GEARED Student Innovation Board

To help address both technological and workforce challenges associated with the exponential growth in distributed resources, the U.S. Department of Energy (DOE) has funded three Distributed Technology Training Consortiums (DTTCs) and a National Network Administrator as a part of the Grid Engineering for Accelerated Renewable Energy Deployment (GEARED). To better engage students in the GEARED Network, Consortium university partners have created Student Innovation Boards. DOE believes that applying fresh approaches and unfettered creating thinking by students to power engineering problem solutions will prove immensely beneficial to utilities, support industry, and consumers. Additional background information is outlined at the end of this document.

Student Innovation Board Members Roles:

- Act as liaison and communicate directly with students and student organizations at your university regarding DTTC and GEARED projects and activities.
- Provide leadership and encouragement for student participation in GEARED projects and activities.
- Along with your fellow SIB member(s), meet periodically to review the status and update progress on GEARED-related student projects and activities; plan for upcoming events; and make recommendations to increase the value of the GEARED project to students.
- Participate in an advisory role with utility, industry and other members of your DTTC Advisory Board.
- Attend and participate in the GEARED annual student conferences when funding time and funding allows.
- A national network website is maintained at: **www.gearedusa.org**. SIB member profiles are listed on this website along with other network activities. SIB members should use the template provided at the end of this document to submit profile information for posting.

Example GEARED projects and activities for students:

- Graduate and undergraduate engineering research projects; Senior Design Projects
- Paper and/or poster presentations at technical and professional society meetings
- Industry and utility-sponsored design competitions
- Campus-based renewable energy demonstration projects (such as smart buildings, energy efficiency, electric vehicles, etc.)
- Preparation/dissemination of papers related to energy, environment, and economic policy issues
- Research clusters to advance distributed technologies (generation, storage), smart grid technologies, and workforce development for the electric power industry
- Market analysis and business model development based on products, processes, and services related to distributed technologies and the smart grid

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Structure of the GEARED Network

The GEARED network consists of three Distributed Technology Training Consortiums (DTTCs) and one National Network Administrator (NNA), all of whom report to the U.S. Department of Energy SunShot Initiative. In addition to the listed university partners, many utilities and supporting industries are part of GEARED.

The Center for Grid Engineering Education (GridEd)
Website: http://grided.epri.com/
Lead Organization: Electric Power Research Institute
Eastern Partnering Universities: Clarkson University, Georgia Institute of Technology, University of North Carolina-Charlotte, and University of Puerto Rico, Mayaguez
Western Partnering Universities: University of Arizona, Portland State University, University of California-Riverside

Foundations for Engineering Education for Distributed Energy Resources (FEEDER)
Website: http://www.feeder-center.org/
Lead Organization: University of Central Florida
Partnering Universities: University of Arkansas, Auburn University, University of California-San Diego, University of Central Florida, University of Florida, Florida State University, University of Hawaii, University of Kentucky, University of Pittsburgh, University of South Carolina, San Diego State University, University of Texas-Dallas

Mid-America Microgrid Education and Training Consortium (MARMET)
Website: http://marmet-center.org
Lead Organization: Missouri University of Science and Technology
Partnering Universities: University of Illinois-Urbana Champagne, Iowa State University, Missouri University of Science and Technology, University of Wisconsin

National Network Administrator (NNA)
Website: http://www.irecusa.org/
Lead Organization: Interstate Renewable Energy Council (IREC)

Background Information on GEARED, Distributed Technologies, and the Smart Grid

The National Academy of Engineering had described the U.S. electrical network as "the supreme engineering achievement of the 20th century." More recently, however, technological developments, environmental concerns, and government policies have changed and are changing the landscape of the traditional electrical grid network. Technological developments include a variety of different types of electric generators – distributed generators – that are creating challenges and opportunities for both providers and consumers. Examples of distributed generators include: reciprocating engines, combustion turbines, microturbines, fuel cells, wind turbines, and solar electric systems. For this project, emphasis will be on distributed solar electric systems, especially photovoltaic (PV) systems, and their integration into the grid.

In addition to distributed generators, various types of energy storage systems are being researched and developed to mitigate the effects of power intermittency that occur with solar and wind resources. Distributed energy storage options include battery and uninterruptible power supply systems designed to improve power quality and reliability, thermal storage, flywheels, compressed air, and pumped hydro storage, among others. In addition, the growing use of electric vehicles, most notably plug-in hybrid electric vehicles (PHEVs), present opportunities to make the grid both cleaner and more efficient. They extract electric energy from the grid when it is most available, use some of it to displace fossil fuels for transportation, and have the capability to return some of it to the grid during peak demand using vehicle-to-grid (V2G) technology.

Government policies, including deregulation, renewable portfolio standards, and various incentive programs, have produced an exponential increase in the number of distributed generators on the electric grid network. The electric power industry fully recognizes the technological challenges posed by these developments and the need to significantly upgrade and modernize the grid. The "smart grid" will help facilitate and accelerate the integration of distributed generators and energy storage systems with the electrical grid network.

In the past, despite aging grid hardware, utilities had a relatively small number of generators to control in making sure that generation (minus losses) was equal to load demand at all times. However, with tens of thousands of distributed generators being integrated into the electrical grid network, operation and control becomes much more complicated. In addition, with the traditional grid, wind-generated electricity does not contribute effectively to either base load or peak load demand as will be possible with a smarter grid. And, because of resource variability, photovoltaic (PV) systems have relatively low capacity factors. Solar thermal electric systems (e.g., concentrating solar power) do have thermal storage, but need water (to produce steam) that is often in short supply in areas with the most sunlight. In short, high penetration of distributed solar and wind electric systems is a huge issue for utilities.

To effectively handle large penetration of distributed power systems, the electric grid must be a highly interconnected and interactive network of power systems, monitoring systems, computer systems,

communication systems, and control systems. In addition to many different types of distributed resources, it will be made up of advanced metering, smart end-use equipment and appliances, smart switchgear, smart sensors, advanced protection and security systems, wireless communications, and sophisticated energy management and control systems. More simply, it will consist of a modernized electrical infrastructure married to a highly intelligent communications infrastructure. Not only will the smart grid help mitigate the effects of power fluctuations from distributed generators, but also the distributed power systems will provide utilities with multiple pathways for the flow of electricity.

Currently the ability to move electricity throughout the country is limited, and the grid needs to be significantly improved to make best use of solar and wind power. Development of the smart grid is a work in progress. It is important to note that communications and control technologies are at the heart of the smart grid. Rapid communication of generation capacity and user demand will result in more efficient management of the transfer of power from generation to load.