Fuel Liquids EXchange (FLEX) Module Requirements

Redesign of the LFMM and the IEM

December 2024

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Contents

Revision History

Name	Date	Reason for changes	Version
Project Team	Dec. 1, 2024	Brand New	0

Abbreviations

AIMMS	Advanced Integrated Multidimensional Modeling Software
AEO	*Annual Energy Outlook*
API	American Petroleum Institute gravity
B	billion
b	barrel
b/d	barrels per day
BFOE	barrel of fuel oil equivalent
Btu	British thermal units
Bu	bushel
cf	cubic feet
EIA	U.S. Energy Information Administration
gal	gallon
GWh	gigawatthour
HSM	Hydrocarbon Supply Module
IEO	*International Energy Outlook*
IEM	International Energy Model
J	joule
kg	kilogram
kW	kilowatt
kWh	kilowatthour
lb	pound
LFMM	Liquid Fuels Market Module
LTEM	Long-Term Energy Modeling (Office)
MAM	Macroeconomic Activity Module
M	thousand
MM	million
MW	megawatt
NEMS	National Energy Modeling System
quad	quadrillion British thermal units
SAF	sustainable aviation fuel
STEO	*Short-Term Energy Outlook*
TCG	Trade Curve Generator
WEPS	World Energy Projection System
WOP	world oil price
WTI	West Texas Intermediate
$1987	1987 year U.S. dollars

Introduction

EIA requires a model that represents the domestic refining industry and the petroleum liquids market to support its domestic modeling efforts. Currently, the Liquid Fuels Market Module (LFMM) works with the International Energy Model (IEM) to meet this objective for the *Annual Energy Outlook* (AEO). The IEM serves an important role in how the current LFMM operates by providing import and export curves for both crude oil and finished products.

After extensive evaluation, the Office of Long-Term Energy Modeling (LTEM) proposes a new Fuel Liquids EXchange (FLEX) module. The primary objectives of the new FLEX module include combining the functionality of the IEM and LFMM to reduce modeler intervention required during an AEO development cycle and modernizing the codebase.

Because the existing LFMM linear program is designed to meet domestic demand, the IEM modeler must spend an inordinate amount of time adjusting assumptions of international trade to achieve acceptable results. During an average AEO development cycle, IEM modelers submit over 300 National Energy Modeling System (NEMS) runs across all cases. To address any single issue, IEM modelers may need to iteratively revise assumptions, which requires up to five integrated runs to be run in sequence. This excess results in a turnaround time of up to one week for relatively simple fixes to issues caused by changes in other NEMS modules.

FLEX will be designed under EIA’s model development guidelines posted on the GitLab wiki. FLEX will continue to represent the crude oil refining industry, transportation and trade of crude oil and refined products, distribution of natural gas liquids from natural gas processing plants, and production of renewable fuels (including ethanol, biodiesel, renewable diesel, and sustainable aviation fuel) and non-petroleum fossil fuels. This module will provide a solution that includes volumes, prices, and flows to be passed into NEMS to create AEO projections.

Purpose

This document highlights the requirements for FLEX prior to development and will facilitate project planning by aligning theoretical and practical model development with the LFMM’s current role in NEMS. Clearly stated requirements will further reduce the likelihood of a failed redesign due to a loosely defined scope.

This document is intended for EIA management, the LTEM team developing FLEX, and future users of FLEX.

Scope

What's in scope?

FLEX will:

- Determine petroleum and other refined liquids production based on feedstock supply and energy demand provided by NEMS modules and production costs
- Represent domestic refining to deliver end-use product prices by sector to NEMS
- Represent domestic transportation between crude oil suppliers, refineries, and liquids consumers consistent with existing infrastructure (see Requirement 2.5 for representing changes to capacity and infrastructure endogenously)
- Represent domestic production of biofuels (for example, ethanol, renewable diesel, and sustainable aviation fuel) that substitute for fossil fuels
- Represent trade of crude oil, finished products, and biofuels with the global market
- Incorporate consistent carbon capture and sequestration (CCS) with appropriate technologies
- Represent current policy such as the Renewable Fuel Standard, Low Carbon Fuel Standard, and tax credits
- Use historical data where appropriate and available
- Benchmark to our *Short-Term Energy Outlook* (STEO) where appropriate
- Be a well-organized, maintainable model in a programming language consistent with existing EIA use cases
- Be able to run offline without other NEMS modules for rapid debugging
- Provide documentation to facilitate future use of the model

What's out of scope for now but considered in development?

As domestic natural gas and liquids markets continue to evolve, FLEX will include a framework that facilitates future development necessary for meeting the primary objectives of FLEX. The following list includes items that are not in scope currently but will be considered while we develop FLEX and may be handled by exogenous inputs. We will design FLEX to accommodate the following future model improvements:

- Addition of new fuel types (for example, ammonia, electrofuels, or e-fuels) that substitute for fossil fuels or additional production methods for existing fuel types
- Further integration with the World Energy Projection System (WEPS) to improve uniformity between the AEO and the *International Energy Outlook* (IEO) (Currently, NEMS and WEPS use the same world oil price and production values—FLEX will continue to use the world oil price and the world liquids demand (from IEO) when generating trade curves.)
- Potential changes to model regionalization

What's out of scope?

The following elements remain out of scope for the FLEX design, so this project will not:

- Incorporate significant changes to the structure or functionality of the LFMM (Currently, we do not expect the base model functionality and structure to change drastically as part of this project. The team will continue to evaluate appropriate changes required to achieve project requirements.)

Team members and audience

The project team associated with FLEX includes the Petroleum and Natural Gas Modeling Team staff, who will design, develop, and test FLEX, as well as management involved in the approval process (Table 1).

In addition to the team in Table 1, we consulted the NEMS modelers and stakeholder teams identified in Table 2 as we identified requirements and drafted this document.

The team will follow the project timeline, which will be updated monthly to reflect current expectations and progress to-date. The modeling team will communicate daily via Microsoft Teams and hold weekly meetings every Thursday with our Team Leader. In addition, we will schedule monthly status update meetings to keep leadership informed of the most recent progress to ensure objectives are aligned each step of the way. Any material changes to the requirements in this document will be presented to management for approval.

Table 1. Fuel Liquids EXchange (FLEX) project team, roles, and responsibilities

Project role	Responsibilities
Executive Sponsor	Evaluate and approve project activities after each Task (1–3)
Project Sponsor	Approve project budget and staff efforts; advocate for project and resources
Team Leader	Approve project budget and staff efforts; advocate for project and resources
Project Manager/Lead Modeler	Project manager; key role in developing component design report, model code, and model documentation; serve as Subject Matter Expert (SME) for refinery operations and petroleum markets
Modeler	Key role in developing model code; serve as SME for alternative fuels
Modeler	Key role in developing model code; serve as SME for refinery operations and petroleum markets
Modeler	Primary lead for data design and processing and Python integration wrapper
Modeler	Serve as SME for international energy markets

Source: U.S. Energy Information Administration

Table 2. National Energy Modeling System teams consulted during requirements development

Team	Date
Integration	January 9, 2024
Transportation	January 9, 2024
Hydrocarbon Supply	January 10, 2024
Industrial	January 10, 2024
Natural Gas	January 11, 2024
Macroeconomics	January 16, 2024
Hydrogen	January 16, 2024
Carbon Capture	January 23, 2024

Source: U.S. Energy Information Administration

Document organization

The second section of this document provides an overview of FLEX, its relationship to NEMS and other EIA data and products, and the assumptions and constraints underlying the development of FLEX requirements.

The following three sections detail model requirements, which have been numbered to align with Appendix A:

1. Integration Requirements
2. Functional Requirements
3. Other System Requirements

We have also included two appendixes covering the following topics:

A. FLEX Hierarchy of Requirements
B. NEMS Restart File Variables in FLEX

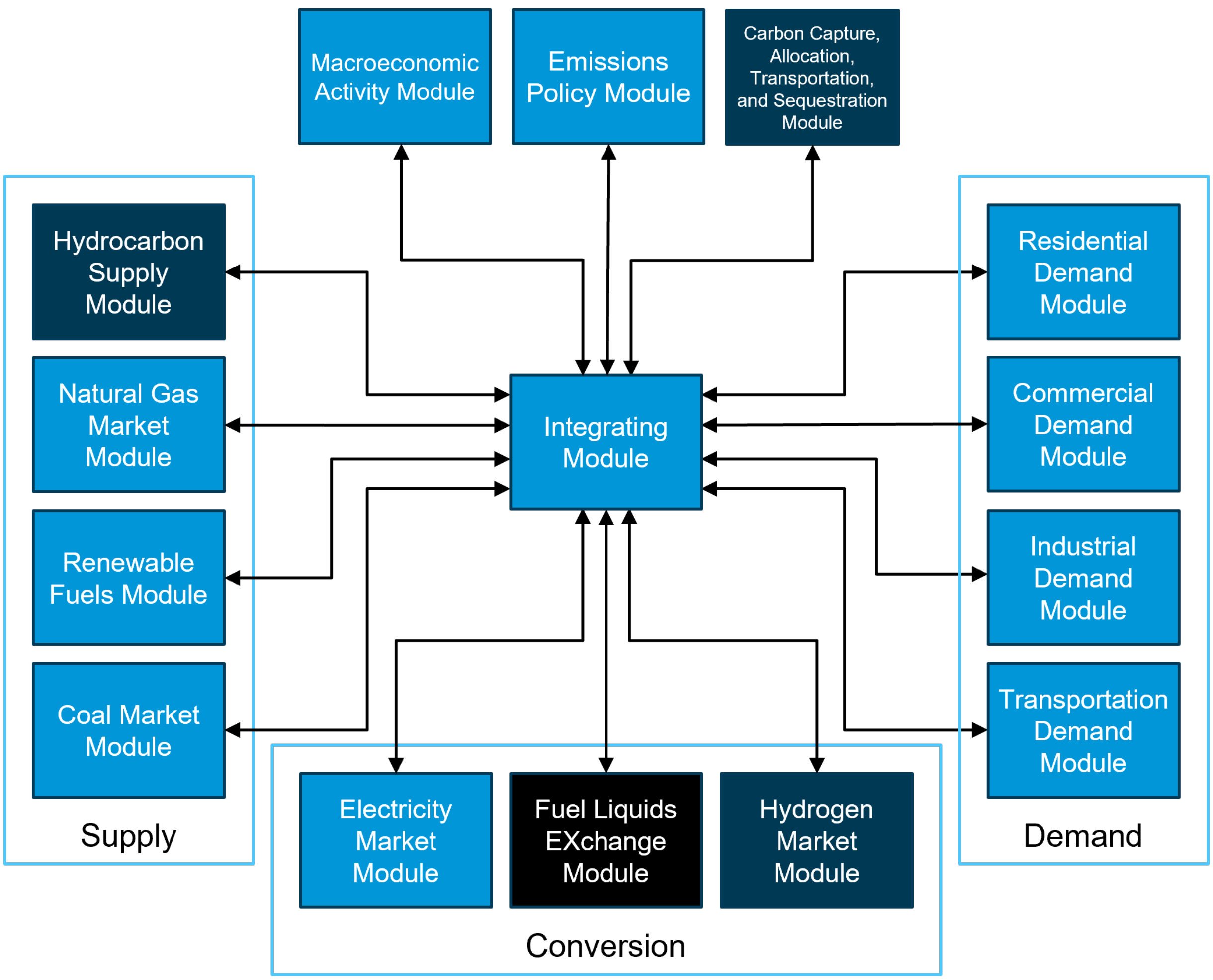
Overview of Fuel Liquids EXchange (FLEX) Module

This section provides an overview of the Fuel Liquids EXchange (FLEX) module, its context within the National Energy Modeling System (NEMS), and the role we expect it to play in our domestic modeling efforts. We also outline the assumptions and constraints that might affect the requirements.

Model perspective

FLEX models petroleum refining activities, the marketing of petroleum products to consumption regions, imports and exports of petroleum liquids, the distribution of natural gas liquids from natural gas processing plants, and the production and marketing of renewable fuels and non-petroleum fossil fuels. It is 1 of 16 individual modules that make up NEMS (Figure 1).

