EIA's Renewable Electricity Long-Term Projections in the Annual Energy Outlook

Understanding Assumptions, Methodology, and Process

Webinar

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By

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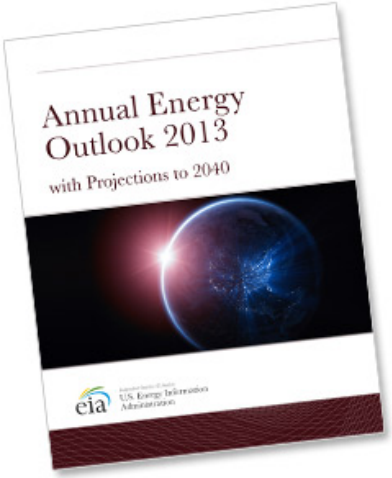
Model and Process Overview

EIA publishes the Annual Energy Outlook (AEO) on an annual basis

- The AEO is a long-term energy projection and analysis that typically looks 25 to 30 years in the future, currently through 2040.

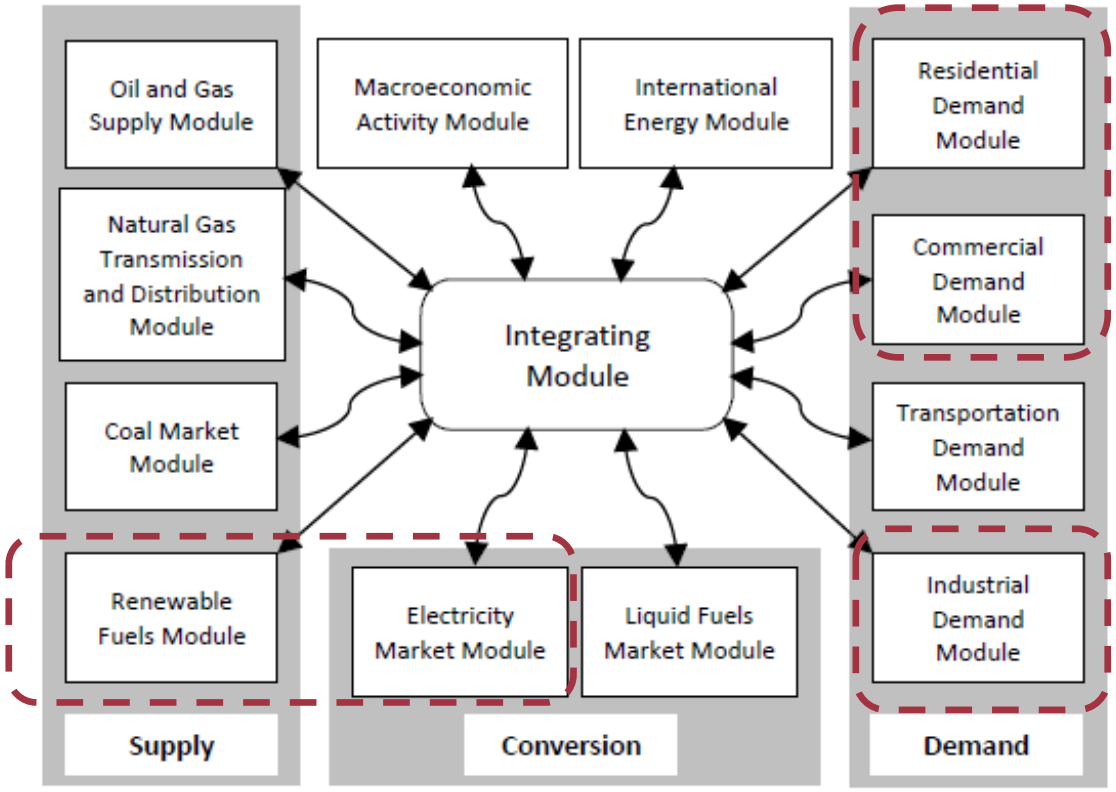


- Each AEO is centered around a Reference case, which is based on current laws and policies. It is not intended to be EIA's prediction of what the future will or should be.

- In addition to the Reference case, EIA generally performs a variety of "side cases", or sensitivity analyses, that examine the effect of changing key assumptions or policies.

Results in the Annual Energy Outlook are based on output from the National Energy Modeling System (NEMS)

NEMS is a long-term integrated modular energy-economic modeling system that projects production, consumption, conversion, trade, and prices subject to various constraints representing market conditions and technology states.

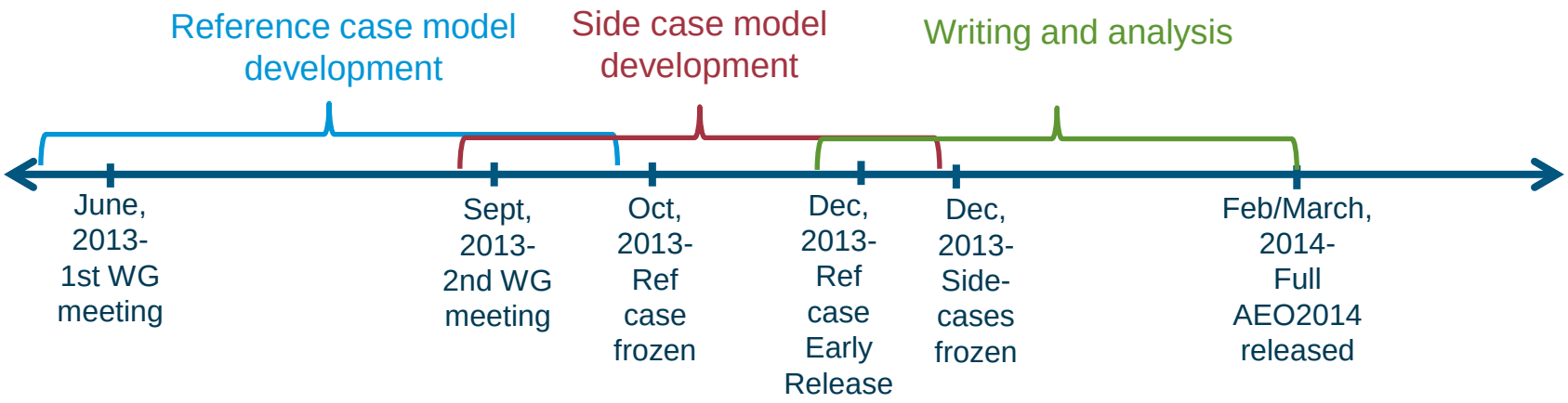


The NEMS development cycle is collaborative, both within and outside of EIA

- Each NEMS module hosts two working group meetings per AEO development cycle: one at the beginning of the model development cycle, and a second to present preliminary results.
- Meetings are open to the public, and presentations/meeting summaries are shared on EIA's website. The renewables working group website is here: www.eia.gov/forecasts/aeo/workinggroup/renewables/
- In addition, model staff hold regular collaborative run reviews within and between module teams in order to consistently review results and identify problems or inconsistencies.

