Deployment Plan for Future European Offshore Grid

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This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 691714.

PROMOTioN

PROGRESS ON MESHED HVDC OFFSHORE TRANSMISSION NETWORKS

After divergence for detailed research, we are converging, developing conclusions and building a plan

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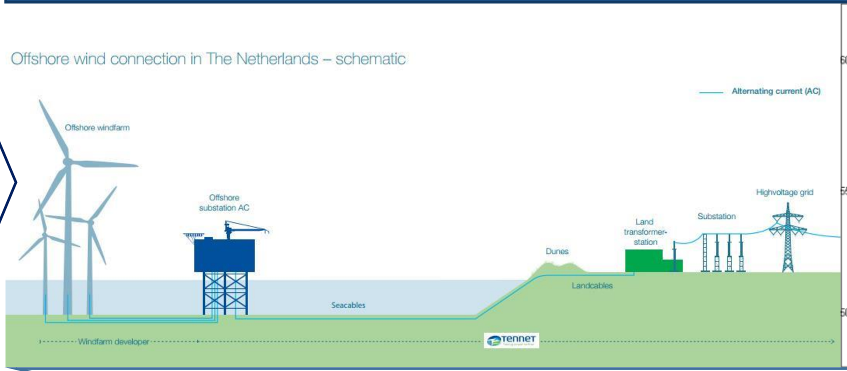
Objectives of our project

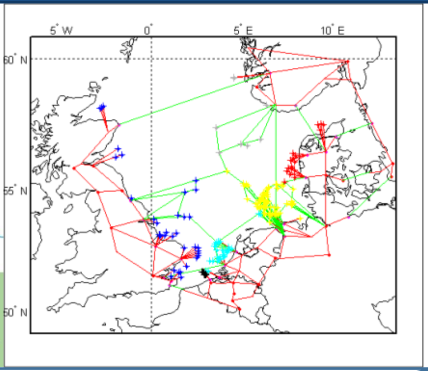
To produce a Deployment Plan for European future offshore grid development.

