Prospects of Bulk Power

**EHV and UHV Transmission**

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Getting more Power out of the Grid

Benefits of EHV & UHV Solutions

The Task: System Interconnection & Transmission Enhancement
Enhancement of Transmission Systems

Extensions of Interconnected Systems

Increased Power Exchange among the Interconnected Systems

Transmission of large Power Blocks over long Distances * (Hydro Resources, Solar Energy)

Renewable Energy Resources at favorable Locations *

* by use of HVDC / FACTS for “remote” Infeed
Power System Development: The Key-Issue – How to avoid Bottlenecks

Globalisation/Liberalisation

Deregulation - Privatization: Opening of the Markets, Independent Transmission Companies ITCs, Regional Transmission Organisations RTOs

Bottlenecks in Transmission

Problem of uncontrolled Loop Flows Overloading & Excess of SCC* Levels System Instabilities & Outages

Investments in Power Systems

System Enhancement & Interconnections:
- Higher Voltage Levels **
- New Transmission Technologies
- Renewable Energies

** Example UCTE: 400 kV is actually too low

* SCC = Short-Circuit Current
If Power Flow exceeds the Design Criteria: **Blackout**

**System Enhancement necessary!**

**Problems only in the synchronous interconnected Systems**


**The US Blackout 2003: Congestion, Overloads and Loop Flows**

* PTDF = Power Transfer Distribution Factor
HVDC: it forces Power to flow

Fault-Current Blocking

Benefits of HVDC in a synchronous AC System

The Firewall for Blackout Prevention

Power & Voltage Control Fault-Current Blocking

Slow Functions

Fast Functions

G ~

Q1

α and γ

Q2

L and C

V1

P

V2

Q1

L and C

Q2

L and C

I1

I2

Fault-Current Blocking
Options of HVDC Interconnections

a) Back-to-Back Solution
b) HVDC Long Distance Transmission
c) Integration of HVDC into the AC System
Getting more Power out of the Grid

The Solutions are HVDC & FACTS

The Challenge: Security of Supply & Green Energy
Ed Stern, President of Neptune RTS: “High-Voltage Direct-Current Transmission will play an increasingly important Role, especially as it becomes necessary to tap Energy Reserves whose Sources are far away from the Point of Consumption.”

Safe and reliable Power Supply for the Mega Cities – “Blackout Prevention”

Customer: Neptune RTS
End User: Long Island Power Authority (LIPA)
Location: New Jersey: Sayreville Long Island: Duffy Avenue
Project Development: NTP-Date: 07/2005
PAC: 07/2007
Supplier: Consortium
Siemens / Prysmian
Transmission: Sea Cable
Power Rating: 600/660 MW monopolar
Transmission Dist.: 82 km DC Sea Cable 23 km Land Cable
India: East-South HVDC Interconnector

Getting more Power out of the Grid

2003  2000 MW

2007

RAI & LFL: full Use of Overload Capacity – without additional Thyristors

2500 MW

DC Station Talcher – State of Orissa
Network Load and aggregated Wind Power Generation during a Week of maximum Load in the E.ON Grid

Problems with Wind Power Generation
- Wind Generation varies strongly
- It cannot follow the Load Requirements

This will be a strong Issue in the German Grid Development

Source: E.ON - 2003

Additional Reserve Capacity is required
Hydro Plants for:
- Base Load and
- Energy Storage

Plus Wind Power

“flexible”

Benefits of HVDC:
- Clean Energy
- CO2 Reduction
- Cost Reduction

Covering Base and Peak-Load Demands
A possible Solution: Integration of **HVDC Transmission** into a synchronous AC System

**Benefits of such a Solution:**
- **Load Sharing**
- **Generation Reserve Sharing**

**Share in installed Wind Energy of 12,223 MW**
- E. ON Netz: 48 %
- Vattenfall Europe Transmission: 37 %
- RWE Transportnetz Strom: 14 %
- EnBW Transportnetze: 1 %

Source: E.ON - 2003

**Installed Generation Capacity:** 120 GW (2006)

**Long-term: 30 - 50 GW**
Prospects of **UHV DC & UHV AC**

Some Countries will need **Bulk Power Transmission Corridors** ...

**Solutions:**
800 kV DC & 1000 kV AC

**DC:** 4-6 GW  
**AC:** 6-10 GW

... Increase in Transmission Distance - and Reduction in Losses
China: AC & DC Power Transmission from West to East - Three Bulk Power Transmission Corridors

Transmission Capacity of each Corridor will be 20 GW in 2020 ...

... the installed Generation Capacity will be 900 GW

Sources:

3 x 20 GW

800 kV DC & 1000 kV AC

North Corridor

Central Corridor

South Corridor
Grid Extension in India - Hybrid AC plus DC

Prospects in China and India:
“Smart” and Strong Grids

Similar Perspectives … as in China

50 GW Hybrid:
≈ 40 GW DC
≈ 10 GW AC

Source: “Brazil-India-China Summit Meeting on HVDC & Hybrid Systems – Planning and Engineering Issues”, July 2006, Rio de Janeiro, Brazil
Solutions for **UHV DC Thyristor Valves**

- UHV DC Valves using proven modular Design based on existing Technology and Know-How for **DC Voltage 800 kV**
- Valve Tower Configuration: Double or Quadruple Valve
- Proven existing **LTT Technology**
Valve Hall Configuration – for UHV DC

DC Neutral

400 kV Valve Hall

400 kV DC

800 kV Valve Hall

“Ready for Transmission”

to 800 kV DC Line
Transformer for UHV DC

- Existing Technology and Know-How can well manage higher DC Voltage Stresses
- Transformers for 800 kV HVDC System are within existing Manufacturing Capabilities
- Transportation Limits and Converter Configuration will determine Type and Size
- R&D in Progress in specific Fields

Works for 800 kV DC Transformer
UHV DC Bushing at Test Lab TU Graz – Austria

800 kV DC Bushing in Test Field
Large System Interconnections: keep them safe by using HVDC & FACTS – in a hybrid Way

HVDC - Long Distance DC Transmission
HVDC B2B - via AC Lines
High Voltage AC Transmission & FACTS

DC – the Stability Booster and “Firewall” against “Blackout”

“Countermeasures” against large Blackouts

Solutions for a “Smart Grid”
Intelligent Solutions for Power Transmission

with HVDC & FACTS from Siemens

... and the Lights will keep shining!
Intelligent Solutions for Power Transmission

with HVDC & FACTS from Siemens

Thank You for your Attention!