Upcoming working group meetings

Topic	Date	Time*
Macroeconomic-Industrial	April 24, 2024	2:00 p.m.
Residential and Commercial Buildings	May 8, 2024	2:00 p.m.
Electricity, Renewables, Coal, and Nuclear	May 15, 2024	2:00 p.m.
Transportation	May 22, 2024	1:00 p.m.
Introduction to the Carbon Capture, Allocation, Transportation, and Sequestration Module	June 5, 2024	11:00 a.m.
Introduction to the Hydrogen Market Module	June 12, 2024	2:00 p.m.
Petroleum and Natural Gas	July 17, 2024	11:00 a.m.

Past Working Group presentations are available at https://www.eia.gov/outlooks/aeo/workinggroup/

If you are interested in attending these meetings over WebEx, email AnnualEnergyOutlook@eia.gov, and indicate your areas of interest.

**All times listed are eastern time.*

Annual Energy Outlook 2025 Working Group Meeting – Electricity, Renewables, Coal, and Nuclear

EIA Electricity, Coal, and Renewables Long-Term Modeling Team
May 15, 2024

Meeting overview

- Overview of NEMS enhancements for *Annual Energy Outlook 2025*
- Electric power sector enhancements:
  - Model performance
  - Legislation and regulation updates
  - Data updates and new features
- Questions and discussion

AEO2025: Enhancing long-term modeling capabilities

- The energy market is rapidly evolving, with new policies and regulations, new macroeconomic trends, and revolutionary technology change.

- The time pressures of an annual publication cycle work against the necessary enhancements to our modeling system, National Energy Modeling System (NEMS).

- AEO2025 development items:
  - Improving carbon capture, transportation, and sequestration modeling (for more information, attend the Introduction to the Carbon Capture, Allocation, Transportation, and Sequestration Working Group, June 5, 2024)
  - Introducing hydrogen representation (for more information, attend the Hydrogen Market Module Working Group, June 12, 2024)
  - Improving electric power sector modeling
  - Improving technology representation
  - More comprehensively addressing existing and upcoming laws and regulations

Improve electric power sector modeling in NEMS

- Goal: Have a model capable of representing a credible zero-carbon emissions electric power sector through one or more likely policy mechanisms
  - Develop or enhance model structures:
    - Seasonal energy storage
    - Bioenergy with CCS (BECCS)
    - Intermittency impacts
    - Electricity pricing
  - More fully represent policies including:
    - Inflation Reduction Act (IRA) provisions (advanced manufacturing, energy communities, credit phaseout)
    - New and proposed regulations by the U.S. Environmental Protection Agency (EPA) (good neighbor rule, 111, mercury rule)
  - Improve model performance
  - Update resource supply curves for wind, solar, and coal

Model performance

Model performance improvements

- Electricity Capacity Planning Submodule (ECP) and Electricity Fuel Dispatch Submodule (EFD) solving now via AIMMS
- Update on parallelization of runs
- Convergence improvements
- Electric Power Hydrogen for Reliability and Trans-Seasonal Storage Module (EPHRTS) updates

Legislation and regulation updates

Updates to state policies

Clean energy standards

- States have interim goals which may include renewable only sales or generation set asides:
  - Delaware – 100% greenhouse gas reduction by 2050
  - Michigan – 100% carbon-free electricity by 2040
  - Minnesota – 100% carbon- free electricity by 2040
  - New Jersey – 100% carbon-free by 2035 (as part of our continuing effort to model executive orders for power sector carbon goals)

State technology deployment mandate

- Maryland mandates 8.5 gigawatts (GW) of offshore wind by 2031.
- Michigan set a target of 2.5 GW of battery storage by 2030.

