技術的および経済的制約を考慮したクリーンエネルギーを持続可能にする為の最適戦略

Sustainable supply and delivery of green energy through optimized strategies taking into consideration technical and economic constraints.

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Abstract

The transition of energy production from the traditional approach to the modern approach has gained immense attraction owing to global concerns about the environment. The conventional methods of generating power have led to serious climate changes, which has encouraged the implementation of several mitigating strategies. One of the main strategies is integrating renewable energy sources into existing traditional systems or establishing a completely renewable system that could extenuate greenhouse gas emissions incurred from the conventional power generating systems. Though the huge penetration of renewable energy resources can lead to a green environment, it comes with adverse repercussions, which requires proper planning to provide a reliable and sustainable supply. Of the many renewable resources available, wind and solar have been extensively used due to their emerging technologies and become a hot topic among researchers worldwide with the solvable challenge of intermittent phenomena. The integration of their relevant technologies in the power system, particularly in distribution networks comprising storage system devices, is considered an efficient and complementary approach. Their well-managed configuration and scheduling via optimal arrangement harvest an effective and reliable power delivery scheme for end-users while saving cost for utility managers. The quest for a sustainable energy transition is therefore increasing worldwide by effectively decarbonizing the energy supply mix in line with the United Nations Sustainable Development Goals (SDGs). The integration of utility-scale intermittent energy resources is directed towards addressing the technical, economic and environmental issues confronting the modern energy supply. In addition, overcoming the grand challenges of sustainability is not limited to electric energy production but also the transportation system, which accounts for around one-fifth of global carbon dioxide (24%) emissions worldwide, where about 70% causes by road transport. Thus, electric mobility, particularly the use of electric vehicles (EV) and electric buses in a frame of V2G and G2V capability, has gained enormous attention in many countries. Renewable energy integration appears to be a promising approach for developing countries, particularly Afghanistan, where there is a mass exodus of unreliable and frequent outages in distribution and transmission networks. With a closer look, wind and solar energy production capacity in Afghanistan is a motivation for stepping up the country's power sector to improve the power performance and self-dependency in electric energy production. Lastly, the fulfilment of the energy demand leads to country's development so that investments and industries will start significant activities, and the spark of the country's economic revolution will be ignited. This doctoral dissertation seeks to present the concerns above and validate their purposed solution mechanisms, algorithms, and relevant technical, economical, and environmental analyses based on multiple simulations in MATLAB software environment. Assigned objectives such as voltage regulation, stability, energy loss, renewable energy penetration, cost-saving, greenhouse gas emission and several other techno-economic factors have been optimized in the search space of multiple constraints. Finally, successful optimization results have been accomplished and the results technically evaluated and elaborated in different illustrations and tables in each chapter which is product of a published article in reputable and institutional esteem recognized journals.

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