International Journal of Scientific Research & Engineering Trends
Volume 4, Issue 6, Nov-Dec-2018, ISSN (Online): 2395-566X

A Review on Smart Grid and its Application

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Abstract:-**Electricity is most versatile and widely used form of energy. The growing worldwide population is dynamic and will create more increase of electricity. Providing stable and sustainable electricity supply is a heavy stress on today's grid. The power grids must be modernized to meet the needs of 21st century society and economy, which increasingly rely on digital and electronic technologies. The Conventional energy sources like coal are also depleting day by day. The Smart Grid pays way to deliver the Growing demand for power and to minimize the increased complexity of power grids. Smart Grid integrates modern technologies and renewable energy resources in to future power grid in order to supply more efficient and reliable electric power. This paper gives overview about the role of fault current limiter, phase measurement unit in smart grid, the demand side management, voltage stability problems in smart grid and application of smart grid in hybrid vehicle.**

Keywords: - conventional energy sources, depletion, power demand, renewable energy, smart grid, integration of sources, voltage stability, energy management etc.

I. INTRODUCTION

Conventional power networks across the globe are undergoing transformation towards smart power grids (SPGs) incorporating advanced monitoring and controlling strategies. Smart grid integrates modern technologies and renewable energy resources in to future power grid in order to supply more efficient and reliable electric power. It will provide new capabilities that increase the efficiency, reliability, interoperability and security of electric system.

A smart grid will also better support wide spread plug in electric vehicle, distributed energy and storage, take advantage of demand response, energy efficiency, and load control. These days in order to improve the power quality and power supply reliability, constructing strong smart grid has become the trend of power grid development. Power systems are designed to maintain the acceptable voltage profile throughout a network under normal operating conditions. In a distribution network, uncertainty and variability associated with renewable energy resources, such as solar power and wind Power can easily cause power fluctuations, voltage instability and frequency deviations.

Also transmission lines traverse harsh terrains and thus effective communication between substations has been a challenge. These problems can be rectified by means of smart grid which support worldwide distributed energy resources by organizing, bidirectional transmission of power and real time information, alternating renewable generation and supply/demand balancing within the distributed networks.

The review paper contains the details of research papers which give the overview of Smart Grid and its application. This work was organized in to five groups consisting different perspective in Smart Grid and its application. The following are the groups.

- Fault Current Limiters.
- Voltage Stability.
- Phase Measurement Unit.
- Energy Management.
- Hybrid Vehicle.

It aims a current and voltage limiting strategy to enhance the stability in grid operation by using super conducting fault current limiter and voltage control methods. The superconducting fault current limiters have the capability to reduce the fault current within the first cycle of fault current. PMU's are used in power system monitoring, information communication and controlling purposes. It is also used for identifying and classifying the faults occurring at any location in a power grid. Additionally the performances of several distributed approaches are evaluated in order to find the best way to deploy Demand side management system. By regulating the charging profiles of Plug-in Hybrid electric vehicle, the variance of load power can be dramatically reduced.

II.FAULT CURRENT LIMITERS

one of the most important topics regarding the application of superconducting fault current limiters

(SFCL) for upcoming Smart Grid was related to its possible effect on the reduction of abnormal fault current and the suitable location in the Micro Grids[21]. Due to the grid connection of the Micro Grids with the current power grids, excessive fault current was a serious problem to be solved for successful implementation of Micro Grids. However, a shortage of research concerning the location of SFCL in Micro Grid was felt. Here a resistive type SFCL model was implemented by integrating Simulink and Sim Power System blocks in Mat lab. The SFCL model could be easily utilized for determining an impedance level of SFCL according to the fault-current-limitation requirements of various kinds of the Smart Grid system. In addition it is able to determine the location and the performance of the SFCL.

Fault Current Limiters (FCL), also focusing on devices in or near to field test status, and then, based on capabilities and characteristics of FCLs and Smart Grid, assign the various types of fault current limiters to the most appropriate nodes in a Smart Grid[24].

- Solid-state FCLs can be installed at Micro Grid and renewable energy resource feeders to replace circuit breaker and maintain protection coordination of the transmission network.
- Resistive superconducting FCL, saturated iron-core superconducting FCL and dynamic FCL can be installed at distribution substations to maintain downstream over-current protection without current harmonics disturbance.
- Saturated iron-core super conducting and resistive FCLs can be installed at optimum locations in the transmission network to reduce fault currents to within a tolerable range when a new power plant was installed. With these placements, the advantages of Smart Grid's communication network and different characteristics of FCL devices in different categories to offer a more flexible and reliable protection for future power grid can be obtained.

