*

- Unlike AEO2017, which was a limited release, AEO2018 will be a full report and will include additional side cases beyond the standard set
  - Reference (existing law and policy)
  - High/low oil and gas resource and technology
  - High/low oil price
  - High/low economic growth
  - Other potential side cases:
    - Extended Policies
    - Energy Storage

AEO2018– Treatment of current laws & regulation

- Federal
  - Parallel case development: Clean Power Plan/No Clean Power Plan versions
- State subsidies non-emitting generation: zero emission credits
  - Illinois: Future Energy Jobs bill
  - New York: Clean Energy Standard legislation
- Regional CO2 programs:
  - AB 398 (California) GHG emissions 2020 = state's 1990 levels/ 2030 40% below 1990
  - Regional Greenhouse Gas Initiative (RGGI) states

Changes in modeling- enhancements to NEMS Electricity Market Module (EMM): new technologies

- Energy storage
- Additional solar PV: single axis vs. fixed tilt
- Additional onshore wind: higher capacity turbines (different hub heights)
- Internal combustion engine

Changes in modeling- enhancements to EMM: renewables

- Renewable generation: include improved representation of renewable generation resources

- Variable renewable integration: assess parameters that are affected by increased generation of non-dispatchable (i.e., variable) generation, such as wind and solar

- Potential hydro builds: re-assess data sources of potential hydro builds

Changes in modeling- enhancements to EMM: renewables *(cont'.)*

- State-level renewable policy: enhance representation of Renewable Portfolio Standards (RPS)

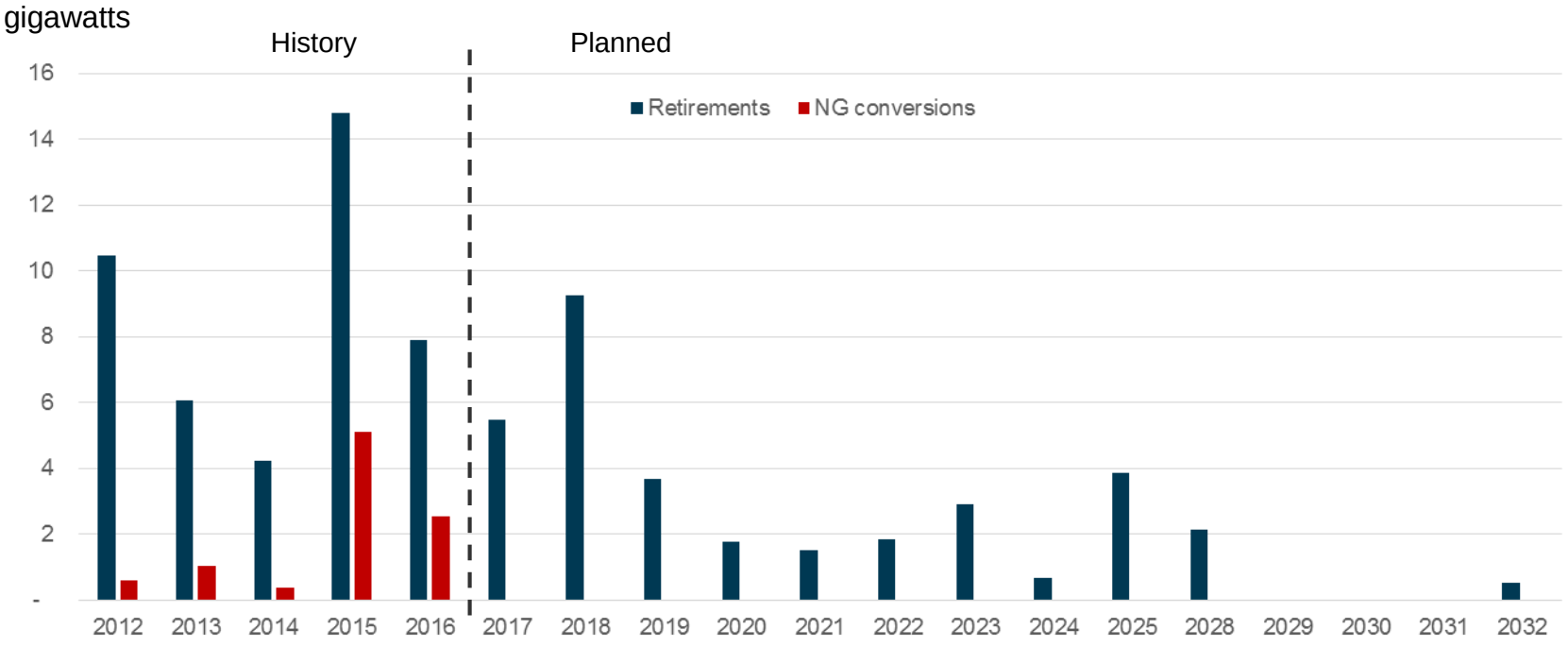
- Utility rate structure: reconsider representation of electric power price with increasing deployment of distributed generation to adequately address the ability to recover system costs

