

Offshore networks integration

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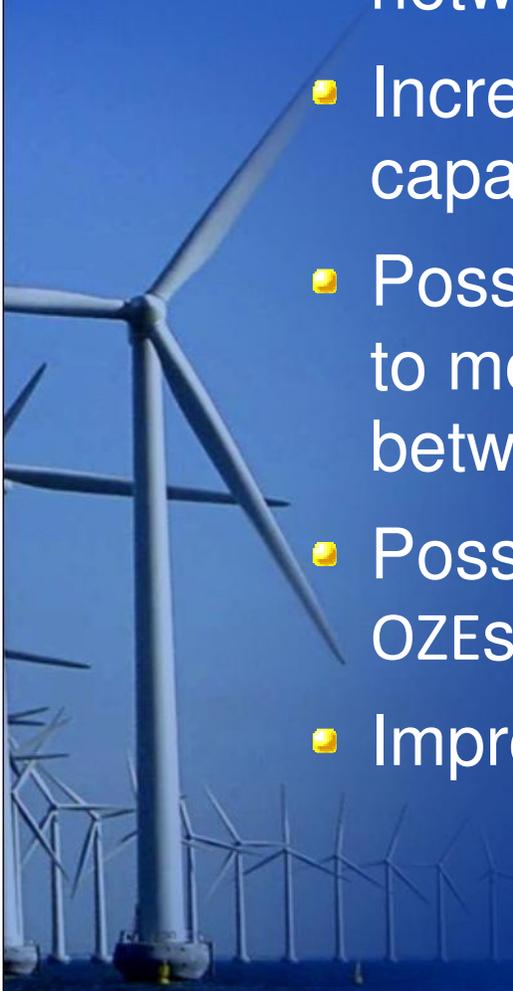
Offshore networks integration

Creation of integrated European offshore network will contribute to construction of uniform, European electric power market, advantageous for all the customers.



Goals / Effects

- Providing remote OWFs with access to network
- Increasing electric power transmission capacity at sea
- Possibility of selling power generated by OWF to more than one country, and trading it between individual countries
- Possibility of connecting with other offshore OZEs (waves, tides)
- Improvement of European energy safety

