

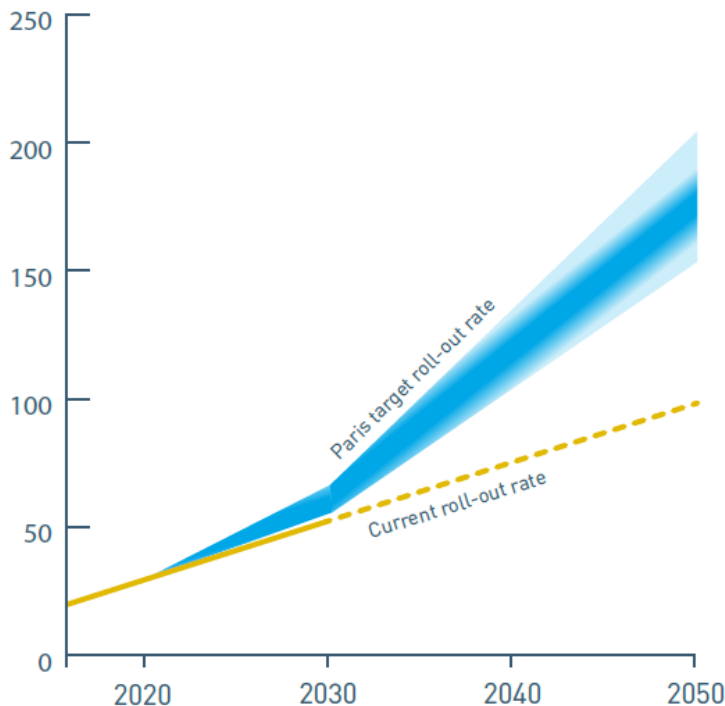
Deployment considerations for HVDC Meshed Offshore Grids in the Northern Seas

TenneT • John Moore

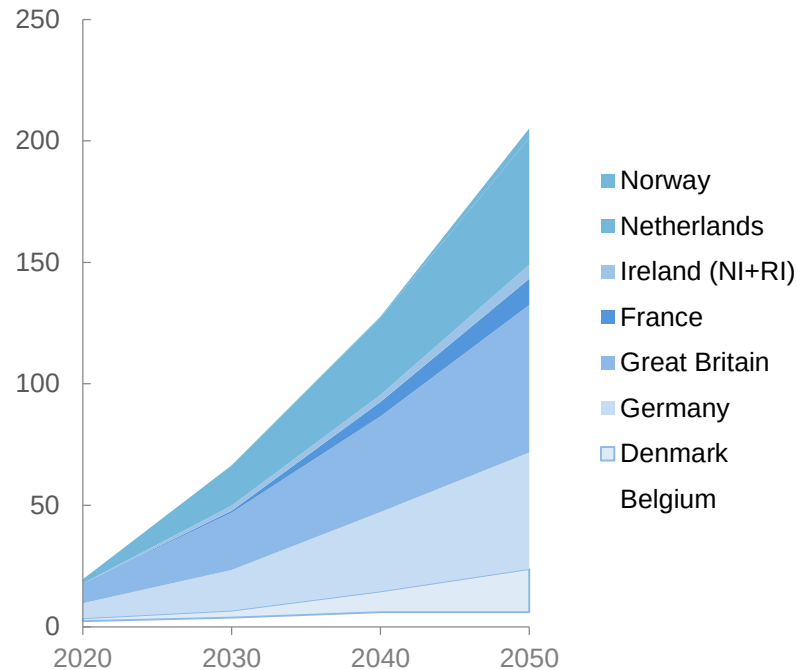
What is the challenge for transmission operators?

Current roll-out rate of offshore wind is insufficient to meet Paris target.

Projected installed offshore wind capacity range in the North Sea [GW]