Figure 1. NEMS overview and modules, including new modules for AEO2025 (dark blue) and AEO2026 (black)



Source: U.S. Energy Information Administration
Note: AEO=*Annual Energy Outlook*

Relation to other NEMS modules

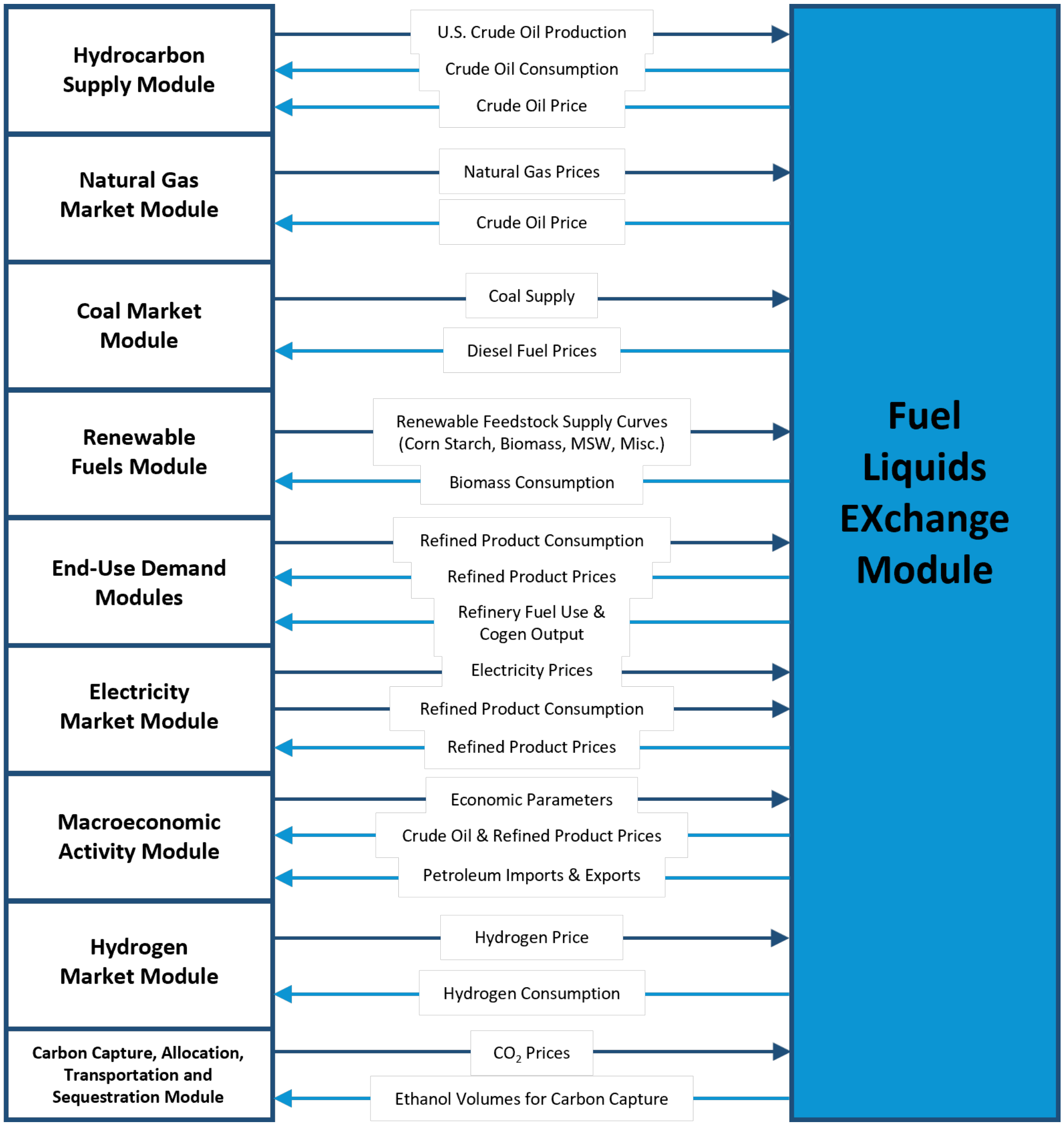
FLEX receives data from and provides data to other NEMS modules (Figure 2).

FLEX receives annual projections through 2050 of the following:

- Domestic petroleum product demands
- Domestic crude oil production levels for nine crude oil types, including average California crude oil
- Costs of energy inputs: natural gas, electricity, coal, hydrogen, and CO_2
- Costs and available quantities of feedstocks (such as soybean oil, corn, etc.) used to produce blending components (such as ethanol and biodiesel)

FLEX provides delivered hydrocarbon commodity prices back to the demand and transformation modules. It also provides additional consumption volumes related to hydrocarbon production, refining, and transportation.

Figure 2. Interactions between FLEX and NEMS by module



Source: U.S. Energy Information Administration
Note: FLEX=Fuel Liquids EXchange module, NEMS=National Energy Modeling System

Software interfaces

In the *Annual Energy Outlook 2023* (AEO2023), NEMS was built around an in-memory Fortran architecture because the spine of NEMS (the main code and integration module) is primarily in Fortran. NEMS modules are written in multiple languages (Fortran, Python, AIMMS, GAMS, etc.) with Fortran sending and receiving data from each program as necessary in a global data structure. NEMS iterates rapidly (often <10 seconds) between data-intensive modules and must complete all inputs, outputs, and calculations in this span for one year before repeating this pattern for subsequent years. To meet these speed goals, NEMS2023 avoids writing to disk and stores data in a binary file (*restart.unf*) without any metadata.

For AEO2025, NEMS is transitioning the main code and integration module from Fortran to Python. The NEMS integration team recently completed a project to rewrite the Fortran program that calls each of the individual modules (main.f) into a Python version (nems_flow.py).

In AEO2023, data from other NEMS modules required by the Liquid Fuels Market Module (LFMM) are written into NEM_TO_LFMM1.gdx. LFMM results interface with the NEMS Integrating Module via file LFMM_TO_NEMS.gdx, which is read into memory. Details specific to the integration of FLEX into NEMS are outlined in FLEX Requirement 1: Integration Requirements. This section describes how this functionality will change with FLEX. The FLEX project will remain agile and adapt to fit the appropriate NEMS framework.

Model functions

FLEX must serve and perform the following functions as part of an integrated NEMS cycle:

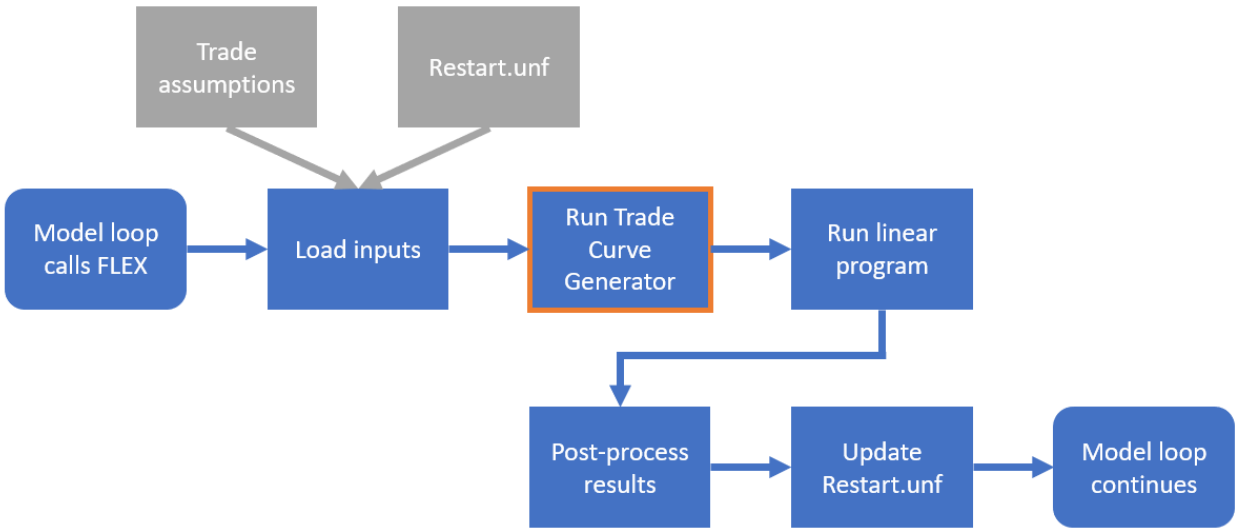
- Provide a slate of domestic prices for finished petroleum products
- Provide regional domestic crude oil prices
- Project the quantity of crude oil processed at domestic refineries
- Project imports and exports of crude oil and petroleum products
- Provide estimates of other refinery inputs (for example, hydrogen) and processing gain
- Project domestic capacity change and/or rationalization for petroleum refineries and alternative fuels facilities
- Project production of alternative fuels
- Project refinery fuel consumption, including electricity, natural gas, still gas, and catalyst coke
- Reflect changes to the petroleum and alternative fuels industries as a result of changes to policies, regulations, taxes, tariffs, and/or subsidies
- Benchmark to our *Short-Term Energy Outlook* (STEO) where appropriate

The Functional Requirements in Section 2 describe and explain how FLEX must carry out these model functions. In addition, a complete list of all NEMS global variables that must be filled by FLEX are listed in Appendix B.

Trade Curve Generator

FLEX will require a connection to international crude oil and petroleum product markets. The approach that FLEX uses to connect with international markets will be very similar to the approach used by the International Energy Module (IEM). Prior to running the linear program (LP), FLEX will generate trade curves in AIMMS. Figure 3 highlights in orange the point at which the Trade Curve Generator (TCG) will run during a FLEX iteration. These curves will be price-quantity step curves that inform FLEX's economic decisions for international trade.

Figure 3. Trade Curve Generator in the Fuel Liquids EXchange (FLEX) module



Source: U.S. Energy Information Administration

Inputs

Inputs to the model are summarized in the following sections.

Assumptions

The TCG will require several exogenous assumptions (Table 3). These assumptions are critical levers to affect FLEX results, but FLEX must simultaneously minimize the time required to manage trade curve assumptions.

Table 3. Trade assumptions and sources in the Trade Curve Generator

Assumption	Source
World Oil Price (WOP)	WOP Core Team
Global liquids demand	WOP Core Team
Crude oil type price coefficients and production shares	Based on last AEO cycle
Supply and demand elasticities	Based on last AEO cycle
Step curve breakpoints	Static
Lower bound for U.S. crude oil exports	Based on last AEO cycle
Product import/export prices and quantities	Based on last AEO cycle, prices adjusted to new WOP
Refinery Region 9[a] product demand price and quantity	Based on last AEO cycle, prices adjusted to new WOP

Source: U.S. Energy Information Administration
Note: AEO=*Annual Energy Outlook*, Refinery Region 9 includes East Canada and Caribbean Islands

Global data system

The TCG will require the inputs from the NEMS restart file (Table 4).

Table 4. Restart variables for the Trade Curve Generator

Input	Source
GDP deflators	Macroeconomic Activity Module
U.S. crude production	Hydrocarbon Supply Module
Brent price	FLEX LP
Total crude oil supply to refineries	FLEX LP
Crude oil import and export quantities	FLEX LP

Source: U.S. Energy Information Administration
Note: GDP=Gross Domestic Product, FLEX=Fuel Liquids EXchange Module, LP=linear program

Trade curve development

The trade curves will be developed using the inputs mentioned in Tables 3 and 4 to generate five sets of curves for the FLEX LP. Using the inputs to form a center point on the curve, the TCG will use the equation for isoelastic curves to build a continuous curve and then approximate step curves using the breakpoint assumption passed into the module.

The curves generated must be step curves for the LP to solve. The curves must not be continuous, which would make it a nonlinear program that would not be able to be solved by LP solvers.

In addition to the five sets of curves, the TCG must compute the difference between total crude oil supply and U.S. crude oil production (from the Hydrocarbon Supply Module [HSM]). This difference will represent non-U.S. crude oil demand.

The following trade-related assumptions must be loaded by the integration wrapper and passed to the LP. The assumptions must not be altered:

- WOP path
- West Texas Intermediate (WTI) spot price
- Lower bound for U.S. crude oil exports

Trade Curve Generator outputs

The outputs of the TCG are summarized below.

Supply and demand curves

- Total crude oil supply
- Product import supply
- Product export demand
- Foreign crude oil import supply
- Refinery Region 9 product demand
- Non-U.S. crude oil demand

User characteristics

Modeler user characteristics

A modeler in the Office of Long-Term Energy Modeling (LTEM) will run FLEX for every AEO production cycle for the Reference case and all additional side cases. The modeler must prepare inputs to the model, run FLEX in a non-integrated environment, run FLEX within an integrated environment, analyze model results, and be able to debug the model.

A modeler will generally have a technical background in either economics or operations research along with some subject matter expertise in petroleum, gas liquids, and biofuels. FLEX will be straightforward for the modeler to update, maintain, and operate.

Analyst user characteristics

An LTEM analyst may be called to evaluate results produced by FLEX or provide insight into the constraints used by the model. This user will not run the model during AEO production cycles, only provide feedback in the form of subject matter expertise.

