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Review of Fault Detection Scheme for Islanded Microgrid with Grid-Forming Inverter

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ABSTRACT: The customary overcurrent-based shortcoming location plans are not appropriate to islanded microgrids because of their reliance on huge issue current homeless people. This paper presents differential insurance based issue discovery. Various elements including the executed issue ride-through procedure, the shortcoming current restricting plan, and the control design of the network framing inverter are thought of. Moreover, the moving window idea is incorporated, which impressively speeds up. The seriousness and sort of short out issue don't influence the usefulness of the proposed technique, and both even/awry short out deficiencies are appropriately distinguished by the plan. Shortcoming qualities of islanded microgrid are not the same as that of matrix associated microgrid because of the framework design and control technique of microsource, which is essential to flexibility issues of customary securities in islanded microgrid. Taking into account impacts of burden impedance and microsource models during the issue, this paper examined current attributes of various branches during an awry shortcoming in the line, introduced stage qualities of line flows on the two sides of the line and the working presentation of current differential assurance.

KEYWORDS:- Distributed Control, Real-time Simulation, Micro-grid

I. INTRODUCTION

Microgrids are small-scale localized grids representing a group of interconnected loads, distributed energy resources and energy storage devices that act as a single controllable entity with respect to the conventional grid. It can connect and disconnect from the conventional grid to operate in both gridconnected mode and islanded mode [1]. Commonly, the distributed energy sources connected to a microgrid are power electronic inverter-based renewable sources such as wind, solar, etc. The system inertia is extremely low in renewablebased islanded microgrids [2]. Further, the quick response of power electronic inverters creates a high rate of change of frequency, voltage and current following any system disturbance. Therefore, the system should have the capability to sense and investigate the system disturbances within a very short time period [3]. In islanded microgrids, the fault current is contributed mostly by the distributed energy sources and partially by the energy storage devices [4]. Thus, the fault current in an islanded microgrid is vastly low as compared to the conventional grid and grid-connected microgrid [5] and becomes highly insignificant especially in high impedance faults. Further, having high fault current circulation through the inverters for a longer time impacts the inverters' performance. Thus, the time available to arrest the fault is also very less in renewable-based islanded microgrids. Therefore, conventional overcurrent protection techniques are not applicable in the case of islanded microgrid faults [2]. In recent years, the wide-area measurement-based fault analysis methods are explored for islanded microgrids using advanced signal processing techniques and machine learning techniques. These methods require massive fault data to train the model accurately, where the big data analysis comes into play [6]. Most applied signal processing technique in fault detection is Discrete Wavelet Transform (DWT), where the selection of mother wavelets and the number of decomposition levels are crucial. The difference of energy, entropy and standard deviation of DWT coefficients of the successive cycle current measurement are considered as features for fault classification in [7], but the mother wavelet is randomly chosen, and fault resistance is considered only up to 2Ω . Since fault resistance can be higher than 2Ω [8], this method cannot guarantee the classification accuracy for high impedance faults. The work carried out in [9] and [10] consider Harmony Search Algorithm and Optimum Wavelet Function Matching Pursuit for



mother wavelet and number of decomposition level selection respectively in fault classification. However, the effect of real system noise is not taken into consideration. Fault analysis includes fault detection, localization, and classification. Without detecting the fault on time with the exact location of the fault, any further protection actions cannot be taken [11]. However, most of the existing works propose fault classification techniques only and fault detection and localization are seldom in the existing literature. Even though the traveling wave fault detection/localization method is popular in conventional systems, they are not applicable to renewable-based islanded microgrid systems due to their insignificant variations in fault current and voltage and quick response of power electronic inverters [12]–[14]. The work carried out in [15] proposes a zone-based method for fault detection, localization, and classification. Here, the difference between successive cycle current measurements taken at each protective zone is fed through DWT for the feature extraction. Fault detection, localization, and classification are considered as a classification problem and Deep Neural Network (DNN) classifier is trained to detect, localize and classify the faults. In this work, for fault localization, each line is equally divided into 10 classes based on line length and the fault is identified to fall in a specific class. Therefore, the fault can only be localized for a specific class and cannot be accurately identified at one particular point. However, the exact fault location is essential for islanded microgrids to shorten the time of line inspection, reduce the outage time and economic loss and improve the reliability of distribution networks.

