A Review of Improving Power Quality in Smart Grid

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ABSTRACT

For remote or localised places, a microgrid can provide electrical power through a combination of distributed generation and local loads. One of the most recent developments in Egypt is the integration of microgrids with the power grid. Power quality issues such as voltage drops, growing usage of distributed generation, deep energy, and power loss can be solved by integrating smart microgrids and utility systems. Some common and serious power quality concerns connected with the integration of smart microgrids and utility systems such as voltage fluctuation and total harmonic distortion (THD) at varied solar irradiance and load situations are being investigated in this study. A MATLAB and Simulink code built for this study was used to model and assess the integration of smart microgrids and utility systems and the power quality issue at varying loads. At various irradiance levels, this study examines five voltage analysis scenarios and two THD situations. While the voltage drop % decreases with high solar irradiance, it increases with low solar irradiance at all load levels, according to the results. In addition, at both high and low loads, THD reduces as solar irradiation increases, and the reverse is true.

Keywords: *Power quality issues, integration of smart microgrids and utility systems, voltage fluctuation, solar photovoltaic system*

INTRODUCTION

The ability to store and analyse large amounts of data, as well as to run simulations quickly. Switches, reclosers, on-load tap changers, and other distributed actuators can help speed up operation. Electrical systems are evolving from conventional to intelligent, and as a result, numerous elements must be taken into account and adjusted to the new circumstances. "Power quality" is a critically significant topic in electrical systems

Redesigning the power quality aspects for future smart electrical systems is necessary because of changes in load characteristics and new challenges modern devices pose to electrical systems. Customers are becoming more aware and the cost of power quality improvement devices is increasing, so it is necessary to revisit the power quality aspects of future smart electrical systems. This would include the use of new instruments and the deployment of new energy sources in consideration of the new problems.[2] In addition to explaining the new tools and problems of smart grids, this chapter provides a brief history of power quality improvement devices before focusing on the "transition conditions of power quality issue" as a bridge to proceed to the new generation of PQI devices.

Today's power grid is a refinement of a technology that was initially implemented more than a century ago. Several new demands have been placed on it in the previous decade, and it is evident to many that the current basic architecture will soon be insufficient.As a result, we've integrated smart grid technology across the board. In a nutshell, a smart grid is an electrical system. With wit and wisdom. One of the goals of the smart grid is to make the network more effective, efficient, and flexible.As a result of these changes: Price decrease for network use; Adding more options for customers; An improvement in PQ, particularly in terms of the impact of voltage sag and the self-healing mechanism that results in higher reliability.

A new research area in the field of power systems is Smart Grid. Smart metres, smart substations, and distribution equipment are all part of the smart grid technology. along with a savvy new generation. This makes advantage of the most recent forms of electronic communication, As per the IEC 61850 norm It is linked to and integrates digital technologies from the modern world. In addition, the Smart grid is self-healing and attack resistant. In this paper, the significance of a smart grid is examined, as well as the notion of a smart grid and its basic components. Electrical grids are vast networks of interconnected towers and substations that transport and distribute vast quantities of electrical energy.

It has power generation facilities built into it. Generally, power plants are positioned away from the most densely inhabited sections of the country. To transmit the generated electricity, transformers step it up a notch or two. At a substation, it is reduced to a lower voltage. Generating stations, transmission lines, and distribution networks make up the three primary components of the electric grid.[4] The transmission line delivers energy to a distribution system, which then distributes it to all of the final users. Transmission lines connect the power plants with the distribution network. In order to lower and raise the voltage to the necessary level, step up and step down transformers are inserted in the transmission line. In order to reduce transmission losses, a step-up transformer is used to increase the voltage. A step-down transformer at the end of a transmission line reduces the voltage to the lowest attainable level. Distribution transformers, feeders, substations, lightning arrestors, utility wires, etc. then distribute the lowered voltage.[1]

It is well-known that technology must be upgraded to keep up with the pace of modern scientific breakthroughs, and therefore it is imperative to look at the current power system's difficulties or limitations.

