OVERVIEW OF PROCESS MODELING ACTIVITIES & CAPABILITIES

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OBJECTIVES

- **Develop reliable and easy-to-use models to estimate the environmental performance and cost of conventional and advanced technologies to produce electricity from coal**
- **Develop a framework for comparing alternative options on a systematic basis**

Objectives- 2

- 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

ADVANCED DESIGN AND ANALYSIS METHODS ARE NEEDED

- **Increasing complexity of advanced processes**
- **Multiple options for component design & selection**
- **Strong interactions among system components**
- **Significant performance and cost uncertainties**

APPROACH

- **Process Technology Models**
- **Engineering Economic Models**
- **Advanced Software Capabilities**
- **Systems Analysis Framework**

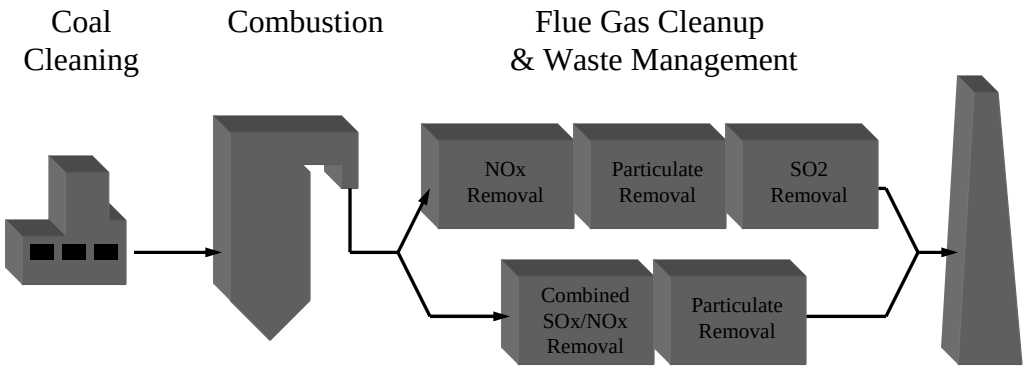
TECHNOLOGIES MODELED AND EVALUATED

- **Integrated Gasification Combined Cycles (IGCC)**
  - **– Air and oxygen blown gasifiers**
  - **– Fixed bed and fluidized bed gasifiers**
  - **– Hot gas and cold gas cleanup systems**
  - **– Byproduct recovery options (e.g., sulfuric acid, Claus plant, direct sulfur reduction process)**
  - **– Other environmental controls (e.g., SCR)**
- **Pressurized Fluidized Bed Combustion (PFBC)**
- **Externally-Fired Combined Cycle (EFCC)**

TECHNOLOGIES MODELED (con't)

- **Pulverized Coal Combustion Plants**
  - **– Selective catalytic reduction (SCR)**
  - **– Wet lime/limestone FGD**
  - **– Lime spray dryer**
  - **– Electrostatic precipitators**
  - **– Fabric filters**
- **Advanced Environmental Control Systems**
  - **– Combined SO_2/NO_x removal**
- **Coal Beneficiation Processes**

INTEGRATED ENVIRONMENTAL CONTROL MODEL (IECM)



PROCESS PERFORMANCE MODELS

- **Calculate detailed mass and energy flows**
- **Employ empirical relationships and models based on available data**
- **Predict component or system efficiency**
- **Predict multi-media environmental emissions**

PROCESS COST MODELS

- **Direct capital cost of major process areas**
- **Total capital cost of system**
- **Variable operating costs**
- **Fixed operating costs**
- **Total cost of electricity**
- **Explicitly linked to process performance model**

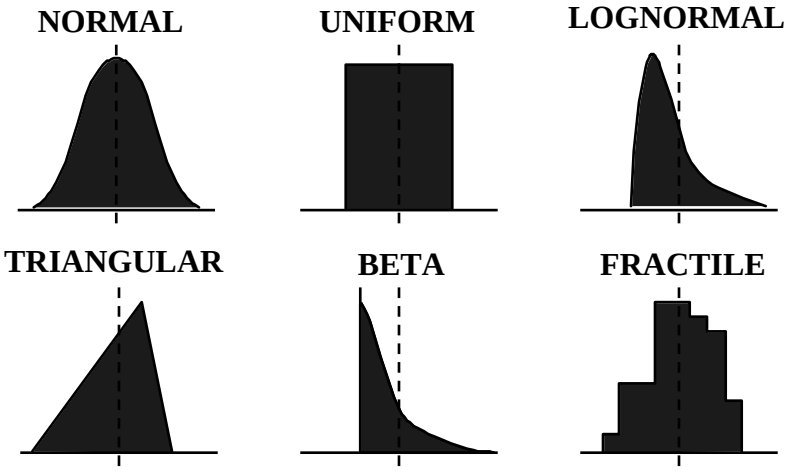
NEW MODELING CAPABILITIES

Process or System	Deterministic	Stochastic
Simulation	√	√
Optimization	√	√
Synthesis	√	√

