MINNESOTA EUI STATEWIDE ENERGY EFFICIENCY POLICY REVIEW
STAKEHOLDER MEETING #4 - NEXT STEPS
<table>
<thead>
<tr>
<th>TODAY’S AGENDA</th>
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<tbody>
<tr>
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<td><strong>Wrap-up / Next Steps</strong></td>
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</tbody>
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Overview of EUI Policy Review

- Project Goals:
  - Understand existing policies concerning EUI
  - Examine (dis)incentives to improve EUI efficiency
  - Recommend policy changes or clarifications to leverage EUI efficiency to meet MN goals
- Conduct 4 public stakeholder meetings (Today is #4)
- Develop roadmap to increase EUI efficiency
- Funding from DOE grant
- Minnesota is leading the country
Infrastructure is any equipment or facilities owned by a utility used to deliver electric energy to consumers.
- Generation, Transmission, Distribution
- Everything upstream of the meter
- Also called supply-side
Definition of EUI Efficiency

Projects owned by a utility that:

- Replace or modify existing infrastructure to conserve energy
- Conserve energy by recovering waste heat from infrastructure
**STAKEHOLDER MEETING TOPICS**

- Meeting 1 – 7/28/2017 - EUI Technologies
- Meeting 2 – 10/20/2017 – EUI Policies
- Meeting 3 – 2/12/2018 – Measuring EUI Success
- Meeting 4 – Today – Lessons Learned and Next Steps
Stakeholder Meeting Conversations

- Joe Paladino – DOE
- Mary Santori – Xcel
- Rich Sedano – RAP
- Ron Schoff – EPRI
- Jeff Haase – GRE
- Nancy Lange – PUC
- Jose Medina – OATI
- Kevin Lawless – Forward Curve
- Greg Anderson – Otter Tail
- Anthony Fryer – DOC
- Lisa Severson – Minnkota
- Tricia DeBlecckere – PUC
- Niels Malskær – Danish Embassy
- Dave Townley – CTC Global
+ Great panel discussions and input from stakeholders
PROJECT OUTCOMES

- Improve beyond normal maintenance definition
- Improve DSM 1% threshold guidance
- Clarify 50MW generation facility automatic exemption
- Incorporate findings from statewide EUI potential study
- Flesh out possible metrics for long-term EUI goals
- Connect related grid/infrastructure initiatives
- Make connections between utility infrastructure planning teams and CIP teams
- Create an Action Plan document outlining how EUI efficiency fits into policy landscape and how to overcome barriers to implementation
Today's Goals

- Present EUI Potential Study Results
- Discuss “Normal Maintenance” Strawman
- Minnesota Grid Modernization Initiative
- Practical Examples of Opportunities
  - High Efficiency Conductors
  - Conservation Voltage Reduction
- Wrap Up and Next Steps
### TODAY’S AGENDA

<table>
<thead>
<tr>
<th>Topic</th>
<th>Presenter/Location</th>
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</tr>
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</table>
Goals
Methodology
  - Separate for Generation and T&D
Results and Conclusions
Utility recommendations

Note: this is a high-level summary. Full report and accompanying webinar will be published soon at https://www.mncee.org/mnsupplystudy/home/
“Potential” = How much opportunity is there to conserve energy

Concurrent DSM study

MN first to look at EUI in this way
An estimated 12-15% of the nation’s electricity production is consumed by generation auxiliary loads, transmission and distribution losses, and substation consumption.
Estimate the potential for improving efficiency and reducing carbon emissions related to Electric Utility Infrastructure in Minnesota.
Potential Study – Objectives

- Devise a method to estimate EUI potential - first study of its kind
- Develop utility recommendations to capture potential
- Inform ongoing EUI policy discussion
These results have been reviewed but are still technically in draft form. There may be some changes/clarifications in the final published results.
Some data collected during the study was provided under a Non-Disclosure Agreement.

All results are presented at an aggregated level and anonymized to prevent identification of data sources.
Heat Rate Improvements
High Efficiency Transformers
Low-loss Conductors
Conservation Voltage Reduction
Models based on TRM heat rate measure
Separate approaches for technical and achievable potential
Adjusted approach to use available data
Not a complete analysis of all unique facilities owned by all utilities serving MN (beyond scope)
  - Accurate at state-level (less so at utility/facility)
  - Aggregated, anonymized results
Technical potential model is top-down

Compare each generation facility in the base data set to “Best-in-Class” by heat rate

Classes defined by fuel, technology, age, capacity, and capacity factor

“Best-in-class” site chosen by a generation expert as high-performing, but within reason

