Perspective

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International Journal of Advanced Research in Electrical Electronics and Instrumentation Engineering

2022
Vol.5 No.12:60

Resilience of a Power Network Using Renewable Energy

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Received date: November 21, 2022, Manuscript No. IJAREEIE-22-15696; **Editor assigned date:** November 23, 2022, PreQC No. IJAREEIE-22-15696 (PQ); **Reviewed date:** December 05, 2022, QC No. IJAREEIE-22-15696; **Revised date:** December 15, 2022, Manuscript No. IJAREEIE-22-15696 (R); **Published date:** December 22, 2022, DOI: 10.36648/ijareeie.5.12.60.

Citation: Li I (2022) Resilience of a Power Network Using Renewable Energy. Int J Adv Res Vol.5 No.12: 60.

Description

One of the most promising alternatives to conventional fossil fuels, which have a negative impact on the environment, is renewable energy. Hybrid Renewable Energy Systems (HRESs) that are connected to a variety of renewable and non-renewable energy sources and storage devices have raised a lot of questions about how to deal with the unpredictability of renewable energy resources, provide reliable electricity, and reduce their reliance on fossil fuels. HRESs' optimal planning and operation are significantly aided by optimization techniques. Traditional deterministic optimization methods, on the other hand, are constrained by systematic uncertainties in environmental, economic, technical, and political factors. These difficulties necessitate integrated inexact optimization techniques that best size the hybrid system components in light of multiple uncertainties. An integrated inexact optimization framework is proposed and their potential applications in HRESs are discussed in this chapter, which provides an overview of the deterministic and inexact optimization techniques and their applications in HRESs.

Power Network

This examines the resilience of renewable energy powered power networks. First, the interval electrical betweenness metric is used to identify the critical nodes. Three distinct attack strategies are established on this foundation. Second, the interval DC power flow model based on uniform sampling and the pure topology model are established taking into account the functional and topological characteristics. In addition, the structure and function of the power network using renewable energy are evaluated in light of three different attack strategies. Finally, performance changes between an attack strategy based on interval electrical betweenness and a conventional power network using renewable energy are compared. The findings demonstrate that the power network utilizing renewable energy suffers significant harm from the interval electrical betweenness based attack. When compared to the results that could be achieved by each system operating independently, the economics and performance of paired renewable energy systems may be enhanced. There is a day/night complementarity in peak output that, for instance, can reduce grid congestion and permit for smaller transmission lines. Sitting solar and wind systems together can reduce overall transmission costs. In a similar vein, combining marine power stations and offshore wind turbines has been proposed as a means of lowering the construction and upkeep costs of each. Wind farms can use water pumped uphill by the excess generation of turbines at night to power hydroelectric systems during the day, which can then be used as energy storage units. These hybrid systems haven't been widely used yet, but they could be a way to get around the limitations of individual renewable systems. Because the failure of those systems will pose a significant threat to national defense and economic security, this is considered crucial. The majority of infrastructures are inseparable from the power system, so ensuring the safety of the power supply from the power grid is extremely important.

Renewable Energy

A long standing concern has been how to comprehensively and accurately assess the impact of integrating renewable energy into the power network. This has prompted researchers to investigate the resilience of renewable energy powered power networks and capacity to maintain a relatively stable network structure and operation when some nodes fail is referred to as robustness. Establishing a model that accurately describes the propagation path and mode of cascading failures in power networks is necessary before evaluating the robustness of renewable energy powered power networks. After that, critical nodes are found and attack plans are made. The change in the networks performance following an attack is used to determine the networks robustness. There are two main types of methods for building a power network model: function and structure. To depicts a robustness assessment framework for renewable energy powered power networks. There are three parts to the entire framework. To begin, the critical nodes of the network are identified, and three attack strategies to reenact failure scenarios are developed. Second, a pure topology model and an interval DC power flow model based on uniform sampling are used to take into account the structural and functional characteristics of the power network that uses renewable energy. Transmission capacity constraints and the limited operational flexibility of conventional generation technologies in current power systems hinder wind energy's rapid expansion and integration. To integrate and utilize more renewable energy without requiring a significant and timely upgrade of the transmission infrastructure, energy storage is an appealing option. Additionally, it could be viewed as a means of altering reinforcement plans. Due to the extreme uncertainty surrounding the generation of wind power, the task of evaluating projects for the deployment of energy storage is challenging. Based on information gap decision theory, this study proposes a robust techno economic framework for evaluating energy storage to deal with wind generation uncertainty. Based on the DC model of the power grid, the total social cost of the system, which includes the fuel and pollution costs of conventional generators and the curtailment costs of wind power, is optimized taking into account generator operational constraints and transmission system capacity limitations.

In order to maintain supply demand equilibrium in power systems, wind power's intermittency and variability necessitate the use of additional fast ramping power sources. Wind power integration into existing power infrastructure necessitates significant system upgrades or the installation of energy storage facilities due to the limited capacity of fast ramping generation technologies like hydro and pumped storage power plants. In addition, the utilization of energy storage facilities will increase the utilization of existing assets, increasing its interest in recent studies and making it an appealing option for capturing variability in wind power. Energy storage deployment necessitates long term assessments, particularly when it is considered as an option for deferring system reinforcement projects. Numerous studies evaluate the economic impact of storage devices in short term power system operation. In addition, planning future energy systems with a lot of intermittent resources is a much harder challenge. Storage devices that are combined or situated close to wind farms operate optimally in other studies. Energy storage system implementation's long term economic and system wide evaluation is presented in without taking into account transmission system capacity constraints. In a transmission network, storage devices can charge at low Locational Marginal Prices (LMPs) and discharge at higher LMPs. As a result, they can serve as an additional transfer capacity in a power network by providing a route for power flow from one time to the next at the same location.