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Editorial

Power System Planning and Quality Control

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The optimum planning of the electrical power expansion and, accordingly, controlling the power quality are recent critical issues in power management. This is especially important due to increasing growth of renewables, distributed generators, and growing application of novel technologies such as light-emitting diode (LED) and related power electronics, etc. The analysis of power quality along with power planning plays a key function in managing the generation, transmission, and distribution of electrical power, and maintaining the quality of the delivered electricity to the customers.

Currently, the solutions to power systems planning lie in a wide range of techniques, covering linear and non-linear optimization and nature-inspired computation, as well as novel machine learning techniques as deep learning. Similarly, power quality analysis and control covers a wide range, from classical signal processing techniques to novel AI-based event detection, and classification techniques by deep learning models.

This Special Issue is a cherry-picked collection of five articles dealing with power system planning and power quality. The articles presented in this Special Issue come from the collaboration of research teams in Austria, Egypt, Ethiopia, India, Iran, Japan, Thailand, and the USA. Here, we present an straightforward summary of the themes of the articles. In a nutshell, the article topics are as follows:

- **The costs of grid reinforcement due to future customers:** In the coming years, current grids of low-voltage power will be challenged by future customers, such as heat pumps, electrical cars, photovoltaic modules, etc. Thus, early quantification of grid reinforcements in the future is an essential operator task. Thormann and Kienberger [1], evaluate various current states of research techniques for quantification of the futuristic needs of grid reinforcement. They indicate that for accurate quantification there is an essence of the simulations for large-scale grids as thousands of low-voltage grids. Moreover, they evaluate the state-of-art studies for the application of customers' coincidence factors. Ultimately, an automatic simulation device for large-scale grids is developed wherein multiple grids properly apply customers' coincidence factors.

- **Integration of renewables in distributed generation:** In the context of distribution network expansion planning, Ayalew et al. have studied the integration of renewables in distributed generation [2]. Distribution system expansion planning is a paradigm of power planning with high socio-economic impacts with the capability of meeting load needs. However, it is challenged by many limitations in terms of operation, societal, and technical needs.The distributed incorporation of generators shapes modern power systems and results in significant financial and technological advantages. In a nutshell, it results in simple expansion planning of the distribution network, less power loss, and an enhanced profile of voltage. Ayalew et al. [2] use an analytical approach to proper planning design for expanding the distribution network of Addis North. They forecast the load demand for the whole decade of the 2020s. In an analytical evaluation, they have concluded that, in their forecasts, by 2030 distributed generation power will have the capability of covering 61.12% of the power requirements.

- **When deep learning predicts the yearly maximum load and the lifetime of the power plants have been considered as one of the constraints in generation expansion planning:** Dehghani et al. [3] deploy a deep learning-based network with bi-directional LSTM prediction of yearly maximum load. They also introduce the lifetime of the power plants in the context of generation expansion planning. As an implementation on a large-scale grid, the proposed technique has been implemented in the power system of Iran. On a test system, they have observed the cost reduction of generation expansion planning by 5.28%. For the power system of Iran, their observation for the generation expansion planning cost shows 7.9% reduction.

- **Deploying the systems of energy storage in generation expansion planning with consideration of renewables and full-year restrictions in an hour-to-hour balance of the power:** Diewvilai et al. [4] have proposed a technique for developing planning the expansion of power plants with consideration of systems for storing energy, renewables, and the restrictions for full-year hour-to-hour balance of power. Although obtaining a generation expansion plan possessing minimum cost, adequate reliability, and acceptable CO_2 emissions for the next few decades requires complicated multi-period mixed-integer linear programming (MILP), as well as massive computations for thousands of likely scenarios with many variables, Diewvilai and Audomvongseree [4] simplified the problem by breaking it into several LP subproblems rather than searching for a globally optimal solution. Their approach has been tested on Thailand's power expansion planning system.

- **Unbalanced voltage compensation:** Finally, Nakadomari et al. [5] propose a technique for the compensation of voltage unbalance using an optimal tap operation scheduling of three-phase individual controlled step voltage regulators (3ϕSVR) and load ratio control transformer (LRT). They show that the appropriate procedure of 3ϕVRs along with LRT effectively resolves the voltage unbalance. Moreover, they show the effect of the appropriate formulation on maintaining the problem.

In conclusion, via the presented articles, we observe a wide range of techniques and considerations for power planning and improvement of the power quality at the same time. Moreover, along with all the other factors, the consideration of the power quality is a strong measure in proper power planning. However, despite all the emphasis on the power quality measurements, it draws the least attention in power planning and power control. Thus, consideration of power quality in power system planning should be more emphasized and targeted by the researchers in this field.

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