

Chapter 28

Geographic Information System for the Smart Grid

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ABSTRACT

This chapter presents fundamental concepts and purpose of the Geographic Information System (GIS) to understand, deploy, monitor, and control the Smart Grid (SG). To enable existing power grid for two-way electricity flow, there is a need to consider deployment of a number of advanced technologies. The SG will have a huge number of devices which are capable of information exchange across the whole electricity network. The GIS is a computer based tool which has the ability to display useful information primarily in the form of labeled digital maps. This capability is useful for transformation of conventional electric grid to a SG by finding suitable locations for timely and economically affordable installation of SG components. Although GIS is in use for electric utilities, new research and advancements in enabling technologies have made it more suitable to play a bigger role in the SG.

INTRODUCTION

The Smart Grid (SG) is an electricity network that intelligently integrates actions of connected users. These interactions are coordinated by the use of advanced digital technology. The SG uses information systems and digital communications for integration, automation, monitoring, and control. The Geographic Information System (GIS) is a software tool that provides decision support capability in the form of digital labeled maps, derived statistics, and reports which can be used to make informed decisions. It is a powerful tool used to model earth, environment, and features. It can help in deployment, monitoring, control, and enhancement of the SG.

Integrated Electronic Devices (IEDs) in SG collect measurements from across the whole electricity network to determine state and health of the system and perform coordinated actions to enhance efficiency, reliability, and compliance. Example actions, at distribution level, are distribution automation and advanced metering operation. The GIS is already used heavily in electricity distribution and telecommunication networks. It can play an important role in SG by presenting collected measurements and

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required, in-progress, or completed actions with time and location information, displayed primarily in the form of maps. This visualization of SG enables electricity utilities and consumers to better understand SG operation, communication, and control. Further, utilities can locate best places for installation of SG components with lower cost, monitor construction progress, and improve equipment utilization. The GIS benefits for the SG are summarized below (Environmental Systems Research Institute [ESRI], 2012b).

- Manage data about condition of utility assets.
- Utilities understand relationship of its assets to each other.
- Utilities understand relationship of networks with surroundings.
- Allows utilities to visualize the electric and communication systems.
- Determine optimal locations for smart grid components.
- Spatial context to analytics and metrics of the SG.
- Help control parts of the SG.

Despite above compelling benefits, there are many challenges associated while using GIS for SG to make important decisions. Knowing these challenges and addressing them will help to increase operational efficiency and network reliability. Utilities must ensure accuracy of their data update and data quality assurance procedures to avoid scenarios of incorrect data controlling the electric distribution system. An agreement on time difference between GIS database update and actual changes made in the system will help to reduce risk of something going wrong. Therefore adherence to standards for processing critical infrastructure data is necessary. Table 1 show abbreviations used in this chapter. Specific objectives of this chapter are as follows.

- To understand basics of GIS in the context of the SG.
- To know GIS benefits for the SG.
- To review issues and challenges in the use of GIS for the SG.
- To know evolving technologies as solutions.
- To identify research trends in the deployment of SG with GIS technology.

The layout of this chapter is as follows. Background section presents an overview of basics of GIS and SG integration. Next, integration and benefits of GIS for SG are explained in details and a case study is presented. The chapter concludes with a review of challenges, proposed solutions, and future research directions.

BACKGROUND

Geographic Information System

Initial use of maps to make a decision is traced back to the work of English physician Dr. John Snow to identify the source of cholera outbreak in London, in 1854. The term Geographic Information System is first used by English geographer Dr. Roger Tomlinson in 1968, known as the father of GIS. He worked for the development of Canada Geographic Information System (CGIS) program in 1960s and 1970s to assist in regulatory procedures of land-use management and resource monitoring. Later, the information

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