Each class designed maximum % improvement

Apply TRM algorithm for savings
<table>
<thead>
<tr>
<th>Class</th>
<th>Fuel</th>
<th>Technology</th>
<th>Capacity</th>
<th>Age</th>
<th>Best-in-class heat rate (kWh/Btu)</th>
<th>Capped Maximum Improvement (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Coal</td>
<td>Subcritical</td>
<td>&lt;200MW</td>
<td>48+</td>
<td>10,436</td>
<td>4%</td>
</tr>
<tr>
<td>2</td>
<td>Coal</td>
<td>Subcritical</td>
<td>&lt;200MW</td>
<td>≤48</td>
<td>11,566</td>
<td>4%</td>
</tr>
<tr>
<td>3</td>
<td>Coal</td>
<td>Subcritical</td>
<td>&gt;200MW</td>
<td>NA</td>
<td>10,036</td>
<td>4%</td>
</tr>
<tr>
<td>4</td>
<td>Coal</td>
<td>Supercritical</td>
<td>All</td>
<td>NA</td>
<td>8,998</td>
<td>2%</td>
</tr>
<tr>
<td>5</td>
<td>Gas</td>
<td>Combined Cycle</td>
<td>&lt;200MW</td>
<td>NA</td>
<td>7,655</td>
<td>6%</td>
</tr>
<tr>
<td>6</td>
<td>Gas</td>
<td>Combined Cycle</td>
<td>&gt;200MW</td>
<td>NA</td>
<td>7,150</td>
<td>6%</td>
</tr>
<tr>
<td>7</td>
<td>Gas</td>
<td>Steam Turbine</td>
<td>&lt;50MW</td>
<td>48+</td>
<td>13,347</td>
<td>3%</td>
</tr>
<tr>
<td>8</td>
<td>Gas</td>
<td>Steam Turbine</td>
<td>&lt;50MW</td>
<td>≤48</td>
<td>20,696</td>
<td>3%</td>
</tr>
<tr>
<td>9</td>
<td>Gas</td>
<td>Combustion Turbine</td>
<td>&lt;50MW</td>
<td>48+</td>
<td>14,426</td>
<td>6%</td>
</tr>
<tr>
<td>10</td>
<td>Gas</td>
<td>Combustion Turbine</td>
<td>&lt;50MW</td>
<td>≤48</td>
<td>15,829</td>
<td>6%</td>
</tr>
<tr>
<td>11</td>
<td>Gas</td>
<td>Combustion Turbine</td>
<td>&gt;50MW</td>
<td>NA</td>
<td>10,500</td>
<td>6%</td>
</tr>
<tr>
<td>12</td>
<td>Biomass</td>
<td>All</td>
<td>All</td>
<td>48+</td>
<td>Case-by-case</td>
<td>5%</td>
</tr>
<tr>
<td>13</td>
<td>Biomass</td>
<td>All</td>
<td>All</td>
<td>≤48</td>
<td>Case-by-case</td>
<td>5%</td>
</tr>
</tbody>
</table>

Modeled Classes of Generation Facilities, Best-in-class HR, and Capped improvement
**Generation Technical Results**

<table>
<thead>
<tr>
<th>Plant Type</th>
<th>Technical Potential (equivalent MWh)</th>
<th>Percentage of Projected CIP Goals</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fuel</strong></td>
<td><strong>Technology</strong></td>
<td><strong>Coal</strong></td>
</tr>
<tr>
<td>Coal</td>
<td>Subcritical</td>
<td>Coal</td>
</tr>
<tr>
<td>Gas</td>
<td>Combined Cycle</td>
<td>Gas</td>
</tr>
<tr>
<td>Gas</td>
<td>Steam Turbine</td>
<td>Gas</td>
</tr>
<tr>
<td>Gas</td>
<td>Combustion Turbine</td>
<td>Biomass</td>
</tr>
<tr>
<td>All</td>
<td></td>
<td>Total statewide annual equivalent MWh</td>
</tr>
</tbody>
</table>

Generation Sector Technical Potential for Conservation by Generation Technology
Achievable model is project-based

- For each class, an example heat rate improvement project is designed to pass a TRC test and maximize savings
- Selected example project applied to each plant in the class (average over a sample size)
- ONE project per site (limits results)
- Apply TRM algorithm for savings
- Assumptions listed in report section 3.1.6
Minnesota Statewide Generation Sector Achievable Potential for Conservation in Equivalent MWh

