Baltic InteGrid
Integrated Baltic Offshore Wind Electricity Grid Development

Pre- feasibility study – Case study 1

Copenhagen, May 23rd

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LUND UNIVERSITY

EU STRATEGY FOR THE BALTIC SEA REGION FLAGSHIP

Interreg Baltic Sea Region

EUROPEAN UNION
EUROPEAN REGIONAL DEVELOPMENT FUND

Outline

- Approach
- Technical assumptions
- Scenario structure
- High & Low offshore wind energy development
- Various HVDC- integration levels
- Scenarios designs and roadmaps
- Scenario comparison
- Extended analysis

Approach

- Technology assumptions
- Localizations and Design of OWE
  - Wind Turbine & foundation layouts
  - Cable layouts & Transformator stations
  - 2 visions, high and low
- Localisation and Design of offshore network
  - Onshore connection points
  - Offshore substations
  - Various levelsof HVDC- integration Zero, Partial, Max
- Component list/Cost- benefit
- Grid functions and services
- Power flow and DC- protection analysis
- Input to market analysis, spatial planning, regulatory questions, etc.

Technology assumptions

Technology Catalogue by DTU

Wind tubrines
Pre-2030: 8 MW
Post-2030: 12 MW

Inter-array voltage
Pre and post 2030: 66 kV AC

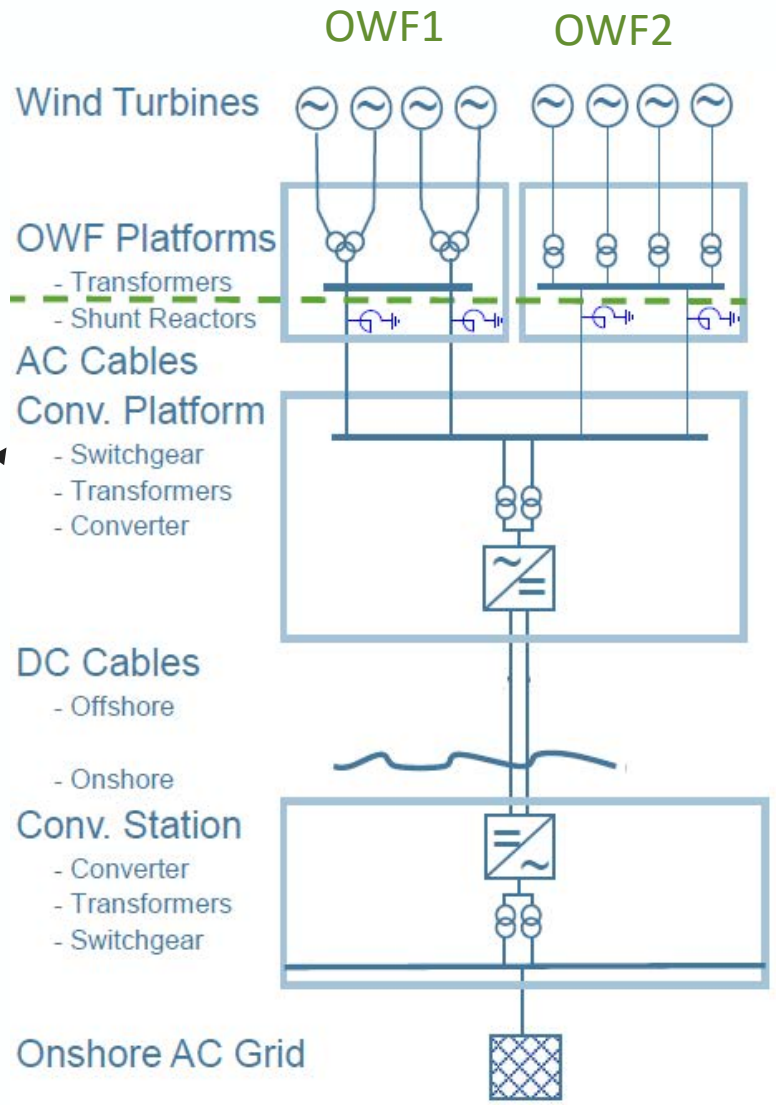
AC transformer substations
Pre and post 2030: 600 MW

AC export cables
Pre and post 2030: 300 kV AC

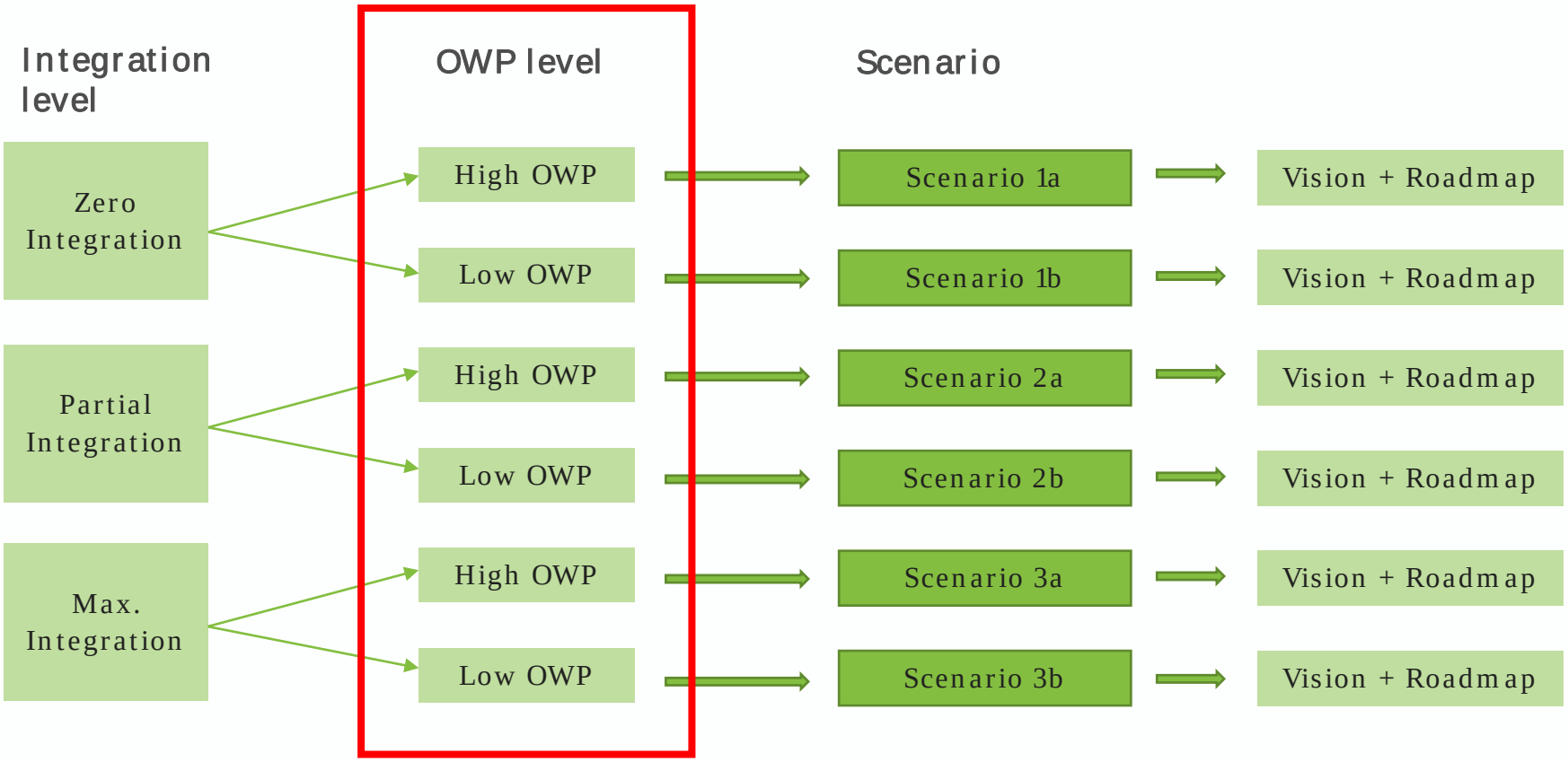
Converter technology
VSC: Modular Multi level
System: Symetrical Monopole or Bipole

HVDC cable voltage (available)
Pre-2030: ± 525 kV → 2500 MW
Post-2030: ± 640 kV → 3000 MW

