System Capacity, Renewables and Advanced Transmission Conductors

Pat Ferguson, Sales Manager, 3M High Capacity Conductors
3M is a global, diversified technology company

- Worldwide sales -- $31.8B US
- 75,000 employees in 65 countries; 31,500 US
- Materials company
- Over 40,000 products in 8 major markets
  - Energy storage
  - Energy efficiency
  - Renewables
  - Transmission and distribution
The Grid is Under Tremendous Pressure

- Power plant retirements, intermittent renewable resources, generators wanting access, plus demand from traditional sources
- Wholesale transactions require flexibility to accommodate changing contracts
- Customers are more and more sensitive to reliability
  - Outages are expensive -- $150B annually in the U.S.*
- Yet:
  - Those same customers aggressively try to block new lines in their area
  - Permitting is expensive, uncertain and lengthy
- The ability to site and build transmission is emerging as one of the highest risks facing the electric industry over the next 10 years

* According to the DOE

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... With the increase in wind and solar resource projections, transmission will be needed to "unlock" renewable resources in remote areas, increase diversity of supply, and provide access to ancillary services required to manage their variability.” 2009 long-Term Reliability Assessment 2009-2018, The North American Electric Reliability Corporation (NERC), Version 1.1- December 15, 2009.
Transmission and Renewables

- The largest impediment to getting energy from grid-scale renewables to market is transmission
- Grid-scale renewables are often located far from demand centers
- The existing system is not designed to handle the intermittent nature of renewables
- Existing infrastructure has aged

“Approximately 260,000 MW of new renewable capacity ... is projected over the coming ten years. ... the integration of this volume...will require significant changes to traditional planning and operating techniques to ensure reliability.” 2009 Long Term Reliability assessment 2009-2018, The North American Electric Reliability Corporation (NERC), Version 1.1 - December 15, 2009, p. 3.
Building New Transmission…

• … is expensive
  • High voltage lines can run from $300 k to > $1,000k per mile

• … is uncertain
  • “priority projects” costs increased 24% between approval and start of construction[1]
  • Arrowhead-Westin (ATC) costs increased 42% due to mitigation costs[2]
  • Hyde Park and South Boston (NSTAR) -- project costs increased by almost 25% due to construction and material costs[3]

• … takes a long time
  • A new line can take between 5 and 10 years to build, most of it not construction time

Dec. 2008 -- The decision gave the San Diego Gas & Electric Co. (SDG&E) the go ahead to build the Sunrise Powerlink Transmission Project, which will likely cost roughly $1.9 billion and stretch 123 miles from Imperial County to the coast.

The power line is set to start operating in 2012, Reuters reported. The 4-1 vote also capped a three-year contentious public debate over a host of environmental and economic issues. SDG&E said the transmission line is necessary for it to meet the state’s renewable energy mandate.

Source: Gridtech Grid, Dec. 2008

Tools are Changing

• Building new lines is still often necessary

• But upgrading lines is an important option
  • Maximize path ratings through robust contingency lines
  • Provide capacity needed for balancing
  • Eliminate transaction constraints
  • Managing cost and schedule goals

• Advanced conductors can maximize an upgrade’s value
Advanced Conductor Technology – High Temp, Low Sag Conductors

- Can operate at higher temperatures with less sag
- Allowing more energy to flow while maintaining clearances
- To varying extents, this allows capacity increases on existing towers, foundations and rights of way
How HTLS Conductors Work

Assumes ACSS and 3M ACCR at 1,300 foot/396.2 meter ruling span; initial tension: 6,557 lbs / 2,974 kg @ 15º C, max. loading @ 30º F / -1º C, no ice, 12 lbs/5.4 kg wind; ambient conditions 2 f/s/0.6 m/s wind, 35º C, perpendicular wind direction, 0.5 emissivity and solar absorption.
Conductor Sag

1,200’, 366 m span, installed to equal initial tensions, sags at final tension.

Combining low sag with less weight improves performance even more.
Types of Conductor on the Market

Aluminum and Steel
- ACSS – Aluminum Conductor Steel Supported
- G(ZT)ACSR – Gap

Aluminum and Nickel
- ACIR – Invar

Carbon fiber/epoxy polymer
- ACCC – Aluminum conductor composite core
- C7 – Aluminum conductor multi strand core

Metal Matrix
- ACCR – Aluminum conductor composite reinforced
Criteria for Advanced Conductors

• Maximum ampacity for existing transmission lines
• Compatible with existing towers and structures
• Suitable for a wide range of environmental conditions
  \((heat, cold, ice, wind, corrosion)\)
• Similar installation to ACSR
• Complete reliability for decades of service

Criteria for Conductor Materials

• High strength-to-weight ratio
• Low coefficient of thermal expansion
• Modulus similar to ACSR
• Long-term stability
• Economically practical to manufacture
## Composite Selection Criteria

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<td>Strength</td>
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<td>Modulus</td>
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Choosing the Conductor - The Key is in the Objectives

• A utility wants a large capacity increase and:
  • *It needs a whole new line*
  • *There is plenty of clearance, towers are in good shape*
  • *Interset structures or towers can be raised easily*
  • *It needs to replace/rebuild a significant portion of the line to get an al/steel solution to work*
  • *It needs to use only existing towers and rights of way*
Upgrading with Advanced Conductors Helps Renewables

- Where there’s an existing line
- Where a new line needs to be built and:
  - The new line links in with the existing grid
  - The existing system needs to be upgraded for n-1 reliability
  - Conventional generation needs capacity to support renewables with ancillary services
  - Fewer or shorter towers could ease permitting and mitigation issues
Value of Upgrading with an Advanced Conductor

- Save cost
- Save time
- Minimize budget risk
- Minimize siting/permitting risk
- Reduce engineering demands
- Reduce footprint in environment/community
- Improve electrical efficiency of transmission grid
- Enable projects that couldn’t be done before
Upgrading existing lines with advanced conductors offers an increasingly important option

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