RESEARCH, EDUCATION, AND TRAINING FOR THE SMART GRID

CHAPTER 9

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INTRODUCTION

- The smart grid will require engineers and professionals with greater expertise and training than the skilled workforce of today.
- *In addition to the technological aspects of development* , engineers will need to study manufacturing, data management, asset optimization, and policy and protocol development.
- The smart grid will also depend upon expanding current research efforts in the areas of cyber security, controls, communication, computational intelligence techniques, and decision support tools. .

RESEARCH AREAS FOR SMART GRID DEVELOPMENT

- Work is under way in developing research support for the intelligent grid in FACTS technology coordination and placement for real - time application, PMUs for real – time voltage stability, and reliability monitoring and control.

- Other research includes advanced distribution automation capable of handling DSM functions with real – time pricing options and mechanisms.

TABLE 9.1. Smart Grid Deployment

Problem	Classical method	Improvement Currently for static model	Recommendation for smart grid deployment
Stability	Lyapunov's Method; Transient energy function; Bifurcation method; Eigenvalue evaluation;	Quasi-steady state modeling;	Index for fast and accurate evaluation; Real time computation; using leaning algorithm and ADP for control coordination
OPF	Interior point method; Trust region method;	SQP, rSQP	ADP and heuristic, hybrid methods to account for prediction and stochasticity.
Economic Dispatch/ Unit Commitment	minimum cost while meeting the constraints;	Variants of nonlinear interior point methods;	Knowledge based system; Computational Intelligent method; to account for uncertainties and randomness
Reliability	State enumeration; Effects analysis; Reliability indices	Probabilistic input data for reliability study	Computational Intelligence and its hybrid method together with dynamics in the data

RESEARCH AREAS FOR SMART GRID DEVELOPMENT

- *The research activities can be classified by the tools required.*

- **Simulation and analysis tools :** Simulate energy markets and energy systems and validate the vision. These tools will combine operations and economics in a single model to analyze and monitor the system as changes are implemented to determine the impacts and ensure fairness.
- **Development of smart technologies from the government and industry:** Jump - start the transformation

RESEARCH AREAS FOR SMART GRID DEVELOPMENT

- **Testbeds and demonstration projects :** Provide experiments of increasing scale to prove the worth of these technologies or reveal their faults; build momentum for change, reduce the perception of risk, and build acceptance of the concept of a transformed energy grid .
- **New regulatory, institutional, and market frameworks :** Support a climate of innovation as technologies develop and evolve; fulfill the need for examination, provided to the network through education and development of research and training.

RESEARCH ACTIVITIES IN THE SMART GRID

- *The critical objectives of technical research include:*

1. Develop advanced techniques for measuring peak load reductions and energy-efficiency savings from smart metering, DR, DG, and electricity storage systems
2. Investigate means for DR, DG, and storage to provide ancillary services
3. Conduct research to advance the use of wide-area measurement and control networks, including data mining, visualization, advanced computing, and secure and dependable communications in a highly distributed environment

RESEARCH ACTIVITIES IN THE SMART GRID

4. Test new reliability technologies including those concerning communications network capabilities in a control room environment against a representative set of local and wide area outage scenarios
5. Identify communications network capacity needed to implement advanced technologies
6. Investigate the feasibility of a transition to time of use (TOU) and real–time electricity pricing
7. Develop algorithms for use in electric transmission system software applications

