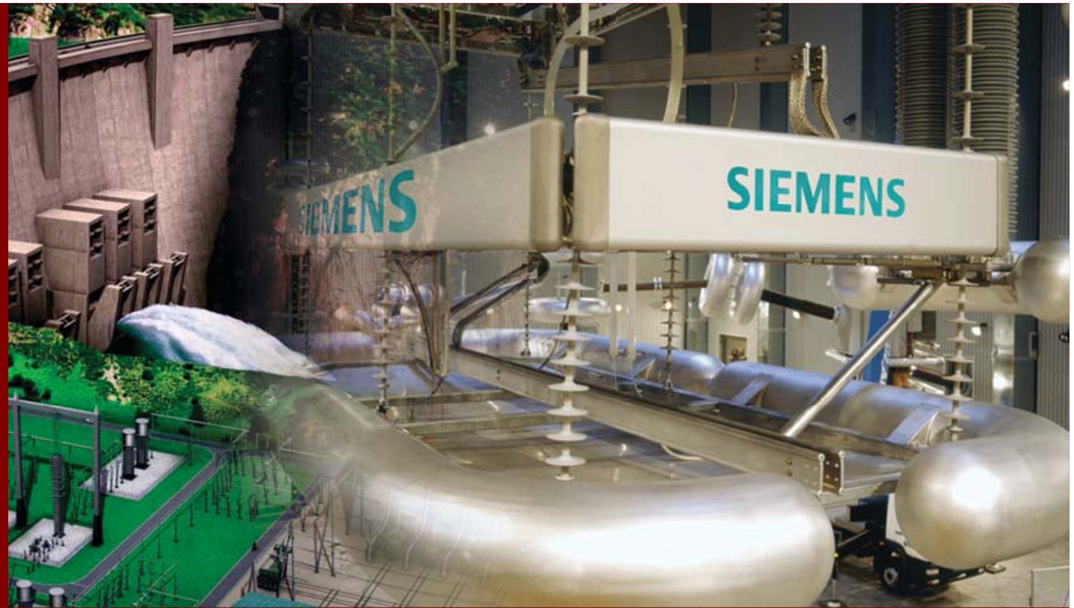


SEE (IEEE-PES France section), Paris, June 16, 2010

Perspectives de l'intégration des réseaux continus et alternatifs pour améliorer le transport de l'énergie électrique

Antoine Larger Kurt Friedrich

SIEMENS

Développement des réseaux électriques

SIEMENS

Extension des systèmes interconnectés

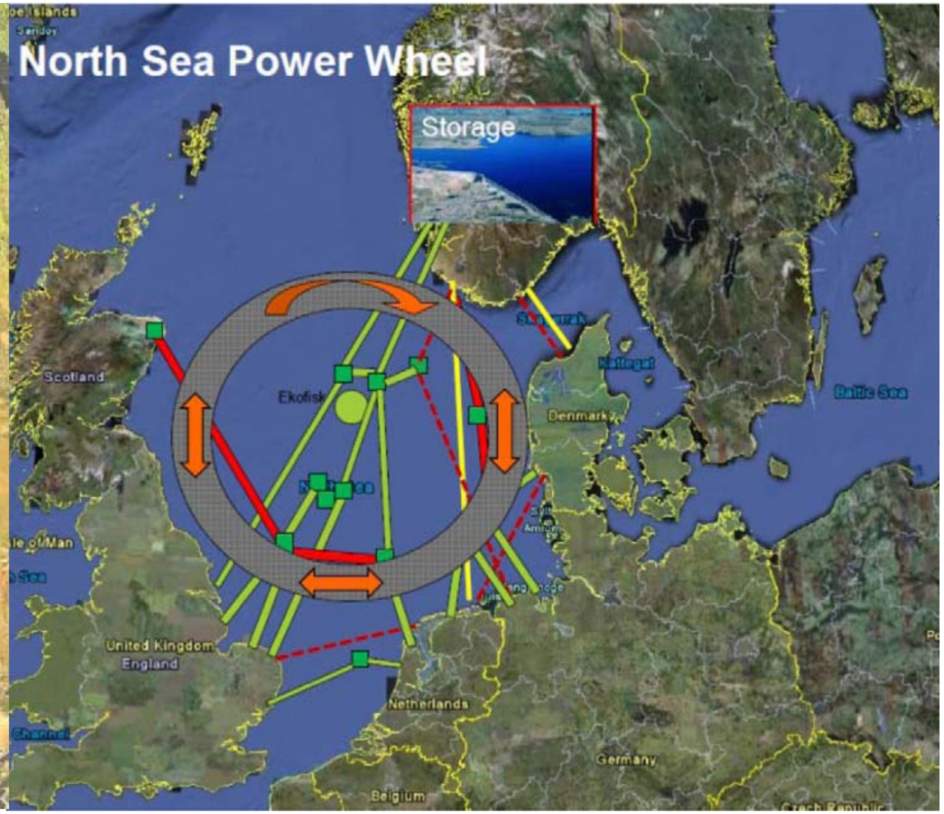
Augmentation des échanges de puissance dans ces réseaux interconnectés

Transmission de fortes puissance sur de grandes distances (Hydro, Eolien et Solaire)

L'intégration des sources d'énergies renouvelables est un enjeu majeur !

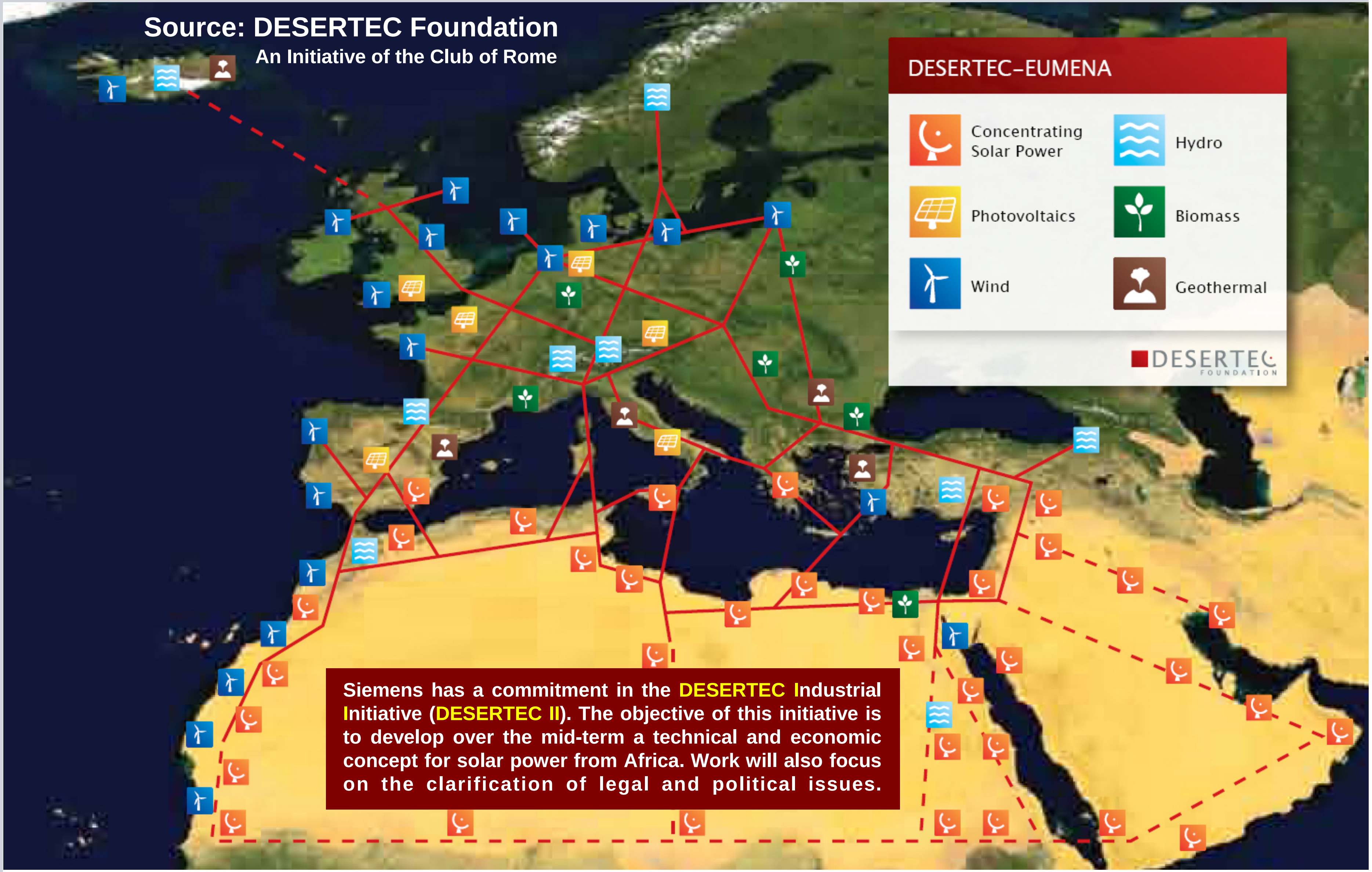
Développement des Interconnections en Europe

Nouveaux concepts : MAINSTREAM, SEATEC …



… et DESERTEC

SIEMENS



Siemens has a commitment in the **DESERTEC I**ndustrial **I**nitiative (**DESERTEC II**). The objective of this initiative is to develop over the mid-term a technical and economic concept for solar power from Africa. Work will also focus on the clarification of legal and political issues.

