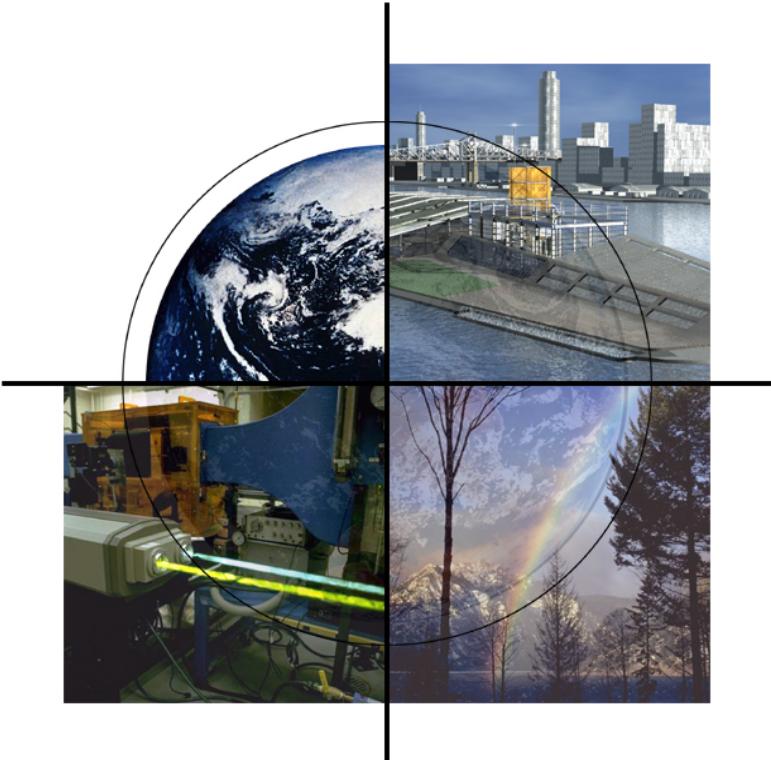


IGCC Dynamic Simulator & Training Center



Stephen E. Zitney

**National Energy Technology Laboratory
Morgantown, WV**

stephen.zitney@netl.doe.gov

Michael R. Erbes

Enginomix, LLC

michael.erbes@enginomix.net

**Gasification Technologies 2006 Conference
Washington, D.C. October 1-4, 2006**



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



NETL Collaboratory



IGCC DS&T Center



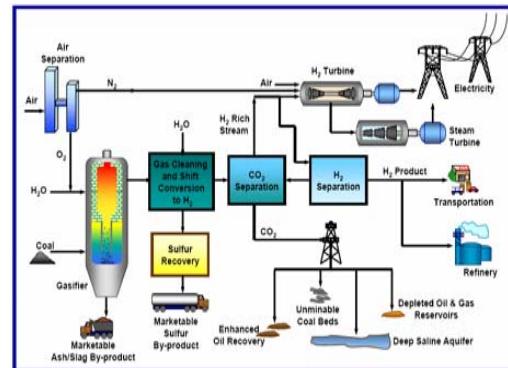
IGCC Dynamic Simulator & Training Center

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?

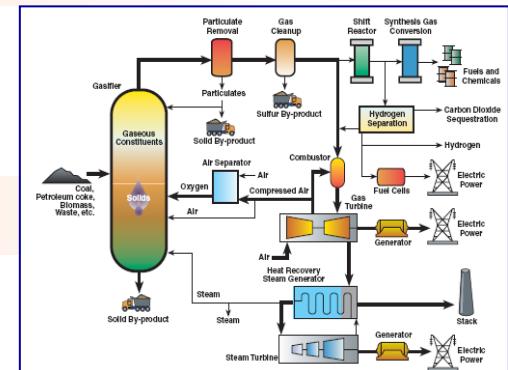
- Only DOE national lab dedicated to fossil energy
- Supports major NETL technology programs and in-house R&D focus areas
 - **Gasification**, FutureGen, Advanced Research
- Supports NETL training mission
 - Provides a trained workforce for the energy industry of the future
 - Promotes R&D and educational 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

