ENERGINET

TenneT
Taking power further

North Sea Wind Power Hub

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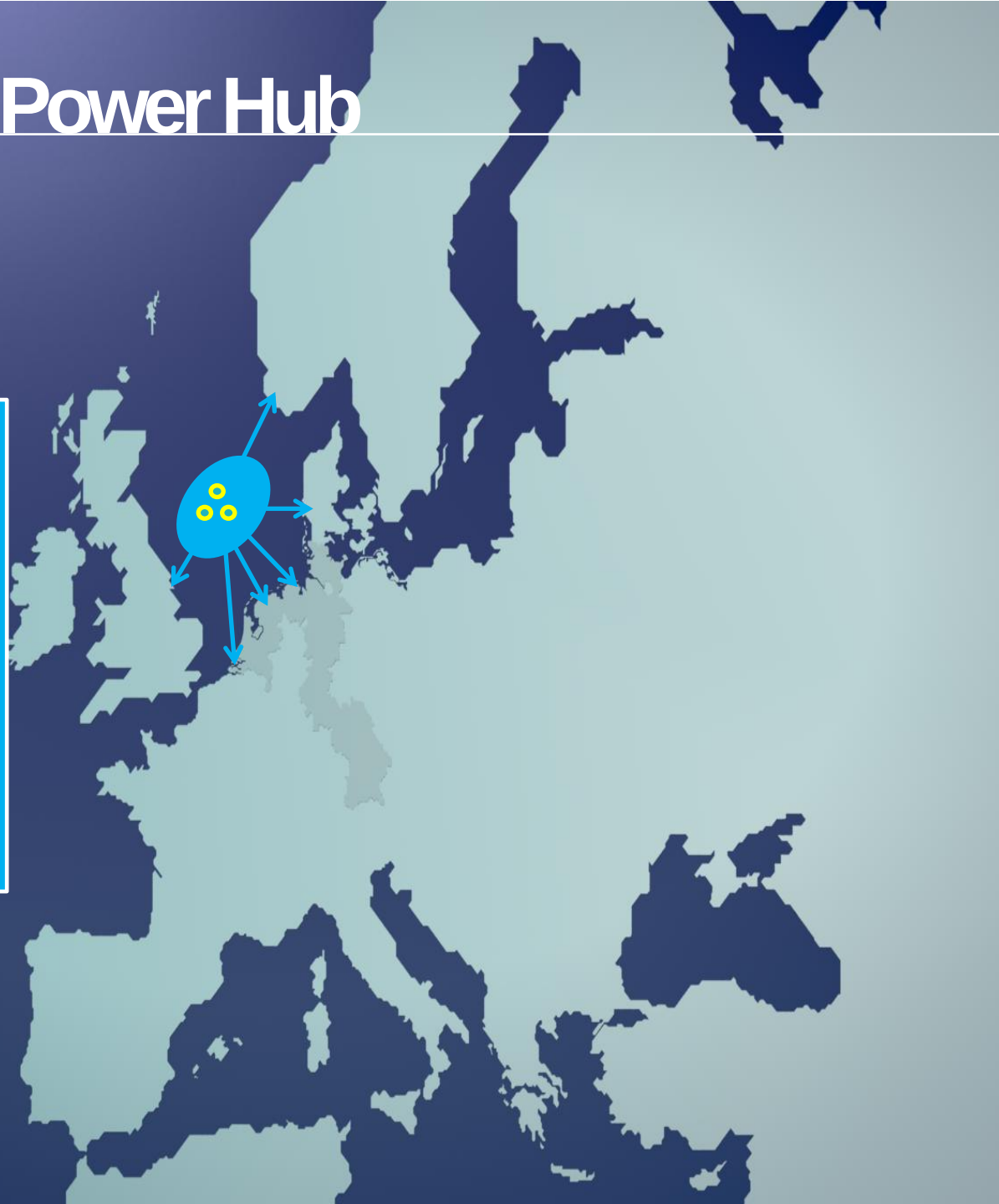
North Sea Wind Power Hub

