A REVIEW PAPER ON SMART MICROGRID WITH LOAD MONITORING

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***Abstract*— Power failure is a significant issue caused by the overloading of power systems. The large power system equipment can be damaged due to overloading. To control overloading during peak demand, the device used is the Arduino Uno, which detects overload and cuts off the supply to prevent power outages and load shedding. The automation of the power system involves two stages, namely monitoring and controlling. In this paper, we aim to develop a setup that shifts the grid based on load variance. The system operates by running a heavy grid automatically when the load is low and consuming less current than the predetermined value. If the heavy load reduces its capacity, a low-current grid occupies the next load, and the system automatically shifts its position. This system ensures efficient use of power and helps prevent power failures due to overloading caused by excessive demand on the power system.**

***Index Terms*—Smart Grid, Smart Meter, Control distributed Generation, Power Outages, Challenges, Future Grid.**

I. INTRODUCTION

There was one time when the world created power at the primary level, a modest quantity, and dispersed energy creation. But with time, this dissipated age of power get brought together with the development of force networks, where age transmission and dissemination were connected under the public system. It is absolute extraordinarily for the proficient distribution and use of energy. Now with the new end need of the present, for proper distribution of this electrical energy, without stealing, corruption, or over-exploitation of existing resources.

Smart grid is presently the popular expression in the power business everywhere. It gives our planet a progressive method of force transmission and dispersion. It has even prepared for the overwhelming majority of progressed types of information expectation and taking care of. The ongoing system ought to be changed with the objective can give security to the system. While on the one hand, it gives us clean energy and planet-saving advantages, and then again, it likewise represents the intricacies of permits howdy tech components of the activity. Abundance qualities have made it conceivable to seclude Smart systems from the current old network. Highlights like brilliant metering, Smart sensors, and Smart security have discoursed exhaustively for a general perspective on this innovation. There are various hardships and issues concerning the use of smart grids are more over exchanged words in the paper.

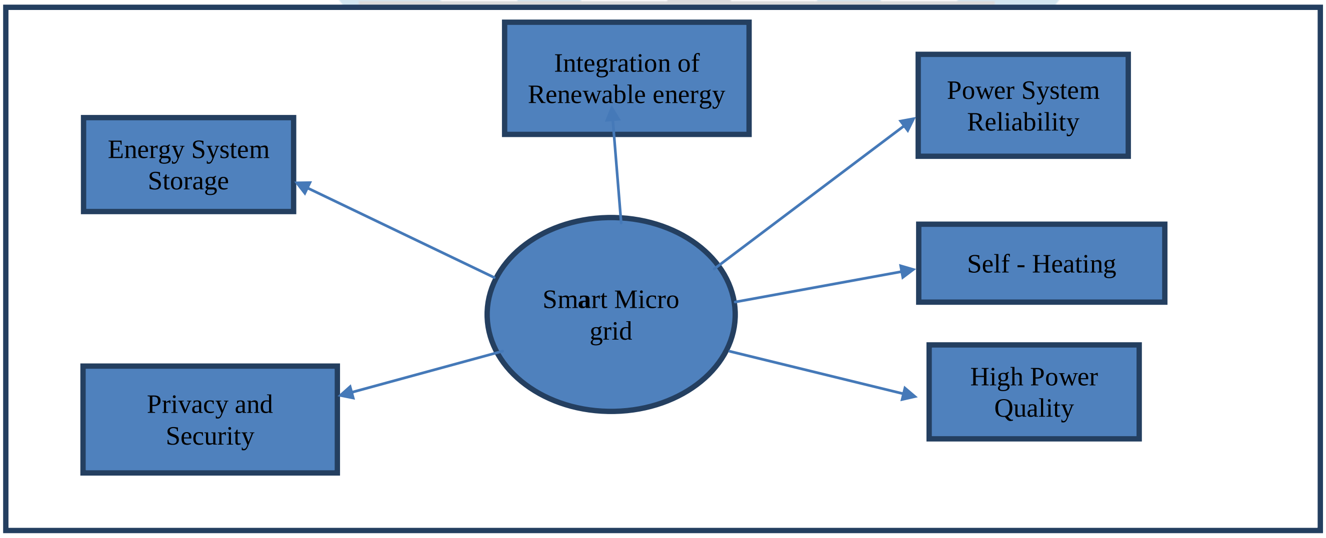

Figure.1 The features of smart grid.

