Chapter 36
Smart Software Applications for a Low Carbon Economy

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ABSTRACT

There are changes underway in the world energy and power systems because of climate change, which will result in smart and intelligent infrastructure for the new energy management and power system. Smart grid software will play an important part in making this new infrastructure intelligent. This chapter investigates software applications that have a potential to be developed for a new low carbon economy. In addition, this paper explains what the standard bodies and user groups driving the development of these new smart software applications. The chapter will also discuss the control points where software can be added to smart grid infrastructure for a low carbon economy.

INTRODUCTION

The energy and power system infrastructure created by the utilities are unidirectional and have largely remained the same with purpose of transmitting and distributing electricity from generators to consumers. The current grid is over engineered to withstand peak demands, which are infrequent and thus, making it inefficient.

Farhangi (2010) states on the current energy and power system infrastructure that "It converts only one-third of fuel energy into electricity, without recovering the waste heat. Almost 8% of its output is lost along its transmission lines, while 20% of its generation capacity exits to meet peak demand only (i.e., it is in use only 5% of the time)."

Climate change, increasing demand in energy and development of innovative new internet technology are converging with current grid to drive the development of new energy efficient smart grid to help mankind meet the challenges of climate change.

A Smart grid according to the United State Department of Energy (DOE) would have the following characteristics (source: www.netl.doe.gov/moderngrid/):

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1. Self healing – Sensors with controls to respond using intelligent software to predict, detect and respond to problems.
2. Motivate consumers to actively participate in the operation of the grid – Intelligent smart software connected to the energy network helping consumer's take better control of homes and business for a low carbon economy.
3. Resist attack – Fault tolerant and resistant to physical and cyber attacks.
4. Quality power – Software to help consumers choose quality of power at different prices.
5. Generation options– Accommodate wide variety of generation options, including green power.
6. Electricity market – Technology to provide real time price of energy to the market to mitigate energy demand and thus bringing more consumer and sellers to the electricity market.
7. Run more efficiently - ICT components to optimise assets, reduce costs, enable low cost generation and increase asset management visibility by removing bottleneck and congestion in the grid network. In addition, help with the reporting and strategic planning of the asset.

Smart grid would make consumers use energy more economically and is being linked to renewable energy targets and reducing carbon emissions. Smart grid should add functionality for monitoring, analysis, communication and control capabilities to maximize the efficiency and throughput to reduce the energy consumption for a low carbon economy. In addition, would provide visibility and pervasive control, to help utilities to transfer energy economically and efficiently. Smart grid would be based on advanced information and communication technology (ICT) components like microprocessor, software technology, communications and the internet (Tai & O'hOgain, 2009). These features are compared in Table 1.

Table 1. The current grid and the Smart grid with smart software (source: www.pjm.com)

20th Century Grid	21st Century Grid
Electromechanical/Analogy	Digital
One-way communications (if any)	Two-way communications
Built for centralized generation	Accommodates distributed generation
Radial topology	Network topology
Few sensor	Monitors and sensors throughout
"Blind"	Self-monitoring
Manual restoration	Semi-automated restoration and eventually, self-healing
Prone to failures and blackouts	Adaptive protection and islanding
Check equipment manually Emergency decisions by committee and phone	Check equipment remotely Decision support systems, predictive reliability
Limited control over power flows	Pervasive control systems
Limited price information	Full price information
Few consumer choices	Many consumer choices

These new ICT components are a set of devices that take measurements and respond to commands and communicate with each other and various control centers. In addition, these devices are also smart and react independently, collaborate and cooperate with other devices in a well coordinated manner. These new smart components, work in conjunction with the old components in the current infrastructure.

These new ICT components make the existing grid smart by adding software at control points. They add intelligence functionality as a new layer to the existing infrastructure for the development of new applications and new business process. Consumers and businesses will have access to timely and user friendly information to make smart choices around energy use, helping the utility business model will change, migrating away from regulated entities to supporting customer options and choices (Geisler, 2009).