Technical

Governmental

Financial





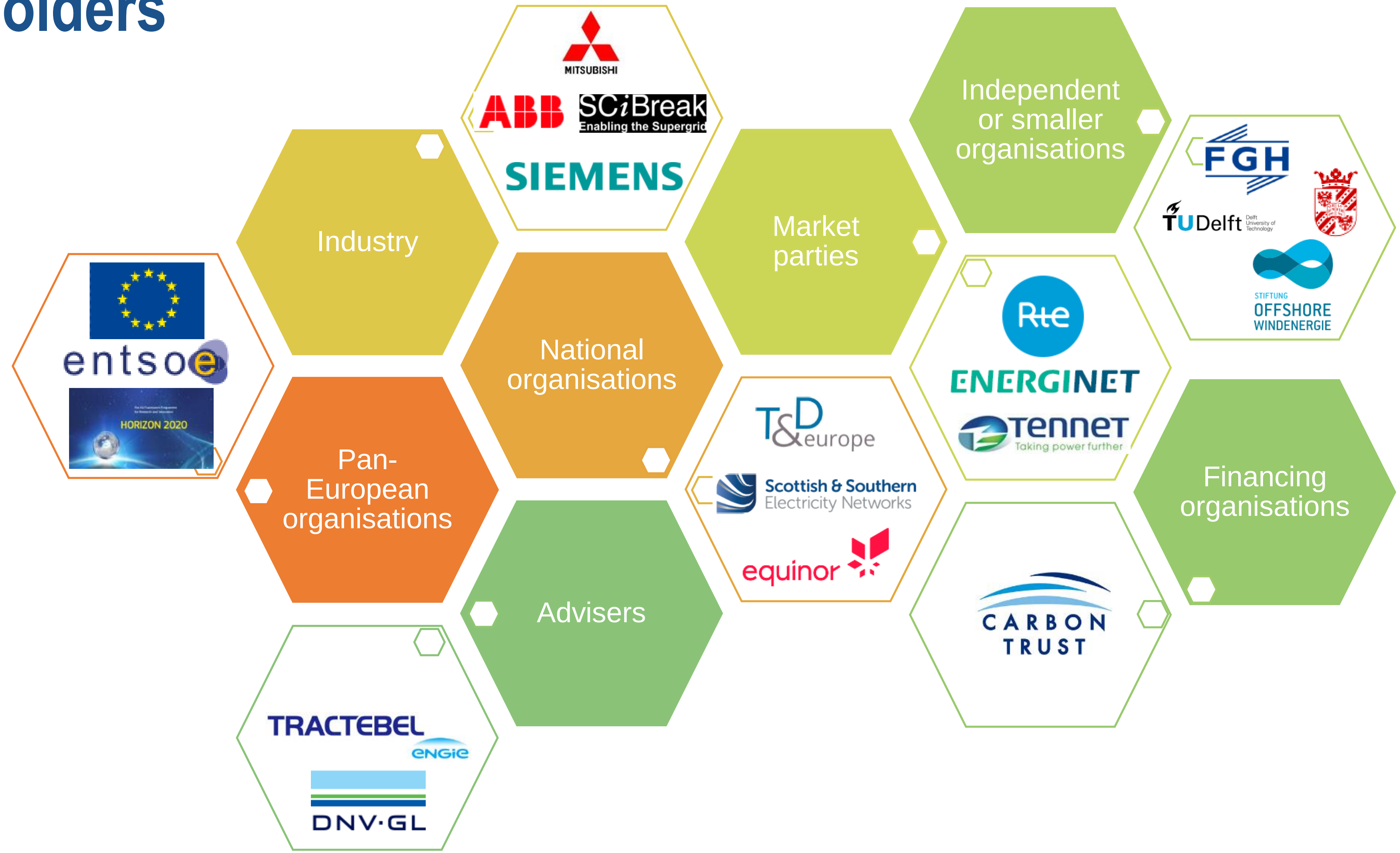
Economic

Market

Legal & Regulatory

Stakeholder Actions & Guidance

Stakeholders



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The final deployment plan integrates results influencing different aspects of a meshed offshore grid

Final deployment plan

Stakeholder guidance on:

- Technology suppliers: next steps to steer towards most promising technical solutions
- Adjustment of support schemes to steer towards specific concept
- EU guidance, e.g. guidelines for next technology programme
- Owner/Operators: possible structures to facilitate build and operations

Per concept

Context	Locations of offshore wind farms, wind scenarios, clustering points, grid requirements (topology), power flows / capacity
Technical choices	Hub architecture, types of cables, technology choices (costs, reliability etc.)
Legal & regulatory framework	Removing legal barriers (jurisdiction, ownership, operation), possible steering actions (support schemes)
Costs	Costs (investment needs), finance requirements and current funding capacity, cost of capital
Benefits	Monetary benefits (social benefits; market integration) Non-monetary benefits (increased supply security etc.)

