



Session 2a
Tang

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Enhanced Power
Reliability and Efficiency
in new HVDC and FACTS
development



History and current HVDC & FACTS Technology

World's first HVDC transmission, Gotland Sweden



Rating:

100 kV

20 MW

Cable type:

Mass-impregnated 1 x 90 mm² Cu

Length:

100 km

Year:

1954

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2007

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HVDC & SVC development

Mercury Arc



1954

Thyristor
Gen 1



1970

Thyristor
Gen 2



1980

Transistor
(IGBT)



2000

Year

HVDC Technologies



600 MW, 200x120x22 meters



350 MW, 120x50x11 meters

HVDC Classic, Thyristor Technology

- Switched Reactive Power Control
- Typical design: valve building plus switchyard
- Overhead lines for long distance bulk power
- Mass impregnated cables for sea
- Back to Back

HVDC Light[®], Voltage Source Technology

- Transistor (IGBT) controlled
- Continuous Reactive Power Control
- Dynamic voltage regulation
- Black start capability
- Typical design: all equipment (excluding transformers) in compact building
- Extruded cables suitable for undergrounding and sea

FACTS Technologies



Static Var Compensation (SVC)

- Thyristor controlled
- Reactive Power Compensation
- Increase of transmission line capacity
- Steady state voltage regulation
- Transient voltage support
- Power oscillation damping





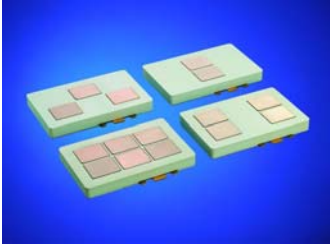



SVC Light (Statcom)

- Transistor (IGBT) controlled
- Flicker compensation
- Very fast response for load compensation

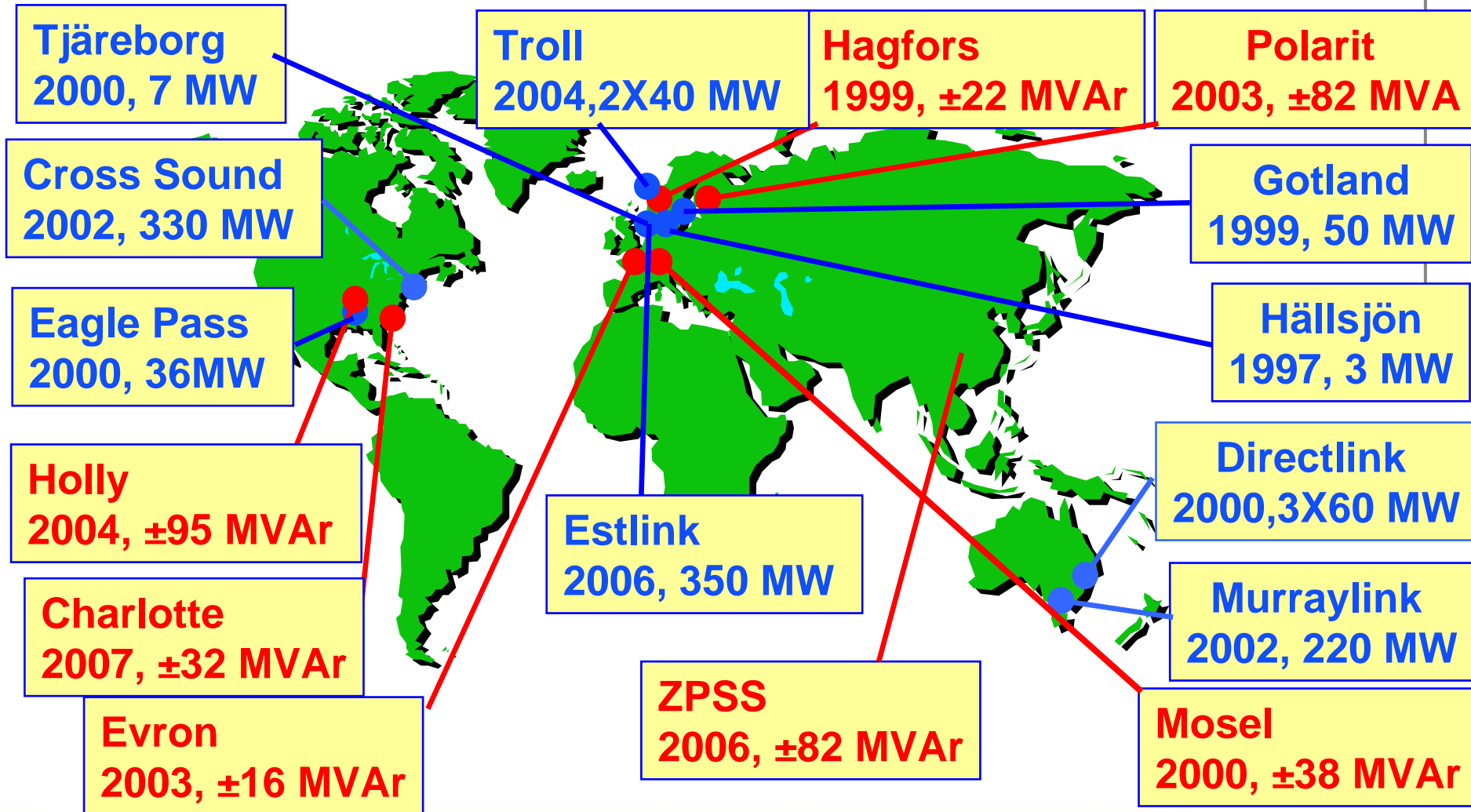
Series Compensation (SC)

