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December 1, 2020

The Annual Energy Outlook (AEO): A Brief Overview

The Annual Energy Outlook (AEO) provides an annual projection of U.S. energy supply, demand, prices, certain energy-related air emissions, and other factors over a 25-30 year period. Congress has an ongoing interest in whether and how to use the AEO in potentially forthcoming discussions about energy policy. Additionally, Congress may examine the resources and guidance it gives the U.S. Energy Information Administration (EIA) to conduct the AEO, and whether any changes are necessary.

EIA—an independent statistical agency within the U.S. Department of Energy (DOE) (P.L. 95-91; 42 U.S.C. 7135)—reports that it publishes the AEO each January to satisfy the Department of Energy Organization Act of 1977, which requires the EIA Administrator to prepare annual reports on trends and projections for energy use and supply. Publicly accessible print records of the AEO date back to 1979.

The AEO has been referenced as an authoritative source by Congress—and its support agencies—and by executive agencies, industry, and others. For instance, the AEO has been referenced at multiple congressional hearings related to energy and climate change. Executive agencies that have used the AEO include the Environmental Protection Agency, to project affected facilities in an oil and gas rulemaking, and the National Highway Traffic Safety Administration, as a part of a rulemaking for federal motor vehicle safety standards. Also, the AEO has been referenced in legislation in the past, for instance, bills to require a particular AEO projection to be used as a baseline for certain analysis and reporting.

What Is the AEO?

The AEO is an annual assessment of U.S. energy markets for the next few decades. It contains numerous projections, including for energy supply by fuel type (e.g., petroleum), energy demand by sector (e.g., transportation), energy prices by fuel type and sector, and energy-related carbon dioxide emissions. The AEO presents these projections in both written summaries and graphics. Many of the graphics in the AEO show historical data alongside the projections. EIA also releases data tables associated with the AEO projections. Projections are reported for the United States as a whole, while some information also is reported regionally.

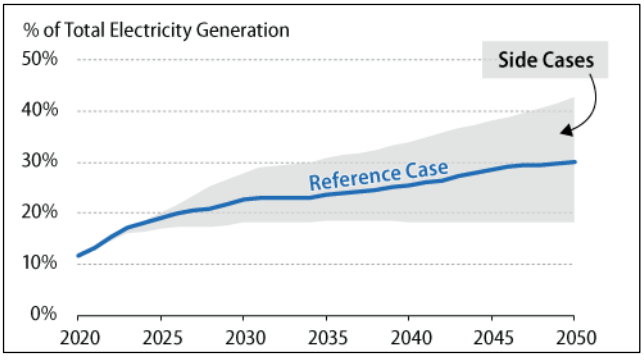
Not all aspects of the energy system are included in the AEO. For example, the AEO does not contain employment projections for the various energy sectors, nor does it contain projections for certain environmental metrics (e.g., methane emissions) associated with energy production.

An integral component of the AEO is its *reference case*—a scenario constructed by EIA which projects future energy system conditions under assumptions detailed in accompanying EIA reports. In general, the AEO's reference case assumes (1) no changes in current U.S. laws and regulations, and (2) the continuation of historic industry and technology trends. The AEO attempts to reflect all federal laws and regulations and most key state laws and regulations that affect the energy sector.

The AEO also includes projections for *side cases*—scenarios with certain alternative assumptions. Side cases can help identify how sensitive model results are to changes in these assumptions. They also can demonstrate the range of possible changes in the energy system, based on the range of assumptions included in the side cases. The 2020 version of the AEO (AEO2020) presented eight side cases exploring the potential impact of differing assumptions about oil and gas supply, oil prices, economic growth rates, and renewable energy costs.

Figure 1 shows how AEO side cases can differ from the reference case, using electricity generation as an example. The dark line shows the AEO2020 reference case projection for the share of electricity coming from wind and solar energy nationwide. In the reference case, that share grows from 12% in 2020 to 30% in 2050. In the AEO side cases, the share of electricity coming from wind and solar energy in 2050 ranges from 18% to 43%. The differences, in this case, arise from assuming lower or higher costs for these and competing energy sources, which affect the market share of wind and solar relative to the reference case.

Figure 1. Projected Share of Total Electricity Generation from Wind and Solar Sources, 2020-2050



Source: EIA, *Annual Energy Outlook 2020*.

Notes: Dark line represents EIA's reference case. Shaded area represents the range of outcomes in EIA's side cases. Assumptions for each scenario are described in the *Annual Energy Outlook 2020*.

EIA does not refer to the AEO as a forecast. For example, in the AEO2020 EIA states that the value of its projections "is not that they are predictions of what will happen, but rather, they are modeled projections of what may happen

given certain assumptions and methodologies." Further, "the AEO2020 Reference case should be interpreted as a reasonable baseline case that can be compared with the cases that include alternative assumptions." In other words, while the AEO is a collection of projections based on certain assumptions, EIA does not intend it to be used as a prediction or a forecast. This distinction is relevant when evaluating the extent to which AEO projections have aligned with actual changes in the energy system. An AEO projection can be expected to approximate actual market changes only if the underlying assumptions are accurate.