LITERATURE REVIEW

Sunil Dubey and Rahul Meena Distributed energy resources, electric vehicles, plug-in hybrid electric vehicles, and smart devices have been shown to have a positive impact on the environment in recent developments in the field of power grid. It saves money. In addition, it's dependable. Smart controls can be used to better meet the requirements. In the absence of coordinated control, power distribution components and distribution transformers may have lower long-term service life.

Using an energy management system and a smart grid, this study provides a smart house that can be controlled without a consumer's involvement while minimising overheating and overloading of the distributed substructure. An architectural and operational paradigm for a residential Energy Management System (EMS) is also proposed in the paper. With the advent of the smart grid, the role of Distribution System Operators (DSOs) and Energy Service Providers (ESPs) will be brought to light in the architectural system (ESPs).

New standardisation research, SG policies in various countries, and essential standards for SG are examined in this paper. Playing a pivotal role in the global economy has been recognised by most governments and industry groups.of SG standards, and they've made significant progress in developing these standards. " It took the efforts of numerous national and international organisations to organise working groups to produce SG guidelines around the world. The chapter introduces some of the most significant SG standards bodies.

For the US government's energy strategy, the most important goal is providing energy supplies at a reasonable cost while also ensuring that the environment is not adversely impacted. The German SG plan focuses on the expansion of the SG's information and communication technology infrastructure, taking national and international standards into account. " The SG's communication medium is subject to cyber-attacks, making cyber security a critical component of the SG.3

Ilhami Colak; Ramazan Bayindir; and Seref Sagiroglu are the three researchers in this study (2020), It's the subject of this study. Many countries' national grids are quite old and rely on old-fashioned technologies for electricity generation, transmission, and distribution, making them difficult to upgrade.

Controllability and monitoring capabilities are also lacking in these systems, which is a problem. Smart grid technologies, on the other hand, include advanced tools for monitoring and controlling the electricity system in both directions from power stations to end-users or vice versa. Precautions can be done in advance so that many vulnerabilities and power collapses can be discovered. Smart metres and vehicle-to-grid connections, as well as the integration of renewable energy into the grid, are also included in the smart grid system's monitoring and management features. It is also possible to use electricity sources efficiently while minimising waste and illegal usage thanks to smart grid technology. A study of the effects of smart grid technology on national grids is presented in this document, as well as recommendations for authorities on how to transition from a traditional grid to a smart grid system.

Riddhi R. Pandya, Assistant Professor Falguni Bhavsar, and The word "power quality" is used to denote a wide variety of electrical power monitoring and measurement. Smart grid power quality issues are discussed in this study. Providing a steady, uninterrupted supply of power is referred to as power quality.

When discussing power quality, it is necessary to use precise vocabulary in order to accurately convey the scenarios and challenges at hand. With the right information and interpretation, fixing problems becomes easier. Equipment manufacturers and customers, not just the energy producer/distributor, play a role in determining some of the qualities of electricity.

Math Jan Meyer, H.J. Bollen, Jin Zhong, Francisc Zavoda Allyson McEachern To better understand how smart grids and power quality are linked, this article provides a general overview of their evolution, as well as a more in-depth look at some of the specifics. Real and virtual energy storage can be divided into two categories. The smart grid's power quality monitoring is explained in great detail.

Other topics covered in the study include: new devices, interference between devices and power lines, emission restrictions, voltage quality, immunity, and weakening the transmission grid. In spite of the many new power-quality difficulties posed by the smart grid, the installation of additional obstacles against the introduction of new technology should not be a result of them..

SCOPE OF POWER QUALITY

Devices that use electronic components are called "electronic A "low reference earth resistance" can be achieved by using separate grounding rods or systems for control and measurement devices. In many cases, these proposals are in direct conflict with the Electrical Codes and are not practical. Keep in mind that sophisticated avionics and nautical electronics [3] do not require a stable connection to the ground.A complete safeguard against poor power quality is not provided by uninterruptible power supplies (UPS). If you're looking for the best power quality protection from your UPS, there are a number of different solutions available. In truth, many low-cost UPS systems do not increase or condition the quality of the electricity; they are simply backup devices.

