Spatial Representation of the Effect of New Generation on Network Security

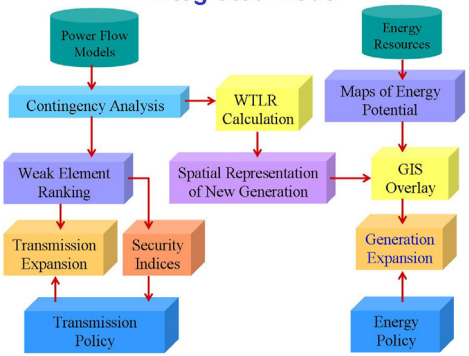
Santiago Grijalva
POWERWORLD CORPORATION

Anthony M. Visnesky Jr.
TREXCO L.L.C.

Context

- It is difficult to optimize the implementation of a large number of renewable and distributed generation projects.
- Large amounts of R&D generation contribute to energy adequacy, but may impact the security of the bulk transmission system.
- The effect of R&D generation on the security of the transmission grid needs to be taken into account in the cost/benefit analysis and in the decision of where to develop new sources.
- This paper addresses the problem of identifying beneficial and poor locations for new generation based on its impact on grid security.
- The spatial information regarding beneficial locations can be overlaid in a GIS platform with energy source potential and economic benefits.

Integrated Model



- An integrated siting model combines beneficial locations based on security with existing energy sources in a GIS platform.

Security Metrics

- The aggregated megawatt contingency overload (AMWCO) is the sum of the overload megawatts through a branch under a set of contingencies.

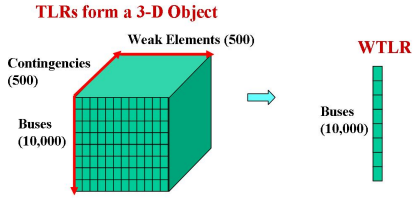
$$\text{AMWCO} = \sum_{\substack{\text{Contingencies that}\\ \text{overloaded the line}}} \text{Rating} \times (\%\text{Overload} - 100)$$

- AMWCO = 0 is the branch is never overloaded.
- The higher the AMWCO, the weaker the branch. Thus the value of the AMWCO can be used to rank weak elements.
- A system thermal security metric can be obtained by adding the AMWCOs of all the branches.

Determining Beneficial Locations

- Generation should be located in places that produce counter-flows on weak elements.
- Need to know how new generation injections impact flows in each branch. This is achieved using post-contingency Transmission Loading Relief sensitivities (TLR):

$$\text{TLR}c,jk,i = \frac{\Delta\text{MW Flow in Line } jk \text{ under CTG } c}{\Delta\text{MW Injection at Bus } i}$$



- Obtain a single weighted TLR (WTLR) for each bus by collapsing the contingency dimension using the AMWCO calculation, and the weak element dimension by weighting the TLRs so that weakest elements would be mitigated first.
- Bus WTLR map shows beneficial and poor locations for generation based on grid security.