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Active Demand and its Integration into the Distribution System with the Use of Metaheuristic Techniques: Opportunities, Conceptual Evolution, and Application Challenges

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Abstract

Non-conventional renewable energy sources integration into distribution systems, data science, and enabling technological infrastructures present formidable challenges in transforming distribution systems, particularly in accommodating active demand. With escalating energy demand emphasizing the need for dependable tracking and predictive methodologies. These methodologies are essential for managing Distributed Energy Resources (DERs) and digital infrastructure. Effectively monitoring active demand requires a comprehensive understanding of the transactional system concept, encompassing digital infrastructure, and decentralized demand. Despite the increasing prominence of metaheuristic techniques in demand response integration, existing literature predominantly focuses on specific techniques rather than providing a characterization of dynamic transaction integration for active demand. Technological advancements, such as smart meters and communication systems, propel the evolution of the demand concept from rudimentary consumption measurement to active consumer involvement. This paper reviews the evolutionary trajectories of essential concepts in the energy sector, namely active demand, DERs, and transactive systems. Through in-depth analysis, Simultaneously, the paper systematically examines prevalent metaheuristic techniques in the literature, specifically focusing on their role in integrating and predicting the behaviors of active demand and DERs. The paper presents a methodology that, if utilized as a roadmap, would facilitate the evidence of stages required for the integration of DERs .

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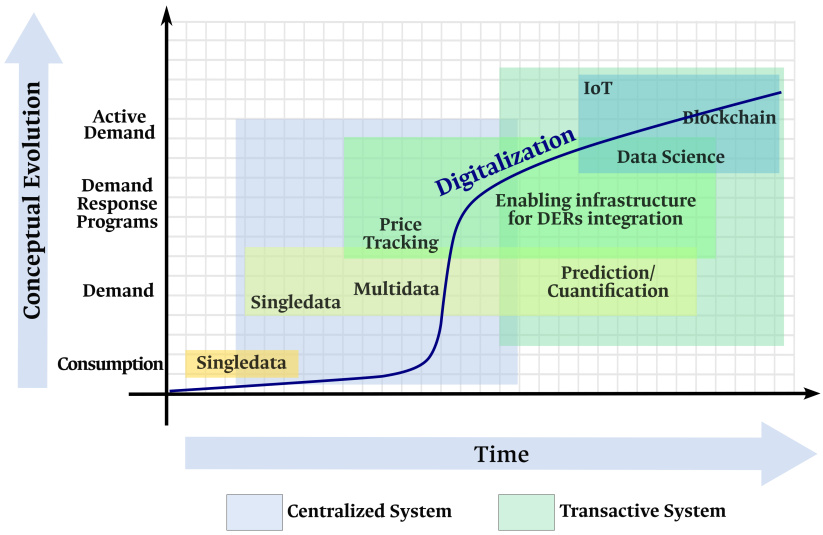

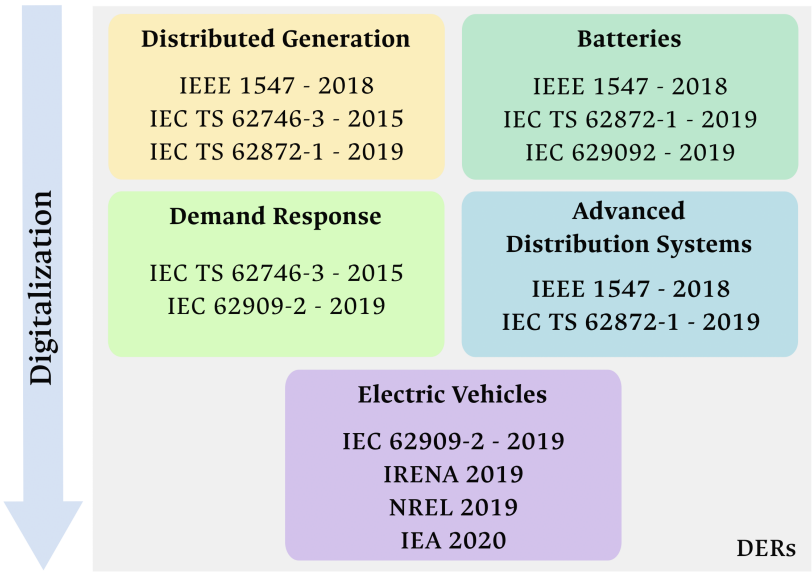

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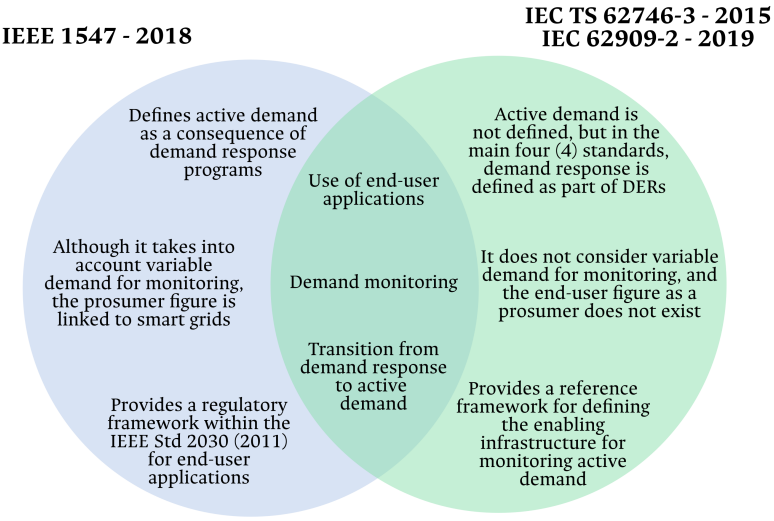

