Report on Recent Accomplishments and Future Directions

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FY99 Projects and Funding

Enhancements to the Integrated Environmental Control Model (IECM)

Sponsor:	Process Analysis Division
Amount:	$50 k
COR:	Gerst Gibbon

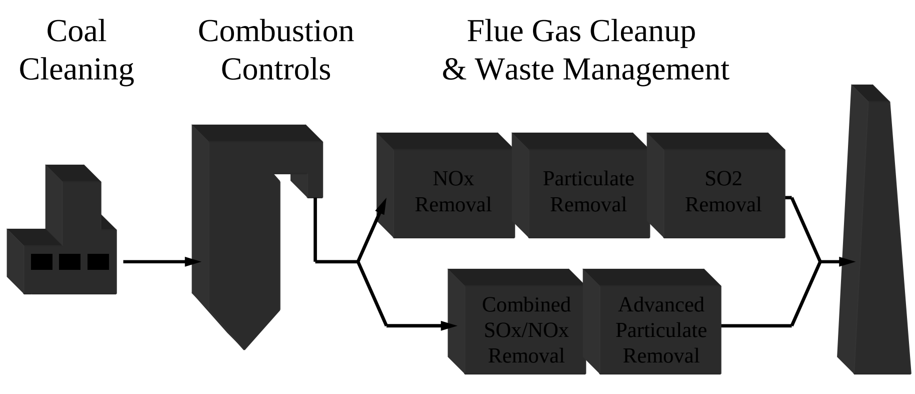
Development of a Framework for the Preliminary Design and Analysis of Vision 21 Plants

Sponsor:	Advanced Research & Technology Development
Amount:	$150 k
COR:	Gerst Gibbon (Bob Romanosky)

Highlights of Activities to Date

- Completed IECM Version 3.1 plus associated technical documentation and user manuals
- Developed new performance and cost models of selected process technologies for the IECM
- Began implementing new models in the IECM code and graphical interface
- Developed a plan to add process optimization options
- Developed a conceptual framework for a Vision 21 preliminary planning model

Integrated Environmental Control Model (IECM)



IECM Performance and Cost Models

- Detailed mass and energy balances, plus empirical relationships for complex process chemistry
- Calculates mass flows, energy flows, efficiency, and multi-media environmental emissions
- Component cost models (5-10 process areas per technology) explicitly linked to flowsheet performance parameters
- Calculates total capital cost, O&M costs, and COE
- Approximately 10-20 performance parameters and 10-20 cost parameters for each technology

The IECM is Now Available for Downloading by the Public

- **Web Access:**
  - ftp://ftp.fetc.doe.gov/pub/IECM
- **FTP Access:**
  - ftp.fetc.doe.gov/pub/IECM
    - anonymous login
    - any password

Preliminary IECM User Group

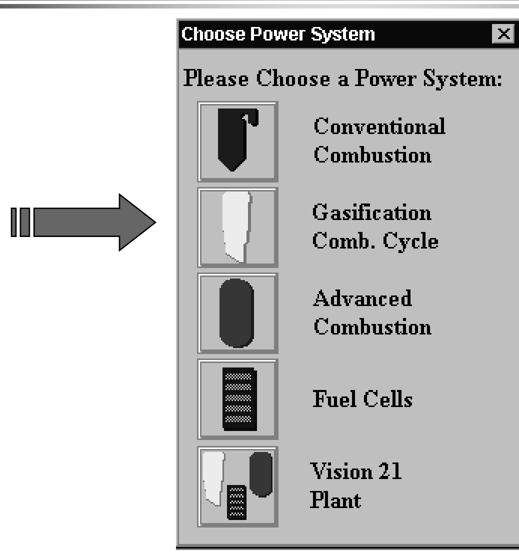
- ABB Power Plant Control
- American Electric Power
- Consol, Inc.
- Energy & Env. Research Corp.
- Exportech Company, Inc.
- FirstEnergy Corp.
- FLS Miljo A/S
- Foster Wheeler Development Corp.
- Lehigh University
- Lower Colorado River Authority
- McDermott Technology, Inc.
- Mitsui Babcock Energy Ltd.
- National Power Plc.
- Niksa Energy Associates
- Pacific Corp.
- Pennsylvania Electric Association
- Potomac Electric Power Co.
- Private Consultants
- Savvy Engineering
- Sierra Pacific Power Co.
- Southern Company Services, Inc.
- Stone & Webster Engineering Corp.
- Tampa Electric Co.
- University of California, Berkeley

New Performance and Cost Models Under Development

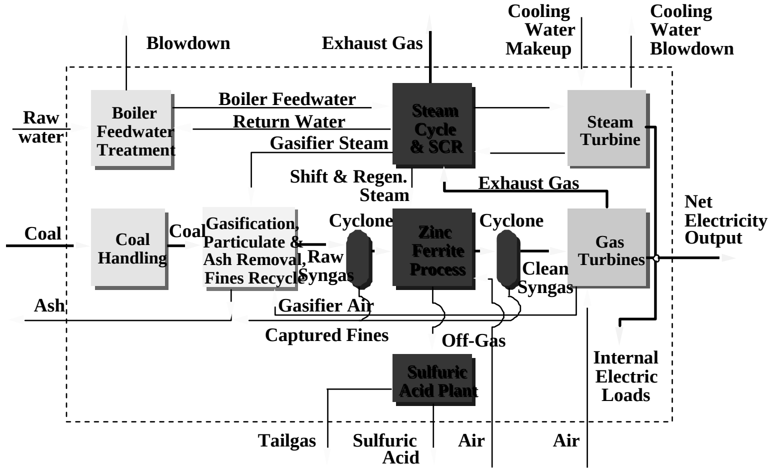
- In-Furnace NO_x Controls
  - Low NOx Burners (LNB)
  - LNB + Overfire air
  - Gas Reburn
  - Selective Non-Catalytic Reduction (SNCR)
  - LNB + SNCR
  - Tangential, Wall, and Cyclone Firing
- Gasification Combined Cycle Systems
  - KRW Gasifier with Hot Gas Cleanup
  - Texaco Gasifier with Cold Gas Cleanup

(live demo of the new in-furnace NOx control options)

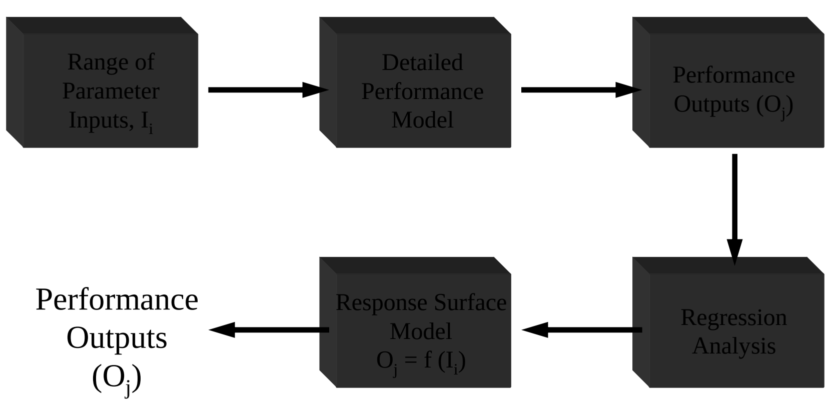
New Gasification Combined Cycle (IGCC) Options



