



**IEEE PES General Meeting, Minneapolis, July 25-29, 2010 –
HVDC & FACTS Subcommittee**

SIEMENS latest **Technology** **Developments and Projects**

Dietmar Retzmann

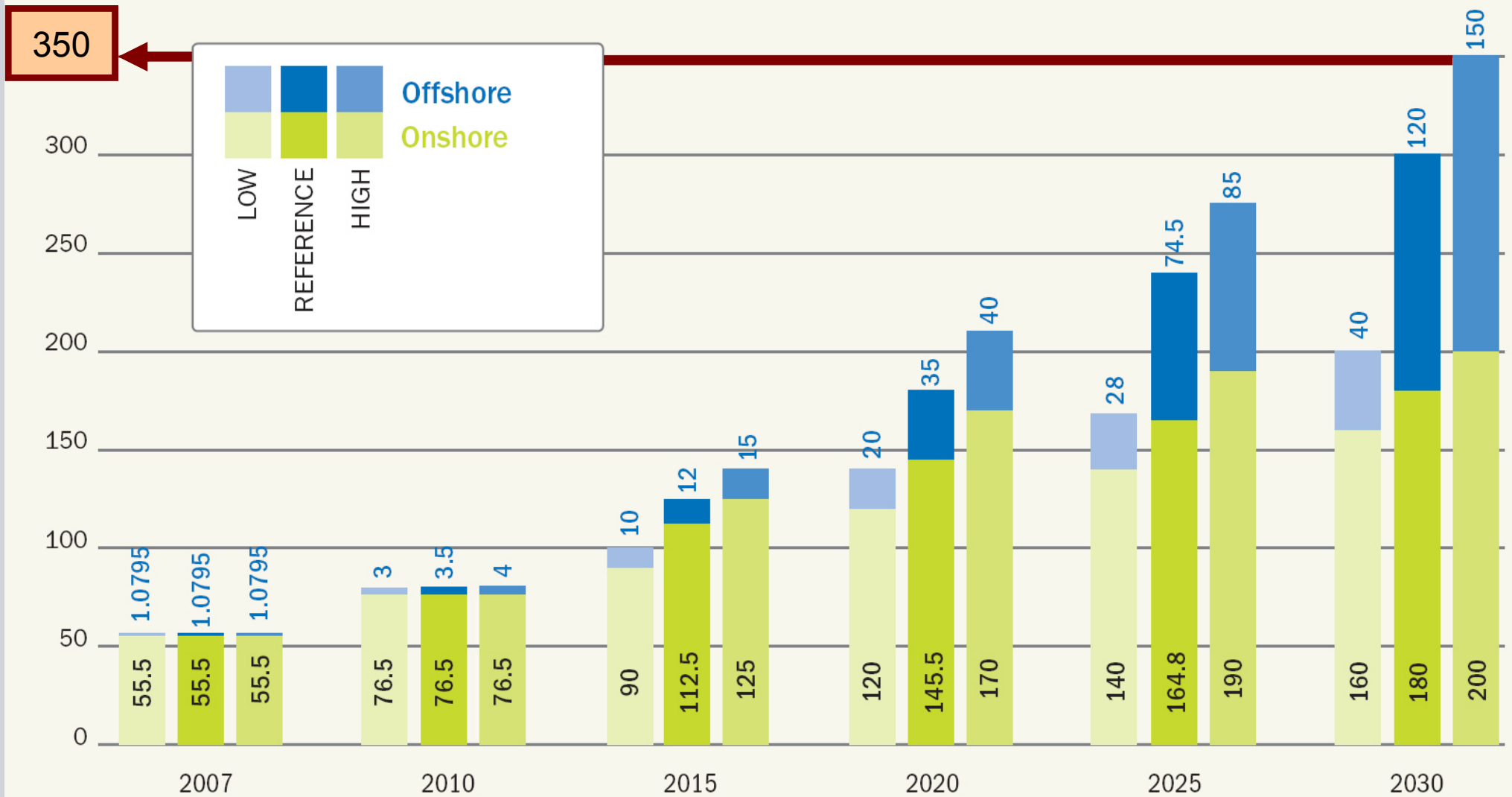


SIEMENS

FOCUS *on*

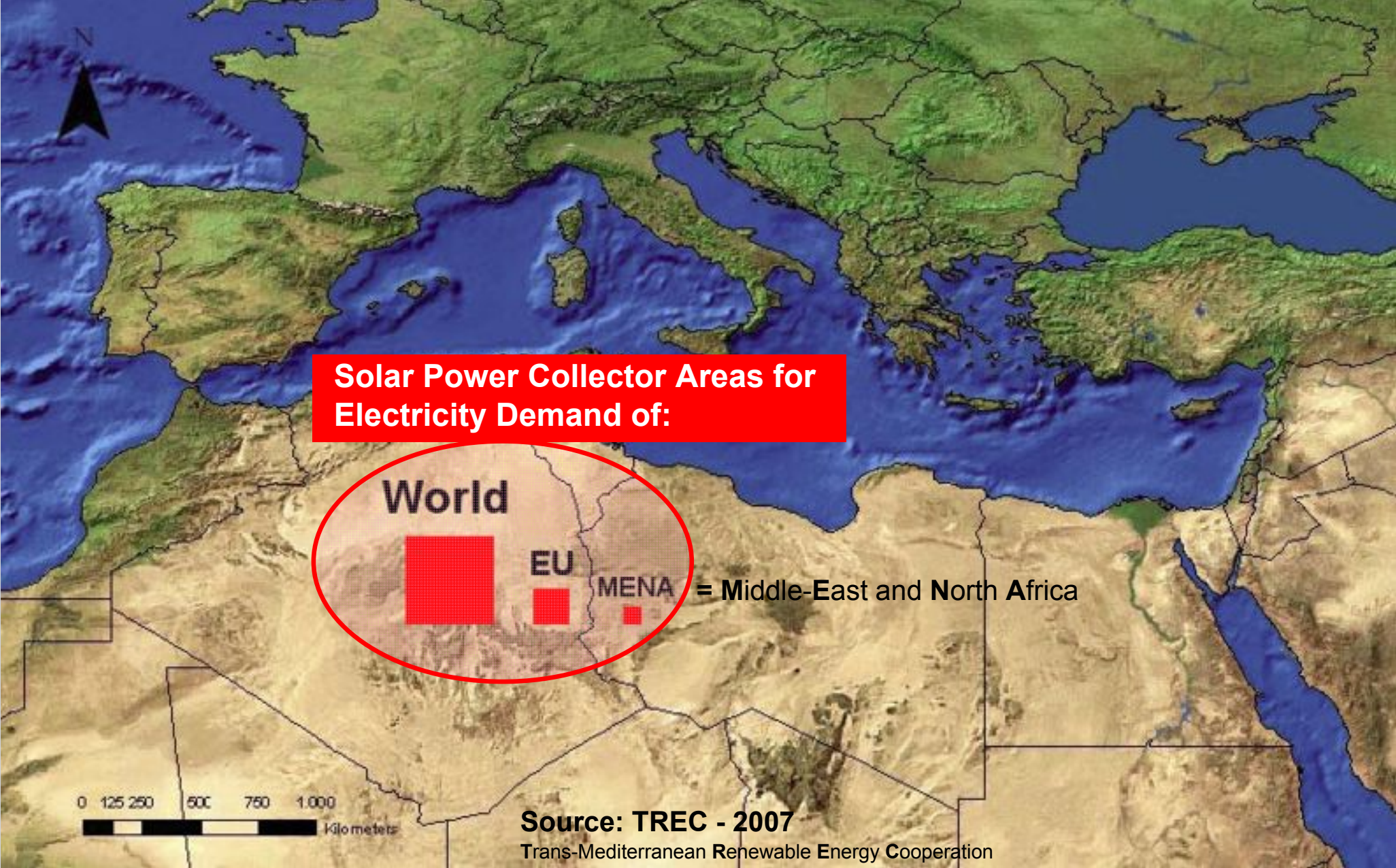
CO₂ Reduction – Green Energy
Megacities – Security of Supply

EWEA's * three Wind Power Scenarios (in GW)



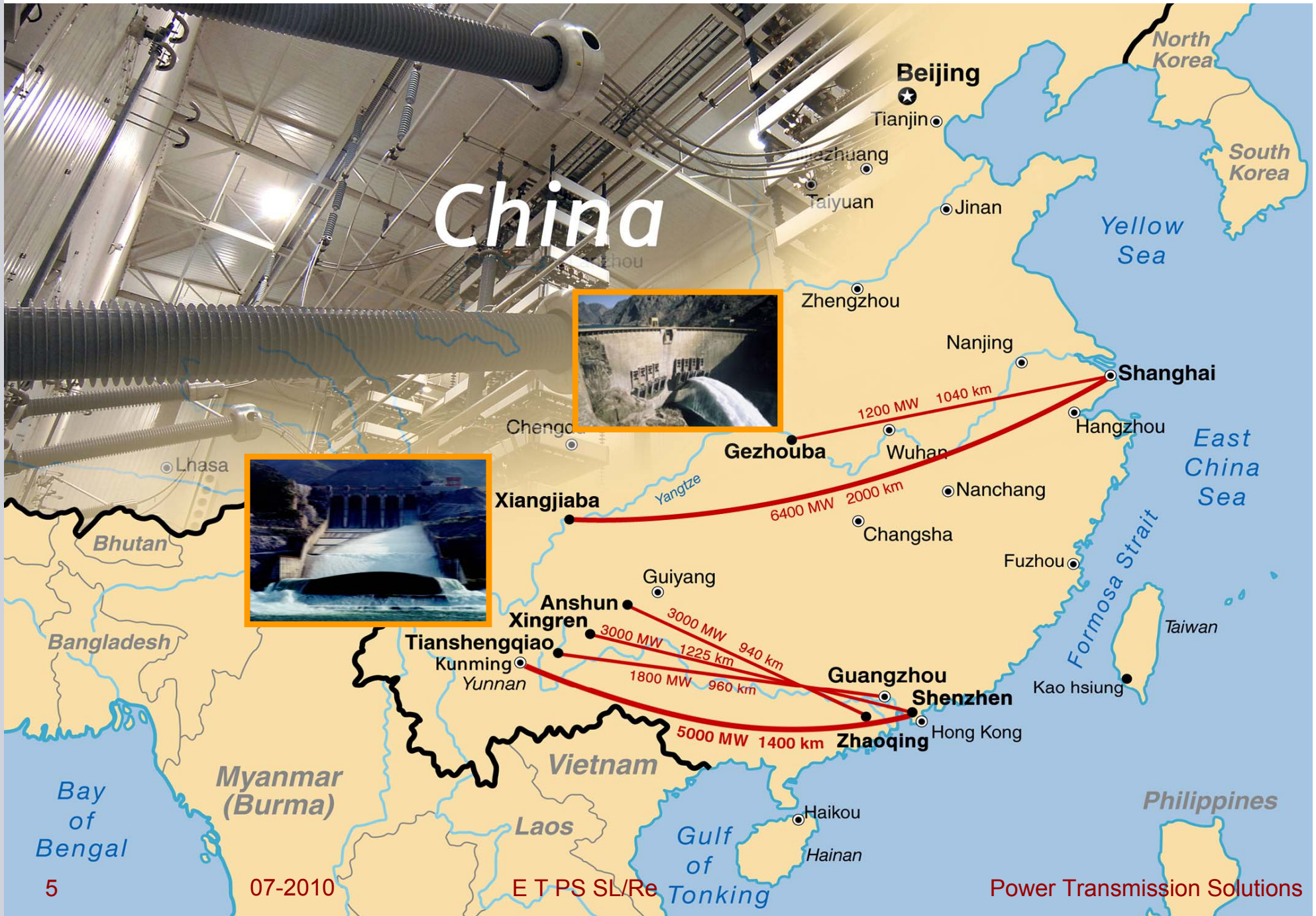
* EWEA: European Wind Energy Association – Pure Power® Wind Energy Scenarios up to 2030 (Report 03-2008)

Green Energy: Prospects of Solar Power from Deserts



HVDC – for Bulk Power from Hydro Plants in China

SIEMENS





SIEMENS

Projects *with*

- **Super Grid Technologies**
- **Smart Grid Technologies**

Siemens received an Order for the **World's first 800 kV UHV DC** in **China Southern Power Grid**

- 图例**
- ⊙ 500kV变电站
 - ⊙ 220kV变电站
 - 500kV线路
 - 220kV线路
 - 400kV线路
 - 500kV直流线路
 - ⊠ 抽水蓄能电厂
 - ⊗ 换流站
 - ⊘ 500kV开关站
 - ⊠ 火电厂
 - ⊠ 水电厂
 - ⊠ 核电站

