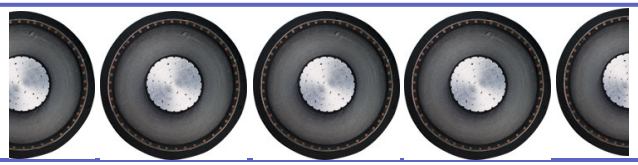
Utbyggingen av vindkraftressursene i Nordsjøen fra Kontinentet

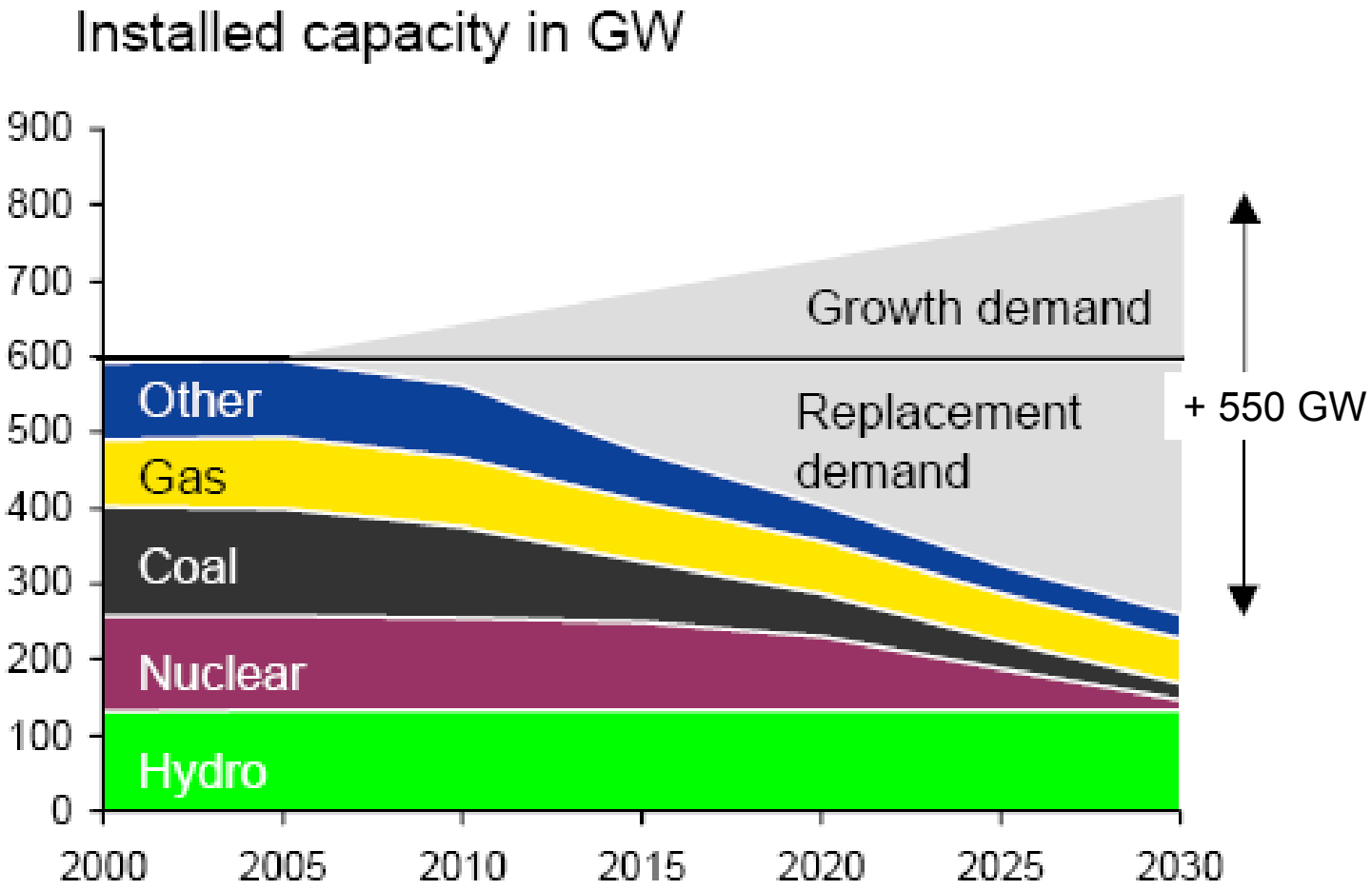
Bo Normark
ABB Grid Systems
Oslo November 12 2007



Agenda

- European energy system
- Transmission technologies
- Off shore wind power grid integration
- Technology development
- Summary

Challenge power generation



Source: EPPSA - European Power Plant Suppliers' Association

Challenge wind power integration

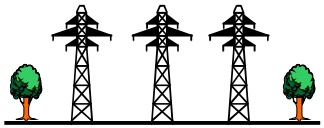
European Commission, Report Directorate-General for Energy 2000

It is by now well appreciated that one of the economic factors limiting the exploitation of Europe's wind resource is the predominantly weak existing public electricity network in those areas most attractive for installation of wind turbines. The basic problem is that the distribution systems were designed to distribute power to consumers and not to collect it.