AC onshore grid
Pre and post 2030: 300-400 kV AC



Scenarios


Integration level
OWP level
Scenario
Zero Integration
Partial Integration
Max. Integration
High OWP
Low OWP
High OWP
Low OWP
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Scenario 1a
Scenario 1b
Scenario 2a
Scenario 2b
Scenario 3a
Scenario 3b
Vision + Roadmap
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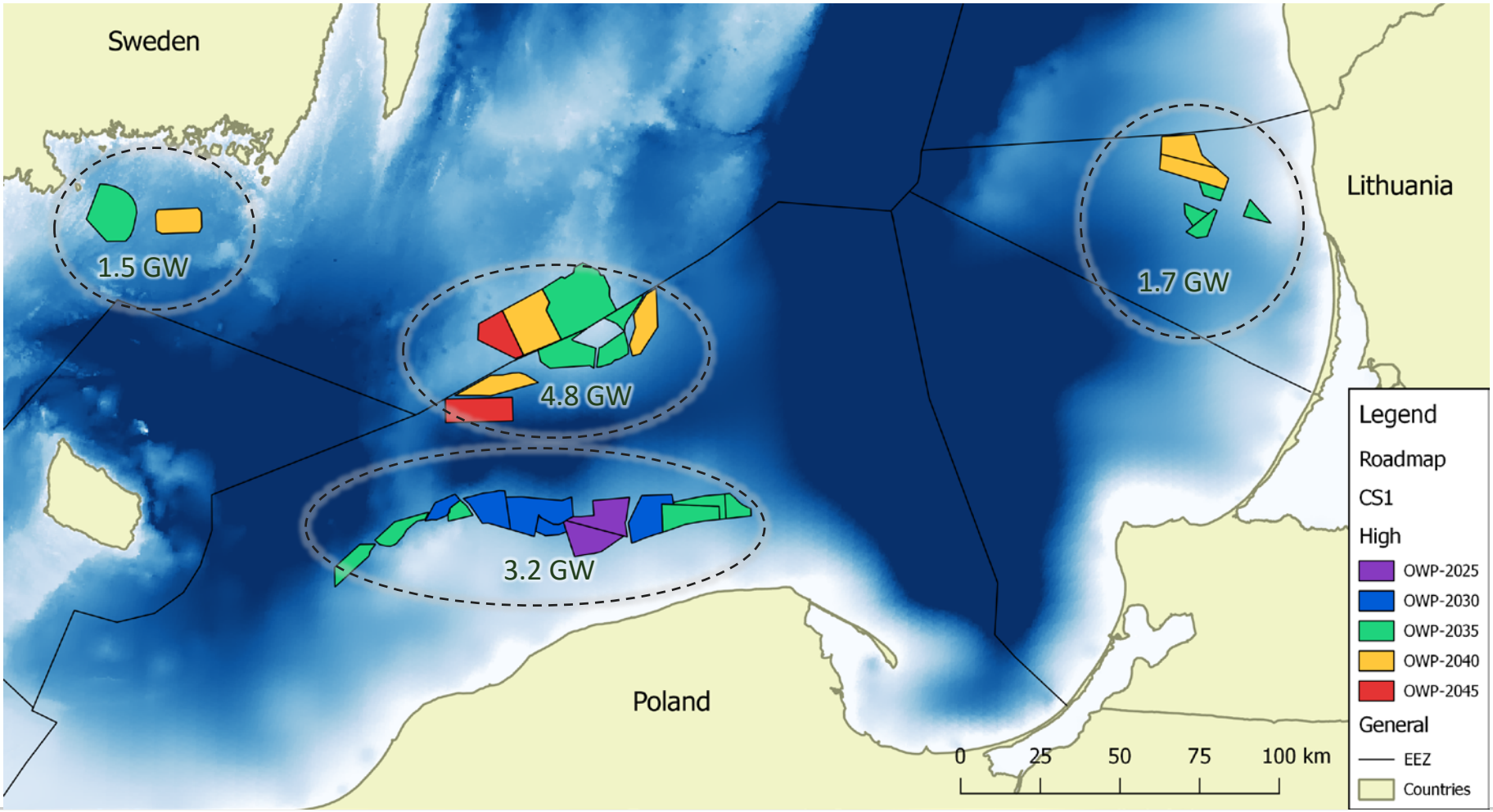
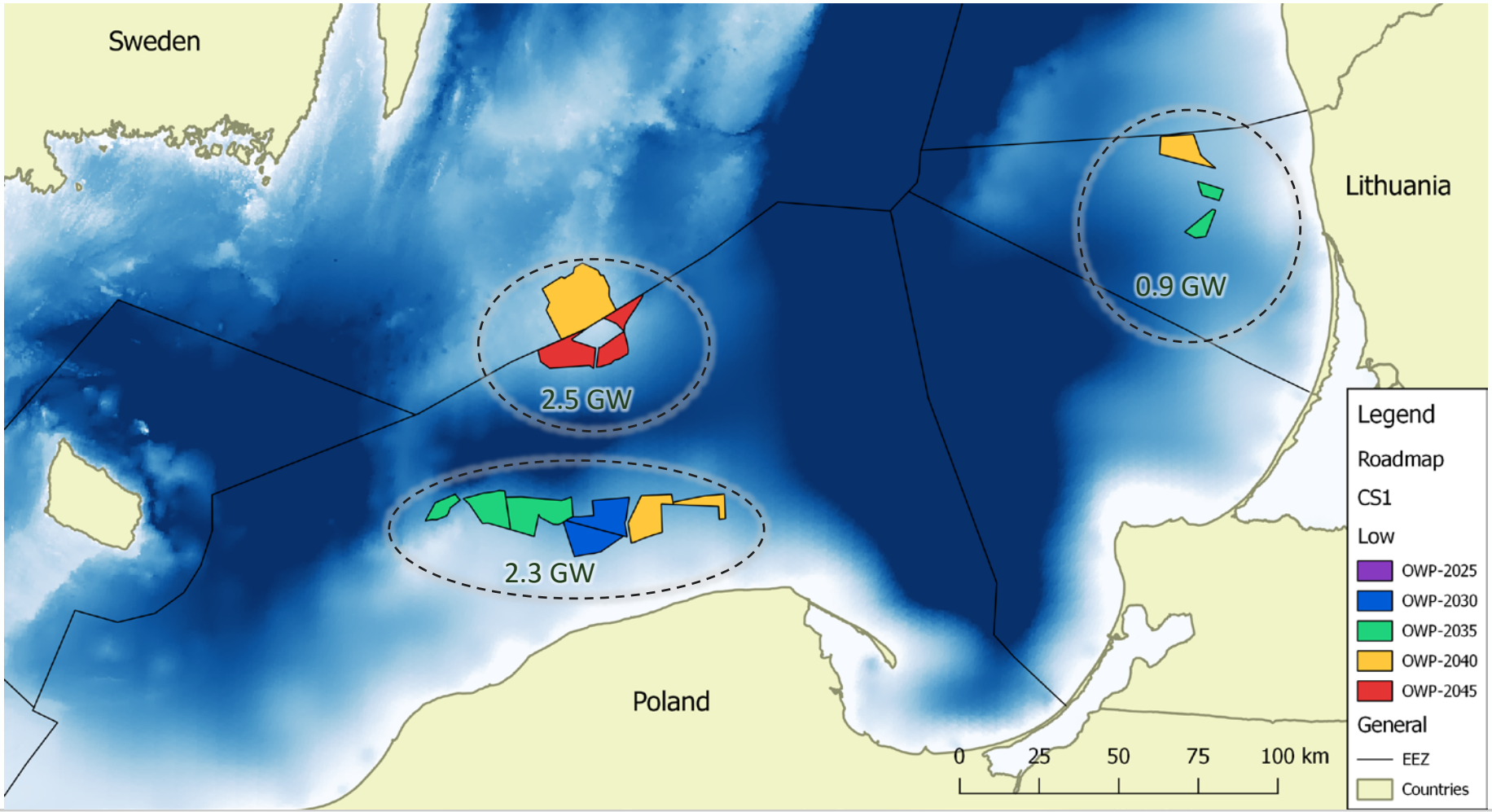
High OWP – 2045