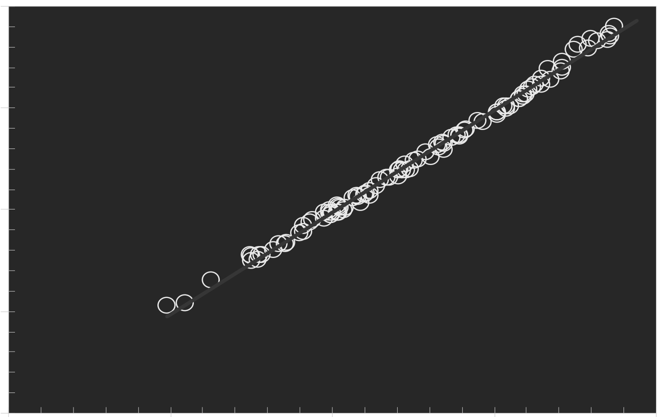
ASPEN Model of an IGCC System



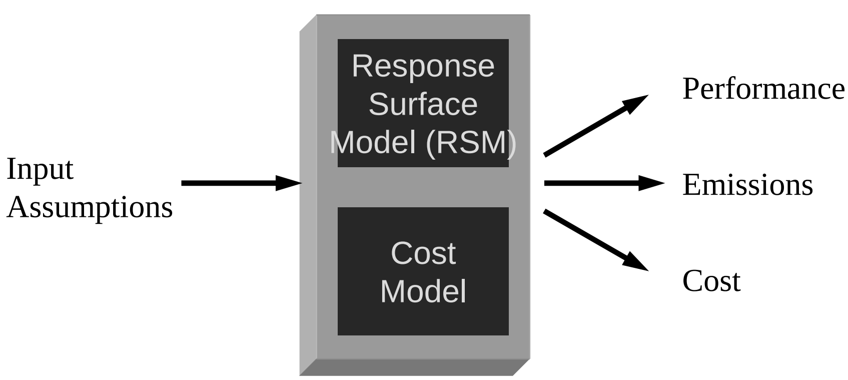
Response Surface Model Development



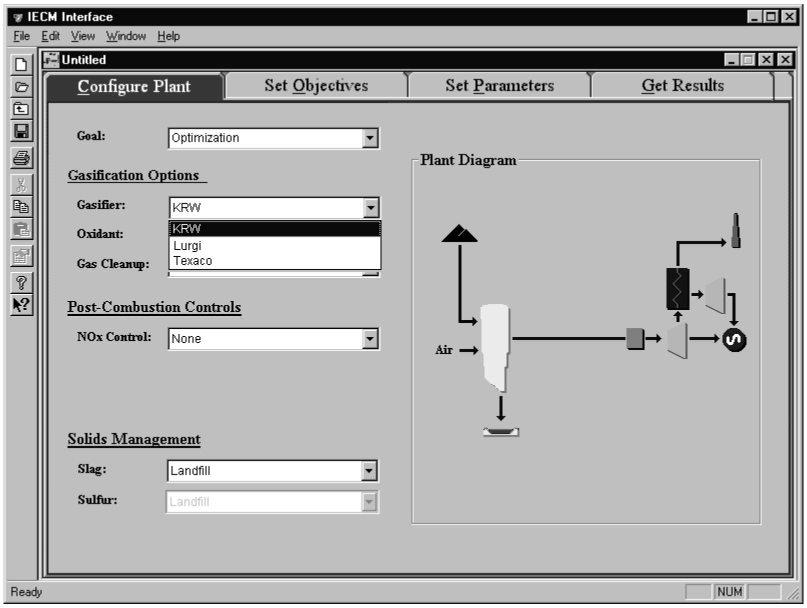
Evaluation of Desktop Model: IGCC Plant Efficiency