II. LITERATURE REVIEW

De Matos, Jose, Ribeiro, Luiz, Gomes, Evander, "Power control in isolated Micro grids with renewable distributed energy sources and battery banks", this paper presented a strategy to control the power generated in order to regulate the battery bank state of charge in standalone Micro grids with distributed renewable energy sources [1].

Agostinelli, Sofia Mordechai, FabioPompei, Laura, “Renewable Sources urban cells micro grid: A Case Study”, The goal of the current study was to design and simulate an electric micro grid to achieve a consistent level of community resilience, as only few research works investigated the resilience of such a system for services dedicated to public education [2].

Zavar, B. A., Palacios-Garcia, E. J., Vasquez, J. C., & Guerrero, J. M. (2019). “Smart Inverters for Micro grid Applications: A Review”, Plug-and-play capability has been the first concept discussed. Regardless of how much effort has been expended to omit the communication requirement, in order to achieve a stable and functional micro grid, especially in the context of accurate active, reactive and harmonic current sharing, this requirement still exists [3].

Anderson, Roger, Ghafurian, Reza,Gharavi, “Smart Grid The Future of the Electric Energy System”, A primary objective of the Smart Grid is to improve our capacity to use more, but cheaper, electricity to power the improvements in the standard-of-living of people on Planet Earth [4].

Alotaibi, I., Abido, M. A., Khalid, M., & Savkin, A. V. (2020),” A comprehensive review of recent advances in smart grids: A sustainable future with renewable energy resources *Energies”*, A thorough review of the advances on the prevailing applications of smart grids has been presented mainly focusing on data management, cybersecurity, different pricing modalities, demand response, renewable power integration, and reliability indices [5].

Thentral, T.M.,Semwal, Purusharth,Pandey, Preeti,Raju, Aishwarya,Mukherjee, Utsahan,Ganguly, Urmi,”Recent Trends in Smart Grid Technology-A Review Paper”, The smart grid has not only provided our Earth with life-sustaining solutions for power generation, transmission, and distribution but has also opened up new venues for advanced level data management and handling [6].

Hu, Jiefeng,Shan, Yinghao,Guerrero, Josep,Ioinovici, Adrian,Chan, K.W.,Rodriguez, Jose,” Model predictive control of micro grids – An overview Renewable and Sustainable Energy Reviews”, the state-of-the-art studies on the predictive control in micro grids have been reviewed. First, the
basic principle of predictive control is presented. After that, recent converter-level and grid-level technologies
are investigated [7].

Ciurans, C., Bazmohammadi, N., Vasquez, J. C., Dussap, C. G., Guerrero, J., & Gòdia, F.,”Hierarchical Control of Space Closed Ecosystems – Expanding Micro grid Concepts to Bioastronautics”, Taking into account the recent advances in space exploration knowledge and technologies, and the increasing tendency towards long-term missions on Mars and Moon, developing efficient and reliable LSSs is of vital importance[8].

Kumar, Abhishek,Hussain, D,Khan, Muhammad,”Micro grids Technology: A Review Paper”, The expression "Microgrid" is winding up increasingly normal in the present vitality designing engineering [9].

Hossain, Eklas,Kabalcı, Ersan,Bayindir, R.,Perez, R.,”A comprehensive study on micro grid technology”, This topic is currently being concerned by the alarms on global warming, pollution and carbon footprint emissions[10].

Bhatta, Rabindra,Shrestha, Rajendra, Negri, Cesar,Schmitt, Konrad,Musraf, Mahatab, Chamana, Manohar,Osman, Ilham,Bayne, Stephen,”Feasibility of a Real-world Test Microgrid Facility to Provide Economic and Resiliency Benefits in Extreme Weather Conditions”, The study of the extreme events and analysis from real world measurements from a microgrid proves the viability of multiple microgrids to provide economic and resiliency benefits to the grid operator and the rate payers [11].

III. SMART GRID

A smart grid is an advanced electricity distribution network that uses digital technologies to optimize the production and consumption of electricity. Another option is to use physical communication (wiring) between the converter control systems in order to regulate the energy balance within the Microgrid[1]. Four aspects are involved in developing an electrical system into a resilient one: prevention of failure, mitigation of energy and economic consequences, reduction of response time, and recovery of electricity supply[2]. "In a microgrid that consists of multiple distributed generators (DGs), energy storage units, and loads, one crucial aspect to consider is the control of power converters, which serve as interfaces between the DGs and the microgrid bus, ensuring efficient energy transfer."