II. LITERATURE REVIEW

Syed Fariborz Zarei et al. [1], have proposes an issue location plot for microgrids with framework shaping inverters. In this paper, a superimposed stage current plan with a voltage-restriction component is proposed which recognizes the shortcomings in an islanded microgrid with lattice shaping inverters. In the proposed technique, various elements including the carried out issue ride-through methodology, the shortcoming current restricting plan, and the control construction of the matrix shaping inverter are thought of. Besides, the moving window idea is incorporated, which extensively speeds up. The seriousness and kind of short out issue don't influence the usefulness of the proposed strategy, and both balanced/deviated cut off are appropriately distinguished by the proposed conspire. At long last, the presentation of the proposed conspire is exhibited by applying different balanced/deviated shortcomings in a test framework.

A. Dagar et al. [2], combination of dispersed energy assets (DER) with power framework is creating as an arising power structure. It is ecumenically in view of the central issues, for example, broad utilization of advances in light of dispersed energy assets, lack of petroleum product in future, radicalism of electrical help ventures and custom cautiousness on natural effect of the ordinary technique for creating electrical power. These issues are changing the idea of customary power age worldwide and present beginning difficulties in the age and conveyance framework. The interconnection of circulated generators has started the idea of microgrid which is the array of interconnected conveyed generators, moderate capacity units and burdens. The commonsense utilization of microgrid faces various specialized difficulties. Conspiring with a consistent security plot is one of the serious difficulties in a microgrid structure. The degree of shortcoming current in both the methods of activity, dynamic conveyed age, two-way progression of force, expanded worth of impedance and nature of correspondence network are the abundant difficulties in conspiring a solid security procedure. The security plot should be dependable, particular, quick and helpless in both the functioning modes. This paper presents the fastidious investigation of the engineering of AC microgrid, DC microgrid and crossover microgrid alongside the related security issues and arrangements. It additionally gives the carping evaluation of accessible difficulties in the security of microgrid in both network tied and islanded mode and accessible assurance procedures for both AC microgrid and DC microgrid. A comprehensive survey has been done in each segment considering the most recent advancements alongside the future movement in the field of microgrid security.

S. F. Zarei et al. [3], shortcoming current limiter (FCL) is probably the most ideal decision for tackling security issues in dynamic conveyance networks containing scattered age (DG). Because of the nonlinear idea of assurance issues and qualities of defensive gadgets (PDs), the choice of FCL type and determination is one of the fundamental difficulties of this methodology. In this paper, a basic and successful logical strategy for FCL impedance estimation is proposed. Knowing just the properties of the quickest wire of the feeder and the defensive gadget introduced toward the start of the feeder (for this situation recloser) does the trick for the execution of the proposed technique. The strategy resolves issues of miscoordination brought about by expanded shortcoming current levels, decrease of reach of PDs, miscoordination because of decrease of reach, blinding of insurance, bogus stumbling of PDs, and breaker intertwine and overcurrent hand-off meld miscoordination. The proposed approach has additionally been streamlined with the goal that the choice of FCL for one feeder just depends on DGs associated with this feeder. In the proposed conspire, the



effect of both regular and inverter-based DGs is thought of, and the transient way of behaving of FCL is explained. Viability of the proposed strategy is exhibited by different reenactments on a test framework in MATPOWER 5.1 tool stash.

P. Patil et al. [4], power framework without legitimate defensive plan is like a temperamental framework, it is more inclined to blame and undesirable stumbling. In significant dissemination framework overcurrent security is utilized for assurance. Subsequently a legitimate coordination ought to be finished overcurrent security conspire. A defensive plan ought to work as quick as could really be expected, however when it works a lesser region should be confined, with the goal that less power outage ought to happen. The two fundamental boundary of overcurrent security conspire are Time setting and current setting. The setting of transfer ought to be with the end goal that, the ideal activity ought to happen. This paper examines the different Linear programming methods carried out on a proposed framework. Double Simplex strategy is quicker when contrasted with different techniques for Linear programming.

