

**Techno-economic
feasibility of HVDC
systems up to 800 kV**

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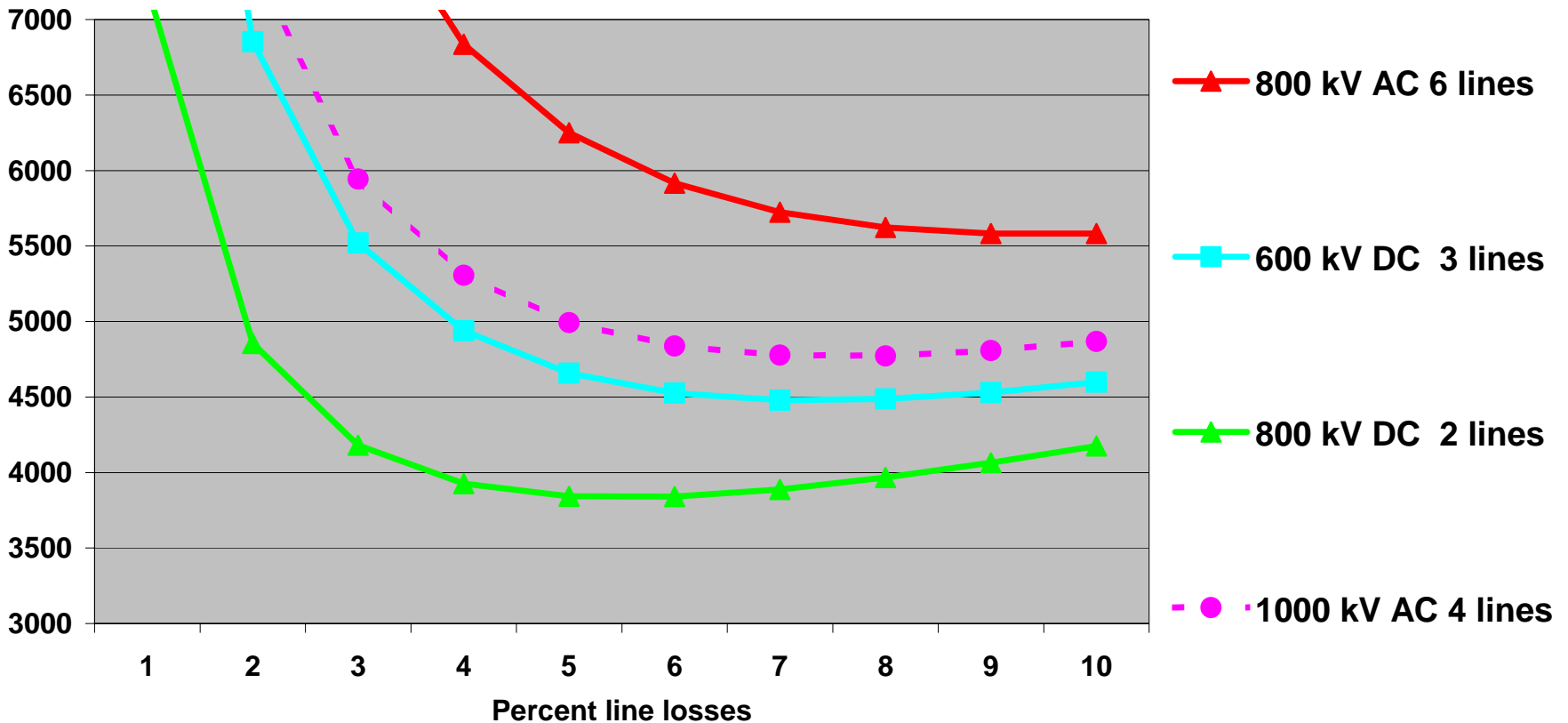


