Transnational grid development supported by innovative HVDC architectures

TGEG'19, Session 2

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Grand Projects'21

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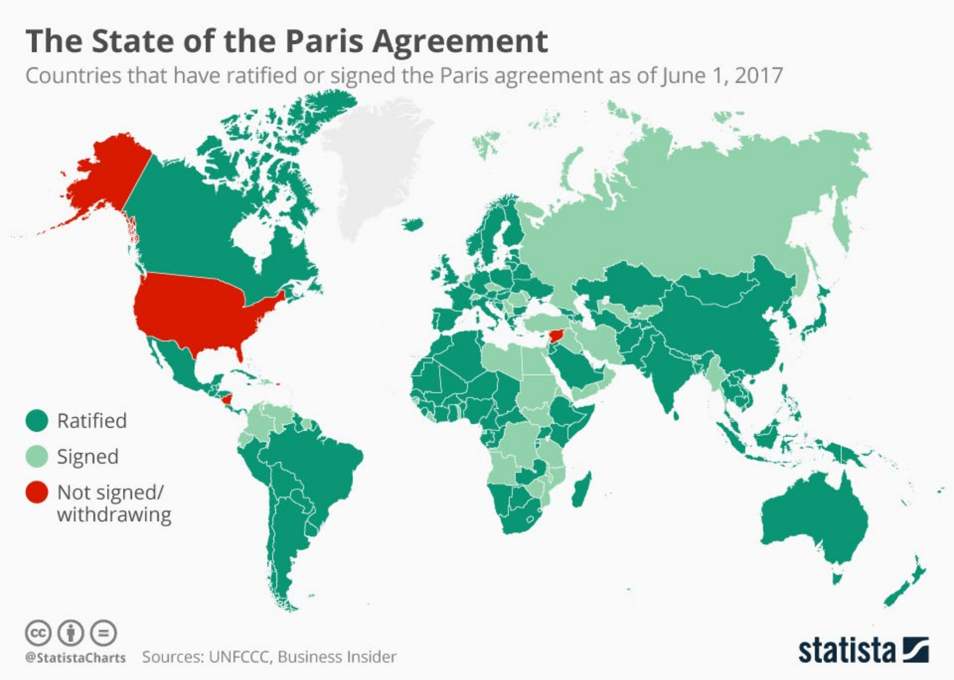
- Context & challenges
- MTDC large power corridors to support electricity highways
- Subsea nodes : building block for offshore grid development?
- Conclusions & Perspectives

Context & challenges



https://www.statista.com/chart/9656/the-state-of-the-paris-agreement/

Humanity is facing 3 major challenges:

- Keep global warming "well below" 2°C
- Reduce air pollution
- Provide everyone access to secured energy

Electricity is central in our lives. The sector is shaken by 3 majors trends:

- Decarbonisation: rush on renewables sources, greater electrification (e.g mobility)
- Digitalisation: increased use of data and communication for optimized management
- Decentralisation: distributed energy sources, storage, new uses and markets

Transmission electricity grids have the opportunity to reinvent and serve the energy transition