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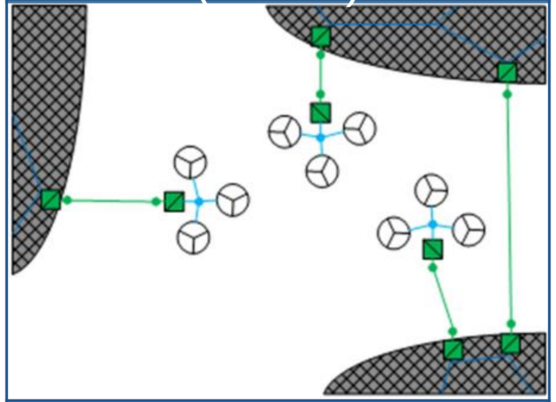
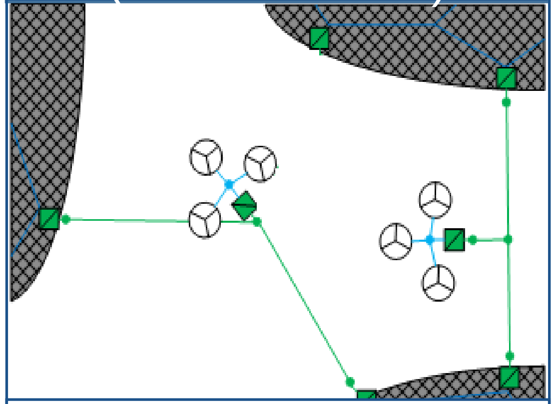
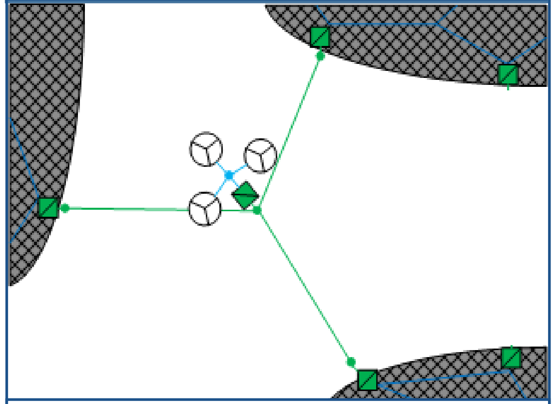
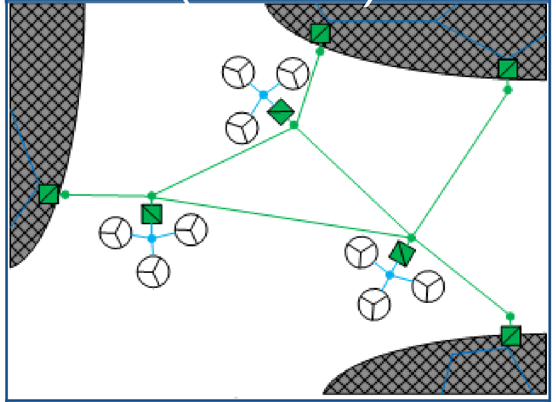
A single "optimal" scenario probably does not exist.
We evaluate 4 hypothetical Concepts

Business as Usual (Radial)	National Distributed (windconnector)	European Centralized Wind Power Hubs	European Distributed (Meshed)
			
• Radial connections • AC & DC point to point connections • Country to Country Interconnection	• OWFs or small clusters connected • AC connection to cluster point • Clusters meshed within National borders	• Clusters of OWFs to large hubs • DC point to point connections to countries • AC & DC meshing	• OWFs or small clusters connected • AC connection to cluster point • Clusters meshed with each other (NO national constraints)

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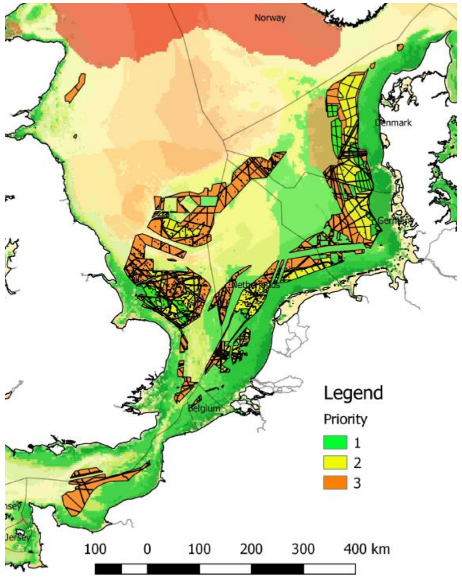
Wind Generation Scenarios important for cost evaluation of infrastructure, and also in systems and protection strategies.

