Utility-Specific Blackstart and Restoration Strategies and Evaluation

- Evaluation of existing restoration strategies and effectiveness of existing blackstart resources
- Improved restoration plans and strategies
- Evaluation of protection performance of existing/new cranking paths
- Guidance on performance requirements from IBRs for blackstart and restoration
- Integration of existing and new IBRs in restoration plans

Background, Objectives, and New Learnings

Power system restoration following a partial or complete blackout is a critical function, with the goals to minimize restoration time and maintain overall system reliability. It involves careful coordination by transmission operations staff with various disciplines such as generation, transmission, protection and equipment experts, and field personnel. Restoration is a complex process because the system- and equipment-related technical issues are different from those encountered during normal operations. Ensuring that the power system can restore from wide scale outages has received increased attention in recent years. In addition, the changing generation mix necessitates a revisit to existing restoration strategies to understand the impact of emerging technologies on system restoration, including resources, energy storage, distributed energy resources. The main objectives of this project are to:

1. Evaluate existing restoration strategies and plans including effectiveness of existing blackstart resources and cranking paths to critical infrastructure.
2. Identify new blackstart unit locations and cranking paths as needed.
3. Review protection on existing and new cranking paths.
4. Evaluate feasibility of existing and new inverter-based resources (IBRs) to provide blackstart and restoration support.
5. Provide guidance on performance requirements from IBRs for blackstart and restoration.

Benefits

The project will help participants to:

- Improve reliability through improved decision-support tools for operators to address system emergencies and restoration.
- Improve blackstart placement and investment decisions.

Project Approach and Summary

The following tasks are envisioned to be performed under this project:

Blackstart Resource Planning

Availability of adequate blackstart generation resources is essential to restoration of a power system following an outage. Reliability standards, worldwide, require transmission and resource planners and operators to evaluate the adequacy of blackstart resources of a restoration plan. In this task, EPRI's Optimal Blackstart Capability (OBC) software tool will be used to facilitate assessment of blackstart capability of a power system. OBC allows transmission planners to take a holistic look at the system and available resources to identify the optimal sequence of energization of non-blackstart units (NBSUs) and feasible system paths to energize the NBSUs and critical loads. In addition, the tool can be used to identify optimal locations, using cost and reliability as criteria, for new blackstart capability to facilitate system restoration.

Cranking Path Evaluation

System operators and planners develop and implement restoration plans based on off-line simulation studies, and accumulated experience and knowledge. One of the

challenges in developing a restoration plan is to sift through numerous possible restoration scenarios and paths, to identify those that are technically feasible. When implementing a restoration plan in an on-line environment following a blackout, operators need to adapt to the actual outage scenarios and available resources. Under this task, EPRI's System Restoration Navigator (SRN) tool will be used to evaluate existing plans and assist in developing alternate strategies assuming unavailability of generators and vulnerable equipment along the established cranking paths.

Optional Task: Protection Performance During Restoration

Protective relaying and control system designs and settings are typically optimized for the expected range of normal system operating conditions. However, during system restoration, the grid can have abnormal characteristics. Therefore, some protective relaying and control schemes may operate undesirably during restoration conditions, and some schemes may not operate when they should have operated. This can impact protection performance and severely delay restoration. Under this task, short circuit, and protection coordination studies to evaluate sensitivity and coordination for each step of restoration will be performed. EPRI's Cranking Path Evaluation tool will be used to automatically study protection on the existing or new cranking paths. In addition, if requested by the funder, hardware-in-loop (HIL) testing of some of the relays in the cranking path to validate protective relay performance and optimize relay settings can be performed.

Optional Task: Integration of IBRs in existing Restoration Strategies

Traditionally, power system restoration after a complete or partial blackout is carried out using transmission-connected conventional generation. Inverter-based resources are kept disconnected during the early restoration stage and are connected only after a majority of the system is restored and stabilized. However, as the penetration of inverter-based resource increases, opportunities must be explored for supporting the early-stage restoration process using battery energy storage, wind, and solar generations. Under this task, steady state, transient and protection studies will be performed to provide insights on when and how these generation resources can be connected during early restoration stages both as a blackstart or non-blackstart resource.

Deliverables

- Interim technical report for each of the tasks with modeling assumptions and analysis results.
- Guidance on IBR modeling for blackstart and restoration studies.
- Updated algorithms used in EPRI restoration tools (as needed).
- Webcasts, presentations, and discussions on interim results and final technical report.

The non-proprietary results will be incorporated into EPRI's Transmission Operations and Planning R&D programs and made available to the public for purchase or otherwise.

Price of Project

Blackstart resource planning and cranking path evaluation for two islands or zones – $125,000

Optional Tasks:
Protection evaluation of four cranking paths – $30,000
Integration of IBR on one cranking path – $45,0000

This project qualifies Self-Directed Funding (SDF) or Tailored Collaboration (TC) funds. Funding can be paid over two years.

Project Status and Schedule

The project is expected to start in the fourth quarter of 2021. The project duration for each participant will vary, depending on the selected tasks, but is expected to last for 8–12 months.

Who Should Join?

RTOs/ISOs and utilities should join the project to review and improve current restoration plans and strategies

Contact Information

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