- Project financing : re-valuate cost of capital to finance new generating capacity by owner type

Changes in modeling- enhancements to EMM: characterizing generation at risk

- Issues to be analyzed
  - Going forward costs: can we represent a distribution of costs?
  - Fixed O&M costs: represented by a greater range of values than modeled in past cycles?
  - Electricity price volatility: is it greater (e.g. in regions with high renewables growth) than has been represented?
    - Or is it some combination of all of the above factors causing greater generation-at-risk?
  - Retirements: how many units ultimately retire of those at-risk?
    - What factors are particular to certain types of generation that make them more or less likely to retire?
    - How do these factors vary by region?

Reported changes in electric generating capacity: planned coal retirements/ coal-to-gas conversions



Source: Form EIA-860 and supplemental sources

Changes in electric generating capacity: nuclear

Ill. & NY Price Support (4.3 GWe, preserved for approximately 10+ years)

- Clinton (1,065 MWe) and Quad Cities (1,819 MWe) no longer closing
- Ginna (582 MWe) and Fitzpatrick (837 MWe) no longer closing

Current Announced Closings (7.2 GWe)

- 2018: Palisades (784 MWe)
- 2019: Oyster Creek (608 MWe), Pilgrim (682 MWe), and Three Mile Island (803 MWe)
- 2020: Indian Point Unit #2 (1,020 MWe)
- 2021: Indian Point Unit #3 (1,035 MWe)
- 2024: Diablo Canyon Unit #1 (1,122 MWe)
- 2025: Diablo Canyon Unit #2 (1,118 MWe)

Changes in electric generating capacity: nuclear *(cont'.)*

- Status of Vogtle and Summer projects will be monitored through the AEO2018 development cycle
- No additional builds likely through 2050 due to lack of project cost and schedule containment for AP1000 new builds, lack of demand growth, strong investments in renewables, and flat demand growth (COLs exist but no plans announced beyond current projects)
- Potential for >6,100 MW of uprates will be analyzed, initial estimate 2/3 likely to occur (~ 4,100 MW)
  - Deregulated plants: ~1,100 MW
  - Regulated plants: ~3,000 MW
- Uprates normally exceed 100 MW

Changes in electric generating capacity: nuclear (cont'.)

- The three categories of power uprates are —
  - measurement uncertainty recapture power uprates
  - stretch power uprates
  - extended power uprates

- Since 1977, the fleet has uprated 158 times, increasing capacity by 7.4 GWe
  - Currently, 537 MWe of uprates are projected for 2017
  - The NRC expects applications in 2017 for 128 MWe to be staggered over the next few years

Analytical agenda for longer term EMM enhancements

- Regional redefinition
- T&D spending projections
- Approaches to modeling electricity price variability
- Potential for DC transmission enhancements to mitigate regional effects of high levels of wind and solar
- Plant-life-extension costs/retirements
- Other issues for consideration?

AEO2018 Outlook Schedule

- Model development: Aug-Oct 2017
- 2nd Working Group Session: mid-Sep 2017
- Expected AEO release: Jan 2018

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Supplemental Slides

New York Clean Energy Standard Specifications

- NY ZEC eligibility requirements: plant must
  - have a history of providing clean energy resources to retail customers in New York;
  - be in jeopardy of closing absent an additional revenue source.
- NY ZEC Load-serving entity obligation:
  - responsible for purchasing ZECs equal to their load share percentage for the entire State
- NY ZEC contract specifications:
  - Term: 12 year contract between plant and NYSERDA
  - Definition: One ZEC= one MWh of production by an eligible facility.