Paris climate agreement
80-95% CO_2 reduction in 2050

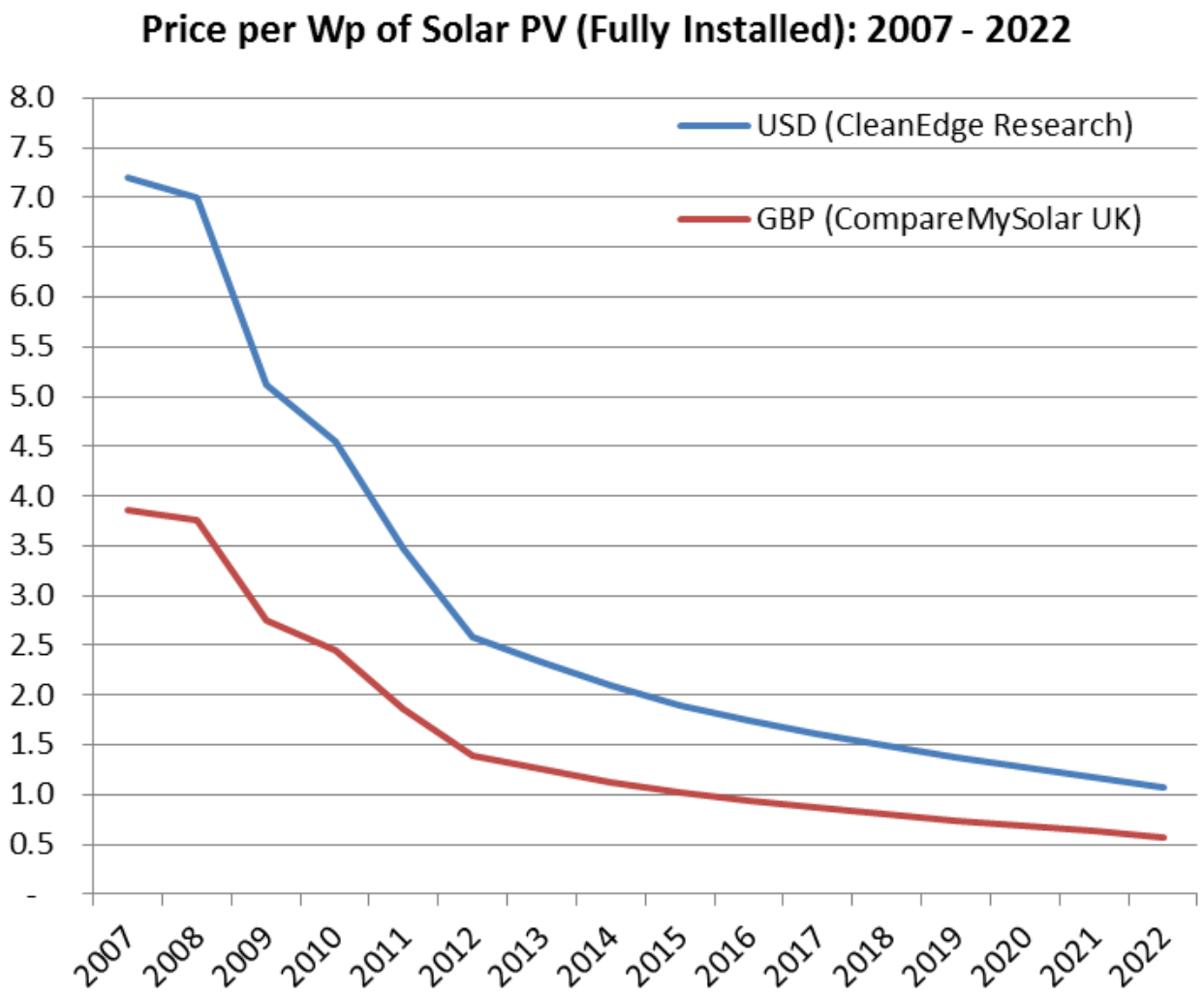
Needed in Europe in 2050
150 GW North Sea Wind

Regional cooperation is essential
Barriers:

- Subsidy schemes
- Focus on national sustainability goals



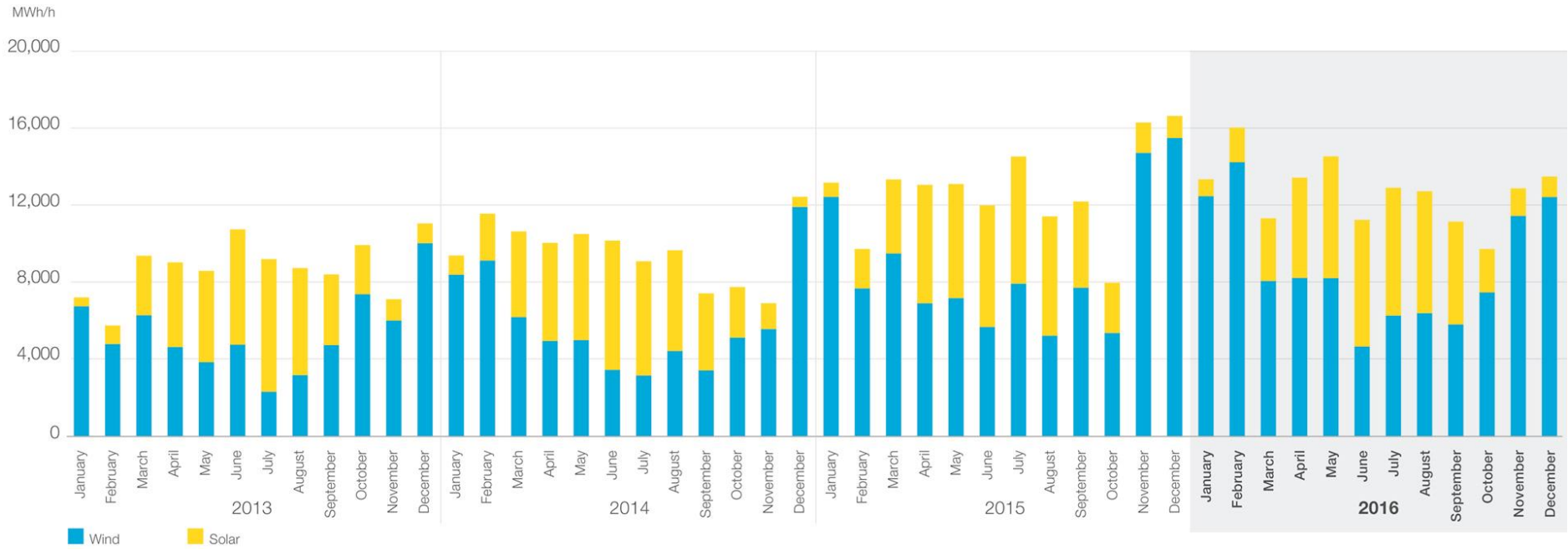
Solar pv: ongoing price decline



Source: renewableenergyhub.co.uk

Sun needs wind

Complementary sources during the year

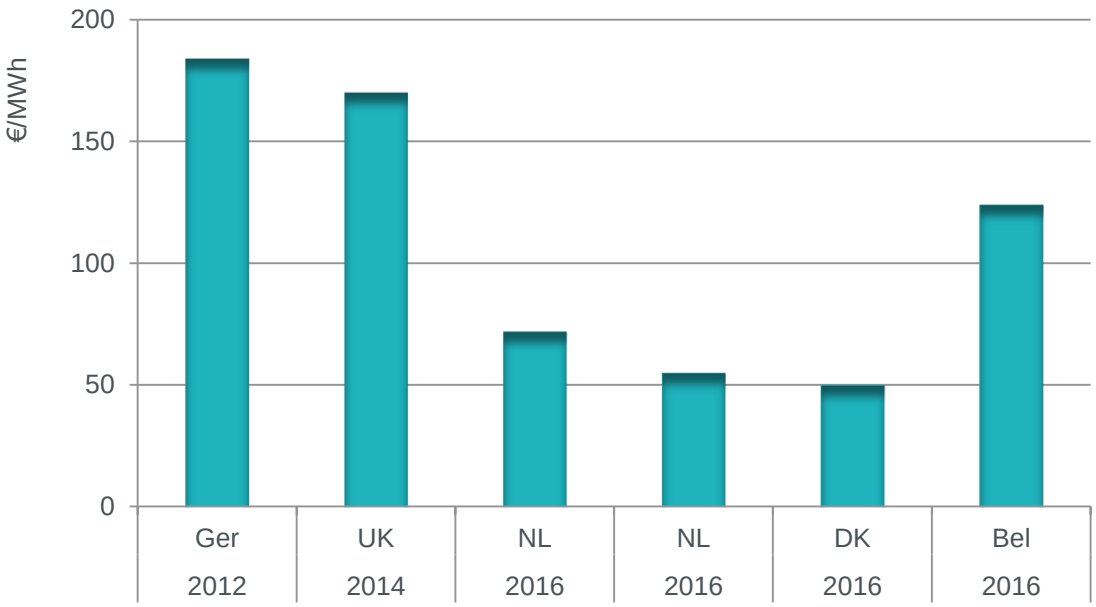


- Best solar pv : wind ratio for Europe = 1 : 2 *
- 1 kWh solar pv → 2 kWh wind energy

