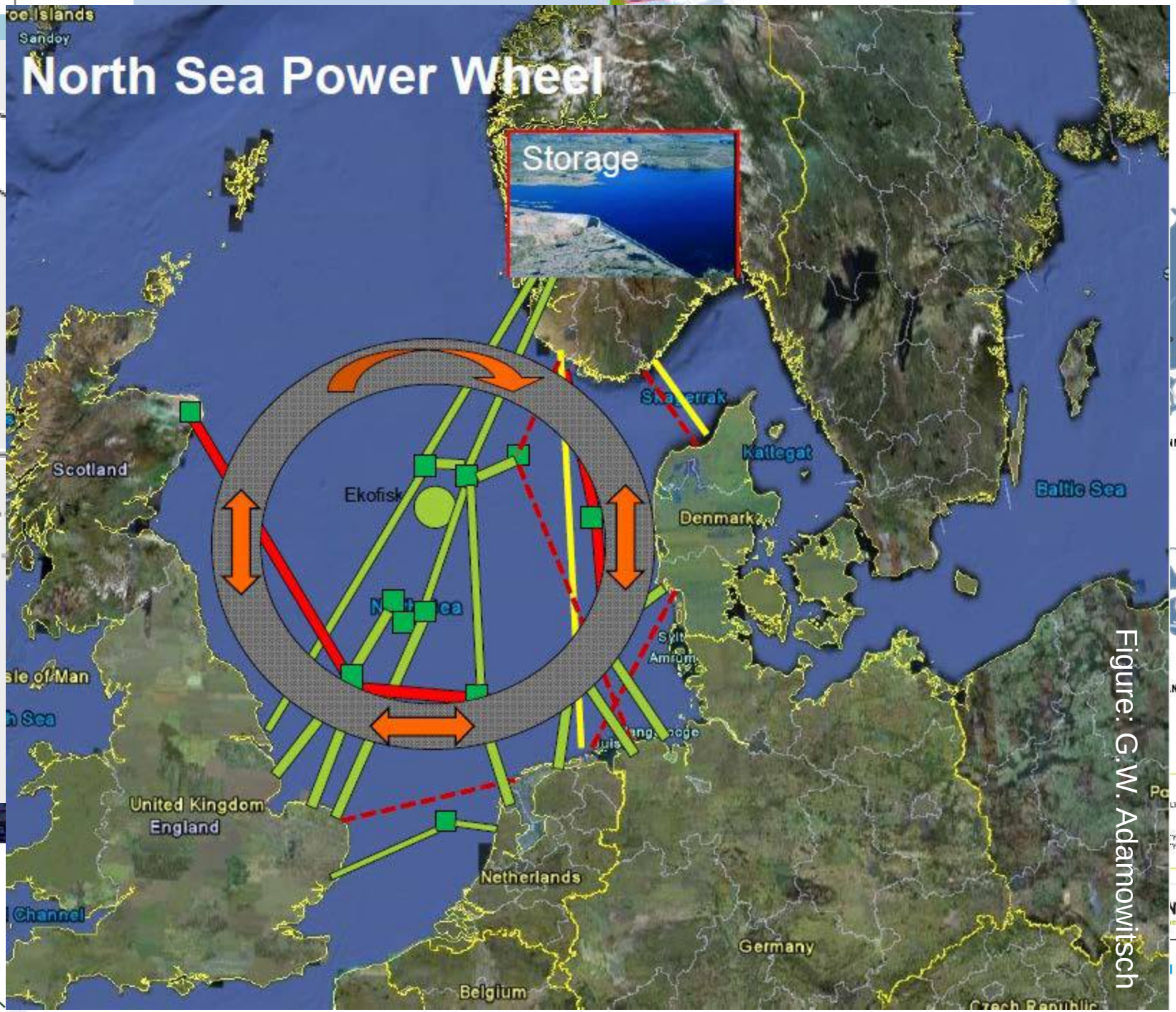
Ravi Srikandam, Paul Kreutzkamp, Jan Decker

A Selection of Results

OFFSHORE GRID

Berlin Seminar on Energy and Climate Policy, 1 March 2012


North Sea Power Wheel
Storage
Scotland
Ekofisk
Skagerrak
Kattegat
Baltic Sea
Denmark
Isle of Man
United Kingdom
England
Netherlands
Germany
Belgium
Czech Republic
Figure: G.W. Adamowitsch

OFFSHOREGRID PROJECT

Facts on Project Framework

PROJECT DNA

- Techno-economic study to identify an efficient offshore grid
- Cost-benefit analysis of different design options = First study that puts assumptions on solid numerical basis
- Budget 1.4 M€, 75% funded by EC
- May 2009 until October 2011

Consortium and Stakeholder Advisory Board

- 3E (Coordinator), Germany Energy Agency (dena), EWEA, Sintef, Senergy Econnect, NTUA, IEO Brec
- Stakeholder Advisory Board: Ofgem, Bundesnetzagentur, Acciona Energia, ABB, Siemens AG, Nexans, Transmission Capital, Mainstream Renewable Power, Entso-E, RG NS, Tennet, Energinet.dk, 50Hertz-Transmission, Statnett, EC BREC, EC DG TREN, TEN-E, EC DG MARE, EACI, Bundesamt f. Seeschifffahrt & Hydrografie, RWE Innogy, Greenpeace

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RESULTS OF THE STUDY

An Overview

- Wind Energy Statistics – Insights into future needs
- Conventional power fleet development
- **Hubs vs. individual connections** (incl. stranded investment calculations → German discusison)
- Concrete case study analysis (e.g.German wind farm teed into the cobra cable.)
- General **techno-economic guidelines** for abstract design modules
  - Tee-in connections
  - Hub-to-Hub connections
- **Techno-economic results** for two meshed offshore grid designs („Super Grids“)
- Check against current political and regulatory framework.

Concrete technical design recommendations.
Recommendations concerning regulatory frameworks, financing, policy.

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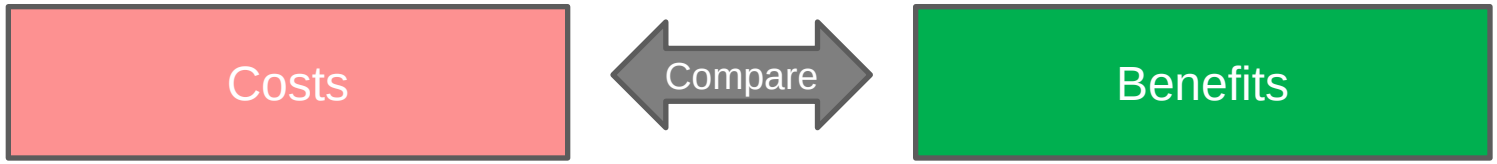
COST BENEFIT ANALYSIS

What to compare?



Infrastructure costs:
- Offhore substation
- Onshore substation
- Subsea cables AC or DC

Taking into account concrete cable ways, water depth, voltage levels, capacities....

Result of infrastructure cost model.