<table>
<thead>
<tr>
<th>Plant Type</th>
<th>Achievable Potential (equivalent MWh)</th>
<th>Percentage of Projected CIP Goals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coal Subcritical</td>
<td>399,914</td>
<td>1.69%</td>
</tr>
<tr>
<td>Coal Supercritical</td>
<td>73,730</td>
<td>0.31%</td>
</tr>
<tr>
<td>Gas Combined Cycle</td>
<td>191,496</td>
<td>0.81%</td>
</tr>
<tr>
<td>Gas Steam Turbine</td>
<td>6,277</td>
<td>0.03%</td>
</tr>
<tr>
<td>Gas Combustion Turbine</td>
<td>22,076</td>
<td>0.09%</td>
</tr>
<tr>
<td>Biomass All</td>
<td>93,289</td>
<td>0.39%</td>
</tr>
<tr>
<td><strong>Total statewide annual equivalent MWh</strong></td>
<td><strong>786,782</strong></td>
<td><strong>3.32%</strong></td>
</tr>
</tbody>
</table>
Generation Achievable Results

Generation Sector Achievable Potential for Conservation by Generation Technology
# Generation Achievable Results

<table>
<thead>
<tr>
<th>Utility Type</th>
<th>Equivalent MWh</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>IOU</td>
<td>509,022</td>
<td>65%</td>
</tr>
<tr>
<td>COU</td>
<td>277,760</td>
<td>35%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>786,782</strong></td>
<td></td>
</tr>
</tbody>
</table>

Statewide Generation Sector Achievable Potential by IOU vs. COU
Generation Achievable Results

Cumulative Persistent Achievable Generation Carbon Emission Reductions

Year
Cumulative Conservation (million tons CO2)

2020 2025 2030 2035 2040
Methodology Highlights

- Bottom-up approach
- Apply TRM measures to existing infrastructure conditions
- Develop estimates of units
Estimated incremental costs for each discrete measure

Included annual O&M, where applicable

Provided cost sources in report

Used avoided costs from EE study

Screened measures with UCTB/C test
Study assumes:

- Long-run maximum achievable percentage is 100%
- Fairly conservative ramp rate
- Developed from previous study
## T&D - Technical Potential Results

<table>
<thead>
<tr>
<th>Group</th>
<th>Technical Potential (MWh)</th>
<th>Percentage of Projected CIP Goals</th>
</tr>
</thead>
<tbody>
<tr>
<td>IOUs</td>
<td>1,564,733</td>
<td>11.4%</td>
</tr>
<tr>
<td>Co-ops</td>
<td>1,273,697</td>
<td>16.1%</td>
</tr>
<tr>
<td>Munis</td>
<td>410,493</td>
<td>7.9%</td>
</tr>
<tr>
<td><strong>Statewide</strong></td>
<td><strong>3,248,923</strong></td>
<td><strong>12.1%</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Measure Category</th>
<th>Technical Potential (MWh)</th>
<th>Percentage of Projected CIP Goals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conservation Voltage Reduction</td>
<td>851,547</td>
<td>3.1%</td>
</tr>
<tr>
<td>Conductors</td>
<td>1,484,739</td>
<td>5.5%</td>
</tr>
<tr>
<td>Transformers</td>
<td>912,637</td>
<td>3.4%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>3,248,923</strong></td>
<td><strong>12.1%</strong></td>
</tr>
</tbody>
</table>
### Economic Potential (MWh)

<table>
<thead>
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<th>Group</th>
<th>Economic Potential (MWh)</th>
<th>Percentage of CIP Goals</th>
</tr>
</thead>
<tbody>
<tr>
<td>IOUs</td>
<td>1,224,109</td>
<td>8.9%</td>
</tr>
<tr>
<td>Co-ops</td>
<td>985,588</td>
<td>12.3%</td>
</tr>
<tr>
<td>Munis</td>
<td>305,446</td>
<td>5.8%</td>
</tr>
<tr>
<td>Statewide</td>
<td>2,515,143</td>
<td>9.3%</td>
</tr>
</tbody>
</table>

### Achievable Potential (MWh)

<table>
<thead>
<tr>
<th>Group</th>
<th>Achievable Potential (MWh)</th>
<th>Percentage of CIP Goals</th>
</tr>
</thead>
<tbody>
<tr>
<td>IOUs</td>
<td>656,633</td>
<td>4.8%</td>
</tr>
<tr>
<td>Co-ops</td>
<td>523,617</td>
<td>6.5%</td>
</tr>
<tr>
<td>Munis</td>
<td>162,269</td>
<td>3.1%</td>
</tr>
<tr>
<td>Statewide</td>
<td>1,342,519</td>
<td>4.9%</td>
</tr>
</tbody>
</table>
## T&D - Results by Measure Category

