Integrated Environmental Control Model (IECM)

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Readme + Version History

November 2, 2026

This document describes the history of changes made to the IECM between the first official release of version 3.1 and the current release.

CONTENTS

The IECM is installed into its own folder, normally in "C:\Program Files". It may be installed in any folder of the user's choosing.

SUPPORTED OPERATING SYSTEMS

The IECM currently runs on:

* Windows 11 64-bit (We expect that it will run on Windows 7 or later, but we do not actively support this.)

* MacOS, Linux and ChromeOS through the use of Wine or related software

Starting with version 13.0, we only support 64-bit operating systems.

INSTALLATION

If you have saved sessions in the default session database (IECM Interface\sessdb\sessdb.idb or sessdb.sdb), you should make a copy of this database before you install to avoid loss of data. Note that sessions from versions prior to 6.2 are not compatible with version 6.2 and later.

The IECM uses a new database format starting with version 8.0.1 Beta. Among other things, this makes the installer more compact and allows the IECM to run under Wine and related software on computers running MacOS, Linux or ChromeOS. If you have saved sessions and/or custom fuels in an older version of the IECM, you will need to download the conversion program from our web site to convert these databases into the new format.

(Note that, although this version of the IECM runs under Wine, the conversion program does not; you have to run it under Windows.)

If you are installing the IECM under Windows, just run the installer to install it. Other situations are addressed below.

PORTABLE VERSION

Starting with version 11.5, we provide a portable version of the IECM. To use it, download the appropriate version (32- or 64-bit), unzip it, and run "iecmint.exe". Note that it is the presence of "iecm_interface.ini" in the IECM folder which causes the IECM to run in a portable manner; if that file is not there, the IECM will store its configuration in the standard location for Windows.

Starting with version 13.0, we only provide a 64-bit portable version.

MACOS, LINUX, AND CHROMEOS

We do not currently provide Mac-, Chrome- or Linux-native versions of the IECM; however, the Windows version currently runs under Wine and related software.

Note that use on ChromeOS currently requires the use of the Linux subsystem. Instructions for setting up the Linux subsystem are currently available at <https://support.google.com/chromebook/answer/9145439>, or you can search for "chromeOS linux subsystem" on your favorite search engine.

We recommend a commercial product, CrossOver, by CodeWeavers (https://www.codeweavers.com/). CrossOver is essentially a commercial version of Wine, which seems to have a bit more functionality. CrossOver is relatively inexpensive, and we recommend using it if you want to run the IECM on a Mac at this time, or if you just want to support development of Wine. There is a trial version which you can use to make sure everything works before you buy it.

The CrossOver Mac portion of the site includes a "Getting Started" section, which includes some frequently asked questions. "Install an Unknown App" is what you will need for the IECM. We suggest running the installer, and thus the IECM, in a Windows 11 bottle.

There is a short video showing how to install the IECM in CrossOver at <https://iecm-online.com/videos/CrossOver.mp4>.

There are some other Wine-related options:

* Porting Kit (https://www.portingkit.com/) - This is a free option which we have successfully used. It is only available for MacOS.

* PlayOnMac (https://www.playonmac.com/) and PlayOnLinux (https://www.playonlinux.com/) - These are free options. In our most recent tests, neither of them worked properly without manual intervention, which we did not attempt. However, the situation may have changed by the time you read this, or they may be more compatible with your computer and/or OS version. Feel free to try them - you can always uninstall them if they don't work for you. Although we did not invest the effort ourselves, we expect that someone who knows their way around Wine would be able to tweak the configuration to get them to work.

* Wine (https://www.winehq.org/) - This is a free option, and all the other options depend on it. You can use Wine directly if that is your preference, however we do not suggest doing this unless you are comfortable working in a terminal window and tweaking the configuration yourself.

You should be able to use either the installer or the portable version. If you are asked to specify which file is the IECM Interface application, e.g. while creating a shortcut, it is iecmint.exe in the folder where the IECM is installed.

KNOWN ISSUES

You may not be able to copy/paste images when running the IECM under Wine. A workaround for graphs is to copy the text, paste it into a spreadsheet, and draw the graph there.

PROBLEMS

If you are having trouble reading an old session or fuel database, note that the IECM uses a different database format starting with version 8.0.1. You will need to download the conversion program from our web site to convert your old database(s) to this format.

If you are running the IECM under Wine, you may notice that some of the fonts and/or controls don't look quite as nice as they do under Windows. We believe that everything is

functional, however our primary focus is functionality under Windows. We are interested in hearing if you have difficulty getting it to work under Wine, however we cannot devote any significant time to getting it to work in a non-Windows environment.

If you have further problems installing or running the IECM, contact technical support by sending email to iecm-team@uwyo.edu. You may also post on the IECM User Forum, which may be accessed via our website (http://www.iecm-online.com/) or directly at <https://groups.google.com/d/forum/iecm-user-forum>.

VERSION HISTORY

02Nov2026 IECM-CS Version 14.0 beta

This version introduces a new plant type.

The following changes have been made since version 13.1:

* Addition of a new plant type: "Low-Carbon Hydrogen Production & Transport".

* A bug affecting unit conversions other than English/Metric in uncertainty graphs has been fixed.

27Jan2026 IECM-CS Version 13.1

This version includes a couple of corrections to version 13.0 beta. It replaces version 13.0 and is being released as the current public release.

The following changes have been made since version 13.0 beta:

* Corrections to the Deep CCS cost model.

* Update to the title, default, min, and max values for Ratio of Indirect LUC / Direct LUC in the Greenhouse Gas LCA module for Biomass.

19Nov2025 IECM-CS Version 13.0 beta

This version is being released as beta; assuming no major issues, it will be promoted to the current public release after 6 months, or when the next version is released, whichever comes first.

The following changes have been made since version 12.0:

* Deep Carbon Capture has been added as an option to the amine system for CO2 capture from 95% to 99%.

* Some titles and screens have been updated for clarity and consistency.

* We are dropping support for the 32-bit version and have changed the installer to avoid false positives on virus scans.

18Nov2024 IECM-CS Version 12.0 beta (first release from University of Wyoming)

The following changes have been made since version 11.5 Public:

* TECHNICAL MODEL ENHANCEMENTS:

o Fuel Database

- A variety of biomasses and waste coals have been added as new fuel options.

- Proximate analysis data has been added for the newly added fuels and some existing coals in the database.

o Pulverized Coal (PC) Plants

- Co-firing of up to three fuels has been added as a new option to evaluate coal-biomass co-firing power plants.

- The boiler efficiency algorithm for non-oxyfuel PC plants has been improved. Primary fuel properties now include optional proximate analysis data to support the efficiency calculation.

- A new life cycle greenhouse gas emissions module has been added to support the life cycle assessment of dedicated coal and coal-biomass co-firing power plants without and with carbon capture and storage.

o Cost Index

- Plant cost indexes for 2021, 2022 and 2023 have been added. The default cost year is now 2023.

o User Manual

- The user manual has been converted to a Windows help file which can be viewed from within the IECM and on our website.

* ADJUSTMENTS:

o Some titles and screens have been updated for clarity and consistency.

o Oxyfuel PC plants no longer have a minimum sulfur requirement to allow more flexibility in retrofit situations.

o The minimum cost year is now 1985, as the modules that used pre-1985 data are no longer part of the IECM.