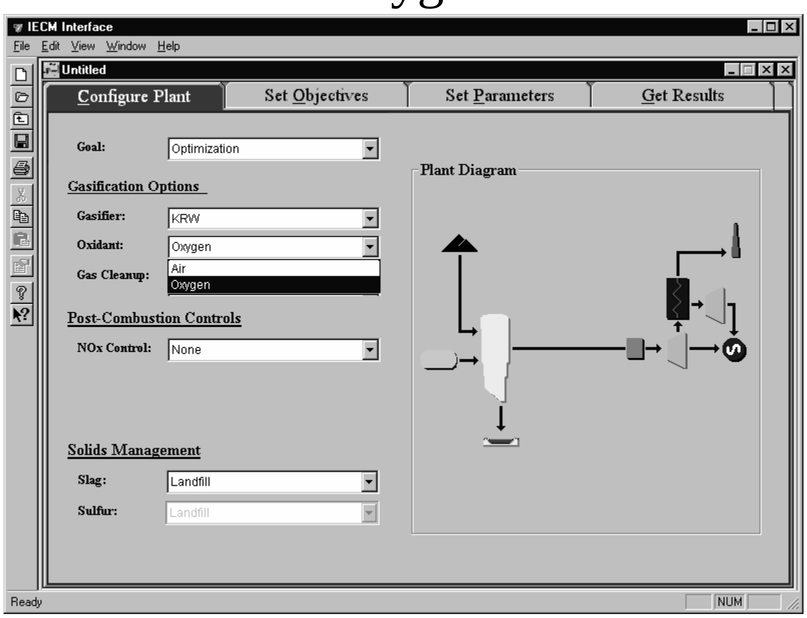
Desktop Model of a Process



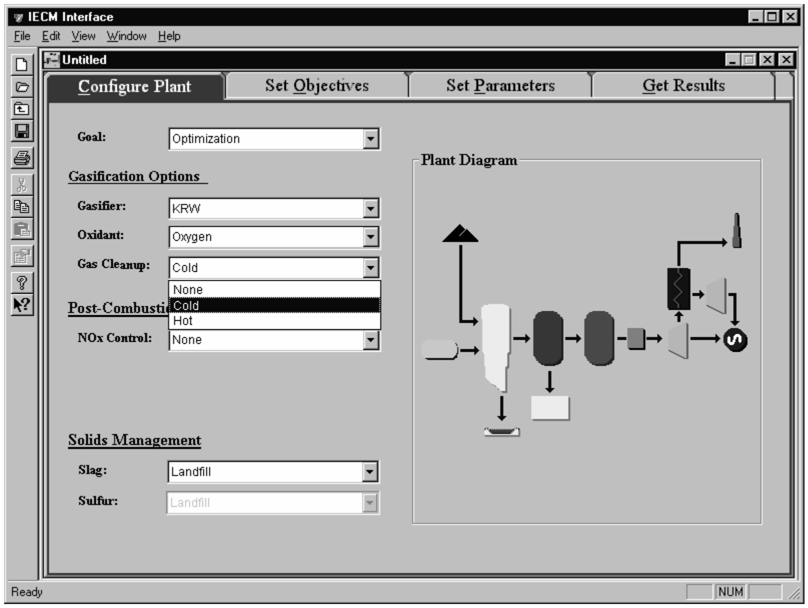
Select KRW Gasifier



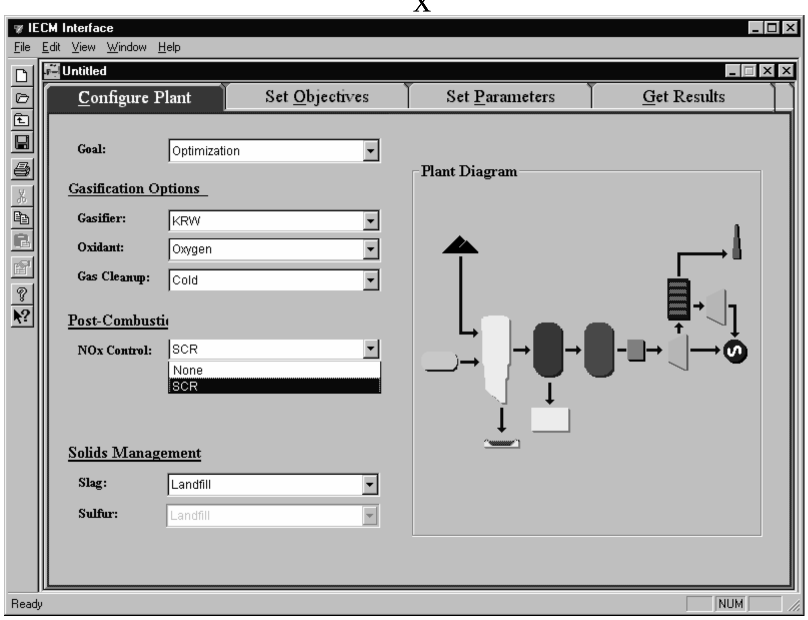
Select Oxygen Plant



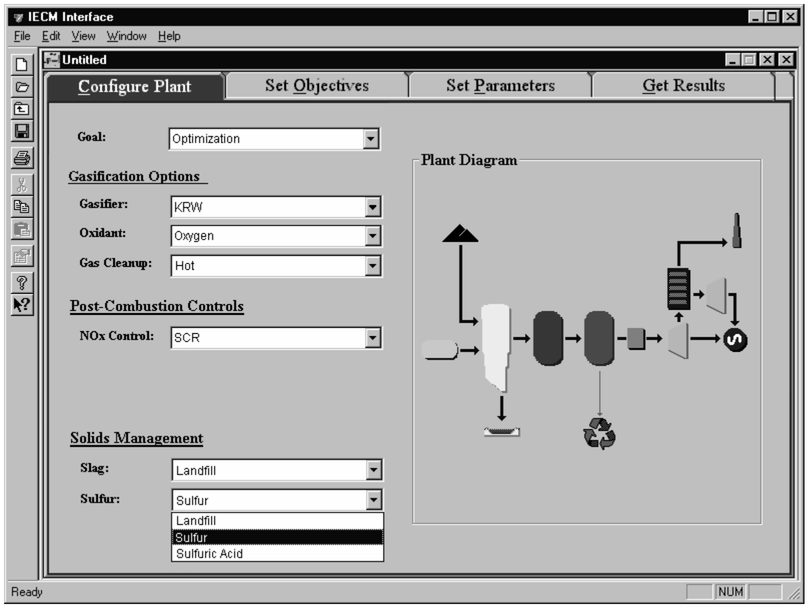
Select Cold Gas Cleanup



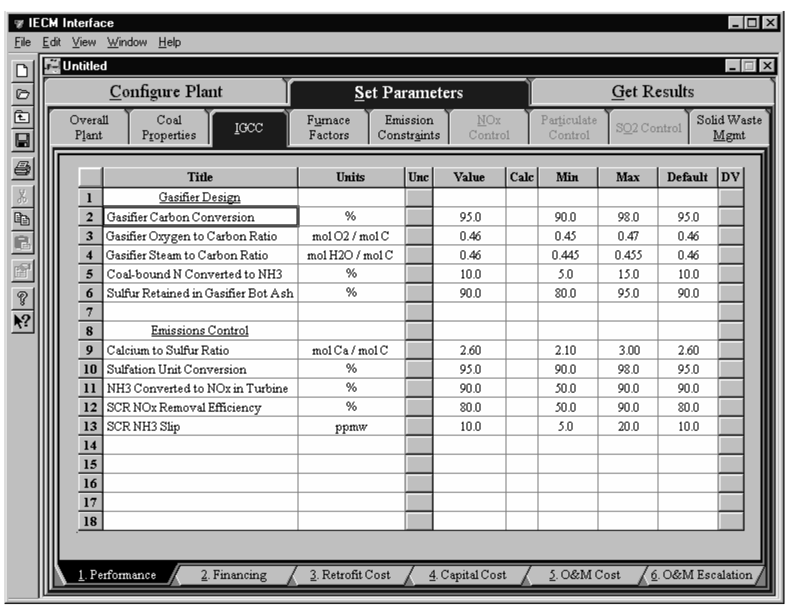
Select NO_x Control



Select Byproduct Recovery



Set Process Parameters



Potential New Models for the IECM (FY 2000)

- Mercury Control Technologies
  - In-Furnace
  - Post-Combustion
- Alternative Fuel Selections
  - Natural Gas
  - Petroleum
  - Fuel Blending
- Advanced Plant Designs
  - Additional Model Parameters
  - Additional Process Technologies

Conceptual Design of a Vision 21 Planner

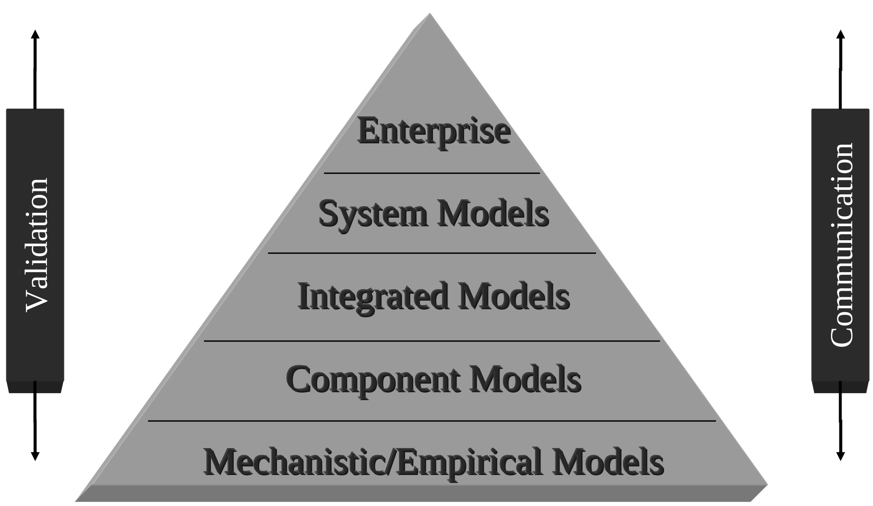
- *A preliminary design model to analyze:*
  - Process Components
  - Systems Integration
  - Performance and Cost
  - Process Optimization
  - Current Uncertainties

