New Research in Power & Energy

- **Smart Grid**
  - Microgrid and reliability analysis
  - Renewable energy integration and storage
  - Demand response
  - Energy efficiency
  - Electric vehicle

  - Development of a test bed to analyze reliability and resiliency of electric power microgrid
  - Using energy storage to mitigate impacts of renewable energy fluctuation
  - Storage sizing to balance wind forecast mismatch
  - NiZ battery storage
  - Compressed air energy storage (CAES)
  - Impact of DR on distribution circuit load shape
  - Demand response algorithms
  - The use of demand response to mitigate power system stress conditions
  - Bi-level and demand-sensitive LED street lighting system
  - Solar water heater vs electric water heater
  - Impact of energy efficient appliance on distribution circuit load shape
  - Impact of high penetration of EV’s on distribution transformers

ARI Research Projects

**Sponsored Projects at ARI**

1. **Partnerships for Innovation (PFI): Role of the Smart Grid in Alleviating Electrical Power System Stress Conditions Through Demand response**
   - Sponsor: US National Science Foundation

2. **A Test-Bed for Analyzing the Security and Resiliency of the DG-integrated Electric Power Distribution Network**
   - Sponsor: US National Science Foundation

   - Sponsor: US National Science Foundation

4. **US-Egypt Cooperative Research: Managing Grid Integration of Large-Scale Wind Power Parks using Energy Storage Technology and Demand Response**
   - Sponsor: US National Science Foundation

[www.ceage.vt.edu/ceage_projects](http://www.ceage.vt.edu/ceage_projects)
Role of the Smart Grid in Alleviating Electrical Power System Stress Conditions Through Demand Response

Pls: Dr. Saifur Rahman and Dr. Manisa Pipattanasomporn

Objective: To design and develop a smart grid sensing and control hardware and software platform that enables efficient and flexible demand response programs with customer choice.

Sponsored by US National Science Foundation

www.ceage.vt.edu/ceage_projects
Peak load and its duration

- In the US 20% of the load happens 5% of the time
- In Australia 15% of the load happens 2.5 days in a year or less than 1% of the time
- In Egypt 15% of the load happens 1% of the time

Demand Response

Load Control at the Customer Level can provide significant short term load reduction

A cheaper option to get load relief

How to incentivize the customer?
**A Test-Bed for Analyzing the Security and Resiliency of the DG-integrated Electric Power Distribution Network**

*Pls: Dr. Manisa Pipattanasomporn and Dr. Saifur Rahman*

Objective: To develop a simulation test bed which can be used to quantify and analyze the impact of future demand and supply side alternatives on the security and resilience of the DG-integrated electric power distribution network.

This test bench can be used to:

- compare and evaluate different peak shaving options: load control or running generators
- compare operating performance of different DER technologies (operational, economic and environmental)
- study microgrid operation in the grid-connected and islanded modes
- etc.

Overall Project Concept
Optimizing Electric Power Distribution Network Operation with Demand Response, Solar PV and Energy Storage to Mitigate the Impact of Growing Electric Vehicle Penetration

**Dr. Manisa Pipattanasonporn**

Objective: To develop a set of algorithms to optimize the operation of an electric power distribution network through a combination of demand response, solar photovoltaics and energy storage to absorb the new crop of EVs, without a significant system upgrade.

Sponsored by US National Science Foundation
www.ceage.vt.edu/ceage_projects

---

**Overall Project Concept**

**Matlab/Simulink**

**Agents developed in JADE (Java)**

**TCP/IP**

**HEM 1**

**HEM 2**

**HEM 3**

**Desktop PC(s)**

**Appliances**

**HEM = Home energy management system (Developed on C++)**
Energy Efficiency

Bi-Level Demand-Sensitive LED Street Lighting Systems

*PIs: Dr. Saifur Rahman and Dr. Manisa Pipattanosomporn*

Objective: To design, develop and demonstrate an energy efficient **bi-level** and **demand-sensitive** LED street lighting system

*Returned to full intensity when traffic is detected.*

*The streetlight will be dimmed at night.*

Sponsored by US Army Corps of Engineers
Department of Defense

---

LED Lighting Project @ US Navy Research Center
People/cars are clearly visible under the white LED light.