* BUG FIXES:

o Automatic conversion between (tons/hr) and (tons/yr) has been disabled for Makeup Water for the Hybrid Cooling System. This conversion was incorrect due to the part-year nature of the wet unit.

o A unit conversion error in Percent of Burned Carbon as CO on the Base Plant Furnace Factors parameter screen for PC plants has been corrected.

o The coal pile runoff calculation in PC plants has been corrected so that it does not include the flow rate of natural gas for the Gas Reburn option.

o On the Stack Diagram and Flue Gas Emissions result screens for PC plants, an error in the calculation of equivalent NO2 and equivalent SO2 has been corrected.

o In PC plants, the model was not completely resetting when the plant design was changed from oxyfuel to non-oxyfuel.

o The screens for Enhanced Oil Recovery are now displayed correctly for all plant types.

20Dec2021 IECM-CS Version 11.5 Public (Carnegie Mellon)

The following changes have been made since version 11.4 Public:

* Model Updates and Enhancements:

o A steam cycle heat rate has been applied to the "NETL ACC" option in NGCC plants.

o Cost years 2018, 2019, and 2020 have been added. 2020 is now the default.

o Capital cost adjustment factors have been added for 11 international regions.

o In the included case studies, NETL Case B12B now uses Case B12A as a reference plant. NETL Case 12 uses Case 11 as a reference plant.

* Interface Updates and Enhancements:

o The IECM now runs as a portable application if it finds its configuration file in the same folder as the application. 32- and 64-bit portable versions of the IECM are now provided as zip files.

o A new "View Parameters with Uncertainty" screen has been added to the Uncertainty Analysis Tools.

o The "Choose Variables" screen in the Uncertainty Analysis Tools has been renamed to "View or Graph Samples" to make its function more clear.

o The right-click menu for parameters and results has been expanded to allow variables for sensitivity analysis and graphs to be chosen directly from the interface screens.

* Bug Fixes:

o Some formatting errors in the interface have been corrected.

o In Selexol CO2 Capture in IGCC plants:

- Turbines were being double-counted in some of the capital cost calculations. This has been corrected.

- A tighter range has been put on the Max Train Size, and the Number of Absorbers has been made read-only to reflect limitations in the underlying capital cost model.

o An error in the default extension for user fuel databases has been corrected.

o A crash when revisiting the "View or Graph Samples" Uncertainty Analysis Tool after turning off uncertainty for a previously viewed variable has been fixed.

o Cost years after 2014 now use the correct factor.

o A crash when editing specific values for a sensitivity analysis on a menu parameter has been corrected.

o A duplicate NGCC Amine system Flue Gas screen has been removed.

o Fixed the region in the included case studies.

o The cost year menu has been changed to ascending order so that it functions as expected on the sensitivity analysis screen.

16Jul2020 IECM-CS Version 11.4 Public (Carnegie Mellon)

The following changes have been made since version 11.2 Public:

* Model Updates and Enhancements:

o The following parameters are now dependent on plant location, with a default region of US Midwest: Average Annual Rainfall, Ambient Air Temperature, Ambient Air Pressure, and Relative Humidity.

o Under Water Systems, NETL's dry cooling (air cooled condenser) model has been added to the IECM as a configuration option for dry cooling. It is not available for hybrid cooling (which uses the original IECM dry cooling model).

o The ESP parasitic load calculation has been updated.

* Interface Updates and Enhancements:

o This version of the IECM is a 64-bit application. There is still a 32-bit version which will be installed automatically if your system requires it, but the default is now 64-bit.

o Formatting has been updated in many interface components, including subscripts in chemical formulas.

o In most cases, the "Copy" command (under the Edit taskbar menu or in the right-click menu) now puts both plain text and html-formatted text on the clipboard. Formatted text is the default, although specific applications, particularly word processors, may override that. "Paste Special" will give you access to the formatted text in most cases.

o Graphs in ANALYSIS TOOLS / Uncertainty are no longer limited to Cumulative Probability Distribution Functions (CDFs) for one variable - now variables can be specified for both the X and Y axes.

o Numbers on graphs may be shown with more significant figures to avoid duplicate labels.

o For NGCC plants, the interface has been updated to refer to the fuel as "Natural Gas" (not "Syngas") and "Heated Syngas" has been removed from the NGCC interface since it does not apply here. (This is strictly an interface correction; the model already handles NGCC correctly.)

o On CONFIGURE PLANT / Unit Systems, all flow units have been moved out of the "Performance Table" category and into a new category: "Result Flow Rates". Flow units now apply to all results, not just tables. Older saved sessions using these options are updated appropriately when they are opened.

o "Total NOx" and "Total SOx" have been added to the stack diagram for PC plants.

* Bug Fixes:

o In the geological reservoir database of the CO2 storage model, NM has been moved to the Southwest region where it belongs, and NH and RI have been added to the state list for the Northeast region.

o A unit conversion error was fixed on two results screens for the Solid Sorbents TSA diagram for a PC plant, and the Chemical Looping diagram for an IGCC plant. These unit conversion options were introduced in the most recent version, 11.2 Public. Tonne/hr was being converted to flow/MWh instead of flow/kWh. The affected quantities are: On the Solid Sorbents TSA diagram: Sorbent Purge, Lean Sorbent, and Rich Sorbent. On the Chemical Looping diagram: CO2 Product.

o Functionality has been restored between the steam turbine heat rate and other steam turbine output quantities in NGCC and IGCC plant models.

19Apr2018 IECM-CS Version 11.2 Public (Carnegie Mellon)

The following changes have been made since version 11.1 beta:

* Enhancements to Graphical Interface and Reports:

o The unit conversion options "mass/kWh" and "mass/BTU in" were changed to "flow/kWh" and "flow/BTU in", respectively. These units now include molar flow rates as well as mass flow rates

o The cost index value for 2017 has been added

o The default cost year is now 2017

o A "User Manual" command has been added to the "Help" menu to display the manual

o Several other adjustments were made to make screens more consistent.

* Bug Fixes:

    o Solid Sorbents PSA fixed to enable bypass option

    o In the PC plant, the "Reference Plant" screen for CCS no longer hides the overall plant O&M cost screen

    o Two missing screens have been added: bypass for the amine system in NGCC plants and the Ionic Liquid input diagram for IGCC plants

* User Documentation:

    o The User manual has been updated to match the current version.

16Jan2018 IECM-CS Version 11.1 beta (Carnegie Mellon)

The following changes have been made since version 9.5 Public:

* New Carbon Capture Technology Models:

    o Pressure-swing solid sorbent systems for PC power plants (three sorbents and two process configurations)

    o Temperature-swing solid sorbent system for PC power plants

    o Two-stage membrane-based system with air sweep for PC power plants

    o Enhanced CO2 purification unit for use with oxyfuel combustion plants and PC plants with the new membrane-based capture system

    o Ionic liquid-based capture system for IGCC power plants

* Enhancements to Graphical Interface and Reports:

    o New capital cost summary tables have been added to plant-level reports

    o The cost year is now shown in the status bar at all times

    o Cost index values for 2015 and 2016 have been added

    o The default cost year is now 2016 (the next release will have 2017).

    o The cost year menu is now in descending order to facilitate selection of recent years.