Objectives

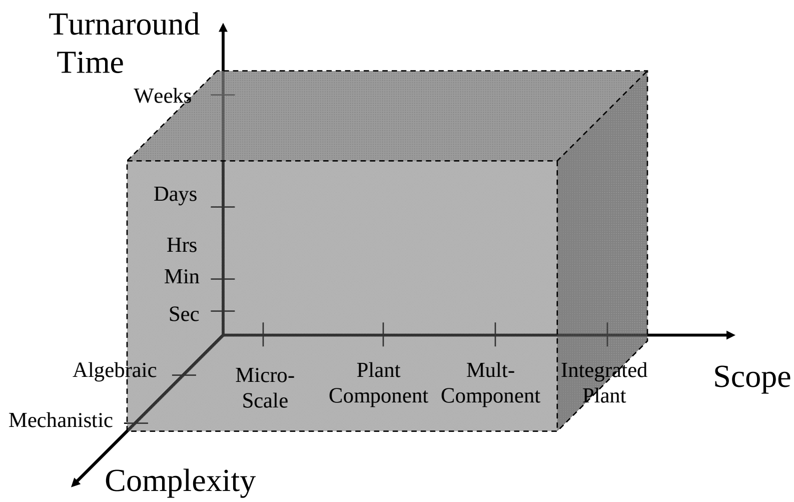
- Develop a flexible and easy-to-use modeling system to estimate the performance, environmental emissions and cost of a preliminary Vision 21 plant design

- Develop a framework for comparing alternative options and on a systematic basis, including effects of uncertainty

A Hierarchy of Process Models



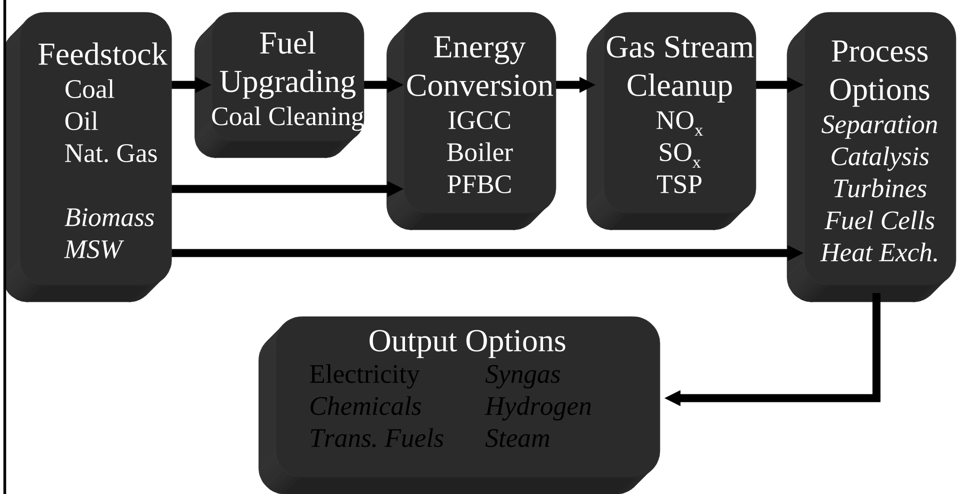
Attributes of Process Models

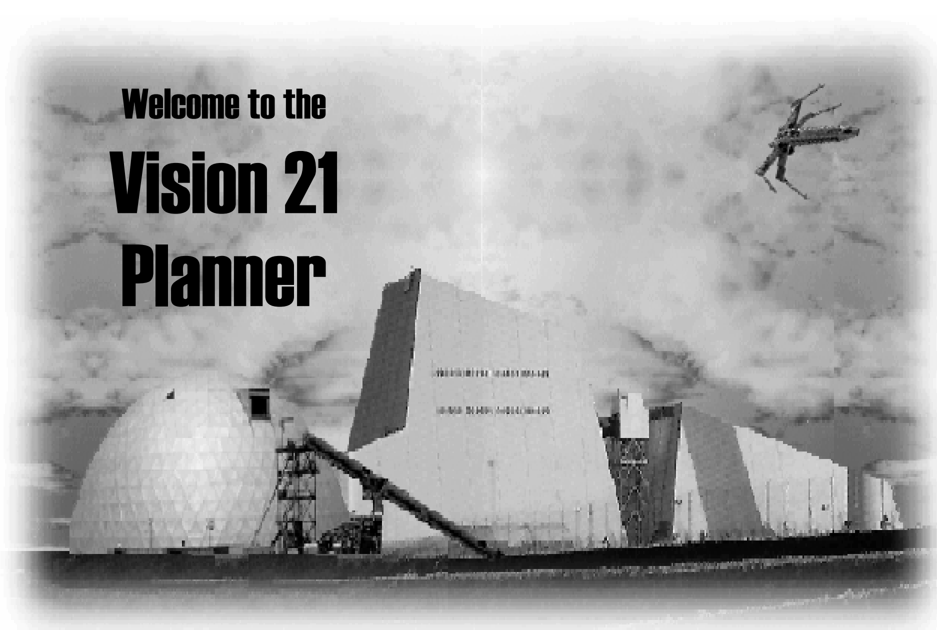


Benefits of Desktop Models

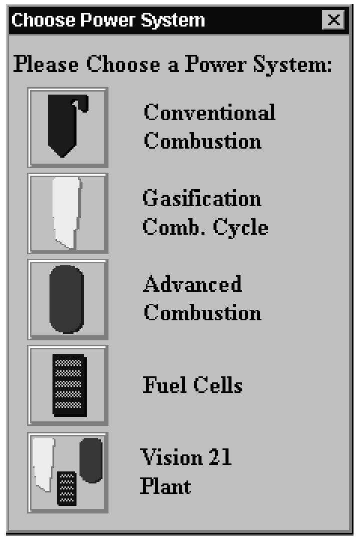
- Precise and accurate representation of detailed models
- Execution takes seconds, not hours
- Can run on any desktop PC
- Amenable to "what if" analyses
- Incorporates process performance, emissions, and cost models in one package
- Useful by analysts and decision makers who have no time, ability or resources (staff, software, hardware, funds) to run complex models

