Efficiency, Capacity, Reliability AND Cost-Effective Carbon Reductions: The Multiple Benefits of High Performance Transmission Conductors (HPTC)
WHY ARE WE HERE?

The Transmission System:
The “Backbone” of Our Electricity-Powered Nation
• Aging system overdue for technological innovation
• Increased capacity needed to accommodate renewables
• Constraints are costly and threaten reliability
• “low hanging fruit” for Energy Efficiency, Carbon Reduction

High Performance Transmission Conductors (HPTC)
• Technologically advanced conductors providing much higher efficiency, capacity, reliability, and strength
• HPTCs also deliver large & cost-effective carbon reductions

• Carbon Reduction => ALL Regulated Air Emissions from Power Plants
The Situation

• **CTC Global:** Inventor of Aluminum Composite Core Conductor (ACCC®), one of several HPTC technologies*

• **ACCC:** 11+ Years of Excellent Global Performance
  • 450 Projects in 40 countries
  • 150 utilities
  • ~40,000 km installed
  • 25 global suppliers

• **ACCC Multiple Benefits**
  • Efficient: cuts line losses by 30% +/-
  • 2X Capacity: uses existing ROW; no new structures
  • Reliable: eliminates line sag, stronger, resists corrosion
  • Lower impact, cost: longer spans, fewer & smaller towers

* 3M, CTC Global, Nexans, Southwire, Tokyo Rope. KNOWN ALSO AS HTLS CONDUCTORS
Outdated Conductors Can’t Meet Critical Needs of the Modern Grid:

- More capacity to accommodate renewables and new loads
- Efficiency to cut costs and emissions
- Ever increasing demands for reliability, resiliency, and security

Modern Conductors carry twice the power & cut losses by 30%
How ACCC Works: Carbon Fiber Replaces Steel

- Carbon-fiber core enables lighter, stronger & more efficient conductors
- 28% more aluminum for same weight & diameter
- Annealed aluminum is more conductive

Conventional Steel Core (100 year old technology)

Advanced Composite Core

Trapezoidal design further improves efficiency
Minimal expansion at high load & temperature
Does not rust, corrode, yield, or fatigue
Stronger and more resilient
2016 Edison Award Winner

AEP Texas: 240 circuit miles, 345 kV line, 3 Phase
Replace Standard Conductor (ACSR) with High Performance Conductor (CTC Global ACCC®)

They Wanted:
• Increased transfer capacity to accommodate load growth
• Improved reliability from storms & corrosion

They Got:
• Efficiency Savings (line losses cut by 30%):
  >283,000 MWh or ~$34 million Annually PLUS 34 MW of avoided
generation capacity (~$34M value) – Fast Payback
• Capacity: 14.6% “Free Capacity”; 2X using existing towers and right of way
• Reliability: Eliminated line sag; stronger than steel; Corrosion resistant;
performance at high loads & temps (resilient)
• Ahead of Schedule: Faster permitting, Live reconductoring
  AND
  >166K Metric Tons CO2/yr . . . FOR FREE!!
Equivalent to removing > 34,000 cars off the road
The Best Untapped Carbon Reduction Option? HIGH PERFORMANCE CONDUCTORS

• Doubled Capacity Inside Existing Corridors:
  ➢ Relieving costly congestion and
  ➢ Opening access to more renewable resources
• Line Losses Slashed by 25-40%.
• Reduced Impacts – Faster Siting and Permitting
• Eliminates line sag, resists corrosion, stronger than steel: More reliable, resilient, and secure
• Energy savings pay for re-conductoring – carbon reductions are free!
What is changing?
Drive to “Get the Most” from the Existing High Voltage Grid:
• Expand & Balance Renewables
• Improve Reliability & Resiliency
• Universal Access & Affordability

What has not yet changed?
Transmission owners, planners, and regulators are not considering the capacity, efficiency, and reliability benefits of High Performance Transmission Conductors in their decisions.
What can we do?

Consider High Performance Transmission Conductor (HPTC) for EVERY transmission project:

• Re-conductor heavily used lines to maintain reliability, reduce losses, and increase capacity
• New lines: minimize environmental impact and maximize capacity & efficiency
• Renewable “feeder” lines

Establish transmission efficiency standards
THANK-YOU

High Performance Conductors
Providing
Efficiency, Capacity, Reliability
AND
Cost-Effective Carbon Reductions:
Back-up and additional info slides follow
See June 2016 Public Utility Fortnightly
Pages 52-54
High Performance Transmission Conductors
Are Improving Grid Efficiency
And Why it matters
By Dave Bryant

“Leveraging high performance conductors has become particularly important today. They not only serve to improve efficiency and reliability, they also allow us to increase the capacity of existing transmission lines so we can access cleaner sources of generation.”

The US National Perspective...