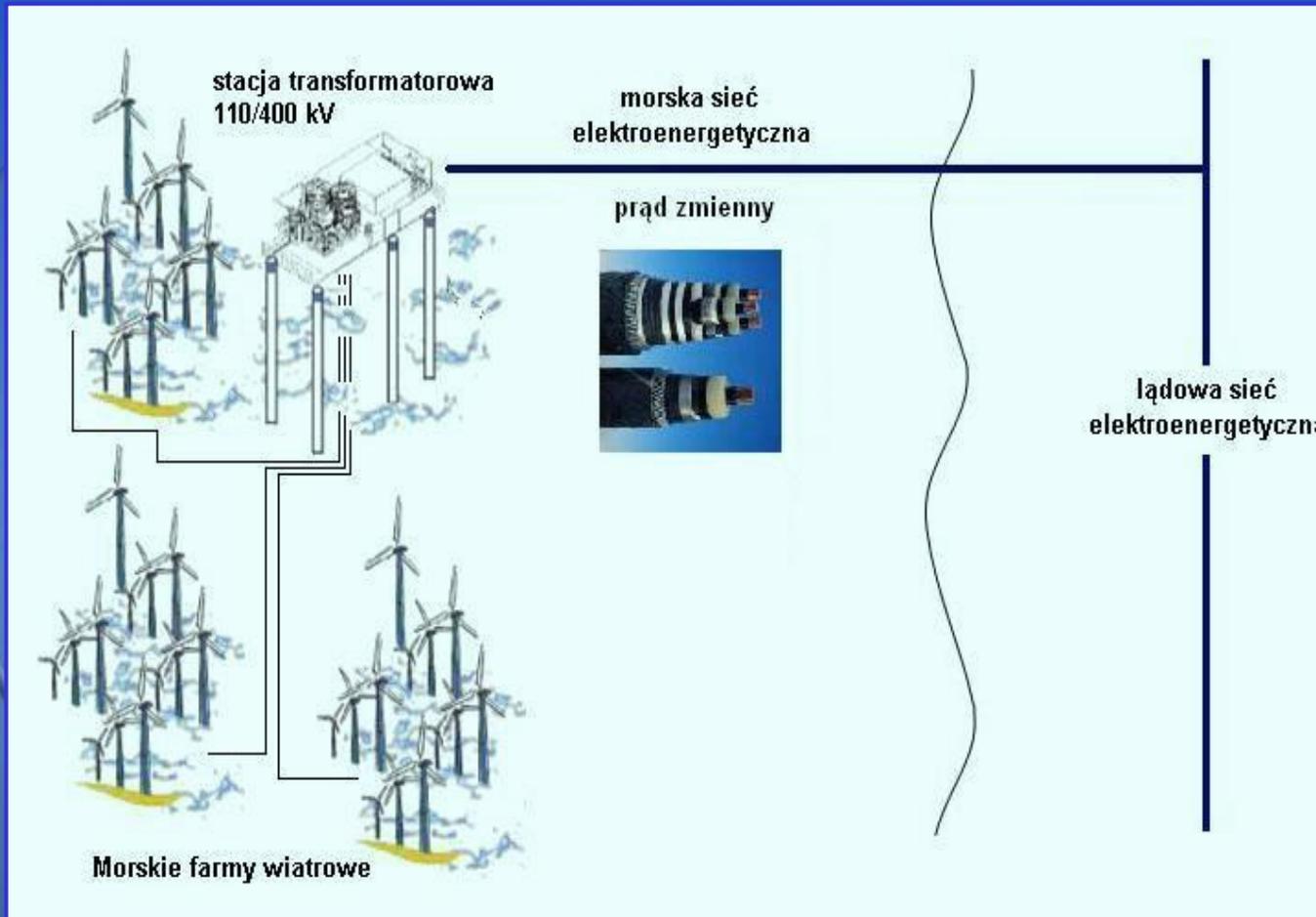


Basic terms

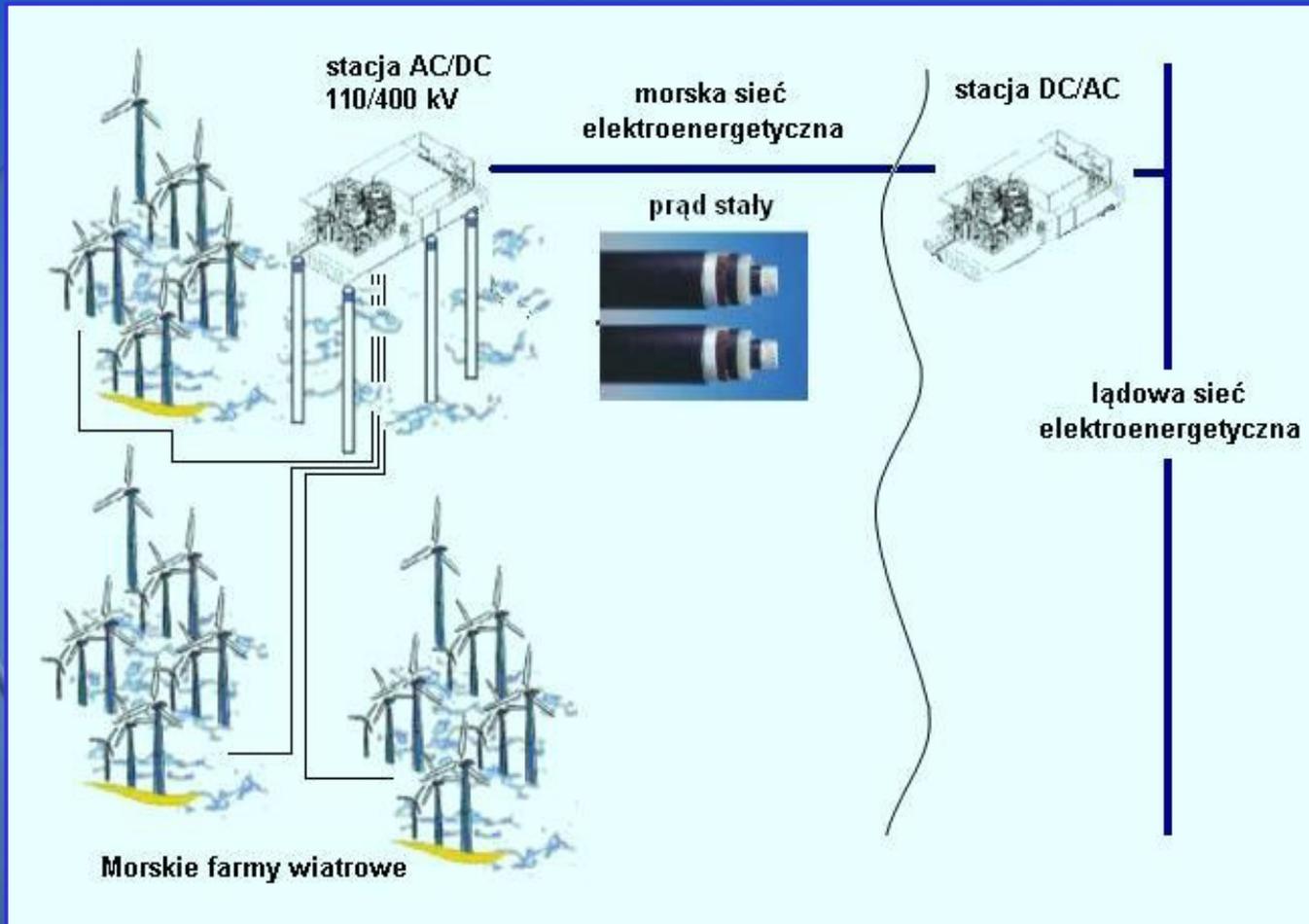
- **HVDC** technology (High Voltage Direct Current), i.e. Technology of electric energy transmission using direct current, with high enough voltage
- **HVAC technology** (High Voltage Alternating Current) technology of electric energy transmission using alternate current, with high enough voltage
- **VSC - Voltage Source Converters** (Light) state of the art generation of AC to DC and DC to AC converters, based on a new type of thyristors, allowing to generate almost perfect sinusoids
- **FACTS devices** enable better use of the existing infrastructure by increasing its flexibility and control capabilities