The AEO2014 Early Release will be published in mid-December

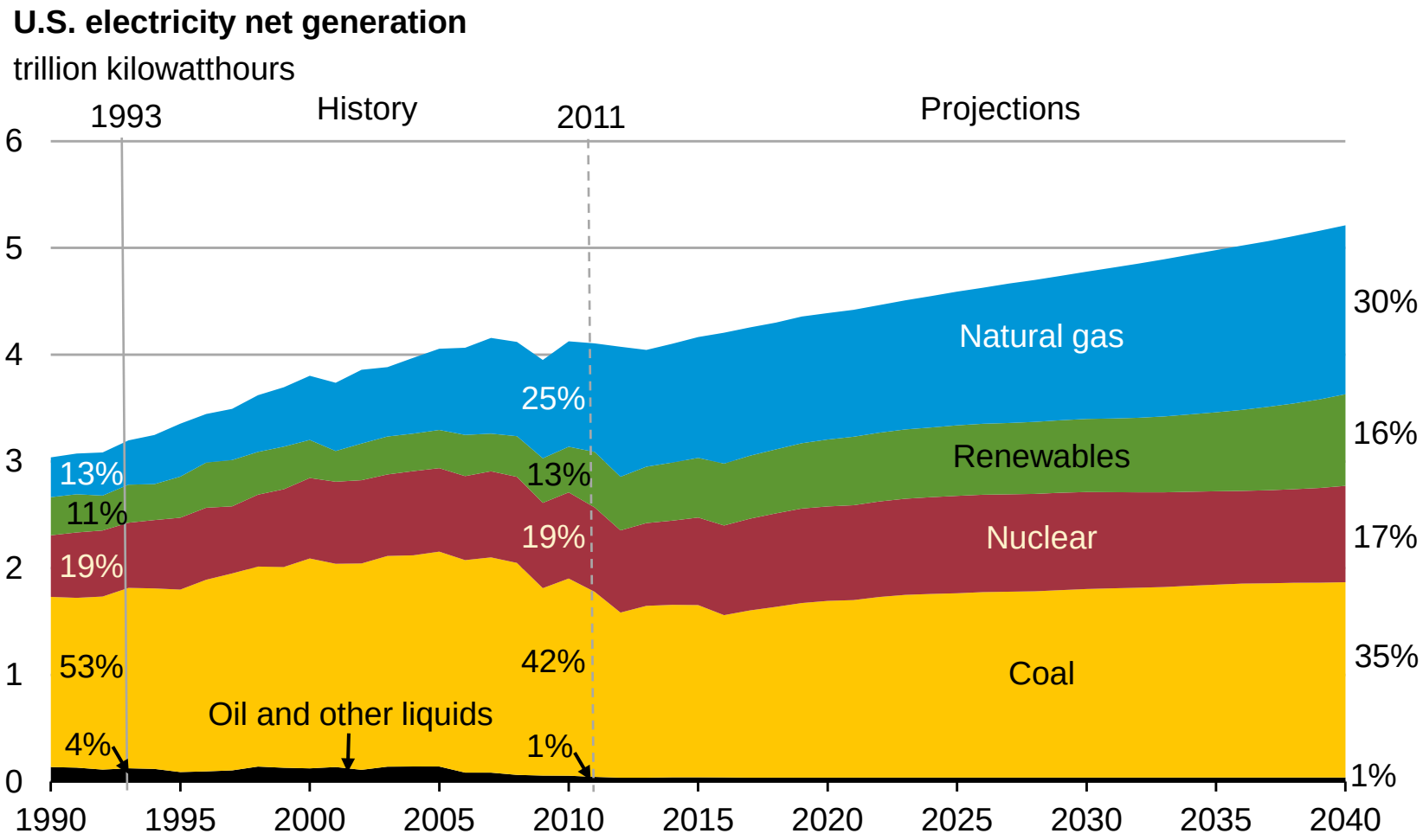
AEO2014 Model Development Calendar



Side cases for the AEO2014 are being developed; EIA welcomes feedback or suggestions for renewables side cases.

Projection Results and Accuracy

Over time the electricity mix gradually shifts to lower-carbon options, led by growth in natural gas and renewable generation

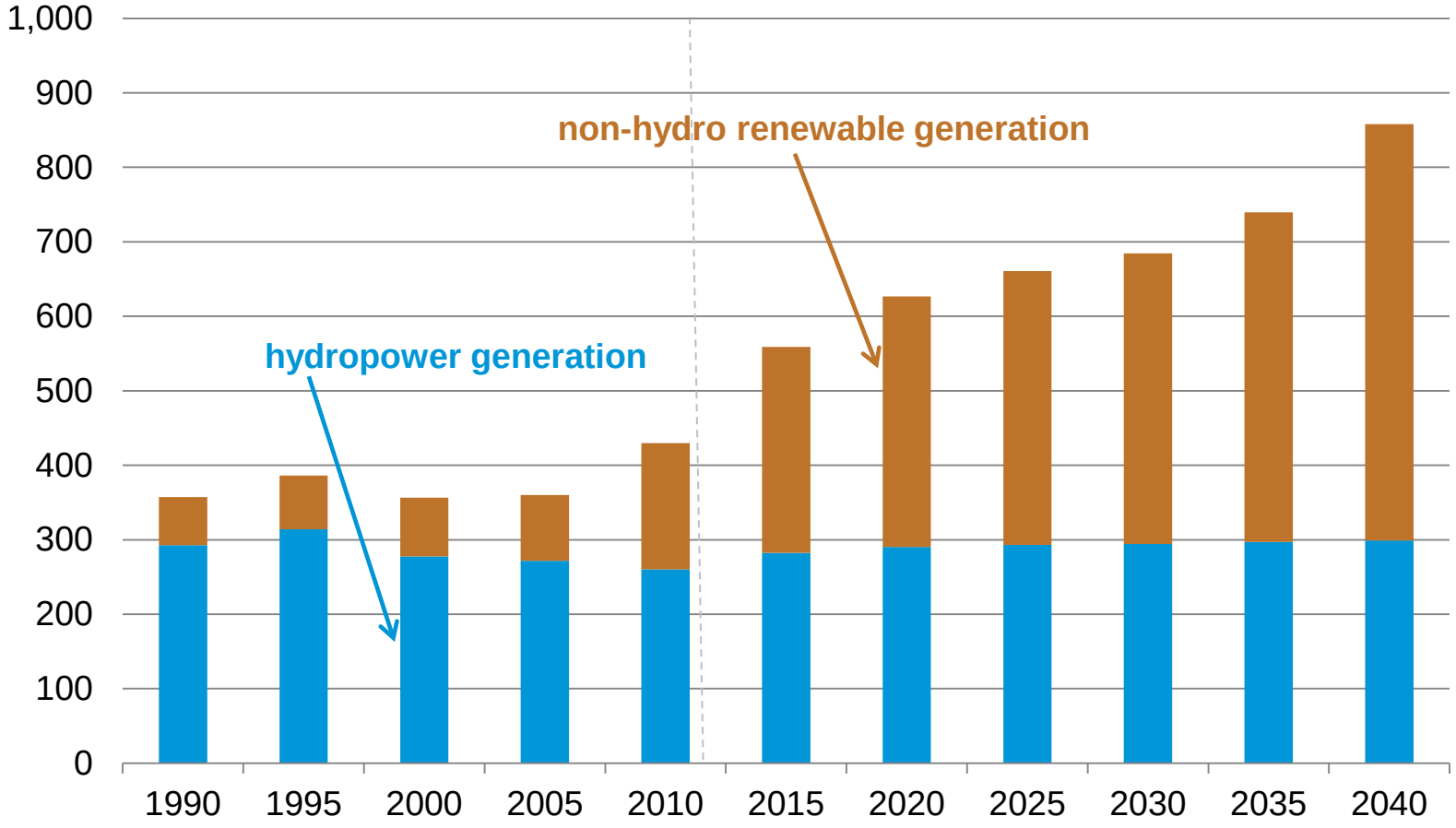


Source: EIA, Annual Energy Outlook 2013

Non-hydro renewables dominate projected growth in renewable electricity generation

