

Possible Senior Design Projects

Related to Smarter Grid Issues in Sensors, Utility Home Area Network, PH&EV

Read “The Smart Grid: An Introduction” by the U.S. Department of Energy (DOE) [1]

“The electric industry is poised to make the transformation from a centralized, producer-controlled network to one that is less centralized and more consumer-interactive” [1]

Societal Problem Viewpoints - What are the large scale energy problems that society will face in the upcoming decades?

1. Society needs energy sources with less impact on the environment. Why should we examine:
 - a) the creation of low carbon power sources?
 - b) the incorporation of green energy resources into a home, business, campus, city?
 - c) the monitoring of green energy resources?
2. Society needs to use existing electrical power more efficiently. Why should we discuss:
 - a) informing the energy consumer about their energy usage?
 - b) controlling devices in a manner that minimizes energy consumption?
 - c) minimizing energy usage while enhancing the utility of the devices to the consumer?
 - d) responding to energy crises such as a summer heat wave without completely taking power away from some of the energy consumers?
 - e) ensuring security of the grid from intentional malice, natural disasters or simple begin neglect?
3. Society seems to desire a choice of how they obtain their power. What choices might be offered?
 - a) Encouraging the use of renewable energy at all energy production scales from small sensors and appliances (think phone or iPad) to residential homes to commercial buildings to utility sized sites.
 - b) Creation of devices, processes and technologies so that the consumer can store power similar to storing fuel in your vehicle gas tank.
 - c) Designing systems that can distribute power among a local area to minimize energy transportation losses.

In the above DOE web link, there are several stakeholder groups: consumer advocates, environmental groups, utilities, technology providers, regulators, and policy makers. Be aware of the context of the problem you attempt to solve. The viewpoints of the above stakeholders are rarely in agreement and each represents a context to what is most vital to “the question” at hand. Take a moment to read the various viewpoints to fuel your innovative thoughts. What is important to you as the new engineer creating innovative designs?

Design Idea Viewpoints - What can we create at Sac State that addresses some aspect of the broad smart grid and energy issues? (much of the following discussion is paraphrased from [1])

1. Smart Grid Tools. What can we do at Sac State about:
 - a) enabling technologies?
 - b) interoperability based on standards?
 - c) low-cost and low-power communication and electronics including sensors and instrumentation?

2. Grid Visualization Technology. What can we do at Sac State about:
 - d) real-time load monitoring?
 - e) load-growth planning?
 - f) responding to short term energy supply crisis?
 - g) integration of Advanced Metering Infrastructure (AMI) into the energy game plan of consumers and the utility managers?
 - h) use of real-time sensor data, weather information, grid modeling and geographical information?
 - i) ensuring security of the grid from intentional malice, natural disasters or simple begin neglect?

3. Energy Communication and Control Technology. What can we do at Sac State about:
 - a) enabling the two-way flow of electricity and information?
 - b) creating the capability to monitor everything from power plants to customer preferences to individual appliances?
 - c) ensuring security of the grid from intentional malice, natural disasters or simple begin neglect?
 - d) using smart meter information to better educate the energy user, to rely grid status information to local devices (electric vehicle, dryer, refrigerator, air conditioner,...)

4. Smart Grid Opportunities [1]: What can we do at Sac State about:
 - a) Allowing the seamless integration of renewable energy sources like wind, solar, hydroelectric and ...
 - b) Ushering in a new era of consumer choice...
 - c) Exploiting the use of green building standards to help "lighten the load"...
 - d) Making use of solar energy 24 hours a day...
 - e) Making large scale energy storage a reality...
 - f) Enabling nationwide use of plug-in hybrid electric vehicles...

The U.S. Department of Energy lists of five fundamental technologies that will drive the smarter grid:

1. Integrate communications, connecting components to open architecture for real-time information and control, allowing every part of the grid to both “talk” and “listen”.
2. Sensing and measurement technologies, to support faster and more accurate response such as remote monitoring, time-of-use pricing and demand-side management.
3. Advanced components, to apply the latest research in superconductivity, storage, power electronics and diagnostics.
4. Advanced control methods, to monitor essential components, enabling rapid diagnosis and precise solutions appropriate to any event.
5. Improved interfaces and decision support, to amplify human decision-making, transforming grid operators and managers quite literally into visionaries when it comes to seeing into their systems.

REFERENCES

- [1] United States Department of Energy, prepared 2008, "The Smart Grid: An Introduction", Available: <http://www.oe.energy.gov/SmartGridIntroduction.htm>