

**U.S. Department of Energy  
National Energy Technology Laboratory  
Regional University Alliance (NETL-RUA)**

**The Grid Technologies Collaborative (GTC)**

**University of Pittsburgh  
Electric Power Industry Conference  
November 12, 2013**



# **DOE NETL – National Energy Technology Lab**

**Owned and operated by the U.S. Department of Energy (DOE)**

**Part of DOE’s national laboratory system**

**Implements a broad spectrum of energy and environmental R&D**

**Has expertise in energy technologies, contract and project management, analysis of energy systems, and international energy issues.**

**In addition to onsite research, NETL’s project portfolio includes R&D conducted through partnerships, cooperative research and development agreements, financial assistance, and contractual arrangements with universities and the private sector.**

**These efforts focus a wealth of scientific and engineering talent on creating commercially viable solutions to national energy and environmental problems.**

## **An applied research collaboration:**

**NETL's energy expertise**

**URS Corporation (a leading provider of engineering, construction and technical services for public agencies and private sector companies around the world)**

**Five nationally recognized regional universities:**

**Carnegie Mellon University (CMU)**

**Pennsylvania State University (PSU)**

**The University of Pittsburgh (Pitt)**

**Virginia Tech (VT)**

**West Virginia University (WVU).**

**Leverages facilities, equipment, professional staff, and other resources**

**Accelerates the development and deployment of innovative energy and environmental technology**

**The commercialization of these technologies invigorates the economy with new high-tech and manufacturing jobs – jobs that are well-suited for the skilled workforce that results from engagement in the cutting-edge, collaborative research of the RUA.**

## The NETL-RUA Grid Technologies Collaborative (GTC)

- Established to support the advancement of key power grid technology developments for both legacy and future grid systems
- RUA Institutions: Universities - CMU, PITT, PSU, VA Tech, WVU; and DOE NETL, UEP, URS Corp.



**URS**



University of Pittsburgh



Virginia Tech

PENNSYLVANIA STATE UNIVERSITY  
PENNSTATE



West Virginia University

University Energy Partnership

**Carnegie Mellon**

## Overview, History, and Status

- **Originated from NETL Strategic Growth Area (SGA) initiatives workshop – May 2011**
- **Selected as one of two SGA's for NETL support in 2012**
- **Formally established with seed funding in August 2012**
- **Group consists of 23 faculty and graduate student researchers from the five RUA universities and personnel from NETL, URS, and UEP**
- **Initial R&D project effort entitled:**
  - **The Next Generation Power Converter:  
Applications for Enhanced T&D Grid Performance and  
Energy Resource Integration**
  - **Benefits and outcomes: creating opportunities for faculty and graduate student researchers; expanding the capabilities and breadth of NETL's research portfolio; engaging industry in technology development and regional growth**

## Steering Committee Members

•**GTC Lead:** Gregory Reed – University of Pittsburgh



•**Program Development:** Wayne Honath – UEP



•**Steering Committee:**

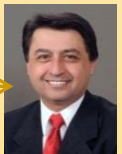
Steven Bossart – DOE NETL



Keith Dodrill – DOE NETL



Paul Ohodnicki – DOE NETL



Gabriela Hug – Carnegie Mellon University



Seth Blumsack – Penn State University



Dushan Boroyevich – Virginia Tech



Parviz Famouri – West Virginia University



Janet Nelson – URS Corporation



**The GTC's Mission is to become a world leader in the development, demonstration and applications of Grid-Scale Power Electronics Devices and Systems**



**The GTC Vision is the realization of an advanced electricity transmission and distribution network that:**

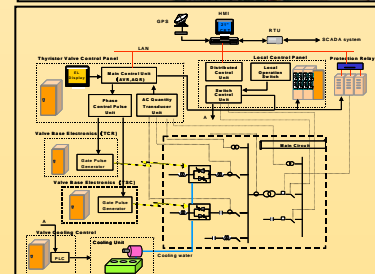
- **Is efficient, flexible, reliable, and resilient to disruptions and other contingency events on the power grid**
- **Changes being made remotely clean energy generation resources, energy storage capacity, and alternate operational concepts**
- **Delivers the most suitable forms of electricity in the most economic manner to end-users and enables greater levels of consumer participation**





