Baltic InteGrid

Integrated Baltic Offshore Wind Electricity Grid Development

Thematic Working Group seminar

Amsterdam, November 29th

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LUND UNIVERSITY

EU STRATEGY FOR THE BALTIC SEA REGION FLAGSHIP

Interreg Baltic Sea Region

EUROPEAN UNION

EUROPEAN REGIONAL DEVELOPMENT FUND

Presentation outline

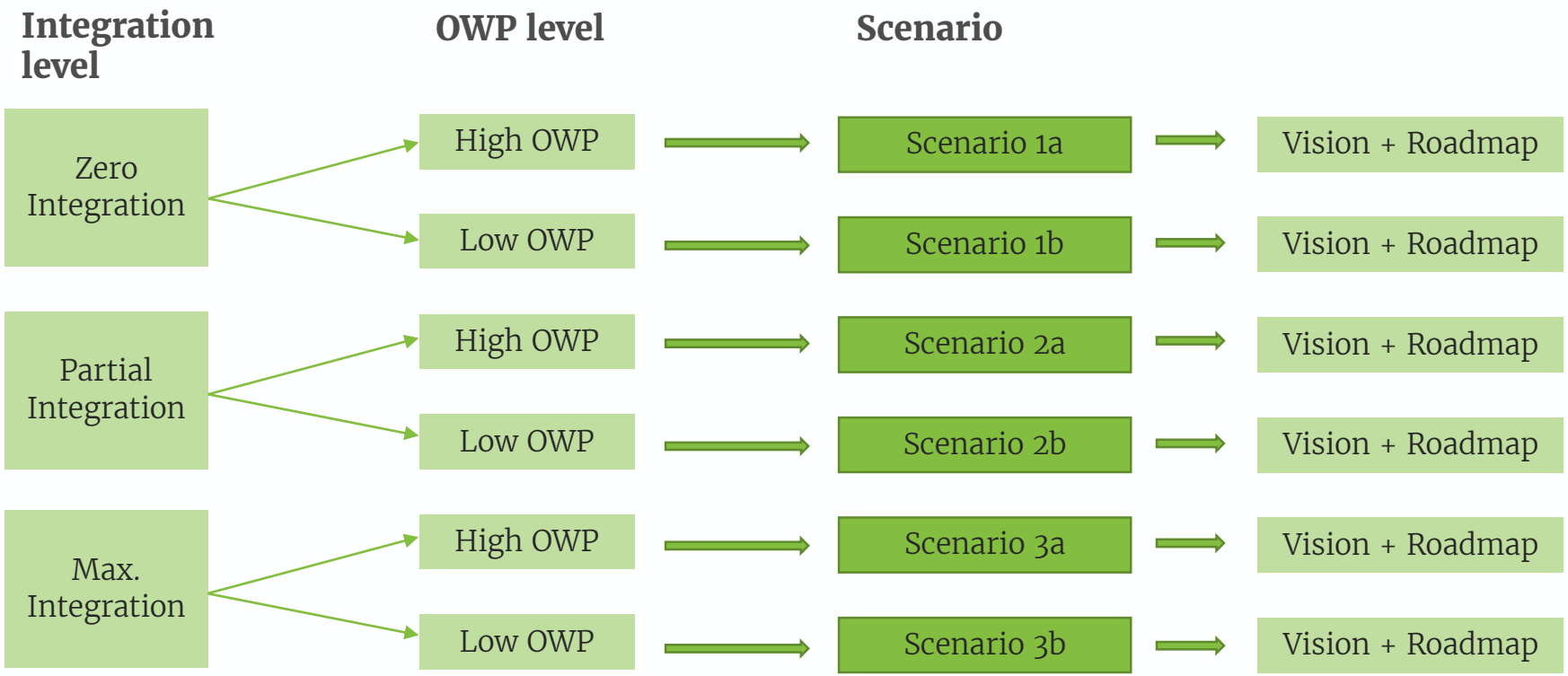
- Scenario structure
- High & Low Offshore Wind Power (OWP) development
- Technology assumptions
- Scenario: Maximum vs Zero grid integration
- Scenario: Partial grid integration

Why perform a case study?

- Design
- Location
- Cost-benefit
- Grid function and services
- Power flow analysis
- Input to market analysis, etc.

Looking into the future,
so we need **scenarios...**

Scenarios


Integration level
OWP level
Scenario
Zero Integration
High OWP
Scenario 1a
Vision + Roadmap
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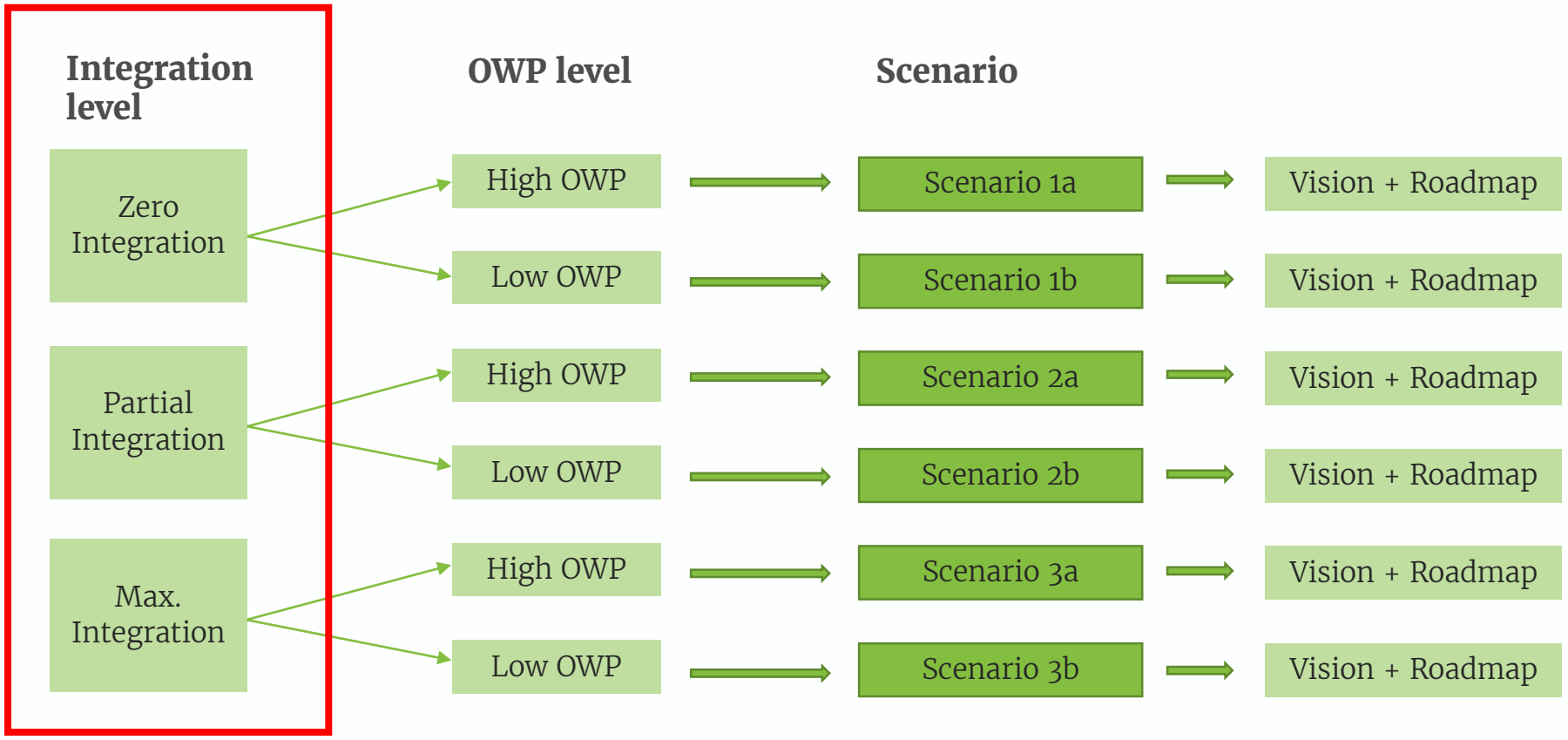
Scenario structure

What variables are changed between the scenarios?