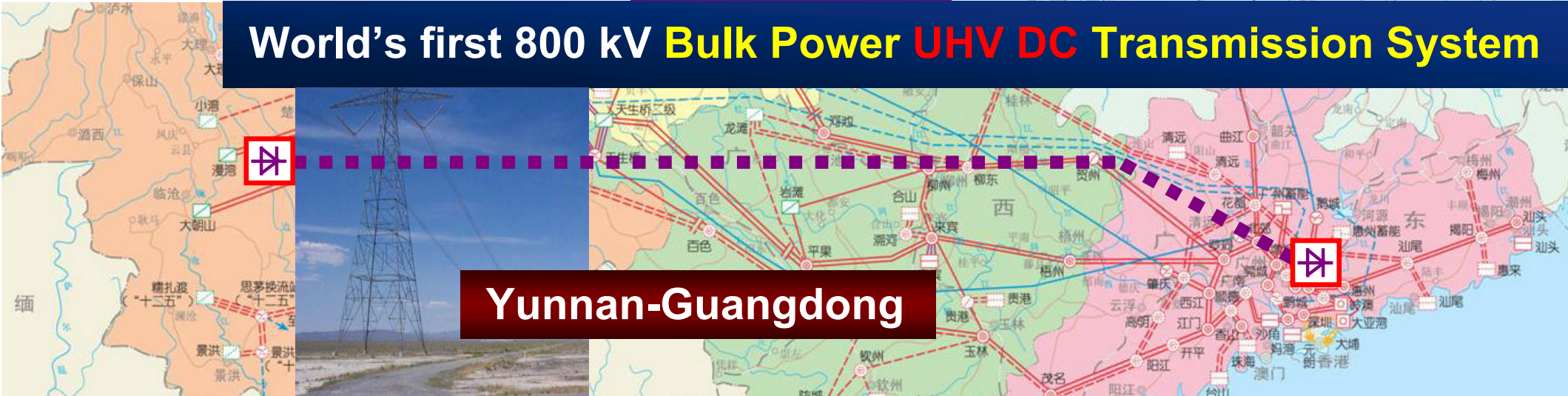
2004年9月编制 (在建及规划项目为2010年水平)



Commercial Operation:

- 2009 – Pole 1
- 2010 – Pole 2

World's first 800 kV Bulk Power UHV DC Transmission System



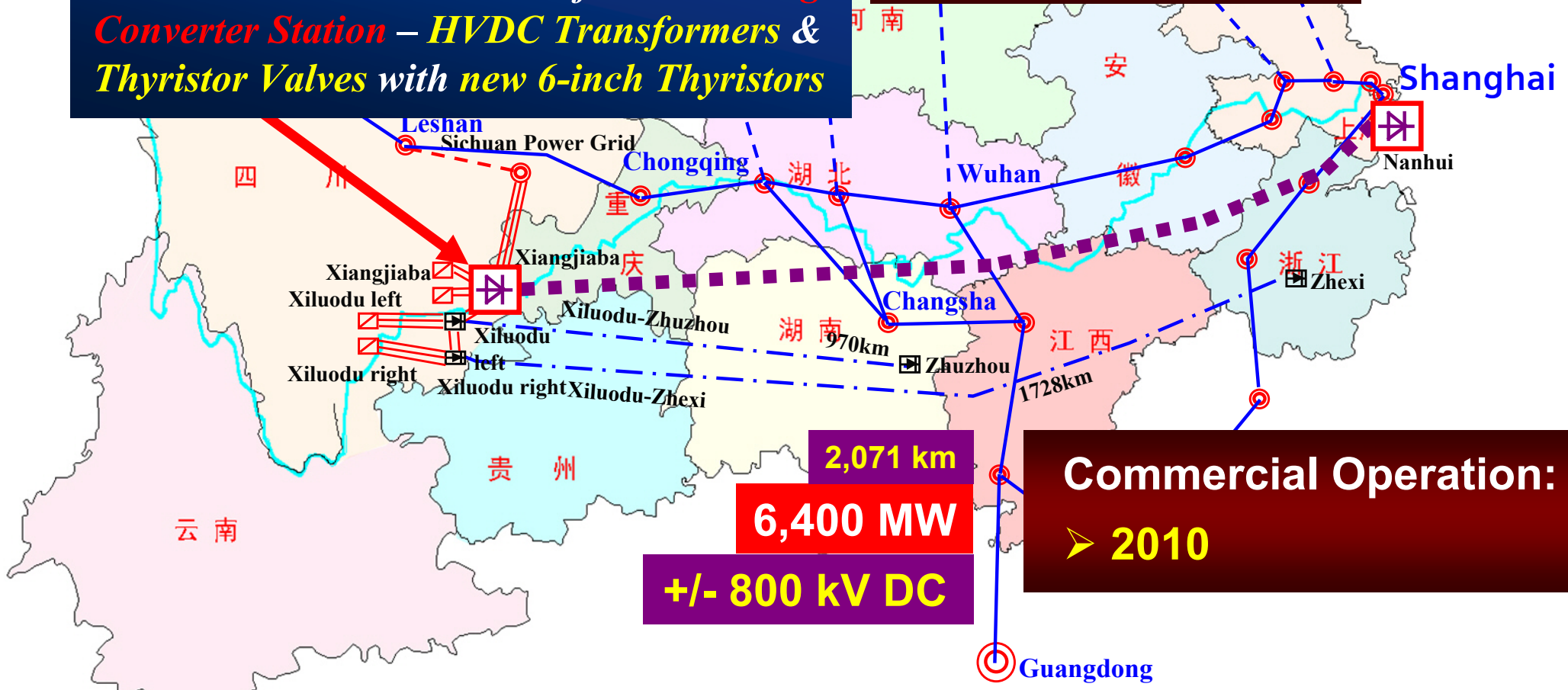
Reduction in CO₂ → versus local Power Supply with Energy-Mix
32.9 m tons p.a. – by using Hydro Energy and HVDC for Transmission

World's biggest and longest 800 kV UHV DC

Transmission Project – State Grid Corporation of China

Siemens received an Order for the *Fulong Converter Station* – HVDC Transformers & Thyristor Valves with new 6-inch Thyristors

Xiangjiaba-Shanghai

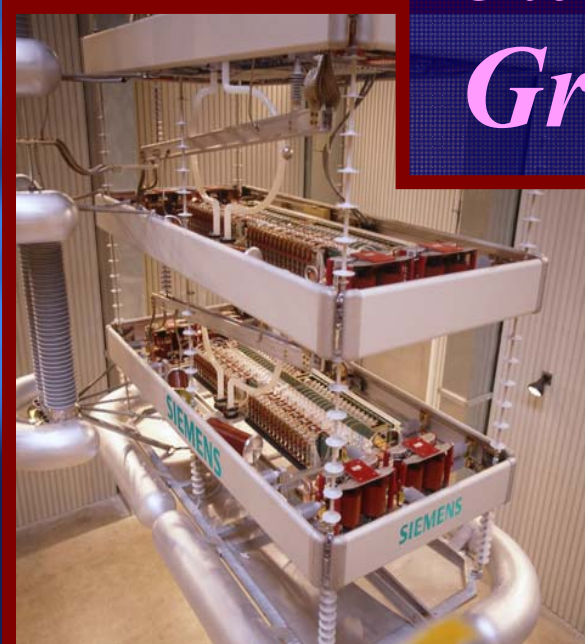


Commercial Operation:
➤ 2010

Reduction in CO₂ — versus local Power Supply with Energy-Mix
41 m tons p.a. – by using Hydro Energy and HVDC for Transmission

SIEMENS

*More Power
out of the
Grid ...*



云南至广东 $\pm 800\text{kV}$ 特高压直流输电工程
投产仪式
2009.12.28 广州

Yunnan-Guangdong

plus CO_2 Reduction

World's first **800 kV HVDC** – **5,000 MW**

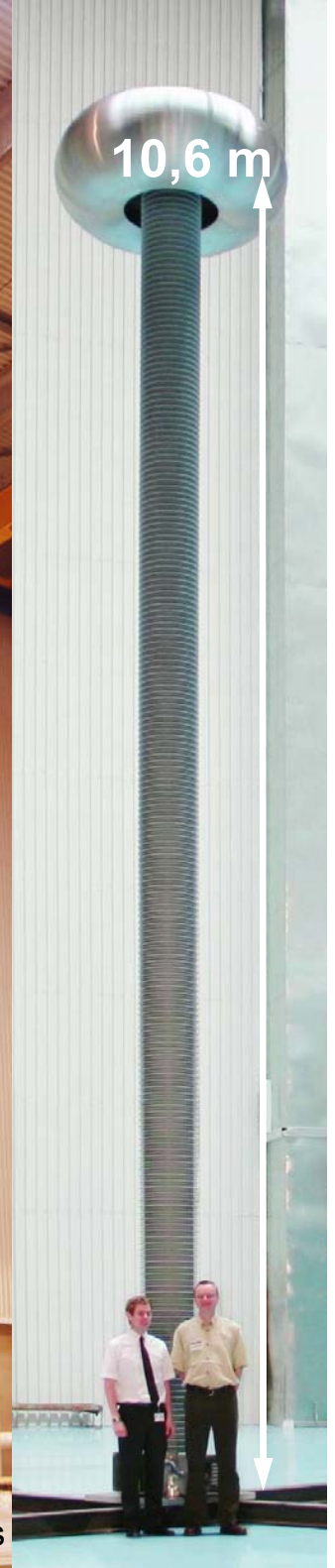
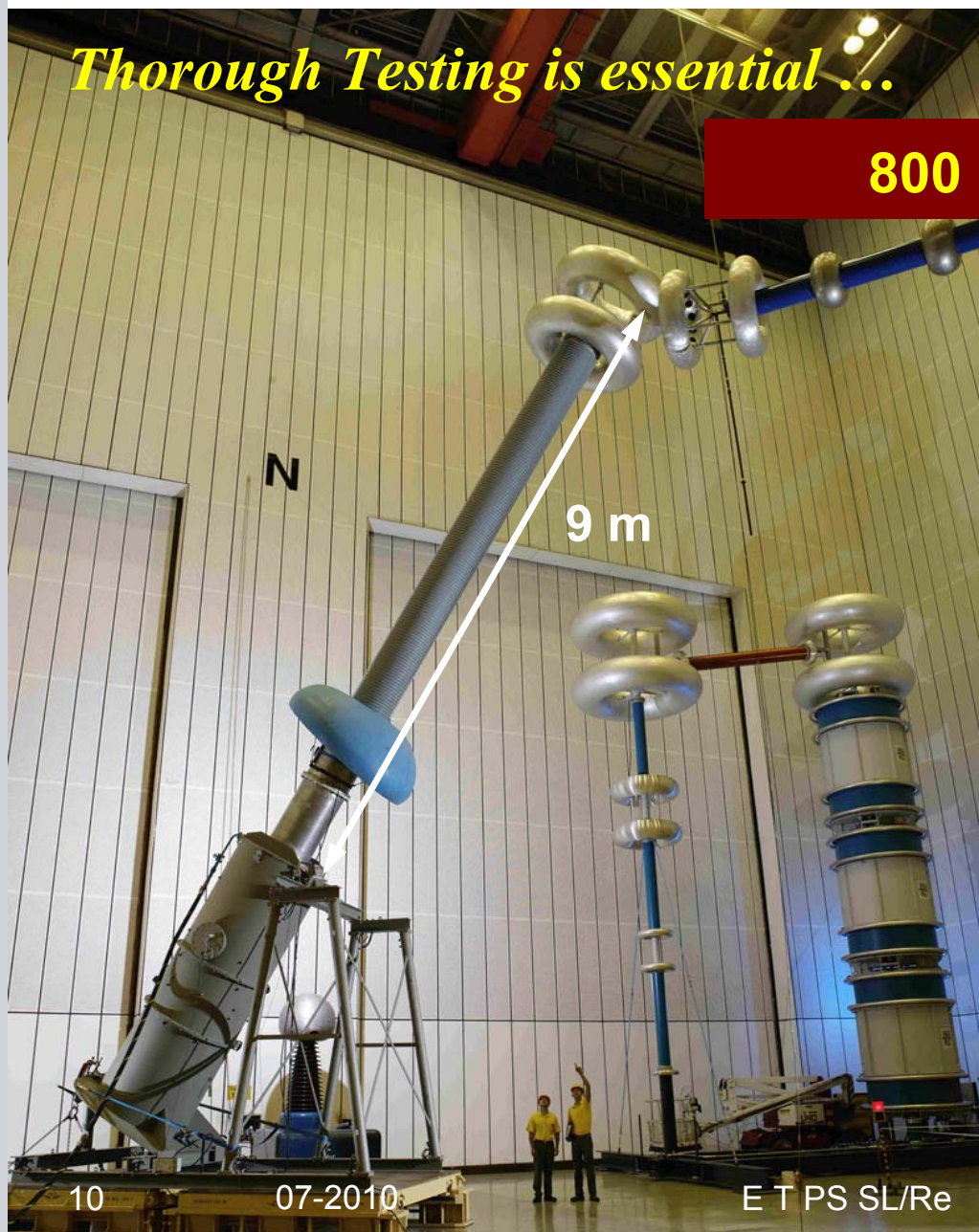
In **China Southern Power Grid**

Testing of UHV DC Bushing, DC Arrestor and Voltage Divider

Thorough Testing is essential ...