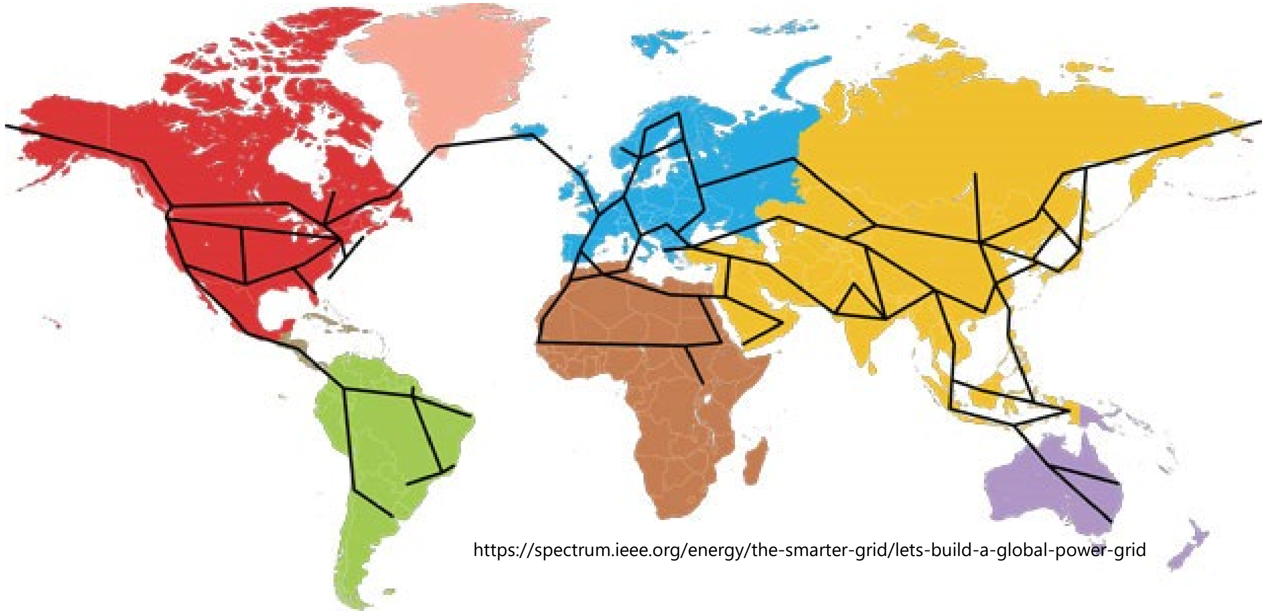
Global Electricity Grids

At world level, studies highlighted the benefit of having a strong, interconnected electricity network providing :

- Greater energy access
- Lower prices for consumers
- Decarbonisation trough larger use and better integration of renewables

cigré

Global Energy Interconnection Development and Cooperation Organization
全球能源互联网发展合作组织



https://spectrum.ieee.org/energy/the-smarter-grid/lets-build-a-global-power-grid

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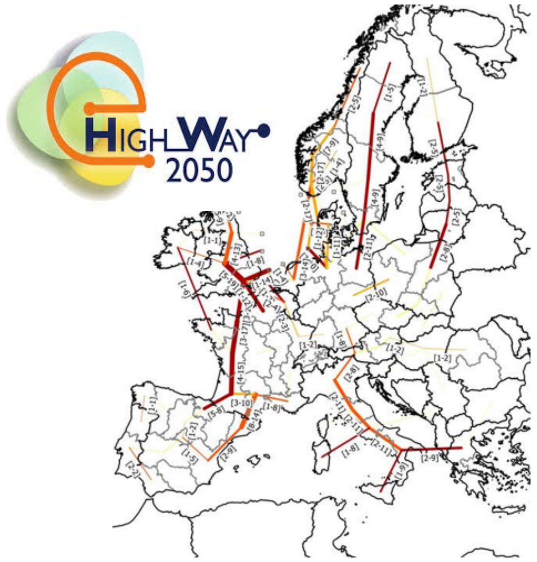
Global Electricity Grids

On European scene : Strong policies and support to key R&I projects from the E.U.