Analysts will generally have less of a technical background in modeling and may have a stronger background in the subject matter of petroleum, gas liquids, and biofuels.

Design and implementation constraints

Software and programming language

As part of the FLEX development project, we will decide to use either AIMMS or Python-based Pyomo as the primary platform for the linear programming model. The Blue Sky and Carbon Capture, Allocation, Transportation and Sequestration Module (CCATS) teams are evaluating Pyomo for modeling purposes. We will consider findings from both teams prior to deciding which platform will be used.

AIMMS provides distinct technical benefits. Other EIA models have successfully used AIMMS, and many LTEM staff are already proficient AIMMS users. This document assumes the AIMMS platform will be used for developing the optimization model for this project. This document includes additional constraints to the system associated with using AIMMS, including the formatting and file types for input and output files. More detail about the comparison between AIMMS and Pyomo as it pertains to FLEX is available in a related memorandum.

As with other NEMS optimization models, the CPLEX solver will be used with the AIMMS optimization model.

The TCG will be developed in AIMMS and run before the LP. We expect using AIMMS with the TCG to simplify and aid in future-proofing FLEX as we find better ways to integrate international liquids trade into the LP.

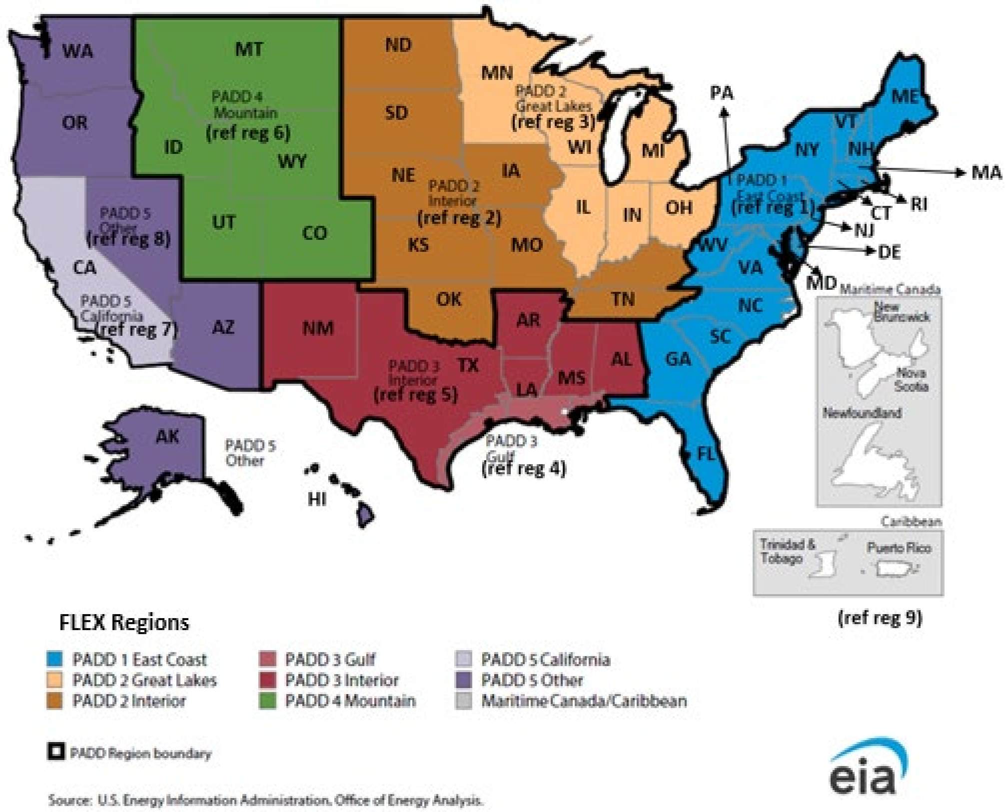
Associated pre- and post-processing of data during runtime will be done in AIMMS.

Pre-processing of data outside of NEMS will be done in Python.

NEMS

The regional representation of NEMS by census division dictates how data are aggregated in the restart file. FLEX will map these data to a set of refining regions in AIMMS, then map them back to NEMS regions after optimization.

Figure 4. Fuel Liquids EXchange (FLEX) Module refining regions



Assumptions and dependencies

Oil prices assumptions

World Oil Price (WOP) path and global crude oil demand projections from the WOP core team will be exogenous inputs into FLEX. The Reference case assumption for global crude oil demand will be used for all cases. The reference WOP path will be used for the Reference case and all side cases except the high and low oil price cases. The high and low oil price cases will use high and low oil price paths. Additional detail is provided in Table 3. FLEX will not replace or evaluate the exogenous WOP projections. However, FLEX will adjust the price of Brent crude oil, given changes in consumption of petroleum products.

FLEX will use Brent crude oil price projections, with the optimization model’s results, to calculate the price of West Texas Intermediate (WTI) crude oil in Cushing, Oklahoma (Refining Region 2). This price will serve as the price of WTI crude oil in the model, and all other crude oil prices will be represented by differentials to this price.

Staff resources

Modelers and advisory staff specified in the Project Team (Table 1) will be available to the project throughout the duration of model design, development, and testing.

FLEX Requirements

1. Integration Requirements

The requirements classified as Integration Requirements relate to any other software, interfaces, or systems related to Fuel Liquids EXchange (FLEX) Module, which will interact with two main systems:

- National Energy Modeling System (NEMS), via restart file
- All files needed for a NEMS model run, including source code and input files, will be part of the NEMS Repository
- FLEX Repository, where preprocessors, input data, and other offline files will be stored

All requirements are identified by an ID number.

1.1 NEMS

Table 5. Requirements for integrating FLEX with NEMS

ID	Requirements	Description
1.1.1	FLEX-NEMS interface	Utilize standard AIMMS-NEMS interface to allow interaction between FLEX and NEMS
1.1.2	NEMS runtime parameters	Use case-specific runtime parameters as specified by NEMS
1.1.3	Restart file interface	Interface with the NEMS restart file, including input and output variables and output data
1.1.4	Debug .csv files	Produce an output .csv file for debugging
1.1.5	Input file formatting	Conduct all input data preprocessing prior to NEMS run; Utilize .txt files where appropriate
1.1.6	STEO data	Benchmark projections to STEO where appropriate; automate process where possible

Source: U.S. Energy Information Administration
Note: FLEX=Fuel Liquids EXchange Module, NEMS=National Energy Modeling System, STEO=Short-Term Energy Outlook

1.2. FLEX Repository

Per Integration Team guidance, all files associated with external (that is, non-Short-Term Energy Outlook [STEO], non-Annual Energy Outlook [AEO]) historical input data or assumptions will be stored as part of a separate FLEX Repository in EIA's GitLab system. This category includes any preprocessing code or routines required for data preparation prior to running FLEX. The only files transferred from the FLEX repository to the NEMS repository will be files that are ready for NEMS runtime.

Table 6. FLEX repository requirements

ID	Requirements	Description
1.2.1	Pre-processed input data	Ensure all exogenous data, historical data is saved in FLEX repository
1.2.2	Data processing files	Make sure all code and data processing tools are included and stored in FLEX repository separate from NEMS
1.2.3	Transfer to NEMS Repository	Ensure any files read directly into FLEX are part of NEMS repository as well

Source: U.S. Energy Information Administration
Note: FLEX=Fuel Liquids EXchange Module, NEMS=National Energy Modeling System

2. Functional Requirements

The functional requirements include the operations, outputs, and methods that the design of FLEX will require. The future *Component Design Report* will include detailed descriptions of how these functions will be met.

2.1. Refining

FLEX must represent the refinery industry to adequately translate crude oil production volumes into the petroleum product consumption volumes projected (Table 7).

Table 7. Refining requirements

ID	Requirements	Description
2.1.1	Petroleum liquids production	Petroleum liquids supply equals NEMS demand
2.1.2	Mass and energy balance	Accounts for byproducts (that is, fuel gas, catalytic coke), utility consumption, and refinery gain
2.1.3	Refinery gate prices	Consistent with historical price relationships
2.1.4	Account for differences in refinery operations, equipment, and crude oil feeds	Differences in refinery equipment and crude oil feed selection
2.1.5	Alternative feedstocks	Differences in refinery operation based on alternative feedstock selection
2.1.6	Refinery consumption	Consumption of refinery utility streams

Source: U.S. Energy Information Administration
Note: NEMS=National Energy Modeling System

2.2. Alternative fuels

FLEX must represent the production of alternative (non-petroleum) fuels, including ethanol, biodiesel, renewable diesel, and sustainable aviation fuel (SAF). FLEX must also be structured to allow for the inclusion of emerging technologies as they become relevant to the domestic and/or global fuels marketplace (Table 8).

Table 8. Alternative fuels requirements

ID	Requirements	Description
2.2.1	Represent production of primary domestic alternative fuels	Includes ethanol, biodiesel, renewable diesel, SAF to supplement refinery production
2.2.2	Feedstock consumption	Model feedstock availability based on the biomass price and quantity developed by the biomass submodule of the Renewable Fuels Module
2.2.3	Production facility gate price	Consistent with historical price relationships
2.2.4	Production facility consumption	Consumption of production facility utility streams
2.2.5	Mass and energy balance	Accounts for byproducts, utility consumption

Source: U.S. Energy Information Administration
Note: SAF=sustainable aviation fuel

2.3. Market crude oil spot prices

Market (for example, spot, marginal, or wholesale) prices have two key purposes in NEMS. First, specific crude oil and spot prices are a required input into the Macroeconomic Activity Model (MAM), which projects macroeconomic drivers. Second, market prices form part of the basis for the calculation of domestic production of crude oil by the Hydrocarbon Supply Module (HSM). The specific spot prices that FLEX will output are included in Table 9.

Table 9. Market spot prices

ID	Requirements	Description
2.3.1	Brent crude oil price	Exogenous assumption to start, then based on crude export curve
2.3.2	West Texas Intermediate crude oil price	Based on domestic price of crude oil
2.3.3	Regional wellhead prices	Regional prices based on refinery demand

Source: U.S. Energy Information Administration

2.4. End-use delivered prices

End-use delivered prices are the key output from FLEX used by demand models to inform their projections (Table 10).

Table 10. End-use delivered prices

ID	Requirements	Description
2.4.1	Market or wholesale price by demand region	Includes competitive market price plus transportation markup between supply and demand region
2.4.2	Buildings sector end-use delivered prices	For residential and commercial buildings, wholesale price plus markup
2.4.3	Industrial sector end-use delivered prices	For the industrial sector, wholesale price plus markup
2.4.4	Electric power sector end-use delivered prices	For power generation and district heat, wholesale price plus markup
2.4.5	Transportation sector end-use delivered prices	For transportation sector, wholesale price plus markup

Source: U.S. Energy Information Administration

2.5. Logistics and trade

Representing both international trade and domestic logistics are key factors when modeling commodity prices to demand markets (Table 11).

Table 11. Trading and logistics

ID	Requirements	Description
2.5.1	Node or region types	Differentiate between refining regions and census divisions
2.5.2	Capacity expansion and rationalization	Allow the capacity of both petroleum and alternative fuels refineries to increase and decrease endogenously
2.5.3	Domestic movement	Represent movements within the United States
2.5.3.1	Pipeline capacity	Represent actual pipeline capacity
2.5.3.2	Alternative modes of transportation	Allow flexibility in crude oil and finished product movement (rail, barge, ship, pipeline, truck)
2.5.3.3	Characterization of transport costs	Represent relative costs for various transportation methods
2.5.4	International trade	Represent movements between United States and rest of the world
2.5.4.1	Supply/demand curves	Generate supply/demand curves for international trade
2.5.4.2	Price representation	Update projected World Oil Price
2.5.4.3	Minimal interaction	Require minimal modeler interaction and maintenance

Source: U.S. Energy Information Administration

2.6. Benchmarking

Our short-term forecasts and long-term projections need to be consistent. We have applied the following rules to projections in the AEO (Table 12):

- STEO forecasts define EIA's short-term (1−2 year) projections, where available
- We will use a 3–5 year window to allow for smooth transition between STEO forecasts and FLEX model results

Table 12. Benchmarking requirements

ID	Requirements	Description
2.6.1	Overwrite values	Overwrite FLEX model results with STEO forecast values where appropriate; automate process where possible
2.6.2	*Short-Term Energy Outlook*	Match STEO results where available
2.6.2.1	Crude oil trade	Match crude oil trade volumes to STEO
2.6.2.2	Finished product trade	Match finished product trade volumes to STEO
2.6.2.3	Product supplied	Match product supplied volumes to STEO
2.6.3	Benchmarking on and off switch	Ability to choose whether or not to benchmark; allow model to solve without matching STEO or AEO
2.6.4	Validation tests	Confirm that overwritten values match values from STEO benchmarking

Source: U.S. Energy Information Administration
Note: FLEX=Fuel Liquids EXchange Module, STEO=Short-Term Energy Outlook, AEO=Annual Energy Outlook

3. Other System Requirements

The requirements below describe additional system requirements of FLEX. These system requirements relate to FLEX's performance as part of the integrated NEMS, the quality of the model and associated code, documentation, and other aspects of quality analysis and quality control throughout the project.

