



**University of  
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## **AVESTAR™ Center for Operational Excellence of Electricity Generation Plants**



[www.netl.doe.gov/avestar](http://www.netl.doe.gov/avestar)

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**Advanced Virtual Energy Simulation Training and Research**

**U.S. Department of Energy**

**National Energy Technology Laboratory**



# AVESTAR™ Center

## Advanced Virtual Energy Simulation Training And Research



- **Motivation**

- Clean energy plants are large, highly-integrated, power and process systems requiring safe, reliable, and efficient operation and control
  - Normal baseload operations, as well as plant startup and shutdown
  - Process and market disturbances (e.g., varying CO<sub>2</sub> capture rates)
  - Feedstock co-firing and switchovers; cycling; load following
  - Faulted operations and rare abnormal situations
- Renewable generation increases need for cycling and load following, while minimizing derates, emissions, and equipment damage
- Changing demographics and rapidly evolving technologies necessitate training the next generation of engineering and operations professionals

- **Mission**

- Accelerate progress toward achieving *Operational Excellence* for *Clean Energy Plants*
  - 1) Asset, 2) Control, 3) Environment & Safety, and 4) People

# AVESTAR™ Center

*Advanced Virtual Energy  
Simulation Training And Research*



- **Simulation-based Technology and Tools Development**

- Develop portfolio of virtual energy plant test beds
  - High-fidelity real-time dynamic simulators
  - Full-scope operator training systems (OTSs)
  - 3D virtual immersive training systems (ITSSs)



- **Collaborative Research**

- Bring together dynamic simulation/control technology, state-of-the-art facilities, and leading energy experts
- Conduct collaborative research on plant dynamics, automation, controls/sensors, real-time optimization, virtual plants, smart manufacturing, and modern grid



- **Training and Education**

- Train industry workforce and educate engineering students using hands-on, simulator-based experiential learning





# IGCC Power Plant with CO<sub>2</sub> Capture

- **Dynamic Simulator/Operator Training System**

- Simulator: Gasification/CC; High-Fidelity, Real-Time (DYNSIM®)
- Feedstocks: Coal, Petcoke, and Biomass; Co-firing, Switchovers
- OTS: HMI Displays (InTouch®), Alarms, Malfunctions, Trends
- Controls: Regulatory (PID), Coordinated (Gasifier/Turbine Lead)
- Operations: Baseload, Startup, Grid Synchronization, Shutdown, Cycling, Load Following, Abnormal Situation Handling

- **3D Virtual Immersive Training System (EYESIM®)**

- Avatar/Field operator; Navigation w/ game pad; Remote functions
- Animations/Sound; Trends; Web pages; Transparent equipment
- Malfunctions; Plant familiarization and walkthroughs
- OTS/ITS for training control room and plant field operators

- **Development Partners**



- **Industrial Collaborators**



Avatar



Valve



Pump



Trend



Column



Gasifier



Gas Leak



Fire

# AVESTAR Future Directions

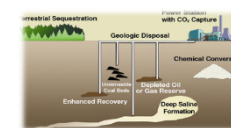
- **Dynamic Simulators**
  - Natural Gas Combined Cycle (NGCC)
  - Supercritical Once-Through (SCOT) Pulverized Coal
- **Virtual Carbon Capture Center (VCCC)**
  - Integrate, test, and optimize operation and control of CO<sub>2</sub> capture technologies with baseline power plants
- **Carbon Capture, Utilization, and Storage (CCUS)**
  - CO<sub>2</sub> Pipeline/Transport, CO<sub>2</sub> Utilization, CO<sub>2</sub> Injection
- **Shale Gas Processing Facilities**
  - Cryogenation, Fractionation (C3/4/5), and Cracking
- **Smart/Advanced Manufacturing**
  - Virtual test beds for SMLC
- **Smart/Modern Grid**
  - Integrated Clean Energy Plants, Renewable Generators, and Energy Storage



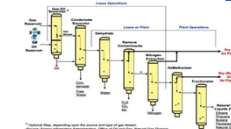
DOE National Carbon Capture Center



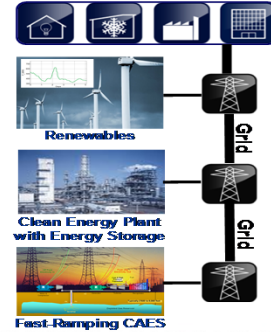
CCUS



Shale Gas Processing



Smart/Modern Grid Loads/Demands



Fast-Ramping CAES





# **AVESTAR™ Center**

## ***Concluding Remarks***

- **Clean energy plants with CCUS require effective operation of large, highly-integrated, power+process systems**
- **Modern grid with renewable generators increases need for cycling and load-following with faster ramp rates**
- **Changing demographics and rapidly evolving technologies necessitate training the next generation of engineering and operations professionals**
- **High-fidelity dynamic simulators with OTSs and 3D virtual ITSs are well suited for training, education, and R&D**
- **AVESTAR Center brings together simulation technology, modern facilities, and leading energy experts**
- **AVESTAR Center accelerates technology transfer and progress toward achieving operational excellence for electricity energy plants**

## Thank You / Questions?

For more information on AVESTAR's simulators, facilities, training, education, and R&D, please visit us at [www.netl.doe.gov/avestar](http://www.netl.doe.gov/avestar) or contact us at [avestar@netl.doe.gov](mailto:avestar@netl.doe.gov).

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