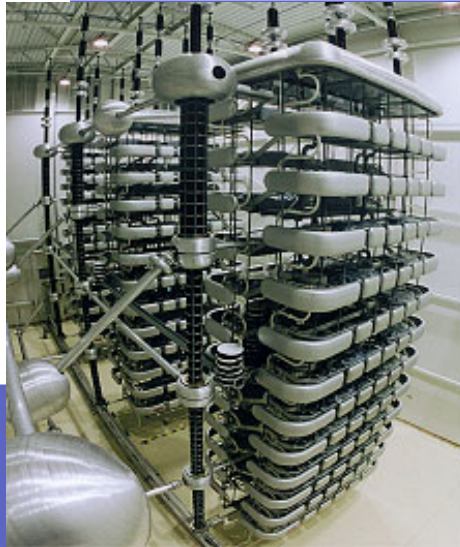


Gunnar Asplund
HVDC R&D Manager
Sweden



Latest HVDC Light
developments

IEEE Montreal
2006-06-21



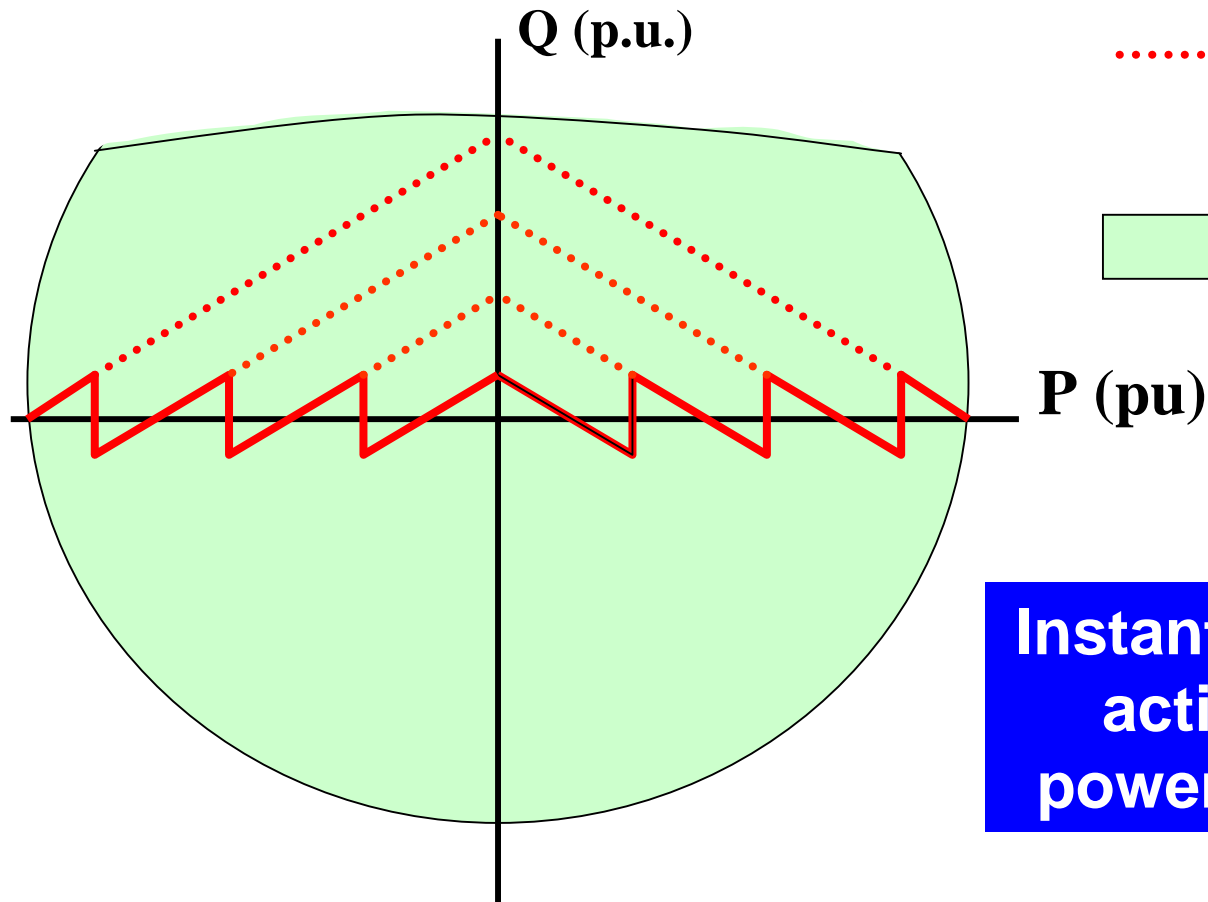
ABB

HVDC Light[®], continuous reactive power control

— HVDC static

..... HVDC dynamic



□ HVDC Light[®]



**Instantaneous control of
active and reactive
power over a wide area**



Comparison HVDC-Classic und HVDC-Light

	HVDC-Classic	HVDC-Light
Technology Convertor	<ul style="list-style-type: none"> ▪ Current Source Converter ▪ Thyristor valve, grid commutation 	<ul style="list-style-type: none"> ▪ Voltage Source Converter (VSC) ▪ Transistor valve (IGBT), self commutation
Between stations	<ul style="list-style-type: none"> ▪ Overhead line ▪ Oil impregnated cable (mainly sea cable) 	<ul style="list-style-type: none"> ▪ Extruded cable for both land and sea
Reactive support	<ul style="list-style-type: none"> ▪ By switched capacitor or filter banks 	<ul style="list-style-type: none"> ▪ By the converter independent of the active power
AC network requirement	<ul style="list-style-type: none"> ▪ Short circuit ratio > 2 	<ul style="list-style-type: none"> ▪ No requirement. Can start black network.
Telecommunication	<ul style="list-style-type: none"> ▪ Needed for start and operation 	<ul style="list-style-type: none"> ▪ Not needed.
Power reversal	<ul style="list-style-type: none"> ▪ Polarity has to be changed 	<ul style="list-style-type: none"> ▪ No polarity change
Multiterminal operation	<ul style="list-style-type: none"> ▪ Complex 	<ul style="list-style-type: none"> ▪ Simple
Dimensions	<ul style="list-style-type: none"> ▪ Valve hall and outdoor ac- yard 	<ul style="list-style-type: none"> ▪ Compact valve arrangement. Low profile and indoor ac and dc- yard 
Applications	<ul style="list-style-type: none"> ▪ Bulk power transfer, back to back, interconnection of asynchronous networks 	<ul style="list-style-type: none"> ▪ Wind farms at sea, oil platforms, reinforcement of ac- systems, back to back between weak systems



