Independent Statistics & Analysis
U.S. Energy Information Administration

National Energy Modeling System (NEMS) Public Release, AEO2025

April 2025

Independent Statistics & Analysis
www.eia.gov

U.S. Department of Energy
Washington, DC 20585

This report was prepared by the U.S. Energy Information Administration (EIA), the statistical and analytical agency within the U.S. Department of Energy. By law, EIA's data, analyses, and forecasts are independent of approval by any other officer or employee of the U.S. Government. The views in this report should not be construed as representing those of the U.S. Department of Energy or other federal agencies.

Table of Contents

Overview

The NEMS Public Release is a copy of the National Energy Modeling System (NEMS) that is the same as the model used by model developers at EIA. The NEMS Public Release has the utility programs, scripts, configuration management tools, and other software that we use in model development. We provide the software and files on the NEMS Public Release *as-is*.

System Requirements

We implement NEMS as a 64-bit application on the Microsoft Windows Server 2022 Standard operating system. The system requires the following software packages that you must obtain from the vendor. We do not provide these software packages:

1) **Intel® Fortran Compiler Classic and Intel® Fortran Compiler:** NEMS was compiled using a free download of the 23.2.0 release for Intel Fortran Compiler Classic and Intel Fortran Compiler for Windows (2023.2.1) 64-bit application. You can find more information on the Intel website.

2) **Fair-Isaac Corporation's (FICO) Xpress optimizer.** We use the Xpress optimizer to solve the EMM's Electricity Capacity Planning linear program (LP); the Liquid Fuels Market Module (LFMM) LP; and the Carbon Capture, Allocation, Transportation, and Sequestration (CCATS) module LP.

   To purchase an Xpress license, please refer to FICO's webpage.

   AEO2025 used Xpress 8.12.

3) **General Algebraic Modeling System (GAMS)**, Version 43.2 We used GAMS for the LFMM in AEO2025. We implement GAMS by using the Xpress solver mentioned above. The GAMS commercial and academic price schedules are available on the GAMS website. We purchased the development license (rather than the run-time license), which allows changes to the linear program matrix during execution of a NEMS run.

4) **Advanced Interactive Multidimensional Modeling Software (AIMMS)**, version 4 (release 4.96.4 licensed with the CPLEX solver. AEO2025 uses AIMMS for the Coal Market Module, the Natural Gas Market Module, Hydrogen Market Module, and the Renewable and Electricity Storage Submodule within EMM.

5) **A Fortran-to-Sqlite library** to use with EMM that holds regional electricity data. SQLite is not required for running NEMS with the default data provided.

6) (Optional) **The S&P Global Macroeconomic Model as implemented with the EViews13 software package.** We currently use the EViews13 standard edition. The S&P Global macro module is executed as a subprocess to NEMS if the macro feedback switch in NEMS is turned on. You can elect to run NEMS without macro feedback, in which case the run uses static macroeconomic inputs taken as is. When the macro feedback switch is on, NEMS will attempt to call the macro model by executing EViews using the S&P Global model's work files as the input to EViews. These EViews work files are not included in the EIA archive, but you can obtain them from EIA after licensing the S&P Global model. You must also get a copy of EViews to run the S&P Global model. Contact S&P Global for more information.

7) **Python 3.11.** Refer to the requirements.txt for the list of packages and version numbers.

NEMS is a computationally intensive 64-bit application, which runs on 64-bit Windows. Our servers that run NEMS have large amounts of RAM to accommodate multiple runs and users simultaneously, but a single copy of NEMS can execute on a single-user system with smaller amounts of RAM.

We run the integrated NEMS run in two parts simultaneously (in parallel) to speed run time, so we use a minimum of two processor cores per integrated run. If a (non-integrated) run is done with modules off (for example, turning off coal, electricity, and renewables), then we need only one processor core per run. With a quad core processor, you can run two integrated parallel runs or four non-integrated runs with little speed loss if sufficient memory is available. You can run NEMS as one process, but it requires about two hours more per cycle.

One run of all components of the NEMS model, or a cycle, takes about four hours on our servers, but most cases are solved by making a series of cycles. A four-cycle NEMS run takes 20+ hours. Runs of some individual parts of NEMS, such as the energy demand models, if run separately, can take only a few minutes. All files of a completed run, input and output, take up about 30 GB of storage, but they compress to about 15 GB once the run finishes.