Scenarios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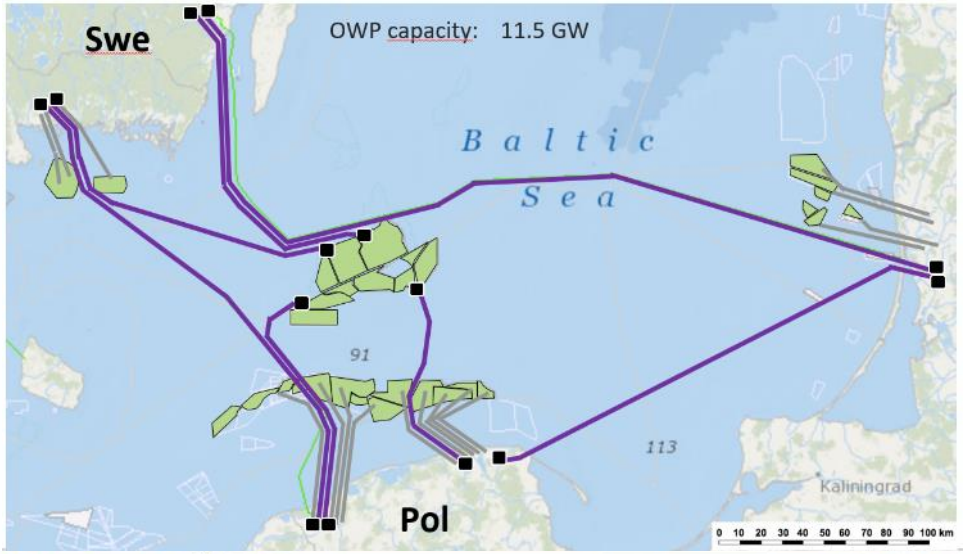
Scenario concept – Integration level

