



## **Advanced Virtual Energy Simulation Training And Research (AVESTAR™) Center**

**CACHE Trustees  
Meeting**

**Nashville, TN**

**June 2-3, 2011**

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# AVESTAR™ Center

## Advanced Virtual Energy Simulation Training And Research

- R&D, training, and education for the operation and control of advanced energy systems with CO<sub>2</sub> capture and storage (CCS)
- Real-time dynamic simulators with Operator Training System (OTS) capabilities
- 3D virtual Immersive Training Systems (ITS)
- IGCC plant with CO<sub>2</sub> capture
  - Deployment: OTS:3/2011; ITS:8/2011
- Major Project Partners

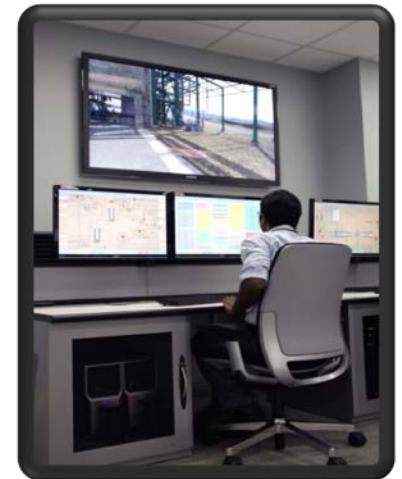


- Industry Collaborators



### Benefits

- OTS for normal and faulted operations as well as plant start-up, shutdown, and load following/shedding
- ITS for added dimension of plant realism
- OTS/ITS for training both control room and plant field operators, promoting teamwork
- Work force development in IGCC plant and CO<sub>2</sub> capture operations
- Advanced R&D in process dynamics, model predictive control, sensors, RT optimization, 3D virtual plants, and more
- Collaboration with advanced energy experts



# IGCC Dynamic Simulator/OTS

## *Capabilities and Features*



- **Simulator Scope**

- Process: “Gasification with CO<sub>2</sub> Capture”
- Power: “Combined Cycle”
- 20 major plant areas plus electrical
- Fuels: Coal, Biomass, Petcoke

- **Model Fidelity**

- High fidelity models for key plant areas (e.g., gasifier, AGR, GT)
- Capture major transients

- **Model Performance**

- Slow (0.5X), real-time, fast (2.5X)
- Multiple dynamic engines running in parallel

- **OTS Features**

- Operator training HMI
- Normal base-load operations
- Startup, shutdown, fuel switchovers, load following
- Faulted operations
  - 200 process malfunctions
  - 30 major malfunctions or accident investigations (ITS)
- Instructor capabilities
  - Scenarios, trending, snapshots
- 600 remote functions (ITS)

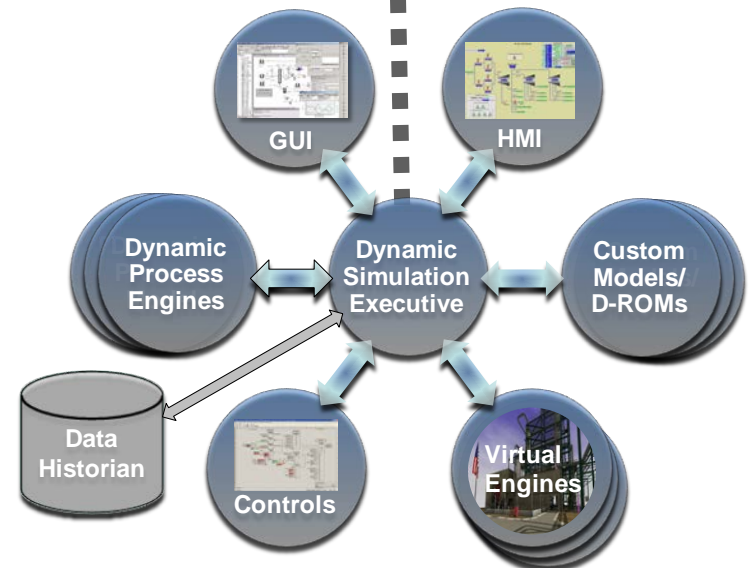
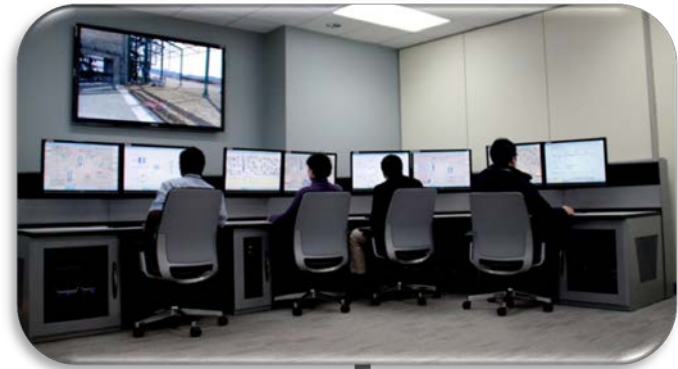
- **Controls**