Schematic of the Proposed Vision 21 Planner

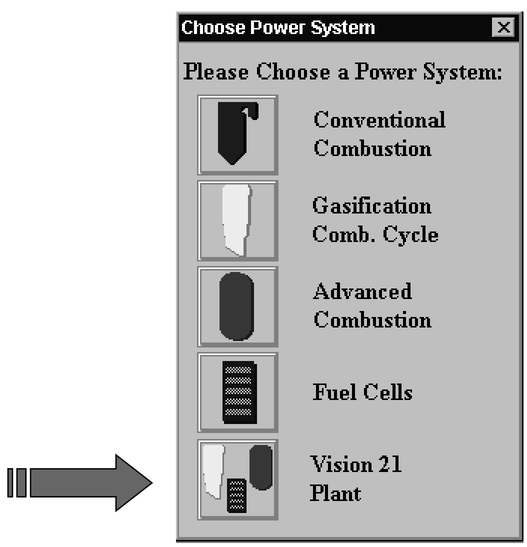




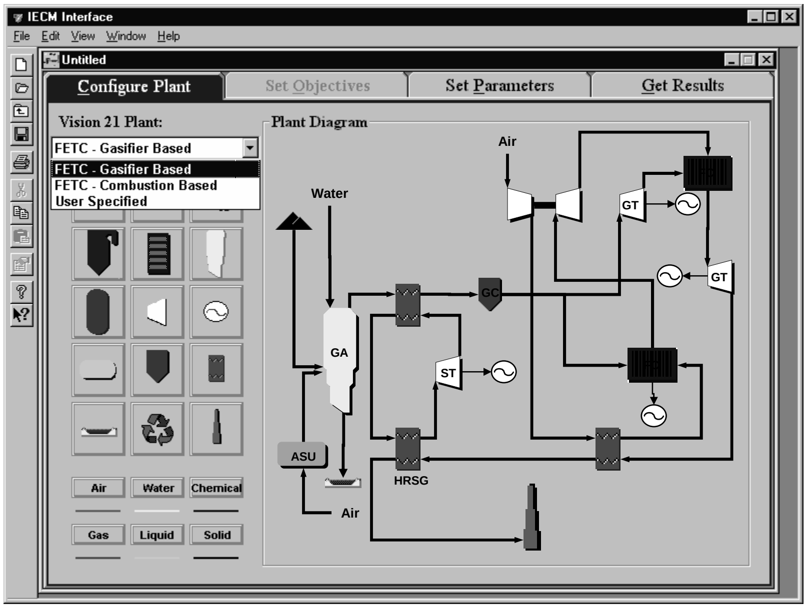
Opening Screen: A Menu of Technology Options



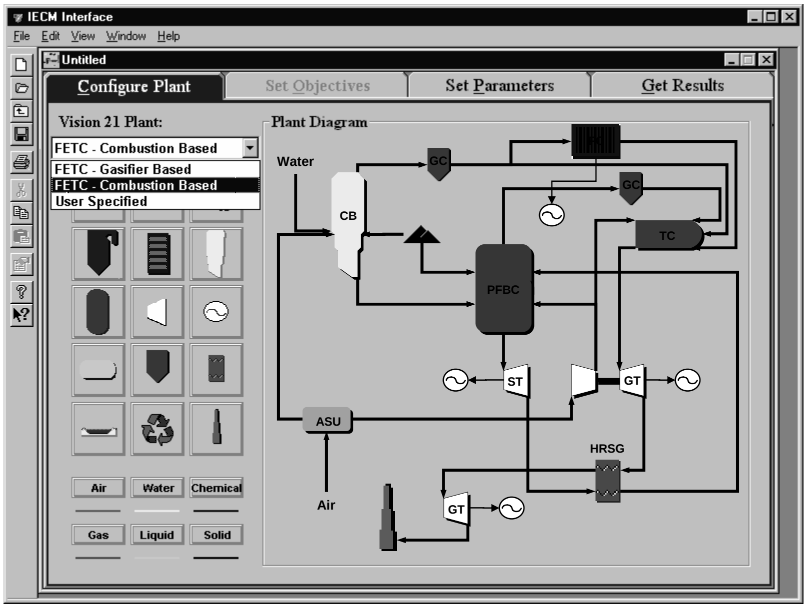
Open Vision 21 Plant Options



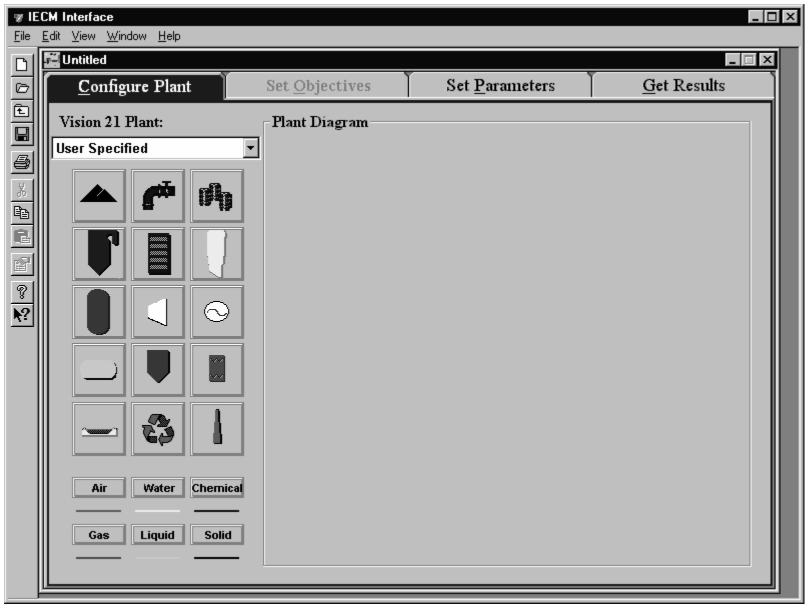
Select Existing Flowsheet - 1



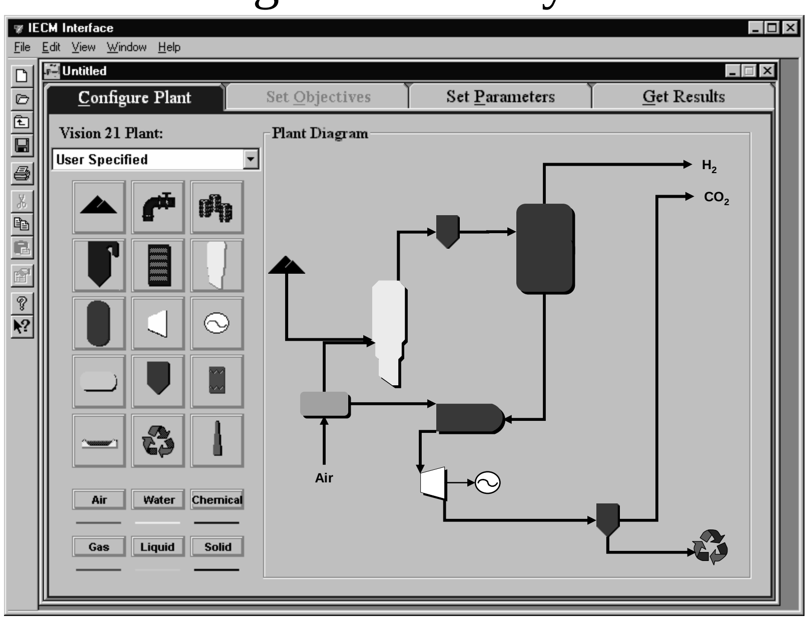
Select Existing Flowsheet - 2



Vision 21 Workbench



Configure a New System



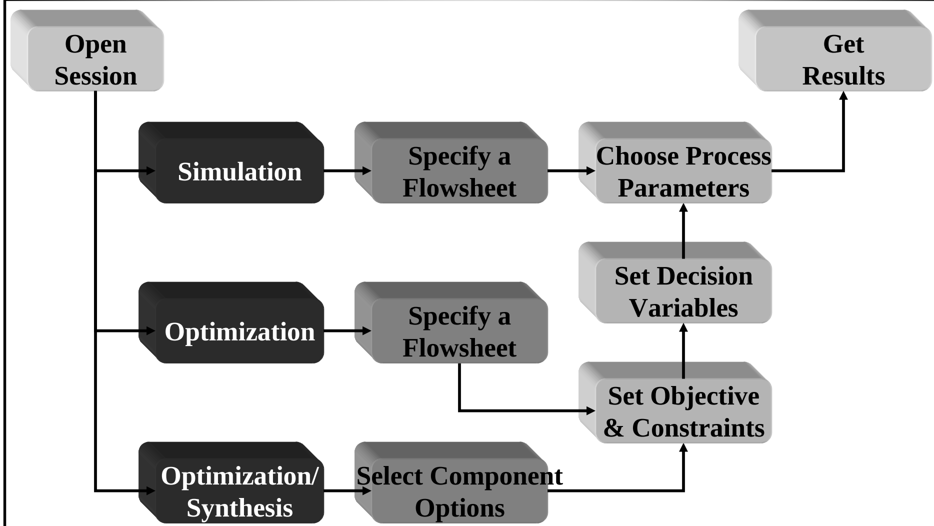
The Vision 21 Planner Would . . .

