January 2006 DOE/EIA 0293(2005)


# Directory of EIA Models 2005

This directory was prepared by the Energy Information Administration, National Energy Information Center. Questions relating to the uses of specific models may be directed to the individual model contacts listed in the model descriptions. Questions about this publication, as well as other energy inquiries, may be directed to the National Energy Information Center on (202) 586-8800.

## Preface

This directory contains information about each model, including the title, acronym, description, followed by more details on characteristics, uses, and requirements. Sources for additional information are identified. Included in this directory are 18 EIA active models as of December 2005. The models are divided into two groups and are listed in alphabetical order within those groups, except for the Integrating Module, which is listed first. The first group lists those models which are part of the National Energy Modeling System (NEMS). The second group lists all other EIA models that are not part of NEMS.

# Contents

## The National Energy Modeling System



## Other EIA Models

# The National Energy Modeling System

## Integrating Module of the National Energy Modeling System (INT)

### Description

The National Energy Modeling System (NEMS) is an energy-economy modeling system of U.S. energy markets used for mid-term projections through 2030, as well as for energy and environmental policy analysis. NEMS projects the production, imports, conversion, consumption, and prices of energy, subject to macroeconomic and financial factors, world energy markets, resource availability and costs, behavioral and technological choice criteria, cost and performance characteristics of energy technologies, and demographics. The model reflects market economics, industry structure, and energy policies and regulations that influence market behavior.

The integrating module of the National Energy Modeling System controls the solution algorithm, manages the global data, and implements greenhouse gas emissions accounting and associated policy options.

This section addresses some aspects of NEMS common to all of the component modules, including computing and archive information.

### Last Model Update

October 2005

### Part of Another Model

Part of the National Energy Modeling System

### Model Interfaces

NEMS comprises the following modules with model contacts as indicated:

| | |
|---|---|
| Integrating Module | Dan Skelly (202) 586-1722 |
| Residential Sector Demand Module | John Cymbalsky (202) 586-4815 |
| Commercial Sector Demand Module | Erin Boedecker (202) 586-4791 |
| Transportation Sector Demand Module | John Maples (202) 586-1757 |
| Industrial Demand Module | Crawford Honeycutt (202) 586-1420 |
| Macroeconomic Activity Module | Ronald Earley (202) 586-1398 |
| International Energy Module | Dan Butler (202) 586-9503 |
| Coal Market Module | Diane Kearney (202) 586-2415 |
| Renewable Fuels Module | Christopher Namovicz (202) 586-7120 |
| Electricity Market Module | Jeffrey Jones (202) 586-2038 |
| Natural Gas Transmission and Distribution Module | Joseph Benneche (202) 586-6132 |
| Oil and Gas Supply Module | Ted McCallister (202) 586-4820 |
| Petroleum Market Module | William Brown (202) 586-8181 |

### Sponsor

- **Office:** Office of Integrated Analysis and Forecasting
- **Division:** Energy Demand and Integration Division
- **Model Contact:** Dan Skelly
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## Documentation

- Energy Information Administration, *Integrating Module of the National Energy Modeling System: Model Documentation 2005*, DOE/EIA-M057 (2005) (Washington, DC, May 2005). *http://tonto.eia.doe.gov/FTPROOT/modeldoc/m057(2005).pdf*
- Energy Information Administration, *National Energy Modeling System: An Overview 2003*, DOE/EIA-0581(2003) (Washington, DC, March 2003). *http://www.eia.doe.gov/oiaf/aeo/overview/index.html*

## Archive Media and Installation Manual(s)

NEMS has been archived for the reference case published in the *Annual Energy Outlook 2006*, DOE/EIA-0581(2006). The NEMS archive contains all of the nonproprietary modules of NEMS as used in the reference case.

The NEMS archive is available on an as-is basis (*ftp://eia.doe.gov/pub/oiaf/aeo/aeo2006.zip*). The purpose of the archive is to disclose the source code and inputs used, as well as to demonstrate that the published results from the AEO reference case can be reproduced by re-running the model. The archive does not include the executable model, although it can be generated from the source code of the model with the appropriate software, some of which is proprietary.

While there is no Installation Manual, brief instructions for compiling the source code, setting up a run, and replicating the AEO reference case are included in a file named "readme.txt" that is included with the archive.

## Coverage

- **Geographic:** Nine Bureau of Census Divisions. Some component analytical modules represent energy production or conversion at different levels of regional detail
- **Time Unit/Frequency:** Annual through 2030
- **Product(s):** Natural gas, electricity, coal, steam coal, metallurgical coal, distillate fuel oil, residual fuel oil, motor gasoline, jet fuel, liquefied petroleum gases, petrochemical feedstocks, kerosene, other petroleum products, methanol, ethanol, nuclear power, hydropower, and other renewable sources
- **Economic Sector(s):** Residential, commercial, industrial, and transportation end-use consumption; coal supply; oil and gas production and natural gas markets; utility and nonutility capacity, and generation of electricity; oil product pricing

## Modeling Features

- **Model Structure:** NEMS is structured as a set of quasi-independent modules, executed iteratively in a convergence algorithm designed to simulate annual energy market equilibria over the projection horizon.
- **Modeling Technique:** NEMS is a simulation of the impacts of present and planned energy market conditions and regulations on the supplies of and demands for energy products. Different techniques are applied in different sectors, as appropriate.
- **Special Features:** The primary design feature of NEMS is its modularity. That is, the model is organized by fuel production — oil, natural gas, coal, and electricity — and by end-use consumption sector. The modularity allows any single module or group of modules to be run independently as a debugging aid or for stand-alone analysis. Furthermore, modularity also allows the flexibility for each sector to be represented in the most appropriate way, highlighting the particular issues important for the sector, including the most appropriate regional structure.

## Non-DOE Data Input Sources

All data sources are listed under the appropriate modules of NEMS, which are listed in the Model Interfaces section.

## DOE Data Input Sources

All data sources are listed under the appropriate modules of NEMS, which are listed in the Model Interfaces section.

## Computing Environment

- **Hardware Used**: Personal computer workstations
- **Operating System:** Windows XP
- **Language/Software Used:**
  - Intel Visual Fortran, Version 9 (*http://www.intel.com/cd/software/products/asmo-na/eng/compilers/219759.htm*)
  - Optimization and Modeling Library (OML) from KMS Optimization Products (*http://www.ketronms.com*)
  - Global Insight Macro Model (*http://www.globalinsight.com*) as implemented with the EViews5 software package from QMS (*http://www.eviews.com*)

The parts of NEMS using OML are the Electricity Market Module, the Coal Market Module, the Petroleum Market Module, and the Natural Gas Transmission and Distribution Module. While the OML libraries are in the archive, the OML software will not run unless the user licenses the OML software with KMS Optimization Products and obtains a key. NEMS can be executed without the Global Insight model, however this holds all macroeconomic results constant at the reference case levels.

- **Memory Requirement:** 1 to 2 gigabyte RAM
- **Storage Requirement**: The archive zip file is 70 megabytes. The extracted files are about 450 megabytes. Compiling and linking the model requires about 1.5 gigabytes. Each integrated NEMS run requires 2 to 5 gigabytes of storage.
- **Estimated Run Time:** Integrated NEMS runs (*AEO2006* version) take 6 hours each with all modules on. Usually three to six runs are executed in sequence, or "cycled," to achieve convergence.

# Coal Market Module (CMM)

## Description

The Coal Market Module (CMM) is one of the four energy supply modules included in the NEMS modeling framework. The CMM simulates mining, transportation, and pricing of coal, subject to the end-use demand for coal differentiated by heat and sulfur content. U.S. coal production is represented in the CMM using 40 separate supply curves — differentiated by region, mine type, coal rank, and sulfur content. Projections of U.S. coal distribution are determined in the CMM through the use of a linear programming algorithm that determines the least-cost supplies of coal for a given set of coal demands by demand region and sector, accounting for minemouth prices, transportation costs, existing coal supply contracts, and sulfur and mercury allowance costs. Over the forecast horizon, coal transportation costs in the CMM are projected to vary in response to changes in railroad productivity and the user cost of rail transportation equipment. The CMM produces projections of U.S. steam and metallurgical coal exports and imports, in the context of world coal trade. The CMM's linear programming algorithm determines the pattern of world coal trade flows that minimizes the production and transportation costs of meeting a set of regional world coal import demands, subject to constraints on export capacities and trade flows.

The CMM consists of two submodules: Coal Production Submodule (CPS), and Coal Distribution Submodule (CDS). The CDS consists of two components: a domestic component representing the U.S. coal market, and an international component representing world coal trade.

The ***Coal Production Submodule (CPS)*** — The CPS produces supply-price relationships for 14 coal producing regions, nine coal types (unique combinations of thermal grade and sulfur content) and two mine types (underground and surface) addressing the relationship between the minemouth price of coal and corresponding levels of capacity utilization at coal mines, annual productive capacity, labor productivity, and the cost of factor inputs (mine labor, mining equipment, and fuel). The CPS generates regional, mid-term (to 2030) coal supply curves for input to the National Energy Modeling System's (NEMS's) Coal Distribution, Electricity Capacity Planning (ECP) and Electricity Fuel Dispatch (EFD) Submodules.

***Coal Distribution Submodule (CDS), Domestic Component*** — The domestic component of the Coal Distribution Submodule (CDS) forecasts coal distribution from 14 U.S. coal supply regions to 14 domestic demand regions. The model consists of a linear program with constraints representing environmental, technical and service/reliability constraints on delivered coal price minimization by consumers. Coal supply curves are input from the CPS, while coal demands are received from the Residential, Commercial, Industrial and Electric Power components of NEMS, with export and import demands being provided by the international component of the CDS.

***Coal Distribution Submodule (CDS), International Component*** — The international component of the CDS projects coal trade flows from 16 coal-exporting regions (five of which are in the United States) to 20 demand or importing regions (four of which are in the United States) for three coal types — premium bituminous, low-sulfur bituminous, and subbituminous. The model consists of supply, demand, trade and transportation components. The major coal exporting countries represented include: United States, Australia, South Africa, Canada, Indonesia, China, Colombia, Venezuela, Poland, and the countries of the Former Soviet Union. The model is used to forecast international coal trade. It provides projections of U.S. coal exports and imports to the domestic component of the Coal Distribution Submodule.

## Last Model Update

November 2005

## Part of Another Model

Part of the National Energy Modeling System (NEMS)

## Sponsor

- **Office:** Office of Integrated Analysis and Forecasting
- **Division:** Coal and Electric Power Division
- **Model Contact:** Diane Kearney
- **Telephone:** (202) 586-2415
- **E-Mail Address:** Diane.Kearney@eia.doe.gov

## Documentation

- **Coal Production Submodule (CPS)**
  - Energy Information Administration, Model Documentation, Coal Market Module of the National Energy Modeling System, Part I, DOE/EIA-M060 (2005) (Washington, DC, April 2005)
- **Coal Distribution Submodule (CDS), Domestic Component**
  - Energy Information Administration, EIA Model Documentation, Coal Market Module of the National Energy Modeling System, Part II-A, DOE/EIA-M060(2005) (Washington, DC, April 2005)
- **Coal Distribution Submodule (CDS), International Component**
  - Energy Information Administration, EIA Model Documentation, Coal Market Module of the National Energy Modeling System, Part II-B, DOE/EIA-M060(2005) (Washington, DC, April 2005), web site *http://www.eia.doe.gov/bookshelf/docs.html*

## Archive Media and Installation Manual(s)

See Integrating Module for the National Energy Modeling System (NEMS)

## Coverage

### *Coal Production Submodule (CPS)*

- **Geographic:** Supply curves for 14 geographic regions
- **Time Unit/Frequency:** 1990 through 2030
- **Product(s):** Nine coal types
- **Economic Sector(s):** Coal producers and importers

### *Coal Distribution Submodule (CDS), Domestic Component*

- **Geographic:** 14 geographic demand regions representing the U.S. domestic coal market (regions include the continental United States, Hawaii, Puerto Rico, U.S. Virgin Islands)
- **Time Unit/Frequency:** Annual forecasts for 1990–2030
- **Product(s):** Bituminous, subbituminous, lignite and waste coals in steam and metallurgical coal markets
- **Economic Sector(s):** Forecasts coal supply to two Residential/Commercial, three Industrial, two domestic metallurgical, one Coal-to-liquids, six Export, and 35 Electricity subsectors

### *Coal Distribution Submodule (CDS), International Component*

- **Geographic:** 16 export regions (five of which are in the United States) and 20 import regions (four of which are in the United States)
- **Time Unit/Frequency:** Each run represents a single forecast year. Model can be run for any forecast year for which input data are available
- **Product(s):** Coking, low-sulfur bituminous coal, and subbituminous coal
- **Economic Sector(s):** Coking and steam

## Modeling Features

### *Coal Production Submodule (CPS)*

- **Model Structure:** The CPS employs a regression model to estimate price–supply relationships for underground and surface coal mines by region and coal type, using projected levels of capacity utilization at coal mines, annual productive capacity, productivity, miner wages, capital costs of mining equipment, and fuel prices.
- **Modeling Technique:** Three main steps are involved in the construction of the coal supply curves:
  - Calibrate the regression model to base-year production and price levels by region, mine type (underground and surface), and coal type
  - Convert the regression equation into supply curves
  - Construct step–function supply curves for input to the CDS, ECP, and EFD

### *Coal Distribution Submodule (CDS), Domestic Component*

- **Model Structure:** The CDS uses 40 coal supply sources representing 12 types of coal produced in 14 supply regions. In the CDS, coal types are defined as unique combinations of thermal grade, sulfur content and mine type. The definition of coal types in the CDS differs slightly from the NEMS CPS, where coal types are defined as unique combinations of thermal grade and sulfur content. Coal shipments to consumers are represented by transportation rates specific to NEMS sector and supply curve/demand region pair, based on historical differences between minemouth and delivered prices for such coal movements. In principle there are 27,440 such rates for any forecast year; in practice there are less since many rates are economically infeasible and a unique transportation rate is not derived for each of the 35 electricity sectors. Coal supplies are delivered to up to 49 demand subsectors in each of the 14 demand regions. Currently the NEMS system provides projections of U.S. coal demand through 2030.
- **Modeling Technique:** The model utilizes a linear programming that minimizes delivered cost to all demand sectors.
- **Special Features:**
  - The NEMS residential, commercial, and industrial models provide demands for those sectors, while the NEMS Petroleum Market Module provides demands for the coal-to-liquids sector and the NEMS Electricity Market Module provides demands for the electricity generation sectors. The CDS provides coal production, Btu conversion factors, minemouth, transportation and delivered costs for coal supplies to meet these demands to the NEMS system.
  - The CDS interfaces with the international component of the CDS to determine quantities of U.S. coal export and imports.
  - The CDS interfaces with the Coal Market Module's Coal Production Submodule to receive supply curves that specify the minemouth price in relation to the quantity demanded. In turn, the CPS receives production quantities from the CDS that are used to revise its prices, if necessary, for subsequent iterations

### *Coal Distribution Submodule (CDS), International Component*

- **Model Structure:** Satisfies coal import demands at the lowest cost based on specified supply and transportation costs, and subject to projected overall levels of available coal export capacities by region and by coal type.
- **Modeling Technique:** The model is a Linear Program (LP), which satisfies demands at all points at the minimum overall "world""coal cost plus transportation cost and is embedded within the Coal Market Module.

