# Southwire
# HTS Cable Program Overview




2005 U.S. DoE Peer Review

2-August 2005

David Lindsay

Director, Ultera

# SPI Project Goals & Objectives:

- **SPI-1: 30-m Installation, Carrollton, GA**
  - The cable system will continue to be operated and studied. Optimizations will be made to improve operating efficiencies and reliabilities.

- **SPI-2: Bixby Substation, AEP, Columbus, OH**
  - To complete a 200 meter demonstration with AEP
    - Install 13.2 kV, 3.0 $kA_{rms}$ (69 MVA) HTS cable system in Bixby substation, about 2 times the power of the Carrollton, GA demonstration
    - Highest current cable project
    - Length would be on the order of 7 times the Carrollton, GA demonstration
    - Design and install a simplified and reliable cryogenic system based on prior experiences
    - Demonstrate underground installation with field installed cable joints built in underground manhole.

# Southwire 30-m Demonstrator

Carrollton, GA USA

**Cable Parameters:**

- 12.4 kV
- 1.25 kA
- FC = 12 kA, 1 sec
- 30-m length

**In past 12 mo.**

- P3, phase-to-gnd fault on bus just outside termination
- Direct lightening strike in HTS yard


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# AEP Project Partners

| *Partner* | | *Area of Responsibility/Expertise* |
|---|---|---|
| Southwire/nktc/Ultera | Ultera™ A Southwire / nkt cables Joint Venture | Cable design, manufacturing, termination design, installation, cryo system design, systems integration, O&M, project management |
| AEP | AEP | Installation site engineering, site civil & electrical construction, Commissioning, Monitoring, O&M |
| ORNL | ornl | Cable research, termination research, testing, cryo design |
| Praxair | PRAXAIR | Cryogenics system design, construction, operations & service |
| AMSC | American Superconductor™ | HTS tape supplier |

# ‘AEP Project’

U.S. Department of Energy
SPI Phase-III

- Utility Partner = American Electric Power
- Location = Bixby Substation, Columbus, OH
- Voltage = 13.2 kV
- Load Rating = 3.0 $kA_{rms}$ AC
- Fault Current Peak = ~56 kA
- Cable Design = Triax
- Other Features = Splice
  Underground
  Multiple 90° Bends
- Energize mid-2006

