Chapter 3
Smart Metering and Pricing Policy in Smart Grids

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ABSTRACT

Pricing policy is one of the tools allowing the involvement of customers in the balance between the supply and the demand in smart grids. The present chapter aims at presenting the smart metering action including the bidirectional measurement of energy for smart houses equipped with renewable energies as well as the way a smart meter communicates data at the required timing to and from the control center. A typical bill establishment explaining how the net billing is produced along with a discussion about different pricing policies that the utility may adopt to reduce the peak load demand is also presented. The work is concluded by a typical simulation of a smart city modeled in LABVIEW software.

INTRODUCTION

Electricity networks are undergoing significant transformation. Clean, small, distributed energy and demand-side resources are challenging the traditional axiom of electricity from large, remote power generation facilities delivered over extensive transmission and distribution (T&D) infrastructure to consumers. This transformation is the result of a number of diverse and disruptive technology innovations. These innovations are changing the design of the electricity network, the flow of electricity in the system, and are driving utilities to forge a complex set of new relationships with stakeholders (e.g., end users, energy services companies, generators).

Smart grid is a network of technologies that delivers electricity from power plants to the end user and connects all supply,grid and demand elements via an effective communication system. The system is the amalgamation of engineering, information and communication technologies, and management of the power grid. The improvements in these technologies can be applied to enhance automation, foster integration of distributed generation from renewables, secure the power system architecture, and enable efðcient demand-side energy management (Recioui and Dassa, 2017;Chellali et al.,2014).

DOI: 10.4018/978-1-7998-4027-5.ch003

A modern electricity distribution system is more complex, has greater redundancy, and allows for greater choice over the manner in which users generate, deliver, and consume electricity. The information and communication technology in the smart grids enables it to make envisioned benefits a reality. These technologies encompass a wide range of operations, such as detecting and identifying faults and a quick response to power outages; providing consumers with near real-time information on the amount and cost of the power they use; improving the security of the system; and linking all elements of the grid to enable better decision making on resource use. With continual up-gradation and modifications these technologies will produce more and better quality data that will give the utilities more flexibility and new opportunities to improve their analysis in areas, such as customer load patterns and tariffs, and thus offer better services to their customers. The technology makes more efficient use of the grid to identify and correct supply and demand imbalances instantaneously and detect faults in a self-healing process that improves service quality, enhances reliability, and reduces costs (Gurlin, 2011; Chafai, 2013; Ouadi, 2013).

The main goal of smart grid is to promote active customer participation and decision making as well as to create the operation environment in which both utilities and electricity users influence each other. New technologies are being deployed, including advanced meters, controllable appliances (Graditi et. al.,2016), distributed energy generation and storage systems, i.e., plug-in hybrid electric vehicle batteries, stand-alone storage systems, and communications capabilities. New laws are being proposed to allow electricity consumers to access pricing information. New dynamic pricing policies are likely to be implemented at the retail level over the next years (Hubert and Grijalva, 2012; Yalcintas et. al., 2015). Energy management controllers (Hu and Li, 2013) are primarily designed to control load within a single home. They often take into account the utility data like load forecasts or ToU pricing for scheduling the household appliances. At the customer side, customers have the incentive to shift their electricity usage from high peak hours to low peak hours so that their electricity bills can be reduced (Jazayeri et al, 2005; Rahimi and Ipakchi, 2010).

Demand Response (DR) is a term to mean ‘‘changes in electricity usage by end customers from their normal consumption patterns in responseto changes in the price of electricity over time’’. Price based DR programs consider ñattening demand ñuctuations as an objective. Both the customer and the utility will get beneðts from DR. It encourages the customer to reduce the peak demand in response to the incentives (Ozturk et.al., 2013). A DR strategy coordinates the requirements between the energy provider and the customer (Medina et. al., 2010). At the utility side, by reducing high peaks, DR programs are helpful in protecting grid from the risk of outages, reduce the usage of spinning reserves during peak load periods, balance the supply demand ratio, and improve the grid reliability (Mahmood et al., 2016; Rasheed et al., 2016; Rasheed et al., 2015). Further DR beneðts include: (i) lower electricity price in wholesale market, (ii) adequacy saving and operational security, (iii) integrated resource planning studies, and (iv) improved choice for using DR (Qdr, 2006; Cappers et. al., 2016). Contrary to DR programs, the integration of renewable energy into residential units provides reliable, efðcient and most attractive solution nowadays. It can curtail electricity cost at residential premises and ñatten the peaks at utility premises.

Smart grid gives opportunity to the end users to bi-directionally communicate with the utility in real time, so consumers can tailor their energy consumption based on individual preferences like price concern, user comfort, etc. Based on different usage patterns of energy, the smart grid offers differential pricing scheme in order to avoid different risk factors like blackout or load shedding, thus allows the user to curtail energy consumption during peak demand. The objective of appliance scheduling in dif-

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