S. F. Zarei et al. [5], medium power conveyed energy assets (DERs) are regularly associated with medium voltage dissemination frameworks by means of voltage source converters (VSCs). A few rules and norms have been created to lay out the required models and necessities for DERs interconnections. In this regard, it is liked to build up the VSC issue ride through (FRT) capacity, which significantly limits the DG blackout period and reconnection time and results in a versatile framework against shortcircuits. Taking into account the huge number of deviated issues in dispersion frameworks, the VSC reaction in such circumstances should be examined, and thusly, its FRT ability should be built up. In this paper, initial, an exhaustive survey on the current FRT strategies has been introduced and examined. As needs be, a versatile virtual impedance-based voltage reference age strategy is proposed, which improves the VSC conduct under shortcircuits and builds the VSC FRT ability. Likewise, a quick sinusoidal current reference limiter is proposed to work on the presentation. To assess the presentation of the proposed plot, state-space examination is introduced, and a total arrangement of reenactments is acted in PSCAD/EMTDC climate. Likewise, an examination with the ordinary strategy is introduced.

S. F. Zarei et al. [6], Microgrid (MG) assurance is one of the primary difficulties in expansion of microgrids. Because of restricted issue current taking care of inverter-based circulated ages (DGs), in islanded activity of MG, assurance issues become more convoluted; and, in this manner, customary security methodologies can't be applied. Subsequently, new assurance techniques that are relevant in islanded and lattice associated methods of activity are essential. In this paper, an exhaustive computerized hand-off based security is presented for the insurance of MGs. The proposed strategy incorporates security of lines, disseminated ages, and the reason behind normal coupling. The design and graphical schematic of the proposed advanced transfers are likewise introduced. The proposed technique is free of the MG activity mode and advantages from single-stage stumbling. In this strategy, because of shortcoming confinement from the two sides of a line, downstream loads and DGs can work after issue leeway. To exhibit the viability of the proposed security strategy, various reproductions are completed on a MG test framework in the PSCAD/EMTDC climate.

S. F. Zarei et al. [7], proposes an issue recognition and insurance system for islanded inverter-based microgrids (IBMGs). Dependable and precise assurance is one of the principal challenges in the multiplication of current microgrids (MGs). Taking into account the restricted shortcoming current of the voltage-recurrence controlled inverter-based circulated energy assets (VF-IBDERs), the assurance is more difficult in islanded IBMGs. In such manner, the control plan of VF-IBDER with an ongoing restricting methodology assumes a significant part. Because of the restricted issue flows near the converter ostensible current, the customary shortcoming location techniques don't work as expected. Moreover, bidirectional issue flows deteriorate security coordination. In this article, initial, a scientific succession network demonstrating for VF-IBDERs is determined to determine their conduct under shortcoming conditions. Then, at that point, a voltage-controlled negative-succession obstruction based shortcoming recognition approach is proposed, which depends on the determined grouping organizations. This amount intrinsically identifies the shortcoming and its heading and is free of the shortcoming current size. The proposed element can be utilized in both the traditional and correspondence helped coordination techniques. Moreover, an insurance coordination system in view of a clear time evaluating approach is utilized. At last, the presentation of the proposed conspire is shown by applying various shortcomings in a test MG in PSCAD/EMTDC climate.

D. E. Olivares et al. [8], the rising interest in coordinating irregular sustainable power sources into microgrids presents significant difficulties from the perspectives of dependable activity and control. In this paper, the significant issues and



difficulties in microgrid control are examined, and a survey of cutting edge control techniques and patterns is introduced; an overall outline of the fundamental control standards (e.g., hang control, model prescient control, multi-specialist frameworks) is likewise included. The paper groups microgrid control procedures into three levels: essential, optional, and tertiary, where essential and auxiliary levels are related with the activity of the microgrid itself, and tertiary level relates to the planned activity of the microgrid and the host network. Each control level is examined exhaustively considering the pertinent existing specialized writing.

III. MICROGRID STRUCTURE

Microgrid solar PV, batteries and wind generation system become very attractive solution in particular for stand-alone applications. Joining the two wellsprings of sun powered and wind can give better unwavering quality and their cross breed framework turns out to be more conservative to run since the shortcoming of one framework can be supplemented by the strength of the other one. The coordination of half breed sun oriented and wind power frameworks into the matrix can additionally help in working on the general economy and unwavering quality of sustainable power age to supply its heap. Essentially, the combination of half breed sun based and wind power in an independent framework can decrease the size of energy stockpiling expected to supply ceaseless power. Sun based power age frameworks use either photovoltaics or concentrated sun based power. The concentration in this paper will be on the photovoltaics type. Itemized portrayals of the various advances, physical science and fundamentals of PV can be found in numerous course readings and papers, for example, [4-7].