## Non-DOE Data Input Sources

### *Coal Production Submodule (CPS)*

- U.S. Department of Labor, Bureau of Labor Statistics
  - Average Hourly Earnings of Production Workers (Coal Mining), Series ID's: EEU10120006 and CEU1021210006
  - PPI for Mining Machinery and Equipment Manufacturing, Series ID: PCU333131333131
- U.S. Census Bureau, 2002 Economic Census — Mining
  - Bituminous Coal and Lignite Surface Mining: 2002, EC02-211-212111 (RV) (Washington DC, December 2004)
  - Bituminous Coal Underground Mining: 2002, EC02-212112 (RV) (Washington DC, December 2004)
  - Anthracite – Mining: 2002, EC02-212113 (RV) (Washington DC, October 2004)
- Global Insight
  - Yield on Utility Bonds
- U.S. Environmental Protection Agency, Emission Standards Division
  - *Information Collection Request for Electric Utility Steam Generating Unit, Mercury Emissions Information Collection Effort* (Research Triangle Park, NC, 1999)

These non-DOE data are used to derive the following inputs for the CPS:

- Average annual coal-mining wages
- Term representing the average annual user cost of mining machinery and equipment
- Average annual price of fuel at U.S. coal mines
- Average mercury content of coal

***Coal Distribution Submodule (CDS), Domestic Component***

- U.S. Department of Commerce
  - Monthly Report EM 545
  - Monthly Report EM 145
- Association of American Railroads
  - *Railroad Facts, 2002 Edition* (Washington, DC, October 2002), and previous editions
- U.S. Department of Labor, Bureau of Labor Statistics
  - PPI for Railroad Equipment, Series ID: WPU144
- Global Insight
  - Yield on Utility Bonds

These non-DOE sources are used to derive the following inputs for the domestic component of the CDS:

- U.S. coal import and export quantities by region
- Labor productivity for rail freight shipments
- Term representing the average annual user cost of capital for railroad equipment

***Coal Distribution Submodule (CDS), International Component***

- SSY Consultancy and Research, Ltd
- International Energy Agency
- IEA Coal Research
- McCloskey Coal Information, Ltd
- Platts International Coal Report
- Energy Publishing LLC's Coal Americas

These non-DOE sources are used to derive the following inputs for the international component of the CDS:

- Coal import demands for international demand regions
- Non-U.S. coal export supply curves
- Diversity constraints for international coal import regions
- Ocean freight rates

## DOE Data Input Sources

***Coal Production Submodule (CPS)***

- Energy Information Administration
  - Form EIA-3, Quarterly Coal Consumption and Quality Report, Manufacturing Plants
  - Form EIA-5, Quarterly Coal Consumption and Quality Report, Coke Plants
  - Form EIA-6A, Coal Distribution Report
  - Form EIA-7A, Coal Production Report
  - Form EIA-423, Monthly Cost and Quality of Fuels for Electric Plants Report
  - *Electric Power Annual — 2003 Spreadsheets* (Washington, DC, January 2005), web site *www.eia.doe.gov*
  - *Petroleum Marketing Annual 2004,* DOE/EIA-0487(2004) (Washington DC, August 2005), Table 2
  - B.D. Hong and E.R. Slatick, "Carbon Dioxide Emission Factors for Coal," in Energy Information Administration, *Quarterly Coal Report,* January-March 1994, DOE/EIA-0121 (94/Q1) (Washington, DC, August 1995).
- U.S. Federal Energy Regulatory Commission
  - Form 423, Monthly Report of Cost and Quality of Fuels for Electric Plants

These DOE data are used to derive the following inputs for the CPS:

- Historical data for the regression model used for estimating coal supply curves
- Base year values for U.S. coal production, productive capacity, productivity, minemouth prices, and fuel costs
- Average heat and sulfur content by supply curve
- Carbon emission factors by supply curve

***Coal Distribution Submodule (CDS), Domestic Component***

- Energy Information Administration
  - Form EIA-3, Quarterly Coal Consumption and Quality Report, Manufacturing Plants
  - Form EIA-5, Quarterly Coal Consumption and Quality Report, Coke Plants
  - Form EIA-6A, Coal Distribution Report
  - Form EIA-7A, Coal Production Report
  - Form EIA-906, Power Plant Report
  - Form EIA-920, Combined Heat and Power Plant Report
  - Form EIA-423, Monthly Cost and Quality of Fuels for Electric Plants Report
  - Coal Transportation Rate Database
- U.S. Federal Energy Regulatory Commission
  - FERC Form 423, Monthly Report of Cost and Quality of Fuels for Electric Plants
  - FERC Form 580, Interrogatory on Fuel and Energy Purchase Practices

These DOE data are used to derive the following inputs for the domestic component of the CDS:

- Historical rail transportation cost data by region (east and west) for the regression model used for projecting coal transportation rate indices
- Coal demand shares by sector and region
- Annual coal supply/transportation contract quantities by coal supply and demand regions, coal quality (Btu and sulfur content) and expiration date
- Average annual base-year coal transportation rates specified by supply curve, demand region and demand sector

***Coal Distribution Submodule (CDS), International Component***

None

## Computing Environment

See Integrating Module of the National Energy Modeling System

# Commercial Sector Demand Module (CSDM)

## Description

The NEMS Commercial Sector Demand Module is a simulation tool based upon economic and engineering relationships that models commercial sector energy demands at the nine Census Division level of detail for 11 distinct categories of commercial buildings. Commercial equipment selections are performed for the major fuels of electricity, natural gas, and distillate fuel, for the major services of space heating, space cooling, water heating, ventilation, cooking, refrigeration, and lighting. The market segment level of detail is modeled using a constrained life-cycle cost minimization algorithm that considers commercial sector consumer behavior and time preference premiums. The algorithm also models the minor fuels of residual oil, liquefied petroleum gas, steam coal, motor gasoline, and kerosene, the renewable fuel sources of wood and municipal solid waste; and the minor services of office equipment (with a separate breakout of personal computers), and "other" in less detail than the major fuels and services. Distributed generation and combined heat and power are represented using a detailed cumulative positive cash flow approach to model penetration of distributed resources. Numerous specialized considerations are incorporated, including the effects of changing building shell efficiencies and consumption to provide district services.

## Last Model Update

October 2005

## Part of Another Model

National Energy Modeling System (NEMS)

## Sponsor

- **Office:** Office of Integrated Analysis and Forecasting
- **Division:** Energy Demand and Integration Division
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- **E-Mail Address:** Erin.Boedecker@eia.doe.gov

## Documentation

Energy Information Administration, U.S. Department of Energy, Model Documentation Report: Commercial Sector Demand Model of the National Energy Modeling System, DOE/EIA-M066 (2006) (Washington, DC, February 2006). *http://tonto.eia.doe.gov/FTPROOT/modeldoc/m066(2006).pdf*

## Archive Media and Installation Manual(s)

See Integrating Module of the National Energy Modeling System (NEMS)

## Coverage

- **Geographic:** Nine Census Divisions: New England, Mid Atlantic, East North Central, West North Central, South Atlantic, East South Central, West South Central, Mountain, Pacific
- **Time Unit/Frequency:** Annual through 2030
- **Product(s):** Electricity, natural gas, distillate, residual oil, liquefied petroleum gas, steam coal, motor gasoline, kerosene, wood, municipal solid waste
- **Economic Sector(s):** Eleven building categories: assembly, education, food sales, food services, healthcare, lodging, large office, small office, mercantile and service, warehouse, other. Ten services: space heating, space cooling, water heating, ventilation, cooking, lighting, refrigeration, PC-related office equipment, non-PC-related office equipment, and other

## Modeling Features

- **Model Structure:** Sequential calculation of forecasted commercial floorspace, service demand, distributed resources penetration, technology choice, and end-use consumption.
- **Modeling Technique:** Simulation of technology choice by decision type, within a service, within a building and Census division, for the current year of the forecast. Commercial Buildings Energy Consumption Survey 1995 and 1999 data are used for initial floorspace, market shares, fuel shares, district service shares. Engineering analyses are used for initial efficiency estimates.
- **Special Features:** Technology choice database and simulation technique is capable of accommodating an extensive range of policy analyses, including but not limited to demand-side management capital incentives, tax credits, and equipment efficiency standards.

## Non-DOE Data Input Sources

- F.W. Dodge
  - Non-residential building construction starts for development of building survival parameters
  - Description of floorspace categorization to enable mapping to DOE sources
- Arthur D. Little Technical Reports, EPRI Technical Assessment Guide, GRI Baseline Data Book, Navigant Consulting, Inc. Technical Reports, ONSITE SYCOM CHP report (references provided in Appendix C to the model documentation)
  - Commercial sector existing equipment characteristics, including typical equipment capacity, installed capital cost, operating and maintenance (O&M) cost, expected physical lifetime based on data from the years 1990–2004
  - Equipment research and development (R&D) advances and projected dates of model introduction, projections for technology availability encompassing the years 2005–2030

## DOE Data Input Sources

- Commercial Building Energy Consumption Survey (CBECS), 1999 characteristics and building-level consumption, 1995 end-use energy consumption
  - Base year floorspace by Census division, building type, building age cohort, energy-consuming characteristics
  - Base year district service consumption totals and relative shares
  - Base year Energy Use Intensity (EUI) by Census division, building type, and energy service
  - Base year equipment stock characteristics by Census division and energy service
  - Base year energy consumption for calculation of nonbuilding consumption to benchmark
- Form EIA-860B, Annual Electric Generator Report — Nonutility, forms for year 2000
  - Historical commercial sector quantities of electricity generated by Census division, generating fuel, and building type
  - Annual consumption of fuels for combined heat and power by Census division and building type
  - Current status of commercial sector generating facilities
- Form EIA-860, Annual Electric Generator Report forms for years 2001–2004
  - Historical commercial sector quantities of electricity generated by Census division, generating fuel, and building type
  - Annual consumption of fuels for combined heat and power by Census division and building type
  - Current status of commercial sector generating facilities
- National Renewable Energy Laboratory (NREL) Interlaboratory Documentation, 1990
  - Forecasted commercial sector renewable energy demand, by renewable source and energy service

## Computing Environment

See Integrating Module of the National Energy Modeling System (NEMS)

# Electricity Market Module (EMM)

## Description

The NEMS Electricity Market Module (EMM) provides a major link in the NEMS framework. In each model year, the EMM receives electricity demand from the NEMS demand modules, fuel prices from the NEMS fuel supply modules, expectations from the NEMS system module, and macroeconomic parameters from the NEMS macroeconomic module and then estimates the actions taken by electric utilities and nonutilities to meet demand in the most economical manner. The EMM then outputs electricity prices to the demand modules, fuel consumption to the fuel supply modules, emissions to the system module, and capital requirements to the macroeconomic module. The model is iterated until a solution is reached for that model year. The EMM consists of four submodules: Electricity Capacity Planning (ECP), Electricity Fuel Dispatch (EFD), Electricity Finance and Pricing (EFP), and Electricity Load and Demand (ELD).

### *Electricity Capacity Planning Submodule (ECP)*

The purpose of the ECP is to determine how the electric power industry will change its mix of generating capacity over the forecast horizon. It evaluates retirement decisions for fossil and nuclear plants and captures responses to environmental regulations, such as the CAAA or limits on carbon emissions. It includes traditional and nontraditional sources of supply. The ECP also represents changes in the competitive structure (i.e., deregulation). Due to competition, no distinction is made between utilities and nonutilities as owners of new capacity.

### *Electricity Fuel Dispatch Submodule (EFD)*

The objective of the EFD is to represent the economic, operational, and environmental considerations in electricity dispatching and trade. The EFD allocates available generating capacity to meet the demand for electricity on a minimum cost basis, subject to engineering constraints and to restrictions on emissions such as $SO^2$, NOx, mercury, and carbon.

### *Electricity Finance and Pricing Submodule (EFP)*

The EFP forecasts financial information for electric utilities on an annual basis given a set of inputs and assumptions concerning forecast capacity expansion plans, operating costs, regulatory environment, and financial data. The outputs of the model include electricity prices by end use sectors for North American Electric Reliability (NERC) and Census regions, financial statements, revenue requirements, and financial ratios for each state of production (generation, transmission, and distribution).

### *Electricity Load and Demand Submodule (ELD)*

Broadly speaking, the ELD submodule has been designed to perform two major functions:

- Translate total electricity consumption forecasts into system load shapes
- Translate census division demand data into NERC region data, and vice versa

## Emissions

The EMM tracks emission levels for sulfur dioxide ($SO^2$), nitrogen oxides (NOx), and mercury (hg). Facility development, retrofitting, and dispatch are constrained to comply with the constraints to the Clean Air Act Amendments of 1990 (CAAA90), the Clean Air Interstate Rule (CAIR), and the Clean Air Mercury Rule (CAMR). An innovative feature of this legislation is a system of trading emissions allowances. The trading system allows a utility with a relatively low cost of compliance to sell its excess compliance (i.e., the degree to which its emissions per unit of power generated are below maximum allowable levels) to utilities with a relatively high cost of compliance. The trading of emissions allowances does not change the national aggregate emissions level set by CAAA90, but it does tend to minimize the overall cost of compliance.