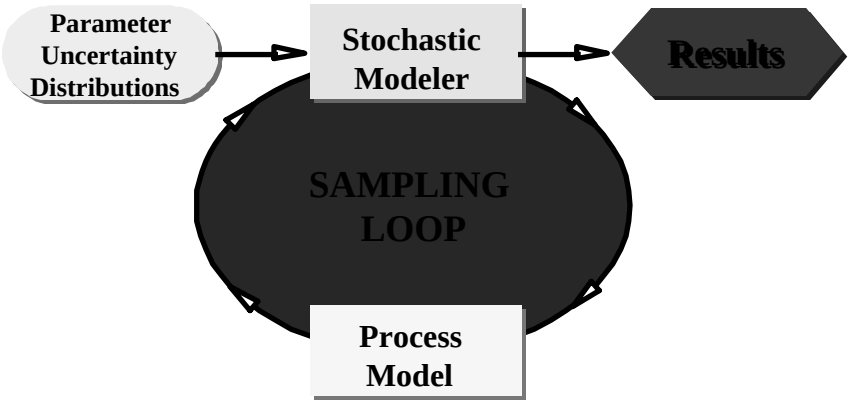
SIMULATION

CONVENTIONAL PROCESS MODELING
(Deterministic Simulation)

PARAMETER UNCERTAINTY DISTRIBUTIONS



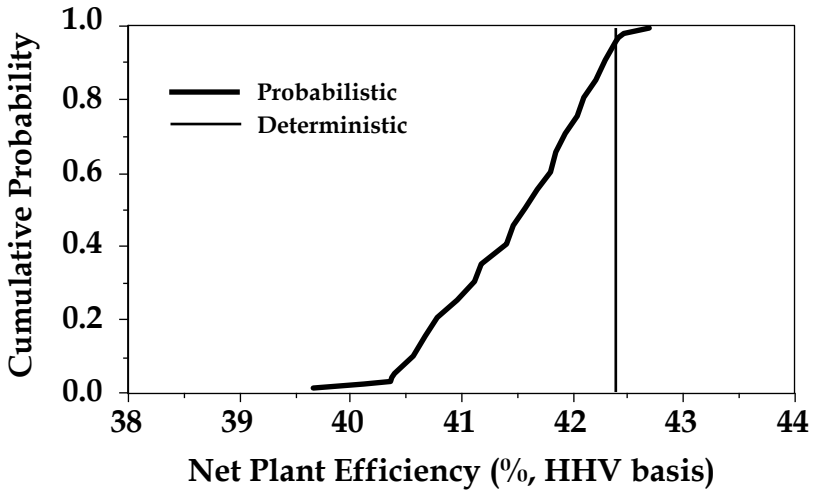
STOCHASTIC SIMULATION



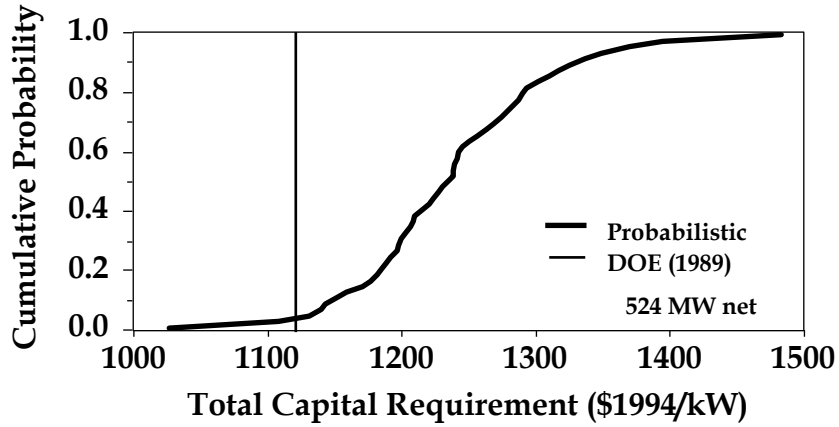
SOME QUESTIONS ADDRESSED BY STOCHASTIC SIMULATION

- **What performance can we expect from this technology (e.g., efficiency, emissions)? What is its expected cost, given current uncertainties?**
- **What is the likelihood of performance shortfalls? Of cost overruns?**
- **What factors or process parameters contribute most to overall uncertainty in performance and cost?**
- **What is the potential payoff of R&D to reduce these key uncertainties and risks?**
- **How does this technology compare to other competing technologies?**