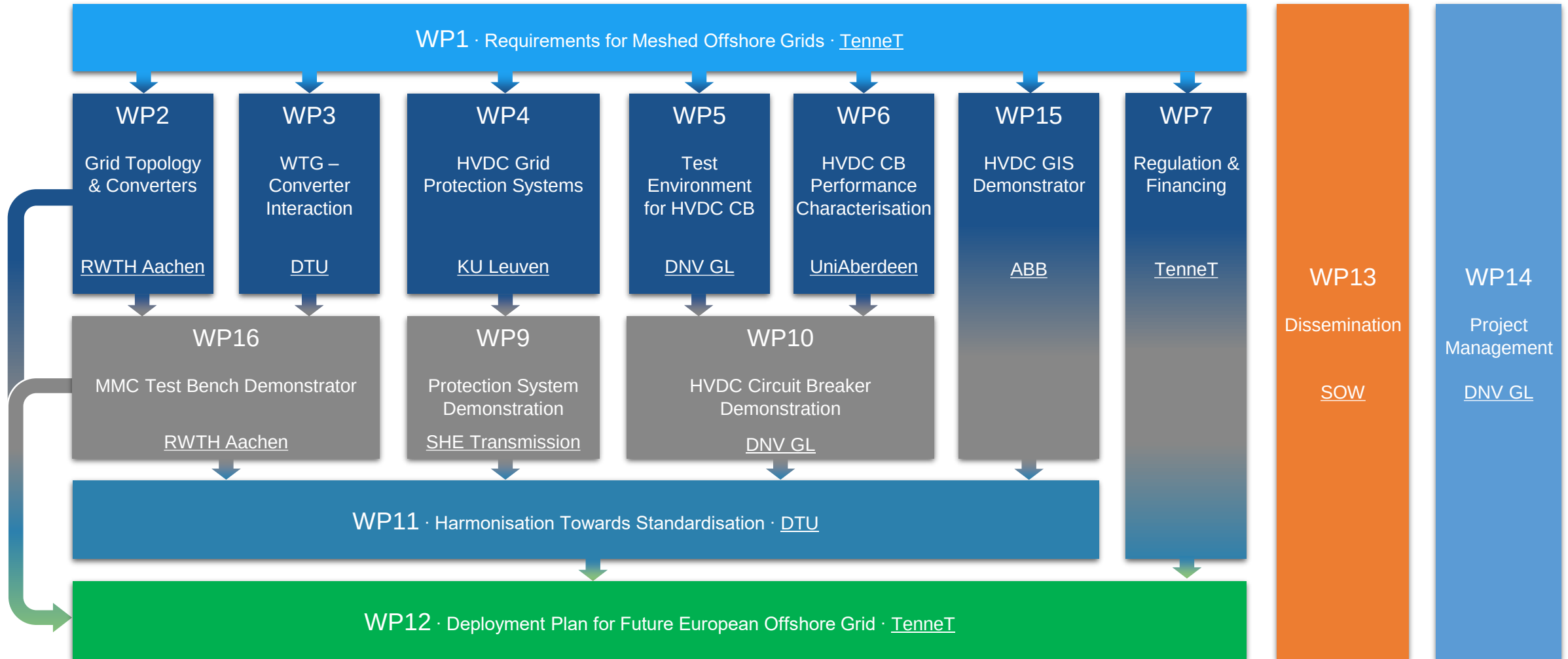
PROMOTioN worked together with different stakeholders to balance national ambition and top down targets



- To hit 2050 Carbon targets we need to accelerate the build of Offshore Wind
- Distance to shore increases as near shore locations filled and resistance increases: 55km today to >100km
- Preparation time increases
- Uncertainty as to technological change and need
- A consistent Legal & Regulatory environment is required to facilitate more efficient evacuation and anticipatory investment
- The infrastructure requires to adopt and provide flexibility options at scale and interact with the onshore grid



PROMOTioN researches into technology and broader issues



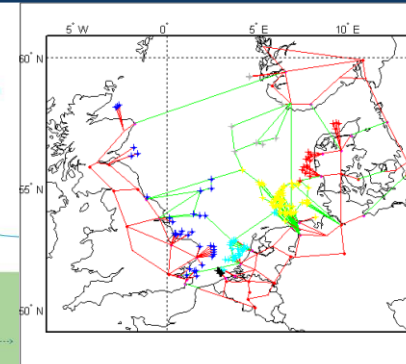
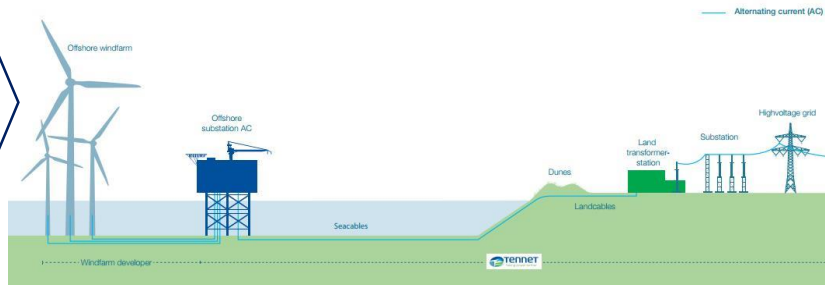
To produce a Deployment Plan for European future offshore grid development.