Dives into countries realities

Highlights reinforcements

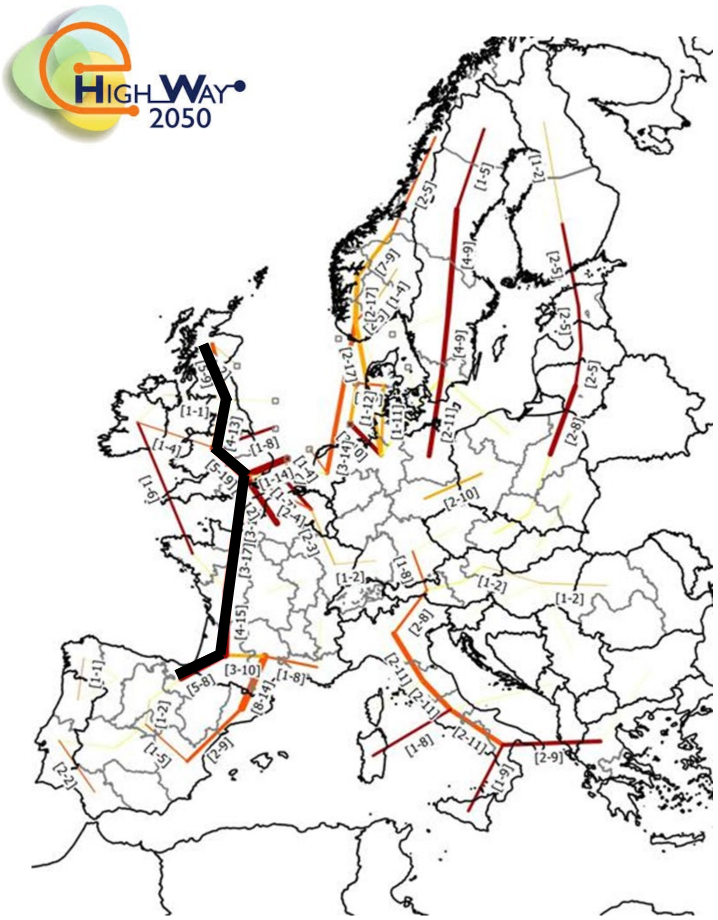
PROMOTioN
PROGRESS ON MESHED HVDC OFFSHORE TRANSMISSION NETWORKS

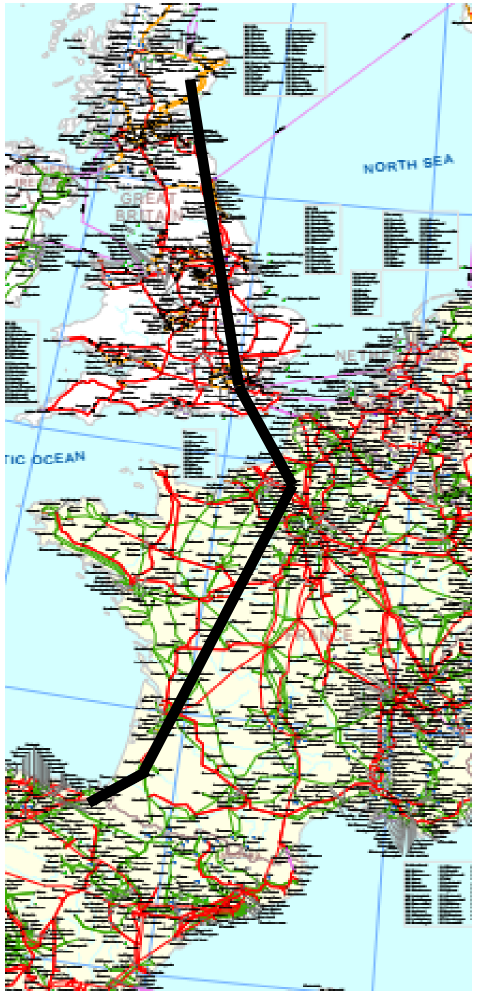
Baltic InteGrid
Integrated Baltic Offshore Wind Electricity Grid Development

Explore the benefits and pave the way for offshore grid extensions

Grid reinforcements and extensions are needed
Europe may be the birthplace of a future global electricity grid

Reinforcements options : HVDC large power corridors





Today, mainly cross border interconnectors

Rely on national grid transmission capability?

With some local AC grid reinforcements?

How far national grids can support high additional transmission requirements?

To implement cross-border and inland electricity highways

HVDC is a competitive option

(e.g. illustrated by the German choices)