In a microgrid that consists of multiple distributed generators (DGs), energy storage units, and loads, one crucial aspect to consider is the control of power converters, which serve as interfaces between the DGs and the microgrid bus, ensuring efficient energy transfer [3]. As a result, there is a lot of research and development taking place in this area, and many companies and organizations are working to create new smart grid solutions. A smart grid is an advanced electrical grid system that uses digital communication technology, sensors, and automation to improve the efficiency, reliability, and sustainability of electricity generation, transmission, and distribution.

IV. SMART METER

A smart meter is an electronic device used for measuring and recording energy consumption in real-time. It is an advanced version of the traditional electricity meter, equipped with communication technology that allows two-way communication between the meter and the utility company. Smart meters enable consumers to monitor their energy usage and provide accurate billing based on the actual amount of electricity consumed. The smart meter is a device which gives electricity consumption and sends this information back to the utility for other purposes[6].

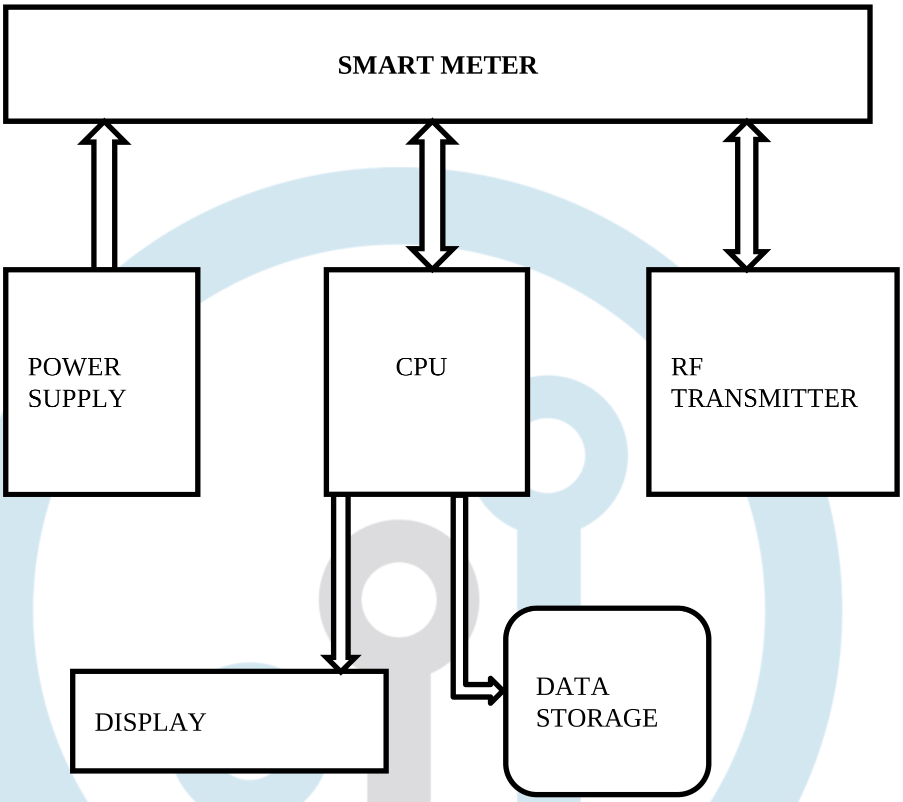

Figure 2. BLOCK DIAGRAM OF SMART METER

Power Supply: The smart meter is powered by the electrical grid, which provides a constant supply of energy.
Measurement Circuit: The measurement circuit is responsible for measuring the amount of electricity consumed by the home or building. It typically includes a current transformer and voltage sensor to measure the current and voltage respectively.
Microcontroller: The microcontroller is the brain of the smart meter. It receives data from the ADC, processes it, and sends it to the communication module. The microcontroller also controls the display and other features of the smart meter.
Display: The display is used to show the energy consumption data to the user. It can display real-time usage, historical usage, and other relevant information.
Data storages: The smart meter may have a built-in memory to store historical usage data. This data can be used for analysis and to help the utility company improve their energy distribution network.
RF Transmitter: An RF transmitter, also known as a radio transmitter, is an electronic device that generates and transmits electromagnetic signals wirelessly through the air using radio frequency waves. These waves can be used to transmit various types of information, such as audio, video, and data.

