

IGCC Dynamic Simulator & Training Center



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IGCC Dynamic Simulator & Training Center *Outline*

- Motivation
- Collaboratory for Process & Dynamic Systems Research
- IGCC DS&T Center
 - Phase I: Scoping Study
 - Phase II: Detailed Planning
 - Phases III-VI: Development and Deployment
- Summary



IGCC DS&T Center



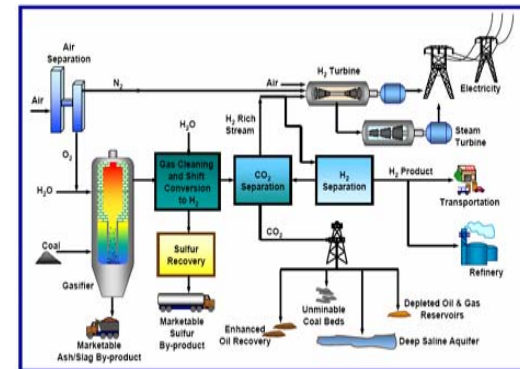
IGCC Dynamic Simulator & Training Center

Motivation

- IGCC emerging as technology of choice for next-generation coal-fired power plants
 - Commercial alliances for “one-stop” IGCC solutions
 - Recent plant announcements
 - Core of DOE’s FutureGen plant
- Rapidly growing demand for experience with IGCC analysis, operation, and control



IGCC Power Plant



FutureGen Plant

IGCC Dynamic Simulator & Training Center

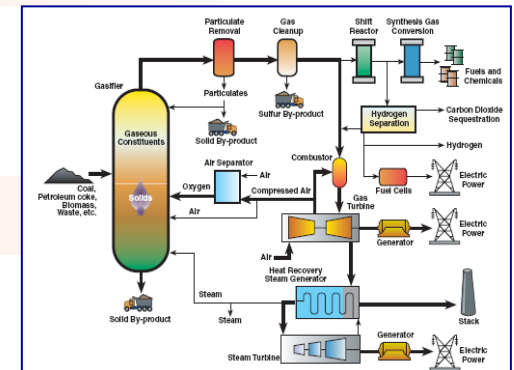
Motivation – Why NETL?

- Only DOE national lab dedicated to fossil energy
- Supports major NETL technology programs and in-house R&D focus areas
 - Gasification, FutureGen, Advanced Research
- Supports NETL training mission
 - Provides a trained workforce for the energy industry of the future
 - Promotes R&D and educational initiatives at U.S. universities to advance energy science/technology
- Aligned with mission of NETL's Collaboratory for Process & Dynamic Systems Research



Collaboratory for Process & Dynamic Systems Research *Overview*

- Goals and Objectives
 - Conduct world-class collaborative R&D in process systems engineering for fossil energy (FE) applications
- R&D Focus Areas
 - High-Fidelity Systems
 - **Dynamic Systems**
 - Systems Optimization
- FE Application Areas
 - **Integrated gasification combined cycles**
 - FutureGen power and hydrogen plant
 - Polygeneration plants
 - Fuel cell/gas turbine hybrids



IGCC Power Plant



Collaboratory for Process & Dynamic Systems Research

- **Director**

- Dr. Stephen E. Zitney, Office of Research & Development, NETL

- **Lead Principal Investigator (PI)**

- Prof. Richard Bajura, Director, National Research Center for Coal & Energy (NRCCE), WVU

- **Co-PIs**

- Prof. Lorenz Biegler (CMU, ChE)
- Prof. I. Grossmann (CMU, ChE)
- Prof. Edward Rubin (CMU, MechE)
- Prof. Richard Turton (WVU, ChE)
- Prof. B. Erik Ydstie (CMU, ChE)

- **Projects**

- **Development of IGCC Dynamic Simulator & Training Center (TBD - WVU/NRCCE)**
- Development of a Multi-Purpose Dynamic IGCC Model for an Energy-Intensive Industry Cluster (Prof. Turton - WVU)
- Plant-wide Control and Real-Time Optimization of IGCC Power Plants (Prof. Ydstie - CMU)
- Integrated APECS Optimization Strategies for Zero-Emission Power Plants (Prof. Biegler - CMU)
- APECS R&D for Fossil Energy Systems (TBD – WVU/NRCCE)
- Aspen-based Performance and Cost Models for Power Systems Analysis (Prof. Rubin - CMU)



