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Uninterrupted Micro Grid Power Management System

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Abstract—Micro grids are low-voltage distribution systems with controllable loads and distributed energy resources that can operate in a coordinated, regulated manner whether they are islanded or connected to the medium-voltage grid (DER). Micro grids are autonomous systems that boost system reliability by communicating their current status to a central control point known as the Central Protection Centre (CPC). The ease, security, and controllability of the power flow are also improved by this function. By linking load centres to a micro grid, households and businesses can get reliable electricity while reducing energy theft, outages, and loss. Automating the full grid parameter monitoring, control, and protection process is challenging. Because DERs are variable energy sources, this becomes even more important with their addition. In this project, the Internet of Things concepts are utilised to address issues including micro grid reconfiguration brought on by faults, shifting energy consumption patterns, and the addition and removal of distributed energy sources (DERs). It aims to automate the process, reduce the establishment's price and size, and lower the supplier's total energy costs by utilising the appropriate processor-based technology.

Keywords: Micro grids, Uninterrupted power, Distributed energy resources, households, microcontroller, energy, and monitoring.

I. INTRODUCTION

Renewable energy sources, like solar electricity, are swiftly being incorporated into the power grid in order to create a sustainable power**.[1]** Contrarily, solar panels produce power sporadically and unpredictably, making it challenging to maintain supply-demand equilibrium and worsening frequency stability. Battery Storage is a crucial technology that can aid in the problem-solving process (BES). The BES's quick response time can be used to help reduce supply-demand imbalances that cannot be managed by the current power infrastructure, including thermal power plants**.[2],[3]** The BES absorbs short-term load fluctuations that power plants cannot handle. The functions of the grid require an ongoing, uninterrupted power supply. Micro-sources and renewable energy sources close to the load, such wind, solar, and hydro, can be used to achieve these attributes and a decrease in

transmission loss. Because it must respond to problems in both the utility grid and the renewable energy grid, the protection of the grid is a considerable challenge. **[4],[24]** Both the load and the source should be swiftly isolated in the case of a fault. Rapid separation could cause selectivity and sensitivity issues. As a result, loads connected to the utility grid and those produced by renewable energy sources must be interchangeable. **[5],[**21] In times of excessive demand and severe system disruptions, these sources are affordable and have a significant environmental impact. Micro-grids are desired because of their positive environmental impacts, such as fewer emissions of greenhouse gases and pollutants, given the current disturbance of the climate.

II. LITERATURE SURVEY

Make a new load-control and load-monitoring strategy and put it into practice. The "Micro grid load management and control methodologies" by Bill Moran state that load controls and management is a crucial part of a micro grid. At all times, the ratio of generation to load must be maintained. The micro grid control system must continuously assess and priorities loads in order to keep this equilibrium**.[6]** To maximize the efficiency of the micro grid, we investigate techniques for tracking, evaluating, prioritizing, and controlling loads under all conditions.[15],[18] On how to discriminate between active and inactive loads, classify loads based on their criticality, and save near-real-time quantitative data for load-generation matching. While the micro grid is deployed and running in grid parallel mode, we discuss the necessity for active load control. The need for high-speed control operation is explained. It is also described how the load management system affects generating dispatch control**.[7],[8]** The interaction between active load management and energy storage is also examined.

The main focus of the "Study of load frequency control by employing differential evolution algorithm" put forth by Kumari, G. Shankar, and S. Gupta was the load frequency control of the power system. Our main goal is to keep the produced power and load demand in balance while preventing frequency or tie-line power flow irregularities. [20]

The "The Key Technology of the Coordinated Control System of Wind Power and Energy-intensive Load" paper by YanQi Zhang, Wang Ningbo, and Kun Ding asserted that the fast expansion of installed wind power capacity in PS has made wind power consumption an urgent issue for new energy sources. Energy-intensive loads have varying degrees of capacity to engage in power grid control due to the feature of adjustment. This paper describes the main station and the sub-station, which are both parts of the wind power and energy-intensive load control system**.[9],[10]** The system may also coordinate a grid with high wind power and energy-intensive loads. The coordinated control system sub-station is located in the command center of an energy-intensive organization and performs tasks including information exchange and energy-intensive load regulation**.[14]**

