Evolution of Novel Process for Smart Inverter for High Penetration of Rooftop solar energy in power utility with secondary distribution network – A Review

[a]KISHOR SHINDE,[b]P.B. MANE
[a]Maharashtra State Electricity Distribution Company Ltd, Aurangabad, Maharashtra, INDIA.
[b]Department of Electronics and Telecommunication Engineering, AISSMS-Institute of Information Technology, S.P. Pune University, Pune, Maharashtra, INDIA.

Abstract: With the critical change of Rooftop Solar Photovoltaic Energy System (RSPES) between the two different Renewable Energy Systems, the real problems, impacts and a few working qualities of the housetop sunlight based PVs with Low Power Utility Network Distribution System (DS) are currently to be examined and explored throught out the worldwide. The most vital target of review looks into about the load flow in LV Networks and searches a way for implementing high penetration PV network. The study papers discuss the implementation of the Smart Inverter-coordinated secondary distribution system with the proximity of distribution generation (DG) units. This paper reviews based on the methods which are utilized to tackle the issues and improvement of performance in the rooftop solar photovoltaic energy system in the period between 2014 to 2017.

Keywords: Renewable energy sources, Rooftop Solar Energy, Photovoltaic, Distribution generation
Received: August 19, 2021. Revised: April 17, 2022. Accepted: May 18, 2022. Published: June 25, 2022.

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1 Introduction

The most appropriate path for confronting the current circumstance of huge energy demand is the use of sustainable and optional energy resources and to expand the proficiency of the frameworks for the conversion of energy and the solar renewable energy is one of the most plentiful and useful energy source while compared with other renewable energy resources such as wind power, Hydro-power, Tidal Power, Geo-Thermal Power, since the solar energy can be transformed into electrical energy as well as heat energy [1]. Evaluation of renewable energy systems' efficiency and their location and sizes in urban areas have been made to improve the competitiveness and sustainability of renewable energy systems under various conditions. Apart from its environmental benefits, the economic benefits of renewable energy contribute to addressing energy poverty by ensuring sustainable access to electrical energy. Installation of solar photovoltaic systems for existing buildings is thought to have some advantages and increase the energy security [2].

The numerous history studies were completed for the energy quality assessment unsettling influences incorporate sudden change in solar insolation, integration of grid and effects of Rooftop Solar PV system. The major concerns with this Rooftop PV are Power Quality, Safety, Low Voltage Distribution Grid (LVDG), and the Transaction Costs [3]. There are many control strategies used for the efficient residential Energy Storage Systems coupled with Photovoltaic units. These control strategies are based on some defined set of rules, optimization with or without utility constraints and the distributed based control. Hence the performance of the entire system can be improved by means of reducing the power requirement, energy losses and voltage unbalance caused by the installations of Small-scale Rooftop Solar PV systems [4].

Optimization methods in the power system are commonly used for solving the Minimization and Maximization problems for improving the overall effectiveness of the system. Different algorithms are used for problem determination of device parameters to reduce the difficulty of calculations to achieve optimal results [5]. The best combination of two is that the smart grid infrastructure is related to more renewable energy resources in a geographical location. Here the optimization algorithm can be used to determine the economic feasibility to ensure reliable power supply to load demand and reduction of cost [6]. Multiple equipment may be used to stabilize inaccurate voltage variations and deviation in high renewable infiltrated distribution systems. In the case of stochastic renewable energy production outputs and demands for load, the Capacitor Banks

(CBs), On-Load Tap Changers (OLTCs), Renewable Energy Source (RES) inverters are correlated to control the network voltage [7].

For house feeding system with high solar penetration levels, the storage capacity and rated power of an Energy Storage Device (ESD) are calculated to fulfill the specified operational requirements of distribution networks. The efficiency of energy storage capacity can be enhanced because the total energy storage system's rate of consumption is increased [8]. The power output of PV generator systems is highly variable due to the high interference of solar radiation. PV power fluctuations can cause harmonic distortion that can be corrected by sufficient electronic power Topologies. The need for greater operative responses to the current voltage regulators is rising because of the rapid growth in high penetration of distributed energy sources, such as PV. The need for higher-speed power regulatory equipment is growing. In order to regulate power distribution voltage, the smart PV inverter can generate and absorb Var reactive power [9]. The Objective results has been reached as optimum solar community designs had large heating solar fractions, high power quality with the minimum amount of establishment costs since the solar rooftop energy has more advantages and used for different purposes [10].

