Independent Statistics and Analysis
U.S. Energy Information Administration

November 13, 2024

MEMORANDUM FOR: Angelina LaRose
Assistant Administrator for Energy Analysis

FROM: Jim Diefenderfer
Director, Office of Long-Term Energy Modeling

SUBJECT: Summary of second AEO2025 Macroeconomic and Industrial Working Group, held on Thursday, October 31, 2024

This memorandum summarizes the presentation and discussion at the second *Annual Energy Outlook 2025* (AEO2025) Macroeconomic and Industrial Working Group meeting. The macroeconomic and industrial groups presented preliminary AEO2025 results and planned module updates. A question-and-answer discussion followed the presentation.

The presentation slides are available in a separate document on our website. All slides, charts, and discussions for AEO2025 are preliminary and, therefore, should not be quoted or cited. We will release the final AEO2025 report in the spring of 2025.

Macroeconomic Activity Module (MAM) updates

We discussed the key updates to the MAM this year, which included the following models:

- S&P Global's U.S. Macroeconomic Model
- Industrial Output Model and real value of shipments data
- Additional disaggregation for select industries in the Industrial Output Model

Industrial Demand Module (IDM) updates

We briefly summarized top-level industrial results from AEO2023. We then discussed the key updates for the IDM in AEO2025, including:

- Implementing technology updates for energy-intensive industries, including new technology options and recycling mechanisms
- Modeling H_2 supply and demand in the National Energy Modeling System (NEMS) by:
  - Moving H_2 production out of the IDM (except for byproduct H_2 from petrochemical cracking) and modeling it in the new Hydrogen Market Module (HMM)
  - Moving total natural gas feedstock demand to the HMM, except those feedstocks used for methanol production
  - Explicitly representing existing H_2 feedstock demand in the IDM (for example, fertilizer production)

  - Adding H_2-based direct reduced iron (DRI) as a technology option in steel (a potential new source of H_2 demand, although little capacity is expected to be built in the Reference case)
- Adding a mechanism for retrofitted carbon capture capacity in the cement industry, in coordination with the new Carbon Capture, Allocation, Transportation, and Sequestration Module (CCATS)
- Including a process-emission-free clinker technology option in the cement submodule
- Determining process emissions for the glass industry
- Adding electric boilers and industrial heat pumps for most end-use industries, which increases industrial electricity demand and decreases industrial fossil fuel demand
- Creating more flexibility and price dependency in the steel industry's decision to switch from blast furnace and basic oxygen furnace capacity to electric arc furnace and DRI capacity
- Flattening industrial natural gas consumption toward the end of the projection period as a result of lower chemical macroeconomic shipments and increased electrification
- Partitioning the aggregate Balance of Manufacturing collection of non-energy-intensive industries into four separate industries
- Benchmarking purchased electricity by industry to the U.S. Census Bureau's latest *Annual Survey of Manufactures*
- Removing the motor model portion of the IDM code due to a lack of sufficiently disaggregated data
- Incorporating new *Short-Term Energy Outlook* series for marketed petroleum coke into IDM benchmarking

We also discussed potential updates for AEO2026 and beyond, such as:

- Representing specific methanol technologies and production, including e-methanol
- Adding more H_2 consumption technologies, mainly for heating
- Increasing CO_2 capture options, including for steel and newly built cement capacity
- Considering more technologies incentivized by funding from the U.S. Department of Energy's (DOE's) Industrial Demonstration Program grants
- Expanding electrification options, including with thermal batteries for industries with high-temperature needs

Discussion

An attendee asked about the negligible deployment of H_2-based DRI capacity in the IDM. Currently, DOE is negotiating two grants, each around half a billion dollars, with Cleveland-Cliffs and SSAB for the implementation of large-scale, H_2-based ironmaking plants. The attendee wanted to know if we believe these projects are feasible or if we are waiting to see them initiated before including the H_2 consumption from those projects in our modeling. We replied we are waiting for the projects to be further developed before including them explicitly in the model.[1]

An attendee asked if we will assume some H_2 is blended into natural gas fuel streams. We replied NEMS will not have H_2 blended into natural gas fuel streams in AEO2025. We currently do not expect blending

[1] This statement was incorrect. We are working on implementing a temporary lower cost for the H_2-DRI technology to represent the funding Cleveland-Cliffs has been awarded for its H_2-based steelmaking.

in the interstate transmission system, based on the costs of infrastructure and separating H_2 back out from the natural gas as well as the customer needs. We said the Electricity Market Module (EMM) in NEMS was testing H_2 blending onsite for power plants, however. We also noted we may use H_2 pipeline blending in a future AEO.

An attendee asked if AEO2026 will be a full AEO or a light AEO. We said it will be a full AEO.

An attendee asked if AEO2026 would incorporate new *Manufacturing Energy Consumption Survey* (MECS) data. We replied MECS2022 data will not be ready in time for AEO2026.[2]

An attendee asked about energy productivity and whether it would be higher than the implied rate of about 1.7% per year in AEO2023. We referred them to the Petroleum, Natural Gas, Biofuels, and Hydrogen working group, which is more focused on energy production.

