Independent Statistics and Analysis
U.S. Energy Information Administration

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MEMORANDUM FOR: Angelina LaRose
Assistant Administrator for Office of Energy Analysis

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

Subject: Summary of Introduction to Hydrocarbon Supply Module (HSM) Working Group Meeting held on July 11, 2024

This memorandum summarizes the presentation given during the *Annual Energy Outlook* (AEO) 2025 Introduction to HSM Working Group meeting and the resulting discussions that took place.

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

Key takeaways and status of HSM implementation in NEMS:

- EIA developed and tested the Hydrocarbon Supply Module (HSM) to replace the Oil and Gas Supply Module (OGSM).
- Representing upstream petroleum and natural gas production allows insight into the impacts of policy and model assumptions.
- HSM functions much like OGSM, but changes include:
  - Written in Python
  - New modeling features (including federal/non-federal land, methane venting/flaring)
  - Streamlined representations
- Changes make HSM simpler to maintain and improve transparency of results.

Will Sommer started the presentation by reviewing HSM's scope, hydrocarbon supply representation, and relationship to other modules in NEMS. Matt Corne then reviewed the new features in the model. Will Sommer closed the presentation by describing methodology updates, comparing HSM and OGSM performance, and previewing new HSM tables to be published in AEO2025.

HSM model overview and enhancements

Will explained that HSM is one of the three new modules that EIA is introducing into the National Energy Modeling System (NEMS) with the release of AEO2025. HSM is an econometric model that projects long-term crude oil, natural gas, and natural gas plant liquid exploration, development, and production. HSM is organized into four submodules:

- Lower 48 Onshore
- Lower 48 Offshore
- Alaska
- Canadian Natural Gas

HSM improves on OGSM by creating a single discounted cash flow methodology across all submodules. The new module has a simplified methodology for calculating enhanced oil recovery (EOR) volumes in the Lower 48 onshore submodule. We have also updated cost and drilling equations in the model.

One significant change is decoupling most of the code related to carbon capture and sequestration that was in OGSM. We have worked with the developers of the new Carbon Capture, Allocation, Transportation, and Sequestration (CCATS) Module to remove all code relating to carbon capture and carbon prices from OGSM. We also have implemented a new methodology for endogenously capturing CO_2 from natural gas processing plants (NGPPs) in HSM. We have coordinated with the CCATS team to transmit CO_2 supply from NGPPs and CO_2 demand from CO_2 EOR to CCATS and to ensure these volumes are responsive to CO_2 prices.

Other significant HSM enhancements include:

- Separating crude oil and natural gas production on federal and non-federal lands to better represent royalties
- Representing methane emissions internally to enable penalties legislated in the Inflation Reduction Act to be applied to vented or flared methane emissions
- Decoupling primary and secondary production decline curves to more accurately represent well dynamics

HSM is programmed in Python, unlike OGSM, which is programmed in Fortran. HSM uses Python and SAS preprocessors to prepare inputs, for example historical well-level production. Another enhancement in HSM is our decision to have the model run every iteration instead of the more limited approach with OGSM. Running the model every iteration increases the module's responsiveness to other NEMS modules.

Discussion

The first question was regarding when the slides would be released. We indicated that we will publish a summary of the meeting and the slides on our working group web page and that we will send an email alerting all attendees when they are posted.

One attendee asked if representative wells in the new module covered both vertical and horizontal wells. Our senior upstream analyst answered that decline curves for representative wells are fit to different groups of formations and geographies. The HSM lead modeler indicated that the onshore submodule is focused on continuous projects—representative horizontal wells. New vertical wells are mostly represented using a Monte Carlo simulation to address future conventional oil and shale gas discoveries.

One attendee stated that oil and natural gas well economics will also be affected by the U.S. Environmental Protection Agency's (EPA) methane regulations on new and existing oil and natural gas operations and asked if we plan to incorporate that policy. We responded that we are aware of the EPA regulations but need to take a more detailed review to understand how to incorporate them into HSM.