Rooftop photovoltaic (PV) frameworks are as a rule progressively introduced in low voltage (LV) distribution networks by customers to lessen the power supply cost. Be that as it may, the extending size of private PV associations prompts hindering effects on the system activity. The first two problems are voltage control and voltage imbalance High PV generation times, a major upset in power control stream and resulting voltage ascends on the LV feeder. Furthermore, Sporadic losses in PV age during cloudy days can lead to genuine voltage drops. In addition, the growing foundation of single-stage housetop PV units at self-assertive zones with various evaluations is furthermore declining the formally poor stage alter profile of conveyance systems [11].

In a regular PV system, the PV cells (masterminded in a solitary module, a series of arrangement associated modules, or a variety of parallel-associated strings) used to create a dc current that enormously relies upon the solar irradiance, temperature, and voltage at the terminals of the PV system. This dc power is changed and connected to the framework by means of a PV inverter. Extra components incorporate a matrix association channel, a network screen or cooperation unit (for synchronization, estimations, hostile to island discovery, and so forth.), and a low-recurrence transformer (which is discretionary relying upon neighborhood directions, the topology converter, and the adjustment used to control it). Other choice is a middle of the road dc– dc power organizes among PV modules and the network tied inverter. The PV machine feature from PV inverter control decouples from this discretionary point. Moreover, it can help the PV system dc yield voltage if required or give galvanic confinement and perform most extreme power point following (MPPT) control [12]. Vitality stockpiling to give voltage direction on a circulation system. The dissemination system has a high entrance of PV generation, which has been appeared to cause neighborhood voltage control issues. The PV stations make utilization of keen PV inverters as proposed by EPRI. This enables them being facilitated to remember the final target to help direct voltage on dissemination systems [13].

To upgrade system productivity and mitigate power blockage in the medium-voltage (MV) and low-voltage (LV) conveyance systems brought about by rising requests, a high infiltration level of sustainable power sources (RESs) to be situated close to clients' destinations will be empowered to give circulated age to neighborhood loads. Such change brings about the development of miniaturized scale frameworks (MGs) in the dispersion networks comprising of interconnected burdens, vitality stockpiling, and conveyed vitality asset (DER) units, for example, photovoltaic (PV) solar-power and little breeze power systems. With a keen interface switch, each MG acts as a subsystem that can function cleverly in parallel or in an insulate mode with the full scale framework. Moreover, each MG will be regarded as a producing asset or devouring asset district/element relying upon the power status age and utilization in its neighborhood specific eras [14]. Conveyed generators, for example, solar PV power utilize sun as fuel, uninhibitedly accessible however the measure of provided fuel to be specific sun radiation are unusual, hence the yield power systems isn't steady and in truth is straightforwardly corresponding to the flighty sun conditions. Another adjustment in the sun's level would affect the power generation calculation of the solar system. PV and wind power input problems can be limited to low voltage systems as the voltage is continuously precisely regulated by a medium voltage system [15].

The ever-increasing penetration of PV panels threatens the activity of the future grid. During periods of low demand, the high active power injection by the PV inverters can result in transformer overloading or a rise of the grid voltage to critical levels. Voltage rise is normally the main limiting

factor to prevent the increase in PV generation in low-voltage (LV) networks. PV inverters give the minimal or maximal energy in just a small fraction of the time so that the remaining power capacity available in the inverter can be used for voltage control. Voltage control by reactive power control and active power is a reduction of cost-effective solution [16]. In high-penetration situations, be that as it may, grid-associated PV frameworks will force new difficulties to the conveyed electrical system. These difficulties will basically be because of 1) the discontinuous idea of PV sources and 2) the disengagement of PV frameworks from the disseminated grid in light of irregular grid conditions. The precariousness of the whole electrical system might be actuated, prompting a power outage and power grid disappointment, and causing extreme results in the client loads. To beat these difficulties, show grid necessities are relied upon to be overhauled with joined institutionalized highlights and custom requests. A few investigations have exhibited the capability of PV frameworks to assume a dynamic part in the control of appropriated grids like what the customary power plants executes [17].