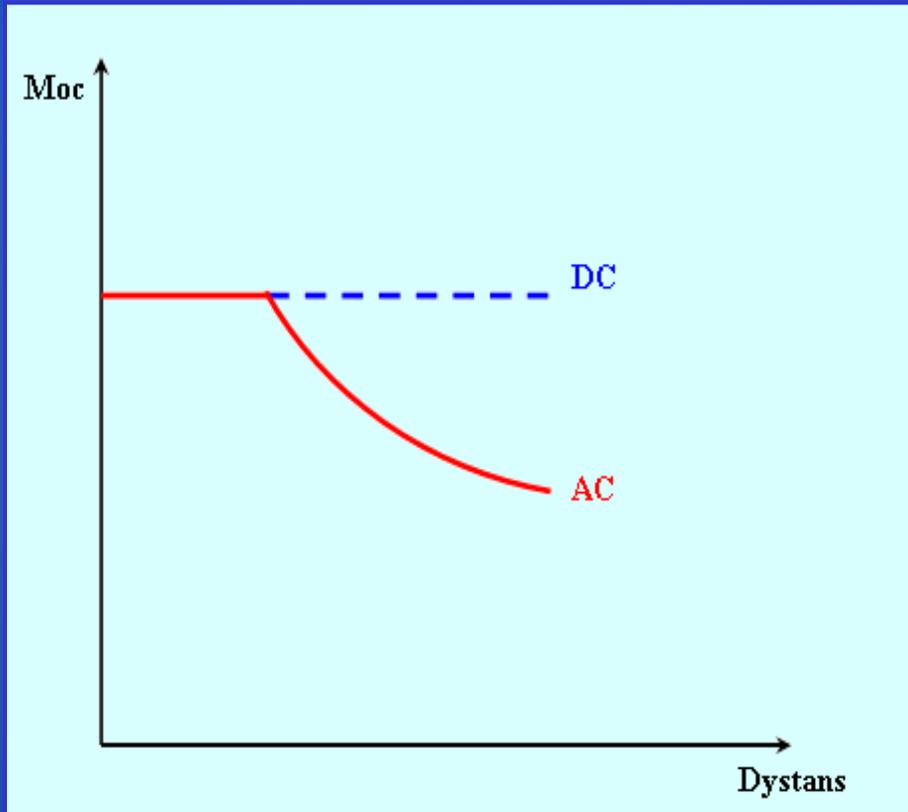
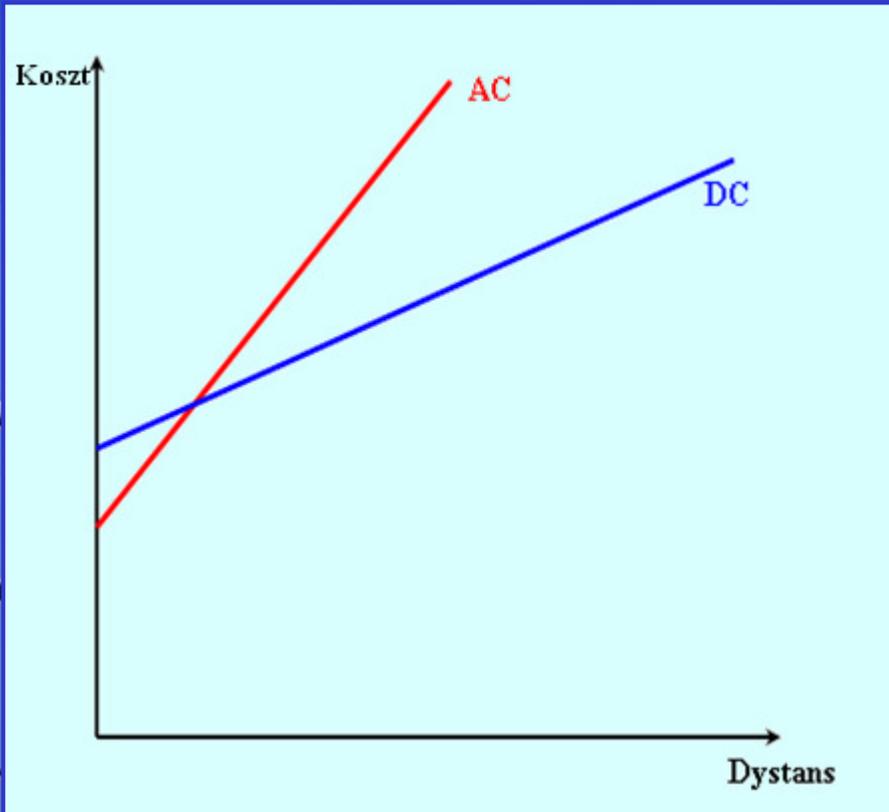
Example of connecting OWF via cable network using HVAC