<table>
<thead>
<tr>
<th>Measure Category</th>
<th>Economic Potential (MWh)</th>
<th>Percentage of CIP Goals</th>
</tr>
</thead>
<tbody>
<tr>
<td>CVR</td>
<td>838,072</td>
<td>3.1%</td>
</tr>
<tr>
<td>Conductors</td>
<td>1,226,736</td>
<td>4.5%</td>
</tr>
<tr>
<td>Transformers</td>
<td>450,334</td>
<td>1.7%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>2,515,143</strong></td>
<td><strong>9.3%</strong></td>
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<th>Measure Category</th>
<th>Achievable Potential (MWh)</th>
<th>Percentage of CIP Goals</th>
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<tbody>
<tr>
<td>CVR</td>
<td>461,053</td>
<td>1.7%</td>
</tr>
<tr>
<td>Conductors</td>
<td>641,319</td>
<td>2.4%</td>
</tr>
<tr>
<td>Transformers</td>
<td>240,147</td>
<td>0.9%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1,342,519</strong></td>
<td><strong>4.9%</strong></td>
</tr>
</tbody>
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T&D – Incremental Results by Year

Incremental MWh

IOUs Co-ops Munis

0 20,000 40,000 60,000 80,000 100,000 120,000

2020 2021 2022 2023 2024 2025 2026 2027 2028 2029 2030 2031 2032 2033 2034 2035 2036 2037 2038 2039
T&D - Cumulative Results by Year
**Overall Statewide Results**

Total Statewide Conservation Potential in MWh (equivalent MWh for generation) 2020-2039

<table>
<thead>
<tr>
<th></th>
<th>Generation</th>
<th>T&amp;D</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technical Conservation Potential</td>
<td>1,399,850</td>
<td>3,248,923</td>
<td>4,648,773</td>
</tr>
<tr>
<td>Economic Conservation Potential</td>
<td>786,782</td>
<td>2,515,143</td>
<td>3,301,925</td>
</tr>
<tr>
<td>Achievable Conservation Potential</td>
<td>786,782</td>
<td>1,342,519</td>
<td>2,129,301</td>
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## Overall Statewide Results

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<th>Generation</th>
<th>T&amp;D</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technical Conservation Potential</td>
<td>0.08%</td>
<td>0.18%</td>
<td>0.26%</td>
</tr>
<tr>
<td>Economic Conservation Potential</td>
<td>0.04%</td>
<td>0.12%</td>
<td>0.16%</td>
</tr>
<tr>
<td>Achievable Conservation Potential</td>
<td>0.04%</td>
<td>0.06%</td>
<td>0.11%</td>
</tr>
</tbody>
</table>

**Total Statewide Conservation Potential as a Percentage of Predicted Electric Sales 2020-2039**

<table>
<thead>
<tr>
<th></th>
<th>Generation</th>
<th>T&amp;D</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technical Conservation Potential</td>
<td>5.9%</td>
<td>13.7%</td>
<td>19.6%</td>
</tr>
<tr>
<td>Economic Conservation Potential</td>
<td>3.3%</td>
<td>9.3%</td>
<td>12.6%</td>
</tr>
<tr>
<td>Achievable Conservation Potential</td>
<td>3.3%</td>
<td>4.9%</td>
<td>8.2%</td>
</tr>
</tbody>
</table>

**Total Statewide Conservation Potential as a Percentage of CIP Electric Goals 2020-2039**
## Overall Statewide Results

Total Conservation Potential in MWh (equivalent MWh for generation) by Sector and IOU/COU. 2020-2039

<table>
<thead>
<tr>
<th></th>
<th>IOU</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Generation</td>
<td>T&amp;D</td>
<td>Total</td>
<td>Generation</td>
<td>T&amp;D</td>
<td>Total</td>
<td></td>
</tr>
<tr>
<td>Technical Potential</td>
<td>965,385</td>
<td>1,564,733</td>
<td>2,530,118</td>
<td>434,465</td>
<td>1,684,190</td>
<td>2,118,655</td>
<td></td>
</tr>
<tr>
<td>Economic Potential</td>
<td>509,022</td>
<td>1,224,109</td>
<td>1,733,131</td>
<td>277,760</td>
<td>1,291,034</td>
<td>1,568,794</td>
<td></td>
</tr>
<tr>
<td>Achievable Potential</td>
<td>509,022</td>
<td>656,633</td>
<td>1,165,655</td>
<td>277,760</td>
<td>685,886</td>
<td>963,646</td>
<td></td>
</tr>
</tbody>
</table>

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CONCLUSIONS - REVIEW CONTEXT

- Models applied to representative samples - results may not apply to individual utilities or facilities
- There is no economic potential for generation separate from achievable
- Several types of measures or facilities not included (expected small contribution)
- Remember this is a unique approach
Achievable conservation in the EUI sector in MN represents approximately 8.2% of utilities’ electric CIP goals from 2020-2039. Technical EUI potential is approximately 19.2% of CIP goals from 2020-2039. Potential is large enough that utilities should pursue it, but not so large that we need to worry about displacing DSM activities (on average, over time).
There are likely policy options to shift some technical potential to become achievable by lowering barriers and calibrating incentives.