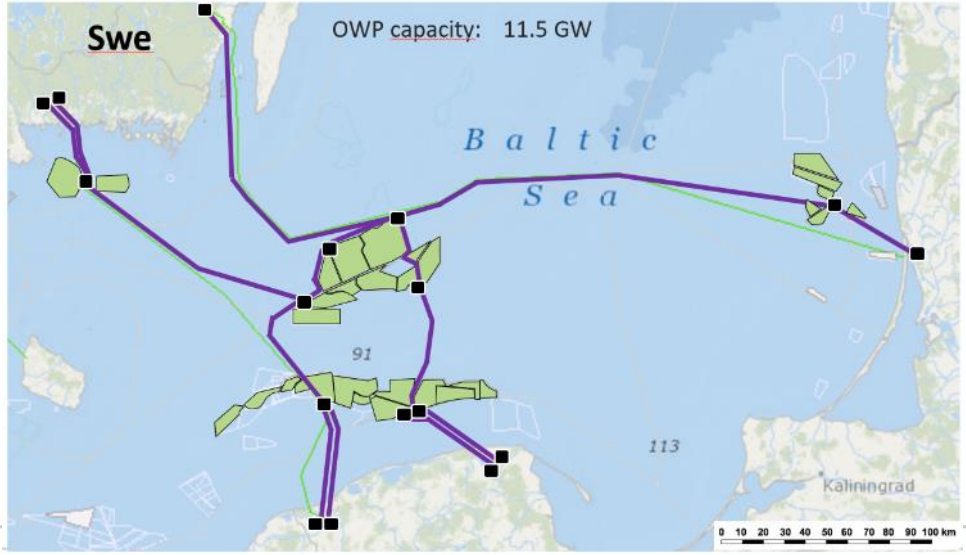
Scenarios

Integration level

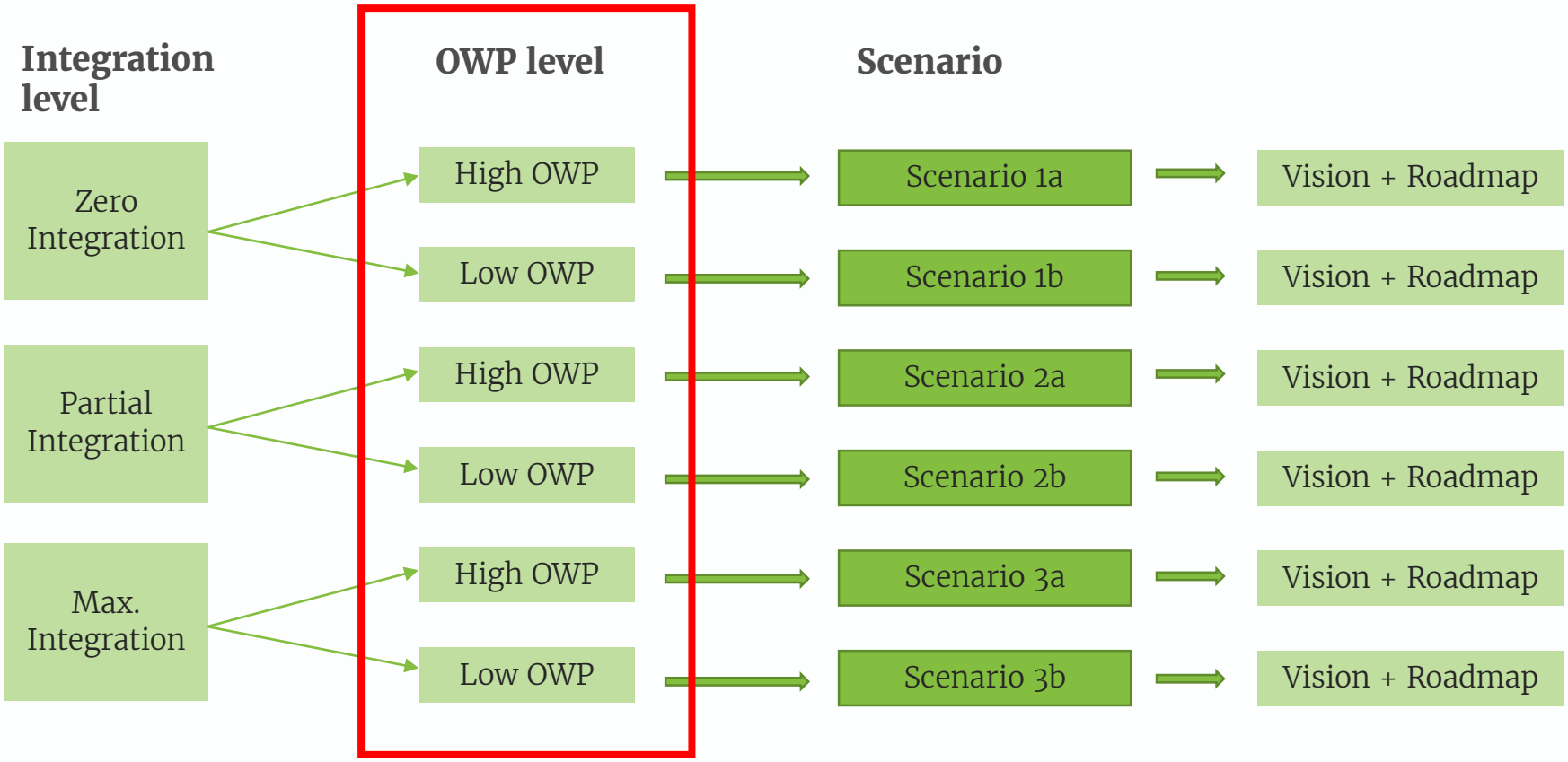
Zero Integration



Max. Integration



Scenarios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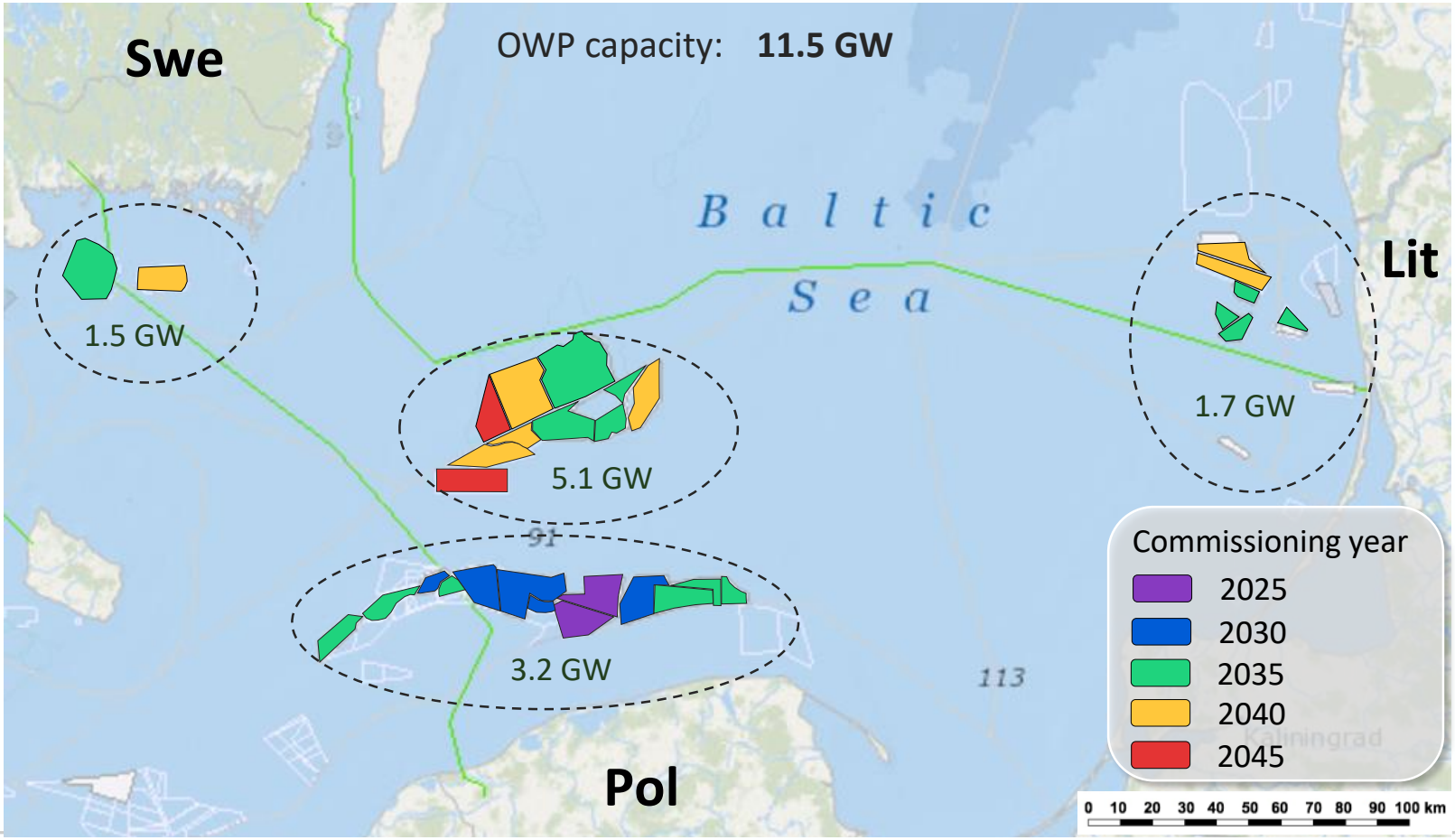
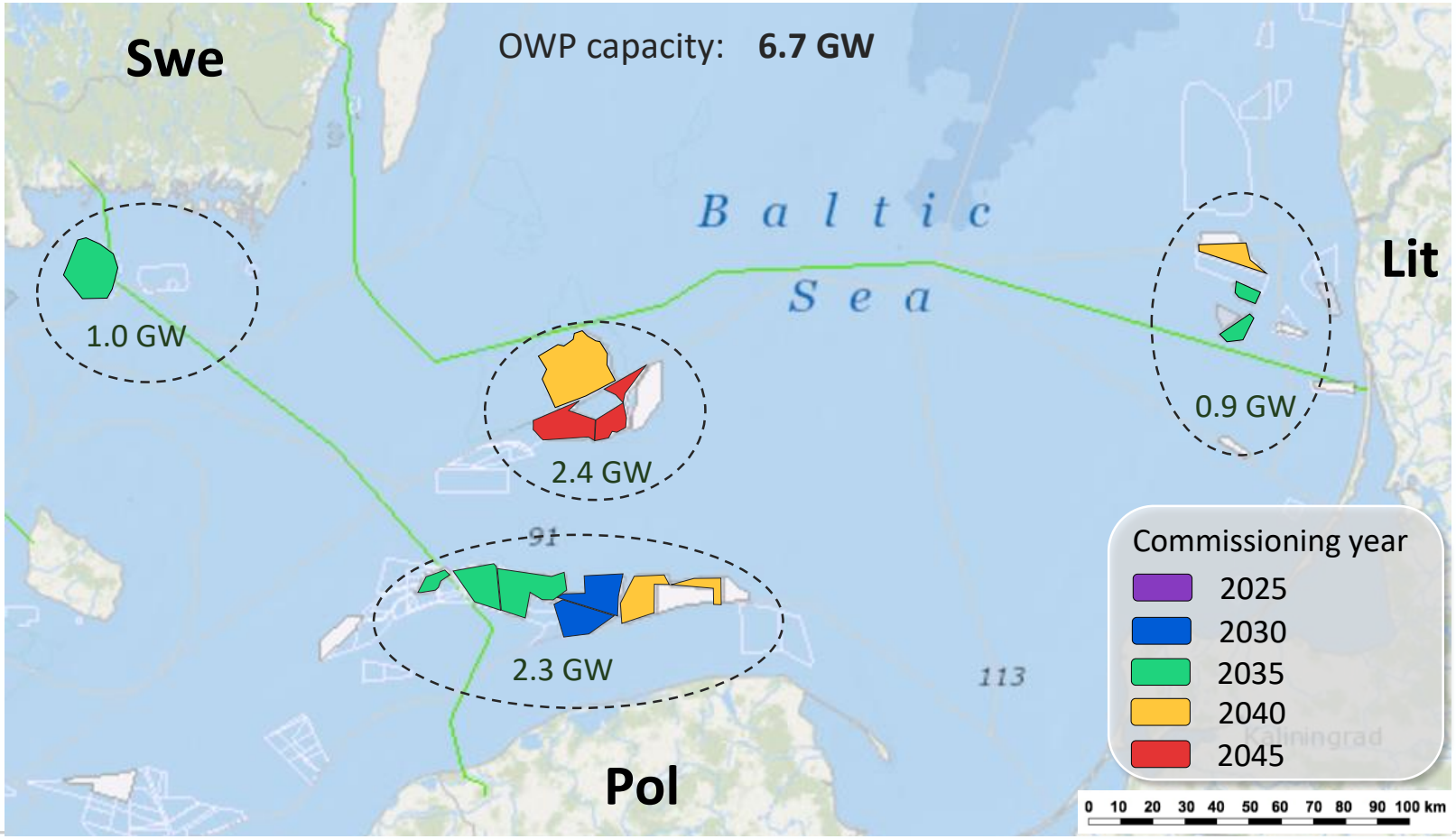
High OWP – 2045



Low OWP – 2045


Swe
OWP capacity: 6.7 GW
Baltic Sea
Lit
1.0 GW
2.4 GW
0.9 GW
2.3 GW
Pol
Commissioning year
2025
2030
2035
2040
2045
0 10 20 30 40 50 60 70 80 90 100 km