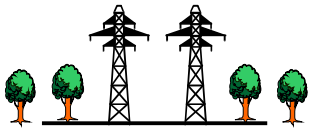
Transmission challenges Europe

- **Needs**
  - Integration of renewable energy
  - Interconnections for increased trading
  - Security of supply
  - Environmentally accepted solutions
- **Solutions**
  - Flexible solutions for wind power integration
  - Affordable underground transmission
  - Improved dynamic performance

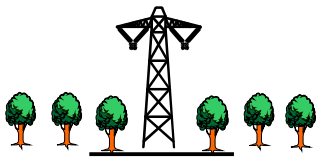
Transmission alternatives today



Conventional HVAC



HVAC with FACTS



HVDC

HVDC Light

AC Transmission

Flexible AC Transmission (FACTS)

⇨ 30-50 % higher capacity

DC Transmission (HVDC)

⇨ 200 – 300 % higher capacity

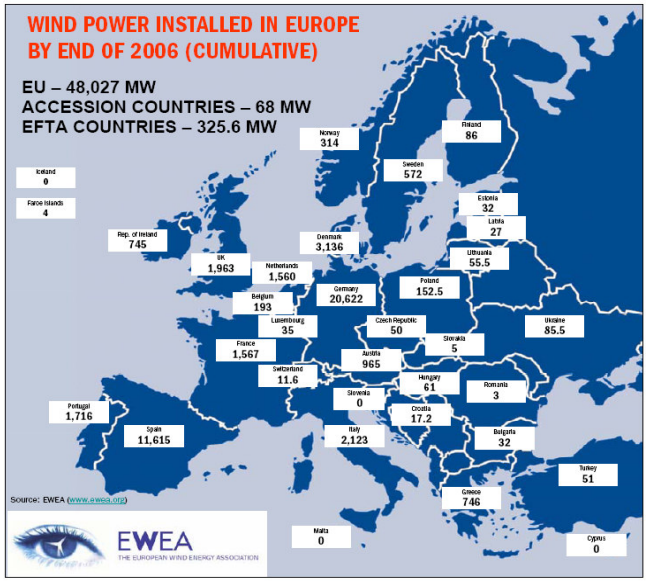
HVDC Light

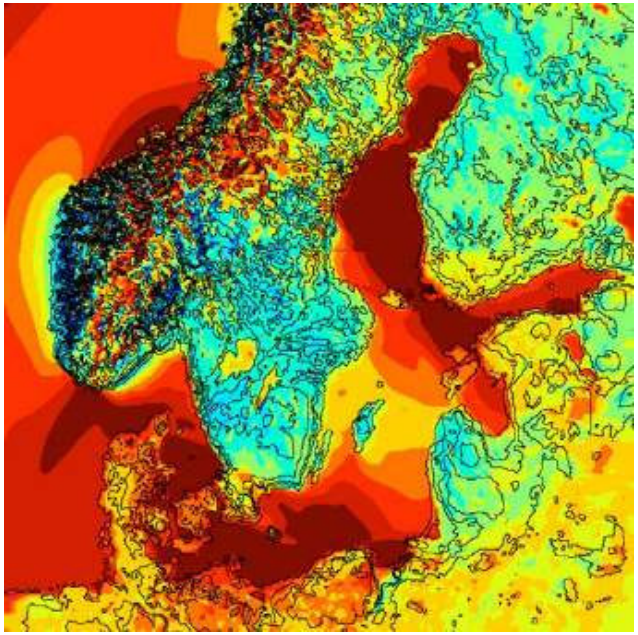
⇨ New transmission alternative

HVDC Technologies

	HVDC-Classic	HVDC-Light
Technology	▪ Thyristors, paper cable	▪ Transistor, plastic cable
Typical application	▪ OHL transmission ▪ Sub sea cable transmission ▪ Back-to-Back	▪ Off shore power supply ▪ Wind power integration ▪ Underground transmission
Size	 **600 MW, 100m x 200m, Height 22 m**	 **550 MW, 50m x 120m, Height 11 m**

Wind Power in Europe





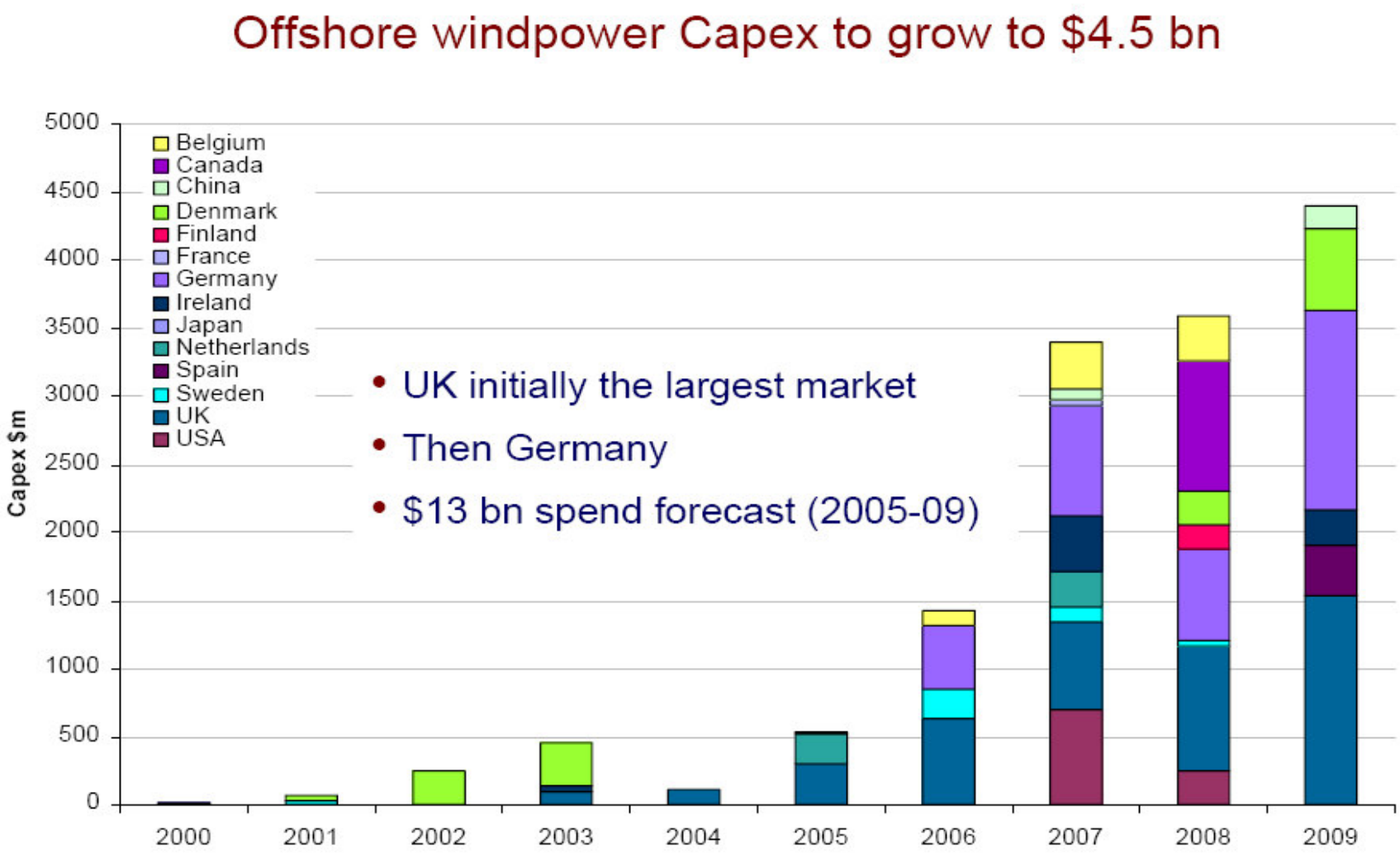
The 48,027 MW installed in the EU by the end of 2006 will produce electricity, equal to around 3% of EU electricity consumption.