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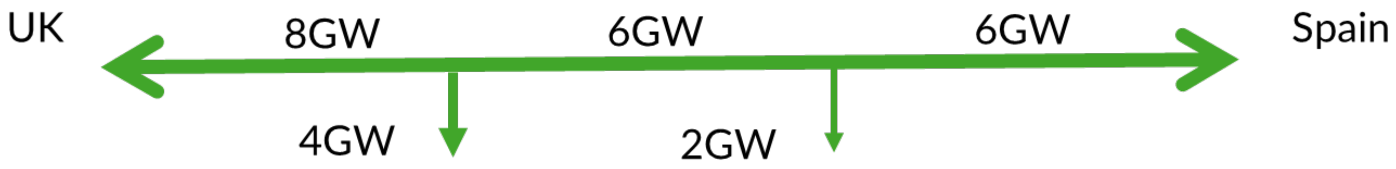
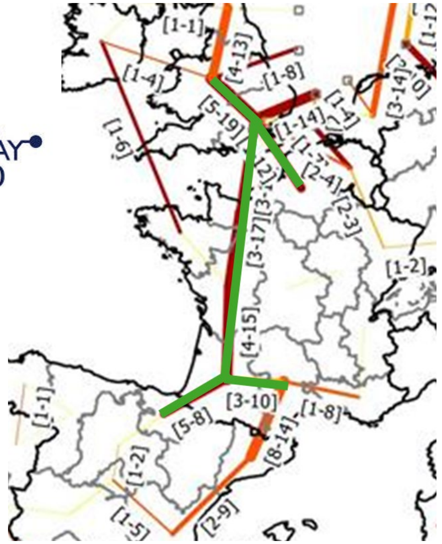
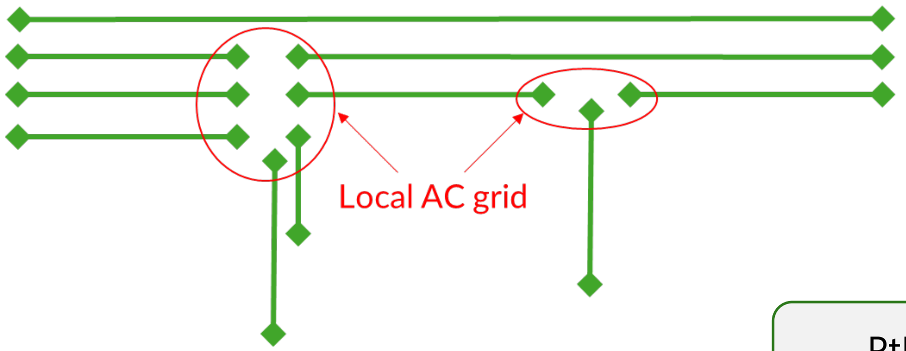
Building large power corridors