To control the voltage and power flow on a high PV penetration feeder, reactive power control of PV inverters and the ability to curtail output power are two essential control schemes. The objective is to move away from fixed power and constant reactive power and to change the reactive power absorption or injection during the day through PV inverters dynamically according to changing circuit conditions. Benefits are looking in quality communication and control techniques to practice these types of controls and dispatch PV plants remotely as part of day-to-day system operation. Remote controls will provide the flexibility and controllability needed to properly operate distribution systems while increasing the use of existing assets and mitigating the adverse impacts often experienced under conditions of extreme PV power construction [18].

To enhance control standards in the LV systems of high PV entrances during yield control of inverters. A PV inverter based arrangement might be more compelling than the customary arrangements from a speculation and transient reaction point of view. For the most part, two systems have been presented with the current PV inverter control plans. The essential shape is receptive power control. In view of voltage affectability investigation of dispersion coordinate as for PV age varieties, Inverter techniques for receptive power control are proposed to create PV infiltration or to ease voltage fluctuations [19]. The circulated sustainable age in local locations most normally includes solar photovoltaic (PV). The private on location vitality sources can be fully incorporated in the intuitive age administration and Operations of HEMS, and permit the smart houses not just depend on the mass power from the transmission frameworks. Because of the intrinsic irregularity and arbitrariness of sunlight based vitality, the vitality Storage gadgets assume an imperative part to enhance the power Quality and vitality productivity as well as maintain the energy system reliability [20].

2 Vigorous Review on High Penetration of Rooftop Solar Energy in Power Utility with Secondary Distribution Network

2.1 Review on Load Flow Study for LV with or without distributed generation

Alam *et.al* discussed about a high entrance of housetop sun powered photovoltaic (PV) assets into low-voltage (LV) dissemination systems makes invert control stream and voltage-rise issues. This for the most part happens at the point when the generation from PV assets generously surpasses the heap request amid high periods of insolation. This paper has researched the sunlight based PV effects and built up an alleviation technique by a successful utilization of distributed energy storage systems incorporated with sun oriented PV elements in the LV systems. The storage system is used to devour superfluous sunlight based PV control locally amid PV crest; also, put away power is used at night for the pinnacle stack bolster. A charging/releasing control system is produced considering the existing charge state (SoC) for storage and planned charge/release time length to adequately use accessible limit for storage. Due to the poor weather conditions, the advanced technique may also moderate the impact of sudden changes to PV output through the transfer of storage in temporary release mode. The rate of charging is balanced progressively to recuperate the charge depleted amid the here and now release to guarantee that the level of SoC is as close to the coveted SoC as could reasonably be expected. A complete battery show is utilized to catch the reasonable conduct of the distributed energy storage elements in a dissemination feeding system. Rooftop PV impacts on relief furthermore, evening crest stack bolster. This system can coordinate the PV yield/evening load profile superior to the customary steady charging/releasing system. A procedure has been produced to acquire the suitable charging/ releasing rates in light of the current SoC level of the

storage gadget and the proposed charging/releasing period to astutely use the restricted limit of storage gadget. In addition, because of unpredictable climatic conditions the advanced technique will moderate abrupt changes in PV yarming by placing the storage in short-term release mode. It can also monitor and change the SoC storage deviation from the target soC standard. [21]. In this paper load profile is considered and effects of low voltage with/without grid are discussed.

Roy et.al delivered a unidirectional energy to consumers and requires insignificant control intercession; they result in to a great extent inactive infrastructure. The establishment of disseminated age (DG) units with critical limit in these uninvolved systems can cause turn around control streams, which will bring about a few clashes with the task of the current assurance framework. In this unique situation, utilities around the globe have begun building up prerequisites to guarantee sheltered and strong link of low- and medium-voltage generators. The specialized framework cipher necessities and controls shift significantly from nation to nation. In some case, any standard shall satisfy the basic need for the DG to be attractive by providing clear requirements and conditions which are necessary for implementation, work and protection. This paper has been exhibited by the present condition of, significant impediments to, and proposals coordinated toward the foundation of loads in DG inside the use of frameworks. Provincial contrasts among the improvement of grid codes have been additionally featured [22].