Kurtz [8] called attention to that decade prior the concentrator cell was just ~30% effective contrasted and over 40% today with the possibility to move toward half before long. Si cells have efficiencies of 26% and multi-intersection III-V-compound cells have efficiencies above 45% (48% in the lab) as brought up in reference [9]. PV modules produce yields that are resolved mostly by the degree of occurrence radiation. As the light force builds, photocurrent will be expanded and the open-circuit voltage will be diminished [10]. The productivity of any photovoltaic cell diminishes with the rising temperature which is non-consistently appropriated across the cell [11]. The sun oriented yield power can be smoothed by the appropriation of sun based power in various topographical regions [12]. Power from sunlight based PV and concentrated sun based power plants is altogether costly and requires huge drop in cost or change in strategies by either financing or constraining the utilization of these advances to have the option to accomplish critical market entrance [13]. Worldwide breeze report (2012) demonstrated that the yearly market became by around 10% to stretch around 45 GW and the aggregate market development was practically 19% [14]. Point by point depictions of the breeze energy can be found in references [4] and [15]. Wind turbines (WTs) are characterized into two sorts: level hub WT (HAWT) and vertical-pivot WT (VAWT). The most noteworthy reachable extraction of force by a WT is 59% of the complete hypothetical breeze power [15]. Cross breed sun based breeze frameworks can be ordered into two sorts: matrix associated and independent. Writing audits for half breed lattice associated and independent sun oriented PV and wind energies were led overall by numerous scientists who have introduced different difficulties and proposed a few potential arrangements. Because of the idea of mixture sun based PV and wind energies, streamlining strategies can assume a decent part in using them effectively. Realistic development strategies, direct programming, and probabilistic methodology are not many instances of streamlining procedures that have been produced for techno-financially ideal crossover environmentally friendly power framework for the two kinds. The creators gave brief depictions about those markers and the different measuring techniques. A survey of control procedures for a half breed sustainable power framework was completed in and one more survey was finished in for streamlining of crossover sustainable power framework with more spotlight on wind and sunlight based PV frameworks.

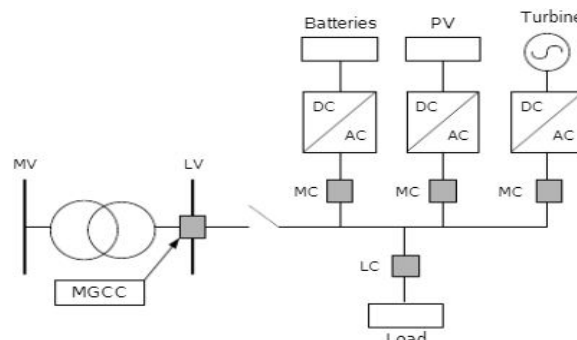


Figure 1: Micro Grid Control Architecture



IV. CONTROL OF MICRO-GRID

In micro-grid system, due to various micro-power types, it is difficult to control them in coordinating to establish a stable voltage and frequency. Now the control strategy commonly used is divided into master-slave station control, the droop control and control based on multi-agent technology, etc. The normal hang control in light of P-f and Q-V attributes further developed in Reference dodges the switch of control techniques and accomplishes the smooth change while working modes change. Reference [9] embraces a coordinated control system that incorporates ace slave control with shared control to control the activity mode progress between matrix associated activity mode and islanding activity method of miniature lattice. Reference [10] thinks about decentralization of the conveyed age units and burdens in the miniature network and focusing on age types and models of the stockpiling gadgets, involving different control methodologies in regulator plan for the circulated age units. At the point when the customary matrix separates or the power quality can't meet the prerequisites, miniature frameworks will disengage with standard lattices and structures into islanding activity.