- Bring together a spectrum of performance and cost models for plant components and integrated systems, suitable for preliminary design and analysis
- Run quickly and easily on a desktop or laptop computer
- Allow new process concepts to be easily modeled
- Allow uncertainties to be characterized explicitly
- Facilitate selection of optimal (most promising) designs
- Be public domain software available to all

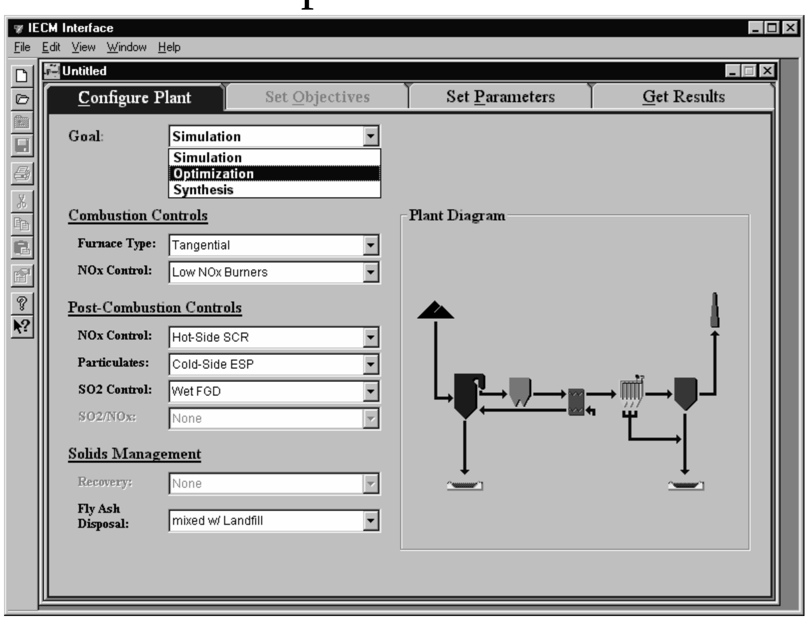
Potential New Software Options

- Process Optimization
  (of a given flowsheet)
- Process Synthesis
  (to define an optimal flowsheet)

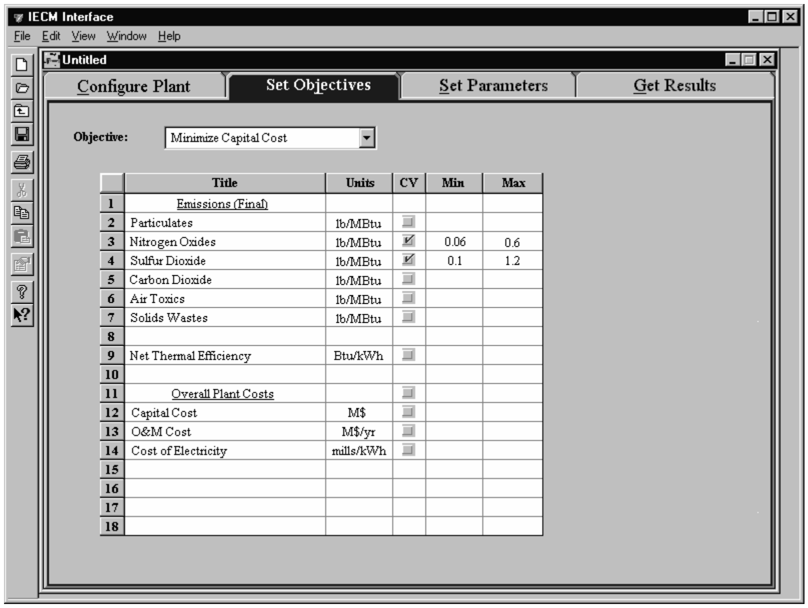
Advanced Design Capabilities: Operation Overview