## Last Model Update

September 2005

## Part of Another Model

Part of the National Energy Modeling System (NEMS)

## Sponsor

- **Office:** Office of Integrated Analysis and Forecasting
- **Division:** Coal and Electric Power Division
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## Documentation

Energy Information Administration, *Model Documentation Report: The Electricity Market Module of the National Energy Modeling System,* DOE/EIA-M068 (Washington, DC, March 2006) *http://tonto.eia.doe.gov/FTPROOT/modeldoc/m068(2006).pdf*

## Archive Media and Installation Manual(s)

See Integrating Module of the National Energy Modeling System

## Coverage

- **Geographic:** 13 North American Electric Reliability Council (NERC) Regions and Subregions, called EMM regions
- **Time Unit/Frequency:** Annually through 2030
- **Product(s):**
  - Electricity prices and price components
  - Fuel demands
  - Capacity additions
  - Capital requirements
  - Emissions
  - Renewable capacity
  - Avoided costs
- **Economic Sector(s):** Electric utilities and non-utilities

## Modeling Features

- **Model Structure:**
  - ***ECP*** — The ECP is executed once a year to determine planning decisions that must be initiated in the current forecast year and completed within the planning horizon. The ECP uses a linear programming (LP) formulation to compete options for meeting future demands for electricity and complying with environmental regulations. It selects the strategies that minimize the total present value of the investment and operating costs over a pre-specified period, subject to certain conditions. These conditions include requirements that demands for electricity (accounting for seasonal and daily fluctuations variations and transmission/distributions losses) are met, minimum reliability requirements are satisfied, and emissions limits are not exceeded.
  - ***EFD*** — The EFD addresses utility and nonutility supplies endogenously; i.e., the EFD dispatches new nonutility sources together with utility fossil-fuel, geothermal, biomass, and nuclear generating capacity. However, existing nonutility supply, along with nontraditional cogenerators, are considered "must run:" units and are placed such that they are always dispatched. Most of these facilities have contracts with utilities to purchase power, so this treatment ensures that the model output reflects actual usage. Traditional cogeneration and intermittent renewable technologies are represented exogenously with the load curve adjusted prior to dispatching other generating technologies.
  - ***EFP*** — The EFP is an accounting system that models regulatory and competitive markets and is completely deterministic. It has solution algorithms for the generation, transmission, and distribution stages of production. Pricing mechanisms are implemented for the generation and transmission stages of production to enhance the model's flexibility in simulating emerging pricing techniques used in the electric power industry.
  - ***ELD*** — The ELD submodule is designed to be a fully integrated part of the NEMS framework. The primary functions of the ELD submodule are to develop regional system load duration curves from demand estimates for the ECP and EFD modules and to translate the nine Census division electricity demand estimates into the 13 NERC regions and subregions that the EMM requires.

- **Modeling Technique**
  - ***ECP*** — The ECP uses a linear programming (LP) formulation to determine planning decisions for the electric power industry. The ECP contains a representation of planning and dispatching in order to examine the trade-off between capital and operating costs. It simulates least-cost planning and competitive markets by selecting strategies for meeting expected demands and complying with environmental restrictions that minimize the discounted, present value of investment and operating costs. The ECP explicitly incorporates current emissions restrictions and provides the flexibility to examine potential regulations such as emissions taxes and carbon stabilization.
  - ***EFD*** — The EFD uses a linear programming algorithm to provide a least-cost solution to allocating (dispatching) capacity to meet demand. Dispatching involves deciding what generating capacity should be operated to meet the demand for electricity, which is subject to seasonal, daily, and hourly fluctuations. The objective of the EFD is to provide an economic/environmental dispatching procedure. In an economic (least-cost) dispatch, the marginal source of electricity is selected to react to each change in load. In environmental dispatching, the demand for electricity must be satisfied without violating certain emissions restrictions. The EFD integrates the cost-minimizing solution with environmental compliance options to produce the least-cost solution that satisfies electricity demand and restricts emissions to be within specified limits.
  - ***EFP*** — The EFP is an accounting system that models regulatory practice and is completely deterministic. It also determines prices in a competitive market. It has solution algorithms for the generation, transmission, and distribution stages of production. Pricing mechanisms are implemented for the generation and transmission stages of production to enhance the model's flexibility in simulating emerging pricing techniques used in the electric power industry. There are many pricing mechanisms that could be used for this purpose. The regulated price uses the traditional cost of service method based on average costs. The competitive price utilizes marginal cost pricing. The modular design of this submodule will allow the user to plug in additional pricing methods as they are needed in the future.
  - ***ELD*** — The basic algorithm can be thought of as an end-use building block approach. The system demand is divided into a set of components called end-uses. The hourly loads for each end-use are forecast. Next, the hourly loads of each end-use are summed to yield the forecast of system load at the customers' meters (i.e., hourly system sales). The final step is to simulate transmission and distribution losses. The regional hourly loads are calculated as the sum of hourly system sales and transmission and distribution losses.

## Non-DOE Data Input Sources

- North American Electric Reliability Council (NERC)
  - *Reliability Assessments Reports*
  - *Electricity Supply and Demand Database*
- Pacific Gas and Electric, Hydro-Quebec, Manitoba Hydro, and British Columbia Hydro
- Environmental Protection Agency (EPA)
  - Allowance Tracking System (ATS)
  - NOx Allowance Tracking System (NATS)
  - "Analyzing Electric Power Generators Under the CAAA, Appendix 5" (Washington, DC, March 1998)
  - Continuous Emissions Monitoring System (CEMS)
- ICF, Incorporated
  - A survey of Canadian taxes
- Oak Ridge National Laboratories, Energy Economic Database (EEDB), various program phases

## DOE Data Input Sources

***Forms and Publications***

- Energy Information Administration, Form EIA-860, Annual Generator Report
  - Capacity and fuel source information
- Energy Information Administration, Form EIA-867, Annual Nonutility Power Producer Report
  - Installed capacity, energy consumption, generation and electric energy sales to electric utilities and other nonutilities by facility

- Energy Information Administration, Form EIA-767, Steam Electric Plant Operation and Design Report
  - Plant operations and equipment design (including boiler, generator, cooling system, flue gas desulfurization, flue gas particulate collectors, and stack data)
- Energy Information Administration, Form EIA-759, Monthly Power Plant Report
  - Monthly data on net generation, consumption of coal, petroleum, and natural gas; and end-of-the-month stocks of petroleum and coal for each plant by prime mover and fuel type combination
- Energy Information Administration, Form EIA-411, Coordinated Regional Bulk Power Supply Program Report
  - Actual energy and peak demand for the preceding year and 10 additional years; existing and future generating capacity; scheduled capacity transfers; projections of capacity, demand, purchases, sales, and scheduled maintenance; assessment of adequacy; generating capacity unavailability; bulk power system maps; near term transmission adequacy; future critical bulk power facilities that may not be in service when required; and system evaluation criteria
- Federal Energy Regulatory Commission (FERC), FERC Form 1, Annual Electric Utility Report
  - Income and earnings, taxes, depreciation and amortization, salaries and wages, operating revenues, and operating and maintenance costs
- Federal Energy Regulatory Commission, Form FERC-423, Monthly Report of Cost and Quality of Cost and Quality of Fuels for Electric Plants
  - Cost and performance data for both existing and future units
- Distributed Utility Associates, Assessing Market Acceptance and Penetration for Distributed Generation in the United States, Spring 1999, prepared for EIA. This report contains cost and performance characteristics for modeling distributed generation in the Electricity Market Module.

***Models and Other***

- Energy Information Administration, Office of Integrated Analysis and Forecasting, Cost and Performance Database for New Generating Technologies
  - A database of current costs and performance characteristics
- U.S. Department of Energy, *Northern Lights: The Economic and Practical Potential of Imported Power from Canada*, DOE/PE-0079 (Washington, DC, December 1987)
  - Capital costs to build
  - Variable and fixed operating and maintenance costs
  - Transmission costs
  - Various publications on Canadian energy supply cited in the Northern Lights bibliography

*System Modules*

- Cogeneration and other electricity production, Commercial and Industrial Demand Modules
- Generation from renewable sources
- Renewables Fuels Module
- Fossil fuel prices — Fuel Supply Modules of NEMS
- $SO^2$ and mercury emissions — Coal Market Module
- Bond rates — Macroeconomic Activity Module
- Capacity utilization by technology — Renewable Fuels Module
- Electricity consumption by sector and region, traditional cogeneration

*Demand Modules*

- Fuel and variable O&M costs, fixed O&M costs, $SO^2$ allowance costs, RPS allowance costs, trade results and nonutility generation — EFD
- Sectoral consumption by time period — ELD
- New plant capital costs, plant type, ownership type, and retrofit decisions — ECP

# Industrial Demand Module (IDM)

## Description

The Industrial Demand Module is based upon economic and engineering relationships that model industrial sector energy consumption at the nine Census Division level of detail. The seven most energy-intensive industries are modeled at the detailed process step level and eight other industries are modeled at a less detailed level. The Industrial Demand Module incorporates three components: buildings; process and assembly; and boiler, steam, and cogeneration.

## Last Model Update

October 2005

## Part of Another Model

Part of the National Energy Modeling System (NEMS)

## Sponsor

- **Office:** Office of Integrated Analysis and Forecasting
- **Division:** Demand and Integration Division
- **Model Contact:** T. Crawford Honeycutt
- **Telephone:** (202) 586-1420
- **E-Mail Address:** Crawford.Honeycutt@eia.doe.gov

## Documentation

Energy Information Administration, *Model Documentation Report: Industrial Sector of the National Energy Modeling System,* DOE/EIA-M064 (Washington, DC, May 2005). *http://tonto.eia.doe.gov/FTPROOT/modeldoc/m064(2005).pdf*

## Archive Media and Installation Manual(s)

See Integrating Module of the National Energy Modeling System

## Coverage

- **Geographic:** Nine Census divisions: New England, Mid-Atlantic, East North Central, West North Central, South Atlantic, East South Central, West South Central, Mountain, Pacific
- **Time Unit/Frequency:** Annual through 2030

## Modeling Features

- **Model Structure:** Nine manufacturing and six nonmanufacturing industries. The manufacturing industries are further subdivided into the energy-intensive and nonenergy-intensive industries.
  - Each industry is modeled as three separate but interrelated components consisting of the process/assembly component (PA), the buildings component (BLD), and the boiler/steam/cogeneration component (BSC).
- **Modeling Technique:** The energy-intensive industries are modeled through the use of a detailed process flow accounting procedure. The remaining industries use the same general procedure but do not include a detailed process flow.

## Non-DOE Data Input Sources

- National Energy Accounts
  - Historical dollar value of output in the industrial sector

## DOE Input Sources

- Form EIA-867, Survey of Independent Power Producers; Form EIA-860, Annual Generator Report
  - Electricity generation, total and by prime mover
  - Electricity generation for own use and sales
  - Capacity utilization
- *Manufacturing Energy Consumption Survey 2002*, March 2005
- *State Energy Data System 2001,* August 2004

## Computing Environment

See Integrating Module of the National Energy Modeling System

# International Energy Module (IEM)

## Description

IEM is a recursive model of world petroleum supply and demand by region derived from EIA's Oil Market Simulation (OMS-PC) Model (retired) with enhanced detail on U.S. market conditions from the NEMS Petroleum Market Model (PMM). IEM determines PAD District-level import supply schedules by refined product type and crude oil grade consistent with estimated world oil price. IEM outputs include forecasted world oil price, non-OPEC oil production and oil consumption by region, and OPEC oil production and capacity utilization.

## Last Model Update

September 2005

## Part of Another Model

National Energy Modeling System (NEMS)

## Sponsor

- **Office:** Office of Integrated Analysis and Forecasting
- **Division:** International, Economic, and Greenhouse Gases Division
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- **E-Mail Address:** george.butler@eia.doe.gov

## Documentation

Energy Information Administration, *Model Documentation Report: NEMS International Energy Module,* DOE/EIA-M071 (2005) (Washington, DC, May 2005). *http://tonto.eia.doe.gov/FTPROOT/modeldoc/m07199.pdf*

## Archive Media and Installation Manual(s)

See the Integrating Module of the National Energy Modeling System

## Coverage

- **Geographic:**
  - ***Demand Regions:*** United States, U.S. Territories, Canada, Mexico, Western Europe, Japan, Australia and New Zealand, Former Soviet Union, Eastern Europe, China, India, South Korea, Other Asia, Middle East, Africa, South and Central America
  - ***Supply Regions:*** United States, Canada, Mexico, Western Europe, Japan, Australia and New Zealand, Russia, Caspian & Other Former Soviet Union, Eastern Europe, China, Other Asia, Middle East, Africa, South and Central America, OPEC Asia, OPEC Middle East, OPEC North Africa, OPEC West Africa, OPEC South America
  - ***U.S. Detail:*** PAD District-level import supply curves
- **Time Unit/Frequency:** Annual through 2030
- **Product(s):** Five grades of crude oil, 14 refined products, two oxygenates (methanol and MTBE), and four intermediate streams
- **Economic Sector(s):** Major oil-consuming countries, regionalized above

## Modeling Features

- **Model Structure:** The model includes three subcomponents: The World Oil Market (WOM); Petroleum Product Supply (PPS); and Oxygenates Supply (OS). The structure of the WOM component is based on the OMS model (now retired), with greater U.S. detail from NEMS PMM.
- **Modeling Technique:** Recursive simulation (search for equilibrium oil price), linear programming (derive import supply curves), econometrics (estimate parameters of OPEC price reaction curve and rest of world crude demand/supply curves)
- **Special Features:** None

## Non-DOE Data Input Sources

None

## DOE Data Input Sources

- Energy Information Administration, *Annual Energy Review, Monthly Energy Review, International Energy Annual*, and *International Petroleum Statistics Report* (Washington, DC, annually)
  - U.S. crude oil supply and demand from PMM, reference demand and supply for rest of world (ROW) regions, initial (unadjusted) import supply curves from WORLD LP model

## Computing Environment

See Integrating Module of the National Energy Modeling System

# Macroeconomic Activity Module (MAM)

## Description

MAM is comprised of three submodules: Macroeconomic, Industry, and Regional. The ***Macroeconomic Submodule*** is the Global Insight Model of the U.S. Economy and is the same model used by Global Insight Inc. to generate the economic forecasts behind the company's monthly assessment of the U.S. economy. The model is a 1,700-equation specification of the U.S. economy that forecasts macroeconomic driver variables at the national level of detail.