800 kV DC

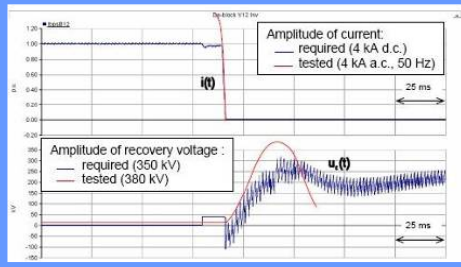
SIEMENS



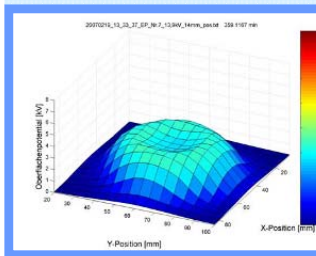
... at internal and external Test Laboratories



PSW Berlin



TU Munich



IPH Berlin



TU Dresden

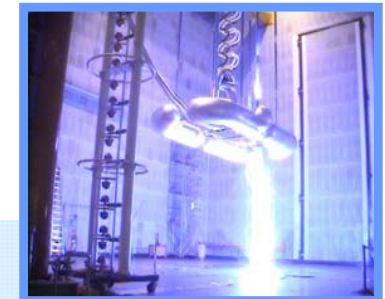
TU Graz



HSP Cologne

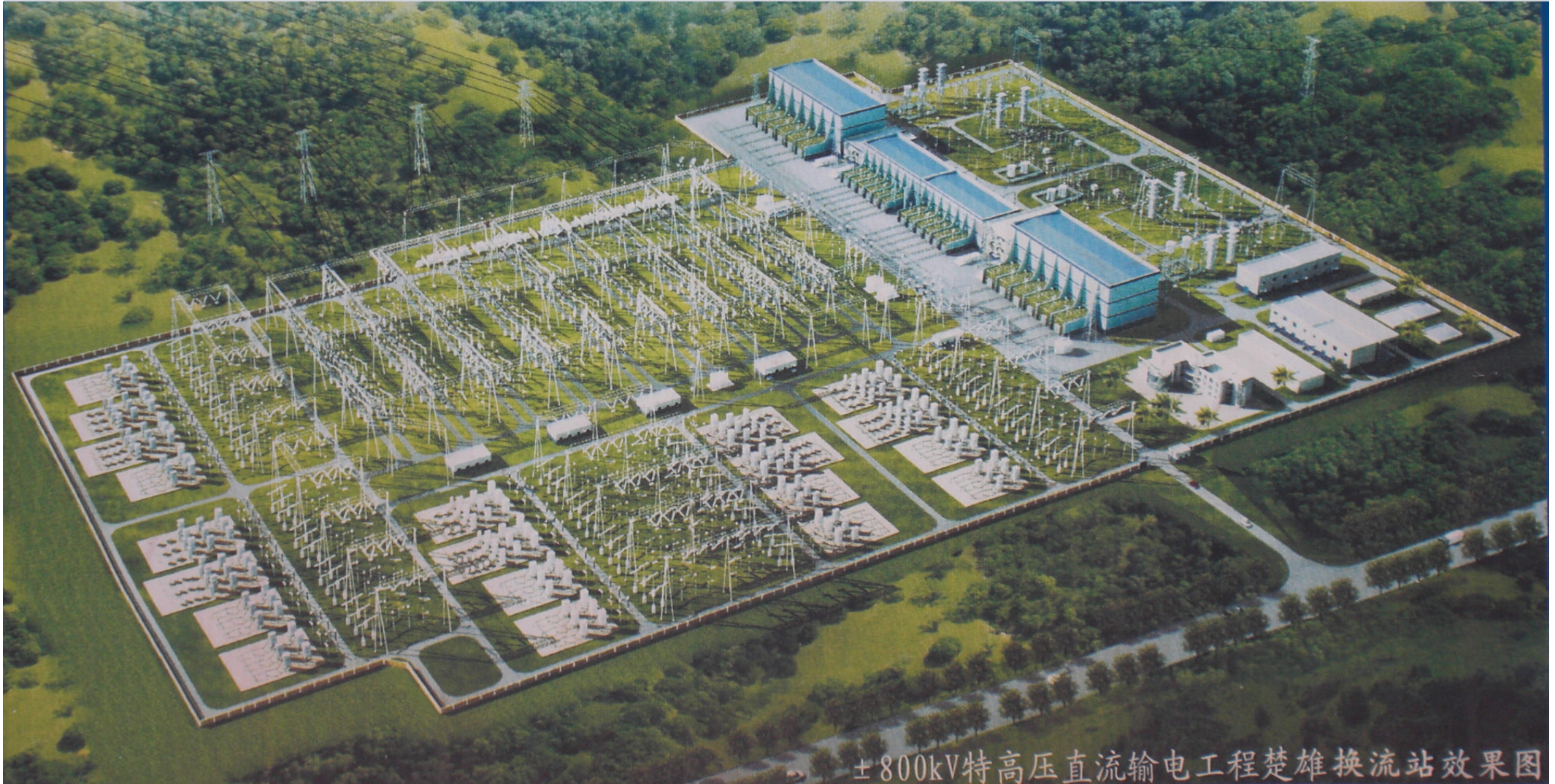
FGH Mannheim

KIT Karlsruhe



Yunnan-Guangdong – from ‘3D Models’ ...

SIEMENS



±800kV特高压直流输电工程楚雄换流站效果图

... to Reality: Sending Station Chuxiong

SIEMENS

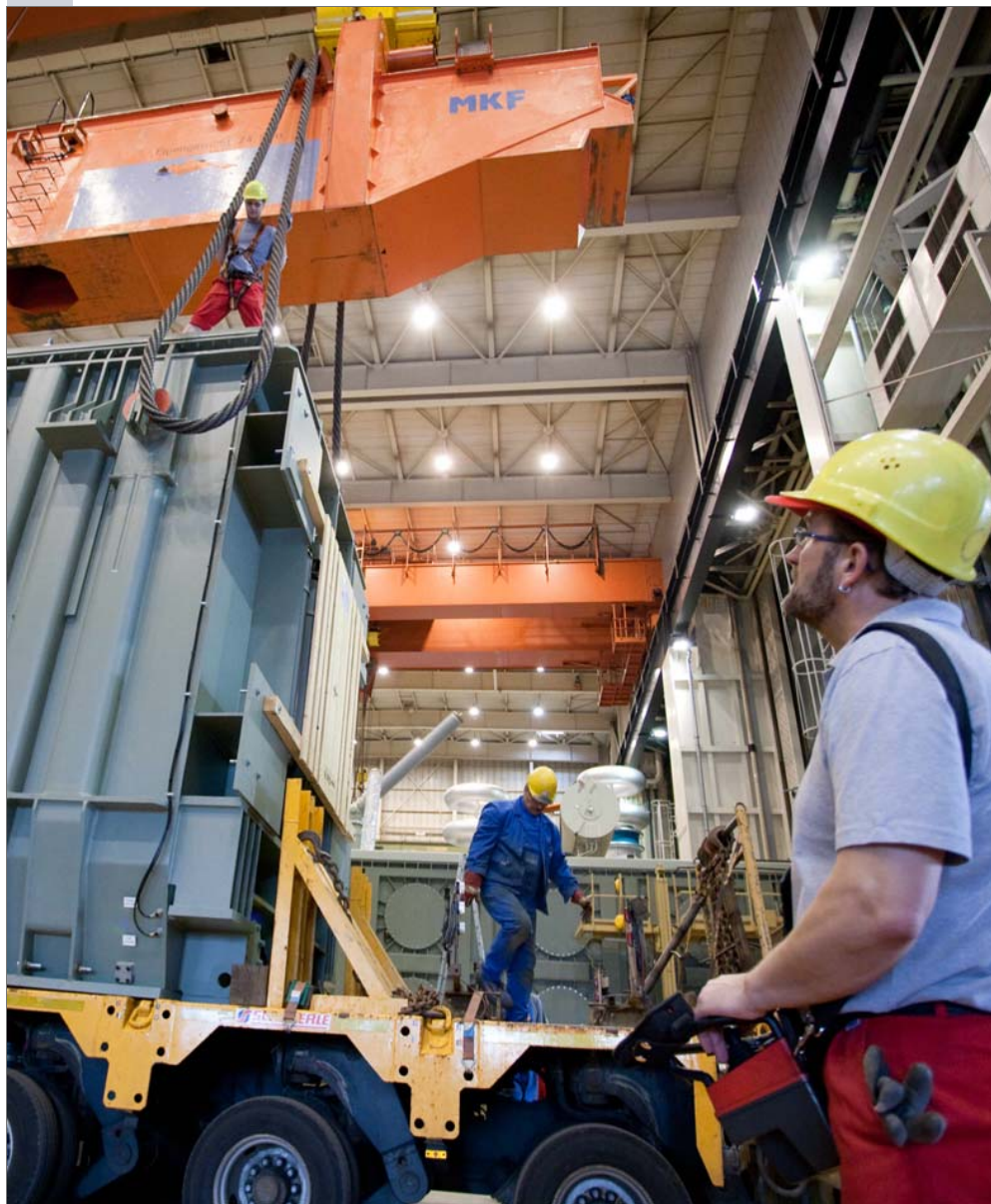


Yunnan-Guangdong: UHV DC – ‘Welcome’

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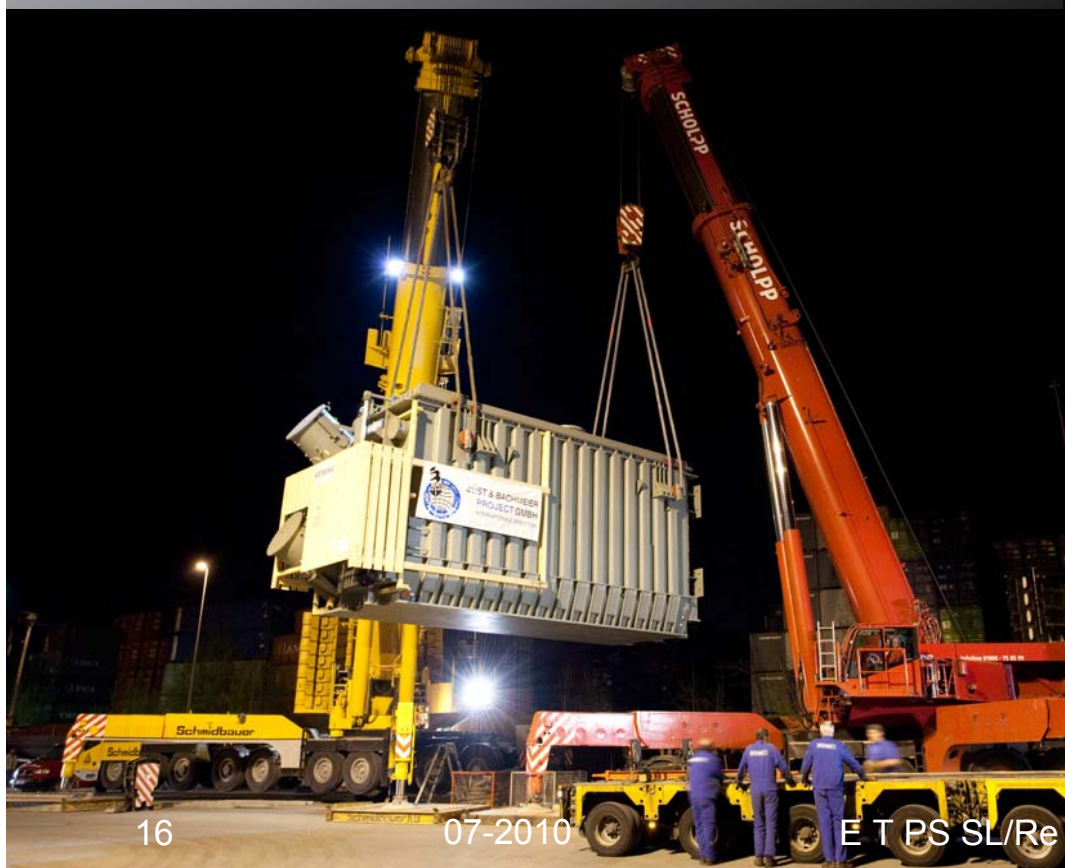


UHV DC Transformers: “ready to go” – at first **SIEMENS** by Truck, however carefully checking the Way...



River Boat in Germany, for going Overseas to China

SIEMENS



Overseas Travel finished – Transformers entering the Harbor in South China

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From “Offshore” to “On-shore”: in two different Ways

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Back on the Road again – Transformers just fitting well, as expected

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UHV DC Transformers: welcome to the City

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UHV DC Substation – coming closer

SIEMENS



UHV DC Transformers arriving



UHV DC Transformers arriving contd.



UHV DC: Transportation – a crucial Issue

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UHV DC Transformers – ‘Welcome’

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Yunnan-Guangdong – UHV DC Valve Halls

