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Stability Prediction in Micro Grid

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ABSTRACT

Traditionally, power generation was localized, with a single power plant supplying power to surrounding towns and using only fossil fuels, but as modernization began, increasing demand for electricity meant that many Blackouts, distribution imbalances, and unavailability of power supply have resulted in high energy costs also in terms of pollution.The idea of a micro grid is growing in popularity as a means of addressing environmental pollution and rising energy demands. The features of Micro grid differs significantly from those of the traditional grid because distributed energy sources (DERs) are typically interfaced with the utility grid by inverters. Stability of system is the capacity to withstand or endure.To improve the accuracy of predicting stability customer demand, machine learning and artificial intelligence techniques have been effectively applied to Micro grids.

KEYWORDS: Micro grid, Simulation techniques, System Stability

I. INTRODUCTION

The enormous and intricate electric power system is controlled by the power system community.Sharing various renewable sources has been, is, and will continue to define the network.The industrial advances and environmental concerns make the interconnection of renewable energy sources tendency toward the distribution network. Micro grids are local power systems of different size, operating inside the distribution systems.Microgrid development is a crucial and ess ential part of the smart grid. With distributed energy resources, it is a small-scale power system. A Micro grid is an assortment of electricity delivery system that includes loads and distributed energy resources and can be operated in a controlled, coordinated manner while connected to the utility grid or while off the grid. The power generators in micro grids use a variety of renewable energy sources, such as photovoltaic modules (PV), mini-hydro, small wind turbines, etc. As a result, micro grids can increase grid efficiency, solve the energy issue, and attract more and more attention. Stability in a power system is the ability of the system to maintain synchronism when constantly subjected to large disturbances. The enormous growth in the global population and economy, together with the rapid surge in urbanisation has great potential to raise the demand in energy consumption in the succeeding upcoming decades which automatically impacts the demand for higher electricity production. Micro grid, a next-generation electric power infrastructure, emerges as a prominent technology to satisfy such high-priority demands to improve the quality of modern human existence [1].Micro grids essentially assist customers in lowering their electricity bills. It also contributes to an increase in security measures implemented in the aftermath of natural catastrophes and other human-caused attacks. On the other hand, it ensures a large reduction in risks associated with the loss of human life and other physical infrastructure tied to traditional grid-related activities.It is a two-way energy distribution and transportation system that allows its customers to make energy-related decisions.Micro grids that use artificial intelligence (AI) are anticipated to eliminate the need for more power plants to distribute electricity. In addition, micro grids incorporate renewable energy resources that may be securely integrated into the grid to supplement the power supply. Expert Systems (ESs), Fuzzy Logic (FL) [4], Machine Learning (ML), and Deep Neural Networks (DNN) have transformed the power distribution process and serve as effective tools for design, simulation, fault diagnostics, and fault-tolerant control in the modern smart grid [3].Load forecasting (LF), power grid stability assessment, fault detection (FD), and micro grid security are a few instances of related problem space in micro grids. Massive amounts of multidimensional and high-dimensional data about the operation of the electric power grid are being gathered thanks to these crucial components.

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Massive amounts of data are used in AI techniques to build smart machines that are capable of performing tasks that require human intelligence. Making decisions quickly and accurately is made possible by AI techniques. In micro grid applications, artificial intelligence is defined as computers that mimic the cognitive processes of grid operators in order to develop self-healing capabilities. For the power system to be reliable and secure, it is essential to assess the stability of the power grid, which includes voltage stability, frequency stability, small signal stability, and transient stability. The ability to maintain an equilibrium operation state or quickly reach a new equilibrium state is referred to as power system stability[5].Adopting a system in which the related loads and generation are considered as a subsystem or micro grid is crucial for realising the potential of distributed generation.

Renewable energy sources like wind, solar, and hydropower can each effectively meet a portion of the world's energy needs. The micro grid technology enhances local energy security and presents significant power supply opportunities for remote communities. This technology significantly contributes to ensuring more secure energy by reducing the need to import energy. Due to the micro grid for renewable energy's connection to the utility grid, frequency regulation doesn't call for any additional work. The biggest problems with micro grids are stability, bidirectional power flows, modelling, low inertia, the effects of load perturbation, and uncertainty. Applications using distributed generators (DGs) have the potential to cause more problems than they can fix. Micro grids, or small-scale energy networks, are powered by renewable energy sources.

II. MICRO GRID CLASSIFICATION

A flexible micro grid must have the ability to import and export energy from and to the grid while managing the active and reactive power flows.Micro grids can be categorized into different groups as follows

SL. No.	Type of MG	Capacity range
1	Small scale	<10KW
2	Medium scale	10KW-1MW
3	Large scale	>1MW

2.1 Overview of micro grid classification

The operating modes of micro grids are known and defined as grid-connected, transited or island, and reconnection modes, which allow a micro grid to increase the reliability of energy supplies by cutting off from the grid in the event of network failure or poor power quality. The micro grid can be an AC power system, a DC power system, or a hybrid system in terms of power. Higher reliability, efficiency, and convenience in connecting to various distribution energy resources are all benefits of DC micro grids over AC micro grids.