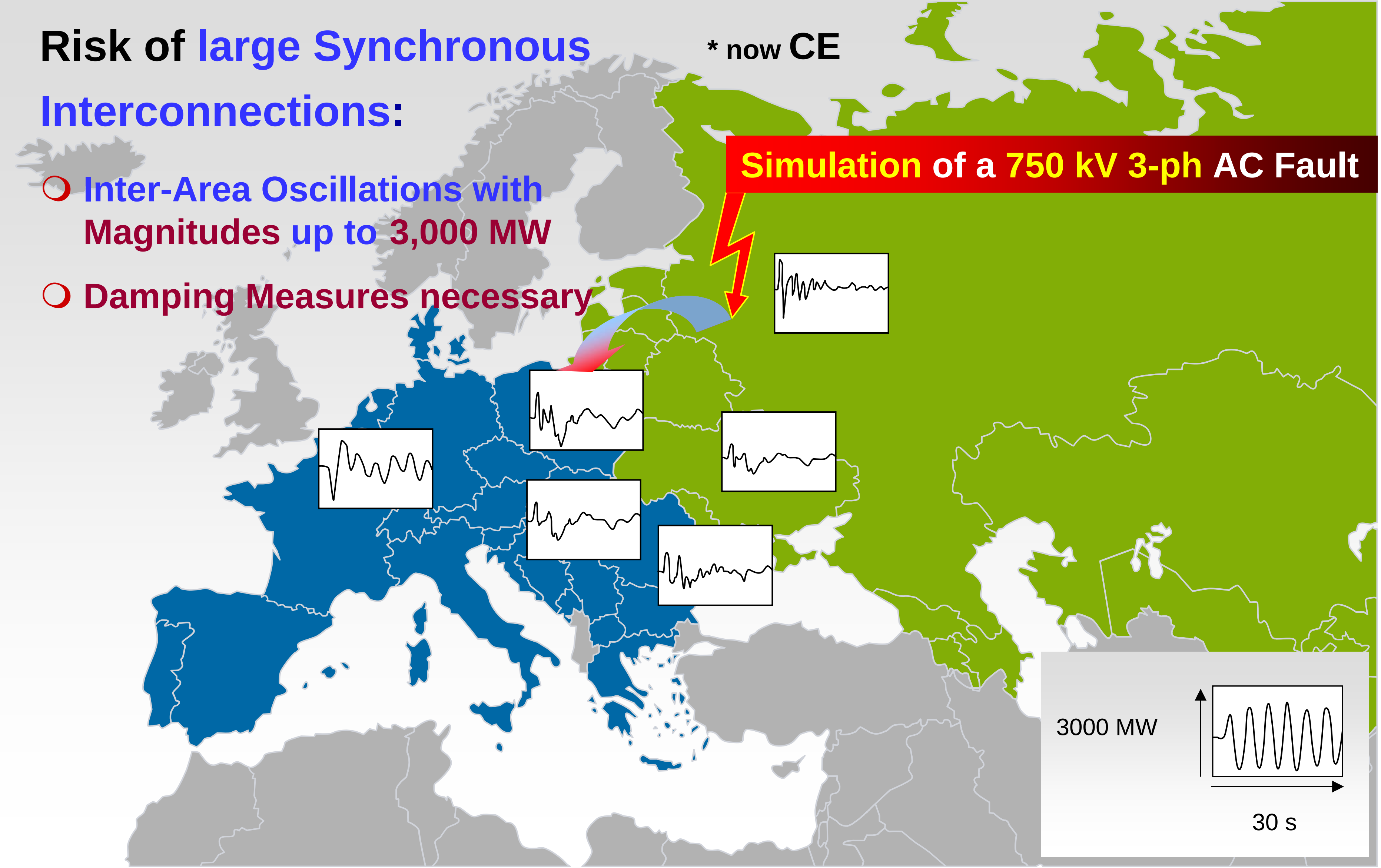
UCTE*-IPS/UPS Interconnection Study

SIEMENS

Risk of large Synchronous Interconnections:

- Inter-Area Oscillations with Magnitudes up to 3,000 MW
- Damping Measures necessary

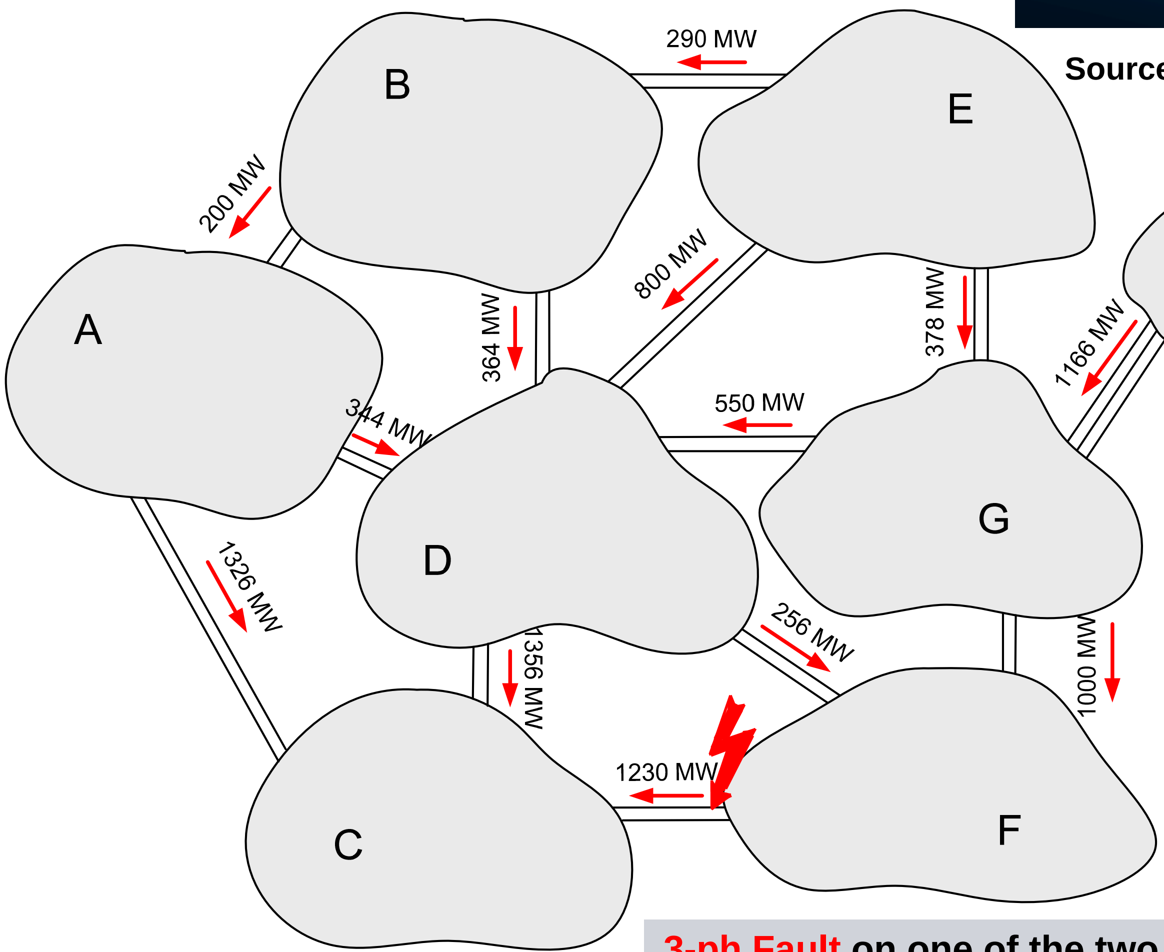
* now CE



Studies for Integrated AC/DC Systems

SIEMENS

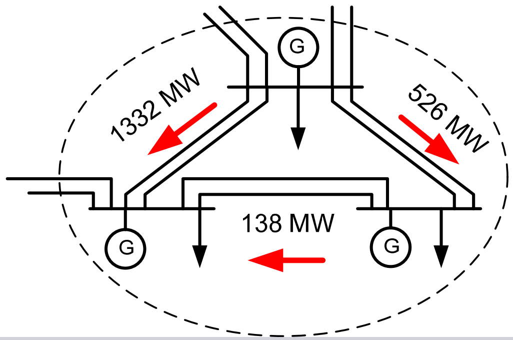
AC Reference System:



Network Structure similar to the European CE System

Source: CIGRE B4 - 304, Paris Session 2006

Equivalent of a Subsystem:



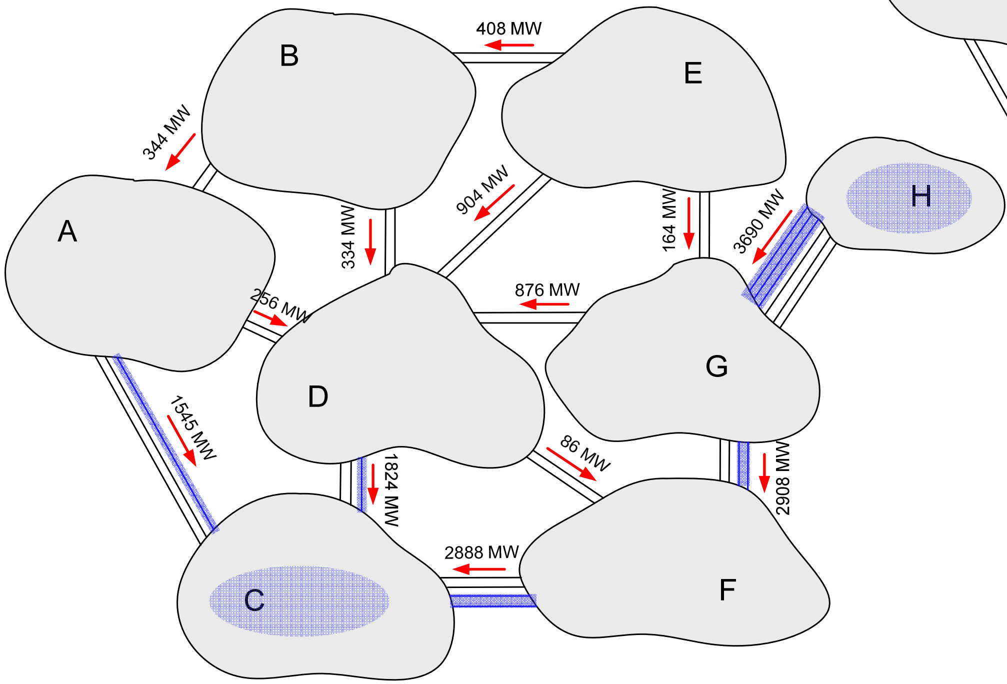
3-ph Fault on one of the two Lines between Subsystems F and C, followed by Disconnection of the Faulty line after 300 ms