It is possible to simultaneously optimize the Power Quality (PQ) and Protection Coordination (PC) levels in a DER-enabled Micro Grid with multiple connection modes [1]. Introduction of DERs in a grid increases the fault currents. Different connection modes for these DERs lead to varying fault levels. Both phenomena jeopardize the PC. A Solid- State Unidirectional Fault Current Limiter (SSUFCL) was used as an interface between the Micro Grid as downstream and the utility as upstream networks, which limits the downstream contribution to the upstream fault currents for increasing the PC and PQ margins, while it was disabled in the case of downstream faults to improve the PQ.

In this way the complete coordination between upstream and downstream networks will be achieved. To simultaneously optimize the PC and PQ, the time and current settings of the Over Current Relays (OCRs) and the characteristics of the SSUFCL are set. The optimization formulation of the protection coordination problem was extracted and Fuzzy optimization technique used to make a compromise between PQ and PC after objectives' fuzzification. Genetic Algorithm (GA) was used to find the proper characteristics of the SSUFCL as well as the best settings of OCRs.

The saturated core fault current limiter (SCFCL) has become one of the leading candidates for commercial fault current limiting devices [13]. The concept developed at Bar-Ilan University, which was later adapted by Grid ON, for a novel compact SCFCL. This uses a superposition of a closed dc magnetic circuit and an open ac magnetic circuit to overcome the intrinsic problem of transformer coupling found in traditional SCFCL designs. It allows single magnetic core for a full ac current cycle limiting. Additionally, the relative short path for the dc magnetic circuit supports copper coils as an alternative to superconducting bias coils, allowing easier market penetration.

A current and voltage limiting strategy to enhance fault ride-through (FRT) capability of inverter-based islanded Micro Grids (MGs), in which the effects of inverter control system and inverter topology (four/three-wire) are considered [8]. With high penetration of distributed energy resources, fault management strategy was great importance for the distribution network operation. A three phase voltage-sourced inverter with multi-loop control system implemented in synchronous, stationary, and natural reference frames was employed here for both four- and three-wire configurations.

This strategy provides high voltage and current quality during over current conditions, which was necessary for sensitive loads. To investigate the FRT capability of the proposed strategy against both asymmetrical and symmetrical faults several time-domain simulation studies are conducted and was tested on the CIGRE benchmark MG to demonstrate the effectiveness of the proposed limiting strategy.

III. VOLTAGE STABILITY

The quantitative framework for assessment of voltage stability in smart power networks is carried out [2].First, new stability indices similar to gain and phase margins in linear time invariant control systems are introduced. These can be computed online in conjunction with load-flow calculations. Then, a novel risk assessment framework incorporating the new stability indices was developed to methodologically quantify the voltage stability risks in power system faces at any given operating condition. In alternative to existing local stability indices and qualitative risk approaches, the indices and framework introduced provide analytical and quantitative evaluation of voltage stability and associated risks.

A demand side management technique can be adopted to provide voltage and power regulation [8]. A new Smart Grid technology Electric Spring (ES) , has earlier been used for providing voltage and power stability in a weakly regulated/stand-alone renewable energy source powered grid. Anew control scheme was used for the implementation of the electric spring, in conjunction with non-critical building loads like electric heaters, refrigerators and central air conditioning system. This control scheme would be able to provide power factor correction of the system, voltage support, and power balance for the critical loads, such as the building's security system, in addition to the existing characteristics of electric spring of voltage and power stability. Here the control scheme was compared with original ES's control scheme where only reactive-power was injected. New avenues for the utilization of the electric spring to a greater extent by providing voltage and power stability and enhancing the power quality in the renewable energy powered Micro Grids by the opening of improvised control scheme.

Two novel fast voltage stability indices (VSIs) applicable to the radial distribution SGs based on the real-time measured voltage data alone, obtained by the SG infrastructures such as smart metering device [18]. Stability studies in distribution Smart Grids (SGs) are very important due to the increased penetration of distributed energy resource making bidirectional flow of electric power. Each VSI depends on the system bus voltages and does not need additional calculations such as power flow solution, converting the actual distribution network into two-bus equivalent system etc.