In the miniature network framework, the expert slave control is that one or a few miniature power control all of miniature power as per V/f control. But the fundamental control source, other miniature powers frequently embrace P-Q control, the consistent power control. The principal control source which takes on V/f control supplies reference of voltage and recurrence to other miniature powers [1]. The course of expert slave control strategy goes as follows [2]:

- 1) When islanding is recognized, or the lattice detaches from the circulation network into the islanding activity mode, miniature matrix control will changes to the expert slave mode, by changing the different miniature power result to arrive at the overall influence.
- 2) When the miniature network loads change the principal power, first and foremost, changes yield current naturally as indicated by the heap change. Simultaneously framework recognizes and computes the power variety to change their result power; when other powers' result power increment, the result of the primary power will consequently decrease likewise to guarantee that the fundamental power generally has sufficient ability to change the difference in quick power.
- 3) When the network needs for dynamic power or responsive power, framework can depend on the principal unit to change. At the point when the heaps increment, as per the heap qualities, framework will diminish voltage properly.

Peer-to-peer control

Peer-to-peer control is that all of the DGs have equal status in the control in the system of micro-grid. There is no hierarchy among the controllers. Each DG is on the control according to signals at the point where system voltage and frequency access.

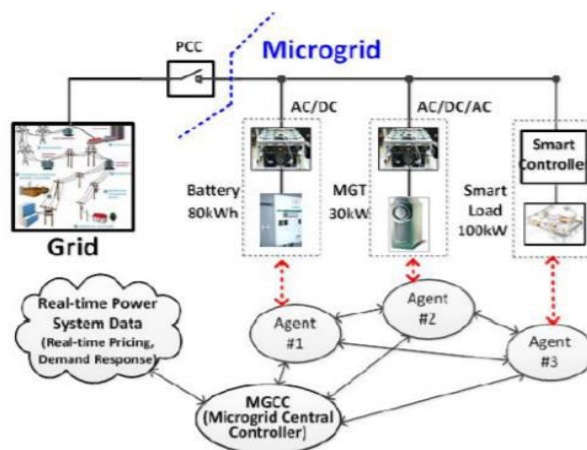


Figure 2: Configuration of Micro-Grid

Only peer-to-peer control can make the micro-grid plug-and-play. In general, in the control strategy DGs are allowed to control by using only local information, namely control does not depend on communication [8]. In peer-to-peer control mode, when the micro-grid runs in islanding mode, each DG used droop control strategy will be involved in the regulation of the voltage and frequency in the micro-grid [9].



V. MANAGEMENT OF MICROGRIDS

Microgrids are relatively weaker to endure disturbances, especially when it operates in the islanding mode. The safety could be exposed with higher risk. And thereby effective operation control and optimal energy management need to be researched.

A. Supervisory and Control Architecture For the sake of friendly integration with the main grid, the normal operation of microgrids is carried out by cooperation of three level supervisory and control systems as follows [11]:

- i. Distribution level: distribution network operator (DNO) and market operator (MO);
- ii. Microgrid level: microgrid central controller (MCC);
- iii. Unit level: local controllers (LCs). DNO/MO are used to achieve dispatch functions at the distribution level.

MCC is the interface between the microgrid and the main grid. It communicates with both DNO/MO and LCs. LCs are developed for distributed energy resources and controllable loads. They could also be used to regulate voltage and frequency. According to the different modes of decision making, the supervisory and control systems are divided into centralized microgrid control and decentralized microgrid control.

B. Operation and Energy Management There are many differences between traditional power systems and microgrids in operational modes, policies of power market and energy, types and penetration of distributed energy systems, and restrictions about characteristics of loads and power quality. As a result, it is necessary to investigate reasonable dispatching and management strategies to guarantee the security, stability, reliability and operation in an efficient and economic manner, which involve the randomness of actual production, the uncertainty of power flow, the operation diversity of the microgrid, the power market, and new energy policies. The research of integration and control are relevant to all distributed energy systems, one or more microgrids and the main grid. Market policies will play an important role, when microgrids operate in the grid-connected mode. One is that a microgrid could input power from but not output to the main grid, while demand of loads is satisfied by inner distributed energy systems to the best of their abilities. The other is that a microgrid could exchange power with the main grid freely, what is more, distributed energy systems and demand-side management are allowed to participate in the bidding processes. The strategies could integrate local thermoelectric demand, weather conditions, pricing, fuel consumption, power quality requirements, wholesale/retail service demands, demand side management requirements, and the level of congestion to make decisions.