HIGHWAY 2050





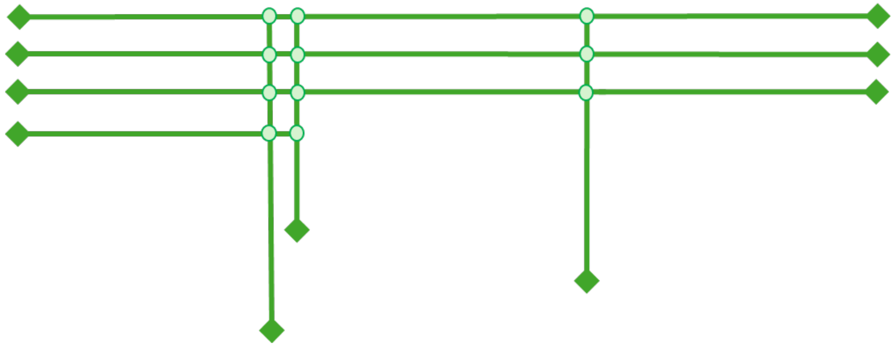
Multiple Point to Point



Full flexibility requires 20 converters

or

Multi Terminal architecture



Full flexibility requires 10 converters

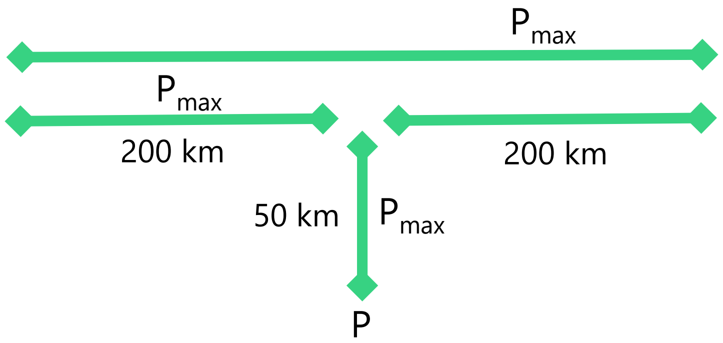
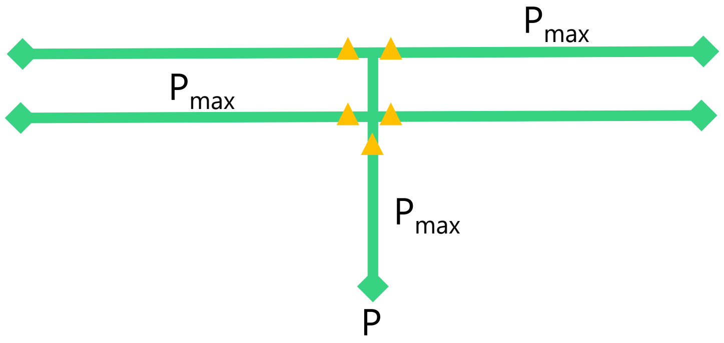
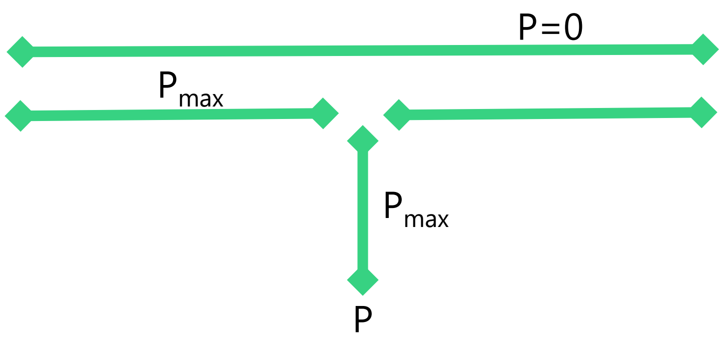
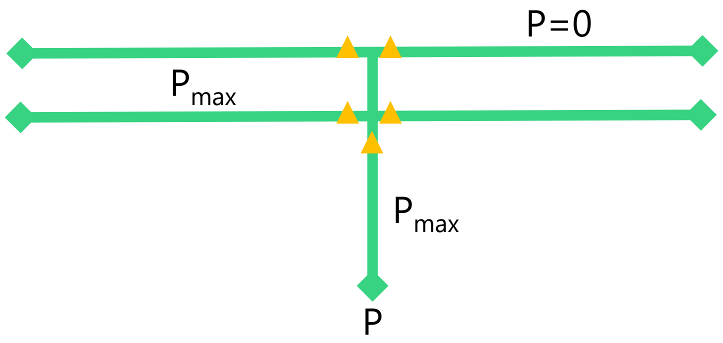
Converter Capex and Opex (e.g. losses) divided by ~2

Converters at both ends

◆ : Converter

Building large power corridors:

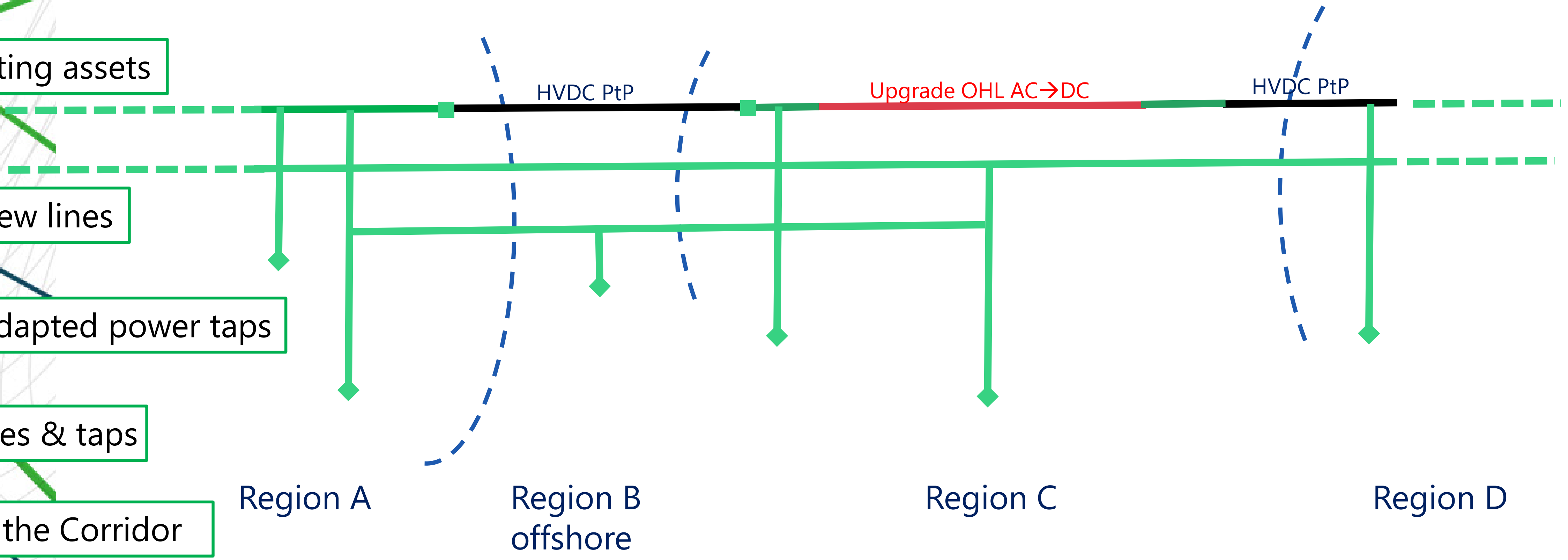
▲ : Substation
◆ : Converter

	Multiple Point to Point	*Multi terminal architecture*
Max power scenario	 Availability of $P=P_{max}$ = 94.5%	 Availability of $P=P_{max}$ = 96%
Lower power scenario	 Availability of $P=P_{max}$ = 94.5%	 Availability of $P=P_{max}$ = 98.6%

Increased availabities trough MTDC architectures

Building large power corridors: Planning

- Using existing assets
- Building new lines
- Building adapted power taps
- Adding lines & taps
- Extending the Corridor



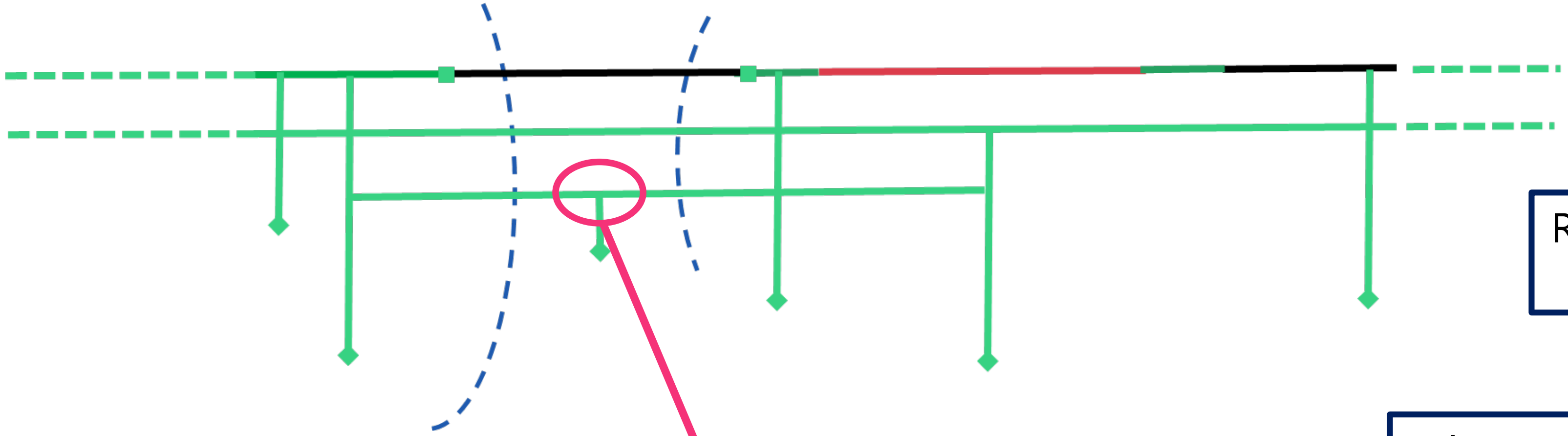
Grid planning & high level architecture principles are key
Step wise implementation is possible