The ***Industry Submodule*** is a derivative of Global Insight's industry and employment models. The models have been tailored in order to provide the industry and employment detail required by the NEMS modeling system.

The ***Regional Submodule*** was developed by EIA and is comprised of the Regional Macroeconomic Model, Regional Industry and Employment Model, and the Regional Commercial Floorspace Model. The first two models were developed during 2004 for use in the preparation of the *Annual Energy Outlook (AEO) 2005* and the third was re-estimated for *AEO2006*.

## Last Model Update

October 2005

## Part of Another Model

National Energy Modeling System (NEMS)

## Sponsor

- **Office:** Office of Integrated Analysis and Forecasting
- **Division:** International, Economic, and Greenhouse Gases Division
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## Documentation

Energy Information Administration, *Model Documentation Report: Macroeconomic Activity Module (MAM) of the National Energy Modeling System,* DOE/EIA-M065 (2006) (Washington, DC, January 2006) *http://tonto.eia.doe.gov/FTPROOT/modeldoc/m065(2006).pdf*

## Archive Media and Installation Manual(s)

See Integrating Module of the National Energy Modeling System

## Coverage

- **Geographic:** Nine Census Divisions
- **Time Unit/Frequency:** Annual through 2030 (for AEO2006)
- **Product(s):** Forecasts of domestic macroeconomic driver variables, at the national, industry, and nine Census Division levels of detail
- **Economic Sector(s):** National and regional economic activity

## Modeling Features

- **Model Structure:** MAM is comprised of three submodules: Macroeconomic, Industry, and Regional. The Macroeconomic and the Industry submodules are acquired from Global Insight, Inc. while the Regional submodule was developed within EIA.
- **Modeling Technique:** The Macroeconomic and Regional submodules are statistically estimated models of economic activity. The Industry submodule employs both an Input-Output structure as well as statistical estimation techniques.
- **Special Features:** None

## Non-DOE Data Input Sources

Procurement of proprietary models from Global Insight, Inc.:

- Global Insight Model of the U.S. Economy
- Global Insight Industry and Employment Models

Additional data is acquired from non-DOE Federal government sources to estimate the Regional Model plus acquisition of commercial floorspace data from McGraw-Hill Construction.

## DOE Data Input Sources

Before the MAM executes its models, over 70 energy prices and quantities are extracted from the output of a NEMS simulation. These represent consumption of fuels and the prices paid for each fuel plus domestic production of energy commodities and constitute exogenous inputs to MAM.

## Computing Environment

See Integrating Module of the National Energy Modeling System

# Natural Gas Transmission and Distribution Model (NGTDM)

## Description

The Natural Gas Transmission and Distribution Model (NGTDM) is the component of the National Energy Modeling System (NEMS) that represents the mid-term natural gas market. The purpose of the NGTDM is to derive natural gas supply and end-use prices and flow patterns for movements of natural gas through the regional interstate network. The prices and flow patterns are derived by obtaining a market equilibrium across the three main components of the natural gas market: the supply component, the demand component, and the transmission and distribution network that links them.

## Last Model Update

November 2005

## Part of Another Model

National Energy Modeling System (NEMS)

## Sponsor

- **Office:** Office of Integrated Analysis and Forecasting
- **Division:** Oil and Gas Division
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## Documentation

- Energy Information Administration, *Model Documentation Natural Gas Transmission and Distribution Module of the National Energy Modeling System,* DOE/EIA-M062 (Washington, DC, May 2005). *http://tonto.eia.doe.gov/FTPROOT/modeldoc/m062(2005).pdf*

## Archive Media and Installation Manual(s)

See Integrating Module of the National Energy Modeling System

## Coverage

- **Geographic:** Demand regions are the 12 NGTDM regions, which are based on the nine Census Divisions with Census Division 5 split further into South Atlantic and Florida, Census Division 8 split further into Mountain and Arizona/New Mexico, and Census Division 9 split further into California and Pacific, with Alaska and Hawaii handled separately. Production is represented in the lower 48 at 17 onshore and three offshore regions. Import/export border crossings include three at the Mexican border, seven at the Canadian border, at the four existing liquefied natural gas onshore import terminals and at seven coastal points for potential new liquified natural gas terminals. Canada is subdivided into an eastern and western region.
- **Time Unit/Frequency:** Annual through 2030
- **Product(s):** Natural gas
- **Economic Sector(s):** Residential, commercial, industrial, electric generators, and transportation

## Modeling Features

- **Model Structure:** Modular; three major components: the Interstate Transmission Submodule (ITS), the Pipeline Tariff Submodule (PTS), and the Distributor Tariff Submodule (DTS).
  - ***ITS***: Integrating module of the NGTDM. Simulates the natural gas price determination process by bringing together all major economic factors that influence regional natural gas trade in the United States. Determines natural gas flows, prices, and pipeline capacity expansion for a simplified network representing the interstate natural gas pipeline system.
  - ***PTS***: Develops parameters for setting tariffs in the ITS for storage and for transportation services provided by interstate pipeline companies
  - ***DTS:*** Develops markups for distribution services provided by local distribution companies and intrastate pipeline companies.

- **Modeling Technique**
  - ***ITS***: Heuristic algorithm, operates iteratively until supply/demand convergence is realized across the network
  - ***PTS***: Econometric estimation and accounting algorithm
  - ***DTS***: Econometric estimation

## Non-DOE Data Input Sources

- Information Resources, Inc., *Octane Week*
  - Federal vehicle natural gas (VNG) taxes
- Canadian Association Petroleum Producers Statistical Handbook
  - Historical Canadian supply and consumption data
- Mineral Management Service, Federal Offshore Statistics 1995
  - Alabama and Louisiana State and Federal offshore production before 1990
- Mineral Management Service
  - Revenues and volumes for offshore production in Texas, California, and Louisiana
- Foster Pipeline Financial Cost Data
  - Pipeline financial data
- Alaska Department of Natural Resources
  - State of Alaska north to south historical natural gas consumption ratio
- Data Resources Inc., U.S. Quarterly Model
  - Yield on AA utility bonds
- Board of Governors of the Federal Reserve System Statistical Release, *Selected Interest Rates and Bond Prices*
  - Real average yield on 10-year U.S. government bonds
- *Oil and Gas Journal*, "Pipeline Economics"
  - Pipeline annual capitalization and operating revenues
- National Energy Board, "Canada's Energy Future: Scenarios for Supply and Demand to 2025," 2003.
  - Basis for setting forecasts for Canadian consuption, unconventional production and offshore production
- Internal Gas Technology Institute report produced for EIA, March 31, 2003
  - LNG supply, liquefaction, and shipping, costs
- Internal Project Technical Liaison, Inc report produced for EIA
  - LNG regasifacation costs
- Fundamentals of the Global LNG Industry 2001
  Natural gas liquefaction costs
- *www.dataloy.com*
  - LNG shipping distances
- Hart Energy Network's Motor Fuels Information Center at
  *www.hartenergynetwork.com/motorfuels/state/doc/glance/glnctax.htm*
  - compressed natural gas vehicle taxes by state

## DOE Data Input Sources

***Forms and Publications***

- Energy Information Administration, Form EIA-23, Annual Survey of Domestic Oil and Gas Reserves
  - Annual estimate of gas reserves by type and State
- Energy Information Administration, Form EIA-176, Annual Report of Natural and Supplemental Gas Supply and Disposition
  - Annual natural gas sources of supply, consumption, and flows on the interstate pipeline network

- Energy Information Administration, Form EIA-857, Monthly Report of Natural Gas Purchases and Deliveries to Consumers
  - Monthly natural gas price and volume data on deliveries to end users
- Energy Information Administration, Form EIA-895, Monthly Quantity of Natural Gas Report
  - Monthly natural gas production
- Energy Information Administration, Form EIA-860, Annual Electric Generator Report
  - Electric generators plant type and code information, used in the classification of power plants as core or noncore customers. Data from this report are also used in the derivation of historical prices and markups for core and noncore service.
- Energy Information Administration, Form EIA-767, A Steam-Electric Plant Operation and Design Report
  - Electric generators plant type and boiler information, by month, used in the classification of power plants as core or noncore customers. Data from this report are also used in the derivation of historical prices and markups for core and noncore service.
- Energy Information Administration, Form EIA-759, Monthly Power Plant Report
  - Natural gas consumption by plant code and month, used in the classification of power plants as core or noncore customers. Data from this report are also used in the derivation of historical prices and markups for core and noncore services.
- *Annual Energy Review*, DOE/EIA-0384
  - Gross domestic product and implicit price deflator
- Federal Energy Regulatory Commission, Form FERC-2, Annual Report of Major Natural Gas Companies
  - Financial statistics of major interstate natural gas pipelines
  - Annual purchases/sales by pipeline (volume and price)
- Federal Energy Regulatory Commission, Form FERC-567, Annual Flow Diagram
  - Pipeline capacity and flow information
- Energy Information Administration, Form EIA-191, Underground Gas Storage Report
  - Base gas and working gas storage capacity and monthly storage injection and withdrawal levels by region and pipeline company
- Energy Information Administration, Form EIA-846, Manufacturing Energy Consumption Survey
  - Base year average annual industrial end-use prices for natural gas
- Energy Information Administration, *Short-Term Energy Outlook,* DOE/EIA-0131
  - National forecast targets for first two forecast years beyond history
- Federal Energy Regulatory Commission, Form 423, Cost and Quality of Fuels for Electric Utility Plants, DOE/EIA-0191
  - Natural gas prices to electric generators
- Department of Energy, *Natural Gas Imports and Exports,* Office of Fossil Energy
  - Import volumes by crossing in the most recent historical year

***Models and Other***

- Energy Information Administration, National Energy Modeling System (NEMS)
  - Domestic supply, imports, and demand representations are provided as inputs to the NGTDM from other NEMS modules

## Computing Environment

See Integrating Module of the National Energy Modeling System

# Oil and Gas Supply Module (OGSM)

## Description

OGSM is used by the Oil and Gas Division in the Office of Integrated Analysis and Forecasting as an analytic aid to support preparation of projections of reserves and production of crude oil and natural gas at the regional and national levels. The annual projections and associated analyses appear in the *Annual Energy Outlook* (DOE/EIA-0383) of the Energy Information Administration. The projections also are provided as a service to other branches of the U.S. Department of Energy, the Federal Government, and non-Federal public and private institutions concerned with the crude oil and natural gas industry.

OGSM projects the following aspects of the crude oil and natural gas supply industry:

- production
- reserves
- drilling activity
- natural gas imports and exports

## Last Model Update

October 2005

## Part of Another Model

National Energy Modeling System (NEMS)

## Sponsor

- **Office:** Office of Integrated Analysis and Forecasting
- **Division:** Oil and Gas Division
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## Documentation

Energy Information Administration, *Documentation of the Oil and Gas Supply Module* (OGSM), DOE/EIA-M063 (Washington, DC, May 2005). *http://tonto.eia.doe.gov/FTPROOT/modeldoc/m063(2005).pdf*

## Coverage

- **Geographic:** Six lower 48 onshore supply regions, three lower 48 offshore regions, and three Alaskan regions
- **Time Unit/Frequency:** Annually through 2030
- **Product(s):** Crude oil and natural gas
- **Economic Sector(s):** Oil and gas field production activities and foreign natural gas trade

## Modeling Features

- **Model Structure:** Modular, containing five major components
  - Lower 48 Onshore Supply Submodule
  - Unconventional Gas Recovery Supply Submodule
  - Offshore Supply Submodule
  - Foreign Natural Gas Supply Submodule
  - Alaska Oil and Gas Supply Submodule
- **Modeling Technique:** The OGSM is a hybrid econometric/discovery process model. Drilling activities in the United States are determined by the discounted cash flow that measures the expected present value profits for the proposed effort and other key economic variables. LNG imports are projected on the basis of unit supply costs for gas delivered into the lower 48 pipeline network.
- **Special Features:** Can run stand-alone or within the NEMS. Integrated NEMS runs employ short-term natural gas supply functions for efficient market equilibration.

