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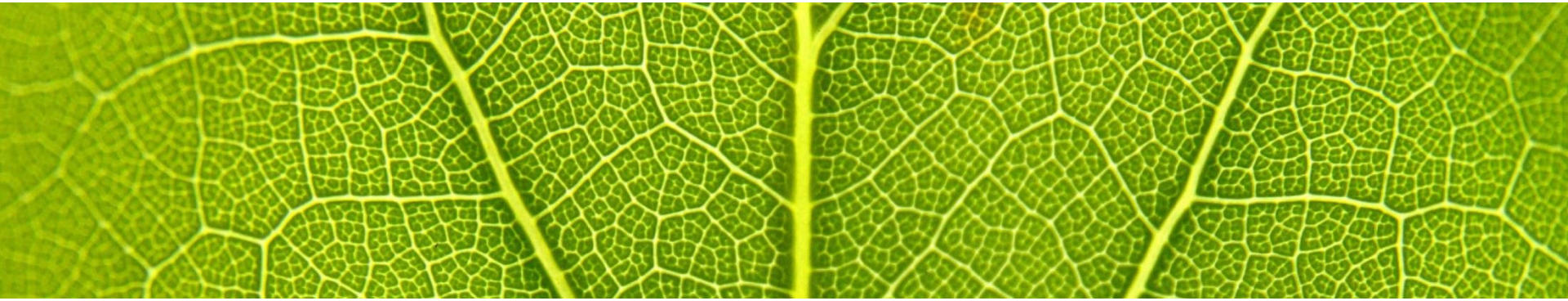


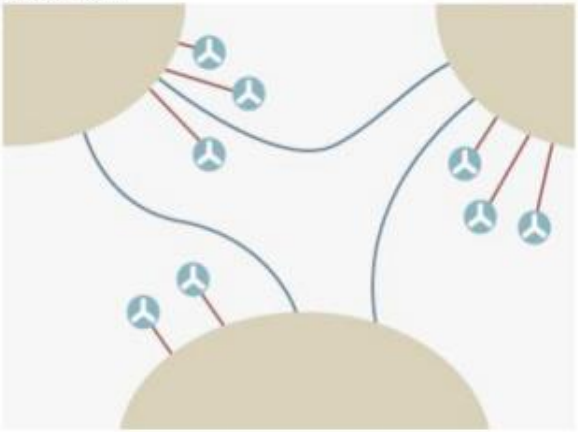
Costs and Benefits of an integrated offshore grid for Northern Seas region

Conference: "Technology Challenges and Regional Approaches for integrating Renewables and Energy Security"

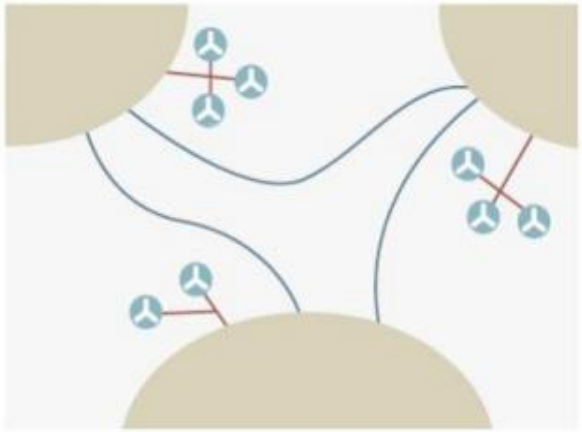
27-28 May 2015, Brussels

Adrian Pawellek

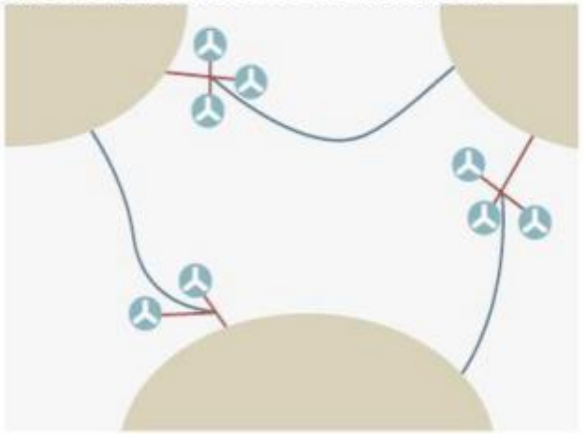
Radial



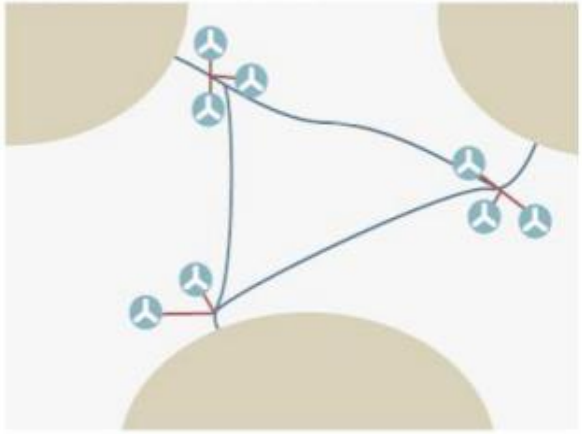
Local coordination



International coordination



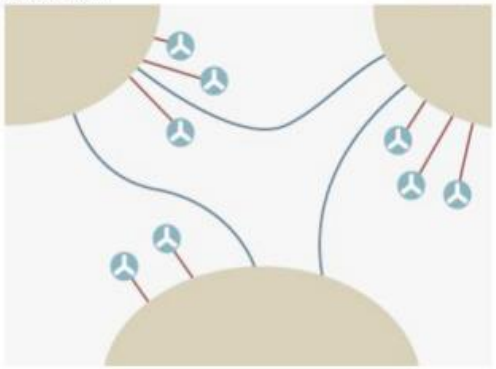
Meshed solution



Is coordinated **meshed** a good alternative to **radial** offshore grid?