**Workshop
Delhi
2005-02-25**



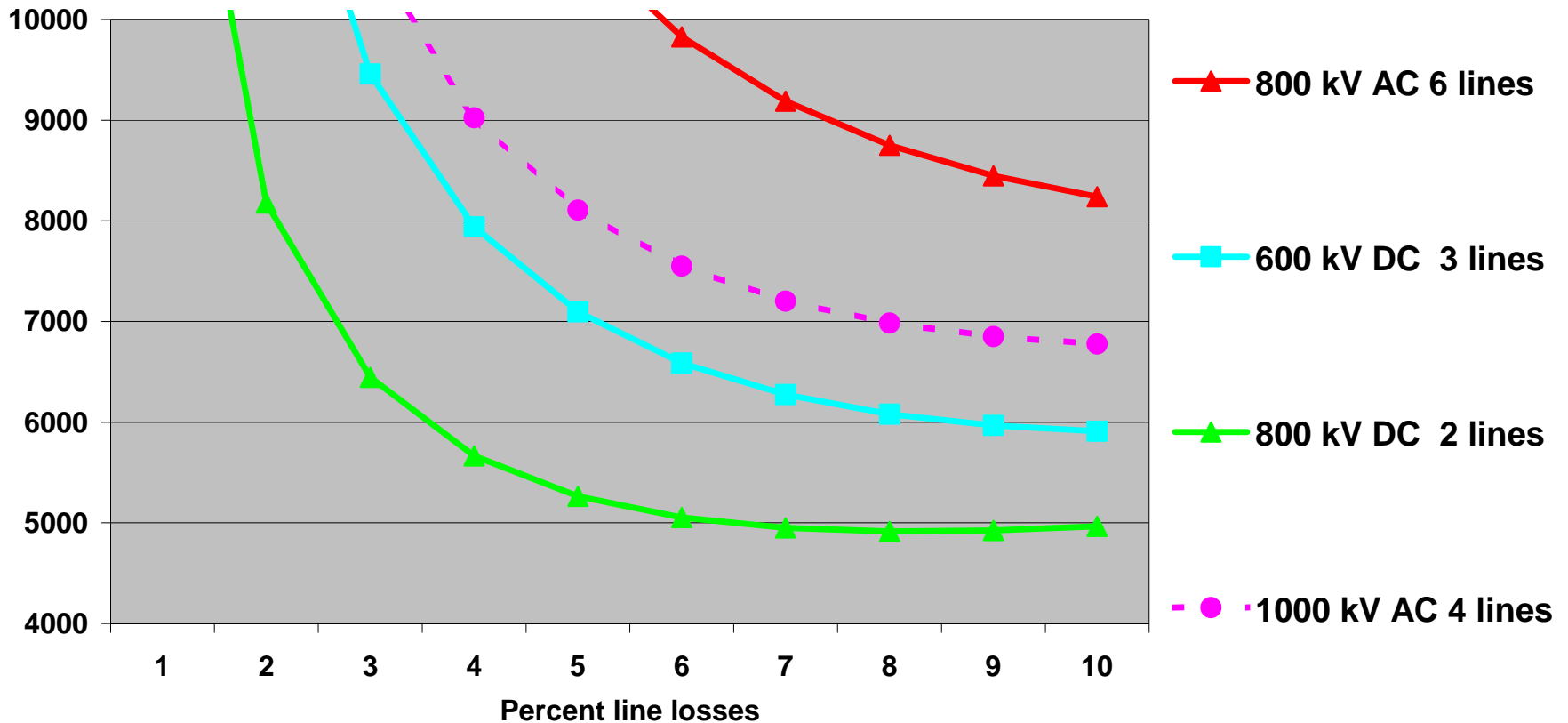
Transmission alternatives

Estimated cost of lines, stations and losses to transmit
12 GW a distance of 2000 km



Transmission alternatives

Estimated cost of lines, stations and losses to transmit
12 GW a distance of 3000 km

