Technical Methods of Minimizing Losses

Day 1 – Session 2  Network Design & Configuration

David Cleaver, Public Utilities Commission of Ohio
Review of Types of Losses

• No-Load Losses – Non productive energy to energize circuits and equipment

• Load Losses – Losses in the form of heat that varies directly with the current

Note: coordinate with Paul’s presentation on losses
Basic Formulas for Considering Strategies to Minimize Losses

- Active power is measured in KW (1000 watts)
- Reactive power is measured in kVAR (1000 volt-amperes reactive)
- Total power is measured in KVA (1000 volt-amperes)

\[ PF = \frac{KW}{KVA} = \cos \Theta \]
Basic Formulas for Considering Strategies to Minimize Losses

- Total power (1000 volt-amperes) = voltage x current
  \[ \text{Total power} = V \times I \]

- Losses (watts) = Current squared x resistance
  \[ \text{Losses} = I^2 R \]

Losses are minimized if \( R \downarrow, I \downarrow, V \uparrow, \text{kVAR} \downarrow \)
Optimize Transmission and Distribution Systems

- Re-conductoring of lines
- Substation projects
- Addition of capacitor banks
- Voltage regulation projects
Re-conductoring of lines

- Replacing existing wires with larger wires between transmission towers or distribution poles
  - Lowers resistance ($R\downarrow$) of the system reducing losses
  - Analogous to improving traffic flow on a highway by adding an extra lane
Substation Projects

• Tying together previously unconnected lines and/or adding or upgrading of transformers and circuits
  – Provides additional energy transformation point closer to load center
  – Greater portion of energy flows across high-voltage lines ($V↑$) instead of lower-voltage lines reducing losses
  – Analogous to adding extra exit to a fast moving highway which is closer to your destination
Capacitor Bank Projects

• Addition or expansion of capacitor banks in a substation and/or on transmission or distribution lines
  – Reduces losses by placing a reactive source at or near the load (kVAR ↓)
  – A portion of the load no longer travels across the entire transmission or distribution center (I ↓)
  – Similar to smoothing out hills and valleys along a highway for more efficient travel
Voltage Regulation Project

• Replacement of existing equipment with larger an/or more efficient equipment
  – Reduces losses and heating associated with smaller equipment (R ↓)
  – Similar to re-conductoring projects
  – Like improving traffic flow on highway by adding another lane
Special Provision in Ohio Energy Law

- Allows utilities to meet energy efficiency and demand reduction benchmarks with projects that project power system losses
- Both transmission and distribution system projects qualify
Examples at the PUCO

- First Energy met statutory requirements for energy efficiency and demand reduction benchmarks through projects that reduced losses.
- DPL met energy efficiency and demand reduction benchmark by converting 205 miles of existing 4kV distribution to 12 kV.
## First Energy Projects

<table>
<thead>
<tr>
<th>Project Name</th>
<th>In Service Date</th>
<th>Loss Reduction (MW)</th>
<th>Annualized Loss Reduction (MWhrs)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Distribution Projects</strong></td>
<td></td>
<td></td>
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<tr>
<td>Re-conductor line along North Street</td>
<td>7/12/2010</td>
<td>0.018</td>
<td>49</td>
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<tr>
<td>Jefferson Substation – replace transformer</td>
<td>10/26/2010</td>
<td>0.01</td>
<td>27</td>
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<tr>
<td>Capacitors – additions</td>
<td>6/1/2010</td>
<td>0.11</td>
<td>287</td>
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<tr>
<td><strong>Total 2010 Loss Reductions</strong></td>
<td></td>
<td>0.138</td>
<td>363</td>
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</table>
# First Energy Projects

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<tr>
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<th>Annualized Loss Reduction (MWhrs)</th>
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<tbody>
<tr>
<td><strong>Transmission Projects</strong></td>
<td></td>
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<tr>
<td>Lakeview 34.5 kV capacitor bank</td>
<td>1/4/2010</td>
<td>0.20</td>
<td>741</td>
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<tr>
<td>New 138 kV delivery point to Cleveland Power</td>
<td>7/12/2010</td>
<td>0.90</td>
<td>3,335</td>
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<tr>
<td><strong>Total 2010 Loss Reductions</strong></td>
<td></td>
<td>1.1</td>
<td>4,076</td>
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## DPL Projects

<table>
<thead>
<tr>
<th>Project Name</th>
<th>Date</th>
<th>Loss Reduction (MW)</th>
<th>Annualized Loss Reduction (MWhrs)</th>
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</thead>
<tbody>
<tr>
<td>4 kV to 12 kV Conversion Project</td>
<td>2010</td>
<td>2.9</td>
<td>10,299</td>
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<tr>
<td></td>
<td>2011</td>
<td>1.4</td>
<td>5,017</td>
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<td></td>
<td>2012</td>
<td>7.1</td>
<td>24,626</td>
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<tr>
<td></td>
<td>2013</td>
<td>4.2</td>
<td>14,628</td>
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<tr>
<td></td>
<td>2014</td>
<td>1.2</td>
<td>4,316</td>
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<td><strong>Total</strong></td>
<td></td>
<td><strong>16.8</strong></td>
<td><strong>58,886</strong></td>
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Questions