the ENERGY lab

PROJECT FACTS

Gasification Systems

Advanced Virtual Energy Simulation Training and Research (AVESTAR™) Center

Background

Gasification of coal and coal-biomass blends produces a hot gas mixture of mostly hydrogen and carbon monoxide known as synthesis gas (syngas). The syngas is used for production or co-production of power, fuels, and chemicals. Dynamic simulation is a highly specialized and increasingly sophisticated computational tool for helping to achieve aggressive operation and control objectives for integrated gasification combined cycle (IGCC) power plants, gasification/natural gas hybrids, and polygeneration systems with carbon dioxide (CO_2) capture technologies. However, key technical challenges and gaps must be resolved before these objectives can be achieved.

Attaining operational excellence from IGCC systems requires maximizing the efficiency and profitability through excellent process control and deriving maximum business value from all plant assets while concurrently reducing negative environmental impacts and improving safety. Dynamic simulation-based technologies, state-of-the-art facilities, and leading energy researches are needed to meet the challenges of high-fidelity dynamic process modeling, advanced process control, and optimal sensor placement. There is also a need to meet technology transfer and outreach objectives by providing comprehensive, hands-on, simulation-based training to engineers and operators in the energy industry to help them avoid or minimize risk events and more quickly recover from abnormal situations.

The Gasification Team at the U.S. Department of Energy (DOE) National Energy Technology Laboratory (NETL) is addressing these issues using a collaborative and integrated approach that leverages the expertise of the NETL-Regional University Alliance. The approach combines theory, computational modeling, experiments, and industrial input to develop methods, models, and tools to support the development and deployment of advanced gasification-based devices and systems.

Project Description

The AVESTAR™ project is focused on developing a comprehensive portfolio of dynamic simulation research, development, and training activities that include (1) developing and applying dynamic modeling and simulation technologies to optimize the operation and control of advanced gasification-based energy plants with carbon capture; (2) enhancing plant-wide simulations with fast, dynamic, reduced-order models based on high-fidelity simulations of gasifiers and CO_2 capture systems; (3) researching, developing, testing, and deploying regulatory and advanced process control strategies; and (4) developing, testing, and deploying real-time dynamic simulators with full-scope operator training system and three-dimensional (3-D) virtual immersive training system capabilities.

CONTACTS

Jenny Tennant
Gasification Systems Technology Manager
National Energy Technology Laboratory
3610 Collins Ferry Road
P.O. Box 880
Morgantown, WV 26507-0880
304-285-4830
Jenny.Tennant@netl.doe.gov

Arun Bose
Project Manager
National Energy Technology Laboratory
626 Cochrans Mill Road
P.O. Box 10940
Pittsburgh, PA 15236-0940
412-386-4467
Arun.Bose@netl.doe.gov

Stephen E. Zitney
Project Manager
National Energy Technology Laboratory
3610 Collins Ferry Road
P.O. Box 880
Morgantown, WV 26507-0880
304-285-1379
Steve.Zitney@netl.doe.gov

PARTNERS

NETL-Regional University Alliance

PROJECT DURATION

Start Date	End Date
10/01/2011	09/30/2013

COST

Fiscal Year 2013 Project Value
$293,876

PROJECT NUMBER

FWP-2012.03.03 Task 6

NATIONAL ENERGY TECHNOLOGY LABORATORY

Albany, OR • Anchorage, AK • Morgantown, WV • Pittsburgh, PA • Sugar Land, TX

Website: www.netl.doe.gov

Customer Service: 1-800-553-7681

U.S. DEPARTMENT OF ENERGY

Goals and Objectives

The goals of the AVESTAR Center project are to (1) create a well-prepared industry workforce trained to safely and effectively operate, control, and manage commercial-scale gasification-based systems with carbon capture; (2) accelerate progress toward achieving operational excellence for advanced gasification-based power plants with carbon capture; and (3) improve strategies for maintaining safe and environmentally sustainable IGCC plant operation under fluctuating operating conditions. Specific objectives include internationally-recognized collaborative research and development (R&D) on dynamic process modeling, advanced process control, optimal sensor placement, and 3-D virtual plant technology, as well as hands-on, simulator-based industry workforce training and augmentation of graduate and undergraduate engineering education in the areas of process simulation, dynamics, control, and safety of clean energy systems.