In other words, for a radial system with *n*-node, the voltage stability analysis was carried out by parallel *n*-microprocessor units independently. The concentrator units can collect and evaluate the computational results and decide about control actions directly or indirectly depending on the system requirements. The accuracy and efficiency of the proposed indicators are tested on a 41-node radial distribution system. Six load models including constant and composite types have been considered, and also SG in various states of operation and four types of distributed generation are analyzed. The comparison results demonstrate that the proposed VSIs are fast and effective to identify the most sensitive node of the radial grids to the voltage collapse based on the smart infrastructures.

The Dispersed distribution of many inverter-based electric springs (ESs) over the power grid as a means to provide stability support for Smart Grid against high penetration of intermittent renewable power has been suggested recently [22]. While single ES has its own local controller, their wide dispersion makes it difficult to coordinate multiple ESs operation. The specific control scheme for the single ES can be designed by introducing the proportional resonant controller. Then, incorporating with the consensus algorithm by neighboring information exchange instead of global communication, the control strategy for multiple ESs was implemented to discover the voltage reference which will be assigned to ESs for tracking the reference voltage. Compared with the conventional droop control, the scheme can maintain the voltage level of the critical load without sacrificing the voltage control accuracy. Simulation can be carried out to show that the distributed voltage control can guarantee the overall coordination of parallel ESs under various operation conditions.

The concept of constant voltage operation is the ultimate goal of power grid development [26]. The topic can be expanded into three aspects: the benefits of constant voltage operation, the technology and equipment to realize constant voltage operation, and the reactive power compensation capacity needed for constant voltage operation. The benefits of constant voltage operation have four aspects:

- Constant voltage operation was the ultimate presentation of the strong Smart Grid.
- Constant voltage operation can resist grid disturbances in the most powerful manner and greatly improve the power system stability.
- Constant voltage operation can effectively eliminate the voltage fluctuation problem involved with the integration of large scale renewable energy.
- Constant voltage operation can minimize the grid power loss. The means to realize constant voltage operation was primarily the modular multilevel converter based STATCOM (MMC-STATCOM), which has encountered great acceptance during recent years. Simulation verifications are run in a modified IEEE 300-bus system and the Pearl River Delta grid in PSS/E. The results indicate that constant voltage operation can greatly improve the stability of power systems and the capacity of installed MMC-STATCOMs was within an acceptable range.

IV. PHASOR MEASUREMENT UNIT

The conventional power system was going through a paradigm change towards Smart Grid [4]. Pharos measurement units (PMUs) have emerged as the edifice for information technology related to wide-area monitoring systems (WAMSs) for power system monitoring, information communication, and control purposes. The PMUs need communication links for a complex interconnected power grid, and proper spatial coordination plays a main role for wireless communication network.

Geographical information system (GWAS) provides a rich set of functions to analyze the power network incorporating geospatial features. Here the investigation is on the impact of topological attributes on commissioning of wireless communication network for PMUs incorporating GWAS aided analysis and to optimize one of the PMU locations as main control station. It is not only used for monitoring automation purposes, but will also ensure control automation. Case studies related to the eastern grid of India corroborate the efficacy of GWAS-aided wireless communication for linking PMUs.

A methodology can be used for identifying and classifying transmission line faults occurring at any location in a power grid from pharos measurement unit measurements at only one of the generator buses [14]. Smart power grids (SPGs) entail comprehensive real-time smart monitoring and controlling strategies against contingencies such as transmission line faults. Here system is based on frequency domain analysis of equivalent voltage and current phase angle at the generation bus. These are the angles made by three-phase equivalent voltage and current phases with respect to reference axis. These angles are estimated through Park's transformation and frequency domain analysis was performed over a fixed time span equal to inverse of system nominal frequency using fast Fourier transformation.

This methodology can be utilized for relaying purposes in case of single transmission lines as well as for system protection Centre (SPC) applications in power grid. The significance of the fault information from the methodology was for assisting SPC in SPGs for transmission line fault detection and classification to restore the transmission lines in starting and to start wide-area control actions to maintain system stability against disturbances generated by occurrence and clearance of fault.

The State estimation plays a critical role in self-detection and control of the Smart Grid [15]. Data integrity attacks called false data injection have shown significant potential in not only determining the state estimation of power systems, and corresponding countermeasures have drawn increased scholarly interest. Instead, leveraging optimal PMU placement to defend against these attacks, while simultaneously ensuring the system observability, has yet to be addressed without incurring significant overhead.
Here the enhancing of the least-effort attack model, which computes the minimum number of sensors that must be compromised to manipulate a given number of states, and develop an appropriate algorithm for optimal PMU placement to defend against data integrity attacks. In the least-effort attack model, the existence of smallest set of sensors to compromise and propose a feasible Reduced Row Echelon form (RRE)- based method to efficiently compute the optimal attack vector. Based on IEEE standard systems, validating the efficiency of the RRE algorithm, in terms of a low computation complexity. Regarding the defense strategy, an effective PMU based greedy algorithm proposed, which can not only defend against data integrity attacks, but also ensure the system observability with low overhead. The results based on various IEEE standard systems show the effectiveness of the proposed defense scheme against data integrity attacks.