Large power corridors: challenges

Decision support and tools for grid planning

Interoperability of systems

Stability issues with HVDC systems embedded in AC system



Regulation framework

Protection schemes and strategies with OHL or hybrid OHL/cables

Upgrading of existing HVAC lines to HVDC

Interoperability of technologies

New building block

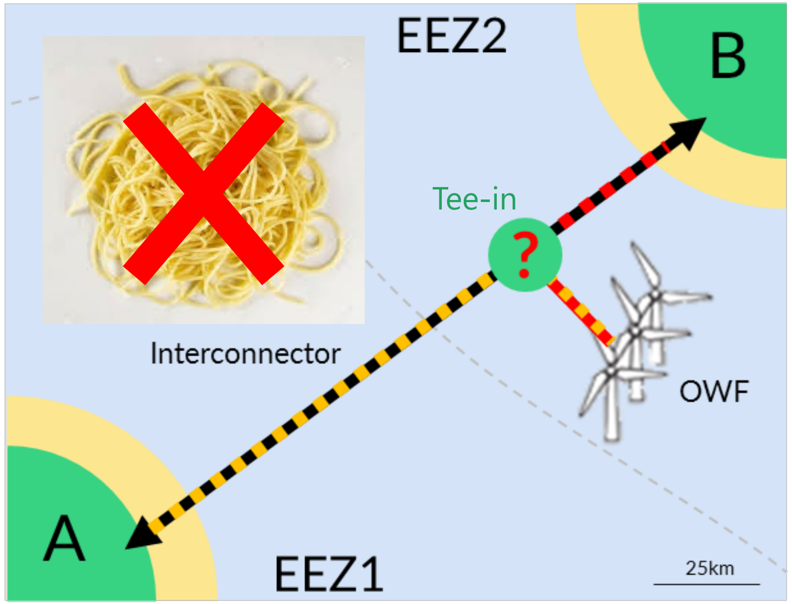
Offshore nodes

Offshore nodes: Synergies for OWF and Interconnector

Context :

- Increase of interconnections
- Offshore wind is booming
- Landfalls place and public acceptance is limiting

Using new or existing interconnectors in the vicinity of windfarms shall generate win-win business case



Benefits of Tee-in connection:

- Mutualize costs
- Rationalized offshore grid & connection points at shore
- Increases RES availability
- Allows for step-wise and modular development

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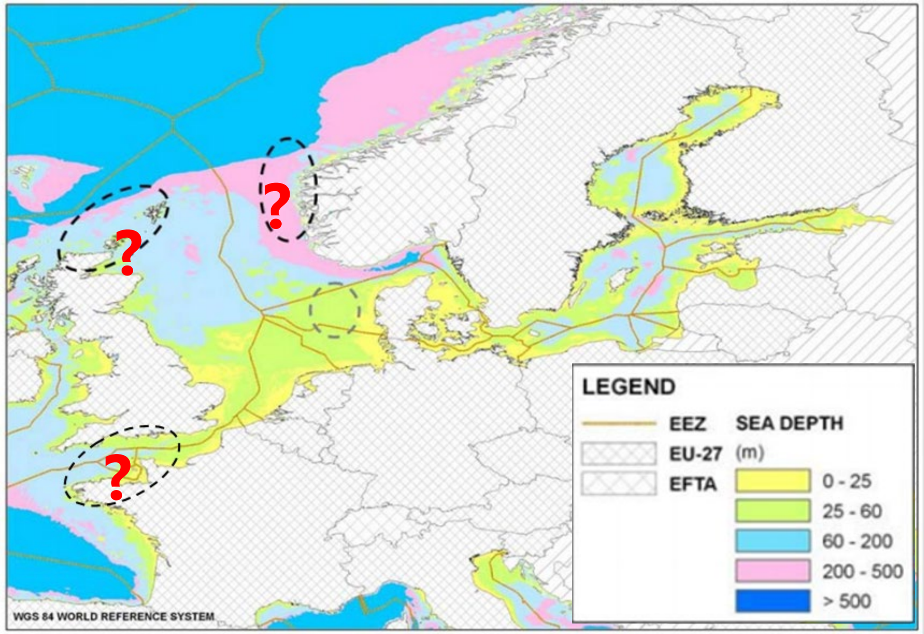
Offshore nodes : going subsea?

