

HVDC Schemes under Construction or Planned

By
Poul Damgaard

Under construction

Storebælt HVDC Link



- Commissioning in 2010
- Getting permission for the converter station on Zealand has delayed the project with 4-5 months
- Contract for HVDC Converter stations placed at Siemens (2008)
- Contract for 400 kV cables and submarine return cable placed at ABB Cables (2008)
- Contract for land return cables placed at NKT
- Construction work started at the station on Funen. Will start on Zealand in January 2009

Planned HVDC link

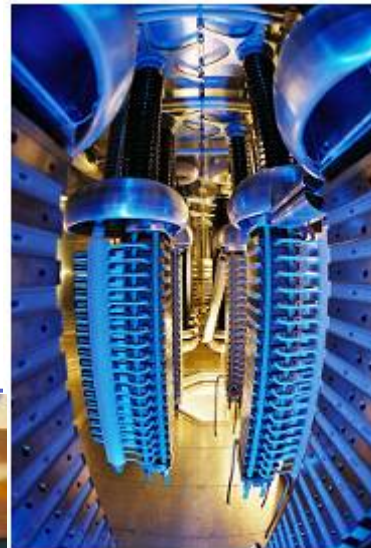


Skagerrak 4

– the fourth pole between Norway and Denmark

- Feasibility study/business Case has been conducted
- Decision taken by Statnett and Energinet.dk in May 2008 to apply for permission to establish a 640 MW, 450 kVdc link in addition to the three running poles which have total capacity of 1050 MW
- Commissioning planned for 2014

Victor Lescale



CIGRÉ 2008 SC-B4 Projects from Sweden



Ongoing projects

Full turn-key projects

- Caprivi Link (Namibia)
- Fenno-Skan 2 (Finland, Sweden)
- Nord E.ON 1 (Germany)
- NorNed (Norway, Netherlands)
- Outaouais (Canada)
- SAPEI (Italy)
- Valhall (Norway)
- Xiangjiaba – Shanghai (China)

Upgrades

- Apollo (South Africa)
- Blackwater (USA)
- Chateauguay (Canada)

Ongoing projects

Full turn-key projects

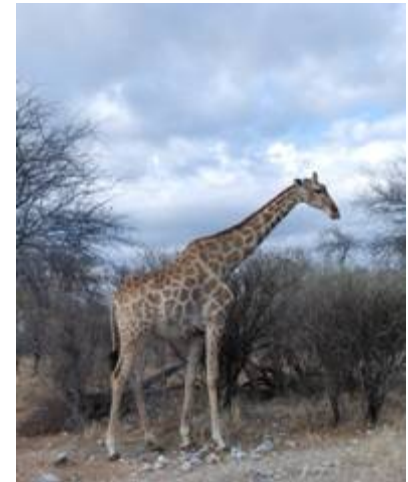
- Caprivi Link (Namibia)
- Fenno-Skan 2 (Finland, Sweden)
- Nord E.ON 1 (Germany)
- NorNed (Norway, Netherlands)
- Outaouais (Canada)
- SAPEI (Italy)
- Valhall (Norway)
- Xiangjiaba – Shanghai (China)

Upgrades

- Apollo (South Africa)
- Blackwater (USA)
- Chateauguay (Canada)

Caprivi Link (Namibia)

- 300MW, 350kVDC
- 970km overhead line with HVDC Light
- Order: 2007-11-09
- In service: January 2010
- Can be expanded to 600MW



Gerus



Zambezi



Fenno-Skan 2

- Fenno-Skan 1 (commissioned 1989)
500MW, 400kVDC
- Fenno-Skan 2 will add 800MW, 500kVDC
 - 200km Cable
 - Order: 2008-05-13
 - In service: 2011



NORD E.ON 1 - Summary



© ABB

Owner

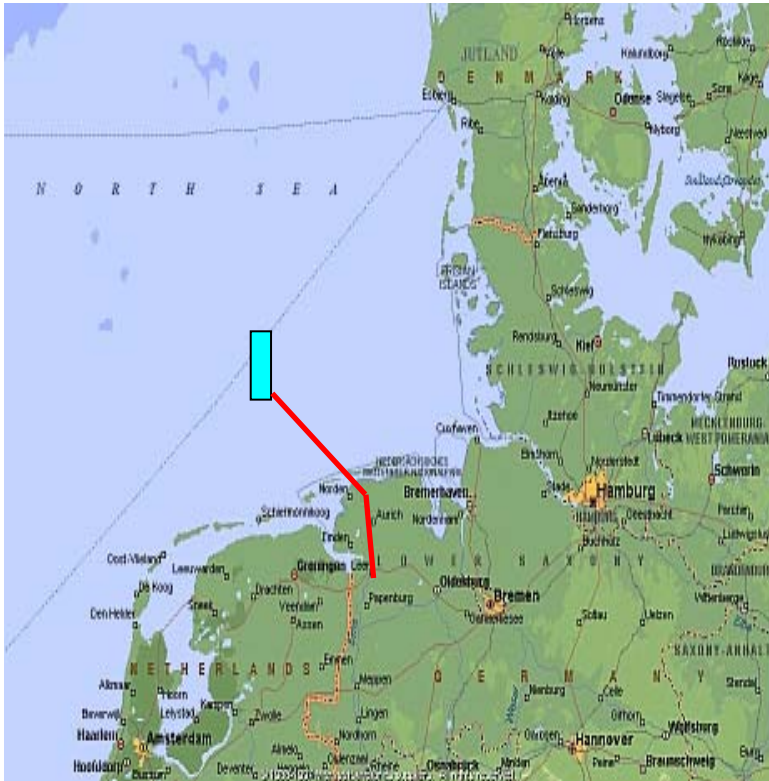
- E.ON Netz Offshore GmbH, Germany

Scope

- 400 MW HVDC Light System
- Offshore station on platform with sub-sea structure
- Onshore station at E.ON substation Diele
- 170 kV GIS switchgear on platform
- Cables
 - Submarine AC cable 170kV (1x1200 m)
 - DC cable submarine to onshore connection (2x128km)
 - DC cable on land (2x75km)
 - Fiber optic cable (203 km)