A Power System can Track State Estimation (PSTSE) using Cubature Kalman Filter (CKF)[17]. Here the approach utilizes synchronized pharos measurements from the Pharos Measurement Units (PMUs) for the execution of the PSTSE. A state forecasting technique has been utilized to forecast the states for the period when PMU measurements are missing due to temporary failure of communication link or data packet loss. This helps in estimating the states of the power system during the period when the field measurements from PMU are not available. The effectiveness of the application of the CKF to the PSTSE can be demonstrated using two test systems.

In Smart Grid execution, one of the most important requirements was fast, precise, and efficient synchronized measurements, which are possible by pharos measurement unit (PMU)[19]. To achieve fully observable network with the least number of PMUs, optimal placement of PMU (OPP) was crucial. In trying to achieve OPP, priority may be given at critical buses, generator buses, or buses that are meant for future extension. Also, different applications will have to be kept in view while prioritizing PMU placement. Hence, OPP with multiple solutions (MSs) can offer better flexibility for different placement strategies as it can meet the best solution based on the requirements.

To provide MSs, an effective exponential binary particle swarm optimization (EBPSO) algorithm was developed. In this algorithm, a nonlinear inertia-weight-coefficient was used to improve the searching capability. To incorporate previous position of particle, two innovative mathematical equations that can update particle's position are formulated. For quick and reliable convergence, two useful filtration techniques that can facilitate MSs are applied. Single mutation operator was conditionally applied to avoid stagnation. The EBPSO algorithm was so developed that it can provide MSs for various practical contingencies, such as single PMU outage and single line outage for different systems.

V. ENERGY MANGEMENT

Demand-side management, together with the integration of distributed energy storage has an essential role in the process of improving the efficiency and reliability of the power grid [7]. Here smart power systems in which users are equipped with energy storage devices are considered. Consumers request their energy needs from an energy provider, who determines their energy payments based on the load profiles of users. The energy consumption and storage of users regulated by a central controller, the energy provider tries to minimize the square Euclidean distance between the instantaneous energy demand and the average demand of the power system.

The consumer's initiate to reduce their energy payment by jointly scheduling their appliances and controlling the charging and discharging process for their energy storage devices. The game theory can be applied to formulate the energy consumption and storage game for the distributed design, in which the players are the users and their strategies are the energy consumption schedules for appliances and storage devices. The facts on the game theory setup and proximal decomposition: two distributed demand side management algorithms executed by users in which each user tries to reduce its energy cost, while still maintaining the privacy of users as well as reducing the amount of required signaling with the central controller. Optimality for both energy provider and users by algorithm can be simulated.

The demand-side management which plays a significant role in allowing consumers, incentivized by utilities, to manage their energy consumption [23]. It will be made by shifting consumption to off-peak hours and thus reducing the peak-to-average ratio (PAR) of the electricity system. Here the beginning by proposing a demand-side energy consumption scheduling scheme for household appliances that considers a PAR constraint. Initially an optimization problem was formulated to minimize the energy cost of the consumers through the determination of the optimal usage power and operation time of throttle able and shift able appliances, respectively. It can be realized that the acceptance of consumers of these load management schemes was crucial to its success. So, the introduction of a multi-objective optimization problem which not only minimizes the energy cost but also minimizes the inconvenience posed to consumers.

In addition to solving the proposed optimization problems in a centralized manner, two distributed algorithms for the initial and the multi-objective optimization problems are also proposed. It can be simulated to show that the proposed demand-side energy consumption schedule can provide an effective approach to reducing total energy costs while simultaneously considering PAR constraints and consumers' preferences. Plug-in hybrid electric vehicles (PHEV) are expected to become widespread in the near future[25]. High penetration of PHEVs can overload the distribution system. The charging of PHEVs in Smart Grid can be controlled to reduce the peak load, known as demand-side management (DSM). Here the focus is on the DSM for PHEV charging at low-voltage transformers (LVTs). The objective was to flatten the load curve of LVTs, while satisfying each consumer's requirement for their PHEV to be charged to the required level by the specified time. First formulating this problem as a convex optimization problem and then propose a decentralized water-filling-based algorithm to solve it. A moving horizon approach was utilized to handle the random arrival of PHEVs and the inaccuracy of the forecast non PHEV load. Here the focus on decentralized solutions so that computational load can be shared by individual PHEV chargers and the algorithm was scalable. Numerical simulations are also used to show the effectiveness of algorithm.