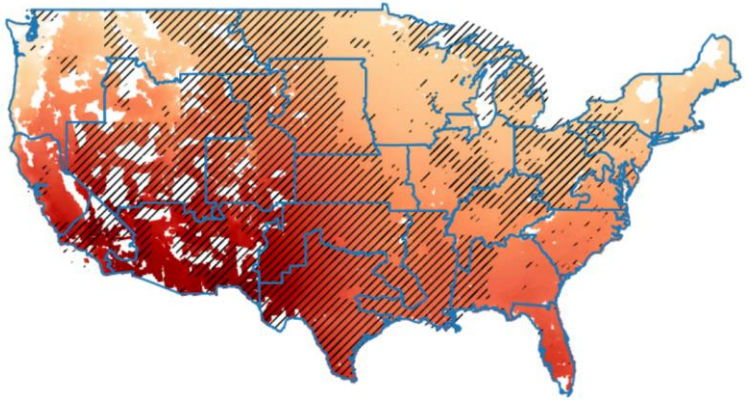
Continuing to monitor state legislation and executive orders through September 2024.

Inflation Reduction Act updates

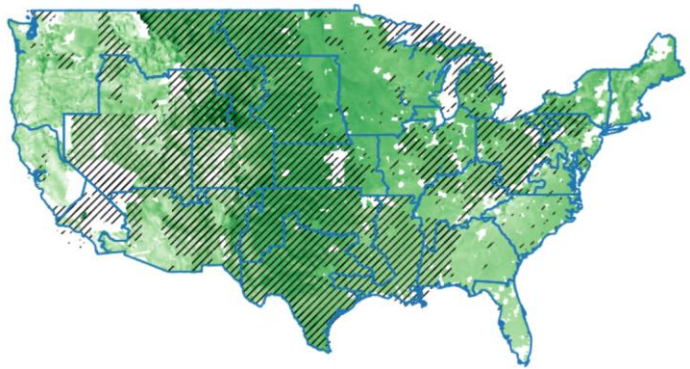
IRA provision	Description	Modeling implementation
Clean Electricity Investment and Production Tax Credit (CE ITC/PTC)	Up to 30% ITC and 10-year $25/MWh PTC for new projects that meet wage and apprenticeship requirements.	Assume wage and apprenticeship requirements are met for all qualifying facilities
CE ITC/PTC qualifying facilities	Facilities that produce electricity and have a GHG emission rate no greater than zero	Applicable for new nuclear, solar, wind, geothermal, hydro, batteries, land-fill gas, municipal solid waste
CE ITC/PTC availability and phaseout	Phaseout in 2032 or after a 75% reduction of CO_2 emissions from 2022-levels, whichever comes later	Will model phaseout endogenously, initial modeling suggests the 75% reduction occurs after 2032.
CE ITC/PTC domestic content bonus credit	Tax credit increased by 10pp/10% if iron, steel, and a certain percentage of other manufactured products are produced in the United States	Some representation of domestic content for wind and possibly other technologies
CE ITC/PTC energy community bonus credit	Tax credit increased by 10pp/10% if in community with a brownfield, coal closure, or loss in fossil fuel-based employment	Representation of energy community credit for wind, solar, and geothermal through resource availability curves
Zero-emission nuclear power production credit	Up to $15/MWh PTC for existing nuclear that meets wage and apprenticeship requirements and meets electricity revenue requirements	Assume wage and apprenticeship requirements are met and calculate revenue requirement endogenously

Energy communities

- The Energy Community Tax Credit Bonus applies a bonus of up to 10pp/10% for projects located in energy communities:
  - Energy communities are defined under the IRA as coal closure, fossil fuel, and brownfield sites
  - Facility can claim either 48E investment tax credit (ITC) or 45Y production tax credit (PTC)
  - Capacity additions in regions where renewable resources and energy communities overlap will receive the bonus credit
- Concurrently, we are improving renewable resource supply curves:
  - Enhancing the representation of resource availability for wind, solar, and geothermal



Solar resource and energy communities (hatched lines)



Wind resource and energy communities (hatched lines)

Modeling updates for the finalized EPA 111 rule to regulate CO_2 emissions from the electric power sector