2.2 Review on Load flow study for LV with or without Generation in smart grid

Sam weckz*et.al* adjusted three-stage four-wire conveyance grids can have fundamentally more circulated age and electric vehicles. Three-stage photovoltaic (PV) inverters and electric vehicle (EV) chargers might be adjusted to exchange control from very stacked to less stacked stages, without over-burdening the inverter or charger. Grid conditions are strengthened by more adapted system operation and more PV boards and EVs can be combined in order to meet the cut-off points of the system. This paper changes a perfect ease-of-charge method for EVs. The load of EVs has been shown to be increased when power is exchanged from one point to the next. Utilizing PV inverters by adjusting inverter, the energy can be infused in every stage will turn into a controllable variable as the aggregate sum of created control does not really should be similarly isolated over the three stages. Modifications are tested using EV chargers and PV inverters to change the device. The grid effect of the expanding measure of EV charging and PV creation can be considerably diminished in the event that they would have the capacity to adjust the grid. Both off-board three-stage EV chargers and three-stage PV elements might be adjusted to adjust a three-stage four-wire dissemination grid. Grid conditions are improved by maintaining the power from a lower stacking stage and by adding the highest stacking into the stage. This work adjusts to the effects of the additional adaptability that these balancers include a combined organized EV charge problem [23].

Molina-García Á *et.al* have demonstrated a power reactive stream control pursuing active PV frameworks incorporation in LV appropriation systems. An option control stream examination was performed by the particular characteristics of LV systems, for example, high resistance/reactance proportion and radial topologies. The presented solution provides high performances, regarding rms-voltage direction, by evaluating the reactive power reference on every node considering the impact of whatever remains of the nodes as far as active and reactive power demanded/generated by them. The local control of each Photovoltaic framework depended on the power converter control, interfacing these elements with the grid and the goods flow discretely. The local regulation was designed based on premise of locally measured input factors. Photovoltaic units in this manner ensure all-inclusive operation, having the capacity to change between islanding-mode and grid-connected mode without upsetting basic burdens associated with them, and permitting smooth advances. Comprehensive outcomes were additionally included and discussed here [24].

2.3 Study of different Load flow for LV distribution network

Ruiz-Rodriguez *et.al* portrayed an approach to investigate voltage unbalance affectability for various most extreme ranges on solitary stage photovoltaic framework (SPPVS) with numerous PV penetration levels in a run of the mill auxiliary outspread dispersion organize (SRDN) in Spain. This examination viably evaluates present necessities as determined in directions regarding most extreme size to be associated. It along these lines causes conveyance organize administrators to characterize ideal points of confinement, contingent upon their unique situation. A stochastic evaluation technique is proposed to represent any irregular blend of SPPVSs in a SRDN. Furthermore, this strategy assesses week by week voltage imbalance amid a one-year era, based on 10-min interims. All the more particularly,

the voltage imbalance in SRDNs with SPPVSs is surveyed for every 10-min interim by methods for a probabilistic outspread three-stage stack stream. A voltage unbalance affectability investigation for various greatest sizes of SPPVSs and PV penetration levels/load flow was performed on a normal SRDN in Spain. The goal was to confirm current necessities as determined in the controls with respect to the most extreme size to be associated [25].

Chao long *et.al* depicted the expanding reception of local photovoltaic (PV) frameworks, the utilization of advancements, for example, on-stack tap changer (OLTC)- fitted transformers, capacitor banks, and moderate voltage problems are considered for remote observation, load flow especially in European-style low voltage (LV) systems. Contingent upon the power system, be that as it may, the consequences for client voltages and control activities (e.g., tap changes or capacitor exchanging) might shift altogether. This work exhibits a system to survey the execution of various OLTC-based control methodologies as far as voltage consistence with the standard BS EN50160 and the quantity of control activities. There are three proposed control procedures: consistent set-point (CSC), time-based (TBC) and remote checking based (RMC). Three control methodologies, steady set-point, time-based and remote-observing based, has been advanced to alleviate voltage rise issues in PV-rich LV systems utilizing OLTC-fitted transformers [26].

2.4. Review on Load flow/Radial feeder/Weak Mesh/with storage/Power quality/Voltage unbalance

Mehdi zerati*et.al* discussed the Low voltage (LV) distribution network voltage increase problem with high penetration of photovoltaic (PV) resources is one of the most important challenges in the development of these renewable resources since it may prevent the maximum PV penetration considering the reliability and security issues of distribution networks. The battery energy storage (BES) systems are used in order to solve the voltage rise during the peak PV generation as well as the voltage drop while meeting the peak load. A coordinated control strategy is proposed to regulate the charge/discharge of BESs using a combination of the local droop based control method and a distributed control scheme ensuring that feeder voltages stay within the permissible limits. It directs the voltage rise/drop problems using the distributed battery energy storage (BES) systems. Accordingly, a coordinated control scheme has been developed to regulate the system voltage and effective usage during regular operations of BESs' storage space. The control system includes a mechanism for local drop control [27].

