U.S. Energy Information Administration

Analysis & Projections
Assumptions to AEO2015

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full report

Introduction

This report presents the major assumptions of the National Energy Modeling System (NEMS) used to generate the projections in the *Annual Energy Outlook 2015* AEO2015 [1] (AEO2015), including general features of the model structure, assumptions concerning energy markets, and the key input data and parameters that are the most significant in formulating the model results. Detailed documentation of the modeling system is available in a series of documentation reports [2].

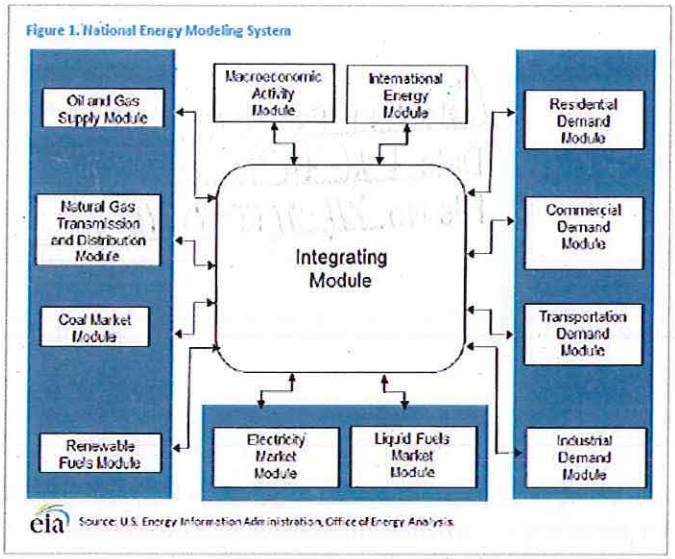
The National Energy Modeling System

Projections in AEO2015 are generated using the NEMS [3], developed and maintained by the Office of Energy Analysis of the U.S. Energy Information Administration (EIA). In addition to its use in developing the Annual Energy Outlook (AEO) projections, NEMS is used to complete analytical studies for the U.S. Congress, the Executive Office of the President, other offices within the U.S. Department of Energy (DOE), and other federal agencies. NEMS is also used by nongovernmental groups, such as the Electric Power Research Institute, Duke University, and Georgia Institute of Technology. In addition, AEO projections are used by analysts and planners in other government agencies and nongovernmental organizations.

The projections in NEMS are developed with the use of a market-based approach, subject to regulations and standards. For each fuel and consuming sector, NEMS balances energy supply and demand, accounting for economic competition across the various energy fuels and sources. The time horizon of NEMS extends to 2040. To represent regional differences in energy markets, the component modules of NEMS function at the regional level: the 9 Census divisions for the end-use demand modules; production regions specific to oil, natural gas, and coal supply and distribution; 22 regions and subregions of the North American Electric Reliability Corporation for electricity; and 9 refining regions within the 5 Petroleum Administration for Defense Districts (PADDs). Complete regional and detailed results are available on the EIA Analysis and Projections Home Page (www.eia.gov/analysis/).

NEMS is organized and implemented as a modular system (Figure 1). The modules represent each of the fuel supply markets, conversion sectors, and end-use consumption sectors of the energy system. The modular design also permits the use of the methodology and level of detail most appropriate for each energy sector. NEMS executes each of the component modules to solve for prices of energy delivered to end users and the quantities consumed, by product, region, and sector. The delivered fuel prices encompass all activities necessary to produce, import, and transport fuels to end users. The information flows also include such areas as economic activity, domestic production, and international petroleum supply. NEMS calls each supply, conversion, and end-use demand module in sequence until the delivered prices of energy and the quantities demanded have converged within tolerance, thereby achieving an economic equilibrium of supply and demand in the consuming sectors. A solution is reached for each year from 2014 through 2040. Other variables, such as petroleum product imports, crude oil imports, and several macroeconomic indicators, also are evaluated for convergence.

Each NEMS component represents the effects and costs of legislation and environmental regulations that affect that sector. NEMS accounts for all combustion-related carbon dioxide (CO2) emissions, as well as emissions of sulfur dioxide (SO2), nitrogen oxides (NOX), and mercury from the electricity generation sector.



The integrating module of NEMS controls the execution of each of the component modules. To facilitate modularity, the components do not pass information to each other directly but communicate through a central data storage location. This modular design provides the capability to execute modules individually, thus allowing decentralized development of the system and independent analysis and testing of individual modules that appropriately reflect each energy sector. NEMS solves by calling each supply, conversion, and end-use demand module in sequence until the delivered prices of energy and the quantities demanded have converged within tolerance, thus achieving an economic equilibrium of supply and demand in the consuming sectors over the projection period. Other variables, such as petroleum product imports, crude oil imports, and several macroeconomic indicators, are also evaluated for convergence.