SIEMENS



800 kV DC

2 x 400 kV DC

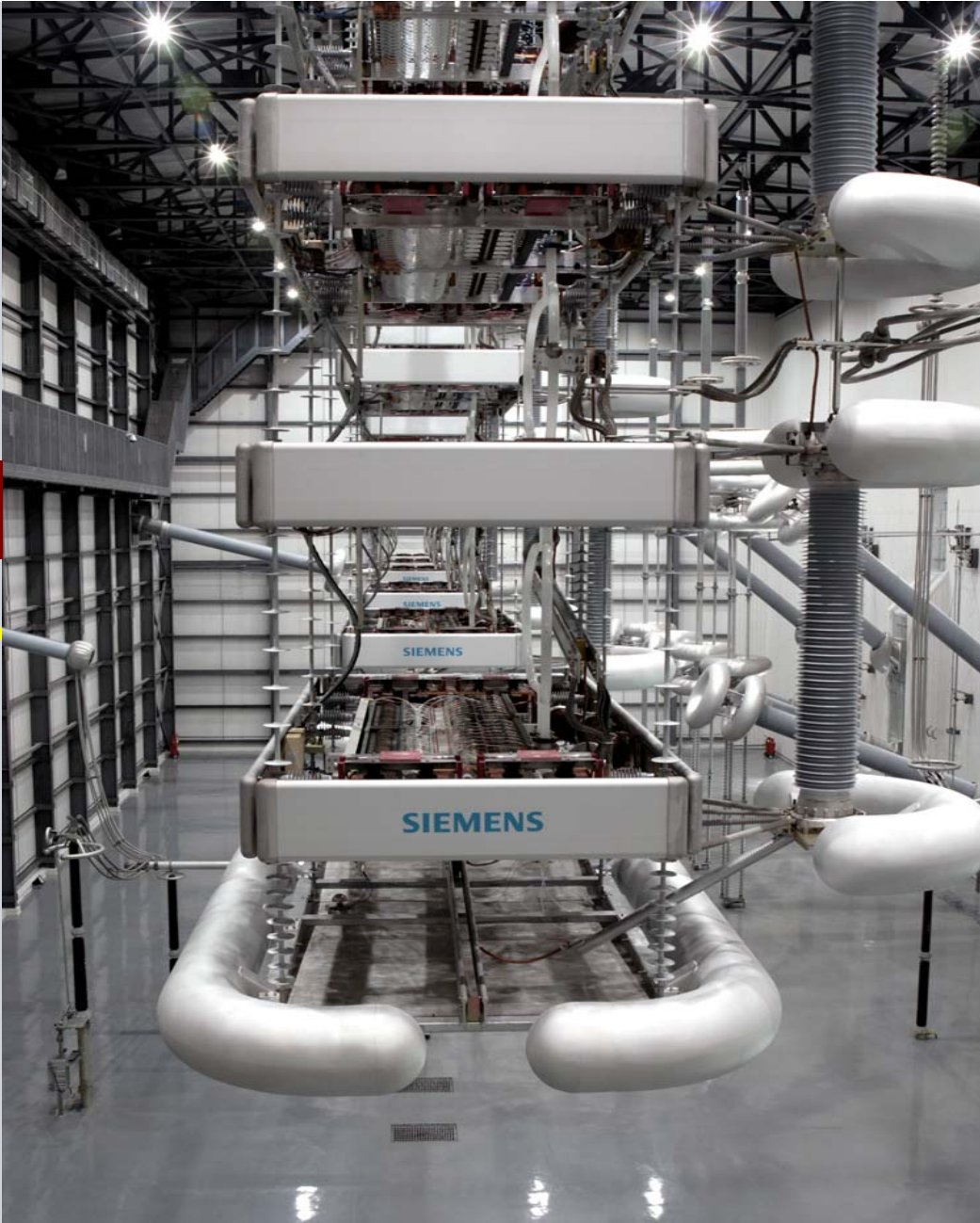
800 kV DC

深入开展学习实践活动 着力提高南方电网主网架 争当科学发展排头兵

UHV DC Valve Hall – from indoor to outdoor



800 kV DC

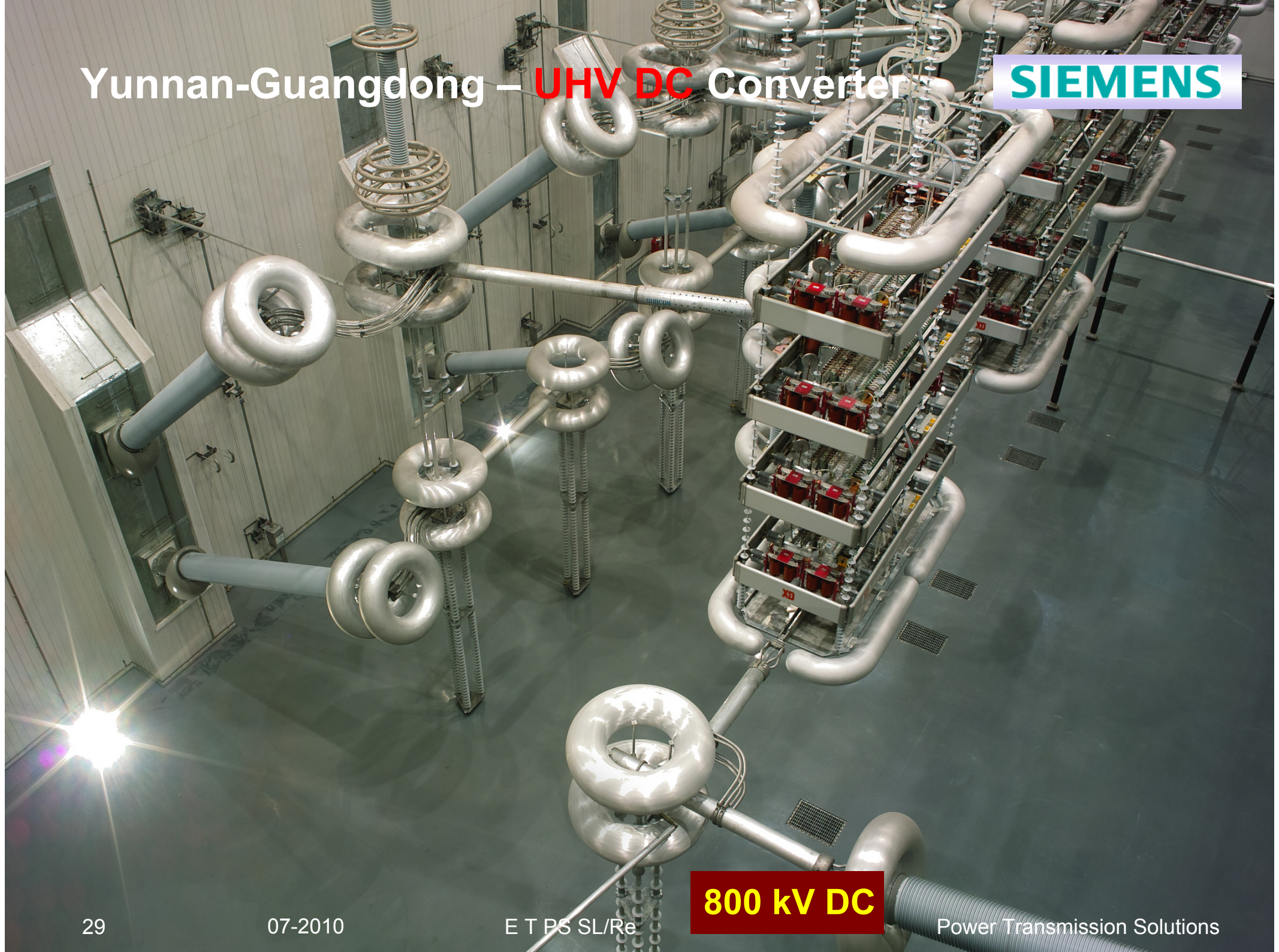


Yunnan-Guangdong – UHV DC Converter



400 kV DC

Yunnan-Guangdong – UHV DC Converter



Yunnan-Guangdong – UHV DC Converter



Yunnan-Guangdong – UHV DC Converter



Station Chuxiong – DC Reactors & DC Yard

SIEMENS



Yunnan-Guangdong – 800 kV DC Lines

SIEMENS



800 kV DC Overhead Line

SIEMENS

Welcome great
Outdoors !



800 kV DC Overhead Line

SIEMENS

Welcome great
Outdoors !



Yunnan-Guangdong: UHV DC – Inauguration Pole 1 SIEMENS



云南至广东±800kV特高压直流输电工程
投产仪式

2009.12.28 广州

云南至广东±800千伏

特高压直流输电工程投产仪式现场

Yunnan-Guangdong: UHV DC – Inauguration Pole 1 **SIEMENS**



Yunnan-Guangdong – UHV DC completed

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*More Power
out of the
Grid ...*

SIEMENS

In Co-Operation with



西安西电电力整流器有限责任公司
XIAN XD POWER RECTIFIER CO., LTD.

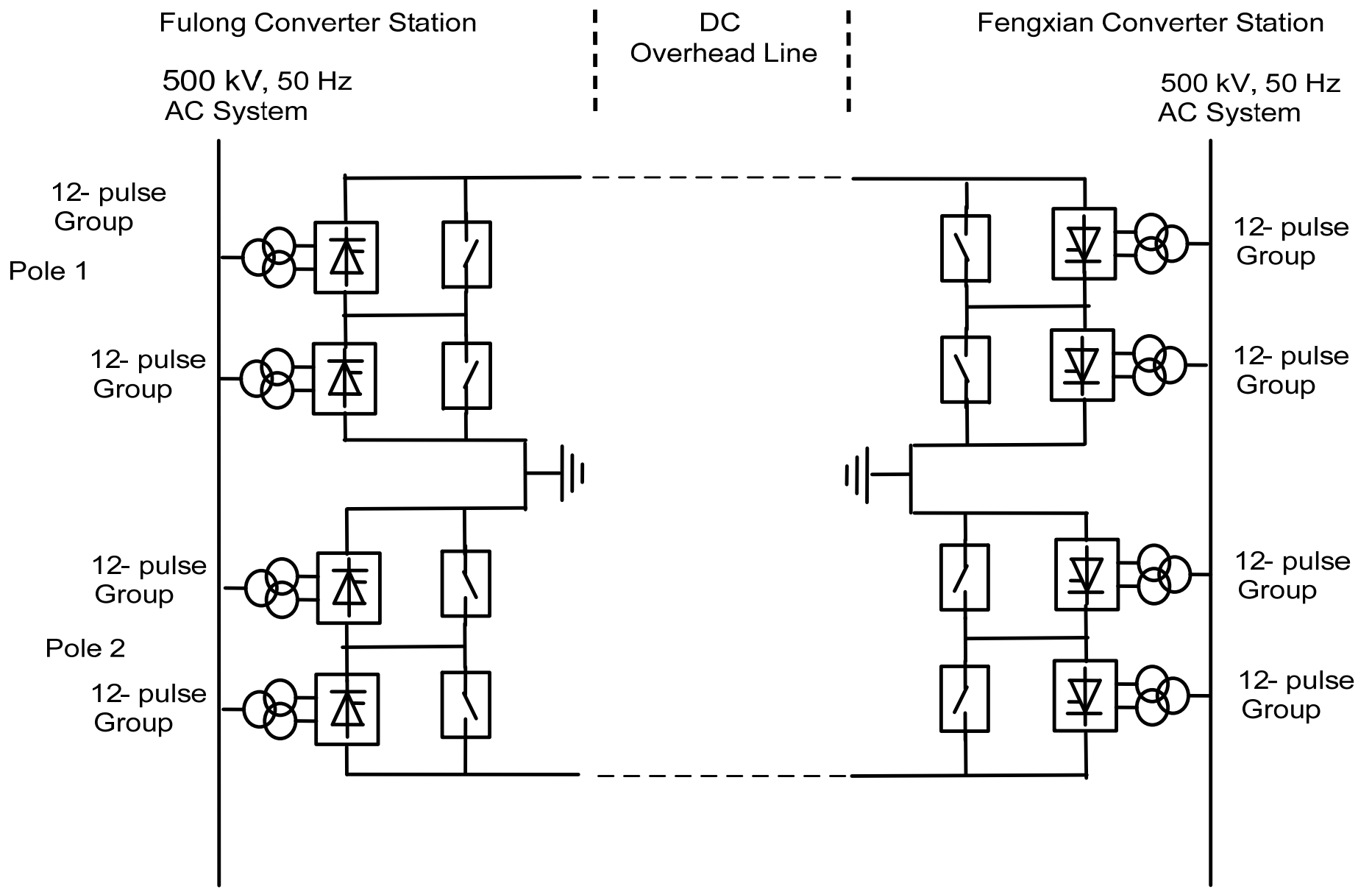
Fulong Converter Station – HVDC
Transformers & Thyristor Valves
with new 6-inch Thyristors

plus CO₂ Reduction

Xiangjiaba-Shanghai

World's biggest and longest **800 kV HVDC**

Schematic Arrangement of Xiangjiaba-Shanghai Converters



Design of Thyristor Valves for Fulong Station: **SIEMENS**

Latest Development of Power Thyristors: 6“-ETT

- DC Current Capability of more than 4,500 A
- Optimum Blocking Voltage of 8.5 kV
- Joining of the Silicon Pellet to a Molybdenum Carrier Disk using low-Temperature high-Pressure Sintering
 - ✓ Excellent thermal Coupling
 - ✓ Low thermal Resistance
 - ✓ Outstanding Short-Circuit Current Capability: **> 80 kA**
- High Reliability, Failure Rate < 10 fit



6" high-Power Thyristor compared with 4" and 5" Elements

PEBBs* for High Voltage: HVDC & SVC PLUS

SIEMENS

HVDC PLUS

The Advanced VSC HVDC

*Power Electronic Building Blocks

Future
Molding
Technologies,

Innovation Meets Experience

SVC PLUS®

The Advanced STATCOM

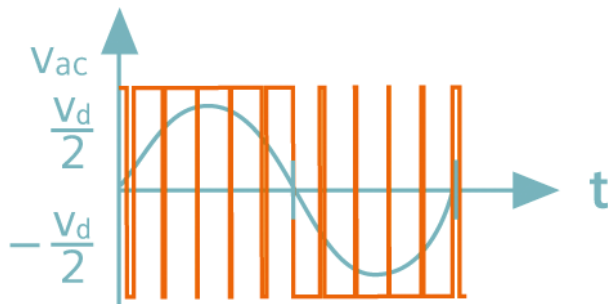
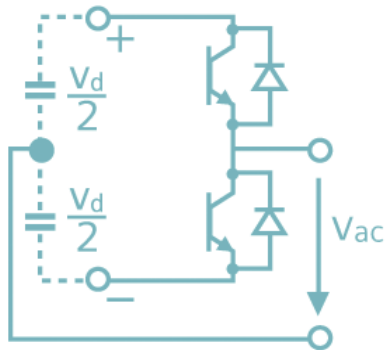
focused on
Green Energy
and CO₂
Reduction