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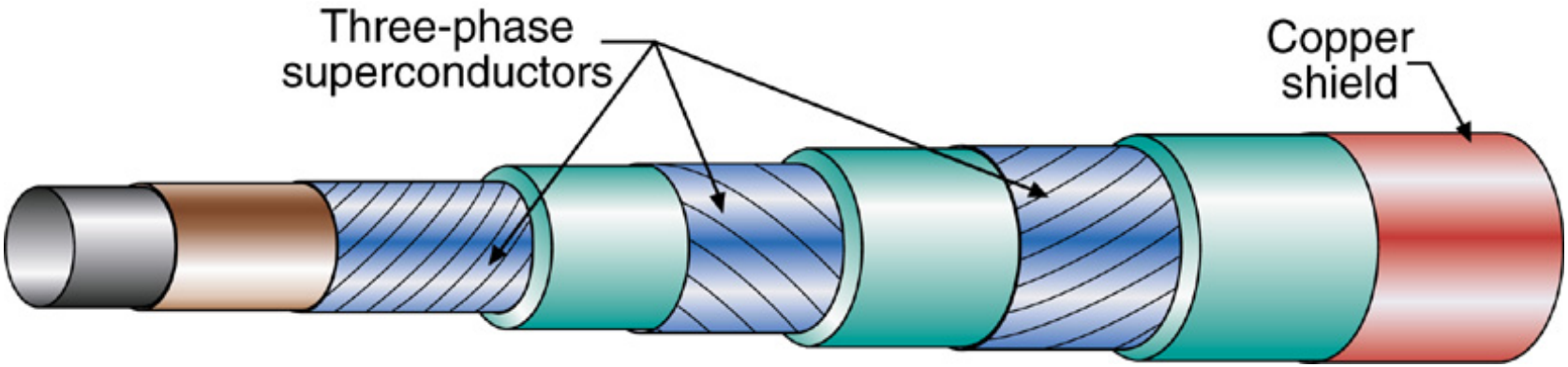
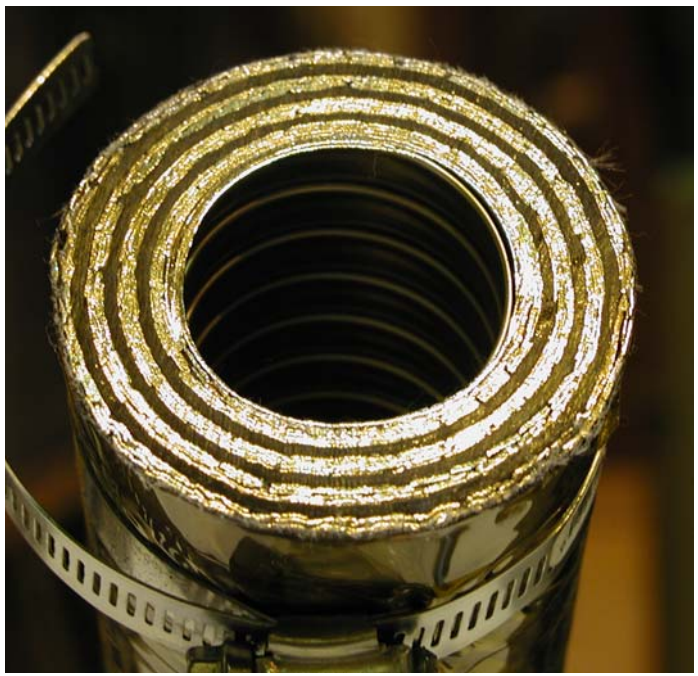
# Tri-axial HTS cable prototype



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# Triax Cable + Termination Qualification Tests