Zitney – GTC, October 1-4, 2006

IGCC Dynamic Simulator & Training Center

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IGCC DS&T Center



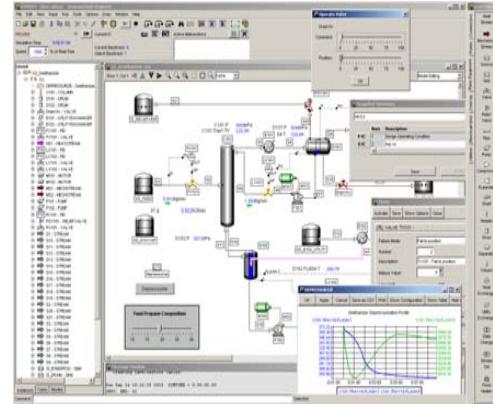
NETL Collaboratory



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

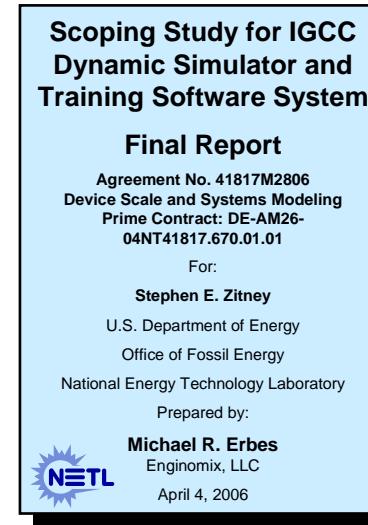
Major Project Phases

- 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																
Phase I																				
Phase II																				
Phase III																				
Phase IV																				
Phase V																				
Phase VI																				