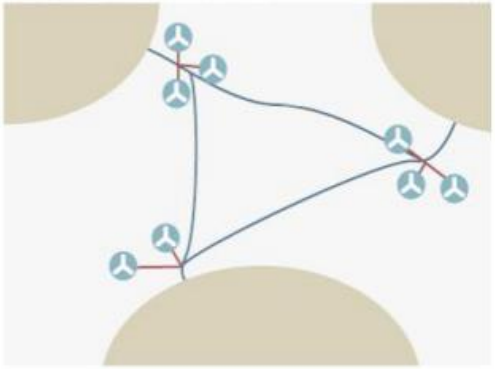
Analysis

Radial



VS

Meshed solution

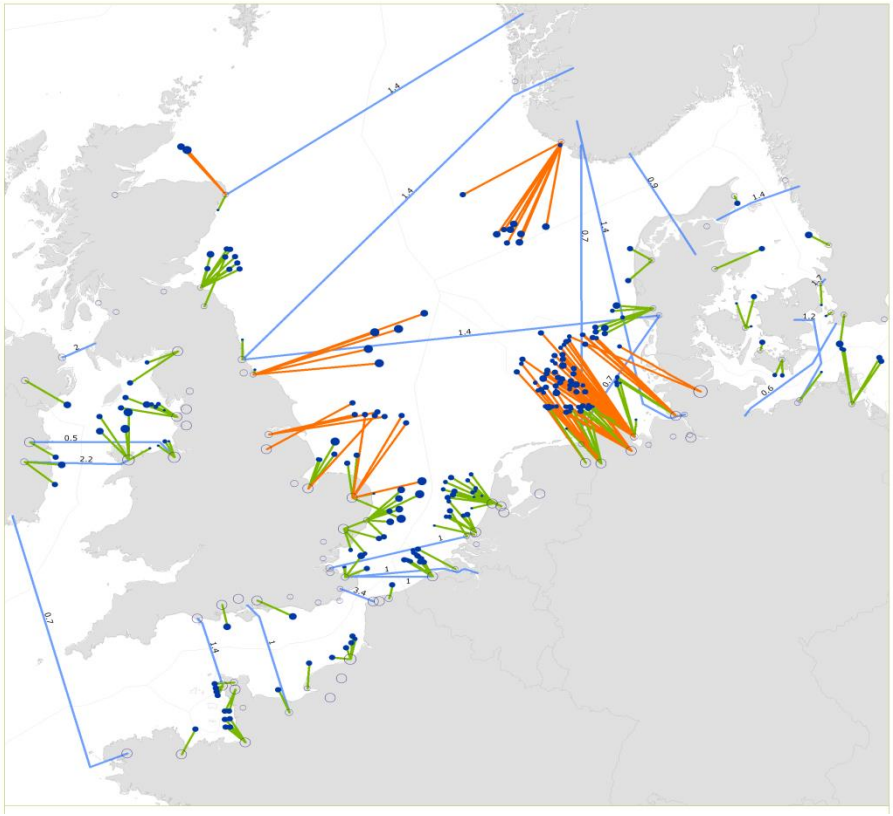


Scenarios

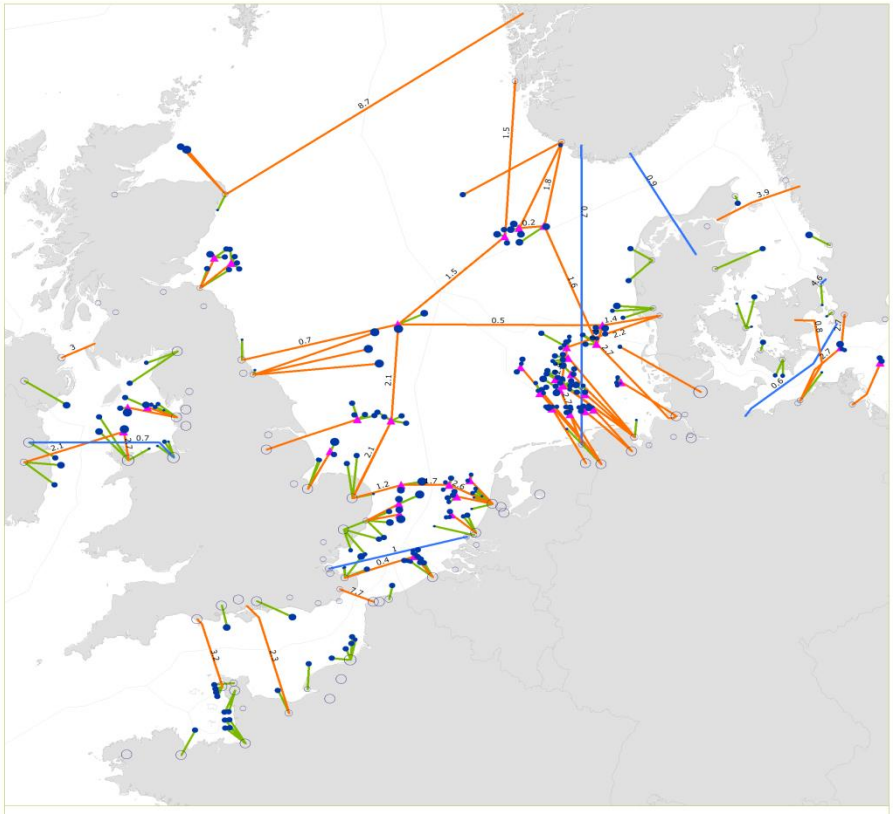
Scenario 1	Scenario 2	Scenario 3
ENTSO-E VISION 4 **100 GW Offshore 2030**	**PRIMES** **67 GW Offshore 2030**	**NSCOGI** **51 GW Offshore 2030**