Benefits of Upgrading the Grid with High Performance ACCC Conductor

<table>
<thead>
<tr>
<th>Description</th>
<th>Value (2016)</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>US Generation</td>
<td>4,093,606,000</td>
<td>MWh</td>
</tr>
<tr>
<td>Delivery System Losses (6%)</td>
<td>245,616,360</td>
<td>MWh</td>
</tr>
<tr>
<td>30% Reduction using ACCC</td>
<td>73,684,908</td>
<td>MWh</td>
</tr>
<tr>
<td>Annual CO2 Reduction (1,100#/MWh)</td>
<td>35,842,454</td>
<td>Metric Tons</td>
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<tr>
<td>Value of Line Loss Reduction (at $50/MWh)</td>
<td>$3.7</td>
<td>Billion</td>
</tr>
<tr>
<td>Generation Capacity Savings (80% Capacity Factor)</td>
<td>10,514</td>
<td>MW</td>
</tr>
<tr>
<td>Value of Generation Capacity Savings</td>
<td>$10.5</td>
<td>Billion</td>
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</tbody>
</table>

*EIA 2014 Utility-Scale
## The California Perspective...

### Benefits of Upgrading the Grid with High Performance ACCC Conductor

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<thead>
<tr>
<th>Description</th>
<th>Value</th>
<th>Unit</th>
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</thead>
<tbody>
<tr>
<td>California Generation (total-direct use)</td>
<td>199,996,478</td>
<td>MWh</td>
</tr>
<tr>
<td>Delivery System Losses (7%)</td>
<td>13,999,753</td>
<td>MWh</td>
</tr>
<tr>
<td>30% Reduction using ACCC</td>
<td>4,199,926</td>
<td>MWh</td>
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<tr>
<td>Annual CO2 Reduction (633 #/MWh)</td>
<td>1,208,433</td>
<td>Metric Tons</td>
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<tr>
<td><strong>Annual Value of Line Loss Reduction (at $50/MWh)</strong></td>
<td>$210</td>
<td>Million</td>
</tr>
<tr>
<td>Generation Capacity Savings (80% Capacity Factor)</td>
<td>599</td>
<td>MW</td>
</tr>
<tr>
<td><strong>Value of Generation Capacity Savings</strong></td>
<td>$599</td>
<td>Million</td>
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</table>

*AND DOUBLE THE POWER CAPACITY OF THE UPGRADED LINES!*
### Benefits of Upgrading the Grid with High Performance ACCC Conductor

<table>
<thead>
<tr>
<th>Description</th>
<th>Value (MWh)</th>
<th>Unit</th>
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</thead>
<tbody>
<tr>
<td>Georgia Generation (total-direct use)</td>
<td>121,271,378</td>
<td>MWh</td>
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<tr>
<td>Delivery System Losses (5.9%)</td>
<td>7,181,503</td>
<td>MWh</td>
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<tr>
<td>30% Reduction using ACCC</td>
<td>2,154,451</td>
<td>MWh</td>
</tr>
<tr>
<td>Annual CO2 Reduction (1,093 #/MWh)</td>
<td>1,177,407</td>
<td>Metric Tons</td>
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<tr>
<td>Annual Value of Line Loss Reduction (at $50/MWh)</td>
<td>$108</td>
<td>Million</td>
</tr>
<tr>
<td>Generation Capacity Savings (80% Capacity Factor)</td>
<td>307</td>
<td>MW</td>
</tr>
<tr>
<td>Value of Generation Capacity Savings</td>
<td>$307</td>
<td>Million</td>
</tr>
</tbody>
</table>

*EIA 2014 Table 7 & 10

AND DOUBLE THE POWER CAPACITY OF THE UPGRADED LINES!
AEP Wins the EEI EDISON AWARD

The EEI announcement... (Please also note outstanding video link)

http://www.eei.org/resourcesandmedia/newsroom/Pages/Press%20Releases/American%20Electric%20Power%20Awarded%20EEI%E2%80%99s%202016%20Edison%20Award.aspx

American Electric Power Awarded EEI’s 2016 Edison Award

CHICAGO (June 13, 2016) – American Electric Power (AEP) today received the Edison Electric Institute’s (EEI’s) 2016 Edison Award, the electric power industry’s most prestigious honor, for its Energized Reconductor Project in the Lower Rio Grande Valley of Texas. A panel of former electric company chief executives selected AEP for the 89th annual award from a group of distinguished finalists.

A video overview of the project is available online.
https://www.youtube.com/watch?v=aPaNHawIdFA&feature=youtu.be
3rd Party Certification of Line Loss Savings and CO² Reduction


CTC Global ACCC® conductor is the first electric transmission conductor in history to earn 3rd Party certification for CO2 emission reductions resulting from improved energy efficiency. ACCC conductor was verified to reduce CO2 emissions associated with transmission line losses by 27 to 31 percent under certain design conditions compared to conventional steel reinforced ACSR conductors, the 100-year old technology currently used in most electric transmission and distribution power lines.

SCS Global’s Certification Assessment of the ACCC conductor considered a range of conductor sizes, line lengths and voltages representing a number of project types in countries such as the U.S., Indonesia, Germany, India and Chile that have varied grid mixes and associated emission factors.

The SCS certification was conducted in accordance with ISO 14044:2006 standard for Life Cycle Assessment (LCA), a methodology used for evaluating the environmental performance of various products.