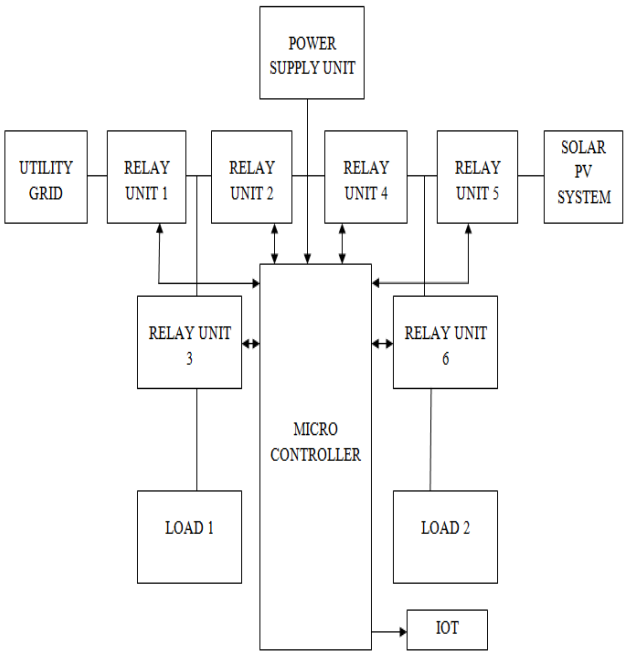
III. SYSTEM ARCHITECTURE

A. Proposed Idea

A relay with one sensing unit and one shifting unit is used in the proposed system. The sensor unit, according to the manufacturer, is capable of identifying over-current, over-voltage, and

under-voltage conditions. Data from the sensors is received by the microcontroller unit, which further processes it before analysis**.[11]** Any departures from the threshold values stored in the database are compared to the gathered readings, and the system issues an alarm. When the system detects an error, it immediately fixes it. Power supply stability is ensured through a synchronized process for node/load detection and removal**[12]**

The potential transformer will reduce the voltage of the power source from 0 to 230 volts to (0-6V). A connection will then be made between the secondary of the potential transformer and the precision rectifier, which will be built using an op-amp. Precision rectifiers have the advantage of generating peak voltage as DC, whereas the remaining circuits only offer RMS voltage.



In bridge rectifier, network's diagonally opposed corners serve as the circuit's input, while the remaining two corners serve as the circuit's output**.[13]**

The direction of current flow via RL remains constant. This current creates a voltage while passing through RL that corresponds to waveform. This bridge rectifier is a FWR because current flows through the RL throughout supplied voltage. The fact that a BR provides an output V that is doubles a traditional full-wave circuit with a given transformer is one benefit it has over the former.

To illustrate this, provide values to a few of the elements shown in scope X and Y. Assume that both circuits utilize the same transformer. The maximum voltage that develops across points A and B in either circuits is 1000 volts. In the typical FW circuit seen in view A, the peak voltage from the CT to either X or Y is 500 volts. The greatest voltage that may be seen across the RL is over 500 volts. The entire secondary voltage, which is 1000 volts, is the highest value that can be rectified in the BR seen in view B. Thus, the resultant voltage across the RL peaks at over 1000 volts.

One class of IC that is frequently utilized is the voltage regulator. Regulator IC units include circuitry for the control element, overload protection, comparator amplifier, and reference source into a single IC. IC units can regulate a fixed positive voltage, a fixed negative voltage, or an adjustable voltage. The regulators may be set up to work with power ratings of mW to tens of watts and load currents ranging from hundreds of mA to tens of amperes.

IV. HARDWARE AND SOFTWARE REQUIREMENT

The power supply unit, microcontroller, utility grid, Solar PV system, relay unit, load, and IOT make up the uninterrupted micro grid power management system. Embedded C and MP Lab IDE are required software.

A.Microcontroller:

The Arduino Uno microcontroller board utilizes the ATmega328P CPU. The board consists of a USB port, a power connection, an ICSP header, six analogue inputs, 14 digital I/O pins, a 16 MHz quartz crystal, and a reset button.