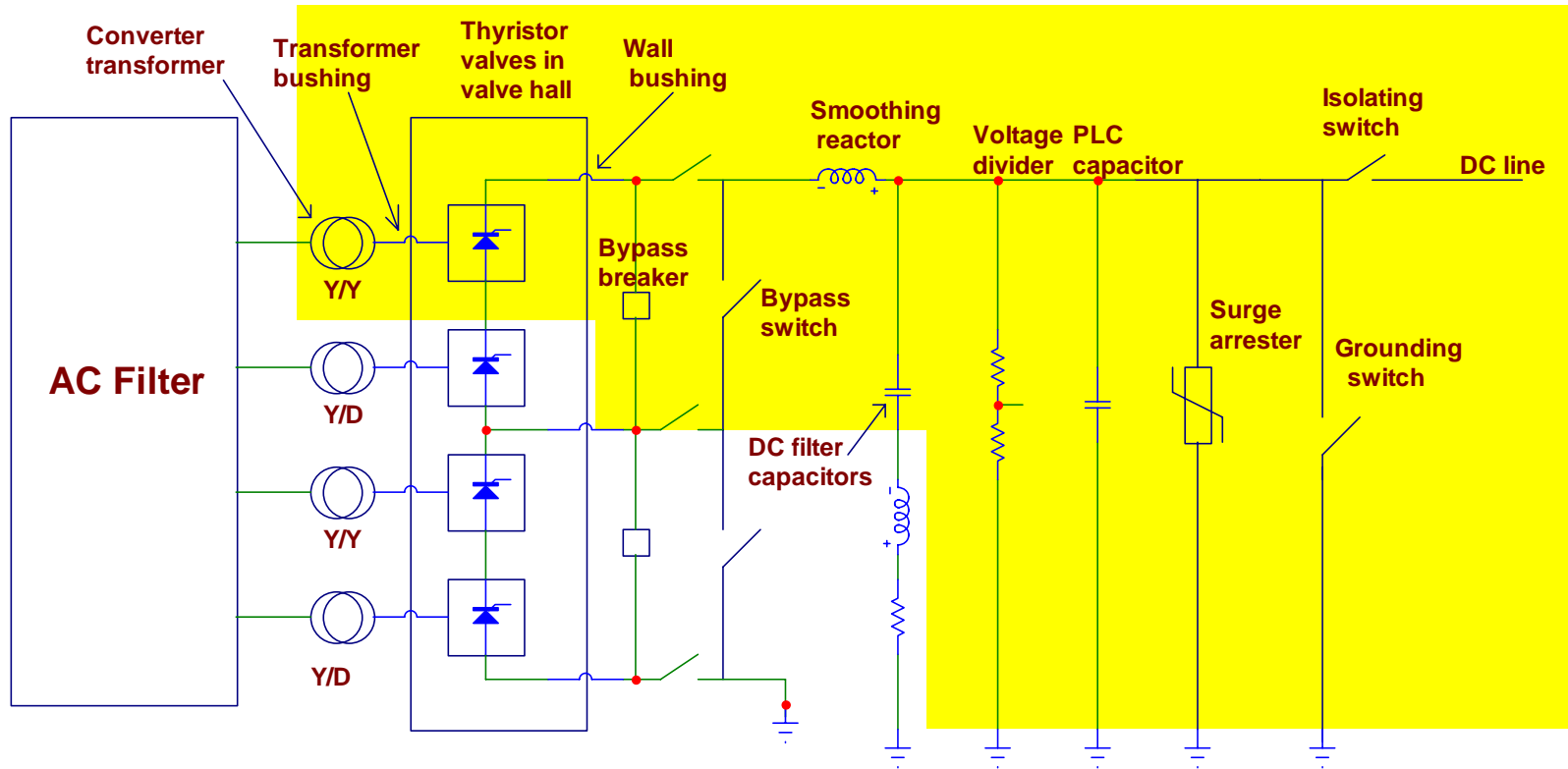


UHVDC- challenges

- **800 kV DC**
 - Station equipment
 - DC Line insulation

- **6000 MW**
 - Current (4000 A) through dc equipment and line
 - AC system at loss of transmission capability

UHVDC- one pole



Exposed to 800 kV dc

Converter station equipment- need for R&D

- **Converter transformers incl. Bushings**
- **Wall bushing**
- Thyristors
- Converter valves
- By- pass breaker
- By- pass switch
- Arresters
- DC Capacitors
- PLC Capacitors
- Control system
- DC Disconnectors
- Voltage measuring devices
- Smoothing reactor
- Valve cooling
- AC Breakers
- AC Disconnectors
- AC measuring devices
- AC filter components
- DC filter reactors
- PLC filter reactors
- DC filter resistors
- Steel structures
- Building
- Fire system
- Electrode

