APPENDIX F5 – GENERATION INTERCONNECTION COSTS METHODOLOGY

Xcel Energy Transmission Planning – White Paper
Generation Interconnection Costs using Random Placement Techniques
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I. PURPOSE

The purpose of this paper is to articulate Transmission Planning's efforts to create a process to identify interconnection costs associated with renewable generation on the Northern States Power (NSP) System using Monte Carlo simulations.

A. Background

Resource Planning approached Transmission Planning to see if there was a way to identify average transmission upgrade costs associated with solar installations. Running individual cases to create a statistically significant amount of results using the Siemen's PSSE program would be time consuming. Transmission Planning decided to try and develop a Monte Carlo type process to see if we could speed up the process to allow for a large amount of generation placed randomly around the system.

The runtime for each case depend on the amount of contingencies that are chosen to run and the portion of the system you choose to monitor. In addition the case chosen based on its size will greatly affect the runtime (MISO cases vs equivalized MNTACT cases). MNTACT cases used for local NERC reliability have been reduced in size by taking remote areas of the eastern interconnection and equivalizing them into a simple load and gen on one bus representing their system. This has the effect of reducing the overall case size and improves runtime.

The sample size needs to be of significant number to be considered statistically significant to produce a believable average. Typically the confidence interval (CI) is affected by the size of the statistical sample. The larger your sample size the lower the margin of error is. Since the number of possible random generation configurations is infinite a sample size of 100 was chosen based on size and time considerations.

B. Analysis

To create a large amount of random topology cases for analysis purposes Transmission Planning proposed incorporating the Python Coding interface with Siemens PSSE program using the API.
The process steps are outlined below:

1. Choose the amount of Monte Carlo runs (a minimum amount for statistical significance)
2. Identify and solve two benchmark cases to mimic the MISO process (MISO generation assumptions are used to dispatch)
    a. Summer peak (solar 100%)
    b. Shoulder (solar 50%)
3. Choose the random amount of new solar generation to be studied
    a. 69 kV: 3-20 MW
    b. 115-230 kV: 50-100 MW
    c. 345 kV: 200 MW
4. Use Python Code to randomly place solar generation around the NSP and GRE systems up to the amount chosen
    a. Python Code will then readjust MISO system generation down to accommodate the new generation addition. This process chooses generation units that are already on-line to be readjusted down in small increments to prevent the area swing bus from taking the full amount of new generation and thus reducing solving errors.
5. The two new summer and shoulder cases are created with new generation mix
6. ACCC is run on both new created cases
7. A compare is run against output from new cases compared to benchmark cases
8. Thermal overload costs are assigned based on newly created overloads or 3% greater difference than benchmark case
    a. Voltage issue costs were not tracked due to the difficulty in determining validity of identified voltage issues
9. Output thermal overload costs are plotted on scatter graph and a mean is identified for Monte Carlo run

C. Business Benefits

Monte Carlo analysis is used in most other industries to examine probabilistic outcomes using random input variable assumptions. It is heavily used in the finance industry to test financial models over good and bad markets. Traditional transmission planning studies involve a large amount of time in both the model development and the output analysis. Verification of all identified transmission issues and verification of contingencies consume a large amount of time. This type of analysis is typically what is required for reliability projects to comply with NERC standards.

Applying Monte Carlo simulation to the power systems will allow us to test future scenarios over a wide range of inputs and develop likely outcomes. The Monte Carlo approach will not replace the traditional reliability studies currently run to meet NERC criteria, but instead will allow us to develop probabilistic futures for changing generation or load mixes based on future assumptions.

D. Summary

When considering the rapidly changing world related to the power system, Monte Carlo simulations will allow Transmission Planning to develop future probabilistic models to help give insights into future assumptions. This type of random analysis will allow for a large amount of future assumptions to be screened quickly. For the generation example above it can be replicated for any amount of generation, type, or general location.

Future applications for stability are a possibility requiring further examination.