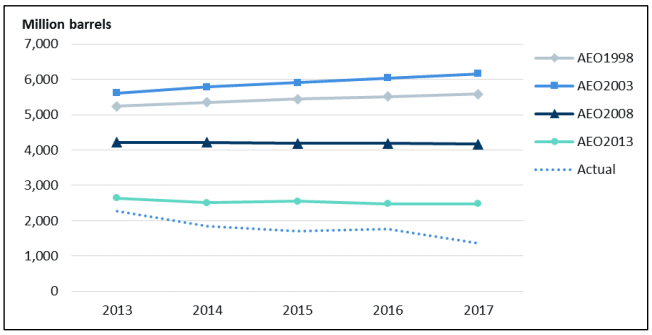
Considerations for Congress

The AEO can provide insight into possible changes in the U.S. energy system. The AEO is used prominently within the energy sector, to justify investments, assess industry trends, and—especially—to inform policy decisions, among other uses. When referring to AEO projections, there are at least four primary considerations: accounting for the unknown, long-term accuracy, policy assumptions, and few alternative sources for U.S. projections.

First, the AEO, like other model-based analysis, can be, and has been, "surprised" by changing developments in U.S. energy markets and the broader economy. In general, models can, to some extent, account for "known unknowns" (e.g., through side cases), but they can struggle to account for "unknown unknowns," such as disruptive technologies or military conflicts. This challenge has raised questions about the usefulness of model projections, including AEO projections. For example, AEO assumptions in the last 20 years did not anticipate certain key developments in U.S. net petroleum imports. (See **Figure 2**.) Solid lines in the figure show AEO projections in five-year increments from 1998 to 2013. The AEO1998 was the first to make projections through 2017, the most recent year of actual data in the most recent retrospective review. Five-year increments were selected as illustrative examples of projection variability over time. The dashed line shows actual petroleum imports. During the time period when the projections were made (i.e., 1998-2013), several factors led to decreased net imports, including advancements in drilling practices which caused a large increase in U.S. oil production. The projections did not fully capture this structural change; all are higher than the actual values. Additionally, the AEO did not anticipate the shock to the energy system caused by the 2008-2009 recession—the AEO2008 overestimated imports in 2013. The decline in U.S. oil demand due to the Coronavirus Disease 2019 pandemic is another example of a market shock which would not likely be anticipated in an AEO projection.

A second challenge with AEO projections is that they tend to be less accurate as they go farther out into the future. (See **Figure 2.**) While all the AEO projections overestimated actual petroleum imports in 2013-2017, the 1998 and 2003 projections are much farther from the actual value than the projections from 2008 and 2013. This challenge is common to economic models, but may be important to consider when interpreting AEO projections.

Figure 2. U.S. Net Petroleum Imports: AEO Projections vs. Actual Imports



Source: EIA, *Annual Energy Outlook 2018 Retrospective Review*.

Notes: Every other year, EIA publishes a retrospective review of the AEO's projections, comparing every AEO projection since 1994 with actual values.

Third, the AEO contains assumptions that existing laws and regulations remain unchanged. Changes in laws, though, can influence the energy sector. For example, repeal of U.S. crude oil export restrictions in 2015 likely explains some of the decline in actual net petroleum imports from 2016 to 2017. EIA defends this practice as being consistent with its mandate to be policy neutral, and has stated in the past, "the [AEO] projections provide policy-neutral baselines that can be used to analyze policy initiatives." Additionally, EIA reports that it "neither formulates nor advocates policy conclusions," and thus is not in the position to include assumptions in the AEO about what policies may (or may not be) enacted by Congress and the states. EIA occasionally assesses potential policy outcomes, usually upon congressional request.

Fourth, few other analyses exist that are comparable to the AEO, in part due to the extensive resources required to produce a multi-decadal projection of the U.S. energy system. One analogous set of projections, the World Energy Outlook (WEO), is produced annually by the International Energy Agency. This agency uses different assumptions than EIA, including assumptions about new policies. Recent editions of the WEO have included policy scenarios focused on achieving United Nations sustainability and climate change goals. For example, the 2020 edition of the WEO included a scenario with net zero greenhouse gas emissions from the global energy sector. Compared to the AEO, the WEO has similar types of data available for the United States (e.g., energy demand by sector), though typically with less granularity. Some, but not all, WEO data are available for free. Several private companies also make projections or forecasts about the U.S. energy sector (e.g., BP's Energy Outlook). Projections offered by private companies differ in the extent to which they make their assumptions and data available to the public.

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