These depend on new network and distributed control theories, computing and evaluating methods so as to support microgrids for reliable, effective and flexible operation. Because of the increasing variety and scale of distributed resources, and the introduction of microgrid technology, a new energy management system (EMS) must be considered for distributed energy systems and microgrids. A new generation of EMS involving a variety of power advanced applications is being developed in order to implement operation and energy management of a microgrid. It is expected to carry out real-time energy management and dispatching on the basis of a hardware platform. C. Ancillary Services The most exciting aspect of microgrid control is the ability to provide ancillary services. As for this aspect, one of opinions is that a microgrid could just operate as a controlled load but will provide power toward the main grid in no case; another is that a microgrid could provide power to the main grid and participate in the power market. In fact, even if a microgrid doesn't provide power to the main grid, it can still provide an important service for the main grid. The control of loads is very important to the main grid in a heavy-burden condition. Some kind of ancillary services are listed, made definitions and explained in detail in literature, mainly including: regulation and load following, reactive supply and voltage control, supply of reserves in long-term or short-term, system blackstart, network stability etc.

VI. FAULT CHARACTERISTICS ANALYSIS

Fault current characteristics analysis Considering the high similarity of PV sources belonging to different zones, a fault that happens in the line between bus P and Q is taken to analyze characteristics of fault current in the microgrid. The equivalent circuit of this system is shown in figure 3. Bus P is connected with the equivalent system containing a energy-storage source, a certain number of PV sources and load lines which have been shown in figure 1. Bus Q is connected with a load branch and a PV source that is able to provide power to the load in this specific zone.

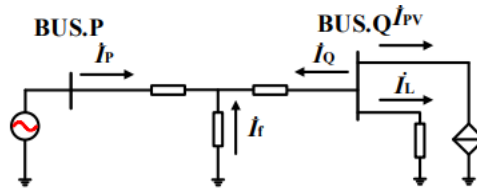


Figure 3: Equivalent circuit of the system during a fault

The frequency of voltage in the islanded microgrid is given by the energy storage source of VF control and it is consistent with that in normal working conditions. Due to the limited current of its source converter, a drop of voltage amplitude happens in the microgrid, and positive sequence voltage of bus Q can be expressed as

$$\dot{U}_{Q(1)} = U_{Q(1)} e^{j\varphi_{Q(1)}}$$

where $U_{Q(1)}$ is the positive sequence voltage amplitude of bus Q, $\varphi_{Q(1)}$ is the positive sequence voltage phase-angle of bus Q, and the positive sequence voltage phase-angle of phase A $\varphi_{QA(1)}$ is set as 0° . The PV source doesn't make a dynamic reactive power compensation in the control strategy because resistive component takes up a majority in the impedance of low-voltage lines, especially for the cable lines. Therefore it can be expressed as $Q^*=0$ in equation (2). The output current of converter increases aiming to maintain the active power reference P^* until it reaches the upper limit ($IPV.max$). Furthermore, q-axis voltage components at the access point of PV source is 0 considering the method of voltage oriented control. Positive sequence current of the PV source connected to bus Q can be calculated as

$$\dot{I}_{PV(1)} = I_{PV(1)} e^{j(\varphi_{Q(1)} + 180^\circ)}$$

Where $IPV(1) = \min\{P^*/U_{Q(1)}, IPV.max\}$, is the positive sequence current amplitude of the PV source, and the positive direction of current is shown in figure 3.

VII. CONCLUSION

the fault current characteristics and the operating performance of current differential protection are analyzed in a typical islanded microgrid. Control strategy of distributed sources during the fault and small load impedance cause the current angle difference between two sides of the fault line to be more than 90° and the differential protection could not operate reliably. Furthermore, the protection based on real-time phase comparison of fault component of negative sequence current is studied to identify the fault line and cut it reliably. The analysis of the fault characteristics and the protection scheme will be verified by simulation results.