No R&D foreseen

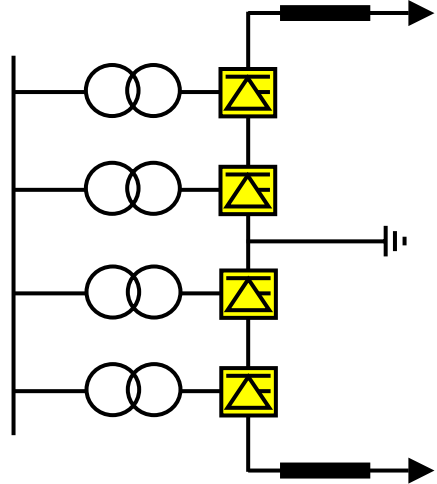
Major R&D needed

Some R&D needed

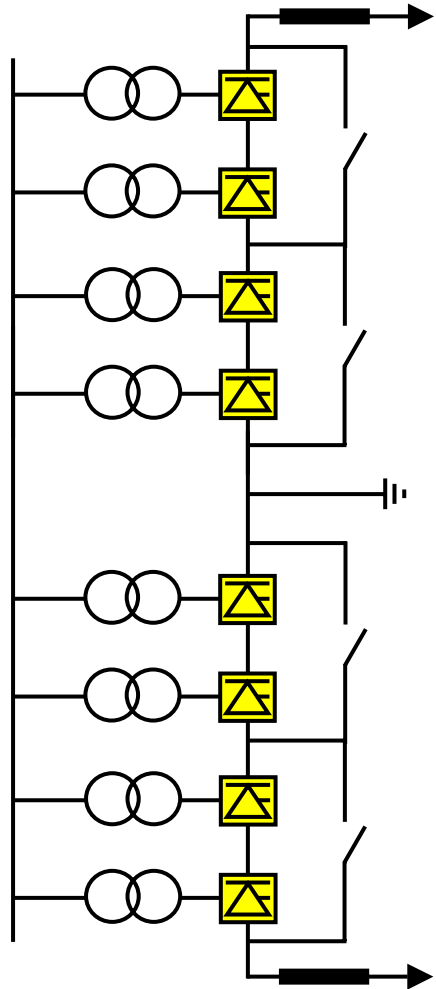


UHVDC alternative circuit configurations

4500 MW



6000 MW

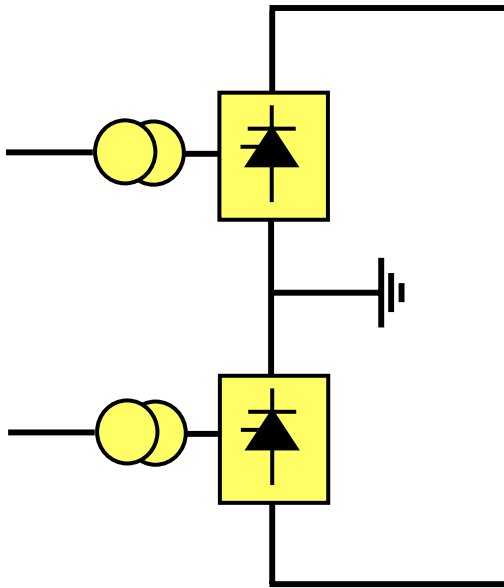


Converter configurations

- 1 x 12 pulse group /pole
 - Maximum rated power 4500 MW
 - Transformer transportation (dimension&weight)
 - Same lay-out as for 500 kV DC projects

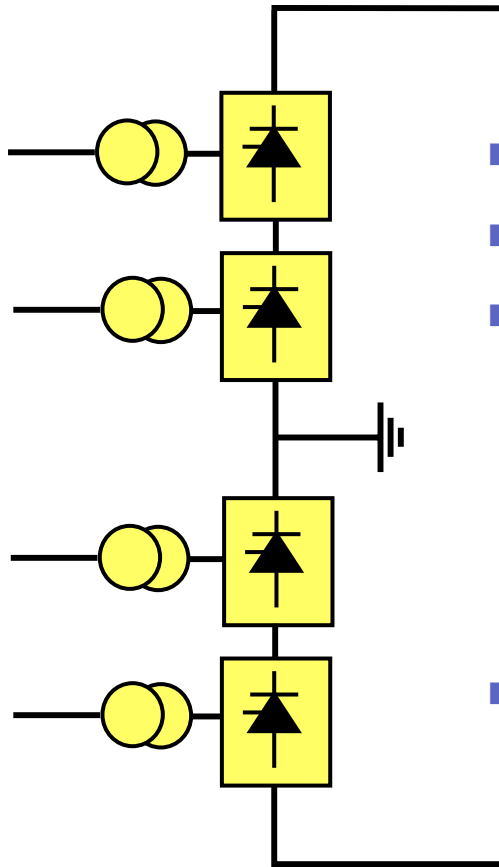
- 2 x 12 pulse groups/pole
 - Maximum rated power 6200 MW at 800 kV
 - Transformer transportation(dimension&weight)
 - Enhanced flexibility & availability

UHVDC, 1 x 12-pulse converter/pole



- “Standard” configuration
- 1 x 12 pulse group/pole
- Max power 4500 MW at 800 kV DC
- Transformer data (4500 MW)
 - No 12 units
 - Single phase 2 winding 450 MVA
 - Weight 430 tons
 - LxWxH 12 x 4 x 5m

UHVDC, 2 x 12-pulse converters/pole



- 2 x 12 pulse groups/pole
- Max power 6200 MW at 800 kV DC
- Transformer data (6200 MW)
 - No 24 units+spares
 - Single phase 2 winding 310 MVA
 - Weight 310 tons
 - LxWxH 10 x 4 x 5 meter
- Installed at Itaipu, in operation for 20 years

Reliability of converters

Large power blocks ask for extremely high reliability!