The Evolution of VSC Technology

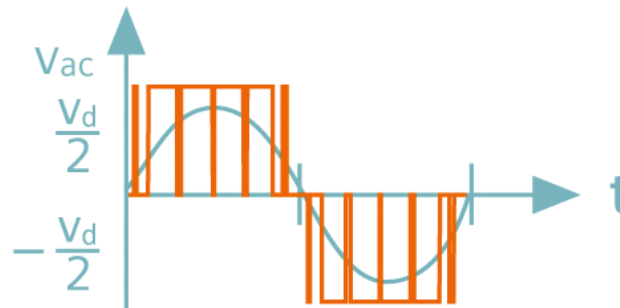
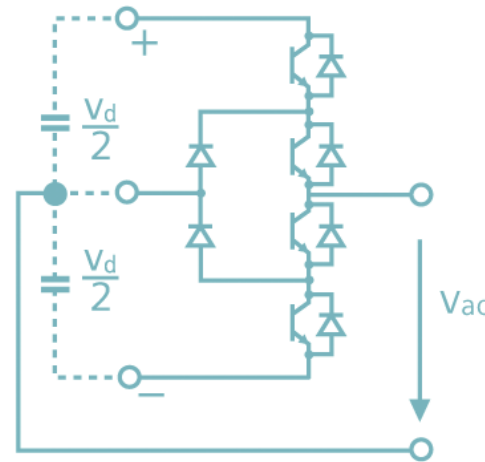
Topologies: Two-Level

Three-Level

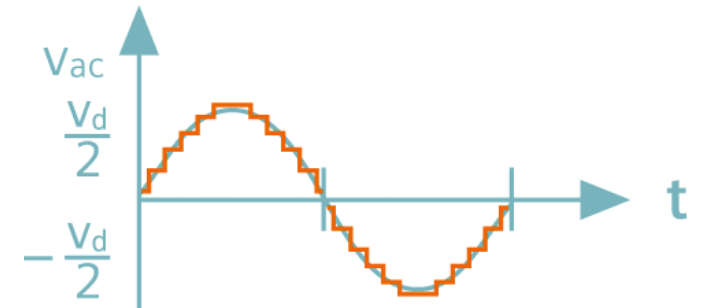
Multilevel



GTO / IGCT

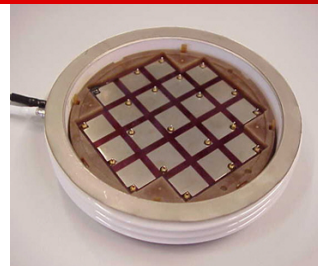


IGBT in PP



IGBT Module

Power Electronic Devices:



Solutions for **Grid Access** and System Enhancement: **SVC PLUS** and **HVDC PLUS**

SIEMENS

Offshore and Onshore



Benefits of HVDC PLUS

SIEMENS

- Low Switching Frequency
- Reduction in Losses
- Less Stresses



In Comparison with 2 and 3-Level Converter Technologies

... with Advanced VSC Technology

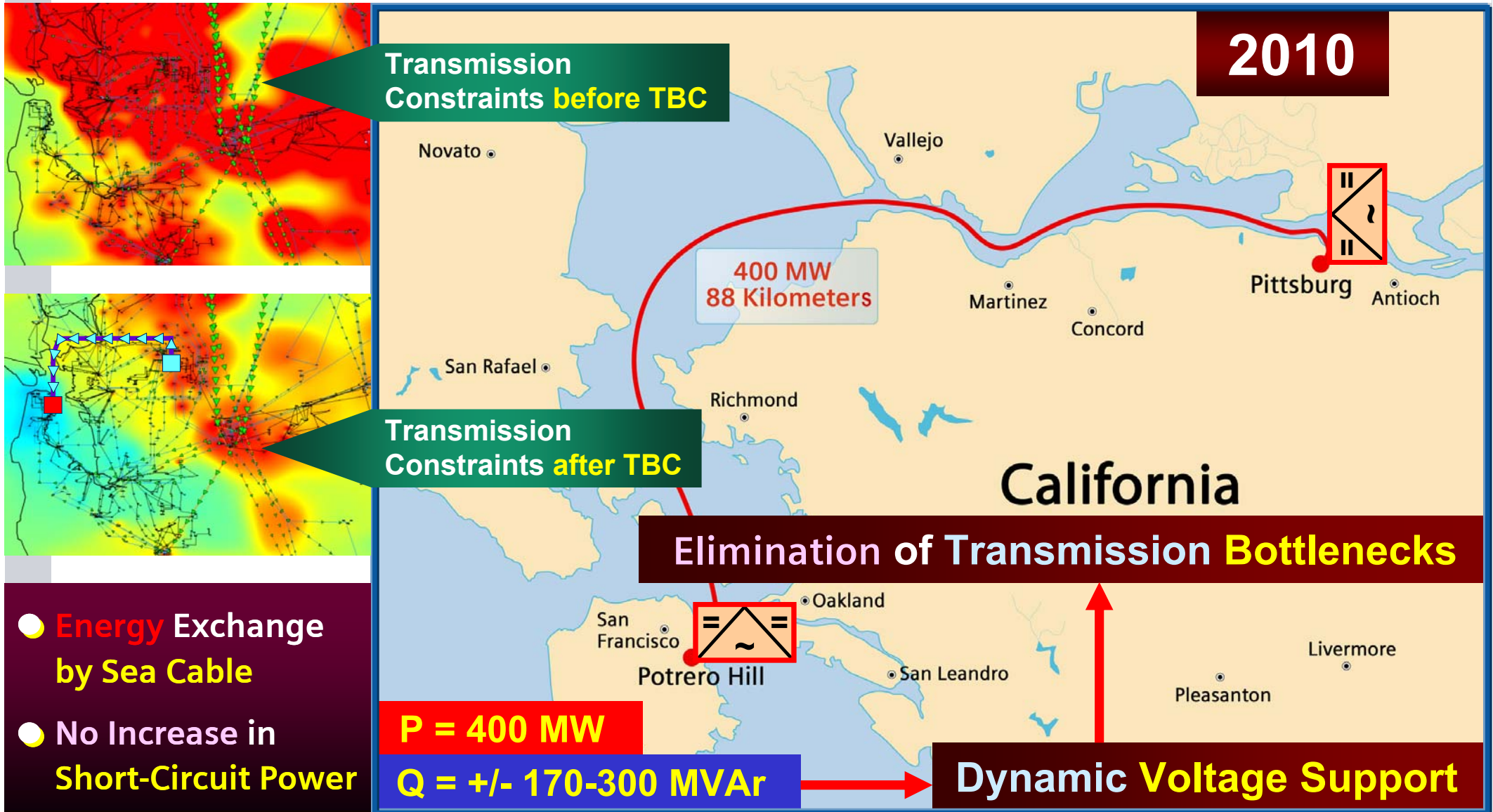
Siemens uses **MMC** Technology
(**M**odular **M**ultilevel **C**onverter)