- Increased transmission capacity
- Increased stability

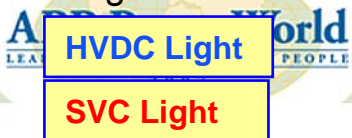
HVDC and SVC, major building blocks

Classic	Light (Statcom)	
		<p>Cable</p> 
		<p>Semiconductor</p>  <p>asile</p>
		<p>Control System</p> 

Projects based on HVDC/SVC Light® Technology



Legend:



Next steps for Light Technology

Next step Light Concept



HVDC

DC Voltage	500 A	1000 A	1500 A
+/- 80 kV	98 MW	194 MW	296 MW
+/-150 kV	185 MW	363 MW	555 MW
+/- 320 kV	350 MW	700 MW	1100 MW



Delivered technology

SVC

Voltage	500 A	1000 A	1500 A
36 kV			+/- 100 MVar





Power electronics

improve grid integration of

- Renewable generation
- Energy storage



Example

- GVEA, Alaska, backup for transmission system loss, win time to start up local generation
- Battery energy storage system (with Saft NiCd batteries) to deliver 27 MW for 15 minutes (up to 46 MW)
- Avoids running backup generation units in costly idle mode

ABB Core Technology Areas

2/2



Insulation, limiting



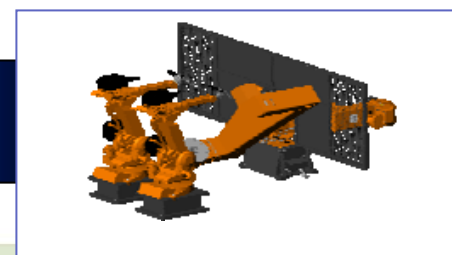
Switching, breaking



Power electronics

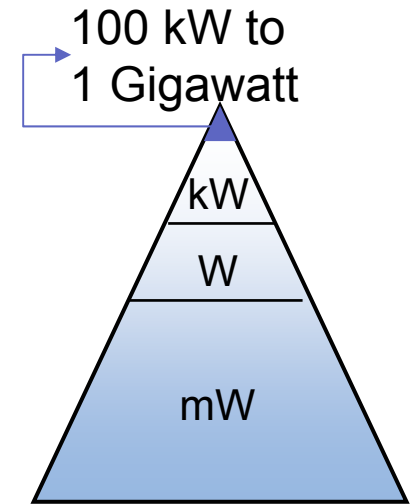


Mechatronics



Core component: semiconductors

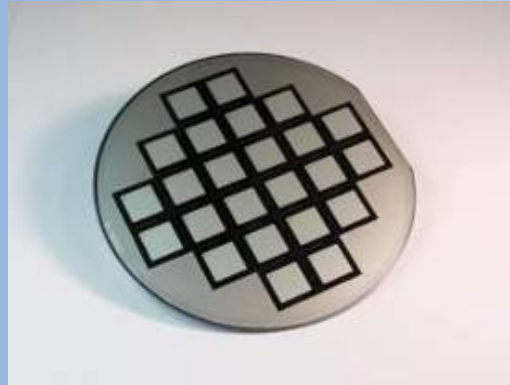
- ABB power semiconductor factory in Lenzburg, Switzerland
- Class 10 Cleanroom (*500 times cleaner than a surgery room*)
- Ensures highest reliability of system operations