Coordinated meshed grid development in the Northern Seas

Radial

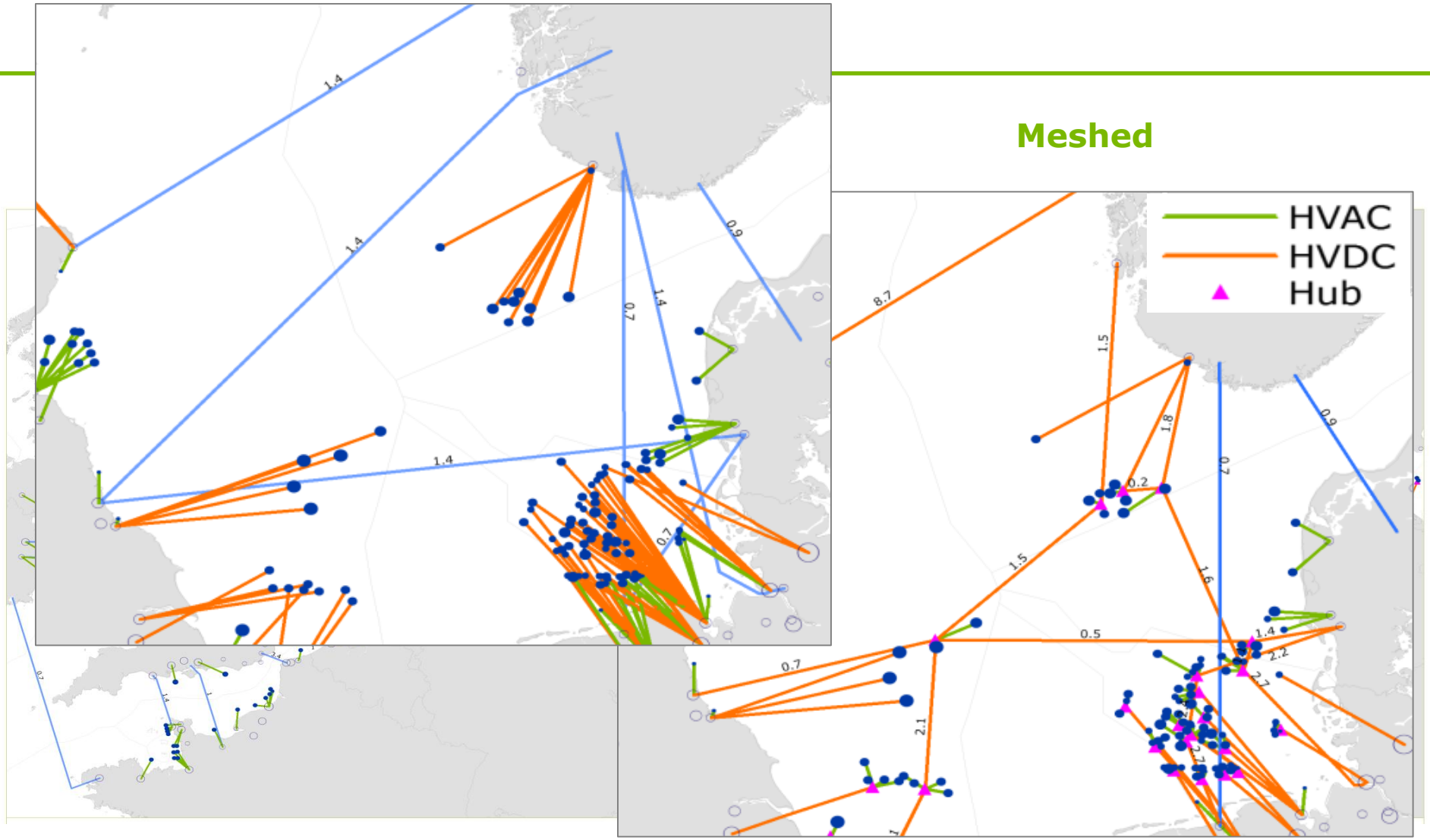


Meshed



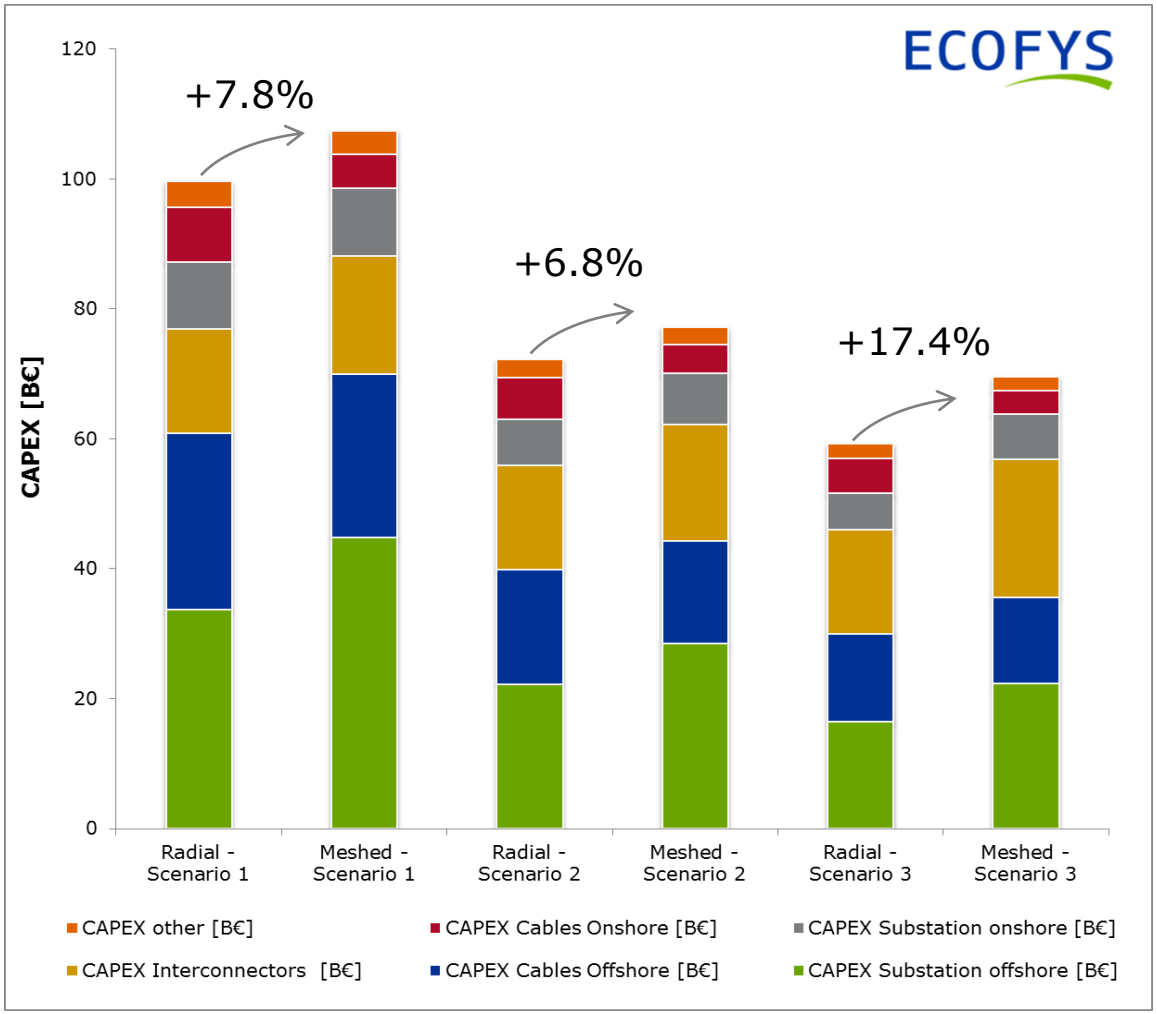
Scenario 1: 100GW Offshore (2030 ENTSOE Vision 4)