NEMS Setup Release Description

The NEMS Public Release is a snapshot of the NEMS system at the time of its creation. The NEMS Public Release directory structure has the following subdirectories.

Table 2: NEMS Public Release key subdirectories

Subdirectory name	Description
input	Input files
source	Fortran source code for NEMS components as well as some *preprocessor* programs
includes	Fortran *include* files used mainly for variable declaration accessed during compilation
scripts	NEMS shell scripts and other programs used to implement NEMS
scedes	NEMS a scenario-descriptor (scedes) files
output	Restart files for each scenario
models	Source, input and output files for Python, GAMS and AIMMS programs
utils	files for deprecated utilities

The settings for a particular run, or scenario of NEMS, are stored in a *scenario-descriptor* file (scedes). NEMS scedes files identify all settings for a NEMS run. NEMS runs have three types of settings: input file names, object file names, and *runtime* options, usually integers, which are interpreted as switches or numerical values for key input assumptions. A scedes file contains all the settings used every time a NEMS run is made.

The scedes files shown below are included and contain the settings used in a run. The scedes files provided are located in the directory created as part of the instructions (for example, file *scedes.ref2025* in the */scedes* folder).

Table 3: Scedes files

AEO2025 cases	Scedes files provided by run submitter
Reference	scedes.ref2025
High Economic Growth	scedes.highmacro
Low Economic Growth	scedes.lowmacro
High Oil Price	scedes.highprice
Low Oil Price	scedes.lowprice
High Oil and Gas Supply	scedes.highogs
Low Oil and Gas Supply	scedes.lowogs
High Zero-Carbon Technology Cost	scedes.highZTC
Low Zero-Carbon Technology Cost	scedes.lowZTC
Alternative Electricity	scedes.nocaa111
Alternative Transportation	scedes.alttrnp

How to Handle Specific Styles

In NEMS for AEO2025, we created scenario-specific files generally by adding suffixes. For example:

- ecpdaty_highztc.xlsx is the HIGHZTC scenario file
- ecpdaty_lowztc.xlsx is the LOWZTC scenario file
- Ecpdaty.xlsx is the reference case file

In the scedes, you would point to the desired file for the scenario being run. For example:

ECPDATYN=$NEMS/input/emm/ecpdaty_highztc.xlsx

NEMS Installation Instructions

1) Clone the repository to your PC's hard drive.

Choose a drive where you want NEMS files to be installed. Create a folder on that NEMS drive to designate this new version/vintage of NEMS. Unzip/extract the contents of the NEMS zip to your new folder on the NEMS drive. Also, create a folder for the NEMS job log such as *Y:\RabbitMQ*.

2) Install Intel® Fortran Compiler Classic and Intel® Fortran Compiler.

NEMS was compiled using a free download of the 23.2.0 release for Intel Fortran Compiler Classic and Intel Fortran Compiler for Windows (2023.2.1). You can find more information on the Intel website.

3) Meson Build System

NEMS Fortran functions were compiled using Meson Build. You can find more information on the Meson website.

4) Install and Configure Cygwin.

Install Cygwin 64-bit version. We are currently using Cygwin version 3.4.9-1.

When the Cygwin opens, it executes a shell script, *.profile*, in your user directory on your C: drive, *C:/users/xxx*, where xxx is your username. Copy the *.profile* file from the root folder into your corresponding *C:/users/xxx* folder. Modify line 5 to use the directory where you cloned the NEMS folder to. Modify line 6 to use folder name you used for your NEMS project.

5) Use F90SQL.

We use the F90SQL runtime library by Canaima Software for certain optional database outputs. Our F90SQL license allows us to distribute the F90SQL linkable routines and distributable files, so you do not need to license F90SQL. To install the F90SQL linkable routine and runtime library, use Windows Explorer to copy:

..\f90sql\f90sqldvf.dll to *C:\windows*

..\f90sql\f90sql.lib to *C:\PROGRA~2\intel\compiler\11.1\065\lib\ia32*

Because the F90SQL library was developed with the HP/Compaq Visual Fortran package, it needs

certain redistributable files from that package. Specifically, for the F90SQL program to work properly, you need to install the redistributable library from **Compaq Visual Fortran 6.6**. The install package for this redistributable library is included on the NEMS Setup Release. Locate the following file on the NEMS Setup Release, and run it to install the redistributables:

\f90_cvf_runtime_libraries\cvf runtime redistributables6.6.exe

6) GAMS.