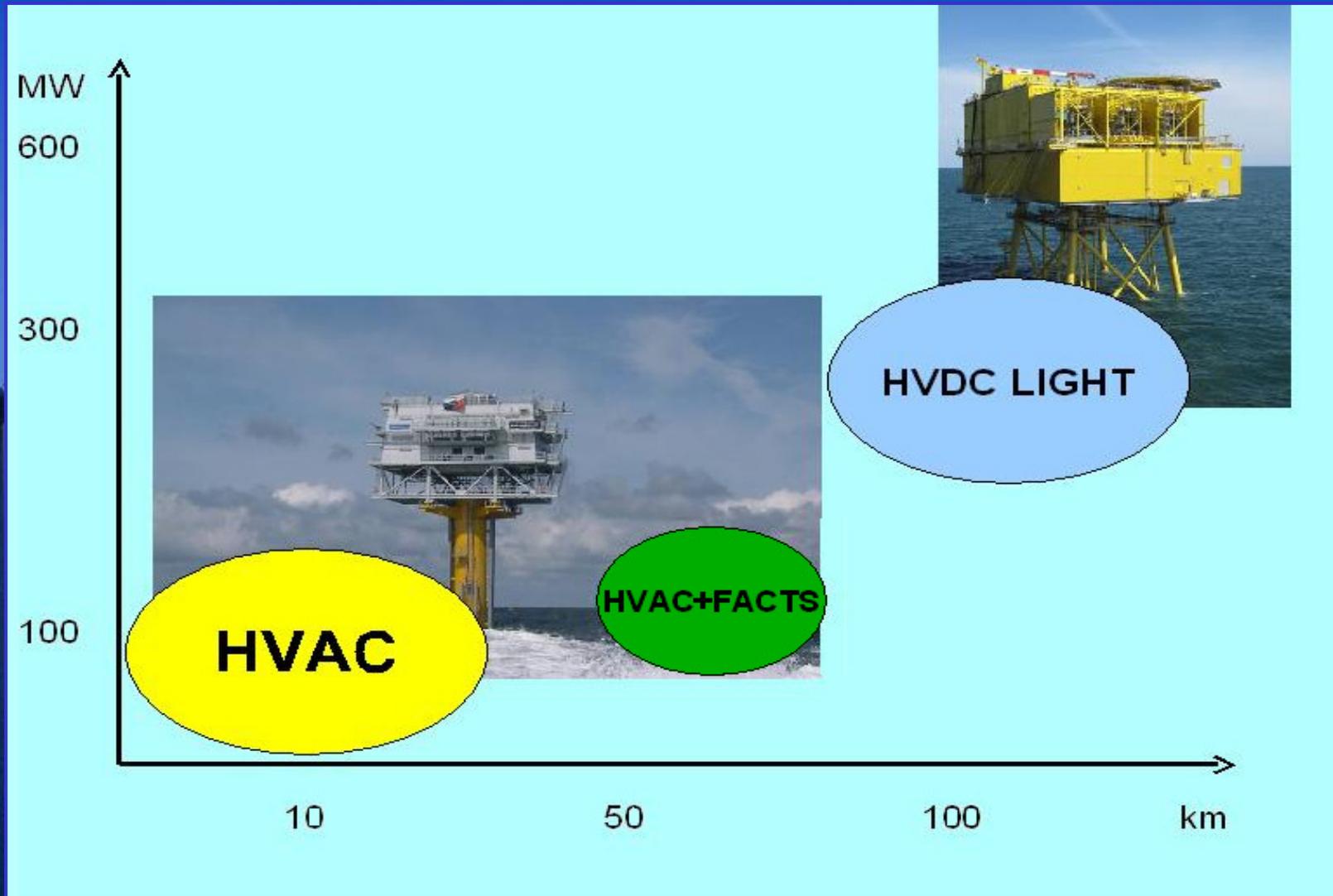
Example of connecting OWF via cable network using HVDC



