Introduction to HVDC

LCC & VSC - Comparison

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HVDC Converter Technology

1. Line Commutate Converter (LCC) HVDC
   – Current Sourced Converter
   – Thyristor based Technology

2. Voltage Sourced Converter (VSC)
   – Self Commutated Converter
   – Transistor (IGBT, GTO etc.) based Technology
LCC – HVDC Scheme

- Current-Sourced
  - "Line-Commutated" HVDC (thyristors)
    - Large industrial rectifiers
  - "Very few applications"

- Self-Commutated
  - "VSC Transmission"
    - Motor Drives
  - "Very few applications"
VSC vs LCC HVDC

LCC HVDC
- Current-sourced
- Line-Commutated

VSC HVDC
- Voltage-Sourced
- Self-Commutated
## Voltage-Sourced versus Current-Sourced converters

### LCC HVDC
- Use semiconductors which can withstand voltage in either polarity
- Output voltage can be either polarity to change power direction
- Current direction does not change
- Store energy inductively
- Use semiconductors which can turn on by control action
- Turn-off and “commutation” rely on the external circuit

### VSC HVDC
- Use semiconductors which can pass current in either direction
- Output voltage polarity does not change
- Current direction changes to change Power direction
- Store energy capacitively
- Use semiconductors which can turn on or off by control action
- Turn-off is independent of external circuit
Converter Rating

Power Flow Control
- HVDC: for both Back to Back and Point to Point schemes (overhead line or cable)

Power Quality
- FACTS: SVC, STATCOM .. for Utilities and Industry

Power Supplies
- Electrolysis substation: for production of aluminium, chlorine, copper, zinc up to 500kA 1500VDC.
- Traction substation: for both AC and DC supplies
- Special supplies, e.g. laboratories
LCC vs VSC Comparison

LCC HVDC

- High power capability, PE device current capability
- Good overload capability
- Requires stronger AC systems
- “Black” start capability, requires additional equipment
- Generates harmonic distortion, AC & DC harmonic filters required
- Coarser reactive power control
- Large site area, dominated by harmonic filters

VSC HVDC

- Lower power capability, PE device current capability
- Weak overload capability
- Operates into weaker AC systems
- “Black” start capability
- Insignificant level of harmonic generation, hence no filters required
- Finer reactive power control
- Compact site area, 50 – 60% of LCC site area
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<thead>
<tr>
<th><strong>LCC HVDC</strong></th>
<th><strong>VSC HVDC</strong></th>
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<tbody>
<tr>
<td>• Requires converter transformers – continuous DC Voltage stress</td>
<td>• Use of conventional transformers – Symmetrical monopole</td>
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<tr>
<td>• Lower station losses</td>
<td>• Higher station losses</td>
</tr>
<tr>
<td>• Lower cost</td>
<td>• Higher cost by 10 – 15%</td>
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<tr>
<td>• Higher reliability</td>
<td>• Lower reliability, due to high component count</td>
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<tr>
<td>• More mature technology</td>
<td>• Less mature technology</td>
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<tr>
<td>• Power is reversed by changing polarity of the converters</td>
<td>• Power is reversed by changing direction of current flow</td>
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<td>• Requires use of MI cables</td>
<td>• Ideal for use with XLPE cables</td>
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<tr>
<td>– Higher voltage capability</td>
<td>– Lower voltage capability</td>
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