Technology assumptions

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

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

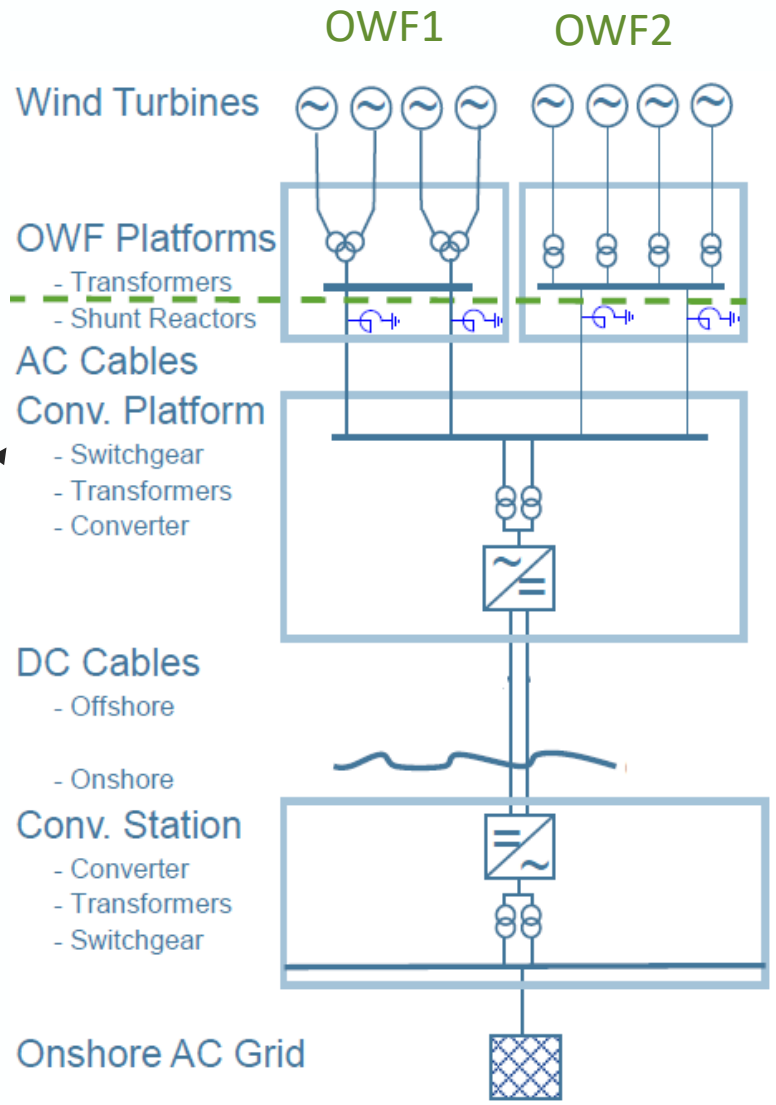
AC transformer substations
Pre and post 2030: 600 MW

AC export cables
Pre and post 2030: 275 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 Grid