The cable is the key for HVDC Light®



Cables from ABB

- 1350 km installed HVDC Light® cables since 1998
- 745 km installed XLPE cables above 220 kV since 1978 out of totally about 4000 km installed world-wide

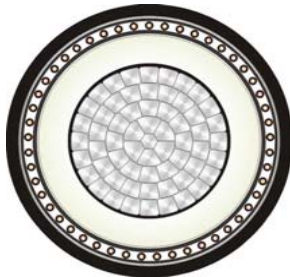


HVDC Light® Cable Development

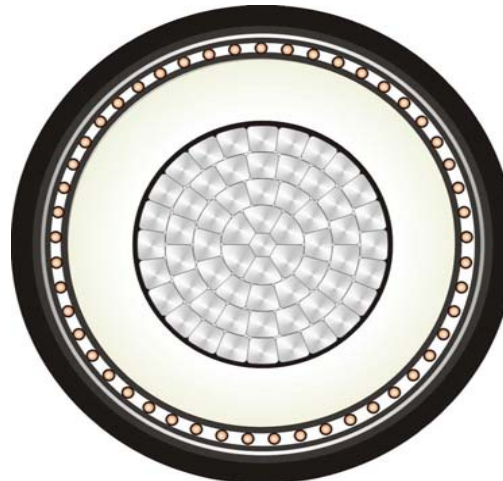
1997
Hellsjön
Prototype cable
95 mm² Al conductor
+/- 10 kV, **3 MW**



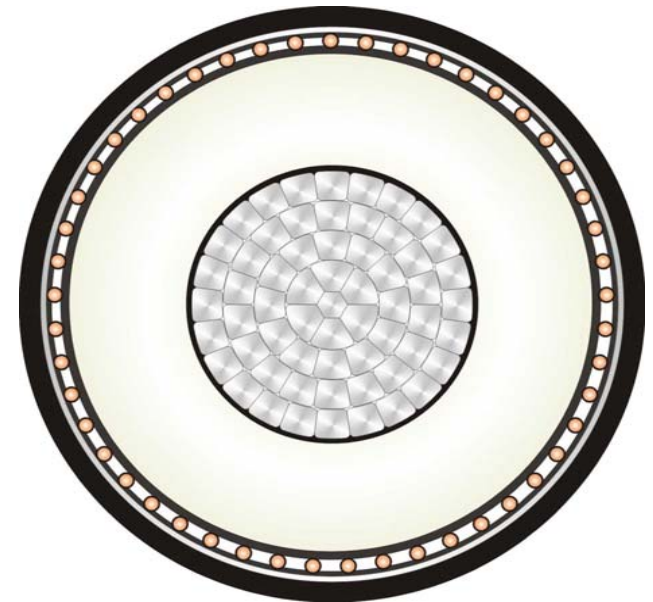
2000
Directlink, 390 km
630 mm² Al conductor
+/- 80 kV, **60 MW**



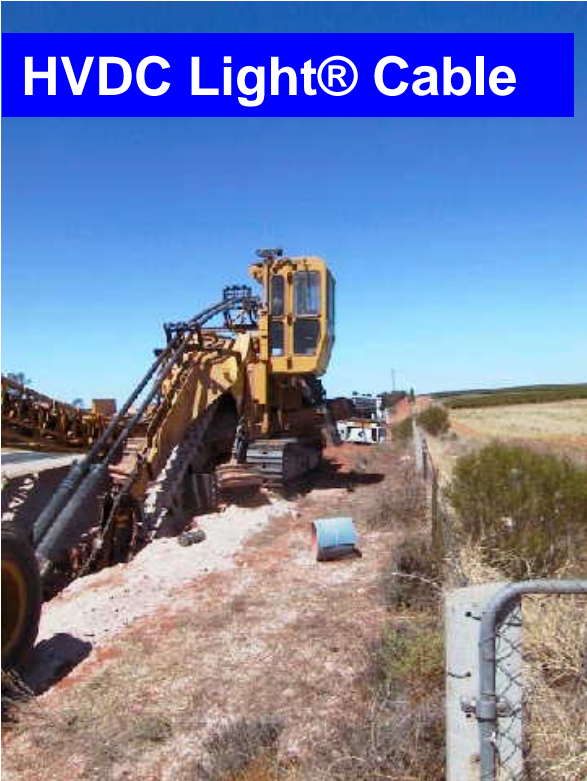
2001
Murraylink, 360 km
1400 mm² Al conductor
+/- 150 kV, **220 MW**