3.1 Performance

Model performance requirements as part of the integrated NEMS can be found in Table 13.

3.1.1 Runtime

Guidance from the Integration Team is that model runtime must be optimized to complete its required functionality. This requirement ensures that a NEMS run can be completed overnight, allowing for daily evaluation of model results by analysts.

3.1.2 Feasibility

FLEX's optimization routine must solve, producing feasible and optimal results, across a wide range of inputs and assumptions. It can only produce infeasible results if given erroneous or *zero* results from other modules via the restart file.

3.1.3 Unique and reproducible results

The solution to FLEX's mathematical program must be a unique solution; alternatively, FLEX must have a procedure in place to handle alternative solutions and modify the mathematical program to arrive at a unique, reproducible solution. This requirement ensures that the NEMS system can reach convergence over multiple iterations.

Table 13. Performance

ID	Requirements	Description
3.1.1	Optimized runtime	Ensures that a NEMS run can be completed overnight
3.1.2	Feasibility	Results must be feasible across a wide range of inputs and assumptions
3.1.3	Unique and reproducible results	Ensures NEMS can reach convergence over multiple iterations

Source: U.S. Energy Information Administration
Note: NEMS=National Energy Modeling System

3.2 Software quality attributes

Software best practices will be followed according to those detailed in Table 14.

Table 14. Software quality practices

ID	Requirements	Description
3.2.1	Discrepancy tracking	Rapid identification of potential issues with model balance
3.2.2	Use of set logic	Dimensions will be defined by root sets with subset structure
3.2.3	AIMMS best practices	Includes use of set logic, case files, procedures for defining parameters, and generalized equations
3.2.4	Python best practices	Best practices to be codified and published
3.2.5	Data processing and regional aggregation and disaggregation	Data aggregation and disaggregation to occur internally endogenously
3.2.6	Naming conventions of regions	Regional names will be consistent and follow set conventions; no use of special characters
3.2.7	CPLEX solver	Tested with CPLEX solver

Source: U.S. Energy Information Administration

3.3 Technical reviews

During the design and development of the FLEX model, the team will leverage staff expertise across the Office of Energy Analysis to review progress. The review requirements aim to ensure that the team gets important feedback regarding model design, is adhering to EIA best practices, and is communicating progress and decisions with key internal stakeholders (Table 15).

Table 15. Technical review plan

ID	Requirements	Description
3.3.1	Technical review of mathematical program	Conducted by senior modelers with linear program experience
3.3.2	Model code peer review	Conducted by EIA staff
3.3.3	Integration team meetings	Monthly coordination meeting

Source: U.S. Energy Information Administration

3.4 Model documentation

We will produce model documentation that is consistent with EIA best practice. The FLEX model documentation will include:

- A full set of mathematical equations used in the optimization model
- Plain Language description of FLEX, including mathematical program, preprocessing, and postprocessing

- Complete list of inputs and outputs
- Visualizations of modeling system, information flow, and curves constructed as part of the objective function (if applicable)

3.5 Debugging tools

The debugging requirements help us debug the model, understand model results, and deconstruct interactions within other modules of NEMS (Table 16).

Table 16. Debugging requirements

ID	Requirements	Description
3.5.1	AIMMS report pages	Visualization of model outputs in the AIMMS environment
3.5.2	Restart file data transfer verification	Record restart file data to .csv format for reference
3.5.3	Error handling	Develop code to ensure NEMS crashes in case of FLEX error
3.5.4	FLEX-NEMS interface code compartmentalization	FLEX-NEMS interface code will not overwrite or benchmark any model results or FLEX outputs it receives

Source: U.S. Energy Information Administration
Note: FLEX=Fuel Liquids EXchange Module, NEMS=National Energy Modeling System

Appendix A. FLEX Hierarchy of Requirements

The matrix of requirements will be the basis for requirements tracking and traceability during model design and development.

Table A1. FLEX hierarchy of requirements

ID	Requirement	Description
1	**Integration**	Includes requirements associated with any other software, interfaces, or systems related to FLEX
1.1	NEMS	Requirements for integrating FLEX with NEMS
1.1.1	FLEX-NEMS interface	Utilize standard AIMMS-NEMS interface to allow interaction between FLEX and NEMS
1.1.2	NEMS runtime parameters	Use case-specific runtime parameters as specified by NEMS
1.1.3	Restart file interface	Interface with the NEMS restart file, including input and output variables and output data
1.1.3.1	Input variables	Restart file input variables required for FLEX
1.1.3.2	Output variables	Restart file output variables provided by FLEX
1.1.3.3	Completion of output data received	Interface of FLEX output data to NEMS
1.1.4	Debug .csv files	Produce an output .csv file for debugging
1.1.5	Input file formatting	Conduct all input data preprocessing prior to NEMS run; utilize .csv files where appropriate
1.1.6	STEO data	Benchmark projections to STEO where appropriate; automate process where possible
1.2	FLEX Repository	All files associated with external (i.e., non-STEO, non-AEO) historical input data or assumptions will be stored as part of a separate FLEX Repository in the Git system
1.2.1	Pre-processed input data	Ensure all exogenous data, historical data is saved in FLEX repository
1.2.2	Data processing files	Make sure all code and data processing tools are included and stored in FLEX repository separate from NEMS
1.2.3	Transfer to NEMS Repository	Ensure any files read directly into FLEX are part of NEMS repository as well
2	**Functional**	Includes the operations, outputs, and methods which will be required in the redesign of FLEX
2.1	Refining	Represent the refinery industry to adequately translate crude oil production volumes into the petroleum product consumption volumes projected
2.1.1	Petroleum liquids production	Petroleum liquids supply equals NEMS demand
2.1.2	Mass and energy balance	Accounts for byproducts (i.e., fuel gas, catalytic coke), utility consumption, and refinery gain
2.1.3	Refinery gate prices	Consistent with historical price relationships
2.1.4	Account for differences in refinery operations,	Differences in refinery equipment and crude oil feed selection

	equipment, and crude oil feeds	
2.1.5	Alternative feedstocks	Differences in refinery operation based on alternative feedstock selection
2.1.6	Refinery consumption	Consumption of refinery utility streams
2.2	Alternative fuels	Represent alternative (non-petroleum) fuels and structure model to allow addition of emerging technologies as they become relevant
2.2.1	Represent production of primary domestic alternative fuels	Includes ethanol, biodiesel, renewable diesel, SAF to supplement refinery production
2.2.2	Feedstock consumption	Model feedstock availability via Policy Analysis System Model (POLYSYS) and Renewable Fuels Module (biomass submodule)
2.2.3	Production facility gate price	Consistent with historical price relationships
2.2.4	Production facility consumption	Consumption of production facility utility streams
2.2.5	Mass and energy balance	Accounts for byproducts, utility consumption
2.3	Market crude oil spot prices	Market crude oil spot prices are required by the Macroeconomic Activity Model (MAM) and the Hydrocarbon Supply Module (HSM)
2.3.1	Brent crude oil price	Exogenous assumption to start, then based on crude export curve
2.3.2	West Texas intermediate crude oil price	Based on domestic price of crude oil
2.3.3	Regional wellhead prices	Regional prices based on refinery demand
2.4	End-use delivered prices	Key output from FLEX used by demand models to inform their projections
2.4.1	Market or wholesale price by demand region	Includes competitive market price plus transportation markup between supply and demand region
2.4.2	Buildings sector end-use delivered prices	For residential and commercial buildings, wholesale price plus markup
2.4.3	Industrial sector end-use delivered prices	For the industrial sector, wholesale price plus markup
2.4.4	Electric power sector end-use delivered prices	For power generation and district heat, wholesale price plus markup
2.4.5	Transportation sector end-use delivered prices	For transportation sector, wholesale price plus markup
2.5	Logistics and trade	Representing both international trade and domestic logistics are key factors when modeling commodity prices to demand markets
2.5.1	Node or region types	Differentiate between refining regions and census divisions
2.5.2	Capacity expansion and rationalization	Allow the capacity of both petroleum and alternative fuels refineries to increase and decrease endogenously
2.5.3	Domestic movement	Represent movements within the U.S.
2.5.3.1	Pipeline capacity	Represent actual pipeline capacity

2.5.3.2	Alternative modes of transportation	Allow flexibility in crude oil and finished product movement (rail, barge, ship, pipeline, truck)
2.5.3.3	Characterization of transport costs	Represent relative costs for various transportation methods
2.5.4	International trade	Represent movements between U.S. and rest of the world
2.5.4.1	Supply/demand curves	Generate supply/demand curves for international trade
2.5.4.2	Price representation	Update projected World Oil Price
2.5.4.3	Minimal interaction	Require minimal modeler interaction and maintenance
2.6	Benchmarking	Our STEO short-term (1-2 year) forecasts and long-term projections need to be consistent
2.6.1	Overwrite values	Overwrite LFMM model results with STEO forecast values where appropriate; automate process where possible
2.6.2	*Short-Term Energy Outlook*	Match STEO results where available
2.6.2.1	Crude oil trade	Match crude oil trade volumes to STEO
2.6.2.2	Finished product trade	Match finished product trade volumes to STEO
2.6.2.3	Product supplied	Match product supplied volumes to STEO
2.6.3	Benchmarking on and off switch	Ability to choose whether or not to benchmark; allow model to solve without matching STEO or AEO
2.6.4	Validation tests	Confirm that overwritten values match values from STEO benchmarking
3	**Other System Requirements**	Items related to performance as part of the integrated NEMS, the quality of the model and associated code, and documentation
3.1	Performance	Model performance requirements as part of the integrated NEMS
3.1.1	Optimized runtime	Ensures that a NEMS run can be completed overnight
3.1.2	Feasibility	Results must be feasible across a wide range of inputs and assumptions
3.1.3	Unique and reproducible results	Ensures NEMS can reach convergence over multiple iterations
3.2	Software quality attributes	Software best practices will be followed
3.2.1	Discrepancy tracking	Rapid identification of potential issues with model balance
3.2.2	Use of set logic	Dimensions will be defined by root sets with subset structure
3.2.3	AIMMS best practices	Includes use of set logic, case files, procedures for defining parameters, and generalized equations
3.2.4	Python best practices	Best practices to be codified and published
3.2.5	Data processing and regional aggregation and disaggregation	Data aggregation and disaggregation to occur internally endogenously
3.2.6	Naming conventions of regions	Regional names will be consistent and follow set conventions; no use of special characters
3.2.7	CPLEX solver	Designed for use with CPLEX solver

3.3	Technical reviews	Leverage staff expertise across the Office of Energy Analysis to review progress and receive important feedback regarding model design, adhering to EIA best practices
3.3.1	Technical review of mathematical program	Conducted by senior modelers with linear program experience
3.3.2	Model code peer review	Conducted by EIA staff
3.3.3	Integration team meetings	Monthly coordination meeting
3.4	Model documentation	Produce mathematical model documentation that is consistent with AIMMS implementation including full set of mathematical equations, plain language description of FLEX, inputs/outputs and visualizations of modeling system
3.5	Debugging tools	Provide ability to debug the model, understand model results, and deconstruct interactions within other modules of NEMS
3.5.1	AIMMS report pages	Visualization of model outputs in the AIMMS environment
3.5.2	Restart file data transfer verification	Record restart file data to .csv format for reference
3.5.3	Error handling	Develop code to ensure NEMS crashes in case of FLEX error
3.5.4	FLEX-NEMS interface code compartmentalization	FLEX-NEMS interface code will not overwrite or benchmark any model results or FLEX outputs it receives

Source: U.S. Energy Information Administration
Note: FLEX=Fuel Liquids EXchange Module, NEMS=National Energy Modeling System

Appendix B. NEMS Restart File Variables in FLEX

The descriptions of variables, sectors, and fuels, is available in the file NEM_LFMM_Restart_Variables.

