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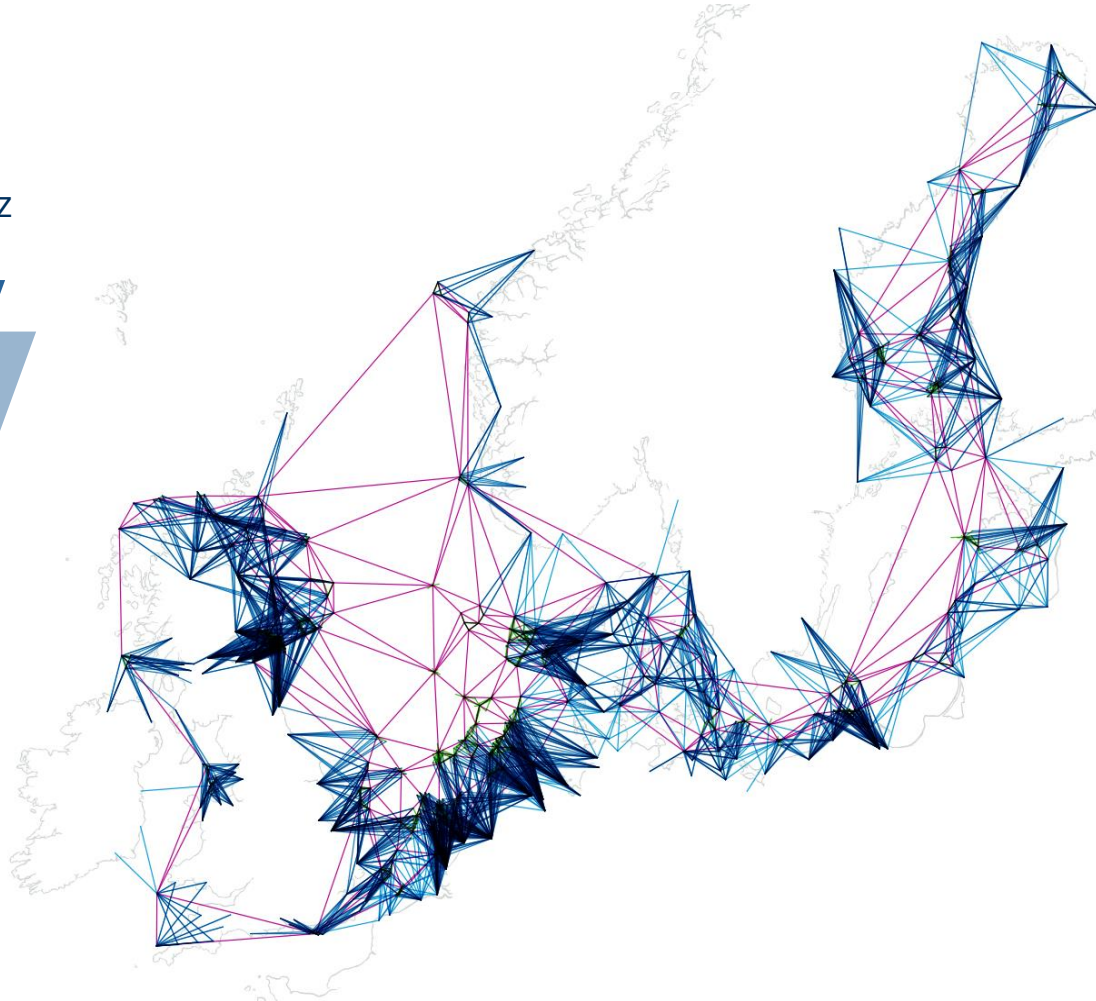
Form follows function?

Dualism between maritime spatial planning and the future offshore grid



Modellers' Exchange Workshop, Brussels // 25.04.2024

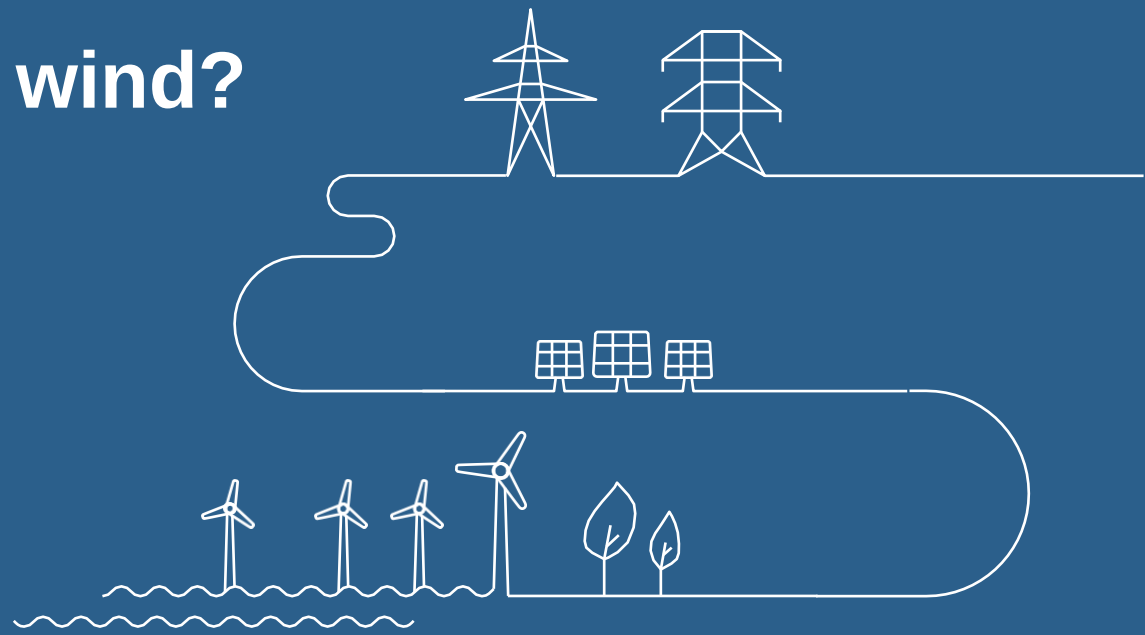
Content of this presentation is subject to the manuscript "High-resolution scenario building support for offshore grid development studies in a geographical information system" published in *Energy Strategy Reviews.*
It depicts the sole view of the author and does not allow any conclusion on the positioning of 50Hertz