New York Clean Energy Standard Specifications (cont')

- Determination of ZEC value
  - 27,618,000 per year (Based on July 2015 – June 2016 output)
  - ZEC price for the first two years: based on the state-determined value of clean generation less the value currently collected through RGGI ($17.48 per MWh)
  - Estimated total annual limit: $483 million
  - Future ZEC prices depend on several factors:
    1. amount of renewable energy being consumed in New York
    2. market revenue forecasts every two years
    3. state-determined value of clean generation estimates for later years
    4. state-determined value of clean generation estimate goes up approximately $2 per MWh each year

Illinois Future Energy Jobs Bill Specifications

- IL ZEC eligibility requirements: utility must serve at least 100,000 retail customers in Illinois

- IL ZEC obligation: Illinois Power Agency (IPA) will procure ZECS to cover 16% of actual amount of utility's sales in 2014

- IL ZEC contract specifications:
  - Term: 10 year contract between plant and Illinois Power Agency (end May, 2027)

- Determination of IL ZEC value
  - Capped in $/MWh at state-determined value of clean generation $16.50/MWh (minus a price adjustment based on power market indices) for the year 2017;
  - Beginning in 2023 the price will increase by $1/MWh each year. Total annual limit: $250 million

Renewable Generation: wind and solar technology options

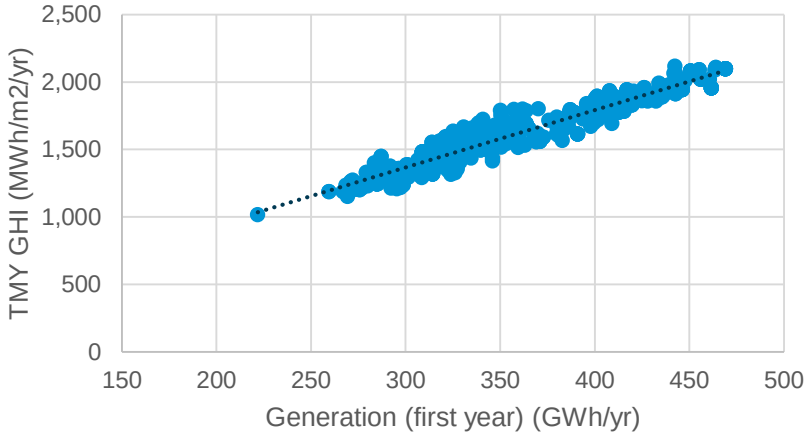
- This AEO, EIA would like to integrate a second technology type for both onshore wind and solar photovoltaic to capture the tradeoffs between performance and cost.

- Potential technology options include looking at:
  - Solar PV:
    - thin film vs. monocrystalline
    - single axis vs. fixed tilt
  - Onshore wind:
    - different hub heights
    - different IEC class turbines

Renewable Generation: solar resource supply curves

- Similar to the representation of regional wind resource supply curves at a regional level, this year EIA will integrate solar resource supply curves.

- This means that at each of the 22 regions the available resource will be broken out into steps instead of an average resource for the entire region.
  - Resource Data Source:
    - Typical Meteorological Year (TMY)
      Global Horizontal Irradiance (GHI)
      Physical Solar Model (PSM)
      National Solar Radiation Database
  - Six supply steps by each NEMS region
  - System Advisory Model (SAM) to relate GHI data to capacity factors