B.Potentiometer:

To control the situation of a sliding contact over a steady opposition, potentiometers change their state. The result voltage of a potentiometer is the distinction in voltage between the fixed and sliding contacts. The full input voltage is applied along the whole length of the resistor in a potentiometer. The two terminals of the input source are fixed to the resistor's end in a potentiometer. To change the result voltage, the sliding contact is moved along the resistor on the result side.

C.Single Relay Board:

An electrical current activates an electromechanical switch known as a relay. The drive circuit, power supply circuit, and isolation circuit are all housed on a single relay board. The relay is constructed using that circuit. The switching actions in the driving circuit are carried out by transistors. The relay is switched on and off using the transistor. By preventing reverse voltage from coming from the relay, an isolation circuit safeguards the controller and transistor from harm. The info beat expected to switch the semiconductor is given by the microcontroller unit. It is utilized to turn one specific contraption on and off.

D.IOT:

The IoT is a network of everyday objects that are equipped with networking, sensors, electronics and software in order to exchange data (IoT). To enable data transfer, everything is essentially connected to a miniature networked computer. A tiny networked computer can be coupled with with lights, toaster ovens, fridges, window boxes, watches, fans, airplane, trains, vehicles, or whatever else around to take input (particularly object control) or accumulate offer informational output (typically object status or other sensory data). As a result, computers will be ubiquitous embedded computing devices that may be connected to the Internet and can be uniquely identified throughout our daily lives. The Internet of Things is off to a fantastic start thanks to affordable, networkable microcontroller modules.

E.LCD:

The 16 characters and 2 lines of alphanumeric text on the LCD screen are associated with a solitary 9-way D-type connector. Following that, the gadget could be associated utilizing E-Block I/O ports. The sequential information design that the LCD show requires is portrayed in full in the client manual. A 5V power source is likewise expected for the showcase. If it's not too much trouble, ensure that the voltage is no higher than 5V since anything over that could harm the gadget. Either the E-blocks Multi developer or a 5V fixed directed power source gives the 5V.

F.Web Server:

The RF handset is viable with the accompanying channels and consents to IEEE802.11b/g/n principles [16]. Two high-goal, rapid ADCs are utilized by the 2.4 GHz collector to make an interpretation of RF signals into quadrature baseband signals, which are then changed over completely to the computerized space. To adjust to changing sign channel conditions, the ESP8266EX integrates baseband channels, RF channels, programmed gain control (AGC), DC offset dropping circuits, and different highlights. Because of the advanced adjustment include, which further works on the linearity of the gadget, the power intensifier can now create state of the art execution of +19.5 dBm normal power for 802.11b transmission and +16 dBm normal power for 802.11n transmission

G.Voltage Sensor

A voltage sensor generates a signal that corresponds to the electric current (AC or DC) that is passing through a wire. An analogue voltage, current, or even a digital output could be created.

H.Arduino IDE

Electronics platform with open source Arduino uses simple hardware and software that makes it easy to use. An Arduino board can take in inputs like a tweet, a button click, or light from a sensor and translate them into actions like turning on an LED, starting a motor, or publishing something online.

I.Embedded C

Embedded C was created to bridge the performance gap between embedded hardware and software design and Standard C. The C language is extended to incorporate natives that are regularly given by DSP processors and are expected for signal-handling applications [17]. With the expansion of named address spaces, numerous location space usefulness, and direct admittance to processor and I/O registers for independent embedded systems, the C language has been expanded

V. HARDWARE IMPLEMENTATION

A sensing unit and a moving unit make up this system. The sensor gadget can identify conditions with overcurrent, overvoltage, and undervoltage [19]. Data from the sensors is

received by the microcontroller unit, which further processes it before analysis. Any departures from the threshold values stored in the database are compared to the gathered readings, and the system issues an alarm. When the system detects an error, it immediately fixes it. Nodes and loads are recognized and eliminated concurrently to keep the power supply stable. In the event that the microcontroller detects a problem, the shifting unit is activated.

