HVDC – Innovative Technology for Smart Grids and Super Grids

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BritNed: Pre-launch Press Event
Maasvlakte, March 31, 2011
The New Electricity Age:
Three steps to sustainable energy supply

1. Optimization of generation – energy mix
2. Increase efficiency along the entire energy chain
3. System optimization / Smart Grid and Super Transmission Grid
Siemens is the leader and trendsetter in HVDC transmission

- With award of BorWin2 and SylWin1 in Germany, Siemens won the orders for the world's largest offshore HVDC transmission systems.

- April 2011: Siemens has put the BritNed HVDC transmission link between Britain and the Netherlands into operation.

- June 2010: With Yunnan–Guangdong, China, Siemens completed world's first ±800-kV DC transmission system (bipolar operation).

- January 2010: With Trans Bay Cable, USA, Siemens energized the world's first HVDC transmission system with innovative multilevel converter technology HVDC PLUS.

- April 2006: With Basslink, Australia, Siemens put into commercial operation the longest submarine cable transmission line at the time.

- November 2001: With Moyle Interconnector, UK, Siemens introduced advanced HVDC converter technology with unique low-maintenance direct light-triggered thyristor power semiconductors.
HVDC transmission systems are undergoing continuous technological improvements

<table>
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<tr>
<th>HVDC “Classic”</th>
<th>HVDC “Bulk”</th>
<th>HVDC “PLUS”</th>
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<tr>
<td>▪ 500 – 660 kV</td>
<td>▪ 800 kV for minimal transmission losses</td>
<td>▪ VSC: Voltage-Sourced Converter</td>
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<td>▪ up to 4,000 MW</td>
<td>▪ 5,000 – 7,200 MW</td>
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**B2B – The short link**

**HVDC-LDT – Long-Distance Transmission**

For decades, voltage and capacity continues increased!
HVDC transmission: Lower line losses and transmission costs compared with AC technology

at about 80 km cable and 800 km overhead lines

SSC: Series and Shunt Compensation
HVDC offers varied technology options for greater efficiency and supply security

HVDC “Classic” / “Bulk” based on thyristor technology

- Very low AC-DC-AC conversion losses
- High transmission capacity up to ±800 kV and up to 8 GW per bipole system
- High overload capability

HVDC PLUS based on transistor technology

- Compact station layout, small footprint
- Black-start capability
- No reactive power compensation and no filter requirements
Development of DC transmission: Worldwide installed capacity is soaring

In addition, over 250 GW are expected by 2020!

Quelle: Cigre WG B4-04 2003 - IEEE T&D Committee 2006
China uses hydro power from country’s interior for load centers on distant south-west coast.

Hydro power in China transmitted by HVDC

Hydro power
> 30 ... 50 GW

Load Center
The world’s first 800-kV HVDC transmission line is a milestone in China

Key figures for the Siemens HVDC line:

- 5,000 MW
- +/- 800 kV DC
- 1,418 km Yunnan – Guangdong
- In operation since December 2009 (Pole 1) and June 2010 (Pole 2)

Reduction in CO₂ compared to electricity from local energy mix: 33 megatons p.a. – through hydro power and HVDC long-distance transmission
Worldwide first 800-kV HVDC system: Converter station and transformer with challenging dimensions
What works in China is feasible in Europe:
Vision for interconnections facilitated by HVDC

Renewable energy in Europe – also great distances to load centers

- Wind power: > 20 ... 40 GW
- Solar power: > 10 ... 20 GW
- Hydro power: > 10 ... 30 GW

Load center

2000 km
1800 km
European offshore super grid: Transmitting electricity through HVDC interconnectors within Northern Europe

Currently existing
Currently planned or just completed (BritNed)
Under study
Under study (EWEA recommended)

EWEA Recommended Grids by 2020
EWEA Recommended Grids by 2030

Source: European Wind Energy Association (EWEA) 2009 / 2010
Integration of wind power: Huge offshore wind farms have to be connected to the grid

- Three wind farms get connected with world’s first offshore MMC:
  - SylWin1 with 864 MW
  - BorWin2 with 800 MW
  - HelWin1 with 576 MW
- The Modular Multilevel VSC technology (MMC) reduces complexity and therefore the space required for installation.
The new Wind Power Offshore substation (WIPOS) from Siemens serves as an interface between the wind turbines and the mainland. Power harvested from wind is collected and then passes through the export cables to reach the point of connection onshore. WIPOS is designed as a floating, self-lifting platform. The platform will be towed by tugs to its destination at sea where the water is about 40 meters deep. Large heavy-duty crane vessel is not needed to lift the platform topside onto its foundation.
Thank you!