Coordinated meshed grid development in the Northern



Scenario 1: 100GW Offshore (2030 ENTSOE Vision 4)

Coordinated meshed grid deployment requires **EUR 4.9 to 10.3 billion** higher CAPEX



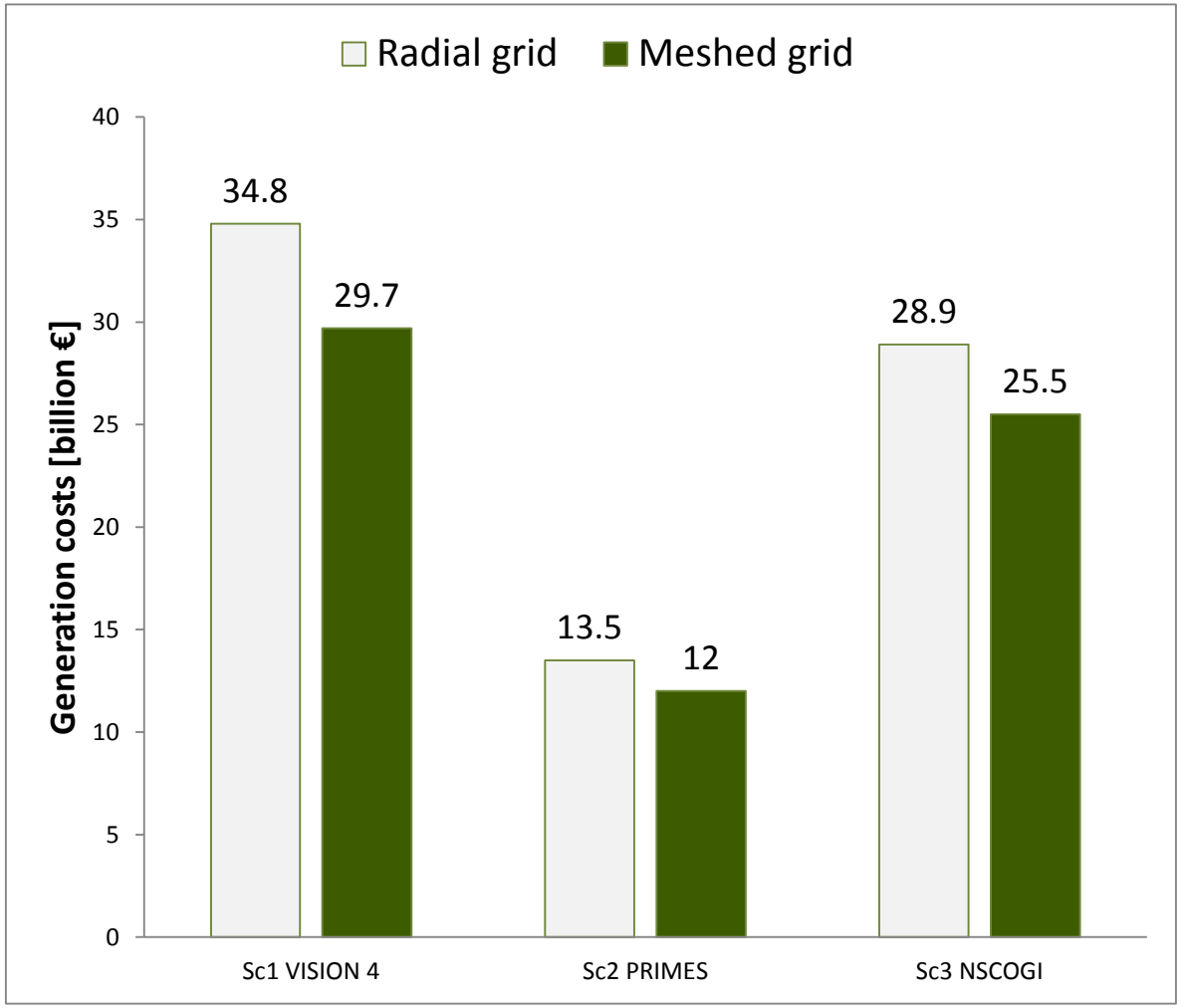
Sc1: 100 GW Sc2: 67 GW Sc3: 51 GW

In the coordinated meshed grid approach:

- more offshore substations are needed
- larger cables are needed
- fewer lines and cables are connected to shore

CAPEX meshed vs. radial	
Scenario 1	+7.8 b€
Scenario 2	+4.9 b€
Scenario 3	+10.3 b€

But is generates significant annual social-economic welfare savings ranging from **EUR 1.5 to 5.1 billion p.a.**



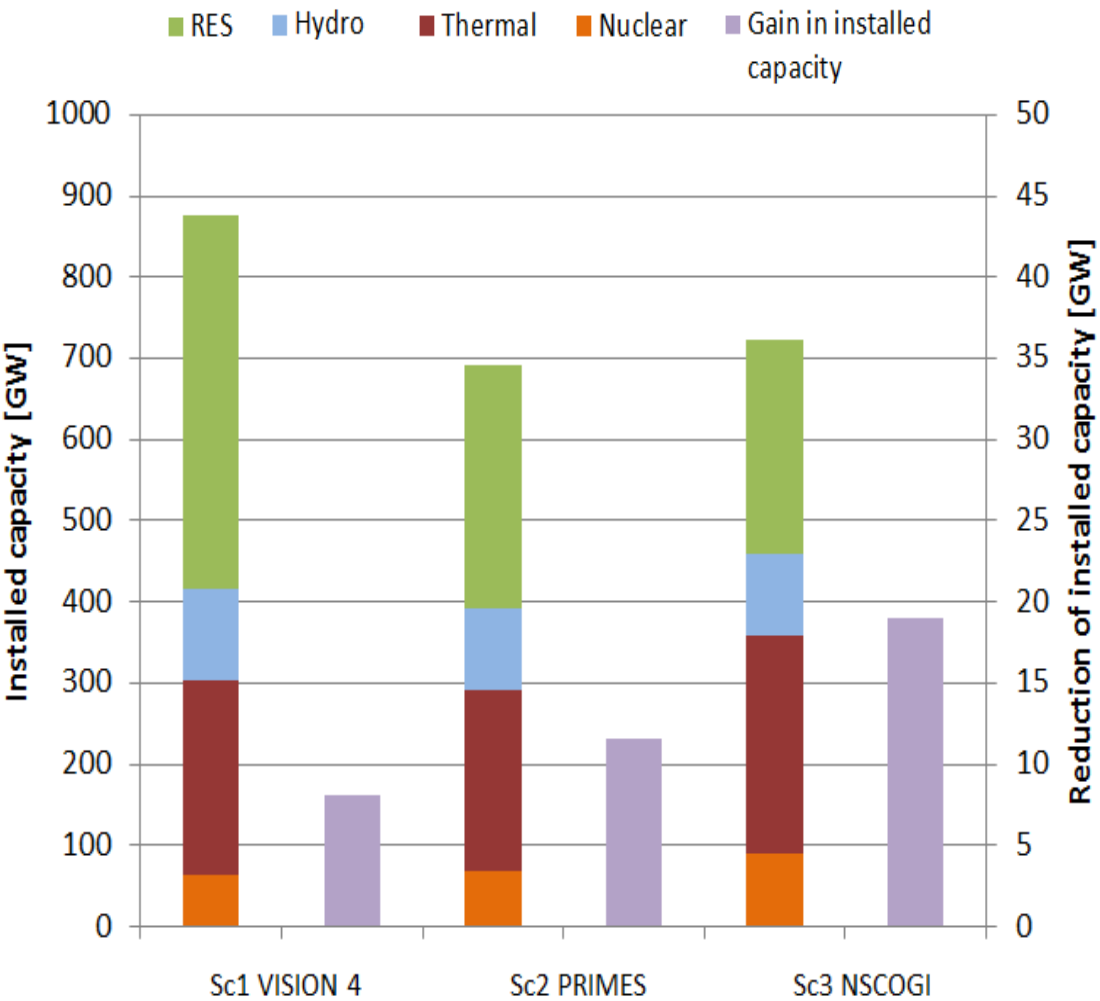
Sc1: 100 GW Sc2: 67 GW Sc3: 51 GW

In the coordinated meshed grid approach:

- less wind is curtailed
- less C02 is emitted
- higher Grid Transfer Capability
- more transmission losses

Annual savings meshed vs. radial	
Scenario 1	-5.1 b€
Scenario 2	-1.5 b€
Scenario 3	-3.4 b€

With further cooperation additional avoided generation investment of **EUR 3.4 to 7.8 billion** are possible



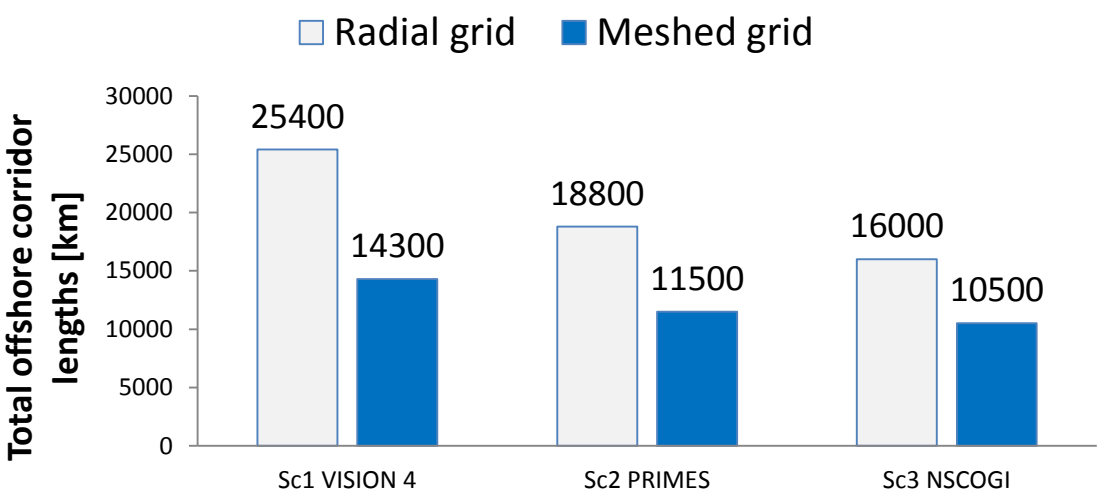
Sc1: 100 GW Sc2: 67 GW Sc3: 51 GW

In the coordinated meshed grid approach:

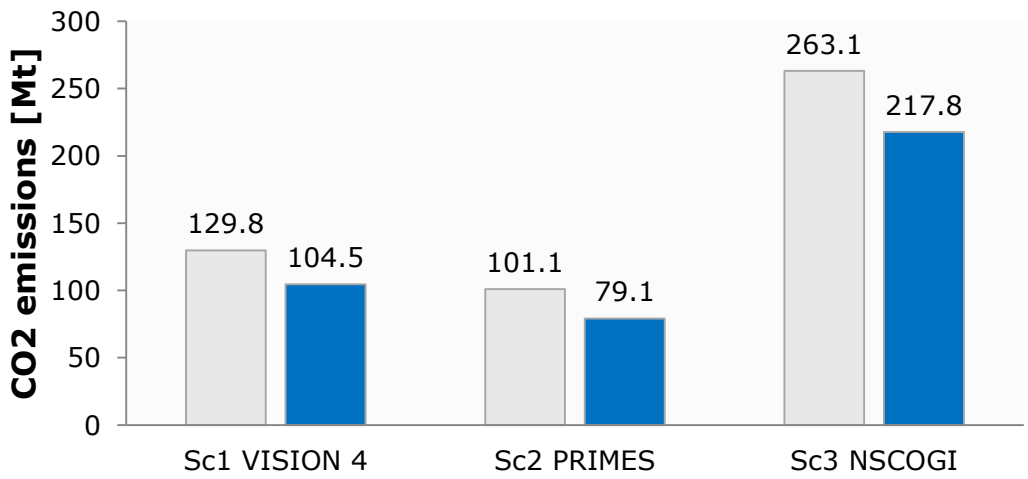
- Increased transfer capacity between power systems
- Avoided investments in new peaking units
- Gains realised only if Reserve Capacity is coordinated between MS

Avoided investment meshed vs. radial	
Scenario 1	-3.4 b€
Scenario 2	-4.8 b€
Scenario 3	-7.8 b€

Main environmental benefits come from reduced offshore network length and CO2 reductions



Network length meshed vs. radial	
Scenario 1	-11100 km
Scenario 2	-7300 km
Scenario 3	-5500 km



CO2 emissions p.a.	
Scenario 1	-25.3 Mt
Scenario 2	-22.0 Mt
Scenario 3	-45.3 Mt

Sc1: 100 GW Sc2: 67 GW Sc3: 51 GW

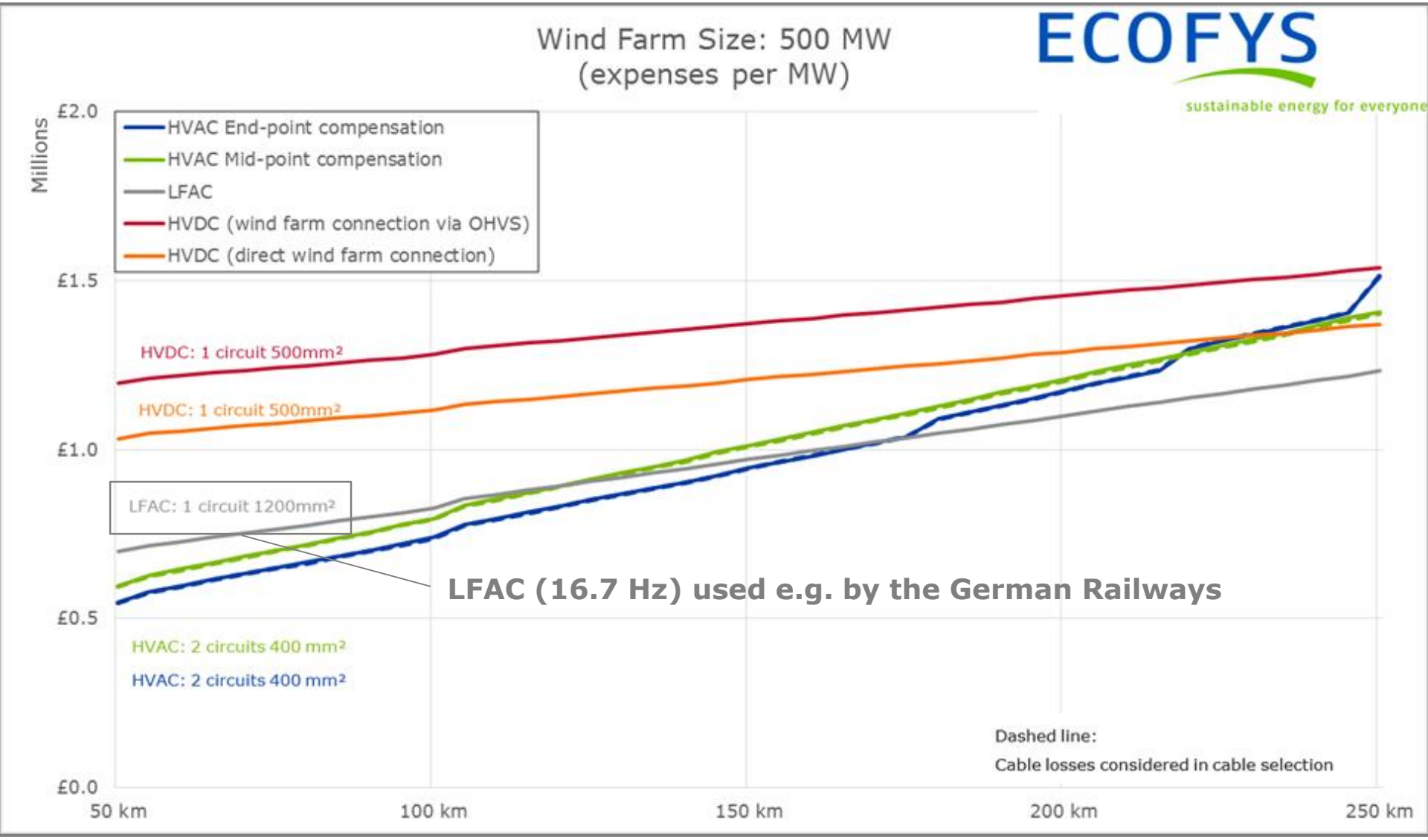
Meshed grid deployment has a strong business case for EU in all scenarios