Technical

Governmental

Financial

Offshore wind connection in The Netherlands – schematic



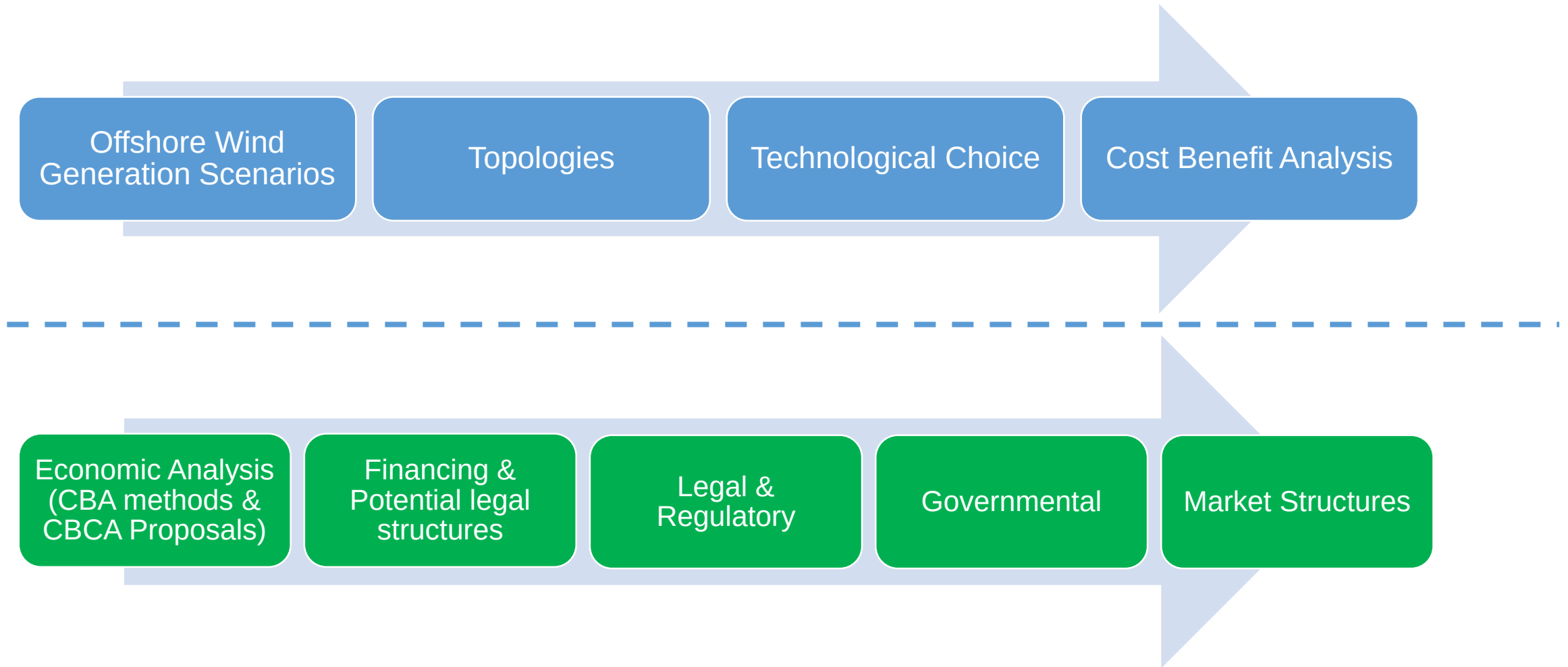
Economic

Market

Legal & Regulatory



Two parallel paths to a Deployment plan:



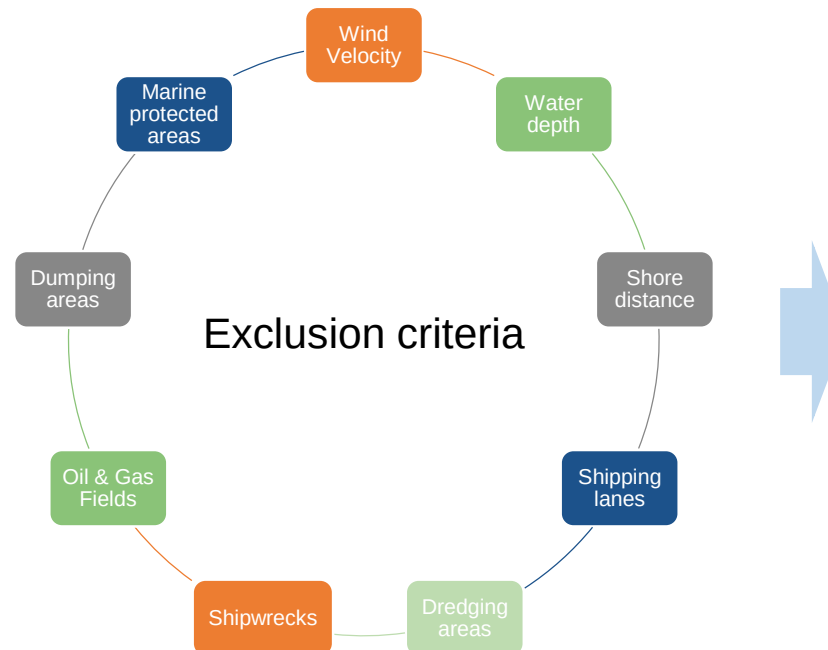
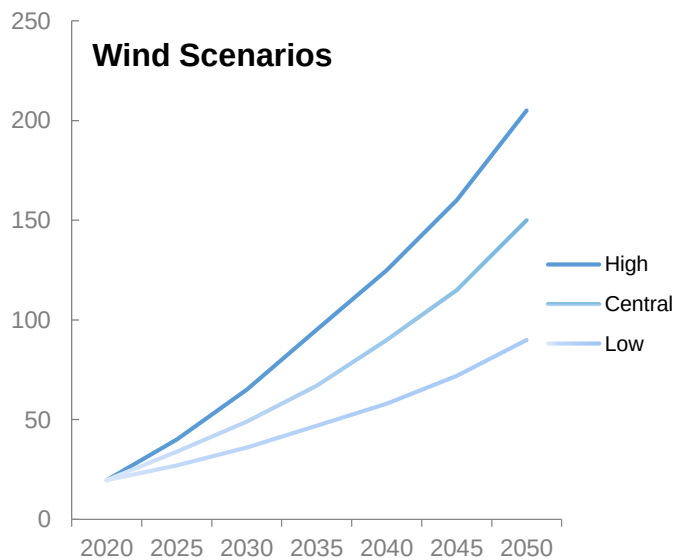
Offshore Wind Generation Scenarios

