The World's Most Efficient High Capacity Transmission Conductor

- Twice the Capacity of ACSR
- 30-40% Reduction in Line Losses
- Proven Reliability Worldwide

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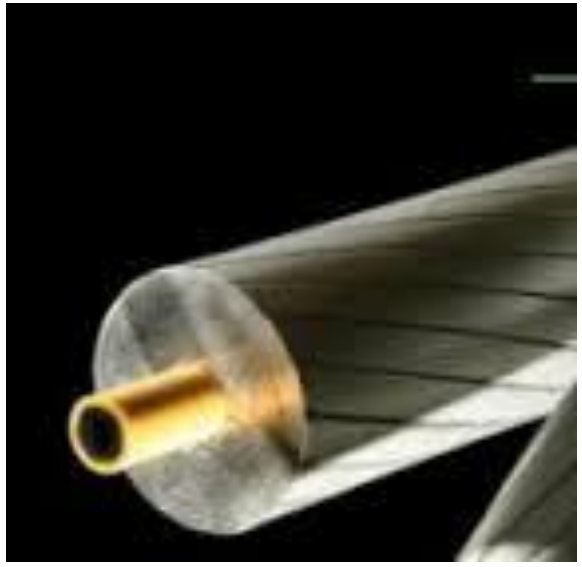
ACCC
The Utility Value Proposition



"Transmission for the 21st Century"

Gulf Coast Electrical Summit

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The High-Capacity, Low-Sag ACCC® Conductor Offers:

- Greater Strength & Reduced Sag
- Increased Spans on Fewer / Shorter Structures
- Twice the Capacity of AAAC, ACSR & others
- Reduced Line Losses by 25 to 40%
- Decreased Fuel Consumption & Emissions
- Improved Longevity
- & Reduced Life Cycle Costs

…And, its been installed by over 100 utilities at more than 275 project sites. This is not a novelty. *<u>This is proven and appropriate technology for our modern grid</u>*

Challenges facing Transmission Owners

- Sag violations and Increasing capacity requirements
- Tower replacement
- Right of Way, Community opposition (NIMBY)
- Shortening Construction Schedules
- Meeting Environmental Goals and Access to Renewable Energy
- Increasing capacity requirements (load growth)
- Reliability Improvement – Adequate capacity in N-1 scenarios
- Cost and finance of projects
- Efficiency and losses – Impact on Rates

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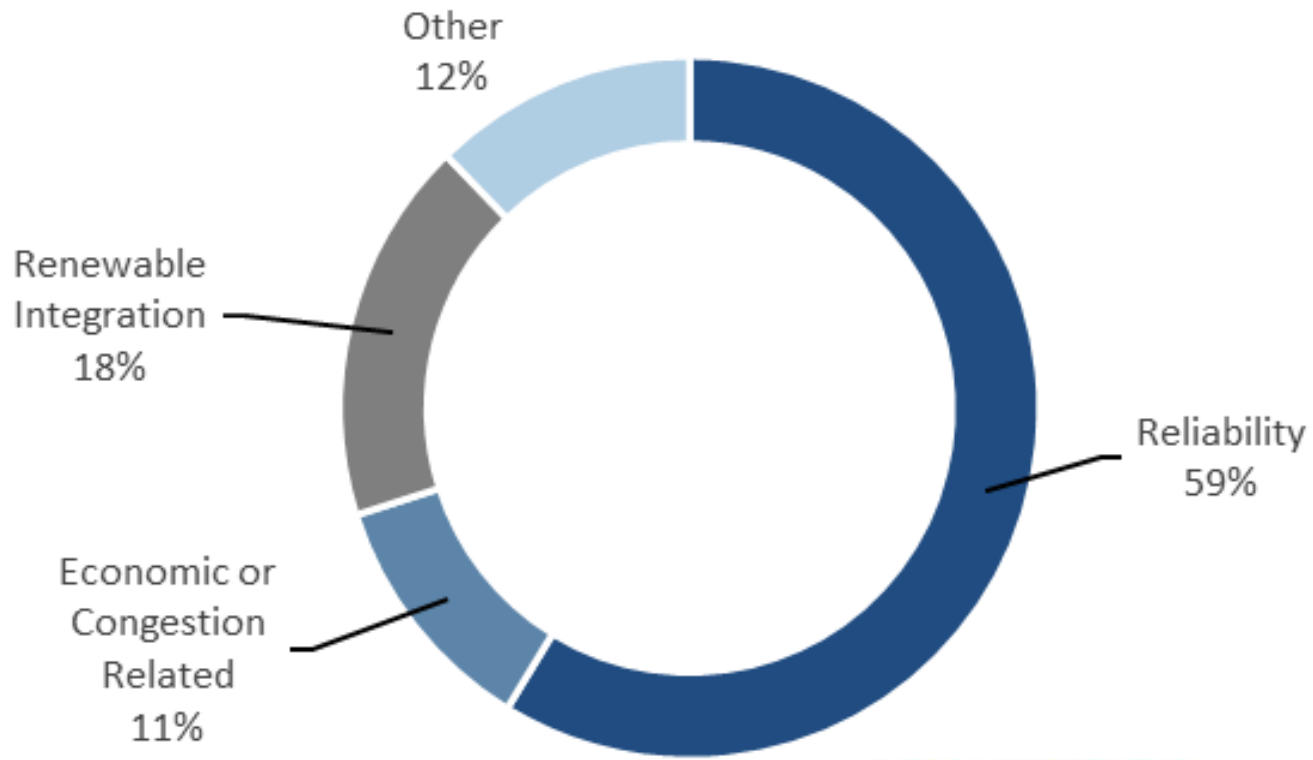
Primary Drivers for New Transmission Projects