Lower system generation costs due to better interconnection = More connection capacity allows to generate where it is cheapest.

Results of European Power Market and Grid Flow Model

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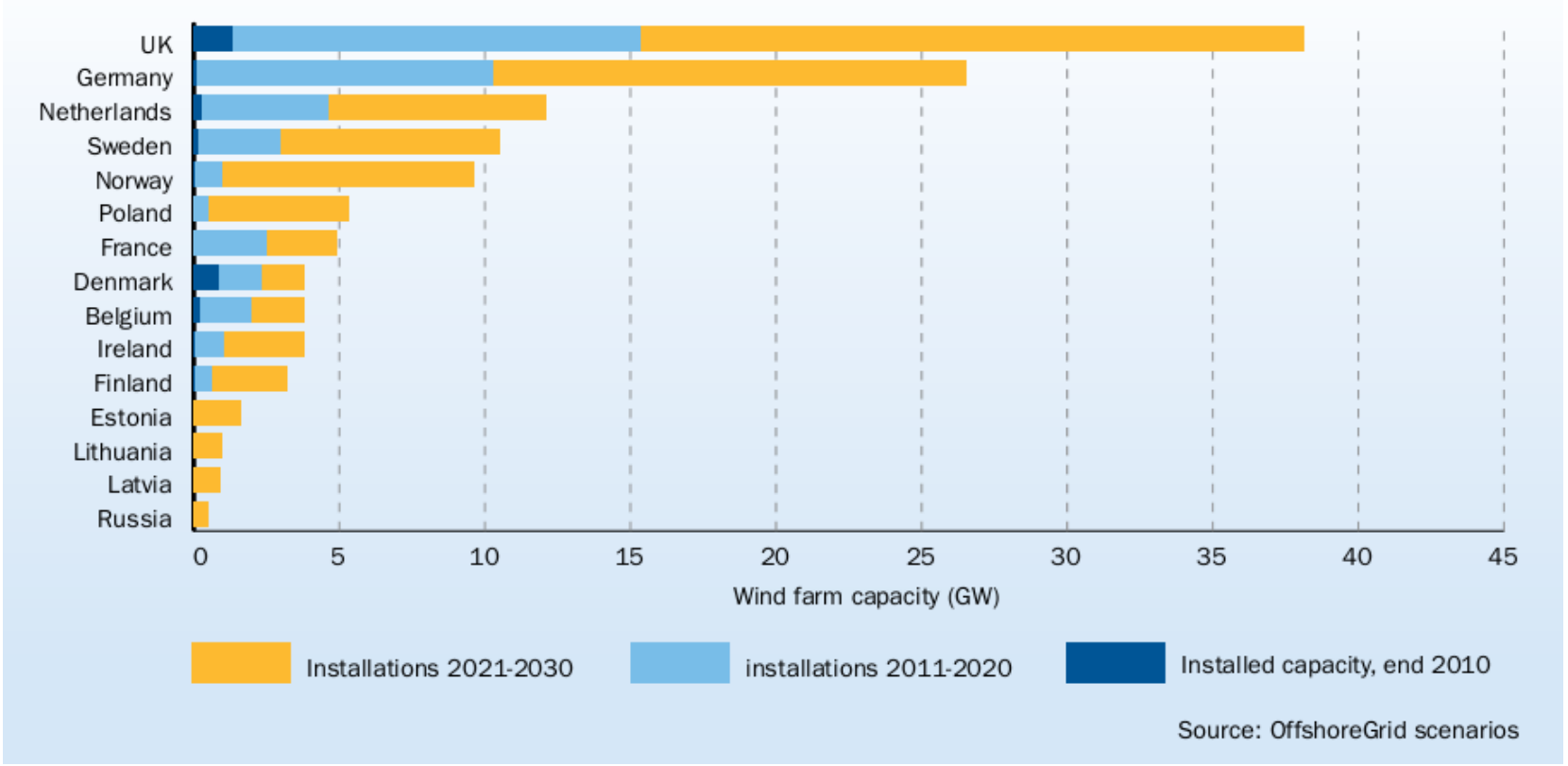
OFFSHORE WIND ENERGY

Input Scenario



126 GW offshore wind energy in Europe in 2030 in 321 offshore wind farms

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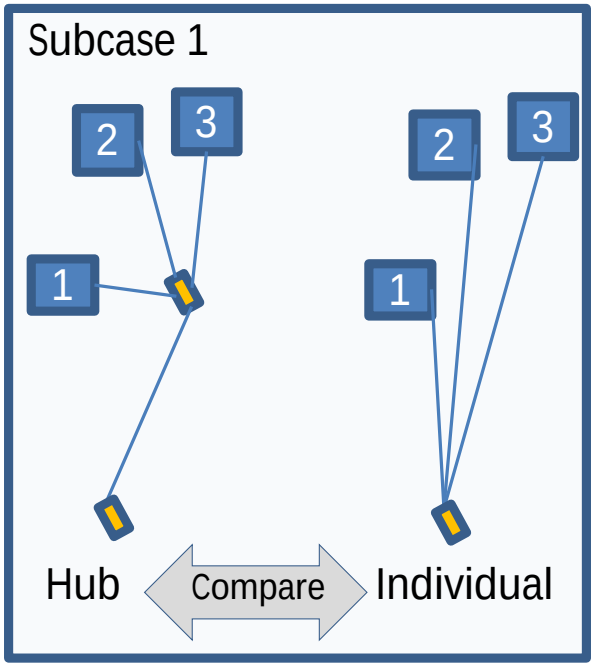
HUB CONNECTION VS INDIVIDUAL CONNECTION