111(d) Existing Source Performance Standards

- Existing coal-fired steam generators:
  - In 2032, operating units will choose to:
    - Retire
    - Convert to a natural gas steam unit
    - Retrofit with CCS
  - *Under consideration:* How to model the option for coal units to co-fire with natural gas
- Existing oil/natural gas-fired steam generators:
  - Assume no change in operation necessary

111(b) New Source Performance Standards

- New natural gas combined cycle (NG-CC):
  - In 2031, new, non-CCS NG-CC units built between 2025 - 2031 will choose to:
    - Retire
    - Operate with a 40% capacity factor limit
  - In 2031, new units will choose to:
    - Build NG-CC with a 40% capacity factor limit
    - Build NG-CC with CCS
  - *Under consideration:* How to model NG-CC with hydrogen as a compliance option
- New natural gas single-cycle combustion turbines:
  - In 2031 units built after 2024 will have a 20% capacity factor limit

Data updates and new features

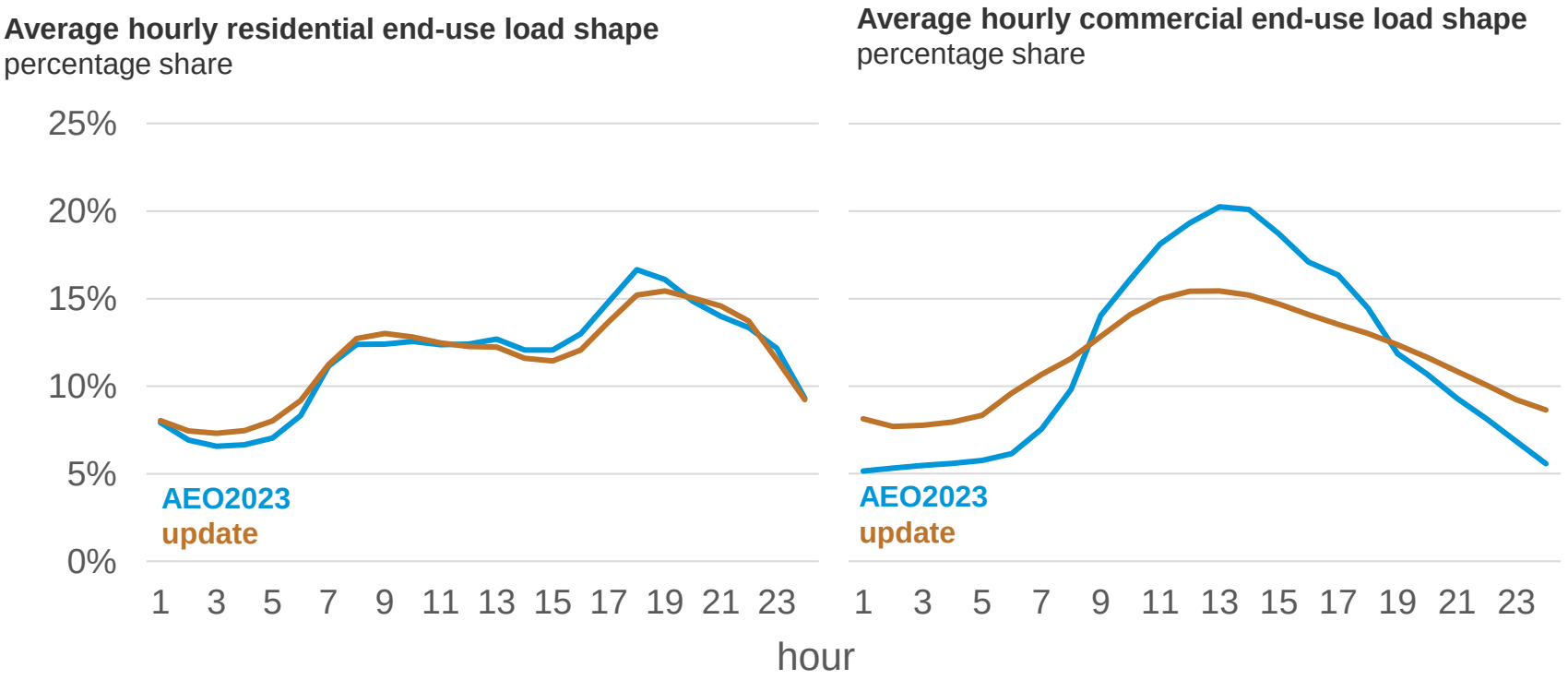
Updated overnight capital cost and resource supply curves

