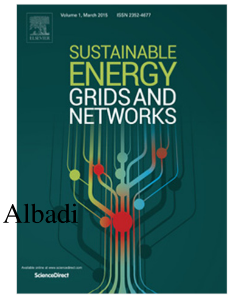
Accepted Manuscript



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PII: S2352-4677(17)30256-4
DOI: https://doi.org/10.1016/j.segan.2018.02.001
Reference: SEGAN 138

To appear in: *Sustainable Energy, Grids and Networks*

Received date : 23 October 2017
Revised date : 15 January 2018
Accepted date : 12 February 2018

Please cite this article as: A.D. Ashkezari, N. Hosseinzadeh, A. Chebli, M. Albadi, Development of an enterprise Geographic Information System (GIS) integrated with smart grid, *Sustainable Energy, Grids and Networks* (2018), https://doi.org/10.1016/j.segan.2018.02.001

ELSEVIER

Development of an Enterprise Geographic Information System (GIS) Integrated with Smart Grid

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ARTICLE INFO

Article history:
Received 00 October 00
Received in revised form 00 November 00
Accepted 00 December 00

Keywords:
Geographic information system (GIS)
Smart grid
Enterprise system
Renewable energy sources
On-line monitoring and control

ABSTRACT

This article uses a Geographical Information System (GIS) platform to create an on-line monitoring system in order to display real-time operational data measured at different points of an electricity network. The network with all its assets will be displayed on a geographical map. This provides the electricity utilities with a tool for monitoring, control, asset management, and demand side management in a smart grid. The system is tested as a pilot using the low-voltage network at Sultan Qaboos University (SQU), Oman. The article illustrates the pilot implementation of an enterprise GIS for application in smart grids, where the technical procedures of development phases of GIS data model and GIS web application have been described in details. The developed system produces spatial representation of the electricity network and its assets including renewable energy systems with their operational data on the map of existing electrical distribution network. It provides the utilities the ability to monitor the system components and their operation performance in real time with their location on a map.

1. Introduction

Nowadays, power sector in many countries is undergoing critical transformation through the creation of smart grids (Hosseinzadeh, et al., 2016). Introduction of a smart grid leads to closer mutual interactions between electricity utilities and their customers, who are connected via distribution systems. Efficient functioning of these segments are essential for sustainable growth in power sector and the economy (Silva et al., 2014). One aim of developing a smart grid is to enable the coordination of Distributed Energy Resources (DER)s. Such coordination is possible through an architecture that empowers monitoring the status of the grid, and controlling the DERs and other resources (Angioni et al., 2017).

In the past, the evolution of the distribution network toward the smart grid model has been essentially focused on two areas: automation of the medium-voltage network and deployment of smart metering. In most cases a deep investigation of the low-voltage network has been left out. This network segment will probably be the most affected by regulatory actions promoting intermittent renewable generations and distributed storage (Barbato et al., 2017). There is a need to develop tools for monitoring this segment of the network. Practical approaches using existing knowledge and commercially available technologies may be used to develop such tools. Geographic Information System (GIS) is a well-developed system that helps in abstracting physical features on the surface of the globe for the management, analysis, and display of geographic data. This data is represented by a series of information sets based on the specific project needs. Applications of GIS have demonstrated several new visions of decision making processes and information management and dissemination (Lin, 2017). Hence, GIS has been introduced to distribution companies for developing accurate database and improving power supply monitoring (Shin, Yi, Kim, Lee, & Ryu, 2011). Use of GIS enables distribution companies to easily access updatable databases which are required for monitoring and maintaining reliable quality power supply, efficient metering, billing and collection, and comprehensive energy audit (Environmental Systems Research Institute [ESRI], 2009).

In the last decade, several researchers investigated the application of GIS for electric utilities (Bock, 2006; Luan et al., 2015; Onyewuchi et al., 2015; Shin, et al., 2011; Short, 2013); GIS was used as a tool for demand side management in residential microgrid (Monika et al., 2015). Advanced application of GIS for wood pole asset management was reported in (Onyewuchi et al., 2015) where information on pole inspections and probabilistic pole loss estimates were integrated with

This work was supported by the Research Council (TRC) of Oman under the grant ORG SQU E1 11 009 Enterprises Transition to Smart Grid in Oman.