Production:



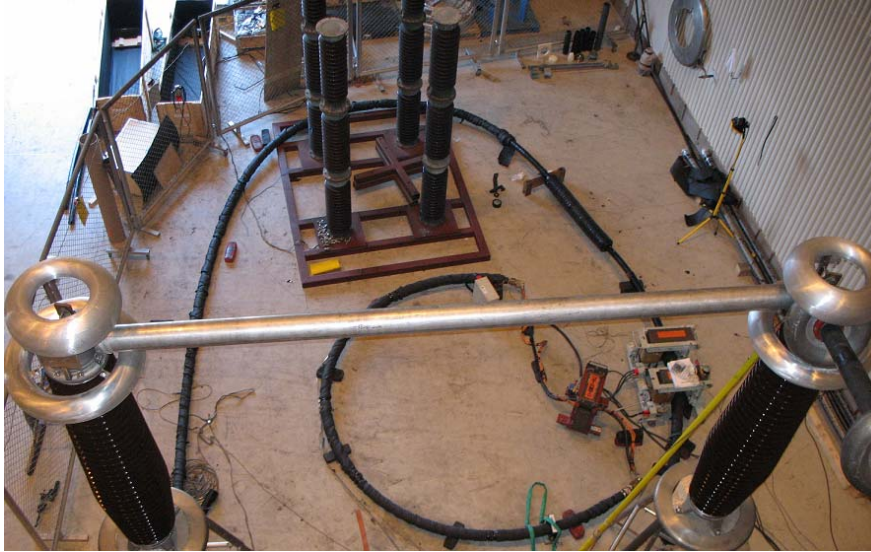
Product:



Troll application:

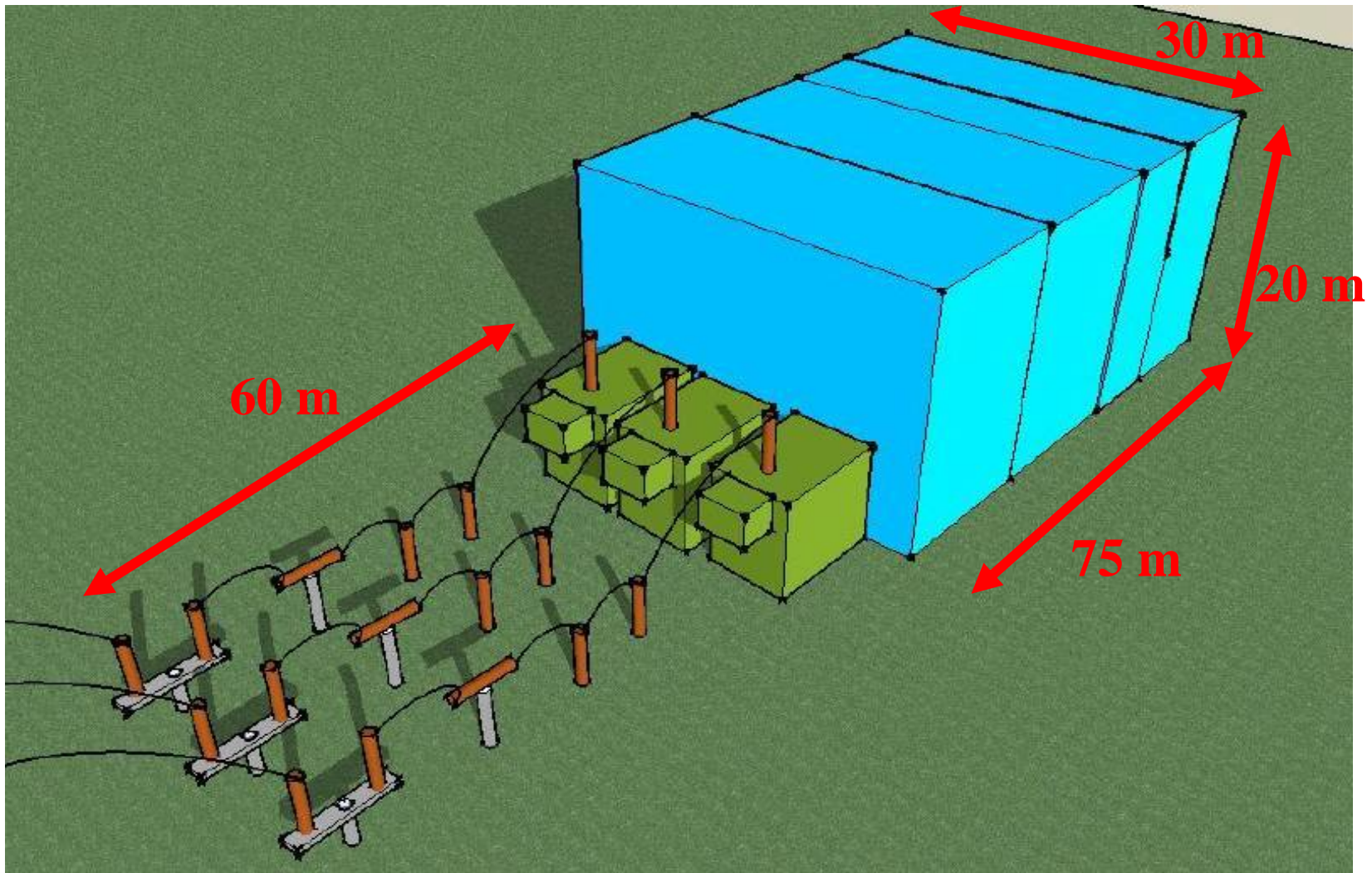


Cable system development



- Voltage: 150 → 320 [kV DC]
- Full type test, 30 days at 600 kV
- Completed Q4 2006

Layout for 320 kV, 350-1100 MW, Converter station



Reliability and efficiency for Light Technology

Proven offshore technology Troll A and Valhall



Customer's need

- Provide power to new compressors and at the same time minimize emission of CO₂ and the overall cost

ABB's response