- Despite higher investment cost for meshed grids already the annual savings make the **meshed grid profitable in all scenarios**
- Generation investment savings requiring cooperation of Member States on reserve capacity increase further the meshed grid attractiveness

	CAPEX	Annual cost	Avoided Investment
Scenario 1	+7.8 B€	-5.1 b€	-3.4 b€
Scenario 2	+4.9 B€	-1.5 b€	-4.8 b€
Scenario 3	+10.3 B€	-3.4 b€	-7.8 b€

- Additional benefits include: better RES integration, lower environmental impact, CO2 reduction, increased competition, enhanced market integration, innovation boost and others

Can **Low Frequency AC** help reduce the offshore grid cost?



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Coordinated meshed grid is an **appealing vision**…

1. **Business Case**
2. **RES Integration**
3. **Environment**
4. **EU Strategy Fit**

So what does it take to get there?

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We need strong cooperation to remove the existing barriers

Grid access issues

Grid access responsibility

Priority grid connection

Connection rules

RES Support

OWF operation

Balancing responsibility

Different ancillary services requirements

Grid operation

Different priority dispatch regulation

Transmission charge deviations

Cross border capacity allocation & congestion management issues

Administrative process

Long, difficult consenting procedures

Marine spatial planning deviations

Power market

Imbalance price

Gate closure time and settlement period

Market integration issues

Investments

Financing

Difference in grid connection cost rules

Distribution of costs and benefits

Technical standard differences

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Let's start a multi-stakeholder round-table today

Do we need a North Sea TSO/ISO?

Do we need a harmonized RES support regime?

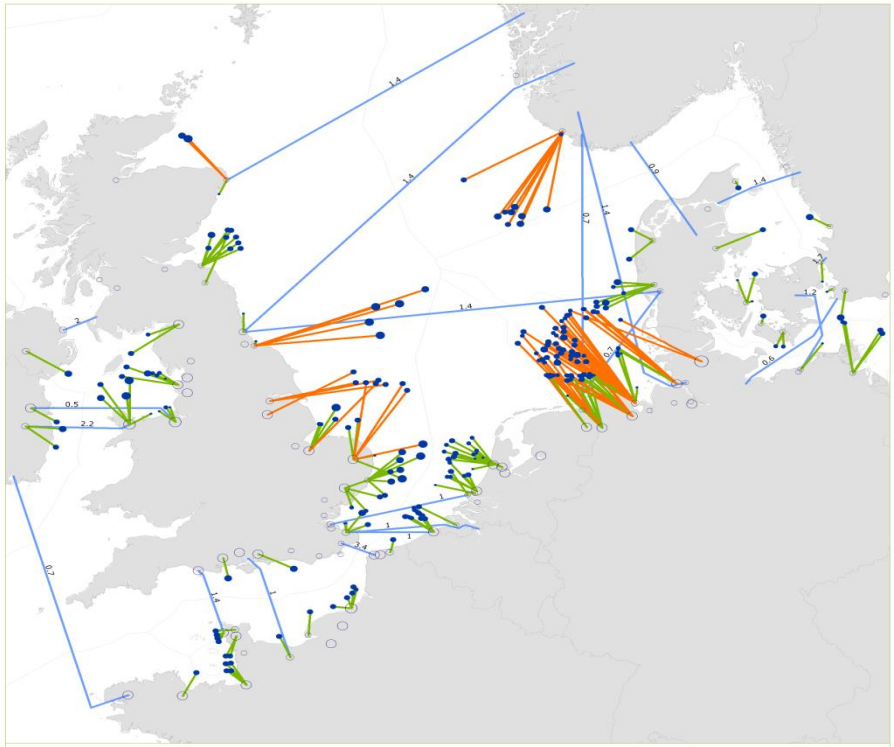
What is a fair allocation of costs and benefits among MS?

Can we make the business case work for all stakeholders?

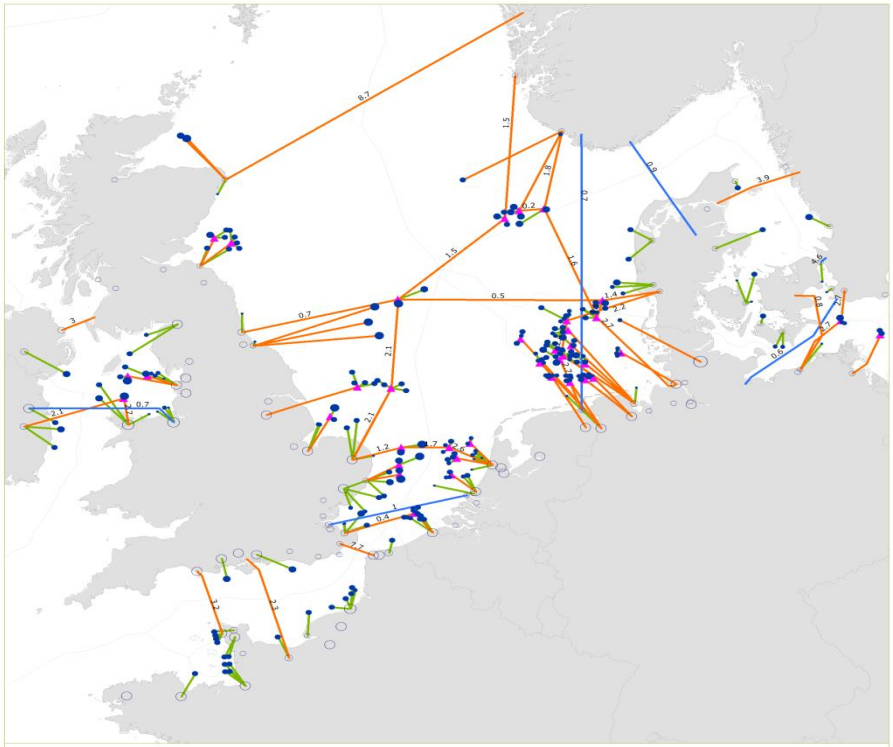
How should the multi-market trading look like?