*Dominik Heide et al. Renewable Energy 35: Seasonal optimal mix of wind and solar power in a future, highly renewable Europe

Price development offshore wind

Break through with Borssele and Kriegers Flak projects in the Netherlands and Denmark



(€/MWh prices based on national subsidy schemes)

System

- Tenders: competition
- Standardisation
- Bigger turbines
- Bigger wind farms
- Permits taken care of
- Seabed surveys

Market

- Low interest rate
- Low steel price
- Low oil price

2016

Borssele I,II	72 €/MWh
Borssele III,IV	55 €/MWh
Kriegers Flak	50 €/MWh

Challenge for wind energy

- Wind energy on land
- Wind energy near shore
- Wind energy far shore
    - Construction (expensive)
    - Maintenance (expensive)
    - Infrastructure (expensive)

Challenge

- German solution: expensive
- How to get cost level down? Below or comparable to near shore
- How to integrate in the environment?
- How to cooperate internationally?
- Far shore for same price as near shore

Solution: location

Shallow waters

Water depth has a significant impact on the development for offshore wind.

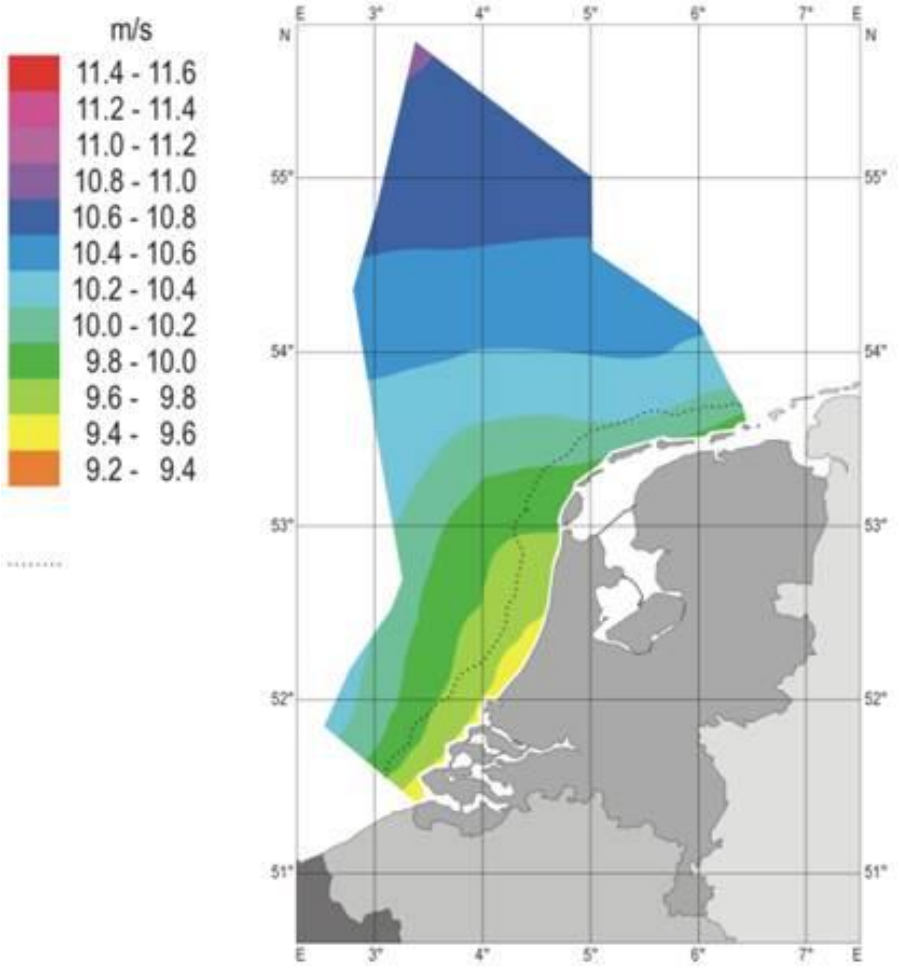
A development in shallow waters contributes significantly to cost reduction.

