Clustering-Driven Decision-Making in the Transition Process to Next-Generation Electric Distribution Grids

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Abstract

In recent times, the evolution of electrical networks has increasingly focused on integrating innovative technologies to ensure the rapid adoption of the "smart grids" concept. These provide a strong link between digital technology and classic technical infrastructure, facilitating an efficient, reliable and sustainable electricity distribution process between distributed generation sources and end users. The foundation of these networks is an integrated energy ecosystem that ensures a secure, economically efficient, and environmentally sustainable supply.

Decision support systems provide smart solutions based on data analysis, scenario modelling and resource optimisation. There is growing interest in integrating Artificial Intelligence techniques into these systems, which can significantly improve decision-making. These include supervised learning algorithms for energy demand forecasting, unsupervised learning (clustering) to identify critical network areas with energy losses or voltage-level problems, fuzzy logic for uncertainty management, and expert systems for decision-making based on heuristic rules. In particular, the application of Explainable Artificial Intelligence is becoming essential for increasing the transparency of automated decisions and facilitating their adoption in practice.

The presentation will address the above indicated aspects, also with exemplificative results taken from the projects finished or currently in progress regarding the impact of clustering-based decision-making on the transition process to the next generation of electric distribution networks.