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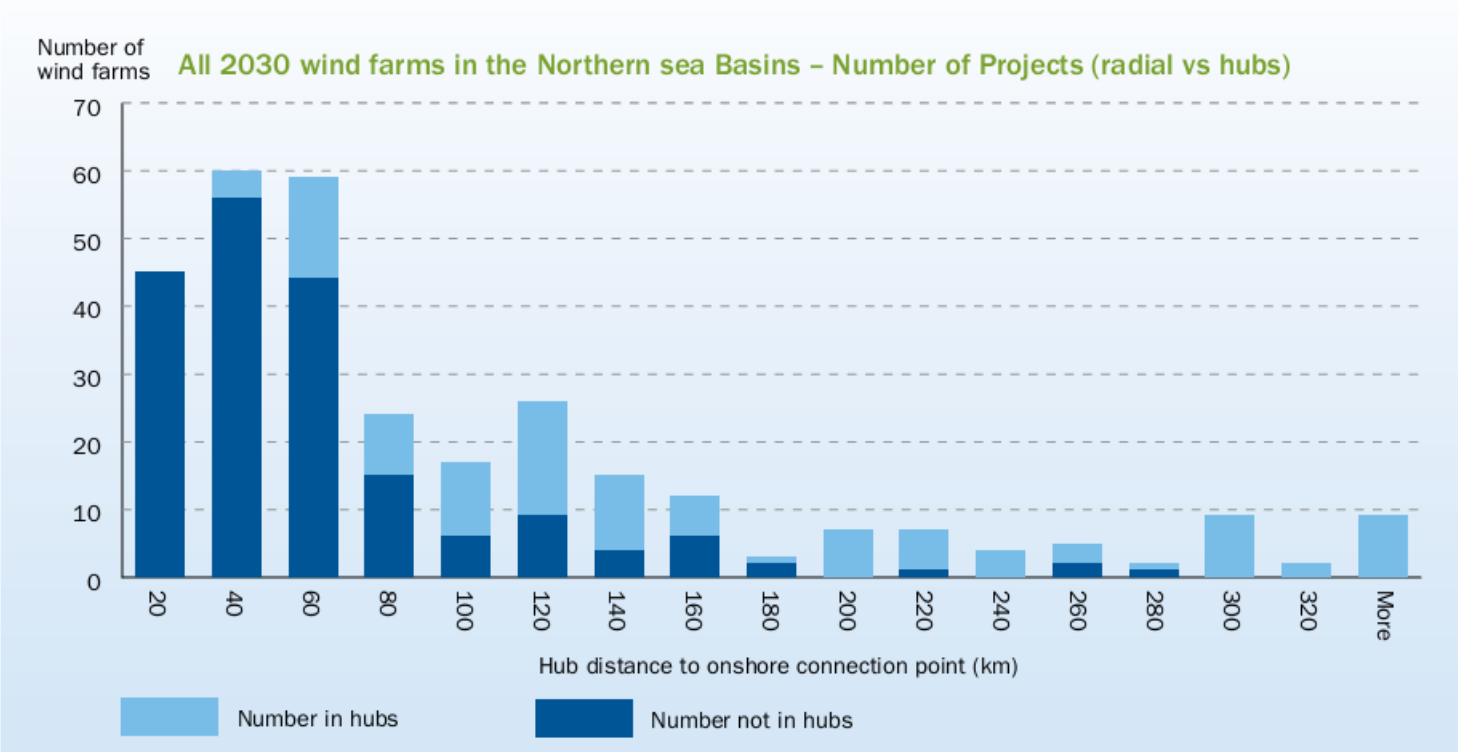
HUB CONNECTION VS INDIVIDUAL CONNECTION

When Beneficial?



- 114 out of 321 wind farms will be clustered in hub connection
- Comparison with the individual connection scenario shows € 14 bn of savings.

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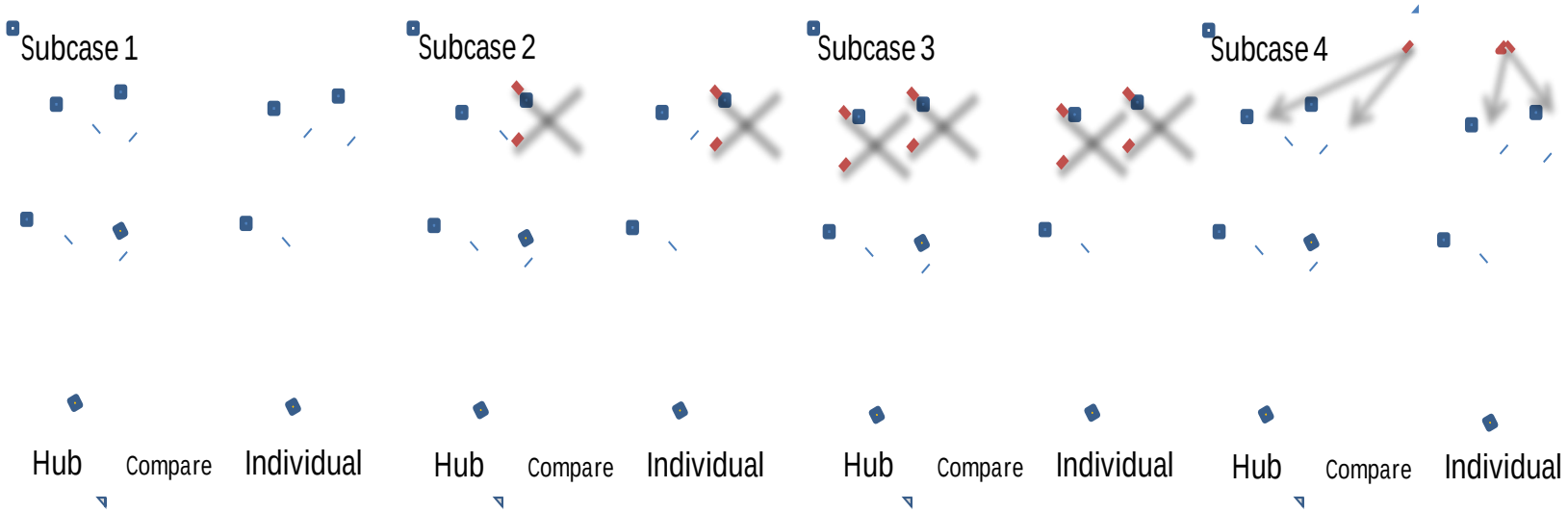
HUB CASE

Additional analyses with 4 hub connection subcases



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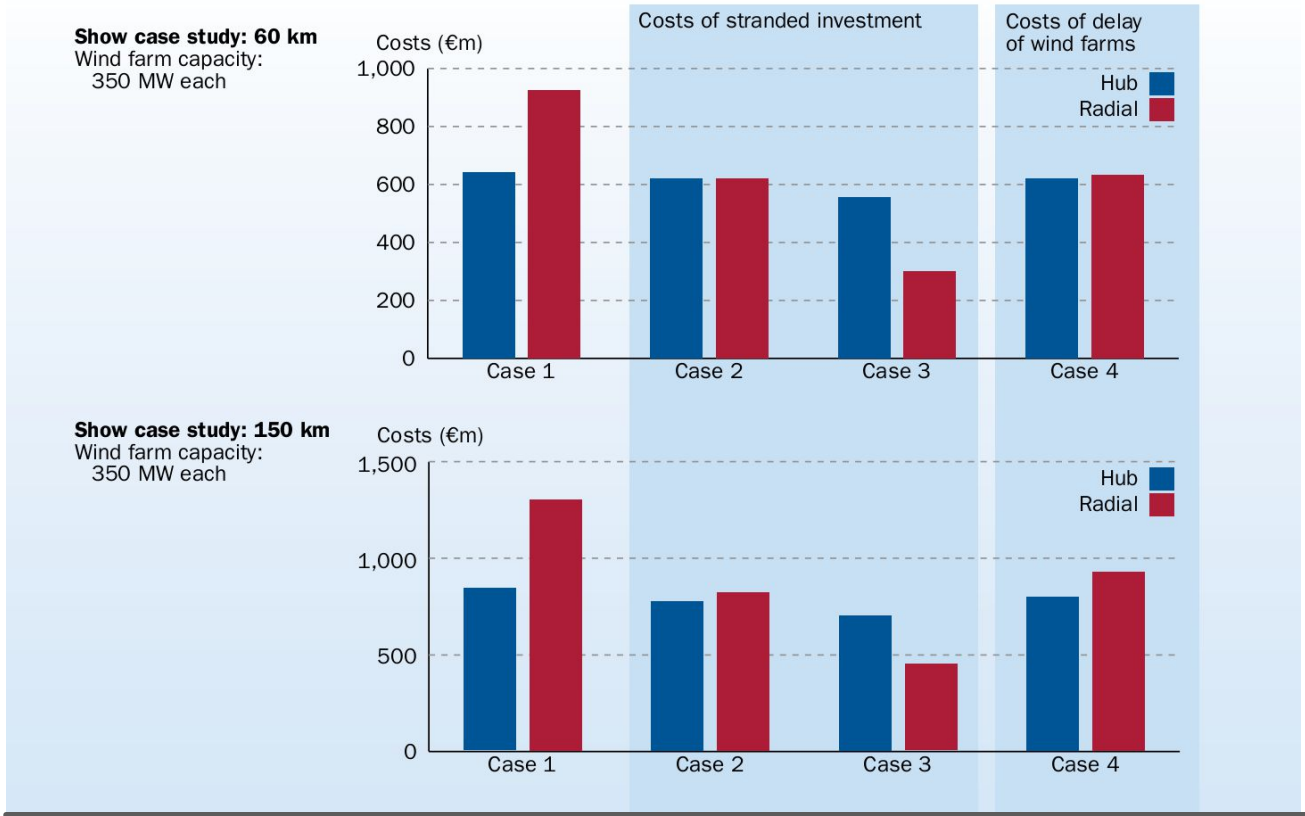
HUB CASES