Carnegie Mellon



University of Pittsburgh



West Virginia University

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IGCC DS&T Center



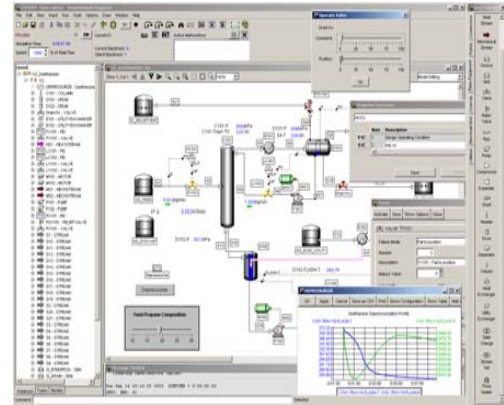
NETL Collaboratory



IGCC Dynamic Simulator & Training Center

Project Goals

- Develop full-scope, high-fidelity, generic IGCC dynamic simulator
- Establish Dynamic Simulator & Training (DS&T) Center



IGCC Dynamic Simulator



IGCC DS&T Center



IGCC Dynamic Simulator & Training Center

Major Project Phases

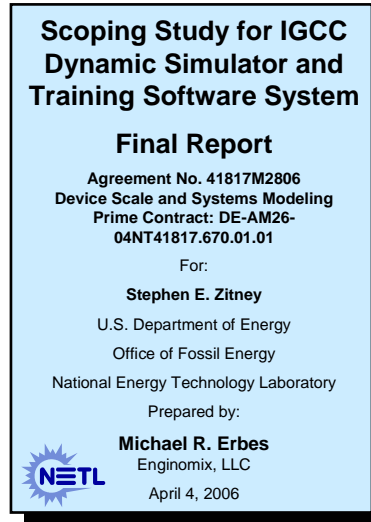
- Phase I – Scoping Study (Complete)
- Phase II – Detailed Planning (Year 1 CPDSR Project)
- Phase III – IGCC Dynamic Simulator Development
- Phase IV – Acceptance Testing/Deployment at DS&T Center
- Phase V – Establishment/Ongoing Support of DS&T Center
- Phase VI – Deployment of Custom IGCC Simulators

	CY05				CY06				CY07				CY08				CY09			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Phase I																				
Phase II																				
Phase III																				
Phase IV																				
Phase V																				
Phase VI																				



Phase I - Scoping Study *Overview*

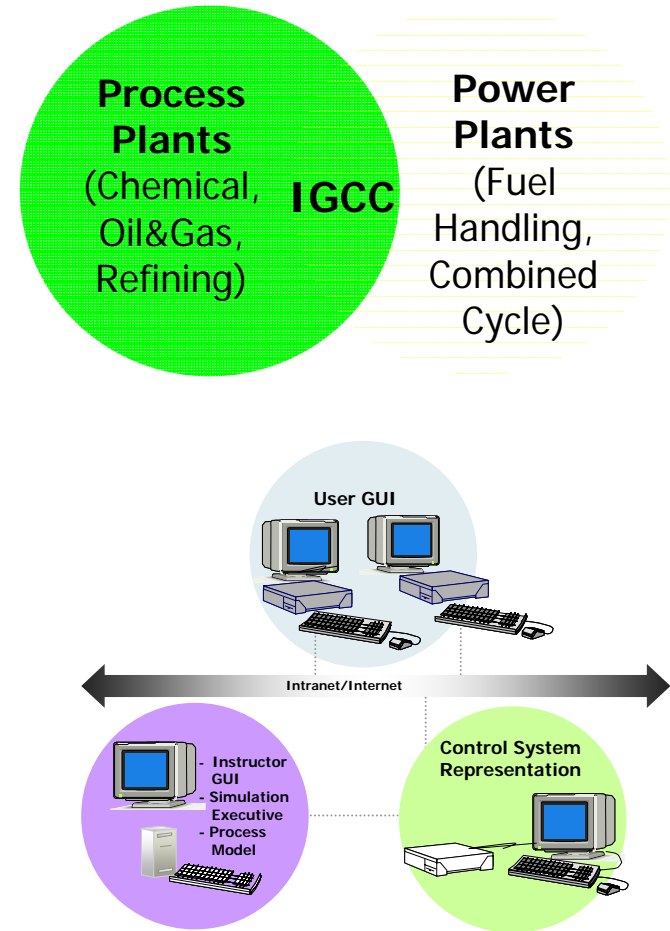
- **Timeframe**
 - October 2005 – April 2006
- **Sponsor**
 - NETL Gasification Program
- **Participants**
 - Michael R. Erbes (Enginomix)
 - Stephen E. Zitney (NETL)
- **Major Accomplishments**
 - Defined simulator requirements and features
 - Evaluated potential operator training system (OTS) frameworks and suppliers
 - Identified DS&T Center requirements and goals
 - Visited AEP and EPRI simulator training centers
 - Developed plan for R&D/industry collaborations
 - Determined initial milestones, deliverables, schedule, priorities, risks, and staffing/resource/cost estimates