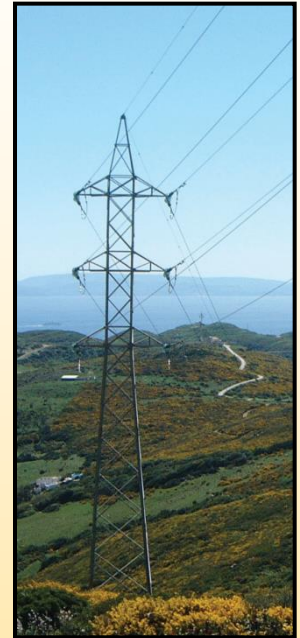
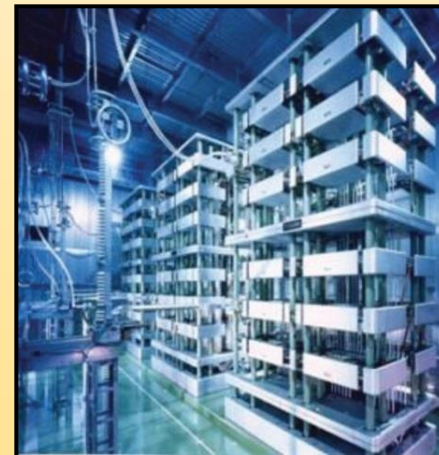
## The GTC engages in three fundamental activities:

- 1) Developing new grid-scale power electronics devices for emerging AC and DC electrical infrastructure, supporting systems and algorithms, and demonstrating their technical and economic value proposition
- 2) Educating the next generation of power electronics engineers through advanced curricula at member universities and training programs for existing professionals
- 3) Partnering with industry and the public sector to advance the state-of-the-art of technology and demonstrate the benefits of advanced power electronics through collaborative research and development, seminars, and workshops



## The core R&D focus areas of the GTC include:

- **Modeling, simulation, and analysis**
- **Power semiconductors and materials development**
- **Circuit and device design, integration, and topologies**
- **Advanced control, systems interface, and protection**
- **Testing and turnkey systems integration**
- **Deployment and operations**



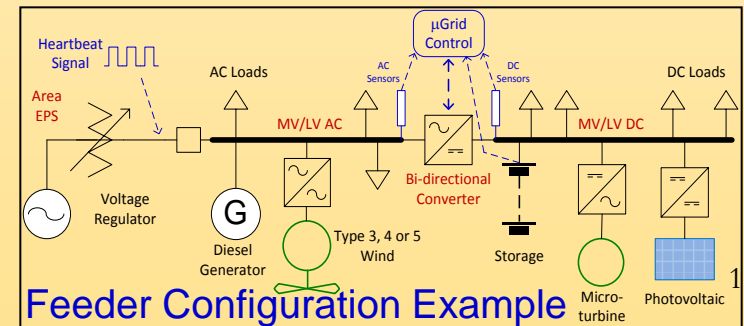
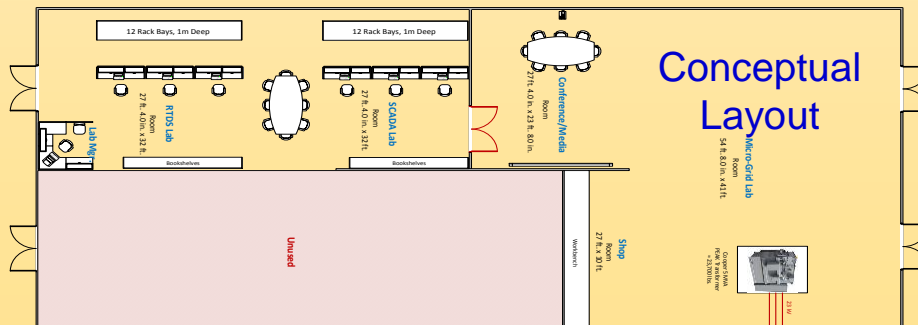
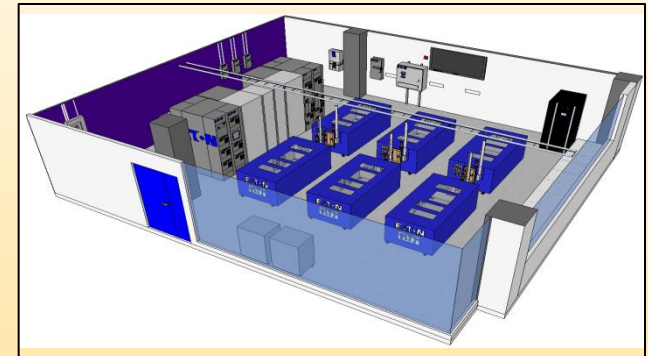
# Example Facilities and Lab Capabilities