Cost comparison of 4 hub connection subcases



- Additional analysis showed that the risk of stranded investment is low. Case of 3 wind farms 60-150km from shore
  - Costs of temporary oversizing are limited.
  - Hubs can be beneficial even if one of the wind farms is not built at all.

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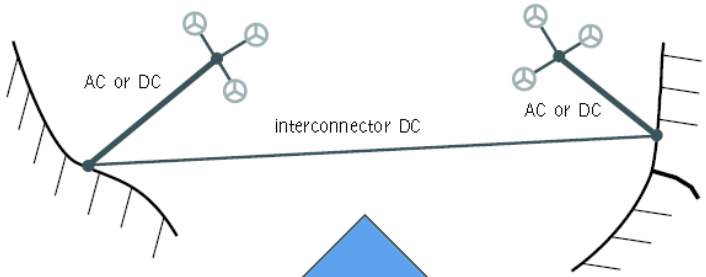
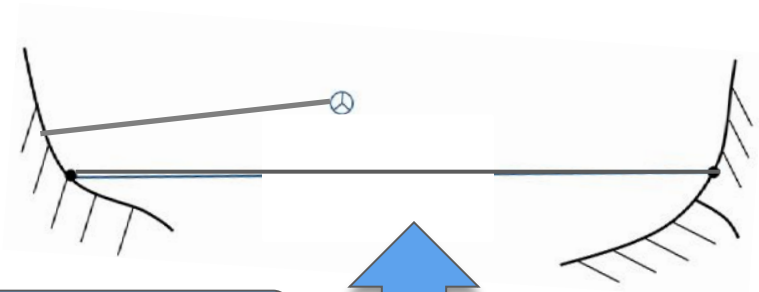
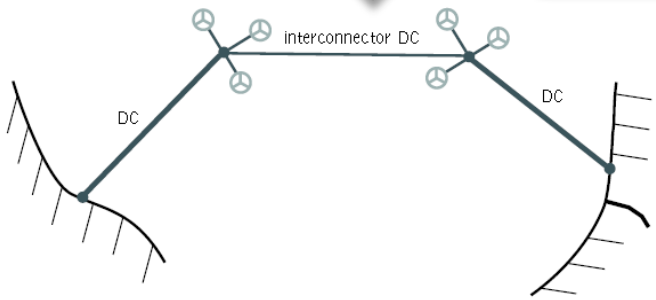
DESIGN CONCEPTS