Content

1. The core challenge – How to connect future offshore wind?
2. Setting up a search graph in GIS – Pencil or Paper?
3. The case of Baltic and North Sea
4. Looking ahead – Coupling with an energy system model

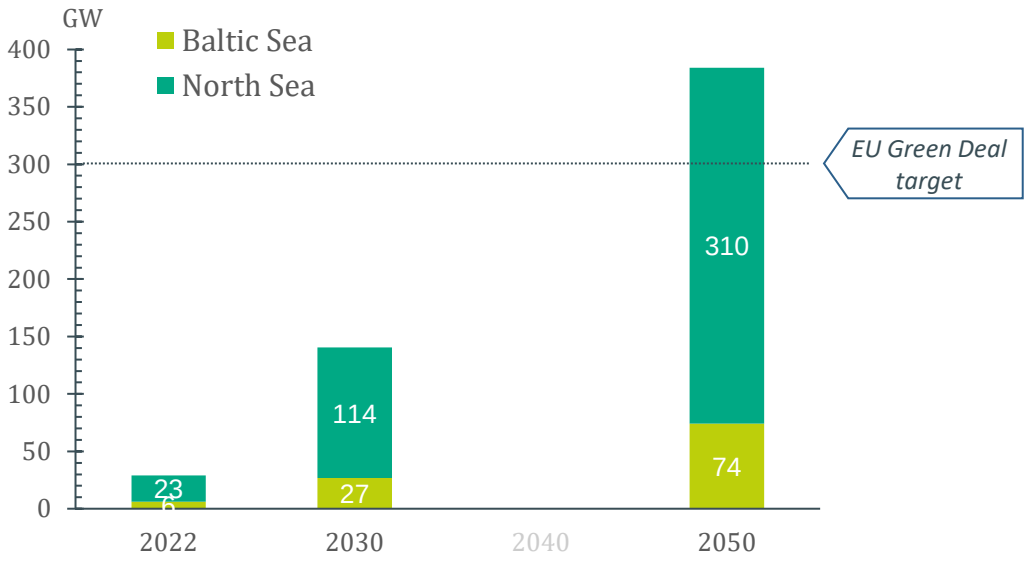
How to connect future offshore wind?