- Offshore wind generation forecast for optimal location of farm location
- During topology discussion clear that pragmatic alignment required with onshore grids
- During Technical discussion with WPs 2-4 discovered that they too need topology to recommend suitable (protection and management) systems

- Prognosis of Offshore Wind Farm development
- Estimations of wind availability
- Water depth
- Spatial limitations (shipping lanes, etc.)
- Distance to shore
- Existing infrastructure
- Validation against TYNDP/ENTSO-E prognosis to 2040 and other publically available reports



Total (GW)	2020	2030	2040	2050
Belgium	2,3	3,7	7,5	8,5
France	0	0,9	6	10,4
Netherlands	2,5	17,3	31,5	53
Germany	5,3	14,9	30	45
Denmark	1,3	2,9	8,1	17,9
Great Britain	8,2	23,3	38,8	60
Ireland (NI+RI)	0	1,9	2,2	5
Norway	0	0	0,4	4
Sweden	0	0	0,5	1,2
Total	**19,6**	**64,9**	**125**	**205**

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Evaluating a Technical Topology

1. Technical layers

Identification of different technical layers of the grid

Pragmatic assessment of potential hub structures and Components

2. Grid design

Impose certain technology option on a typical part of the grid

Long list and timing of technical components (conclusions from other WPs)

3. Costs

Estimate costs for given technology option

Use open sources and estimates from public sources for cost for elements

4. Non-monetary criteria

Approach A

Give a ‘pass/no-pass’ decision according to non-monetary criteria

Approach B

Score and attach weights to each type of criteria (including cost criteria)

5. Final decision

Select technically feasible option with the lowest costs

Select an option with the highest total score

Evaluated over time
With availability

Approach Evaluation matrix Example

Bipole connection	Weight	Number	Cost	Weighted Score	Weight	Total Score
Cost/ Number of components	100%	**25**	**€ 1,977,500,000**	**7.0**	45%	**3.15**
Platform		2	€ 600,000,000			
DC Cables		2	€ 800,000,000			
AC Cables		0				
HB Converters		2	€ 520,000,000			
DCCB		4	€ 32,000,000			
ACCB		2	€ 280,000			
Transformers		2	€ 24,820,000			
Inductors		4	€ 200,000			
Switches		4	€ 120,000			
Busbars		2	€ 50,000			
Gas/ Air Insulaiton		0				
Additional equipment (capacitors, rea		0				
OPEX		1	€ 30,000			
Criteria: Performance	**Weight**	**Score**	**Weighted Score**	**Weight**		**Score**
	100%	**15**	**4.9**	30%		**1.47**
Speed	30%	8	2.4			0.72
Reliability	30%	3	0.9			0.27
Risk of failure	40%	4	1.6			0.48
Criteria misc.	**100%**	**21**	**7.30**	25%		**1.83**
Availability	55%	8	4.40			1.32
Extensibility	25%	6	1.50			0.45
Interoperability	20%	7	1.40			0.42
					100%	6.45

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Topology/architecture is being analysed using proposed solutions from technical work packages

Control	• Operation and communication devices and strategies	Technology Choice
HVDC Equipment	• Components of the hub	
Link configuration	• Type of connection (bipole/ monopole). Voltage.	
Protection strategy	• 3 Fundamental protection philosophies and several protection strategies.	
Hub design	• Platform or island. Type of busbar arrangement.	
Meshing AC/ DC	• AC or DC nodes and connections.	
Topology	• Scenarios, layout of the grid power flows.	Context
Security criterion	• Maximum allowed loss of power infeed.	