etc…

What do you think?



Scenario 1 Wind Farms: Radial Connection to Grid



Scenario 1 Wind Farms: Meshed Connection to Grid

Grid connection
- HVAC
- HVDC
- Hub
- Interconnectors [Source: Tractebel]

Note that route is indicated as straight line. Distance calculation accounts for deviations around constrained areas.

Interconnector capacity is shown in GW

Substations [source: Tractebel] Available capacity (MW)
- 9,600 to 19,200
- 4,800 to 9,600
- 2,400 to 4,800
- 1,200 to 2,400
- 600 to 1,200
- 0 to 600

Wind Farm Capacity (MW)
- 1,200 to 2,400
- 600 to 1,200
- 300 to 600
- 150 to 300
- 0 to 150

EEZ Borders

Date:	Author:	Reviewer:	Projection:	Version:
27/06/2014	ACR	VGA	Longitude / Latitude	4

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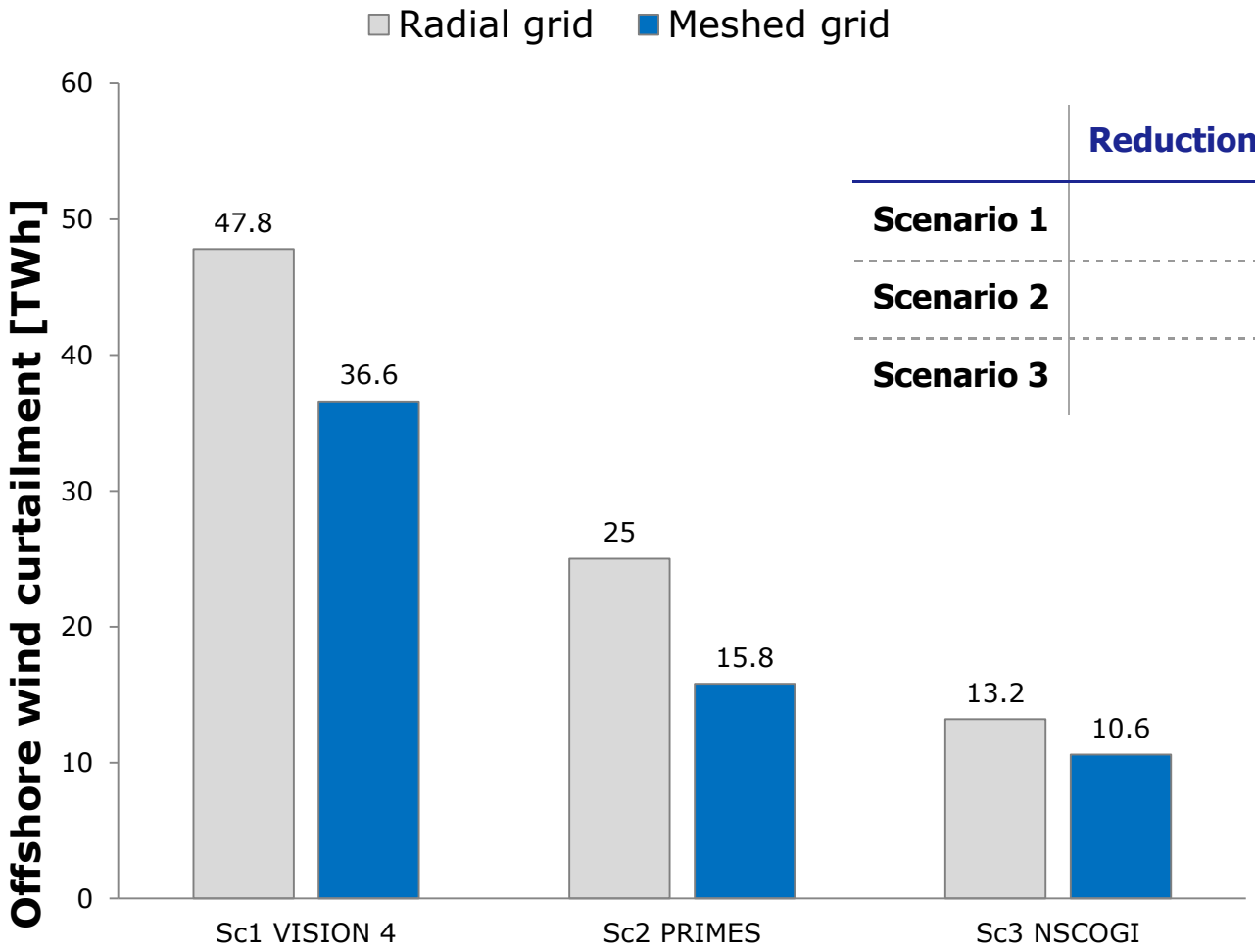
Full Report: https://ec.europa.eu/energy/sites/ener/files/documents/2014_nsog_report.pdf

Back up



	Reduction of off. wind curtailment
Scenario 1	-11.2 TWh
Scenario 2	-9.2 TWh
Scenario 3	- 2.6 TWh