Prospects for HVDC - Getting more Power out of the Grid

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High Voltage Power Transmission and Distribution
Getting more Power out of the Grid

The Task: System Interconnection & Transmission Enhancement

SIEMENS
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
HVDC: it forces **Power to flow**

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**Fault-Current Blocking**

```
L and C
```

**Slow Functions**

```
V1  P  V2
I1  L  I2
Q1  α and γ  Q2
```

**Fast Functions**

```
G~  Power & fast Voltage Control
```

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**Fault-Current Blocking**

```
G~
L and C
```

**Slow Functions**

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LTT – Light Triggered Thyristors

The safest Valve Technology

LTT: Technical & Economical Advantages

- 80% less Electronic Components
- Less Electric Wiring & Fiber Optic Cables
- Reduced Spare Part Requirements
- Wafer-integrated Overvoltage Protection

Thyristor Valve with Direct-Light Triggered 100 mm Thyristors with integrated Break-over Protection

Maximum Reliability & Availability - Benefits of LTT
Advanced Power Electronic Components

Direct **Light-Triggered Thyristor (LTT)**

- 80 % less Electronic Components
- Flame-retardant Valves to UL Standards*
- High Reliability

Valve Group - Example Indoor for HVDC

* Underwrites Laboratories (US Standard for Flame Retardance Tests)
Advanced Power Electronic Components

Direct **Light-Triggered Thyristor (LTT)**
- 80% less Electronic Components
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Valve Group - Example Outdoor for FACTS

*Underwrites Laboratories (US Standard for Flame Retardance Tests)
Europe - HVDC Moyle Interconnector

The Task:
Sea-Cable Transmission

World's first HVDC with LTT and wafer-integrated BOD

- Operated by:
  Moyle Interconnector Ltd., Northern Ireland

- System Data:
  Rating 2x250 MW
  Voltage 250 kV DC
  Thyristor 8 kV LTT
  Cable Length 64 km

Benefits
- Energy Exchange by Sea Cable
- Sharing of Reserve Capacity
- No Increase in Short-Circuit Power

2001
Ballycronan More
Auchencrosh

Benefits: World's first HVDC with LTT and wafer-integrated BOD
300 MW TNB-EGAT HVDC Interconnection

GURUN HVDC CONVERTER STATION

Source: "Hotel DC"

Adaptation to the local Architecture

Source: TENAGA NASIONAL BERHAD

PTD H 1 MT/Re

Power Transmission and Distribution
HVDC Long Distance Transmission Gui-Guang

Rating: 3000 MW
Voltage: ± 500 kV
Contract: Nov. 1, 2001
Project completed 6 Months ahead of Schedule by Sept. 2004
Thyristor: 5" LTT with integrated Overvoltage Protection
### HVDC Long Distance Transmission Gui-Guang II

**Customer:** China Southern Power Grid Company  

**Project:** Guizhou-Guangdong ±500 kV Line II  

**Location:** Xingren-Shenzhen China  

**Project Order:** May 2005  

**Commercial Operation:** Pole 1 - June 2007  
 Pole 2 - Dec. 2007  

**Project Team:** Chinese Corporations and Siemens  

**Type of Plant:** Long Distance DC OHL  

**Power Rating:** 3000 MW bipolar  

**Transmiss. Dist.:** 1125 km
India: East-South HVDC Interconnector

- DC Station Kolar - close to Bangalore
- 2003: 2000 MW
- 2007: 2500 MW
- RAI & LFL: full Use of Overload Capacity – without additional Thyristors

SIEMENS
Hydro Plants for:
- Base Load and
- Energy Storage

Plus Wind Power

“flexible”

Covering Base and Peak-Load Demands

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

Basslink HVDC: remote Infeed of Green Energy

2005
Optimization of the Transmission System

- **Loy Yang**
  - 3.2 km
- **McGaurans Beach**
  - 57.4 km
- **Five Mile Bluff**
  - 295 km
- **Georgetown**
  - 6.4 km
  - 1.7 km
  - 8.9 km
  - 2.1 km

- **Bass Strait**
  - **Converter Station**
  - 500 kV Substation
  - Transition Station
  - **Underground Cable**
  - **Sea Cable**
  - **Converter Station**
  - 220 kV Substation

- **Commercial Operation:** Nov. 2005
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
Some Countries will need Bulk Power Transmission Corridors …

Solutions: 800 kV DC & 1000 kV AC

DC: 4-6 GW

AC: 6-10 GW

… Increase of Transmission Distance - and Reduction of Losses
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
Conclusions – Use of State of the Art HVDC Technologies

- LTT Thyristors – less Electronic and less Power Components:
  - Increase in Reliability

- Use of Double & Triple tuned Filters:
  - Space Savings
  - Increase in Availability

- Active VSC Filters for AC & DC:
  - highest Harmonic Performance

- Advanced Controls with WIN TDC:
  - a Standard for Industrial & Utility Applications
  - Product Life Cycle of more than 25 Years
FACTS & HVDC worldwide – Example Siemens

Series
- FSC
- NGH
- TPSC
- TCSC

Parallel
- SVC
- MSC/R
- STATCOM
- Flicker STATCOM
- B2B/GPFC
- UPFC
- CSC

Load Flow
- PTD H 1 MT/Re

Plus 18 Projects for HVDC Long Distance Transmission ...

... and over 110 Industry SVCs all over the World

Status: 11-2006

In total: over 150 SVCs

8 alone between 2000 & 2005 in 4 Continents
Power System Expansion …

... with Advanced Transmission Solutions

From Congestion, Bottlenecks and Blackout towards a “Smart Grid”
Intelligent Solutions for Power Transmission

with HVDC & FACTS from Siemens

... and the Lights will keep shining!

SIEMENS
Intelligent Solutions for Power Transmission

with HVDC & FACTS from Siemens

Thank You for your Attention!