Second Macro-Industrial Working Group Meeting
Updates and preliminary results

September 30, 2021 | Washington, DC

By
Office of Integrated and International Energy Analysis
Office of Long-Term Energy Modeling
Annual Energy Outlook 2022 (AEO2022) Macro-Industrial Working Group: Overview

- AEO2022 macroeconomic updates and preliminary results
- AEO2022 industrial updates and preliminary results
- Longer-term plans for industrial modeling
- Discussion and questions
Review of preliminary AEO2022 macroeconomic results
Key preliminary AEO2022 macro results

• AEO2022 real GDP grows an average of 2.1% per year from 2021 to 2050

• Average growth of consumption is 2.5% over the projection period

• Nonresidential fixed investment is projected to grow 2.9% per year from 2021 to 2050 in the AEO2022

• Growth of nonfarm business productivity averages 1.9% over the projection period

Summary of the Macroeconomic Activity Module (MAM) in the National Energy Modeling System (NEMS)

- **NEMS**
  - NEMS macro baseline variables
  - NEMS energy variables
  - Other NEMS modules

- **MAM**
  - Macroeconomic submodule runs the New Scenario using new Energy Inputs from NEMS
  - Industrial submodule runs the New Scenario of values of shipments by industry sectors
  - Employment submodule runs the New Scenario of employment by sector
  - Regional submodule
  - Commercial floorspace submodule

MAM applies the ratios of the New Scenario values more than the Baseline values onto the Macro Baseline variables to obtain solution.
U.S. economy recovered in second quarter of 2021 from 31.4% real GDP contraction in the second quarter of 2020

Source: IHS Markit May 2021 Long-Term U.S. Macroeconomic Model
Growth in GDP and its components are slower in the AEO2022 projection than historically.

Average annual percentage growth:

- Real GDP: 2.2% (2.5% previous 30 years, 2.7% projected 30 years)
- Consumption: 2.6% (2.7% previous 30 years, 2.6% projected 30 years)
- Fixed nonresidential investment: 4.3% (3.1% previous 30 years, 4.3% projected 30 years)
- Fixed residential investment: 0.9% (0.0% previous 30 years, 3.1% projected 30 years)
- Exports: 3.5% (3.5% previous 30 years, 4.7% projected 30 years)
- Imports: 4.1% (4.1% previous 30 years, 5.2% projected 30 years)

Impact of the pandemic makes comparison of preliminary AEO2022 projections to past AEOs difficult

Source: U.S. Energy Information Administration, Annual Energy Outlook 2022 preliminary run
Inflation remains moderate throughout the projection and bond yields gradually rise from historic lows.

Consumption gains in share of the demand mix

Change in GDP share over projection period (percentage points)

- Consumption: AEO22 (2021-50) 4.8%, AEO21 (2020-50) 2.4%
- Government: -5.2%, -3.6%
- Nonresidential investment: -2.0%, 2.4%
- Residential investment: -0.7%, 2.4%
- Inventories: 0.0%, 1.1%
- Import: 0.6%, 2.1%
- Export: 2.1%, 2.1%

AEO2022 real GDP growth is similar to other projections

Projection | 2020-50 |
---|---|
AEO 2022 | 2.2% |
AEO 2021 | 2.1% |
IHSM (May 2021) | 2.2% |
CBO (Mar 2021) | 1.8% |
OASDI (2021) | 2.0% |
Oxford (May 2021) | 2.1% |

Macroeconomic Module changes for AEO2022

• Update of IHS Markit U.S. macroeconomic model

• Update of Industrial Output model historical data

• Update of Employment by Industry model historical data
Review of preliminary AEO2022 industrial results
AEO2022 major updates for industrial—current status

• Incorporate 2018 *Manufacturing Energy Consumption Survey* results to establish updated historical baseline (in progress)

• Improve combined-heat-and-power calculations (completed)

• Allow ethane and naphtha feedstock switching in bulk chemical subroutine (completed)

• Update ethane and propane price methodology (in progress)

• Integrate more effective fuel price sensitivity in process flow models (pushed to AEO2023)
**Manufacturing Energy Consumption Survey (MECS) 2018**