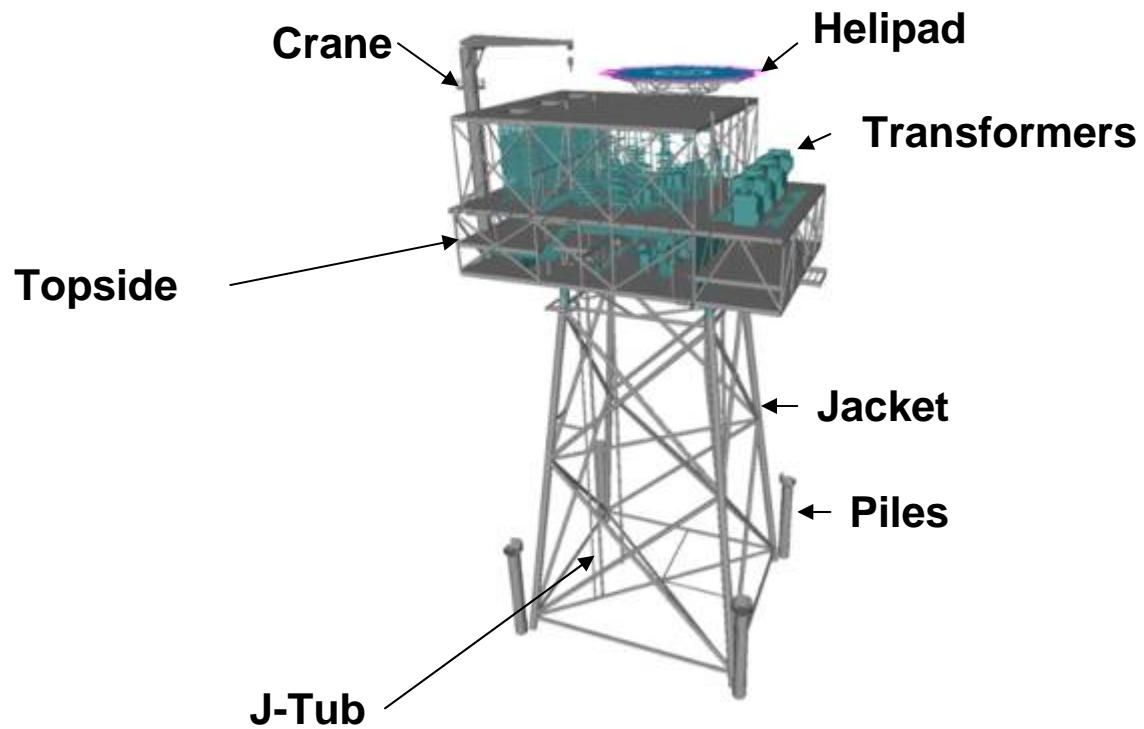
NORD E.ON 1 – Contract schedule



- 2007-09-17** Contract award
- 2008-06-02** Start installation of land cable
- 2008-07-07** Start civil construction onshore
- 2008-11-10** Start installation onshore
- 2008-11-12** Start installation of equipment at offshore fabrication yard
- 2009-05-01** Module & sub-sea structure ready to sail
- 2009-06-23** Start installation offshore cable
- 2009-08-07** Offshore platform ready for cable installation
- 2009-08-15** HVDC system ready for energization
- 2009-09-01** System ready for transmission testing
- 2009-09-15** Start trial run
- 2009-11-24** Acceptance



NORD E.ON 1 – layout platform - Overview



NordE.ON 1 – Land cable laying



2008-06-09 First cable pull



NorNed kabel HVDC Project

NorNed, Norway – The Netherlands

The longest underwater high-voltage cable in the world.



Clients: Statnett SF, Norway and
TenneT bv , Netherlands

Order date December 2004

In service: April 2008

Transmission capacity: 700 MW

AC Voltage: 300 kV at Feda

400 kV at Eemshaven

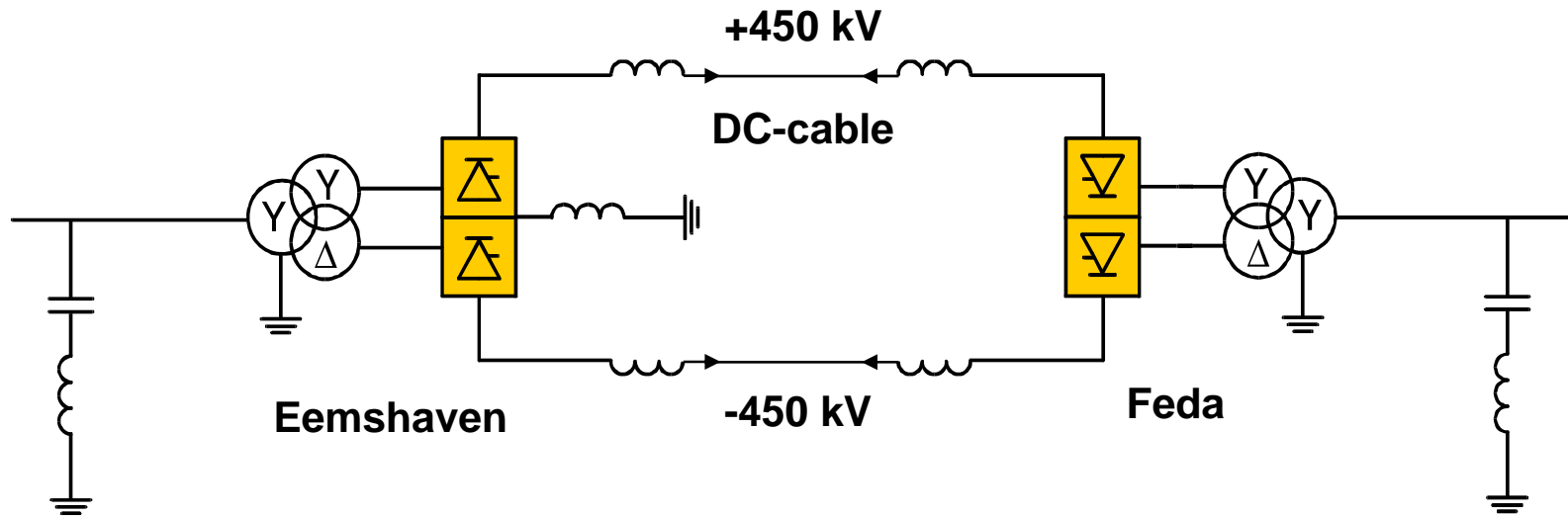
DC Voltage: ± 450 kV

Length of DC cable: 2* 580 km

Main reason for choosing HVDC: Long submarine cable distance and non-synchronous AC systems, absolute control of power flow fits with the market coupling