If your UPS has to provide power quality protection, such as voltage control or surge protection, check to see if the feature is built-in. In spite of additional gas supply from the Krishna-Godavari Basin, domestic coal continues to face supply challenges. We should be concerned about this because it is predicted to get worse. This has resulted in the need to import fuel from outside of India.

There is a major issue for the Indian Power Sector because of the failure to meet the scheduled objective from the coal blocks that have been secured. They claim that the major causes of this are a lack of permission, a lack of land acquisition, and infrastructure challenges. In India, coal is the primary source of energy generation. Indian Railways and Indian ports are anticipated to see a dramatic increase in the amount of coal transported within the country, as well as a dramatic increase in the amount of imported coal that may be unloaded. In both cases, India has a shortfall of capacity.

Boilers, turbines, and generators are all missing fundamental components, as well as adequate supply of equipment for the plant's "Balance of Plant," including coal stock handling, ash handling plants, and construction equipment.It is difficult for rookie project managers to select a trusted supplier, evaluate its progress and performance, and ensure that sustainable quality supply is maintained.

Transmission is limited to one gear. With a limited bandwidth and sluggish transmission rates, the SCADA (Supervisory Control and Data Acquisition) system currently used in the current power system often takes several seconds to respond to an urgent situation

RESEARCH METHODOLOGY

When a power breakdown occurs or an outage occurs on the distribution side or at the customer's location, the utility only learns about it after receiving a complaint. However, if a Smart Grid System is in place, utilities will be able to get information more quickly thanks to smart automated devices connected to the smart network. In a few nanoseconds, it will be capable of identifying the broken part and generating a detailed repair plan from the service personnel, allowing them to fix the problem more quickly.

To ensure uninterrupted power supply, it may be necessary to re-route the power flow. This type of equipment has been found to wear out over a lengthy period of time and needs to be replaced with new equipment at a certain point in time. These devices are made up of a variety of components, and each one is replaced. Smart Grid technology, on the other hand, is able to identify equipment that are nearing the end of their useful life and assist in developing a cost-effective replacement strategy. Additionally, users can plan their usage based on the information they have available to them. As a result, they will be able to save money and electricity, as well as improve their everyday habits. In addition, the Smart Grid system's ability to supply energy more quickly is its most important benefit.

Voltage Quality Improvements

With smart grids, one goal is to increase the electricity system's efficiency (or to keep it from degrading) without the need for massive investments in transmission lines and other infrastructure. Reliability, voltage quality, and affordability are just a few of the aspects that customers will see as benefits..

BLOCK DIAGRAM

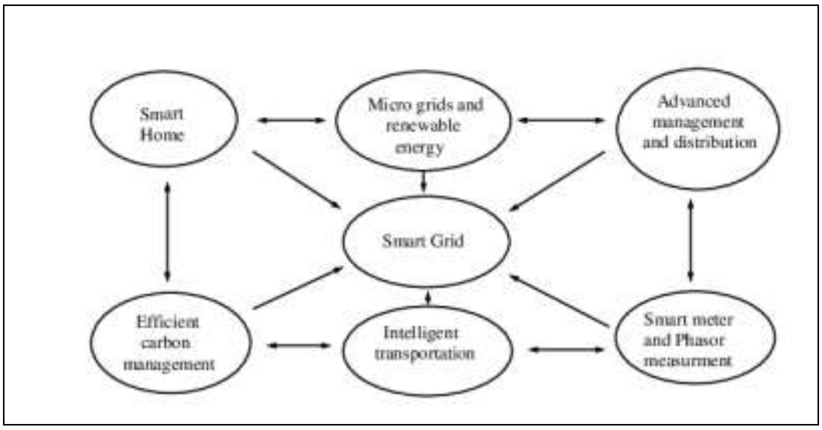

Fig 1.*Block Diasgram of Overall system*

Regenerative components in smart grids help to alleviate the consequences of low power quality (PQ) by increasing the power transmission framework. Each stage of the PQ opportunity can benefit from the promoted control strategy's whole filter and necessary elements.