Modular Building Stones of an Offshore Grid

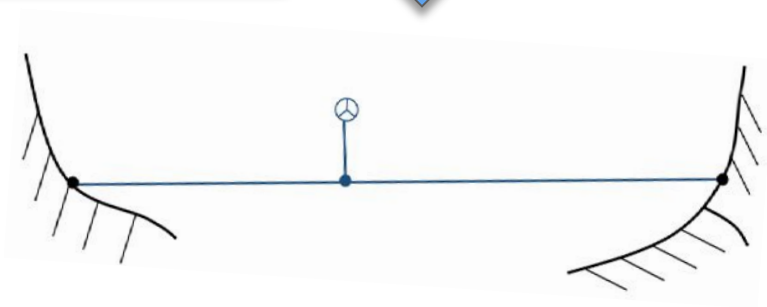




Cost-**Benefit** Comparison



Hub-to-hub connection



Interconnector Tee

- All typical design concepts can be reduced to these design modules

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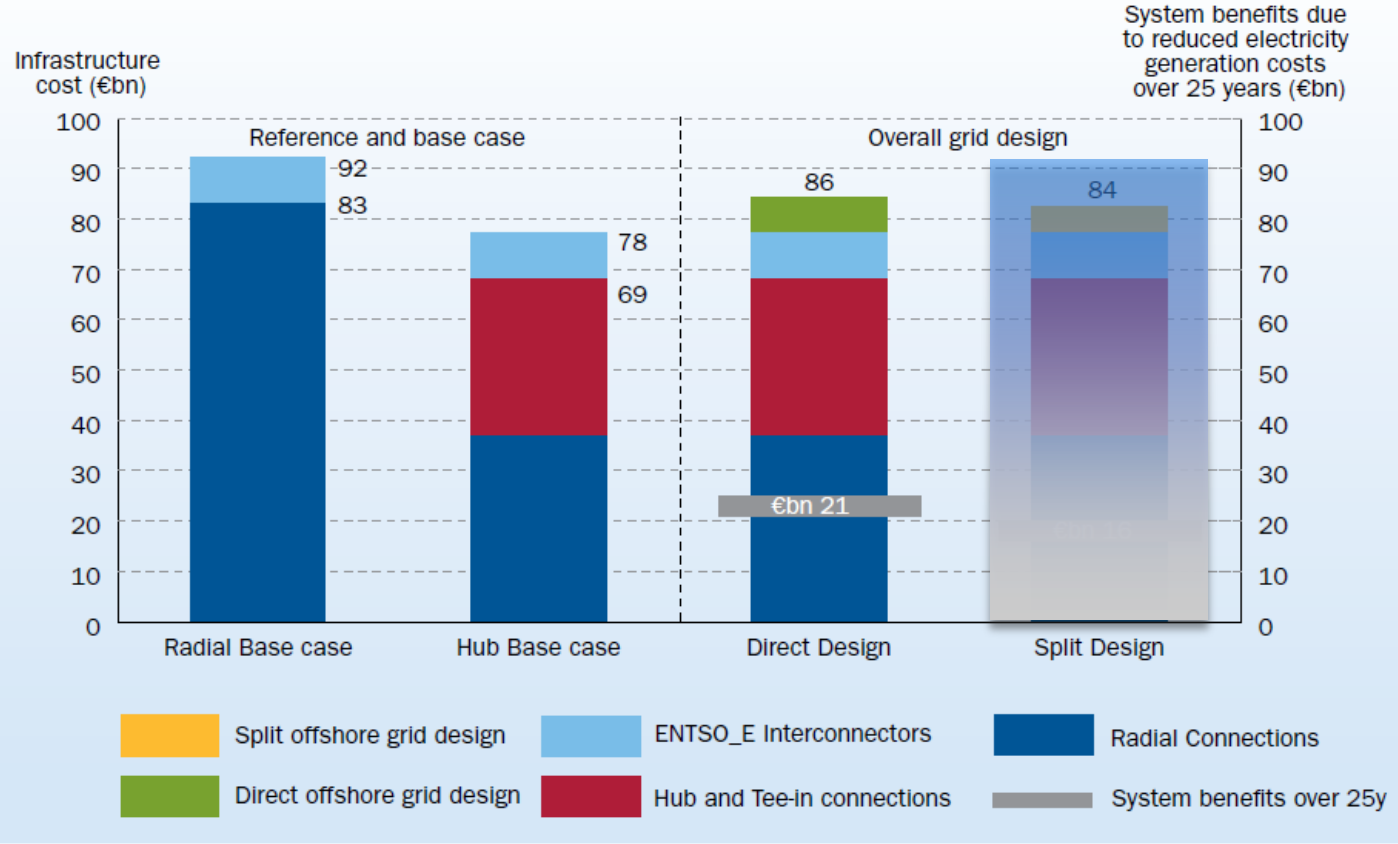
OFFSHOREGRID RESULTS

Costs and Benefits – The Numbers



- Hub connection saves €14 bn .
- Additional connections cost €5-8bn and bring benefits of €bn 16-21
- The financial numbers speak clearly for an offshore grid.

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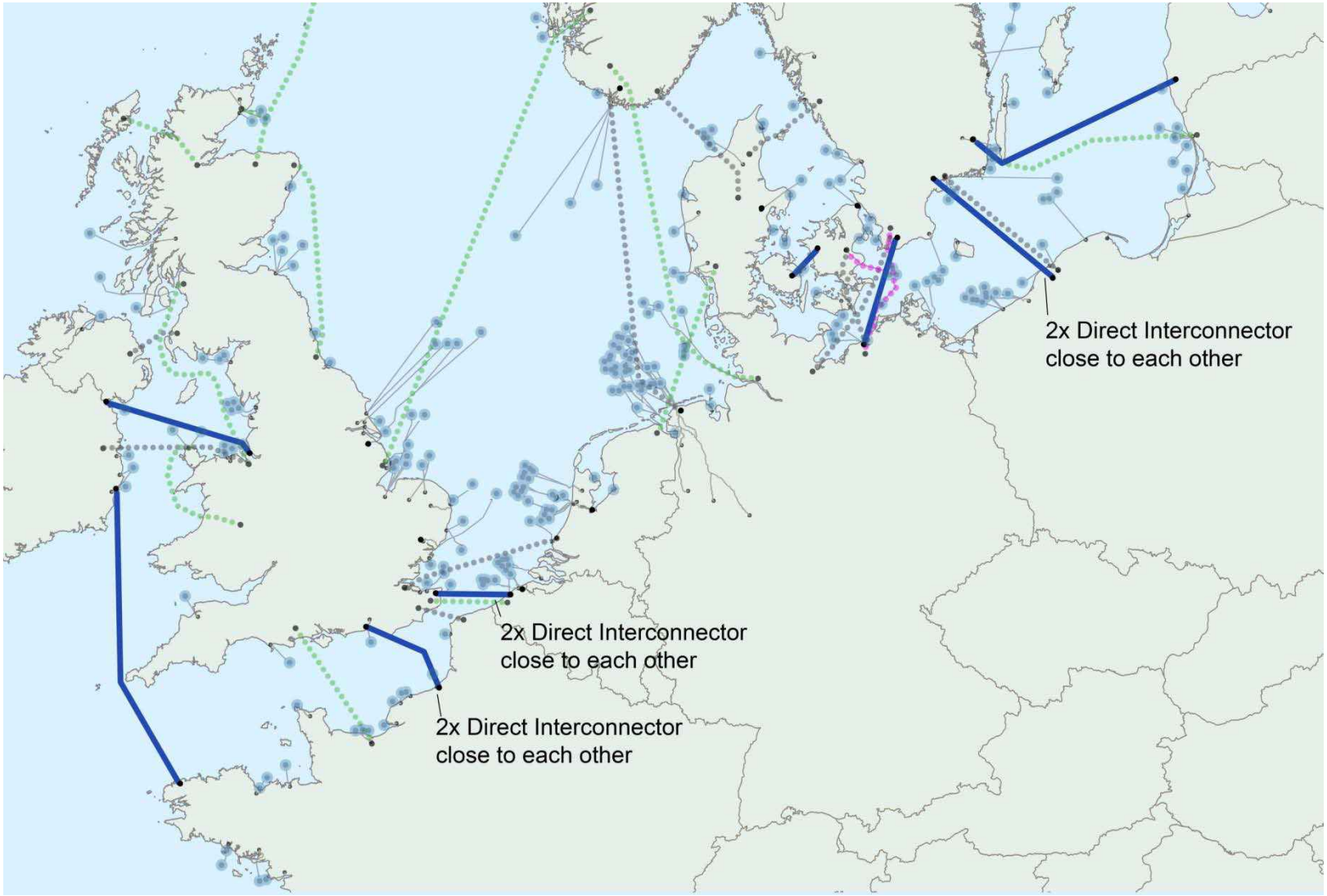
DIRECT DESIGN AS AN EXAMPLE