- Updated capital cost and performance characteristics for electric power generating technologies:
  - Includes technologies with significant historical and recent additions (combined cycle, wind, solar), as well as technologies with few installations (nuclear, carbon capture and storage)

- Wind and solar resource supply curves were updated in 2019 to reflect new regionality, but we are substantively reassessing available land and resources with the Energy Communities analysis.

Full report

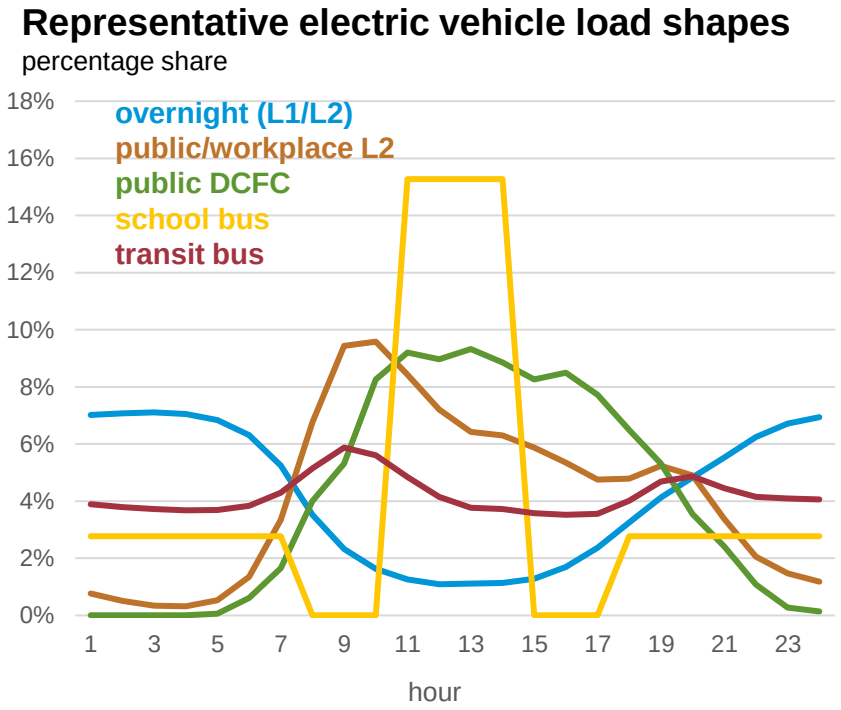
On average, residential and commercial end-use load shapes maintain their overall pattern with slightly lower peak load



Data source: NREL ResStock (for residential end-use load shapes) and ComStock (for commercial end-use load shapes)

Increase number of load shapes and modes for electric vehicles for transportation end use

- Expanding number of electric vehicles (EV) modes modeled from 5 in AEO2023 to 10
  - Light-duty vehicle (LDV) home, LDV public Level 2 (L2), LDV public DC fast-charging (DCFC), school bus, transit bus, intercity bus, commercial light truck, freight truck fleet, freight truck non-fleet, and passenger rail
- Charging falls into 7 general load shapes
  - Overnight (Level 1/L2), public/workplace L2, public DCFC, school bus, transit bus, public truck DCFC, passenger rail



Home charging and commercial charging demand allocated from transportation to residential and commercial sectors, respectively

- End-use electricity prices depend on revenue requirements to each customer class, dividing by the corresponding sales.
  - Home and commercial charging should not be accounted for in the transportation sector, but in the residential and commercial sectors, respectively.

