Optimization of connections between feeders in an emerging distribution system

Hilary Brown, Colorado School of Mines

Motivation
- Smart Grid Initiative
- Increasing penetration of distributed generation sources (DGs), including renewables
- How to adapt legacy systems for future innovation

Purpose
To develop a tool to be used in distribution system planning by utility engineers to improve distribution system reliability through asset management.

Feeder addition problem
Given a distribution system with DGs, add networked connections such that the cost of the addition is feasible while improving the reliability and satisfying power flow constraints in islanded mode.

Optimization
\[
\min \{f(x), h(x)\}, \text{ such that: }
\begin{align*}
    f(x) &\leq f_{\text{max}} \\
    h(x) &\leq h_0 \\
    0.95 &\leq V_a \leq 1.05 \\
    S_{ab} &\leq 1.00
\end{align*}
\]

Cost, \(f(x)\)
- Cost of addition
\[
f(x) = \sum_{i=1}^{N_C} C_i \chi_i
\]

Reliability, \(h(x)\)
- Energy not supplied (ENS)
\[
h(x) = T \sum_{j=1}^{M} P_j \forall P_j \geq 0
\]

Application - Roy Billinton Test System (RBTS)

Genetic algorithm
Uses guided stochastic search to approximate Pareto front for the topology

Look-up table of Pareto optimal solutions for decision maker

Conclusions
The multi-objective GA performed as well or better than the heuristic method, with the advantage that it provides a solution set, instead of only one solution.

Future work
Incorporate stochastic nature of system elements. How does the reliability measure used effect the results?

Acknowledgments
* This work was completed under the aegis of PSERC Project T-41, "Implications of the Smart Grid Initiative on Distribution System Engineering".
* Thanks to Dr. Siddharth Suryanarayanan for his role as advisor for this work.
* Thanks to Julieta Giraldez for her assistance with this poster presentation.