ErhanDemirot*et.al* to expand the entrance level of photovoltaic (PV) control generation in low-voltage (LV) matrices by methods for sunlight based inverters with responsive power control ability. This paper highlights frail purposes of quality responsive control procedures which are now forced by certain matrix codes, and afterward, the examination presents another receptive power control technique that depends on affectability investigation. The affectability investigation demonstrates that a similar measure of responsive power turns out to be more viable for network voltage bolster if the sun powered inverter is found toward the finish of a feeder. In light of this principal learning, each inverter can be assigned a subordinates value for the area power factor, and a less receptive power consumption can be achieved with the net voltage help. With a specific end goal to anticipate pointless responsive power retention from the framework amid allowable voltage run or to increment responsive power commitment from the inverters that are nearest to the transformer amid matrix overvoltage condition, the proposed strategy joins two hang works that are acquired from the standard cosϕ (P) and Q (U) techniques. Its execution examination regarding lattice misfortunes and voltage variety with various responsive power techniques is given by displaying also, mimicking a genuine rural LV network are derived from two conventional methods: cosϕ (P) and Q (U). As the created control approaches the ostensible power and the matrix voltage approaches as far as possible esteem, the cosϕ (P, U) technique looks like cosϕ (P) technique. Furthermore, inverters closer to the transformer give the abnormal state genuine power infusion a more receptive power absorption [28].

Kashani MG *et.al* has proposed a voltage adjustment and control strategy for distributed low-voltage PV micro inverters by using immediately available information estimates, i.e. voltage and power at the ECP of inverters. Inverter voltage control strategies, including Volt-Watt and Volt-VAR, have been created to help higher penetration integration of photovoltaic (PV) generation. These methods ordinarily concentrate on voltage control as measured at the Point of Common Coupling (PCC). Executing voltage control with distributed inverters inside a low voltage organizer was trying due to the upward voltage of the PCC and the Electrical Connection Point (ECP). This technique has been shown to minimize surplus PV micro inverters and control decrease while supporting voltage control plans at the PCC. Test outcomes were given from

simulation-only scenarios and a Power-Hardware-In-The-Loop (PHIL) test stage [29].

Brandao DI *et.al* introduced a feasible power stream management strategy amid various periods of a three-phase four-wire dissemination control framework by methods for single-phase converters self-assertively associated among the stages. The goal was to increase the power quality in the point of the common link of a micro grid, increase the voltage load profile across the lines and reduce the overall loss of distribution. The strategy depended on a master/slave association where the distributed single-stage converters go about as slave units driven by a centralized master controller. Active, reactive, and unbalance control terms were handled by the master controller and shared relatively among distributed vitality assets to accomplish the remuneration focus at the point-of-common-coupling. The proposed control procedure was assessed in simulation considering the model of a genuine urban power dispersion network under non-sinusoidal and asymmetrical voltage conditions. The main results, concerning both steady-state and temporary circumstances, announced and debated at last [30].

2.5 Review on Load flow with High PV penetration of DG

ReinaldoTonkoshi*et.al* discussed about the over voltages of LVs with high photovoltaic (PV) infiltration are normally prevented by limiting the PV capacity of the feeder to exceptionally conventional appreciation, regardless of whether the basic time frames infrequently happen. This paper talks about the utilization of hang based dynamic power reduction systems for overvoltage anticipation in spiral LV feeders as a methods for expanding the introduced PV limit and vitality yield. The APC conspires that all inverters/houses are similarly suspensive, however APC's dedication to overvoltage counteraction from all inverters is exceptional. Inverters support the feeder downstream, which has an effect on their income are expected to reduce more power than others. An approach which proposed the results of the inverter sharing of OPLs (APC-OPLS) and demonstrated its adequacy. Be that as it may, this component comes to the detriment of expanded OPL concerning the essential APC conspire [31].