Almost twice amount of energy could be produced if with the same amount of power if located at best wind sites

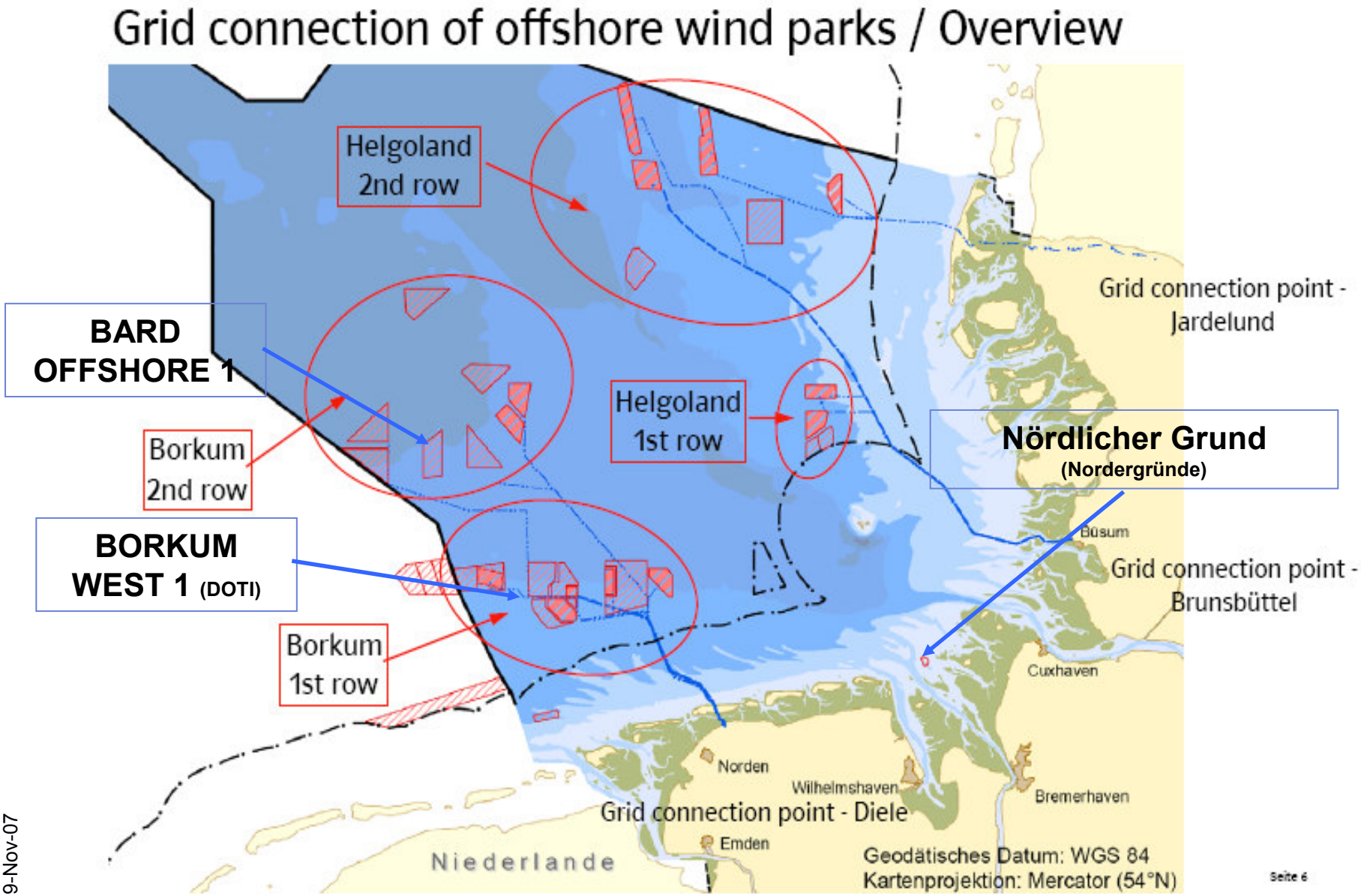
Grid Integration of renewable energy

- New technologies for grid expansion can offer renewable energy:
  - Location on best production sites.
  - Access to the market
  - Back up power
- New technologies will also improve the grid instead of degrading the grid by improved voltage, frequency and reactive power control