NERC Long Term Reliability Assessment Dec 2013



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A few of CTC's USA &International Customers:

Why Did These Utilities Choose ACCC?

Because, after discovering its technical merits and evaluating its durability, it provided the most economical solution for their specific projects

Summary of Technical Advantages:

Low Thermal Sag and High Strength Allow:

- *Increased capacity, increased revenue & reduced congestion*
- *Fewer short-circuit events & improved reliability*
- *Increased spans between fewer and/or shorter structures*

Added Aluminum Content (without any weight penalty) Allow:

- *A 25 to 40% reduction in line losses (depending upon load)*
- *Reduced fuel consumption & reduced emissions*
- *Reduces generation capacity requirements*

Additional Advantages:

- *Higher strength core reduces risk of mechanical failure*
- *Composite core is impervious to corrosion*
- *Composite core resists cyclic load fatigue*

The Value of Line Loss Reduction

Value of Line Loss Reductions

	Peak Amps	Temperature at peak amps (C°)	Load Factor	MVA	Annual Line Losses (MWh)	Line Loss Reduction	Value of Reduction (at $50/MWh)	Value of Reduction per lineal conductor (meter)	(foot)
ACSR	1,000	95	53%	398	76,917	----	----	----	----
ACCC®	1,000	82	53%	398	56,588	20,329	$1,016,450	$3.39	$1.03
ACSS	1,600	194	53%	637	251,998	----	----	----	----
ACCC®	1,600	156	53%	637	179,022	72,976	$3,648,800	$12.16	$3.71

Reduced line losses saves money… every year

Assumptions: 100 km (62 mile) 230 kV line; Drake Equivalent Conductors; 53% Load Factor; 30° C Ambient; 2 fps Wind; .5 Emissivity; .5 Absorbtivity; $50/MWh; $1MM/MW; Coal Fired (2.19#/kWh); CO_2 $25/MT

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The Value of Emission Reduction

Value of Emission Reductions

	Peak Amps	Load Factor	MVA	Line Loss Reduction (MWh)	CO_2 Reductions (Metric Tons)	SO_x Reductions (Metric Tons)	NO_x Reductions (Metric Tons)	Value of CO_2 Reduction per lineal conductor (meter)	(foot)
ACSR	1,000	53%	398	----	----	----	----	----	----
ACCC®	1,000	53%	398	20,329	63,513	290	98.6	$5.29	$1.61
ACSS	1,600	53%	637	----	----	----	----	----	----
ACCC®	1,600	53%	637	72,976	250,572	1144	389	$20.88	$6.36

Reduced line losses reduces fuel consumption

…and associated emissions

Assumptions: 100 km (62 mile) 230 kV line; Drake Equivalent Conductors; 53% Load Factor; 30° C Ambient; 2 fps Wind; .5 Emissivity; .5 Absorbtivity; $50/MWh; $1MM/MW; Coal Fired (2.19#/kWh); CO_2 $25/MT

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ACCC has an Answer to these Challenges

- Composite technology as a possible solution
  - Strength/Weight ratio 5X Steel
  - CTE 1/7 that of Steel
  - Corrosion resistance
  - Fatigue resistance
  - Being used as solution in many other industries
    - Aircraft, automotive, sports equipment, enclosures
- This allows combinations of
  - More capacity for same OD and weight (more aluminum)
    - or same capacity with smaller OD and less weight
  - Less sag with increased capacity with same towers and ROW
  - Longer spans (or shorter towers)
  - Potentially lower overall project costs and shorter schedules

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Alternatives to ACSR

- ACCC – Composite core, annealed aluminum trap wire (1350-0)
- ACCR – Metal matrix composite core, zirconium-aluminum alloy round or trap wire
- Invar – Lower CTE steel core (not as low as ACCC, magnetic losses)
- ACSS – Annealed aluminum wire, steel core carries weight
- ACSS/TW-285 – Stronger steel, various aluminum wire types
- Gap – Like ACSS but core/conductor greased “gap” for pre-tensioning (difficult installation, grease leakage)

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ACCC Advantages

- Low thermal sag -> cure NERC clearance violations
- Lighter weight -> Smaller towers, smaller “footprint”
- Lower losses -> energy savings, keeps rates lower
- Corrosion resistance
- Fatigue resistance

