ETown Concept for Smart Grid Simulation and Demonstration Projects

West Virginia University

Program Overview

West Virginia University researchers are defining an innovative research and development program in "Smart Grid" simulation and deployment at community and regional levels. The program is based on a recommendation developed by WVU researchers in a Microgrid research planning workshop. The recommendation is:

> *Develop an **ETown** Smart Grid Simulation and Demonstration Program that **ties together physical and virtual demonstration testbeds** and integrates energy production and use, sustainable environments, human factors, and implementation and adoption of Smart Grid and Microgrid technologies.*

The ***ETown*** concept is based on six integrated inter-related aspects of community life and economic enterprise:

- **E**nergy
- **E**nvironment
- **E**cology
- **E**lectronics
- **E**xperimentation
- **E**ducation

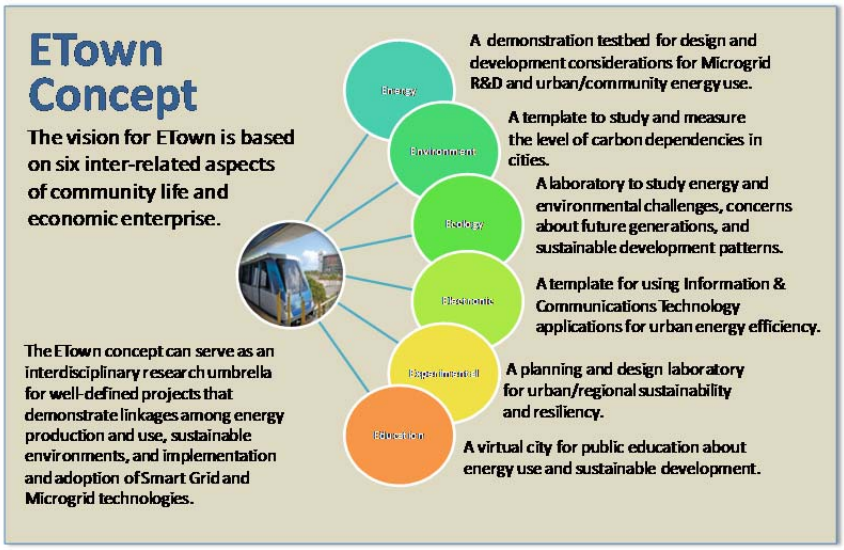

Figure 1. The ETown Vision

Through ETown, we can:

- Model and demonstrate energy efficient, environmentally responsible energy production, distribution, and use in a knowledge-based, clean-energy economy
- Establish virtual and real communities as laboratories for "living experimentation" in truly sustainable development and energy management – production, distribution and use – founded on Smart Grid/Microgrid implementation concepts
- Establish a research nexus for energy, environment, economic, engineering, design, and social research, including modeling and simulation exchange between virtual and real environments
- Establish a center for lifelong learning about energy use and community life.

Alignment with National Goals

ETown aligns with the U.S. DOE Smart Grid Implementation Strategy (SGIS). U.S. DOE emphasizes in its Smart Grid Research and Development Multi-Year Program Plan (MYPP), 2010-2014, that

> *"Advanced modeling and simulation will be required to test new technologies and overcome the traditional long timeframe in the electricity industry for testing, obtaining regulatory approval, and deploying new technologies in the national electricity grid,"*

including the need to

> *"…portray Smart Grid performance and economic impacts on both actual and representative segments of the U.S. distribution grid, in context with surrounding bulk generation and transmission systems, market structures, reliability coordination, and utility operations."*[1]

Potential To Develop ETown at West Virginia University

The WVU Advanced Energy Initiative (AEI) encourages and supports innovative interdisciplinary energy research and development projects. The ETown concept is an innovative approach to R&D in new grid technologies, their societal acceptance and deployment.

- ***ETown provides a unifying research framework*** for otherwise separate and isolated projects

Research Goal

The research goal for an ETown partnership is to sponsor, promote, and stimulate a range of new modeling, simulation, and visualization projects in energy systems development and management. Example research theme areas include:

- Modeling, simulation, and visualization capabilities for Smart Grid applications and sustainable energy whose analytical quality and relevance ***establish WVU as an international leader***.
- Systems for the ***support of the US DOE*** in forecasting R&D needs and impacts of proposed and in-process R&D, including training for analysts and decision-makers.
- Energy systems research that links ***modeling, simulation and application to real-world problems***.