* Technical and User Documentation:

    o New technical reports for each of the new CO2 capture systems

    o The old User Manual, Tutorial and Getting Started documents have been combined into a single user manual. Work on this is still in progress, but we have posted the current draft document, which will be updated for the next (non-beta) release.

16Feb2017 IECM-CS Version 9.5 Public (Carnegie Mellon)

The following changes have been made since version 9.2.1 Public:

* Case Study Library:

o v 9.5 includes a library of three files covering five case study sessions that replicate the performance and cost parameters and results from recent DOE/NETL reports on "Bituminous Baseline" systems and an advanced membrane capture system. The following NETL cases can now be accessed and replicated in the IECM using the library files:

- Bituminous Baseline study Rev 2a: PC plants w/o and w/ CCS (Cases 11 and 12)

- Bituminous Baseline study Rev 3: PC plants w/o and w/ CCS (Cases B12A and B12B)

- Advanced Capture Systems: PC plant w/ 2-stage membrane capture (Case 5A)

* New Technology Models:

o Hybrid cooling system model (wet + dry cooling water systems)

o Life cycle water use for power plants with and without CCS

o Cansolv CO2 capture process parameters are used for the NETL Case B12B library case. (Note: this is not a generalized model of the Cansolv process.)

* Technology Model Updates:

o Add site-specific cost factors to account for geographic variations in power plant capital cost, specifically, geographic variations in construction materials and labor costs, construction labor productivity, equipment cost and seismicity factors. Default values are based on EPRI studies.

* Restrictions on Plant Designs for CO2 Capture:

o All post-combustion capture systems on PC plants require SCR as pre-treatment for NOx reduction. Ammonia and membrane-based systems also require FGD for SOx removal. (FGD is also strongly recommended with amine-based CO2 capture systems.)

* Bug Fixes and Adjustments:

o The parameter "Steam Cycle Heat Rate" is now editable for IGCC and NGCC plants.

o The parameter "Steam for Soot Ratio" is now editable for PC plants.

o The parameter "Construction Time" is now set in the Overall Plant module, though it may be overridden in other modules, as needed.

o The uncertainty engine is now available for the chemical composition of fuels, with a note that uncertainty on those screens should only be used for batch processing.

o Cooling water for CO2 product compression is now included in the water module for oxyfuel and IGCC plants with CO2 capture and storage.

o A few small bugs in the interface were fixed.

21Dec2016 IECM-CS Version 9.4b (Carnegie Mellon)

The following changes have been made:

* Site-specific cost factors have been added to the IECM to account for geographic variations relevant to power plant cost estimation, specifically, geographic variations in:

  o Construction materials cost

  o Construction labor cost

  o Construction labor productivity

  o Seismicity factors

* The IECM has been expanded to incorporate a case study that replicates the performance and cost parameters and results in a recent (2012) NETL study of a membrane-based system for CO2 capture.

* New process performance and cost models of a solid sorbent system for post-combustion CO2 capture similar to (and based on) the system developed and modeled in the NETL-supported Carbon Capture Simulation Initiative (CCSI) project have been developed and implemented in the IECM.

29Jul2016 IECM-CS Version 10.1 beta (Carnegie Mellon)

The following changes have been made since version 10.0 beta:

* New CO2 Capture Options:

  o One ionic liquid-based process was added as a new technology option for pre-combustion CO2 capture at IGCC plants.

  o Pressure swing-based processes with three solid sorbents and two configurations were added as a new technology option for post-combustion CO2 capture at PC plants.

  o The Cansolv process was added as a new option to the amine-based post-combustion CO2 capture.

* Adjustments and Bug Fixes:

  o The parameter of Steam Cycle Heat Rate was made editable for IGCC and NGCC plants.

  o The parameter of Steam for Soot Ratio was made editable for PC plants.

  o The parameter of Construction Time was set in the Overall Plant module, though it may be overridden in other modules as needed.

  o The uncertainty engine was provided for chemical compositions with a note that uncertainty on those screens should only be used for batch processing.

  o A couple of small bugs in the interface were fixed.

19May2016 IECM-CS Version 9.2.1 Public (Carnegie Mellon)

The following changes have been made since the January 14 update (9.1.0.4):

* Session Database:

o Upon startup, click "Open Sessions" to access two NETL Bituminous Baseline cases: Case 11 (supercritical PC plant) and Case 12 (SCPC with post-combustion CCS). Both cases are based on the 2013 (Revision 2a) NETL study. [Note: A future IECM will add two new SCPC cases based on the 2015 (Revision 3) NETL Bituminous Baseline report.]

* Technology Model Updates:

o The default cost year was updated to 2014.

o The power use for wet cooling tower was updated for NGCC plants with and without CCS.

o For the wet cooling tower, an alum dosage was added to makeup water treatment.

o For chemical wastewater treatment, the default and maximum values of alum dosage were updated.

o For the amine-based CO2 capture system, sorbent loss calculations were updated to account for losses associated with flue gas acid gasses entering the absorber.

o Fuel properties may now be used in batch processing to run multiple cases with different user-specified fuel composition.

* Bug fixes and adjustments:

o Two reporting errors were corrected, including mislabeled results on the aux boiler diagram for the ammonia-based CO2 capture system, and makeup water for the membrane-based CO2 capture system.

o For the wet FGD system module: the unused parameter "Stacking Cost" was removed from the O&M Set Parameters screen. An inconsistency between reagent use and cost calculations was fixed. An error in the WetFGD/ Lime configuration was fixed.

o For the oxyfuel and amine-based CO2 capture systems, a couple of unit conversion errors were fixed.

o The amount of activated carbon used for amine-based CO2 capture was added to the Set Parameters screen.

o Some contingency costs did not allow values outside the range shown on the Set Parameter screen. Now they are allowed with a warning.

o The number of significant figures in unit conversion factors and molecular weights were increased to reduce round-off errors.

o In the uncertainty editor, a couple of unit conversion errors for nominal values have been fixed.

18Apr2016 IECM-CS Version 10.0 Beta (10.0.0.5) (Carnegie Mellon)

The following changes have been made since version 9.2:

* New Models:

    o Hybrid Cooling

    o Water Life Cycle Assessment

* Updates:

    o Cooling water for CO2 product compression has been added to oxyfuel and IGCC plants.

09Apr2016 IECM-CS Version 9.2 (Carnegie Mellon)

The following changes have been made since the January 14 update (9.1.0.4):

* Updates:

    o The default cost year was updated to 2014.

    o The power use for wet cooling tower was updated for NGCC plants with and without CCS.

    o Alum dosage was added to makeup water treatment for the wet cooling tower.

    o The default and maximum values of alum dosage were updated for chemical wastewater treatment.

    o Sorbent loss calculations were updated to account for losses associated with flue gas acid gasses in the amine-based CO2 capture system.

    o Three capital cost variables including land use, financing cost, and other owner's costs and a fixed O&M cost variable called taxes & insurance were added to the IECM.

    o A "Demister" control option for removing flue gas water was added to the wet FGD system.