As a result of a sudden drop in voltage, known as voltage sag or surge, or a total loss of voltage, there is a voltage variation. Voltage drop or dip is the most alarming PQ issue in a power delivery system. Some loads, such as radio frequency generators in semiconductor production or flow rate dependent pumps in the process industry, may be affected by voltage sag, but they will be unaffected.

For a brief while, the system's frequency exceeds or falls below a predetermined threshold. Variations in the frequency of a big power distribution system have essentially no impact on diverse equipment types. Nano-grids, on the other hand, may have greater frequency variations, which could lead to overheating of induction motors and saturation of the system's voltage-to-hertz (V/Hz) ratio. Voltage imbalance variations arise when the voltage unbalances of a three-phase power system are outside of the set range. Negative sequence currents flow with a positive sequence current, increasing or decreasing motor losses or efficiency. Motor torque variation and motor failure are the result of this. In addition to increasing cable losses, it has a negative impact on UPS, inverter, and VFD performance.

Current unbalance variations arise when current unbalances fall outside of a preset range in a three-phase power system. Because of the flaw in the load, a voltage imbalance is created.

Overloading of transformers, increased stress on insulation, and other undesirable impacts can result from the existence of DC offset in an AC power system. Continuous departure from an ideal sinusoidal power frequency waveform comprises DC offset, harmonics and interharmonics as well as notching and noise.

A harmonic voltage or current is one whose sine wave frequency is an integer multiple of the fundamental power frequency. Harmonic wave distortion is to blame for everything from communication interference to heating and solid-state gadget malfunction.

It is possible to detect interharmonics in the form of discrete or large frequency bands. Induction motors, cyclo-converters, and static frequency converters are the primary sources of interharmonic distortion. Power-line carrier signals can also benefit from the use of interharmonics. Although the effects of interharmonics on power line carrier signalling and display devices such as CRTs are not fully understood, research has revealed that they can produce visual flicker.[3]

As current is switched from one phase to another, the regular operation of power electronics equipment causes a periodic voltage disturbance. A short circuit occurs between the two phases at this point. Because of this issue, weak power supply systems can produce noise currents that can cause control system misoperation.

Noisy conductors and lines, such as those in power systems' neutral conductors or signal lines, carry unwanted electrical impulses with a spectral content below 200 kHz. Equipment such as power electronic devices, control circuits, arcing equipment, and loads using solid-state rectifiers can all contribute to noise in the power supply. It is possible to introduce undesired noise into power systems while switching between different types of power supply. The system's features and the noise's source define the frequency and amount of the noise. Noise in a system is typically less than one percent of the voltage. Noise can damage electronic devices such as microcomputers and programmable controllers.

Transient power delivery system characteristics include both impulsive and oscillatory variations in system voltages and currents. In oscillatory transients, low-frequency sub-cycles (5 kHz), medium frequencies (5-500 kHz), and high-medium frequencies (0.5-5 MHz) are also considered, as well as voltage variations outside of a prescribed range. Changes in voltage or current at sub-cycle frequencies and over the preset range are referred to as impulsive transients. Because of the oscillatory oscillations, transient over voltages may occur, resulting in damage to line insulators or tripping, component failure, and the need to restart the hardware.

The term "smart grid" refers to a system of electrical distribution that makes use of a wide range of energy-saving and renewable-energy technologies..

CONCLUSION

These new smart grids aim to increase reliability, cost-effectiveness and efficiency simultaneously. Energy consumption is predicted to climb, necessitating an increase in power system innovation. Renewables and electric vehicles are two of the technologies that Smart Grids are designed to support. Despite the fact that several pilot projects have been launched, electrical corporations aren't doing much to promote the Smart Grid. The comparison between the current grid and the smart grid implies that more research is needed to ensure a successful adoption. PQ monitoring is a critical component of total system performance, and we can see this from PQ monitoring. Consequently, the smart grid environment necessitates the use of contemporary advanced communication technologies to solve and monitor PQ issues. It is possible to improve the quality and dependability of service that customers receive via smart grids. However, they must emphasise the necessity of power quality for the smart grid's performance and reliability.

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