Wind conditions

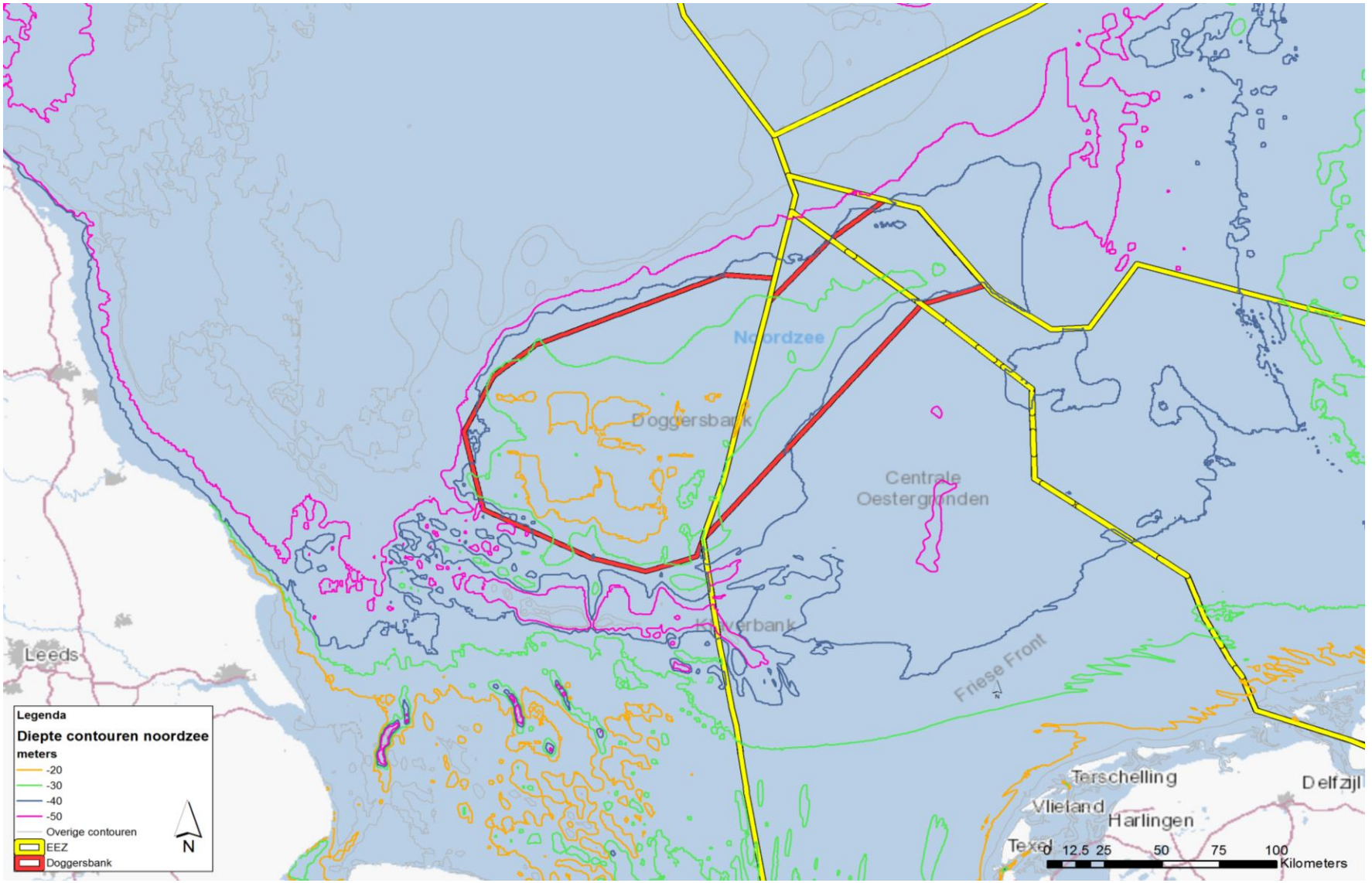
Wind conditions get better further at sea, which partially compensates the increase in cost for distance.

Central location

For a European coordinated roll-out, a central location is important.