- Future model development (beyond AEO2025): feedback between electricity prices and EV charging behavior:
  - Charging behavior may change as EV penetration increases and infrastructure is developed.
  - EV charging could potentially take advantage of lower electricity prices when solar generation is available.
  - We need to consider EV infrastructure costs (at least at distribution-level).

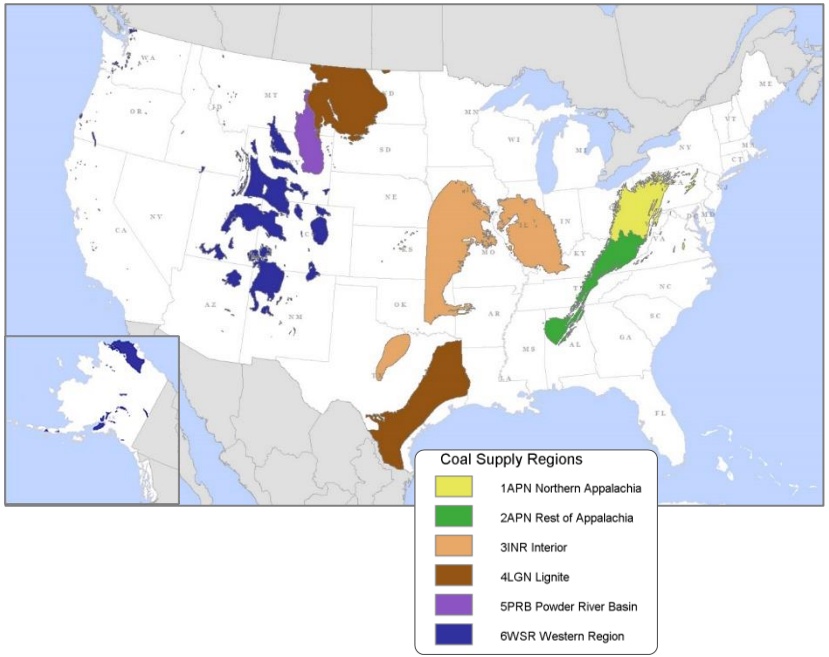
Restructure/reduce coal supply region in the Coal Market Module (CMM)

- U.S. coal production has been declining for the last 10–15 years due to demand disintegration as coal power plants continue to close. The CMM contained a detailed representation of coal supply by geographic region, coal type, mine type, and sulfur grade, which has become less relevant in today's coal market, as production in some supply areas has declined to near zero.
  - The new formulation of coal supply has combined all U.S. supply into six geographic supply regions, two mine types, five coal ranks for total of 14 possible supply curves.
  - Although coal sulfur content is still modeled, it is not considered a critical component of coal use because most coal-fired generation has installed selective catalyst reduction technology (SCRs) or other means of handling sulfur.
  - The number of active transportation pathways between these supply curves and the regional coal demand sinks will also be greatly reduced.

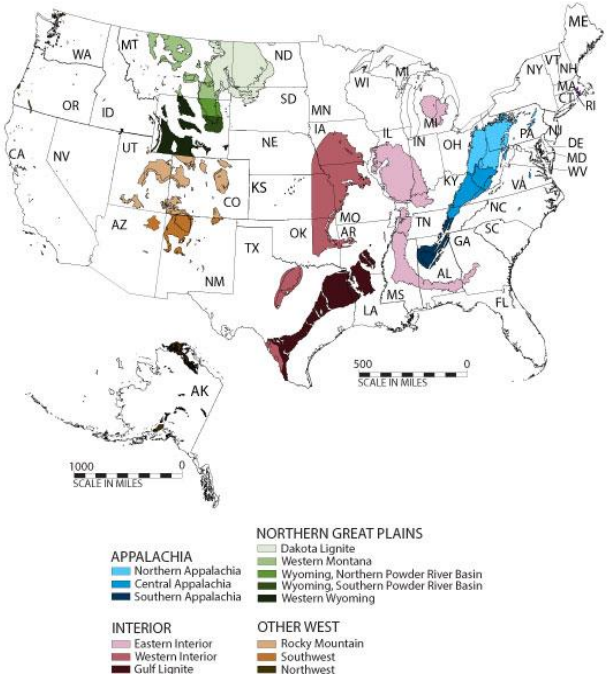
- We expect some efficiency gains from having a reduced transportation matrix in the CMM and easier coal use decisions from EMM resulting in faster solve times in both modules.