Simulator Requirements

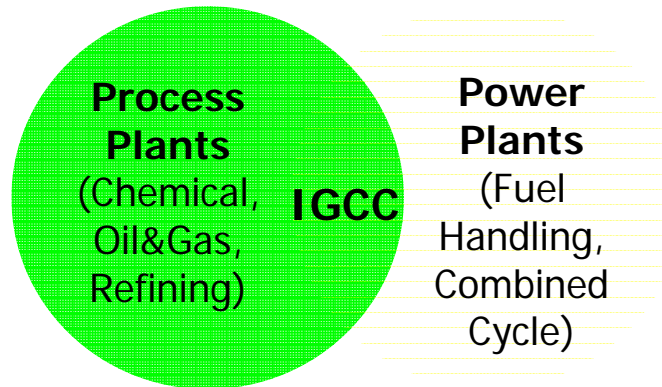
Overview

- Generic, real-time, high-fidelity, dynamic IGCC model (Process + Power)
- Full-scope OTS capabilities
- Full DCS emulation
- Unified platform for model building and training
- Suitable for engineering studies
- Ease-of-use for process/control system modeling
- Extendable to FutureGen and polygeneration plants



Simulator Requirements

Process and Power Modeling Scope



- **Gasifier**
 - Slurry and dry feed technologies
- **Air Separation Plant**
- **Gas Cooling & Cleanup**
- **Combined Cycle**
- **Fuel Handling**

Simulator Requirements

Dual Primary Goals

- **Full-Scope Operator Training Capabilities**
 - Malfunctions, Trips & Alarms
 - Scenarios, Trending & Snapshots
 - Startup/Shutdown
 - Load Following, Load Shedding
 - Response to fuel and ambient variations
- **Suitable for Engineering and Systems Studies**
 - Analyzing control strategies (turbine lead, gasifier lead)
 - Leverage existing NETL technology & models
 - Aspen Plus, Dynamics, and Custom Modeler
 - Evaluating new technologies
 - Integration of fuel cells
 - Carbon capture and storage
 - Alternate gasifier technologies
 - Advanced cleanup technologies



Simulator Requirements

- **NETL Collaboratory**

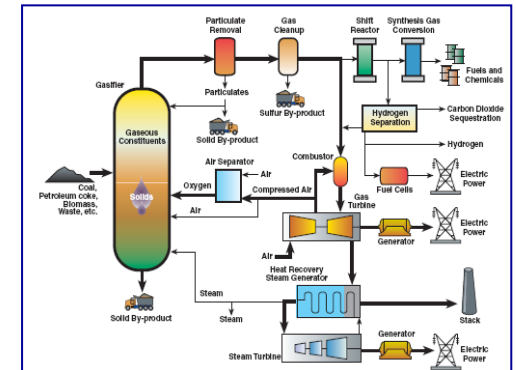
- Multiple users across various groups
- Different levels of expertise
- Educational and research missions



NETL Collaboratory

- **Generic IGCC Plant Modeling**

- Not based on existing IGCC plant or control system
- Process and control logic to be designed as part of project



IGCC Power Plant

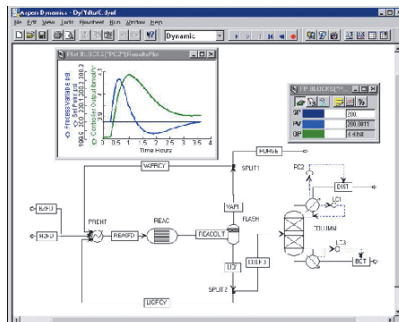


Simulator Frameworks

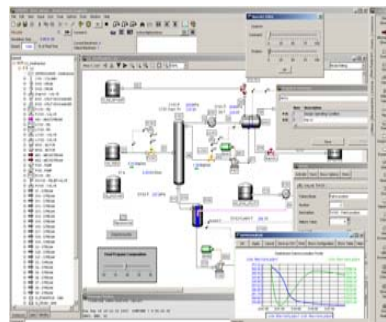
- Major dynamic simulator frameworks evaluated as part of scoping study included:
 - 3KeyMaster (Western Services)
 - Aspen Dynamics (AspenTech)
 - DynSim (SimSci-Esscor)
 - ProTrax (Trax)
 - SimSuite (GSE Systems)
 - UniSim (Honeywell)



