

INTERNATIONAL ENERGY MODULE

The international energy module (IEM) consists of four submodules (Figure 4) that perform the following functions:

- world oil market submodule calculates the average annual world oil price (imported refiner acquisition cost) that is consistent with worldwide petroleum demand and supply availability
- crude oil supply submodule provides imported crude oil supply curves for five crude oil quality classes
- petroleum products supply submodule provides imported refined product supply curves for twelve types of refined products
- oxygenates supply submodule provides imported oxygenates supply curves for methyl tertiary butyl ether (MTBE) and methanol.

The world oil price that is generated by the world oil market submodule is used by all the modules of NEMS as well as the other submodules of IEM. The import supply curves for crude oils, refined products, and oxygenates are used by the petroleum market module.

World Oil Market Submodule

In NEMS, the U.S. oil market is modeled in considerable detail, while foreign markets use a less detailed approach. EIAs modeling of the near-to mid-term world oil market depends on two key assumptions: (1) oil is the marginal fuel and (2) the Organization of Petroleum Exporting Countries (OPEC) is the marginal supplier of oil. The first assumption implies that competition between oil and other fuels is not significant enough to impact the world oil price. In

addition, prices remain sufficiently low such that the market penetration of new technologies that would reduce the demand for oil is inhibited. In the second assumption, OPEC producers are assumed to expand oil production capacity in order to meet the growth in worldwide oil demand.

The various price cases examined by EIA differ in the magnitude to which OPEC producers expand their production capacity. Lower prices imply considerable capacity expansion activity with a probable assist from foreign investment interests. Higher prices imply an unwillingness on the part of OPEC producers to invite foreign investment participation. The world oil market submodule forecasts the world oil price and produces a regional world oil market supply/demand balance that is consistent with the forecasted price. The world oil price forecast is based upon a regression analysis of the price in the previous time period and the percent utilization of OPEC production capacity. IEM has either the capability to forecast world oil prices given OPEC production capacity estimates or the capability to forecast OPEC production given an exogenous world oil price path.