Topologies

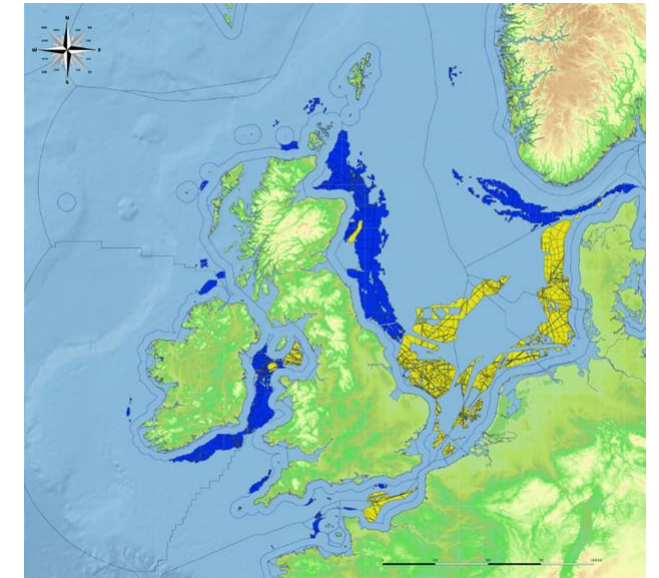
Technological Choice

Cost Benefit Analysis

1. Top down market
2. GIS mapping studies
3. Country Allocation



PROMOTiON Projected Locations



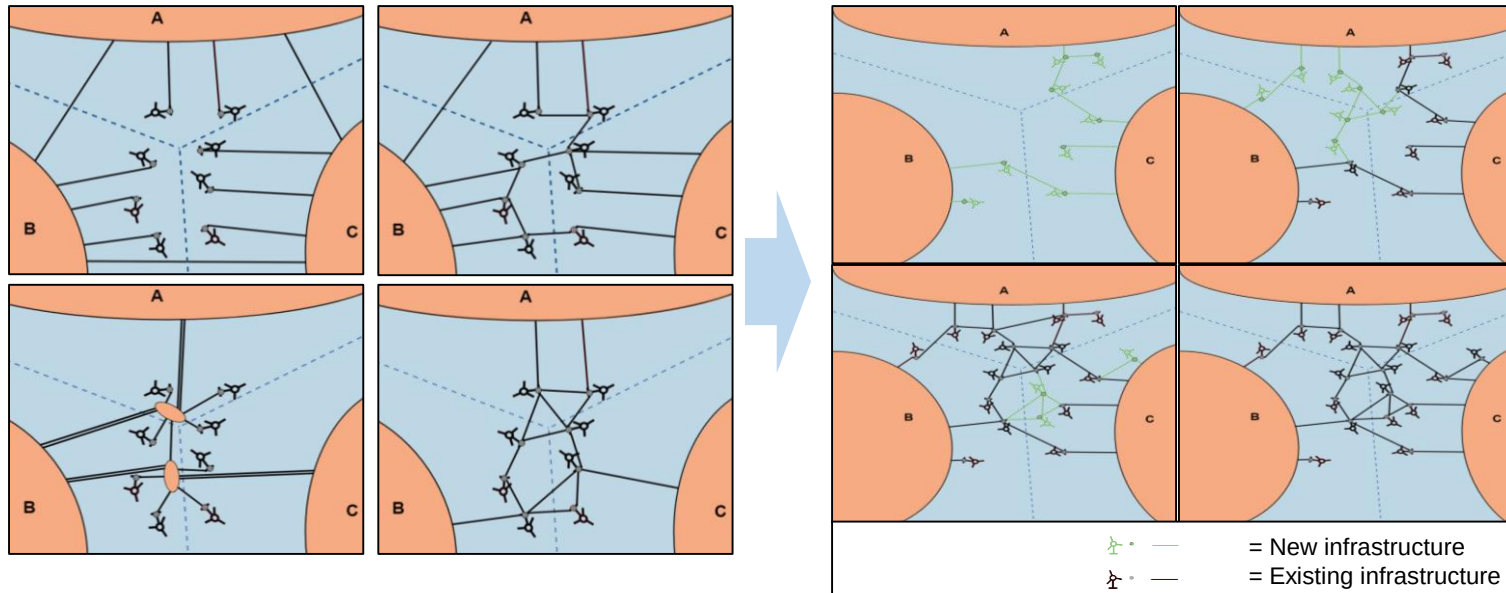
Offshore Wind
Generation Scenarios

Topologies

Technological Choice

Cost Benefit Analysis

1. Concepts
2. Temporal development
3. Optimisation



Step 1: Primary
Optimization
(Minimization of the
investment cost to
evacuate offshore
wind energy)