Renewable generation

billion kilowatthours

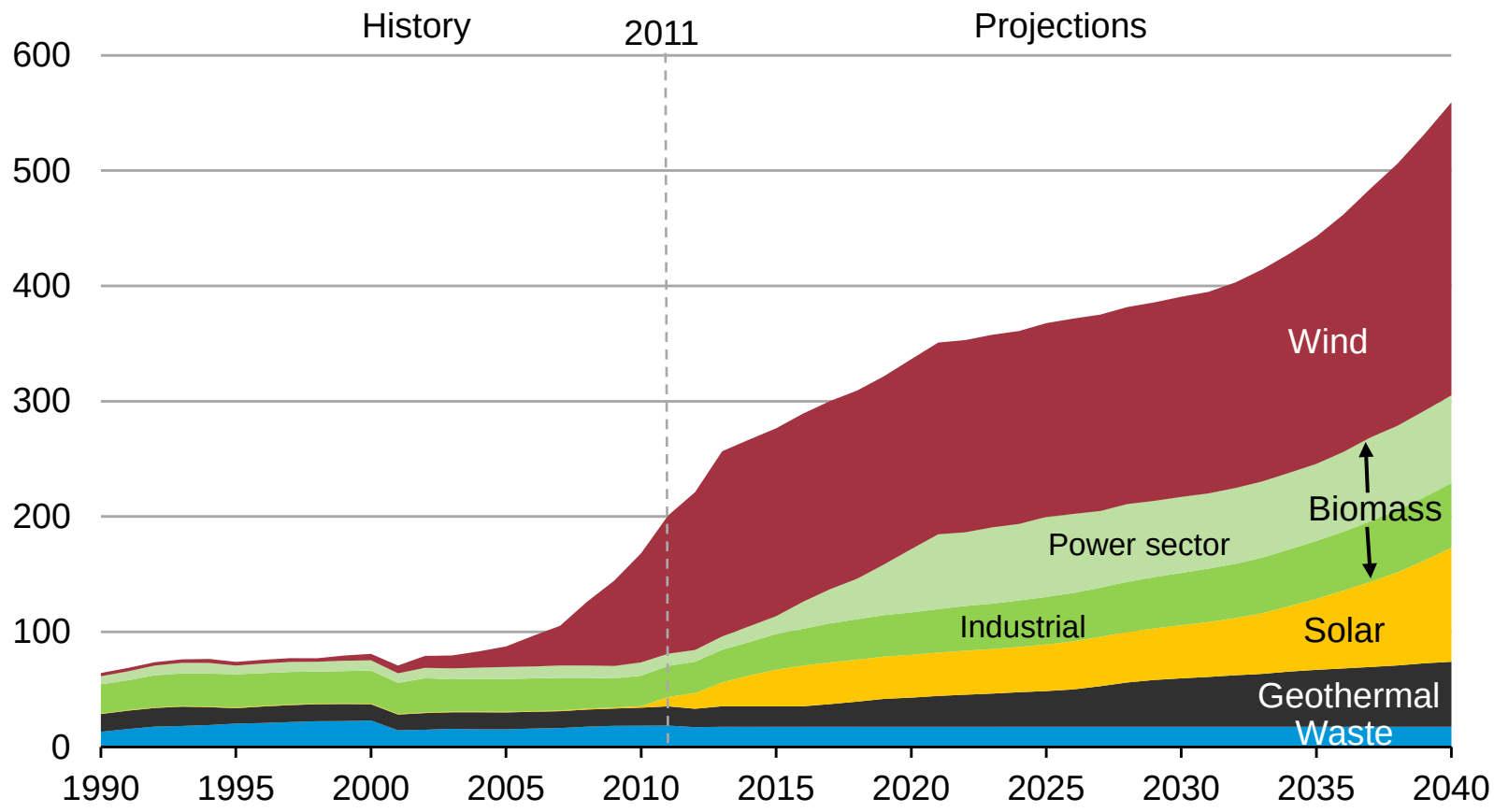


Source: EIA, Annual Energy Outlook 2013

Non-hydro renewable generation more than doubles between 2011 and 2040

Non-hydropower renewable generation

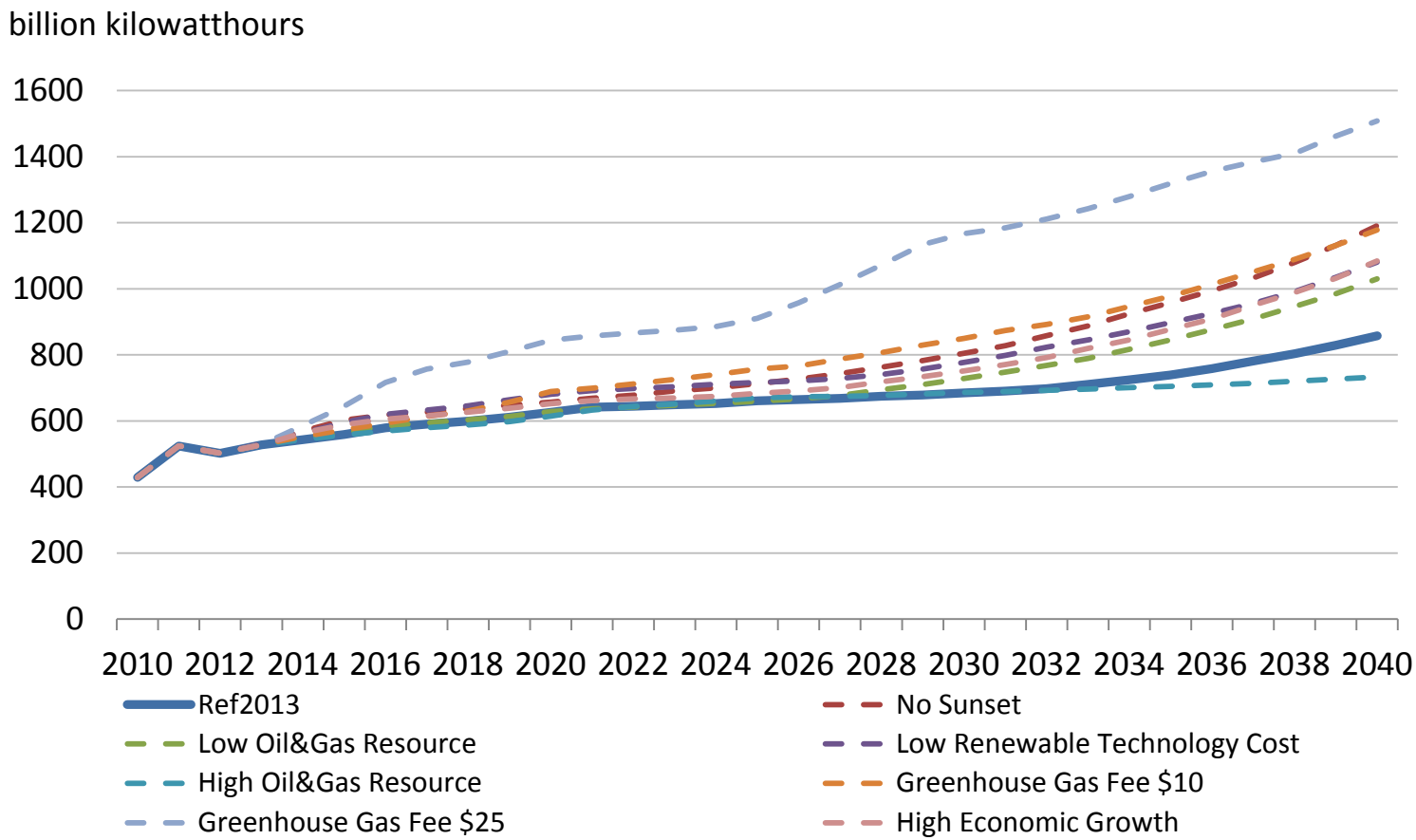
billion kilowatthours



Source: EIA, Annual Energy Outlook 2013

Each AEO also includes several side cases which test the sensitivity of results to different assumptions about technology cost, resource availability, and alternative policies