NEMS is programmed to invoke version 43.2 of GAMS (64-bit). If you buy the Xpress solver link and obtain the Xpress solver license independently from GAMS (as we did), you will need to copy the Xpress licensing file (*xpauth.xpr*) to the GAMS folder in which *gams.exe* resides. That folder may have a file called *xpauth.ini*; if so, you must delete it because it interferes with GAMS finding and using the *xpauth.xpr* license file. You will have to change a setting line in the scedes file to identify your specific version of GAMS. The scedes key to change is GAMSVERS.

7) AIMMS.

The version installed for NEMS was 4.96.4.6

The AIMMS software is downloaded and set up without a standard installation process, which AIMMS refers to as an *installation free release*. We located our AIMMS software in a folder accessible to all users called *C:\AIMMS_installation_free_releases* rather than the default location in a specific user home directory.

C:/AIMMS_Installation_Free_Releases/4.96.4.6-x64-VS2017

The above location is identified in the NEMS run submitter via the scedes file option AIMMSLOC. For us, the setting for AIMMS we used for AEO2025 was:

C:/AIMMS_Installation_Free_Releases/4.96.4.6-x64-VS2017

We first saved the download installation free executables in the folder

C:\aimms_installation_free_releases.

The first time a user runs AIMMS from that location, AIMMS unzips a full installation folder into the user's app folder (for example*, C:\users\xxx\AppData\Local\AIMMS\IFA\AIMMS\ AIMMS4.96.4.6-VS2017*) and from then on looks there when you invoke either the original downloaded executable or invoke from the AIMMS desktop icon. This setup is not ideal for NEMS. To make the folder available without multiple copies installed and to be locatable to NEMS via the AIMMS toolkit, we copied our AIMMS appdata folder (*C:\users\dsa\AppData\Local\AIMMS\IFA\AIMMS*4.96.4.6-x64-VS2017) to *C:\aimms_installation_free_releases*\4.96.4.6-x64-VS2017 and set up shortcuts on the desktop to point to the executable ..*bin**aimms.exe* in that folder.

8) Run NEMS.

You can set up NEMS runs in several ways. **For the AEO2025 runs, we used parnems to set up the parallel version of NEMS.** Three NEMS executables and output folders divide NEMS into two simultaneously run processes to speed up run time. To replicate the AEO2025 cases, use parnems. If you run a subset of NEMS modules (such as one, on a standalone basis), you should use jognems instead of parnems.

8.1 Run with the GUI

You can run NEMS through the GUI which simplifies the NEMS setup process. Most EIA users run NEMS this way. Launch the GUI by double-clicking on the RunNEMS.bat file located in the NEMS folder. The following **Figure *1*** shows the screenshot of the GUI that will launch.