Directly feeds into our policy conversation.
There is not currently enough consistent, recent data to calculate conservation potential using loss studies.

However, loss studies can be used by utilities to identify conservation opportunity and to track improvement over time internally.
16 utility recommendations identified to capture EUI potential

Included in final report and factsheet
POTENTIAL STUDY OUTCOMES

- Full Final Report
- Factsheet and Utility Recommendations
- High-Level project screening tools

All project materials to be posted to web at: https://www.mnc.ee.org/mnsupplystudy/home/
### TODAY’S AGENDA

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</tr>
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</table>
Defining “Normal Maintenance” & CIP EUI Project Review/Approval Process

Anthony Fryer: CIP Coordinator
“Electric utility infrastructure projects must result in increased energy efficiency greater than that which would have occurred through normal maintenance activity.”
Purpose of Strawman Proposal

1. Define Normal Maintenance
   - Establish threshold for screening EUI efficiency projects
   - Determine process for establishing energy use baseline used to calculate energy savings

2. Step-by-step process to standardize EUI project review and approval process

Objective: Provide utilities with a consistent and predictable process for EUI project proposal submission and review
Defining “Normal Maintenance”

Normal Maintenance - Defined differently for projects depending on specific equipment or facility and the proposed efficiency improvement

DER proposal for determining normal maintenance:

• Action that does not change or alter the fundamental design or nature of the facility or equipment, and meets at least one of the listed criteria (on page 2)

Submit project details for DER review early in planning process
Establishing Baseline for Energy Savings Estimation

Beyond Normal Maintenance: Actions resulting in efficiency greater than “normal maintenance”

Establishing Baseline: Proposed EUI project should be compared to scenario defined as normal maintenance to calculate energy savings

Savings Methodology: Will depend on type of project proposed

Ultimately: Baseline used for energy savings calculations is subject to approval by DER
Proposed EUI Project Review & Approval Process

• Step 1 – Develop EUI Project Outline (narrative summary of project)
• Step 2 – Define Normal Maintenance for Existing Equipment
• Sept 3 – Define Beyond Normal Maintenance for Proposed EUI Project
• Step 4 – Submit Project Information (Steps 1-3) to DER
• Step 5 – Determine Propose Energy Savings Methodology
• Step 6 – Estimate Energy Savings
• Step 7 – Implement EUI Project and Claim CIP Credit
Questions?

Anthony Fryer
Coordinator – Conservation Improvement Program
Minnesota Commerce Department
anthony.fryer@state.mn.us – 651.539.1858
COFFEE BREAK
**Today’s Agenda**

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Opportunities and Barriers to Utility Infrastructure Efficiency

Minnesota Stakeholder Meeting

July 30, 2018
Presentation Objectives

I. Background
   A. Overview of High Performance Conductors (HPC)
   B. Performance Comparison
   C. ACCC® Conductor as example of high efficiency conductor

II. Examples of T&D EE Projects
   A. New T&D ROW
   B. Existing ROW requiring upgrade ACCC® Conductor case studies
      a) AEP
      b) SCE
      c) Excel
   C. Existing ROW not yet requiring upgrade

III. What do we do with this info?
   A. Potential policy considerations
Options to Reduce T&D Losses include:

- Change the way the grid is operated
- Improve transformer and other substation equipment efficiency
- Change the way the structures hold the conductors
- Utilize the advantages of high performance conductors (HPC)
Overview of High Performance Conductors

**Traditional (post-WWI) conductor (ACSR):**
Aluminum Conductor Steel Reinforced: Aluminum round wire wrapped around steel wire core

**Aluminum Conductor Steel Supported (ACSS):**
Aluminum trapezoidal wire wrapped around zinc galvanized, steel wire; Improvement made in 1974 by using trapezoidal wire to close-up the holes between round wire and less sag

For given diameter conductor, line losses were reduced almost 28% due to having MORE Aluminum; resistance “R” reduced, but the weight increased from the addition of aluminum

**BUT conductor sag was still an issue**
Overview of High Performance Conductors

Several companies worldwide developed HPC designs to address thermal sag in ACSR lines
(Thermal Sag: Expansion of the conductor as it heated from temperature and I^2R line loss heating)

- Long spans between towers (rivers, lakes, mtn-to-mtn, etc)
- Heavily loaded lines could sag excessively and fail involving safety/fire hazards

Most designs focused on replacing the steel supporting core wire with another material that does not expand as much as steel does when heated.