- DCS control emulation
- Coordinated control

# IGCC Dynamic Simulator/OTS

## Software – Invensys Operations Management

- **Dynsim™**
  - Gasification and CO<sub>2</sub> capture through gas turbine
  - Process controls and ESD logic
- **Dynsim Power™**
  - Steam cycle
- **InTouch™**
  - Human machine interface (HMI)
  - “Look and feel” of plant DCS operator interface
- **EYESim™**
  - Virtual engines for ITS
- **Sim4Me®**
  - Executive for integration of dynamic engines
  - Distribution of engines across CPUs for real-time performance



# IGCC Immersive Training System/ITS

## *Capabilities and Features*

- **3D Virtual Plant Model**

- 3D computer-aided design (CAD)
- 3D stereoscopic visualization model
- Plant photographs for photorealism



- **3D Immersive Interaction**

- Avatar represents field operator
- Navigation using game pad
- Single operator
  - 3D visor with head tracking
- Multiple operators
  - Projector with 3D glasses



# IGCC Immersive Training System/ITS

## *Capabilities and Features*

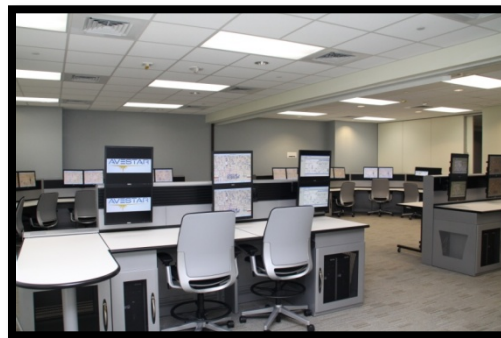
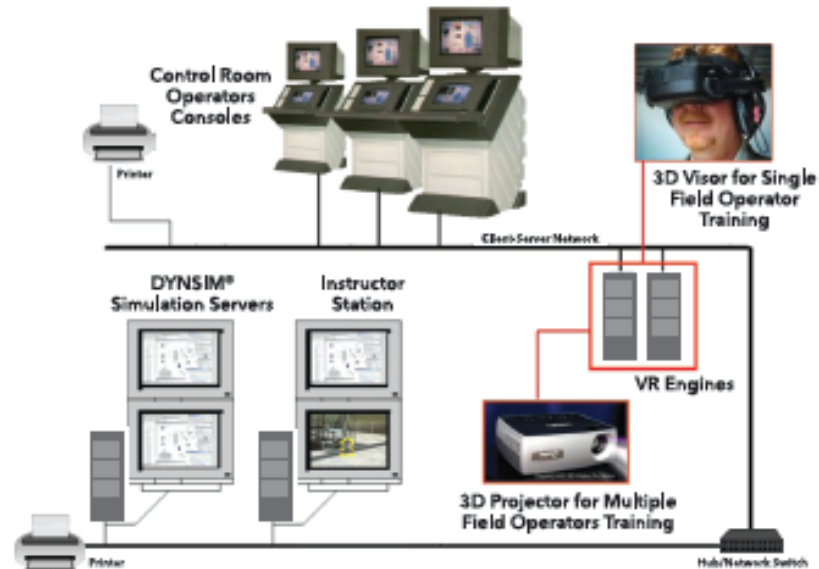
- **3D Real-time Content/Interactions**
  - Realistic response to operator actions
  - Remote field functions
    - e.g., hand valves, pump switches
  - Collision geometry and sound
  - Popup trends (variables vs. time)
  - Transparent equipment objects
    - e.g., tank levels
  - Highlighted virtual content/scenarios
    - Gasifier
      - Hot spots, plugging
    - CO<sub>2</sub> capture
      - Distillation column operation for CO<sub>2</sub> absorber
    - Power generation
      - Gas turbine combustion modes



# OTS/ITS Solution and Infrastructure

## Software and Hardware Integration

- Software integration
  - Real-time executive
  - Dynamic simulator/OTS
  - HMI displays
  - Virtual reality (VR)/ITS
- Hardware integration
  - Local area network
  - OTS/HMI
    - 8 operator computers
    - 20 dynamic engines
  - ITS
    - 2 computers
    - 2 virtual engines
  - Instructor stations
    - 4 computers
  - Engineering stations
    - 2 computers



Operator Training System (OTS)  
Control Room at NETL



Immersive Training System (ITS)  
3D Virtual Plant Room at NETL

# IGCC Training Program

- **Training Courses**

- IGCC Operations; Gasification, Combined Cycle, and CO<sub>2</sub> Capture Operations

- **Target Audience**

- Electric power providers
  - Research/process engineers, plant engineers, control room and field operators, shift supervisors
- Engineering & construction firms
- Equipment vendors
  - Gasifier, CO<sub>2</sub> capture, and turbine suppliers
- Research, consulting, and training entities
- U.S. DOE national laboratories
- Universities
  - Students, professors, chemical engineers, control engineers
- Others interested in learning more about IGCC plant operations and control



# AVESTAR Center Advanced R&D

- **High-fidelity dynamic modeling/simulation**
  - Gasification, CO<sub>2</sub> capture, Turbines
  - Partial differential equation (PDE) models
  - Computational fluid dynamics (CFD)
  - Dynamic reduced order models (ROMs)
- **Sensors and control**
  - Model predictive control
  - Sensor placement
- **Real-time optimization**
- **Virtual plant simulation**
  - Immersive training
- **Operator training and education**