Step 1



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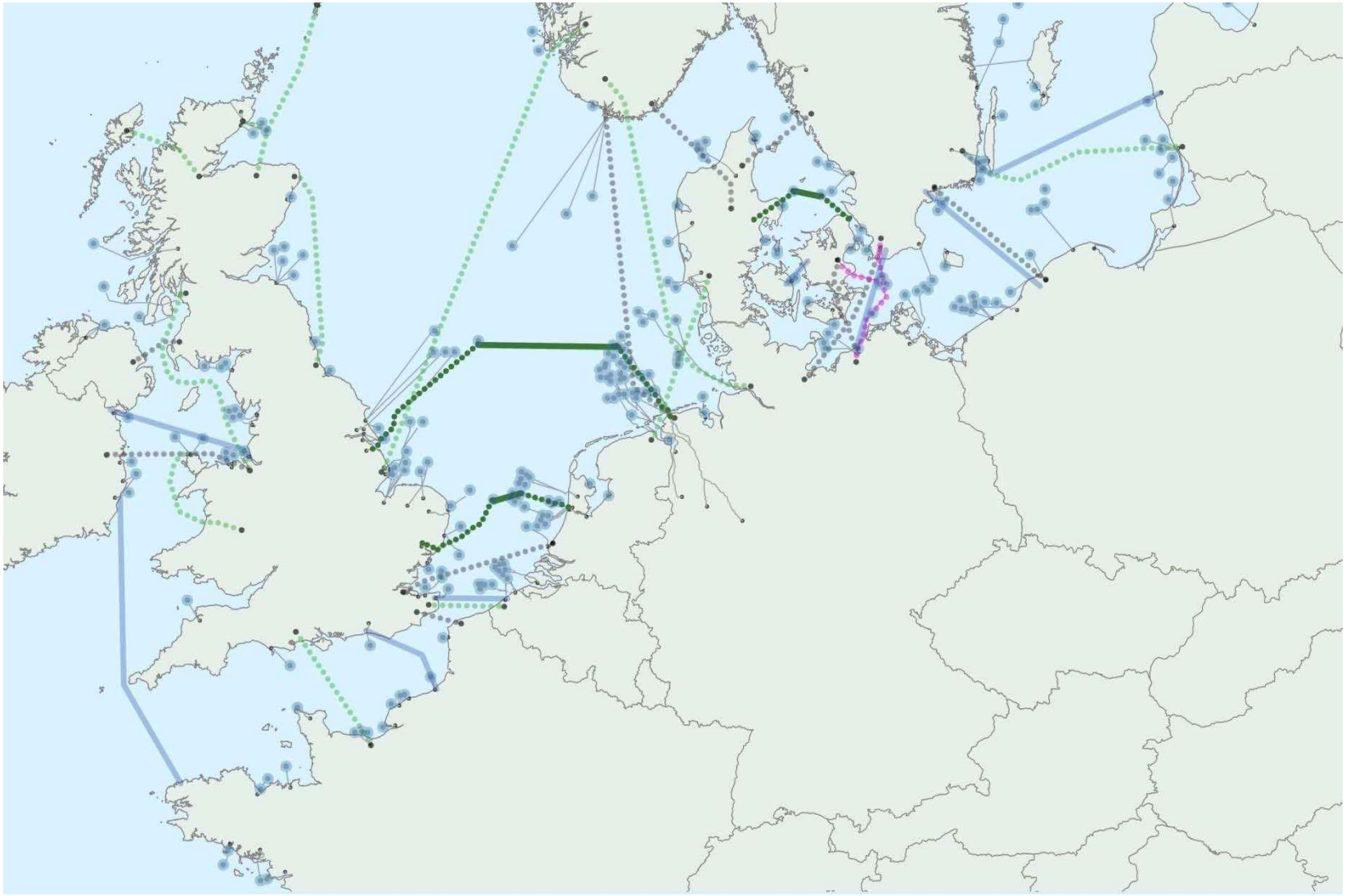
DIRECT DESIGN AS AN EXAMPLE

Step 2



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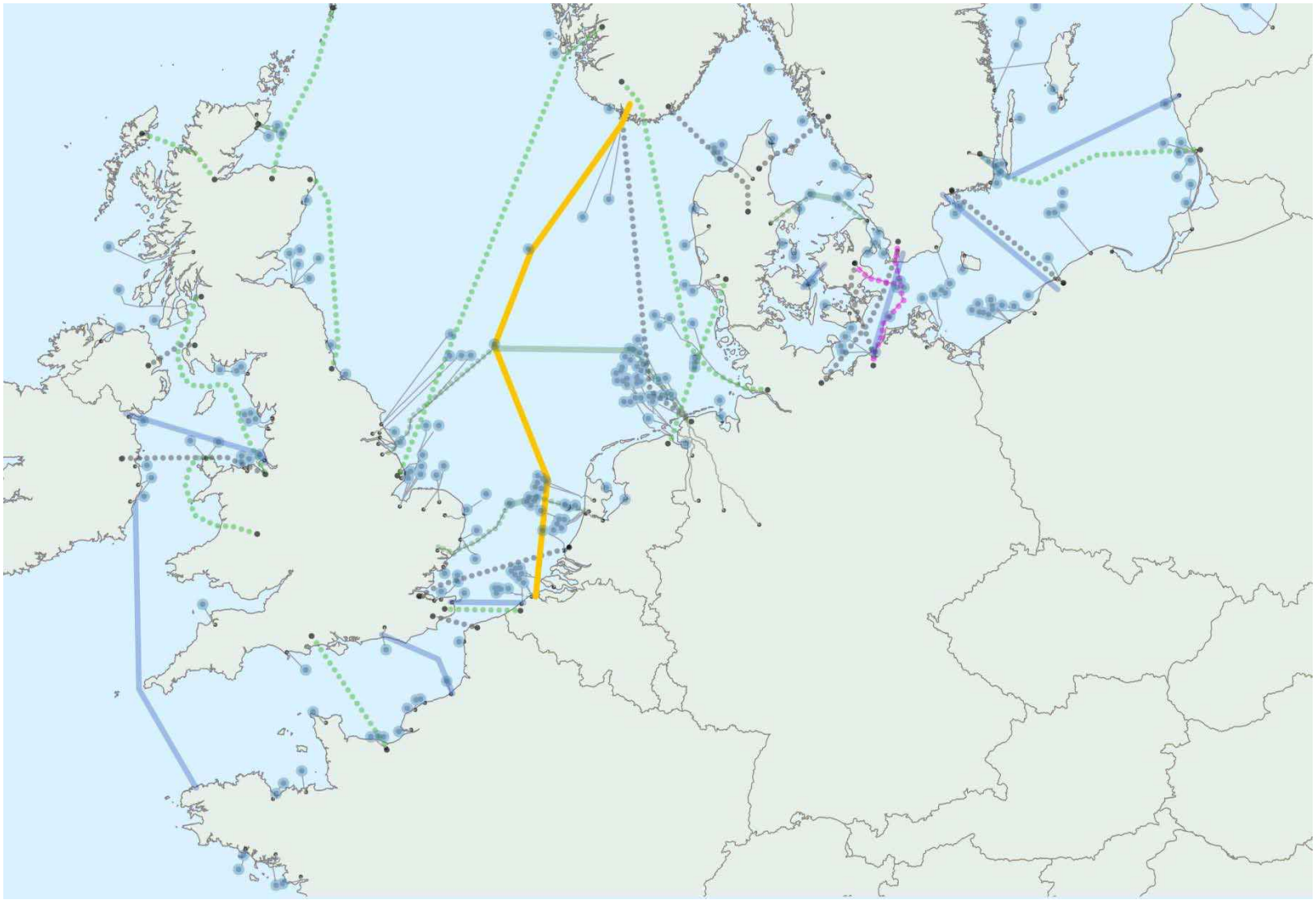
DIRECT DESIGN AS AN EXAMPLE