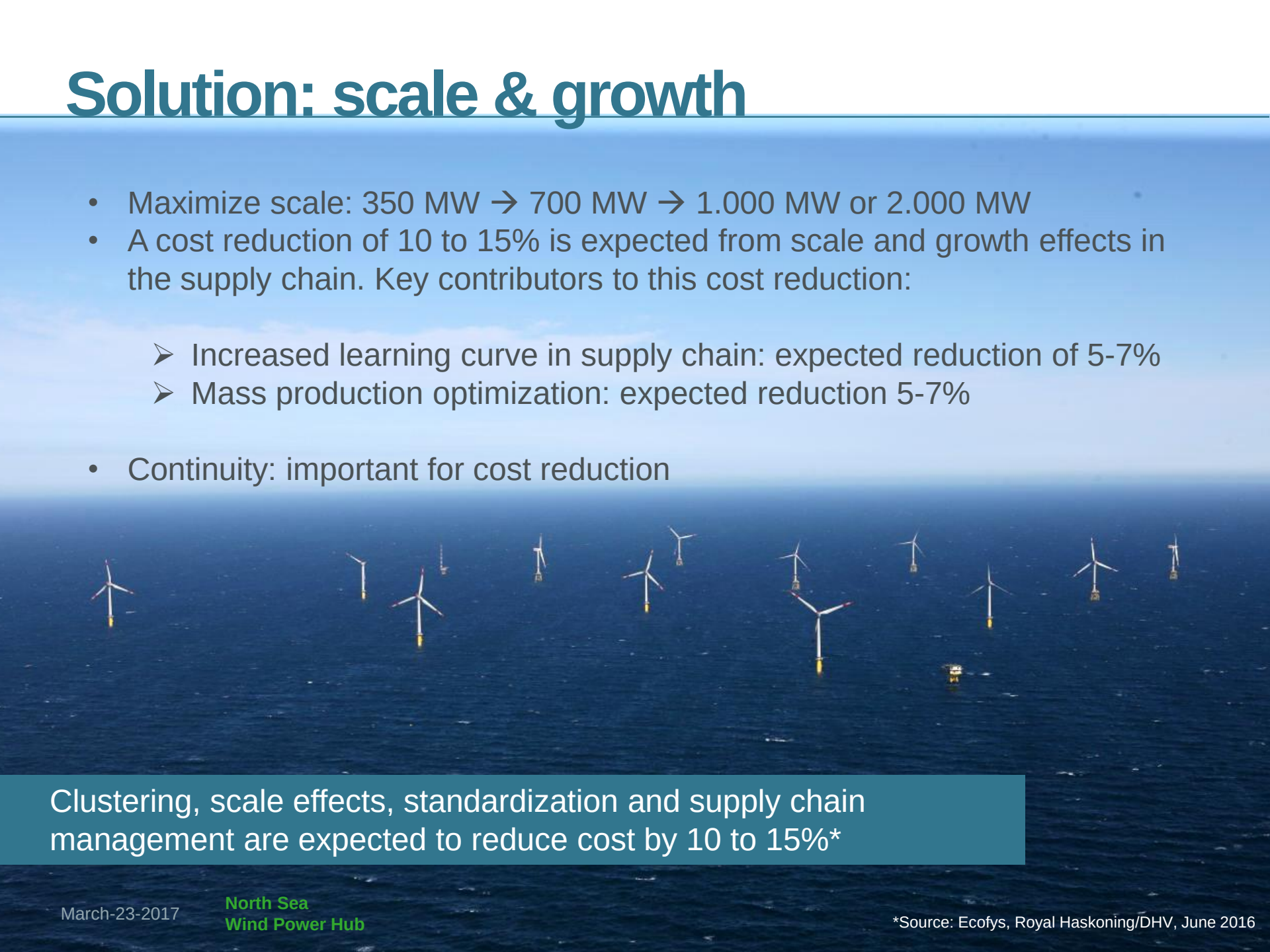


Solution: location



Solution: scale & growth

- Maximize scale: 350 MW → 700 MW → 1.000 MW or 2.000 MW
- A cost reduction of 10 to 15% is expected from scale and growth effects in the supply chain. Key contributors to this cost reduction:
  - Increased learning curve in supply chain: expected reduction of 5-7%
  - Mass production optimization: expected reduction 5-7%
- Continuity: important for cost reduction