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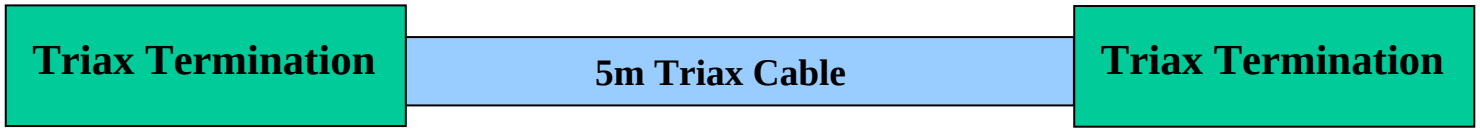
# Triax Cable + Termination Qualification

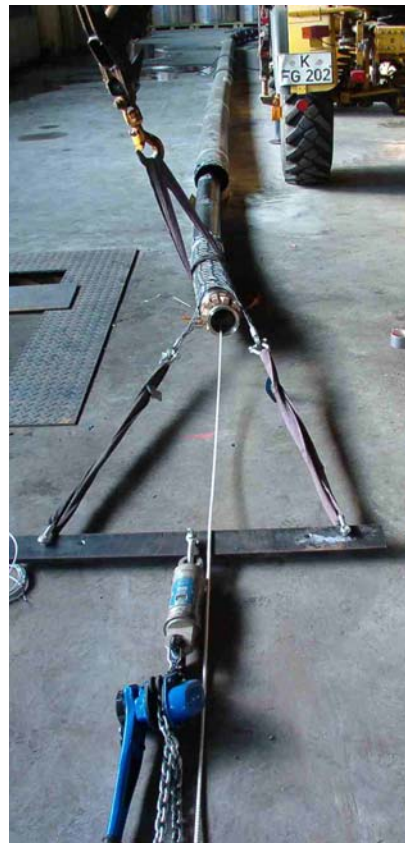



The following has been successfully tested:

1. Single-phase DC current tests (measure critical current)
2. 3-phase DC currents at 3 kA for 12 hours (thermal stability)
3. Single-phase AC current to 3 kA (AC loss measurements)
4. 3-phase AC current to 3 kA (thermal stability for cable + terminations)
5. Single-phase rated voltage for 1 hour
6. 3-phase rated voltage for 1 hour
7. PD measurements at 15.6 kV, single-phase (per IEEE 48-1996 termination spec)
8. AC withstand to 39 kV, single-phase (per ICEA S-94-649-2000 cable spec)
9. BIL to 110 kV (per IEEE & ICEA specs)

# Pulling & Mechanical Verifications

**No damage or degradation to cable or cryostat from pulling**



Cryostat Pulling

Cable Pulling

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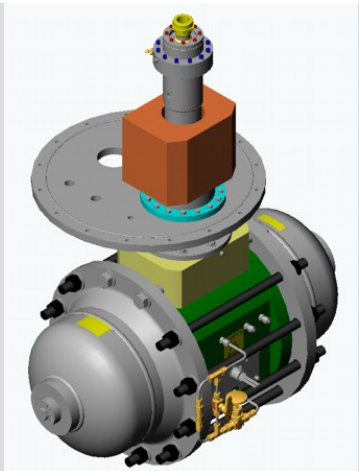
# Cryogenic Cooling

Experience 1: Stirling coolers
2 years operation at AMK

Experience 2: Open system
4+ years operation at Carrollton

**Hybrid System**
Vacuum
+
Pulse-Tubes

New: Q-drive + pulse tube
- low vibration
- low maintenance



PRAXAIR

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# Worst-Case Fault Current Test

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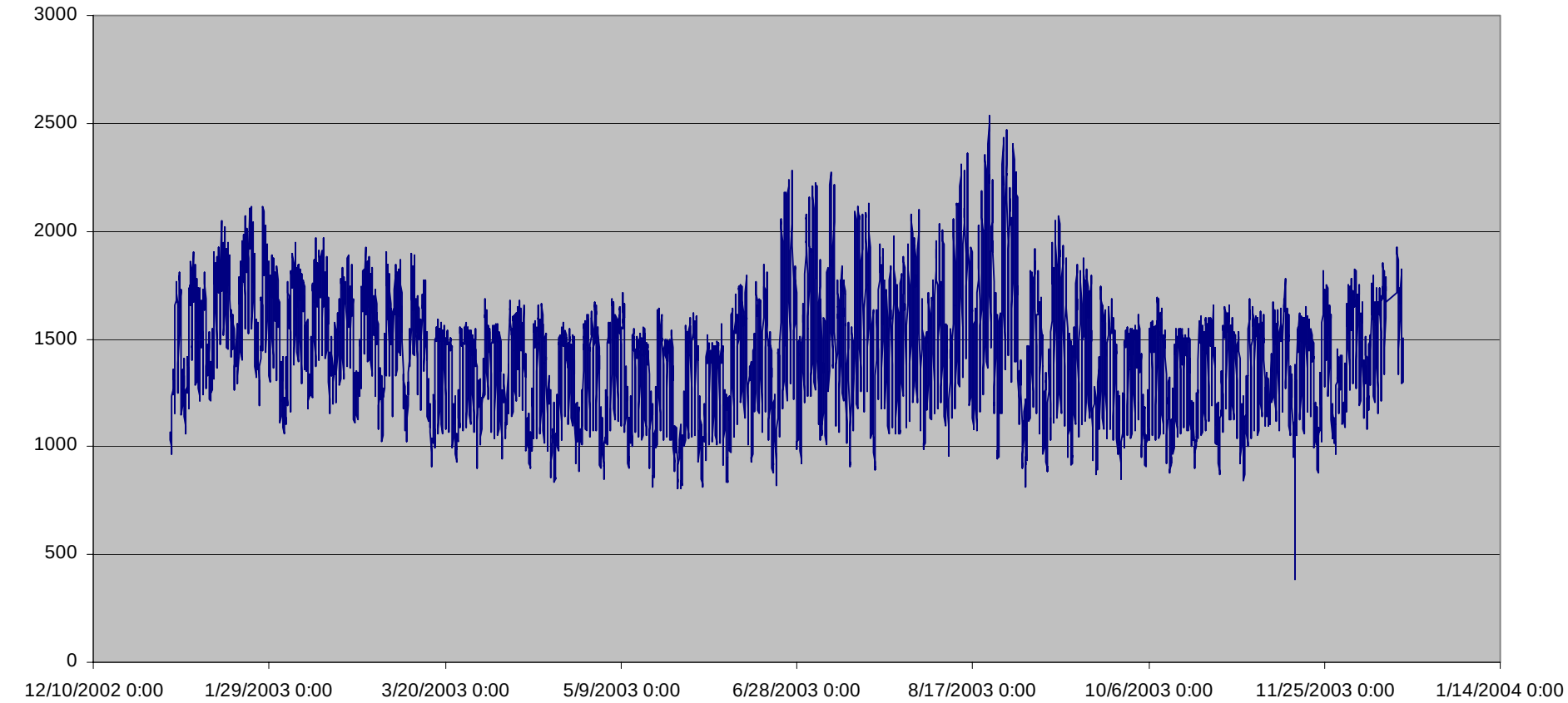
# 2003 Bixby Load Curve