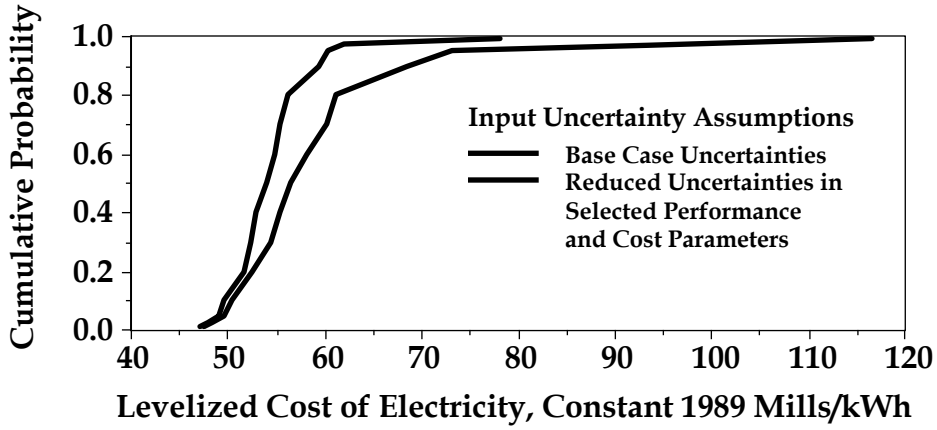
EFCC PLANT EFFICIENCY



SECOND GENERATION PFBC SYSTEM TOTAL CAPITAL COST



VALUE OF TARGETED RESEARCH

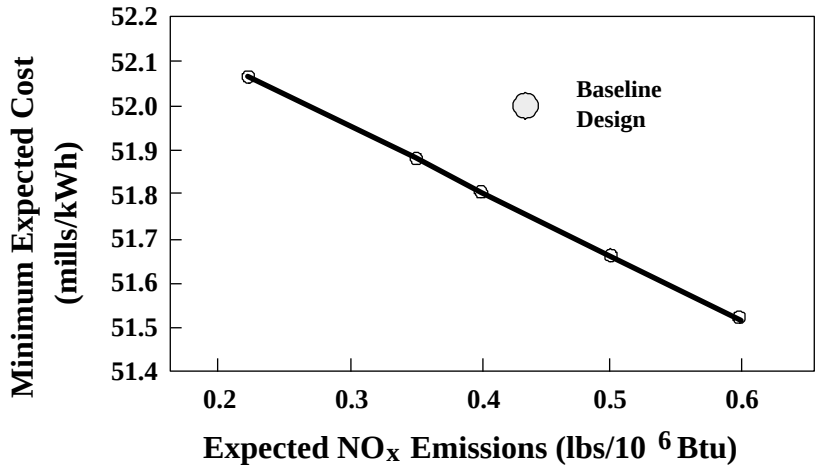


OPTIMIZATION

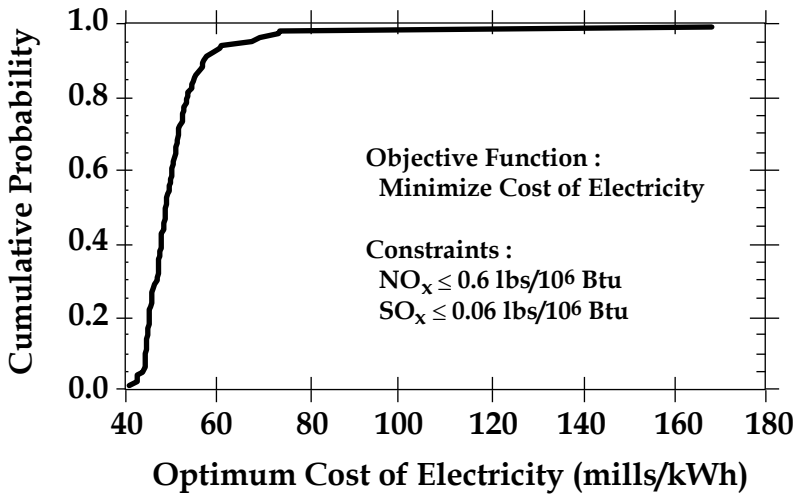
SOME QUESTIONS ADDRESSED BY OPTIMIZATION CAPABILITIES

- **Is there a better choice of parameter values for this process to improve its performance? To lower its cost?**
- **What levels of performance and cost can we expect from an optimized design?**
- **How do uncertainties in process performance and cost variables affect the optimal design?**
- **What design choices will minimize the risk of a performance shortfall? Or the risk of a cost overrun?**