2006
Southern Link
1600 mm² Al conductor
+/- 300 kV, **700 MW**

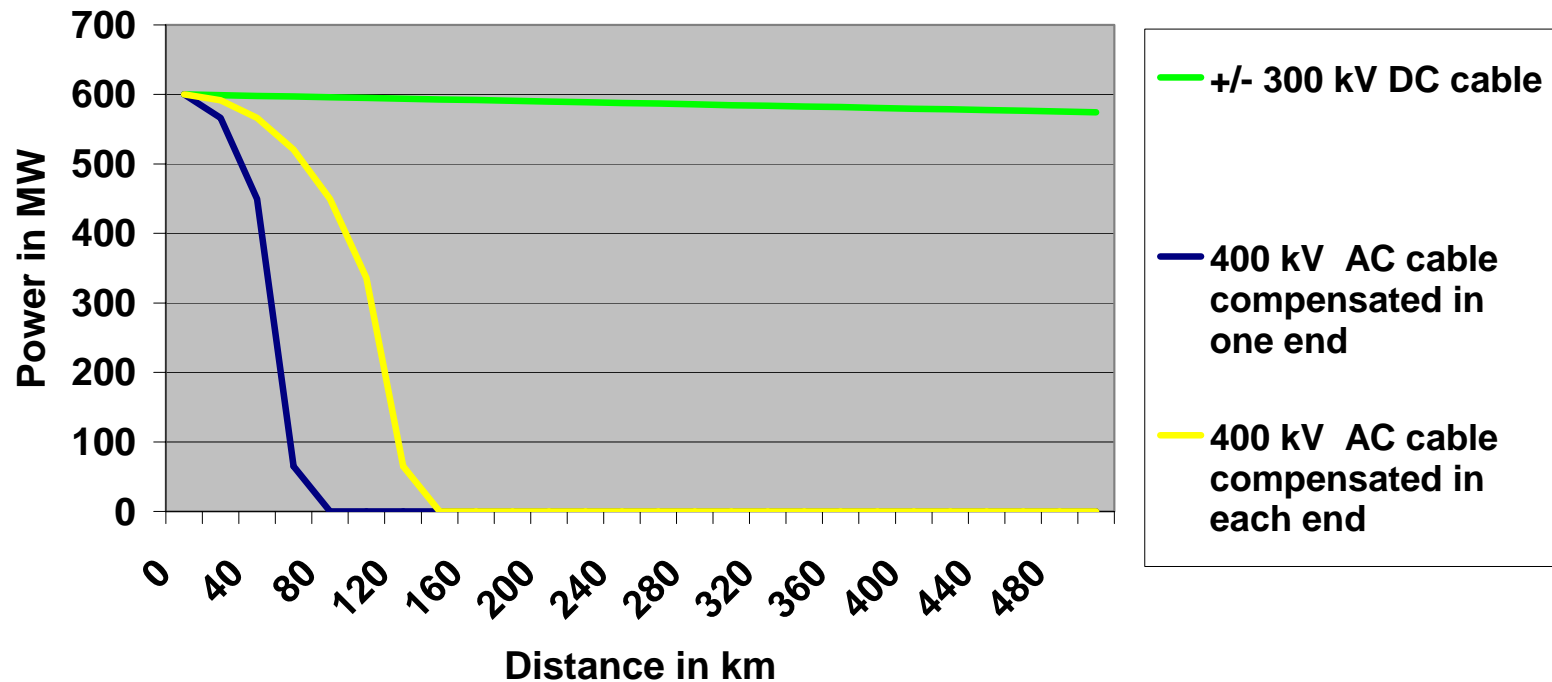


Cable laying



HVDC Light® , transfer capability

Power capability of ac and dc cables



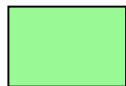
**HVDC Light® has no limitation
in distance**



HVDC Light[®], Matrix



DC Voltage	500 A	1000 A	1500 A
+/- 80 kV	M1- 95 MVA	M2- 190 MVA	M3- 285 MVA
+/-150 kV	M4- 178 MVA	M5- 356 MVA	M6- 535 MVA
+/- 300 kV	M7- 356 MVA	M8- 713 MVA	M9- 1070 MVA