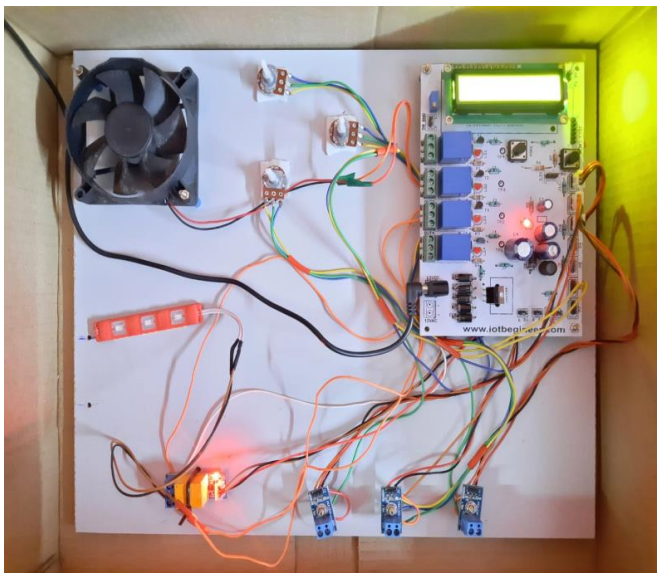


Figure 2 Working Model of the System

The supply to the load is maintained constant by connecting to another source that is readily accessible and utilizing the relay as the shifting device. This greater range makes it easier to monitor the system's energy usage and helps to resolve problems like these. Utility grid and solar power are the two major power sources in the circuit diagram above. Between the source and the load are the detecting and shifting units. Solar energy is DC, thus it must be stored in a battery before being converted to AC by an inverter. It is then supplied to the load.

The control of faults inside a micro grid powered by the Internet of Things is another focus of the work. The IOT idea handles problems including the addition and removal of distributed energy resources, fluctuating energy consumption patterns, and micro grid reconfiguration due to faults. Micro grids are low-voltage distribution systems with dispersed energy resources, controlled loads, and the ability to operate in a regulated and coordinated manner whether they are islanded or linked to the medium-voltage grid.

Micro grids are autonomous systems that boost system dependability by communicating their current status to a central control point known as the Central Protection Centre (CPC). This feature also enhances the simplicity, security, and controllability of the power flow. Households and businesses can obtain consistent electricity while decreasing energy theft, outages, and loss by connecting load centres to a micro grid. Automation of the entire grid parameter monitoring, protection, and control process, however, is a difficult task.

Due to the changeable nature of DERs, this becomes even greater significance [22]. This study addresses difficulties including micro grid reconfiguration owing to faults, changing

energy consumption patterns, and the addition and removal of DERs using the ideas of the Internet of Things (IOT). The objective is to use the proper processor-based technology to automate the process, decrease the cost and size of the facility, and lower the total cost of energy to the provider.

A.USB Over current Protection

The Arduino UNO contains a poly fuse that resets to prevent shorts and overcurrent in your computer's USB connections. Even though the majority of computers already have security built in, the fuse adds an extra layer of protection. The fuse will immediately terminate the connection if more than 500 m A is applied to the USB port and prevent it from resuming until the short or overload is resolved [23]. The USB connection and power jack are longer than the previous measurement, therefore the UNO PCB can only be 4 and 2.1 inches long and wide, respectively. The Arduino UNO's present boot loader is incompatible with ROBOTC. The ROBOTC Firmware can be downloaded to the Arduino UNO in its current version, however user program cannot be downloaded. The Arduino UNO firmware has a fault that prevents flash write commands from beginning anywhere other than at the beginning of flash memory, which is the cause of this (0x000000). On this page's bottom, you can find further technical details.