## NETL – AVESTAR™ IGCC Immersive Training System



## PITT – ELECTRIC POWER SYSTEMS and TECHNOLOGIES LABS

- EPSL – Benedum Hall, 2013 opening
  - Low voltage power, micro-grid, power electronics, etc..
- EPTL – Off-campus RD&D facility (2014/2015)
  - Planning for medium voltage facility
  - 15 kV-ac, 5 MVA -and- 1 kV-dc, 1 MVA capacity
  - Distribution Feeder Infrastructure
  - Resource and Load Integration (u-Grid at Dist. Level)
  - Renewables, Storage, EV, Power, Electronics, etc.
  - RTDS, Relaying, Automation, Control, Communications



# Example Facilities and Lab Capabilities

## PSU – GridSTAR

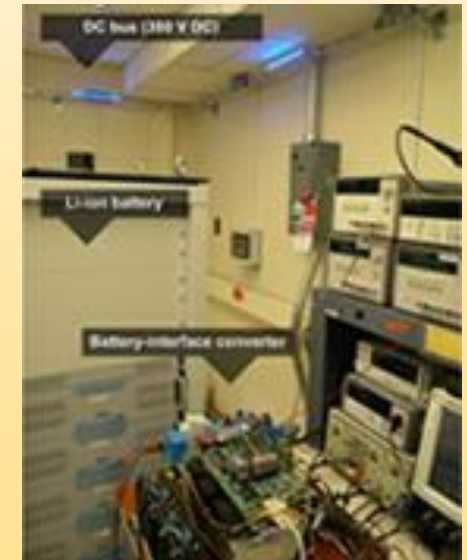
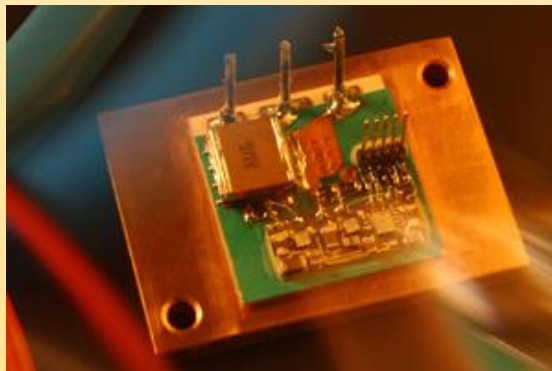
Philadelphia  
Navy Yard

- Net zero energy
- Building level and distribution system facilities
- Technology testing demonstration