Step 2: Secondary
Optimization
(Optimization of the
interconnection
capacity between
countries)

Step 3:
Technical feasibility
of the proposed grid
Setup of a detailed
grid model



Offshore Wind
Generation Scenarios

Topologies

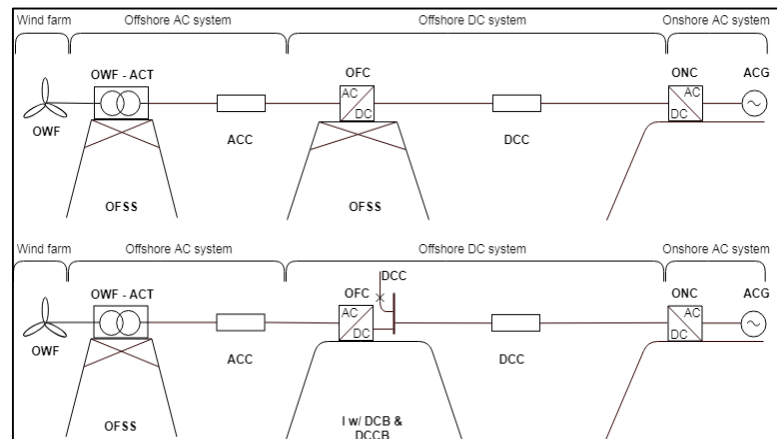
Technological Choice

Cost Benefit Analysis

1. Cost data / inputs
2. Clustering
3. Hub design: bare bones and Protection
4. Costing the network

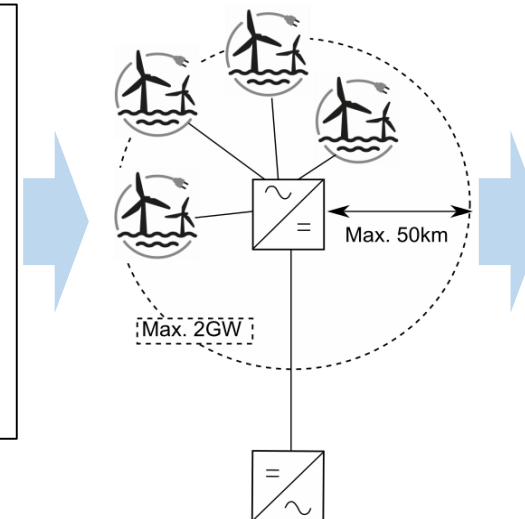
Standard voltages, e.g. 525 kV
Standard configuration: Bipole with fixed return
Standard cable sizes – current Max 2 GW
No onshore load shedding – N-1

Cost Data
Collection



Different Hub structures per Concept with different components (standard architectures depend on distance/power flows)

Protection Strategies determined by WP4



Costs Analysis

Investments
- AC equipment & cables
- DC Hub Equipment
- cables

Protection Costs
(where required)

Operating Costs



Offshore Wind
Generation Scenarios

Topologies

Technological Choice

Cost Benefit Analysis

1. Network Costs
2. Benefits Analysis
3. Non Quantitative analysis
4. KPIs - LCoT

Costs Analysis

Investments

- AC equipment & cables
- DC Hub Equipment
- cables

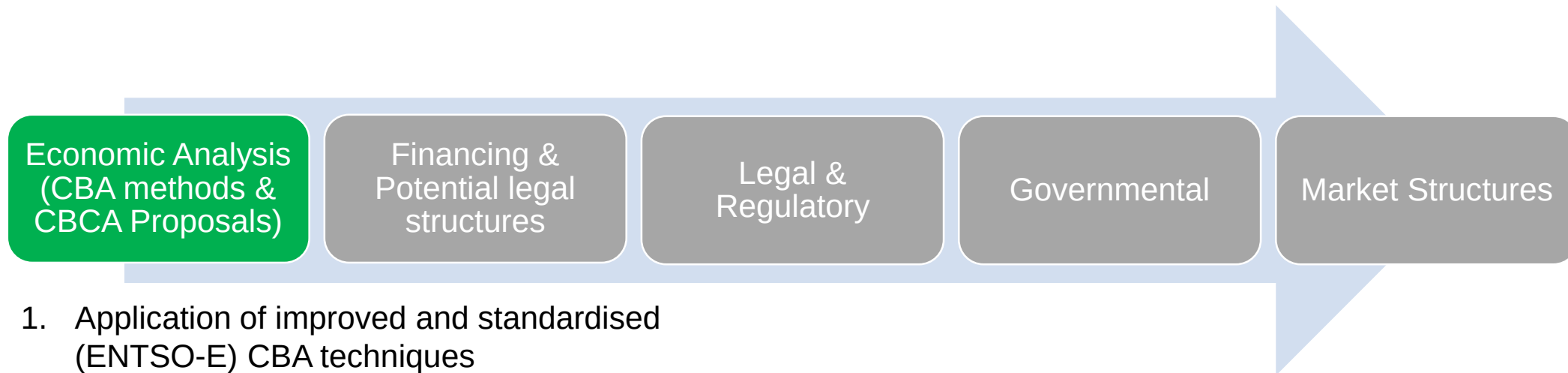
Protection Costs (where required)