OWP capacity: **11.2 GW, 47 TWh/y**

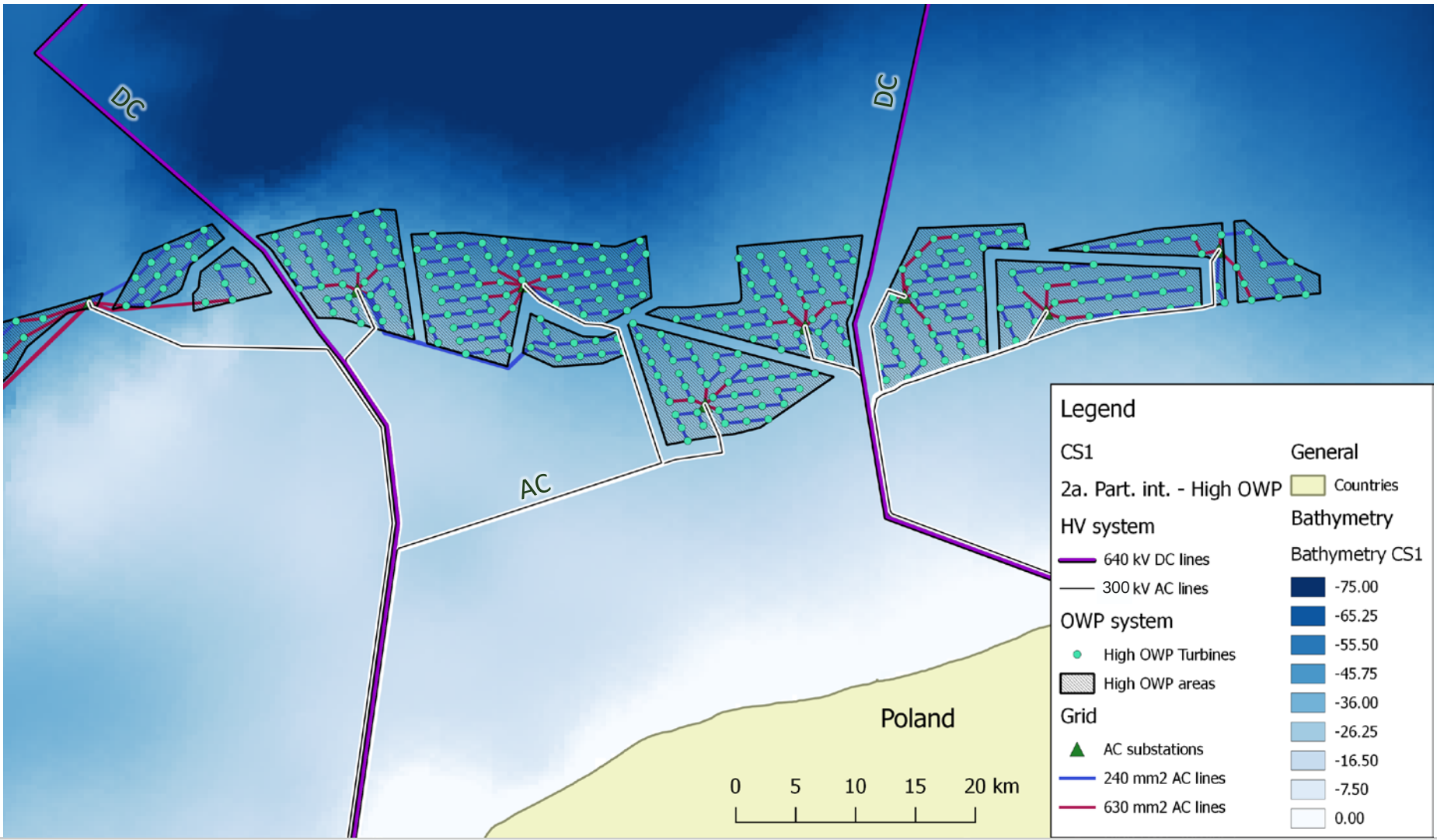


Low OWP – 2045

OWP capacity: **5.7 GW, 24 TWh/y**



High OWP – Wind turbine & cable layouts – Detailed view Slupsk



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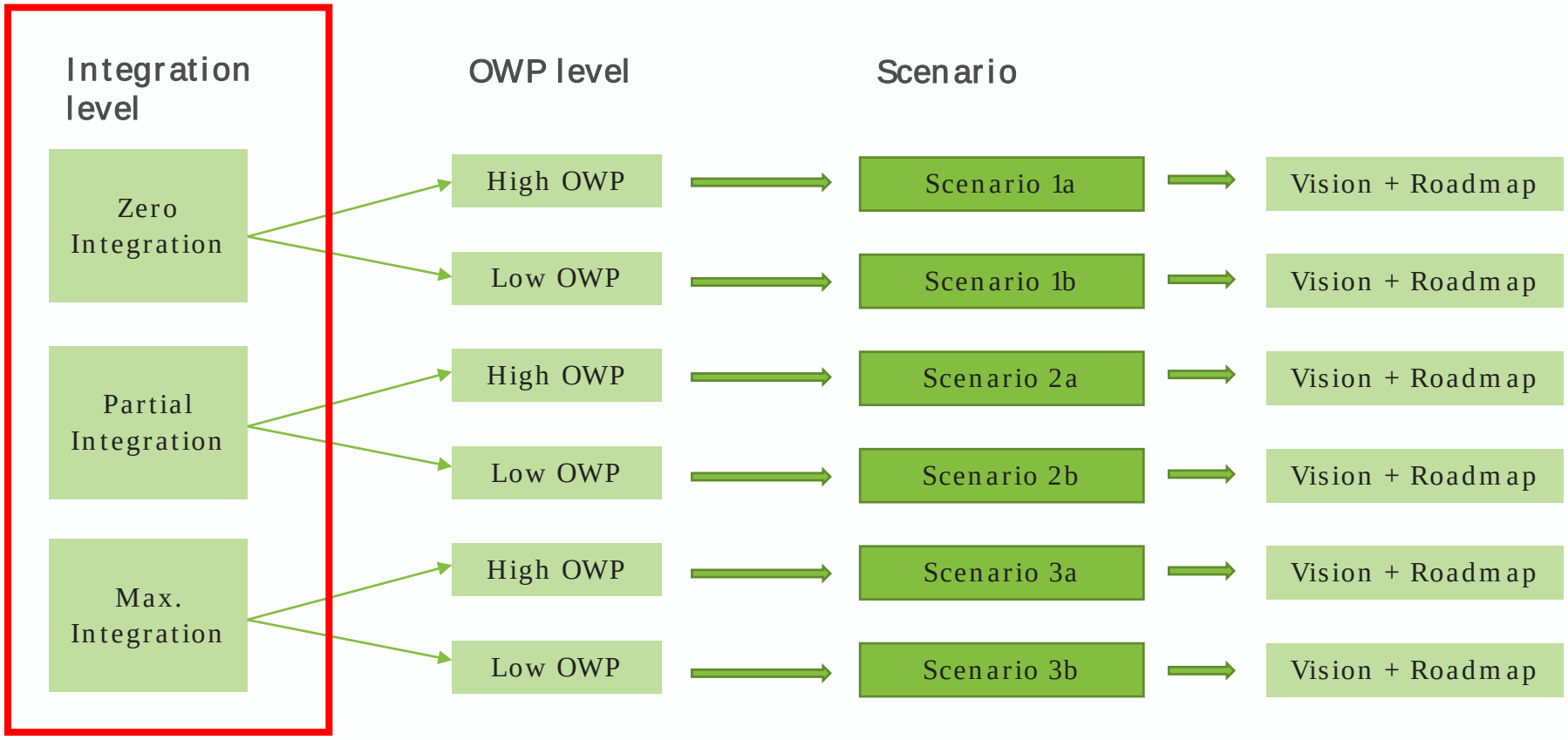
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Scenario concept – Integration level