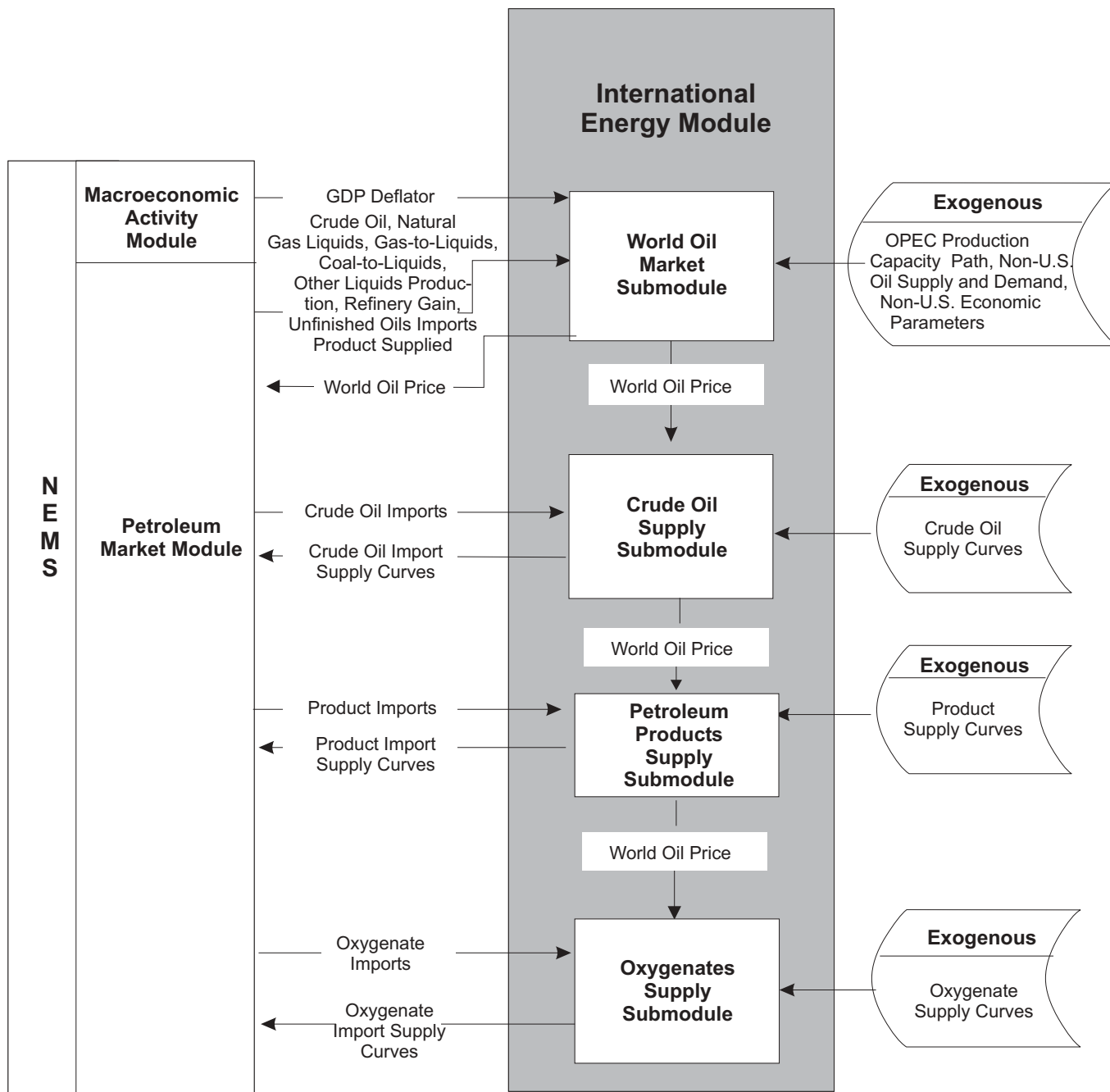
Crude Oil Supply Submodule

The crude oil supply submodule consists of a set of import supply curves to all five Petroleum Administration for Defense Districts (PADDs) for each of five quality classes of crude oils and for each simulation year. The petroleum market module uses the supply curves to determine the quantities and prices of the crude oils to be imported. Because the petroleum market module is a linear programming formulation, the imported crude oil supply curves are formulated as 3-step, piecewise-linear functions. The five classes of imported crude oils categorized by sulfur content and American Petroleum Institute (API)

IEM Outputs	Inputs from NEMS	Exogenous Inputs
World oil price Crude oil import supply curves Refined product import supply curves Oxygenate import supply curves	Domestic crude oil production Domestic natural gas liquids production Domestic gas-to-liquids production Domestic coal-to-liquids production Domestic other liquids production Domestic refinery gain Domestic product supplied GDP price deflators Domestic crude oil imports Domestic refined product imports Domestic oxygenate imports Domestic unfinished oils imports	OPEC production capacity path Reference non-U.S. oil supply and demand Non-U.S. economic parameters Base import supply curves for crude oils, refined products, and oxygenates

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Figure 4. International Energy Module Structure



gravity include: low-sulfur light, medium-sulfur heavy, high-sulfur light, high-sulfur heavy, high-sulfur very heavy.

The imported crude oil supply curves are developed exogenous to NEMS using a large-scale linear programming formulation of international refining and transportation. This formulation, known as the

World Oil Refining, Logistics, and Demand (WORLD) model, is run repetitively, parameterizing on the import levels of the five crude oil classes into each PADD. From these runs, base price/quantity relationships for imported crude oils are established. Within NEMS, these base relationships are shifted as a function of the world oil price and presented to the petroleum market module as a flexible set of

crude oil import alternatives. By observing which import supply curves are selected by the petroleum market module, it becomes possible to map these selections back into the WORLD model in order to provide estimates of future sources of crude oil imports to the United States.

Petroleum Products Supply Submodule

The petroleum products supply submodule consists of a set of import supply curves to all five PADDs for each of twelve refined product types and for each simulation year. The petroleum market module uses the supply curves to determine the quantities and prices of refined products to be imported. Because the petroleum market module is a linear programming formulation, the imported refined product supply curves are formulated as 3-step, piecewise-linear functions. The twelve types of imported refined products include: traditional gasoline (including aviation), reformulated gasoline, reformulated gasoline blending stocks for oxygenated blending (RBOB), traditional distillate fuel, low-sulfur No. 2 heating oil, low-sulfur diesel fuel, high- and low-sulfur residual fuel, jet fuel (including naphtha jet), liquefied petroleum gases, petrochemical feedstocks, and other petroleum products.

Similar to the imported crude oil supply curves, the imported refined product supply curves are also developed exogenous to NEMS using the WORLD model. By observing which import supply curves are selected by the petroleum market module, it becomes possible to map these selections back into the WORLD model in order to provide estimates of fu-

ture sources of refined product imports to the United States.

Oxygenates Supply Submodule

The oxygenates supply submodule consists of a set of import supply curves to all five PADDs for the oxygenates MTBE and methanol and for each simulation year. The petroleum market module uses the supply curves to determine the quantities and prices of oxygenates to be imported. Because the petroleum market module is a linear programming formulation, the imported oxygenate supply curves are formulated as 3-step, piecewise-linear functions. Similar to the imported crude oil supply curves, the imported oxygenate supply curves are developed exogenous to NEMS using the WORLD model. By observing which import supply curves are selected by the petroleum market module, it becomes possible to map these selections back into the WORLD model in order to provide estimates of future sources of oxygenate imports into the United States.

Because of the potential expansion of the U.S. ethanol industry and the lack of commercial markets for other oxygenates, it is assumed that ethanol, ethyl tertiary butyl ether (ETBE), tertiary amyl methyl ether (TAME), and tertiary butyl alcohol (TBA) are all supplied from domestic sources. Therefore, IEM does not provide import supply curves for these oxygenates.

By presenting NEMS with a flexible array of import choices, valuable insights can be gained on such issues as the future crude oil/refined product import composition, potential U.S. refinery expansion (both distillation capacity and downstream capacity), and future sources of petroleum imports (including Persian Gulf import dependence).