Operating Costs

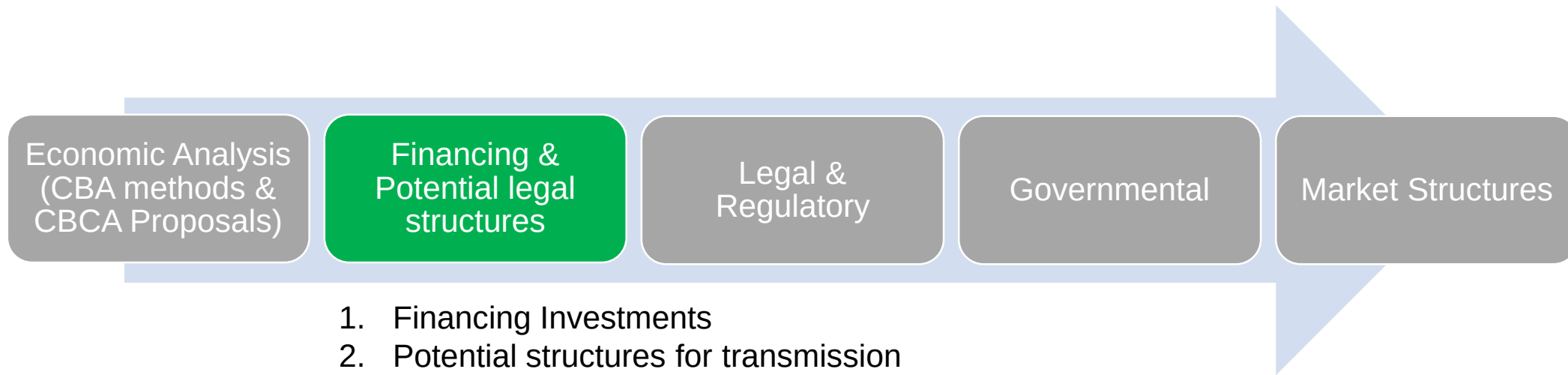
#	NAME	METHOD
B1	Socio Economic Welfare	Quantitative
B2	RES Integration	Quantitative
B3	CO2 Variations	Quantitative
B4	Societal Well-being	Qualitative
B5	Grid losses	Quantitative
B6	Security of Supply – Adequacy	Quantitative
B7	Security of Supply – Flexibility	Qualitative
B8	Security of Supply – Security	Qualitative
B9	Security of Supply – Resilience	Qualitative
S1	Environmental	
S2	Social	
S3	Other	