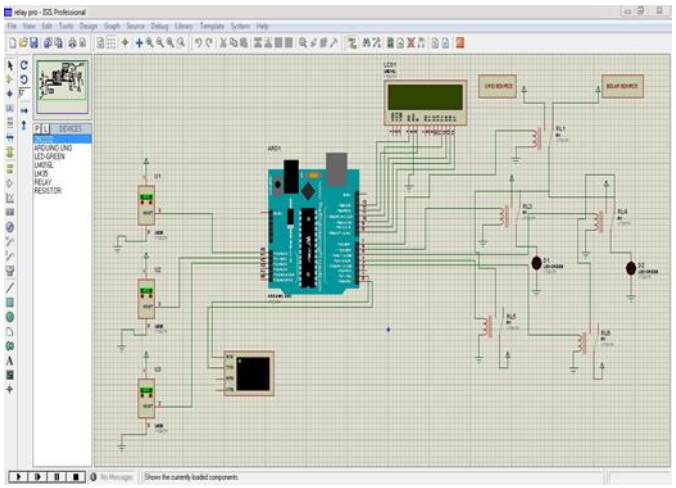


Figure 3 Simulation in Proteus

You will need to re-burn your boot loader on your Arduino UNO boards using the Arduino Open Source language and a modified boot loader file because ROBOTC is currently unable to burn a new boot loader. At the point when you compose a memory page to the Arduino, the boot loader erases the past page and embeds another one. Since both the Eradicate Address and the Stacked Location start at nothing, downloading firmware is sans mistake. Despite the fact that we start at memory address 0x7000, the Boot loader deletes information starting at zero while building a client application since the "Load Address" guidance doesn't change where to wipe information.

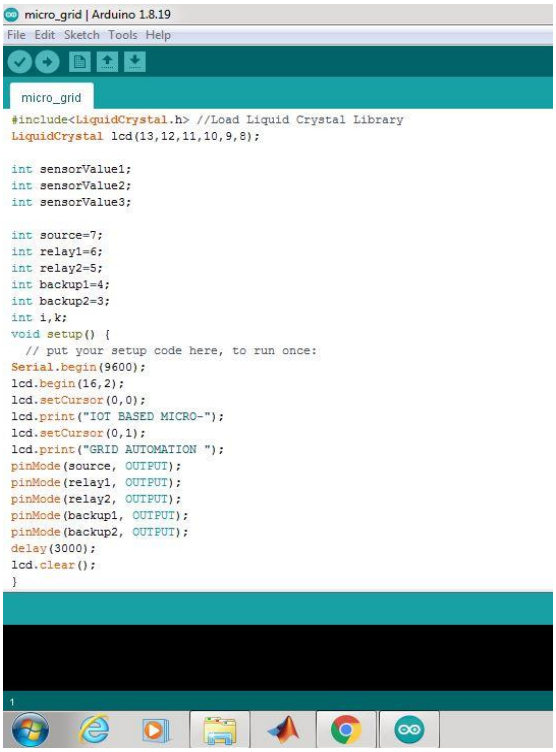


Figure 4 Code Used for Arduino UNO

The board has three screw openings that can be utilized to connect it to a surface or case.The area of simple sources of info 0 to 5, the power header, and the ICSP header is shared by computerized pins 0 to 13 as well as the adjoining AREF and GND pins. Arduino can receive information about its surroundings with the aid of a variety of sensors and utilize that information to operate lights, motors, and other actuators. The Arduino development environment and the Wiring-based Arduino programming language are used to programme the board's microcontroller (based on Processing). Arduino creations can run on their own or in conjunction with software to operate.

B.Web Server Controlling Section

For the Web of Things market, Coffee's ESP8266EX offers a completely coordinated Wi-Fi SoC answer for satisfy purchasers' continuous needs for effective battery use, a smaller plan, and trustworthy execution. The ESP8266EX can work as a free application or as a captive to a host MCU because of its broad and independent Wi-Fi organizing capacities. Programs facilitated by the ESP8266EX begin taking off from the blaze. The implanted rapid store upholds framework execution improvement and memory advancement. The ESP8266EX can likewise be utilized as a Wi-Fi connector in any microcontroller design by using SPI/SDIO or I2C/UART interfaces.