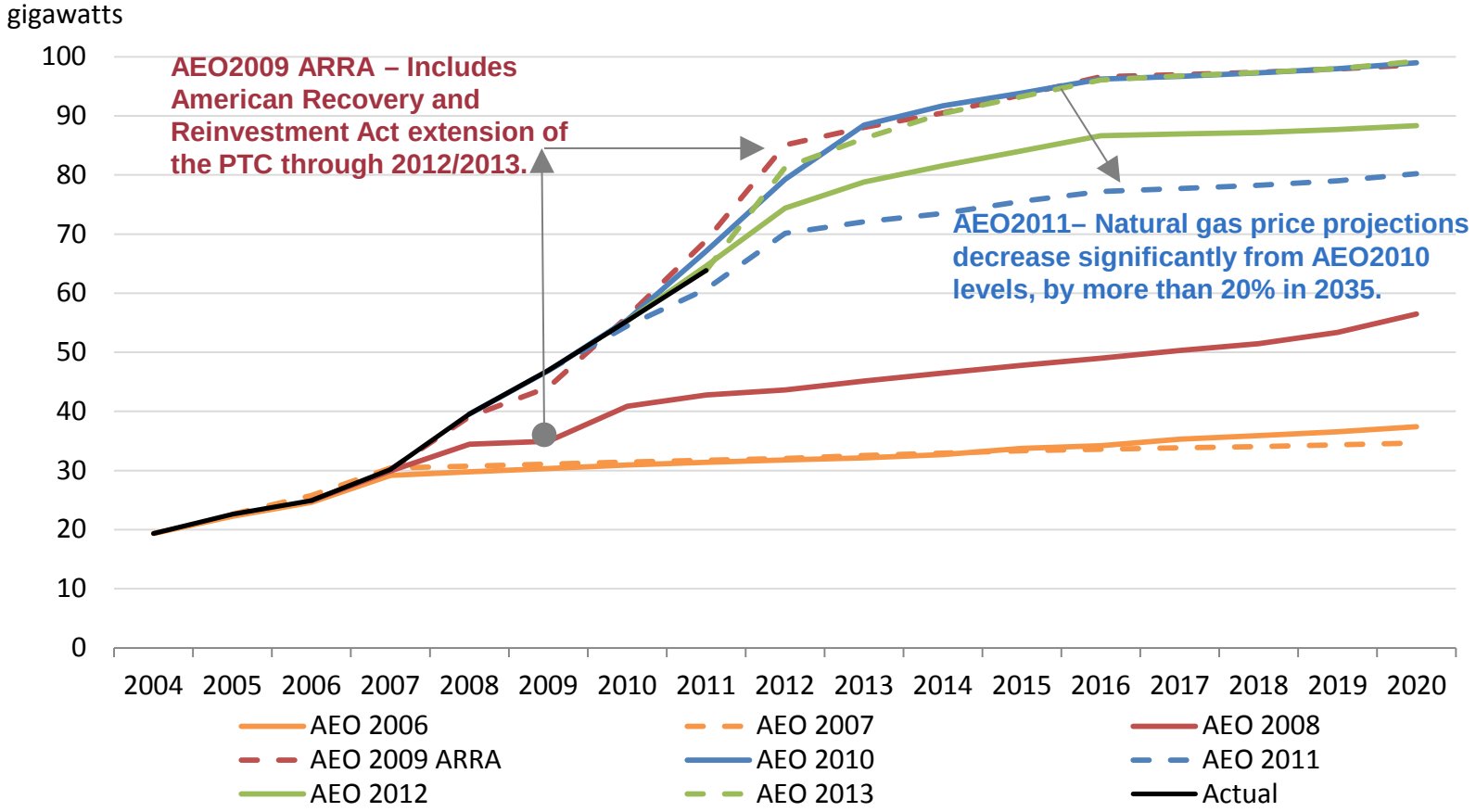
Total Renewable Electricity Generation in Different Scenarios of the AEO2013



Source: EIA, Annual Energy Outlook 2013

AEO projections have performed well over time; however, they are based on current laws and policies, so paths are subject to policy-driven swings from year to year.

Total Renewable Generation Capacity Compared Across Annual Energy Outlooks Over Time



Source: EIA, Annual Energy Outlook 2013

Representation of Current Federal Laws and Policies

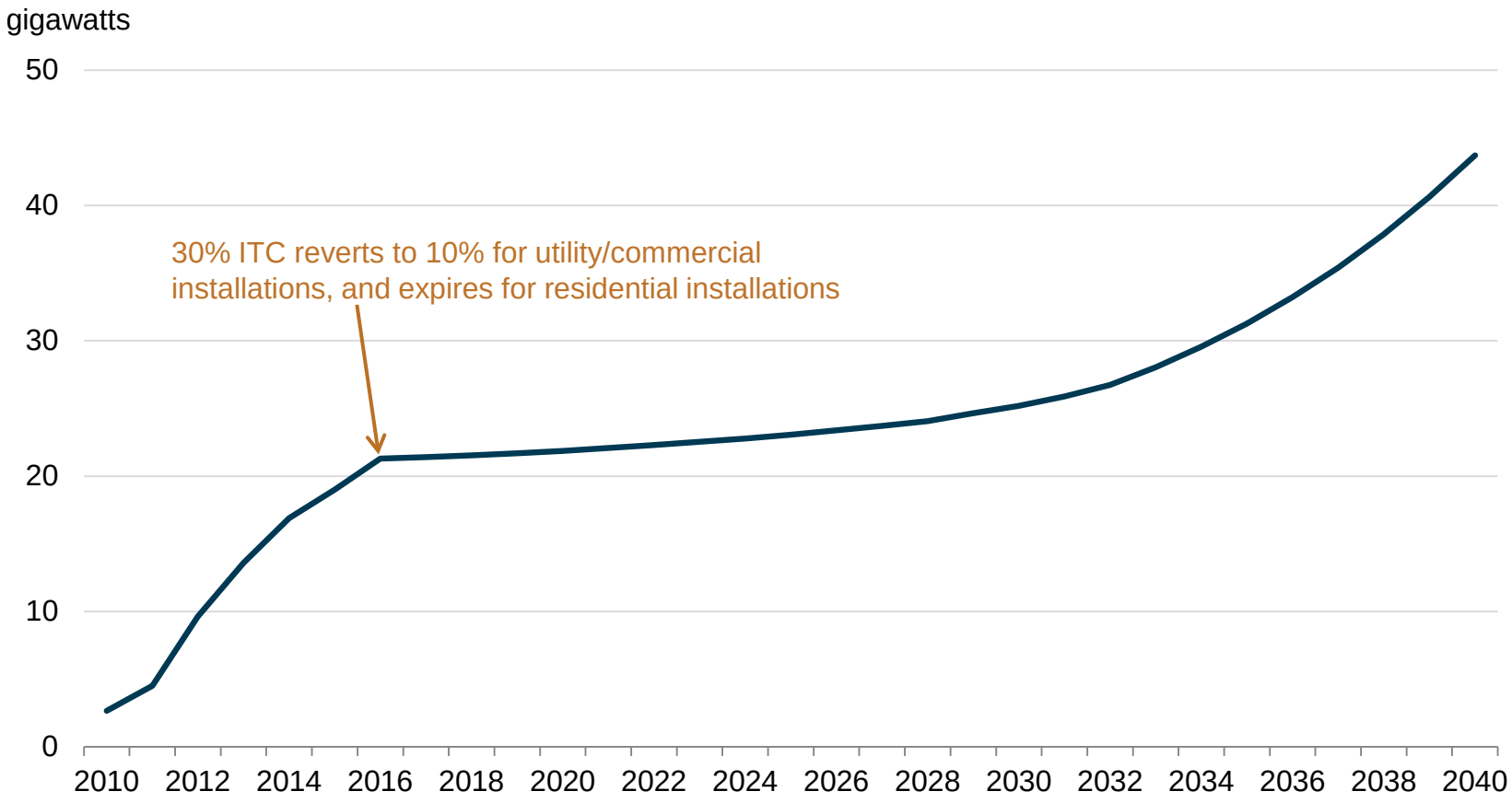
Investment Tax Credit (ITC)

