Chapter 32
Energy Infrastructure Security in the Digital Age

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ABSTRACT

In this article, the current application of information technology in the energy infrastructure security will be introduced. The digital system can help us to identify the framework of energy infrastructure security, characterize the energy network, generate the strategy of self-recovery and handle the uncertainty of identified damage. It will also integrate the comprehensive evaluation of population distribution, roadway safety, the constraint of transportation routes, transportation capacity and capability for the optimal emergency response planning with the minimal potential impact to the community for the management of intelligent and secure energy infrastructure.

ENERGY INFRASTRUCTURE SECURITY

According to the Department of Homeland Security (DHS, 2015), the energy infrastructure is divided into three interrelated segments, including: electricity, petroleum, and natural gas. The U.S. electricity segment contains more than 6,413 power plants (this includes 3,273 traditional electric utilities and 1,738 nonutility power producers) with approximately 1,075 gigawatts of installed generation. Approximately 48 percent of electricity is produced by combusting coal (primarily transported by rail), 20 percent in nuclear power plants, and 22 percent by combusting natural gas. The remaining generation is provided by hydroelectric plants (6 percent), oil (1 percent), and renewable sources (solar, wind, and geothermal) (3 percent). The heavy reliance on pipelines to distribute products across the nation highlights the interdependencies between the Energy and Transportation Systems Sector. The reliance of virtually all industries on electric power and fuels means that all sectors have some dependence on the Energy Sector. The Energy Sector is well aware of its vulnerabilities and is leading a significant voluntary effort to increase its planning and preparedness. Cooperation through industry groups has resulted in substantial information sharing of best practices across the sector. Many sector owners and operators have exten-

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sive experience abroad with infrastructure protection and have more recently focused their attention on cyber-security.

The definition of national security can be regarded as "…the protection or the safety of a country's secrets and its citizens…" (Macmillan Dictionary, 2015). Therefore, the national security depends on the government and its parliaments to protect the state and its citizens against all kind of national crises. The common elements of national security are military security, political security, economic security, environmental security, security of energy and natural resources, cyber-security, empowerment of women (Romm, 1993; Paleri, 2008; Lippmann, 1943; Buzan, Wver & Wilde, 1997;Diamond, 2010; Rollins, John, and Henning, 2009; Lemmon, 2013; Devanny & Harris, 2014; Davis, 2010; Taylor, 1974; US NATO Military Terminology Group,2010; Obama, 2010). Energy security is the central part between national security and the accessibility of natural resources for energy consumption.

The long-term solutions to enhance energy security have included the methods to reduce dependence on the energy source which is imported from the other countries, grow the supplier team, and exploit indigenous fossil fuel or renewable energy resources, and decrease the demand by energy conservation. The short-term solutions to enhance energy security are trying to satisfy the availability and consumption of petroleum, natural gas, nuclear power and renewable energy. Thus, the energy infrastructure is vital to local and national security. The potential attack and natural disaster may impact the energy security. Since the loss or damage quantity is very difficult to be predicted or even cannot be predicted, the following and corresponding rescue will be delayed and this will raise the public safety threats. Therefore, qualitative and quantitative decision-making tools, which rely on the historical expert system and the mathematical modeling, are becoming more and more necessary because they can provide the reasonable and scientific analysis and optimization in the energy security enhancement and energy infrastructure intelligence. In this chapter, the preliminary framework of mathematical model will be introduced. It will include the definition and characterization of energy network with the capability of self-recovery and the efficacy of the road map generation to handle the uncertainty of identified damage.

There are a lot of government agencies which are trying their best to achieve the target of energy infrastructure security. Besides the Department of Homeland Security, another organization which has always focused on the national infrastructure security is Federal Energy Regulatory Commission. Based on the website information from Federal Energy Regulatory Commission(FERC,2015), FERC is an independent agency that regulates the interstate transmission of electricity, natural gas, and oil. FERC also reviews proposals to build liquefied natural gas (LNG) terminals and interstate natural gas pipelines as well as licensing hydropower projects. The Energy Policy Act of 2005 gave FERC additional responsibilities as outlined and updated Strategic Plan. As part of that responsibility, FERC:

- Regulates the transmission and wholesale sales of electricity in interstate commerce
- Reviews certain mergers and acquisitions and corporate transactions by electricity companies
- Regulates the transmission and sale of natural gas for resale in interstate commerce
- Regulates the transportation of oil by pipeline in interstate commerce
- Approves the siting and abandonment of interstate natural gas pipelines and storage facilities
- Reviews the siting application for electric transmission projects under limited circumstances
- Ensures the safe operation and reliability of proposed and operating LNG terminals;
- Licenses and inspects private, municipal, and state hydroelectric projects
- Protects the reliability of the high voltage interstate transmission system through mandatory reliability standards