## Non-DOE Input Sources

- Alaskan Oil and Gas Field Size Distributions, U.S. Geological Survey
- Alaska Facility Cost by Oil Field Size, U.S. Geological Survey
- Alaska Operating Cost, U.S. Geological Survey
- Basin Differential Prices, *Natural Gas Week*, Washington, DC.
- State Corporate Tax Rate, Commerce Clearing House, Inc., *State Tax Guide*
- State Severance Tax Rate, Commerce Clearing House, Inc., *State Tax Guide*
- Federal Corporate Tax Rate, Royalty Rate, U.S. Tax Code
- Onshore Drilling Costs – (1) American Petroleum Institute*, Joint Association Survey of Drilling Costs (1970-2003)*, Washington, DC.; (2) Additional unconventional gas recovery drilling and operating cost data from operating companies
- Offshore Lease Equipment and Operating costs, Department of Interior. Minerals Management Service (correspondence from Gulf of Mexico and Pacific OCS regional offices)
- Offshore Technically Recoverable Oil and Gas Undiscovered Resources, Department of Interior. Minerals Management Service (correspondence from Gulf of Mexico and Pacific OCS regional offices)
- Offshore Exploration, Drilling, Platform, and Production Costs, American Petroleum Institute, *Joint Association Survey of Drilling Costs (2002)*, ICF Resource Incorporated (2002), Oil and Gas Journals
- Canadian Wells Drilled, Reserves, and Production, Canadian Association of Petroleum Producers, *Statistical Handbook*
- Canadian Unconventional Recoverable Resource Base, National Energy Board*, Canada's Energy Future, Scenarios for Supply and Demand to 2025*, 2003, Table A6.1
- Canadian Conventional Natural Gas Resources, National Energy Board, *Canada's Conventional Natural Gas Resources, A Status Report*, April 2004, Table 1.1A
- Unconventional Gas Resource Data – (1) USGS 1995 National Assessment of United States Oil and Natural Gas Resources; (2) Additional unconventional gas data from operating companies
- Unconventional Gas Technology Parameters – (1) Advanced Resources International Internal studies; (2) Data gathered from operating companies

## DOE Data Input Sources

- Onshore Lease Equipment Cost, Energy Information Administration. *Costs and Indexes for Domestic Oil and Gas Field Equipment and Production Operations (1980-2003)*, DOE/EIA-0185 (80-03)
- Onshore Operating Cost, Energy Information Administration*. Costs and Indexes for Domestic Oil and Gas Field Equipment and Production Operations (1980-2003)*, DOE/EIA-0185 (80-03)
- Emissions Factors, Energy Information Administration
- Oil and Gas Well Initial Flow Rates, Energy Information Administration, Office of Oil and Gas
- Wells Drilled, Energy Information Administration, Office of Oil and Gas
- Expected Recovery of Oil and Gas Per Well, Energy Information Administration, Office of Oil and Gas
- Undiscovered Recoverable Resource Base, Energy Information Administration, *The Domestic Oil and Gas Recoverable Resource Base: Supporting Analysis for the National Energy Strategy*, SR/NES/92-05
- Oil and Gas Reserves, Energy Information Administration*. U.S. Crude Oil, Natural Gas, and Natural Gas Liquids Reserves (1977-2003)*, DOE/EIA-0216 (77-03)

## Computing Environment

See Integrating Module of the National Energy Modeling System

# Petroleum Market Model (PMM)

## Description

The Petroleum Market Model is a simulation of the U.S. petroleum industry. It includes 12 domestic crude oil production regions, five refining centers with full processing representations and capacity expansion capability and gas plant liquid production, and nine marketing regions. The heart of the model is a linear program optimization which ensures a rational economic simulation of decisions of petroleum sourcing, resource allocations, and the calculation of marginal price basis for the products. Eighteen refined products are manufactured, imported, and marketed. Seven of these products are specification blended, while the remaining 11 are recipe blended. Capacitated transportation systems are included to represent existing intra-U.S. crude oil and product shipments (liquefied petroleum gas, clean, dirty) via pipeline, marine tanker, barge, and truck/rail tankers. The export and import of crude oil and refined products are also simulated. All imports are purchased in accordance with import supply curves. Domestic manufacture of methanol and ethanol are represented as though the processing plants are merchant facilities. Transportation is allowed for ethanol shipments to the demand region terminals for splash blending. The program is written in FORTRAN, which includes callable subroutines allowing full communication with the LP portion of the model, which is in the form of an MPS resident file.

## Last Model Update

January 2006

## Part of Another Model

National Energy Modeling System (NEMS)

## Sponsor

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- **Division:** Oil and Gas Division
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## Documentation

- Energy Information Administration, *EIA Model Documentation Petroleum Market Model of the National Energy Modeling System* (NEMS), DOE/EIA-M059 (2005) (Washington, DC, May 2005). *http://tonto.eia.doe.gov/FTPROOT/modeldoc/m059(2005)-1.pdf*

## Archive Media and Installation Manual(s)

See Integrating Module of the National Energy Modeling System

## Coverage

- **Geographic:** Twelve domestic crude oil production regions (East Coast, Gulf Coast, Mid-Continent, Permian Basin, Rocky Mountain, West Coast, Atlantic Offshore, Gulf Offshore(2), Pacific Offshore, Alaska North, and Alaska Offshore); five refining regions (Petrolum Area Defense Districts I-V); nine market demand regions, the Census divisions (New England, Mid Atlantic, East North Central, West North Central, South Atlantic, East South Central, West South Central, Mountain, Pacific)
- **Time Unit/Frequency:** Annual through 2030
- **Product(s):** LPG, conventional motor gasoline, conventional high-oxygen motor gasoline, reformulated motor gasoline, California Air Resources Board (CARB) gasoline, E85, jet fuel, distillate fuel oil, highway diesel, ultra-low sulfur highway diesel, low-sulfur residual fuel oil, high-sulfur residual fuel oil, petrochemical feedstocks, asphalt/road oil, marketable coke, still gas, and other
  - ***Refinery Processes:*** crude distillation, vacuum distillation, delayed coker, fluid coker, visbreaker, fluid catalytic cracker, thermal cracker, hydrocracker-dist, hydrocracker-resid, solvent deasphalter, resid desulfurizer, FCC feed hydrofiner, distillate HDS, naphtha hydrotreater, catalytic reformer-450 psi, catalytic reformer-200 psi, alkylation plants (sulfuric and hydrofluoric), catalytic polymerization, pen/hex isomerization, butane isomerization, etherification, butanes splitter, dimersol, butylene isomerization, total recycle isomerization, naphtha splitter, C2-C5 dehydrogenator, cyclar unit hydrogen plant, sulfur plant, aromatics recovery plant, lube + wax plants, FCC gasoline splitter, gas/H2 splitter, stream transfers, fuel system, steam production, power generation

- ***Crude Oil:*** Alaska low sulfur light, Alaska mid sulfur heavy, domestic low sulfur light, domestic midsulfur heavy, domestic high sulfur light, domestic high sulfur heavy, domestic high sulfur very heavy, imported low sulfur light, imported mid sulfur heavy, imported high sulfur light, imported high sulfur heavy, imported high sulfur very heavy
- ***Transportation Modes:*** Jones Act dirty marine tanker, Jones Act clean marine tanker, LPG marine tanker, import tankers, clean barge, dirty barge, LPG pipeline, clean pipelines, dirty pipelines, rail/truck tankers. These cover all significant U.S. links.

## Modeling Features

- **Model Structure:** FORTRAN callable subroutines, which update the linear programming matrix, re-optimize, extract and post-process the solution results, update system variables, and produce reports
- **Modeling Technique:** Optimization of linear programming representation of refinery processing and transportation which relates the various economic parameters and structural capabilities with resource constraints to produce the required product at minimum cost, thereby producing the marginal product prices in a manner that accounts for the major factors applicable in a market economy
- **Special Features:** Choice of imports or domestic production of products is modeled, capacity expansion is determined endogenously, product prices include fixed and environmental costs, oxygenated and reformulated gasolines and low-sulfur diesel fuel are explicitly modeled

## Non-DOE Data Input Sources

Information Resources Inc. (IRI), WORLD Model data; National Petroleum Council; ICF Resources, *Oil and Gas Journal,* Jacobs Consultants

## DOE Data Input Sources

- EIA-14, Refiners' Monthly Cost Report
- EIA-182, Domestic Crude Oil First Purchase Report
- EIA-782A, Refiners'/Gas Plant Operators' Monthly Petroleum Product Sales Report
- EIA-782B, Reseller/Retailer's Monthly Petroleum Product Sales Report
- EIA-782C, Monthly Report of Prime Supplier Sales of Petroleum Products Sold for Local Consumption
- EIA-759, Monthly Power Plant Report
- EIA-810, Monthly Refinery Report
- EIA-811, Monthly Bulk Terminal Report
- EIA-812, Monthly Product Pipeline Report
- EIA-813, Monthly Crude Oil Report
- EIA-814, Monthly Imports Report
- EIA-817, Monthly Tanker and Barge Movement Report
- EIA-820, Annual Refinery Report
- EIA-826, Monthly Electric Utility Sales and Revenue Report with State Distributions
- EIA-856, Monthly Foreign Crude Oil Acquisition Report
- EIA-860B, Electric Generation Report — Nonutility
- FERC-423, Monthly Report of Cost and Quality of Fuels for Electric Plants
- In addition to the above, information is obtained from several Energy Information Administration formal publications:

  *Petroleum Supply Annual, Petroleum Supply Monthly, Petroleum Marketing Annual, Petroleum Marketing Monthly, Fuel Oil and Kerosene Sales, Natural Gas Annual, Natural Gas Monthly, Annual Energy Review, Monthly Energy Review, State Energy Data Report,* and *State Energy Price and Expenditure Report.*

## Computing Environment

See Integrating Module of the National Energy Modeling System

# Renewable Fuels Module (RFM)

## Description

The RFM consists of five analytical submodules that represent major renewable energy resources — landfill gas, wind energy, solar, biomass, and geothermal electric.

The purpose of the RFM is to define the technological, cost and resource size characteristics of renewable energy technologies. They are provided to the Electricity Market Module (EMM***)*** for grid-connected electricity capacity planning decisions. The characteristics include available energy capacity, capital costs, fixed operating costs, variable operating costs, capacity factor, heat rate, construction lead time, and fuel product price.

The ***Landfill Gas Submodule (LFG)*** provides the NEMS Electricity Market Module with annual regional projections of energy produced from landfill gas. The submodule provides regional forecasts of electric capacity to be decremented from electric utility capacity requirements, as well as capital and operating costs for the calculation of electricity prices.

The purpose of the ***Wind Energy Submodule (WES)*** is to project the cost, performance, and availability of wind-generated electricity, and provide this information to the Electricity Capacity Planning (ECP) component of the Electric Market Module (EMM) for building the new capacity in competition with other sources of electricity generation.

The purpose of the NEMS ***Solar Submodule (SOLAR)*** is to define the costs and performance characteristics of central station Solar Thermal (ST) and Photovoltaic (PV) electricity generating technologies and to pass them to the EMM for capacity planning decisions.

The ***Biomass Submodule*** passes to the EMM cost and performance characteristics by EMM regions and years. The fuel component of the cost characteristics is determined from the regional biomass supply schedules and then converted to a variable O&M cost.

The purpose of the ***Geothermal Electric Submodule (GES)*** is to provide the Electricity Capacity Planning (ECP) module the amounts of available geothermal generating capacity and its cost and performance characteristics for competition in the ECP for new regional electricity supply in the Western United States.

## Last Model Update

November 2005

## Part of Another Model

National Energy Modeling System (NEMS)

## Sponsor

- **Office:** Office of Integrated Analysis and Forecasting
- **Division:** Coal and Electric Power Division
- **Model Contact:** Christopher Namovicz
- **Telephone:** (202) 586-7120
- **E-Mail Address:** cnamovicz@eia.doe.gov

## Documentation

Energy Information Administration, *Model Documentation Report, Renewable Fuels Module of the National Energy Modeling System,* DOE/EIA-M069 (2001) (Washington, DC, February 2001). *http://tonto.eia.doe.gov/FTPROOT/modeldoc/m0692001.pdf*

## Archive Media and Installation Manual(s)

See Integrating Module of the National Energy Modeling System

## Coverage

***Landfill Gas Submodule***

- **Geographic:** 13 modified EMM regions
- **Time Unit/Frequency:** Annual through 2030
- **Product(s):** Generating capacity
- **Economic Sector(s):** Electric utility sector

***Wind Energy Submodule***

- **Geographic:** 13 EMM Regions: East Central, Texas, Mid-Atlantic, Mid-America, Mid-Continent, Northeast, New England, Florida, Southeastern, Southwest, Western, Rocky Mountain, California, South Nevada
- **Time Unit/Frequency:** Annual through 2030
- **Product(s):** Electricity
- **Economic Sector(s):** Electric utility sector, nonutility generators (NUGS)

***Solar Submodule***

- **Geographic:** *For PV 13 EMM* Regions: East Central, Texas, Mid-Atlantic, Mid-America, Mid-Continent, Northeast, New England, Florida, Southeastern, Southwest, Western, Rocky Mountain and Arizona, California and South Nevada. *For solar thermal:* Western, Rocky Mountain, California, South Nevada
- **Time Unit/Frequency:** Annual through 2030
- **Product(s):** Electricity

***Biomass Submodule***

- **Geographic:** 13 EMM Regions
- **Time/Unit Frequency:** Annual through 2030
- **Product(s):** Electricity

***Geothermal Electric Submodule***

- **Geographic:** EMM Regions 11, 12, 13
- **Time Unit/Frequency:** Annual through 2030
- **Product(s):** Electricity
- **Economic Sector(s):** Electric generators

## Modeling Features

***Landfill Gas Submodule***

- **Model Structure:** Sequential calculation of landfill gas to electricity generation, followed by derivation of regional and sector energy shares based on estimates of the percentage of landfill gas combusted
- **Modeling Technique:** Econometric estimation of municipal solid waste generation, coupled with an energy share allocation algorithm for deriving electric generation capacity and energy quantities by sector and region
- **Special Features:** Allows for the modeling of regional and national resource recovery efforts

***Wind Energy Submodule***

- **Model Structure:** Sequential calculation of available wind capacity by EMM Region, wind class and year, with a deduction of that year's installed capacity from the remaining available capacity
- **Modeling Technique:** Accounting function of available windy land area and conversion of land area to swept rotor area and then to available generation capacity
- **Special Features:** Accounting for policy and/or production incentives

***Solar Submodule***

- **Model Structure:** Read input file for time-of-day and seasonal capacity factors by region
- **Modeling Technique:** None
- **Special Features:** None

***Biomass Submodule***

- **Model Structure:** Data from nine Census divisions are restructured into 13 EMM supply regions
- **Modeling Technique:** None
- **Special Features:** Accounting for production tax incentives

***Geothermal Electric Submodule***

- **Model Structure:** The model operates at the level of individual geothermal sites aggregated to segmented EMM regional averages
- **Modeling Technique:** Levelized electricity costs from each supply segment of each site in each region are arrayed in increasing cost order, then aggregated into three increasing average-cost segments in each iteration in each year, along with attendant quantities (megawatts) and average heat rates and capacity factors
- Incorporates short-term cost elasticities of supply, technological optimism, and learning