Accomplishments

The AVESTAR team successfully deployed 3-D virtual IGCC immersive training systems at NETL and West Virginia University that allow users to interact with plant equipment, activate transparent views, display pop-up trends and web pages, and experience equipment sound effects and malfunctions and visual training scenarios. The team signed a memorandum of understanding with Pierpont Community and Technical College and the WVU Research Corporation to establish a cooperative working arrangement for providing workforce training and education on the safe, efficient, and reliable operation of clean energy plants.

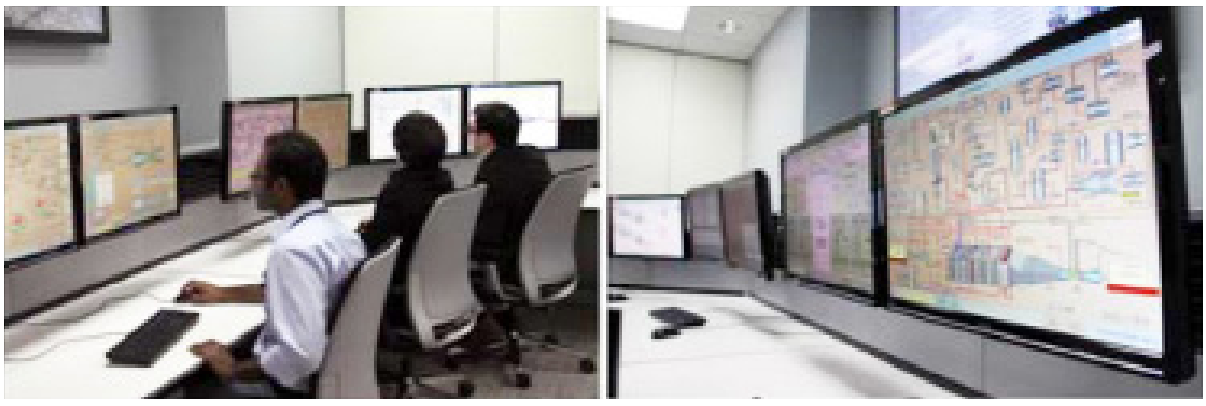
AVESTAR Center researchers delivered nine presentations highlighting recent progress on dynamics, operations, and control R&D for gasification and CO_2 capture systems at the 29th Annual International Pittsburgh Coal Conference; delivered a dozen presentations highlighting recent progress on dynamics, operations, and control R&D of clean energy plants at the 2012 Annual Meeting of the American Institute of Chemical Engineers; and showcased AVESTAR in an exhibit and presentation at the 2012 Gasification Technologies Conference in Washington, DC.

AVESTAR Center partners, Fossil Consulting Services and Invensys Operations Management, provided comprehensive combined cycle training for power plant operators from Petrobras, a Brazilian integrated energy company. Using AVESTAR's combined cycle dynamic simulator, experiential learning scenarios covered the operation and control of all major combined cycle systems, including gas and steam turbines; condensate, feed water, and circulating water systems; heat recovery steam generator; and sulfur recovery unit. Base-load plant operations were emphasized, along with startup, shutdown, and abnormal situation handling. Petrobras employees learned how to operate and control the near-zero-emission power plants critical to a cleaner energy future. The AVESTAR team also hosted scientists and engineers from Cooperative Research Network, the technology research arm of the National Rural Electric Cooperative Association, for hands-on dynamic simulator-based demos and in-depth presentations and discussions on operation and control of clean energy plants.

The team improved IGCC plant response to disturbances by developing controller enhancements that ranged from retuning feedback control loops and multiplicative feed-forward control to other control techniques such as split-range control, feedback trim, and dynamic compensation. In addition, improvements in IGCC coordinated plant-wide control strategies for "Gasifier-Lead," "Gas Turbine-Lead," and "Plant-wide" operation modes have been proposed and their responses compared. Other potential IGCC controller improvements have been identified as a result of using advanced process control, including model predictive control, as a supervisory control layer.

Benefits

The AVESTAR Center, by successfully executing its mission to create a well-trained industry workforce, optimize the operation and control of gasification-based power plants, and improve strategies for maintaining safe and environmentally sustainable IGCC plant operation, will provide our nation with clean, reliable, and cost-effective solutions to meet future energy needs.



Advanced Virtual Energy Simulation Training and Research (AVESTAR™) Center at NETL.