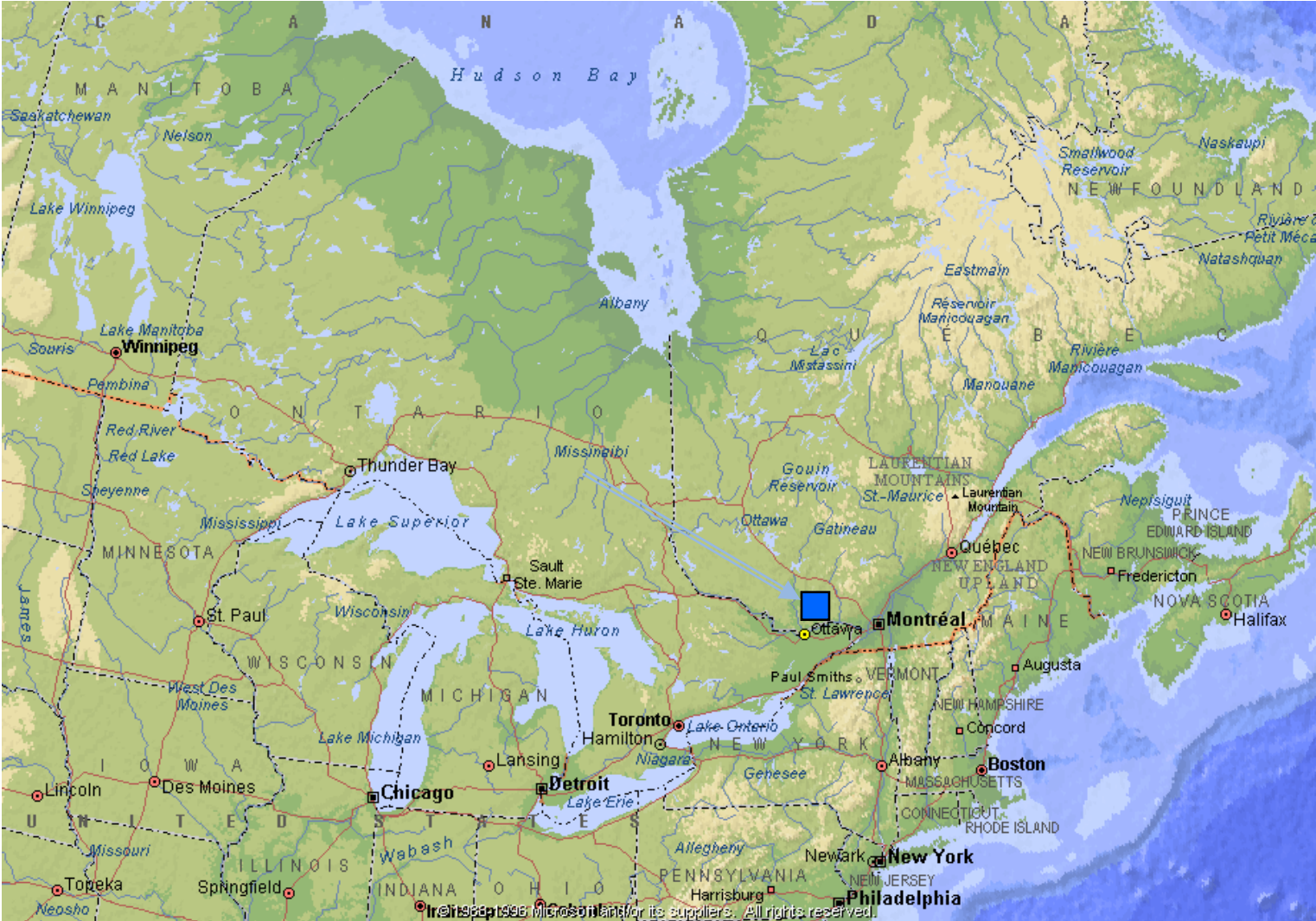
NorNed kabel HVDC Project *Symmetric monopole*



- Rating 600 MW \pm 450 kV
- Low losses 3.7 %
- Continuous 700 MW
- Cable length 580 km
- No sea electrode

OUTAOUAIS

Location



Outaouais BtB

- 2 x 625 MW
- Client: Hydro Québec (TransEnergie)
- Order: (NTP) 2006-10-23
- 2007-06-12 Access granted to site
- 2008-05-21 Start of installation
- 2008-10-xx Commissioning starts
- 2009-03-26 Commercial operation and PAC

Progress – June 2008



June, 10 – Building from Ontario yard



June, 10 – Control Room – Second Floor



June, 10 – 240kV BI.01 trafo foundations



June 10, Québec side – NE filter

SAPEI - Map



SArdinia
PEninsular
Italy

Bipole, 1000MW

Cable, 435km, 1600m



SAPEI - General

- SAPEI – Client Terna, consultant CESI.
- Bipole 2 x 500 MW, 500 kV DC, 400 kV AC.
- Cables 2 x 435 km, 1600 m (+2 x 70 km MV).
- Special:
 - Use of existing SACOI anode on Sardinia.
 - High salt contamination level, indoor solutions.
 - Minor seismic requirements
 - Similar to Italy-Greece
- Scope: Everything except civil construction.
- Contract date: 2006-06-06
- Pole 1 in operation 2008-09-30
- Pole 2 in operation 2009-09-30



Sapei – Latina installation AC filter



Valhall – General

Power From Shore = PFS

Description

- One HVDC light station off-shore and one on-shore
- 292 km HVDC Cable

Main data

- $P = 78 \text{ MW}$
- $U_{DC} = -150 / 0 \text{ kV}$
 $U_{AC} = 11 \text{ kV on offshore and } 300 \text{ kV onshore}$

In service

September 2010



HIGHLIGHTS FROM LISTA SITE WEEK 22



The two valve cooling skids lifted/slide in place



IGBT-valves surrounded by corona shield

Xiangjiaba – Shanghai

- 6400MW, 800kVDC, 2000+ km
(The world's longest and most powerful transmission)
- Order: 2007-12-17
- In service: 2011-06-30
- Studies ready, and most reports approved
- Site activities already in full swing



Fengxian Site XS – May 15, 2008



The wall around the very large site is being erected. In some parts, it will be 16m high to reduce the noise level outside.