## Non-DOE Data Input Sources

***Landfill Gas Submodule***

- Franklin Associates, data prepared for the Environmental Protection Agency
  - National annual quantity of municipal solid waste generated
  - Current annual percentages of municipal solid waste combusted and landfilled
- Government Advisory Associates, Resource Recovery Database, and *Resource Recovery Yearbook*
  - Plant-specific electricity generation, Btu energy content of MSW
  - Plant locations and energy-consuming sectors
- Electric Power Research Institute, *TAG Technical Assessment Guide*
  - Capital cost; fixed and variable operation and maintenance costs
  - Plant capacity factor

***Wind Energy Submodule***

- Princeton Economic Research, Incorporated (PERI)
  - WNDSLICE preprocessing program
- Electric Power Research Institute and U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy
  - *Renewable Energy Technology Characterizations* (EPRI TR-109496, December 1997)

***Solar Submodule***

- California Energy Commission:
  - Cost and performance characteristics, solar thermal technology
- Electric Power Research Institute and U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy
  - *Renewable Energy Technology Characterizations* (EPRI TR-109496, December 1997)
- Electric Power Research Institute
  - Cost and performance characteristics, PV technology
- IRS Tax Code
  - 10-percent investment tax credit
- National Solar Radiation Database
  - Regional insulation

***Biomass Submodule***

None

***Geothermal Electric Submodule***

DynCorp I&ET, "Geothermal Supply and Cost Performance Characteristics," contract deliverable for Purchase Order #36727 for the Energy Information Administration, Coal and Electric Power Division, Office of Integrated Analysis and Forecasting, June 30, 2000

## DOE Data Input Sources

***Landfill Gas Submodule***

- Source reduction factor
- Waste stream adjustment factor
- Landfill gas-fueled capacity
- Projected shares of MSW combusted and landfilled
- Heat content of MSW
- Current capacities for MSW and landfill gas-fueled units

***Wind Energy Submodule***

- Energy Information Administration, *Annual Energy Review 1991,* DOE/EIA-0384(91) (Washington, DC, June 1992)
- Pacific Northwest Laboratory
  - Reports PNL-7789, DOE/CH10093-4, and PNL-3195
- DOE/EPRI, Turbine Verification Program — "TVP Project-at-a-Glance" Series

***Solar Submodule***

- Electric Power Research Institute and U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, "Technology Characterizations," EPRI (TR-109496, December 1997)

***Biomass Submodule***

None

***Geothermal Electric Submodule***

None

## Computing Environment

See Integrating Module of the National Energy Modeling System

# Residential Sector Demand Module (RSDM)

## Description

The NEMS Residential Sector Demand Module is an integrated dynamic modeling system that projects residential energy demand by service, fuel, and Census Division. The modeling methodology is based on accounting principles and considers important issues related to consumer behavior. Housing and equipment stocks are tracked over the forecast period for ten major services. The major services considered are space heating, space cooling, clothes washing, dish washing, water heating, cooking, clothes drying, lighting, refrigeration, and freezers. A logit function is used to estimate market shares of each equipment technology within each major service based on either the installed capital and operating costs or the life-cycle cost. Miscellaneous appliance consumption is calculated as a function of Unit Energy Consumption (UEC), a measure of energy intensity developed from the Residential Energy Consumption Survey (RECS) database.

## Last Model Update

October 2005

## Part of Another Model

The Residential Sector Demand Module is designed, executed, and maintained as part of the National Energy Modeling System (NEMS)

## Sponsor

- **Office:** Office of Integrated Analysis and Forecasting
- **Division:** Energy Demand and Integration Division
- **Model Contact:** John Cymbalsky
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- **E-Mail Address:** John.Cymbalsky@eia.doe.gov

## Documentation

Energy Information Administration, Model Documentation Report: Residential Sector Demand Model of the National Energy Modeling System, DOE/EIA-M067 (2005) (Washington, DC, April 2005).
*http://tonto.eia.doe.gov/FTPROOT/modeldoc/(m067)2005.pdf*

## Archive Media and Installation Manual(s)

See Integrating Module of the National Energy Modeling System

## Coverage

- **Geographic:** Nine Census Divisions: New England, Middle Atlantic, East North Central, West North Central, South Atlantic, East South Central, West South Central, Mountain, Pacific
- **Time Unit/Frequency:** Annual through 2030
- **Product(s):** Fuel consumption including: electricity, natural gas, distillate, liquefied petroleum gas, kerosene, geothermal, wood, solar, and coal; energy consumption per household; equipment stock and efficiency
- **Economic Sector(s):** Domestic residential sector
  - **Services:** Space heating, space cooling, clothes washers, dishwashers, water heating, cooking, clothes drying, refrigeration, freezers, lighting, color televisions, furnace fans, personal computers, electric appliances, other appliances, secondary space heating
  - **Housing Types:** Single-family, multifamily, mobile homes

## Modeling Features

- **Model Structure:** Sequential algorithm composed of housing and equipment stock flow algorithms, technology choice algorithm, housing shell integrity algorithm, end-use consumption, and emissions calculations
- **Modeling Technique:** Housing and equipment stock turnover are modeled using linear decay functions. Market shares for each type of equipment choice are based on a logit function employing installed capital costs and operating costs. Unit energy consumption estimates, fuel prices, and equipment market shares are user inputs that drive the calculation of final end-use consumption
- **Special Features:** Technology choice logit function has the ability to use installed capital, and operating costs or life-cycle costs to determine new market shares

## Non-DOE Data Input Sources

- American Home Appliance Manufacturers Association
  - Shipment-weighted efficiency ratings for refrigerators, clothes washers, dishwashers, freezers, room air conditioners
- U.S. Bureau of the Census, *Current Construction Report–Series C25 Characteristics of New Housing: 2004* (Washington, DC, 2005)
  - New housing and base year market shares for some services and equipment types
- Gas Appliance Manufactures Association, *Consumers' Directory for Certified Efficiency Ratings, 2004*
- Lawrence Berkeley Laboratory, *Energy Data Sourcebook for the U.S. Residential Sector, 1997*
  - Residential equipment technical characterization data
  - Expected minimum and maximum appliance lifetimes
  - Expected lifetimes of housing types
- Navigant Consulting, *EIA Technology Forecast Updates — Residential and Commercial Buildings, 2004*
- Arthur D. Little, *Electricity Consumption by Small End Uses in Residential Buildings*, 1998.

## DOE Data Input Sources

- U.S. Department of Energy, Energy Information Administration, *A Look at Residential Energy Consumption in 2001*
  - Base-year market shares for services and equipment types
  - Base-year housing stock
  - Unit energy consumption values (UECs)

## ComputingEnvironment

See Integrating Module of the National Energy Modeling System

# Transportation Sector Module (TRAN)

## Description

The Transportation Sector Module incorporates an integrated modular design based upon economic, engineering, and demographic relationships that model transportation sector energy demand at the nine Census Division level of detail. The Transportation Sector Module comprises the following components: Light Duty Vehicles, Light Duty Fleet Vehicles, Commercial Light Trucks, Freight Transport (truck, rail, and marine), Aircraft, and Miscellaneous Transport (military, mass transit, and recreational boats). The model provides sales and stock estimates for conventional and alternative fuel/advanced technology light duty vehicles, heavy duty vehicles, and aircraft. Energy consumption and travel demand is estimated for all transportation modes and is disaggregated by fuel type and market segment.

## Last Model Update

September 2005

## Part of Another Model

Yes, part of the National Energy Modeling System (NEMS)

## Sponsor

- **Office:** Office of Integrated Analysis and Forecasting
- **Division:** Energy Demand and Integration Division
- **Model Contact:** John Maples
- **Telephone:** (202) 586-1757
- **E-Mail Address:** John.Maples@eia.doe.gov

## Documentation

Energy Information Administration, Model Documentation Report: Transportation Sector Model of the National Energy Modeling System, DOE/EIA-M070 (2005) (Washington, DC, June 2005).
*http://tonto.eia.doe.gov/FTPROOT/modeldoc/m070(2005).pdf*

## Archive Media and Installation Manual(s)

See Integrating Module of the National Energy Module System

## Coverage

- **Geographic:** Nine Census Divisions: New England, Mid Atlantic, East North Central, West North Central, South Atlantic, East South Central, West South Central, Mountain, Pacific
- **Time Unit/Frequency:** Annual through 2030
- **Product(s):** Motor gasoline, aviation gasoline, diesel/distillate, residual oil, electricity, jet fuel, LPG, CNG, methanol, ethanol, hydrogen, lubricants, pipeline fuel natural gas
- **Economic Sector(s):** Forecasts are produced for personal and commercial travel, freight trucks, railroads, domestic and international marine, domestic and international aviation, mass transit, military use

## Modeling Features

- **Model Structure:** Light-duty vehicles are classified according to the six EPA size classes for cars and light trucks. Freight trucks are divided into three weight classes: Class 3, Classes 4 through 6, and Classes 7 and 8. Buses are disaggregated into commuter, intercity, and school classifications. The air transport module addresses domestic and international passenger and freight travel by regional, narrow body, and wide body aircraft. Rail transportation is composed of freight rail and three modes of personal rail travel: commuter, intercity and transit. Water borne freight is divided into domestic and international categories.
- **Modeling Technique:** The modeling techniques employed in the Transportation Sector Module vary by module: econometrics for passenger travel, freight travel, and new vehicle market shares; economic and engineering based for technology adoption in the light duty vehicle, heavy duty vehicle, and aircraft models; and structural for light-duty vehicle, heavy duty vehicle, and aircraft capital stock estimations.
- **Special Features:** The Transportation Sector Module has been designed to allow the user to examine changes in energy demand based on changes in various demand drivers and policy. The range of policy issues that the transportation model can evaluate are: fuel taxes and subsidies, fuel economy levels by size class, CAFE levels, vehicle pricing policies by size class, demand for performance within size classes; fleet vehicle sales by technology type, alternative fuel/advanced technology light duty vehicle sales shares, the Energy Policy Act, travel reduction, criteria emission standards, and greenhouse gas emissions.

## Non-DOE Data Input Sources

- National Energy Accounts
- U.S. Department of Transportation, Federal Highway Administration, Highway Statistics
- U.S. Environmental Protection Agency, Office of Transportation and Air Quality, *Light-Duty Automotive Technology and Fuel Economy Trends: 1975 Through 2004*, EPA420-S-04-002, April 2004
- National Highway Traffic and Safety Administration, *Mid-Year Fuel Economy Report*, 2004
- Oak Ridge National Laboratory, *Transportation Energy Data Book Edition 24*, ORNL-6973, December 2004
- Oak Ridge National Laboratory, *Fleet Characteristics and Data Issues*, January 2003
- Department of Commerce, Bureau of the Census, Truck Inventory and Use Survey Data 1997
- State of California, California Air Resources Board, California LEV Regulations with Amendments Effective August 14, 2004
- U.S. Department of Transportation, Bureau of Transportation Statistics, Office of Airline Information, Air Carrier Summary Data
- Mitre Corporation for U.S. Department of Transportation, Federal Aviation Administration, Airport Capacity Benchmark Report 2004, September 2004
- Jet Information Services Inc., World Jet Inventory: Year-End 2004, December 2004
- Boeing Company, Current Market Outlook 2004, December 2004

## DOE Data Input Sources

- *State Energy Data System (SEDS)*, DOE/EIA-0214 (99), May 2001
- *Short-Term Energy Outlook (STEO)*, DOE/EIA-0202 (October 2005)

## Computing Environment

See Integrating Module of the National Energy Modeling System

# Regional Short-Term Energy Model (RSTEM)

## Description

The Regional Short-Term Energy Model (RSTEM) model is a new and greatly expanded version of the Short-Term Integrated Forecasting System (STIFS) model. While the STIFS model was almost entirely framed as a national-level model, the RSTEM uses regional as well as national data, providing a national forecast with regional detail.

RSTEM is used to generate short-term (12 to 24 months), monthly forecasts of U.S. supplies, demands, imports, stocks, and prices of various forms of energy. The RSTEM model consists of over 4000 equations, including identities. The estimated equations are regression equations that, together with the identities, form a system of interrelated forecasting equations. The selection of functional form and the estimation technique is generally done on an equation-by-equation basis. The general method of estimation is ordinary least squares, or two-stage least squares. Some equations incorporate a correction for autocorrelation of the error term. RSTEM is an integrated information system, bringing together energy quantities and prices from various sources within EIA (and from elsewhere) in a consistent, time series format. This energy information is coupled with other economic and non-economic information to form a modeling database from which forecasting equations are estimated, saved and later used to produce monthly projections and reports. Other models that run outside the RSTEM system are needed to generate some forecast information, such as the macroeconomic forecasts.

The most detailed regional forecasts are in the natural gas and electricity markets, partly because these markets tend to have strong regional differences and have available regional data. However, considerable effort has been made to provide regional forecasts for key petroleum products, as well. The only regional consideration for coal demand is for the demand from the electric power sector, although that is the bulk of the market. The same is true for renewables.

## Petroleum Products Supply Model Description

The driving forces in the Petroleum Product Supply Model are estimated refinery inputs and refined product demands. Estimated refinery outputs of individual products yield share weights with which to disaggregate total refinery inputs. Net product imports and inventory change bear the burden of balancing product supply with product demand.

New additions to the Petroleum Products Supply Model are:

- Regional Residential Heating Oil Model
- Regional Motor Gasoline Model
- Regional Residential Propane Model

The objective of the *Regional Residential Heating Oil Model* is to generate residential retail price forecasts for the four census regions: Northeast, South, Midwest, and West. Regional residential heating oil prices are estimated as a function of the wholesale distillate fuel price, regional stocks, and weather factors. Regional residential heating oil prices are then aggregated to the U.S. level by weighting regional prices by estimated regional demand factors. Regional residential heating oil prices are estimated as a function of the wholesale distillate fuel price, regional stocks, and weather factors. Regional residential heating oil prices are then aggregated to the U.S. level by weighting regional prices by estimated regional demand factors. Similarly, the national forecast for gasoline prices in the *Regional Motor Gasoline Model* will be determined from regional supplies and demand and both the national average price and demand are generated along with regional prices and demands. The *Regional Residential Propane Model* generates residential price forecasts for the four census districts: Northeast, South, Midwest, and West. Regional residential propane prices are estimated as a function of the wholesale propane price to the petrochemical sector, regional stocks, and weather. Regional residential propane prices are then aggregated to the U.S. level by weighting regional prices by estimated regional demand factors.