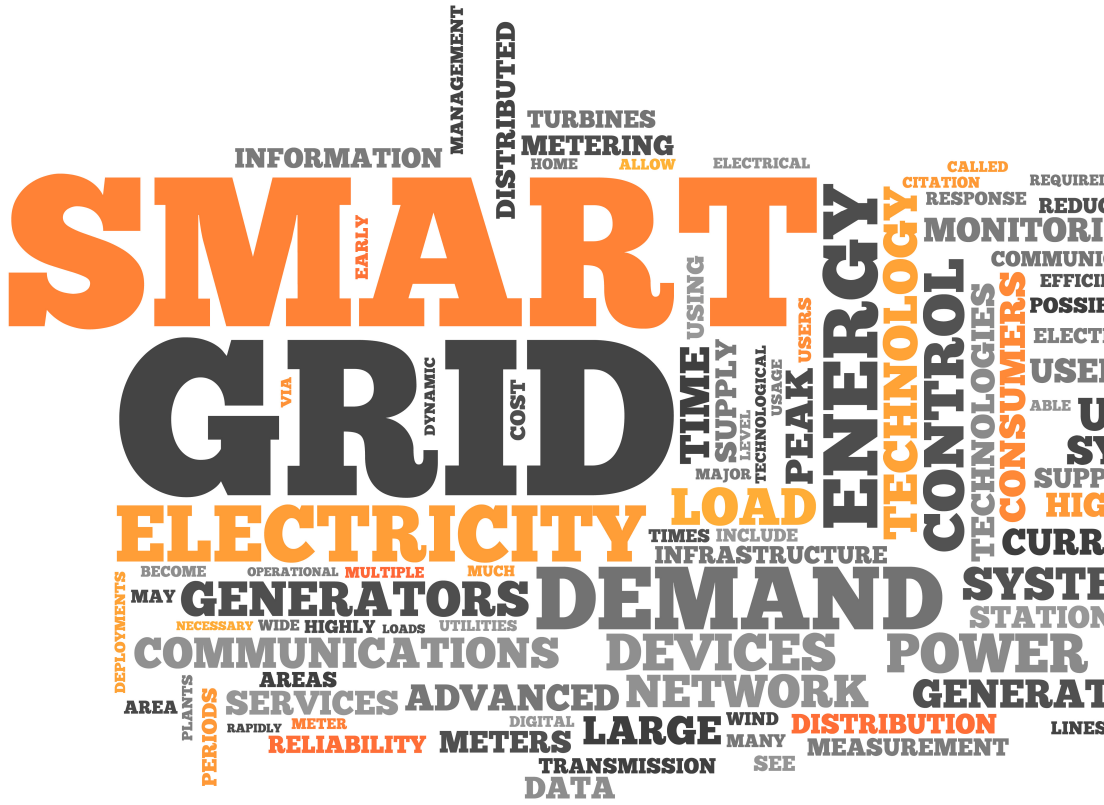
RESEARCH ACTIVITIES IN THE SMART GRID

8. Promote the use of underutilized electricity generation capacity in any substitution of electricity for liquid fuels in the transportation system of the United States

9. Develop interconnection protocols to enable electric utilities to access electricity stored in vehicles to help meet peak loads