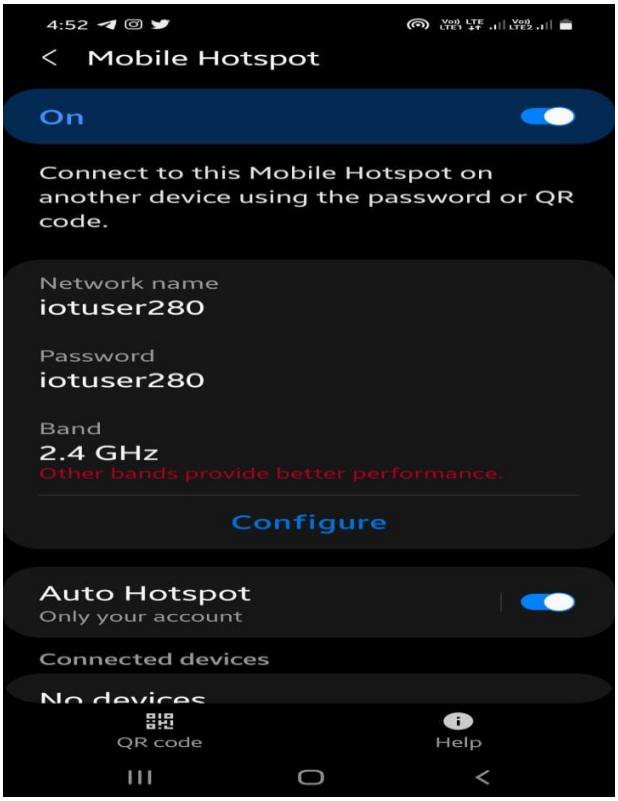


Figure 4 Wifi Configuration

Filters, RF baluns, power amplifiers, low noise receive amplifiers, power management modules, and antenna switches are all included with the ESP8266EX [25]. The tiny form factor eliminates superfluous electronics and reduces PCB space. The ESP8266EX contains a 32-bit enhanced Tensilica L106 Diamond series CPU and on-chip SRAM in addition to Wi-Fi. Through the GPIOs, it may be connected to sensors and other hardware. Sample code for numerous applications is available in the Software Development Kit (SDK).

VI. RESULTS AND CONCLUSION

IoT can be used to address protection and management problems as the micro-grid rapidly increases and increasingly relies on renewable energy sources. This system can check its state continuously and save energy thanks to automation. Through the Internet of Things, the system is able to remotely monitor and control the network. In order to monitor and secure the network in both grid-connected and islanded modes of operation, IoT was used in micro-grids in this study. Possible source changes could be made based on energy market trends. Prioritizing-based functioning results in a more stable and reliable supply since it allows the system to incorporate additional sources and loads. This test bench application shows how useful it is for microgrid automation. This test bench application illustrates its usefulness in microgrid automation and energy optimization.