Engineers call this class of conductor: High Temperature, Low Sag or HTLS conductor
Comparison testing performed by Hydro One on a 65 meter span, 1600 amps, Drake size
Carbon-fiber core is smaller, lighter, but stronger than the steel it replaces.

28% more aluminum for same weight & diameter.

Annealed aluminum is more conductive.

Trapezoidal design further improves efficiency.

Minimal expansion at high load & temperature.

Does not rust, corrode, yield, or fatigue.

For same diameter, 2X more amp flow and ~30% less line loss vs ACSR.
Examples of T&D EE Projects
Some Observations Upfront

• HPC have been installed in the US for decades
• The HTLS conductors have been solving sag issues for over a decade
• HPC technologies are cost-effective solutions that are being implemented under the current policy framework
  • ACCC alone has 95 projects in the US since 2005
• BUT, utilities are “discovering” broader applications for some HPC
• Recognizing HPC for energy efficiency as well as for reliability/resiliency is “new”
New/Rebuild T&D Right-of-Way (ROW)

• New / Rebuild ROW construction is a very long and politically challenging process

• HPC (low sag) allow:
  • For fewer and/or shorter structures (cost savings)
  • Efficiency improvements over ACSR for the same diameter conductor (energy and emissions savings)
New/Rebuild T&D Right-of-Way (ROW)

For new line OR when structures MUST be replaced, HPC can:

- Eliminate the need for larger structures and ROW expansions
- Carry up to twice the ACSR current with greatly reduced thermal sag (some may weigh more and some will be amp limited by sag)
- Reduce structural costs and ROW (fewer/shorter structures saves money, time & environmental impact)
- Reduce line losses by 25 to 40% (for any given conductor size when using trapezoidal wire designs)
- The HPC’s improved efficiency can:
  - Reduce generation costs and associated fuel consumption
  - Reduce emission and water use associated with power generation
  - Reduce generation capacity and reserve needs

Efficiency can be traded for capacity and cost – Policy guidance can direct / influence choices
EXISTING ROW requiring upgrade: Case Studies

• HPC can enable more performance on existing ROW. They can provide:
  • More power flow to relieve congestion, improve reliability, and increase resiliency
  • Reduce line loss
  • Line-for-line reconductoring using existing structures (weight matters)

• ACCC ® CASE STUDIES:
  • AEP
  • SCE
  • Xcel Energy
Description: 240 circuit miles, 345 kV line, double bundle

Project: replace 1,440 miles of ACSR conductor with ACCC®

Objectives
• Improve reliability (less sag and corrosion)
• Increased capacity to serve growth
• Retain existing structures – to reduce costs
• Eliminate down time with Live Line Reconductoring

Additional benefits received by AEP
• Project completed eight months ahead of schedule and over $100M below budget
• Project completed at a small fraction of cost of traditional rebuild
• Reduced line losses by 30%
  ➢ Saving $15 million/yr. (300,000 MWh at $50)
  ➢ Reducing CO2 emissions by ~200,000 metric tons per year (= 34,000 cars off the road)
  ➢ Freeing up ~28 MW of generation

This project won EEI Transmission Project of the Year - 2016

Video: https://www.youtube.com/watch?v=aPaNHawldFA&feature=youtu.be
SCE Reconducter Project – Big Creek Corridor

Project: 137.2 Circuit Mile, 230 kV Line

- Very Low Load Factor lines, but...
- With P1 (N-1) constraint; load shed in low hydro conditions; line sag violation
- Original project approved as REBUILD with ACSR at $135M cost and energized by 12/31/2018
- Revised project: RECONDUCTOR utilizing existing structures; Replace original ACSR Dove Conductor with same diameter ACCC® Dove Conductor; expediting project completion.

Objectives:

- Remove N-1 constraint; load shed
- Increase 4 hr emergency rating
- Increase capacity to allow for load growth

What SCE Received

- Total project cost was reduced to $87M
- 4 hr emergency rating increased by 62% (from 936 Amps to 1520 Amps)
- Substantial increase in ROW operating capacity (>>20%)
- Project completed ahead of schedule
- Line losses reduced by 28% (very low load factor line) saving:
  - 3,000 MWh/year = $150,000 annual savings (@$50 / MWh)
  - Freed up 0.4 MW of generation assets that only “served” the losses
  - CO2 reduction of ~750 metric tons per year = removing 167 cars (~$11,250 / yr @ $15/ton

“Using ACCC minimizes the need to modify structures limiting the need for licensing/permitting enabling a scheduled completion date of December 31, 2018.” - SCE
Xcel Reconductort Project – Muleshoe, TX