Problem statement and research focus

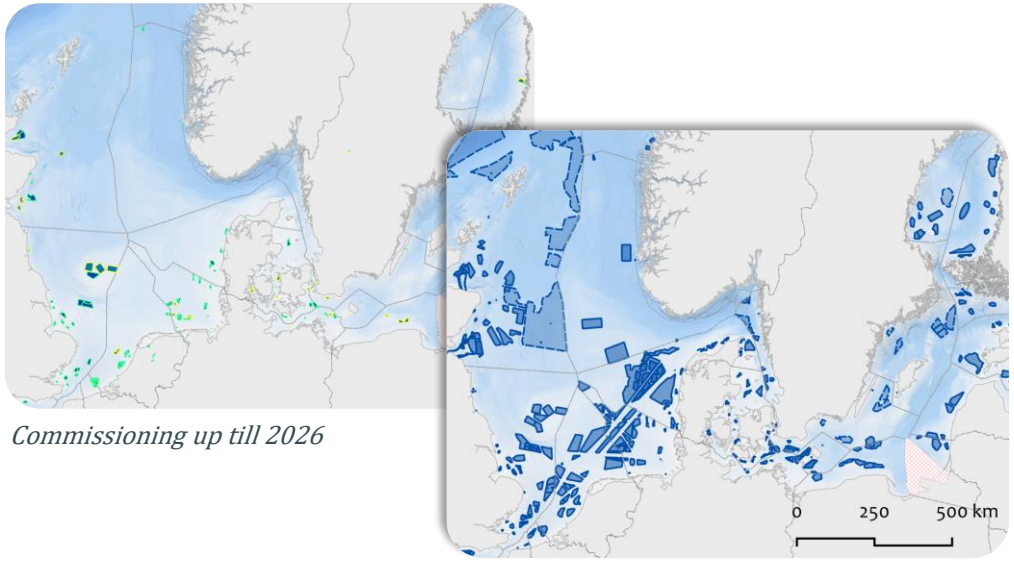


Ambitions for offshore wind almost doubled in past two years

Offshore wind power capacity in Northern Europe



Wind farm development areas in Europe



Commissioning up till 2026

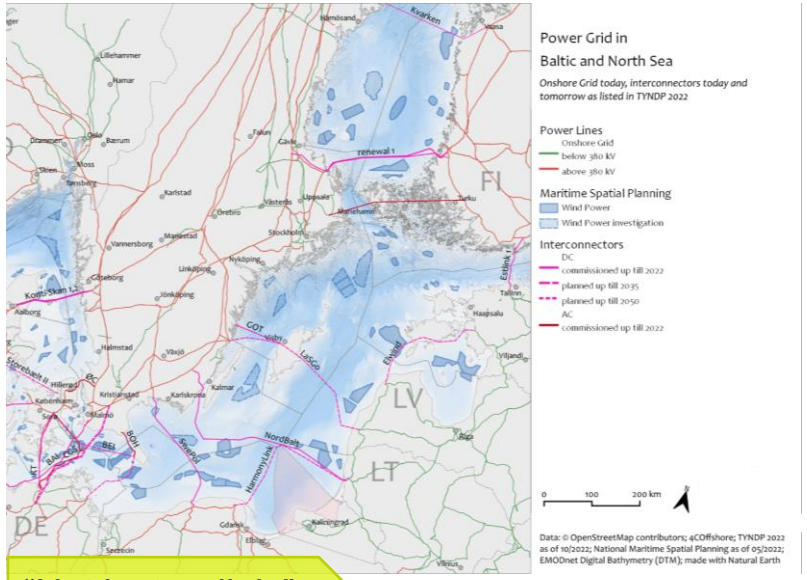
Designation areas

How to integrate unprecedented amounts of offshore wind efficiently into the energy system?

Data: 4C Offshore, Wind Europe 2022, TYNDP 2020, ONDP 2024, Non-Binding Agreements by EU Member States 2023, National Maritime Spatial Planning data

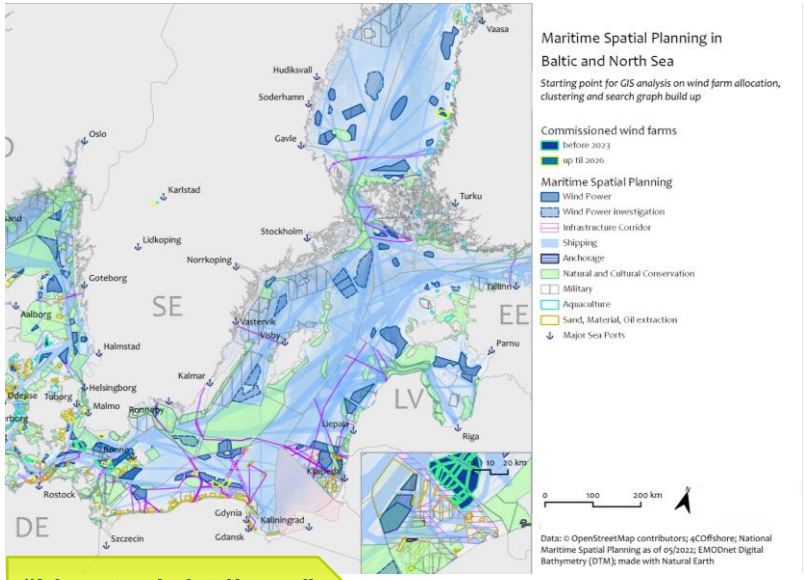
Not just for the green power – considerations for the development of offshore grid infrastructure

Increased Interconnection of Markets



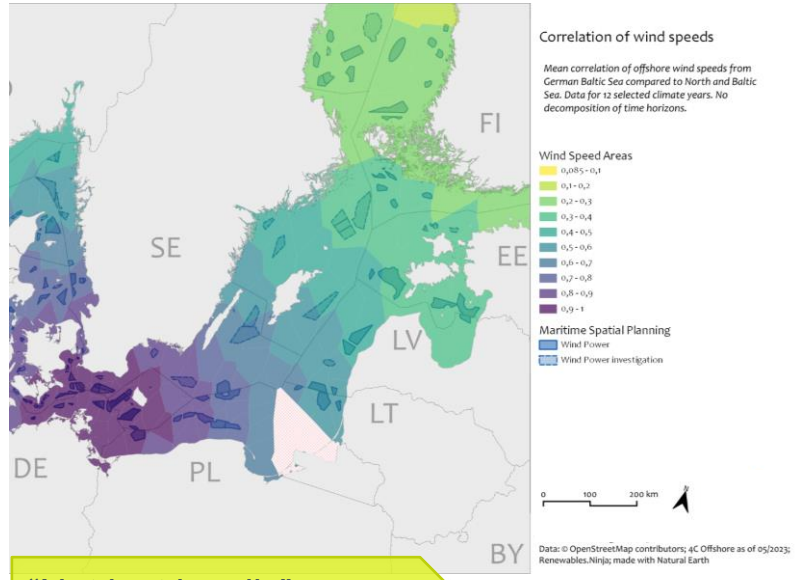
"Not just radials"

Competing Maritime Spatial Interests



"No straight lines"