REFERENCES

- [1] Seyed Fariborz Zarei, Mohamad Amin Ghasemi and Saeed Peyghami, Frede Blaabjerg, "A Fault Detection Scheme for Islanded-Microgrid with Grid-Forming Inverters", 2021 6th IEEE Workshop on the Electronic Grid (eGRID).
- [2] A. Dagar, P. Gupta, and V. Niranjana, "Microgrid protection: A comprehensive review," *Renewable and Sustainable Energy Reviews*, vol. 149, p. 111401, 2021.
- [3] S. F. Zarei and S. Khankalantary, "Protection of active distribution networks with conventional and inverter-based distributed generators," *International Journal of Electrical Power & Energy Systems*, vol. 129, p. 106746, 2021.
- [4] P. Patil, A. Badar, and T. P. Hinge, "Application of Linear Programming for Overcurrent Protection," in 2021 International Conference on Intelligent Technologies (CONIT), 2021, pp. 1-4.
- [5] S. F. Zarei, H. Mokhtari, M. A. Ghasemi, and F. Blaabjerg, "Reinforcing Fault Ride Through Capability of Grid Forming Voltage Source Converters Using an Enhanced Voltage Control Scheme," *IEEE Trans. Power Delivery*, 2018.
- [6] S. F. Zarei and M. Parniani, "A Comprehensive Digital Protection Scheme for Low-Voltage Microgrids with Inverter-Based and Conventional Distributed Generations," *IEEE Trans. Power Delivery*, vol. 32, no. 1, pp. 441-452, 2017.
- [7] S. F. Zarei, H. Mokhtari, and F. Blaabjerg, "Fault detection and protection strategy for islanded inverter-based microgrids," *IEEE Journal of Emerging and Selected Topics in Power Electronics*, vol. 9, no. 1, pp. 472-484, 2019.



- [8] D. E. Olivares, A. Mehrizi-Sani, A. H. Etemadi, C. A. Cañizares, R. Iravani, M. Kazerani, A. H. Hajimiragha, O. Gomis-Bellmunt, M. Saeedifard, R. Palma-Behnke, G. A. Jiménez-Estévez, and N. D. Hatziargyriou, “Trends in microgrid control,” *IEEE Trans. Smart Grid*, vol. 5, no. 4, pp. 1905–1919, 2014.
- [9] J. M. Guerrero, M. Chandorkar, T. Lee, and P. C. Loh, “Advanced Control Architectures for Intelligent Microgrids; Part I: Decentralized and Hierarchical Control,” *Ind. Electron. IEEE Trans.*, vol. 60, no. 4, pp. 1254–1262, 2013.
- [10] M. Yazdani, A. Mehrizi-sani, G. S. Member, and A. Mehrizi-sani, “Distributed Control Techniques in Microgrids,” *Smart Grid, IEEE Trans.*, vol. 5, no. 6, pp. 2901–2909, 2014.
- [11] S. D. J. D. J. McArthur, E. M. M. Davidson, V. M. M. Catterson, A. L. L. Dimeas, N. D. D. Hatziargyriou, F. Ponci, and T. Funabashi, “Multi-Agent Systems for Power Engineering Applications-Part I: Concepts, Approaches, and Technical Challenges,” *IEEE Trans. Power Syst.*, vol. 22, no. 4, pp. 1743–1752, 2007.
- [12] W. Liu, W. Gu, W. Sheng, X. Meng, Z. Wu, and W. Chen, “Decentralized multi-agent system-based cooperative frequency control for autonomous microgrids with communication constraints,” *IEEE Trans. Sustain. Energy*, vol. 5, no. 2, pp. 446–456, 2014.
- [13] Q. Li, F. Chen, M. Chen, J. M. Guerrero, and D. Abbott, “Agent-Based Decentralized Control Method for Islanded Microgrids,” *IEEE Trans. Smart Grid*, vol. 7, no. 2, pp. 637–649, 2016.
- [14] J. Rocabert, A. Luna, F. Blaabjerg, and I. Paper, “Control of Power Converters in AC Microgrids.pdf,” *IEEE Trans. Power Electron.*, vol. 27, no. 11, pp. 4734–4749, 2012.
- [15] R. Olfati-Saber, J. A. Fax, and R. M. Murray, “Consensus and cooperation in networked multi-agent systems,” *Proc. IEEE*, vol. 95, no. 1, pp. 215–233, 2007.



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