- Extended through 2016 in 2008 by the Energy Improvement & Extension Act of 2008. Eligible renewable sources include:
  - Solar thermal and PV electric (30% through 2016, 10% thereafter excluding residential)
  - Geothermal electric (10% permanent)
  - (end-use sectors) Solar water/space heat applications (30% through 2016), ground-source heat pumps (10% through 2016), small wind (30% through 2016)
- In the American Recovery & Reinvestment Act enacted in 2009, the 30% ITC was extended as an option for PTC eligible technologies.

EIA projects a declining growth rate of solar PV capacity additions if the 30% ITC expires as scheduled

Cumulative Solar PV Capacity

Electric Power and End –Use Sectors



Source: EIA, Annual Energy Outlook 2013, run AEO2013HR8. d021213a

Production Tax Credit (PTC)

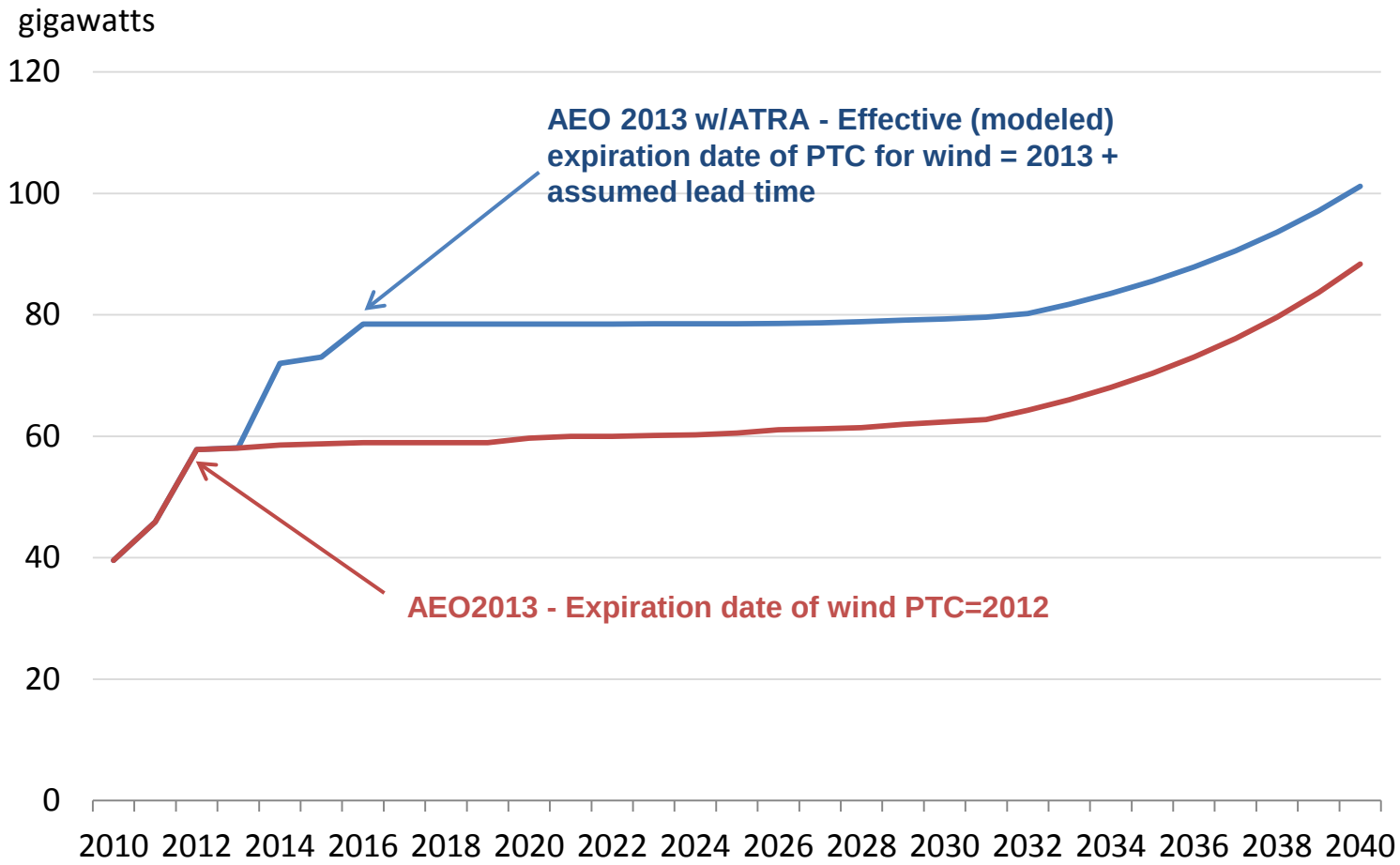
- Eligible fuels modeled in the AEO2013 include:
  - Wind
  - Hydro
  - Geothermal electric
  - Biomass
  - LFG/MSW

- Initially authorized by EPACT1992. Most recently extended for all eligible technologies *under construction* by the end of 2013 as a result of the American Taxpayer Relief Act (ATRA) passed in January 2013.

- ATRA was passed about two months after the AEO2013 Reference case was frozen. We ran a special ATRA side case, which is summarized in the Issues in Focus section of the AEO2013.

Wind capacity projections tend to be sensitive to modeled changes in the PTC expiration dates