Fengxian Site XS – May 15, 2008



The piling material is transported to site in barges.



Ongoing projects

Full turn-key projects

- Caprivi Link (Namibia)
- Fenno-Skan 2 (Finland, Sweden)
- Nord E.ON 1 (Germany)
- NorNed (Norway, Netherlands)
- Outaouais (Canada)
- SAPEI (Italy)
- Valhall (Norway)
- Xiangjiaba – Shanghai (China)

Upgrades

- Apollo (South Africa)
- Blackwater (USA)
- Chateauguay (Canada)

Apollo refurbishment, new valves



Apollo refurbishment. Status as per June 2008

Order: 2006-08-04

AC-filter 2 in operation 15/1-08

Bridge 2 & 4 in operation 3/2-08

Bridge 6 & 8 in operation 14/2-08

Pole 2 in operation 17/2-08

Bridge 1 & 3 in operation 11/4-08

AC-filter 1 branch 24,13 & 11 in operation 22/4-08

AC-filter 1 branch 5 & 7 in operation 30/4-08

Bridge 5 in operation 7/5-08

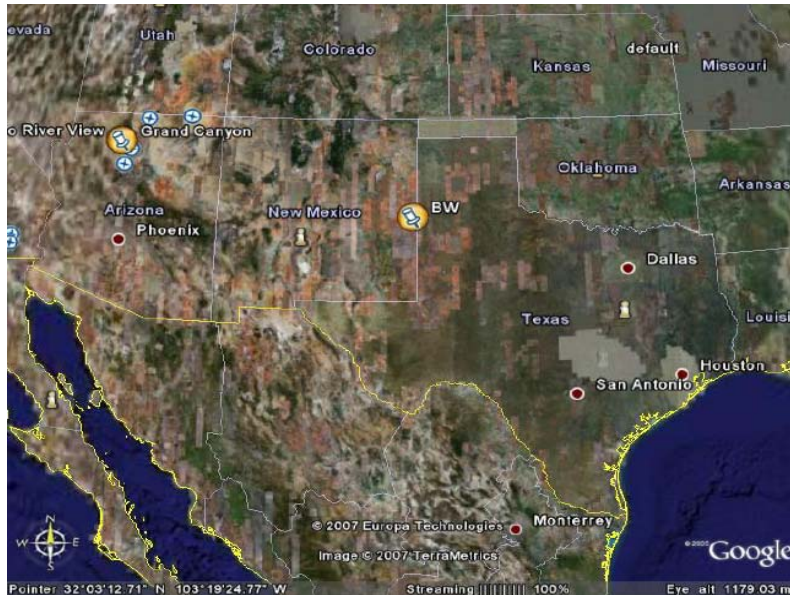
Bridge 7 in operation 12/5-08

Pole 1 in operation 12/5-08

Trial operation completed 1/6-08



Blackwater Upgrade Project



- Upgrade of the Cooling System
- Upgrade of the Control System
- Replacement of DC Current Transducers
- Replacement of battery system.

- Owner: Public Service Company of New Mexico (PNM)
- Commissioning:
 - Cooling: April 2008
 - Control: November 2009
- Rating: 200 MW, +/- 56.8 kV, 3.6 kA
- Reason:
 - >20 years old
 - unsolved control problem
 - problem with maintenance and spare parts.
 - larger wind farms => reliable system important
 - The cooling system needs upgrade to run 220 MW continuously

Blackwater Upgrade Project

- Major events already covered:
 - Order 2006-12-21
 - Cooling system commissioned
 - System studies (stability, and similar) ongoing
- Exchange of control system: End of October 2009
(PAC planned for November 2009)

Chateauguay Control Upgrade

- Upgrade of the Control System in Chateauguay. Replacement of light guides and DC Current Transducers.
- Owner: Hydro Québec
- Order date: February 2008
- Commissioning: June 2009
- Rating: 2 X 500 MW
- Reason for upgrade: Poor reliability of the existing Control & Protection system.
- Planned stop times:
 - Block 1: 28 days
 - Block 2: 22 days



Other Control Upgrades Already Done

- Skagerrak (Norway, Denmark)
 - Stop time: 14 days (18 days)
- CU (USA)
 - Stop time: 23 days
- Square Butte (USA)
 - Stop time: 6 weeks (of 8 weeks planned due to generation stop, anyway)

SIEMENS

HVDC Projects and Activities

Energy Sector
Power Transmission Division



HVDC Projects under execution, status Aug./08

Project		Country	In-Service
Ballia-Bhiwadi	2500 MW, 500 kV	India	2009
Yun-Guang	5000 MW, 800 kV	China	2010
Storebelt	600 MW, 400 kV	Denmark	2010
Brit-Net	1000 MW, 400 kV	UK - Netherland	2010
Xiangjiaba-Shanghai	6400 MW, 800 kV	China	2010
Cometa	400 MW, 250 kV	Spain	2011
Trans Bay Cable	400 MW, 400 kV	USA	2010

Yun - Guang, China, 2010

Customer	China Southern Power Grid Co., Ltd.
Project name	Yunnan-Guangdong ± 800 kV UHVDC Transmission Project
Location	Province Yunnan to province Guangdong
Type of plant	Long distance transmission
Power rating	5000 MW, bipolar
Transmission distance	1418 km
Voltage levels	800 kV DC, 525 kV, 50 Hz
Thyristor voltage	Direct-light-triggered, 8 kV
Number of thyristors	5760



Factory Tests of first 800 kV DC Equipment Already completed for Yun-Guang UHVDC Project (Status August 2008)



Converter Valves	100% Completed
800kV DC Surge Arrester	100% Completed
800kV DC Bypass Breaker	100% Completed
800kV DC Disconnectors	100% Completed
DC Filter Capacitor C1	100% Completed
800 kV DC Insulators (Shenmatech)	100% Completed
800kV DC Voltage Divider	100% Completed
800kV DC Wall Bushing	on-going
800kV DC Current Measuring system	on-going
800 kV converter transformer	on-going