Leveraging smoothened volatility

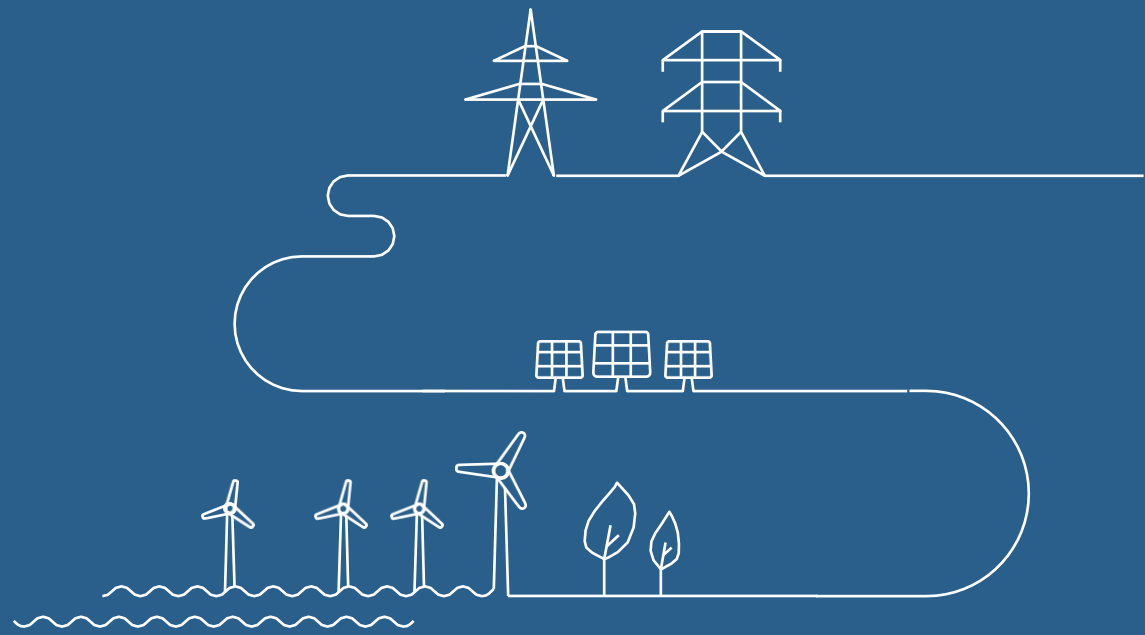


"Not just locally"

How to design "good" scenarios for transmission capacity expansion studies?

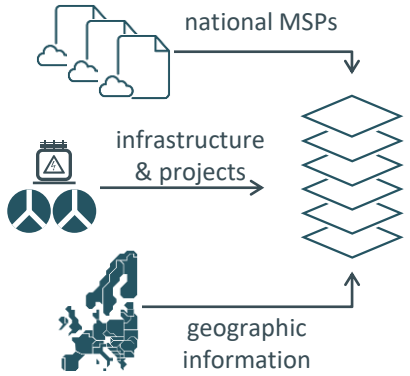
Pencil or computer?

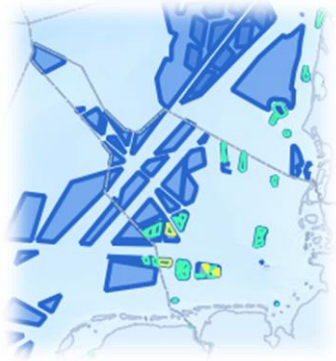
Setup of a search graph in GIS

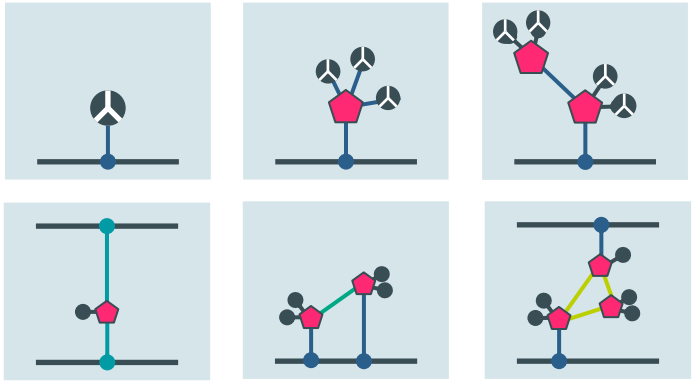


Search graph – setup of candidate lines for investment

Input Data → GIS analysis → Optimisation of investment decisions → Power flow calculations → Final Results







I Data consolidation — QGIS

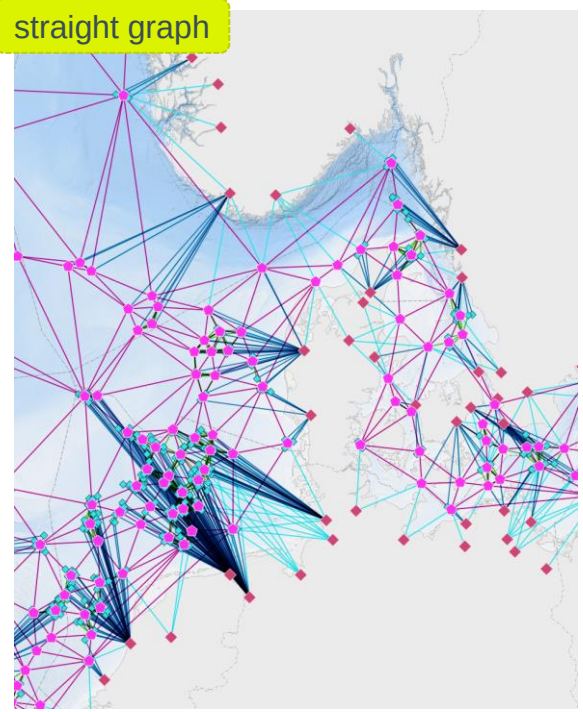
II Point allocation — QGIS

III Link creation — QGIS

https://qgis.org/en/site/ version 3.26.1 with python version 3.9.5
https://pgrouting.org/