Step 3



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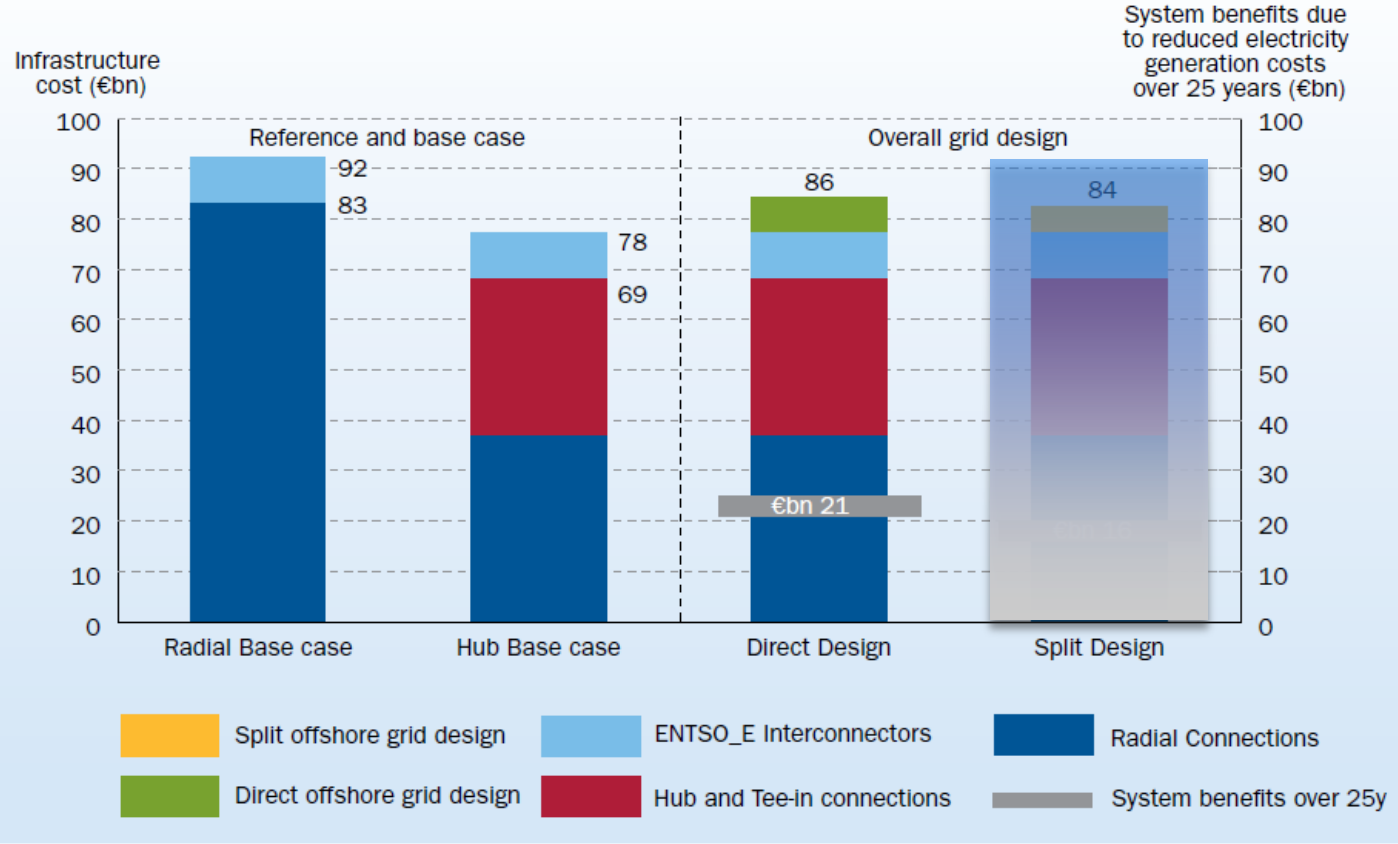
OFFSHOREGRID RESULTS

Costs and Benefits – The Numbers



- Hub connection saves €14 bn .
- Additional connections cost €5-8bn and bring benefits of €bn 16-21
- The financial numbers speak clearly for an offshore grid.

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OFFSHORE GRID POLICY RECOMMENDATIONS

Key Conclusion

- Apart from the techno-economic benefits laid-out in the offshore grid report, integrated solutions produce other benefits
  - Lower environmental impact
  - Improved redundancy and security of supply
- General recommendation to favour a meshed grid.
- Policy frameworks have to be designed accordingly
  - System perspective vs. operator perspective:
    - Any interconnector has negative impact on the economics of existing interconnectors.
    - Merchant interconnector concept encourages to obstruct new interconnections
- Classic case of regulatory economics

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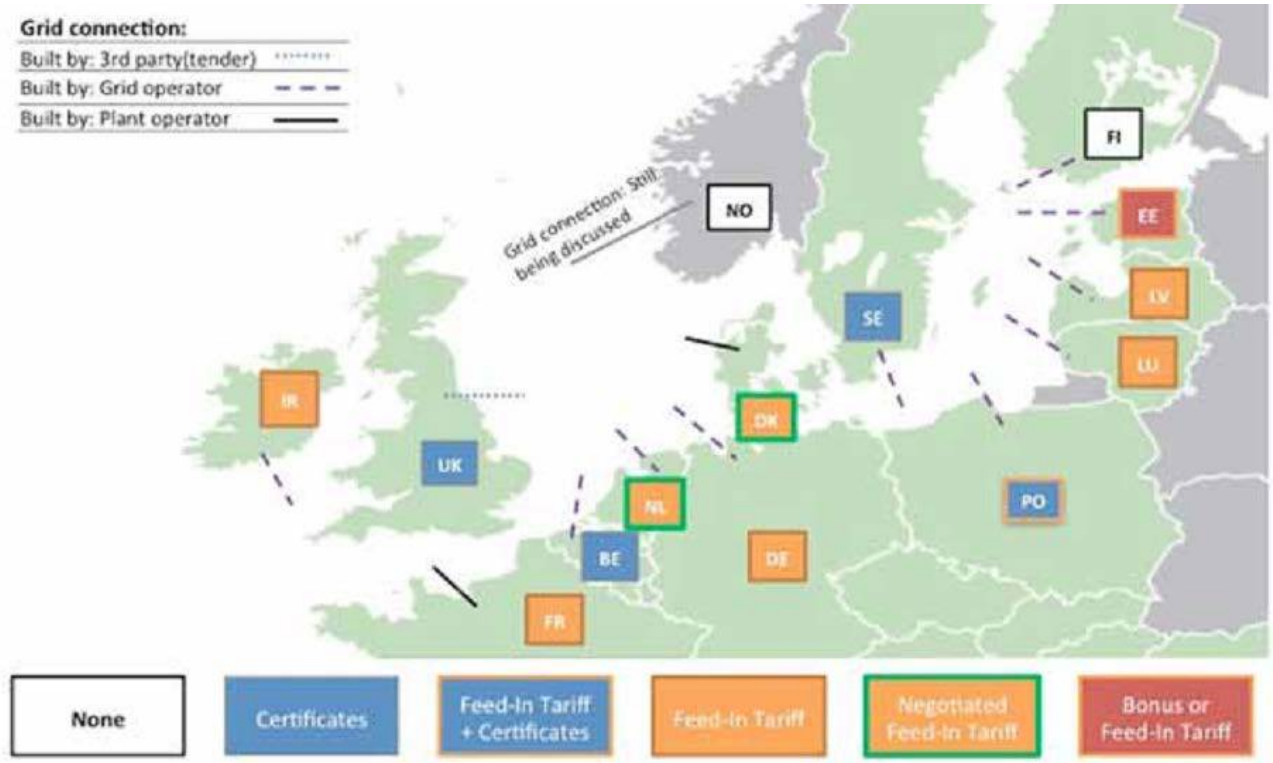
OFFSHORE WIND SUPPORT SCHEMES AND GRID CONNECTIONS