Table B1. NEMS restart file variables in FLEX

Restart Variable	Units	Dimension	Input or Output
AB32_AB_ALLOW_P	$1987/ton	Year	Input
AB32_AB_COVD_EM_REF	MMton CO2	Year	Output
COALEMM_N_CFR	Scalar		Output
COALEMM_N_CPTY	Scalar		Output
COALEMM_N_HRAT	Scalar		Output
COALEMM_N_IGRP	Scalar		Output
COALEMM_N_PLTS	Scalar		Output
COALEMM_N_PTP	Scalar		Output
COALEMM_N_RG	Scalar		Output
COALEMM_N_RY	Scalar		Output
COALEMM_PLNT_EMF	Scalar	ECP Plant Types, Coal Ranks	Output
COALEMM_RCLCLNR	Percent	Coal Demand Region, Year, Utility Demand Sectors	Output
COGEN_CGREFCAP	MW	Census Regions, Years, Num of Combined Heat and Power Fuels	Output
COGEN_CGREFGEN	GWh	Census Regions, Years, Num of Combined Heat and Power Fuels	Output
COGEN_CGREFQ	tBtu	Census Regions, Years, Num of Combined Heat and Power Fuels	Output
CONVFACT_API50PL	API		Output
CONVFACT_APICA	API		Output
CONVFACT_APICAMG	API		Output
CONVFACT_APICRDDOM	API		Output
CONVFACT_APICRDEXP	API		Output
CONVFACT_APICRDIMP	API		Output
CONVFACT_APIDIL	API		Output
CONVFACT_APIHVSO	API		Output
CONVFACT_APIHVSW	API		Output
CONVFACT_APILLSW	API		Output
CONVFACT_APILTSO	API		Output
CONVFACT_APILTSW	API		Output
CONVFACT_APIMDSO	API		Output
CONVFACT_APIMMSO	API		Output
CONVFACT_APISYN	API		Output
CONVFACT_CFASQ	Btu/b		Input
CONVFACT_CFAVQ	Btu/b		Input
CONVFACT_CFBIOBUTE	Btu/b	Year	Input
CONVFACT_CFBIOD	Btu/b	Year	Input
CONVFACT_CFBTLLIQ	Btu/b	Year	Output
CONVFACT_CFBUQ	Btu/b		Input
CONVFACT_CFCBOB	Btu/b	Year	Input
CONVFACT_CFCBQ	Btu/b	Year	Input
CONVFACT_CFCBTLLIQ	Btu/b		Output
CONVFACT_CFCCQ	Btu/b	Year	Input
CONVFACT_CFCRDCA	Btu/b	Year	Output

CONVFACT_CFCRDDILBIT	Btu/b	Year	Output
CONVFACT_CFCRDHVSOUR	Btu/b	Year	Output
CONVFACT_CFCRDHVSWT	Btu/b	Year	Output
CONVFACT_CFCRDLSCOND	Btu/b	Year	Output
CONVFACT_CFCRDLT2SWT	Btu/b	Year	Output
CONVFACT_CFCRDLTSOUR	Btu/b	Year	Output
CONVFACT_CFCRDLTSWT	Btu/b	Year	Output
CONVFACT_CFCRDMD2SOUR	Btu/b	Year	Output
CONVFACT_CFCRDMDSOUR	Btu/b	Year	Output
CONVFACT_CFCRDSYN	Btu/b	Year	Output
CONVFACT_CFCTLLIQ	Btu/b	Year	Output
CONVFACT_CFDSCM	Btu/b	Year	Output
CONVFACT_CFDSCQ	Btu/b	Year	Output
CONVFACT_CFDSEL	Btu/b	Year	Output
CONVFACT_CFDSIN	Btu/b	Year	Output
CONVFACT_CFDSLQ	Btu/b	Year	Output
CONVFACT_CFDSQ	Btu/b		Output
CONVFACT_CFDSQT	Btu/b	Year	Output
CONVFACT_CFDSRS	Btu/b	Year	Output
CONVFACT_CFDSTR	Btu/b	Year	Output
CONVFACT_CFDSUQ	Btu/b	Year	Input
CONVFACT_CFE85Q	Btu/b	Year	Output
CONVFACT_CFEEQ	Btu/b		Input
CONVFACT_CFELQ	Btu/kWh		Input
CONVFACT_CFETQ	Btu/b	Year	Input
CONVFACT_CFFTLIQ	Btu/b		Input
CONVFACT_CFIBQ	Btu/b		Input
CONVFACT_CFIMUO	Btu/b	Year	Input
CONVFACT_CFJFK	Btu/b		Input
CONVFACT_CFJFQ	Btu/b	Year	Output
CONVFACT_CFLGQ	Btu/b	Year	Output
CONVFACT_CFLUQ	Btu/b		Output
CONVFACT_CFMEQT	Btu/b		Input
CONVFACT_CFMGQ	Btu/b	Year	Output
CONVFACT_CFNGL	Btu/b	Year	Output
CONVFACT_CFNPQ	Btu/b		Input
CONVFACT_CFOTQ	Btu/b	Year	Input
CONVFACT_CFPCQ	Btu/b		Input
CONVFACT_CFPET	Btu/b		Input
CONVFACT_CFPFQ	Btu/b	Year	Output
CONVFACT_CFPPQ	Btu/b		Input
CONVFACT_CFPRQ	Btu/b		Input
CONVFACT_CFRBOB	Btu/b	Year	Input
CONVFACT_CFRGQ	Btu/b	Year	Output
CONVFACT_CFRSQ	Btu/b		Input
CONVFACT_CFSGQ	Btu/b		Input
CONVFACT_CFTGQ	Btu/b	Year	Output
CONVFACT_CFUBAQ	Btu/b	Year	Input
CORNTO	Dimension		Input
CRSTEP	Dimension		Input
CYCLEINFO_CURIRUN	Dimension		Input

ECPCAP	Dimension		Input
ECPFPH	Dimension		Input
EMABLK_JBUIN	$1987/Btu	Year	Input
EMABLK_JBUINPF	$1987/Btu	Year	Input
EMABLK_JCLCLNR	$1987/Btu	Years, Utility Demand Sectors	Input
EMABLK_JDSCM	$1987/Btu	Year	Input
EMABLK_JDSEL	$1987/Btu	Year	Input
EMABLK_JDSIN	$1987/Btu	Year	Input
EMABLK_JDSRS	$1987/Btu	Year	Input
EMABLK_JDSTR	$1987/Btu	Year	Input
EMABLK_JETTR	$1987/Btu	Year	Input
EMABLK_JISIN	$1987/Btu	Year	Input
EMABLK_JISINPF	$1987/Btu	Year	Input
EMABLK_JJFTR	$1987/Btu	Year	Input
EMABLK_JKSCM	$1987/Btu	Year	Input
EMABLK_JKSIN	$1987/Btu	Year	Input
EMABLK_JKSRS	$1987/Btu	Year	Input
EMABLK_JLUIN	$1987/Btu	Year	Input
EMABLK_JMGCM	$1987/Btu	Year	Input
EMABLK_JMGIN	$1987/Btu	Year	Input
EMABLK_JMGTR	$1987/Btu	Year	Input
EMABLK_JOTIN	$1987/Btu	Year	Input
EMABLK_JOTTR	$1987/Btu	Year	Input
EMABLK_JPCIN	$1987/Btu	Year	Input
EMABLK_JPFIN	$1987/Btu	Year	Input
EMABLK_JPPIN	$1987/Btu	Year	Input
EMABLK_JPPINPF	$1987/Btu	Year	Input
EMABLK_JRHEL	$1987/Btu	Year	Input
EMABLK_JRHTR	$1987/Btu	Year	Input
EMABLK_JRLCM	$1987/Btu	Year	Input
EMABLK_JRLEL	$1987/Btu	Year	Input
EMABLK_JRLIN	$1987/Btu	Year	Input
EMABLK_JRLTR	$1987/Btu	Year	Input
EMEBLK_EDSTR	MMton/quad	Year	Input
EMEBLK_EJFTR	MMton/quad	Year	Input
EMEBLK_ELGTR	MMton/quad	Year	Input
EMEBLK_EMGTR	MMton/quad	Year	Input
EMEBLK_ENGIN	MMton/quad	Year	Input
EMEBLK_EOTIN	MMton/quad	Year	Input
EMEBLK_EOTTR	MMton/quad	Year	Input
EMEBLK_ERSTR	MMton/quad	Year	Input
EMISSION_CCS_PMM	MMton CO2		Output
EMISSION_EMEL_PHG	$/ton	Coal Demand Region, Year	Input
EMISSION_EMELPSO2	$/ton	Years, SO2 Compliance Groups	Input
EMISSION_EMETAX	$1987/ton		Input
EMISSION_EMTRC	MMton	Census Regions, Air Emissions Particulates, Years	Input
EMISSION_EXTRARISK	Percent	Year	Input
EMISSION_NUM_SO2_GRP	Dimension		Input
EMISSION_SO2_SHR_BY_CLRG	Fraction	Coal Demand Region, SO2 Compliance Groups	Input
INDOUT_HYDROGEN2REF	BFOE	Year	Input

INDOUT_INQLGHP	tBtu	Census Regions, Years	Input
INDREP_QCCRF	tBtu		Output
INSTEP	Dimension		Input
INTOUT_BRENT_PRICE	$1987/b	Year	Output
INTOUT_ICOCANADA	MMb/d	Year	Input
INTOUT_ICOMEXICO	MMb/d	Year	Input
INTOUT_ICONORTHSEA	MMb/d	Year	Input
INTOUT_ICOOPAMERICAS	MMb/d	Year	Input
INTOUT_ICOOPEC	MMb/d	Year	Input
INTOUT_ICOOPNOAFRICA	MMb/d	Year	Input
INTOUT_ICOOPPERSIANGULF	MMb/d	Year	Input
INTOUT_ICOOPWESTAFRICA	MMb/d	Year	Input
INTOUT_ICOOTHERAFRICA	MMb/d	Year	Input
INTOUT_ICOOTHERAMERICAS	MMb/d	Year	Input
INTOUT_ICOOTHERASIA	MMb/d	Year	Input
INTOUT_ICOOTHERMIDEAST	MMb/d	Year	Input
INTOUT_ICOTOTAL	MMb/d	Year	Input
INTOUT_IHPASIA	MMb/d	Year	Input
INTOUT_IHPCANADA	MMb/d	Year	Input
INTOUT_IHPCARIBBEAN	MMb/d	Year	Input
INTOUT_IHPNORTHEUROPE	MMb/d	Year	Input
INTOUT_IHPOPAMERICAS	MMb/d	Year	Input
INTOUT_IHPOPEC	MMb/d	Year	Input
INTOUT_IHPOPNOAFRICA	MMb/d	Year	Input
INTOUT_IHPOPPERSIANGULF	MMb/d	Year	Input
INTOUT_IHPOPWESTAFRICA	MMb/d	Year	Input
INTOUT_IHPOTHER	MMb/d	Year	Input
INTOUT_IHPSOUTHEUROPE	MMb/d	Year	Input
INTOUT_IHPTOTAL	MMb/d	Year	Input
INTOUT_ILPASIA	MMb/d	Year	Input
INTOUT_ILPCANADA	MMb/d	Year	Input
INTOUT_ILPCARIBBEAN	MMb/d	Year	Input
INTOUT_ILPNORTHEUROPE	MMb/d	Year	Input
INTOUT_ILPOPAMERICAS	MMb/d	Year	Input
INTOUT_ILPOPEC	MMb/d	Year	Input
INTOUT_ILPOPNOAFRICA	MMb/d	Year	Input
INTOUT_ILPOPPERSIANGULF	MMb/d	Year	Input
INTOUT_ILPOPWESTAFRICA	MMb/d	Year	Input
INTOUT_ILPOTHER	MMb/d	Year	Input
INTOUT_ILPSOUTHEUROPE	MMb/d	Year	Input
INTOUT_ILPTOTAL	MMb/d	Year	Input
INTOUT_IT_WOP	$1987/b	Year	Output
INTOUT_P_C_MC_DEMAND	$1987/b	Refine Reg 9 Demand Curve, Years, Petroleum Prod Streams	Input
INTOUT_P_FOREIGN_CRUDE	$1987/b	Crude Type	Input
INTOUT_P_NON_US_DEMAND	$1987/b	Crude Type	Input
INTOUT_P_TOTAL_CRUDE	$1987/b	Crude Oil Curve Steps, Years	Input
INTOUT_Product_Export_P	$1987/b	Petroleum Prod Streams, International Regions, Prod Import Curve Steps, Years	Input
INTOUT_Product_Export_Q	MMb/d	Petroleum Prod Streams, International Regions, Prod Import Curve Steps, Years	Input