## VATech – Center for Power Electronics Systems (CPES)

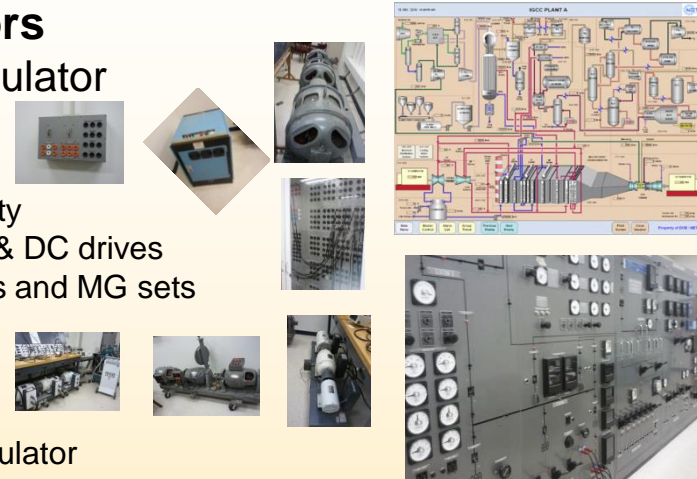
- dedicated to improving electrical power processing and distribution that impact systems of all sizes – from battery-operated electronics to vehicles to regional and national electrical distribution system



# Example Facilities and Lab Capabilities

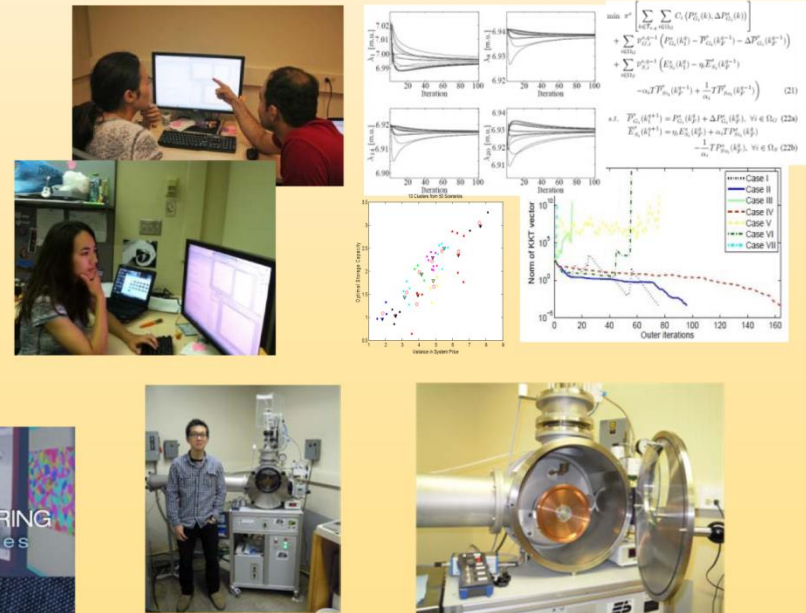
## WVU – Electric Power Systems Lab and Simulators

- Complete AVESTAR platform with IGCC Dynamic Simulator
- Electric Power and Electro-Mechanical Systems lab
  - 15kW: 150V DC; 15kVA: 120/230 60Hz generation
  - 6 load centers 12 wire distribution with 110/230V 1- $\phi$ /3- $\phi$  availability
  - Fully meter-equipped power benches with AC variable frequency & DC drives
  - 5kVA Inverter for DG applications and various type dynamometers and MG sets
  - dSpace/LabView real-time data acquisition and control systems
  - Yokogawa 3/4-wire power acquisition harmonic analyzers
- Hampden Power System Simulator
  - Low voltage electric generation-transmission-distribution-load simulator



## CMU – Smart Controls and Materials Lab

- Power Systems Group
- Smart Controls and Optimization Techniques for Improved Operation of the Power Grid
- Simulation Based
- Magnetic Materials Lab
- Electron Microscopy Facility
- Magnetic Properties of Materials
- Rapid Solidification
- Synthesis Lab



## Next Generation Power Electronics Converter Development

- **Utility T&D scale advanced power electronics converter design and development for FACTS and DC based applications**
- **A key interface to power grid modernization and advancement**
- **Efficient, bidirectional connection and control interfaces**
- **Initial applications at utility-scale distribution level**
- **Control concepts and interfaces extended to transmission system level and applications**
- **Initial focus areas:**
  - **Renewable/Clean energy integration**
  - **Energy storage interconnection**
  - **Traditional and emerging AC and DC loads**
  - **Hybrid AC/DC System Architectures**
- **2012 Results Published in the GTC R&D Progress Report (Feb. '13)**