Offshore wind market



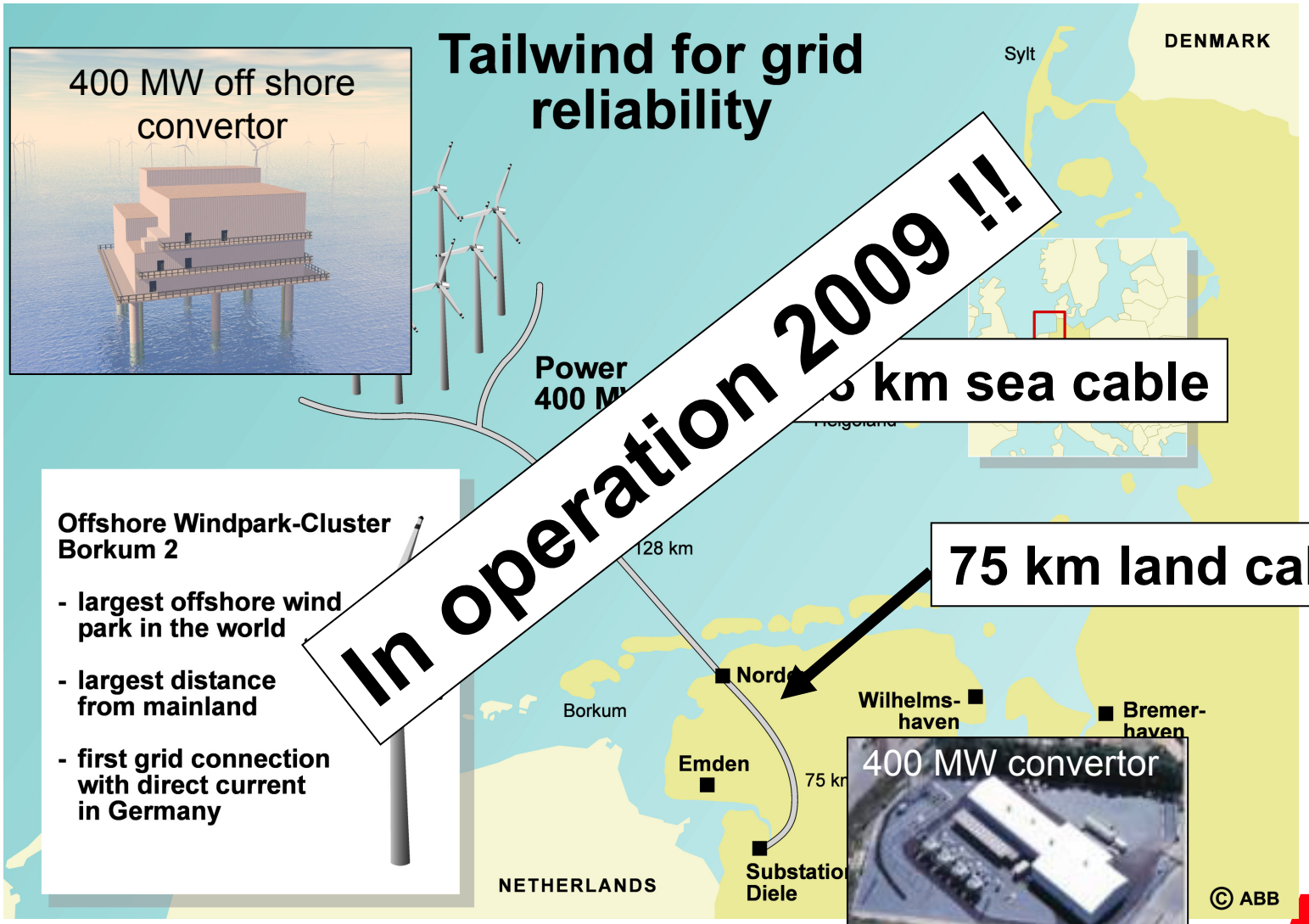
Example Germany, North Sea



Example Germany

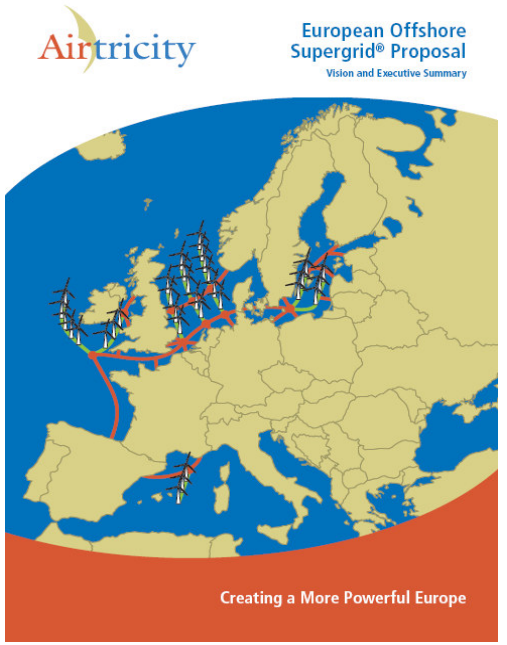
- Historically every developer planned a network-connection for each wind farm
  - More than 20 cable connections (AC&DC) through the Wattenmeer were planed
- Since 1st of January `07 the TSOs are responsible for the network connections. E.ON Netz in the North-Sea.
  - E.ON is planning 4 clusters
- Immediate reaction from TSO:s

