Introduction to HVDC

LCC & VSC - Comparison

Dr Radnya A Mukhedkar

Group Leader, Senior Principal Engineer

System Design

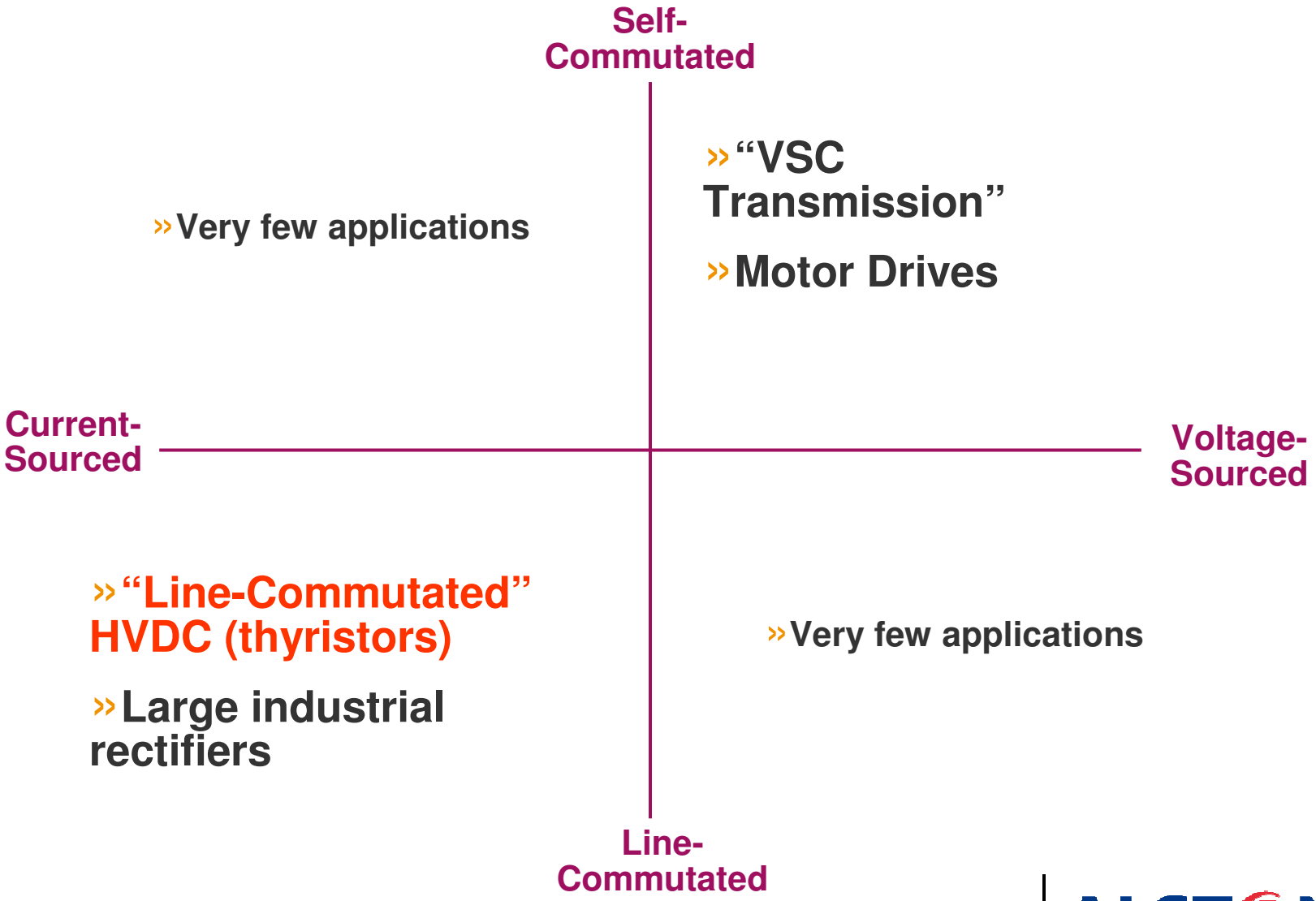
ALSTOM

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



GRID | ALSTOM

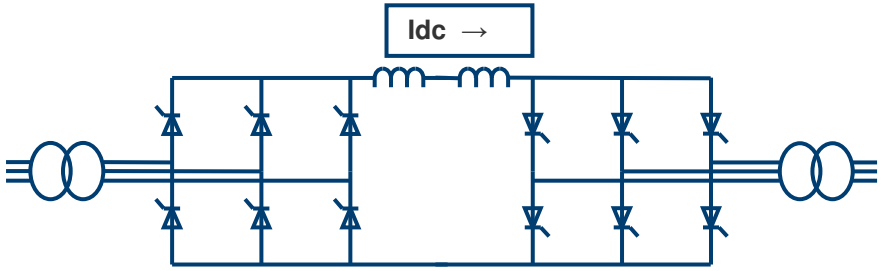
VSC vs LCC HVDC

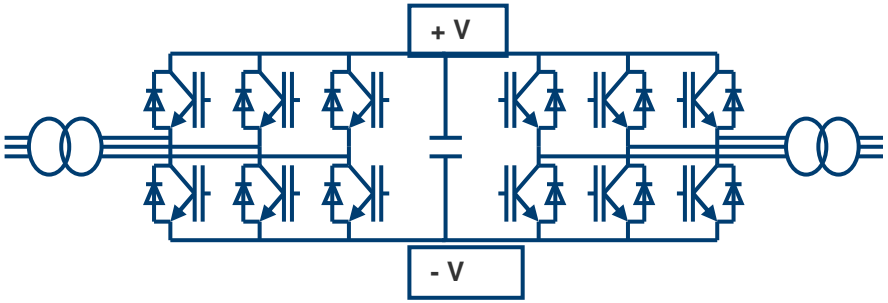
LCC HVDC

- Current-sourced
- Line-Commutated

VSC HVDC

- Voltage-Sourced
- Self-Commutated





GRID | ALSTOM

Voltage-Sourced versus Current-Sourced converters

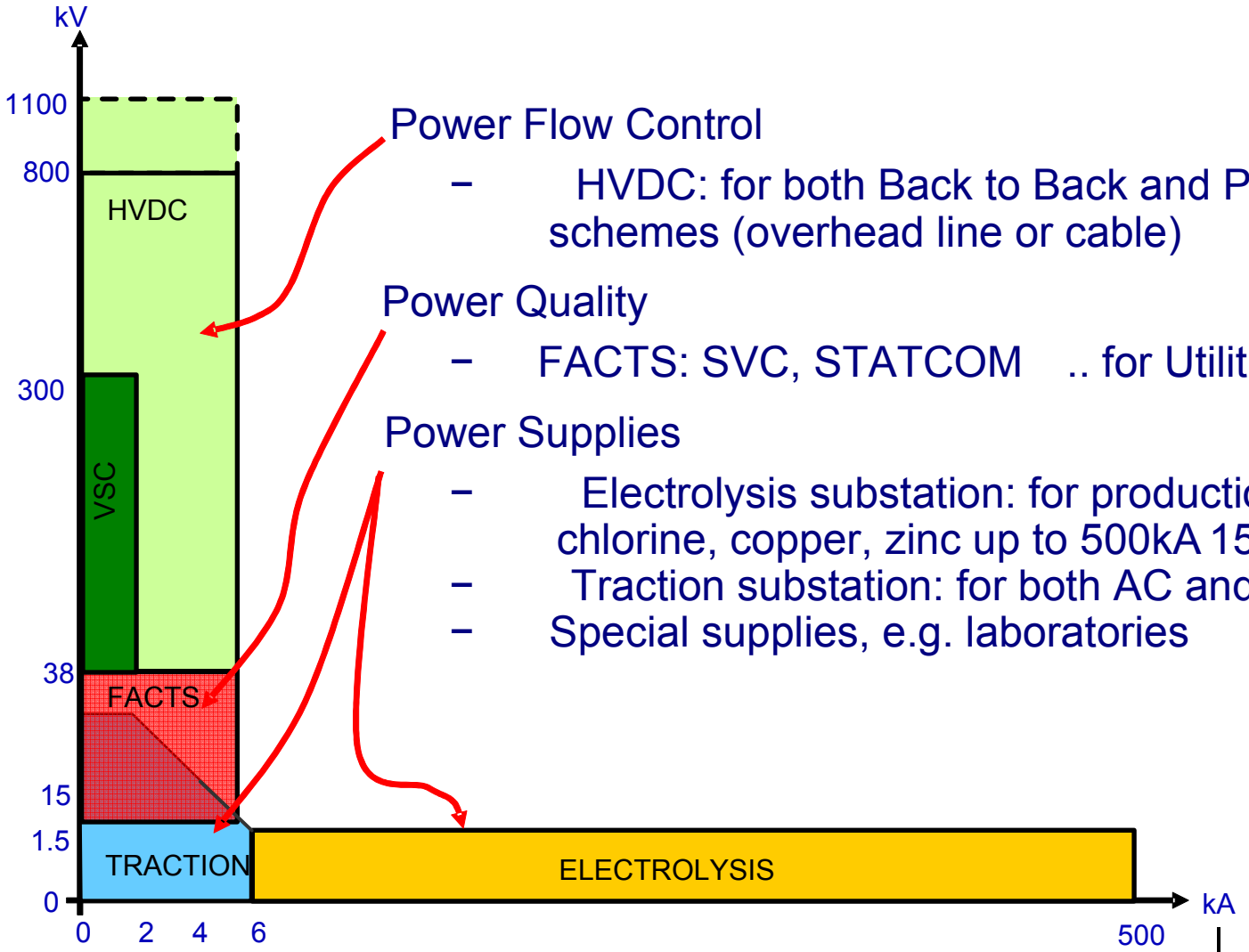
LCC HVDC

- 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

GRID | ALSTOM

LCC vs VSC Comparison

LCC HVDC	VSC HVDC
•High power capability,	•Lower power capability
- PE device current capability	- PE device current capability
•Good overload capability	•Weak overload capability
• Requires stronger AC systems	• Operates into weaker AC systems
• “Black” start capability, requires additional equipment	•“Black” start capability
• Generates harmonic distortion, AC & DC harmonic filters required	• Insignificant level of harmonic generation, hence no filters required
• Coarser reactive power control	• Finer reactive power control
• Large site area, dominated by harmonic filters	• Compact site area, 50 – 60% of LCC site area

GRID | ALSTOM

LCC vs VSC Comparison

LCC HVDC	VSC HVDC
• Requires converter transformers – continuous DC Voltage stress	• Use of conventional transformers – Symmetrical monopole
•Lower station losses	•Higher station losses
•Lower cost	•Higher cost by 10 – 15%
•Higher reliability	•Lower reliability, due to high component count
• More mature technology	•Less mature technology
•Power is reversed by changing polarity of the converters	•Power is reversed by changing direction of current flow
• Requires use of MI cables – Higher voltage capability	• Ideal for use with XLPE cables – Lower voltage capability

www.alstom.com