* Bug fixes and adjustments:

    o Two reporting errors were corrected, including mislabeled results on the aux boiler diagram for the ammonia-based CO2 capture system, and makeup water for the membrane-based CO2 capture system.

    o A few fixes were made for FGD. One unused parameter "Stacking Cost" was removed from the FGD's O&M Set Parameters screen. Inconsistency between reagent use and cost calculations was fixed. An error in the WetFGD/ Lime configuration was fixed.

    o A couple of unit conversion errors were fixed for oxyfuel and amine-based CO2 capture systems.

o The amount of activated carbon used for amine-based CO2 capture was added to the Set Parameters screen.

o Some contingency costs did not allow values outside the range. Now they are allowed with a warning.

o Significant figures of unit conversion factors and molecular weights were increased to reduce round-off errors.

14Jan2016 Update (version 9.1.0.4) to correct a bug that caused the IECM to crash when "Plant or Project Book Life" was changed. No other changes.

22Oct2015 Update (version 9.1.0.3) to correct a bug in WetFGD+Lime. No other changes.

09Sep2015 IECM-CS Version 9.1 (Carnegie Mellon)

The following changes have been made between the previous beta version (9.0.1) and this version (9.1):

* This version includes additional technology options and updates, plus bug fixes. The major changes include:

o Three new configurations for oxyfuel combustion, depending on the coal sulfur level.

o Updates to the capital cost model of the post-combustion chemical looping system.

o Update to the CO2 product compressor cost model for the IGCC/Selexol capture system.

o Update to the default thermal efficiency of auxiliary gas-fired power plants for post-combustion carbon capture (amine- and ammonia-based systems).

o Bug fixes related to the new interface.

o Adjustment to some titles for consistency across screens.

o Edit functions such as copy, paste, and print available on most screens.

19Nov2014 IECM-CS Version 9.0.1 Beta (Carnegie Mellon)

The following changes have been made between the previous public version (8.0.2) and this version (9.0.1 Beta):

* Software Enhancements:

o A new collapsible menu for navigation instead of the previous upper and lower "tabs"

o A new "Configure Session" step at the top of the menu, where unit conversion options are now located

o A new analytical option in the interface called "Analysis Tools" (with some cool stuff)

o Addition of process diagrams to the Set Parameters screens

o Various adjustments to user interface screens for better readability and consistency.

* Technology Additions and Updates:

o A new site-specific CO2 storage cost model and geological reservoir database

o A new post-combustion calcium looping-based CO2 capture system for PC plants

o A new option for IGCC plants to specify custom fuels and resulting syngas composition

o Update to default process and project contingency factors for all IECM technologies in the Set Parameters screens (to reflect their current level of maturity and cost estimating basis)

o Updates to the oxyfuel performance and cost models for PC plants, including the air separation unit, compression & purification unit, and direct contact cooler

o Update to cost model of pre-combustion chemical looping option for IGCC plants

o Update to direct capital costs of IGCC plants

o Bug fixes related to certain performance and cost parameters.

05Nov2012 IECM-CS Version 8.0.2 (Carnegie Mellon)

The following bug fixes and adjustments have been made since 8.0.1 Beta:

* Capital Cost Parameter screens for CCS in PC, NGCC were being hidden by overlapping O&M Cost screens; the O&M screens have been moved to tab 7.

* Heat-to-Electricity is now hidden in the Ammonia system when there is an aux boiler, for consistency with the Amine system.

* There was a stray "Overall O&M" process type in IGCC; this has been removed.

* The "value" in the summary in the unc editor no longer has unit conversions applied when it is a "menu".

* Input Tools and Result Tools have been combined into a single Unit Tools dialog; the cost year and inflation control have been removed, as they are normally set on the Overall Plant Financing Parameter screen.

* Regen Heat Requirement in the Ammonia system now affects the rest of the plant.

* The "Delete This Fuel" button is now enabled when a new fuel is added to a previously empty database.

* Unit conversions are now done on the Fuel Properties screen.

* Default Cost is now displayed for the currently selected coal in the database browser.

* A couple of titles have been shortened to allow the full title and units to be displayed.

* A couple of calculations in the Chemical Looping module were not properly accounting for the Purification Unit when used with a GE gasifier. This affected Purge Out of the Purification Unit, and the CO2 flow in the Pipeline Transport results.

* CO2 Product Purity in Chemical Looping has been made read-only.

* Operating Labor Rate is now properly displayed on the Overall Plant O&M Cost Parameters screen for IGCC plants. It has been made read-only on the GE Gasifier O&M Cost screen.

The following is a summary of updates have been made since 7.0.0 Beta which affect costs:

* There is now a separate Real Escalation Rate for fuels.

* Cost year 2011 has been added and made the default.

* A couple of the CCS technologies had been using the wrong cost year for their disposal costs.

* Pre-production costs have been updated to not include utility costs and CO2 transportation and storage.

* Transport & storage costs removed from the cost of CO2 captured on the total cost result screens.

* Operating Labor Cost updated based on NETL 2010 Baseline Rev 2.

* Natural gas cost updated to 6.55 $/MBtu (6.719 $/mscf) in 2007 dollars in accordance with NETL Baseline REV2 (2010).

* Cost of Illinois #6 changed to 38.18 $/ton in accordance with NETL Baseline REV2 (2010).

* Direct capital costs updated for NGCC plants based on DOE/NETL Baseline Study, 2010, Rev2.

There is a paper, "Understanding the pitfalls of CCS cost estimates", in the "IECM Publications" section on our web site which gives a more detailed explanation of the changes we've made regarding the inclusion/exclusion of T&S costs in CCS costs.

10Sep2012 IECM-CS Version 8.0.1 (beta) (Carnegie Mellon)

(This version is being released as a "beta" since there have been some significant changes since the previous beta. We anticipate releasing a new public release 8.0.2 in November.)

The following changes have been made since 7.0.0 Beta:

* New Features:

o A new database format makes the installer simpler and smaller, and allows the IECM to run under Wine on MacOS X (Intel) and Linux. A conversion program is available for older fuel and session databases. (Running on non-Windows operating systems is not officially supported, but we expect it to continue to work.)

o A fuel database "userfuels" is be created in the "sessdb" folder if it doesn't already exist, to give users a place to save their own coals without having to create and keep track of their own database. (Additional databases can still be created if desired.)

o New Chemical Looping module.

* Adjustments:

o Pre-production costs updated to exclude utility costs and CO2 transportation and storage.

o Non-utility O&M costs are levelized in all results, not just on the "Total Cost" screens.

o Transport & storage costs removed from the cost of CO2 captured on the total cost result screens.

o Some predefined configurations have been updated.

o Some O&M costs have been moved to the Overall Plant.

o Overall Plant O&M Costs have been split across 2 screens.

o Numerous interface adjustments to make things clearer and/or more consistent.

o The default session database is now created by the interface if it doesn't already exist rather than having the installer overwrite it.

o Various updates based on NETL Baseline REV2 (2010):

- Default natural gas cost and composition

- Operating labor cost

- Cost of Illinois #6

- PFC factor for Power Block and Wet Cooling Tower in NGCC

- Amine, Ammonia Heat-to-Electricity Efficiency

o More information provided on CO2 Summary screens.

o Separate Real Escalation Rate for fuels.

o Cost year 2011 has been added and made the default.

o Wastewater treatment costs and energy use are now being reported on summary screens.

o Some optimizations to speed up graphs and saving samples when unit conversions are involved.

o Some optimizations in "Export Samples".

o Some improvements in the Uncertainty Editor.

o Cleaned up graphing dialog.