HVDC PLUS: Trans Bay Cable Project, USA

Security of Supply for San Francisco Area

SIEMENS



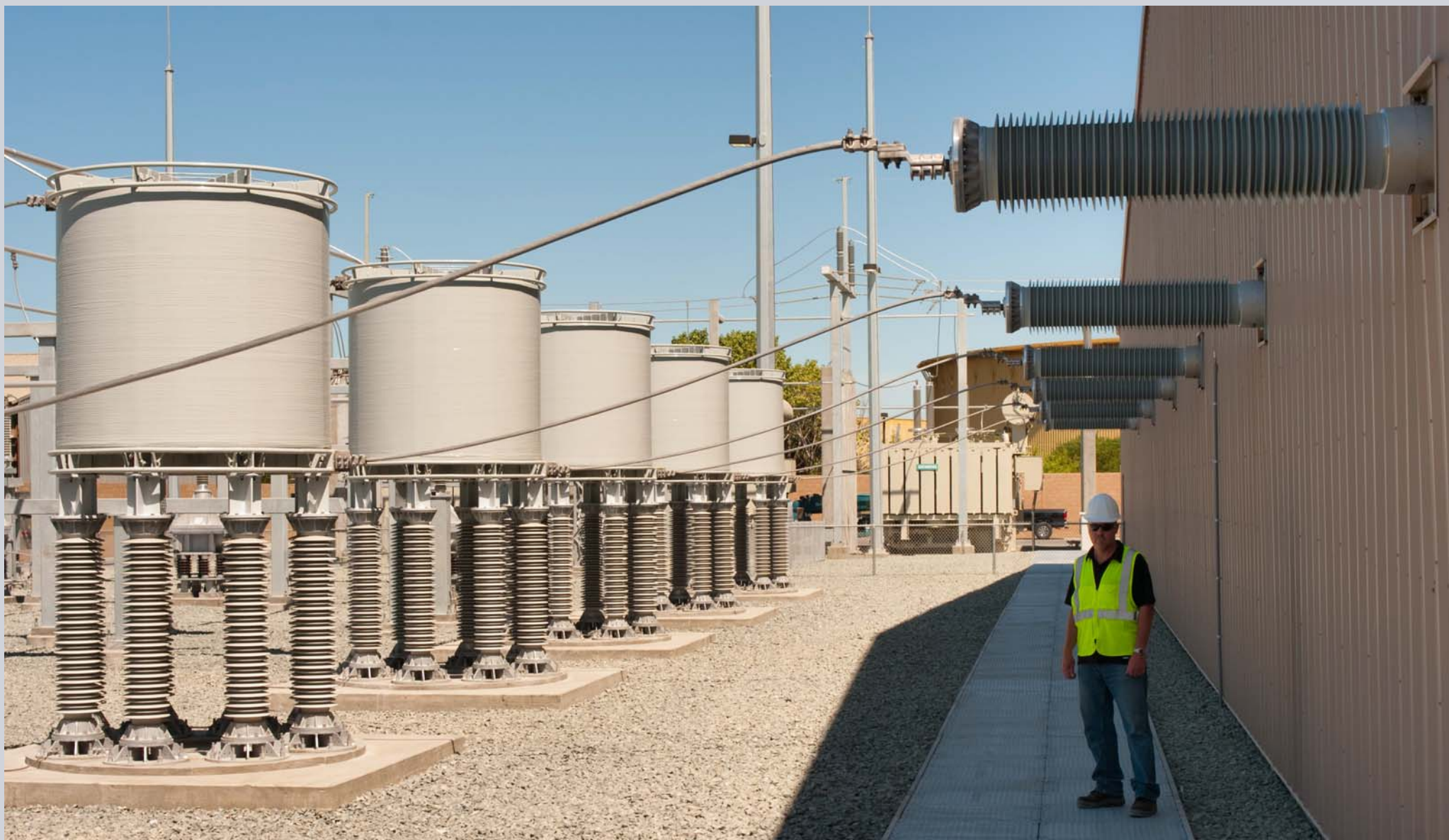
HVDC PLUS: Trans Bay Cable Project, USA

SIEMENS



HVDC PLUS: Trans Bay Cable Project, USA

SIEMENS

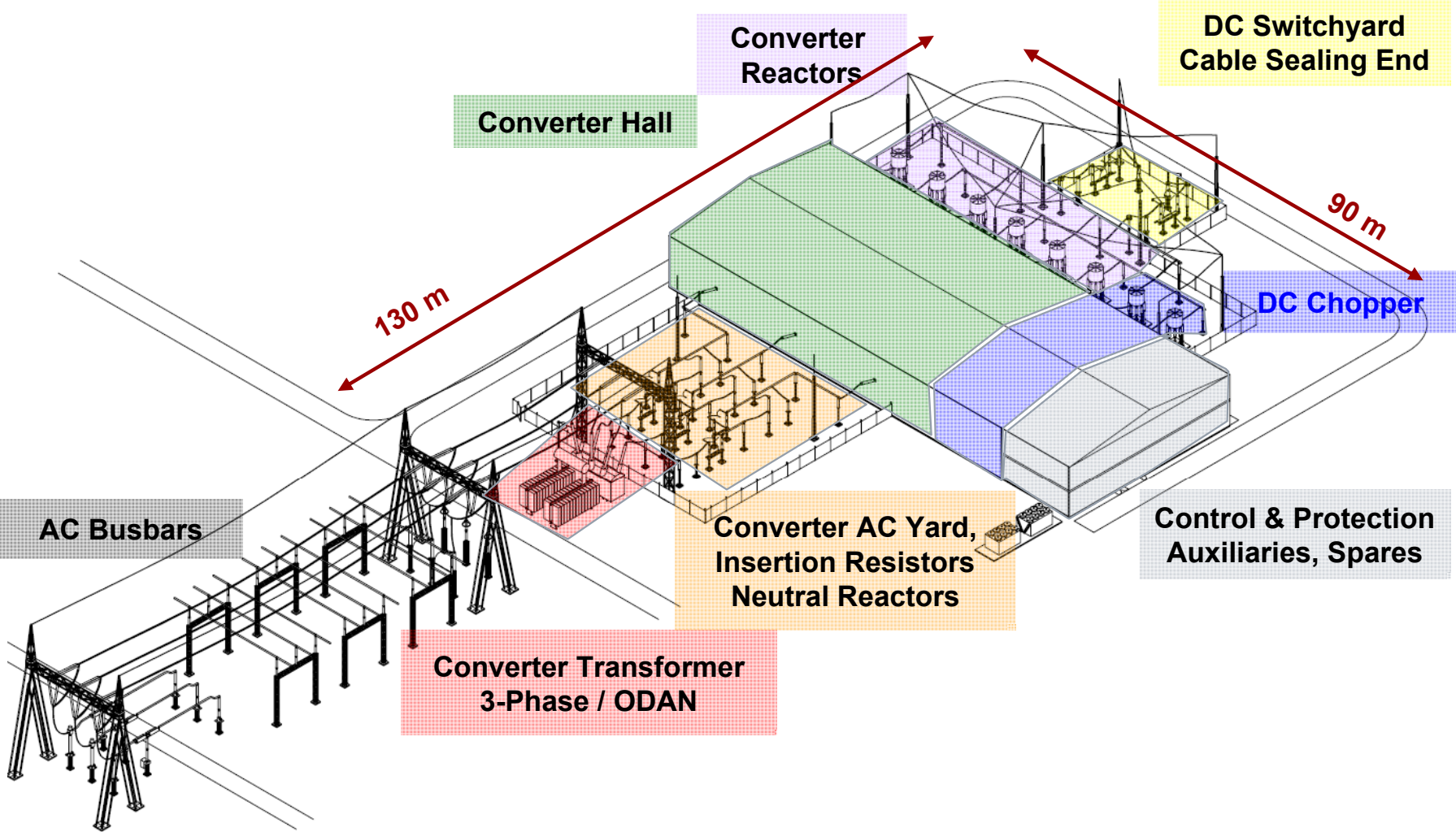


HVDC PLUS: Trans Bay Cable Project, USA

SIEMENS



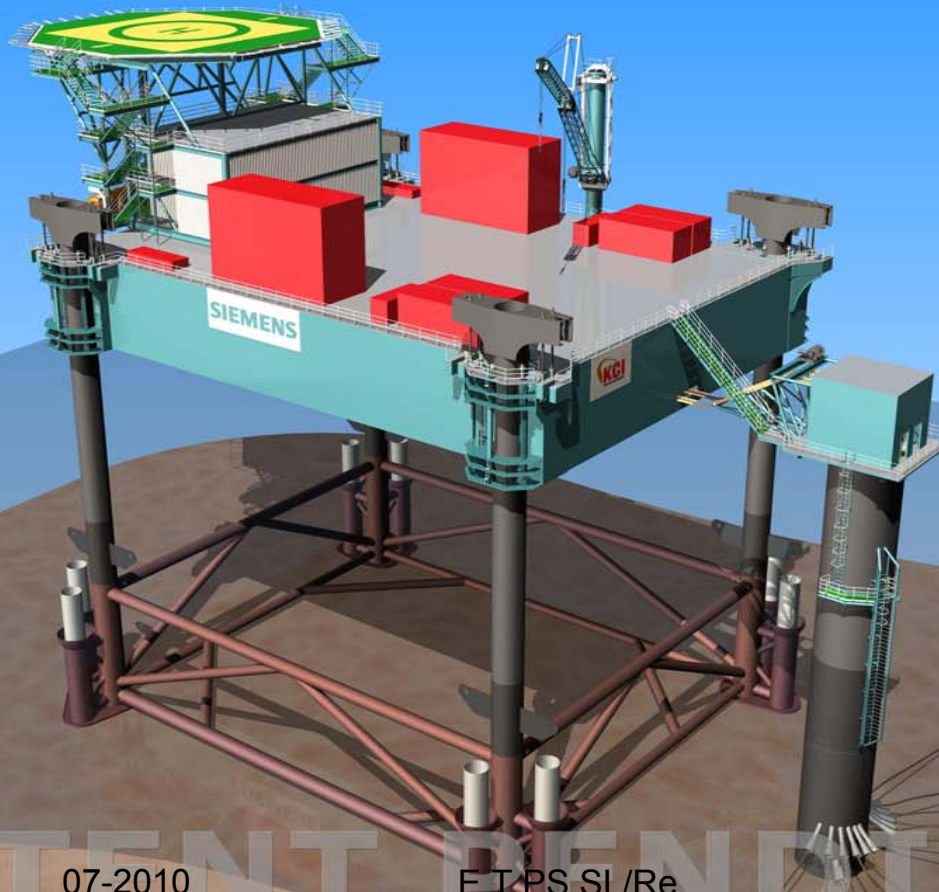
Onshore Station Layout – Example 400 MW, +/- 200 kV



Grid Access of Green Energy with **HVDC PLUS**:

SIEMENS

WIPOS – Advanced self-lifting Offshore Platform Layout



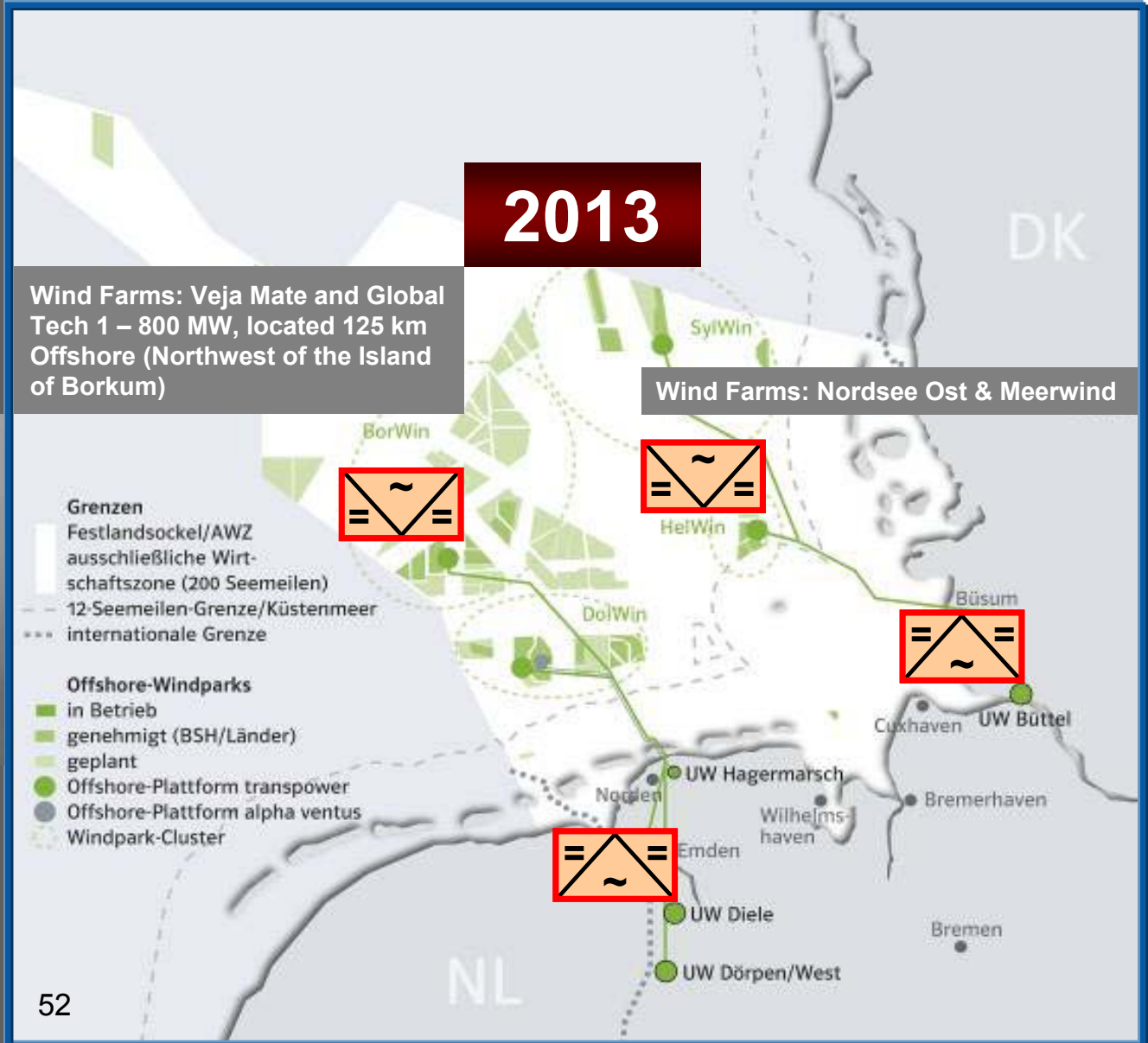
HVDC PLUS and WIPOS: BorWin 2, Germany – SIEMENS

World's first VSC HVDC with 800 MW and HelWin 1 at 576 MW

- The Siemens **Wind Power Offshore Substation (WIPOS)** is designed as a floating, **self-lifting** Platform
- The Platform will be towed by Tugs to its Destination at Sea, where the Water is about 40 meters deep



- A large heavy-duty Crane vessel is not needed to lift the Topside onto its Foundation
- The **Modular Multilevel VSC Technology (MMC)** reduces Complexity and therefore the Space required for Installation



SVC PLUS[®]

The Advanced STATCOM

Innovation Meets Experience

Applications of **MMC** Technology
(**M**odular **M**ultilevel **C**onverter)

SIEMENS

Single Units:

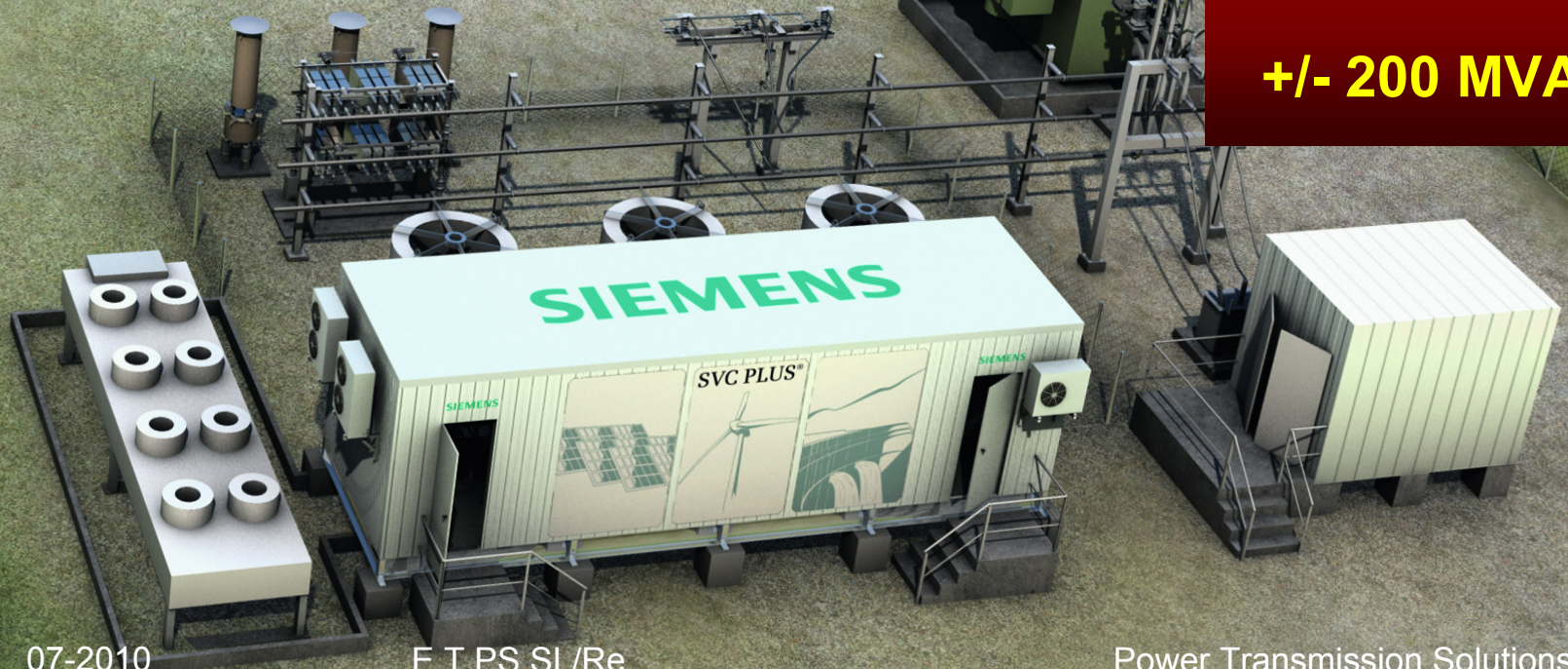
S: +/- 25 MVar

M: +/- 35 MVar

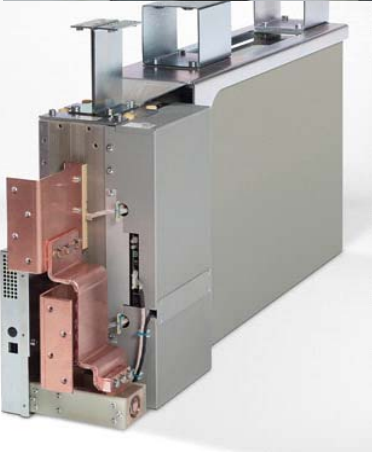
L: +/- 50 MVar

Up to 4
parallel Units:

