

Automatic generation control of a future multi-source power system considering high renewables penetration and electric vehicles: Egyptian power system in 2035

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Abstract-

Egypt aims to diversify electricity generation sources and targets 42% of its power capacity through different renewable energy sources (RESs) by 2035. Such an increased share of RESs will make grid operation and control more tedious and may have a negative impact on power system frequency stability. Therefore, this paper is the first study that studies the automatic generation control of future multi-source power systems (e.g., Egyptian Power System (EPS) in a future 2035 scenario) considering high RESs penetrations and electric vehicles (EVs). The RESs in this future scenario include photovoltaic plants, wind generation plants, concentrated solar power plants, and hydropower plants. The EPS also contains other traditional power plants based on fossil fuels (i.e., coal, oil, and natural gas) and nuclear power plants. Moreover, this study investigates the effect of participation of EVs in enhancing the frequency stability of the future-scenario EPS. Furthermore, this study proposes a fractional-order proportional integral derivative (FOPID) controller for load frequency control (LFC), and its parameters are tuned using RUNge Kutta optimizer (RUN), which is a new optimization algorithm. To assess the FOPID controller performance, it was compared with a proportional-integral-derivative controller, proportional-integral controller, and integral controller. The results showed the positive effect of EVs' participation in frequency regulation of the future-scenario EPS, the effectiveness of RUN optimizer in LFC application, and the superior performance of the FOPID controller over its peers of controllers used in the literature in improving frequency stability through reducing frequency deviations caused by different disturbances and under various power system conditions.

Index Terms- automatic generation control, Egyptian power system, electric vehicle, FOPID controller, frequency regulation, load frequency control, renewable energy sources.

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