MINIMIZE TOTAL COST SUBJECT TO NO_x EMISSION CONSTRAINT



EFFECT OF UNCERTAINTIES ON OPTIMAL DESIGN COST

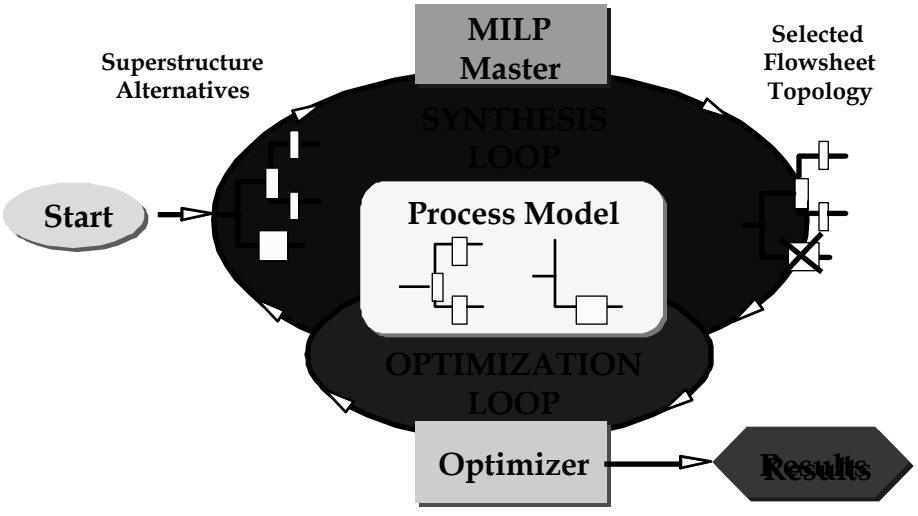


SYNTHESIS

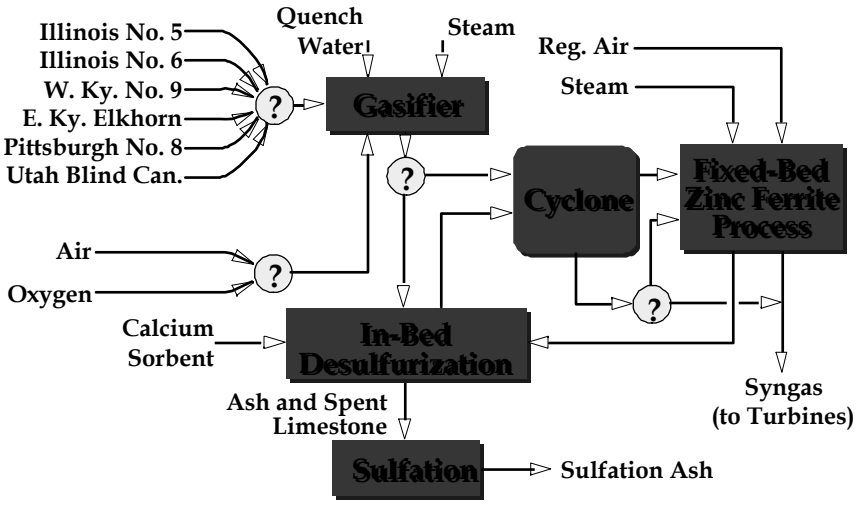
SOME QUESTIONS ADDRESSED BY PROCESS SYNTHESIS CAPABILITIES

- **How should the flowsheet be configured to achieve performance goals at lowest cost?**
- **What are the feasible flowsheet options to meet specified goals and constraints? Which options are not feasible?**
- **What are the cost savings (or performance gains) from moving to a more optimal design?**

PROCESS SYNTHESIS



SYNTHESIS OF IGCC SYSTEM



MODEL APPLICATIONS

- Process design
- Risk analysis
- Cost estimation
- R&D management
- Technology evaluation
- Environmental compliance
- Marketing studies
- Strategic planning