EON 2 off shore cluster



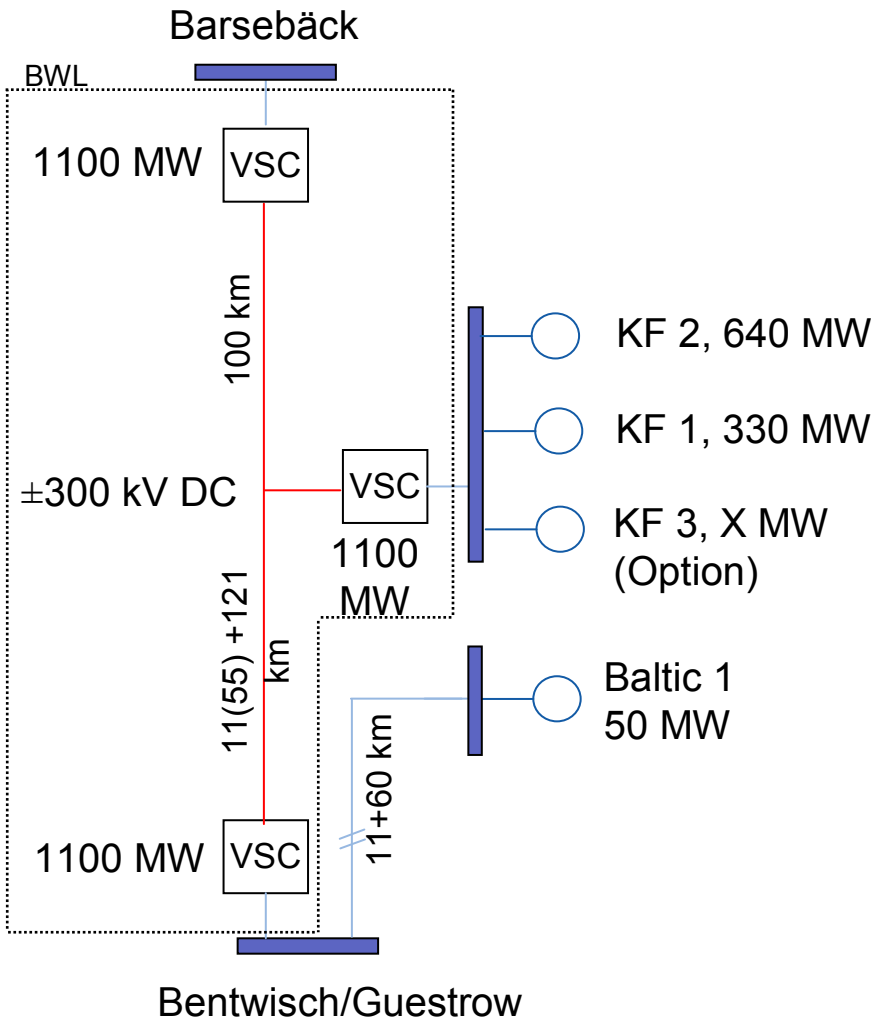
Supergrid concept

- Main concept, combine:
  - Integration of renewable energy
  - Interconnections for trading
  - Security of supply
- Benefits
  - Reduced investment
  - Increased trading capacity
  - Back-up power, e.g. hydro power can support wind power
  - Large geographic area gives more stable production



Kriegers Flak, individual cables

Kriegers Flak, “Supergrid” concept



Wind power, consequential grid upgrades

dena
Deutsche Energie-Agentur

2010 - 2015

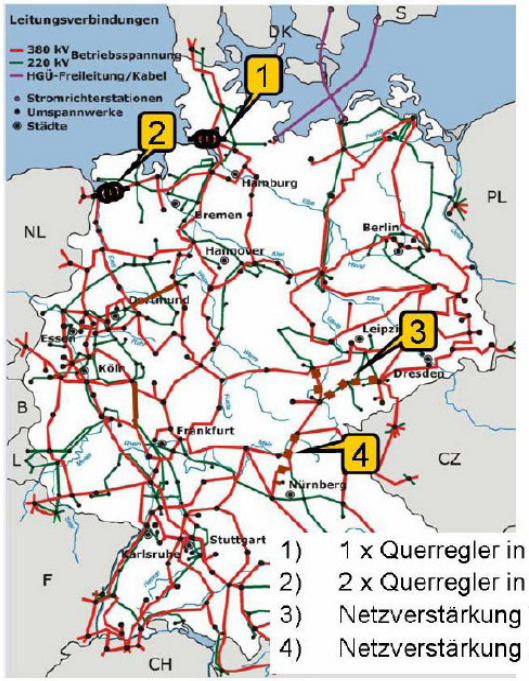
Figure 3: Grid upgrades and network extension between 2010 and 2015

1) Diele – Niederrhein (200
2) Wahle – Mecklar (190km)
3) Zubeseilung Bergkamen – Gersteinwerk
4) Zubeseilung Kriftel – Pkt. Eschborn

2007 - 2010

1) Hamburg/Nord – Dollern (45 km)
2) Ganderkesee – Wehrendorf (80 km)
3) Neuenhagen – Bertikow/Vierraden (110 km)
4) Lauchstädt – Vieselbach (80 km)
5) Vieselbach – Altenfeld (80 km)
6) Altenfeld – Redwitz (60 km)
7) Netzverstärkung Franken II