An attendee asked if AEO2025 would incorporate the effects of new manufacturing plants, such as for batteries and other renewable energy-related technology components. We replied that the projected macroeconomic output series from the MAM capture output from new manufacturing plants for these industries, depending on how recently the facilities were built. However, the level of macroeconomic detail modeled in NEMS is not disaggregated enough to discern growth in these specific industries. For example, NEMS projects the aggregate Electrical Equipment, Appliance, and Component Manufacturing output instead of battery production specifically. In the IDM, we use total output from the macroeconomic series and don't generally model specific plants unless the plant is large or is incorporating a new technology (such as the aforementioned H_2 DRI projects).

An attendee asked if Slide 20 included the reduction in natural gas feedstock consumption resulting from the new fuel and feedstock accounting with the HMM. We replied that the chart should include all feedstock—for H_2 and methanol—as well as heat and power. Depending on what table and row you look at when the AEO is released, the HMM feedstock may or may not be included. Both the H_2 consumption and the electricity and fuel used to produce the H_2 will be available, but you will need to pay attention to the labels and notes in the tables.

An attendee asked when the full AEO2025 would be released. We replied it will be released some time next spring.

An attendee appreciated the addition of the H_2 DRI technology for steelmaking. He wanted to know if we would be adding aqueous electrolysis or molten oxide electrolysis technologies to the iron and steel industry in the future. We replied we are always looking to expand beyond the existing technologies that we model, but we have not considered those technologies so far. Generally, when deciding on which technologies to add, we look at how far along they are in terms of development and readiness, as well as if we can get good cost and efficiency parameters for the new technologies.

The same attendee also was glad for the addition of the calcium-silicate-based clinker technology in the cement industry. He asked if we would be looking at other non-traditional clinker chemistries, such as

[2] Although we said MECS2022 data would not be ready for AEO2026, we later found out that MECS2022 probably will be released in time for us to incorporate it.

CO_2-cured cements, magnesium oxide cements, or others. He also inquired about substituting supplementary cementitious materials or fillers to displace some of the clinker (in contrast with different clinker chemistries). Regarding other nontraditional clinker technologies, we said we may or may not consider some of those listed; it will depend in part on how similar they are to the Brimstone technology we already added. If the technologies behave similarly and have similar costs, we probably wouldn't add them, even if the process or materials were different. As for clinker substitution, we said some amount of clinker can be substituted in the model currently, and we might look at increasing that number or making it a function of other factors in the future.

An attendee noted that for electrification of industrial process heating, the efficiency varies greatly by temperature. For instance, lower temperatures (up to 165°C or maybe 200°C) can be served by high-temperature industrial heat pumps. Above that, electric resistance, electric arcs, and other technologies can be used but are less efficient. We replied we will split electrification up a bit by industry. All the end-use industries will be able to use electric boilers and heat pumps for steam. However, food, rubber products, and miscellaneous manufacturing are the only industries where we will allow heat pumps for process heat because the process temperatures for those industries are typically lower.

Attendees

Guests (Teams/phone)	*Affiliation*
Martha Moore	American Chemistry Council
Hellen Chen	American Council for an Energy-Efficient Economy
David Shin	American Petroleum Institute
Matthew DeGrandis	Deloitte Consulting
John "Skip" Laitner	Economic and Human Dimensions Research Associates
Jeffrey Rissman	Energy Innovation LLC
Nik Sawe	Energy Innovation LLC
Matthew Ives	GTI Energy
Roxana Shafiee	Harvard University
John Meyer	Leidos
Colin McMillan	National Renewable Energy Laboratory
Amogh Prabhu	OnLocation, Inc.
Peter Whitman	OnLocation, Inc.
Banafsheh Jabarivelisdeh	OnLocation, Inc.
Sharon Showalter	OnLocation, Inc.
Frances Wood	OnLocation, Inc.
Richard Fullenbaum	RFF Consulting LLC
Hannah Kolus	Rhodium group
Francesco Memoli	Tenova Inc.
Joe Perez	The Ohio Consumers Counsel
Alyssa Leibold	U.S. Bureau of Labor Statistics
Joe Cresko	U.S. Department of Energy
Jason Frost	U.S. Department of Energy
Eric Goode	U.S. Department of Energy
Keith Jamison	U.S. Department of Energy
Natalie Lefton	U.S. Department of Energy
Marc Melaina	U.S. Department of Energy
Rachel Reolfi	U.S. Department of Energy
Jun Shepard	U.S. Department of Energy

EIA attendees (Teams/phone)

Daniel Agee
Tuncay Alparslan
Jeffrey Bennett
Erin Boedecker
Peter Coletti
Jim Diefenderfer
Michael Dwyer
Kathryn Dyl
Mindi Farber-DeAnda

Peter Gross
Kevin Jarzomski
Christina Jenq
Ari Kahan
Mala Kline
Angelina LaRose
Tom Lorenz
Emily Meredith
Chris Namovicz
Boon Teck Ong
Kelly Perl
Elizabeth Sendich
Nicholas Skarzynski
Matthew Skelton
Manussawee Sukunta
Russell Tarver
Rubaiyat Tasnim
Lejla Villar
Neil Wagner
Mary Webber
Josh Whitlinger
James Willbanks
Stephen York