Region: Columbus District: Columbus Station: BIXBY (#0071) Meter: BIXBY STATION 13 KV TOTAL Data Date Range: 01/01/2003 00:00:00 to 01/01/2004 23:59:00 Data Filter: MAX each 1 hr. period Filtered On: kVA Total Report Generated: 02/06/2004 07:40:04

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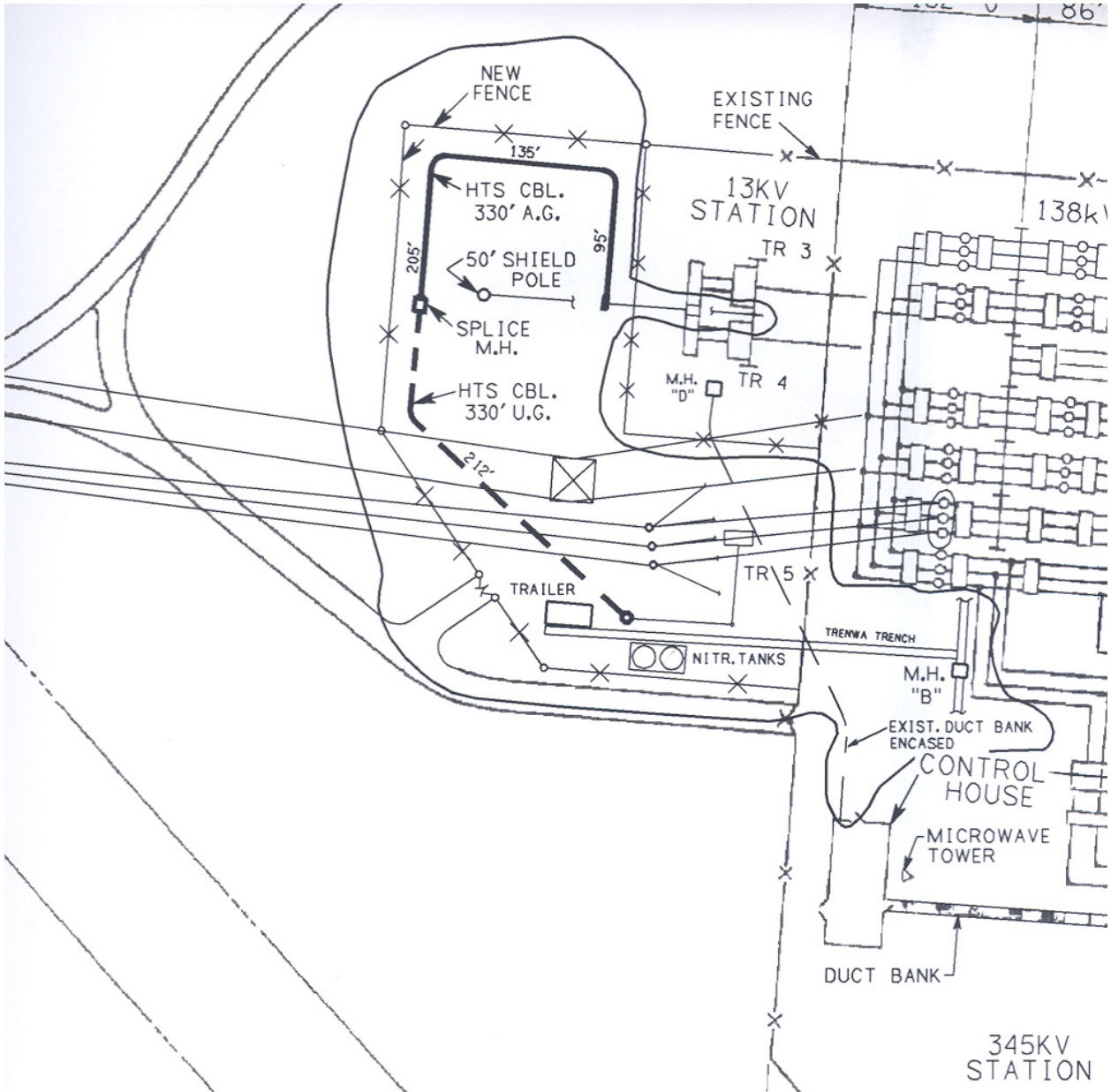
# AEP Site Layout

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# 200 m HTS cable demo at AEP

- Bixby substation, Columbus, OH
- Development and manufacturing 2002-2005
- Installation/energize in the grid of American electric Power Co in 2006
- Operation 2006-2007 +

- **~200 meters in length**
- **Voltage = 13.2 kV**
- **Current = 3,000 Amps ACrms**
- **Power Rating = 69 MW**