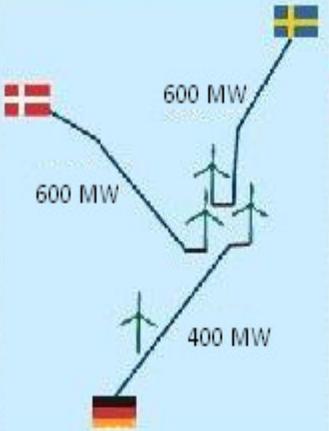
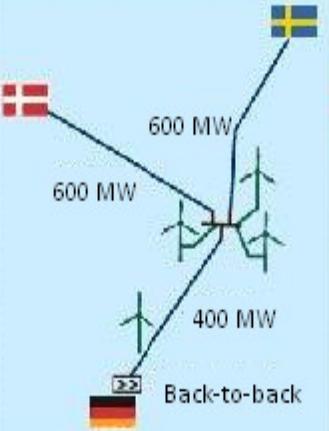
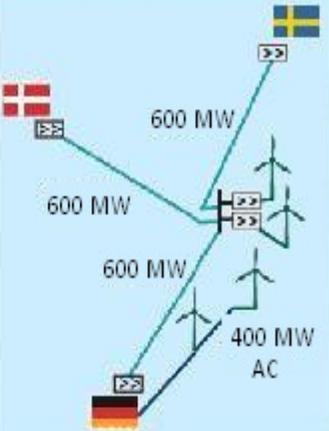
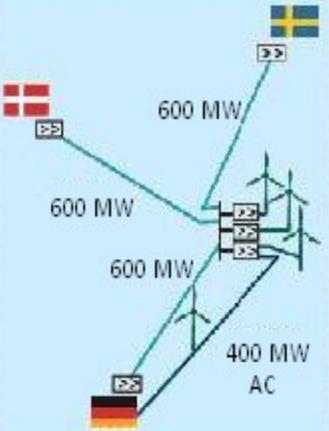
Reasons for switching from HVAC to HVDC



Offshore transmission technologies



Connection methods, e.g. Kriegers Flak

	(A) Oddzielny, połączenie MFW z sieciami krajowymi	(B) Połączenie kombinowane w technologii AC	(C) Połączenie HVDC oparte na technologii VSC (bez Kriegers Flak 1)	(D) Połączenie hybrydowe oraz wydzielone połączenie AC Kriegers Flak 1
Koncepcja				
Typ rozwiązania	Oddzielny	Kombinowany	Kombinowany	Kombinowany
Maks. moc wymiany międzysystemami Nordel - UCTE	0	400 MW	600 MW	1000 MW

Probable development

Stage I: Local Networks (domestic)

Appointing and implementing coordinated connection of wind power stations at the national level

