



The National Energy Modeling System: An Overview

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Introduction

The *National Energy Modeling System: An Overview* (Overview) provides a summary of the National Energy Modeling System (NEMS), which makes projections published in our *Annual Energy Outlook* (AEO).

NEMS is an energy-economy modeling system of U.S. energy markets for the period extending through 2050. This model projects the production, imports, exports, conversion, consumption, and prices of energy, subject to a number of assumptions. The assumptions encompass macroeconomic and financial factors, world energy markets, resource availability and costs, behavioral and technological choice criteria, technology characteristics, and demographics. NEMS produces a general equilibrium solution for energy supply and demand in the U.S. energy markets on an annual basis.

Our Office of Energy Analysis develops and maintains NEMS, and analysts perform policy analyses requested by decision makers in the White House; the U.S. Congress; offices within the U.S. Department of Energy, including program offices; and other government agencies. NEMS was first used for projections presented in the AEO1994.

This [NEMS documentation page](#) has more details about each module. The [Assumptions page](#) contains separate reports about the latest assumptions for each module.

NEMS modular structure

The NEMS system contains three main parts:

- A central database to store and pass inputs and outputs between the various components
- Energy modules that represent various demand, transformation, and supply projection activities
- An integration, or convergence, module that determines when the system has reached an equilibrium between supply and demand

NEMS is a modular system ([Figure 1](#)) that consists of the following components:

Four supply modules:

- Renewable Fuels Module (RFM)
- Natural Gas Market Module (NGMM)
- Oil and Gas Supply Module (OGSM)
- Coal Market Module (CMM)

Four demand modules:

Oil and Gas Supply Module

OGSM is a comprehensive framework used to analyze oil and natural gas supply potential and related issues. Primarily, it projects domestic crude oil and natural gas production in response to price data received endogenously (within NEMS) from NGMM and LFMM. Projected natural gas and crude oil wellhead prices are determined within NGMM and LFMM, respectively. As the supply component only, OGSM cannot project prices, which are the outcome of the equilibration of both demand and supply.

OGSM provides expected natural gas production to NGMM for use in its short-term domestic nonassociated gas production functions and associated-dissolved natural gas production. Nonassociated gas production refers to natural gas produced from gas wells; associated-dissolved natural gas is natural gas produced from oil wells. The interaction of supply and demand in NGMM determines nonassociated gas production.

OGSM provides domestic crude oil production to LFMM. The interaction of supply and demand in LFMM determines the level of imports. System control information (such as projection year) and expectations (such as expected price paths) come from the Integrating Module. Major exogenous inputs include resource levels, finding-rate parameters, costs, production profiles, and tax rates—all of which are critical determinants of the oil and natural gas supply outlook of OGSM.

We include additional details in the OGSM [documentation](#).

Natural Gas Market Module

NGMM models the transmission, distribution, and pricing of natural gas in NEMS. The model code is a quadratic program that maximizes consumer plus producer surplus, minus transportation costs, subject to linear mass balance and capacity constraints. For all months in a year, NGMM determines the production, flows, and prices of natural gas in a state-level representation of the U.S. pipeline network¹ and a regional-level representation of the Canada's and Mexico's pipeline network, connecting domestic and foreign supply regions with demand regions. End-use natural gas consumption by sector, storage, and liquefied natural gas (LNG) export terminals are all integrated into the network by demand region.

NGMM accepts various exogenous inputs. For instance, imports of LNG into North America are set to historical levels in the United States and set exogenously for Canada and Mexico, according to results from our [International Energy Outlook](#). NGMM also receives inputs from other NEMS modules such as macroeconomic variables from MAM, expected production of nonassociated natural gas and associated-dissolved natural gas from OGSM, and the amount of commercial floorspace by census division from CDM.

We include additional details in the NGMM [documentation](#).

¹ Alaska's natural gas market is modeled in the NGMM independent of the integrated network.