Average electricity savings of 75% was experienced after the installation.

**Monthly Electricity Consumption**
Grid Integration of Renewables

US-Egypt Cooperative Research: Managing Grid Integration of Large-Scale Wind Power Parks using Energy Storage Technology and Demand Response

Pi: Dr. Saifur Rahman

Objective: This joint research proposes using an energy storage technology and demand response techniques for managing the grid integration of large wind parks with special focus on large scale storage technologies.

Sponsored by US National Science Foundation
www.ceage.vt.edu/ceage_projects

Egypt Wind Power Issues

Opportunities:

- Generate electricity to export EU via Mediterranean Ring or undersea cable
- Country aims to generate 12% of power from wind power farms by 2020: target 7,000 MW

Challenges:

- In-country technology base
- Available manpower
- Power system stability issues due to high penetration of wind turbines
- Transmission line upgrades

Source: IISD Report, Clean Energy Investment in Developing Countries, Wind power in Egypt, October 2009
Portal for Smart Grid Information Collection and Archival

Smart Grid Information Clearinghouse

PIs: Dr. Saifur Rahman and Dr. Manisa Pipattanasomporn

Objective: To design, populate, manage and maintain a public SGIC web portal that reaches out to a broad user community both for information gathering and knowledge delivery.

www.SGIClearinghouse.org

Sponsored by US Department of Energy
Platform for Collaboration Among Muslim Majority Countries

ICEIS
(www.iceis.net)

International Center for Energy and Information Systems (ICEIS)

International Center for Energy and Information Systems is a center of excellence which helps to foster collaboration between US academic researchers and their counterparts in developing and emerging countries focusing on energy and information systems. The goal is to formulate regional and global solutions for energy development and environmental sustainability, and associated information systems topics including secure data communication for the reliability, security and resilience of the energy supply systems. ICEIS offers its clients seminars, workshops, joint studies and training activities. The Center collaborates with its member institutions in countries in Africa, Asia and the Middle East through the regional hubs in Egypt, Turkey, Jordan, Qatar/UAE, Bangladesh and Indonesia to ensure broader participation. These interactions foster technical discussions and help bring about energy development and use in conjunction with environmental protection. The Center’s goal is to foster collaborative research, and provide a platform for workshops, training programs and sharing project development experience. In particular, the Center will work with the community of researchers, professionals and policy makers to develop strategies and mechanisms to: (i) facilitate and foster interaction and exchange among energy and information systems (EIS) researchers across a broad range of institutions, programs and technologies, (ii) enable sharing of knowledge generated by EIS research with the broader engineering and scientific communities, sharing and integrating experimental tools and platforms, (iii) facilitate and foster collaboration and information exchange between EIS researchers and industry, (iv) facilitate international collaboration on EIS research and (v) provide policy makers in these countries access to analytical tools, technical experts and field experiences from member countries.

International Center for Energy and Information Systems (ICEIS)

A plan for collaboration

A consortium of existing and emerging centers of excellence in Muslim majority countries in the Gulf (GCC), North Africa, West Asia, Central Asia, South Asia and Southeast Asia focusing on Energy and Information Systems
How can a consortium like ICEIS help

- A consortium to share and coordinate information about national research needs and available local expertise
- Identify experts globally who have the knowledge and experience necessary to address specific scientific issues
- Provide a platform for collaboration among international senior and young researchers both from academia and industry
Outcome of Collaboration

- Trained work force
- Research faculty
- Research facility
- A platform for global collaboration in scientific publications
- A best practice for collaboration in academia-industry-government
Thank you

Prof. Saifur Rahman
Virginia Tech, USA
Email: srahman@vt.edu

www.saifurrahman.org