Available

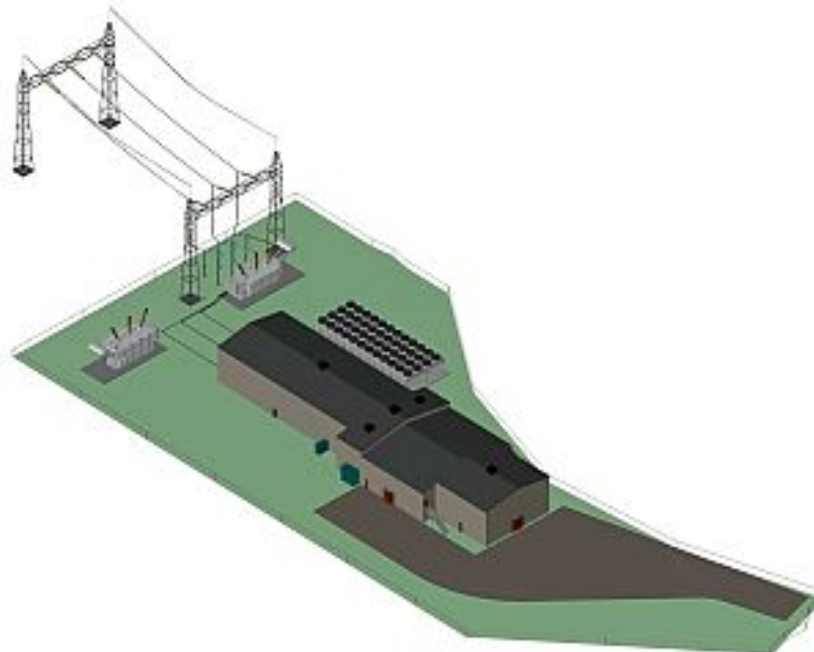
2006



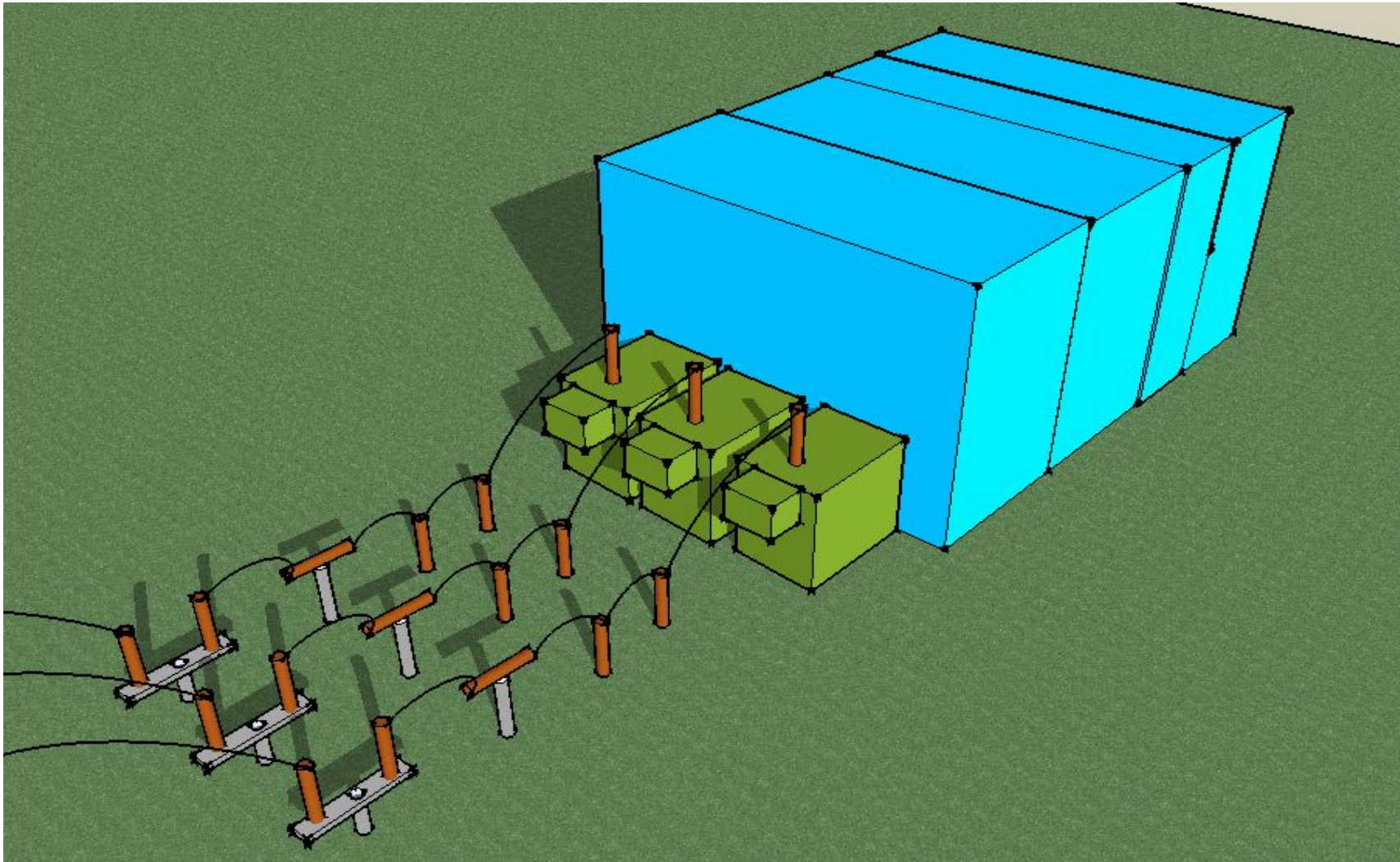
Estlink 350 MW, +/- 150 kV, 75 km sea cable, 25 km land cable



Esopo june 14



HVDC Light layout for 300 kV



The southern link HVDC Light +/- 300 kV 700 MW



AC line emulation

N-1 criteria

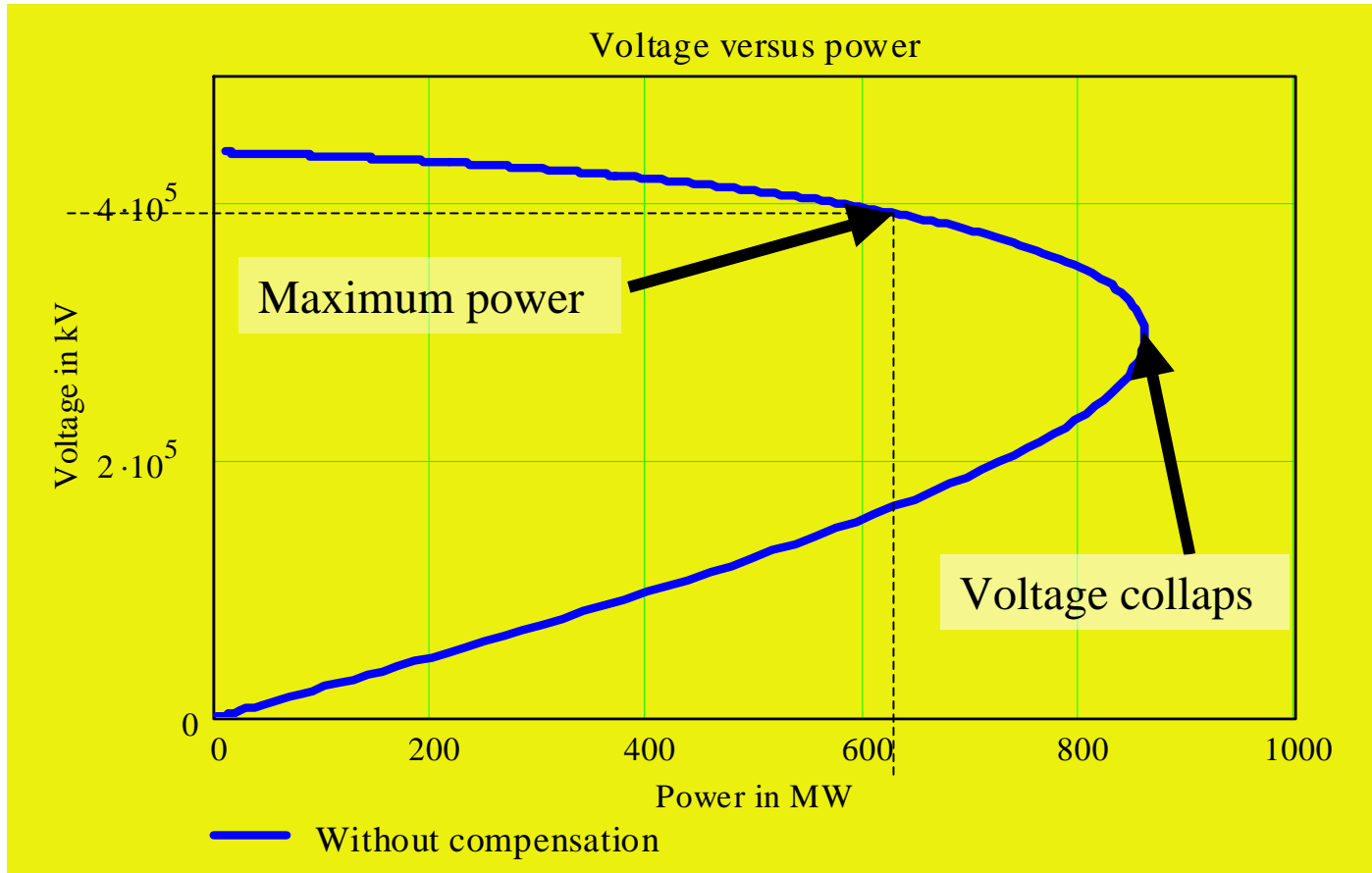
The ac- system should not be loaded more than it can safely withstand the loss of any line or generator

