Chapter 1
Optimized Energy Consumption and Demand Side Management in Smart Grid

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ABSTRACT

This chapter reviews prevailing methodologies and future techniques to optimize energy consumption. It discerns that smart grid provides better tools and equipment to control and monitor the consumer load, and optimize the energy consumption. Smart grid is essentially composed of smart energy equipment, advance metering infrastructure and Phasor Measurement Units (Synchrophaors) that helps to achieve optimized energy consumption. The chapter also places focus on demand side management and optimized energy consumption scheduling; and establishes that both, the utilities, as well as the users can play a vital role in intelligent energy consumption and optimization. The literature review also reveals smart protection, self-healing systems and off-peak operation result in minimizing transmission and distribution losses, as well as optimizing the energy consumption.

Abbreviation:

DSM: Demand Side Management
IT: Information Technology
AMI: Advance Metering Infrastructure
DERs: Distributed Energy Generations
DRM: Demand Response Management

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ECS: Energy Consumption Scheduling
ECA: Energy Consumption Algorithm
PMU: Phase Measuring Unit
PAPR: Peak to Average Power Ratio
HEC: Home Energy Controller
HEM: Home Energy Management
HAN: Home Area Network
ZNEBs: Zero Net Energy Buildings
DLM: Direct Load Management
DLC: Direct Load Control

INTRODUCTION

Smart grid is an emerging topic in today's research community. It provides range of solutions to optimize the energy consumption. It is the collection of conventional generation, transmission and distribution network, communication network, energy storage devices, distributed generation, advance network control, decision support applications and home energy management systems. In simple words, it is the integration of Information Technology (IT) with electrical power system to improve the power production and utilization (Fang, Misra, Xue, & Yang, 2012, Ghafurian, 2011). In order to improve the production, optimize the energy consumption, and to reduce the transmission and distribution losses, the existing system should be made efficiently (Fadlullah et al., 2011). To provide reliable and efficient as well as optimal energy supply to the end user, we need to change our traditional grid into smart grid. The concept of smart grid technology getting importance due to the fact that it can efficiently manage the consumers load according to the restriction imposed by the supplier. The reduction in energy consumption and the increase in the efficiency mainly depend upon the electric appliances in the residential, commercial and industrial area. Therefore, to achieve both of these goals, the existing appliances should be replaced by smarter ones (Stragier, Hauttekeete & De Marez, 2010). Smart grid technology is based on advance and smart control system that can utilize the potential of two way communication. In this new technology, a continuous and effective communication module needed between two control center i.e., one at the consumers end the other at grid end. It is the smart grid which can gathers information about all the ongoing actives of power supplier and can shape, monitor the consumers load by employing different controlling and monitoring scheme. The components of the smart grid i.e., advance metering infrastructure (AMI), demand response management (DRM), smart protection system, and self-fault detection and correction. Self-fault detection and correction can help in optimizing the energy consumption and can improve the system efficiency (Deng et al., 2011). Energy consumption and optimal energy management refers either to reducing energy consumption directly or shifting the high power appliances from peak hours to off-peak hours. In case of residential area the direct load reduction in energy consumption can be achieved by training the end users and by installing smarter appliances in that area. To shift peak load to off-peak hours, the utilities communicate with the consumers to inform them about high price per kWh in peak hours and incentivize them to shift the high load appliances to off-peak hours (Mohsenian-Rad, Wong, Jatskevich & Schober, 2010). To efficiently utilize the available power and to reduce the line losses the energy consumption or peak hours demand should be minimized because in peak hours when the