

**Workshop on Energy Flexibility in Smart Buildings and
Smart Grids**

10 December 2021,

Instituto Superior de Engenharia do Porto,

Porto, Portugal



**Energy Flexibility
Smart Grid & Buildings**

**Overview of Distribution Systems Expansion Planning including
Distributed Energy Resources**

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Type of talk: Invited talk

Abstract:

Distributed energy resources integration in electrical distribution systems has been increased in recent years, bringing new solutions to provide sustainable energy with low environmental impacts. This trend is expected to continue in the next years, encouraged by global agreements, national and international policies, and government incentives to limit green-house gas emissions and alleviate climate change. Nevertheless, the massive integration of such resources directly impacts the operation and planning of electrical distribution systems. The keynote addresses the inclusion of distributed energy resources in the distribution systems expansion planning problem. Such planning problem defines the most economic expansion actions required to meet the growing demand, while maintaining a safe operation and guaranteeing the quality of the service for the users. The classic planning problem aims to optimize the location and size of substations and circuits as well as the fulfillment of electrical, operational, and financial constraints along a planning horizon. Different methods have been used to solve the problem such as heuristics, metaheuristics, and classic optimization techniques. Recently, the planning problem has become even more complex due to the ongoing transformation of the distribution system from a passive to an active network. Key factors of this evolution are the presence of distributed energy resources in the distribution network. Such resources can include wind turbines, photovoltaics, electric vehicles, energy storage systems, controllable loads, among others. Herein, an overview of the proposals applied to the modern planning problem are introduced, identifying and classifying current and future research in this area.

Related References:

- [1] T. D. de Lima, A. Tabares, N. Bañol Arias, and J. F. Franco, "Investment & generation costs vs CO₂ emissions in the distribution system expansion planning: A multi-objective stochastic programming approach," *International Journal of Electrical Power and Energy Systems*, vol. 131, no. February, 2021.
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- [3] J. M. Home-Ortiz, M. Pourakbari-Kasmaei, M. Lehtonen, and J. R. S. Mantovani, "A mixed integer conic model for distribution expansion planning: Matheuristic Approach," *IEEE Transactions on Smart Grid*, vol. 11, no. 5, pp. 3932–3943, 2020.

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- [5] T. D. de Lima, J. F. Franco, F. Lezama, J. Soares, and Z. Vale, "Joint optimal allocation of electric vehicle charging stations and renewable energy sources including CO2 emissions," *Energy Informatics*, vol. 4, Sep. 2021.
- [6] A. Tabares, J. F. Franco, M. Lavorato, and M. J. Rider, "Multistage long-term expansion planning of electrical distribution systems considering multiple alternatives," *IEEE Transactions on Power Systems*, vol. 31, no. 3, pp. 1900–1914, 2016.
- [7] J. F. Franco, M. J. Rider, and R. Romero, "A mixed-integer quadratically-constrained programming model for the distribution system expansion planning," *International Journal of Electrical Power and Energy Systems*, vol. 62, pp. 265–272, 2014.