First 800 kV Converter Transformer in Factory



800 kV Thyristor Valve during Dielectric Type Test



800 kV Bus Arrester with Composite Housing



Height = 12.2 m

Weight = 1000 kg

LIWL = 1900 kV

SIWL = 1600 kV

800 kV Bypass Breaker during Type Testing



800 kV Double Break Disconnecter with composite insulator

SIEMENS



800 kV DC Voltage Divider during Type Testing

Composite housing
SF₆ insulated

LIWL 1900 kV

SIWL 1600 kV

Creepage distance ≥ 32.7 m

Clearance ≥ 9.1 m

Height 10.4 m

Weight 1400 kg



New Generation of Thyristors

6" Thyristor (8 kV /4.5 kA) for XJB-SHA UHVDC Project



4 inch

5 inch

6 inch

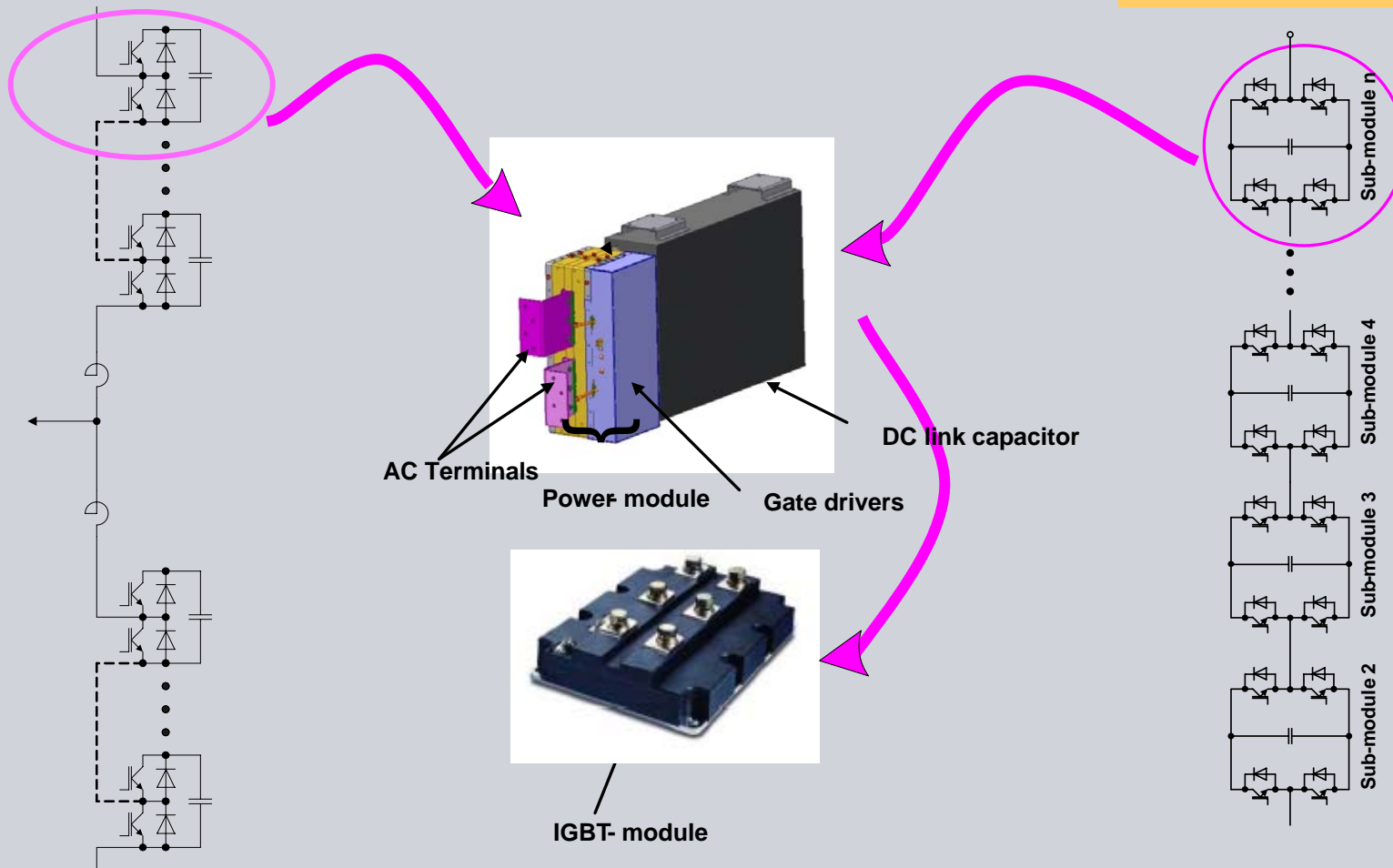


Modular Multilevel Voltage Sourced Converter for HVDC and FACTS Applications



HVDC PLUS

SVC PLUS Active Filter PLUS

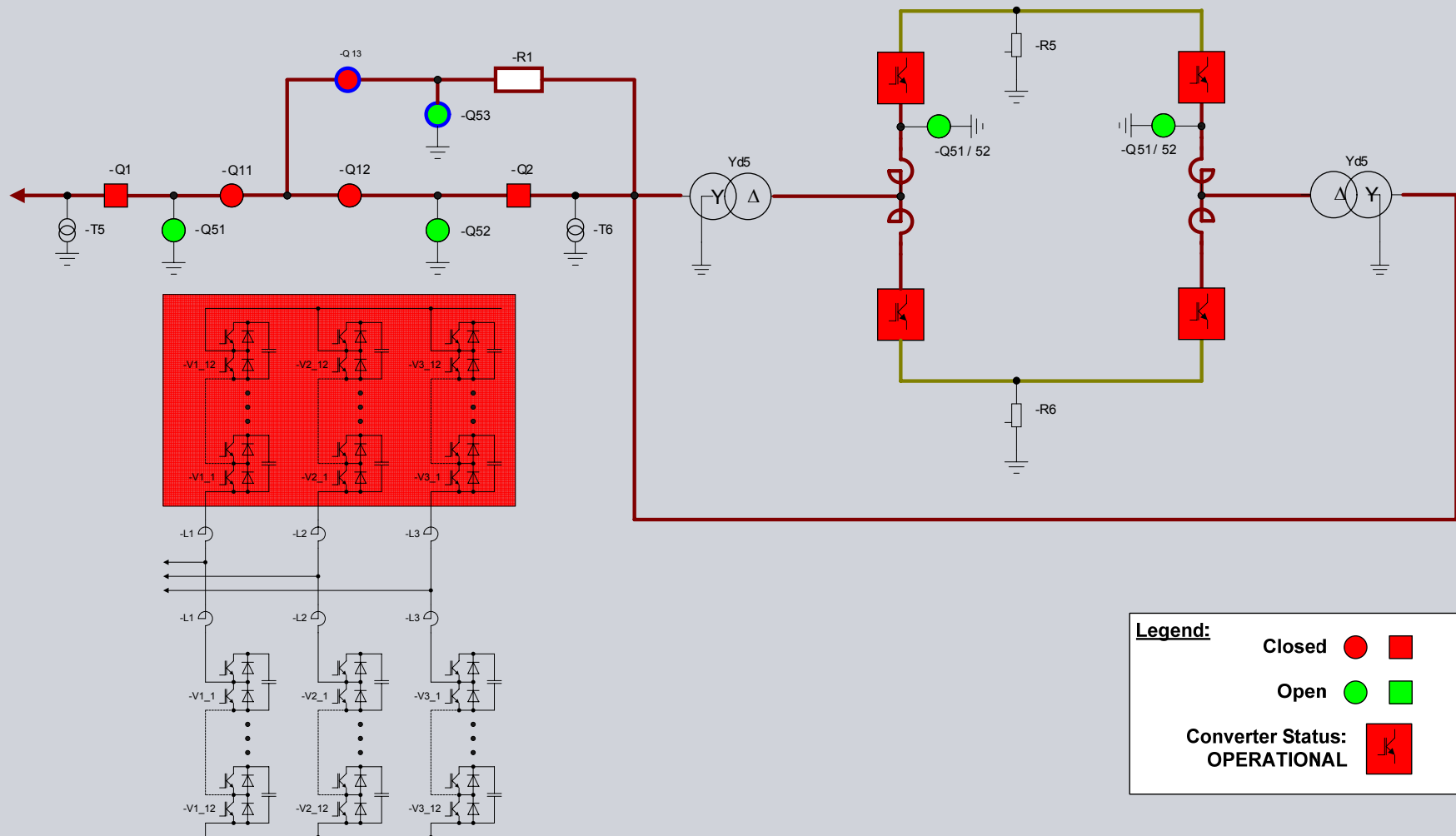


First Application of Modular Multilevel Converter Active Filter Installation in Neptune HVDC Project

SIEMENS



32 MW HVDC PLUS in BtB Configuration

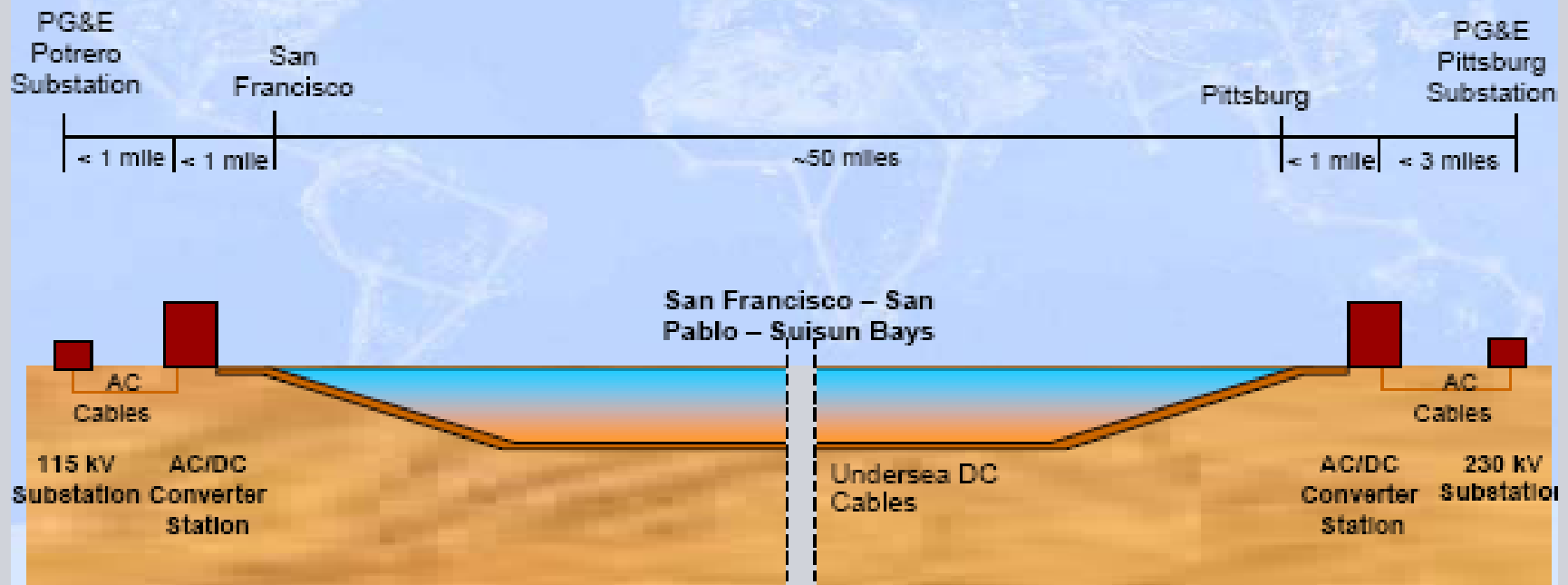


HVDC PLUS

Trans Bay Cable Project, USA, 2010

SIEMENS

- Converter: Modular Multilevel HVDC PLUS Converter
- Rated Power: 400MW @ AC Terminal Receiving End
- DC Voltage: $\pm 200\text{kV}$
- Submarine Cable: Extruded Insulation Submarine Cable