Scenarios

Integration level

Zero Integration

Onshore AC- & DC connection points

Scenario concept – Integration level

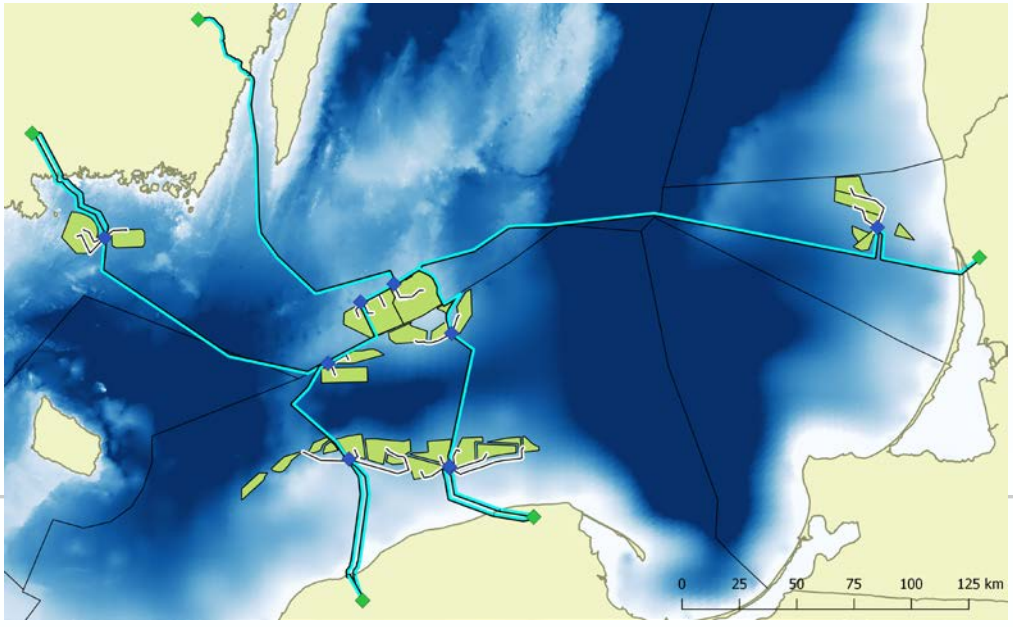
Scenarios

Integration level

Zero Integration

Onshore AC- & DC connection points

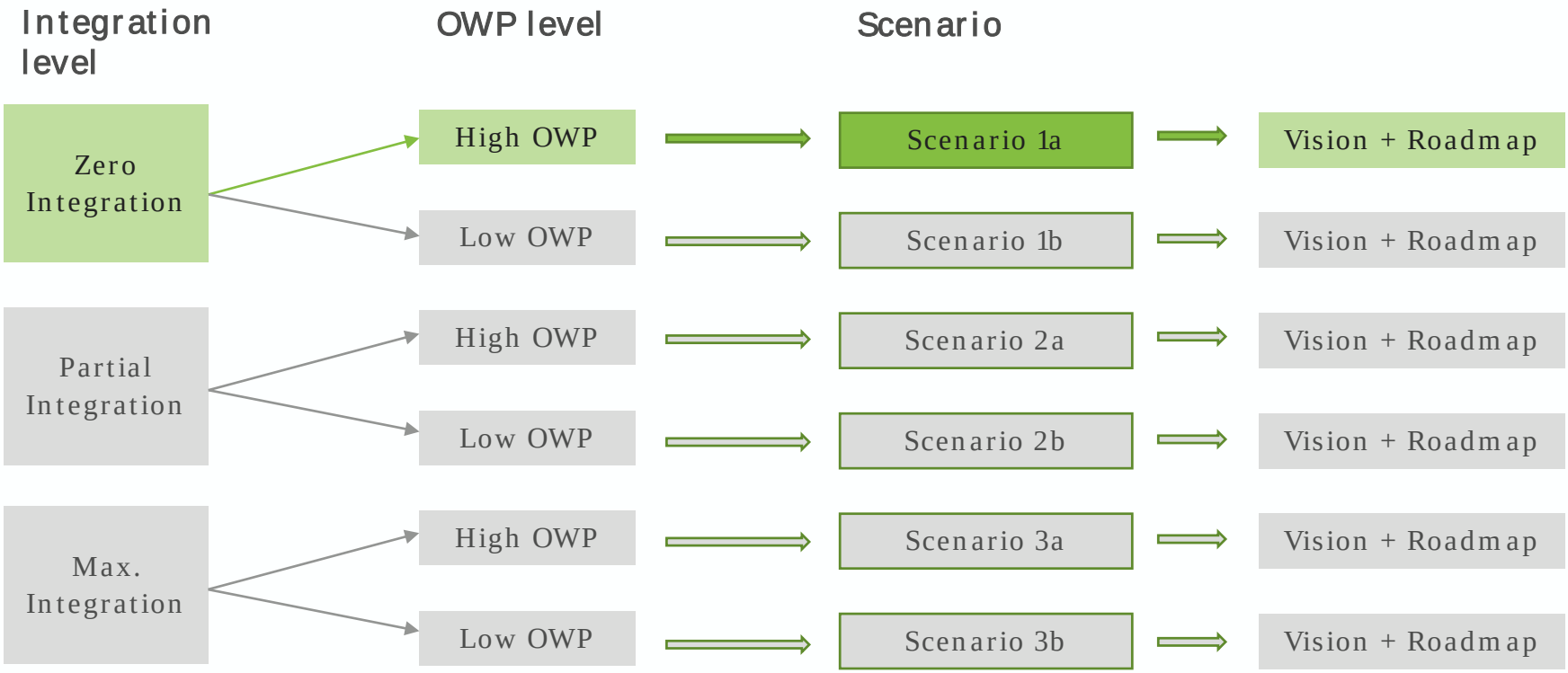
Max. Integration



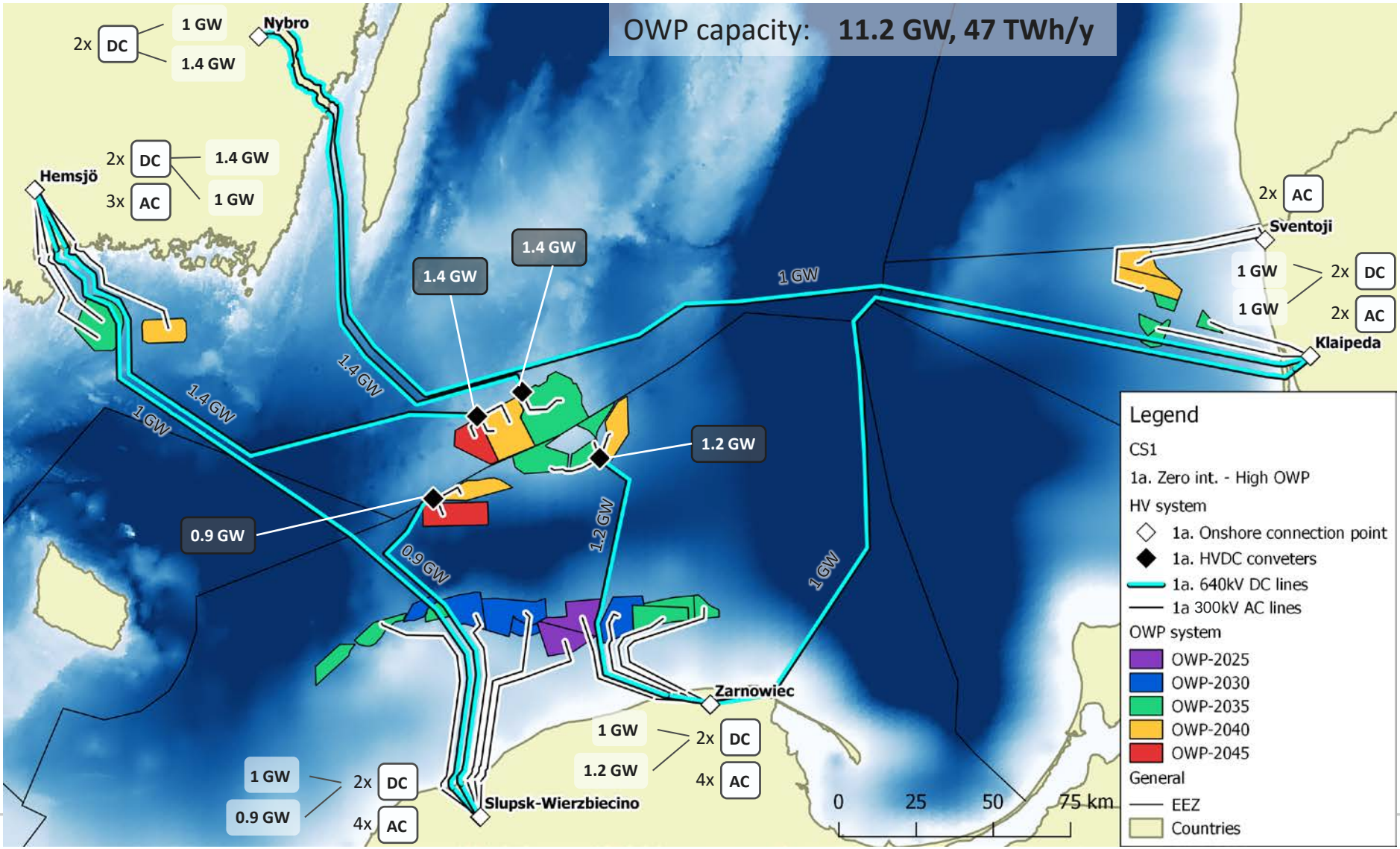
Only onshore DC connection points

Scenarios

Focus on High OWP for this presentation!