Stage II: Switching to international network

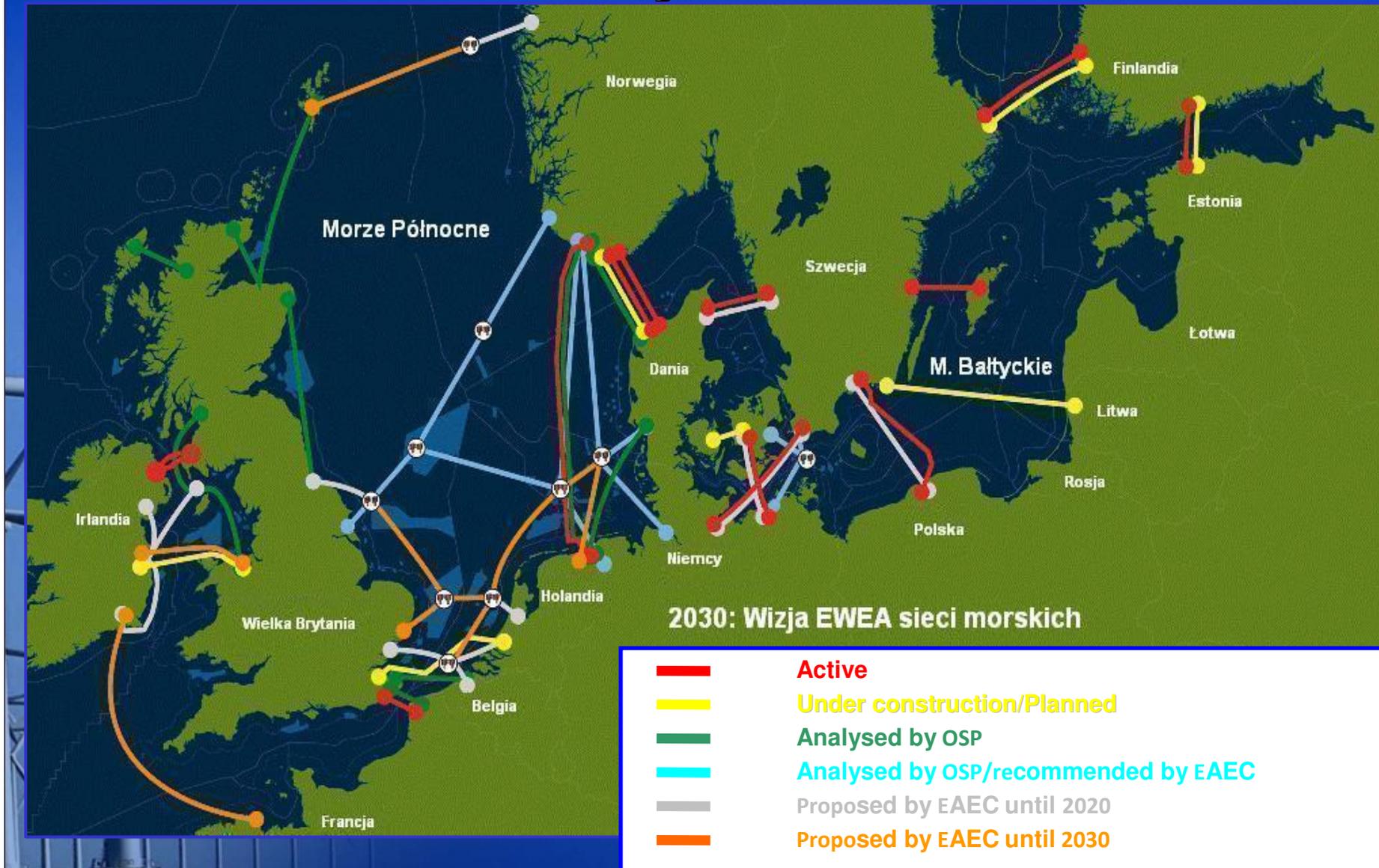
Multilateral network planning process. Completing pilot projects of connecting wind power stations to various energy markets (e.g. Kriegers Flak). Optimization of the HVDC VSC technology based on the acquired experience, followed by adjusting subsequent planned offshore connections to the OWF connection

Stage III: International network

Step-by-step completion of the planned investments which form international integrated offshore network



Concept of integrated offshore networks system



International connection projects recommended by EAEC

Lp	Nazwa Projektu	Kraje	Moc [MW]	Status	
1	NorNed	Norwegia - Niemcy	700	Uruchomione	
2	Skagerak	Norwegia - Dania	940		
3	Linia HVDC	Francja - Wlk. Brytania	600		
4	Kontek	Niemcy - Dania	600		
5	Linia HVDC	Niemcy - Szwecja	300		
6	SwePol	Szwecja - Polska	600		
7	Linia HVDC	Szwecja - Wyspa Gotland	260		
8	Estlink	Finlandia - Estonia	350		
9	Fenno Skan	Szwecja - Finlandia	500		
10	Moyle	Irlandia Płn. - Szkocja	500		
1	Great Belt	Dania	600	2010	Planowane w budowie
2	Fenno Skan II	Szwecja - Finlandia	800	2011	
3	BritNed	Wlk. Brytania - Holandia	1000	2011	
4	EastWest	Irlandia - Walia	500	2012	
5	Estlink II	Finlandia - Estonia	700	2013	
6	Upgrid	Norwegia - Dania	350	-	
7	Nordbalt	Szwecja - Litwa	700 - 1000	2016	