Now **2,000 MW additional Power** from H to C

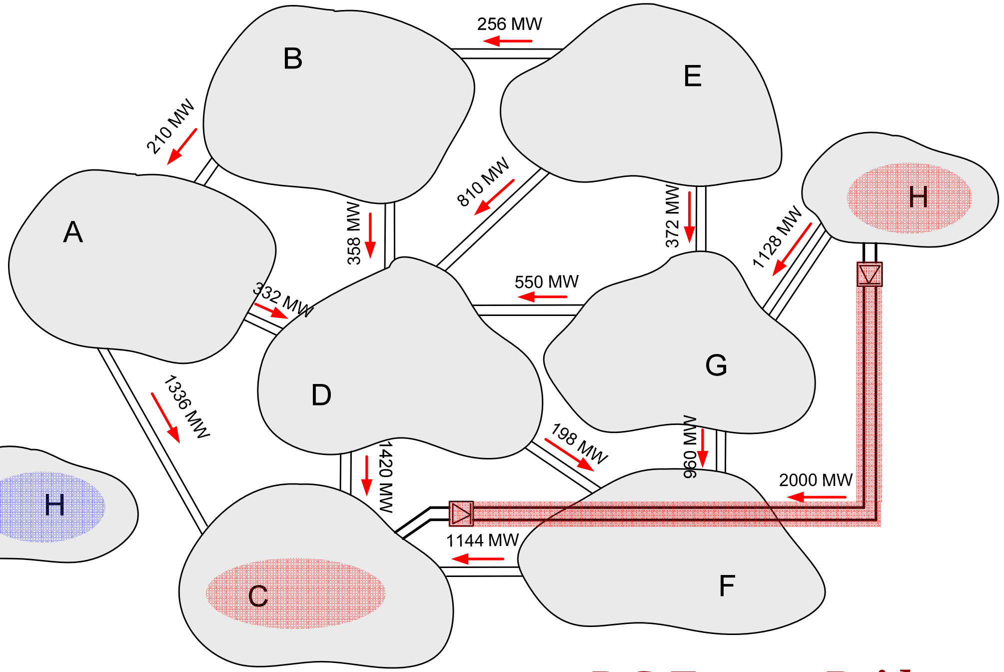
SIEMENS

System with AC Extension:

Load Flow for the System strengthened to transmit additional 2,000 MW from Subsystem H to Subsystem C



Additional AC Lines



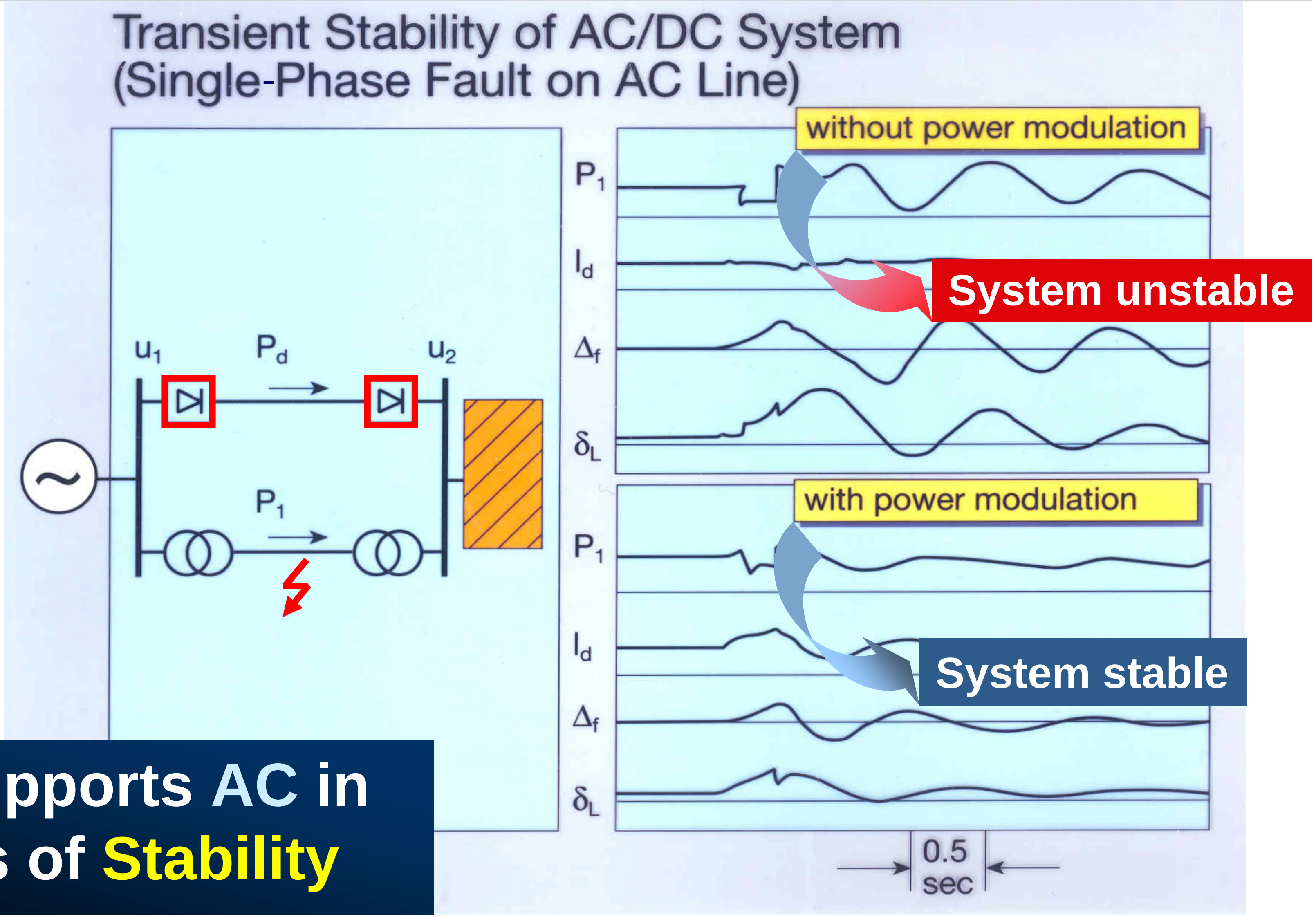
DC Energy Bridge

System with DC Extension:

Load Flow for the Reference System with an additional 2,000 MW HVDC Transmission from Subsystem H to Subsystem C

Benefits of Hybrid System Interconnections

SIEMENS



DC supports AC in Terms of Stability

Studies for Integrated AC/DC Systems

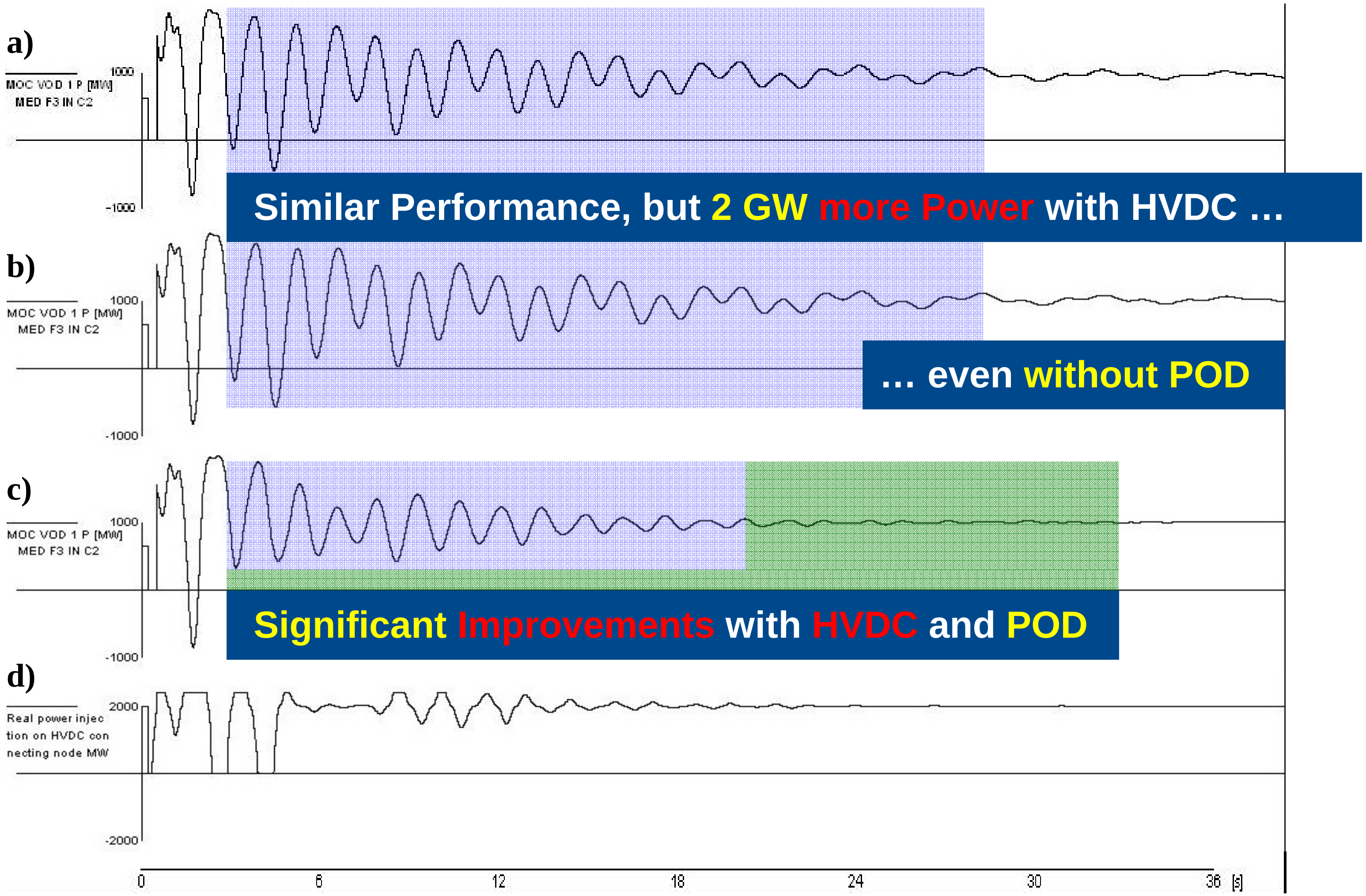
SIEMENS

Reference System with initial Power Flow:

2 GW System Extension with HVDC, POD blocked:

System Extension with HVDC, POD enabled:

POD Output Signal HVDC:



Développement des réseaux électriques
Rôle de l'électronique de puissance

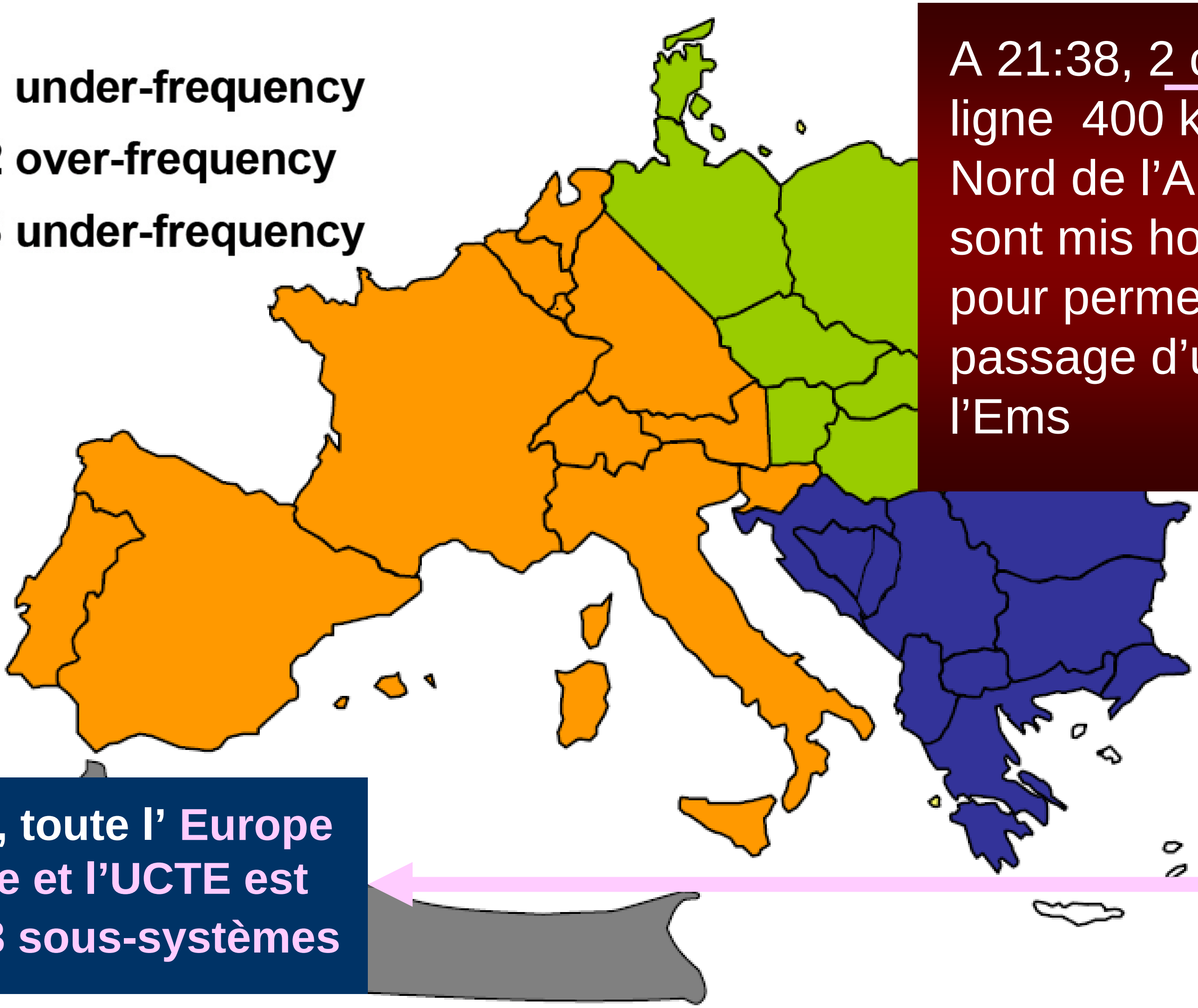
SIEMENS

Globalisation/ Libéralisation	**Dérégulation – Privatisation: Ouverture des marchés, apparition de nouveaux acteurs et de nouvelles règles**
Les réseaux sont congestionnés	**Les échanges sont mal maitrisés:** **-surcharges, non contrôle du Icc (*)** **-instabilités, pannes majeures**
	Les réseaux sont près de leurs limites !
Vers de nouveaux investissements	**Pour plus de sécurité et un développement durable:** ◆ **Des niveaux de tension plus élevés** ◆ **Des nouvelles technologies de transport** ◆ **Des Energies renouvelables**

*** Icc = courant de court-circuit**

Panne européenne du 4 Novembre 2006

- Area 1 under-frequency
- Area 2 over-frequency
- Area 3 under-frequency



A 21:38, 2 circuits d'une ligne 400 kV dans le Nord de l'Allemagne sont mis hors tension pour permettre le passage d'un bateau sur l'Ems

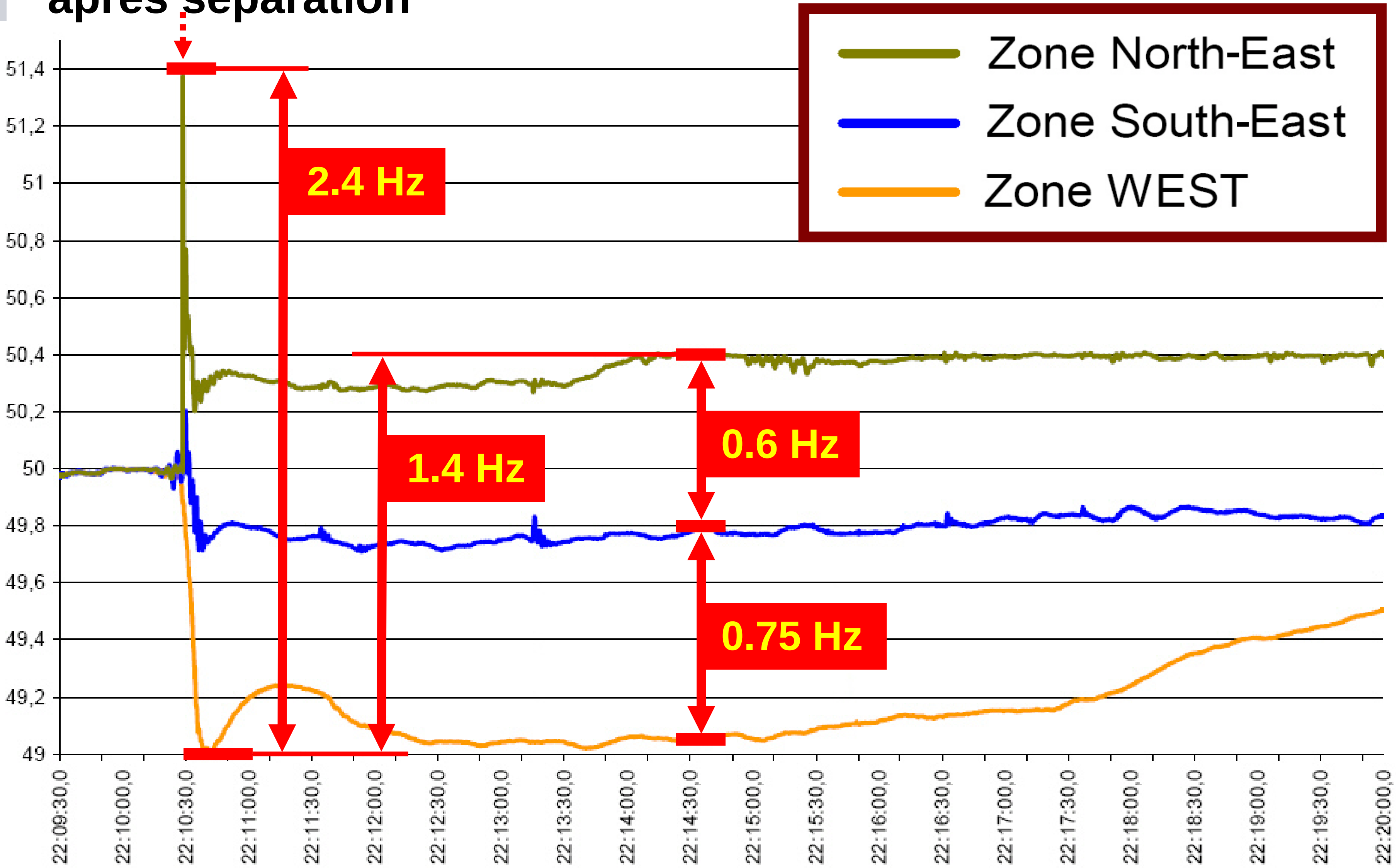
n-2 !

