**Literature Review for Distribution System Restoration**

The below list provides a cross-reference for the research papers reviewed for research in service restoration. There is a brief description in-front of each research paper.

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| **Sr#** | **Title** | **Description/Methodology** |
| 1 | Switching Device Cognizant Sequential Distribution System Restoration | This paper considers types, capabilities & operational limits of different switching devices making it practical. It develops an optimization framework for sequential re-configuration using an assortment of switching devices and repair process in distribution system restoration. The switching operation problem is decomposed into two mixed-integer linear programming (MILP) subproblems. The first subproblem determines the optimal network topology and estimates the number of steps to reach that topology, while the second subproblem generates a sequence of switching operations to coordinate the switches. Validated on IEEE-123 node feeder. |
| 2 | Multi-time step service restoration for advanced distribution systems and Microgrids. | In this paper a multi-time step service restoration methodology is proposed to optimally generate a sequence of control actions for controllable switches, ESS and dispatchable DGs for system restoration. Loads are considered as constant PQ-loads under CLPU Conditions |
| 3 | Sequential Service Restoration for unbalanced Distribution Systems and Microgrids | The sequential service restoration (SSR) framework is applied for three phase unbalanced DS & MGs and can adapt to various operating conditions. Mathematical models are introduced for three-phase unbalanced power flow, voltage regulators, transformers & loads. The SSR problem is modeled as a MILP & tested on IEEE-123 node test feeder.(used OpenDSS) |
| 4 | Towards a MILP modeling framework for distribution system restoration. | This paper introduces a DSR modeling framework, which can generate optimal switching sequences and estimated time of restoration in the presence of remotely controllable switches, manually operated switches, and dispatchable DGs. Two mathematical models, a variable time step model and a fixed time step model, are presented and compared. The proposed models are formulated as a mixed-integer linear programming model, and their effectiveness is evaluated via the IEEE 123 node test feeder. |
| 5 | Distribution System Restoration with MGs using spanning tree search. | This paper presents a graph theoretic DSR incorporating MGs that maximizes the restored loads and minimizes the # of switching operations. This research is tested on GridLab-D |
| 6 | MDP-based distribution network reconfiguration with renewable distributed generation: An approximate dynamic programming approach | State based sequential network reconfiguration strategy by using a Markov decision process with the objective of minimizing renewable distributed generation curtailment and load-shedding under operational constraints. Available power o/p of DGs and the system topology in each decision time are represented as Markov state. Also introduces dynamic programming to address the curse of dimensionality. |
| 7 | Coordinated restoration of Transmission and Distribution system using decentralized scheme. | The TS-DS system is divided into several sub-systems according to their physical connections. In order to implement independent but coordinated decision making of the subsystem. A decentralized decision making framework is considered by model de-coupling & iterative interaction b/w TS & DS. The proposed decentralized restoration scheme achieves independent decision-making of the TSO & DSO in the coupled TS-DS system. |
| 8 | Decentralized Data-driven load restoration in coupled transmission & distribution systems with wind power. | A new decentralized data-driven load restoration scheme is proposed for the restoration of WPS integrated TDS. Wasserstein metric based ambiguity sets are presented. |
| 9 | Spatio-temporal coordinated bulk system restoration considering RES penetration. | Two-stage Receding Horizon Optimization model. |
| 10 | Value of Distribution Network reconfiguration in presence of RES. | The paper aims to assess thoroughly the potential loss reduction achievable through hourly reconfiguration in DNs with high RE generations. The study takes into account the hourly load variations, renewable generation fluctuations and switching cost. The reconfiguration problem is modeled as a MICP problem. The model uses conic forms of power flow equations. |
| 11 | Robust Distributed coordination of parallel restored sub-systems in Wind Power Penetration Transmission System | This paper proposes a Robust distributed coordination scheme to achieve re-connection and load recovery of parallel restored subsystems in wind power penetrated transmission systems. |