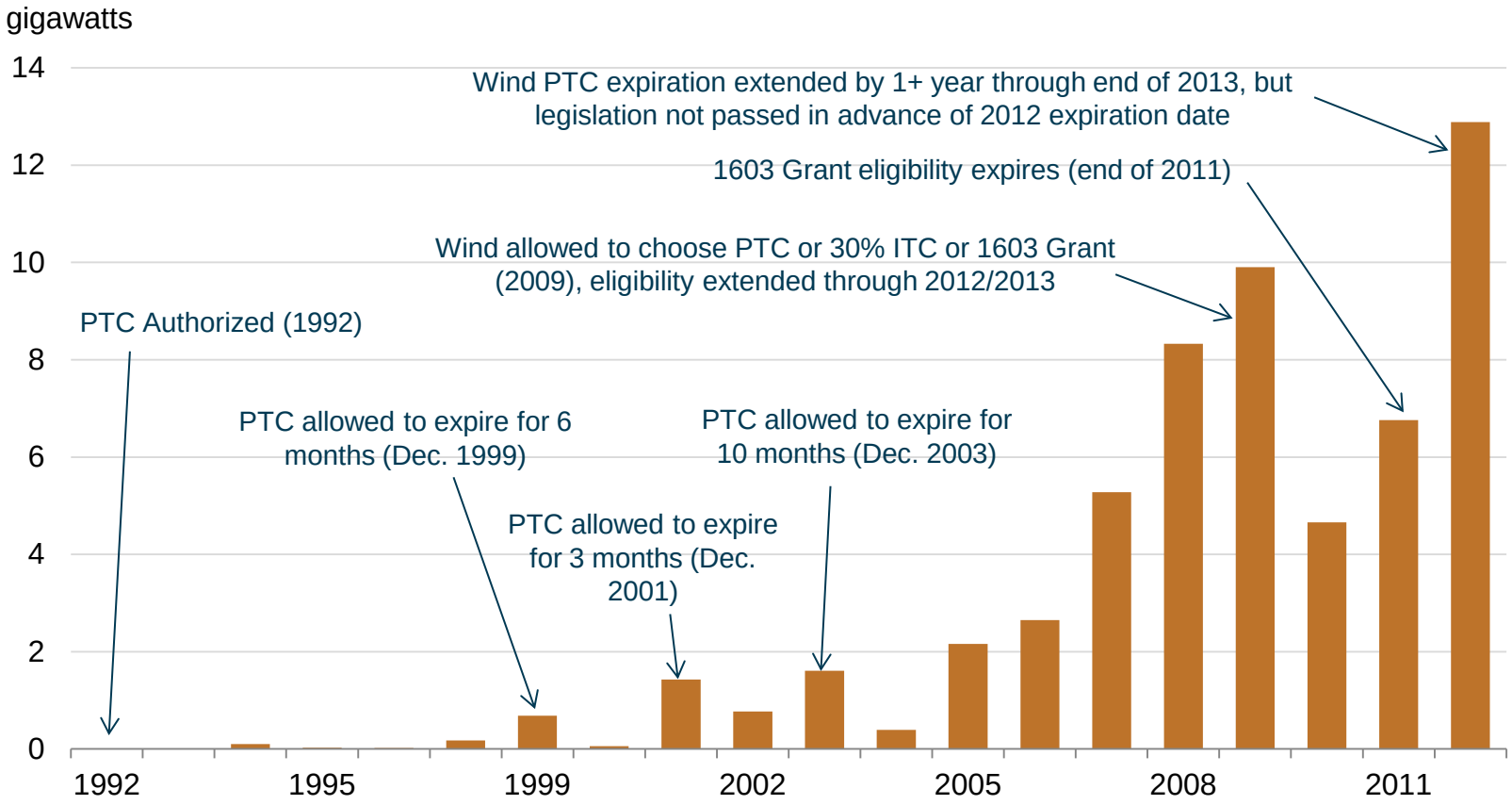
Cumulative Onshore Wind Capacity in the AEO2013 ATRA Case



Source: EIA, Annual Energy Outlook 2013

Projecting under current laws and policies is challenging when policies are updated on a short-term basis or are allowed to expire

Annual Capacity Additions by Initial Year of Operation



Source: EIA, Form EIA-860

The American Recovery and Reinvestment Act of 2009 included several key adjustments to the PTC and ITC

- All PTC-eligible technologies became eligible to choose the ITC or PTC
  - NEMS does not currently allow projects to “choose” between the PTC and ITC.
  - EIA assumes that onshore wind, geothermal, hydro and MSW/LFG projects take the PTC, while biomass and offshore wind projects take the ITC based on exogenous analysis of project economics.

- ITC-eligible technologies became eligible to elect the 1603 cash grant program if under construction by the end of 2011
  - Current and previous AEO’s do not explicitly model the cash grant differently from the ITC

Accelerated Depreciation

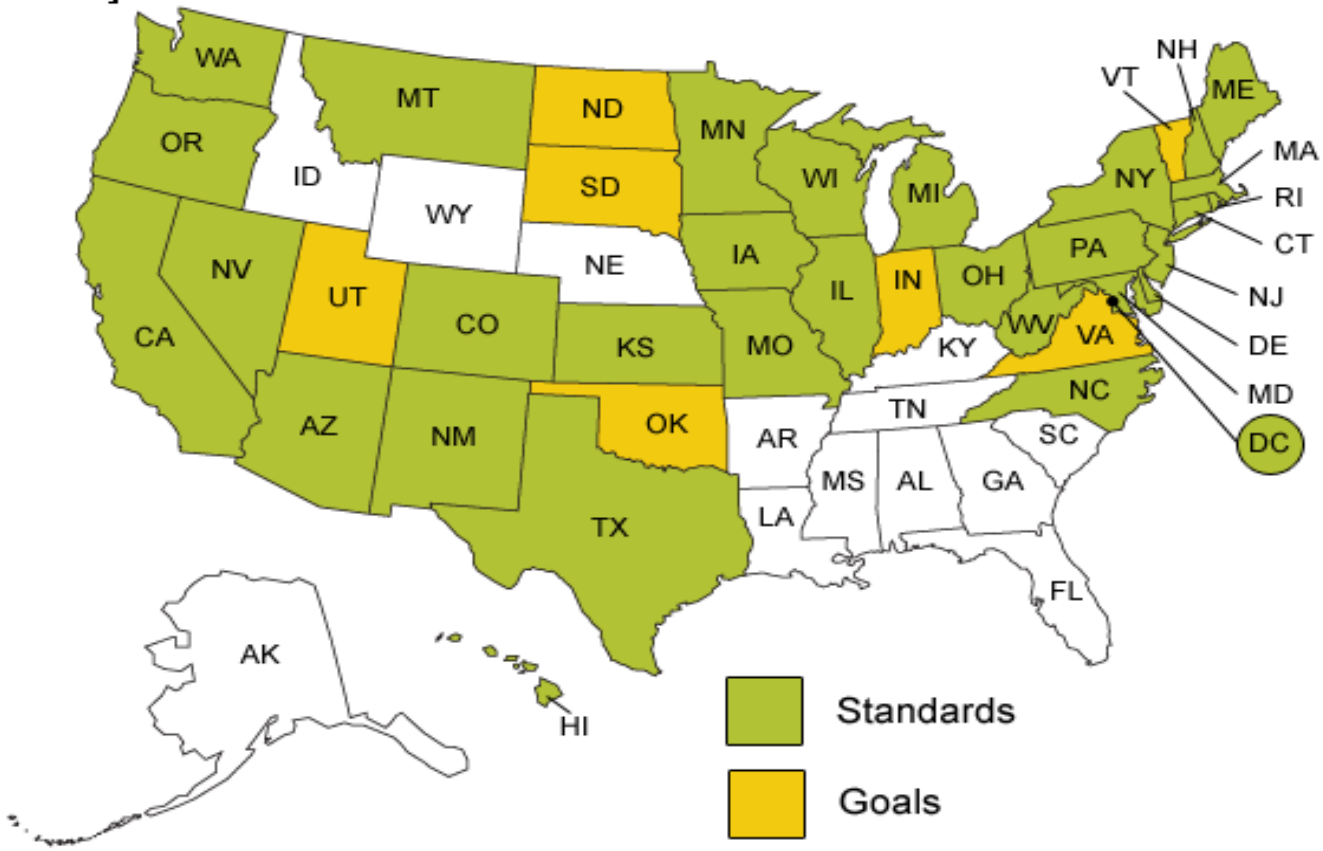
- Under the Modified Accelerated Cost Recovery System (MACRS)* , renewable energy equipment tends to have more rapid depreciation schedules relative to some other asset types. While assets can depreciate over periods ranging from 3 to 50 years, most renewable generation technologies are classified as 5-year assets.
  - Combustion turbine and nuclear plants get 15-year depreciation
  - All other electric power sector technologies get 20-year depreciation
- Bonus depreciation has been used as a short-term policy lever, adding to the difficulty in modeling near-term market behavior.

* the current depreciation method for most assets for the purpose of Federal taxes.

Representation of Current State & Regional Laws and Policies

The majority of States have a Renewable Portfolio Standard. EIA models mandates but not goals in its AEO projections.

