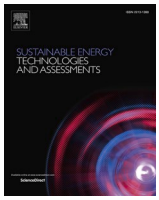
Sustainable Energy Technologies and Assessments 57 (2023) 103190

Contents lists available at ScienceDirect

Sustainable Energy Technologies and Assessments

journal homepage: www.elsevier.com/locate/seta



Dynamic load modeling for bulk load-using synchrophasors with wide area measurement system for smart grid real-time load monitoring and optimization

Mohammad Kamrul Hasan [a,*], Musse Mohamud Ahmed [b], Nur Farhana Wani [b], Ali Hashim Abbas [c], Lulwah M. Alkwai [d], Shayla Islam [e,*], A.K.M. Ahasan Habib [a], Rosilah Hassan [a]

[a] Faculty of Information Science and Technology, Universiti Kebangsaan Malaysia, Malaysia
[b] Department of Electrical and Electronics Engineering, Universiti Malaysia Sarawak, Malaysia
[c] College of Information Technology, Imam Ja'afar Al-Sadiq University, Al-Muthanna 66002, Iraq
[d] College of Computer Science and Engineering University of Ha'il, Ha'il, Kingdom of Saudi Arabia
[e] Department of Computer Science, UCSI University Malaysia, Malaysia

ARTICLE INFO

Keywords:
Dynamic load modeling
Parameter estimation
Phasor measurement units
Exponential dynamic load model

ABSTRACT

Bulk data modeling in a smart grid dynamic network has been performed using an automated load modeling tool (ALMT), an on-load tap changer, and exponential dynamic load modeling. However, studies have observed that a small parameter variation may lead to considerable variations in measuring grid big data. Therefore, this study presents dynamic real-time load modeling, monitoring, and optimization method for the bulk load. The case study was conducted on Sarawak Energy Berhad (SEB), Malaysia. The grid system's real-time data and load modeling achieved the objectives. Dynamic load model was achieved by using load response in MATLAB Simulink environment. This paper also includes new parameter estimations of the load composition at the selected bus. The simulation results of load models were compared with the recorded data by applying an event of bus tripping time interval. The Least Square Error Method was used to converge the estimated parameter values on load composition and compared with the actual recorded data until optimized load models were achieved. This work is a precious and significant contribution to utility research to identify, monitor, and optimize the most appropriate representation of system loads.

Introduction

Load modeling is crucial to power system analysis, planning, and control [1–3]. It started to attract power engineer attention when the blackout incident happened in Sweden in 1983 due to the inappropriate representation of system loads. Development of the existing load in the grid leads to significant changes in the transmission and distribution network, especially in power demand [4,5]. Electricity consumption in Malaysia is rising in every sector of industrial, commercial, and residential [6,7]. The increasing power demand forced utility companies to improve grid reliability by preventing the grid from operating beyond its capability. Therefore, it is required to have load modeling by practicing the real data and load models to secure reliable power system operation. Dynamic load brings a meaning of load with a large voltage that varies in current, power, and voltage, such as induction motors. Induction motors lead to dynamics and are transient to the power system since it has a high start-up current that can trigger frequency and voltage fluctuations [8–10]. Voltage instability happens when the power system cannot preserve steady-state voltage because of high load demand, faults in operating conditions, and the distribution system's unable to encounter the demand of reactive power to the load. Due to that, it can be heavily loaded on the generation or transmission, equipment failure to customer's load, bulk load, and the worst have vanished on important data [11,12]. Due to that, past research on static and dynamic load characteristics, load modeling, and system performance involved the bulk load in the system. Load modeling was studied by evaluating voltage stability to make the solution considering economics, reliability, and security [13]. However, in handling this method, load characteristics are severe. They must be simulated and assessed by considering the dynamics of the

* Corresponding authors.
E-mail addresses: mkhasan@ukm.edu.my, hasankamrul@ieee.org (M.K. Hasan), shayla@ucsiuniversity.edu.my (S. Islam).

https://doi.org/10.1016/j.seta.2023.103190
Received 1 September 2022; Received in revised form 27 March 2023; Accepted 30 March 2023
Available online 10 April 2023