Advanced Transmission Technologies

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The State of Technology in Various Industries

Automobiles

Then
1932 Ford Sedan

Now
2005 Ford Escape Hybrid

Computing Devices

Then
Comptometer

Now
iMac G5

Electric Transmission

Is it the same?
Commercially Available Advanced Transmission Technologies (1)

VSC-HVDC, STATCOM, SVC, FACTS

D-VAR, D-SMES

Composite Core Conductors

XLPE Cables

(1) U.S. DOE National Transmission Grid Study – May, 2002
Advanced Transmission Technologies Increase Reliability

• Higher controllability over grid helps prevent cascading events
  – Prevents voltage / reactive power collapse
  – Prevents equipment overloads

• Undergrounding eliminates major causes of outages
  – Hurricanes, ice storms, tree contacts, lightning, fires

• Several studies confirm reliability of underground transmission
  – NC Utilities Commission (Nov. 2003) found that u/g outage rates are 50% less than overhead
  – MD Public Service Commission (Feb. 2000) found that u/g systems of urban utilities have lower frequency & duration of outages
  – Australian government (Nov. 1998) found that high voltage u/g systems had 80% less outages than overhead
Underground Transmission Technology Is Proven, Fully Operable and Integrated with Grid

- Europe: Almost 5500 km (3400 miles) of high voltage HVDC and HVAC > 110 kV underground transmission -- all integrated into grid (1)
  - % of all transmission > 220 kV (by length) that is underground:
    - Denmark 16%; United Kingdom 6%
  - 25% of new < 400 kV transmission in France is required to be underground

- Traditional and advanced underground HVDC transmission technologies provide high availability with manufacturer warranties, availability guarantees, liquidated damages, etc.

- Advanced underground HVDC technology implemented in Sweden (Gotland 1999), Australia (2000 Directlink multi-terminal and 2002 Murraylink) and US (2002 Cross Sound Cable)

Advanced Underground HVDC Transmission Technology: Low Impacts, Affordable

• Virtually no visual impacts
• Installation techniques are very simple
  – Installation similar to underground fiber optic cable
• No Electric Fields or AC EMF issues
  – HVDC and HVAC underground cables have no electric fields
  – Advanced underground HVDC cables - DC magnetic fields directly over cable are within natural variations of the earth’s DC magnetic field
• Efficient use of existing rights-of-way (roads, pipelines, railroads, etc.)
• O&M cost of advanced underground HVDC less than overhead HVAC
• Advanced underground HVDC cost comparable to underground HVAC
• Advanced underground HVDC costs are declining, overhead HVAC costs are increasing
Murraylink – World’s Longest Underground Transmission Link

- In operation since October 2002
- 220 MW HVDC system based on VSC
- Distance 110 miles – all underground
- Average ROW width 13 feet (min 10 feet)
- Converter station sites ~ 3.5 acres each
- Permitting ~ 24 months
- Construction ~ 21 months
- 1 cable failure, found and repaired in 6 days
- 392 cable joints - no failures
- Availability + 98%
- Cost (includes 132 kV and 220 kV interconnections) ~ US$ 97M
- Annual O & M cost ~ US$1.5M/year
Murraylink – Environmental Awards

- **Australian Case EARTH Award**
  - 2002 Environmental Excellence Award

- **The Institution of Engineers, South Australia Division; 2003 Engineering Excellence Awards**
  - Project infrastructure category
  - Overall project winner
  - Environmental category

- **Royal Australian Planning Institute of South Australia; Environmental Planning and Conservation Award**

- **LandCare Australia; National Recognition for Re-vegetation Along Cable Route**

(right of way ≈ 10 ft)
The State of Technology in Various Industries

**Automobiles**
- Then: 1932 Ford Sedan
- Now: 2005 Ford Escape Hybrid

**Computing Devices**
- Then: Comptometer
- Now: iMac G5

**Electric Transmission**
For More Information......

• Our web sites:
  - General          www.transenergieus.com
  - CSC             www.crosssoundcable.com
  - Australia        www.transenergie.com.au

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BACKUP SLIDES
Cable Installation Comparison

fiber optic cable

power cable
Cable Installation Gotland - Rock Cutting
Ploughing of the HVDC Light Cable - Gotland
Murraylink Cable Installation

- right of way ≈ 10 ft
- 392 field joints
Murraylink – Temporary Housing for Cable Splicing
Murraylink – Land Cable Trenching
Murraylink – Open Cut Cable Trench
HVDC Light - Bridge Conduit / Cable Crossing
Existing Underground/Sub-sea HVDC Light Projects

- 14 Converters
- 790 MW
- Sub-sea 40 km
- Underground 450 km

- Tjäreborg 2000
  - 7 MW, 4 km

- Gotland 1999
  - 50 MW, 70 km

- Directlink 2000
  - 3X60 MW, 3X 65 km

- Cross Sound 2002
  - 330 MW, 40 km sub-sea

- Murraylink 2002
  - 220 MW, 180 km
Planned Underground/Sub-sea HVDC Light Projects

- 6 Converters
- 430 MW
- Underground 100 km
- Sub-sea 290 km
DC Magnetic Fields

- The earth’s natural DC magnetic field total intensity varies around the earth from approximately 200 mG to 700 mG
- Murraylink’s maximum DC field intensity at 3 feet above the ground directly over the cable is 80 mG
- At distances from the cable greater than 10 feet, the change in the earth’s natural magnetic field is extremely small