CIGRE SC B4 Meeting, Paris, France, Sep. 2008



New HVDC Projects in China

Guangfu Tang

China Electric Power Research Institute

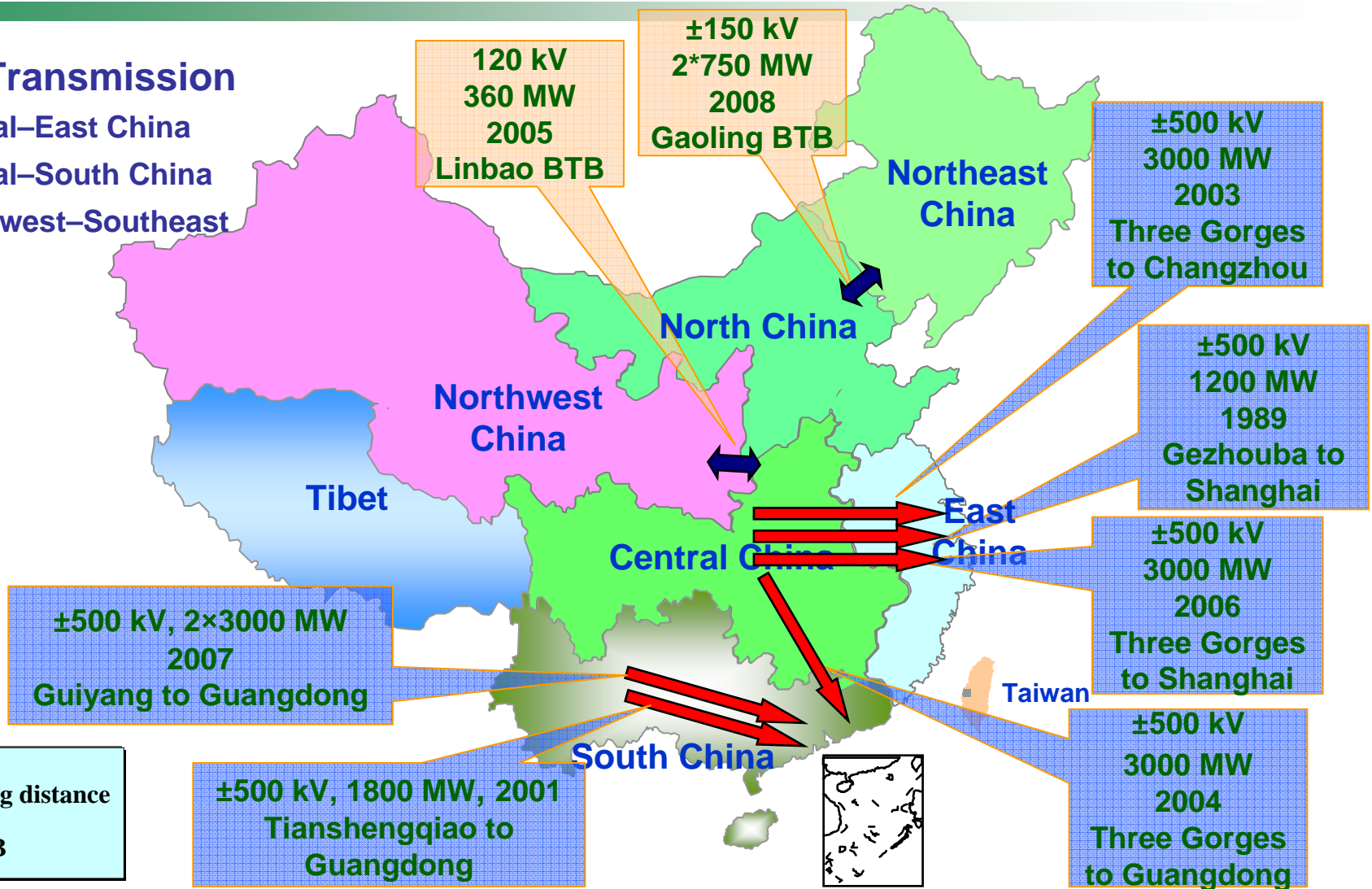
August, 2008



HVDC Projects in Service

Power Transmission

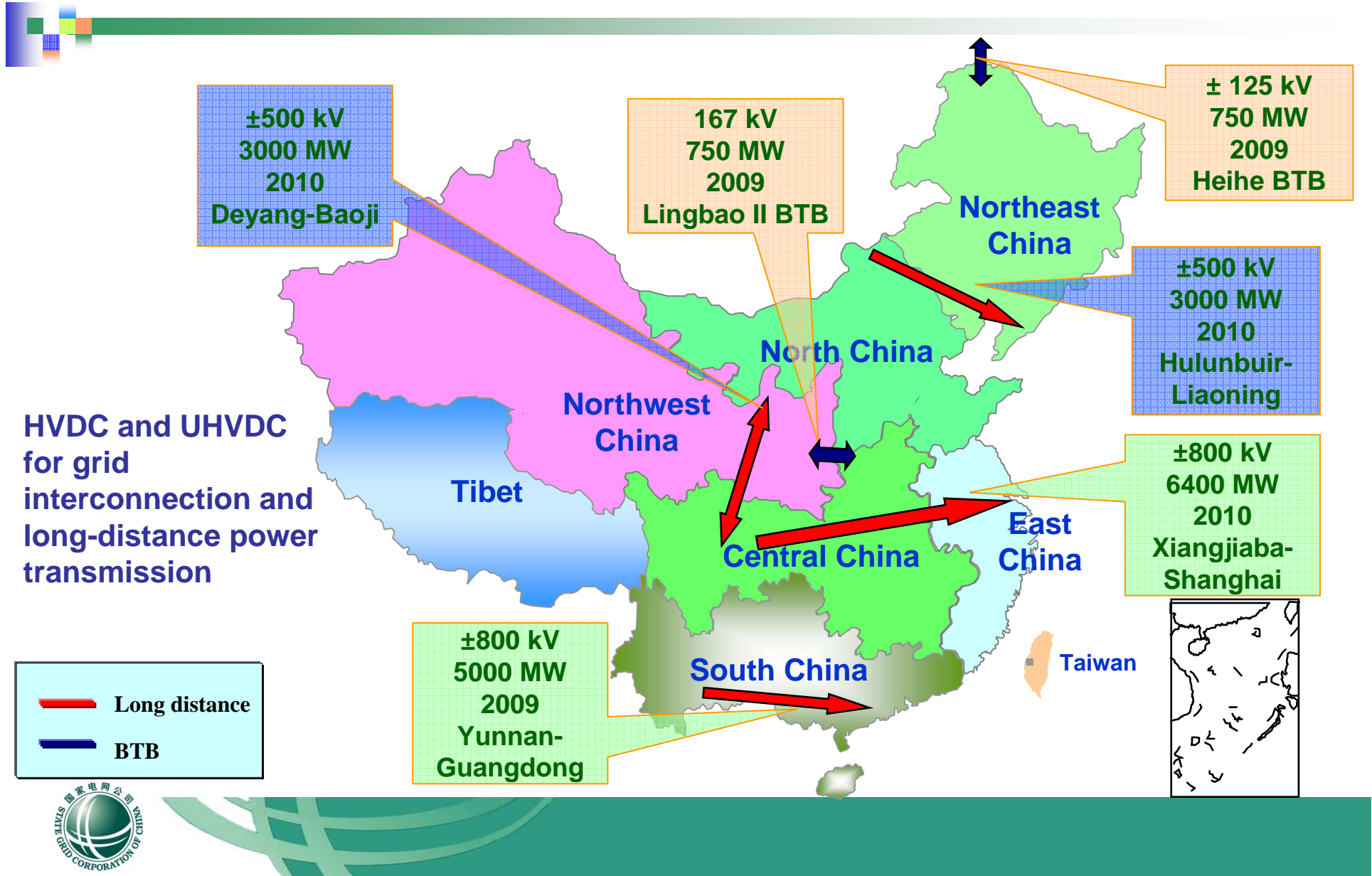
- Central–East China
- Central–South China
- Southwest–Southeast China