Significance

ETown provides a real-world demonstration R&D testbed environment for issues of national significance:

- A multi-disciplinary laboratory for ***the integration of Smart Grid and Microgrid technologies***
- ***The "Branding" of innovative approaches*** to modeling and demonstrating Smart Grid and Microgrid applications for well-designed communities of the future
- The nature of ***human interactions with Smart Grid and Microgrid technologies***
- Guidelines for ***urban/regional sustainability and resiliency*** based on grid innovations
- Research templates for ***ICT applications for urban energy efficiency***
- ***Low-carbon city and regional footprints***

[1] U.S. Department of Energy, Office of Electricity Delivery and Energy Reliability, Smart Grid Research and Development Multi-Year Program Plan: 2010-2014, *Chapter 3.3 Modeling, p. 38.*

Partnership Development

WVU AEI will develop ***strategic partnerships*** with utilities, government agencies, and energy industry partners as well as economic development residential development partners to design, develop, and implement the ETown concept. The ETown partnership will select one or more methods for establishing ETown as a physical/virtual living laboratory for research about how ***sustainability and livability are affected by new grid technologies.***

Facilities and Capability Development

The physical ETown environment can be implemented in several ways, including:

- A built or re-built "livable" community, city or neighborhood scale
- A research park community
- A continuity of government / continuity of operations center.

Opportunity for WVU and Collaborating Partners

A Smart Grid is shaped by and greatly impacts our built environment and the way we live and work, tying it closely to sustainable communities concepts. ***ETown*** as a living laboratory ***enables concept exploration*** (e.g., where Microgrids may be best deployed), ***emerging technology testing and evaluation***, and development of system planning and delivery models for electricity, all of which are required ***to transform the nation's aging centralized power grid*** into a more efficient, more reliable, and more climate-friendly decentralized system.

A virtual Microgrid can model a physical Microgrid which can in turn provide data to improve the models underlying the physical Microgrid. Modeling, simulation, and visualization technologies are significant enablers for interdisciplinary research because they can unify visually mathematical models from participating disciplines (e.g., economics, engineering, consumer behavior, design, etc.). Running a virtual environment in parallel with a physical environment enables moving innovation swiftly to the real environment and solving real world problems in an optimized virtual environment.

Better decision support tools and new modeling capabilities will be needed because of the differences between current power systems technologies and next-generation, Smart Grid approaches to improving the electric grid. Successful deployment of Smart Grid depends upon simulation models that represent technology performance accurately and that enable performance evaluation in an environment that matches the real-world environment. Three key overarching challenges that must be met are

- Accurate models of engineering characteristics
- Control strategies, and
- Operation of a wide variety of Smart Grid assets with sufficient fidelity that options for the design and configuration of a Smart Grid can be explored and continue to evolve.[2]

The ETown concept can serve as ***a research and development umbrella*** that systematically links well-defined projects that demonstrate linkages among energy production and use, sustainable environments, and implementation and adoption of Smart Grid and Microgrid technologies. A Microgrid Demonstration Program based on the ETown concept will ***illuminate and lead thinking in Smart Grid/Microgrid technology application, policy issues, and regulatory mechanisms***.

[2] *Smart Grid R&D: 2010-2014 MYPP, p. 39.*

Summary

"ETown" is an environmentally conscious, energy efficient, "low-carbon footprint," knowledge economy, community-oriented program. It is a merging of virtual and real physical environments to explore and experiment with operational, social, behavioral, political/regulatory, environmental, and economic issues related to Smart Grid technology deployment and its adoption by civic, social, and industrial, and government entities.

The success of the ETown research collaborative depends upon the expertise, intellectual engagement, enthusiasm, and research and development resources of the participating organizations. It will, in effect, create ***a new research community with a collective focus*** on the use of modeling, simulation, data integration, and visualization to solve important social, economic, scientific, and engineering problems in energy systems. The partnership focus will have a transformational impact on the broader scientific and engineering community. Properly focused and resourced, it will be established as a leading research center in Smart Grid and related applications for sustainable energy use in well-designed communities.

For additional information, please contact:
Floyd K. (Rusty) Russell — rusty.russell@mail.wvu.edu
Research Program Coordinator / Homeland Security Liaison — 304.293.5037
Office of the Vice President for Research and Economic Development — 304.293.7498 (FAX)
West Virginia University
PO Box 6216
Morgantown, WV 26506-6216