## Petroleum Products Demand Model Description

Nonutility petroleum products consist of the following: motor gasoline, jet fuel, nonutility distillate fuel oil, nonutility residual fuel oil, liquefied petroleum gases (LPGs), and other (minor) petroleum products. The major determinants of demand for these products are: transportation activity, economic activity (i.e., gross domestic product, manufacturing output, etc.), prices and weather. Most of the estimating relationships incorporate monthly seasonal dummies and dummy variables (Dxxxx) to capture one-time events or conditions.

Utility demand for distillate and residual fuel oil is derived separately through simulation of the electricity model (see Electricity Supply and Demand section).

## "Other" Petroleum Products Demand Model Description

Most discussion on petroleum product demand focuses on the five major products used in the transportation, residential, commercial, and utility sectors: motor gasoline, jet fuel, distillate fuel, residual fuel, and liquefied petroleum gas. However, the third largest category of product demand is "other" petroleum products, which is made up of 14 different products and represents about 14 percent of total petroleum product demand.

## Energy Prices Model Description

Key primary energy prices (including West Texas Intermediate oil prices and Henry Hub natural gas prices) are determined in part by expert opinion and not simply the result of models. The prices are important in their own right, because they are widely used for budget planning and other purposes by Federal and local government agencies, as well as corporate planners. These prices are also used in the projections of individual energy market prices at the national and regional level (e.g. motor gasoline, heating oil, diesel fuel, natural gas delivered to consumers and delivered electricity) and help determine overall energy supply and demand in the model.

## Electricity Model Description

The STIFS model determines monthly aggregate U.S. electricity demand by three major sectors (residential, commercial, industrial) and provides a national-level supply balance. In STIFS, U.S. electricity supply is comprised of two major components: domestic net electricity generation (that is, electric power actually transmitted to the transportation grid by electric utility-owned and nonutility-owned power plants) and net electricity imports (principally from Canada). Generation sources (fuels used in power production) identified in STIFS are coal, petroleum, natural gas, nuclear power, hydroelectric and other renewables, including wind and solar, wood and waste, and geothermal. A catchall category representing the total of transportation and distribution losses of electricity and other items, including any pure statistical discrepancy between electricity supply and electricity demand, rounds out the demand/supply balance.

New additions to the Electricity Demand Model are the:

Regional Electricity Demand Module

The *Regional Electricity Demand Module* provides average monthly demand forecasts for the national electricity balance and for the regional demand details. Time series energy-econometric models of energy consumption, supply, and prices have been built for the electricity markets. These consumption markets for each region and particular states are broken out into three sectors: residential, commercial, and industrial.

## Coal Model Description

The RSTEM model determines total coal consumption as the total demand for four major sectors: electric power; coke plants; residential and commercial; and general industry. Electric power sector demand, the largest component of U.S. coal demand, is determined in RSTEM's electricity model.

## Natural Gas Model Description

Natural gas demand is calculated for six sectors, including four major consumption or end-use categories as well as estimated consumption of natural gas by pipelines and natural gas consumption by gas field and natural gas plan operations. In addition, a small amount of gas exports is accounted for. Weather (particularly in the residential and commercial sectors), household formation (residential sector), commercial employment (commercial sector), natural gas prices relative to competing fuel prices, and industrial output (industrial sector) are all important factors in the short-term determination of natural gas demand.

New additions to the Natural Gas Model are the:

Regional Natural Gas Demand Model
Natural Gas Supply and Pricing Module

The *Regional Natural Gas Demand Model* is designed to provide analytical and forecasting support by the nine U.S. Census Divisions. The discussion is confined to the non-power end-use sectors (residential, commercial and industrial). The demand for natural gas in the electric power sector is determined through the interaction of the electricity demand and supply components of RSTEM and is documented separately. The natural gas consumption market equations are aggregated into regional and national determinations of non-power end-use natural gas demand.

The *Natural Gas Supply and Pricing Module* provides a procedure for determining equilibrium spot natural gas prices, in the context of equating broad national supply aggregates to demand aggregates built up from detailed sectoral demand representations by Census Division (or RSTEM electric supply regions in the case of power sector natural gas demand). Spot natural gas price forecasts from this module are designed to allow for efficient calculation of regional end-use sector delivered natural gas price forecasts for use in regional end-use demand flows and regional natural gas storage forecasts.

## Macro Bridge Model

The Macro Bridge is designed to address the problem of maintaining regional macroeconomic forecasts (which are only available on a quarterly basis) consistent with monthly national macroeconomic forecasts, the latter of which are to serve as the basis for assumptions about growth in aggregate output, income and employment for its monthly model simulations. The national and regional macroeconomic forecasts are both supplied by Global Insight (GI). Once each quarter, the baseline forecasts for both the regional and national macroeconomic forecasts are expected to be entirely consistent. For interim monthly forecasts, however, a procedure is required to adjust the quarterly regional forecasts so that they reflect aggregate economic activity that is consistent with the monthly national forecasts. The Macro Bridge program utilizes simple scaling routines that align and update GI regional macroeconomic data and forecasts with monthly macroeconomic data and forecast updates from the GI quarterly model of the U.S. economy.

## Last Model Update

February 2006

## Part of Another Model

No

## Sponsor

- **Office:** Office of Energy Markets and End Use
- **Division:** Energy Markets and Contingency Information Division
- **Model Contact:** Dave Costello
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## Documentation

- Energy Information Administration, *Short-Term Energy Outlook, Model Documentation Statistical Overview* (Washington, DC, May 1998)
- Energy Information Administration, *Short-Term Energy Outlook, Petroleum Products Supply Model Description* (Washington, DC, August 2000)
- Energy Information Administration, *Short-Term Energy Outlook, Petroleum Products Demand Model Description* (Washington, DC, October 1998)
- Energy Information Administration, *Short-Term Energy Outlook, "Other" Petroleum Products Demand Model Description* (Washington, DC, June 1998)
- Energy Information Administration, *Short-Term Energy Outlook, Energy Prices Model Description* (Washington, DC, July 2000)
- Energy Information Administration, *Short-Term Energy Outlook, Electricity Model Description* (Washington, DC, August 1998)
- Energy Information Administration, *Short-Term Energy Outlook, Coal Model Description* (Washington, DC, October 1998)
- Energy Information Administration, *Short-Term Energy Outlook, Natural Gas Model Description* (Washington, DC, May 1999). *http://www.eia.doe.gov/emeu/steo/pub/aamd.html#doc*

## Coverage

- **Geographic:** National and regional

| | | |
|---|---|---|
| Macroeconomic/Weather/Household | | |
| Macro Data/Projections | 9 Census Divisions | GI quarterly regional macro model/U.S. bridge |
| Household Characteristics | 9 Census Divisions | RECS/Census/NEMS and interpolations |
| Weather | 9 Census Divisions | CPC/NOAA |
| Electricity Demand (Retail Sales) | 9 Census Divisions + NY, FLA, CA, TX and Ak+HI | Based on EIA state-level sales and revenue |
| Natural Gas Demand | 9 Census Divisions | Based on EIA state-level sales and revenue |
| Natural Gas Supply | National/Regional Hybrid 3 production regions (Federal Gulf of Mexico, other Lower 48, and Alaska | National-level mechanism for benchmark gas commodity price, selected regions for basis differential calculations. End-use prices (including power sector prices) are at the Census Division or power supply region level. Gas in storage handled at the AGA regional level. |
| Coal Supply | 3 Production Regions (Eastern, Interior, and Western) | Provided Exogenously to RSTEM by EIA's Office of Coal, Nuclear, Electric and Alternate Fuels |
| Petroleum Prices/Inventories | 5 PADD Regions for retail gasoline prices and gasoline, distillate fuel and propane inventories. 4 U.S. Census Regions for retail heating oil and propane prices. | Based on EIA's PSM, PMM and price survey data. |

National Components

Gasoline/Hwy. Travel Demand
Jet Fuel Supply/Demand
Non-power Distillate Fuel Demand/Supply
Non-power Residual Fuel Demand/Supply
LPG Supply/Demand Balance
Other Petroleum Products Supply/Demand
Crude Oil Supply/Demand
Petroleum Products Imports
Coal Demand
Electricity Imports
Electricity Exports
Electricity Production
Natural Gas Imports
Natural Gas Exports

- **Time Unit/Frequency:** Monthly with forecasts up to 24 months
- **Product(s):**
  - Petroleum Products Supply Model
    - *Refinery Inputs*
      - Crude oil
      - Unfinished oils
      - Liquefied petroleum gas (LPGs)
      - Pentanes plus
      - "Other" petroleum products

- *Refinery Outputs*
  - Motor gasoline
  - Jet fuel
  - Distillate fuel oil
  - Residual fuel
  - Liquefied petroleum gases (LPGs)
  - "Other" petroleum products

– Petroleum Products Demand Model
  - *Motor gasoline*
  - *Jet fuel*
  - *Nonutility distillate fuel oil*
  - *Nonutility residual fuel oil*
  - *Liquefied petroleum gases (LPGs)*
  - *"Other" petroleum products*

– "Other" Petroleum Products Demand Model
  - *Crude oil*
  - *Pentanes plus*
  - *Unfinished oils*
  - *Aviation gasoline blend components*
  - *Petrochemical feedstocks*
  - *Propane*

– Electricity Model
  - *Power generation by fuel type*
  - *Consumption of fuels for power generation and combined heat and power (CHP)*
  - *Residential, commercial, industrial demand*
  - *Imports*
  - *Exports*

– Coal Model
  - *Coal production by region (Appalachian, Interior, Western)*
  - *Coking coal, general industrial, and residential/commercial demand*
  - *Primary and secondary coal stocks*
  - *Imports*
  - *Exports*

– Natural Gas
  - *Production by major region (Federal Gulf of Mexico, Other Lower 48, Alaska)*
  - *Pipelines, gas field, natural gas plant operations*
  - *Exports*
  - *Imports*
  - *Residential, commercial, and industrial demands*

## Modeling Features

- **Model Structure:** Accounting and algorithmic to balance supply and demand
- **Modeling Technique:** The estimated equations are regression equations that together form a system of interrelated forecasting equations. The general method of estimation is ordinary least squares.
- **Special Features:** RSTEM is updated monthly to produce new demand and supply forecast balances for the *Short-Term Energy Outlook*.

## Non-DOE Data Input Sources

- U.S. Department of Labor, Bureau of Labor Statistics
  - *Employment and Earnings*
- U.S. Federal Reserve System, Board of Governors
  - *Industrial Production*
- U.S. Department of Labor, Bureau of Labor Statistics
  - *Monthly Labor Review*
- U.S. Department of Commerce, National Oceanic and Atmospheric Administration
  - *Monthly State, Regional, and National Heating/Cooling Degree-Days Weighted by Population*
- U.S. Department of Commerce, Bureau of Economic Analysis
  - *National Income and Product Accounts of the United States*
- U.S. Department of Commerce, Bureau of Economic Analysis
  - *Survey of Current Business*

Most of the data sources provide monthly data and are used directly. Quarterly data are interpolated into monthly series.

## DOE Data Input Sources

The historical energy data used to estimate the model come primarily from various EIA electronic databases, which merge data regularly reported in several EIA publications: *Quarterly Coal Report, Petroleum Supply Monthly*, *Petroleum Marketing Monthly*, *Electric Power Monthly*, *Natural Gas* Monthly, and *Monthly Energy Review.* Because of data limitations there are inconsistencies in the level of disaggregation of each type of fuel. For example, electricity and natural gas demands are represented by market sector, but petroleum products are generally represented only as national totals or for a combination of sectors (distillate and residual fuel oil are exceptions). Market-level data are available for the regulated industries (electricity and natural gas) while product-level data are available for most petroleum product markets, particularly for data frequencies higher than annual.

## Computing Environment

- **Hardware Used:** Personal computers
- **Language/Software Used:** EViews 5.1

# Short-Term Nuclear Annual Power Production Simulation (SNAPPS)

## Description

SNAPPS forecasts the short-Term monthly and annual electric power generation by U.S. commercial nuclear power plants. SNAPPS is a relatively simple, straightforward accounting model programmed in Microsoft Excel. The model consists of codes that provide accounting for each nuclear reactor's generation for the projection period.

## Last Model Update

November 2004

## Part of Another Model

No

## Sponsor

- **Office:** Office of Coal, Nuclear, Electric and Alternate Fuels
- **Division:** Coal, Nuclear and Renewables Division
- **Model Contact:** Jim Finucane
- **Telephone:** (202) 287-1966
- **E-Mail Address:** jim.finucane@eia.doe.gov

## Documentation

- Energy Information Administration, *Short-Term Nuclear Annual Power Production Simulation Documentation,* Version 4 (Washington, DC, June 1990)
- Energy Information Administration, *Short-Term Nuclear Annual Power Production Simulation Documentation* (Washington, DC, November 1984) and Addendum (September 1986)

## Archive Media and Installation Manual(s)

- SNAP893 — Archived for the *Short-Term Energy Outlook* (July 1989)
- SNAP9103 — Archived for the *Short-Term Energy Outlook* (January 1991)
- SNAP92Q4 — Archived for the *Short-Term Energy Outlook* (4th Quarter 1992)
- SNAP93Q1 — Archived for the *Short-Term Energy Outlook* (1st Quarter 1993)
- SNAP93Q2 — Archived for the *Short-Term Energy Outlook* (2nd Quarter 1993)
- SNAP93Q3 — Archived for the *Short-Term Energy Outlook* (3rd Quarter 1993)
- The model with associated data are archieved monthly.