Compatibility needed



- Regulatory frameworks & support schemes pose problem
  → Should be made compatible, otherwise an integrated offshore grid will not be possible

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OFFSHORE GRID RECOMMENDATIONS

Key Conclusion

- The following key benefits of an interconnected offshore grid are supported by the OffshoreGrid findings:
  - Can be highly beneficial from an economic perspective
  - Contributes to reaching the 20-20-20 target
  - Will increase the security of supply
  - Is a step towards an integrated electricity market
  - Helps to smooth fluctuations and integrate RES
  - Further connects northern storage capacities to the power system

The advantages of an offshore grid speak a clear language.

Now policy support as well as EU coordinated review of regulatory regimes is needed to implement innovative design solutions and create the beneficial offshore grid.

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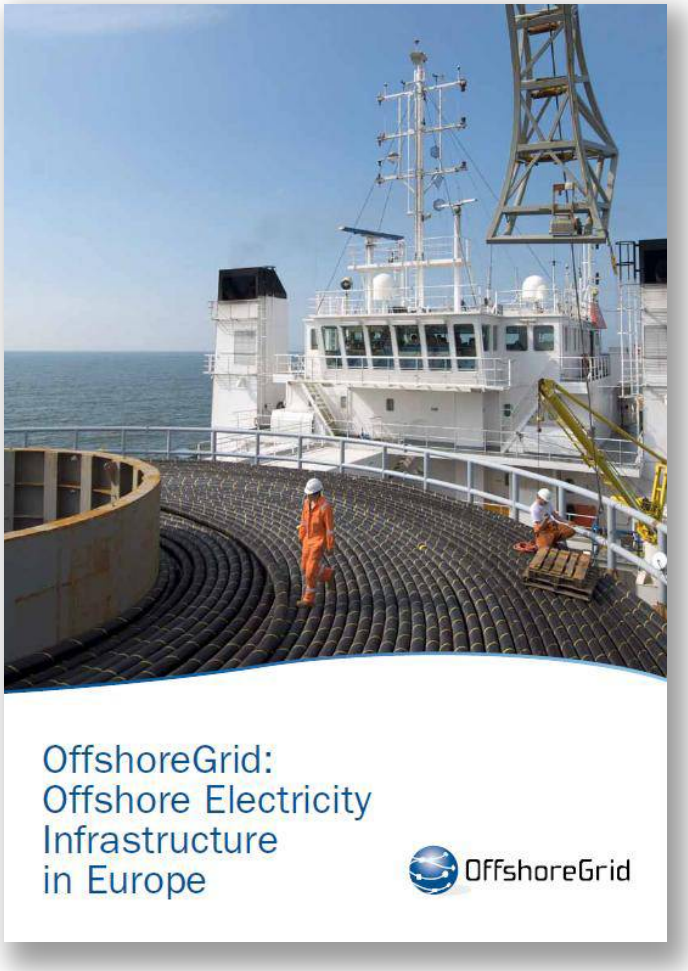
VISIT THE WEBSITE → WWW.OFFSHOREGRID.EU

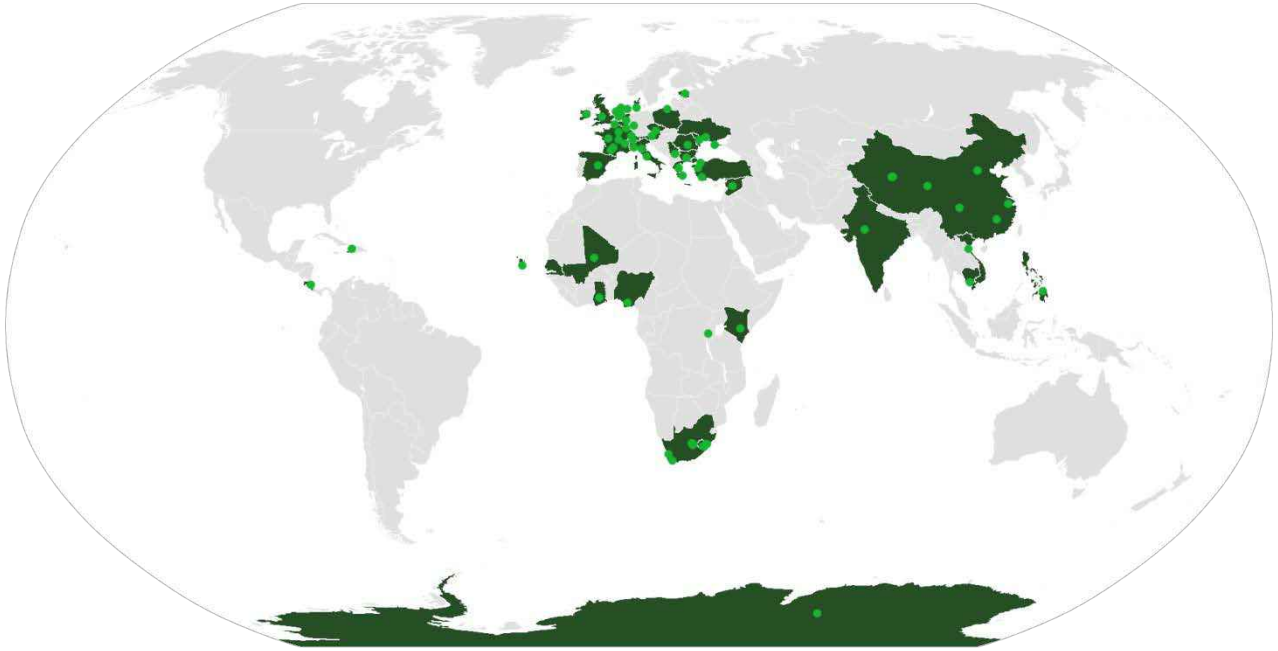
Final report pdf version

Furthermore:

- Executive summary
- Annexes
- Maps
- Guidelines from Case-independent-model
- Other WP Deliverables



THANK YOU



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