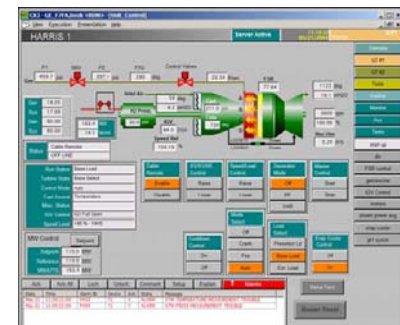
SimSuite at AEP



Aspen Dynamics



DynSim



3KeyMaster



IGCC Training Center *Requirements*

- **Location**
 - National Research Center for Coal & Energy
 - West Virginia University, Morgantown, WV
- **Demo and Training Services**
 - IGCC plant operation and control demos
 - IGCC plant familiarization training
 - Computer-based training program
 - “Train the Trainer” program
- **Staffing Resources**
 - R&D Manager, IGCC DS&T Center
 - Trainers and support staff
- **Hardware Resources**
 - Standard Windows-based PCs
 - Instructor station, display units, and cabinets



WVU's NRCCE



IGCC DS&T Center

Key Project Deliverables

- IGCC Full-Scope Simulator
- Systems Training Materials
- Integrated Operating Instructions
- Computer-Based Training Program
- Intelligent Tutoring System
- IGCC Power Plant Familiarization Course



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NETL Collaboratory



Phase II – Detailed Planning

Overview

- **NETL Collaboratory project**
 - Funding: ~\$450K
 - Start Date (Duration): September 2006 (1 Year)
 - Staffing Resources
 - PI, R&D Manager, IGCC DS&T Center, TBD (WVU, NRCCE)
 - Co-PI, Process & Dynamic Systems, Dr. S. Zitney (NETL)
 - Consultant, IGCC Simulation, Dr. M. Erbes (Enginomix)
 - Consultant, Dynamic Simulation, Prof. L. Biegler (CMU)
 - Consultant, Process Control, Prof. E. Ydstie (CMU)
- **Collaborators**
 - EPRI and other industry participants



Phase II – Detailed Planning

Primary Tasks

- **Project Planning**
 - Develop detailed project milestones, deliverables, budget, and schedule
 - Select software/services vendor
- **Simulator Planning**
 - Determine scope of “generic” IGCC process
 - Generate detailed process and control system design
 - Prepare detailed simulator specification
- **IGCC DS&T Center Planning**
 - Hire R&D manager
 - Develop detailed R&D and training services plan
 - Initiate acquisition of hardware/software infrastructure
- **Collaboration Planning**
 - Define scope of technology R&D collaborations
 - Establish industry experts group



Phase II – Detailed Planning

Data Typically Provided to OTS Vendor

- **Systems and process descriptions**
 - Collaboration with EPRI & other technology partners
- **Equipment specifications & data sheets, P&ID's**
- **DCS graphics, control algorithms, control configuration, logic diagrams**
- **Process flow diagrams, steady-state simulation data (at varying loads & ambients)**
- **Process operating procedures**
- **Lists of upsets/malfunctions to be simulated**



Industry Experts Group

Requirements

- **Promote collaboration between project team and industry**
- **Provide feedback to ensure project team is meeting industry's needs**
- **Promote awareness to power and energy industry**
- **Target members from:**
 - Electric utilities
 - Engineering, procurement & construction (EPC) firms
 - Gasifier suppliers
 - Research institutes
 - Academic researchers



IGCC Dynamic Simulator & Training Center

Phases III-VI

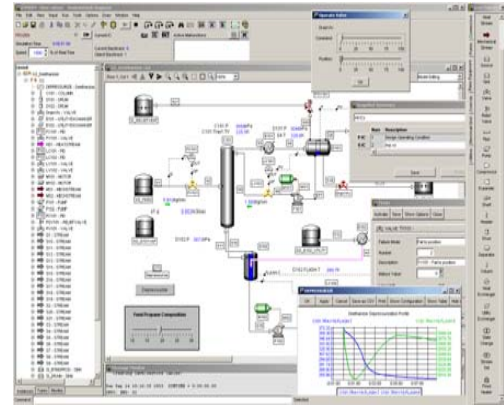
- **Phase III: Development of Simulator**
- **Phase IV: Acceptance Testing/Deployment**
- **Phase V: Establishment of IGCC DS&T Center**
 - Ongoing simulator verification/validation support
 - Establish IGCC DS&T Users Group
- **Phase VI: Development and Deployment of Custom IGCC Site-Specific Simulators**
 - Custom simulators built on well-tested technology
 - Potential significant reduction in time, cost, and technical risk for site-specific IGCC simulators



IGCC Dynamic Simulator & Training Center

Project Summary

- Full-scope, high-fidelity, generic IGCC simulator
- Dynamic Simulator & Training (DS&T) Center
- NETL Collaboratory
- R&D collaborations
 - Operator training system (OTS) vendor
 - EPRI, ...
- Industry participation
 - CoalFleet, ...
 - Custom simulators
- Potential extensions
 - FutureGen
 - Polygeneration, ...



IGCC Dynamic Simulator



IGCC DS&T Center



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Thank You!

- **For additional information, please contact:**
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