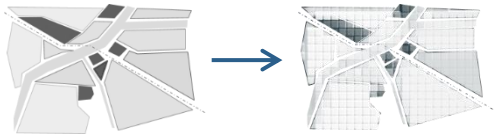
Graph refinement – make the search graph more accurate

straight graph



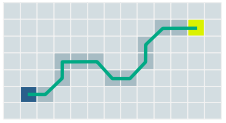
Multi-Criteria-Analysis

1 Rasterization



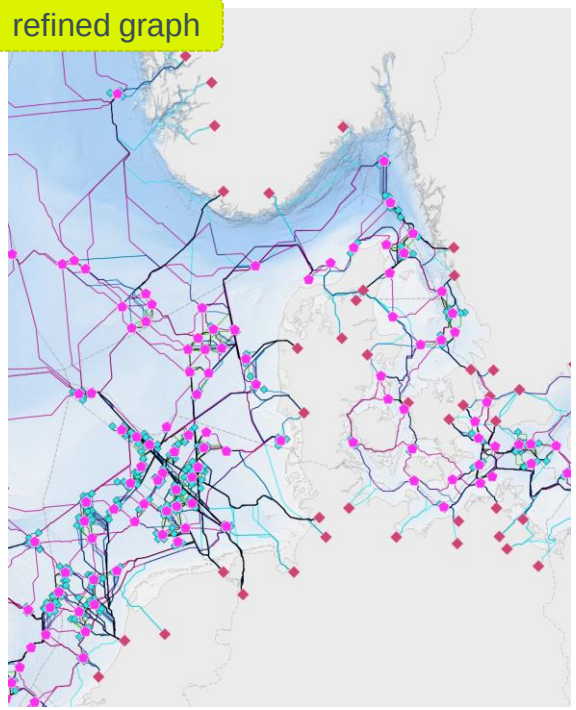
2 Advanced hierarchy process

3 Least cost path search



n *for all graph elements*

refined graph

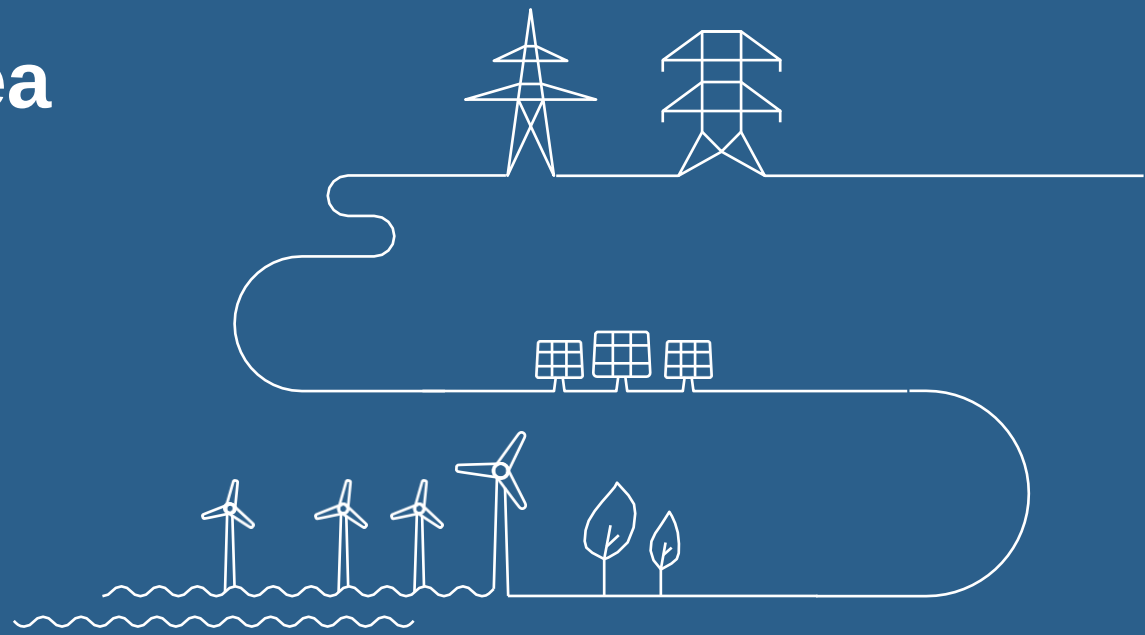


Key input for graph refinement is the maritime spatial planning in all countries