INTOUT_Product_Import_P	$1987/b	Petroleum Prod Streams, International Regions, Prod Import Curve Steps, Years	Input
INTOUT_Product_Import_Q	MMb/d	Petroleum Prod Streams, International Regions, Prod Import Curve Steps, Years	Input
INTOUT_Q_C_MC_DEMAND	MMb/d	Refine Reg 9 Demand Curve, Years, Petroleum Prod Streams	Input
INTOUT_Q_FOREIGN_CRUDE	MMb/d	Crude Type	Input
INTOUT_Q_NON_US_DEMAND	MMb/d	Crude Type	Input
INTOUT_Q_TOTAL_CRUDE	MMb/d	Crude Oil Curve Steps, Years	Input
INTOUT_START_PRICE	$1987/b	Year	Input
INTOUT_WTI_PRICE	$1987/b	Year	Input
INTREG	Dimension		Input
LCFS_C	Dimension		Output
LFMMOUT_AB32_DS	$1987/Btu	Year	Output
LFMMOUT_AB32_ET	$1987/Btu	Year	Output
LFMMOUT_AB32_JF	$1987/Btu	Year	Output
LFMMOUT_AB32_KS	$1987/Btu	Year	Output
LFMMOUT_AB32_MG	$1987/Btu	Year	Output
LFMMOUT_AB32_PR	$1987/Btu	Year	Output
LFMMOUT_AB32JETCOVER	Scalar	Year	Output
LFMMOUT_BIMQTY	Mb/d		Output
LFMMOUT_BIOBUTEEXP	Mb/d	Year	Output
LFMMOUT_BIOBUTEIMP	Mb/d	Year	Output
LFMMOUT_BIOBUTEPRICE	$1987/b	Year	Output
LFMMOUT_BIOBUTESTK	Mb/d	Year	Output
LFMMOUT_BIODIMPPD	Mb/d	PADD Region, Years	Output
LFMMOUT_BIODSTKCHG	Mb/d	Year	Output
LFMMOUT_CFP_Actual	MMton CO2 per Trill	LCFS Categories, Years	Output
LFMMOUT_CFP_Baseline	MMton CO2 per Trill	LCFS Categories, Years	Output
LFMMOUT_CFP_Carb_Offset	MMton CO2	LCFS Categories, Years	Output
LFMMOUT_CFP_Offset_Prc	$1987/Mton CO2	LCFS Categories, Years	Output
LFMMOUT_CFP_PeToTrills	MMton	LCFS Categories, Years	Output
LFMMOUT_CFP_Waiver	MMton CO2	LCFS Categories, Years	Output
LFMMOUT_CORNCD	MMbu	Uses for Corn, Census Regions, Years	Output
LFMMOUT_DOM_CONSUME	Volume Units		Output
LFMMOUT_ETHSTKCHG	Mb/d	Year	Output
LFMMOUT_ETHTOT	Mb/d	PADD Region, Years	Output
LFMMOUT_FEEDSTOCKS	Volume Units		Output
LFMMOUT_GRAINCD	MMbu	Census Regions, Years	Output
LFMMOUT_GRD2DSQTY	Mb/d	PADD Region, Years	Output
LFMMOUT_GRN2MGQTY	Mb/d	PADD Region, Years	Output
LFMMOUT_GROSS_EXPORT	Volume Units		Output
LFMMOUT_GROSS_IMPORT	Volume Units		Output
LFMMOUT_INTERMEDIATE	Volume Units		Output
LFMMOUT_LCFS_Actual	MMton CO2 per Trill	LCFS Categories, Years	Output
LFMMOUT_LCFS_Baseline	MMton CO2 per Trill	LCFS Categories, Years	Output
LFMMOUT_LCFS_Carb_Offset	MMton CO2	LCFS Categories, Years	Output
LFMMOUT_LCFS_Offset_Prc	$1987/Mton CO2	LCFS Categories, Years	Output
LFMMOUT_LCFS_PeToTrills	MMton	LCFS Categories, Years	Output
LFMMOUT_LCFS_Waiver	MMton CO2	LCFS Categories, Years	Output
LFMMOUT_LFEXPLEASE			Output
LFMMOUT_LFMMCODE			Output

LFMMOUT_LFREFRENT			Output
LFMMOUT_MOTOR_FUEL	Mb/d		Output
LFMMOUT_P_CRUDE_EXPORTS	$1987/b		Output
LFMMOUT_P_CRUDE_IMPORTS	$1987/b		Output
LFMMOUT_P_RFCRUDEINP	$1987/b	PADD Region, Crude Type, Years	Output
LFMMOUT_PROFIT_BBL	$1987/b	PADD Region, Years	Output
LFMMOUT_Q_CRUDE_EXPORTS	Mb/d		Output
LFMMOUT_Q_CRUDE_IMPORTA	Mb/d		Output
LFMMOUT_Q_CRUDE_IMPORTS	Mb/d		Output
LFMMOUT_Q_CRUDE_TO_CAN	Mb/d	PADD Region, Crude Type, Years	Output
LFMMOUT_QBIOBUTE	Mb/d	Census Regions, Years	Output
LFMMOUT_QNGRFPD	tBtu	PADD Region, Years	Output
LFMMOUT_REF_CAP	Mb/d		Output
LFMMOUT_REF_UTL	Fraction		Output
LFMMOUT_REFGAIN	Mb/d	PADD Region	Output
LFMMOUT_REFINE_PROD	Volume Units		Output
LFMMOUT_RENEWDIMP	Mb/d	Census Regions, Years	Output
LFMMOUT_RENEWDIMPPD	Mb/d	PADD Region, Years	Output
LFMMOUT_RFBIOBUTECD	Mb/d	Census Regions, Years	Output
LFMMOUT_RFBIOBUTERR	Mb/d	PADD Region, Years	Output
LFMMOUT_RFCRUDEINP	Mb/d	PADD Region, Crude Type, Years	Output
LFMMOUT_RFCRUDEWHP	$1987/b	PADD Region, Crude Type, Years	Output
LFMMOUT_RFIPQAG	Mb/d	PADD Region, Years	Output
LFMMOUT_RFIPQAR3	Mb/d	PADD Region, Years	Output
LFMMOUT_RFIPQAS	Mb/d	PADD Region, Years	Output
LFMMOUT_RFIPQBU	Mb/d	PADD Region, Years	Output
LFMMOUT_RFIPQCBOB	Mb/d	PADD Region, Years	Output
LFMMOUT_RFIPQCD	Mb/d	PADD Region, Years	Output
LFMMOUT_RFIPQCG	Mb/d	PADD Region, Years	Output
LFMMOUT_RFIPQDL	Mb/d	PADD Region, Years	Output
LFMMOUT_RFIPQDS	Mb/d	PADD Region, Years	Output
LFMMOUT_RFIPQDU	Mb/d	PADD Region, Years	Output
LFMMOUT_RFIPQET	Mb/d	PADD Region, Years	Output
LFMMOUT_RFIPQGO3	Mb/d	PADD Region, Years	Output
LFMMOUT_RFIPQIS	Mb/d	PADD Region, Years	Output
LFMMOUT_RFIPQJF	Mb/d	PADD Region, Years	Output
LFMMOUT_RFIPQLU	Mb/d	PADD Region, Years	Output
LFMMOUT_RFIPQMG	Mb/d	PADD Region, Years	Output
LFMMOUT_RFIPQMN3	Mb/d	PADD Region, Years	Output
LFMMOUT_RFIPQPC	Mb/d	PADD Region, Years	Output
LFMMOUT_RFIPQPF	Mb/d	PADD Region, Years	Output
LFMMOUT_RFIPQPP	Mb/d	PADD Region, Years	Output
LFMMOUT_RFIPQPR	Mb/d	PADD Region, Years	Output
LFMMOUT_RFIPQPY	Mb/d	PADD Region, Years	Output
LFMMOUT_RFIPQRBOB	Mb/d	PADD Region, Years	Output
LFMMOUT_RFIPQRG	Mb/d	PADD Region, Years	Output
LFMMOUT_RFIPQRH	Mb/d	PADD Region, Years	Output
LFMMOUT_RFIPQRL	Mb/d	PADD Region, Years	Output
LFMMOUT_RFOTHERINP	Mb/d	PADD Region, Years	Output
LFMMOUT_RFPRDDIESEL	Mb/d	Census Regions, Years	Output
LFMMOUT_RFS_WAIVER	$1987/b		Output

LFMMOUT_RFSACTUAL	Mb/d		Output
LFMMOUT_RFSCREDITS	Bgal		Output
LFMMOUT_RFSCREDPRC	$1987/b		Output
LFMMOUT_RFSDSRS	$1987/b	Census Regions, Years	Output
LFMMOUT_RFSDSTR	$1987/b	Census Regions, Years	Output
LFMMOUT_RFSJFTR	$1987/b	Census Regions, Years	Output
LFMMOUT_RFSMANDATES	Bgal		Output
LFMMOUT_RFSMGTR	$1987/b	Census Regions, Years	Output
LFMMOUT_RFSRBOB	$1987/b	Census Regions, Years	Output
LFMMOUT_RFSSAFETY	Bgal		Output
LFMMOUT_SAF2JTQTY	Mb/d	PADD Region, Years	Output
LFMMOUT_SBOQGD	Mb/d	PADD Region, Years	Output
LFMMOUT_SBOQRJH	Mb/d	PADD Region, Years	Output
LFMMOUT_WGRQGD	Mb/d	PADD Region, Years	Output
LFMMOUT_WGRQRDH	Mb/d	PADD Region, Years	Output
LFMMOUT_WGRQRJH	Mb/d	PADD Region, Years	Output
LFMMOUT_YGRQGD	Mb/d	PADD Region, Years	Output
MACOUT_MC_JPGDP		Years 1987-1989	Input
MACOUT_MC_NP	MM	Census Regions, Years	Input
MACOUT_MC_RMCORPBAA	Percent	Year	Input
MACOUT_MC_RMTCM10Y	Percent	Year	Input
MAXNF2	Dimension		Input
MAXNFR	Dimension		Input
MCDETAIL_MC_DETAIL			Input
MCSTEP_	Dimension		Input
MNCRUD	Dimension		Input
MPBLK_PASIN	$1987/MMBtu	Census Regions, Years	Output
MPBLK_PDSAS	$1987/Btu	Census Regions, Years	Output
MPBLK_PDSCM	$1987/Btu	Census Regions, Years	Output
MPBLK_PDSEL	$1987/Btu	Census Regions, Years	Output
MPBLK_PDSIN	$1987/Btu	Census Regions, Years	Output
MPBLK_PDSRS	$1987/Btu	Census Regions, Years	Output
MPBLK_PDSTR	$1987/Btu	Census Regions, Years	Output
MPBLK_PELIN	$1987/Btu	Census Regions, Years	Input
MPBLK_PETTR	$1987/Btu	Census Regions, Years	Output
MPBLK_PGIIN	$1987/Btu	Census Regions, Years	Input
MPBLK_PJFTR	$1987/MMBtu	Census Regions, Years	Output
MPBLK_PKSAS	$1987/Btu	Census Regions, Years	Output
MPBLK_PKSCM	$1987/Btu	Census Regions, Years	Output
MPBLK_PKSIN	$1987/Btu	Census Regions, Years	Output
MPBLK_PKSRS	$1987/Btu	Census Regions, Years	Output
MPBLK_PLGAS	$1987/Btu	Census Regions, Years	Output
MPBLK_PLGCM	$1987/Btu	Census Regions, Years	Output
MPBLK_PLGIN	$1987/Btu	Census Regions, Years	Output
MPBLK_PLGRS	$1987/Btu	Census Regions, Years	Output
MPBLK_PLGTR	$1987/Btu	Census Regions, Years	Output
MPBLK_PMETR	$1987/Btu	Census Regions, Years	Output
MPBLK_PMGAS	$1987/Btu	Census Regions, Years	Output
MPBLK_PMGCM	$1987/Btu	Census Regions, Years	Output
MPBLK_PMGIN	$1987/Btu	Census Regions, Years	Output
MPBLK_PMGTR	$1987/Btu	Census Regions, Years	Output