- Turnkey 2x40 MW \pm 60 kV HVDC Light[®] offshore transmission system with high voltage Motorformer

Customer's benefits

- Compact and low weight design reduces investments on platform
- Reliable power supply

Offshore power supply, performance driver

■ Increased reliability

■ Forced Outage Rate 5/year → 2/year → 1/year

■ Increased availability

■ Maintenance intervals 1/year → 1/2years → 1/5years

■ Reduced start-up time

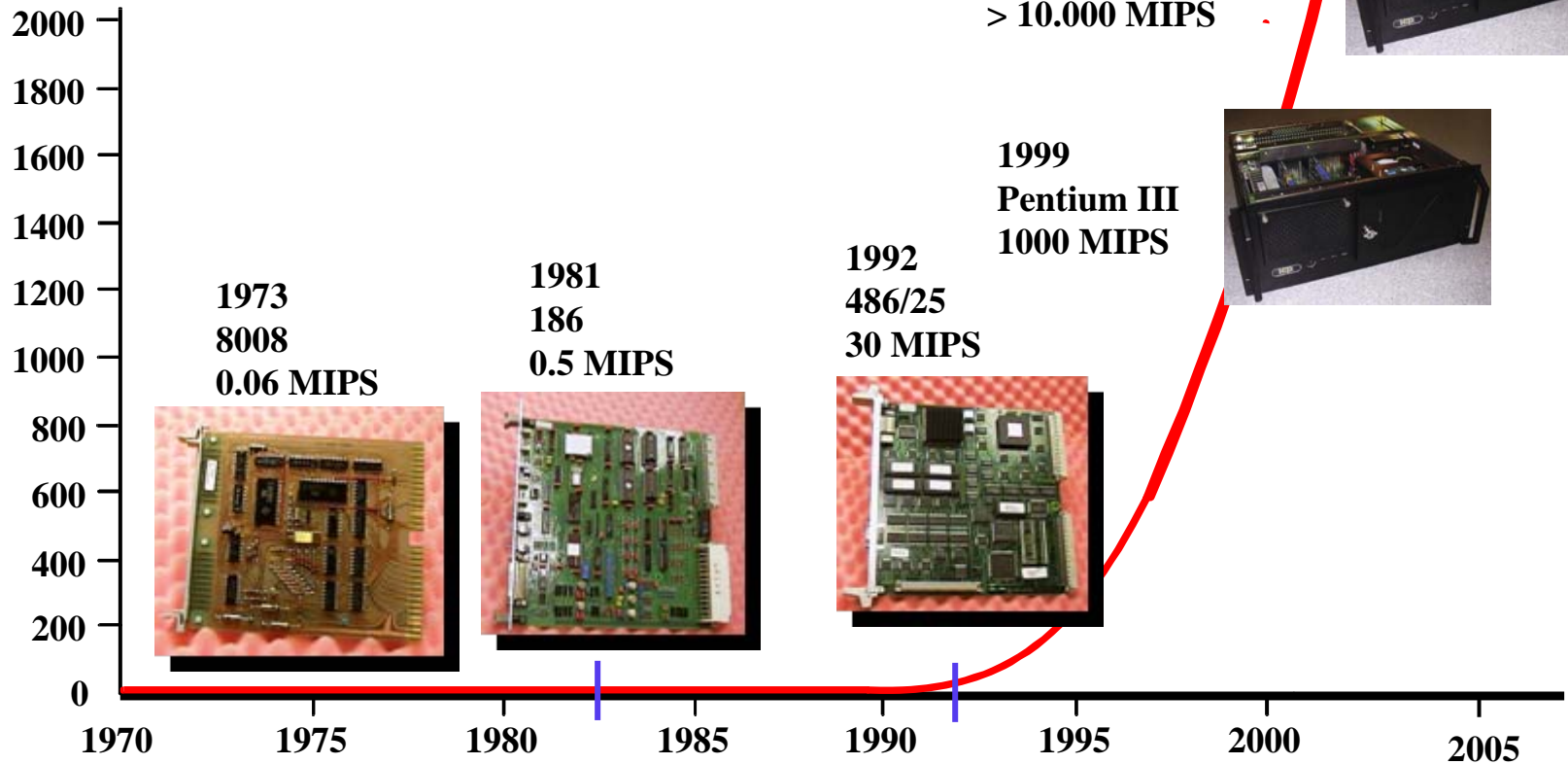
■ Commissioning time month → weeks → days