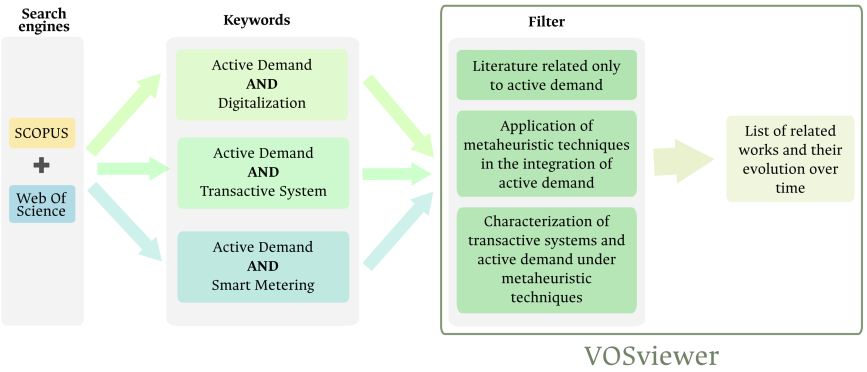

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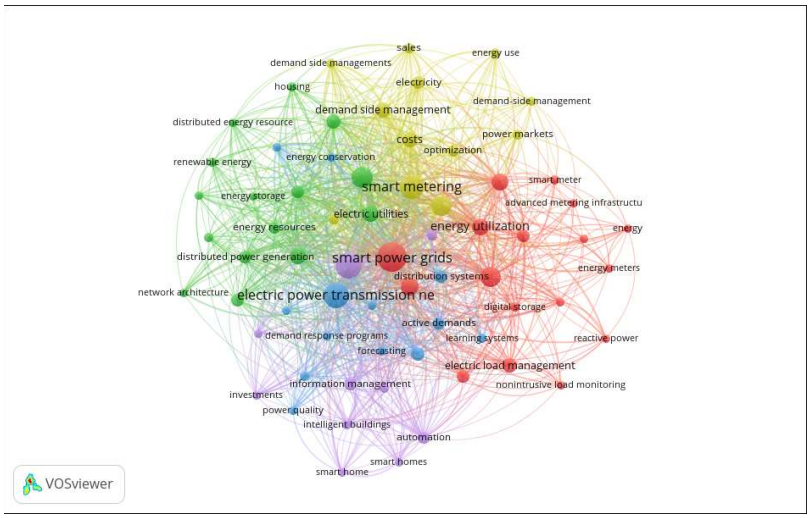

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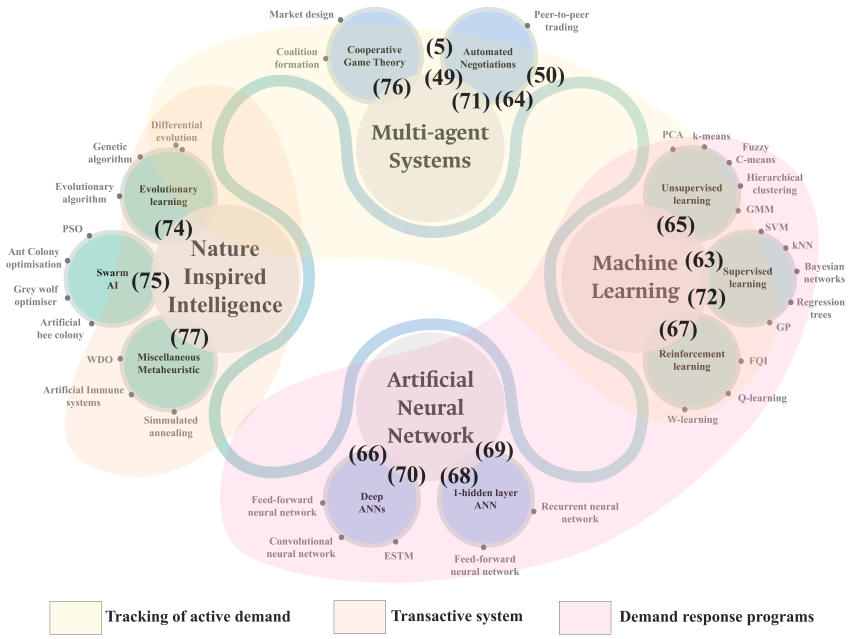