Vers 22:10, toute l' Europe est touchée et l'UCTE est coupé en 3 sous-systèmes

Source: UCTE – Final Report 2007-01-30

Fréquences des 3 sous-systèmes après séparation

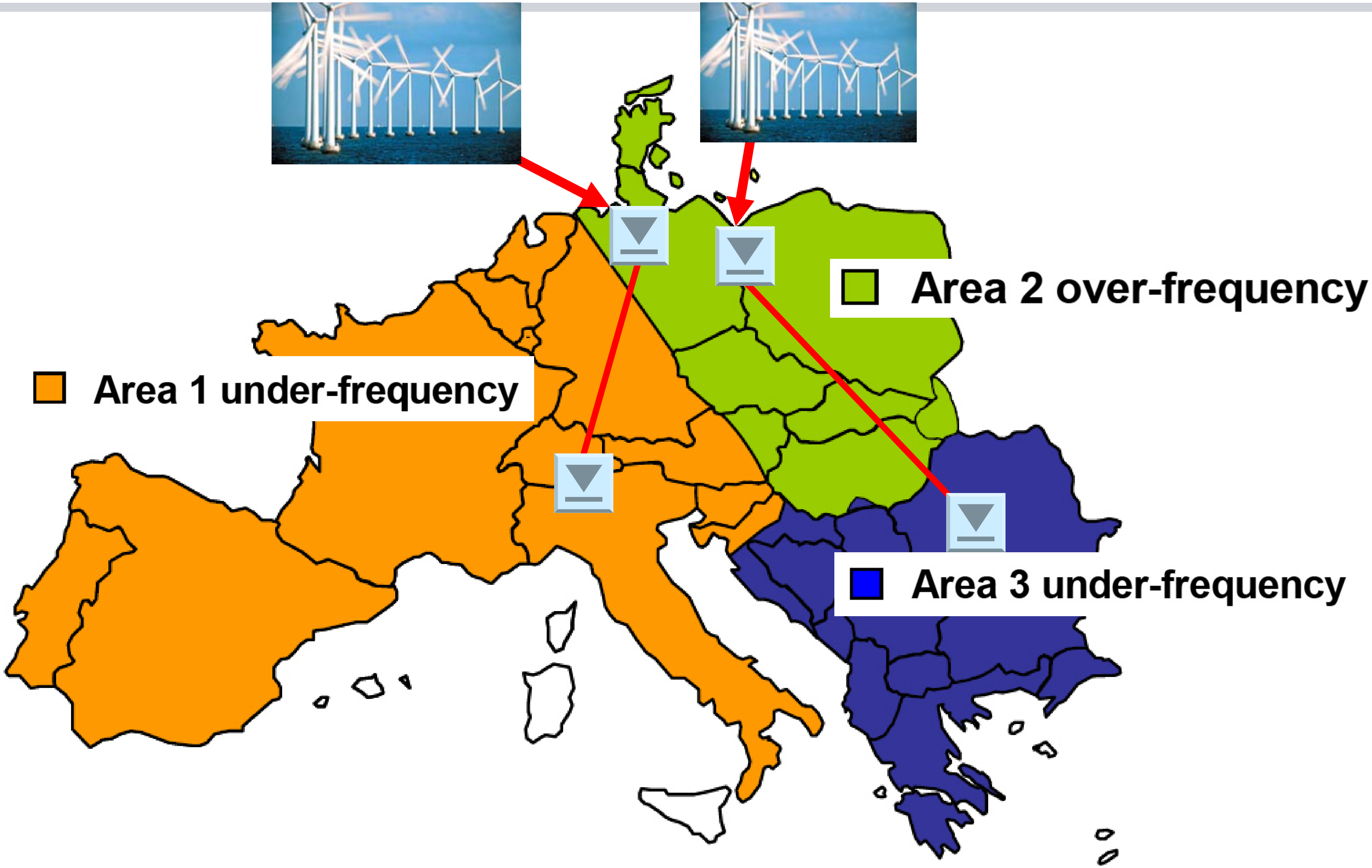
SIEMENS



Source: UCTE – Final Report 2007-01-30

La solution : transmission d'énergie d'origine éolienne par HVDC de la zone 2 vers les zones 1 et 3

