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Long-term electrical energy consumption formulating and forecasting via optimized gene expression programming

S. Hr. Aghay Kaboli [a, **], A. Fallahpour [a], J. Selvaraj [a], N.A. Rahim [a, b, *]

[a] University Malaya Power Energy Dedicated Advanced Centre (UMPEDAC), Level 4, Wisma R&D University Malaya (UM), JalanPantai Baharu, 59990, Kuala Lumpur, Malaysia
[b] Renewable Energy Research Group, King Abdulaziz University, Jeddah, 21589, Saudi Arabia

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ABSTRACT

This study formulates the effects of two different historical data types on electrical energy consumption of ASEAN-5 counties. On this basis, optimized GEP (gene expression programming) is applied to precisely formulate the relationships between historical data and electricity consumption. The optimized GEP is a more recent extension of GEP with high probability of finding closed-form solution in mathematical modeling without prior knowledge about the nature of the relationships between variables. This merit is provided by balancing the exploration of solution structure and exploitation of its appropriate weighting factors through use of a robust and efficient optimization algorithm in learning process of GEP. To assess the applicability and accuracy of the proposed method, its estimates are compared with those obtained from ANN (artificial neural network), SVR (support vector regression), ANFIS (adaptive neuro-fuzzy inference system), rule-based data mining algorithm, GEP, linear and quadratic models optimized by PSO (particle swarm optimization), CSA (cuckoo search algorithm) and BSA (backtracking search algorithm). The simulation results are validated by actual data sets observed from 1971 until 2011. The results confirm the higher accuracy of the proposed method as compared with other artificial intelligence based models. Future estimations of electrical energy consumption in ASEAN-5 countries are projected up to 2030 according to rolling-based forecasting procedure.

1. Introduction

Today, existing grids are under pressure to deliver the growing demand for power, as well as provide a stable and sustainable supply of electricity. These complex challenges are driving the evolution of smart grid technologies. Since the smart grid is taken as the future power grid development goal. The construction of the smart grid will exert significant impacts on the electric power industry. In smart grid environment, the capacity of DGs (distributed generators), T&D (transmission and distribution) system's efficiency will be optimized, thus it brings a challenge to the grid's stability while storing the electricity for future use has lots of difficulty and requires huge investment. Improper and inaccurate forecasts on this area will lead to electricity shortage, energy resource waste, loss of profit due to the penalty paid for under/over estimate of electricity consumption and even grid collapse. Therefore, accurate electricity demand forecasting is essential to move towards the smart grid technology [1].

According to the time horizon, the electricity consumption forecasting is classified as short-term, medium-term and long-term forecasts.

Short-term forecasting (several days ahead in hourly steps) has attracted substantial attention due to its importance for power system control, economic dispatch and the order of unit commitment in electricity markets.

Midterm forecasting (several months ahead in weekly or longer steps) is especially interesting for companies operating in a deregulated environment, as it provides them with valuable information about the market need of energy, scheduling the maintenance of the units, the fuel supplies, electrical energy imports/exports.

Long-term (years ahead in annual or longer steps) forecasting has been always playing a vital role in power system management

* Corresponding author. University Malaya Power Energy Dedicated Advanced Centre (UMPEDAC), Level 4, Wisma R&D University Malaya (UM), JalanPantai Baharu, 59990, Kuala Lumpur, Malaysia.
** Corresponding author.
E-mail addresses: kaboli@um.edu.my (S.Hr.A. Kaboli), nasrudin@um.edu.my (N.A. Rahim).

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