One attendee asked if the methane emission rates per unit of hydrocarbon extracted are fixed or assumed to improve over time as additional natural gas pipeline takeaway and technological improvement in drilling occurs. We answered that the methane emissions rates are fixed per unit of hydrocarbon extracted at present.

Another attendee asked if we had any updates on how the resource base (or remaining wells to drill) will be handled. Our HSM lead modeler explained that we reviewed production rates in select plays where we had been aggressive in OGSM, and we understand that select geographic areas are very productive in the model based on limited historic drilling activity. We have reviewed some of these assumptions to reduce the number of wells that can be drilled in geographic areas that we believe do not have universally productive underlying geology.

A follow-on question from another attendee asked how we are accounting for resource-in-place limitations. We explained that most onshore projects are based on geologic formations and all past drilling decisions. We consider well spacing, geology, and repeatability across a county (within a play) to identify how many productive wells remain in a play or county area and where productivity declines will occur.

One attendee asked if we tested HSM responsiveness overall. For example, how much does supply increase from a permanent 10% rise in petroleum price over the baseline value? We explained that we performed tests over the past year and found HSM sufficiently responsive in terms of elasticity related to price. But we have yet to test a fully integrated HSM in the coming AEO2025.

One attendee asked if the impact of technological change on drilling costs is modeled similarly in HSM to the prior module, OGSM. We explained that the approach used in HSM and OGSM is almost identical.

One attendee asked if we are updating decline rates to the latest state regulations (for example, California well distances to infrastructure). We responded that we apply decline rates to historical data, but we do not evaluate decline rates as a function of state regulations. However, we do limit well spacing to model regulations, which require greater offsets between wells and infrastructure or residential and commercial areas. We currently model a similar law in Colorado in HSM. We will duplicate this methodology to model the California law.

Our last question was if we include natural gas liquids (NGLs) for non-shale oil and natural gas resources in HSM, which we do.

Attendees

Guests (Webex)	Affiliation
Charles Paris	Bureau of Ocean Energy Management (BOEM)
Mark Jensen	BOEM
Mike Johnson	Canada Energy Regulator
Ryan Safton	Canada Energy Regulator
Greg Dowd	U.S. Environmental Protection Agency (EPA)
Julien Isnard	EPA
Samuel Schon	ExxonMobil
Matthew Ives	GTI Energy
Boddu Venkatesh	ICF
Harry Vidas	ICF
Hitesh Mohan	Intek, Inc.
Kenneth Walsh	Leidos
Douglas Hengel	LNG Allies
Wesley Cole	National Renewable Energy Laboratory (NREL)
MacKenzie Mark-Moser	NREL
Amogh Prabhu	OnLocation, Inc.
Delia Morris	OnLocation, Inc.
Richard Fullenbaum	RFF Consulting LLC
Anna van Brummen	Rhodium Group
Ben King	Rhodium Group
Joseph Fallurin	Rocky Mountain Institute
Florent Catu	Tsinghua University
Brian Lavoie	U.S. Department of Energy (DOE)
Gavin Pickenpaugh	DOE
Ken Vincent	DOE
Natalie Lefton	DOE
Emil Attanasi	U.S. Geological Survey (USGS)
Jarrett Whistance	University of Missouri
Wyatt Thompson	University of Missouri

EIA participants (Webex)

Monica Abboud
Greg Adams
Jeffrey Bennett
Erin Boedecker
Zachary Chairez
Singfoong Cheah
Michael Cole
Peter Colletti
Troy Cook
Matthew Corne (presenter)
Anna Cororaton
Jim Diefenderfer
Kathryn Dyl
Mindi Farber-DeAnda
Adrian Geagla
Peter Gross
Ari Kahan
Mala Kline
Angelina LaRose
Katie Lewis
Trinity Manning-Pickett
John Maples
Chris Namovicz
BoonTeck Ong
Brittany Phalon
Corrina Ricker
Mark Schipper
Elizabeth Sendich
Sauleh Siddiqui
Matthew Skelton
Andrew Smiddy
William Sommer (presenter)
Daniel Stadt
Manussawee Sukunta
Gregory Vance
Neil Wagner
Mary Webber
Josh Whitlinger
Stephen York