- 2007



1) 1 x Querregler in Brunsbüttel
2) 2 x Querregler in Diele
3) Netzverstärkung Thüringen
4) Netzverstärkung Franken I

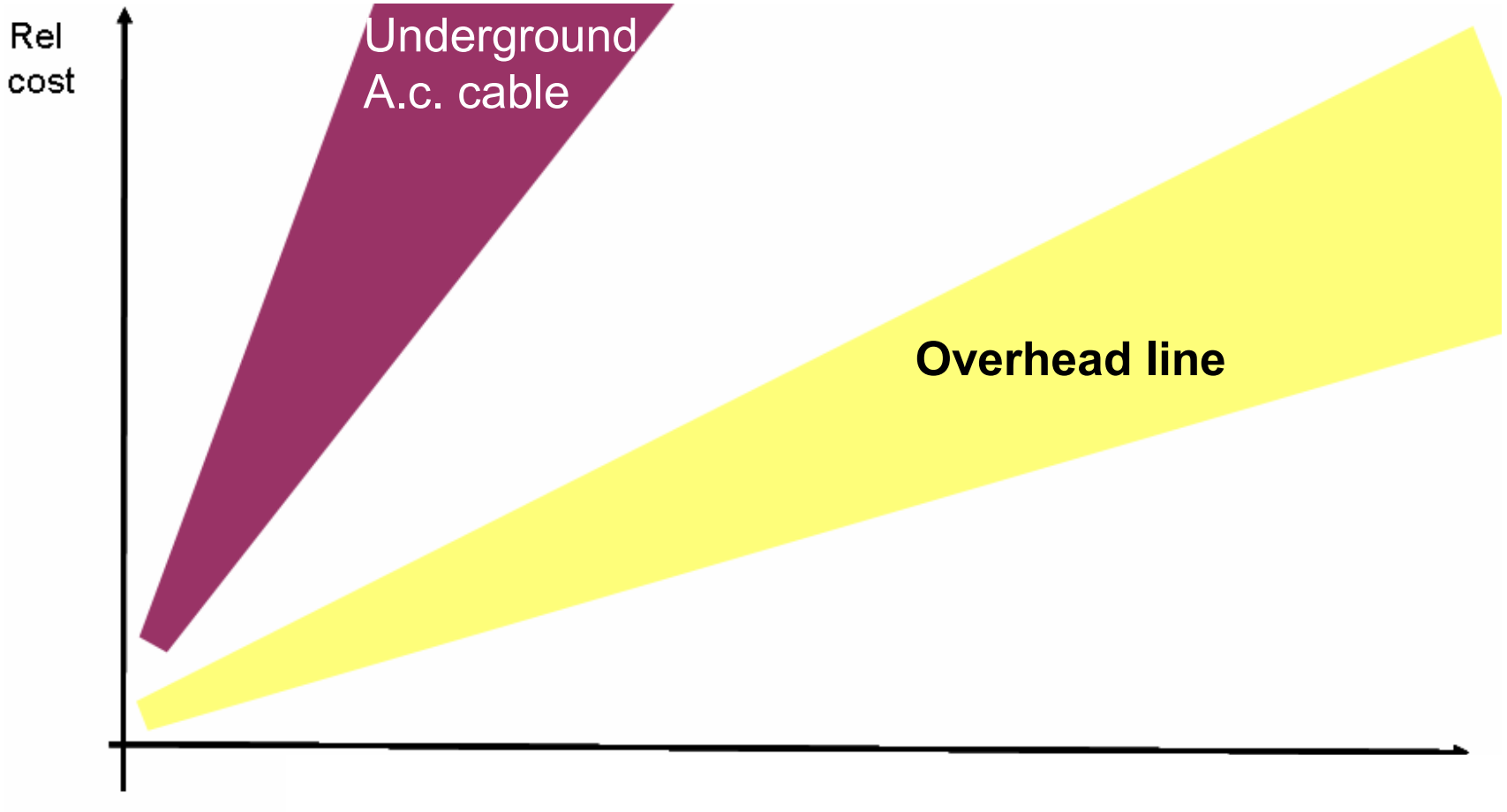
ABB

Challenge to build new infrastructure in Europe…

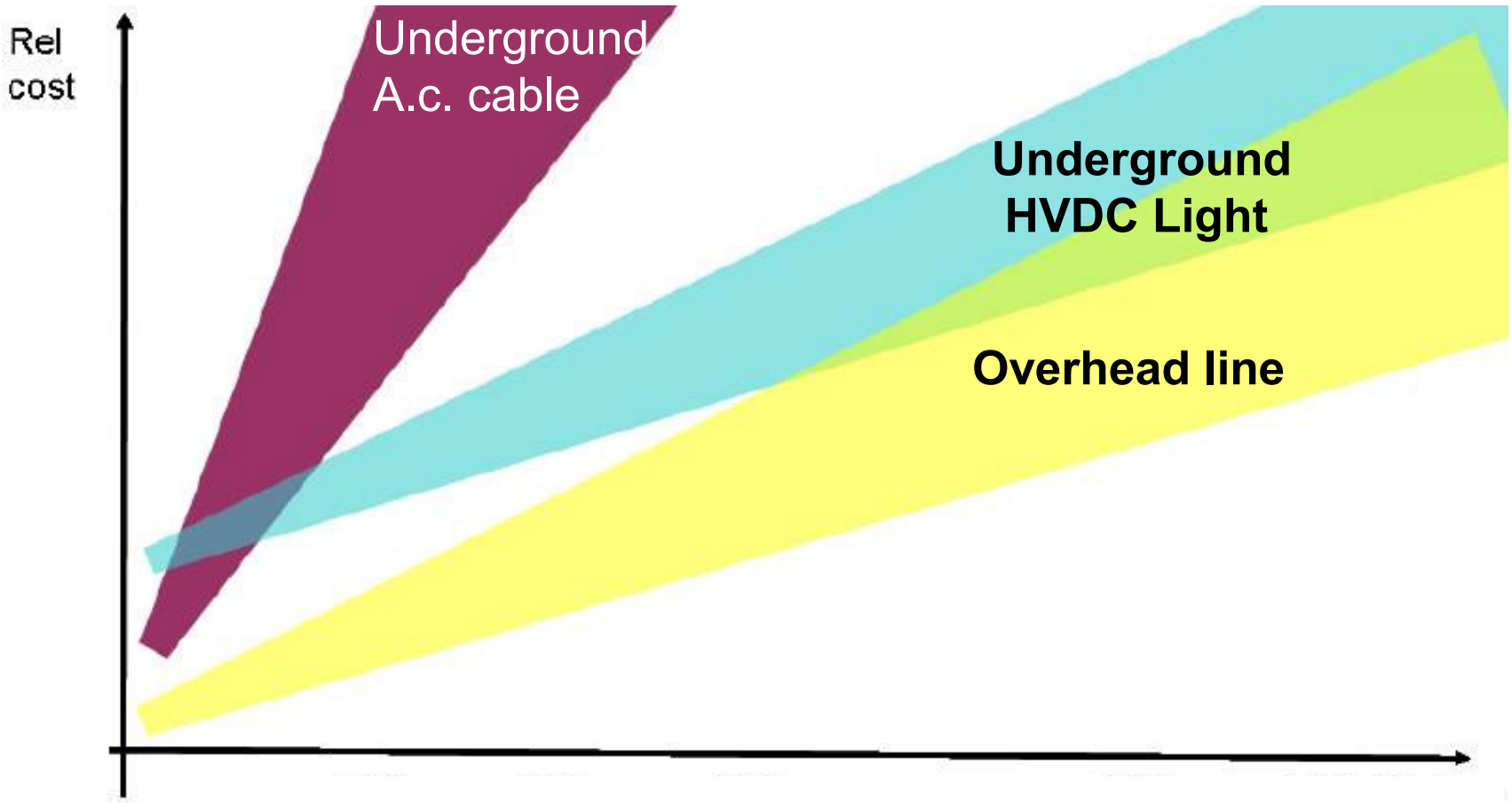
"It takes ten to 15 years to construct a line," says Wolfgang Kerner, policy officer at the European Commission... **The problem is practically zero acceptance by people of new power highways in their neighborhoods.** "Under today's circumstances it is almost impossible to create critical infrastructure"

Source: EU report 2006, Status of Priority Interconnections

Relative cost for on land transmission



Relative cost for transmission



New underground alternative, HVDC Light

- **Addresses today's concerns with overhead lines**
  - Low public acceptance
  - Increased EMF standards
- **Addresses today's concerns with underground transmission**
  - No limitation in distance
  - Drastic reduction in cost, fault location and repair times
- **Improves grid performance**