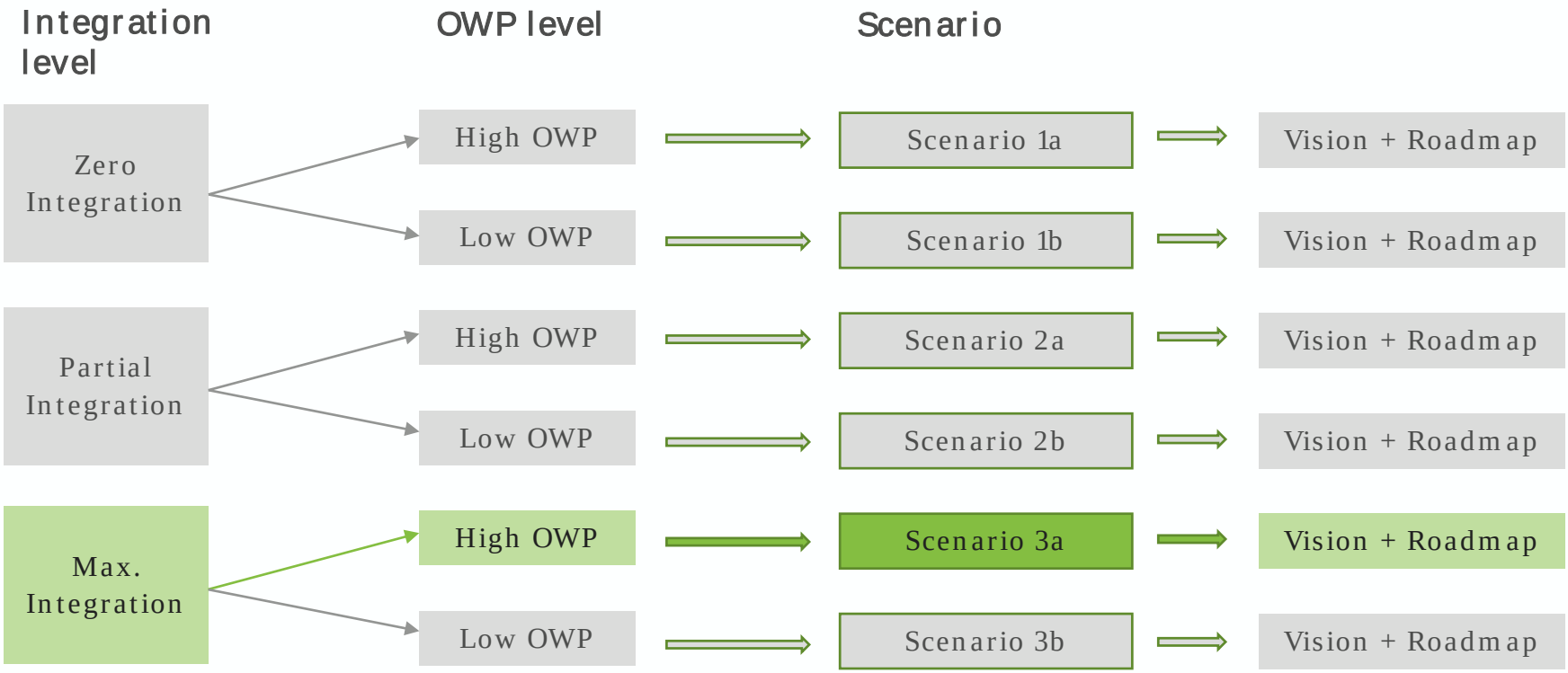


1a. High OWP, Zero integration – DC Overview



Cables viewed schematically

Scenarios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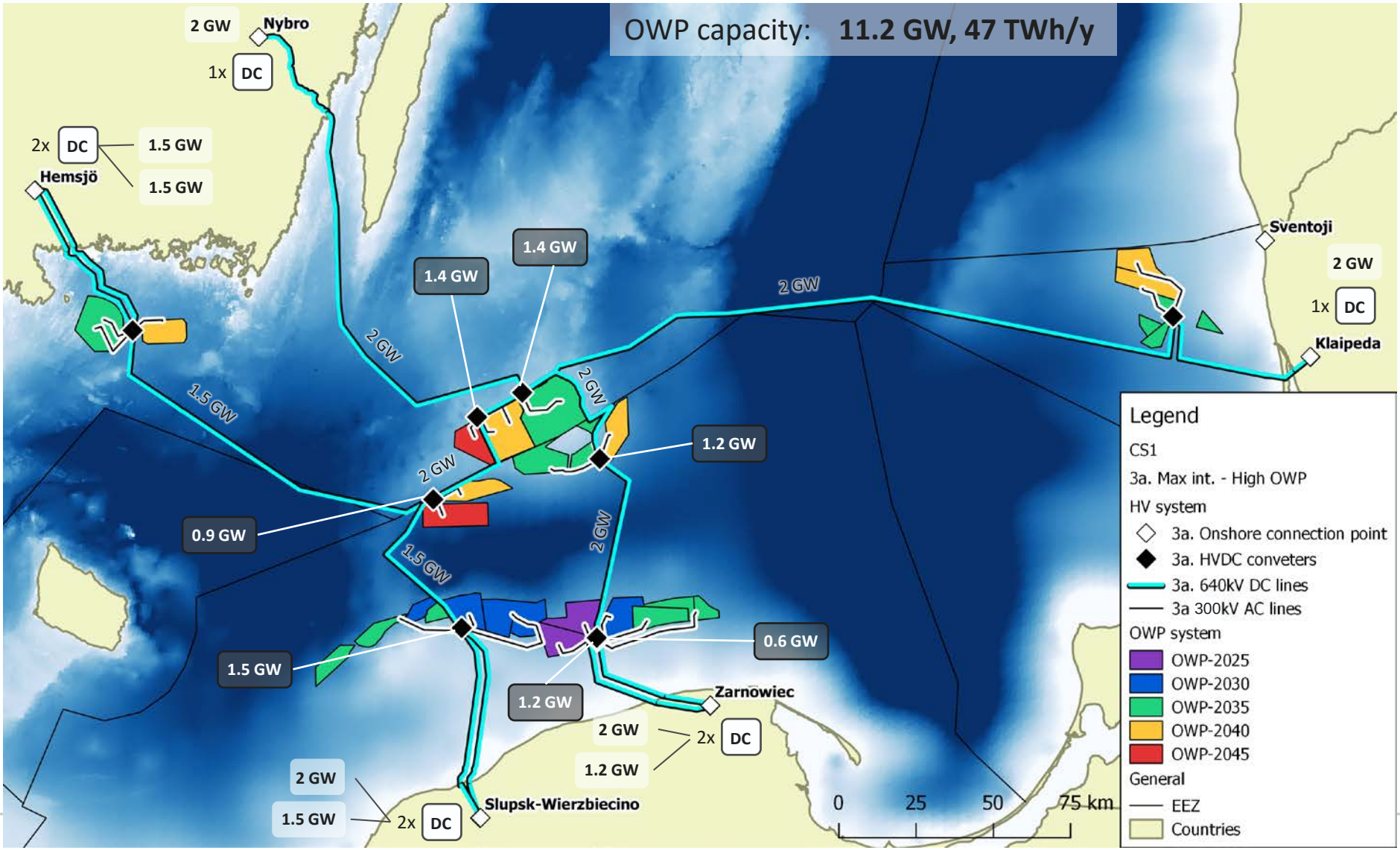
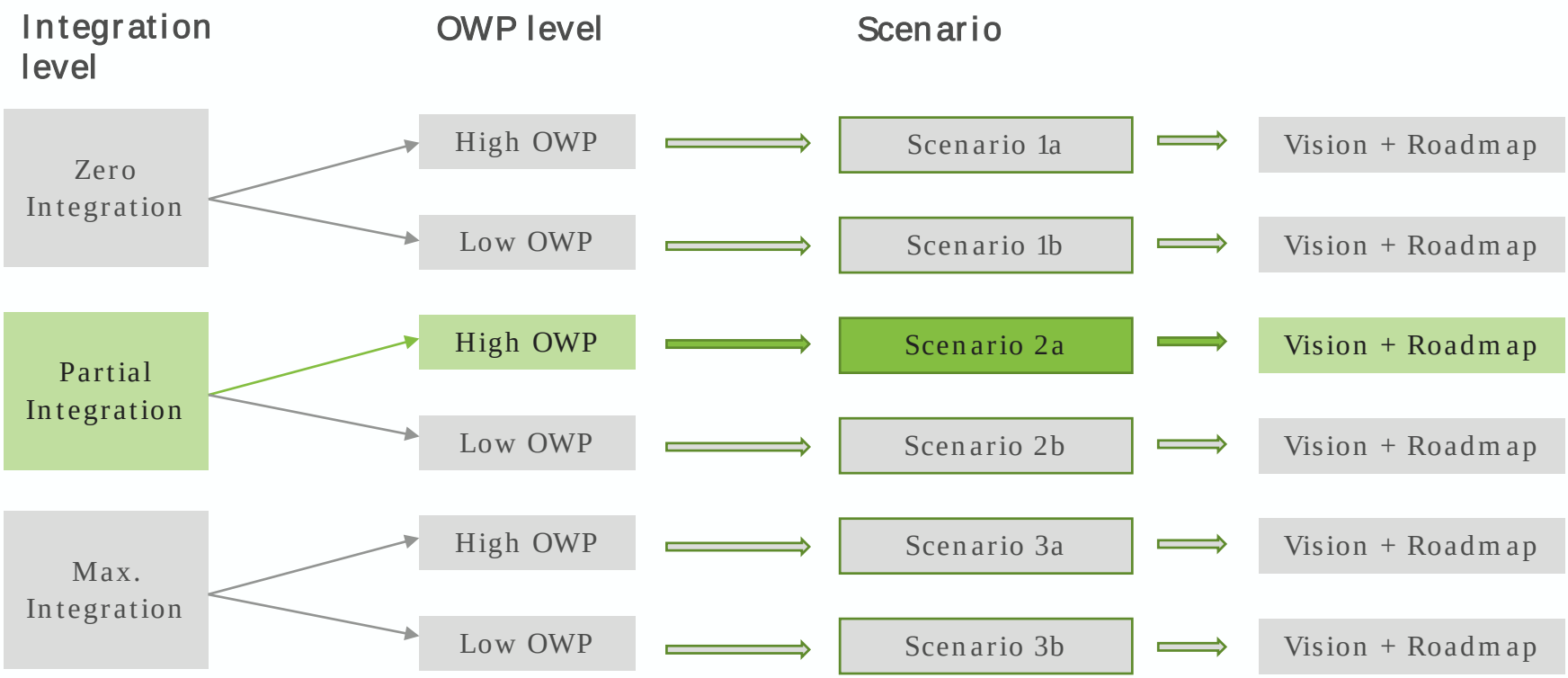
3a. High OWP, Max integration – DC Overview