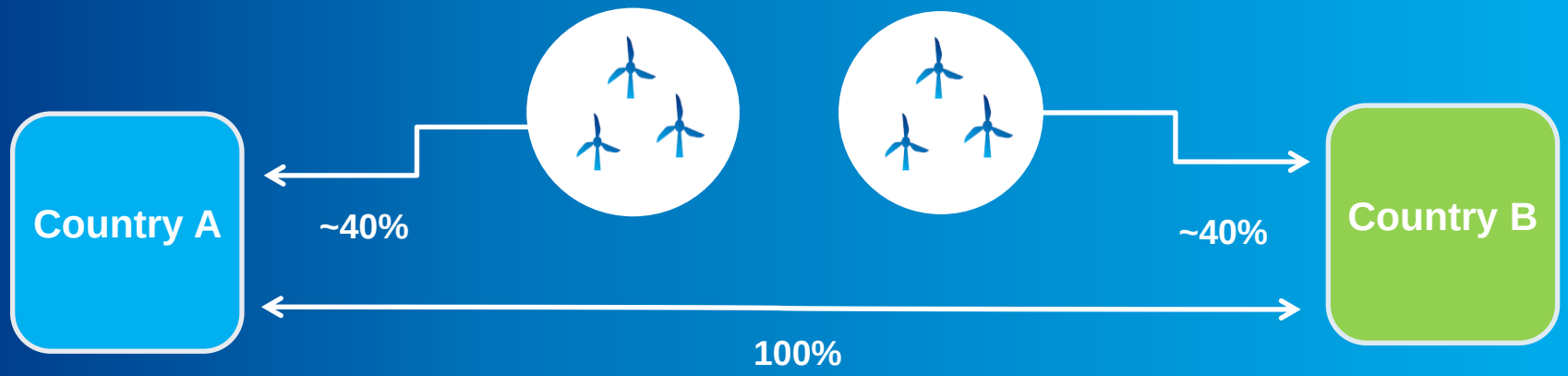


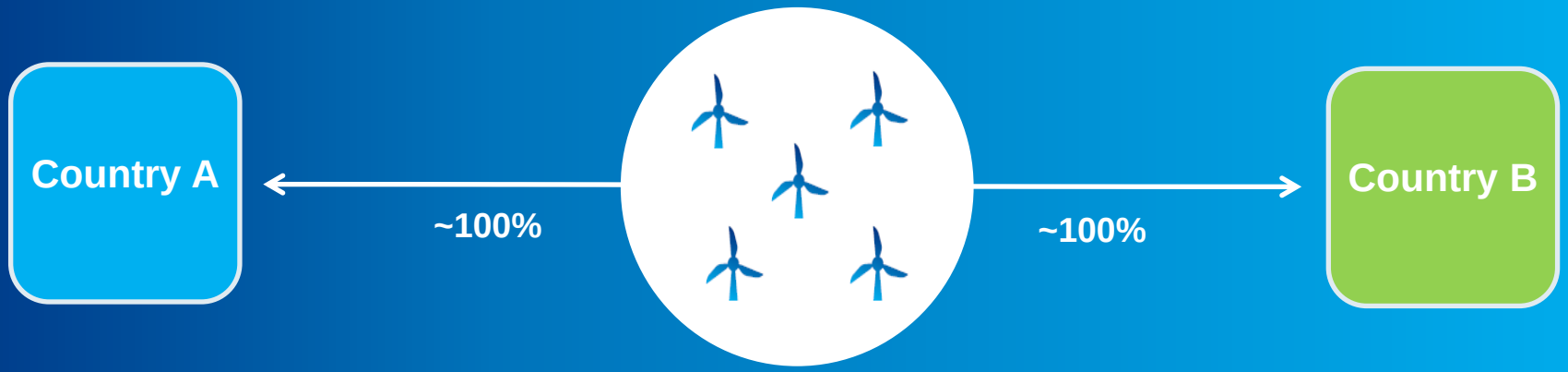
Clustering, scale effects, standardization and supply chain management are expected to reduce cost by 10 to 15%*

*Source: Ecofys, Royal Haskoning/DHV, June 2016

Solution: infrastructure

The *'wind-connector'*: offshore wind infrastructure and interconnector are one





North Sea Wind Power Hub

The Power Link Island: a modular approach (30 GW per island, 70-100 GW in total)

- Far shore becomes near shore
- Distribution point for different countries
- Space for multiple converters (AC→ DC)

Solution: North Sea Wind Power Hub

Hub and spoke model

Studies

- Windconnector NL - UK
- (small) Power Link Island on IJmuiden Ver wind area
- Electrification oil & gas platforms IJmuiden Ver

Cooperation

- Energinet.dk
- Partnerships other infrastructure operators

Offshore wind

3 phase (parallel) development

Short Term	→	Under development at the time
Medium Term	→	Use potential near shore locations.
	→	Preparation for international cooperation
Long Term	→	Far shore 150 GW: North Sea Wind Power Hub (70-100 GW)
	→	International cooperation necessary

Ecological aspects

In close consultation with environmental organizations

- Dogger Bank = Natura2000 area
- Continuous alignment with NGO’s
- Vast experience in preventing ecological impact
- Biodiversity development
- Future of offshore wind depends on cost reduction