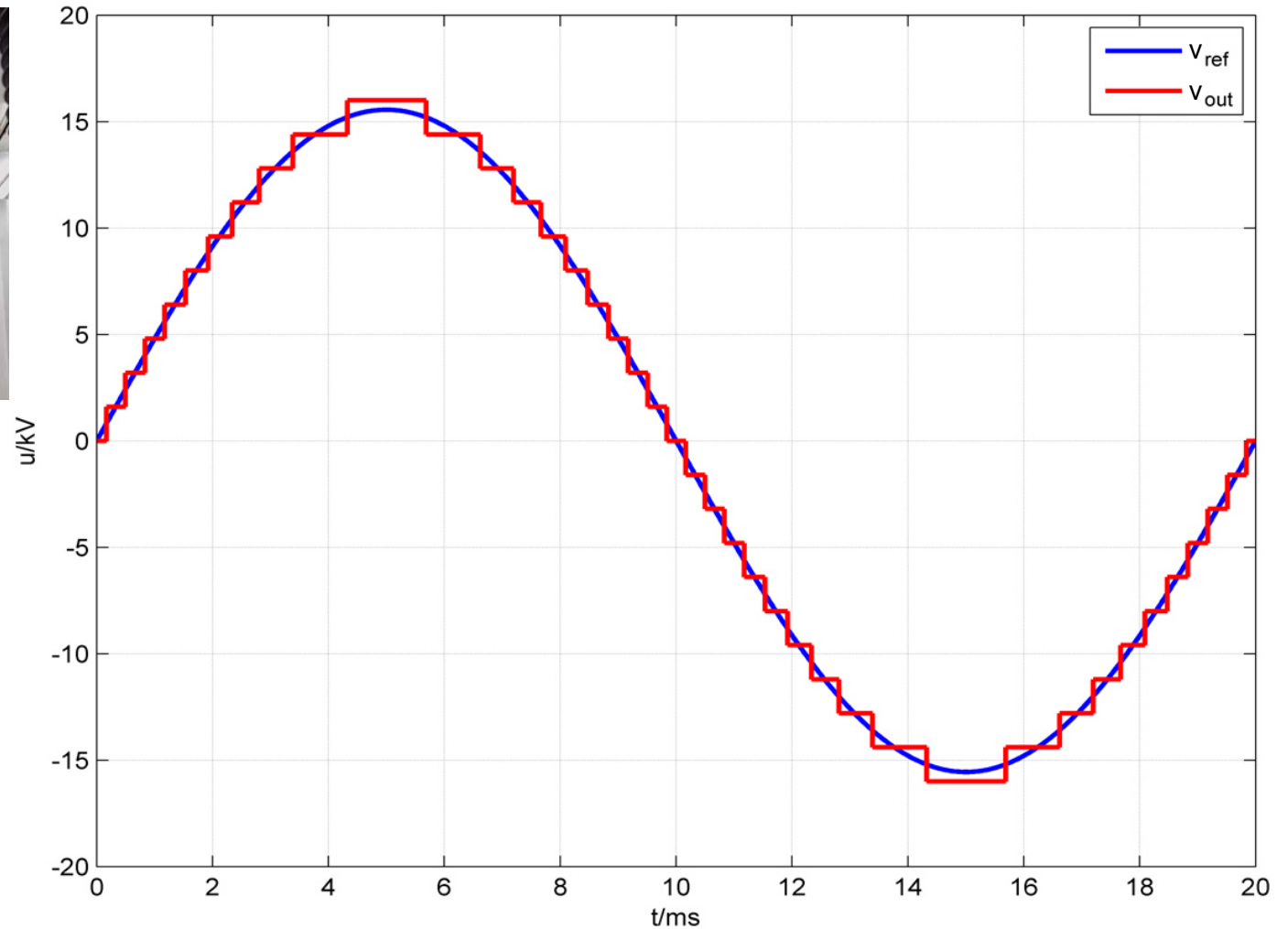
+/- 200 MVar



From Power Module to Converter – the **Multilevel Voltage Generation**



Power Module
with DC Capacitor



SVC PLUS: the Advanced STATCOM

SIEMENS

2009 - 2014

18 Systems in 9 T & D Projects



Rating: up to +/- 200 MVar

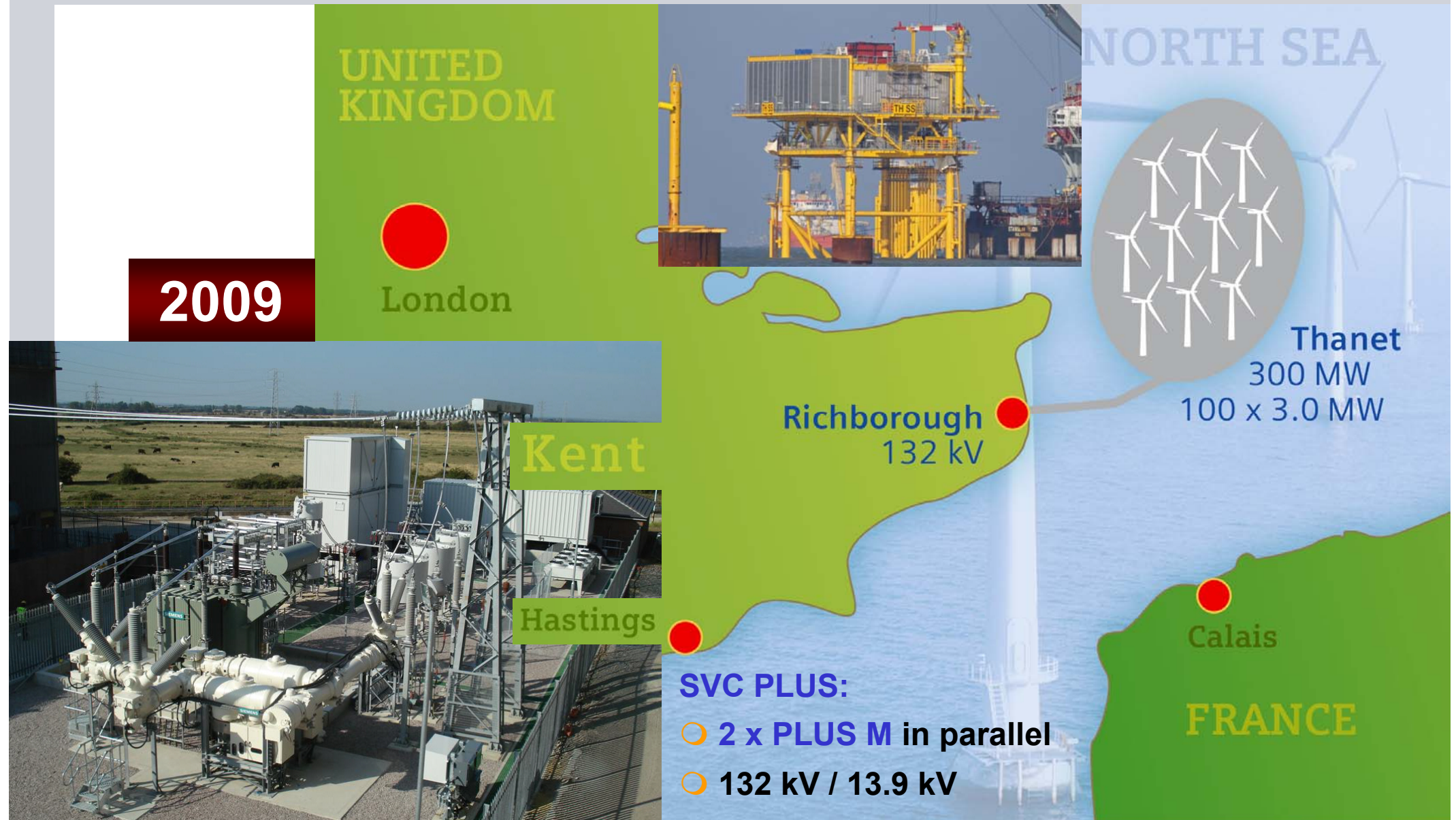
Dynamic Voltage Support



Grid Access of Green Energy with SVC PLUS:

SIEMENS

Thanet, UK – 2 SVC PLUS Systems for 300 MW Wind Farm



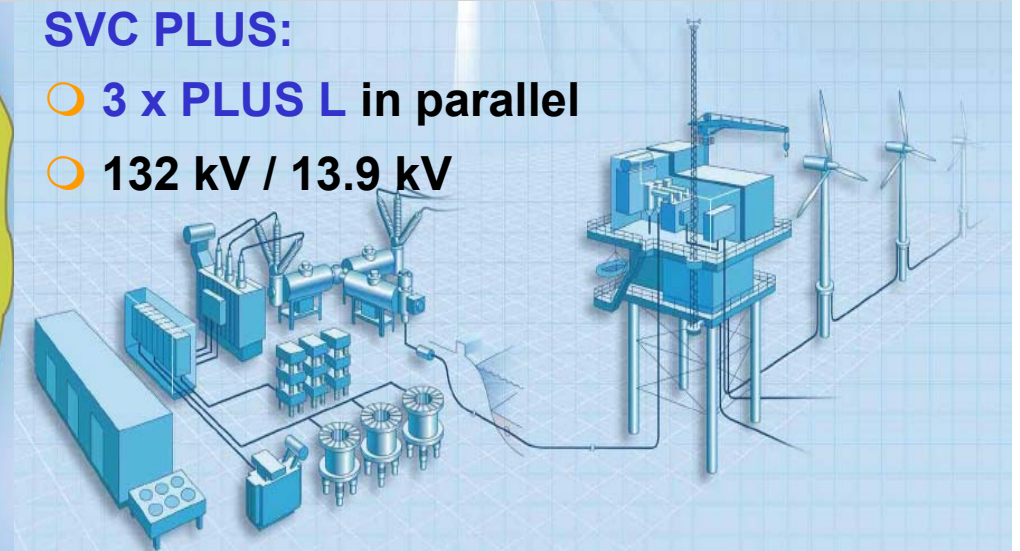
Grid Access of Green Energy with SVC PLUS: Greater Gabbard, UK – 3 SVC PLUS Systems ...

SIEMENS



SVC PLUS:

- 3 x PLUS L in parallel
- 132 kV / 13.9 kV



SVC PLUS:

- 4 x PLUS L in parallel
- 150 kV / 13.9 kV

2012
... and London Array

2011

Greater Gabbard
500 MW
140 x 3.6 MW

World's largest Offshore Wind Farm
630 MW & Upgrade up to 1 GW

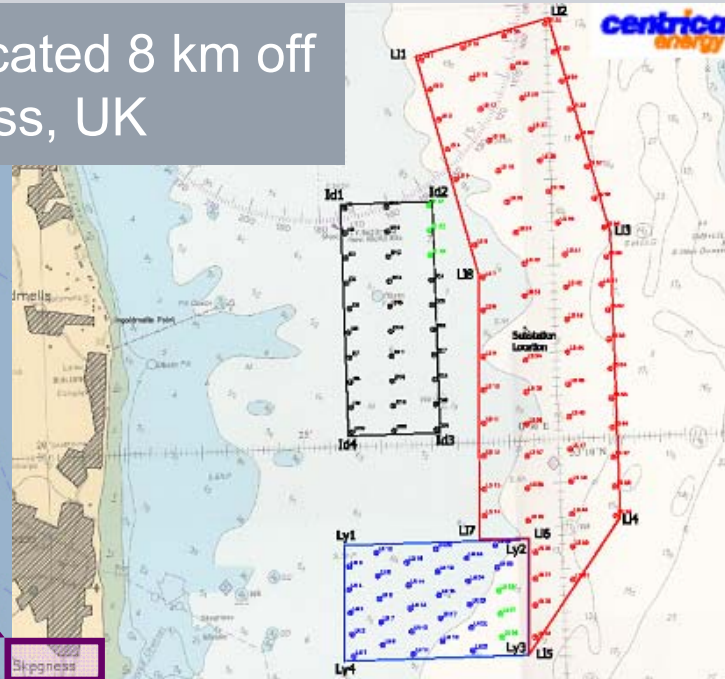
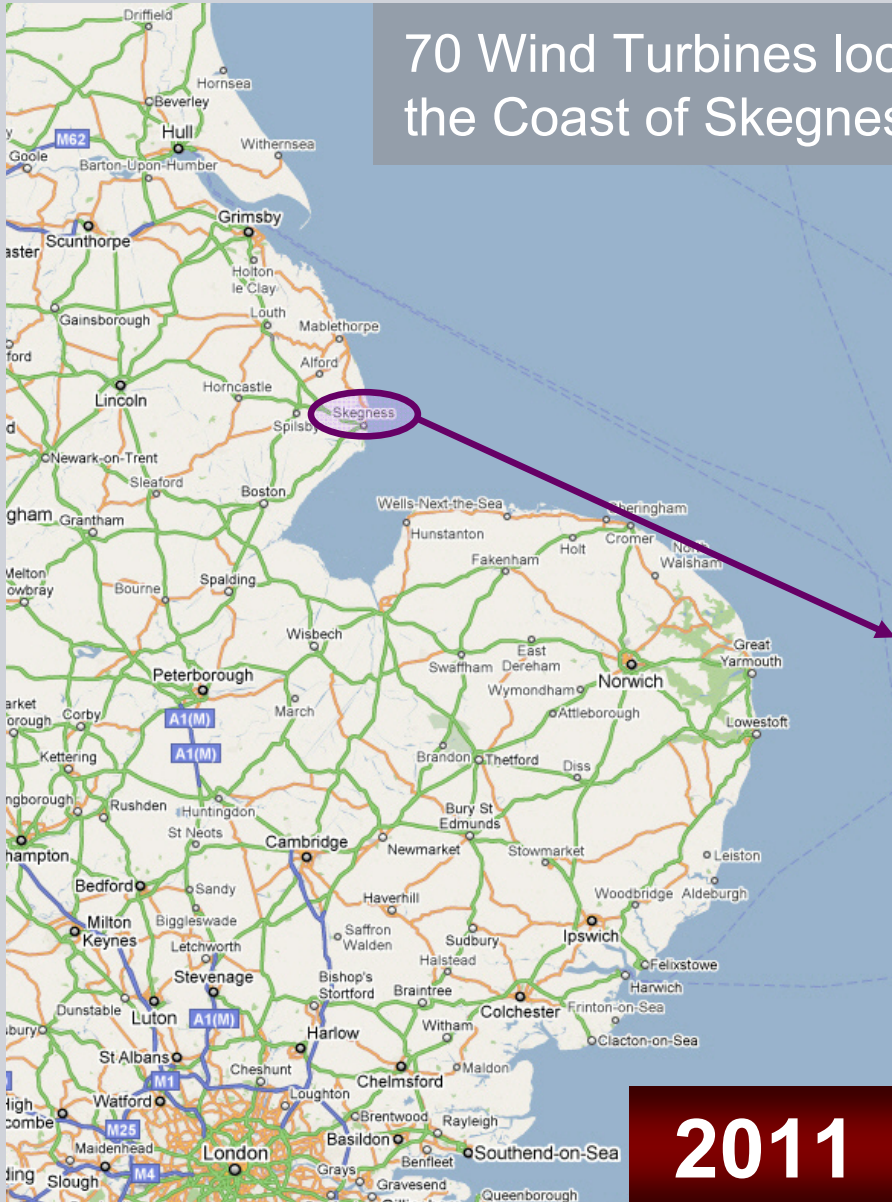


