OPTIMAL TECHNOLOGIES

AEMPFAST

Case Study: Distribution Automation Application for Pepco Holdings, Inc.

Challenge

Pepco Holdings Inc. has developed a Blueprint for the Future for its several distribution utilities that includes investment in new technologies such as advanced meter infrastructure (AMI), distribution automation, smart thermostats linked to the AMI system, and an improved communications network.

As part of its Distribution Automation initiative, PHI engaged Optimal to demonstrate Optimal's ability, using AEMPFAST, to add optimization intelligence and enhanced performance to PHI's Automated Sectionalization and Restoration (ASR) system for isolating system faults, reconfiguring the system, and restoring electric service to customers outside the immediate problem area, with the goal of fewer outages, faster restoration, and other operating efficiencies.

The primary project objective was to demonstrate AEMPFAST's ability, in immediate post-fault conditions, to identify specific system re-control and minimum load reductions necessary to allow safe re-closure of tie switches under specified fault and high-load conditions measures, allowing PHI to rapidly restore certain service where the PHI ASR was not able to do so. AEMPFAST was tasked to demonstrate how PHI could improve the reliability indexes (SAIDI and SAIFI) for the subject system by (1) evaluating and quantifying bus-level stresses before and after a fault, (2) determining optimized system re-controls, and (3) identifying optimal shedding of specific loads using load curtailment to meet PHI-prescribed system performance and service objectives.

SUMMARY: Under post-fault, overloaded load conditions, AEMPFAST identified safe system reconfiguration and load migration measures that accelerated service restoration to a maximum number of customers.

CALL OUT

- TBD - for now include what AEMPFAST Service item it is related to here

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Solution

The project test bed was an 8-feeder section of a radial PHI distribution system, served by 4 substations, having a total of ______ buses, on which the PHI ASR system of intelligent relay devices, advanced protective devices, circuit switching devices (tie switches) for post-fault interconnection of feeders, and a computer program had been deployed. The PHI ASR system resides in PHI substations, and is operated via distributed control.

For the Project, four fault locations under two different load profiles were selected to cover as many possible tie-switch closures and service restoration possibilities as possible and demonstrate AEMPFAST's load migration and load curtailment applications. A "Normal Load Scenario" corresponded to the high load numbers given to Optimal by PHI engineers. A second scenario for each fault location, "Overloaded Load Scenario," corresponded to a load level where any of the load migrations, if implemented without load curtailment, would bring the system close to voltage collapse. In this scenario, load migration would fail to occur if the existing ASR system alone were used because the ASR would be able only to identify the potential overload, without finding ways to eliminate the overload; the ASR simply would reject the switch closure that was necessary to enable load migration. In the Project, AEMPFAST would seek to identify ways to eliminate the projected overload through (1) optimized system re-controls to minimize active and reactive power losses, and (2) optimized load curtailment to minimize feeder flow under load migration.

In the project, Optimal established a baseline for AEMPFAST's performance against existing PHI ASR system performance using the project system and agreed-upon project fault scenarios.

Optimal then worked with PHI engineers to construct a highly detailed, bus-branch electrical model of the Project system, using PHI's various available data sources (PHI's GIS and DMS data, and other electronic and non-electronic data sources) and AEMPFAST's model building functionality, and built and tested the model. An accurate electrical model is critical to any type of distribution system analysis. The model allowed application of AEMPFAST loadflow and optimization analytics to the Project system.

Applying AEMPFAST optimization and analysis to the Project system model, together with PHI-prescribed system operational objectives, Optimal identified solutions for improving the performance of the Project network under (1) prescribed project fault scenarios, and (2) diverse sectionalizing and restoration schemes.

For each fault scenario and sectionalization/restoration scheme, Optimal used AEMPFAST, first, to carry out system re-control optimization, identify the set of controls that would minimize active and reactive power losses under the post-fault Overloaded Load Scenario, and analyze other system benefits; and second, to carry out optimized load curtailment, minimize line overloads, and analyze other system benefits. Optimal used AEMPFAST's line flow minimization objective and performed the load curtailment based on AEMPFAST's Resource Sensitivity Indexes providing ranked, bus-specific optimization outputs for active power.

Results

Under all Overloaded Load fault scenarios, using AEMPFAST's non-linear grid optimization, analysis, and asset-ranking capability, Optimal achieved safe post-fault load migration and restoration of the maximum amounts of specified load, safely maximizing the number of customers served, where the existing PHI ASR system alone was able to respond only by denying re-closure under projected overload on the reconnected feeders.

The Project demonstrated that the AEMPFAST model-building and optimization approach complements the existing ASR system by providing:

- Improved system reliability and system reliability indexes (SAIDI/SAIFI);
- Increased capacity to serve more load under high-load and other fault conditions, including multiple fault scenarios;

- Optimized distribution system management of fault response, overloads, P and Q losses, load reduction (curtailment) dispatch, and generation (P and Q) deployment and dispatch, among other applications; and
- Optimized operation of complex circuits by automatic determination, tracking, and application of ASR logic (i.e., "no rule based programming") when an ASR-comparable solution is required.

Optimal also identified certain other potential applications and benefits of AEMPFAST that PHI could apply in its Blueprint for the Future initiative, including, for example, leveraging its AMI to provide granular feeder load data that would allow a range of enhanced grid analyses and optimized demand response, post-fault load migration, and other applications.

About Optimal

Optimal's proprietary AEMPFAST optimization and analysis software and services platform is the enabling technology to produce a Smart Grid – a grid with the visibility, operational awareness, Actionable Intelligence, and automation to be more reliable, energy efficient, and green. The AEMPFAST platform's core functionalities will support and accelerate achievement of a smarter grid by integrating with varied "smart" distribution network systems (EMS, DMS, OMS, GIS, SCADA) to apply fast non-linear analysis and optimization that runs very large (100,00+ buses), highly detailed system models in near-real time and will deliver ranked, bus-specific outputs of critical value to distribution system operators.

AEMPFAST's competitive advantages among the market leading distribution network analysis and optimization technologies include the following:

- Core engine: AEMPFAST offers a fast, repeatable and accurate Non-Linear Optimization engine that can analyze and optimize very large and detailed distribution (and transmission) networks in near-real time.

- Resource Sensitivity Indexes: AEMPFAST optimization and analysis outputs provides the operational awareness network engineers and operators need in order to meet their business objectives, e.g., losses, congestion, load management, DG/DR/storage dispatch, by determining the impact of network assets and load toward prescribed optimization objectives.

- Real and Reactive Power: AEMPFAST provides simultaneous optimization and analysis of system real and reactive power assets, contributing to improved system voltage profiles, energy efficiency and reliability

- Fine Granularity: analyzes the effects of home level loads and small amounts of DG towards optimization objectives. Enables analysis and optimization of the lateral distribution feeders.

- Supports multiple optimization objectives

- Bus oriented architecture that allows "plug and play" with third party systems using standard communication protocols

- 3 and 1 phase unbalanced network analysis

- Optimized Meter Location

- Distributed Generation and Load profiling