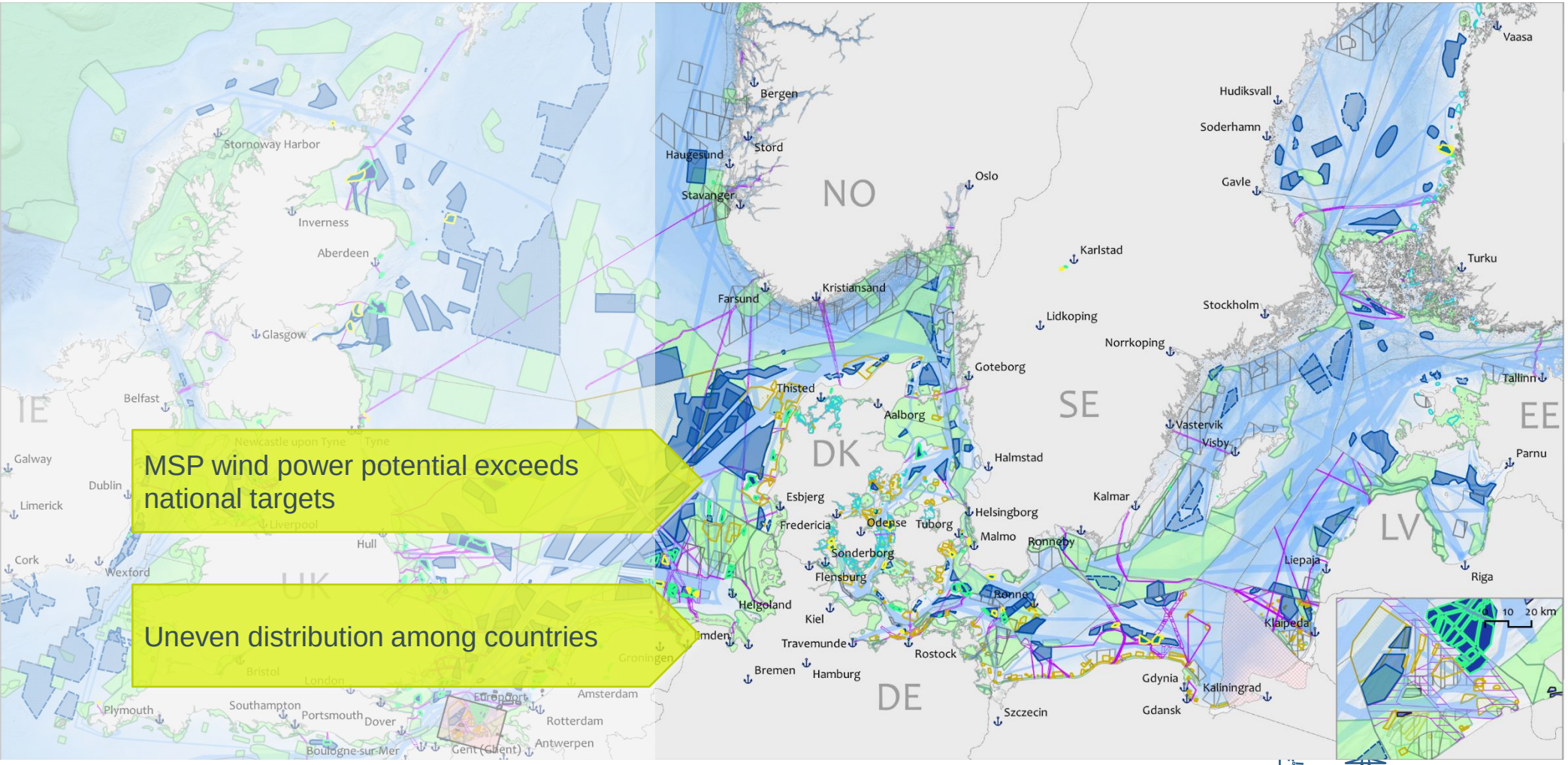
Sources: de Lima 2016, Göpel 2013

The case of Baltic and North Sea

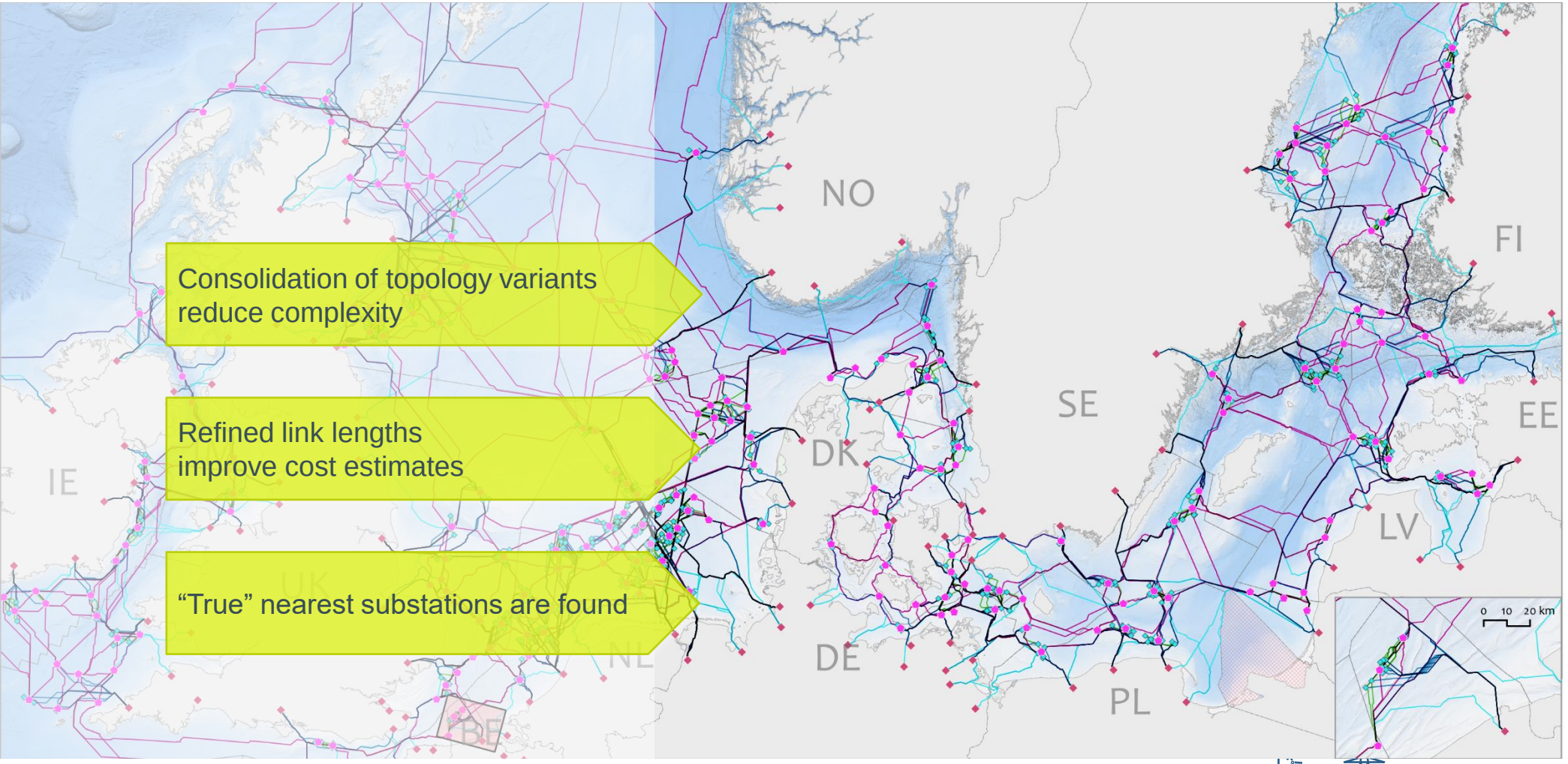
Application of the GIS methodology



The sea space is managed intensively



Refined search graph reduces uncertainty in the analysis



Search Graph Baltic & North Sea

Network of potential transmission paths to realise hybrid interconnectors, offshore hubs and radial connections