* Bug Fixes:

o The "Export Samples" command was not exporting some variables in result tables.

o The energy penalty in Selexol is now dependent on the compressor efficiency.

o CO2 Unit Compression Energy is now calculated in Selexol.

o "Turbine Shaft Losses" in NGCC/IGCC was including "Total Steam Turbine Output" in the calculation.

o Sessions are now properly unlocked when "save as" is used to save the session in a different database.

o "Menu" inputs that represent numeric values are properly converted when the user changes unit systems.

o Title-only input lines are now displayed correctly.

o SiO2 in coal ash properties adjusted to make totals 100%.

o The "No Mixing" Flyash Disposal option wasn't being properly recognized.

o The Membrane and Ammonia systems were using the wrong cost year for the CO2 disposal cost.

o The Amine system no longer tries to regenerate more sorbent than is actually used if the user sets the Nominal Sorbent Loss to be extremely low.

o Turning off the CO2 Product Compressor in the Membrane system was not fully disabling the compressor.

o In the IGCC, the user-specified syngas composition was not being consistently used.

03Nov2011 IECM-CS Version 7.0.0 (beta) (Carnegie Mellon)

The following changes were made between the previous public version (6.2.4) and the beta version (7.0.0):

* Two new CO2 capture technologies (post-combustion) added for PC and NGCC plants:
    - o Ammonia (chilled)
    - o Membrane separation
* New software capabilities
    - o User-specified samples option added to Uncertainty Editor
    - o A new command- "Export Samples" added to the File/Export menu
* New default values for some model parameters
    - o Cost year changed from 2009 to 2010
    - o Inflation rate changed from 3.5% to 3%
    - o Natural gas cost adjusted to $6.0/MBtu for NGCC plants
    - o Maximum lean CO2 loading changed from 0.5 to 0.3 for ammine system
    - o Gas turbine type changed from 7FA to 7FB for NGCC and IGCC plants
    - o Plant gross power output changed from 500MW to 650MW for PC plants
    - o Plant type changed from Subcritical to Supercritical for PC plants
    - o Min/Max values for some parameters
    - o Some common variables (e.g. chemical costs) moved to the Overall Plant section and made read-only in individual modules
* Bug fixes
    - o Unit conversions in exported graphs and some table columns
    - o Floating point errors in exceptional cases
    - o Base case cost year for wet cooling tower at IGCC and NGCC plants
    - o Export of difference graphs
    - o Incorrect presentation of some results (e.g. flue gas temperature out of stack in some cases)

07May2010 IECM-CS Version 6.2.4 (Carnegie Mellon)

The following changes were made between the beta version (6.2.1) and the current public version (6.2.4):

* New default values for several model parameters (including financial parameters and CO2 storage cost)

The following changes were made between the previous public version (5.2.2) and the beta version (6.2.1):

* New Technology Options

o Advanced amine system for CO2 capture

o Integrated steam cycle model for PC plants

o Dry feed IGCC gasifier and sulfur capture system

o 7FB gas turbine option for IGCC plants

o Wet tower, dry tower and once-thru cooling water systems

o Wastewater treatment systems for PC plants

* Updated Capital and O&M Cost Models

o Aligned to NETL 2007 baseline studies

* New default values for some model parameters

* New Software Capabilities

o Improved user-friendly screens for data entry

o Advanced graphing and uncertainty analysis capabilities

13Nov2009 IECM-CS Version 6.2 (Carnegie Mellon)

See the Technical Documentation.

10Aug2009 IECM-CS Version 6.1.0 (beta) (Carnegie Mellon)

Enhancements

1. Ambient pressure sensitivity added to plant performance for IGCC and NGCC.

2. Steam cycle heat rate is now a function of boiler type (PC), cooling technologies and CO2 capture options (PC, NGCC).

3. Energy penalty for cooling system in NGCC, IGCC updated.

4. Some parameter defaults have been updated.

30Jun2009 IECM-CS Version 6.0.0 (beta) (Carnegie Mellon)

New Features

1. Once-through cooling option added to all power plant systems
2. Wet cooling tower option added to all power plant systems
3. Cooling water treatment option added to all power plant systems
4. Dry cooling tower option added to all power plant systems
5. Wastewater treatment system added to PC systems
6. Consumptive water use is now calculated
7. Shell gasifier added as an IGCC system option
8. Mercury capture added as an IGCC subsystem option
9. Sulfinol (sulfur capture) added as an IGCC subsystem option
10. Selected plant-level parameters moved to a new parameter screen

no release IECM-CS Version 5.2.3 (final) (Carnegie Mellon)

New Features

1. Graphs can now be scaled and re-labeled.
2. Sample size increased from 200 to 250 (larger shows no improvement in quality)
3. Graph smoothing turned off as default

Enhancements

1. GE 7FB gas turbine option calibrated (and activated). This also has 3-stage cooling
2. IECM now compatible with all non-default monitor DPI settings.
3. Beavon-Stretford molar gas table (inlet) corrected.

01Jun2007 IECM-CS Version 5.2.2 (final) (Carnegie Mellon)

New Features

1. IECM can be run from a compact disk
2. NETL default coals added (5 total)
3. NETL natural gas added (1 total)
4. An advanced graphing system was added. Ability to graph results against inputs (scatter plot) added (but grayed out)
5. Graphing tools expanded to allow any variable graphed against another variable. A separate interface with online help for the graphing tools is also available.

Enhancements

1. GE 7FA gas turbine 3-stage cooling added (was one stage)
2. Session database template updated (tables added)
3. File attributes cleared when creating database copies
4. Chemical Engineering Cost Index updated (2006 added)
5. Critical fluid properties updated (temp, pres, vol) [used for compressor and transport models)
6. Pipeline model updated
    a. Peng-Robinson interaction parameters
    b. Pipeline max distance increased to 1000 km
    c. Pipeline minimum elevation decreased to -100 m
    d. Pipeline elevation error fixed
7. Fixed an error in the Selexol makeup rate (use variable capacity factor)
8. Fixed an error in the Claus plant catalyst makeup (use variable capacity factor)
9. lognormal "error factor" corrected
10. ASU capital cost equation updated
11. Selexol sulfur capital cost year basis corrected

02Feb2007 IECM-CS Version 5.2.1 (final) (Carnegie Mellon)

New Features

1. GE 7FB gas turbine option placeholder added (but not shown)
2. H2S removal from the CO2 selexol unit added

Enhancements

1. Installer files added (support DLLs for graphs)

30Nov2006 IECM-CS Version 5.2.0 (final) (Carnegie Mellon)

Enhancements

1. User docs updated.
2. Texaco gasifier name changed to GE (entrained)

01Nov2006 IECM-CS Version 5.1.3 (final) (Carnegie Mellon)

Enhancements

1. Stack emission table corrected.

31Aug2006 IECM-CS Version 5.1.2 (beta) (Carnegie Mellon)

Enhancements

1. GE gasifier energy use updated.
2. GE gasifier capital costs updated.

21Jun2006 IECM-CS Version 5.1.1 (beta) (Carnegie Mellon)

Enhancements

1. NGCC iteration problem fixed (all simulations converge when amine system added)

19Jun2006 IECM-CS Version 5.1.0 (beta) (Carnegie Mellon)

New Features

1. CO2 pipeline model added; automatically included with all CO2 capture technologies.
2. Navigation buttons added to "Configure Plant" section.
3. Comprehensive gas stream component table added.
4. Comprehensive solids stream component table added.
5. VR-Suite models and plugins created (www.vrac.iastate.edu).