States with Renewable Portfolio Standards (mandatory) or Goals (voluntary), January 2012



Source: Energy Information Administration

The NEMS electricity market module is constructed at a 22-region level, so there are inherent limitations to how well NEMS can model state-level policies.

Renewable Portfolio Standards must be simplified in order to be incorporated into the NEMS modeling structure

1. Catalog each state RPS target, qualifying sources, and restrictions on generation from existing sources. In cases with distinct targets for different types of providers, approximate a weighted average target for the state.
2. Apportion state level targets to EMM regions on a sales-weighted basis. Project covered sales for each state/region based on projected growth rates for that region.
3. To get total regional percentage target for each region in each year, sum target area (state, EMM region) required sales and divide by projected sales.

↓

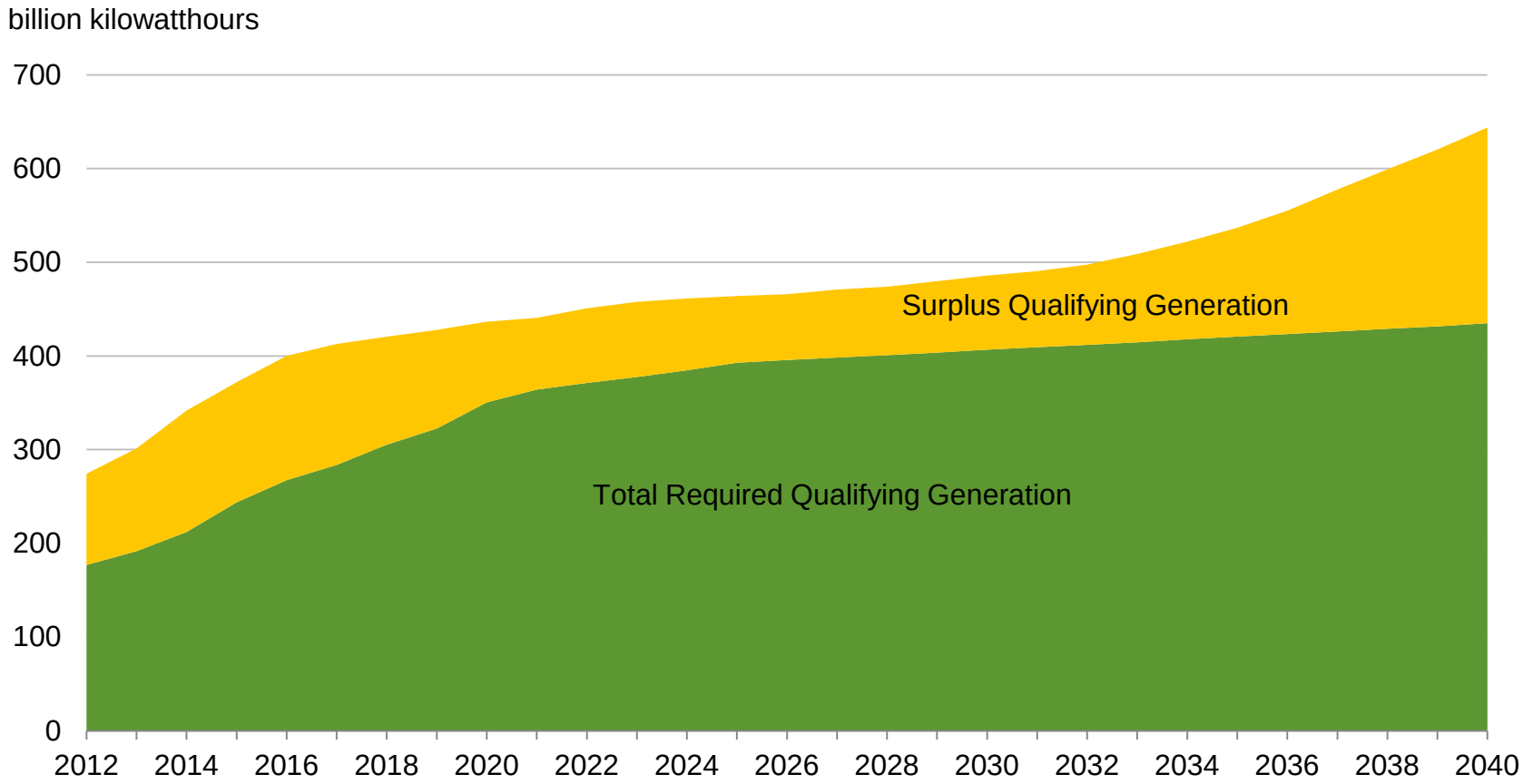
The required percentages of total renewable sales for each region and year serve as regional-level constraints in the EMM's linear program.

Renewable Portfolio Standards must be simplified in order to be incorporated into the NEMS modeling structure

- Qualifying sources and restrictions are set at the regional level. Generally there are not major differences in qualifying sources within a region.
- Trading within regions is implicitly allowed; trading across regions is generally allowed for regions with contiguous boundaries and modeled transmission interconnections, but there may be additional cost associated with interregional trade.
- Aside from general regional representation, recognized limitations to current NEMS representation of RPSs may be more problematic for state policies that include:
  - carve-outs and set-asides, or significant distributed generation targets
  - targets that include energy efficiency measures as qualifying sources
  - cost containment clauses

RPS targets are generally in a state of surplus at the national level, particularly in the near and late portion of the projection

Total RPS-eligible generation versus total required renewable generation



Source: EIA, Annual Energy Outlook 2013, run AEO2013HR8. d021213a

Capital Cost, Performance, and Learning Assumptions

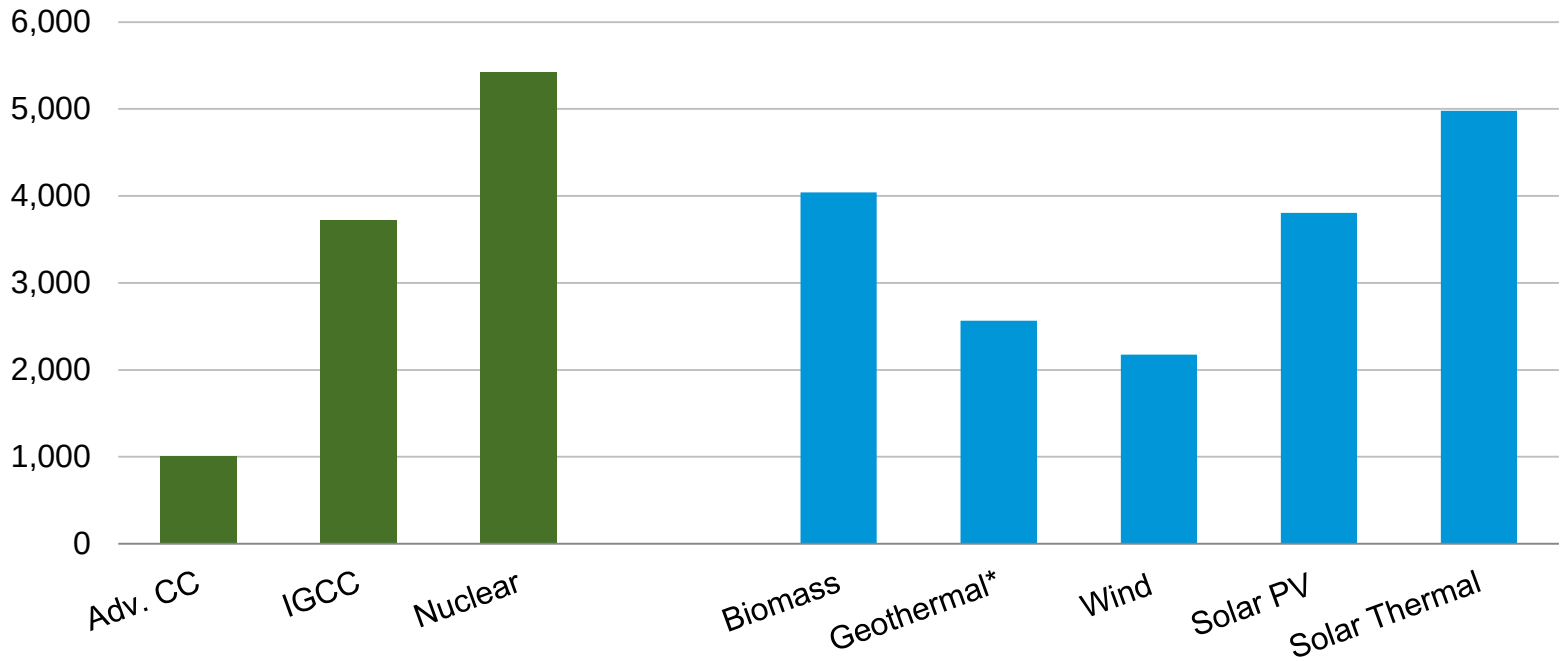
The electricity market (EMM) module represents capacity planning, dispatch, and pricing for the electric power sector; the renewable fuels module provides supply and technology information for the EMM.