Ognjengagrica et.al talked about the progress is to develop smart photovoltaic (PV) high penetration distribution systems include coincidental age diminishing as a contrasting option to grid fortifications. Micro inverters are assuming control fame of string inverters in private and some business zones for the most part because of expanded vitality reap. This paper shows how micro inverters with an altered overvoltage security plan could give a dependable shortening arrangement and suit extra PV limit. Two wide-territory abbreviation plans were proposed for a run of the mill Dutch private feeder with thickly bunched PV. Initial, a solitary most dire outcome imaginable was utilized to exhibit the abilities of the proposed abridgement conspires: the dispersion arrange administrators can upgrade between different needs, for example, add up to feeder yield, monetary correspondence between associated parties, voltage levels, voltage unbalance, and diminishing execution time. Not only can micro inverters be used to turn PV into a more solid source of vitality, but also to make a granular voltage control capacity and probably different administrations essential for the DSO [32].

Emilio Ghiani et.al clarified that with the developing number and limit of photovoltaic (PV) establishments associated with appropriation systems, control quality issues identified with voltage direction are getting to be applicable issues for control circulation organizations and for PV proprietors. In numerous nations, similar to Italy, this has required the correction of the benchmarks concerning the association with people in general distribution system of circulated inexhaustible age. The new models require an adaptable task of generation plants that must be able to change the dynamic and receptive power powerfully in capacity of the system parameters in nearby control or following outer commands. In LV conveyance systems, when high PV penetration in dissemination systems exist, voltage direction issues may happen, and smart highlights of current inverters can be executed to enhance the voltage profile/load flow and the entire exhibitions of PV framework [33].

2.6. Comparison study of the performance of different method of Load flow with distributed Generation in LV secondary Distribution

Salvador Ruiz-Romero *et.al* comprehend the distributed generation combination troubles, the evaluation and the effect of dissatisfaction of system disappointment and how the combination of DG grid affects voltage regulation at medium voltage (MV) and low voltage level (LVs) are present at the power distribution organization. The results showed that a correspondence mechanism exists between all

generators of defensive frameworks, a particular defensive framework for annoying surrenders and a stage control framework between the generators and the device. In addition, voltage control synchronization is important to ensure the nature of power supplies. RES can be ideally coordinated into the dissemination grid, as has been as of now accomplished in the transmission framework with expansive scale inexhaustible plants [34].

Pedramsamadi*et.al* centers around the issues of load planning and power exchanging frameworks with high penetration of sustainable power source assets (RERs). We embrace estimated dynamic programming to plan the activity of various sorts of machines including must-run and controllable apparatuses. We accept that clients can pitch their overabundance control age to different clients or to the service organization. Since it is more gainful for clients to exchange vitality with different clients locally, clients with abundance age contend with each other to pitch their individual additional energy to their neighbors. An estimated dynamic program was proposed to plan the task of various sorts of apparatuses, and a theoretical diversion strategy was introduced to show the cooperation of clients with the age of overabundance management. Clients with abundance control age pick their offered cost and yield age to such an extent that they acquire a bigger offer of the market and their income is augmented [35].

2.7 Review of optimal load flow study for LV Secondary Distribution network

Van Dao *et.al* has shown ample estimations in order to prepare a direct square problem to optimize CVR execution on the smart grid platform. Considering photovoltaic inverters (PVs) as controllable var sources prepares for a viable execution of protection voltage decrease (CVR) in dissemination frameworks with numerous voltage regulating devices. The optimization issue was explained by utilizing a worked in solver of the Mat lab programming implanted in an iterative-based calculation. This calculation was all around checked by contrasting its created result and a trustful arrangement acquired from looking at all conceivably planning blends of voltage regulating devices and PVs in the improved Maehongson test framework in Thailand. Adequacy of the calculation is likewise represented on that test framework with a thought of time-variation load and PV generation. All uncovered highlights show the high capacity of applying CVR utility in appropriation context the proposed technique for success of shut circle [36].

A. Aronescu *et al.* have formulated the Optimization of Solar Photovoltaic (PV) units involving the necessary objective function with set of constraints. In their proposed methodology, they have considered four main objective functions for getting optimal solution for each and every constraint. The optimal PV system was formulated by applying the objective functions for 1. Maximum Annual Incident Energy, 2. Minimum Plant Cost, 3. Minimum Field Area, 4.Minimum cost of energy unit. They have designed the PV system with the consideration of design specifications such as the length and width of the field, collector specifications (Number of rows, Distance between the rows, width and Inclination angle), and the number of photovoltaic modules connected both in series and parallel in the string. The combined approach of Theoretical and Practical Optimization based on the characteristics of PV with inverters, specifications of collector and field was performed for the optimization of solar PV field. Hence their proposed methodology provides an insight to the design of PV solar fields optimally [37].