## R&D Project – Next Generation Power Electronics Converter Development Task Breakdowns and Deliverables

### System Level Modeling

- Develop models of either AEP distribution or Philadelphia Navy Yard in MATLAB/Simulink and PSCAD platforms
- Develop models and perform initial laboratory testing of distributed generator converters
- Journal publication on inverter model and testing

### Converter Topology Design

- Transition MATLAB/Simulink models of converter design to PSCAD
- Expand research on low frequency dynamic interactions
- Design hybrid AC/DC test bed

### Smart Control Methodology

- Develop multi-time scale control of storage devices
- Develop method to determine optimal sizing of converter and storage, and optimal location
- Advanced converter materials and devices

### Interface & Communication Protocols

- Develop and test network estimation strategies
- Identify and test required DNP3 and IEC61850 features
- Study interactions of communications and network estimation; study vulnerabilities and their mitigation

### Demonstration Site Plan and Development

- Navy Yard micro-grid data for modeling
- Multi-scale transmission and distribution modeling and optimization
- Production cost modeling

### Simulation Platform Development

- Program support for the AVESTAR simulator development of the base case T&D grid and control topology
- Direct support/input for development of NETL in-house R&D program for GTC efforts

## Proposals for Grid Research Projects

- To date, 11 projects have been funded for a total of \$2.4 Million
- An additional 7 projects, totaling \$7.8 Million are pending

## Grid Research Publications and Presentations

- GTC members have published or presented 22 papers on grid technology research
- An additional 5 papers have been accepted, and 4 more are under review

## Coordinating Efforts with DOE Grid Tech Team (GTT)

## Strategize on Growth and Continued Collaborations

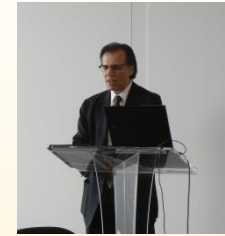
## Continued Industry Outreach

## Establish Industry Partnership Program



# GTC First Annual National Conference

June 10, 2013 – Arlington, VA





# 2013 Univ. of Pittsburgh EPIC

## November 11-12, 2013

### Pitt University Club

## 2013 EPIC Highlights (Advancing Grid Technologies- from Macro to Micro):

- **MONDAY 11/11:**
- Keynote Speakers and Special Guests:
  - Chancellor Nordenberg
  - Patricia Hoffman (U.S. DOE), Ravaithi Advaithi (EATON)
- Electric Power Graduate Student Research Symposium and Poster Session
- Electric Power Systems Lab Tours
- Corporate Exhibits and Student Networking Session – Monday Evening
- **TUESDAY 11/12:**
  - ***DOE Grid Technologies Collaborative Workshop***
  - Microgrid Panel / Live Webinar
- **Industry Representation and Invited Speakers**
  - ABB, Altsom Grid, American Electric Power, Concurrent Technologies, Dominion Virginia Power, EATON, Elster, Emerson Process Management, FirstEnergy, Mitsubishi Electric, NIST, NRECA, Pitt-Ohio Express, RAND Corp., Siemens Energy, John A. Swanson, U.S. Dept. of Energy, ...

**8<sup>TH</sup>**  
ANNUAL  
PITT

**ELECTRIC POWER**  
INDUSTRY CONFERENCE

Presented by the Swanson School of Engineering & the Center for Energy

**2013 Univ. of Pittsburgh EPIC**

**GTC Workshop**

**November 12, 2013**

## **Following up on the GTC National Conference in June**

- **Five guests who attended the GTC conference are serving as our panelists this morning**
- **Each will discuss their organization's interest in grid technologies,**
- **Each will provide their perspective on opportunities or gaps in areas of grid research**