Chapter 14
Cyber-Physical System for Smart Grid

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ABSTRACT

A smart grid is an advanced utility, stations, meters, and energy systems that comprises a diversity of power processes of smart meters, and various power resources. The cyber-physical systems (CPSs) can play a vital role boosting the realization of the smart power grid. Applied CPS techniques that comprise soft computing methods, communication network, management, and control into a smart physical power grid can greatly boost to realize this industry. The cyber-physical smart power systems (CPSPS) are an effective model system architecture for smart grids. Topics as control policies, resiliency methods for secure utility meters, system stability, and secure end-to-end communications between various sensors/controllers would be quite interested in CPSPS. One of the essential categories in CPSPS applications is the energy management system (EMS). The chapter will spotlight the model and design the relationship between the grid and EMS networks with standardization. The chapter also highlights some necessary standards in the context of CPSPS for the grid infrastructure.

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INTRODUCTION

Energy and electricity are considered one of the most important sources entering in all areas of life at present. The revolutionary progress in our society and our economy depends entirely on how energy and electricity are managed. Energy transfer over long distances to meet the need for social and economic activities requires much effort. It needs electrical networks, which are substantial interconnected material networks that are the infrastructure and backbone of energy supply and use today (Yu et al., 2011). Recently, there is an increasing demand for green power generation and more energy-efficient use due to environmental concerns as well as limited non-renewable energy sources.

A report presented by (International Energy Agency,2014) defined as the world energy outlook report, indicates that the global energy demand is expected to grow by 37% by the year 2040, so, that energy efficiency is critical to relieving pressure on energy supplies while meeting increasing demands without shortage or interruption. Although renewable energy sources i.e. hydro, biomass, solar, geothermal, and wind are available, their harvesting is one of the most difficult challenges, so advanced technologies are needed to make this energy supply more reliable and safer. Internationally, several governments in many countries have adopted new energy policies and incentives using smart and modern technology, some of which have been widely disseminated. In the United States, the all-of-the-above energy strategy has been launched by President Obama. RE generation from wind, solar, and geothermal sources have doubled since 2008, and a 20% RE target by 2020 has been set (McCrone et al., 2020). In Europe, a 20% RE target by 2020 has also been set by the European Commission (Amin,2018). In China, a 15% RE target was set to achieve by 2020, and an even more ambitious target of 86% RE by 2050 has recently been set by the Chinese Government (Hove, 2020) (Amin, 2014).

According to what was previously mentioned, there is a need for a revolutionary rethinking of how to supply and use electrical energy efficiently and effectively. Smart Grids (SGs) are a new paradigm for energy supply and use efficiently, and intelligently integrating stakeholder behaviors and actions into the energy supply chain provides sustainable and safe electrical energy with high efficiency (Ali and Choi,2020). One of the most important elements of the success smart energy networks is the integration and smooth interaction of the infrastructure of the energy grid as physical systems, information sensing, processing, intelligence, and control as electronic systems. Besides, the use of cyber-physical systems (CPSs) enables us to address special integration and interaction issues in energy systems.

In Smart Grids that use information technologies in communications, computing, and control, a mechanism is needed to ensure the stability and security of the electrical networks. The process of integrating both advanced communications and control mechanisms into a physical network may be affected by some vulnerabilities and make it vulnerable to threats and breaches of network privacy. The security of these networks is often breached by manipulating data and adding other fake data to the smart grid control system (Gavriluta et al.,2020). CPS mechanisms play an important role in improving network defenses and detecting and mitigating attacks. AI technologies also aid in analysis processes and improve network reliability. The use of screening and assessment of contingencies strategies in the power system is contributed by a degree of protection to physical security. The use of contingency analysis (CA) helps to evaluate the security of the power system and covers faults, disturbances, and planned outages. the power systems steady-state and transient security analysis serves as a base of cyber-physical security for the smart grid. The cybersecurity system is one of the most important key elements in ensuring the confidentiality and security of the smart grid(Sun et al., 2016). In these systems, intrusion detection systems are used (IDS) firewalls to defend control centers and field devices against any external inter-

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