Project: ~10 Circuit Mile, 230 kV Line
- 2017 Southwest Public Service project in Muleshoe, TX
- Chose ACCC of same diameter / weight as ACSR being replaced
- Use existing towers
- Traditional approach would rebuild towers to allow a larger conductor to be used: estimate $10 - $15M

Objectives:
- Increase capacity
  - Remove overload conditions with sag violations
  - Allow for load growth
- Use existing towers
  - Lower cost
  - Rapid project completion

What Excel/SPS Received
- Total project cost estimate: $7M-$8M
- Operating capacity increase of about 50% (emergency capacity an additional 50% amps)
- Quick project completion under maintenance practices / permits (no construction permit required)
- Line losses reduced by 27% saving 7,410 MWh per year:
  - $222 K energy savings per year at $30/MWh
  - 0.8 MW generating capacity “freed up”
  - 3,860 tons of CO2 per year not emitted (1,146 #/MWh – Texas 2016)
Reconductoring with ACCC over existing structures:

• **Much lower cost than rebuilding** (structures are typically half of a transmission line budget)

• **Doubles the capacity of ACSR lines at same size/weight**
  (adds operating and emergency capacity for resiliency / reliability)

• **Reduces sag to fix clearance violations & improve reliability**

• **Shortens construction schedules and associated outage times**

• **Limits permitting needs to maintenance provisions**

• **Improves system efficiency immediately (via lower line losses):**
  
  • Reduces energy generation costs and associated fuel consumption
  • Reduces associated air emissions
  • Reduces associated water usage
  • Reduces generation capacity needs
EXISTING ROW not yet requiring upgrade

• For a reconductoring project that is not yet a reliability issue, the “Payback” currently has a >10 year timeframe at 10% discount rate

• Look at opportunities through the lens of end-use energy efficiency rules / regs / tests
  • High load factor
  • Straight-forward validation of savings (I²R)
What do we do with this info?
Policy Considerations

• T&D Energy Efficiency Policy Guidance:
  • Policy should direct utility attention to incremental investment for loss reductions
  • All T&D projects should have EE savings included in the Cost/Benefit analysis at the planning stage
  • EE savings should include costs for energy/fuel savings, CO₂ savings, SOx/NOx savings, water reduction savings, other (e.g. low-income emission reduction impacts), ...
  • Follow the approved guidance for end-use EE projects
  • Register T&D EE projects?
Thank You
TODAY’S AGENDA

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Wrap-up / Next Steps
Grid Modernization: Distribution System Planning Update

July 30, 2018
Minnesota EUI Stakeholder Meeting
Nancy Lange, Chair
Minnesota Public Utilities Commission
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Next Steps...
• The electric distribution grid is at a **time of significant change**;

• Changing **customer demands, new technologies, and evolving public policy** will drive increased deployment of new grid technologies and DER;

• **Development of tomorrow’s grid is already underway**, and investments are being made today that will influence the capabilities of the future grid;

• **Updates to distribution planning process will be needed...**
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Guiding Principles from March 2016 Staff Report

• Maintain and enhance the safety, security, reliability, and resilience of the electricity grid, at fair and reasonable costs, consistent with the state’s energy policies;

• Enable greater customer engagement, empowerment, and options for energy services;

• Move toward the creation of efficient, cost-effective, accessible grid platforms for new products, new services, and opportunities for adoption of new distributed technologies;

• Ensure optimized utilization of electricity grid assets and resources to minimize total system costs;

• Facilitate comprehensive, coordinated, transparent, integrated distribution system planning.
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A. How do Minnesota utilities currently plan their distribution systems?
Establish a baseline understanding of our utility planning processes

B. What does each utilities current year plan look like and assume?
Understand the current state of plans

C. Are there ways to improve or augment the utilities’ planning processes?
Provide stakeholders an opportunity to identify potential improvements in planning processes

Load Forecasts
Risk Analysis
Mitigation
Budgeting

2017

Scenario Planning
Hosting Capacity Investments
Distributed Resources
Technological Changes

? ?
Comprehensive input received from many utilities and parties:

**Utilities, Cooperatives, Others**
- Dakota Electric
- Great River Energy
- Minnesota Power
- Minnesota Rural Electric Association
- Otter Tail Power
- Xcel Energy

**Stakeholders**
- Alevo
- Advanced Energy Economy
- Department of Commerce
- Citizens Utility Board
- Energy Storage Association
- Fresh Energy
- Interstate Renewable Energy Council
Utility Similarities:
• Annual distribution system capital budgets;
• Metrics for planning;
• Low load growth and DER penetration;
• Varied system visibility even within distribution systems;
• Limited distribution engineering staff;
• Limited connection between DSP and IRP/Transmission Planning; and,
• DER treatment in forecasts (short term energy vs. long term capacity).
Utility Differences:
• Various stages of grid modernization;
• Degrees of implemented technology and how used;
• Levels of DER-interconnection requests and DER-penetration levels;
• Distribution system spend by year (factor of 10);
• Geographic region and density;
• Occurrences of (and need for) special distribution projects or studies; and,
• Age of existing infrastructure.
Stakeholders Summary:

- General support for distribution system planning of some kind;
- Variation in outcomes and expectations of a DSP;
- Variation on whether plans should be approved or constitute prudence;
- Stakeholder participation is important; and,
- Similar planning concepts should be applied to all utilities, but how they are applied will vary.
### Grid Modernization - Phased Approach

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1. Minnesota distribution system planning should be advanced to aide the Commission in:

- Providing a foundational understanding of utility system distribution long-term plans;
- Providing context for individual utility investment requests;
- Ensuring utilities are proactively planning for potential futures and incorporating non-traditional methods of planning;
- Ensuring a system that accommodates future reliability, efficient uses of resources, and maximizes customer benefits; and,
- Supporting public policy goals.
Distribution System Planning – Reasons to Continue

2. Any distribution system planning process should:
   • Be informed by stakeholder input;
   • Be iterative and improve with each cycle;
   • Create realistic expectations for the utility, the Commission, and stakeholders;
   • Bridge knowledge gaps;
   • Ensure cost effective solutions by increasing visibility into investment decisions and plans;
   • Be tailored to each utility’s system and allow for flexibility based on changing factors; and,
   • **NOT impede a utility in their need to plan and act on distribution system investments.**
• **Spring 2018**: draft Integrated Distribution System Planning requirements issued for comment
• **Filing requirements** (varies by utility)
  • At least one stakeholder meeting prior to filing
  • Baseline distribution system and financial data
  • Hosting capacity and interconnection requirements (Xcel)
  • Distributed energy resource scenario analysis
  • Long-term distribution system modernization and infrastructure investment plan
  • Non-wires alternatives analysis
Xcel will file its first IDP November, 2108

OTP, MP and Dakota Electric, November 2019

_EUI stakeholder objective: better capture EUI efficiency opportunities to improve the overall generation, transmission and distribution efficiency_

Information from the EUI potential study and policy review can be important inputs into the utilities’ IDPs.
Lead Staff: Tricia DeBleeckere

Tricia.DeBleeckere@state.mn.us
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Placeholder for OATI slides (removed for circulation)
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- Understand existing policies concerning EUI
- Examine (dis)incentives to improve EUI efficiency
- Recommend policy changes or clarifications to leverage EUI efficiency to meet MN goals
PROJECT OUTCOMES

- Improve beyond normal maintenance definition
- Improve DSM 1% threshold guidance
- Incorporate findings from statewide EUI potential study
- Flesh out possible metrics for long-term EUI goals
- Connect related grid/infrastructure initiatives
- Make connections between utility infrastructure planning teams and CIP teams
- Create an Action Plan document outlining how EUI efficiency fits into policy landscape and how to overcome barriers to implementation
In-person stakeholder meetings complete
Stakeholder survey - late summer/early fall
Draft Action Plan - end of 2018
Final Action Plan - Spring 2019
Disseminate results - 2019 and beyond
Still opportunity for involvement/feedback
**Timeline**

- **July**: Stakeholder Meeting #4
- **August**: Stakeholder Survey #2
- **September/October**: Survey Report
- **December**: Draft Action Plan
- **January**: Webinar on Draft Action Plan
- **April**: Final Action Plan
- **May**: Project Results Webinar or Mtg (Local Stakeholders)
- **June**: Project Results Webinar or Mtg (National Stakeholders)
Action Plan Contents

- Existing literature review
- Identified barriers to EUI implementation
- Policy solutions to overcome barriers
- Summary of stakeholder conversations
- Survey results
- Specific guidance developed
- Long-term vision for EUI efficiency in MN
EUI High Efficiency Technology Deployment

Stage 1: Reliability and Safety
Stage 2: Policy Clarification
Stage 3: Mature Policy Landscape

EUI Efficiency as a Business Case Only

Planning Processes
Integrate EUI Efficiency

Leverage CIP Tools to Increase EUI efficiency

Policy clarification leads to balanced goals/incentives, leading to increased implementation.

Time
Thank You to all Stakeholders for the great conversations and input

Special Thank You to presenters
CONTACT INFORMATION

Travis Hinck
Travis.Hinck@GDSAssociates.com
612-961-3052

Carl Nelson
cnelson@mnccee.org
612-335-5871

Adam Zoet
adam.zoet@state.mn.us
651-539-1798

project webpage at https://www.mnccee.org/mnsupplystudy/home/