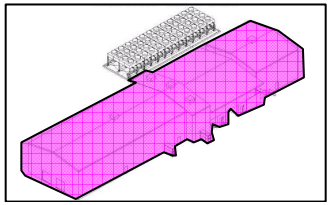
Development, HVDC Light convertors

1997
Hellsjön
+/- 10 kV

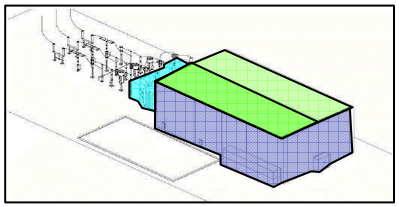
1999
7 MW - 50 MW
+/- 80 kV

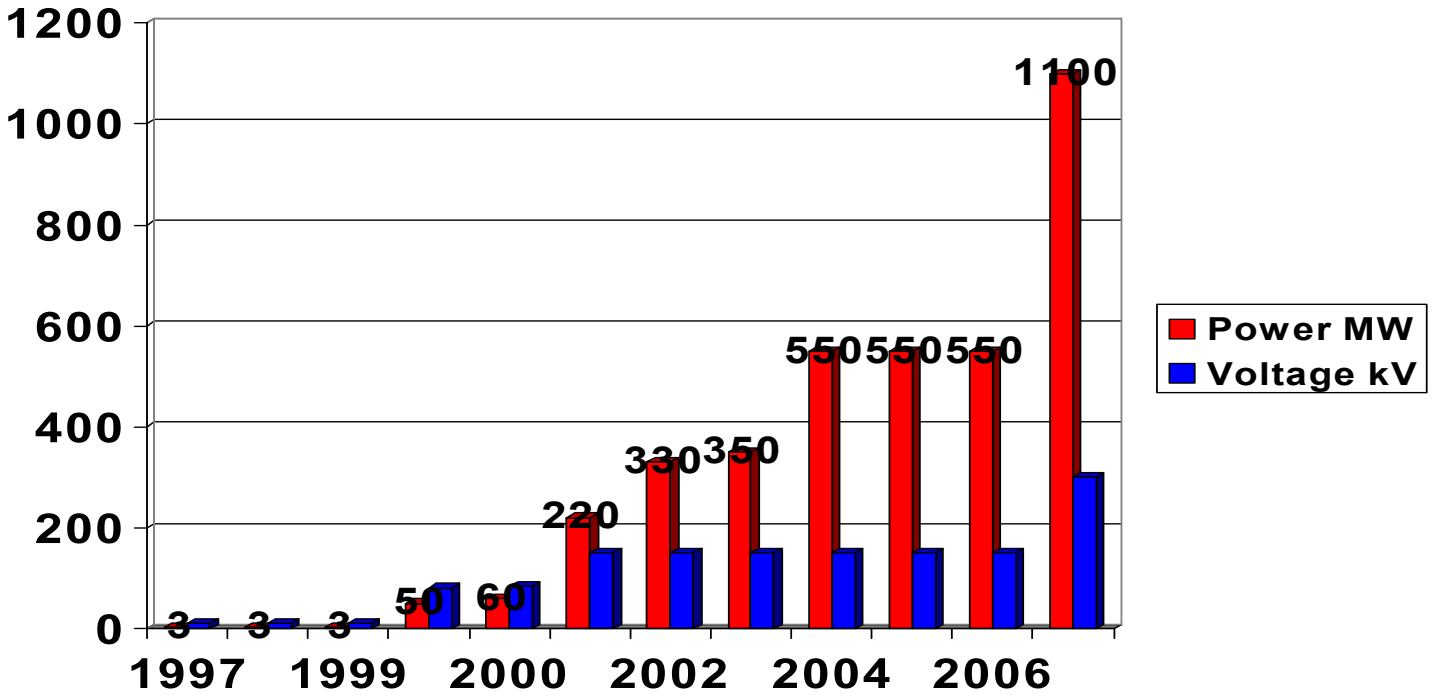
2001
up to 330 MW
up to +/- 150 kV

2004
up to 550 MW
up to +/- 150 kV



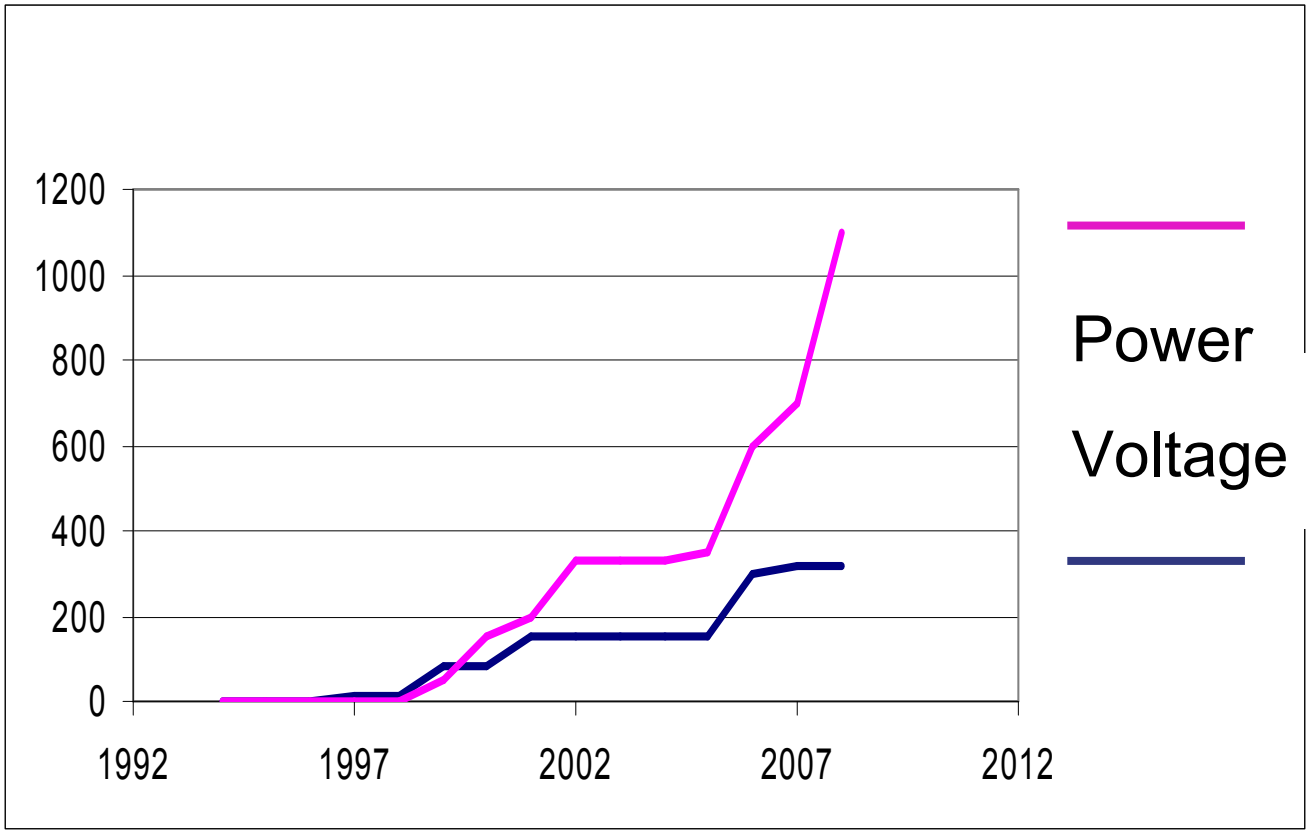
2007
up to 1100 MW
up to+/- 320 kV





HVDC Light Cable Development

- Development started in the early 90's
- Commercial introduction with Gotland cable in 1998



Offshore power supply, performance driver

- Increased reliability
  - Forced Outage Rate 5/year → 3/year → 1/year
- Increased availability
  - Maintenance intervals 1/year → 1/2years → 1/5years
- Reduced start-up time
  - Commissioning time month → weeks → days

Summary

- New technologies for grid expansion can offer renewable energy:
  - Location on best production sites.
  - Access to the market
  - Back up power
- Integrated approach for Europe will increase the value of existing and new renewable generation
- Underground transmission becoming realistic alternative

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