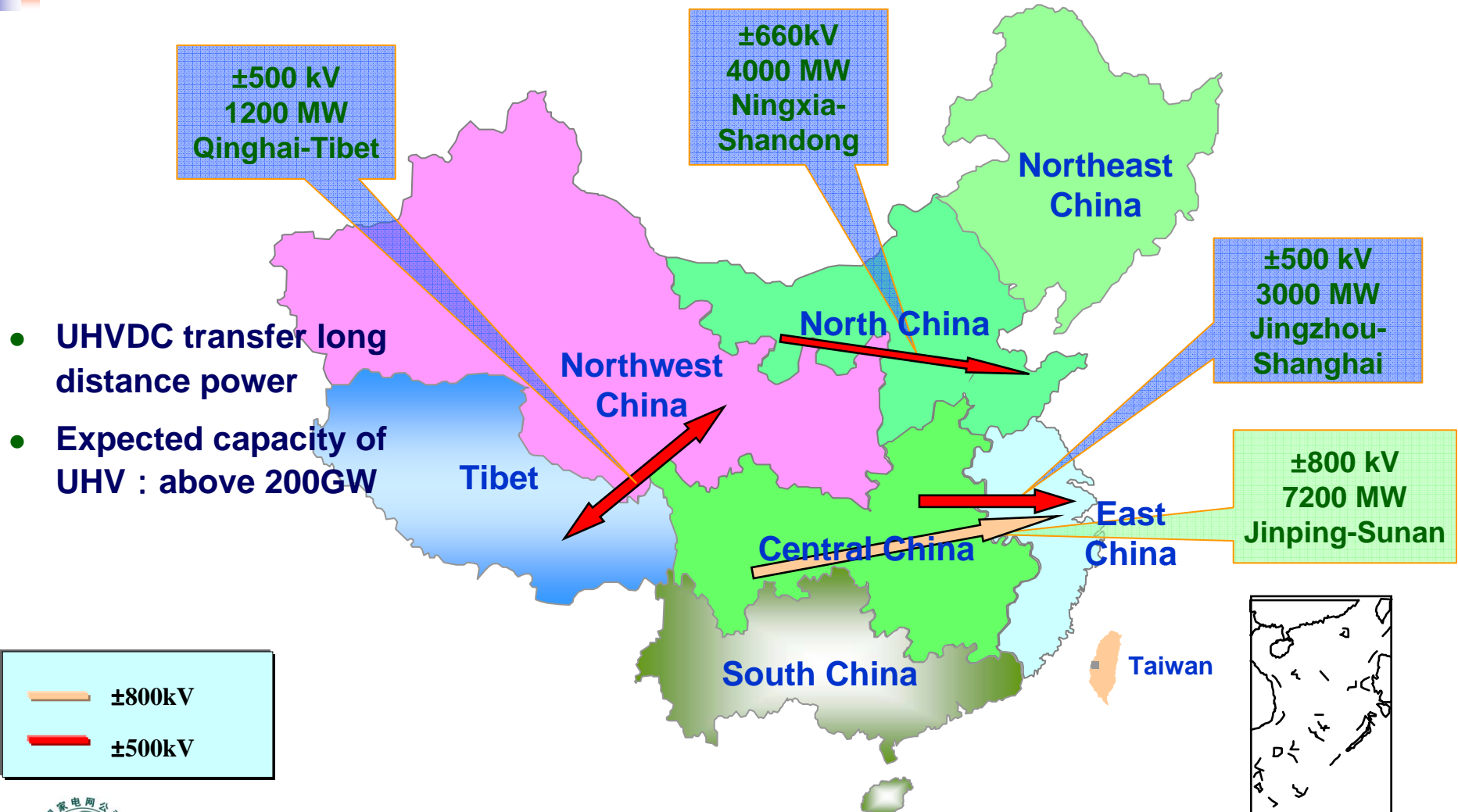
→ Long distance
→ BTB



HVDC Projects Under Construction



HVDC Projects in Planning By the End of 2008



Jinping - Sunan UHVDC project

- **Overview of the UHVDC project**
 - From Yulong of Sichuan to Tongli of Jiangsu
 - Totally 7200MW at bipolar
- **System Scheme**
 - Converter topology: Bipolar
 - DC voltage: $\pm 800\text{kV}$
 - AC voltage: 500kV
 - Transmission distance: 2098km
- **Schedule**
 - Start at 2008 , Commission at 2011 (Bipolar)



Ningxia - Shandong HVDC project

■ Overview of the HVDC project

- From Yinchuan of Ningxia to Qingdao of Shandong
- Totally 4000MW at bipolar

■ System Scheme

- Converter topology: Bipolar
- DC voltage: $\pm 660\text{kV}$
- AC voltage: 500kV, 330kV
- Transmission distance: 1348km

■ Schedule

- Start at 2008 , Commission at 2010 (Bipolar)



Jingmen - Fengjing HVDC project

■ Overview of the HVDC project

- From Jingmen of Hubei to Fengjing of Shanghai
- Totally 3000MW at bipolar

■ System Scheme

- Converter topology: Bipolar
- DC voltage: $\pm 500\text{kV}$
- AC voltage: 500kV
- Transmission distance: 970km

■ Schedule

- Start at 2008 , Commission at 2011 (Bipolar)



Qinghai - Tibet HVDC project

- **Overview of the HVDC project**
 - From Geermu of Qinghai to Lasa of Tibet
 - Totally 1200MW
- **System Scheme**
 - DC voltage: $\pm 500\text{kV}$
 - AC voltage: 500kV
 - Transmission distance: 1038km
- **Schedule**
 - Start at 2008 , Commission at 2010(Monopolar)





Thanks !