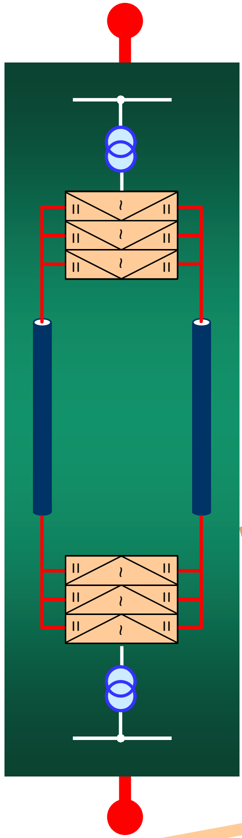
SIEMENS

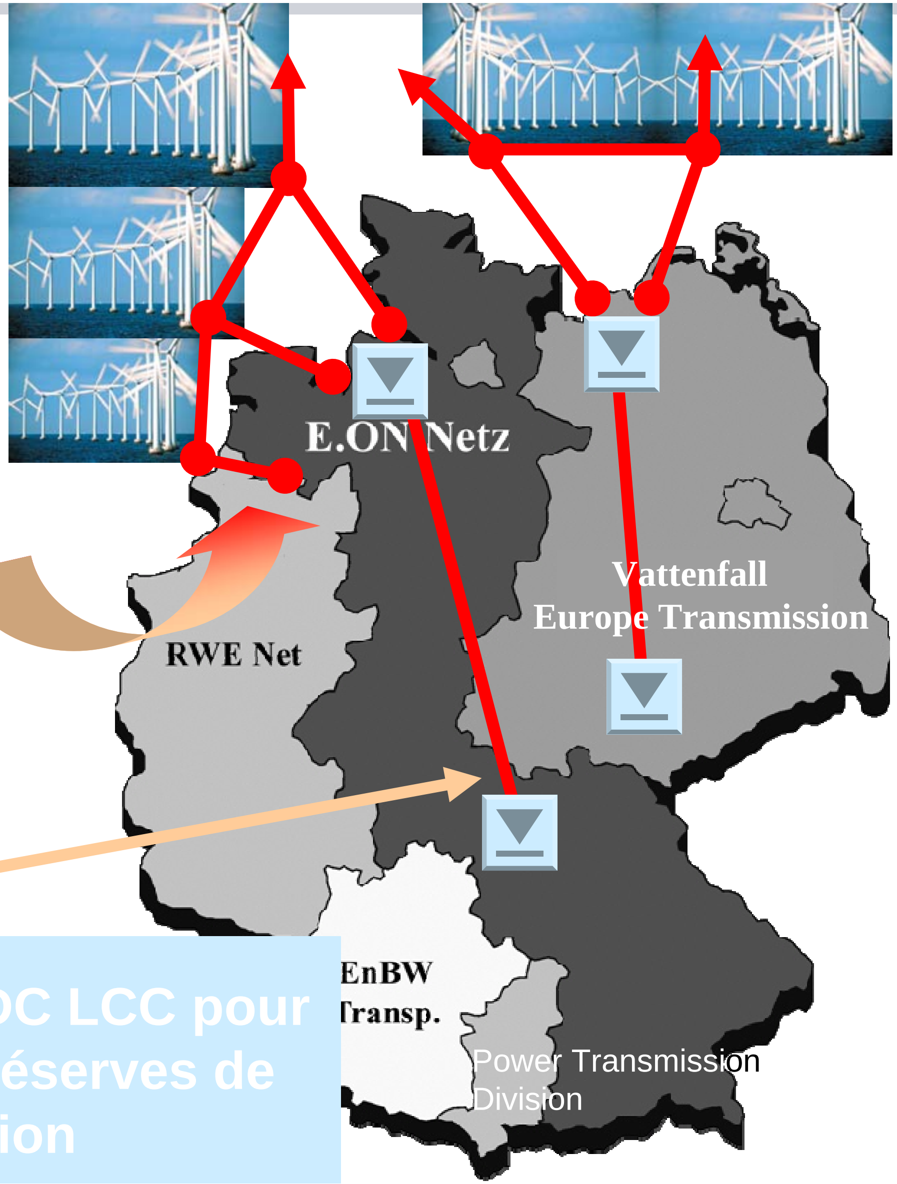


Intégration de l'éolien Offshore au réseau – la perspective allemande

SIEMENS

Technologie VSC HVDC pour la connexion au réseau en multi-terminal



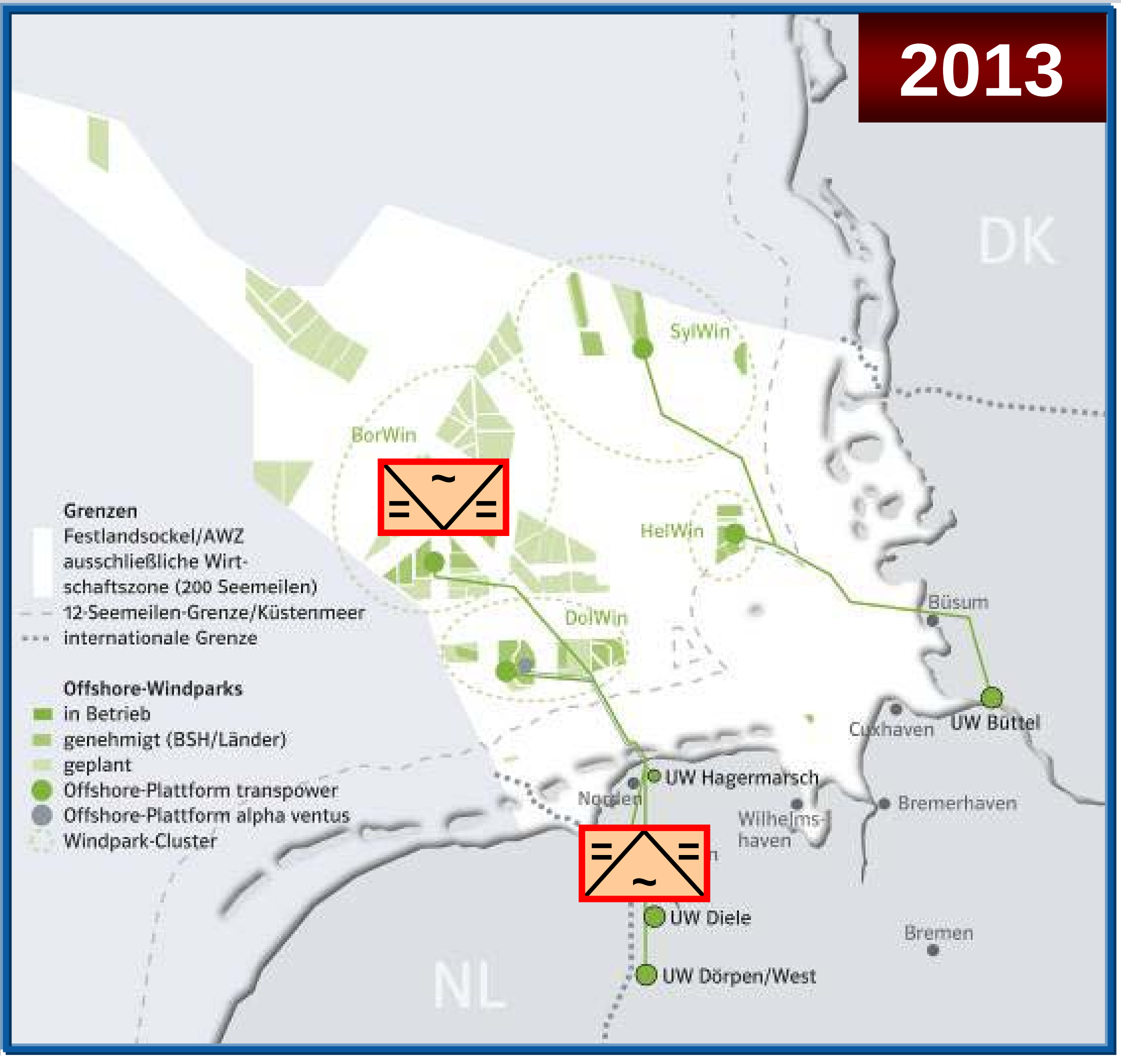


Technologie HVDC LCC pour le partage des réserves de génération

HVDC PLUS and WIPOS: BorWin 2, Germany – World's first VSC HVDC with 800 MW

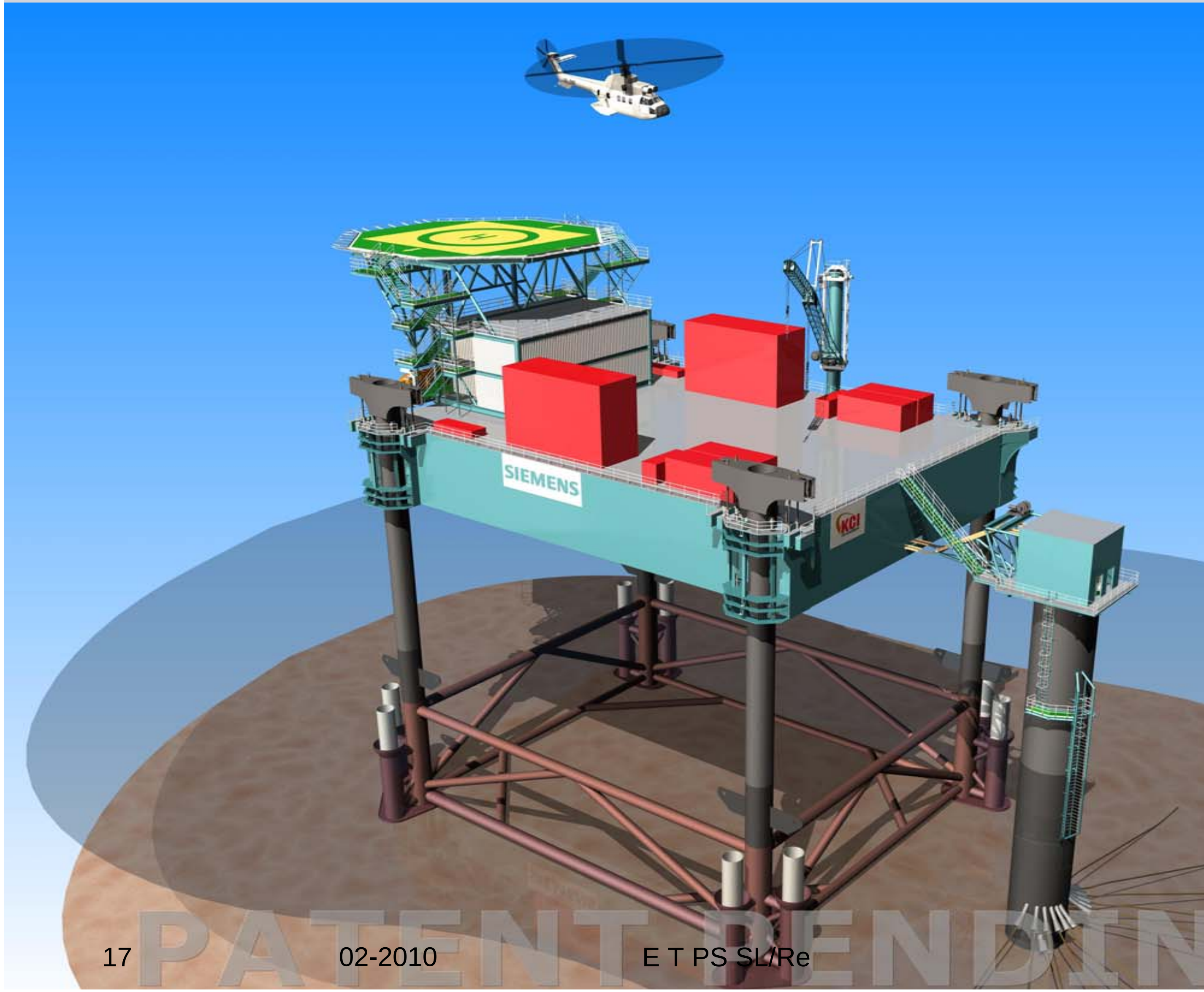
SIEMENS

- Wind Farms: Veja Mate and Global Tech 1 – 800 MW, located 125 km Offshore (Northwest of the Island of Borkum)
- 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



Grid Access of Green Energy with HVDC PLUS:
WIPOS – Advanced Offshore Platform Layout *

SIEMENS



- Siemens Wind Power Offshore Substation (WIPOS) is designed as a floating, self-lifting * Platform
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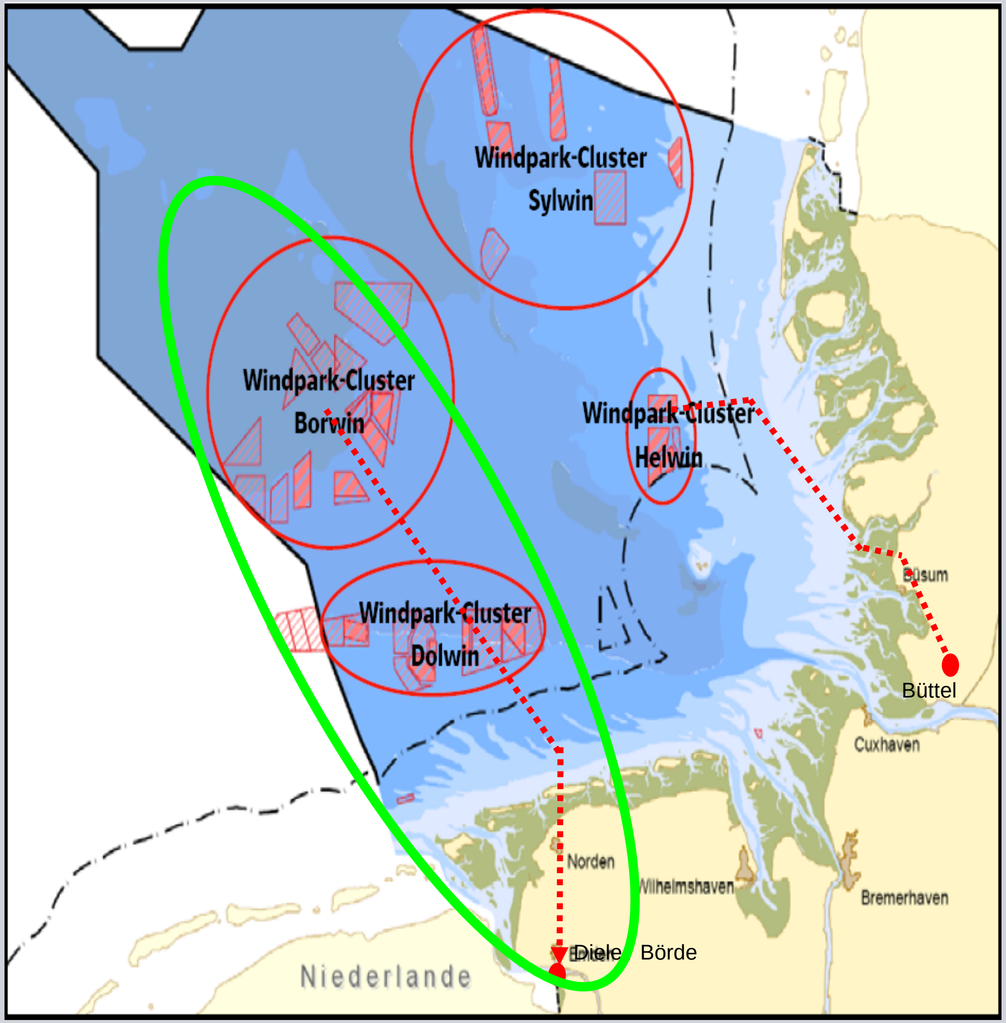
HVDC PLUS
Contract for Borwin 2 Offshore HVDC

SIEMENS

Overview OWP, Cable routes and Connection Points



Transpower Project

Borwin 2

Converter Stations

Power 800MW @ +/-300kV DC

one station on Offshore Platform

Offshore Wind Parks (OWP): Veja Mate (Bard), Global Tech 1 (Wetfeet) each 400MW rated

DC-Cable 300 kV extruded:

- **127 km Submarine Cable**
- **75 km Land Cable**

AC-Cable 150kV: 39 km

- **OWP-Connection**

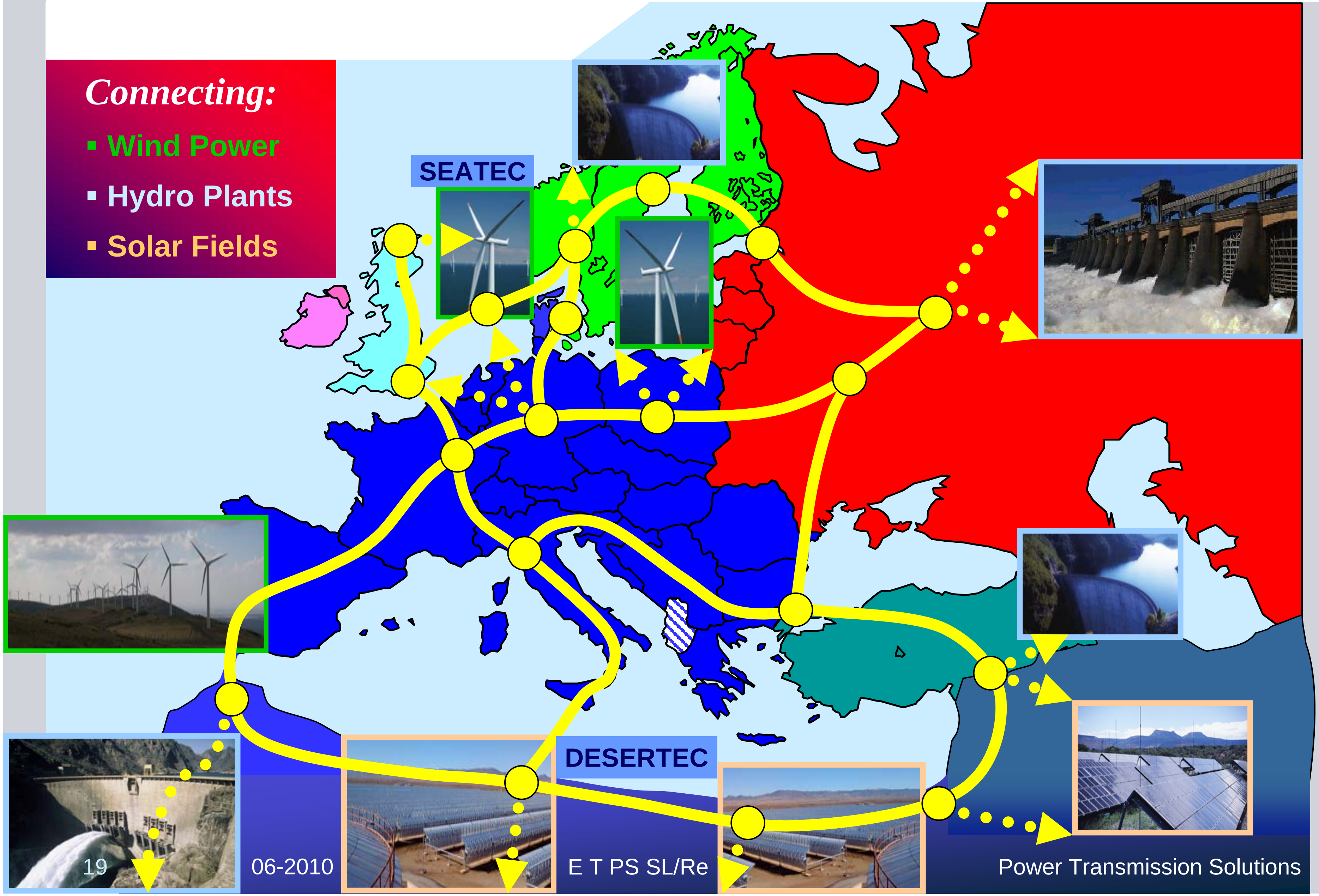
Service Contract

La Vision: Un super-réseau DC en Europe?

SIEMENS

Connecting:

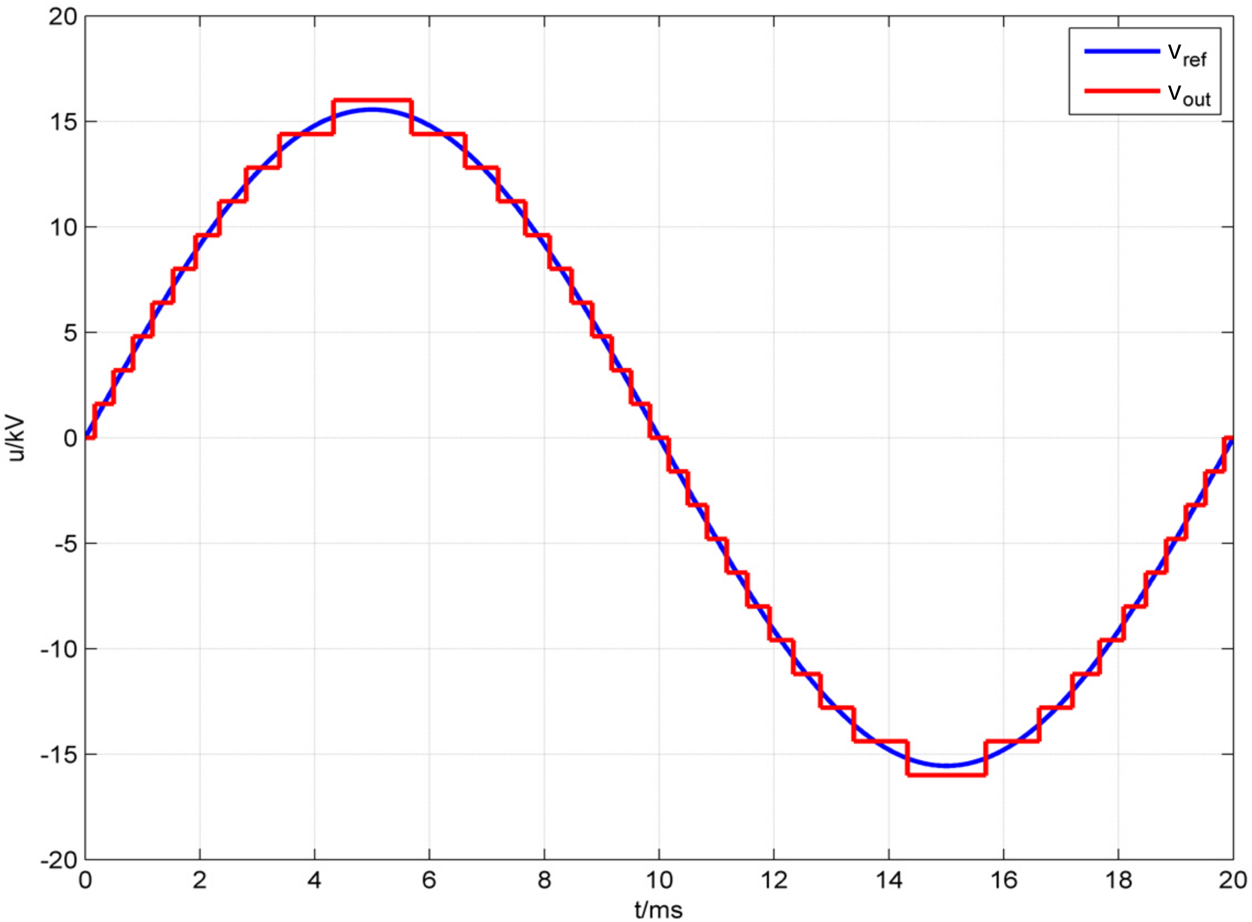
- Wind Power
- Hydro Plants
- Solar Fields




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 CO_2
Reduction
SIEMENS
SVC PLUS

From Power Module to Converter – the Multilevel Voltage Generation

Power Module
with DC Capacitor



SVC PLUS: the Advanced STATCOM

SIEMENS

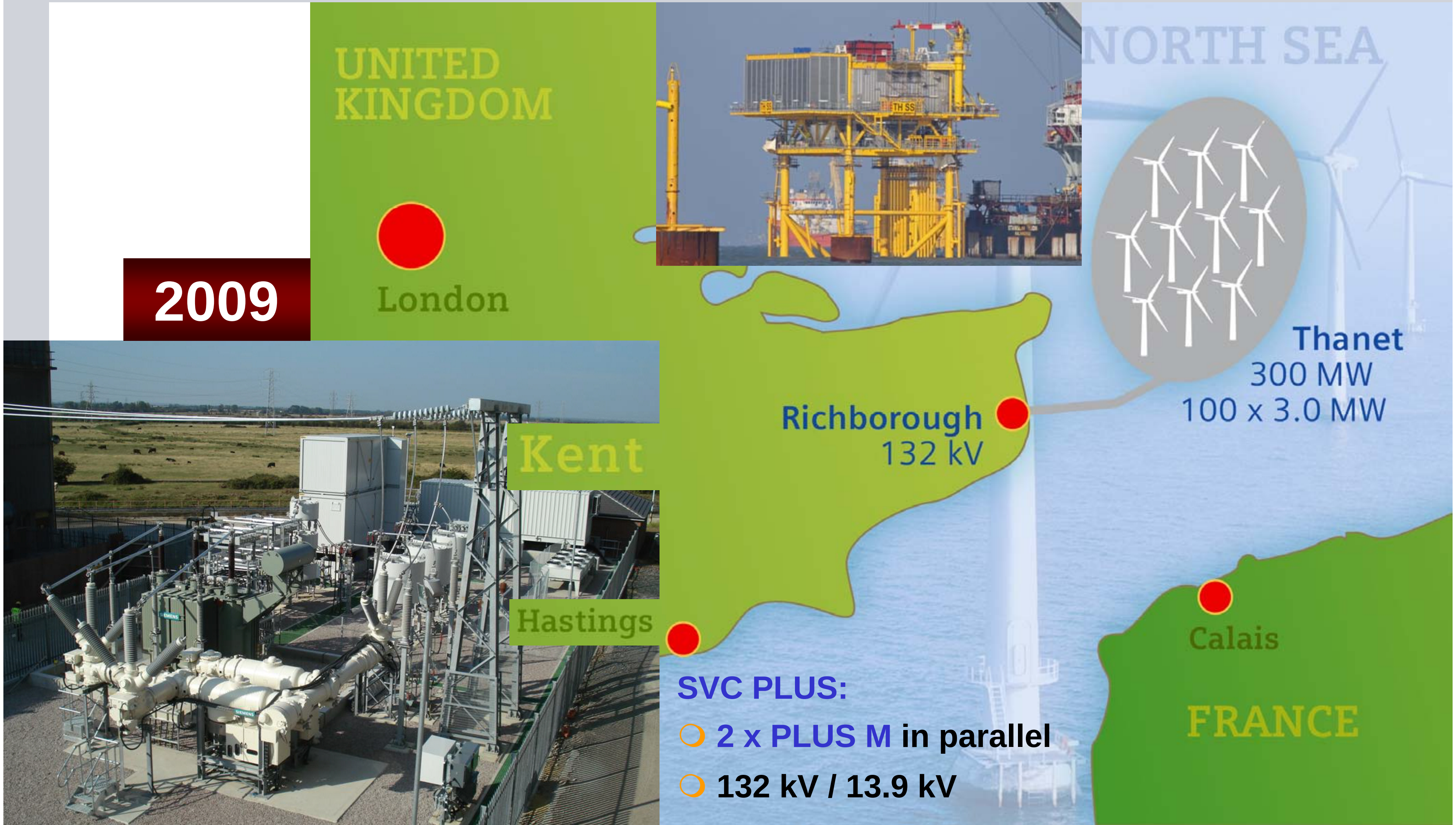
2009 - 2012

15 Systems in 7 Transmission Projects:

Rating: up to +/- 200 MVAr

Dynamic Voltage Support

Grid Access of Green Energy with SVC PLUS:
Thanet, UK – 2 SVC PLUS Systems for 300 MW Wind Farm



SVC PLUS:

- **2 x PLUS M in parallel**
- **132 kV / 13.9 kV**

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Tendances

sur le marché du transport de l’électricité

China: over 217 GW * of additional HVDC Transmission Capacity are expected between 2010 and 2020