Power Quality for Wind Farm Grid Access



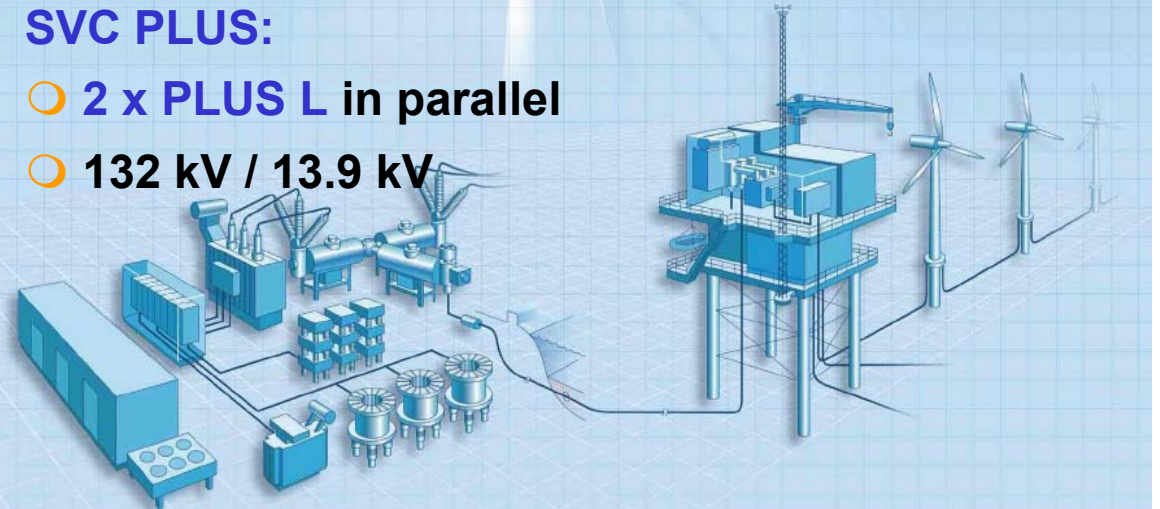
2 SVC PLUS Systems: LINGS 250 MW – CENTRICA, UK

70 Wind Turbines located 8 km off the Coast of Skegness, UK



SVC PLUS:

- 2 x PLUS L in parallel
- 132 kV / 13.9 kV



2011

Power Quality in AC Systems

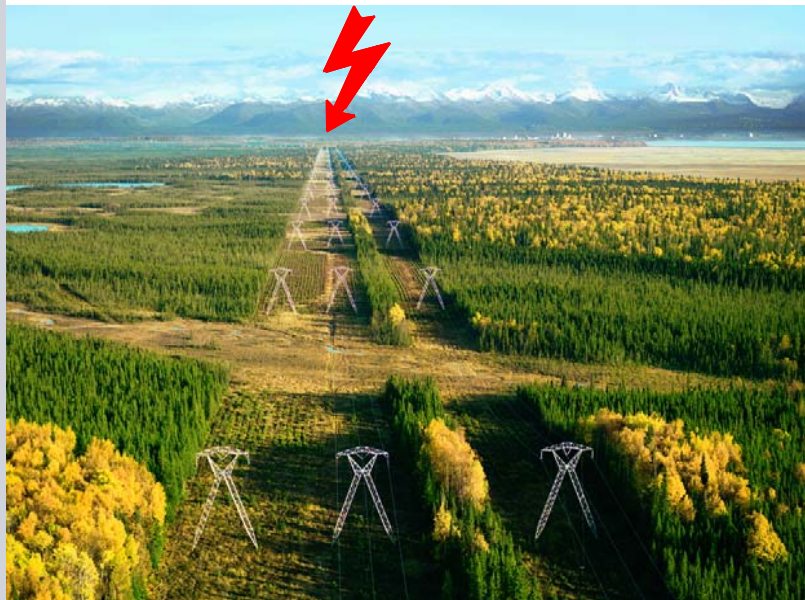
2 SVC PLUS Systems – Kikiwa Project, South Island, New Zealand

SVC PLUS:

- 2 x PLUS M in parallel
- 220 kV / 11 kV
- Dynamic Voltage Support during and after AC Line Faults (Voltage Dip Compensation)



2009



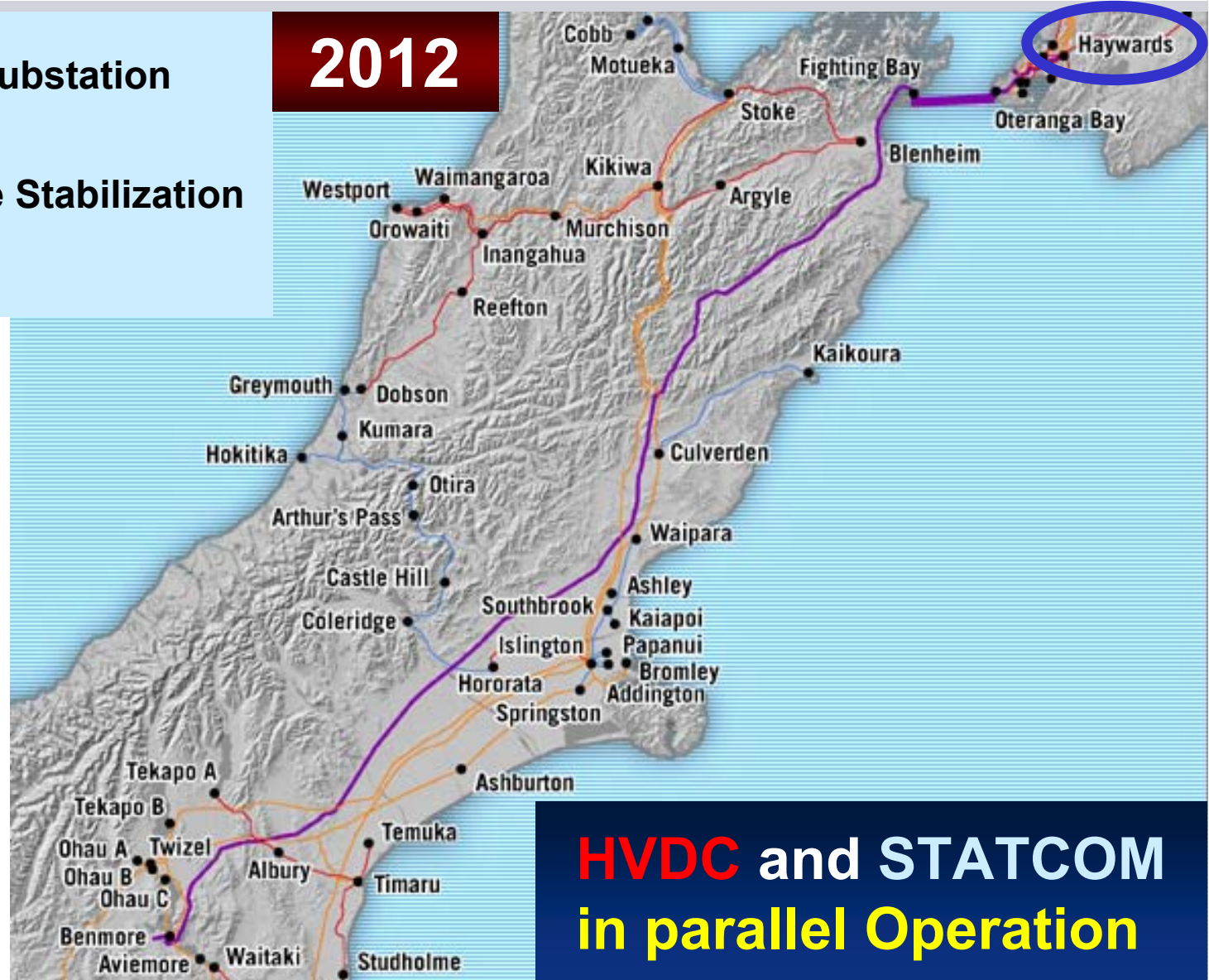
HVDC and SVC PLUS for Inter-Island Link Pole 3, Transpower New Zealand Ltd.



SVC PLUS for Haywards Substation

- 1 x PLUS C
- 220 kV Dynamic Voltage Stabilization
- Reactive Power Control

2012



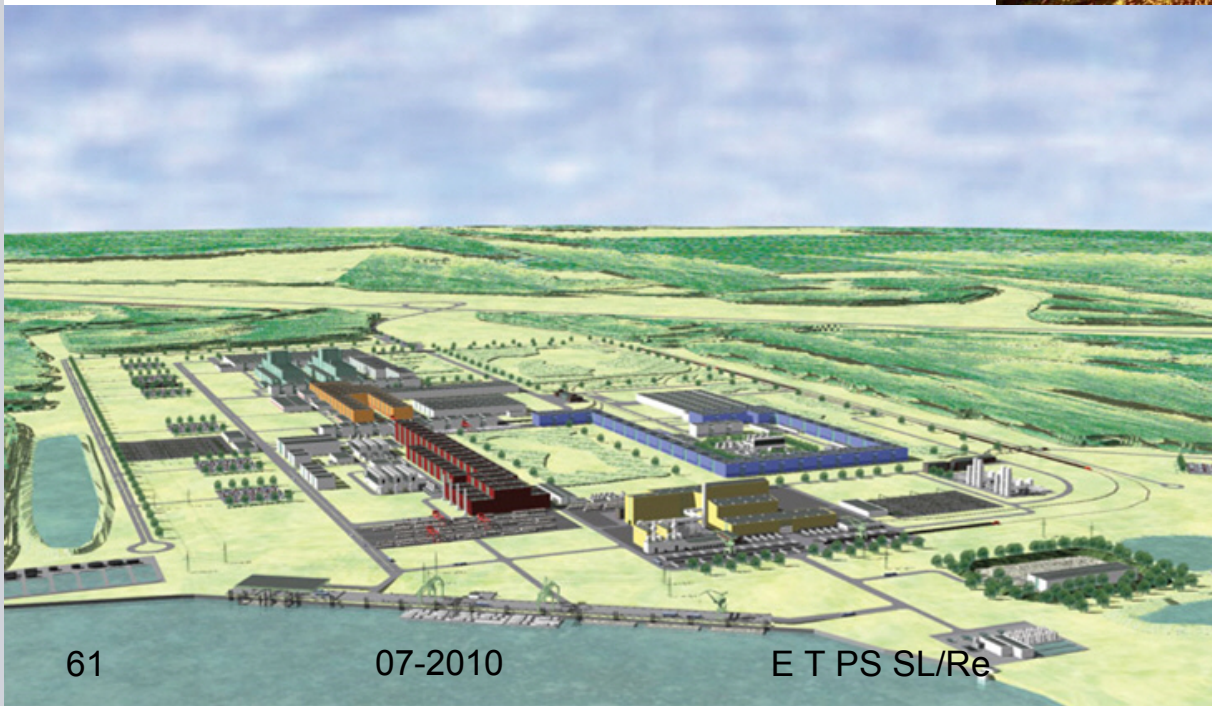
Power Quality for Industrial Systems



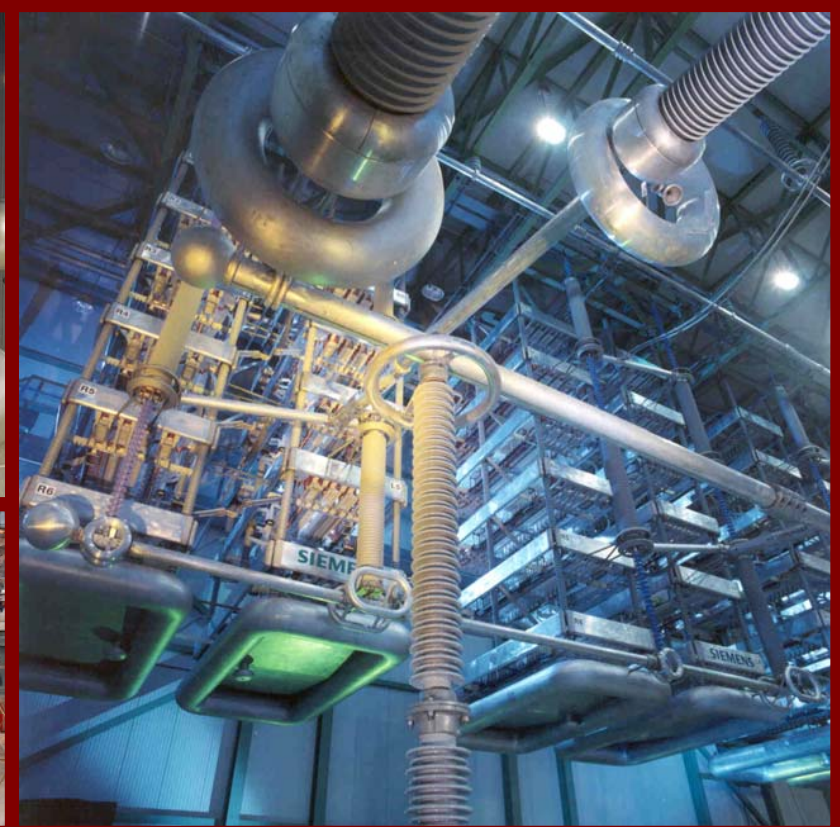
SVC PLUS, ThyssenKrupp, Mobile County, Alabama, USA

SVC PLUS for a **new Steel Plant**

- 1 x PLUS C
- Open Rack Solution
- Flicker Compensation



2010



Conclusions:

Prospects of Power Electronics

The Future ? **Global Link for Green Energy**

SIEMENS

with **HVDC & FACTS** – including **DESERTEC & SEATEC**



**Thank You for Your
Attention !**