MPBLK_PNGIN	$1987/Btu	Census Regions, Years	Input
MPBLK_POTAS	$1987/Btu	Census Regions, Years	Output
MPBLK_POTIN	$1987/Btu	Census Regions, Years	Output
MPBLK_POTTR	$1987/Btu	Census Regions, Years	Output
MPBLK_PPFIN	$1987/Btu	Census Regions, Years	Output
MPBLK_PRHAS	$1987/Btu	Census Regions, Years	Output
MPBLK_PRHEL	$1987/Btu	Census Regions, Years	Output
MPBLK_PRHTR	$1987/Btu	Census Regions, Years	Output
MPBLK_PRLAS	$1987/Btu	Census Regions, Years	Output
MPBLK_PRLCM	$1987/Btu	Census Regions, Years	Output
MPBLK_PRLEL	$1987/Btu	Census Regions, Years	Output
MPBLK_PRLIN	$1987/Btu	Census Regions, Years	Output
MPBLK_PRLTR	$1987/Btu	Census Regions, Years	Output
MX_NCI_NCI	Dimension		Input
MX_NCL_NCL	Dimension		Input
MX_RNK _RNK	Dimension		Input
MX_SO2_SO2	Dimension		Input
MXPBLK_XPALMG	$1987/b	Census Regions, Years	Input
MXPBLK_XPELIN	$1987/Btu	Census Regions, Years	Input
MXPBLK_XPGIIN	$1987/Btu	Census Regions, Years	Input
MXQBLK_XQASIN	tBtu	Census Regions, Years	Input
MXQBLK_XQDSCM	tBtu	Census Regions, Years	Input
MXQBLK_XQDSEL	tBtu	Census Regions, Years	Input
MXQBLK_XQDSIN	tBtu	Census Regions, Years	Input
MXQBLK_XQDSRS	tBtu	Census Regions, Years	Input
MXQBLK_XQDSTR	tBtu	Census Regions, Years	Input
MXQBLK_XQETTR	tBtu	Census Regions, Years	Input
MXQBLK_XQJFTR	tBtu	Census Regions, Years	Input
MXQBLK_XQKSAS	tBtu	Census Regions, Years	Input
MXQBLK_XQLUIN	tBtu	Census Regions, Years	Input
MXQBLK_XQMGAS	tBtu	Census Regions, Years	Input
MXQBLK_XQNGTR	tBtu	Census Regions, Years	Input
MXQBLK_XQOTIN	tBtu	Census Regions, Years	Input
MXQBLK_XQOTRF	tBtu	Census Regions, Years	Input
MXQBLK_XQPCAS	tBtu	Census Regions, Years	Input
MXQBLK_XQPCRF	tBtu	Census Regions, Years	Input
MXQBLK_XQPFIN	tBtu	Census Regions, Years	Input
MXQBLK_XQRHAS	tBtu	Census Regions, Years	Input
MXQBLK_XQRHEL	tBtu	Census Regions, Years	Input
MXQBLK_XQRLAS	tBtu	Census Regions, Years	Input
MXQBLK_XQRLEL	tBtu	Census Regions, Years	Input
MXQBLK_XQRLRF	tBtu	Census Regions, Years	Input
NCNTRL_CURCALYR			Input
NCNTRL_CURITR			Input
NCNTRL_FCRL			Input
NDREGN	Dimension		Input
NDRGN1	Dimension		Input
NUMCGF	Dimension		Input
NUTSEC	Dimension		Input
OGDIST	Dimension		Input
OGSMOUT_OGCO2AVL	MMcf		Input

OGSMOUT_OGCO2PLF	$1987/MMcf		Output
OGSMOUT_OGCO2PRC	$1987/MMcf		Input
OGSMOUT_OGCO2PUR2	MMcf		Input
OGSMOUT_OGCO2QLF	MMcf		Output
OGSMOUT_OGCO2TAR	$1987/MMcf		Input
OGSMOUT_OGCRDHEAT	Btu/b	Crude Type, Years	Input
OGSMOUT_OGCRUDEREF	Mb/d	PADD Region, Crude Type, Years	Input
OGSMOUT_OGNGPLBU	Mb	HSM Districts, Years	Input
OGSMOUT_OGNGPLET	Mb	HSM Districts, Years	Input
OGSMOUT_OGNGPLIS	Mb	HSM Districts, Years	Input
OGSMOUT_OGNGPLPP	Mb	HSM Districts, Years	Input
OGSMOUT_OGNGPLPR	Mb	HSM Districts, Years	Input
OGSMOUT_OGNGPLPRD	Mb	HSM Districts, Years	Input
PMMFTAB_ADVCAPCD	Mb/d	Census Regions, Years	Output
PMMFTAB_CBIODUAL		Year	Output
PMMFTAB_CELLIMPFRAC	Fraction	Census Regions, Years	Output
PMMFTAB_CLLCAPCD	Mb/d	Census Regions, Years	Output
PMMFTAB_CONEFF	Scalar	Year	Input
PMMFTAB_CRNCAPCD	Mb/d	Census Regions, Years	Output
PMMFTAB_DSCSHR	Percent	Census Regions, Years	Output
PMMFTAB_DSMURS	$1987/Btu	Census Regions, Years	Output
PMMFTAB_DSMUTR	$1987/Btu	Census Regions, Years	Output
PMMFTAB_E85ICCREDIT	$1987/b	Year	Output
PMMFTAB_GRNCAPCD	Mb/d	Census Regions, Years	Output
PMMFTAB_JFMUTR	$1987/Btu	Census Regions, Years	Output
PMMFTAB_LCFSSAFE		Year	Input
PMMFTAB_MGMUTR	$1987/Btu	Census Regions, Years	Output
PMMFTAB_MINREN	Mb/d	Year	Output
PMMFTAB_PALBOB	$1987/b	Census Regions, Years	Output
PMMFTAB_PALMG	$1987/b	Census Regions, Years	Output
PMMFTAB_PDS	$1987/b	Census Regions, Years	Output
PMMFTAB_PDSCRB	$1987/b	Census Regions, Years	Output
PMMFTAB_PDSL	$1987/b	Census Regions, Years	Output
PMMFTAB_PDSU	$1987/b	Census Regions, Years	Output
PMMFTAB_PJF	$1987/b	Census Regions, Years	Output
PMMFTAB_PLMQTYCD	Mb/d	Census Regions, Years	Output
PMMFTAB_RFENVFX	$1987/Btu	Census Regions, Years	Output
PMMFTAB_RFHCXH2IN	MMb/d	PADD Region, Years	Output
PMMFTAB_RFIMPEXPEND	$1987/b	Year	Output
PMMFTAB_RFQEL	MMb/d	Year	Input
PMMFTAB_RFQIN	MMb/d	Year	Input
PMMFTAB_RFQNGPF	MMb/d	Census Regions, Years	Output
PMMFTAB_RFQRC	MMb/d	Year	Output
PMMFTAB_RFQSECT	MMb/d	Year	Output
PMMFTAB_RFQTR	MMb/d	Year	Output
PMMFTAB_SBO_PRICE	$1987/b	Census Regions, Years	Output
PMMFTAB_SBO2GDTPD	MMb/d	PADD Region, Years	Output
PMMFTAB_SBO2SAFPD	MMb/d	PADD Region, Years	Output
PMMFTAB_SBOQTYCD	Mb/d	Census Regions, Years	Output
PMMFTAB_UBAVOLDS	Mb/d	PADD Region, Years	Output
PMMFTAB_UBAVOLMG	Mb/d	PADD Region, Years	Output

PMMFTAB_WGR_PRICE	$1987/b	Census Regions, Years	Output
PMMFTAB_WGR2GDTPD	MMb/d	PADD Region, Years	Output
PMMFTAB_WGR2SAFPD	MMb/d	PADD Region, Years	Output
PMMFTAB_WS_RBOB	$1987/b	Census Regions, Years	Output
PMMFTAB_YGR_PRICE	$1987/b	Census Regions, Years	Output
PMMFTAB_YGR2GDTPD	MMb/d	PADD Region, Years	Output
PMMOUT_BTLFRAC	Mb/d		Output
PMMOUT_CBTLFRAC	MMb/d		Output
PMMOUT_CRNPRICE	$1987/bu	Census Regions, Years	Output
PMMOUT_CTLFRAC	Mb/d		Output
PMMOUT_DCRDWHP	$1987/b	Oil & Gas Regions, Years	Input
PMMOUT_ETHNE85	Fraction		Output
PMMOUT_GLBCRDDMD	MMb/d	Year	Output
PMMOUT_GTLFRAC	MMb/d		Output
PMMOUT_OS_WOP	$1987/b	Year	Input
PMMOUT_PRDSTKWDR	MMb/d	PADD Region, Years	Input
PMMOUT_QBMRFBTL	tBtu	Census Regions, Years	Output
PMMOUT_QCLRFPD	tBtu	PADD Region, Years	Output
PMMOUT_QMERF	tBtu	Census Regions, Years	Output
PMMOUT_RFPQNGL	MMb/d	PADD Region, Years	Output
PMMOUT_RFQDCRD	MMb/d		Input
PMMOUT_RFQNGPL	Mb/d	PADD Region, Years	Output
PMMOUT_RFQPRCG	MMb/d	PADD Region, Years	Output
PMMOUT_RFQPRDT	MMb/d	Census Regions, Years	Output
PMMOUT_RFSPRFR	MMb/d	Year	Output
PMMOUT_RFSPRIM	MMb/d	Year	Input
PMMOUT_TRGNE85	Fraction		Output
PMMOUT_UBAVOL	Mb/d	PADD Region, Years	Output
PMMOUT_XDCRDWHP	$1987/b	Oil & Gas Regions, Years	Input
PMMOUT_XRFQDCRD	$1987/b	Oil & Gas Regions, Years	Input
PMMOUT_XTL_CO2AVAIL	MMton	PADD Region, Years	Output
PMMRPT_BIMQTYCD	Mb/d		Output
PMMRPT_BIODCONCD	Mb/d		Output
PMMRPT_BIODEXP	Mb/d	Census Regions, Years	Output
PMMRPT_BIODIMP	Mb/d	Census Regions, Years	Output
PMMRPT_BIODPRICE	$1987/b	Census Regions, Years	Output
PMMRPT_BLDIMP	MMb/d	PADD Region, Years	Output
PMMRPT_CLLETHCD	Mb/d	Census Regions, Years	Output
PMMRPT_CRNETHCD	Mb/d	Census Regions, Years	Output
PMMRPT_ETHE85CD	MMb/d	Census Regions, Years	Output
PMMRPT_ETHEXP	Mb/d	Census Regions, Years	Output
PMMRPT_ETHIMP	Mb/d	Census Regions, Years	Output
PMMRPT_ETHTOTCD	MMb/d	Census Regions, Years	Output
PMMRPT_GRNETHCD	Mb/d	Census Regions, Years	Output
PMMRPT_MUFTAX	$1987/Btu	Year	Output
PMMRPT_OTHETHCD	Mb/d	Census Regions, Years	Output
PMMRPT_PETHANOL	$1987/b	Census Regions, Years	Output
PMMRPT_PETHM	$1987/b	Census Regions, Years	Output
PMMRPT_QPRDEX	Mb/d	Exported Products, Years	Output
PMMRPT_RFBDSTCAP	MMb/d	PADD Region, Years	Input

PMMRPT_RFCRDOTH	Mb/d	PADD Region, Years	Output
PMMRPT_RFDSTCAP	MMb/d	PADD Region, Years	Output
PMMRPT_RFDSTUTL	MMb/d	PADD Region, Years	Output
PMMRPT_RFETHE85	MMb/d	PADD Region, Years	Output
PMMRPT_RFIMCR	MMb/d	PADD Region, Years	Output
PMMRPT_RFIMTP	MMb/d	PADD Region, Years	Output
PMMRPT_RFIPQCLL	Mb/d	PADD Region, Years	Output
PMMRPT_RFMETI	MMb/d	PADD Region, Years	Output
PMMRPT_RFMETM85	MMb/d	PADD Region, Years	Output
PMMRPT_RFMTBI	MMb/d	PADD Region, Years	Output
PMMRPT_RFPQIPRDT	MMb/d	PADD Region, Years	Output
PMMRPT_RFPQUFC	MMb/d	PADD Region, Years	Output
PMMRPT_RFQARO	MMb/d	Census Regions, Years	Output
PMMRPT_RFQDS	MMb/d	Census Regions, Years	Output
PMMRPT_RFQEXCRD	MMb/d	PADD Region, Years	Output
PMMRPT_RFQEXPRDT	MMb/d	PADD Region, Years	Output
PMMRPT_RFQICRD	MMb/d	PADD Region, Years	Output
PMMRPT_RFQJF	MMb/d	Census Regions, Years	Output
PMMRPT_RFQKS	MMb/d	Census Regions, Years	Output
PMMRPT_RFQLG	MMb/d	Census Regions, Years	Output
PMMRPT_RFQMG	MMb/d	Census Regions, Years	Output
PMMRPT_RFQOTH	MMb/d	Census Regions, Years	Output
PMMRPT_RFQPCK	MMb/d	Census Regions, Years	Output
PMMRPT_RFQPF	MMb/d	Census Regions, Years	Output
PMMRPT_RFQRH	MMb/d	Census Regions, Years	Output
PMMRPT_RFQRL	MMb/d	Census Regions, Years	Output
PMMRPT_RFQSTG	MMb/d	Census Regions, Years	Output
PMMRPT_TDIESEL	Mb/d	Census Regions, Years	Output
PMORE_PBUIN	$1987/Btu	Census Regions, Years	Output
PMORE_PBUINPF	$1987/Btu	Census Regions, Years	Output
PMORE_PETIN	$1987/Btu	Census Regions, Years	Output
PMORE_PETINPF	$1987/Btu	Census Regions, Years	Output
PMORE_PISIN	$1987/Btu	Census Regions, Years	Output
PMORE_PISINPF	$1987/Btu	Census Regions, Years	Output
PMORE_PLUIN	$1987/Btu	Census Regions, Years	Output
PMORE_PPCIN	$1987/Btu	Census Regions, Years	Input
PMORE_PPPIN	$1987/Btu	Census Regions, Years	Output
PMORE_PPPINPF	$1987/Btu	Census Regions, Years	Output
PMORE_PPRCM	$1987/Btu	Census Regions, Years	Output
PMORE_PPRIN	$1987/Btu	Census Regions, Years	Output
PMORE_PPRINPF	$1987/Btu	Census Regions, Years	Output
PMORE_PPROLENERF		Census Regions, Years	Output
PMORE_PPRRS	$1987/Btu	Census Regions, Years	Output
PMORE_PPRTR	$1987/Btu	Census Regions, Years	Output
PMORE_PSULFURIN		Census Regions, Years	Output
PONROAD_PDSTRHWY	$1987/MMBtu	Census Regions, Years	Output
PRDEXP	Dimension		Output
QBLK_QASIN	tBtu	Census Regions, Years	Input
QBLK_QBMRF	tBtu	Census Regions, Years	Output
QBLK_QCLRF	tBtu	Census Regions, Years	Output
QBLK_QDSCM	tBtu	Census Regions, Years	Input