Enhancements

1. Cost indices updated.
2. Cost indices updated; basis year changed to 2003.
3. NGCC iteration problem fixed

19Aug2005 IECM-CS Version 5.0.3 (final) (Carnegie Mellon)

Enhancements

1. CO2 Control Menu corrected.
2. Supported IGCC coals increased.
3. O2-CO2 COE (actual) corrected.
4. Oxidized mercury removal across FGD updated.

15Aug2005 IECM-CS Version 5.0.2 (beta) (Carnegie Mellon)

Enhancements

1. Cost indices updated; basis year changed to 2002.
2. Steam input to GE gasifier is a function of coal and gasifier temperature (no longer user-specified).
3. GE syngas concentrations updated.
4. Energy use summary added to PC Plant summary screen.

5. Sulfur recovery power use corrected (sulfur byproduct credit).

14Apr2005 IECM-CS Version 5.0.1 (DOE only) (Carnegie Mellon)

New Features

1. Oxyfuel option added to PC plant (ASU w/ recycled flue gas)
2. Flue gas recycle module added.

Enhancements

1. Booklife input corrected.
2. Ash properties for coals corrected.
3. Coal costs updated.
4. ASU construction time reduced from 4 to 2.5 years.
5. ASU cost year basis for capital cost corrected.
6. ASU power use equations are now a function of purity.

06Dec2004 IECM-CS version 4.1.0 (alpha) (Carnegie Mellon)

New Features

1. Electricity cost basis options added to PC plant.
2. Reagent unit costs input screen added (consolidation).
3. Added ultra super-critical boiler to PC plant. Heat rate adjusted.

Enhancements

1. PC base plant water cost corrected.
2. PC base plant preproduction cost corrected.
3. By-product management inputs for energy use removed.
4. Wet and dry FGD steam cost basis corrected.
5. ASU gas components reported as flue gas, not a syngas.
6. Base plant COE maximum input increased to 200 $/MWh.
7. WGSR and selexol capital costs corrected for larger plants.
8. Wet FGD bypass improved (identical to amine system).

9. CO2 emission constraint use corrected.

13Oct2004 IECM-CS version 4.0.5 (internal) (Carnegie Mellon)

New Features

1. Amine scrubber flue gas bypass added.
2. Hydrolizer added to IGCC to convert COS to H2S
3. Emission constraint for CO2 capture added.

Enhancements

1. Amine scrubber steam and power cost basis corrected.
2. Compiler software upgraded; models recalibrated

20Aug2004 IECM-CS version 4.0.4 (rereleased) (Carnegie Mellon)

Enhancements

1. Context-sensitive help updated.

30Jun2004 IECM-CS version 4.0.4 (beta) (Carnegie Mellon)

New Features

1. Natural gas properties for amine scrubber available.
2. Hydrolizer for IGCC system added (COS converted to H2S).
3. Emission tax on CO2, SO2, and NOx for total emissions added.
4. Emission from aux. boiler added to stack result table.
5. Added subtotal to overall costs for IGCC and NGCC.
6. Added super-critical boiler to PC plant. Heat rate adjusted.

Enhancements

1. Wet FGD bypass corrected.
2. Natural Gas HHV calculation corrected.
3. HRSG capital cost equation updated.
4. Temperature and Pressure exiting ASU corrected.

5. Net MW value reported corrected.
6. Coal and Oil costs added to database and assigned unique values.
7. Aux. boiler stack emission corrected.

07May2004 IECM-CS version 4.0.3 (beta) (Carnegie Mellon)

New Features

1. Natural gas was expanded to include C2H6, C3H8, COS, H2S, and HCl.
2. Syngas components for C2H6 and C3H8 were added.

Enhancements

1. Ammonia injection into SCR units were corrected.

26Apr2004 IECM-CS version 4.0.2 (alpha) (Carnegie Mellon)

Special version for an internal project with DOE, ISU, CMU, and REI

05Jan2004 IECM-CS version 4.0.1 (alpha) (Carnegie Mellon)

Enhancements

1. Syngas water saturation prior to combustion improved.
2. Construction times updated across all plant types.
3. Steam saturation of fuel gas into combustor improved.

24Oct2003 IECM-CS version 4.0.0 (alpha) (Carnegie Mellon)

New Features

1. V21P 3.6.x module components incorporated into IECM-CS.
2. IGCC GE gasifier performance inputs menu-driven.
3. Gasifier cold-gas efficiency added to results.
4. Shift reactor (WGSR) and CO2 scrubber added.

5. CO2 sequestration input and output options added.
6. Online help file for CS modules added.

Enhancements

1. Performance of selexol CO2 capture calibrated to CMU model developed independently.
2. Cost models of selexol CO2 capture calibrated to CMU model developed independently.
3. Selexol CO2 and WRSR output diagrams improved.
4. Online help file upgraded.

26Aug2003 IECM-CS version 3.5.5 (beta) (Carnegie Mellon)

New Features

1. User database files can be named, saved, and opened.
2. Net plant efficiency added to results.
3. Power use breakdown added to results.

Enhancements

1. NGCC heat rate corrected.
2. Amine scrubber energy use corrected.
3. Amine scrubber regeneration heat corrected.
4. Fuel selection screen corrected.
5. Natural gas flow rate corrected.

02May2003 V21P version 3.6.0 (alpha) (Carnegie Mellon)

New Features

1. IGCC KRW system with hot-gas cleanup added (IGCC) - offline.
2. IGCC GE gasifier system with cool gas quench added (IGCC).
3. IGCC E-Gas system added (IGCC) - offline.
4. Water gas shift reactor added (IGCC).
5. CO2 capture module by selexol process added (IGCC).

6. DBA flow rate added to result table
7. Combustion with natural gas combined cycle (NGCC) added as a new plant type. (CS)

Enhancements

1. Limestone with additives (DBA) molecular weight, reagent purity, flue gas exiting wet FGD, and wet solids removed were corrected (lime values used instead of limestone)
2. Interface window opens to 800 x 600 for monitor resolutions greater than 800 x 600. The interface continues to open full-screen for monitor resolutions below 800 x 600.
3. Unit conversion of sq ft/T-R set (ESP) corrected.
4. Ash removed from Wet FGD corrected.
5. Natural gas density used in natural gas final cost corrected.
6. Wet FGD capital costs updated.
7. Wet FGD performance input parameter values updated
    a. No spares
    b. 100% of flue gas treated by one vessel
    c. Higher maximum SO2 removal efficiency

14Nov2002 Alpha version 3.5.3 (IECM CS - special version) (Carnegie Mellon)

New Features

1. Uncertainty can be turned on and off by technology type. It is accessed from an additional pane.

Enhancements

1. User data (session input and output) are saved to user-specified files; previously they went into one standard file.
2. "Save" and "Save As..." now work like other Windows applications.
3. Database files holding session data can be saved to any

location and retrieved. This allows the IECM to be used on a network, by multiple users, and data traded.

