Chapter 4
Efficient Control Strategies to Optimize Electricity Cost and Consumer Satisfaction

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ABSTRACT

Increasing consumer demand of electricity is difficult for the conventional power system network to handle, regarding both cost and infrastructure. Instead of expanding the expensive infrastructure, power engineers are now focusing on improving efficiencies and effectiveness of existing power networks. This chapter specifically focuses on low cost electricity supply, by introducing the novel concept of digital energy management system in hybrid AC/DC micro-grid. It is assumed that grid is partially powered by time varying renewable resources. The concept of minimizing time average electricity cost is introduced by efficient utilization of these renewable resources and by making the load demands more flexible to operate while taking converter losses into account. Real time pricing model is introduced to elaborate the advantage of time-of-use pricing. Control decisions will be achieved by proposing a load scheduling and hybrid switching (LSHS) algorithm. This algorithm will be capable of supplying low cost electricity while serving the load demands under specific delay bounds.

INTRODUCTION

Developing new technologies such as; renewable generation, smart storage, demand side management and demand response are transforming the methods of consuming and producing energy (Strbac & Goran, 2008). By optimizing the energy resources and energy utilization, an energy-efficient electricity supply chain can be achieved, which can minimize the greenhouse effect and can also improve grid stability (Molderink, et al., 2010). Now a days, the major concern in power networks, is energy efficiency and the cost of energy generation. During the period of 1970 – 80, due to oil embargo first time the world

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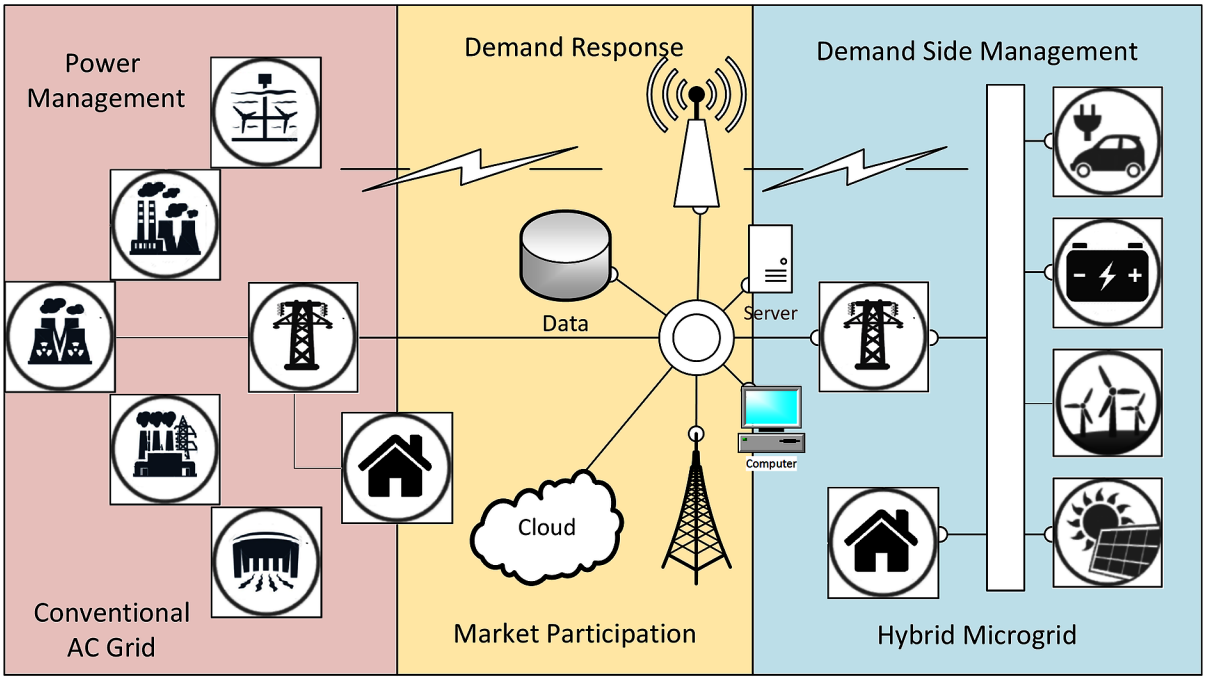
Figure 1. Smart power network



realized the importance of energy optimization. A new research era, regarding energy management, starts with the invention of time varying renewable energy generations (Simes, et al., 2012). But our legacy power system is unable to facilitate the increasing number of load demands and these renewable energy generations. The generating capacity is also increasing but at higher expenses (Niyato, Xiao, & Wang, 2011). To overcome this problem a new concept of smart grid is introduced to make power system intelligent and prone to the addition of renewable energy resources (Simes, et al., 2012). Another concept of hybrid AC/DC micro-grid is presented in Liu, Wang, Loh, and Chiang (2011) under the platform of smart grid which incorporates the advantages of both the AC and DC grids connected together by multi-bidirectional converters. The hybrid micro-grid optimizes the load demands and the generation by observing available renewable energy resources and the conversions inefficiencies under the constraints of power quality issues (Guerrero, Loh, Lee, Chandorkar, & Mukul, 2013). At the end, customers need an uninterrupted cheap electricity supply with the quality of service, which is only possible when the generation is from renewable resources and the load demands are delay tolerant (Chen, Sinha, Shroff, & B, 2012). A preliminary view of expected working areas in this field is shown in Figure 1. It illustrates the basic idea of working smart grid supporting micro generations, grid concept, utility applications and the consumer load demands. The objective of this research domain is to establish a working methodology in the area of smart grid optimization, which helps in:

1. Optimizing the efficiency of present generating power plants.
2. Optimizing the capacity of working grids.
3. Incorporating a number of renewable energy resources within grids.
4. Improving power system reliability and sustainability.