V. CONTROL DISTRIBUTED GENERATION

A distributed generator in a microgrid is a small-scale power generation unit that generates electricity using renewable energy sources such as solar, wind, and biomass. In a microgrid, a distributed generator is used to provide reliable and sustainable power to local communities or businesses to [10-12].
To ensure optimal performance and stability of a microgrid with distributed generators, a control system is required to manage the distribution and flow of power between the various components of the system, including the generators, energy storage devices, and loads. This control system is known as a Distributed Energy Resources Management System (DERMS)[8].
The DERMS acts as the brain of the microgrid, managing the power output of the distributed generators to ensure that the energy supply matches the demand. It monitors the status and performance of each generator in real-time, adjusting their output based on the needs of the microgrid [11].

VI. POWER OUTAGES

A power outage in a smart microgrid refers to a disruption in the delivery of electricity to customers within the microgrid's boundaries. A microgrid is a localized energy system that can operate independently or in conjunction with the main power grid. It typically includes distributed energy resources, such as solar panels and batteries, that can generate and store electricity locally.
In a smart microgrid, advanced control and communication technologies are used to monitor and manage the flow of electricity in real-time. These technologies enable the microgrid to automatically respond to changes in energy demand and supply, and to isolate and restore power to specific areas of the microgrid in the event of a power outage.

VII. CHALLENGES

Smart microgrids face several challenges that need to be addressed for their effective implementation and operation. Some of the key challenges are:

Integration of Distributed Energy Resources (DERs): Smart microgrids are characterized by the integration of various DERs such as solar panels, wind turbines, and energy storage systems. Integrating these resources seamlessly into the microgrid requires advanced control and communication systems that can manage the complex interactions among these resources.

Cybersecurity: Smart micro grids rely on advanced communication technologies that make them vulnerable to cyber-attacks. Cybersecurity threats such as hacking, malware, and phishing attacks can compromise the microgrid's security and disrupt its operations. Robust cybersecurity measures need to be implemented to protect against such threats.

Cost-effectiveness: Smart micro grids can be expensive to implement and operate, especially for small-scale installations. The cost of advanced technologies such as energy storage systems and communication networks can be prohibitive for some applications. Cost-effective solutions need to be developed to make smart microgrids more accessible.

Regulatory challenges: Smart micro grids may face regulatory challenges due to their unique characteristics, such as the integration of DERs and the use of advanced communication technologies. Regulatory frameworks need to be developed that promote the adoption of smart microgrids while ensuring safety, reliability, and affordability.

VIII. FUTURE GRID

The future of smart grids is expected to be transformative, with significant advancements in technology, infrastructure, and energy management practices[9]. Here are some of the key trends that are likely to shape the future of smart grids:

Distributed Energy Resources (DERs): DERs, such as solar panels, wind turbines, and energy storage systems, are expected to play a significant role in the future of smart grids. The integration of DERs into the grid will enable greater energy independence and resilience, and help to reduce carbon emissions[10].
Advanced Analytics and Artificial Intelligence: Advanced analytics and artificial intelligence will be critical in optimizing the performance of smart grids. These technologies will enable real-time monitoring and analysis of grid operations, and help grid operators to anticipate and respond to changes in energy demand and supply.
Electric Vehicles (EVs): The widespread adoption of EVs is expected to have a significant impact on the future of smart grids. EVs can be used as mobile storage devices, enabling grid operators to store excess energy during periods of low demand and supply it back to the grid during peak demand.
Internet of Things (IoT): The integration of IoT devices into the grid will enable greater visibility and control over grid operations. IoT sensors can be used to monitor and optimize energy consumption, detect faults and issues, and automate processes.
Micro grids: Micro grids, which are localized energy systems that can operate independently or in conjunction with the main grid, are expected to become more prevalent in the future of smart grids. Microgrids can help to improve grid resiliency and reliability, and enable greater energy independence.

IX. CONCLUSION

Smart microgrids represent a promising solution for addressing the challenges of modern energy systems, such as grid resiliency, energy security, and carbon emissions reduction. By integrating advanced technologies, such as distributed energy resources, communication networks, and control systems, smart microgrids can operate more efficiently, respond more quickly to changes in energy demand and supply, and support the integration of renewable energy bring sources.
However, the implementation and operation of smart microgrids face several challenges, including the integration of DERs, cybersecurity risks, interoperability, cost-effectiveness, and regulatory challenges. These challenges need to be addressed through the development of advanced technologies, standards, and regulatory frameworks that promote the adoption and operation of smart microgrids.
Despite these challenges, the future of smart microgrids looks promising, with significant advancements expected in technology, infrastructure, and energy management practices. The widespread adoption of smart microgrid technologies is expected to about significant benefits, including improved energy efficiency, reduced carbon emissions, and greater grid resiliency and reliability.

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