4. Default values for stock and bond fractions are updated. The result is a new discount rate and fixed charge factor.
5. Bond and stock rates are updated according to EPRI TAG 1999.
6. Federal and state tax rates were updated to reflect the EPRI TAG 1999.
7. Several errors in the energy penalty, TRR, and power cost functions of the CO2 module were corrected.

Remaining Issues

1. Tax changes present in the EPRI TAG 1999 must be made.
2. The debt, and stock inputs should be replaced with calc inputs that are a function of inflation.
3. Natural gas and fuel oil have been temporarily removed from the fuel selection options.
4. Total Plant Investment (TPI) has been changed to match the EPRI TAG 1999. The change implicitly alters the way the total cash expended and AFUDC are handled.

24Oct2002 Alpha version 3.5.2 (IECM CS - special version) (Carnegie Mellon)

New Features

1. Auxiliary boiler added to CO2 module to produce steam and optional electricity. Options include:
    a. None (no auxiliary boiler0
    b. Steam production for use in CO2 regenerator
    c. Steam and auxiliary power (from a steam turbine)

Enhancements

1. Process area capital costs were updated for the CO2 module. Cost scaling parameters were modified.

2. Steam taken from a base plant steam turbine is treated as equivalent electricity (electricity no longer produced).
3. SO2 removal efficiency is set to maximum when CO2 capture is configured.

29Oct2001 Alpha version 3.5.0 (IECM CS - special version) (Carnegie Mellon)

New Features

1. CO2 removal added as a process type (Config screen menu).
2. MEA-solvent CO2 scrubber added as CO2 removal type.
3. FGD Reheater Temperature Change input added.
4. Plant diagram area expanded to allow for additional icon.
5. Total Capital Required (TCR) can be adjusted by a factor to allow for situations where the plant is partially or fully paid off.
6. Petroleum (oil), natural gas (ngas), and other (other) are added as possible fuel types. The tabs reflect the word "fuel" instead of "coal". Several fuel properties are added.
7. NH3 added as a flue gas constituent
8. CuO and NOXSO technologies removed

Enhancements

1. Conversion from acfm to acmm fixed.
2. Context-sensitive help via "F1" corrected.
3. Utility and Power cost refer to the same items for all modules: base plant electricity cost and module energy penalty.
4. ESP utility cost is a function of gross plant size, as the other modules already were.
5. Mercury removal constraint maximum set to 99.
6. Spray Dryer SO2 maximum removal default set to 90.

7. Wet FGD SO2 maximum removal default set to 99.

Remaining Issues

1. Base plant financial input assumptions modified to consider due to deregulation of the power industry (e.g., interest rates, booklife, taxes, cost of energy, net present value, internal rate of return, payback period, financial structures).
2. Inputs should be hidden if they are not being used.
3. HCl is removed in scrubber but not added to discharge.
4. SCR should include bypass
5. SCR has no power cost
6. Sorbent concentration in flue gas out (input) for CO2
7. CO2 capital cost basis on actual flow rate not normal
8. Add Total Hours of Operation to the perf summary table
9. Change result table units from kg/kWh to g/kWh
10. Update fuel costs

30Apr2001 Final version 3.4.5 (Carnegie Mellon)

Enhancements

1. Mercury input tab is visible in all plant configurations.
2. ESP and FF total mercury removal without control default is now displayed for the user to override.

30Nov2000 Alpha version 3.4.4 (Carnegie Mellon)

New Features

1. Stack emission rates of equivalent SO2, equivalent NO2, ash, and Hg in units of lb/MBtu added.

Enhancements

1. Printed results show the proper name of the technology. SCR

was being shown on Boiler NOx technology printouts.

2. Ash properties sum to the proper number.
3. Notations added where equivalent NO2 is used rather than NOx.
4. Boiler direct capital cost adjusted from net plant size basis to gross size basis.
5. ESP specific collection area corrected (which corrects capital costs also).
6. Uncertainty on variables used to changed output units is not implicitly used (e.g., capacity factor).
7. Base plant retrofit factors can be safely set to zero to simulate $0 capital costs (no floating point divide by zero).

05Oct2000 Alpha version 3.4.3 (Carnegie Mellon)

New Features

1. User documentation updated with Mercury module additions and modifications to other modules.
2. Air preheater flue gas exit arrow is yellow with "Inj." text above it on plant diagram to exhibit flue gas injections.
3. The yellow arrow opens the Mercury input and result screens.

Enhancements

1. Mercury flow rate in and out of the injection result diagram is removed and replaced with a text note to see TSP device(s).
2. Carbon injection user input calculation corrected.
3. NOXSO module NOx and SOx constraints corrected to eliminate divide by zero problems.

Known Problems

1. Ash properties in the coal are not added correctly. The sum appears above the properties.

29Sep2000 Alpha version 3.4.2 (Carnegie Mellon)

New Features

1. Mercury removed in solid streams is tracked and reported in disposal diagrams.
2. Results saved in the user session database are deleted when the software is upgraded to maintain backward compatibility.

Enhancements

1. Mercury removed from CS-ESP is 31% for bituminous coal with no activated carbon injection. This is based on full ICR data.
2. Mercury removal from a fabric filter is 39% for bituminous coal with no activated carbon injection. This is based on full ICR.
3. Solids management input and result screens are linked to their respective icons on the plant diagram.
4. Uncertainty graphs are displayed for newly installed versions of the IECM software.

Remaining Issues

1. Activated carbon injection input calculation error for SCR/FGD.
2. Flue gas injection indicator on the plant diagram with navigation.
3. NOXSO module produces a divide by zero in all configurations.

26Sep2000 Alpha version 3.4.1 (Carnegie Mellon)

New Features

1. Flue gas component summary tables display total NOx, total SOx, and total flue gas in mass and molar flow rates.
2. SO3 removal efficiency added to the air preheater, cold-side ESP, fabric filter, wet FGD, and spray dryer. (SO3 conditioning was already intrinsically present in the hot-side SCR). Default values correspond to the Southern Company method.
3. Mercury speciation and mass flow rate is tracked throughout all

the IECM components. Default inputs are a function of coalrank, technology, and speciation type.

a. Concentration in coal

b. Speciation after cooling (elemental vs. oxidized)

c. Removal efficiency in the boiler, ESP, FF, and wet FGD

d. Speciation adjustments in the SNCR and SCR

e. Results displayed on all output diagrams (removal and flow)

4. Mercury removal constraint added; ESP and FF removals adjusted as a function of the removal in the wet FGD and speciation change in the SCR.
5. Carbon injection with or without water injection module added upstream of particulate and desulfurization units to enhance mercury removal (lessen the requirement of the FF or ESP).

a. Overall mercury removal constraint

b. Calculated removal efficiency in wet FGD

c. ESP and FF removal efficiency adjusted to meet constraint

d. Water is injected as a function of the required temperature drop (enhancing mercury removal).

e. Carbon injected is a function of the necessary removal, flue gas temperature, and SO3 content of the flue gas.

f. Capital and O&M cost model added using the EPRI TAG format and default values from DOE (based on EPA defaults).

Enhancements

1. Session database generation fixed. A table was not being created and causing graphs not to display.
2. Interface window size reduced to allow other windows to remain on top (e.g., Microsoft Office Shortcut Bar).
3. Flue gas component summary tables display weight and volume percent when the output units are changed to "% Total".
4. The fraction of total SOx as SO3 was updated to incorporate the default values from the Southern Company method. The default is

a function of the fueltype and the coalrank.