Comment:

This means that an HVDC Light transmission inside an ac network should have the same capability as an ac line

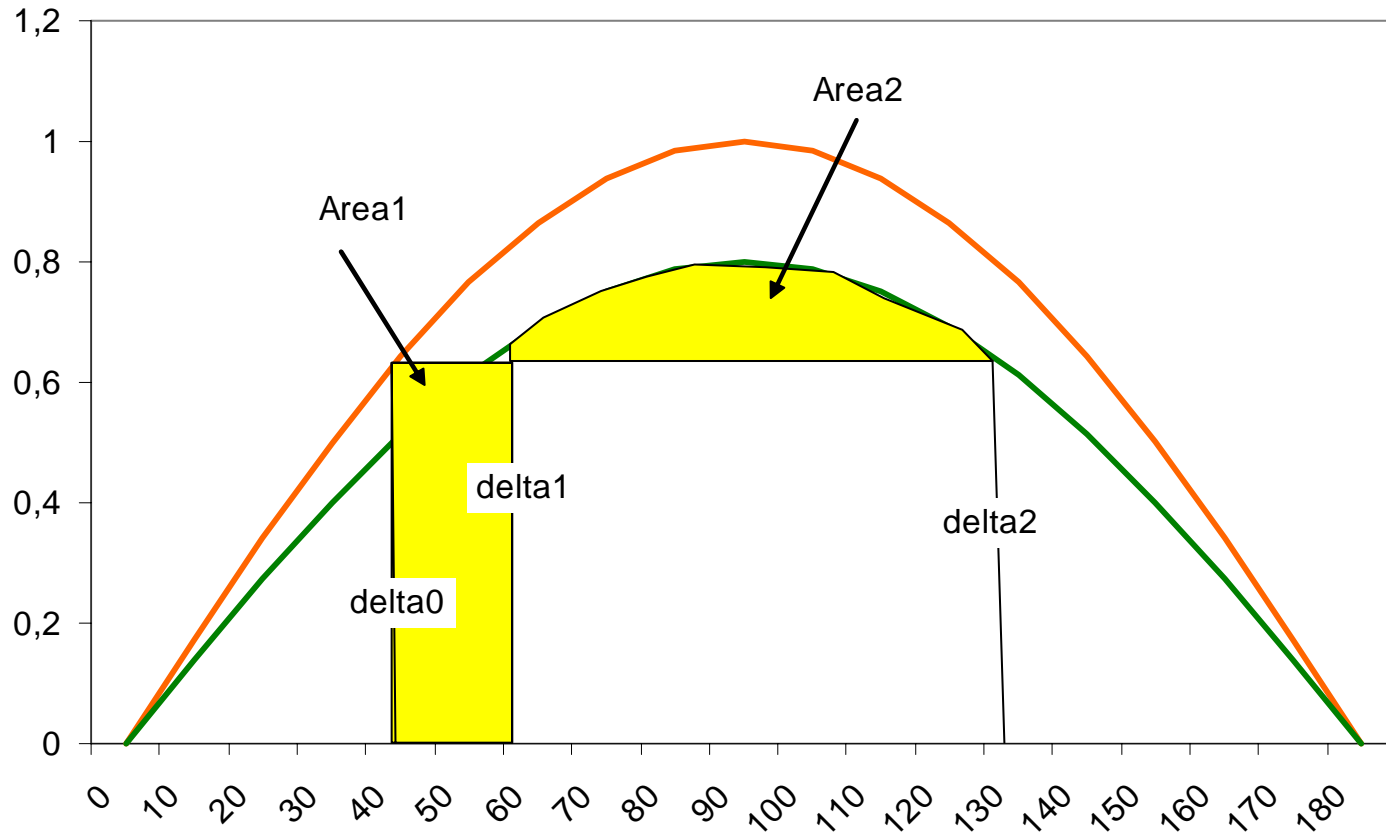


Voltage stability of one remaining ac- line