Summary for Light reliability

- Achievements so far in existing plants
 - Calculated number of outages / year have been reduced from 5 to ~ 2
 - Calculated availability has been increased from 96% to 98.5%
 - Further improvements are expected and have also been observed in existing plants
- “Best in class” existing plants
 - In Troll we have to date 4 converter years with zero outages and 100% availability. This is particularly extraordinary since this is achieved in the first year of operation.
 - In Cross Sound Cable we have 1 outage the last 12 calendar month (2 converter years) after completed implementation of improvement package.

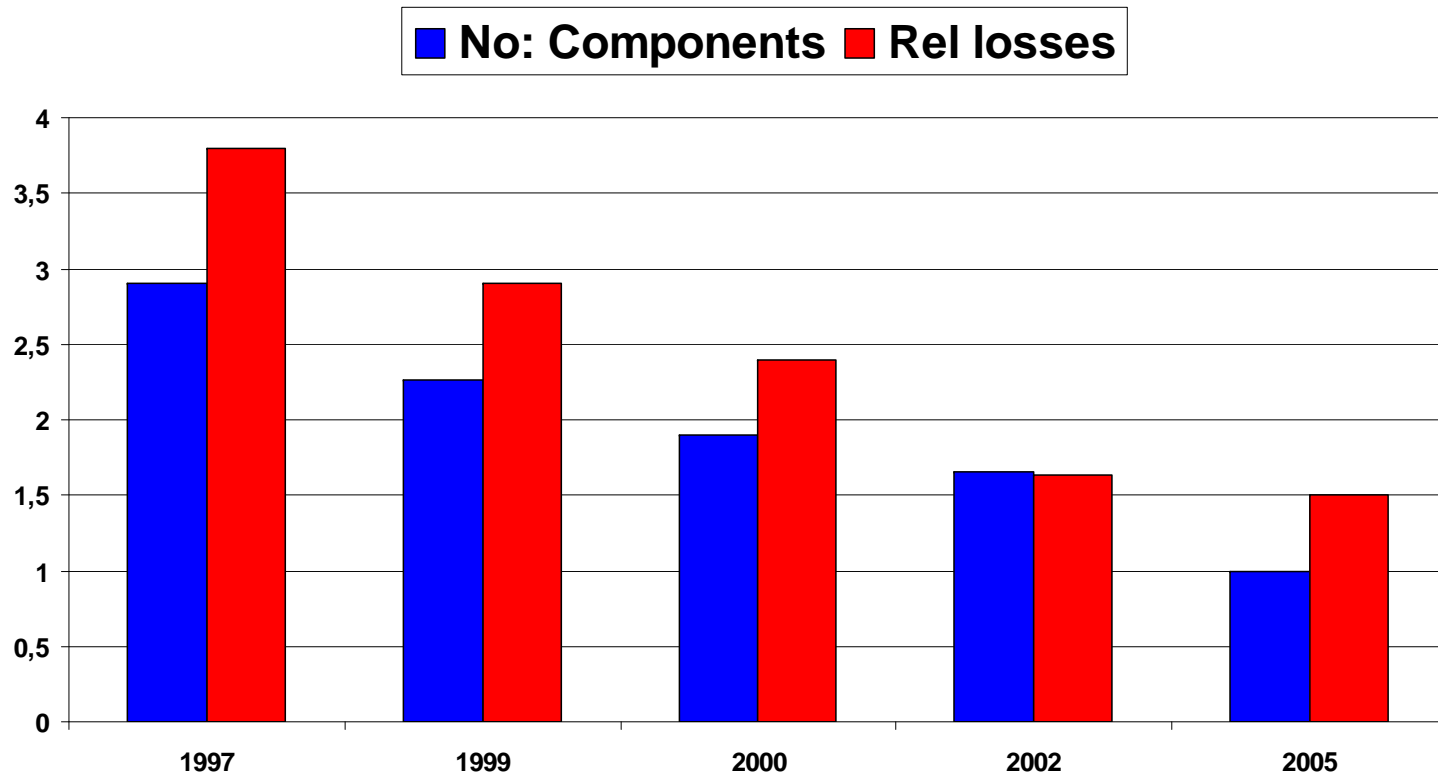
Development computerized C&P

MIPS
(Million Instructions Per Second)



IGBT/Control development HVDC Light®

- Number of components reduced 65% since 1997
- IGBT Voltage constant 2.5 kV
- Losses reduced 60% since 1997



Long distance Bulk Power Transmission

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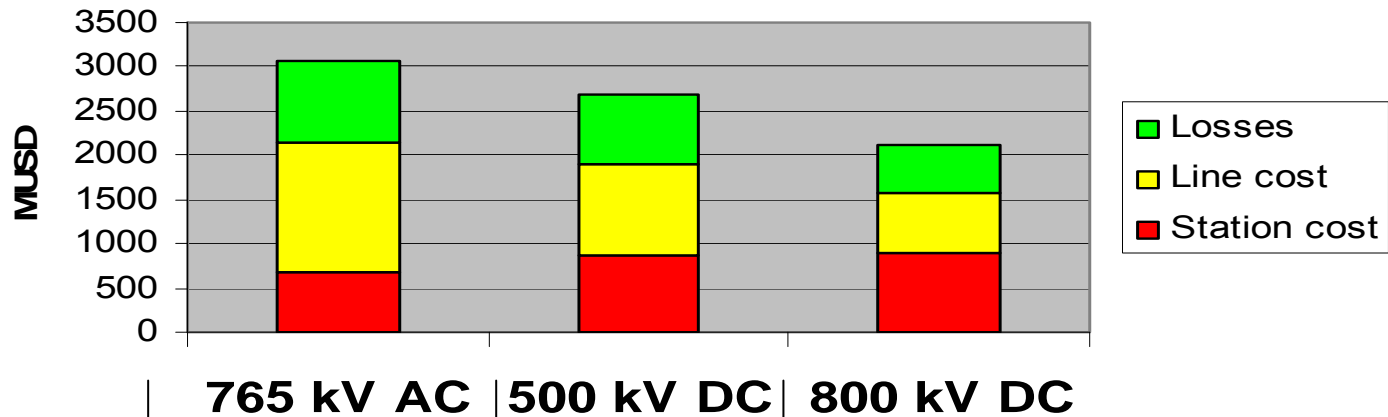
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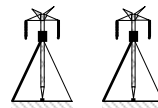
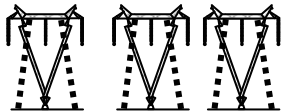
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800 kV DC for long distance bulk power transmission

Transmission of 6000 MW over 2000 km. Total evaluated costs in MUSD



Number of lines:



Right of way (meter)

~300

~ 120

~ 90

800 kV DC for long distance bulk power transmission



- 800 kV Classic DC with OHL
- Transmission capability: 6400 – 9000 MW

Summery

- HVDC&FACTS made for efficiency and reliability
 - Efficient transmission
 - Stabilizing networks
 - Lower losses

- HVDC&FACTS new development adds to efficiency and reliability
 - Light Technology; a standardized way with high reliability
 - 800 kV DC; A new rating for higher efficiency

AABB