Pre and post 2030: 300-400 kV AC



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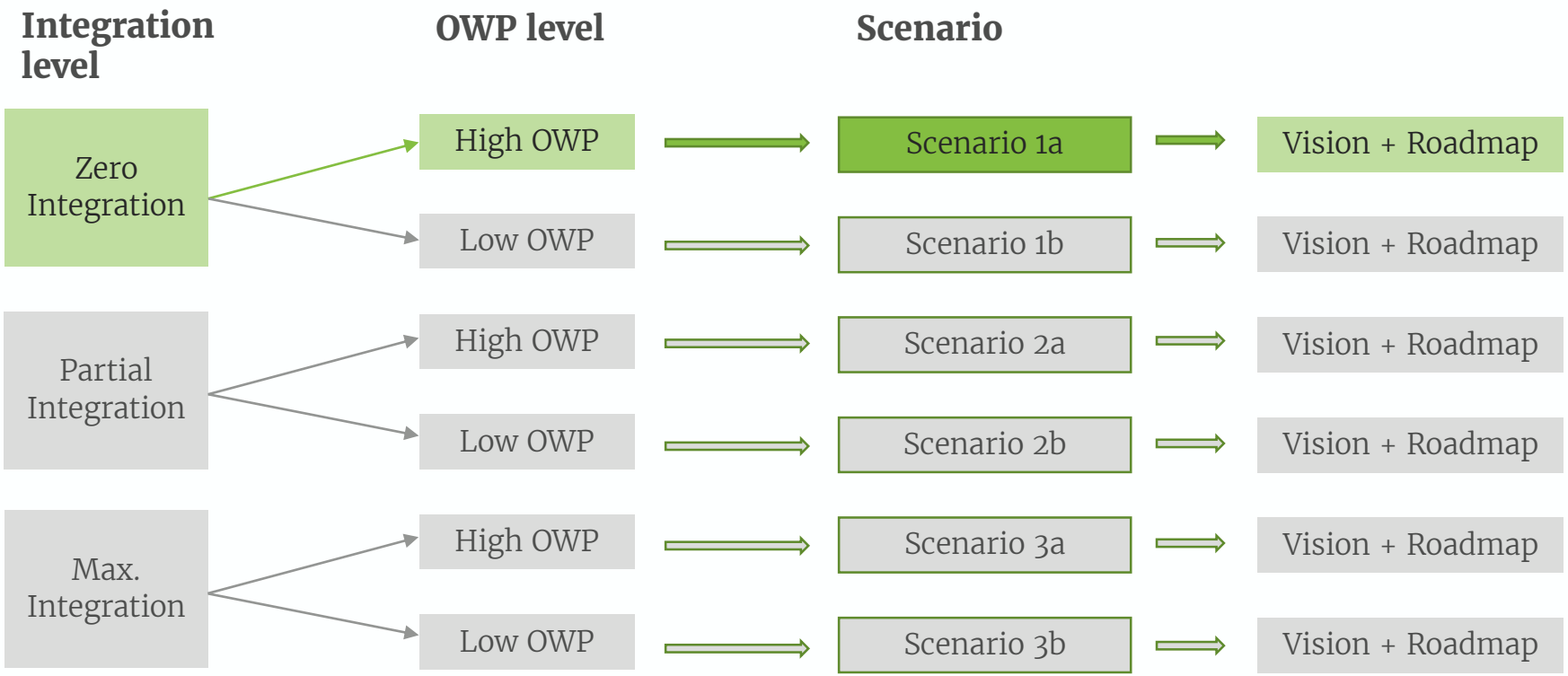
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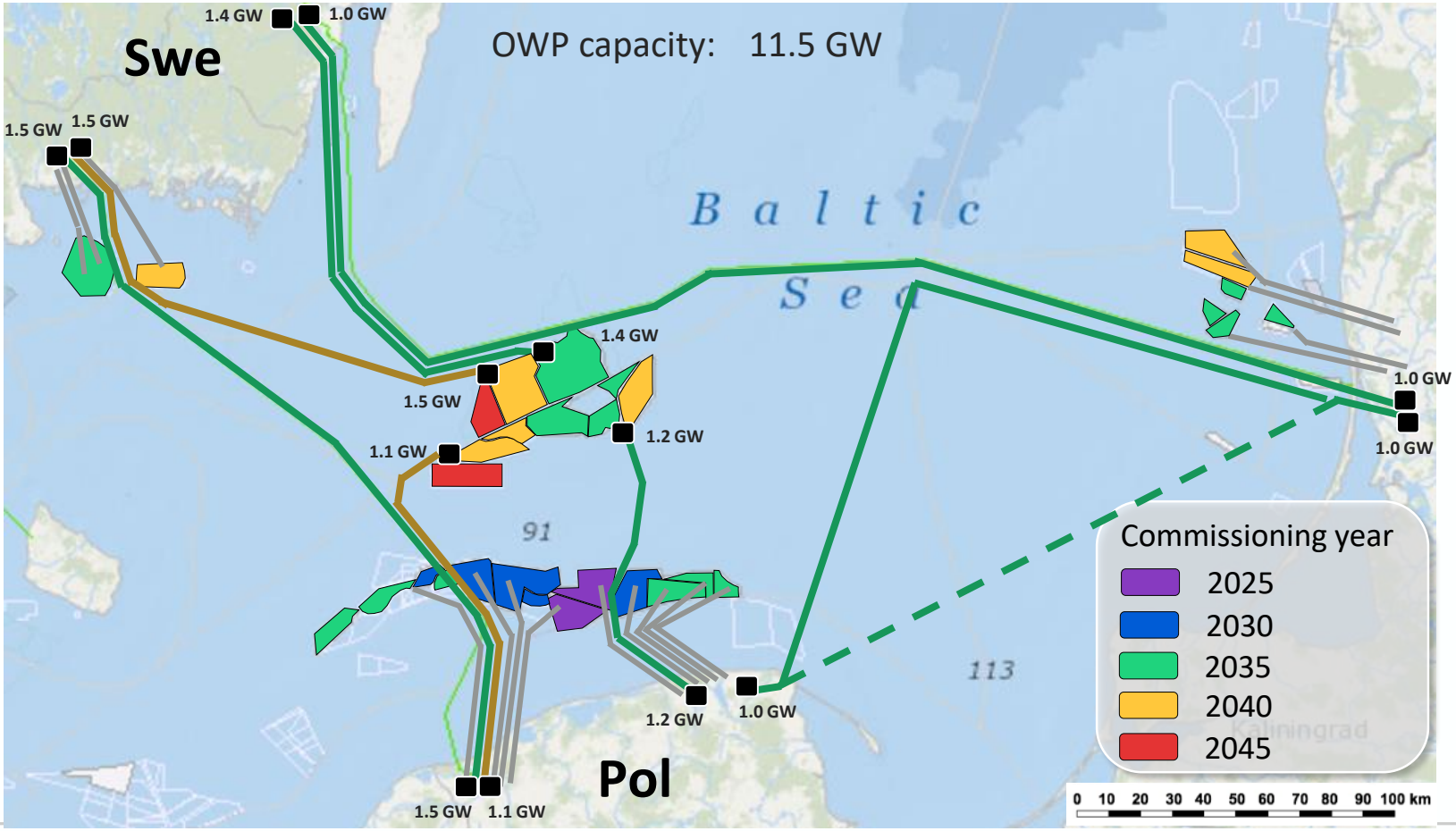
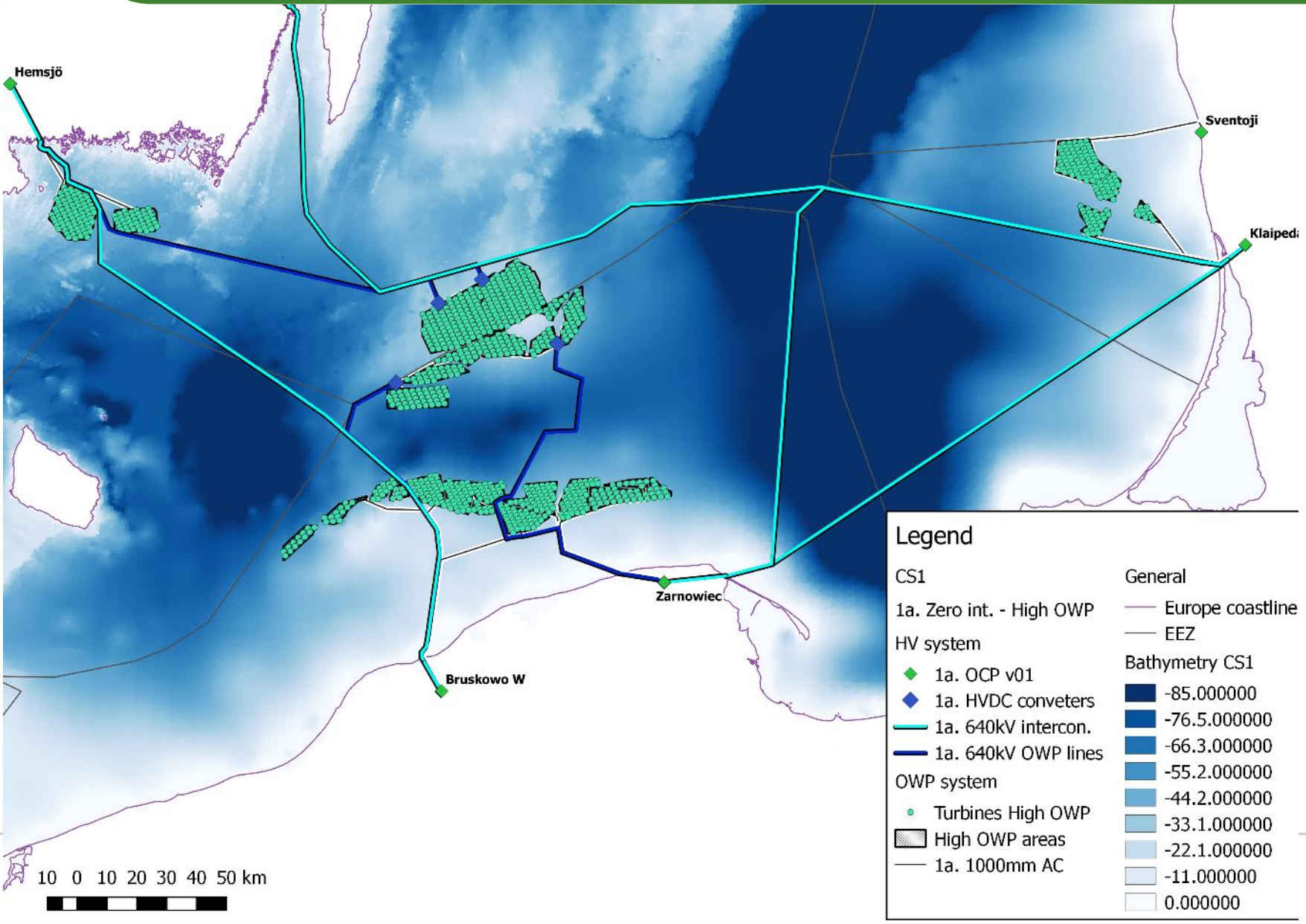
(1a) Zero integration – High OWP – Vision 2045