Needs for standardizing solutions

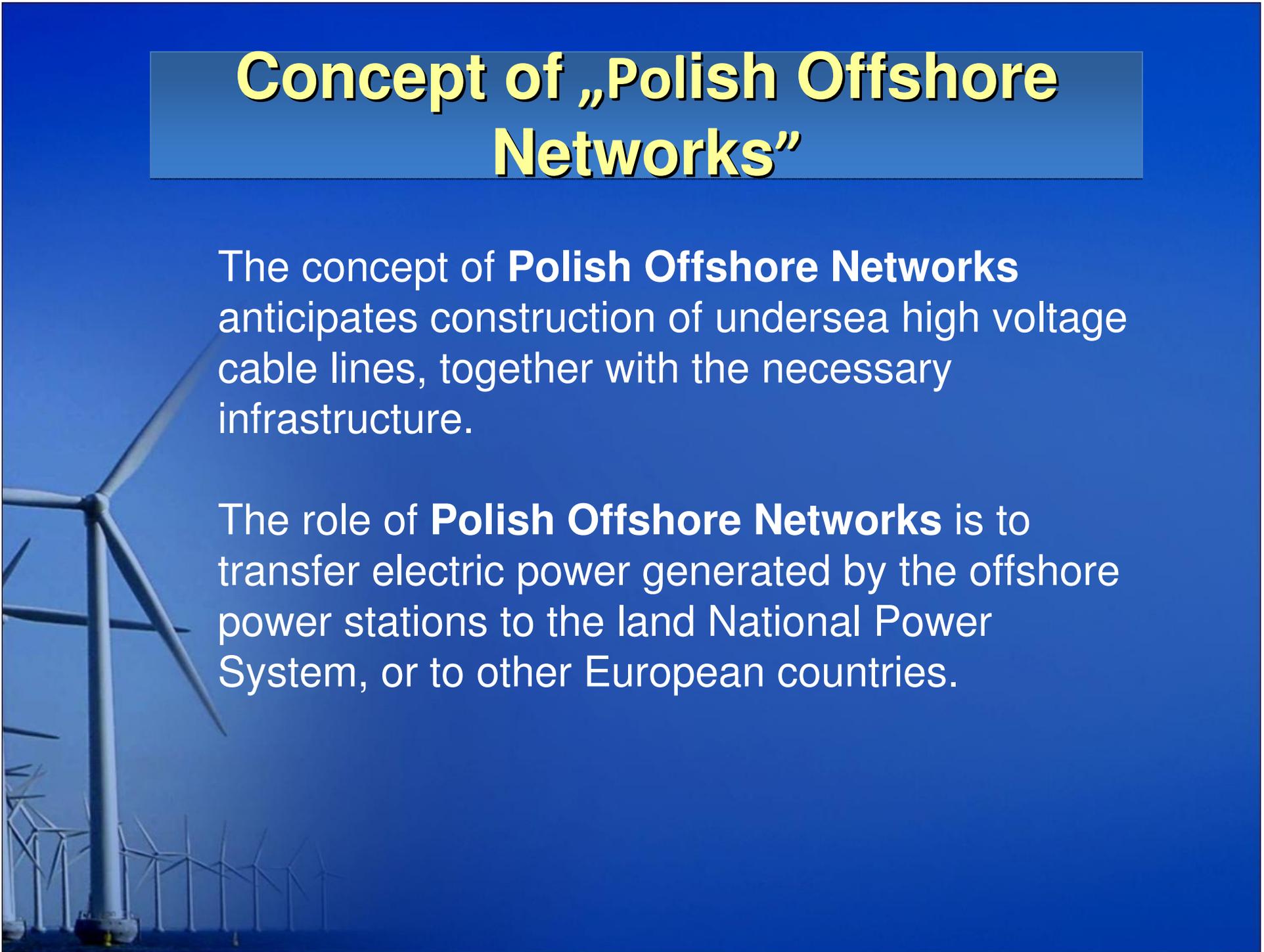
- Involvement and coordination of interested countries' actions
- Improvement of land networks
- Technology development and optimization of VSC network
- Common procedures regarding the electric energy market
- Balancing: contracts and agreements between countries
- Agreements with OSP
- Various domestic systems of supporting wind power stations
- Diverse, free and complex system of entitlements



Concept of „Polish Offshore Networks”

The concept of **Polish Offshore Networks** anticipates construction of undersea high voltage cable lines, together with the necessary infrastructure.