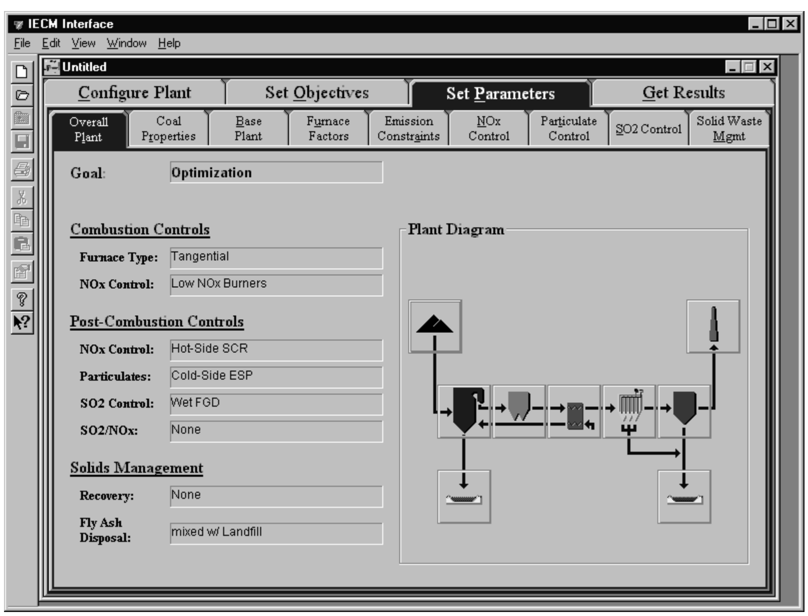
Select Optimization Mode



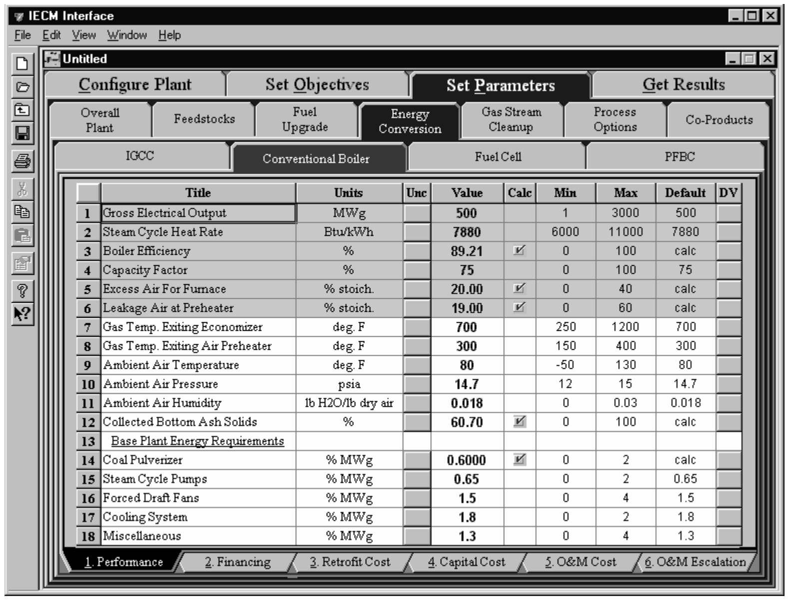
Set Objective and Constraints



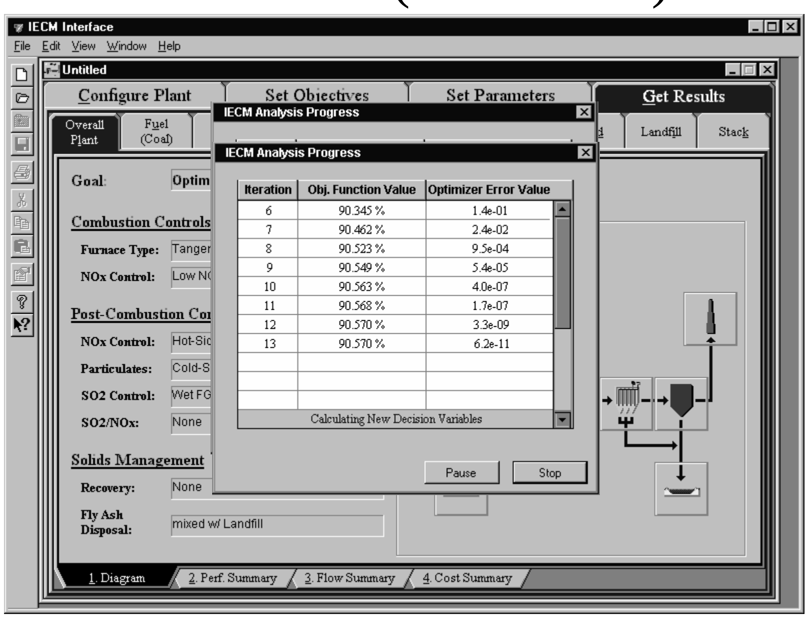
Set Parameter Values



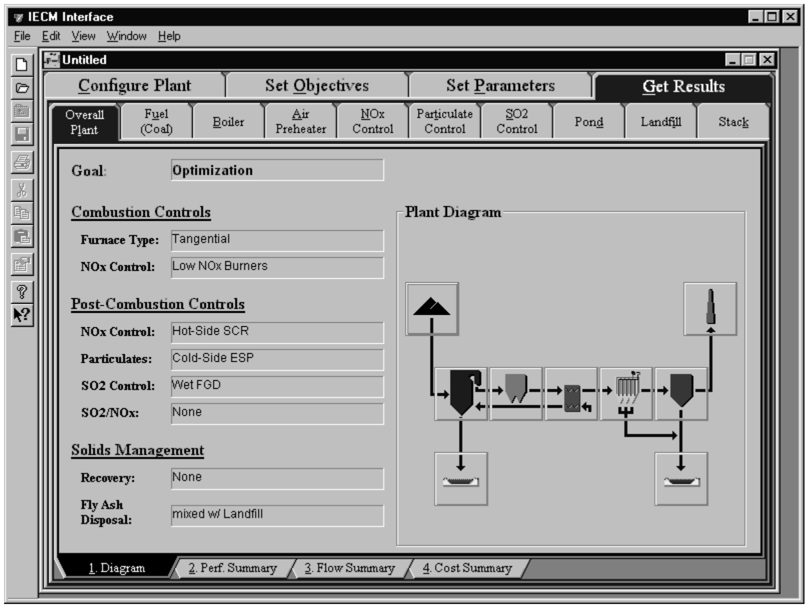
Select Decision Variables



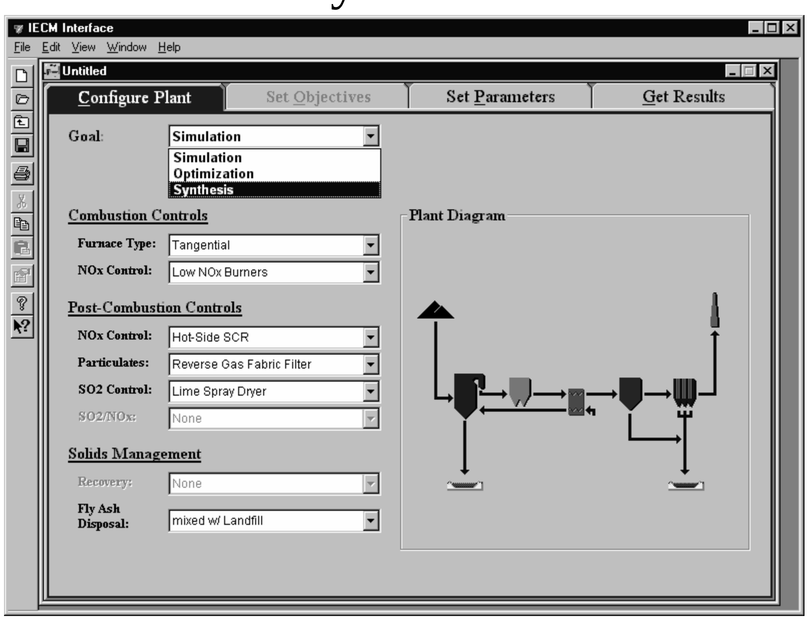
Get Results (Run Model)