Cables viewed schematically

Scenarios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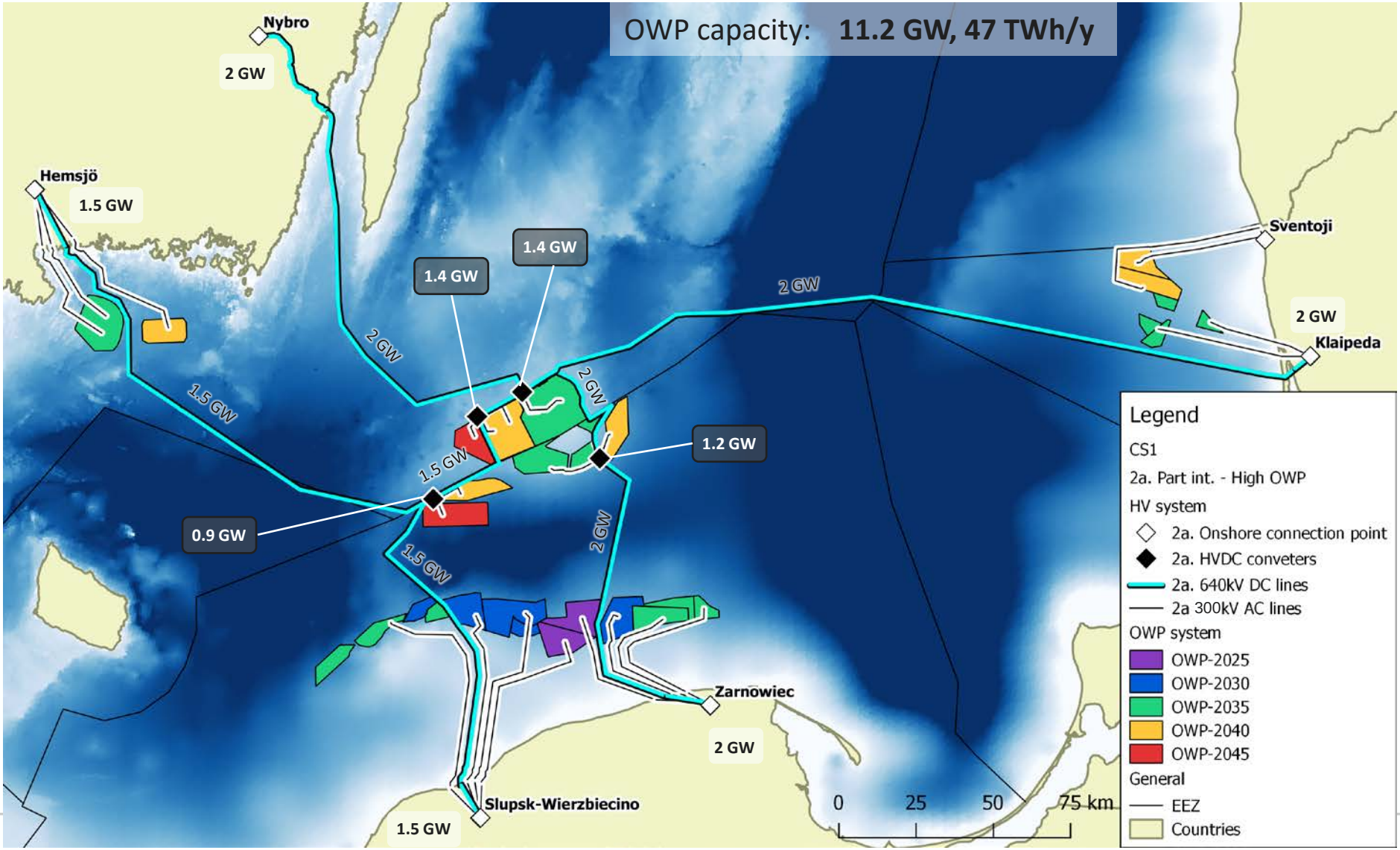
2a. High OWP – Part integration – Overview Grid



Cables viewed schematically

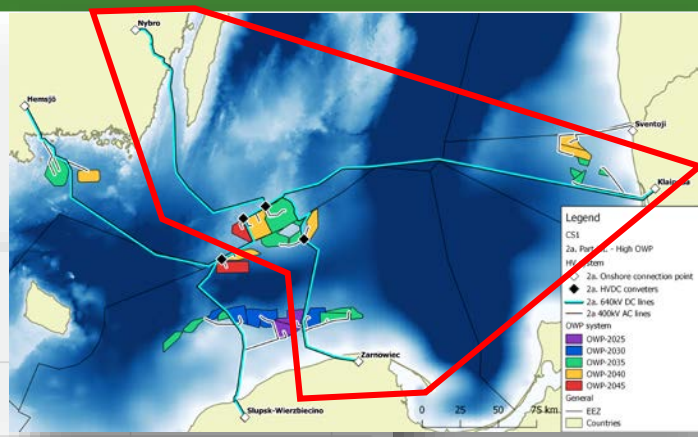
Component comparison

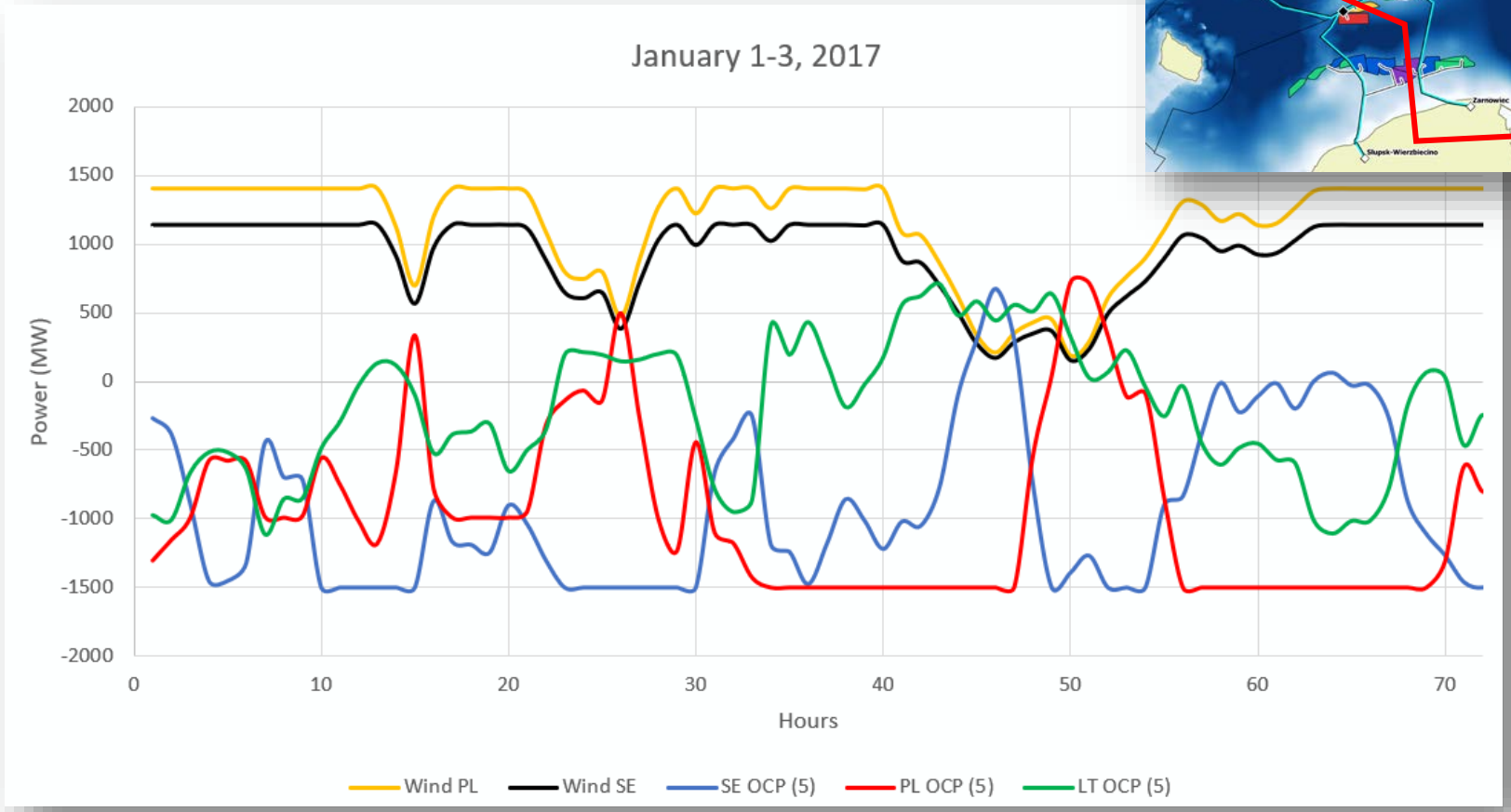
Zero vs Partial vs Max grid integration

Feature \ Integration	Zero (1a)	Partial (2a)	Max (3a)
DC converter substations	14	9	17
DC cable length (km)	3 283	1979	2 378
DC conductor volume (km* mm^2)	3.8* 10^6	4.8 * 10^6	6.4* 10^6
OWP on DC system (GW)	4.8	4.8	11.2
Onshore AC transformers	15	15	0
AC export cable length (km)	1073	1073	354
AC export cond. vol. (km* mm^2)	1.7* 10^6	1.7* 10^6	0,6* 10^6