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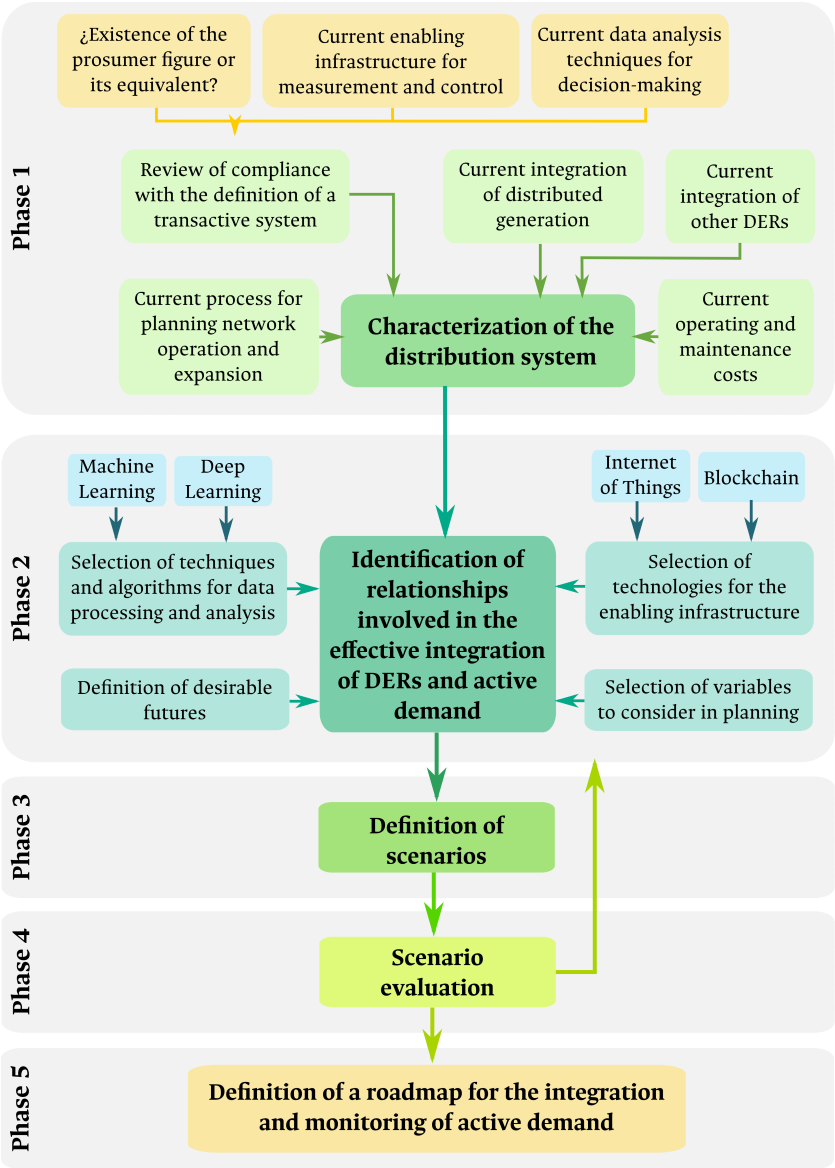
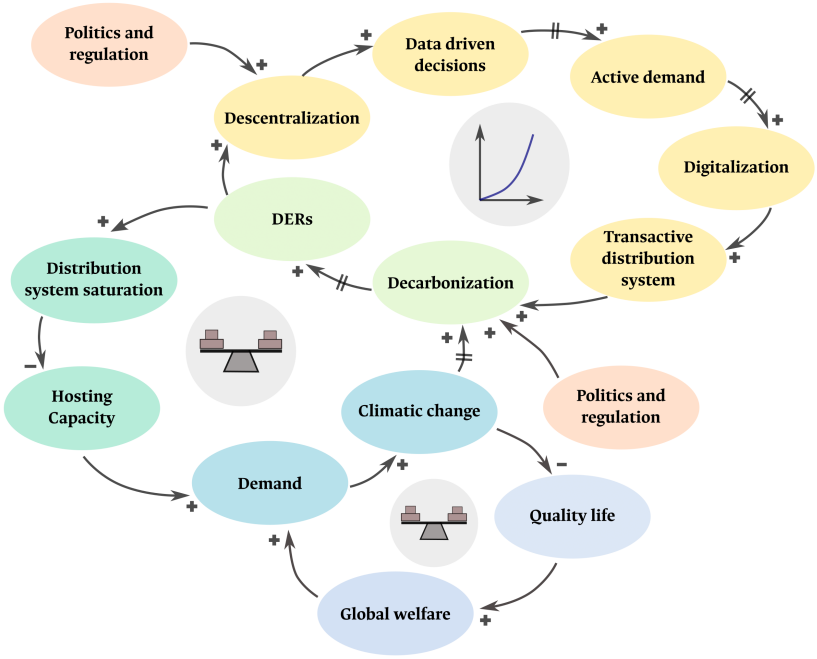
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