SIEMENS

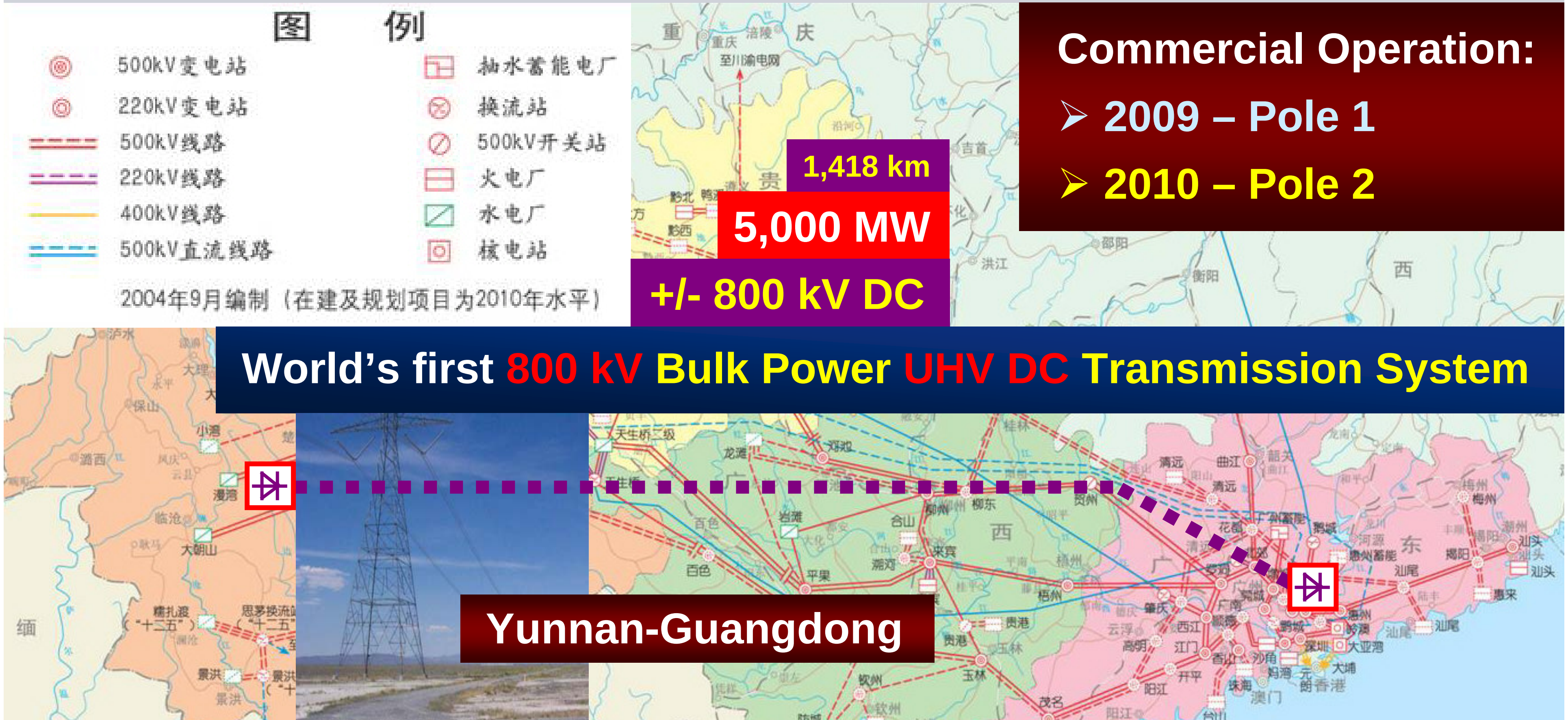
1. Yunnan – Guangdong
800 kV, 5000 MW, 2009/10
2. Xiangjiaba – Shanghai
800 kV, 6400 MW, 2010
3. Qinghai – Tibet
500 kV, 1200 MW, 2011
4. Mongolia – Tianjin
660 kV, 4000 MW, 2012
5. Russia – Liaoning
660 kV, 4000 MW, 2012
6. Nuozhadu – Guangdong
800 kV, 5000 MW, 2012
7. Jingping – Sunan
800 kV, 7200 MW, 2012
8. Xiluodu – Guangdong
500 kV, 2 x 3200 MW, 2013
9. Humeng – Tangshan
660 kV, 4000 MW, 2013
10. Ningdong – Zhejiang
800 kV, 7200 MW, 2013
11. Xiluodu – Zhejiang
800 kV, 7200 MW, 2013
12. Sichuan – Hunan
660 kV, 4000 MW, 2014
13. Xiluodu – Hunan
660 kV, 4000 MW, 2014
14. Humeng – Shandong
800 kV, 7200 MW, 2014
15. Hami – Henan
800 kV, 7200 MW, 2014
16. Mengxi – Jiangxi
800 kV, 7200 MW, 2015
17. Mongolia – Shandong
800 kV, 7200 MW, 2015
18. Shaanxi – Jiangsu
660 kV, 4000 MW, 2016
19. Jiuquan – Jiangsu
800 kV, 7200 MW, 2016
20. Zhundong – Henan
800 kV, 7200 MW, 2016

21. Baoqing – Liaoning
660 kV, 4000 MW, 2017
22. Hami – Shandong
800 kV, 7200 MW, 2017
23. Tibet – Chongqing
800 kV, 7200 MW, 2017
24. Jinghong – Thailand
500 kV, 3000 MW, 2018
25. Ximeng – Wuxi
800 kV, 7200 MW, 2018
26. Baihetan – Hubei
800 kV, 7200 MW, 2018
27. Wudongde – Fujian
1000 kV, 9000 MW, 2018
28. Northwest – North
B2B, 1500 MW, 2018
29. Mongolia – Jing-Jin-Tang
800 kV, 7200 MW, 2019
30. Russia – Liaoning
800 kV, 7200 MW, 2019
31. Zhundong – Jiangxi
1000 kV, 9000 MW, 2019
32. Tibet – Zhejiang
1000 kV, 9000 MW, 2019
33. Baihetan – Hunan
800 kV, 7200 MW, 2020
34. Yili – Sichuan
1000 kV, 9000 MW, 2020
35. Kazakhstan – Chengdu
1000 kV, 9000 MW, 2020

* Options for further Projects > 7 GW

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

SIEMENS



1,418 km

5,000 MW

+/- 800 kV DC

Commercial Operation:

- 2009 – Pole 1
- 2010 – Pole 2

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

Yunnan-Guangdong

Reduction in CO_2 ⟶ versus local Power Supply with Energy-Mix

32.9 m tons p.a. – by using Hydro Energy and HVDC for Transmission

Yunnan-Guangdong: UHV DC – ‘Welcome’

SIEMENS

Yunnan-Guangdong – UHV DC Converter

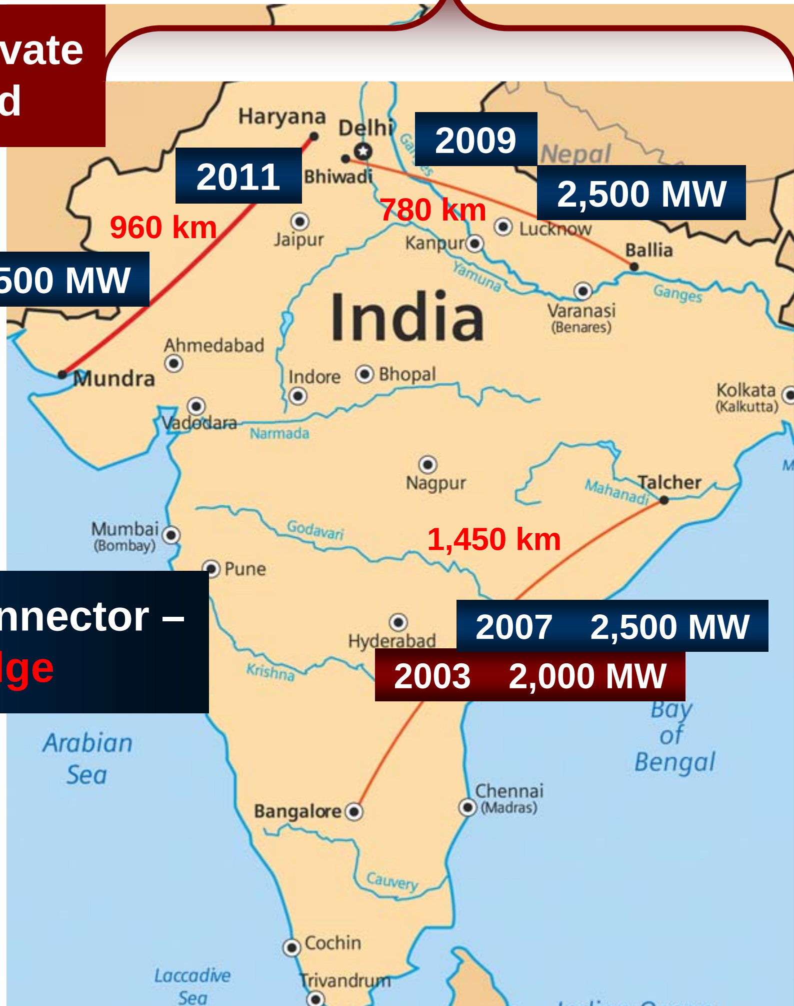
SIEMENS

800 kV DC

India – Three "Classic" HVDCs at 500 kV of which Adani and Ballia-Bhiwadi are fully integrated into the AC Grid

SIEMENS

Adani HVDC – a private Investor goes ahead



East-South Interconnector – the DC Energy Bridge

Ballia-Bhiwadi – Power Grid Corporation of India Ltd

Further Examples of Projects with Integrated AC/DC Transmission:

- Cahora Bassa, Mozambique-South Africa, 1977-79, 1920 MW, 533 kV, 1400 km
- Gezhouba-Shanghai, China, 1989/1990, 1200 MW, 500 kV, 1040 km
- Tianshengqiao-Guangzhou, China, 2000, 1800 MW, 500 kV, 960 km
- Guiguang I, China, 2004, 3000 MW, 500 kV, 940 km
- Guiguang II, China, 2007/2008, 3000 MW, 500 kV, 1230 km
- Neptune, New York, 2007, 660 MW, 500 kV, 105 km Cable
- Yunnan-Guangdong, 2009/2010, 5000 MW, 800 kV, 1420 km
- Trans Bay Cable, HVDC PLUS, San Francisco, 2010, 400 MW, 200 kV, 88 km Cable
- Xiangjiaba-Shanghai, 2011, 6400 MW, 800 kV, 2071 km

Examples of Integrated AC/DC Systems

Merci

Pour votre attention !