2.8. Review of Load flow for LV network taking into consideration the Reverse power flow during high Generation and Low Demand

Zio et.al explained the distributed generation (DG) systems are expanding rapidly with increased use of renewable energy sources. Embedding DG to the distribution network may be costly due to the grid reinforcements and control adjustments required in order to maintain the electrical network reliability. Deterministic load flow calculations are usually employed to assess the allowed DG penetration in a distribution network in order to ensure that current or voltage limits are not exceeded. However, the risks of limit breaches due to uncertainties in network operating conditions can be ignored. The power demand from the loads of MV distribution networks is affected by variability, which reflects on the power flows and voltage profile throughout the feeders. Within a DG penetration assessment, we presented a probabilistic load flow analysis using Monte Carlo simulations to account for load variability. We quantified the maximum DG power that can be connected to each bus of the distribution network without modifying protection, control and automation systems. We simulated customer demand variability and defined maximum DG power for each network bus that does not breach operating limits [38].

Mohammadi FD *et.al* built a scalable, detailed micro grid state space model that manages basic

components and loads and also generates inverter-based inverters, e.g. PQ and VSI. The design was particularly suitable for configuring control with the ostensible frequency and voltage estimates of the VSI inverters and active and reactive PQ inverter power description points. The model was also useful for evaluating and upgrading the reliability of small signals. The low-frequency methods of the power-sharing dynamics were shown to drift to new areas and relative stability were achieved by introducing a PQ inverter to the structure. In the meantime, a decentralized drop controller with parallel VSI inverters was developed to maintain energy sharing reliability. At long last, the dynamic model was utilized to outline and execute dispersed secondary frequency controllers thinking about the characteristics of storage devices. These display and management techniques were seen with and without PQ inverters using an 11 Bus Micro grid [39].

2.9. Review of Load flow and steady state/transient analysis for LV secondary Distribution Network

Prabhu et.al clarified about the execution of load stream investigation and solidness examination by utilizing Mi control innovation. In the past paper the heap stream investigation and steadiness examination was not found by utilizing ETAP programming. This paper demonstrates the dependability execution and the MI control innovation was clarified and distinctive displaying setup was likewise clarified. This paper clarifies the diverse load stream investigation and furthermore has the improvement procedure utilized as a part of Fast Decoupled strategy and furthermore gives the Contingency examination by the heap stream technique. It finishes up the power framework reproduction by having long haul age and transmission, here and now operational recreations and market investigation, for example, stack anticipating [40].

Nitinkumarsaxena et.al clarified the dynamic remuneration procedures give a superior voltage reaction yet at a cost was high; interestingly, by trading the voltage reaction off the static compensator lowers wage costs. The use of both static and dynamic off setters together will provide a financially sound receptive power compensation for pre-defined temporary voltage containment points while the load flow is being loaded. This article shows the importance of receptive capacity pay in permanent, dynamic states of a settled condenser (FC) and STATCOM system. The key commitments of the paper are: (1) evaluation of the payout of receptive power using the static FC, and the dynamic compensator, STATCOM, and (2) rapid voltage recovery by the use of a hereditary calculation-based tuning to increase the consistently STATCOM controller, (3) assessment of responsive power pay cost for enduring and dynamic conditions because of progress in stack as well as info request, and (4) correlation of reactions got for the improved case with a previous reference pay method. The utilization of STATCOM alone gives an in fact reasonable arrangement, yet the presentation of static compensator can give an in fact and monetarily practical arrangement. The state pay is observed to be constant, while the dynamic wage is to be done through STATCOM and hence the payment can be decreased viable by implementing FC for pay in a non-defecting state [41].

2.10. Study of different type of LV Distribution network

Caire et.al specially Low Voltage (LV) systems are being confronted by a growing number of small size producers who need interconnection. Since most distribution systems are not designed to “receive” large injections of power these small generation units may affect these networks in particular as regards the quality of the energy supplied, the reliability, and protection of the entire distribution system from LV to MV. Then the MV voltage profile validated this technique [42].