**Cost-Benefit
Report per
Concept-
Scenario**



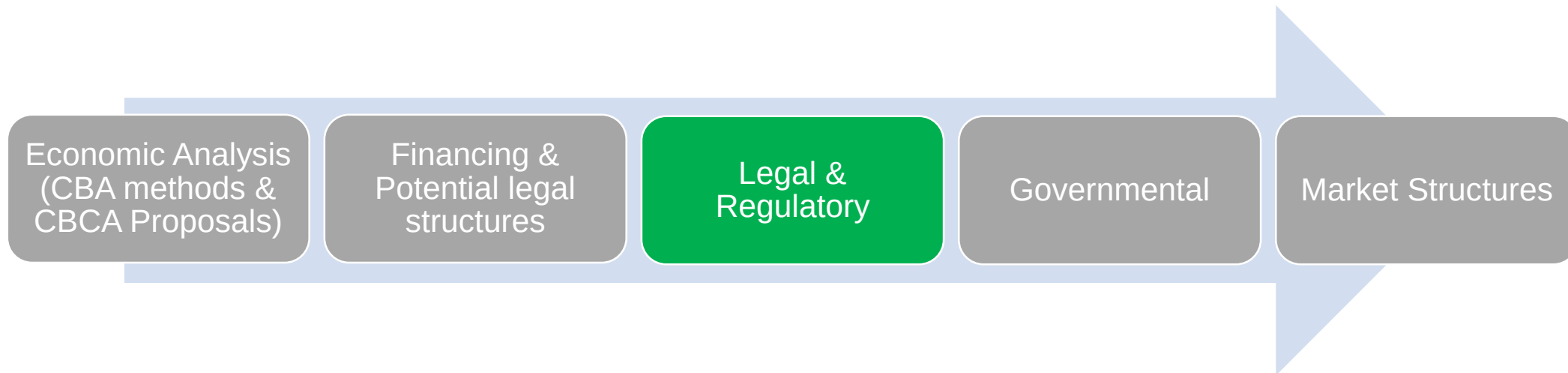


1. Application of improved and standardised (ENTSO-E) CBA techniques
2. Formal and standard Cross Border Cost Allocation

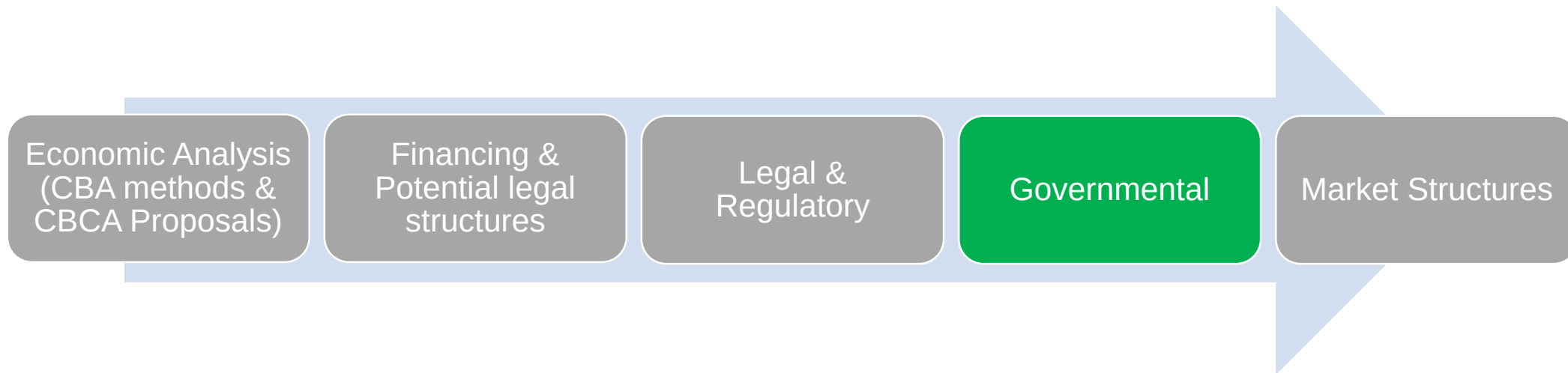


1. Financing Investments
2. Potential structures for transmission owners/operators

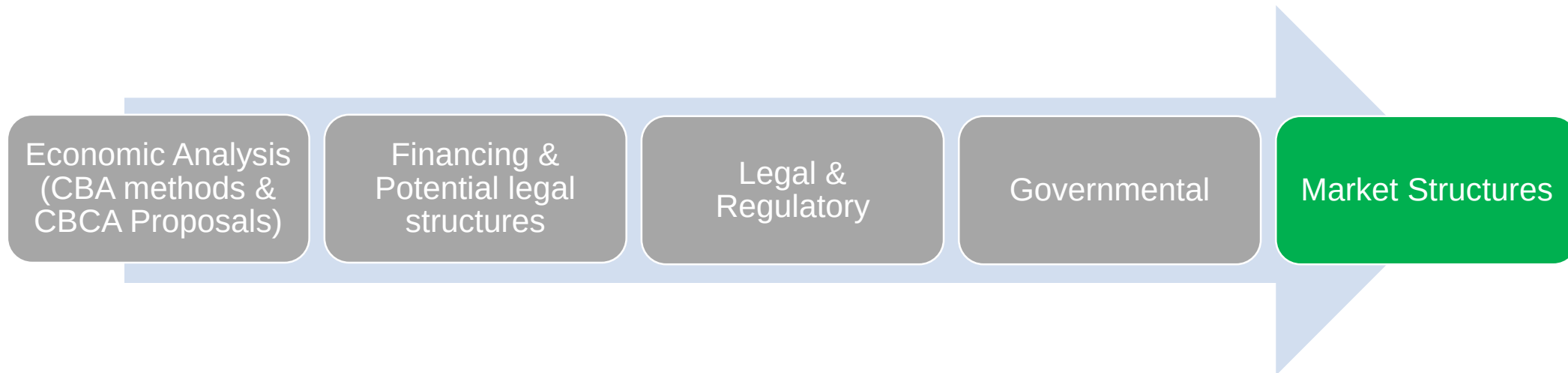




1. Cooperation – Develop a mixed partial agreement
2. A robust Legal definition of a Hybrid Asset
3. Agreement on approach to regulating the grid (who and how)
 1. Finance of Anticipatory assets
 2. Transmission owner income regulation
 3. Offshore wind support schemes
4. Decommissioning regulation

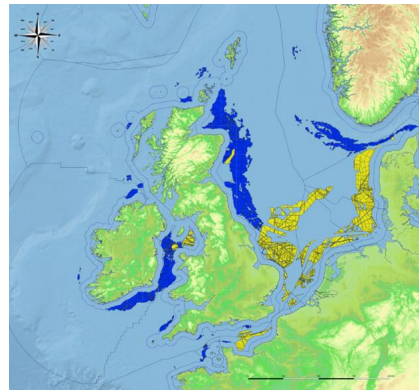


1. Planning & permit Processes alignment/simplification
2. Public Participation and Consultation



1. Market structures from extension of country bidding zone into EEZ to small zones models
2. Market models where meshing exists