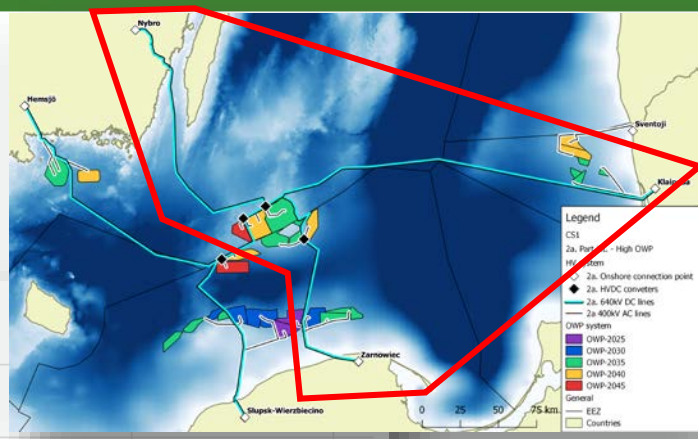
Extended analysis

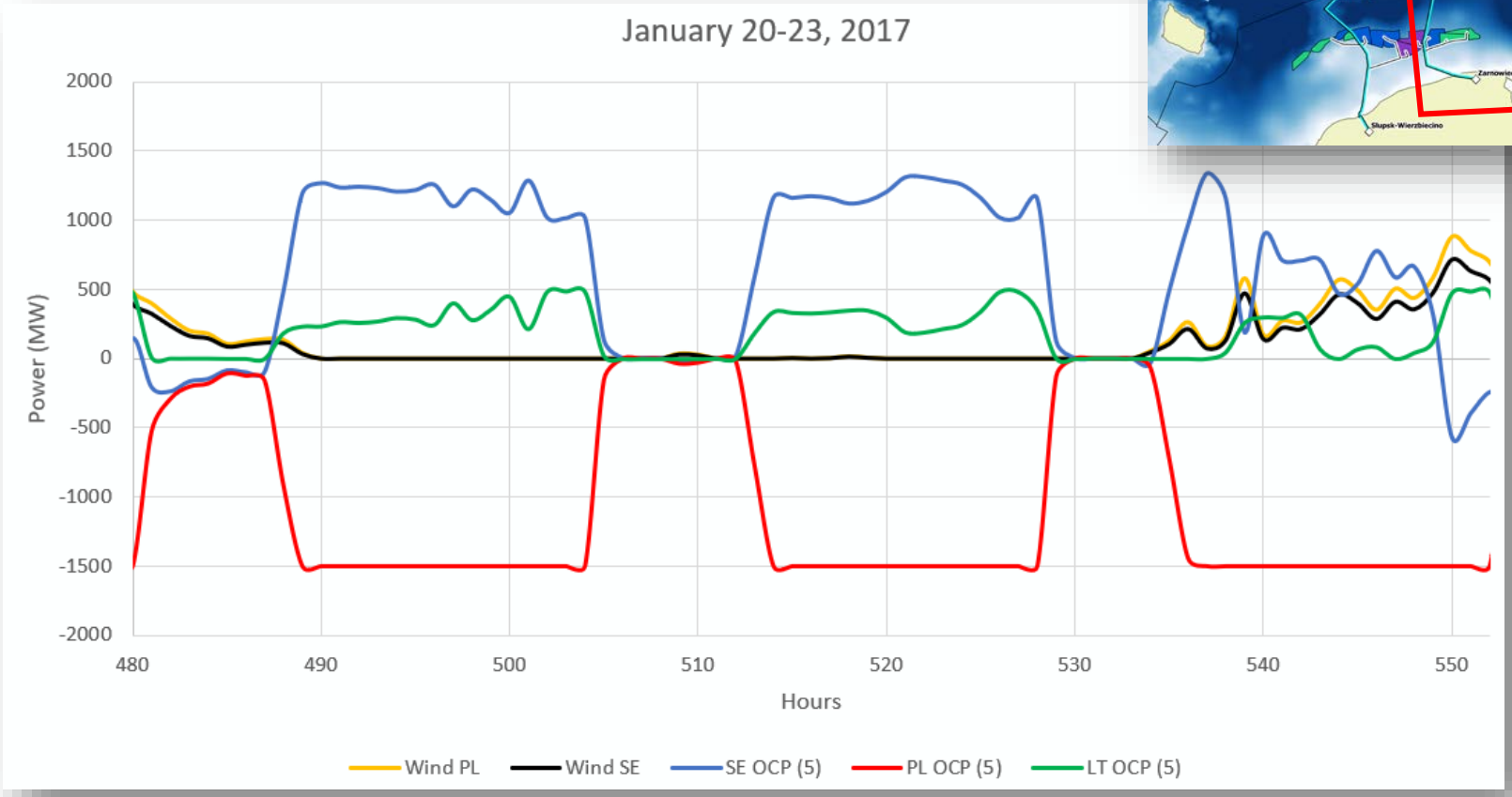
Integrated power trade with wind – Example 1





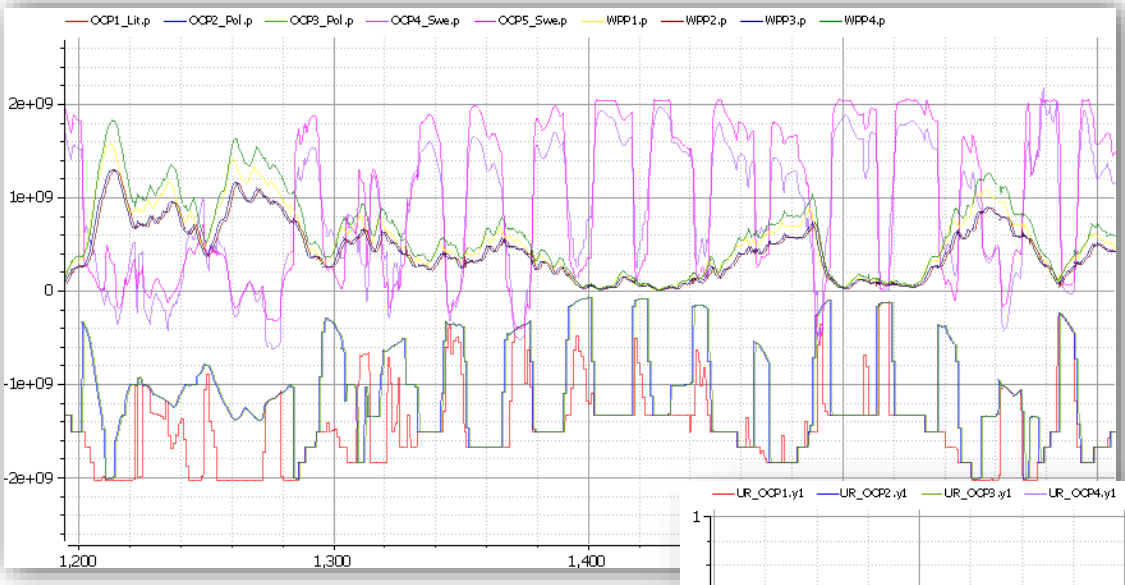
Integrated power trade with wind – Example 2