A real-time information based demand-side management (DSM) system with advanced communication networks can be made in Smart Grid [5]. DSM make smooth peak to- average ratio of power usage in the grid, which in turn reduces the waste of fuel and the emission of greenhouse gas. The first target to minimize PAR with a centralized scheme. To motivate power providers, another centralized scheme targeting minimum power generation cost is provided. But, customers may not be motivated by a centralized scheme since such a scheme requires total control and privacy from them.

This also requires too much real-time data exchange for frequent DSM deployment. To tackle these issues, we propose game theoretical approaches so that most of the computation was performed locally. In this game, all the customers are motivated by extra savings if participating. Additionally, all parties benefit from the DSM system to the same level because both the centralized schemes and the game theoretical approach minimize global PARare proved. Additionally, evaluation of the performance of several (partially) distributed approaches in order to find the best way to deploy DSM system.

Formulating the dynamic pricing problem as a convex optimization dual problem and propose a day-ahead time-dependent pricing scheme in a distributed manner which provides increased user privacy [20]. Internet of Things (IoT) has now a dayaro used as an enabling technology for context-aware and interconnected “smart things”. Smart things with advanced power engineering and wireless communication technologies have realized the possibility of next generation electrical grid, Smart Grid, which allows users to deploy smart meters, monitoring their electric condition in real time. At the same time, increased environmental consciousness was driving electric companies to replace traditional generators with renewable energy sources which already being productive in user’s homes. One of the most incentive ways was for electric companies to institute electricity buying-back schemes to encourage end users to generate more renewable energy. An alternative from the previous works, renewable energy buying-back schemes with dynamic pricing to achieve the goal of energy efficiency for Smart Grids.

The framework seeks to achieve maximum benefits for both users and electric companies. This was one of the first attempts to tackle the time-dependent problem for Smart Grids with consideration of environmental benefits of renewable energy. Numerical results show that our framework can significantly reduce peak time loading and efficiently balance system energy distribution.

VI. HYBRID VECHICLE

Electric vehicles (EVs) and renewable energy sources offer the potential to substantially decrease carbon emissions from both the transportation and power generation sectors of the economy [3]. More implementation of EVs will have a number of impacts and benefits, including the ability to assist in the integration of renewable energy into existing electric grids. The literature indicates that EVs can significantly reduce the amount of excess renewable energy produced in an electric system. Studies on wind–EV interaction are much more detailed than those on solar photo voltaic (PV) and EVs.

The advent of the plug-in hybrid electric vehicles (PHEVs), the vehicle-to-grid (V2G) technology was attracting increasing attention recently [11]. It was believed that the V2G option can aid to improve the efficiency and reliability of the power grid, as well as reduce overall cost and carbon emission. It is the possibility of smoothing out the load variance in a household Micro Grid by regulating the charging patterns of family PHEVs was investigated. First, the mathematic model of the problem to be built up. Then, the case study to be conducted, which demonstrates that, by regulating the charging profiles of the PHEVs, the variance of load power can be dramatically reduced. Then, the energy losses and the subsidy mechanism are also reviewed. Hence, the impacts of the requested net charging quantities and the battery capacity of PHEVs on the performance of the regulated charging are investigated. Plug-in hybrid electric vehicles (PHEVs) and electric vehicles (EVs), commonly referred to as plug-in electric vehicles (PEVs), could trigger a stepwise electrification of the whole transportation sector [16]. However, the potential impact of PEV charging on the electric grid was not fully known, yet. It’s an iterative approach, which integrates a PEV electricity demand model and a power system simulation to reveal potential bottlenecks in the electric grid caused by PEV energy demand. An agent-based traffic demand model was used to model the electricity demand of each vehicle over the day. An approach based on interconnected multiple energy carrier systems can be used as a model for a possible future energy system. Experiments demonstrating that the model was sensitive to policy changes, e.g., changes in electricity price result in modified charging patterns. By implementing an intelligent vehicle charging solution it can be demonstrated how new charging schemes can be designed and tested using this framework.