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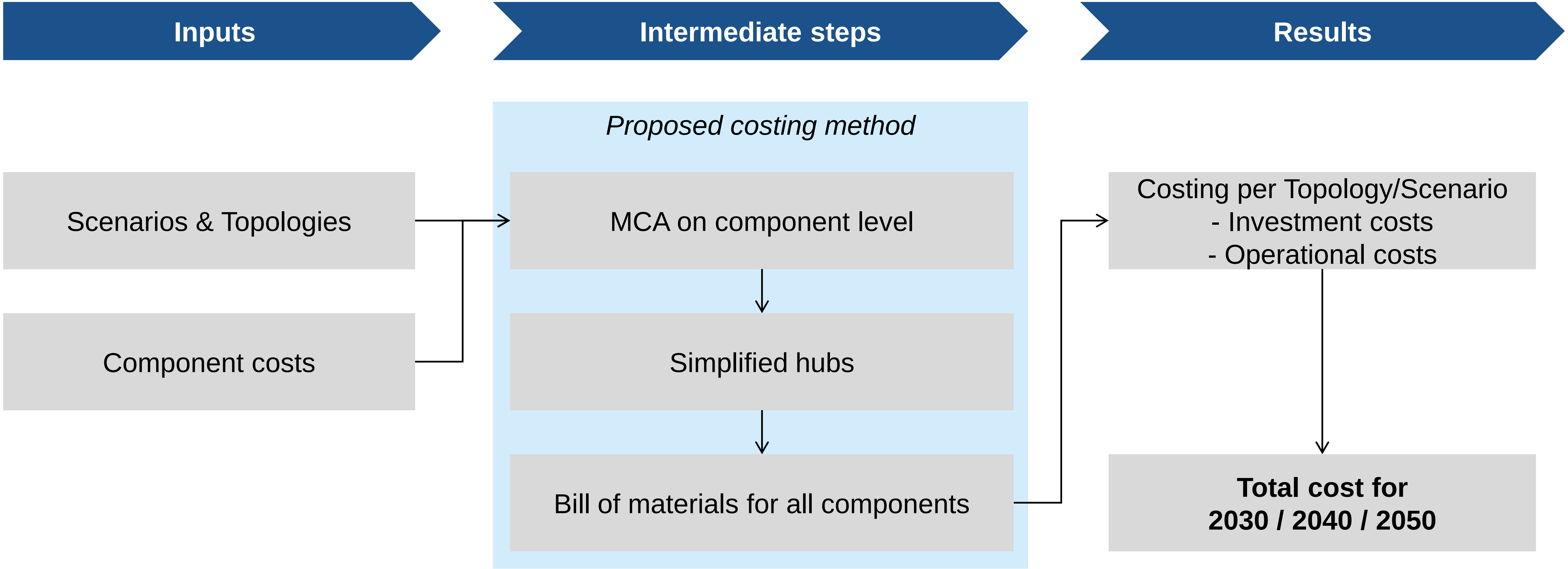
The total cost for each scenario topology is derived from scenarios and component costs



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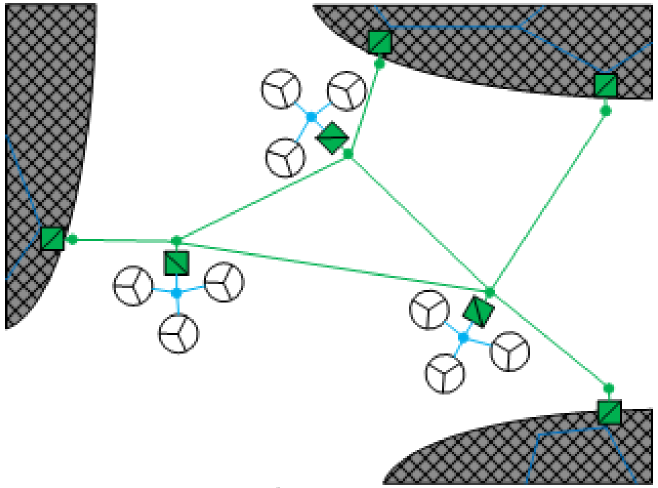
Meshing could offer additional benefits compared to a pure radial topology



Challenge

Meshing increases interconnection capacity → Leads to increased market coupling → **Question** How large is the societal benefit?

Method

Topology scenarios

Market information → Onshore generation profiles; Onshore load profiles

Extensive modelling study:

- Creating a model with load / generation per country/region
- Incorporating MOG
- Analyze benefits (welfare)

Benefits for European system (FGH)

Case study: benefits for UK specifically (CT)

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Legal & Regulatory Framework requires modification to support meshing and cross-border assets

- Structure of legal system complicated by hierarchy from global to national laws
- Key Issues and potential options around legal framework identified in WP7
- Structure of solutions from WP7 applied in WP12…

	Current status	Barriers	Options for solutions	Recommendations	Stakeholder actions
Issue	Description current state of affairs; international, EU and national L&R frameworks	• Identification and analysis of barriers • Significance of barriers	• Options to overcome barriers • Analysis of impact and feasibility	• Recommendations for solutions based on (final) WP 7 input • ‘Steering potential’ of L&R solutions for desired MOG development	• Assigning issue owner(s) • Assigning required actions per stakeholder

Legal Instruments

Hybrid Assets

Support Schemes

Financing challenges & investors' concerns

CBA

- What is the investment requirement?
- What are the operational costs?
- When is finance needed?