The version of NEMS used for AEO2015 generally represents current legislation and environmental regulations, including recent government actions for which implementing regulations were available as of the end of October, 2014, as discussed in the Legislation and Regulations section of the AEO. The potential effects of proposed federal and state legislation, regulations, or standards—or of sections of legislation that have been enacted but require funds or implementing regulations that have not been provided or specified—are not reflected in NEMS. Because AEO2015 is a short version of the report, the scenarios are limited. EIA is undertaking a separate analysis of the proposed rules of the Environmental Protection Agency's Clean Power Plan, which will be available after AEO2015 is published.Â A list of the specific federal and selected state legislation and regulations included in the AEO, including how they are incorporated, is provided in Appendix A.

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Footnotes

[1] U.S. Energy Information Administration, *Annual Energy Outlook 2015* (AEO2015), DOE/EIA-0383(2015), (Washington, DC, April 2015).

[2] NEMS documentation reports are available on the EIA Homepage (www.eia.gov/analysis/model-documentation.cfm).

[3] U.S. Energy Information Administration, The National Energy Modeling System: *An Overview 2009*, DOE/EIA-0581(2009) (Washington, DC, October 2009), http://www.eia.gov/oiaf/aeo/overview.

Table A16. Renewable energy generating capacity and generation
(gigawatts, unless otherwise noted)

Net summer capacity and generation	Reference case							Annual growth 2013-2040 (percent)
	2012	2013	2020	2025	2030	2035	2040	
Electric power sector[1]								
Net summer capacity								
Conventional hydroelectric power	78.1	78.3	79.2	79.6	79.7	79.8	80.1	0.1%
Geothermal[2]	2.6	2.6	3.8	5.3	7.0	8.2	9.1	4.7%
Municipal waste[3]	3.6	3.7	3.8	3.8	3.8	3.8	3.8	0.1%
Wood and other biomass[4]	2.9	3.3	3.5	3.5	3.6	4.2	5.5	1.8%
Solar thermal	0.5	1.3	1.8	1.8	1.8	1.8	1.8	1.2%
Solar photovoltaic[5]	2.6	5.2	14.4	14.7	15.7	17.9	22.2	5.5%
Wind	59.2	60.3	82.0	83.0	86.3	95.6	108.2	2.2%
Offshore wind	0.0	0.0	0.0	0.0	0.0	0.0	0.0	- -
Total electric power sector capacity	**149.4**	**154.7**	**188.6**	**191.6**	**198.0**	**211.2**	**230.6**	**1.5%**
Generation (billion kilowatthours)								
Conventional hydroelectric power	273.9	265.7	291.0	292.8	293.4	293.8	295.6	0.4%
Geothermal[2]	15.6	16.5	26.8	38.5	52.4	62.3	69.6	5.5%
Biogenic municipal waste[6]	16.9	16.5	20.0	20.3	20.1	20.0	20.2	0.8%
Wood and other biomass	11.1	12.2	24.7	36.2	40.4	47.1	58.8	6.0%
Dedicated plants	9.9	11.1	13.4	15.1	16.7	20.4	30.3	3.8%
Cofiring	1.2	1.1	11.3	21.1	23.7	26.7	28.5	12.7%
Solar thermal	0.9	0.9	3.6	3.6	3.6	3.6	3.6	5.1%
Solar photovoltaic[5]	3.3	8.0	29.7	30.3	32.6	37.6	47.1	6.8%
Wind	140.7	167.6	230.6	233.8	243.3	276.1	317.1	2.4%
Offshore wind	0.0	0.0	0.1	0.1	0.1	0.1	0.1	- -
Total electric power sector generation	**462.3**	**487.4**	**626.4**	**655.6**	**685.9**	**740.7**	**812.1**	**1.9%**
End-use sectors[7]								
Net summer capacity								
Conventional hydroelectric power	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.0%
Geothermal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	- -
Municipal waste[8]	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.0%
Biomass	4.9	5.0	5.4	5.4	5.4	5.5	5.6	0.4%
Solar photovoltaic[5]	4.6	6.2	11.4	15.5	21.5	28.7	36.7	6.8%
Wind	0.2	0.2	0.7	0.7	0.9	1.1	1.5	7.7%
Total end-use sector capacity	**10.4**	**12.1**	**18.2**	**22.4**	**28.6**	**36.0**	**44.6**	**4.9%**
Generation (billion kilowatthours)								
Conventional hydroelectric power	1.4	1.4	1.4	1.4	1.4	1.4	1.4	0.0%
Geothermal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	- -
Municipal waste[8]	3.6	3.6	3.6	3.6	3.6	3.6	3.6	0.0%
Biomass	26.5	27.2	29.1	29.3	29.4	29.4	30.5	0.4%
Solar photovoltaic[5]	7.1	9.6	17.9	24.8	34.7	46.3	59.3	7.0%
Wind	0.2	0.3	0.9	1.0	1.2	1.5	2.1	8.0%
Total end-use sector generation	**38.8**	**42.1**	**52.9**	**60.1**	**70.2**	**82.3**	**96.9**	**3.1%**

Table A16. Renewable energy generating capacity and generation (continued)
(gigawatts, unless otherwise noted)