- Updating unit energy consumptions for manufacturing industries based on MECS 2018 results
  - The amount of energy needed to produce one unit of output for a given industry

- Updating non-manufacturing industries using other data sources
  - Sources:
    - *Economic Census 2017* (U.S. Census Bureau)
    - *National Agriculture Statistics Survey* (U.S. Department of Agriculture)
    - *Fuel Oil and Kerosene Sales* report (EIA)
  - Most significant changes are in construction (more natural gas) and agriculture (less overall fuel use)

- Changing the base year for the Industrial Demand Module to 2018
MECS energy consumption changes 2014–2018

- We conduct the survey every four years, and we released 2018 data this year.

- MECS supplies baseline energy consumption by manufacturing industry and fuel.

- MECS 2018 versus MECS 2014
  - Higher natural gas, hydrocarbon gas liquid consumption
  - Lower coal consumption
  - Similar electricity purchases

Sources: U.S. Energy Information Administration, MECS 2014, MECS 2018

MECS first use of fuel and feedstock
trillion British thermal units

20,000
15,000
10,000
5,000
0

2014 2018
1,586 1,481
1,578 1,119
2,446 2,898
6,412 7,320
2,600 2,591
4,809 4,894

biomass
coal
hydrocarbon gas liquids*
natural gas
net electricity
petroleum/other

*excluding natural gasoline
Energy intensity increased for natural gas and HGLs

• Comparing 2018 to 2014, manufacturing industries as a whole use more natural gas and less coal per unit of output.

• The decrease in coal consumption is most significant in paper and chemicals.

• Hydrocarbon gas liquid (HGL) intensity increases.
  – More use as chemical feedstock

Manufacturing industries fuel intensities
thousand British thermal units per 2012 dollar of shipments


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Energy intensity declined in most heavy industries

• Retirement of less-efficient equipment, replacement with newer, more-efficient equipment decreased energy intensity for many industries.

• The bulk chemicals industry built many new, energy-intensive facilities (like ethylene crackers)
  – Feedstock has been a major source of demand growth, but doesn’t become more efficient

Combined heat and power (CHP)

• Improved iron and steel, paper calculations
  – CHP in specific technologies is now counted.
  – The paper industry can now sell electricity to the grid.

• Implemented new technology parameters from 2020 study, adjusted weighting parameters in code
  – Results vary by industry, but generation is lower overall.

Chemical submodule changes

• The chemicals industry is the largest industrial energy consumer, and has recently been growing significantly.
  – Energy-intensive, with limited efficiency opportunities

• Changes allow switching between ethane and naphtha as feedstock for ethylene production, based on cost of feedstock and values of co-products.
  – Naphtha substitution is not expected to occur in the Reference case, but it could happen in some side cases (such as Low Oil Price).

• Substitute propane and normal butane for ethane when model reaches U.S. ethane production limit

• Update ethane and propane pricing model to reflect supply and demand dynamics between projected domestic feedstock production
Example ethane and naphtha capacity switching

trillion British thermal units

- Ethane more economical than naphtha
- Naphtha more economical than ethane
- More flexible capacity is built

Baseline naphtha consumption
Flexible naphtha consumption
Ethane consumption

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New chemical model changes the feedstock makeup

AEO2021 Reference case
trillion British thermal units

AEO2022 preliminary Reference case run
trillion British thermal units

Updated ethane and propane price projection methodology

- Considers constrained ethane supply
- Explicitly includes ethane and propane feedstock consumption drivers
- 2021 is a “historical” data point

Longer-term modeling and data enhancements

- Incorporate electric boilers

- Integrate more effective fuel price sensitivity in process flow industries

- Enhance sensitivity of industrial energy intensity to changes in capacity utilization

- Consider more carbon functionality (hydrogen, electrification, carbon capture)

- Continue to investigate the source of the extra natural gas left for the non-manufacturing sectors

- Restructure the industrial module more broadly: convert some parts into Python, allow for more systematic data importation from annual data sources
Questions or comments?
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AEO economic activity and STEO macroeconomic projections

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