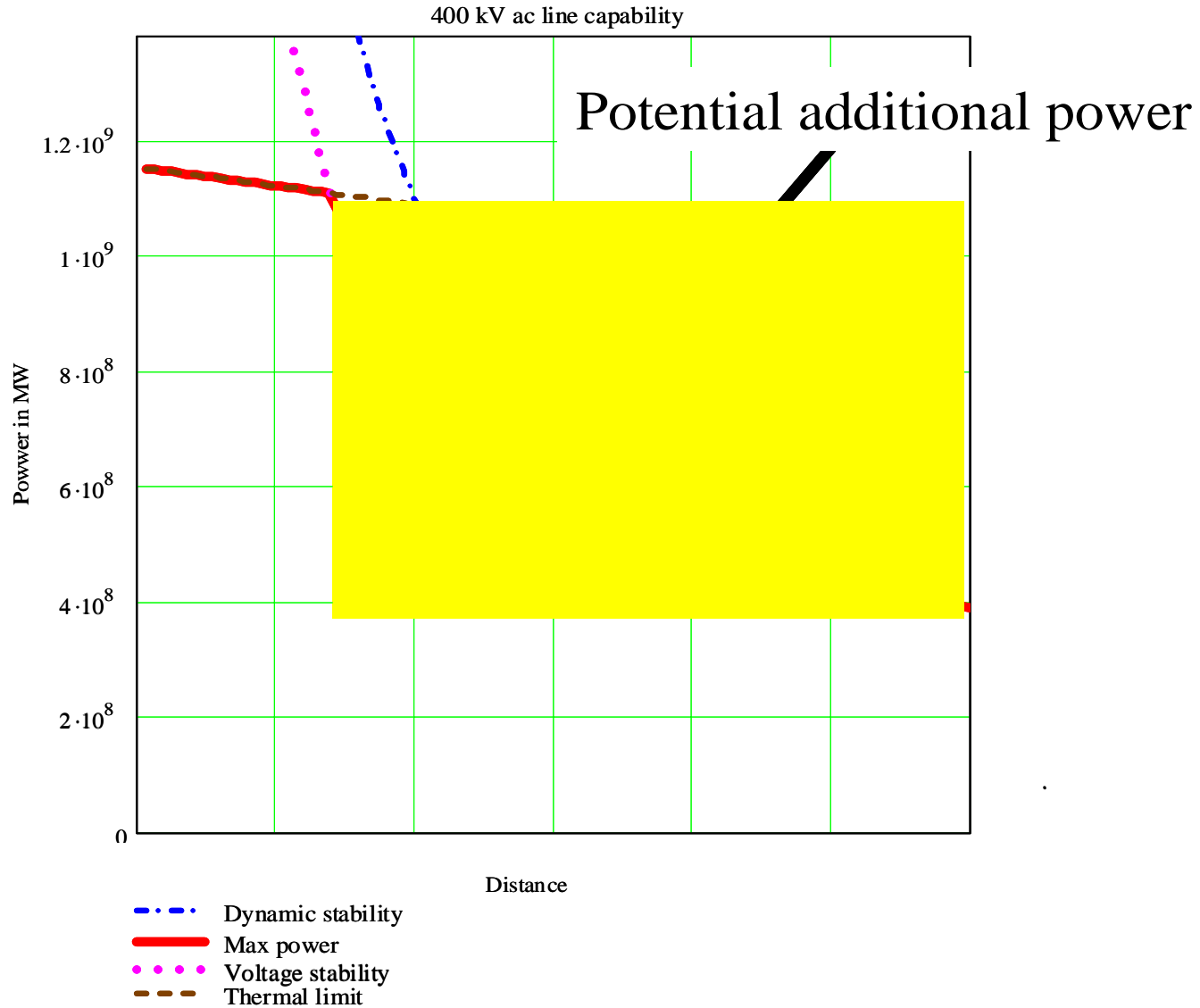


Dynamic stability

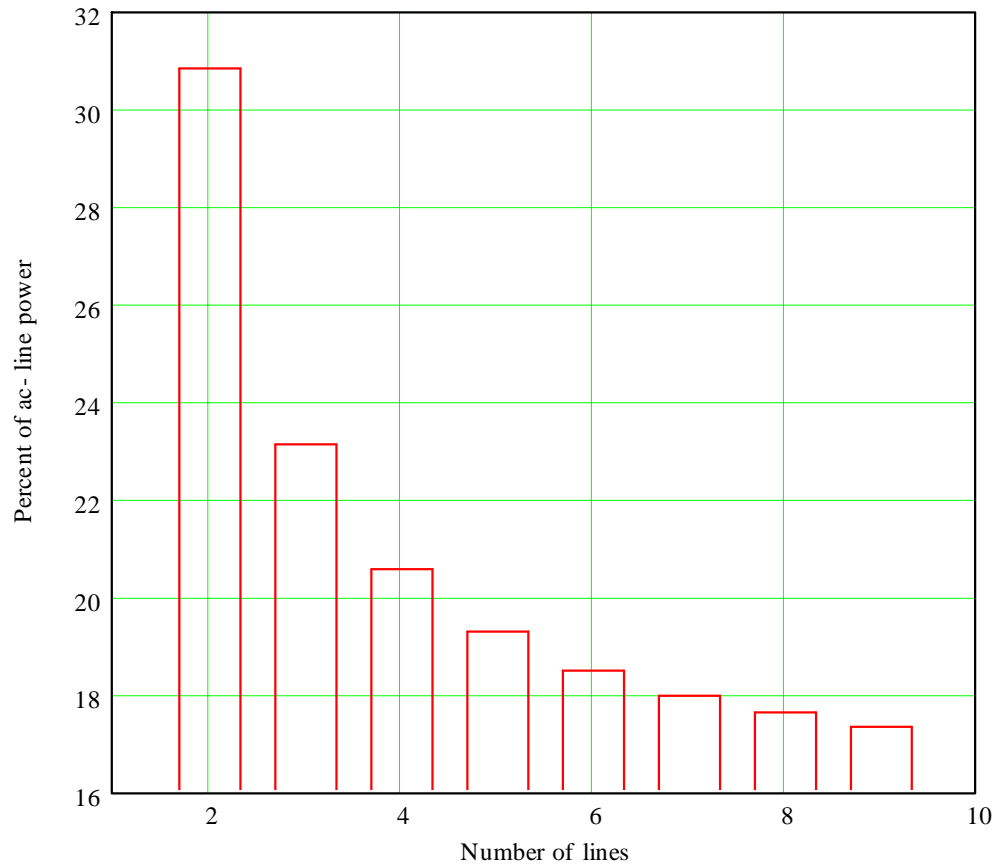
Equal area



AC line



Damping power needed in the HVDC Light

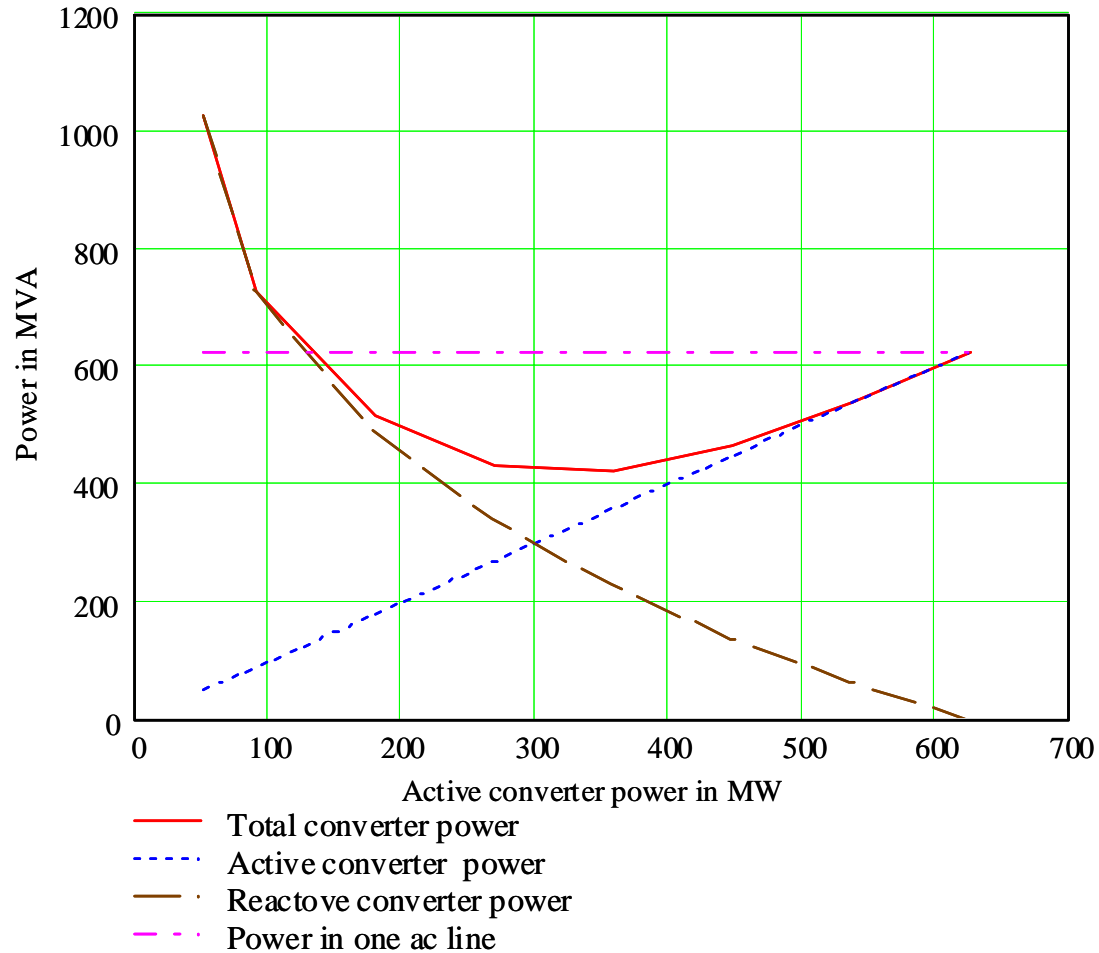


Inertia 4 s