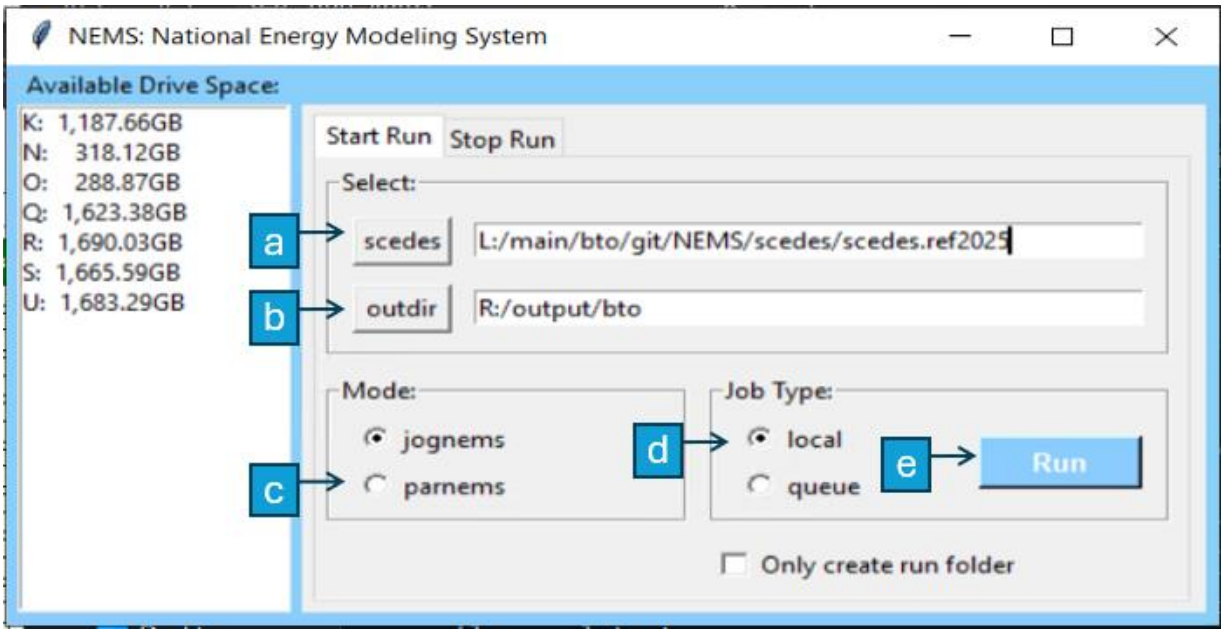

Figure 1: NEMS GUI to Launch a NEMS Run

You will have the following options to configure your NEMS run:

a. scenario descriptor (scedes) file: Select the appropriate scedes file for the scenario you want to run
b. run output directory: Select the output directory where you want the final NEMS output to be saved
c. NEMS run mode: Select the NEMS run mode you want to use. For the AEO2025 runs, we used parnems to setup the parallel version of NEMS.
d. Job Type: We have a queue server to distribute the NEMS run load across multiple servers. If you do not have a queue server setup, use the "local" Job Type option.
e. Run: Click on this button once you've completed the setup and are ready to initiate the NEMS run

8.2 Run with Cygwin terminal

Parnems and jognems: From a Cygwin prompt, go to the directory with the scedes file you will use (via the cd command). Launch the run using the parnems or jognems command, for example, *parnems common_scenario user_scenario* where *common_scenario* is a common scenario descriptor file and *user_scenario* is the suffix name of a user scedes file such as **ref2025** (for the file ***scedes.ref2025***) in the current directory. The common scenario descriptor file is generally a file in */scedes*, such as ref2025.

When you make a NEMS run, the settings for that run are stored in both the directory from which the run was launched and the output directory of the run. You may initialize new runs using the *scedes.all* files from previous runs.

The run output directory, such as */output/[user]/scenario/dMMDDYYa/* will contain written output from the run. You can switch to that directory to examine the run. Parallel runs have subfolders p1, p2, and p3 to hold output from the parallel components of a run. The file *nohup.out* contains the primary trace output of the run as well as any error messages. For parallel runs, a *nohup.out* will be in each of the p1, p2, and p3 folders. Any error messages from the p1 execution will be in the *p1/nohup.out* and so on. Numerous other files are written during the course of a NEMS runs holding debug and trace information.

Many of these files are useful only to NEMS developers of a particular module, and many are larger than a gigabyte. Files in the output directory with the extension *.gz* have been compressed. The command uncompress **.gz* restores them to their original state.

9 The NEMS report writer (*NEMRWR*).

You can run the NEMS report writer to compare one run with others in a convenient format using the RW_reporter_main.py python file under the reporter folder. The NEMS report writer will generate all NEMS tables into the reporter/output folder labeled *TN nnn.xlsx* where *nnn* corresponds to the NEMS table number.

Another NEMS report writer output file is the *test.d000000a.RAN*. The *.RAN* file is used with the software *graf2000* (that is, *grafnem*, and provided in the scripts folder) to review run results graphically. The *.RAN* file is useable only when *ftab* is run for a single scenario at a time, as is case in the run output directory. *Graf2000* provides a scrollable on-screen version of the *ftab* output, as well as the ability to graph any row in any *ftab* table in a comparison (up to eight cases at once).