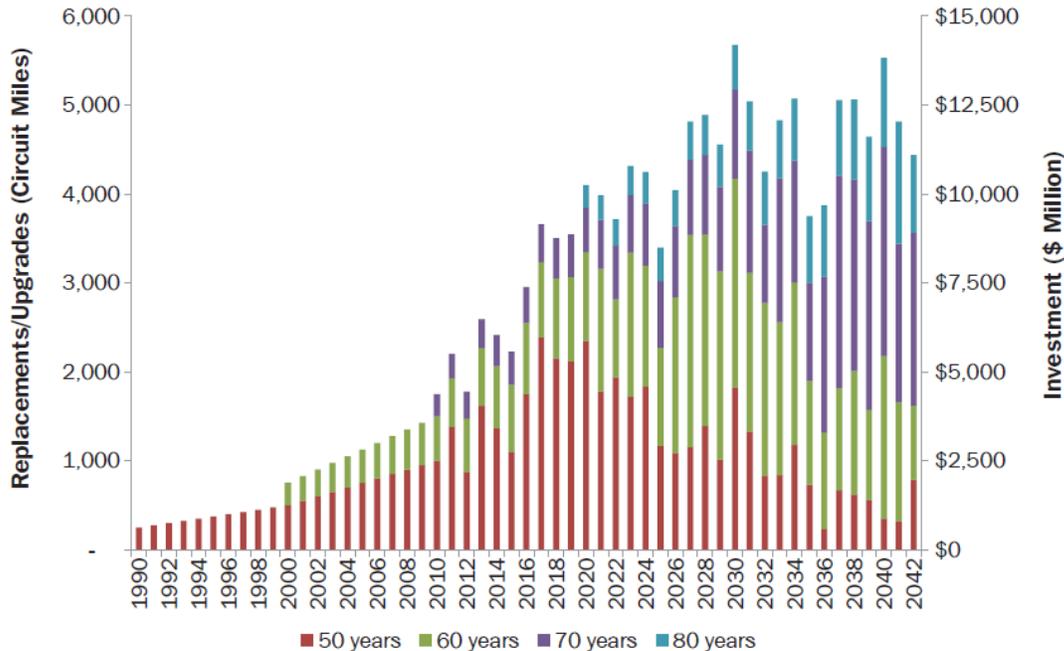


Advanced Electric Transmission Technologies

The nation's transmission grid is aging in all regions, notably most of the over 200,000 miles of 115-500kV circuits are at least 50-75 years old and need to be replaced. New capacity is needed for new generating resources. New innovative transmission technologies are commercially available to modernize and upgrade this infrastructure. Decisions about how to replace old circuits should reflect the best cost-effective available technologies with more capacity, efficiency, visual attractiveness, operational flexibility, and with reduced environmental impacts.

Projected Circuit Miles Replaced/Upgraded and Total Projected Investment (\$m)



Source: The Brattle Group, December 2014, "Dynamics and Opportunities in Transmission Development"

Examples of Advanced Transmission Technologies Include:

- **Advanced Conductors**
 - New materials can provide increased capacity, lower line losses and lighter weight that can be beneficial in reconductor projects (re-use of existing towers).
- **FACTS (Flexible Alternating Current Transmission Systems) Devices**
 - These devices, such as Static Var Compensators (SVC) and Static Synchronous Compensator (STATCOM), provide reactive power and dynamic regulation of voltage and frequency to maintain power system stability. They can also be used to control power flows and optimize system performance.
- **Dynamic Line Rating Systems**
 - These devices can be used to determine capacity and apply line ratings in real time. This can enable system operators to take advantage of additional capacity when it is available based on actual conditions, rather than fixed assumptions.
- **Asset Health Monitoring Systems**
 - These real-time information systems help reduce maintenance costs and proactively prevent equipment failures in T&D substations.
- **Fiberoptic Protection and Control Systems**
 - Used with digital relays, these systems replace much of the standard wiring with fiberoptic cable, improving system protection, reducing overall costs and providing a higher level of security.