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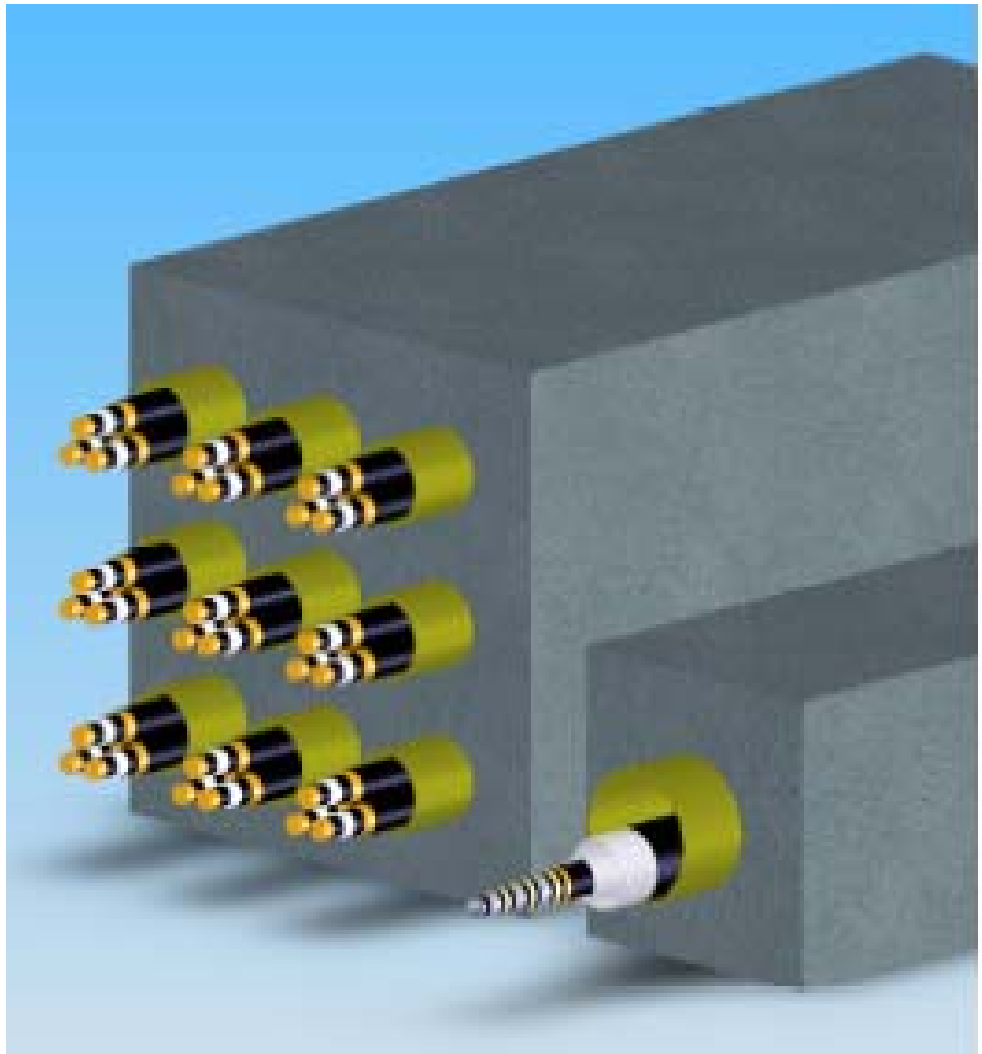
# 69 MVA power transfer at 13 kV (AEP-Bixby)

- 3x3 duct bank, 9 circuits
  - 6 inch ducts
  - 1000 kcmil copper
  - Copper conductors de-rated due to heating in adjacent ducts

**OR**

- One Triax HTS cable



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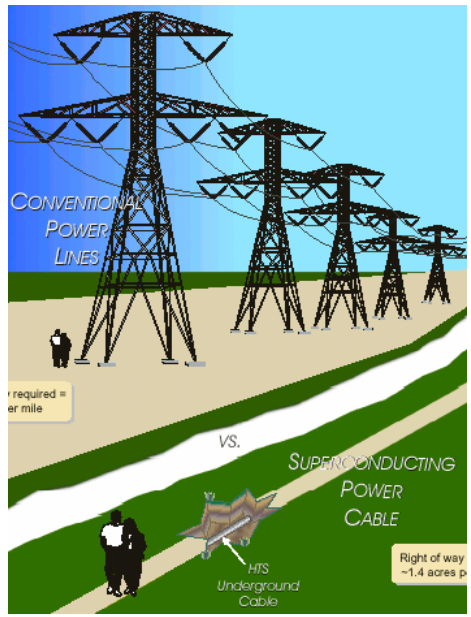
# Maximize use of Existing Rights-of-Way

- HTS cables offer high power density, 3,000+ Amp/phase
- Reduce voltage levels: ***"Transmission level power at distribution level voltages"***
- Lower real estate cost by moving transformation substations to out-lying areas. Stations in dense urban areas can become smaller 'breaker and switching only' stations.




**HTS Cables can help resolve:**

- **EMF from underground copper transmission cables**
- **Transformer installation & oil containment**
- **Thermal issues for HV copper cables – heat dissipation**
- **HV permitting issues with municipalities and regulators**
- **Real estate costs in dense urban areas**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