Decreasing costs of RES integration

- Bottom fixed platform are feasible in the North and Baltic seas as it is relatively shallow (<60m)
- But future windfarms will be located in deep water



Floating platforms are an option, but:

- Non negligible impact on sea users
- HVDC Dynamic cables are probably too risky to be used on interconnectors

Subsea node is an interesting solution to connect RES to interconnectors

Subsea nodes : challenges

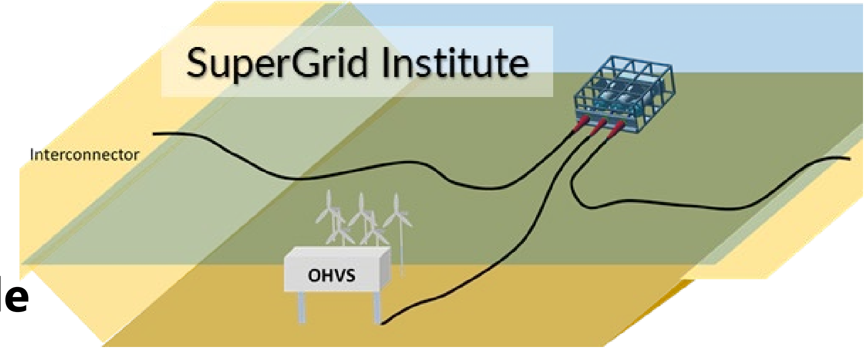
Expected requirements

- >320 kV DC, 3 ways branching unit
- Disconnecting capabilities
- Remote control & monitoring
- Installable and protectable at reasonable cost
- Maintenance free

State of art and technological gap

- Oil & Gas take advantage of 36kV subsea nodes (AC)
- HVDC extruded cable system is a mature technology
- HVDC GIS have been long-term tested

HV bricks are available to foresee a subsea HVDC node



Challenges are on sea watertightness, power supply and marine installation

Conclusions

- Global electricity grids are expected to bring large societal benefits
- Regulatory and technological challenges remain but projects/initiatives are pushing
- Europe can be a central place for the development of such grids
- HVDC MTDC is a good option to support its growth
- Planning is crucial : stepwise but coordinated with a long term strategic vision
- Offshore assets are key towards a global electricity grid for energy transition
- Subsea node would ease a step-wise and modular development

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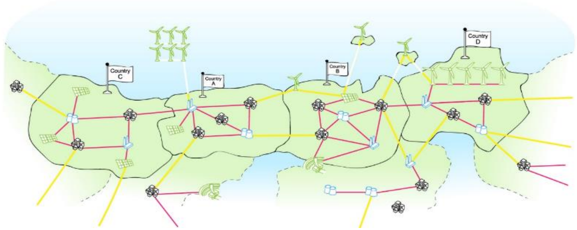
An Independent R&I center, developing Key technologies for the future electricity grids



Institute for Energy Transition (ITE)

- Private company federating academics and industrials
- Created trough the french investment program

Lyon (Villeurbanne), France
Launched in 2014, 170 researchers and 55 patents

High value technologies and services :

- Increased energy efficiency
- Massive RES integration

Unique test platforms for own prototyping and third parties testing

Hyperbaric test vessel for combined testing

Transnational grid development supported by innovative HVDC architectures

Thank you for your attention

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