Net summer capacity and generation	Reference case							Annual growth 2013-2040 (percent)
	2012	2013	2020	2025	2030	2035	2040	
Total, all sectors								
Net summer capacity								
Conventional hydroelectric power	78.4	78.5	79.5	79.9	80.0	80.1	80.4	0.1%
Geothermal	2.6	2.6	3.8	5.3	7.0	8.2	9.1	4.7%
Municipal waste	4.1	4.1	4.3	4.3	4.3	4.3	4.3	0.1%
Wood and other biomass[4]	7.8	8.3	8.9	8.9	9.1	9.6	11.1	1.1%
Solar[5]	7.6	12.7	27.6	31.9	39.0	48.3	60.6	6.0%
Wind	59.4	60.5	82.7	83.8	87.3	96.7	109.7	2.2%
Total capacity, all sectors	**159.8**	**166.8**	**206.8**	**214.1**	**226.6**	**247.2**	**275.2**	**1.9%**
Generation (billion kilowatthours)								
Conventional hydroelectric power	275.2	267.1	292.3	294.2	294.7	295.2	297.0	0.4%
Geothermal	15.6	16.5	26.8	38.5	52.4	62.3	69.6	5.5%
Municipal waste	20.6	20.1	23.7	23.9	23.7	23.7	23.8	0.6%
Wood and other biomass	37.6	39.4	53.8	65.5	69.8	76.5	89.3	3.1%
Solar[5]	11.2	18.5	51.3	58.7	70.9	87.5	110.1	6.8%
Wind	141.0	167.8	231.5	234.9	244.6	277.8	319.3	2.4%
Total generation, all sectors	**501.2**	**529.5**	**679.4**	**715.6**	**756.2**	**823.0**	**909.1**	**2.0%**

[1]Includes electricity-only and combined heat and power plants that have a regulatory status.
[2]Includes both hydrothermal resources (hot water and steam) and near-field enhanced geothermal systems (EGS). Near-field EGS potential occurs on known hydrothermal sites, however this potential requires the addition of external fluids for electricity generation and is only available after 2025.
[3]Includes municipal waste, landfill gas, and municipal sewage sludge. Incremental growth is assumed to be for landfill gas facilities. All municipal waste is included, although a portion of the municipal waste stream contains petroleum-derived plastics and other non-renewable sources.
[4]Facilities co-firing biomass and coal are classified as coal.
[5]Does not include off-grid photovoltaics (PV). Based on annual PV shipments from 1989 through 2013, EIA estimates that as much as 274 megawatts of remote electricity generation PV applications (i.e., off-grid power systems) were in service in 2013, plus an additional 573 megawatts in communications, transportation, and assorted other non-grid-connected, specialized applications. See U.S. Energy Information Administration, *Annual Energy Review 2011*, DOE/EIA-0384(2011) (Washington, DC, September 2012), Table 10.9 (annual PV shipments, 1989-2010), and Table 12 (U.S. photovoltaic module shipments by end use, sector, and type) in U.S. Energy Information Administration, *Solar Photovoltaic Cell/Module Shipments Report, 2011* (Washington, DC, September 2012) and U.S. Energy Information Administration, *Solar Photovoltaic Cell/Module Shipments Report, 2012* (Washington, DC, December 2013). The approach used to develop the estimate, based on shipment data, provides an upper estimate of the size of the PV stock, including both grid-based and off-grid PV. It will overestimate the size of the stock, because shipments include a substantial number of units that are exported, and each year some of the PV units installed earlier will be retired from service or abandoned.
[6]Includes biogenic municipal waste, landfill gas, and municipal sewage sludge. Incremental growth is assumed to be for landfill gas facilities. Only biogenic municipal waste is included. The U.S. Energy Information Administration estimates that in 2013 approximately 7 billion kilowatthours of electricity were generated from a municipal waste stream containing petroleum-derived plastics and other non-renewable sources. See U.S. Energy Information Administration, *Methodology for Allocating Municipal Solid Waste to Biogenic and Non-Biogenic Energy* (Washington, DC, May 2007).
[7]Includes combined heat and power plants and electricity-only plants in the commercial and industrial sectors that have a non-regulatory status; and small on-site generating systems in the residential, commercial, and industrial sectors used primarily for own-use generation, but which may also sell some power to the grid.
[8]Includes municipal waste, landfill gas, and municipal sewage sludge. All municipal waste is included, although a portion of the municipal waste stream contains petroleum-derived plastics and other non-renewable sources.
- - = Not applicable.
Note: Totals may not equal sum of components due to independent rounding. Data for 2012 and 2013 are model results and may differ from official EIA data reports.
Sources: 2012 and 2013 capacity: U.S. Energy Information Administration (EIA), Form EIA-860, "Annual Electric Generator Report" (preliminary). 2012 and 2013 generation: EIA, *Monthly Energy Review*, DOE/EIA-0035(2014/11) (Washington, DC, November 2014). **Projections:** EIA, AEO2015 National Energy Modeling System run REF2015.D021915A.