Investor requirements

- Amount >Eur 100bln (2030 ENTSO-E)
- Public private solution required, exc. Credit rating downgrade
- Transmission tariff design

Ownership models

- Multiple structures utilize various technologies not all used by local colleagues.

CBCA

- Which party pays and when?

Funding Capacity Operators

- TSO/DSO funding limits
- Equity
- Debt
- Not funded with debt
- Government support required
- Transmission revenue models

Risk

- Regulatory/ Legal criteria
- Owner regs/monopoly
- Complexity
- Consistency – retroactive risk
- Permitting risk
- Public acceptance

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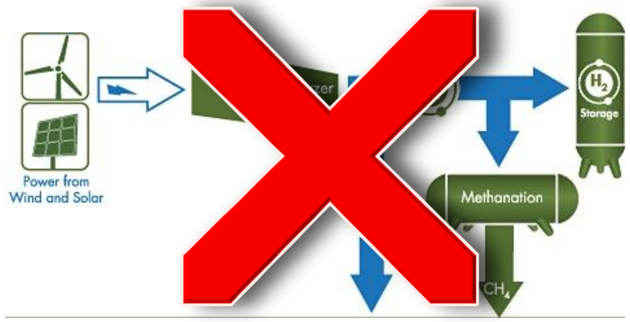
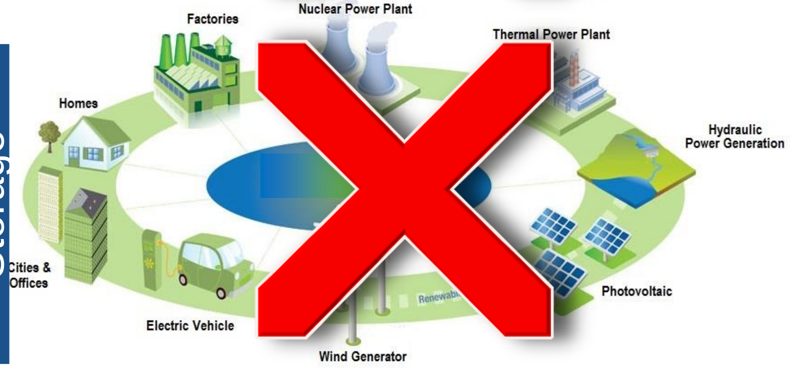
Boundaries of the deployment plan

Power to Gas

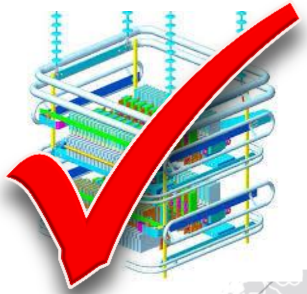


Power to Consumption

Distributed Storage

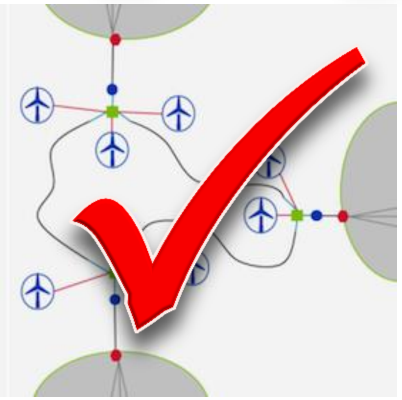


Primary Goal:
Efficient, secure evacuation of offshore generated wind energy to shore



New Technology

Grid Reinforcement



Aggregated viewpoint

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The final deployment plan will combine our results to provide a foundation for the next phase, connecting wind to shore

Final deployment plan

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Any Questions?

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APPENDIX

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