1a. High OWP, Zero integration – DC Overview



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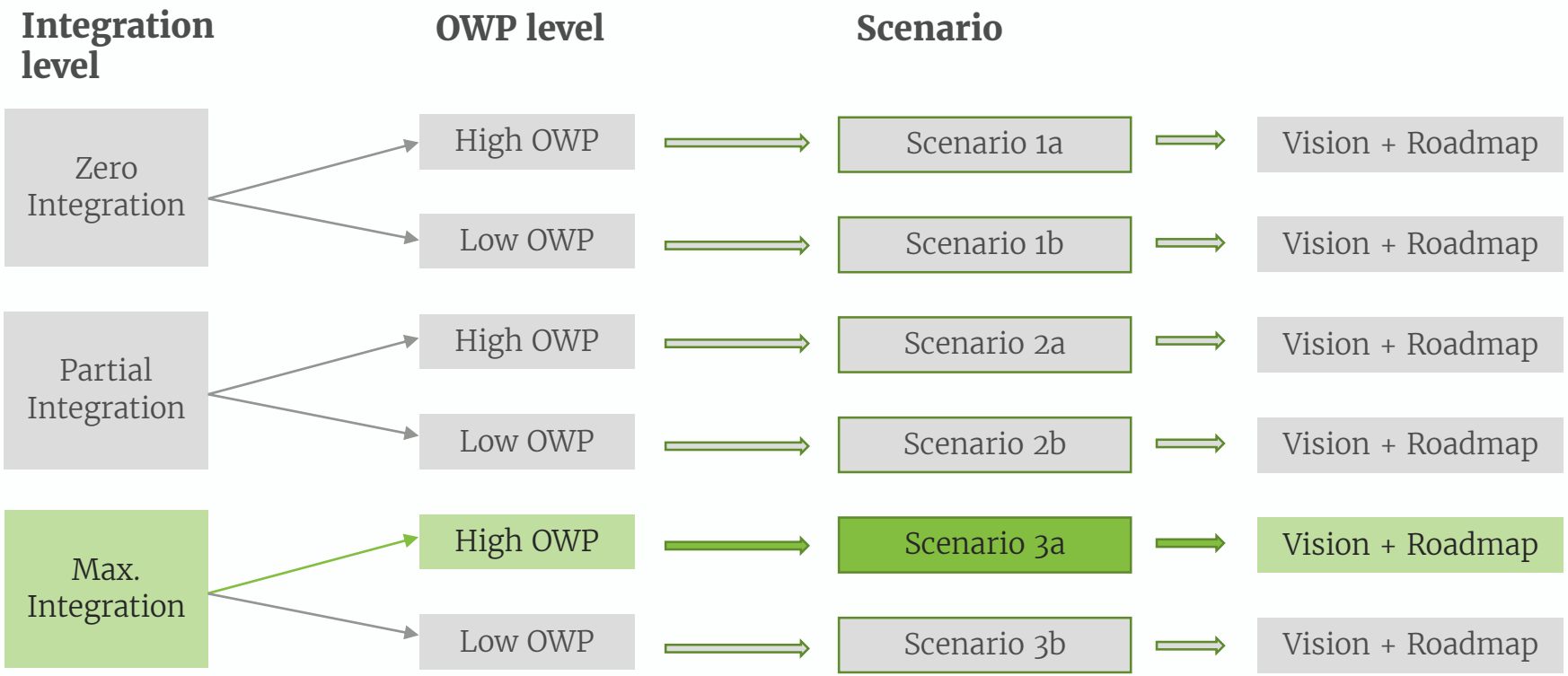
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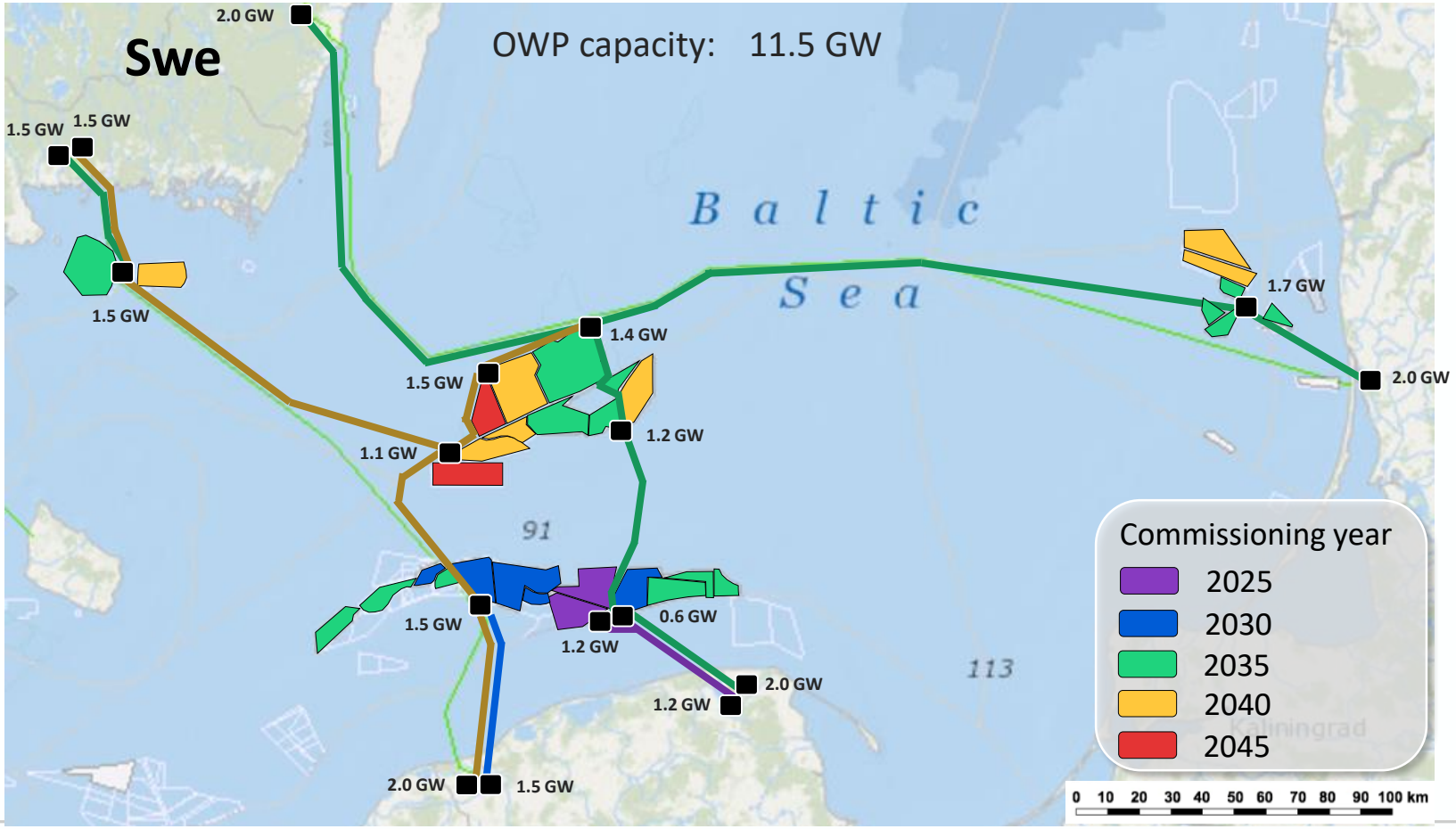
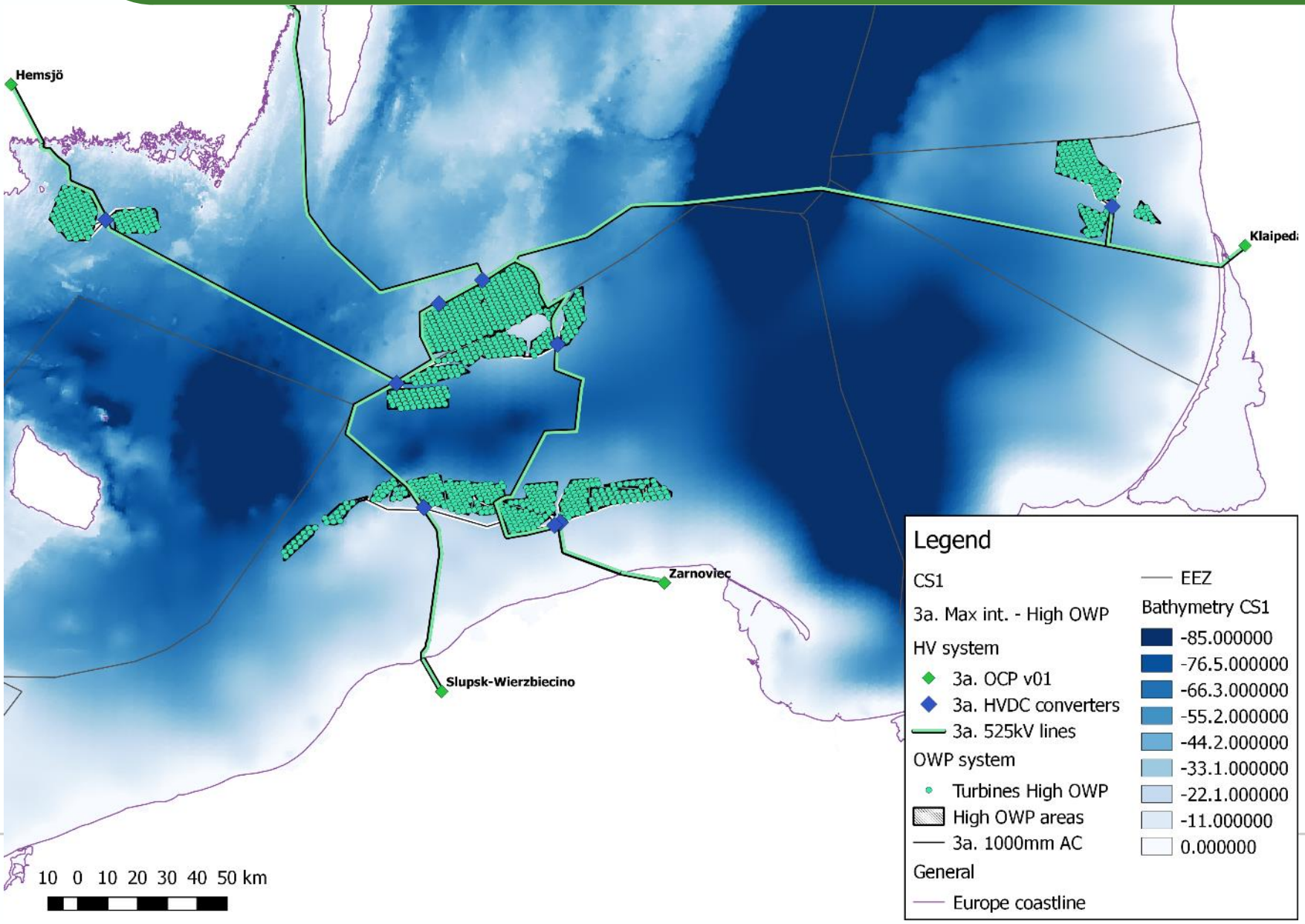
(3a) Max integration – High OWP – Vision 2045