Wang et.al explaining that the ENSs was proposed in low voltage (LV) dispersion systems with high entry of photovoltaic hopper to illuminate voltage rise-/drop problems (PVs). The voltages are determined by charging the ESS during peak generation and the stored power will be released to sustain the voltage during the high loading time. Detailed research is carried out in relation to the effect of the storage system with PV source on feeder voltages. For distributed ESSs there is a proposed organized control strategy that involves both distributed and restricted controls. The distributed control by measuring the agreement controls the feed voltages inside the device as much as possible, while the restricted control guides the charging condition (SoC) of each ESS within the soc. The entire control system maintains the direction of voltage while the storage limits are correctly used under various conditions of service. Distributed ESSs are used for voltages control in high-pV penetration LV appropriation schemes. The effect of ESS on power supply voltages was investigated with a PV source. An coordinated voltage management strategy for storage capacities of ESSs was proposed for daily activities [43].

GuiNing *et al.* have proposed an Automatic Distributed Photo-Voltaic (PV) System Design Tool,

which could be completely used and incorporated the current data and demonstrating procedures, i.e. data from Building Information Model (BIM), and in addition propelled streamlining strategies, to encourage exact PV system simulation and optimization. Your proposed system right off the bat made a thorough analysis of the shade and radiation on the premise of the current BIM monitor and according to these findings, carries out a programmed PV configuration procedure designed to achieve the lowest cost-effectiveness. A short time later, a Coordinate Transform Mechanism (CTM) was intended to consequently exchange the computed PV outline into the BIM model, which encourages the acknowledgment of programmed organization. Their proposed instrument have been connected to a rooftop PV venture and checked by means of both numerical and observational examinations. The got comes about demonstrated that contrasted with human-based plan; it can boost design efficiency, increase power production and reduce capital expenditure per unit output [44].

3 Comparative Analysis

Reference	**Technique**	**System Requirements**	**Results & Conclusion**
Alam*et. al* [21]	High peneterati on of Rooftop operation	PV unit Storage device	Improved penetration rate at unsteady climate also and usage of restricted storage devices.
Roy *et.al* [22]	Load flow of high PV unit	DG unit	ensure safe and reliable interconnect ion of generators in low- and medium-voltage networks

The different types of LV distributed system are studied and their functions with addition to that are studied**.** DG connected to an LV distribution network that measures the energy supply efficiency, reliability and protection of the entire LV to MV distribution system. Similarly, PV unit connected with ESS gives better performance and power utility and Automatic Distributed Photovoltaic System Design Tool gives Improved Design Efficiency, Power output. Reduced Capital investment and minimized cost-to-power ratio.

4 Future Perspective

Even though many strategies are employed to give better performance and power utility of a system there always an increased need of obtaining better performance and reduced utilization of power. Similarly, stability of system should be always tend to constant for achieving effective results. In addition to that voltage rise and excess power generation are to be tackled. Other than that factors such as cost-effectiveness, field area reduction, improved efficiency are included for betterment. Consequently, for high penetration smart inverters are included with grids such that there is a need to improve inverter power to a great extent which are all discussed previously and also tackled individually in various existing works. But a work which tackles all the above stated issues comprisingly is not put forth. So in future a framework can be designed by considering all the above things and a novel algorithm can be implemented to overcome all the issues for obtaining better results and for High Penetration of Rooftop solar energy with better performance. As a part of extension to future work the power factor of a system can be optimized. In order to achieve it the Total harmonic distortion (THD) should be reduced for grid connected inverter. Perhaps, this is not considered for a PV network previously. So a cascaded inverter configuration can be included in PV network for obtaining better power factor. Thus an innovative framework can be put forth upcoming as a research part.

5 Conclusion

Renewable energy sources are utilized for various purposes and effective form of energy production. Thus solar energy has improved efficiency in power generation among renewable energy sources. Thus in this paper analysis about the high penetration of rooftop solar energy in power utility by using the smart inverter and also discussed about the secondary distribution network as next generation grid. This paper is primarily targeted at analyze various methodologies for tackling the above stated issue. As the review process intiated by analyzing the rooftop solar system and the secondary distribution network with smart inverter. Followingly, the various methodologies employed for high penetration of PV network with power utility in distribution networks

are stated and improvements have been briefly reviewed and the related findings confirmed in this article.

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