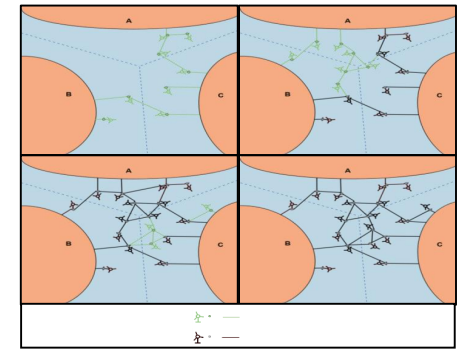


- Hybrid Assets
- CBCA
- Planning
- Environment
- Finance
- Small Zones

- Procurement



**Cost-Benefit
Report per
Concept-
Scenario**



	Converter Technology	HVDC Cables	System control	HVDC GIS	HVDC Circuit Breakers	Protection Philosophy
0	Half bridge	XLPE	Point-point	320 kV SF6	Test circuit	Clearing strat.
1	500 kV	500 kV	Radial MT	500 kV SF6	Hybrid	Deflection
2	800 kV	640 kV	Meshed MT	SF6 Alternative	Mechanical	IED
3	Full bridge	800 kV	WPP	Diagnostic tech	VARC	Test circuit
4						
5						
6						
7						
8						
9						



Deployment plan gives direction and says what is needed

- what we propose as the best solution will never be built
- grids or sub grid structures will appear incrementally
- we suggest ground rules for potential development and interoperability.

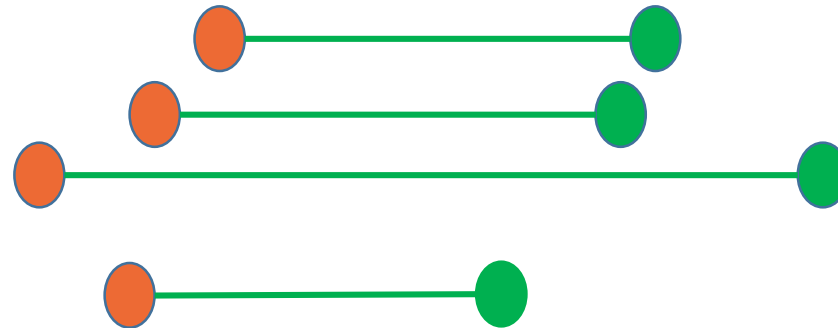


Legal & Regulatory

- Hybrid Asset
- Mixed partial agreement
- Coordinated planning

Technology

- DCCB Industrial test
-



Illustration



Boundaries of the deployment plan

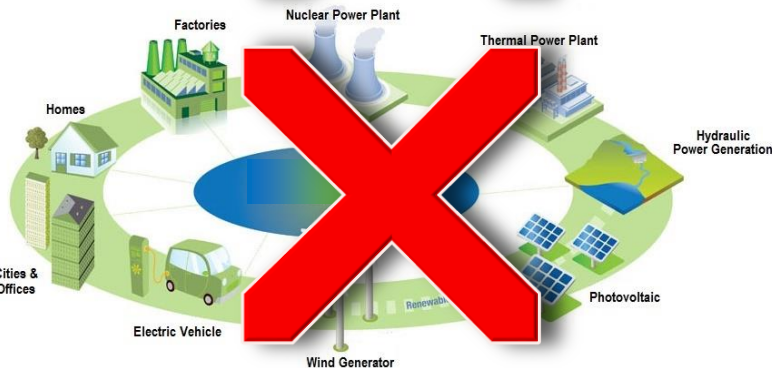
Power to Gas



Power to Consumption

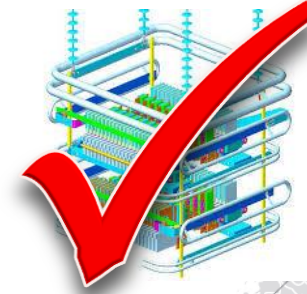


Distributed Storage



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

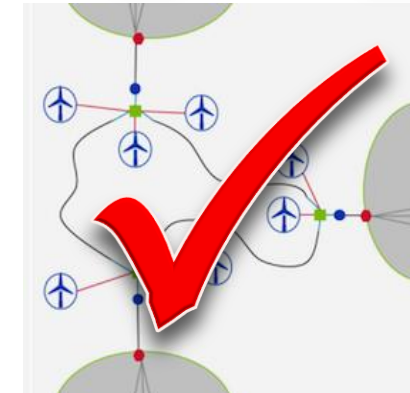
New
Technology



Grid Reinforcement



Aggregated
viewpoint





About PROMOTioN

PROMOTioN is a European Union funded Horizon 2020 project consortium, formed to address the technical, regulatory, financial and legal challenges for offshore HVDC transmission networks. It consists of 33 organizations including European HVDC manufacturers, Transmission System Operators (TSO), academic institutions, testing institutions and consultants. This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 691714.

For more information please visit www.promotion-offshore.net





Any Questions?