| 12 | Coupled Transmission and Distribution System with Wind Power | Robust Data Driven Load Restoration (DDLR) models are constructed in-order to handle uncertainties and ensure the feasibility of decentralized schemes. The Wasserstein metric is used to describe the ambiguity sets of probability distributions in order to build the complete DDLR model and realize computationally tractable formulation. A data driven model-nested analytical target cascading (DATC) algo is developed to obtain the final load restoration results by iteratively solving small-scale mathematical models. Tested on IEEE 118-bus Transmission Systems and thirty IEEE-33 node Distribution System. |
| 13 | Networked MGs for service restoration in resilient DS (IET2017) | Stochastic MILP is formulated with the objective to maximize the served load while satisfying the operational constraints of DS & MG- Two approaches centralized and Decentralized. In this Paper a coordinated power exchange mechanism for Networked MGs to restore power distribution systems with outages is proposed. The MGs optimally dispatch their DG output powers in order to pick-up on outage customers. It uses AMPL & OpenDSS with IEEE-123 node as test feeder. |
| 14 | A two-level simulation-assisted sequential restoration model with frequency dynamics constraints. | OUR MAIN PAPER |
| 15 | Placement and Implementation of Grid-Forming and Grid-Following virtual inertia & Fast Frequency response. | Demand Response (DR) can enhance system flexibility at critical conditions by regulating customer loads. Thermostatically controlled loads (TCL) demonstrate the characteristic of Energy storage and can be employed as conventional batteries to enhance system flexibility & resilience |
| 16 | Self-healing Resilient DS based on sectionalization into MG | Novel comprehensive operation & self-healing strategy for a DS with both dispatchable & non-dispatchable DGs. To incorporate uncertainties associated with DERs & load consumption we formulate the problem as a stochastic program. A scenario reduction method is applied to achieve a trade-off b/w the accuracy of the solution and the computational burden. Normal mode and Emergency mode of operation are considered. Formulated as MINLP |
| 17 | Optimal self-healing strategy for MG Islanding | The problem is formulated as a MIQP. Chance-constrained programming approach is used to model the probabilistic o/p limit of PV generation. Markov inequality and Latin Hyber-cube sampling techniques are applied to convert & incorporate the chance constraints into the MIQP problem. This work also discusses the interaction among NMGs. With support from/to other MGs. The transitioning process from grid-connected to islanded is greatly improved. MG’s reliability and resiliency are enhanced. |
| 18 | Resilient DS by MG formation after natural disaster | A distributed multi-agent coordination scheme is designed via local communications for the global information discovery as inputs of the optimization which is suitable for autonomous communication requirements after the disastrous event.MILP approach. A global information discovery for the optimization as a distributed multi-agent coordination via local communication by applying average consensus algorithm. |
| 19 | Transportable energy storage systems for more resilient DS with multiple MGs. | A Temporal-Spatial TESS model which is related to both transportation networks and DSs is proposed to represent the difference b/w TESS & ESS in terms of flexibility and cost reduction of ESS sharing among MGs. The problem is formulated as a MILP while considering several network and TESS constraints. |
| 20 | Adaptive Formation of MG with mobile emergency resources for critical service restoration in extreme conditions. | This is a good research paper that covers frequency deviation while restoring critical loads. |
| 21 | Frequency Dynamics constrained UC with BESS | A dynamic frequency control strategy with batteries is proposed. Immediately after a generator tripping, the injections of batteries are adjusted instantly to provide dynamic frequency support. Such actions would be able to ensure minimum system power imbalance while reducing stress on synchronous units to provide the inertia & primary reserve. |
| 22 | Zonal-Inertia constrained generator dispatch considering load frequency relief | This paper develops a formulation of zonal inertia constrained generator dispatch for PS with a diversified generator portfolio considering DGs, PV, WT and ESS. zonal-inertia constraints are formulated in UC & optimal power flow to limit the RoCoF in the event of network separation load frequency relief is also considered. |
| 23 | Dynamic modeling of sequential service restoration in islanded single master MG | Good practical work |
| 24 | MGs for service restoration to critical load in a resilient DS | This paper proposes a resiliency based methodology that uses MGs to restore critical loads on distribution feeders after a major disaster.The service restoration method is implemented using MATLAB. The Matlab program can call GridLab-D to perform power flow analysis. Tested on 4 feeder 1069 test system. |
| 25 | Distributed secondary control strategy for MG operation with dynamic boundaries | Good paper regarding hierarchical control, where the primary control is used to stabilize the system voltage and frequency using droop control while secondary control is needed to eliminate such deviations. |