MULTIDISCIPLINARY RESEARCH ACTIVITIES

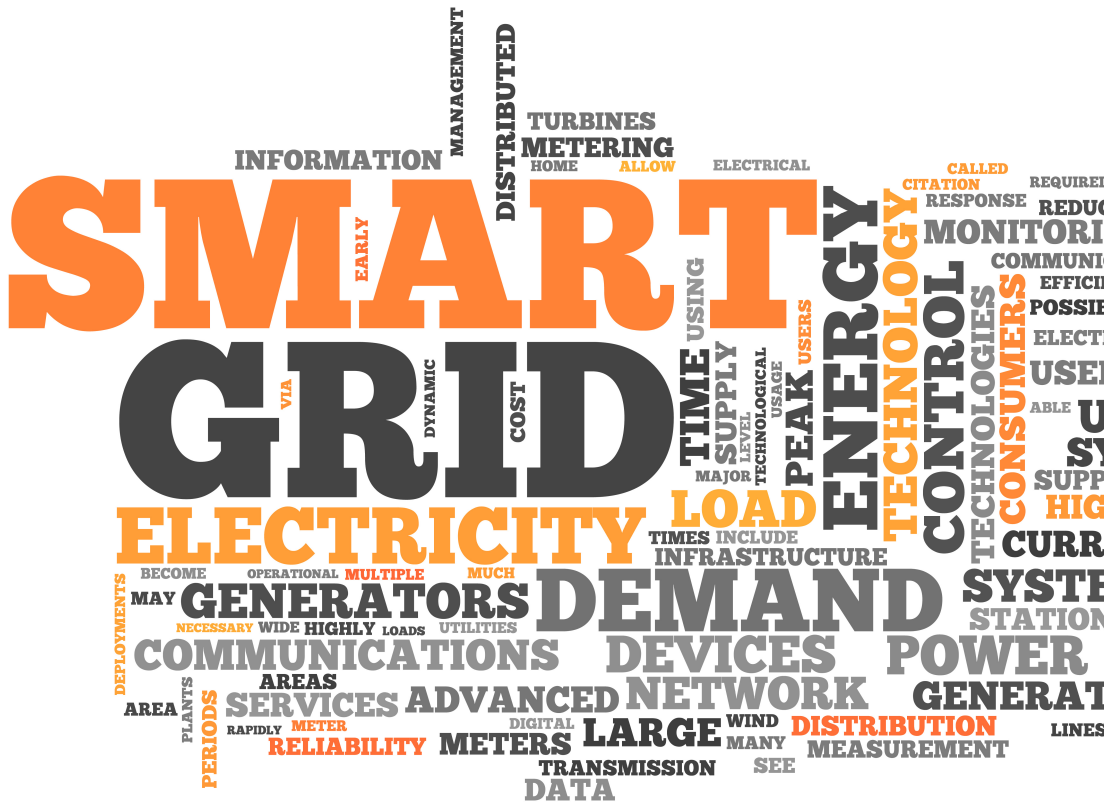
- In addition to technical research, interdisciplinary research areas, such as economics, finance, policy, and environmental science, will incorporate aspects of development and implementation.
- Systems engineering courses such as intelligent systems and adaptive controls, pricing for new and emerging power markets, financial engineering, socioeconomics, and studies on climate change and environmental implications are all relevant to this discipline.



MULTIDISCIPLINARY RESEARCH ACTIVITIES

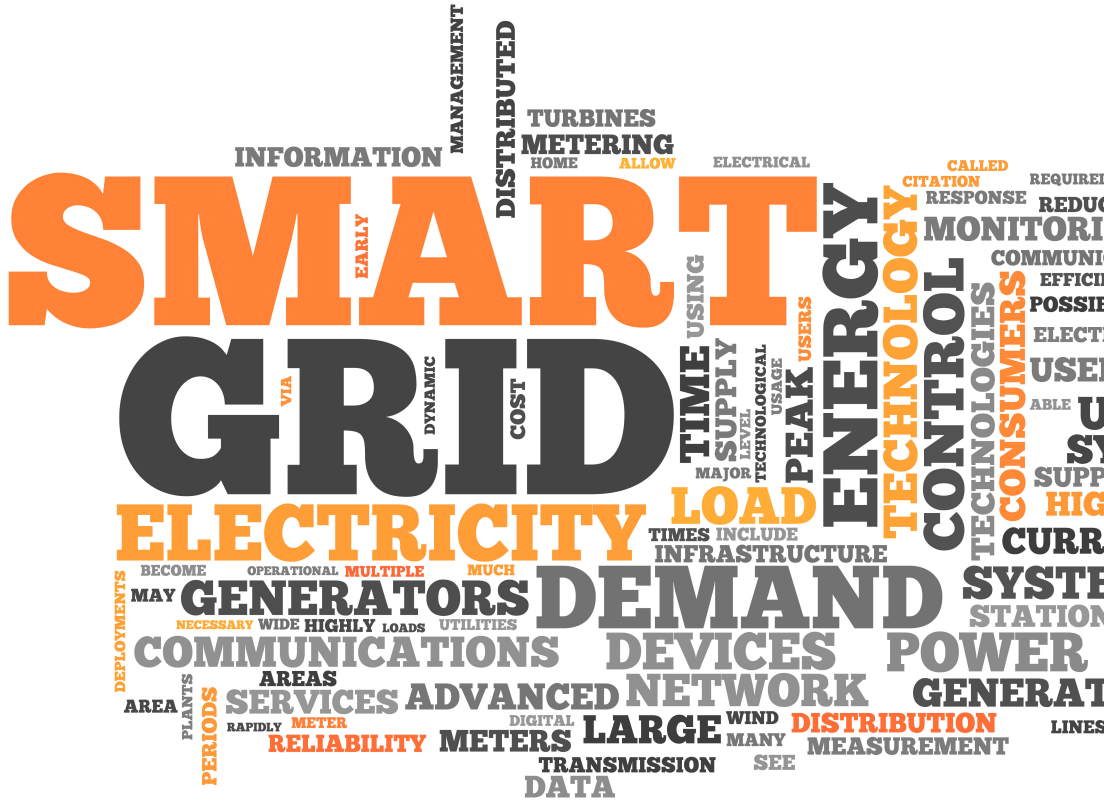
- *The following lists some of the activities which demonstrate the need for interdisciplinary research and education:*