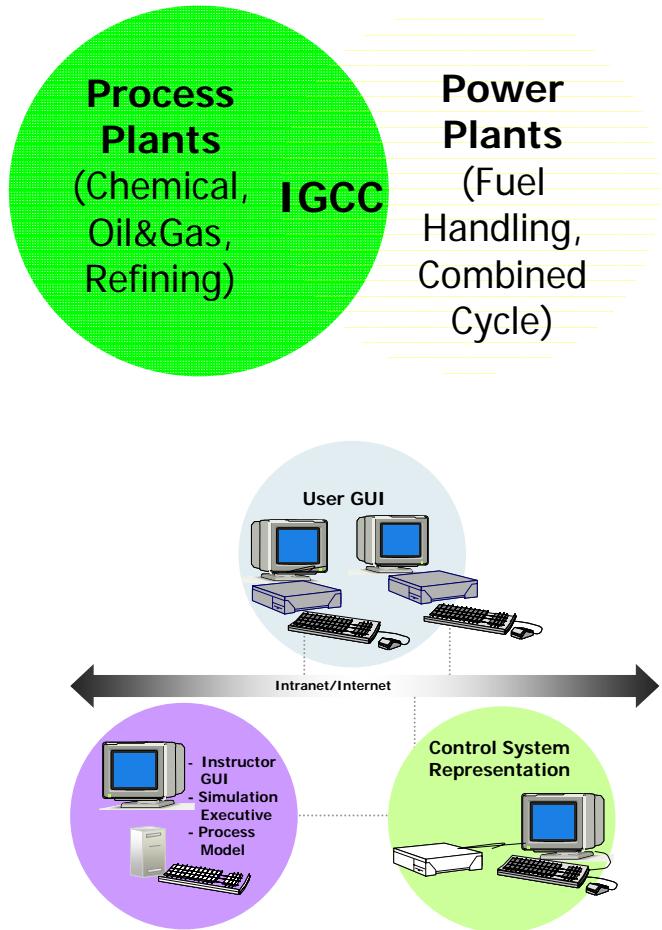
Phase I - Scoping Study Overview

- **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



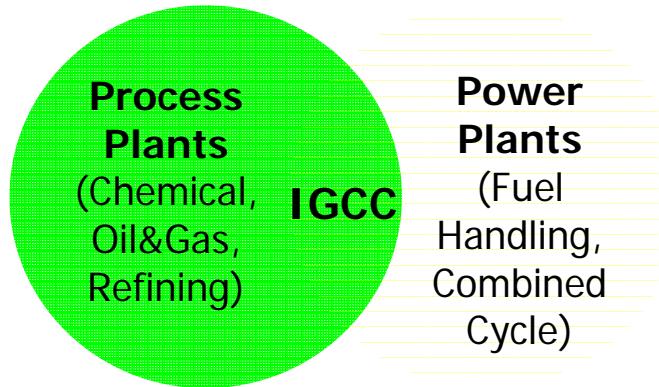
Simulator Requirements Overview

- 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

Ease-of-Use and Integrated Modeling Framework

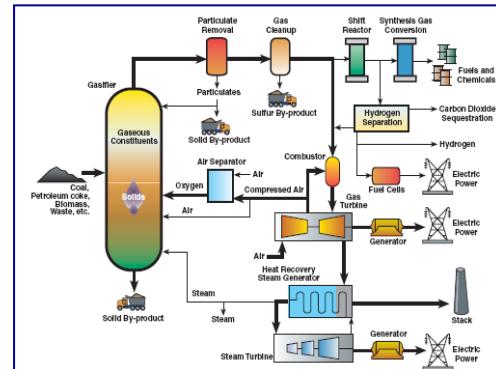
- **NETL Collaboratory**

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



- **Generic IGCC Plant Modeling**

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



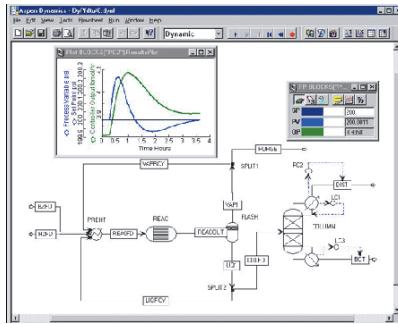
IGCC Power Plant

Simulator Frameworks

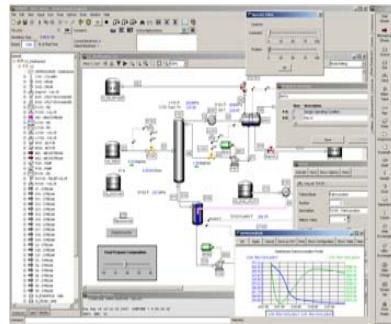
- Major dynamic simulator frameworks evaluated as part of scoping study included:
 - 3KeyMaster (Western Services)
 - Aspen Dynamics (AspenTech)
 - DynSim (SimSci-Esscor)
 - ProTrax (Trax)
 - SimSuite (GSE Systems)
 - UniSim (Honeywell)



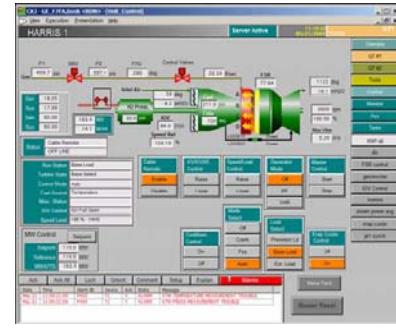
SimSuite at AEP



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

IGCC Dynamic Simulator & Training Center

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IGCC DS&T Center



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

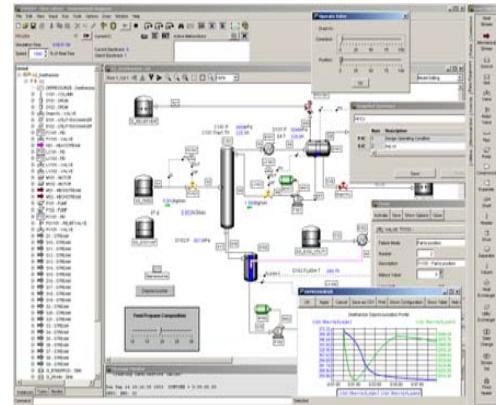
Phases III-VI

- **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

IGCC Dynamic Simulator & Training Center

Thank You!

- **For additional information, please contact:**
 - Stephen E. Zitney, NETL
 - EML: stephen.zitney@netl.doe.gov
 - TEL: 304-285-1379
 - Michael R. Erbes, Enginomix
 - EML: michael.erbes@enginomix.net
 - TEL: 650-289-0670 x1