A methodology can be used for modeling the load demand of plug- in hybrid electric vehicles (PHEVs)[10]. Because of the stochastic nature of vehicle arrival time, departure time and daily mileage, probabilistic methods are chosen to model the driving pattern. So, these three elements of driving pattern are correlated with each other, which make the probability density functions (pdfs)-based probabilistic methods inaccurate. Here a fuzzy logic based stochastic model was built to study the relationship between the three elements of driving pattern. Moreover, a load profile modeling framework (LPMF) for PHEVs can be used to synthesize both the characteristics of driving pattern and vehicle parameters into a load profile prediction system.

Based on this stochastic model of PHEV, a two-layer evolution strategy particle swarm optimization (ESPSO) algorithm can be used to integrate PHEVs into a residential distribution grid. A novel business model was developed for PHEVs to provide ancillary service and participate in peak load shaving. A virtual time-of-use rate was used to reflect the load deviation of the system. Then, an objective function was developed to aggregate the peak load shaving, power quality improvement, charging cost, battery degradation cost and frequency regulation earnings into one cost function. The ESPSO approach can benefit the system in four major aspects by:

- Improving the power quality;
- Reducing the peak load;
- Providing frequency regulation service; and
- Minimizing the total virtual cost.

Finally, simulations are carried out based on different control strategies and the results have demonstrated the effectiveness of the proposed algorithm Stochastic charging behavior of plug-in hybrid electric vehicles (PHEVs) under different charging strategies brings new challenges for distribution networks such as feeder overloading and loss increase [12]. By this the augmented penetration of these vehicles mandates employing new operative tools to inspect their impacts on electrical grids. Therefore, a novel optimal stochastic reconfiguration methodology to moderate the charging effect of PHEVs by changing the topology of grid using some remote controlled switches. Uncertainties associated with network demand, energy price, and PHEV charging behavior in different charging frameworks is handled with Monte Carlo simulation and the proposed stochastic problem was solved with krill herd optimization algorithm. Numerical studies on Tai-power distribution system verify the efficacy of proposed reconfiguration to improve the system performance considering PHEV charging loads.

Utilizing plug-in hybrid electric vehicles (PHEVs) was growing fast and booming nowadays [6]. This can be as portable loads and energy sources may be connected to standard sockets at home. As a result, extra electrical loads, grid to vehicle, generations, and vehicle to grid, have several impacts on distribution networks, e.g., network energy loss.

Here a two-stage optimization method to minimize the energy loss of Micro Grid with different penetration levels of PHEVs is implemented. In the first stage, a novel convex quadratic objective function for active power management of PHEVs was proposed, and daily required energy of PHEVs was calculated based on stochastic model of PHEV owners' behavior. It was supposed that PHEVs can be employed as distributed capacitors. Therefore, reactive power of PHEVs was specified in the second stage.

Afterward, the proposed methodology was applied to a realistic distribution network. It will be illustrated that network energy loss was likely to rise considerably in the case of increasing penetration level of PHEVs without smart charging strategy; to reduce network energy loss; a smart management scheme will have to be considered. It also shows the impact of PHEVs' active and reactive power management on energy loss reduction.

VII. CONCLUSION

The papers are analyzed and made the conclusion that with these, the full use of the advantages of smart grid communication network and different characteristics of Fault Current Limiter (FCL) devices in different categories to offer a more flexible and reliable protection for future grid. Consequently the optimum arrangement of Super Conducting Fault Current limiter (SFCL) with renewable energy which limits all fault currents and have no negative effect in source of integration point. Constant voltage operation is the ultimate form of strong Smart Power systems. Constant voltage operation can efficiently solve the problem of voltage fluctuations caused by the access of renewable energy. It also indicates that the constant voltage operation can greatly improve the stability of power system. Here the main contribution of pharos measurement unit is significant to detect and classify transmission line fault occurring anywhere in the grid. It also ensures control automation. It is also used in the improvement of network reliability, reducing network downtime, and data synchronization between different state grids as envisioned for smart grid, thus delivering acceptable quality of power to user.

The energy consumption and the storage optimization problems were also studied. The Demand Side Management is in role to motivate and benefit all parties including whole society, power suppliers and customers. DSM also offers a promising win-win situation for both the electric company and its users. Demand Side Management of plug-in hybrid electric vehicle will become necessary to reduce peak loads as the penetration of plug-in hybrid electric vehicles becomes greater. The plug-in hybrid electric vehicle can provide frequency regulation service and save peak load of the system. It aims to minimize the load deviation from the average demand over the day.

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