Protection time 100 ms



HVDC Light compared to an ac- line



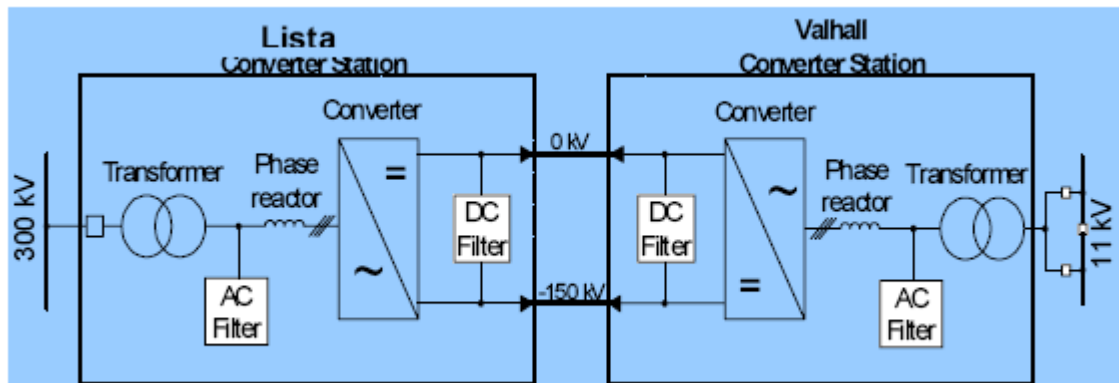
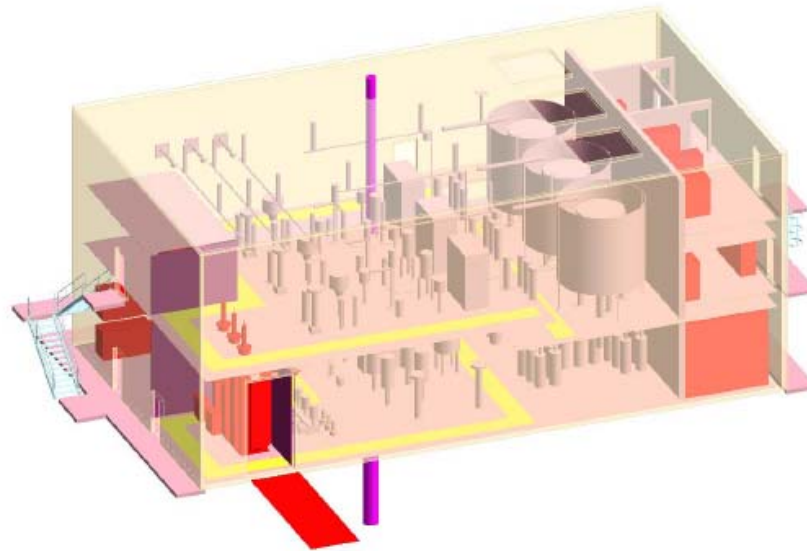
Off shore

Valhall 78 MW, 292 km cable

The existing Valhall complex.