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



Zero vs Max grid integration

Feature \ Scenario	1a (Zero)	3a (Max)	Difference
Converter substations	14	17	+21 %
DC cable length (km)	3 730	2 434	-35 %
DC conductor volume (km*mm^2)	4.48*10^6	6.53*10^6	+46 %
OWP on DC system (GW)	5.1	11.5	+56 %
Onshore AC transformers	15	0	-100 %
AC export cable length (km)	1 093	374	-66 %
Total component cost			
Total installation cost			

Next up:

- Adding results for partial integrated scenario (2a)
- Same analysis for Low OWP scenarios

Scenario comparison

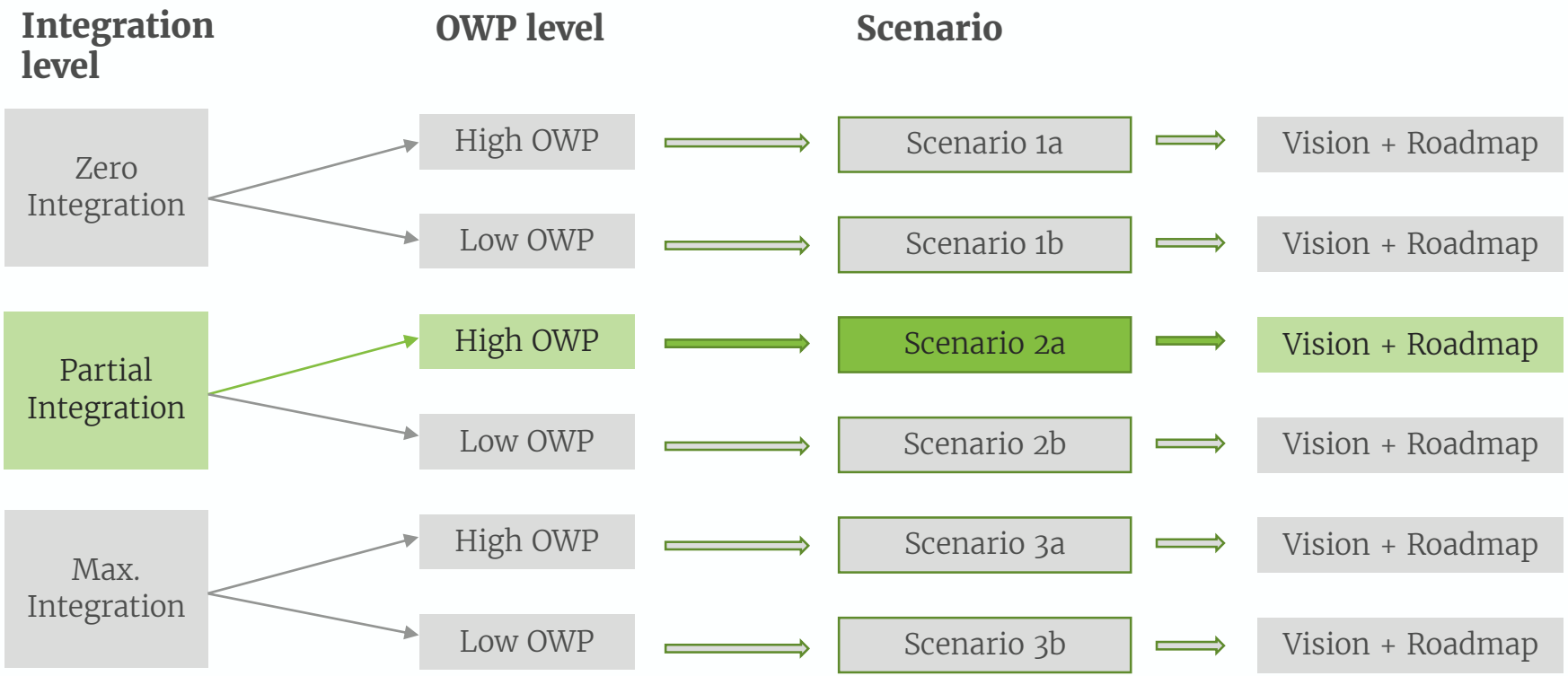
Other comparisons to make…

Feature \ Scenario	1a (Zero)	3a (Max)	Difference
Market capacity - power			
Market capacity - energy			
Flexibility			
Fault resiliency			
Wind energy curtailed			
…			

Further analysis:

- Market power flow in combination with wind patterns
- DC system utilization factor
- Alternative cabling
- Power flow control strategies
- DC protection zones