Network Points
- HUB
- OWF
- POC

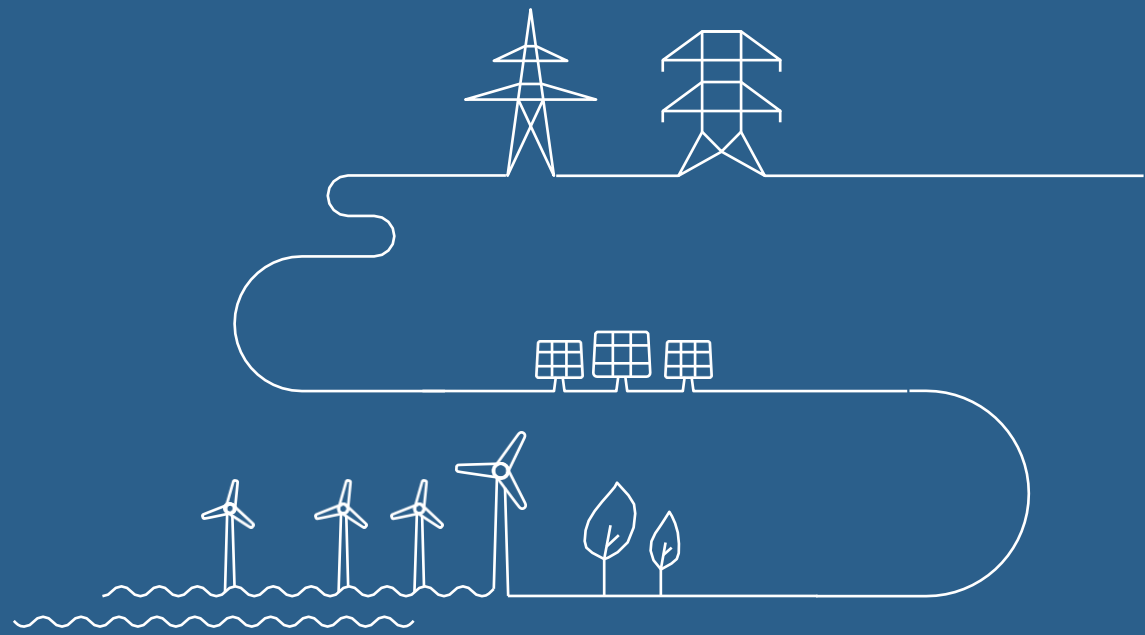
Search Graph
- HUBchain
- HUBradial
- HUBspoke
- OWFradial

Data: © OpenStreetMap contributors; National Maritime Spatial Planning as of 05/2022; EMODnet Digital Bathymetry (DTM); made with Natural Earth

Search graph does neither denote any forecast on likelihood nor preference for offshore grid topologies of the future