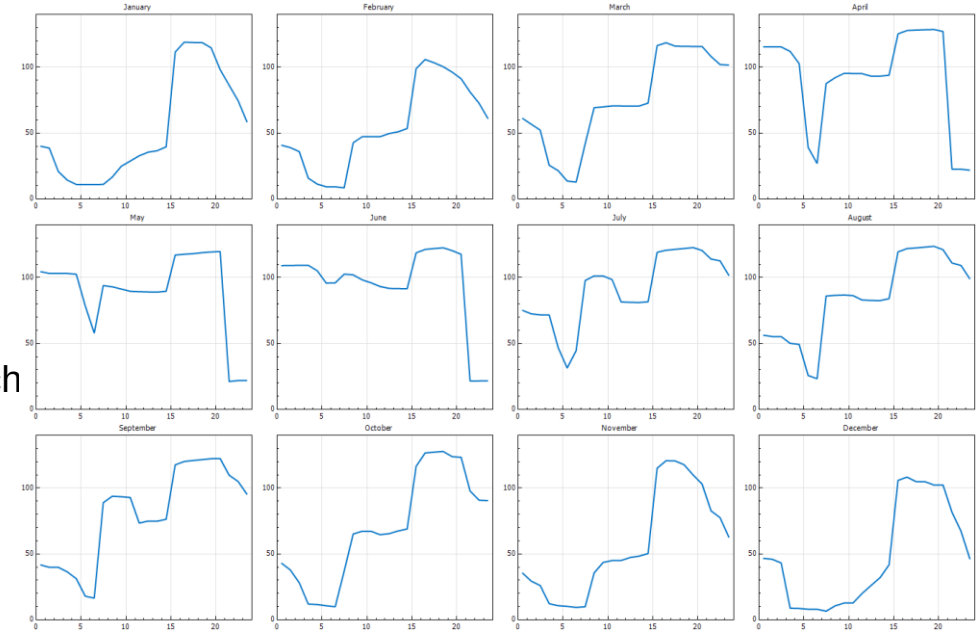


Renewable Generation: solar thermal with energy storage

- Currently, EIA models solar thermal as a central-receiver tower without integrated energy storage.
- EIA is changing the existing technology to a power tower with molten salt energy storage.
  - System Advisory Model (SAM) dispatch optimization method to develop static, regional, hourly-generation profiles

Example CSP power tower with storage generation profiles

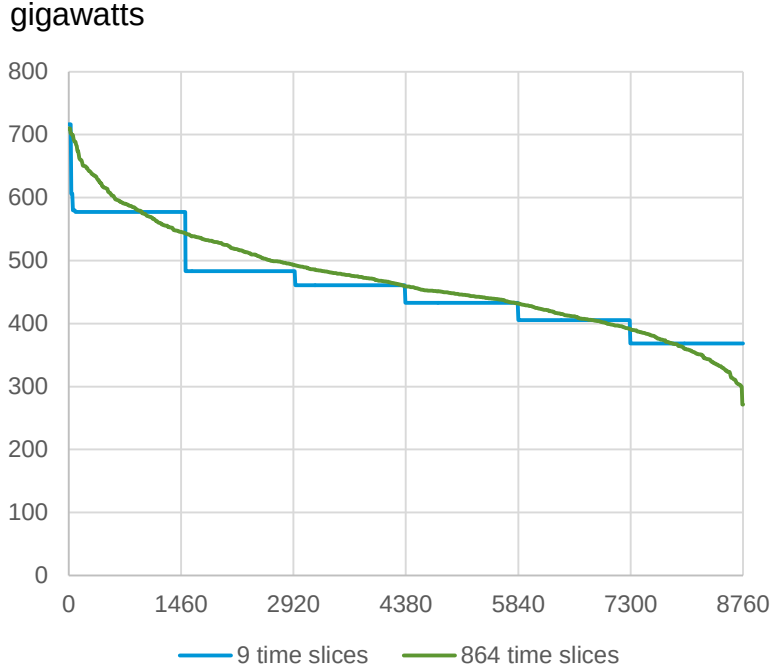
generation (MWh)



Curtailments and Energy Storage

- In AEO2017, EIA introduced energy curtailments for solar PV technologies using an 864-hour simulation.
  - Consisting of 12 months by three 24-hour day-types.
  - For AEO2018, EIA will modify wind curtailments to use a similar approach.
- EIA will use the same 864-hour model to determine a value for the stored curtailed energy which it will use to integrate energy storage as a capacity expansion option.

Example load duration curve



Renewable Portfolio Standards

- In addition to EIA's standard policy update to reflect continued changes in RPS policies, EIA is updating the methodology for representing RPS targets.
- Previously, EIA used preprocessing efforts to estimate a single overall target for each of the 22 EMM regions.
- The new approach will allow for multiple targets within each region and include more specificity in relation to:
  - Set-asides or carve-outs for specific technologies (for both end-use and utility-scale)
  - Limitations on *regional* trading
  - Alternative compliance payments
  - Credit multipliers
  - Type of utility participating

Project Financing

- In Fall 2016, EIA commissioned an external consultant to examine the impact of weighted average cost of capital (WACC) and its components, allowing for better representation of investment decisions of companies operating in the U.S. power markets in NEMS.

- The study finds notable variations in WACC across different ownership types: lower WACC for traditional utilities, while higher WACC for merchant generators or renewable generators.

- Future modeling efforts: testing whether separately accounting for differences in the types of generators that are limited to a particular market structure has a notable impact on NEMS projections.