Scenarios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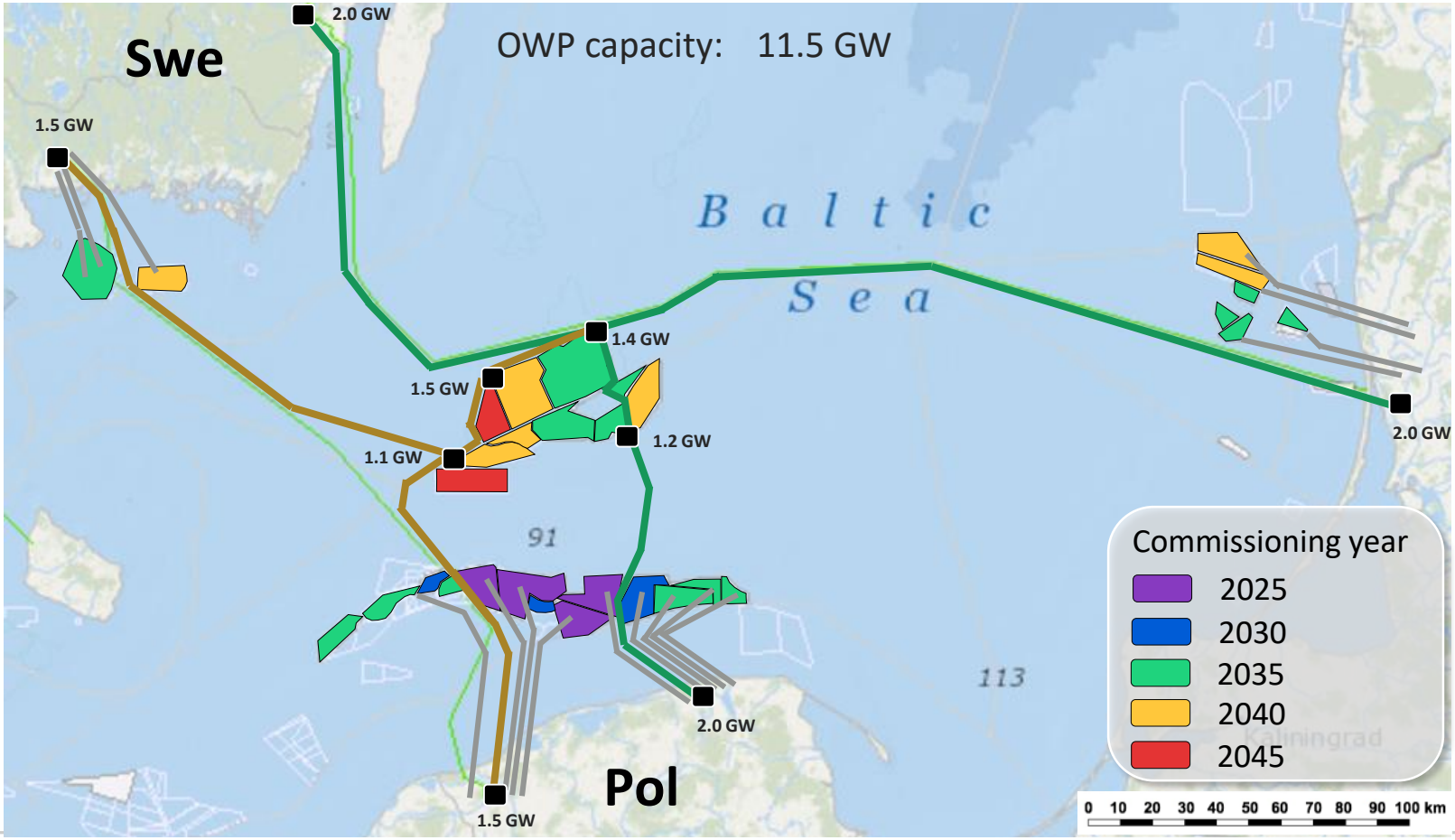
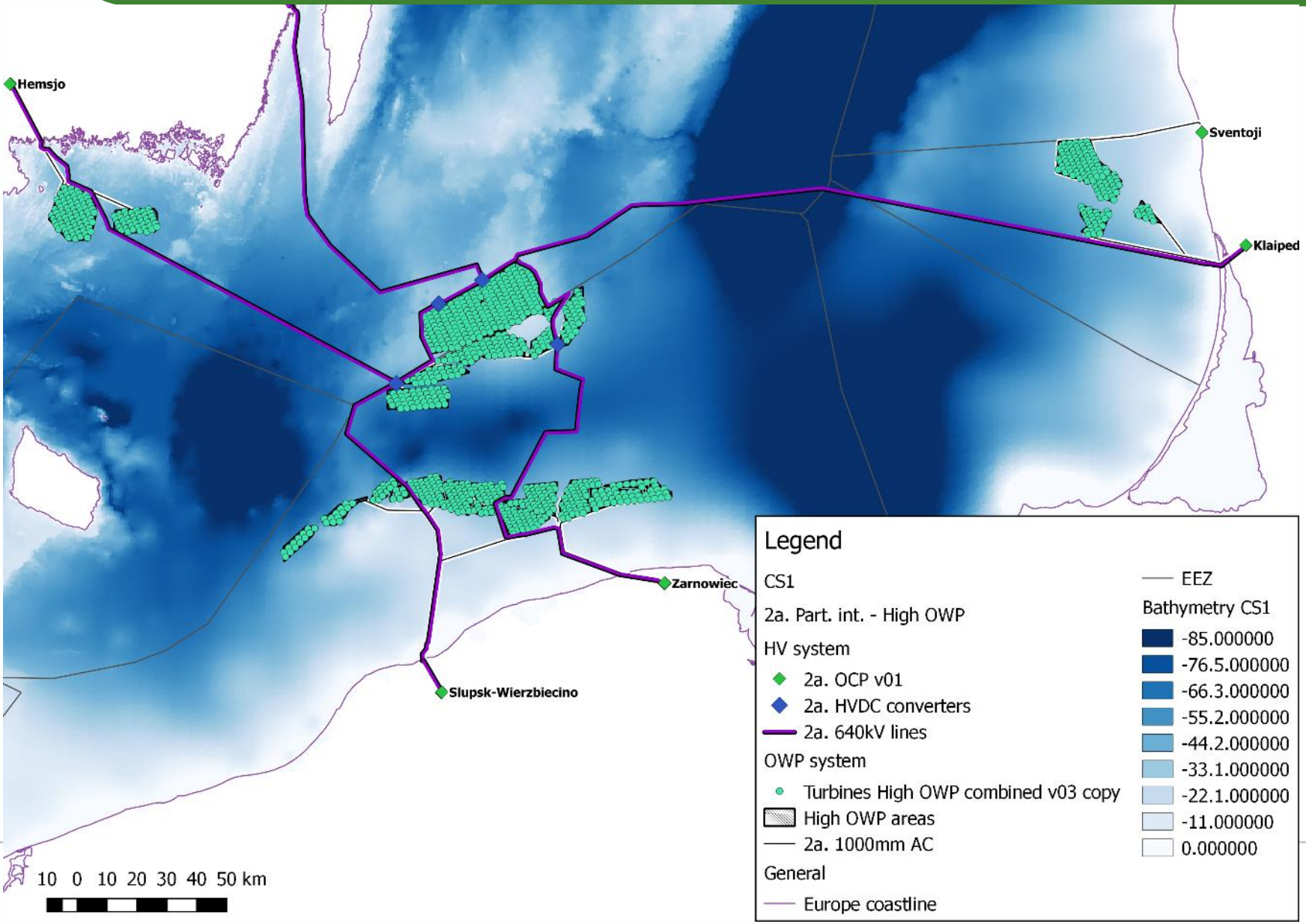
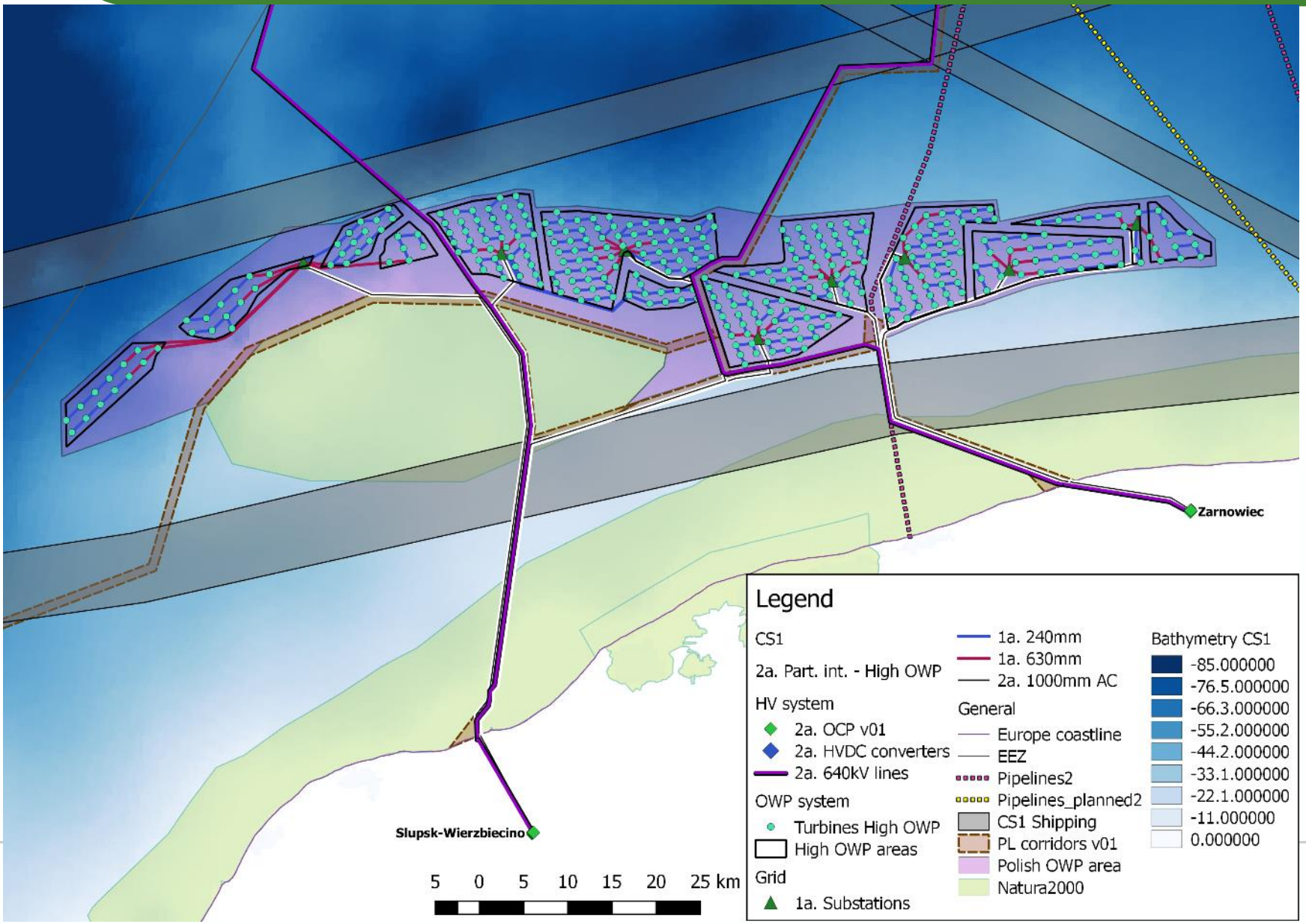
(2a) Partial integration – High OWP – Vision 2045



2a. High OWP – Part integration – Overview Grid



2a. High OWP – Part integration – Detailed view



Contact & Disclaimer

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