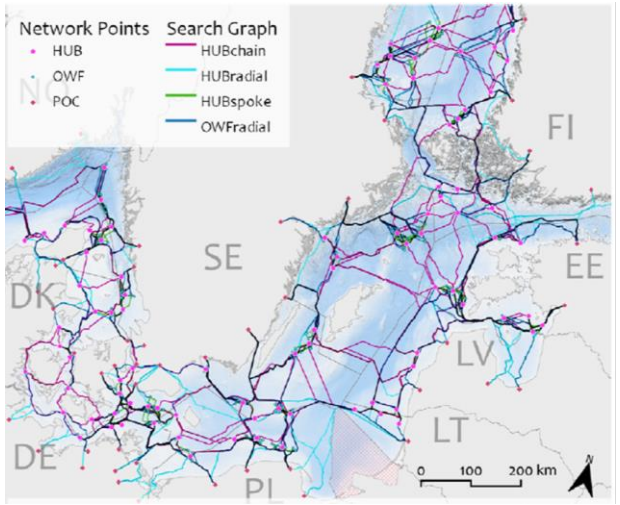
Looking ahead

Conclusions from GIS analysis and next steps

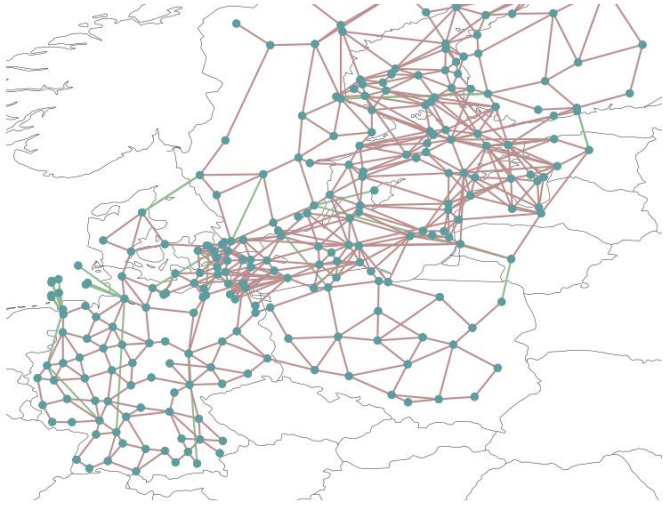


Coupling the Search Graph with an Energy System Model

Input Data → GIS analysis → Optimisation of investment decisions → Power flow calculations → Final Results



QGIS



PyPSA

Attention points

- Reduction in model run time
- Dualism between grid development and spatial planning
- Understand path dependencies
- Discuss least regret investments
- …

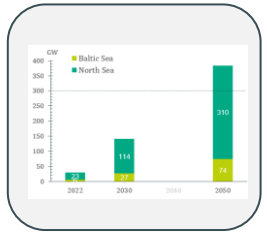
The next generation offshore grid…

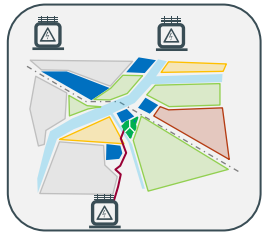
… faces unprecedented ambitions and speed in offshore wind power uptake …

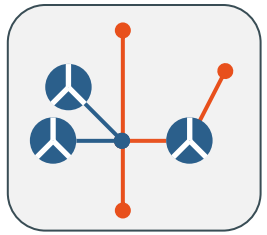
… evolves in a heavily managed sea space…

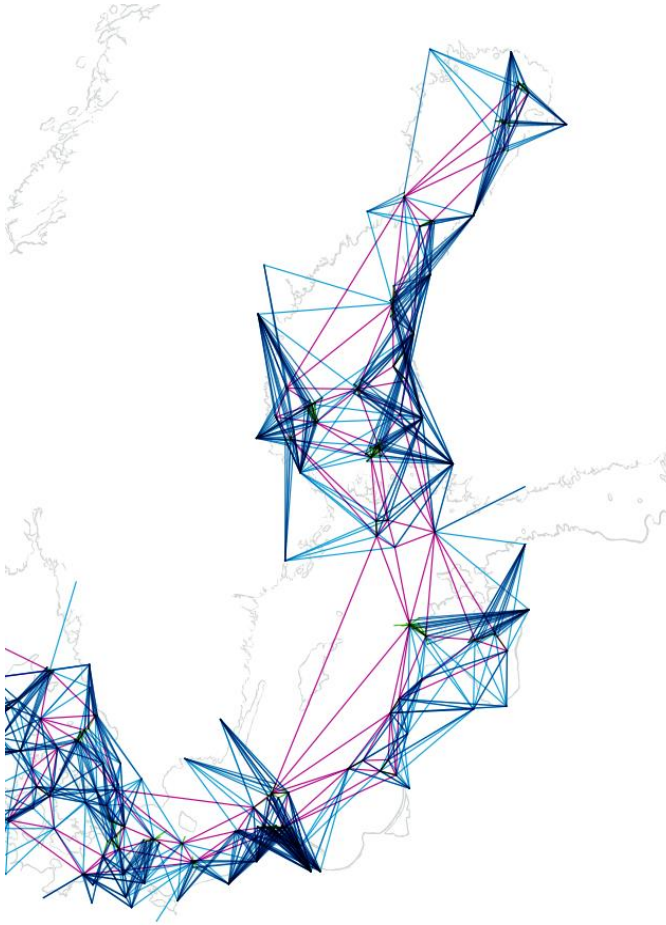
… rendering its development a complex optimisation problem …

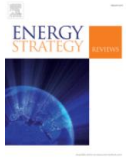
… where a GIS analysis can provide a high-resolution, yet tangible search graph for subsequent optimisation exercises.











Fliegner, Möst 2023: High-resolution scenario building support for offshore grid development studies in a geographical information system
Energy Strategy Reviews

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