- Development of advanced techniques for measuring peak load reductions and energy-efficiency savings
- Investigate means for demand response, distributed generation, and storage to provide ancillary services
- Conduct research to identify and advance the use of wide - area measurement and control networks
- Research on network asset management and architectures



MULTIDISCIPLINARY RESEARCH ACTIVITIES

- Test new reliability technologies, including those concerning communications network capabilities, in a grid control room environment
- Investigate the feasibility of a transition to TOU and real - time electricity pricing
- Development of algorithms for use in electric transmission system software applications



SMART GRID EDUCATION

- Creating a professional development curriculum is a vital component for the future power industry.
- Smart grid fundamentals will include defi nitions, architecture, metrics of performance requirements, discussion of development of analytical and decision support tools, as well as RER.
- Grid design will be based on cross boundaries of knowledge in communication theory, optimization, control, social and environmental constraints, and dynamic optimization techniques.

SMART GRID EDUCATION

- *Desired elements of the curriculum have been identified to facilitate the development of the smart grid include:*

1. Direct digital control
2. Roles of system operators
3. Power systems dynamics and stability
4. Electric power quality and concomitant signal analysis
5. Transmission and distribution hardware and the migration to middleware

SMART GRID EDUCATION

6. New concepts in power system protection
7. Environmental and policy issues
8. Reliability and risk assessment
9. Economic analysis, energy markets, and planning

SMART GRID EDUCATION

- *Course curriculum requires the following key features:*

- Planning and operation under uncertainties
- Use of real - time measurements, techniques and tools such as PMUs and SE for analysis of stability, reliability, and efficiency.
- Renewable energy with vulnerability and penetration strategies and associated storage technologies
- Performance measures and issues which include sustainability, power quality, interoperability, and cyber security

SMART GRID EDUCATION

- Development of new adaptive and stochastic optimization techniques that will facilitate resource allocations and scheduling such as unit commitment, restoration, and reconfiguration
- Marketing and pricing ancillary services and business cases for smart grid deployment
- You can find a sample syllabus for a smart grid fundamentals course will be divided into several modules in the SMART GRID Fundamental of Design and Analysis, by written James MOMOH

TRAINING AND PROFESSIONAL DEVELOPMENT

- Training and re-education must equip current and potential employees at all levels of grid development with knowledge of advanced cyber security tools and technologies for critical controls systems, which the Department of Homeland Security has identified as top priorities.

- Industry experts and regulatory bodies are agreed in stating that resilience and cyber security are critical areas of concern for the future grid.

- This chapter has highlighted research and education in a proactive approach for achieving a robust, scalable power system network development.
- The importance of upgrading workforce skills and training the future workforce was emphasized.

DO YOU HAVE ANY QUESTIONS?

Thank you for your *time* and *consideration*