Recent Siemens’ HVDC Activities

Yuriy Kazachkov
Siemens PTI
LIPA saved over $20 million last summer by using the new Neptune HVDC cable to bring power to Long Island during the peak summer season in July, August, and September.
Sayreville HVDC Converter Station
**Power Transmission and Distribution**

**2500MW – 500kV**

awarded *March 2007 – Power Grid Corp. of India*

<table>
<thead>
<tr>
<th>Customer</th>
<th>Power Grid Corp. of India Ltd.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Name</td>
<td>Ballia-Bhiwadi</td>
</tr>
<tr>
<td>Location</td>
<td>Uttar Pradesh Province, Rajasthan Province</td>
</tr>
<tr>
<td>Power Rating</td>
<td>2500MW</td>
</tr>
<tr>
<td>Type of Plant</td>
<td>HVDC Classic Bipole, 800km Long</td>
</tr>
<tr>
<td>Voltage Levels</td>
<td>± 500kV DC, 400kV AC, 50Hz</td>
</tr>
<tr>
<td>Type of Semiconductors</td>
<td>LTT 8kV (3600)</td>
</tr>
</tbody>
</table>
### 600MW – 400kV
awarded May 2007 – Energinet/ Storebælt HVDC

<table>
<thead>
<tr>
<th>Costumer</th>
<th>Energinet.dk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Name</td>
<td>Storebælt</td>
</tr>
<tr>
<td>Location</td>
<td>The Island Funen and Zealand in Denmark</td>
</tr>
<tr>
<td>Power Rating</td>
<td>600MW</td>
</tr>
<tr>
<td>Type of Plant</td>
<td>HVDC Classic Monopole 56km Submarine Cable</td>
</tr>
<tr>
<td>Voltage Levels</td>
<td>± 400kV DC, 400kV AC, 50Hz</td>
</tr>
<tr>
<td>Type of Semiconductors</td>
<td>LTT 8kV (1440)</td>
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</tbody>
</table>
5000MW – 800kV awarded June 2007 – China Southern Grid Company

<table>
<thead>
<tr>
<th>Costumer</th>
<th>China Southern Power Grid</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Name</td>
<td>Yunnan - Guangdong</td>
</tr>
<tr>
<td>Location</td>
<td>Chuxiong City/ Yunnan Zengcheng City/ Guangdong</td>
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<tr>
<td>Power Rating</td>
<td>5000MW</td>
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<tr>
<td>Type of Plant</td>
<td>Long Distance Bipole 1418km</td>
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<tr>
<td>Voltage Levels</td>
<td>± 800kV DC 525kV AC, 50Hz</td>
</tr>
<tr>
<td>Type of Semiconductors</td>
<td>LTT 8kV (5760)</td>
</tr>
</tbody>
</table>
1000MW – 450kV awarded June 2007 – National Grid and TenneT

Costumer: BritNed Development Ltd
Project Name: BritNed
Location: Isle of Grain, UK
Maasvlakte, NL
Power Rating: 1000MW
Type of Plant: HVDC Classic Bipolar
260km Submarine Cable
Voltage Levels: ± 450kV DC
400kV AC, 50Hz
Type of Semiconductors: LTT 8kV (3360)
400MW – 250kV
awarded October 2007 – Red Eléctrica de Espana (REE)

<table>
<thead>
<tr>
<th>Costumer</th>
<th>Red Eléctrica de Espana</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Name</td>
<td>Cometa</td>
</tr>
<tr>
<td>Location</td>
<td>Spain – Mallorca</td>
</tr>
<tr>
<td>Power Rating</td>
<td>2 x 200MW</td>
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<tr>
<td>Type of Plant</td>
<td>HVDC Classic Bipole 250km Submarine Cable</td>
</tr>
<tr>
<td>Voltage Levels</td>
<td>± 250kV DC 400kV / 230kV AC, 50Hz</td>
</tr>
<tr>
<td>Type of Semiconductors</td>
<td>LTT 8kV</td>
</tr>
</tbody>
</table>
### Costumer
Trans Bay Cable LLC

### Project Name
Trans Bay Cable Project

### Location
- Pittsburg, CA
- San Francisco, CA

### Power Rating
400MW

### Type of Plant
59-mile HVDC PLUS Submarine Cable

### Voltage Levels
± 200kV DC
230kV/138kV AC, 60Hz

### Type of Semiconductors
IGBT (5184)
Trans Bay Cable Project, USA
World’s 1st VSC HVDC with Modular Multilevel Converter (MMC) Technology

Energy Exchange by Sea Cable
No Increase in Short-Circuit Power

P = 400 MW, ± 200 kV DC Cable
Q = +/- 170-300 MVAr

Dynamic Voltage Support

P = 400 MW, ± 200 kV DC Cable
Q = +/- 170-300 MVAr
Benefits of Trans Bay Cable Project:
by-passing existing O/H Transmission

Transmission Constraints after TBC

Trans Bay Cable

Transmission Constraints before TBC

Significant Improvements

HVDC PLUS makes it feasible
Trans Bay Cable Project, USA
World’s 1st VSC HVDC with ± 200 kV XLPE DC Cable

- Converter: Modular Multilevel HVDC PLUS Converter
- Rated Power: 400 MW @ AC Terminal receiving End
- DC Voltage: ± 200 kV
- Submarine Cable: Extruded Insulation DC Cable
The Evolution of HVDC PLUS and VSC Technology

Power Electronic Devices:

- GTO / IGCT Module
- IGBT in Power Pack
- IGBT
VSC Technology – 2 or 3 Level

High harmonic Distortion

High Stresses resulting in HF Noise
The Advanced Multilevel Approach:

MMC – Modular Multilevel Converter

- Small Converter AC Voltage Steps
- Low Rate of Voltage Rise
- Low Generation of Harmonics
- Low Level of HF Noise
- Low Switching Losses
Features and Benefits of HVDC PLUS

- Multilevel Topology
- Modular Concept
- Standard Power Electronics
- Compactness of Station Design
- Low Switching Frequency
- Elimination of high Frequency Stresses
- Conventional AC Transformers
- Proven Siemens WinTDC core hardware
HVDC PLUS
Benefits of HVDC PLUS

Example 400 MW

HVDC "Classic"
Many Thanks ..... Questions?