- Existing and planned capacity information are directly incorporated into the historical baseline and projections.
- Key baseline assumptions for new plants include: capital and O&M costs, heat rates, construction lead times, and cost of capital.
- The electricity market module is based on a least-cost linear program that minimizes costs subject to the constraint of meeting demand and other system, environmental, and policy constraints.

EIA updated initial capital cost assumptions for all generation technologies for the AEO2013; projected costs are model outputs.

Overnight capital costs for plants entering service in 2012

2011$/kilowatt



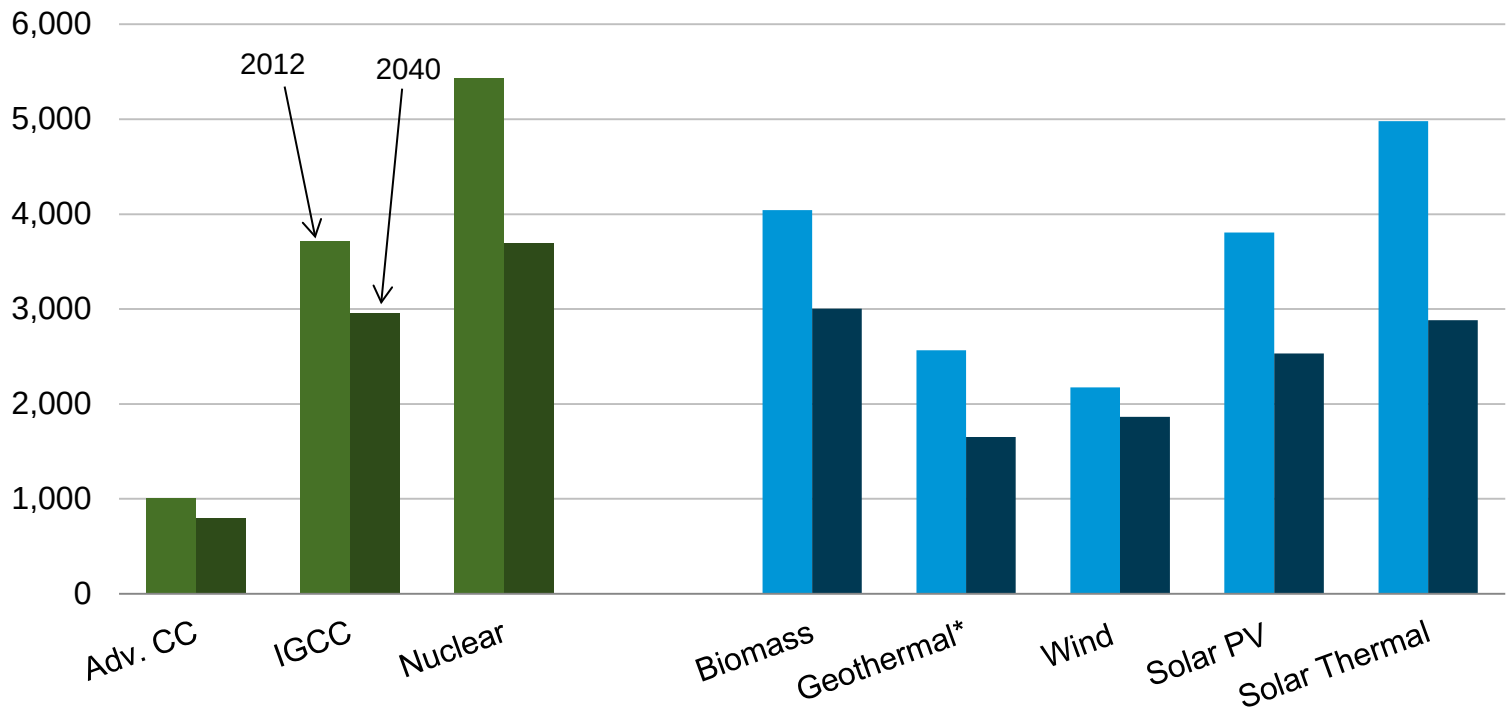
*geothermal cost refers to a specific group of relatively low-cost sites in the NWPP region, and are not intended to reflect an average cost.

Source: EIA, Annual Energy Outlook 2013

Cost declines over time are modeled based on a "learning by doing" model as well as a projected materials price index.

Overnight capital costs for plants coming online in 2012 and 2040

2011$/kilowatt



*geothermal cost refers to a specific group of relatively low-cost sites in the NWPP region, and how those site costs would decline over time due to learning and materials price changes. However, assuming that site was built, the costs for sites that are actually built in 2040 would be higher.

Source: EIA, Annual Energy Outlook 2013

Cost declines due to learning are modeled as a function of modeled capacity growth and assumed learning rates

- Technologies are classified as revolutionary, evolutionary, or mature. Each technology has an associated learning rate that characterizes how much costs decline for each capacity doubling.
  - Offshore wind and solar thermal are classified as revolutionary
  - Solar PV, biomass, and geothermal are classified as evolutionary
  - Onshore wind, hydroelectric, and MSW are classified as mature
- There is also an assumed minimum learning rate, which operates even if no capacity is added.
  - Accounts for non-market learning such as government funded R&D
- Wind performance (capacity factor) is also allowed to improve due to learning over time.

NEMS has several features to capture some of the planning and operational complexities of intermittent resources

- TOD/Seasonal match to load
- Ensuring capacity margin/ intermittent capacity credit
- Accounting for excess production
- New in the AEO2014 – spinning reserves

Renewable technology, markets, and policy are rapidly evolving. We welcome external feedback as we continue to refine and update EIA's renewable electricity modeling efforts.

- Join our working group meetings (contact Gwen Bredehoeft at gwendolyn.bredehoeft@eia.gov to be added to this list)
- Contact us directly with feedback, suggestions, or additional questions (see contacts list on the next slide)

Contacts

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(on detail outside of EIA until April, 2014)

Gwen Bredehoeft – Operations Research Analyst, gwendolyn.bredehoeft@eia.gov

For more information

U.S. Energy Information Administration home page | www.eia.gov

Annual Energy Outlook (publication, results, model documentation, and assumptions) | www.eia.gov/aeo

Levelized Cost and Levelized Avoided Cost| www.eia.gov/renewable/workshop/gencosts/

Today in Energy | www.eia.gov/todayinenergy