- **Breakthrough Overhead Line Design (BOLD)**

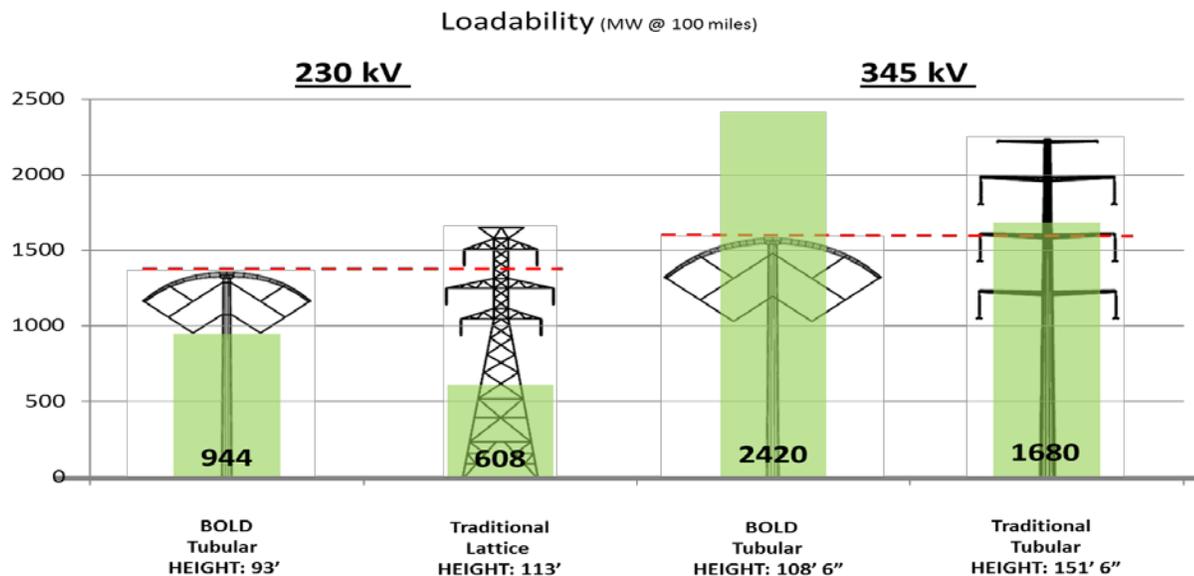
- BOLD has a cost advantage on a price/MW capacity basis versus traditional overhead lines, and significantly less expensive than underground lines.
- Using optimized bundled conductors, BOLD's lower impedance leads to reduced energy losses. Economic savings associated with reduced energy losses can be significant.
- The ability to rebuild with BOLD in existing right-of-ways can save both time and money. There is also the ability to potentially reduce right-of-way width for new lines.
- The lower-profile aesthetic design has less impact on communities and view shed, potentially lowering public resistance to new or upgraded lines and helping to expedite the siting and construction process.

BOLD vs. Conventional Modern Designs

BENEFITS	BOLD 345 kV	BOLD 230 kV
Increased Capacity*	10-60%	15-75%
Lower Tower Height	(25-35%)	(20-30%)
Lower Magnetic Field Levels	(45-50%)	(45-50%)
Lower Energy Losses*	Up to (33%)	Up to (15%)

*Comparisons dependent on conductor selection.

- BOLD can be used for new or replacement transmission circuits up to 500 kV.
- Costs for BOLD differ depending on design standards, but current estimates put BOLD on par with conventional designs before considering any benefits.
- BOLD is up to 33% less expensive than conventional on a cost per MW basis; this also means fewer lines are required to achieve the same level of capacity.
- Savings associated with reduced line losses further offset up-front material cost.
- BOLD benefits are much greater compared to the aging lines now in service.



Resolutions and Policy Positions to date Supporting Deployment of Advanced Innovative Electric Transmission Technologies:

- National Association of Regulatory Utility Commissioners
- The Council of State Governments-National, and South, Midwest, West regionals
- Southern States Energy Board
- Statehouses: Arkansas, Louisiana, Montana

BOLD Engineering information is available, see October 26, 2015 article at <http://tdworld.com/overhead-transmission/aep-s-bold-response-new-industry-challenges>. Parameters have been tested and field-verified in coordination with the Electric Power Research Institute.