QBLK_QDSEL	tBtu	Census Regions, Years	Input
QBLK_QDSIN	tBtu	Census Regions, Years	Input
QBLK_QDSRS	tBtu	Census Regions, Years	Input
QBLK_QDSTR	tBtu	Census Regions, Years	Input
QBLK_QELAS	tBtu	Census Regions, Years	Input
QBLK_QELRF	tBtu	Census Regions, Years	Output
QBLK_QETTR	tBtu	Census Regions, Years	Input
QBLK_QJFTR	tBtu	Census Regions, Years	Input
QBLK_QKSAS	tBtu	Census Regions, Years	Input
QBLK_QKSCM	tBtu	Census Regions, Years	Input
QBLK_QKSIN	tBtu	Census Regions, Years	Input
QBLK_QKSRS	tBtu	Census Regions, Years	Input
QBLK_QLGAS	tBtu	Census Regions, Years	Input
QBLK_QLGRF	tBtu	Census Regions, Years	Output
QBLK_QLGTR	tBtu	Census Regions, Years	Input
QBLK_QMGAS	tBtu	Census Regions, Years	Input
QBLK_QMGCM	tBtu	Census Regions, Years	Input
QBLK_QMGIN	tBtu	Census Regions, Years	Input
QBLK_QMGTR	tBtu	Census Regions, Years	Input
QBLK_QNGRF	tBtu	Census Regions, Years	Output
QBLK_QNGTR	tBtu	Census Regions, Years	Input
QBLK_QOTAS	tBtu	Census Regions, Years	Input
QBLK_QOTIN	tBtu	Census Regions, Years	Input
QBLK_QOTRF	tBtu	Census Regions, Years	Output
QBLK_QOTTR	tBtu	Census Regions, Years	Input
QBLK_QPCAS	tBtu	Census Regions, Years	Input
QBLK_QPCIN	tBtu	Census Regions, Years	Input
QBLK_QPCRF	tBtu	Census Regions, Years	Output
QBLK_QPFIN	tBtu	Census Regions, Years	Input
QBLK_QRHAS	tBtu	Census Regions, Years	Input
QBLK_QRHEL	tBtu	Census Regions, Years	Input
QBLK_QRHTR	tBtu	Census Regions, Years	Input
QBLK_QRLAS	tBtu	Census Regions, Years	Input
QBLK_QRLCM	tBtu	Census Regions, Years	Input
QBLK_QRLEL	tBtu	Census Regions, Years	Input
QBLK_QRLIN	tBtu	Census Regions, Years	Input
QBLK_QRLRF	tBtu	Census Regions, Years	Output
QBLK_QRLTR	tBtu	Census Regions, Years	Input
QBLK_QSGRF	tBtu	Census Regions, Years	Output
QMORE_QBUIN	tBtu	Census Regions, Years	Input
QMORE_QBURF	tBtu	Census Regions, Years	Output
QMORE_QETIN	tBtu	Census Regions, Years	Input
QMORE_QETINPF	tBtu	Census Regions, Years	Input
QMORE_QISIN	tBtu	Census Regions, Years	Input
QMORE_QISRF	tBtu	Census Regions, Years	Output
QMORE_QLUIN	tBtu	Census Regions, Years	Input
QMORE_QPPIN	tBtu	Census Regions, Years	Input
QMORE_QPRCM	tBtu	Census Regions, Years	Input
QMORE_QPRIN	tBtu	Census Regions, Years	Input
QMORE_QPROLENERF	lb	Census Regions, Years	Input
QMORE_QPRRF	tBtu	Census Regions, Years	Output

QMORE_QPRRS	tBtu	Census Regions, Years	Input
QMORE_QPRTR	tBtu	Census Regions, Years	Input
QMORE_QPYRF	tBtu	Census Regions, Years	Output
QONROAD_CFDSTRHWY	MMBtu/b	Year	Output
QONROAD_QDSTRHWY	tBtu	Census Regions, Years	Output
QSBLK_QSDSCM	tBtu	Census Regions, Years	Input
QSBLK_QSDSIN	tBtu	Census Regions, Years	Input
QSBLK_QSDSRS	tBtu	Census Regions, Years	Input
QSBLK_QSDSTR	tBtu	Census Regions, Years	Input
QSBLK_QSJFTR	tBtu	Census Regions, Years	Input
QSBLK_QSLGCM	tBtu	Census Regions, Years	Input
QSBLK_QSLGIN	tBtu	Census Regions, Years	Input
QSBLK_QSLGRS	tBtu	Census Regions, Years	Input
QSBLK_QSLGTR	tBtu	Census Regions, Years	Input
QSBLK_QSMGCM	tBtu	Census Regions, Years	Input
QSBLK_QSMGIN	tBtu	Census Regions, Years	Input
QSBLK_QSMGTR	tBtu	Census Regions, Years	Input
REFREG	Dimension		Input
TRANREP_E85AVAIL	Fraction	Census Regions, Years	Output
TRANREP_FCLOGIT0	Scalar	Census Regions	Input
TRANREP_FCLOGIT1	Scalar		Input
TRANREP_FCLOGIT2	Scalar		Input
TRANREP_FCLOGIT3	Scalar		Input
TRANREP_FCLOGIT4	Scalar		Input
TRANREP_QAGTR	tBtu	Census Regions, Years	Input
TRANREP_QFFV	tBtu	Census Regions, Years	Input
TRANREP_QLUTR	tBtu	Census Regions, Years	Input
TRANREP_TRQLDV	tBtu		Input
TRANREP_XQAGTR	tBtu	Census Regions, Years	Input
TRANREP_XQFFV	tBtu	Census Regions, Years	Input
TRANREP_XQLUTR	tBtu	Census Regions, Years	Input
TRANREP_XTRQLDV	tBtu		Input
UECPOUT_FR_OR_TRANCOST		Max Number of EMM Fuel Regions	Input
UECPOUT_MUST_STORE		Max Number of EMM Fuel Regions, Years	Input
UECPOUT_TnS_Costs		Max Number of EMM Fuel Regions, Years	Input
UEFPOUT_PELBS	$1987/Btu	Census Regions, Years	Input
USO2GRP_CTL_CDSL1		Coal Demand Region, Refinery Region	Input
USO2GRP_CTL_CLDR		Coal Demand Region	Input
USO2GRP_CTL_OTHER	tBtu	Domestic Coal Supply Curves, Years	Input
USO2GRP_CTL_TRATE	tBtu	Domestic Coal Supply Curves, Coal Demand Region	Input
USO2GRP_CTL_TYPE		Domestic Coal Supply Curves	Input
USO2GRP_EFD_RANK		Coal Supply Curves	Input
USO2GRP_XCL_1TESC		Domestic Coal Supply Curves, Years in Full ECP Planning Horizon, Years, Coal Demand Region	Input
USO2GRP_XCL_2TESC		Domestic Coal Supply Curves, Years in Full ECP Planning Horizon, Years, Coal Demand Region	Input
USO2GRP_XCL_HG	MMton/quad	Coal Supply Curves	Input
USO2GRP_XCL_MX_PCAP		Domestic Coal Supply Curves	Input
USO2GRP_XCL_PCAP	tBtu	Domestic Coal Supply Curves, Years	Input

USO2GRP_XCL_PECP	$1987/Btu	Domestic Coal Supply Curves	Input
USO2GRP_XCL_QECP	tBtu	Domestic Coal Supply Curves, Years in Full ECP Planning Horizon, Years	Input
USO2GRP_XCL_SO2	lb/Btu	Coal Supply Curves	Input
USO2GRP_XCL_STEPS	Dimension		Input
WDCRVS	Dimension		Input
WRENEW_CRNSUP_ETH_Q	MMbu		Input
WRENEW_CRNSUP_P	$1987/Btu		Input
WRENEW_CRNSUP_TOT_Q	MMbu		Input
WRENEW_MP_BM_BT		Number of Wood Supply Curve Types	Input
WRENEW_MP_BM_CM		Number of Wood Supply Curve Types	Input
WRENEW_MP_BM_ET		Number of Wood Supply Curve Types	Input
WRENEW_MP_BM_H2		Number of Wood Supply Curve Types	Input
WRENEW_MP_BM_IN		Number of Wood Supply Curve Types	Input
WRENEW_MP_BM_PW		Number of Wood Supply Curve Types	Input
WRENEW_MP_BM_RS		Number of Wood Supply Curve Types	Input
WRENEW_QBMBTCL	tBtu	Number of Wood Supply Curve Types Plus Total, Coal Demand Regions, Years	Output
WRENEW_QBMET	tBtu	Census Regions, Years	Input
WRENEW_QBMETCL	tBtu	Number of Wood Supply Curve Types Plus Total, Coal Demand Regions, Years	Output
WRENEW_QBMH2CL	tBtu	Number of Wood Supply Curve Types Plus Total, Coal Demand Regions, Years	Input
WRENEW_QBMINCL	tBtu	Number of Wood Supply Curve Types Plus Total, Coal Demand Regions, Years	Input
WRENEW_QBMPWCL	tBtu	Number of Wood Supply Curve Types Plus Total, Coal Demand Regions, Years	Input
WRENEW_QBMRSCL	tBtu	Number of Wood Supply Curve Types Plus Total, Coal Demand Regions, Years	Input
WRENEW_QCLETH	tBtu	Census Regions, Years	Output
WRENEW_QELETH	tBtu	Census Regions, Years	Output
WRENEW_QNGETH	tBtu	Census Regions, Years	Output
WRENEW_SOYOILSUP_BIOD_Q	MMlb		Input
WRENEW_SOYOILSUP_P	$1987/lb		Input
WRENEW_SOYOILSUP_TOT_Q	MMlb		Input
WRENEW_SOYSUP_P	$1987/bu		Input
WRENEW_SOYSUP_TOT_Q	MMbu		Input
WRENEW_WDSUP_P_AG	$1987/Btu	Wood Supply Curve Steps, Coal Demand Region, Years	Input
WRENEW_WDSUP_P_EC	$1987/Btu	Wood Supply Curve Steps, Coal Demand Region, Years	Input
WRENEW_WDSUP_P_FR	$1987/Btu	Wood Supply Curve Steps, Coal Demand Region, Years	Input
WRENEW_WDSUP_P_UM	$1987/Btu	Wood Supply Curve Steps, Coal Demand Region, Years	Input
WRENEW_WDSUP_Q_AG	tBtu	Wood Supply Curve Steps, Coal Demand Region, Years	Input
WRENEW_WDSUP_Q_EC	tBtu	Wood Supply Curve Steps, Coal Demand Region, Years	Input
WRENEW_WDSUP_Q_FR	tBtu	Wood Supply Curve Steps, Coal Demand Region, Years	Input
WRENEW_WDSUP_Q_UM	tBtu	Wood Supply Curve Steps, Coal Demand Region, Years	Input

Source: U.S. Energy Information Administration

Note: Unused variables may or may not be used by Fuel Liquids EXchange Module (FLEX). To be determined. NEMS=National Energy Modeling System