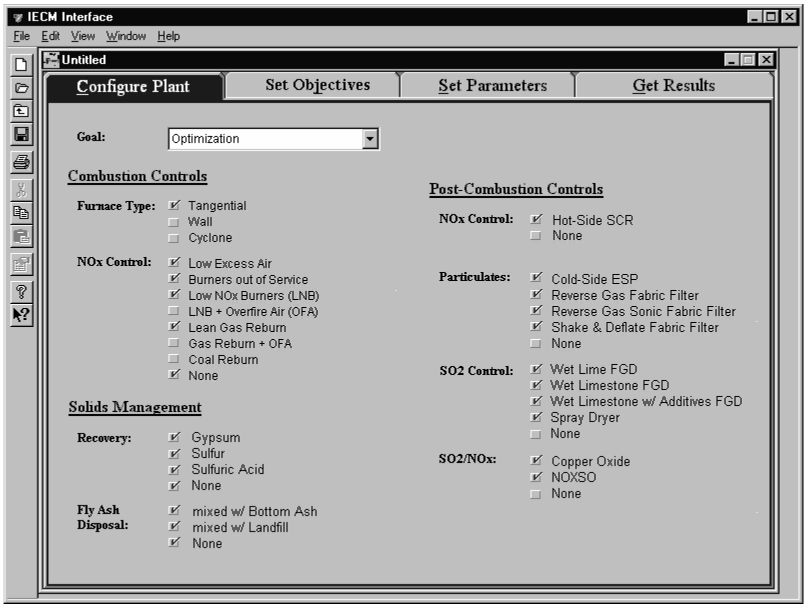
View Results



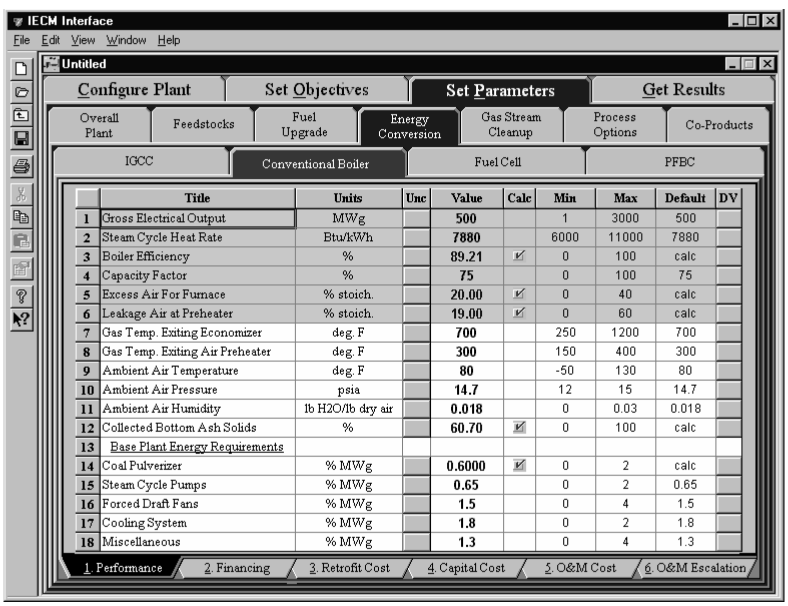
Select Synthesis Mode



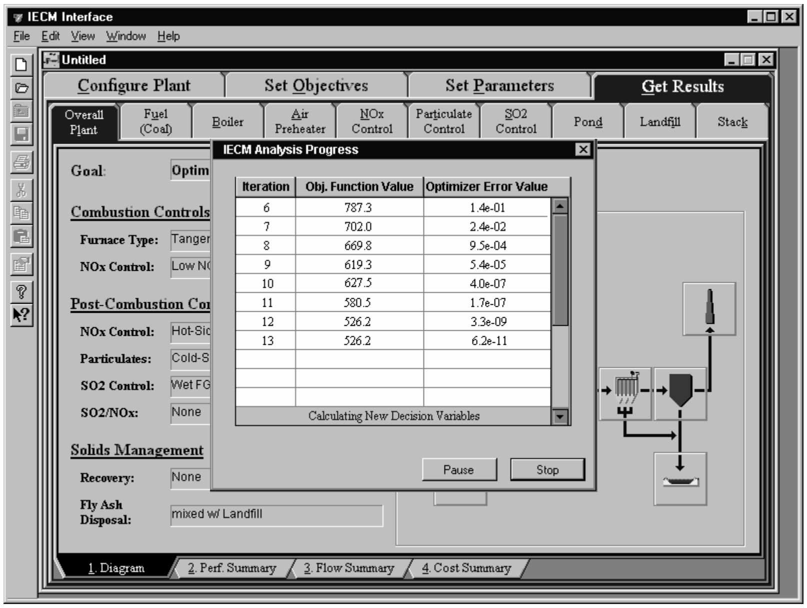
Select Possible Technologies



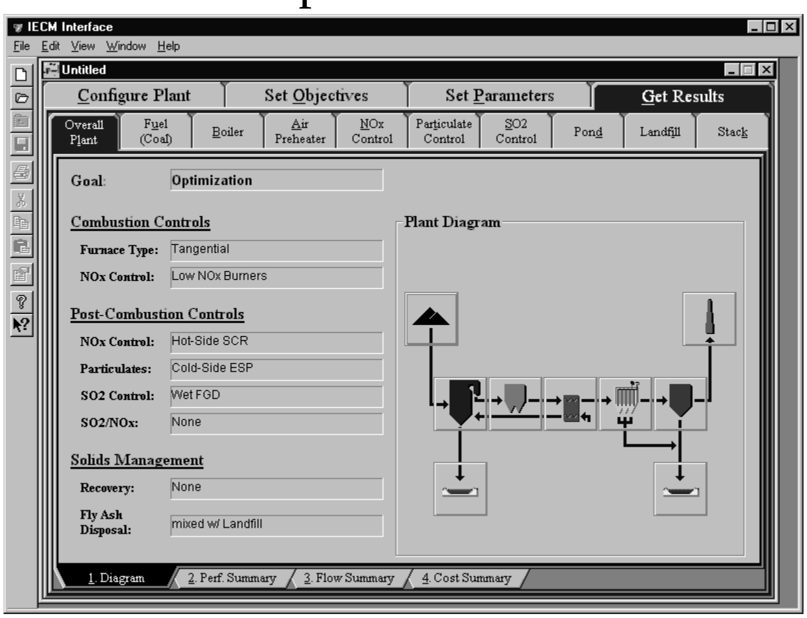
Set Parameters



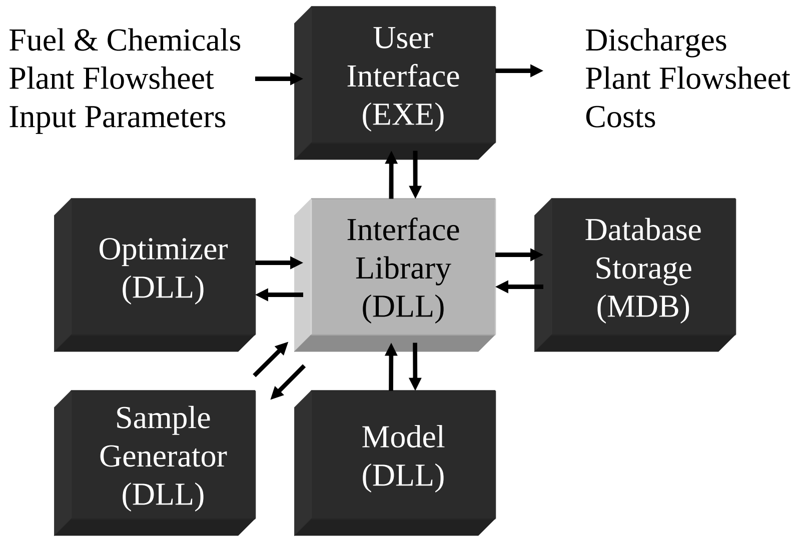
Get Results (Run Model)



View Optimal Flowsheet



Details of the Programming Module Structure



Where Do We Go from Here?

- To enhance the use of the IECM we could:
  - Add new models of environmental control systems and advanced technology options of interest to DOE (both performance and cost)
  - Add new output reports and software features
  - Conduct case studies of specific issues
  - Add process synthesis and optimization capabilities
  - Offer user training programs and user support

Where Do We Go from Here?

- To develop the Vision 21 Planner we would:
  - Implement preliminary versions of enabling technology models (both performance and cost)
  - Use the Vision 21 Planner as a testbed for systems integration development
  - Add process synthesis and optimization capabilities
  - Incorporate dynamics modeling of integrated systems
  - Develop linkages to more detailed models of process components and systems (modeling hierarchy)