100 % separation of poles, 3000MW each

Far going separation of groups, 1500 MW each:

- **Geographical**
- **Mechanical**
- **Electrical**

Example:

- **AC-yard**
- **Auxiliary power**
- **Control**
- **Cabling**
- **AC-filters**
- **Cooling, water supply**

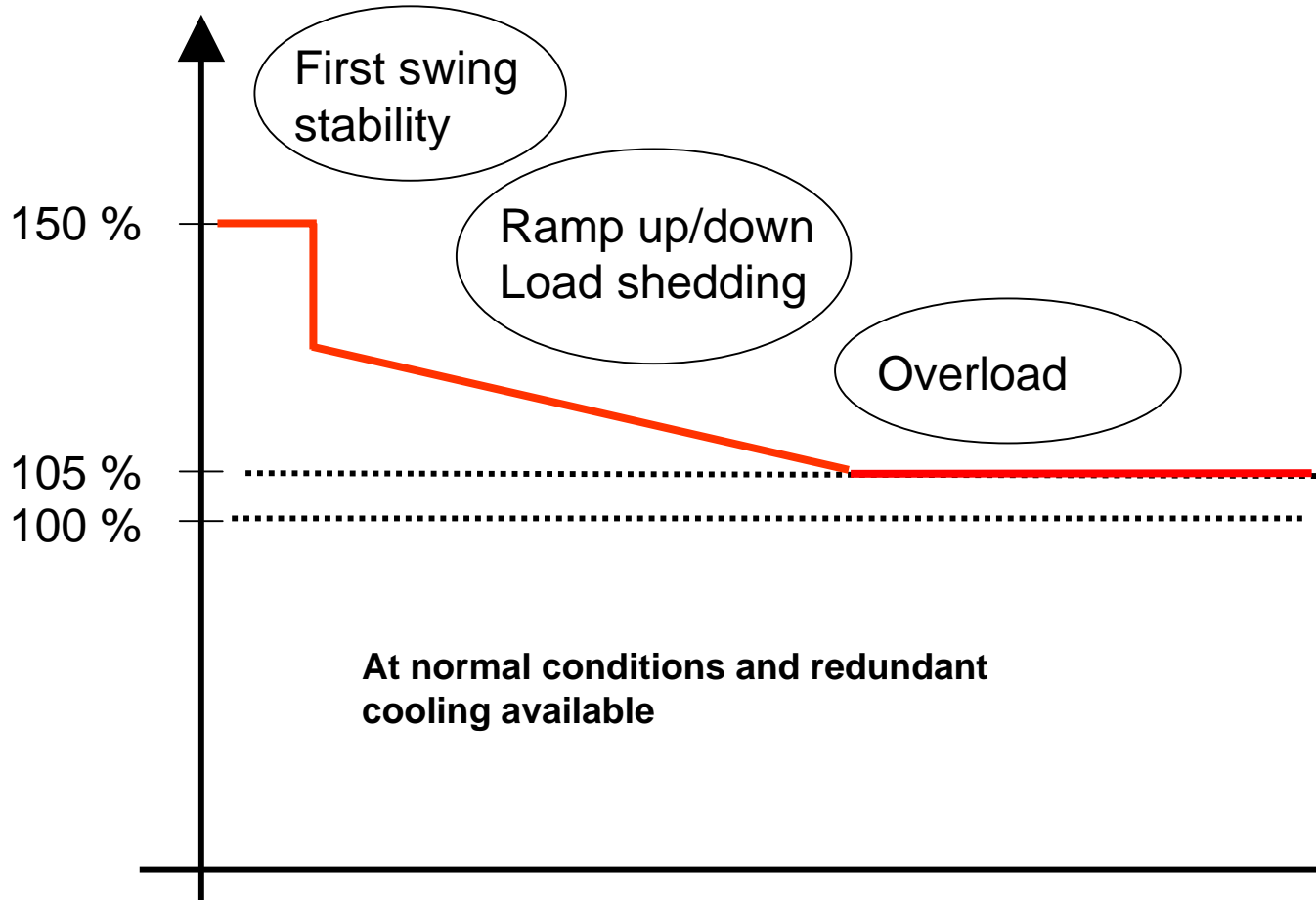


Reliability & Availability, converter stations

	Design Target 1 x 12 - p group	Design target 2 x 12-p group
Bipole trip	0,05 / year	~0,05 / year
Pole trip	2 / year	~0,5 / year
12-pulse group trip	-	2 / year
Availability (forced)	99,75 %	~99,90 %

Overload capability/ 12 pulse group

Overload capability is an efficient way to limit the effect of a disturbance



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