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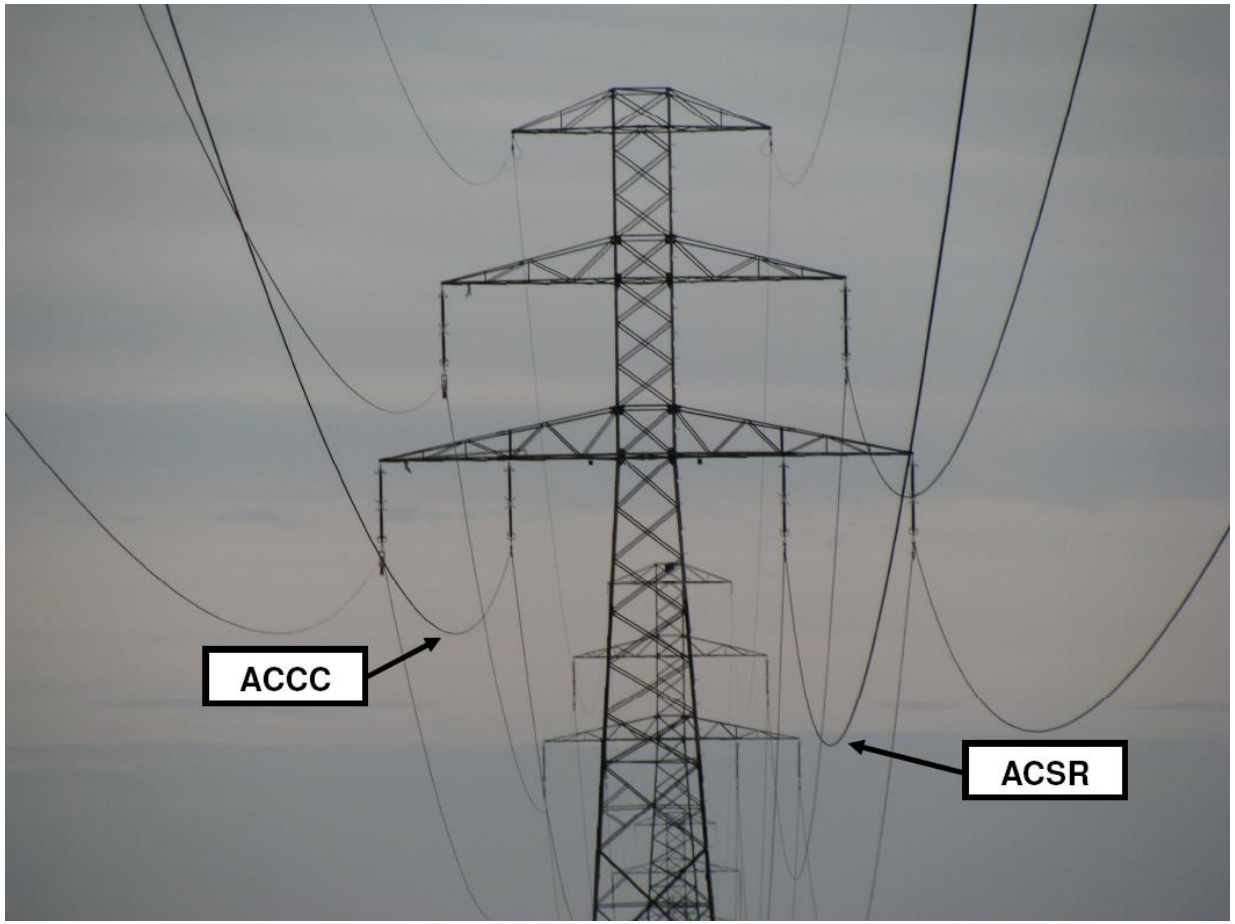
Reduced Sag



(80 vs 100 feet, ACCC vs. ACSS)

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“Drake ≠ Drake”

- Name of conductors based on round wire ACSR outside diameter
- Trap wire has more conductor cross-sectional area for same O.D.
- ACCC trap wire has even more due to smaller, lighter core
- Must think in terms of ampacity
- Example: ACSR and ACCC Drake, same sag

“Drake”	O.D. (inches)	Amps (at rated temperature)*
ACSR	**1.108**	**908**
ACCC	**1.108**	**1786**

* ACSR 75C, ACCC 180C, Amb: 25C, wind 2 fps, Lat 32N, June 21

Case Study: AEP Texas

- Sag limited feed to city
- Reliability impact for city. ERCOT required fix
- Hard constraints on ROW
- AEP did live replacement of two bundled 345 kV Drake

Case Study 90th South

- Pacificorp, 90 South to Oquirrh, Utah
- In city construction, extensive underbuild, pole upgrade very expensive
- Sub-trade coordination “impossible”
- ACCC allowed upgrade with existing poles, minimal impacts, saved 100 structures
- Called “Magic wire” by utility

Case Study: NV Energy Carson City

- 129 mile line Carson City to Reno
- Sag limited, very old (1954)
- Permits for upgrade “unavailable”
- Would take 7 years to permit
- ACCC allowed upgrade with existing structures
- Done in 4 months
- Conductor survived fire that destroyed poles and wind that uprooted poles

Case Study: Lake Nzilo, Congo, 4,491 ft