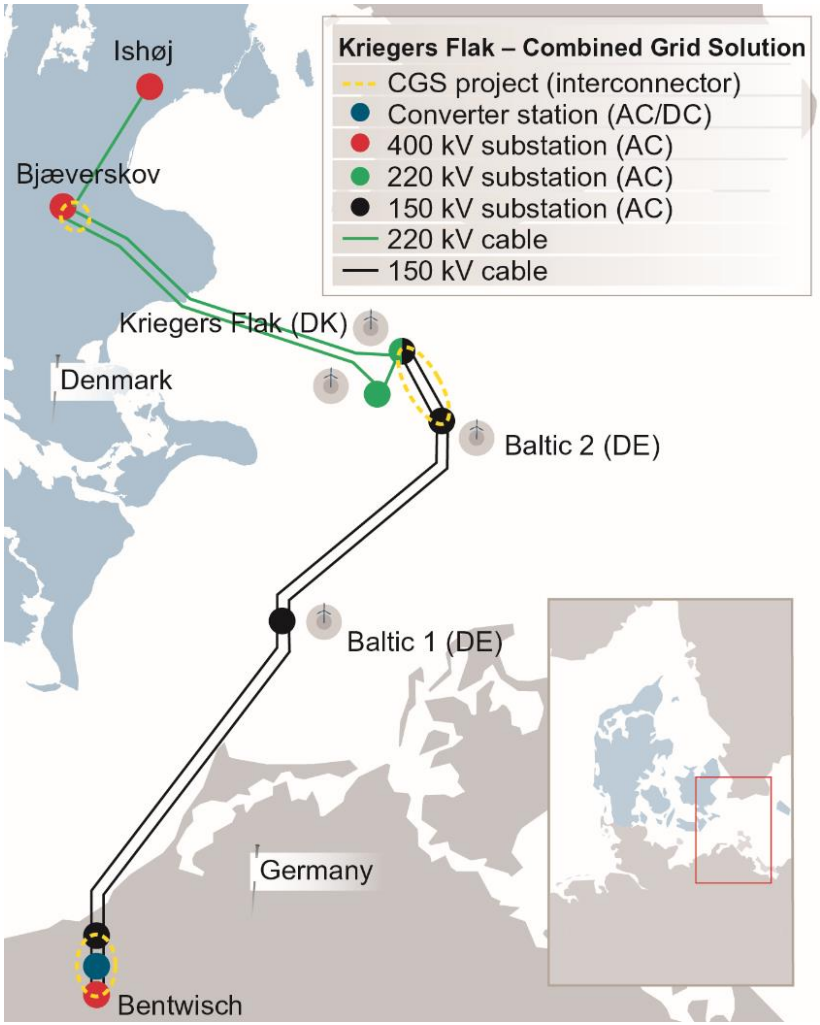

Kriegers Flak

Combined grid solution

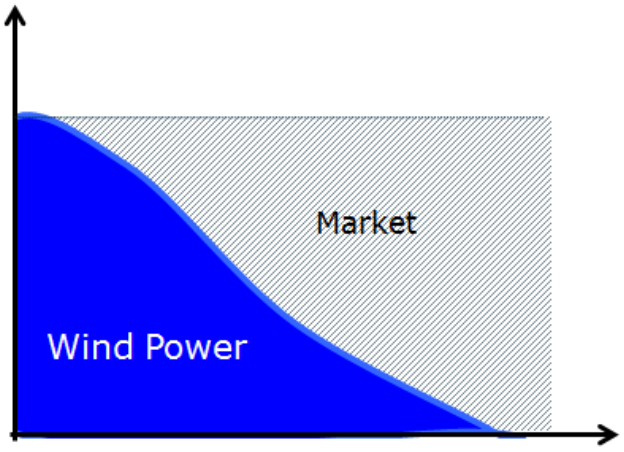
50hertz ENERGINET.DK
Co-financed by the European Union
European Energy Programme for Recovery

Kriegers Flak CGS

Lessons learned



- Common Grid Solution
- Offshore Wind prices record low
- Offshore HVCD not an option
- Master Controller ensures efficient



50hertz ENERGINET

Co-financed by the European Union
European Energy Programme for Recovery

Power to gas on Island

Potential synergies

- Making green gas right at the wind power source.
- Onsite flexible consumption of wind power reduce transmission losses and optimize grid utilization.
- Gas is much cheaper to transport over long distances than power.
- Potential synergies with existing North Sea gas infrastructure.

- **After 2030 electrolysis is expected to be a mature technology for making green hydrogen**