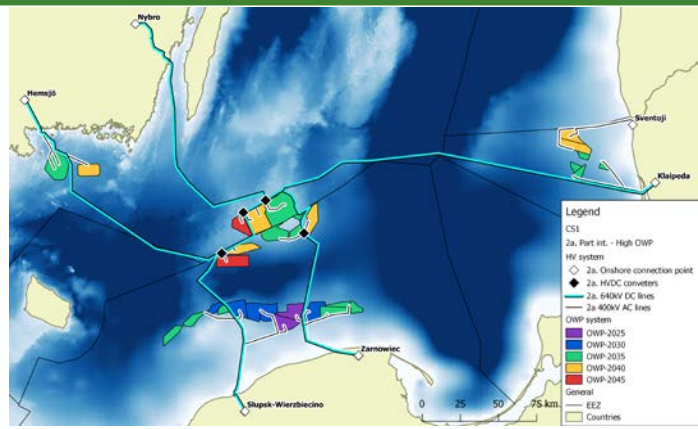




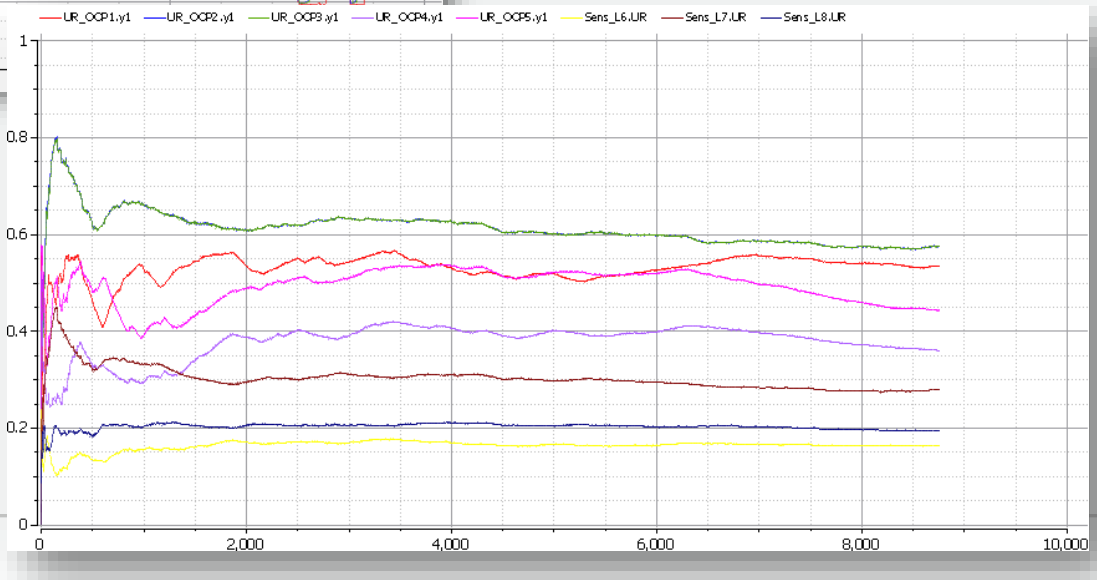
Integrated power trade with wind – Example 3

Intra hour power flow

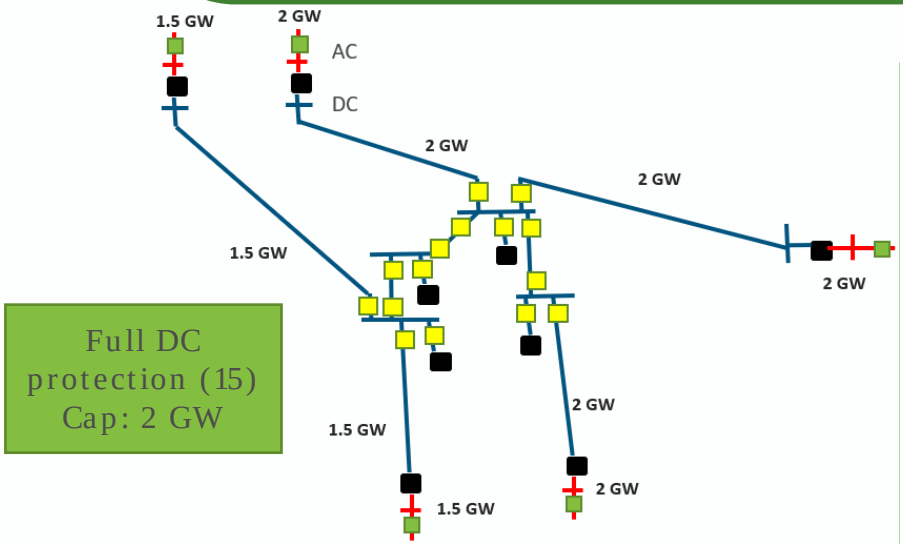




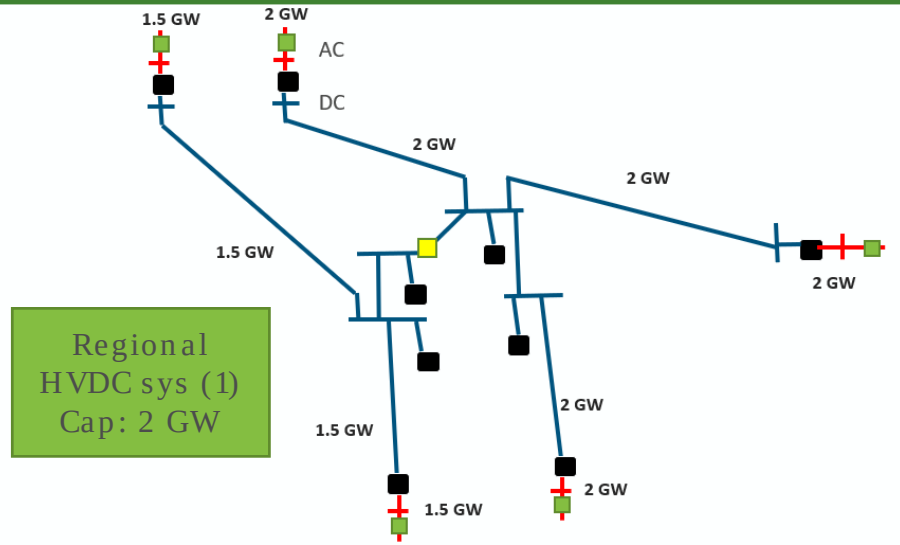
Utilization rates



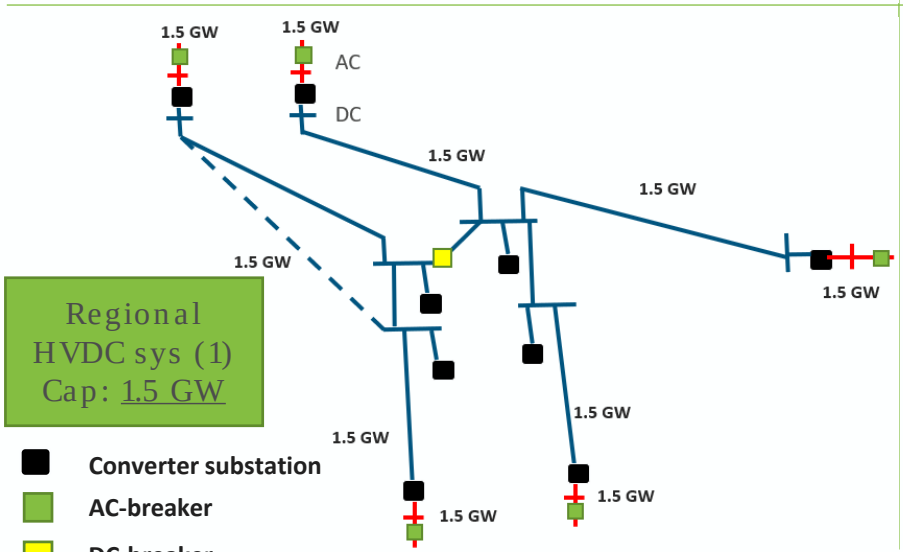
Partial designs (2a) with DC breaker alternatives



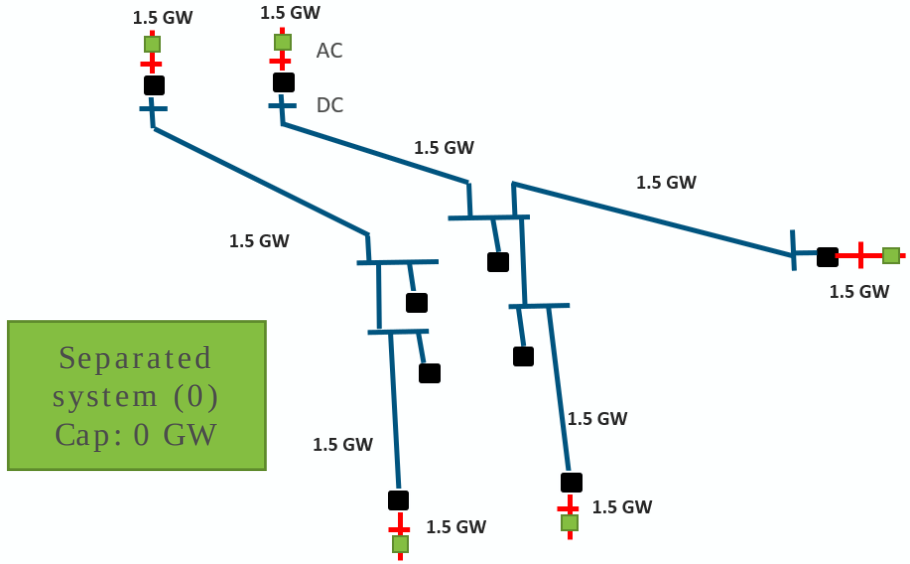
Full DC protection (15)
Cap: 2 GW



Regional HVDC sys (1)
Cap: 2 GW



Regional HVDC sys (1)
Cap: 1.5 GW



Separated system (0)
Cap: 0 GW

Contact & Disclaimer

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