2.2 Operating characteristics of Micro grid

The IEEE/CIGRE joint working groups have divided conventional power system stability issues into three categories: rotor angle stability, voltage stability, and frequency stability. These categories are based on the physical phenomenon of instability. The ability of generators to maintain synchronism following a disturbance is referred to as "rotor angle stability." It is the balance between the mechanical torque and the electro-magnetic torque of the generator rotor. The ability of the power system to maintain the constant frequency under various circumstances is referred to as frequency stability.It is the equilibrium between generation, load, and power loss. Voltage stability is the capacity of the power system to maintain constant voltage on all buses in the face of disruptions. On each bus, it is the equilibrium between the load demand and power supply. The analysis of power system stability issues heavily relies on the dynamic behaviour of synchronous generators, which is one of the three types of traditional grid stabilities. DGs serve as the primary source of electricity in the micro grid. As a result, the dynamic behaviours of the Micro grid are determined by the DGs' dynamic properties. DGs can be divided into two groups based on the interface modes: 1) DGs interfaced with inverters;

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2) DGs directly connected to Micro grid. Batteries, flywheel energy storage, small direct-drive wind turbines, micro gas turbines, PV, and other energy sources are all connected to the micro grid by inverters. While small hydro, diesel, and double-fed induction generators are connected to the micro grid without inverters. In order to build a Micro grid, renewable energy is typically used as much as possible. As a result, inverter interfaced DGs are frequently used in Micro grids, which significantly alters how they operate in comparison to traditional grids.

III. MICROGRID STABILITY ANALYSIS

For effective energy consumption, micro grids use a variety of artificial intelligence (AI) techniques, including machine learning, deep learning, and artificial neural networks (ANN). For load prediction problems, various DL algorithms are used.

For predicting the stability of the MG, a number of cutting-edge machine learning algorithms have been used, including Support Vector Machines (SVM), K-Nearest Neighbour (KNN), Logistic Regression, Naive Bayes, Neural Networks, and Decision Tree classifier. The MG dataset that was used in the study was obtained from the machine learning repository at UC Irvine. With the rapid growth in the world's population and economy, a high growth in the demand for electricity has been predicted. Thus, in order to minimise power loss, it becomes necessary to efficiently distribute electricity to homes and businesses. The possibility exists for micro grids to minimise these power losses during power distribution. Artificial intelligence and machine learning techniques have been successfully applied to MGs to increase customer demand prediction accuracy. Analysis and evaluation of the various machine learning algorithms are absolutely necessary in order to choose the one that will work best for MGs.

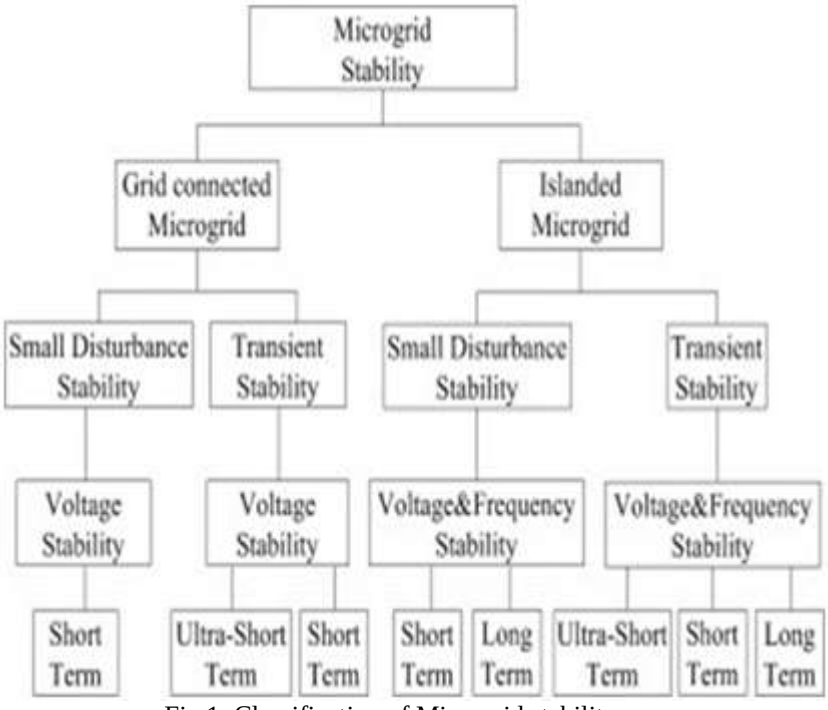

Fig 1: Classification of Microgrid stability

IV. CONCLUSION

The classification and analysis methodologies for micro grid stability differ significantly from those used for traditional grid. The microgrid stability classification methodology put forth in this paper takes into account a number of significant factors that affect the performance of the microgrid, including the mode of operation, the types of microgrid disturbances, the time frame, and the physical characteristics of the instability process. As a result, the classification methodology can provide a more accurate description of the features of Microgrid stability. The research framework for microgrid stability is established with the aid of the small signal stability, transient stability, and stability improvement methodologies.

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