CVSR-Integrated Meshed Power Grid Analysis

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CVSR-Integrated Meshed Power Grid Analysis

Background and motivation:
- Complexity of grid changed the formation of power system year by year.
- Currently, many power flow control units are available but expensive.
- The CVSR can be used to regulate the reactance on the primary side of transformer to control power

Technical approach:
- Transformer sensitivity analysis is done.
- Piecewise optimization improves the results.
- Optimal location approaches are presented.
- All simulations are completed using OpenDSS and MATLAB using IEEE 342 system.

Conclusion:
- Transformer sensitivity analysis helped us to determine the device specifications.
- Piecewise optimization results are close to the benchmark results.
- Optimization results shows the effect of CVSR devices.
Calculations by linear optimization gives the big errors since assumption is made on the sensitivity curves.
Therefore, piecewise linearization will be solution for more accurate transformer sensitivities.
Increasing the segment number improves the results.
Results from Table I are very close to the benchmark results.

**Table I: 4-Segment Piecewise Optimization Results for IEEE 342 Test System**

<table>
<thead>
<tr>
<th>Xhl23 (ohm)</th>
<th>Xhl24 (ohm)</th>
<th>P23 by OpenDSS</th>
<th>P23 by Sensitivities</th>
<th>P24 by OpenDSS</th>
<th>P24 by Sensitivities</th>
<th>Transformer Limits</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.76</td>
<td>4.76</td>
<td>1133.96 kVA</td>
<td>1133.96 kVA</td>
<td>944.72 kVA</td>
<td>944.72 kVA</td>
<td>No Limit</td>
</tr>
<tr>
<td>4.76+1.283</td>
<td>4.76+0</td>
<td>1099.11 kVA</td>
<td>1000</td>
<td>981.11 kVA</td>
<td>980.757 kVA</td>
<td>1000</td>
</tr>
<tr>
<td>4.76+1.997</td>
<td>4.76+0.529</td>
<td>947.48 kVA</td>
<td>950</td>
<td>947.07 kVA</td>
<td>950</td>
<td>950</td>
</tr>
<tr>
<td>4.76+2.88</td>
<td>4.76+1.364</td>
<td>892.84 kVA</td>
<td>900</td>
<td>891.88 kVA</td>
<td>900</td>
<td>900</td>
</tr>
</tbody>
</table>
Optimal Location

- Couple approaches were studied.
- Area-based optimal location gives the best fit for the meshed-grid power system.
  - No distance info is required.
  - No matter what, pick the areas depending on the overloaded transformer or bus.

Fig. 4: Area-Based Optimal Location
Fig. 5: Risk-Free Optimal Location
Fig. 6: Distance-Based Optimal Location
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