Restructure the coal supply regions in the CMM

New coal supply regions (6 regions with 14 curves)



Old supply regions (14 regions with 41 curves)



New coal supply curves

Supply curve	Supply region	Supply region name	Mine type	Coal rank
1	1APN	Northern Appalachia	Surface	Bituminous
2	1APN	Northern Appalachia	Underground	Bituminous
3	1APN	Northern Appalachia	Surface	Waste coal
4	1APN	Northern Appalachia	Underground	Premium
5	2APR	Rest of Appalachia	Surface	Bituminous
6	2APR	Rest of Appalachia	Underground	Bituminous
7	2APR	Rest of Appalachia	Underground	Premium
8	3INR	Interior	Underground	Bituminous
9	3INR	Interior	Surface	Bituminous
10	4LGN	Lignite	Surface	Lignite
11	5PRB	Powder River Basin	Surface	Subbituminous
12	6WSR	Western Region	Underground	Bituminous
13	6WSR	Western Region	Surface	Subbituminous
14	6WSR	Western Region	Surface	Bituminous

Addition of biomass energy with carbon capture as a negative emission generating technology

- BECCS is modeled as a separate plant type from biomass (wood) while using the same biomass supply.

- Performance and costs assumptions per the most recent capital cost study:
  - Based on 50–megawatt bubbling fluidized bed with 95% carbon sequestration efficiency
  - Learning rate share between biomass and sequestration

- We assume plant operators opt for 45Q tax credit for carbon dioxide sequestration (does not stack with other tax credits).

- EIA considers generation from biomass to be carbon-neutral; (net negative) CO_2 emissions will be calculated as −[*fuel consumption* × *emission factor* × (*removal rate*)], where *emission factor* = 93.8 million metric tons of CO_2 per quadrillion British thermal units.

Contact information for EIA Electricity, Coal, and Renewables Modeling Team

- Chris Namovicz, Team Leader — Chris.Namovicz@eia.gov
- Laura Martin — Laura.Martin@eia.gov
- Manussawee Sukunta — Manussawee.Sukunta@eia.gov
- Augustine Kwon — Augustine.Kwon@eia.gov
- Cara Marcy — Cara.Marcy@eia.gov
- John Taber — John.Taber@eia.gov
- Richard Bowers — Richard.Bowers@eia.gov
- David Fritsch — David.Fritsch@eia.gov
- Kien Chau — Kien.Chau@eia.gov
- Vikram Linga — Vikram.Linga@eia.gov
- Kenneth Dubin — Kenneth.Dubin@eia.gov
- Ed Thomas — Edward.Thomas@eia.gov
- Cindy Cheah — Singfoong.Cheah@eia.gov
- Nina Vincent — Nina.Vincent@eia.gov
- Alexander Felhofer — Alexander.Felhofer@eia.gov

For more information

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

Annual Energy Outlook | www.eia.gov/aeo

Short-Term Energy Outlook | www.eia.gov/steo

International Energy Outlook | www.eia.gov/ieo

Monthly Energy Review | www.eia.gov/mer

Today in Energy | www.eia.gov/todayinenergy

State Energy Profiles | www.eia.gov/state

Drilling Productivity Report | www.eia.gov/petroleum/drilling/

International Energy Portal | http://www.eia.gov/international/overview/world

National Energy Modeling System GitHub | https://github.com/EIAgov/NEMS

Questions