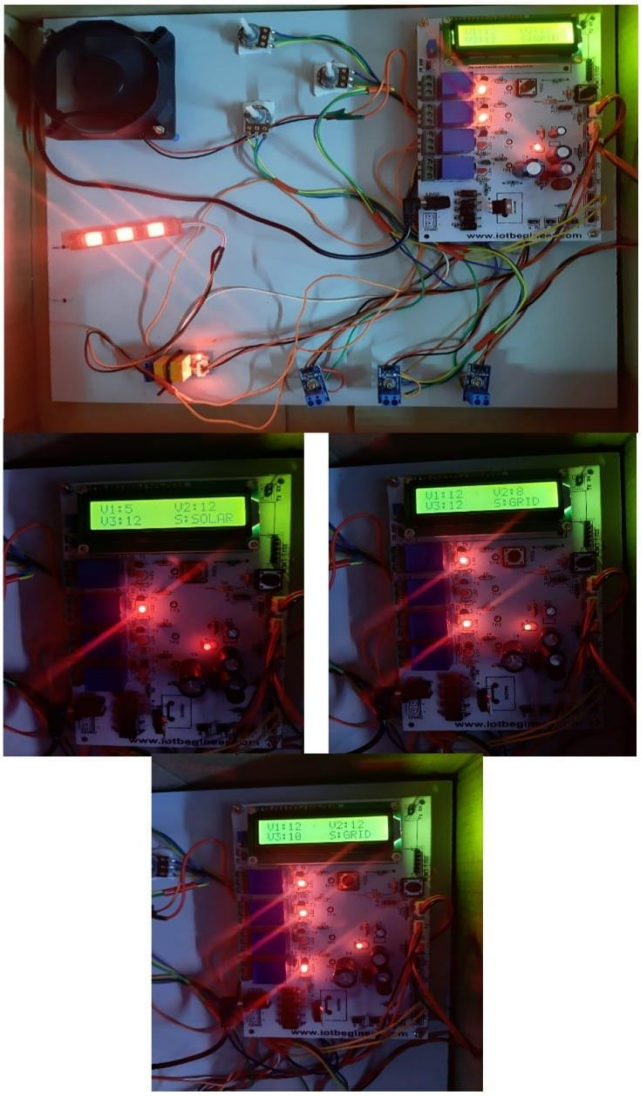


Figure5 Overall System

The area unit will need a range of intelligent improvement algorithms and methodologies, each with their own advantages and disadvantages. If we can use IoT to run micro-grids, their adaptability will be significantly increased. In the near future, the process will need to be enhanced. Because this process solely relies on wireless commands, the cost of connecting equipment will be greatly lowered. The appeal of micro-grids will spread to people everywhere.

REFERENCES

1. Yin, Xuefei & Zhu, Yanming & Hu, Jiankun. (2021). A Sub-grid-oriented Privacy-Preserving Microservice Framework based on Deep Neural Network for False Data Injection Attack Detection in Smart Grids. IEEE Transactions on Industrial Informatics. PP. 1-1. 10.1109/TII.2021.3102332.
2. Q. Long et al., "Microgrid Power Flow Control with Integrated Battery Management Functions," 2020 IEEE Power & Energy Society General Meeting (PESGM), 2020, pp. 1-5, doi: 10.1109/PESGM41954.2020.9281437.

3. ZHANG Gaohang, LI Fengting, ZHOU Qiang. Day-ahead hierarchical dispatching model considering friendliness of wind power[J]. Power System Protection and Control, 2019, 47(6): 118-124.
4. Liao Siyang, Xu Jian, Sun Yuanzhang. Control of energy-intensive load for power smoothing in wind power plants[J]. IEEE Transactions on Power Systems, 2018, 36(6): 6142-6154.
5. KANG Chongqing, YAO Liangzhong. Key scientific issues and theoretical research framework for power systems with high proportion of renewable energy[J]. Automation of Electric Power Systems, 2017, 41(9): 2-11.
6. Z. Feng et al., "Energy Management Strategy of Microgrid Based on Fuzzy Control," 2018 2nd IEEE Advanced Information Management,Communicates,Electronic and Automation Control Conference (IMCEC), 2018, pp. 1-1670, doi: 10.1109/IMCEC.2018.8469588.
7. National Energy Administration. 2018 grid integration condition of wind power[R]. 2109.
8. Hu Diangang, Qi Xiaolin, Li Shaoyu, et al. Price decision model of high-load users considering optimal wind bidding strategy[J]. Power System Technology, 2016, 40(8): 2265-2272.
9. Chen Runze, Sun Hongbin, Jin Hongyang. Pattern and benefit analysis of energy-intensive enterprises participating in power system dispatch[J]. Automation of Electric Power Systems. 2015, 39(17): 168-175.
10. WANG Jian, LU Zongxiang, QIAO Ying. Research on Demand Response Mechanism of Wind Power Local Accommodation Utilizing Energy-Intensive Loads[J]. Power System Technology, 2017, 41(07): 2115-2124.
11. S. Rhili, J. Hmad and H. Trabelsi, "Distributed Operation and Control Using Interconnected Nanogrid System," 2020 17th International Multi-Conference on Systems, Signals & Devices (SSD), 2020, pp. 267-271, doi: 10.1109/SSD49366.2020.9364248.
12. Keita Tokumitsu, Hiruyuki Amano, “Development of Thermal Power Plant Model for Balancing and Frequency Control Analysis,” CRIEPI Technical Report, No. R14018, 2016.
13. B. Zhao et al., "Energy Management of Multiple Microgrids Based on a System of Systems Architecture," in IEEE Transactions on Power Systems, vol. 33, no. 6, pp. 6410-6421, Nov. 2018, doi: 10.1109/TPWRS.2018.2840055.
14. W. Bai, M. Sechilariu and F. Locment, "On-grid/off-grid DC microgrid optimization and demand response management," 2020 22nd European Conference on Power Electronics and Applications (EPE'20 ECCE Europe), 2020, pp. 1-10, doi: 10.23919/EPE20ECCEEurope43536.2020.9215679.
15. E. M. Shishkov, A. V. Pronichev and E. O. Soldusova, "Microgrid Energy Management System for Reducing Required Power Reserves," 2019 International Youth Conference on Radio Electronics, Electrical and Power Engineering (REEPE), 2019, pp. 1-4, doi: 10.1109/REEPE.2019.8708759.
16. B. Moran, "Microgrid load management and control strategies," 2016 IEEE/PES Transmission and Distribution Conference and Exposition (T&D), 2016, pp. 1-4, doi: 10.1109/TDC.2016.7520025.