## Coverage

- **Geographic:** Total United States, individual States, individual reactors, ten Federal regions, or four Census regions
- **Time Unit/Frequency:** 18-month forecasts quarterly; 5-year forecasts annually, up to 25 years
- **Product(s):** Projections of electricity generation from nuclear power plants
- **Product(s):** Projections of fees paid into the nuclear waste fund
- **Economic Sector(s):** Electric utilities which own or operate nuclear power plants

## Modeling Features

- **Model Structure:** The model consists of codes that provide accounting for each nuclear reactor's generation over the projection period.
- **Modeling Technique:** The model develops reactor activity schedules, determining if the reactor is generating power or is in extended shutdown. Individual reactor monthly generation is computed by multiplying the designated capacity (net or gross) times the appropriate capacity factor times the hours the reactor operates in that month. For the remainder of the projection period, SNAPPS uses average, full-cycle capacity factors, which are functions of reactor type (BWR or PWR) and fuel cycle (1st, 2nd, or equilibrium). The resulting reactor generation values are then cumulated into monthly, annual, and regional totals. The model contains the option of using positive refueling times in lieu of seasonality factors.

## Non-DOE Data Input Sources

- Nuclear Regulatory Commission, *NRC Operations Center Plant Status Report* (updated weekly)
  - Scheduled outage data (start date and duration)
- Nuclear Regulatory Commission, *Operating Data Reports*
  - Historical generation data (reactor name, date, historical generation, and type of generation) from end of EIA-06 data to current
- David Andress, Washington Consulting Group, *Analysis of Capacity Factors* (March 1990)
  - Cycle-specific data (cycle capacity factor)
  - Generic parameters (monthly capacity factor adjustment [seasonality] factors)
- David Andress, System Sciences, *Analysis of Capacity Factors* (September 1984)
  - Cycle-specific data (cycle capacity factor)
  - Generic parameters (monthly capacity factor adjustment [seasonality] factors)

## DOE Data Input Sources

***Forms and Publications***

- Energy Information Administration, Form EIA-759, *Monthly Power Plant Report*
  - Historical Generation Data (1986 through 2000: reactor name, date, historical generation and type of generation)
- Energy Information Administration, Form EIA-906, *Power Plant Report*
  - Historical Generation Data (2001 on: reactor name, date, historical generation and type of generation)
- Office of Civilian Radioactive Waste Management, Form RW-859, Nuclear Fuel Data
  - Cycle-specific data (cycle number, cycle start date, cycle generation time, cycle capacity factor, cycle full-power days, refueling start date and refueling time)
- Energy Information Administration, Form EIA-860A, Annual Electric Generator Report — Utility
  - Basic reactor characteristics (reactor capacities)

***Models and Other***

- Energy Information Administration, International Nuclear Model (INM) maintained by the Office of Coal, Nuclear, Electric, and Alternate Fuels
  - Basic reactor characteristics (reactor type, reactor name, reactor capacities, DOE region, start dates [initial criticality, first electricity and commercial operation], State code and reactor retirement date)
- Energy Information Administration, Office of Coal, Nuclear, Electric and Alternate Fuels
  - Generic parameters
  - Default capacity factor
  - Default full power days
  - Default refueling time
  - Monthly capacity factor adjustment (seasonality) factors
  - Annual capacity factor adjustment (trend) factors

## Computing Environment

- **Hardware Used:** PC
- **Operating System:** Windows
- **Language/Software Used:** MS Excel
- **Storage Requirement:** 5 Mb for model and data
- **Estimated Run Time:** 5 seconds
- **Special Features:** None

# System for the Analysis of Global Energy Markets (SAGE)

## Description

SAGE is an integrated set of regional models that provide a technology-rich basis for estimating regional energy consumption. For each region, estimates of 42 end-use energy service demands (e.g., car, commercial truck, and heavy truck road travel; residential lighting; steam heat requirements in the paper industry) are developed on the basis of economic and demographic projections. Projections of energy consumption to meet the energy demands are estimated on the basis of each region's existing energy use patterns, the existing stock of energy-using equipment, and the characteristics of available new technologies, as well as new sources of primary energy supply.

SAGE provides projections of total world primary energy consumption, as well as projections of regional energy consumption by primary energy type (oil, natural gas, coal, nuclear, and hydroelectric and other renewable resources) and projections of net electricity consumption. Projections of carbon dioxide emissions resulting from fossil fuel use are also provided. All projections are computed in 5-year intervals through the year 2030.

## Last Model Update

October 2005

## Part of Another Model

No

## Sponsor

- **Office:** Office of Integrated Analysis and Forecasting
- **Division:** International, Economic, and Greenhouse Gases Division
- **Model Contact:** Barry Kapilow-Cohen
- **Telephone:** (202) 586-5359
- **E-Mail Address:** Barry.Kapilow-Cohen@eia.doe.gov

## Documentation

Energy Information Administration, System for the Analysis of Global Energy Markets, Model Documentation (SAGE), 2003, Volume 1**,** *DOE/EIA-M 072(2003)/1* (Washington, DC, August 2003).
*http://tonto.eia.doe.gov/FTPROOT/modeldoc/m072(2003)1.pdf*

Energy Information Administration, System for the Analysis of Global Energy Markets, Model Documentation (SAGE), 2003 - Volume II - Data Implementation Guide, DOE/EIA-M 072(2003)/2 (Washington, DC, August 2003).
*http://tonto.eia.doe.gov/FTPROOT/modeldoc/m072(2003)2.pdf*

## Archive Media and Installation Manual(s)

Archived on a CD-R

## Coverage

- **Geographic**: World by selected countries and major regions
- **Time Unit/Frequency:** Projections of energy consumption by 5-year intervals through the year 2030
- **Product(s):** Oil, natural gas, coal, nuclear, hydroelectric and other renewable resources, and net electricity consumption.
- **Economic sectors:** Residential, commercial, industrial, transportation, electric power

## Modeling Features

- **Model Structure:** The model consists of 16 regional Market Allocation (MARKAL) models that derive total energy demand at the service demand level (e.g., residential lighting; road travel, etc.)
- **Modeling Technique:** The model utilizes a linear program to minimize total system costs
- **Special Features:** The demands for energy services are elastic to their own prices, thus allowing the model to compute a bona fide supply–demand equilibrium

## Non-DOE Data Input Sources

- International Energy Agency (Paris), Coal Information (Paris)
  - Total final energy consumption by fuel
  - Energy consumed by end use sector and fuel
- International Energy Agency, Electricity Information (Paris)
  - Energy consumed by fuel by electric utilities
- International Energy Agency (Paris), Energy Balances of OECD Countries (Paris)
  - Consumption of energy source (oil, natural gas, coal, nuclear, other) by end-use sector (industrial, building, transportation, electric utility) for OECD countries
- International Energy Agency, Balances and Statistics of Non-OECD Countries (Paris)
  - Consumption of energy source (oil, natural gas, coal, nuclear, other) by end-use sector (industrial, building, transportation, electric utility for Non-OECD countries
- Global Insight, Inc., World Overview (Lexington, MA)
  - Historical (1970–2004) GDP (in 2000 U.S. dollars expressed in purchasing power parity rates)
  - GDP projections (2004–2025)
- Global Insight, Inc., World Industry Monitor
  - Apparent consumption (in 1997 U.S. dollars) by ISIC classification and country (2002–2012)

## DOE Data Input Sources

- National Energy Modeling system (NEMS), International Energy Module
  - World oil production capacity and oil production
- World Oil Refining, Logistics, and Demand (WORLD) Model
  - World oil trade
- National Energy Modeling system (NEMS), Coal Export Submodule
  - Flows in international coal trade
- Energy Information Administration, *Annual Energy Outlook* (Washington, DC, annual)
  - U.S. consumption of energy source (oil, natural gas, coal, nuclear, other) by sector (industrial, transportation, building, and electric utility)
  - U.S. carbon emissions
  - U.S. net electricity consumption
- Energy Information Administration, *Annual Energy Review* (Washington, DC, annual)
  - GDP deflators
- Energy Information Administration, *International Energy Annual* (Washington, DC, annual)
  - Oil consumption in quadrillion Btu and million barrels per day
  - Natural gas consumption in quadrillion Btu and trillion cubic feet
  - Coal consumption in quadrillion Btu and million short tons
  - Nuclear energy consumption (equated to generation) in quadrillion Btu and billion kilowatthours
  - Hydroelectricity and other renewable energy consumption in quadrillion Btu
  - Net electricity consumption in billion kilowatthours
  - Carbon dioxide emissions in million metric tons

## Computing Environment

***Software Requirements:*** SAGE is a PC based application requiring Microsoft Windows 2000 Professional (or later) operating system as well as Microsoft Office 2000 (or later). While the SAGE source code, written in the General Algebraic Modeling System (GAMS), is publicly available at EIA's website, three other commercial software packages are required to use this source code. These consist of GAMS along with a powerful commercial linear programming solver (e.g., XPRESS/CPLEX), and VEDA-SAGE, the data handling and results analysis "shell" overseeing all aspects of working with SAGE.

# Wellhead Gas Productive Capacity Model (GASCAP)

## Description

GASCAP estimates the historical wellhead productive capacity of natural gas for the lower 48 States and projects the productive capacity for 4 years. The *Short-Term Energy Outlook (STEO)* output for low, base and high cases is used to estimate the number of active rigs and oil and gas well completions. The projected oil production is used to estimate the oil–well gas production (which is assumed to be producing at capacity) using a constant gas–oil ratio. The gas demand is also taken from *STEO*. The difference between demand and oil–well gas production is assumed to be the gas–well gas demand and the production as long as capacity exceeds demand.

## Last Model Update

September 2002. All SAS programs were moved from the mainframe to PC Enterprise Guide.

## Part of Another Model

No

## Sponsor

- **Office:** Office of Oil and Gas
- **Division:** Reserves and Production Division
- **Model Contact:** Velton Funk
- **Telephone:** (214) 720-6171
- **E-Mail Address:** Velton.Funk@eia.doe.gov

## Documentation

Energy Information Administration, *Model Documentation for the Wellhead Gas Productive Capacity Model,* DOE/EIA-M052 (Washington, DC, March 1995)

## Archive Media and Installation Manual(s)

None

## Coverage

- **Geographic:** Lower-48 natural gas producing States
- **Time Unit/Frequency:** Evaluates more then 20 years of historical data and projects productive capacity for 4 years
- **Product(s):** Natural gas
- **Economic Sector(s):** Not applicable

## Modeling Features

- **Model Structure:** The model consists of a series of Statistical Analysis System (SAS) procedures utilizing a modified rate of gas production versus cumulative gas production (Rate-cum) equation
- **Modeling Technique:** SAS, utilizing the least squares, nonlinear regression procedure (NLIN) with the Marquardt computational method, was used to fit hyperbolic equations to the data by year of first production
- **Special Features:** Estimates conventional and coalbed gas–well productive capacity separately

## Non-DOE Data Input Sources

- IHS Inc., Richardson, TX, Oil and Gas Reports
  - State monthly natural gas production by well
- Baker Hughes Incorporated
  - Number of active rotary rigs and number of active rotary gas rigs
- American Petroleum Institute
  - Drilling statistics monthly tapes

## DOE Data Input Sources

- Energy Information Administration, *Natural Gas Annual*, DOE/EIA-0131 (Washington, DC, annually)
  - Marketed wet natural gas production by State
  - Gross gas production by State
  - Oil well gas production by State
- Energy Information Administration, *Natural Gas Monthly,* DOE/EIA-0130 (Washington, DC, monthly)
  - State marketed gas production
- Energy Information Administration, *Monthly Energy Review,* DOE/EIA-0035 (Washington, DC, monthly)
  - Crude oil production
  - World oil price (imported refiner acquisition cost)
  - Marketed gas production
  - Natural gas wellhead price
- Energy Information Administration, *Short-Term Energy Outlook,* DOE/EIA-0202 (Washington, DC, quarterly)
  - Marketed dry natural gas demand
  - Oil and gas price forecasts

# World Oil Refining, Logistics, and Demand Model (WORLD)

## Description

The *WORLD* model is a linear programming model which simulates the operation of the worldwide petroleum industry based on user-specified assumptions regarding the time horizon and scenario of interest. The *WORLD* model simulates regional effects. Insights at the level of individual countries or refinery type can be obtained, but only where the model has been appropriately disaggregated.

## Last Model Update

May 2003

## Part of Another Model

No

## Sponsor

- **Office:** Office of Integrated Analysis and Forecasting
- **Division:** International, Economic, and Greenhouse Gases Division
- **Model Contact:** Dan Butler
- **Telephone:** (202) 586-9503
- **E-Mail Address:** George.Butler@eia.doe.gov

## Documentation

Energy Information Administration, *WORLD Oil Refining Logistics Demand Model,* DOE/EIA-M058 (Washington, DC, March 1994). *http://tonto.eia.doe.gov/FTPROOT/modeldoc/m05894.pdf*

## Archive Media and Installation Manual(s)

See Integrating Module of the National Energy Modeling System

## Coverage

- **Geographic:** Regional Disaggregation
  - Representation of the world's major regions with flexibility to redefine regions to meet specific needs
  - Flexibility to create refining subregions, e.g., to distinguish different classes of refiners
- **Time Unit/Frequency:** Annual through 2030
- **Product(s):** Crude oils and refined products
- **Economic Sector(s):** Petroleum refining and transportation

## Modeling Features

- **Model Structure:** *WORLD* is a linear programming model which simulates the operation of the worldwide petroleum industry based on user-specified assumptions regarding the time horizon and scenario of interest
- **Modeling Technique:** Linear programming
- **Special Features:** None

## Non-DOE Data Input Sources

Various industry sources for refinery processes, crude oil assays, and refined product specifications

- *Oil and Gas Journal*
- IEA/OECD, quarterly and annual statistics on OECD Nations but also numerous other countries
- UN, mainly for third world countries
  - Crude supply and product demand data
- Hydrocarbon processing
- NPRA, API, and NPC data

## DOE Data Input Sources

Energy Information Administration, *International Energy Annual,* DOE/EIA-0219 (Washington, DC, annually)

- *Petroleum Supply Annual*
- *International Energy Annual*, *Annual Energy Outlook, International Energy Outlook*
  - Crude supply and product demand data

## Computing Environment

See Integrating Module of the National Energy Modeling System

## Software Requirements

- OMNI for matrix generation
- CPLEX for optimization