5. Particulate removal requirement is reduced for the ESP when a wet FGD is present (to account for FGD ash removal).
6. Technology navigation combo box (at the bottom of input and result screens) are linked to the other navigation tabs.
7. Landfill and Pond result screens combined into a "Solids Mgmt." result tab.
8. Sulfuric acid dew point is calculated as a function of the gas pressure, SO3 partial pressure, and moisture partial pressure.
9. User saved results are discarded when upgrading IECM to a newer version to maintain configuration and input compatibility.

Remaining Issues

1. Sulfuric acid removed with ash not tracked
2. COHPAC or PJ-FF addition technologies to enhance mercury removal.
3. Uncertainty functions for mercury removal, speciation, and activated carbon cost.
4. Trace removal efficiencies cannot be accessed when there is no additional mercury controls.

29Aug2000 Beta version 3.3.1 (Carnegie Mellon)

Enhancements

1. Average natural gas properties used instead of methane in CuO and SNCR modules (mass flow and cost).
2. Natural gas O&M cost added to SNCR result sheet.

01Jun2000 Beta version 3.3 (Carnegie Mellon)

New Features

1. LNB menu options are not accessible for cyclone boilers.

2. Ammonia from SNCR and SCR are summed and reported together in performance result table.
3. Urea and natural gas are added to the performance result table. Total fuel was replaced with coal flow rate.
4. SNCR and SCR are allowed to be present together.
5. Some objects are masked when printing.
6. Disclaimer added to installer program.

Enhancements

1. Maximum NOx removal for SNCR is calculated based on an assumption of 20 ppm NH3 slip. The removal is enhanced when LNB is added (lowers NOx emission factor to a "low nox" classification). Min and max for the parameter were relaxed as well.
2. LNB wall NOx removal is constant for an emission factor less than 0.45 lb/MBtu and greater than 1.1 lb/MBtu (limit of regression curves).
3. LNB capital cost for large plants (>500 MWg) are based on EPA cost data. Smaller plants are based on DOE cost correlations.
4. In-Furnace Controls selection popup now is a function of the boiler type (e.g., no LNB with cyclone boiler). Other inputs are hidden/shown as a function of the popup selection. Results shown on the Boiler NOx result diagram are also hidden/shown as a function of the popup.
5. Gross plant size performance input limits tighted to 100->1,500 due to limits in boiler NOx regression curves.
6. SNCR energy penalty only effects net plant size for urea (water pumps).
7. Removal of NOx by natural gas reburn is a function of the gas energy input and the boiler type (continuous function).
8. SNCR stoichiometry removed from input screen. It is shown on

the SNCR result diagram.

9. Boiler NOx Capital Cost units on input screen corrected.
10. Context-sensitive help added.

Remaining Issues

1. SNCR stoichiometry should be present as an input and provide an alternative method of determining NH3 slip and NOx removal efficiency.
2. Slip from the SNCR should reduce the stoichiometry calculated for the SCR if it is present also.
3. Urea/NH3 which is unreacted and not present as slip need to be burned.
4. Flue gas bypass of SCR.
5. Inclusion of N2O and ammonia in flue gas array.
6. LOI correlation to boiler NOx retrofit parameters.
7. Inclusion of ammonia salts in solids array.
8. Multiple session operations (add results)
9. O&M cost savings for gas reburn
10. Horizontal scroll bars for large table result screens.
11. Upgrade uninstall control via roll-back with Windows NT4.

14Feb2000 Alpha version 3.205 (Carnegie Mellon)

New Features

1. WISE installer used; benefits include version management (Backup folder) and flexibility in installing all software (including system files).
2. User coal and session database files are generated by interface if they do not exist; they are not installed.
3. New variables are added by the interface to existing sessions as they are opened (backward compatibility).
4. Unit conversion of annualized plant cost in mass/ton

removed.

5. Flexibility of interface code added; allows creation of optional screens and screen components (dynamically show or hide input/output screens & components).
6. Result tables can be generated landscape or portrait.
7. Annualized cost summary table for each technology added.
8. Flue gas component summary table for all technologies.
9. Inputs for cost summary table added.
10. Sluice water input expressed as %water instead of %solids (fabric filter, cold-side ESP, wet FGD, boiler)

Enhancements

1. Flue gas moisture additions when urea injected
2. LNB and SNCR+LNB parameters set to zero for cyclone boilers.
3. Compatibility with version 3.1 sessions restored; alpha versions remain incompatible (input lines mismatched).

16Dec1999 Alpha version 3.204 (Carnegie Mellon)

New Features

1. Total annual plant cost per ton of NOx/SOx/Ash demo.

08Dec1999 Alpha version 3.203 (Carnegie Mellon)

Enhancements

1. Natural gas cost minimum reduced from 3.5 to 2.0
2. Retrofit capital costs were scaled incorrectly

06Dec1999 Alpha version 3.202 (Carnegie Mellon)

New Features

1. Gas Reburn implemented

a. specify energy percent from natural gas

b. flue gas composition adjusted (mass balance)

c. NOx reduction based on uncontrolled plant

d. SCR removal adjusts to reburn removal

e. result diagram shows natural gas used

2. O&M Costs

a. labor basis and year updated

b. natural gas cost added ($/MCF)

3. Cost Year (1998) added, using 1997 values

Enhancements

1. Chlorine combustion corrected

13Nov1999 Alpha version 3.201 (Carnegie Mellon)

New Features

1. Coal input screen has new field for summing components
2. Better graph and axis titles
3. Smoother graphs
4. Additional parameter to control graph smoothness
5. Half and negative half normal functions added
6. Process type navigation popup added (bottom of all screens)
7. Boiler NOx reduction model (perf & cost)
8. Input and output lines can be hidden when appropriate
9. Input unit changes added

Enhancements

1. Spray dryer SO2 removal input (override now works)
2. NOx emission factor input (override now works)
3. SCR catalyst cost units corrected (now $/cu ft)
4. Base plant cost year corrected (now 1993)
5. Miscellaneous cosmetic interface errors fixed
6. Placement of graph legend corrected

7. Default coal components corrected (Low Sulfur & WPS Utah)
8. LOI removed from coal prior to and added in after combustion
9. SNCR cost year initialization corrected (costs were being evaluated in 1977 dollars)

19May1999 Final version 3.1 released (Carnegie Mellon)

12Jul1998 Version 2.0 released (DOE only) (Carnegie Mellon)

01Jul1997 Version 1.0 released (DOE only) (Carnegie Mellon)

New Features

1. Windows 95 and NT support (ported from Analytica on Macintosh)
2. Modular programming components
    a. Stochastic Engine (FORTRAN)
    b. Technical Model (FORTRAN)
    c. Graphical interface library (C++)
    d. Graphical interface (C++)
2. Simple, robust and stand-alone graphical user interface (GUI)
    a. Floating palettes
    b. Menus
    c. Tool bars
    d. Multi-document support (sessions, graphs)
    e. Tab-based navigation
3. Robust tables and graphs (commercially licensed DLLs)
4. Robust database support (Microsoft Access format)
5. Limited access to underlying model structure and variables
6. Enhanced performance (compared to Macintosh)
7. No 3rd party licenses requiring payment
8. Color hilighting