HVDC module

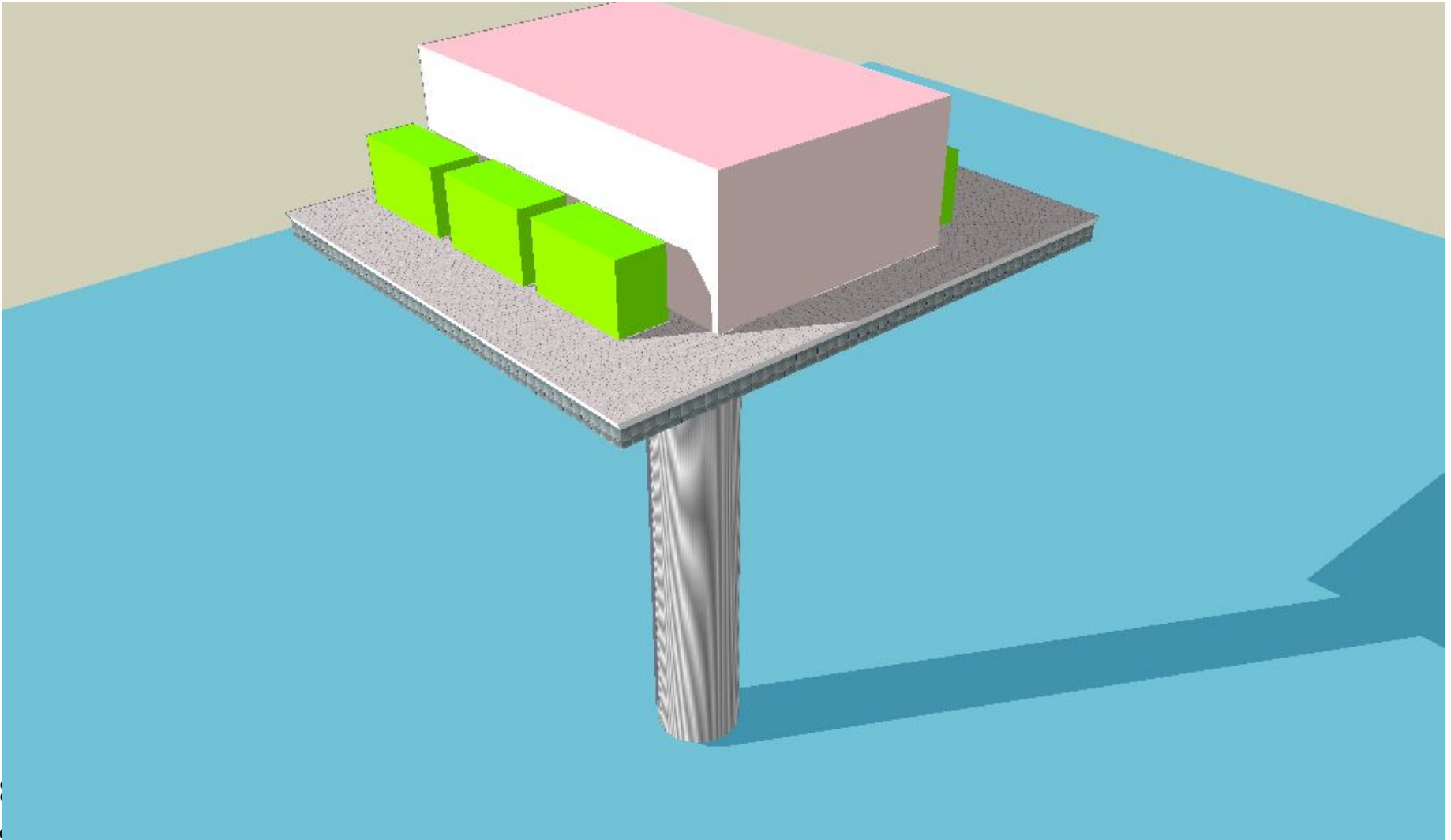


Troll A, converters on the platform

The converters are housed in a pre-fabricated module, shipped and lifted onto the platform.

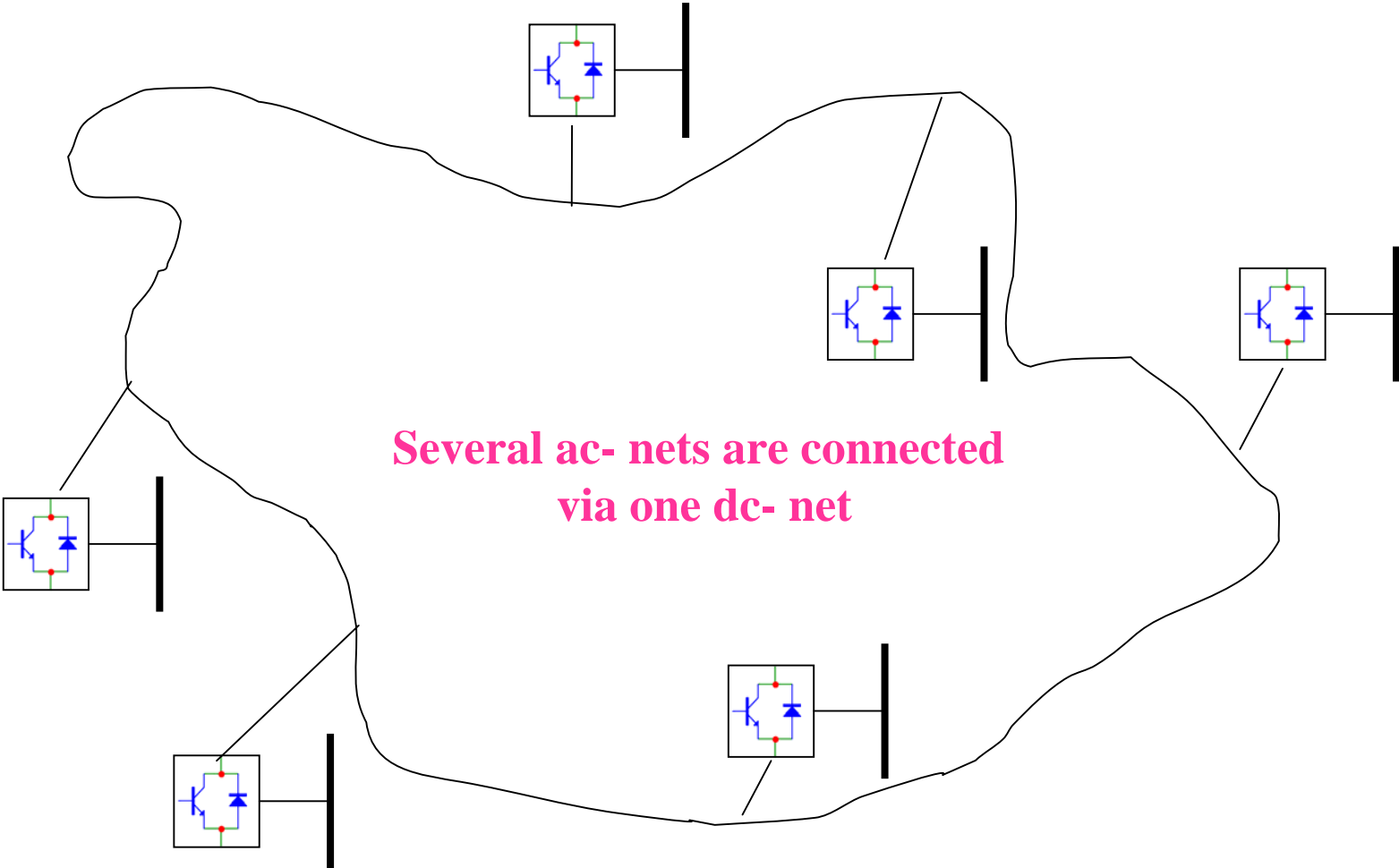


HVDC Light for wind



10 Multiterminal

HVDC Light- multi terminal



Several ac- nets are connected
via one dc- net