17. Luna L. Glória, Gabriel H. S. Costa, Débora B. S. Oliveira, Jessica C. de Bona, Neimar A. Oliva, Cesare Q. Pica, Mathias A. Ludwig, "A Load Prioritization Model for a Microgrid Operation in the Islanded Mode", Transmission & Distribution Conference and Exhibition - Latin America (T&D LA) 2020 IEEE PES, pp. 1-6, 2020.
18. S. K. Mumbere, A. Fukuhara, Y. Sasaki, A. Bedawy, Y. Zoka and N. Yorino, "Development of An Energy Management System Tool for Disaster Resilience in Islanded Microgrid Networks," 2021 20th International Symposium on Communications and Information Technologies (ISCIT), 2021, pp. 97-100, doi: 10.1109/ISCIT52804.2021.9590605.
19. A. Calpbinici, E. Irmak, E. Kabalcı and R. Bayındır, "Design of an Energy Management System for AC/DC Microgrid," 2021 3rd Global Power, Energy and Communication Conference (GPECOM), 2021, pp. 184-189, doi: 10.1109/GPECOM52585.2021.9587523.
20. H. A. Shayanfar and S. Malek, "Photovoltaic microgrids control by the cooperative control of multi-agent systems," 2015 30th International Power System Conference (PSC), 2015, pp. 287-293, doi: 10.1109/IPSC.2015.7827761.
21. M. Hao and X. Zhen, "A control strategy for voltage source inverter adapted to multi — Mode operation in microgrid," 2017 36th Chinese Control Conference (CCC), 2017, pp. 9163-9168, doi: 10.23919/ChiCC.2017.8028816.
22. W. Jing, W. Xiaohui, W. Jia and D. Hong, "Research on operation control of micro sources within a microgrid," 2012 Power Engineering and Automation Conference, 2012, pp. 1-4, doi: 10.1109/PEAM.2012.6612473.
23. R. Heydari, T. Dragicevic and F. Blaabjerg, "Coordinated Operation of VSCs Controlled by MPC and Cascaded Linear Controllers in Power Electronic Based AC Microgrid," 2018 IEEE 19th Workshop on Control and Modeling for Power Electronics (COMPEL), 2018, pp. 1-4, doi: 10.1109/COMPEL.2018.8460046.
24. G. Huang, L. Zhong, L. Zhang and K. Yu, "Architecture Design and Switching Control Strategy of Integrated Operation System of Zone Type Microgrid," 2021 International Conference on Intelligent Transportation, Big Data & Smart City (ICITBS), 2021, pp. 497-500, doi: 10.1109/ICITBS53129.2021.00127.
25. Z. Fan, B. Fan, J. Peng and W. Liu, "Operation Loss Minimization Targeted Distributed Optimal Control of DC Microgrids," in IEEE Systems Journal, vol. 15, no. 4, pp. 5186-5196, Dec. 2021, doi: 10.1109/JSYST.2020.3035059.