The role of **Polish Offshore Networks** is to transfer electric power generated by the offshore power stations to the land National Power System, or to other European countries.



Concept of „Polish Offshore Networks”

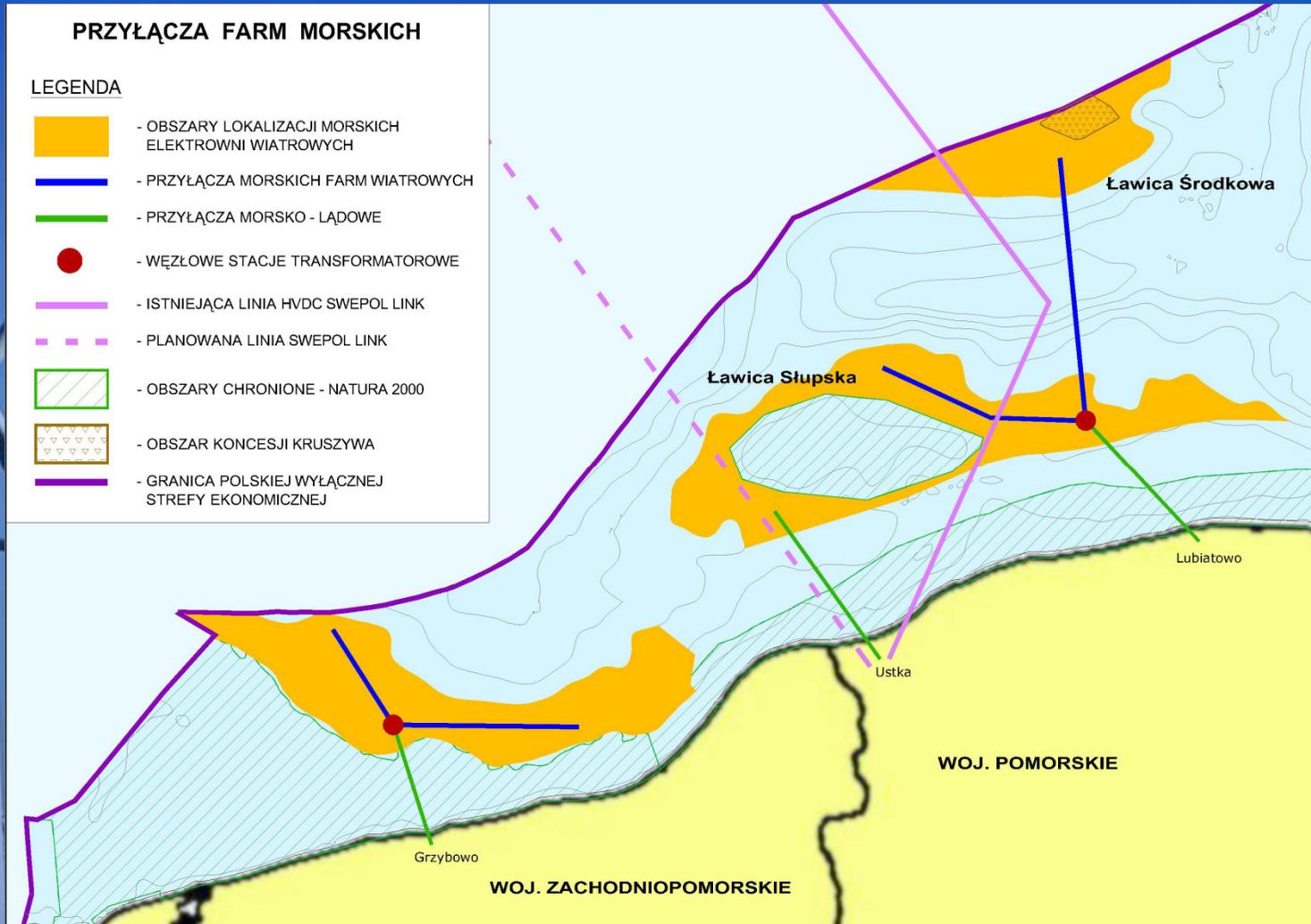
The simplified system of *Polish Offshore Networks* consists of two basic network elements with separate functions :

- Service Lines of Sea Wind Farms
- Sea-Land Service Lines

Transformer stations are included in the system.



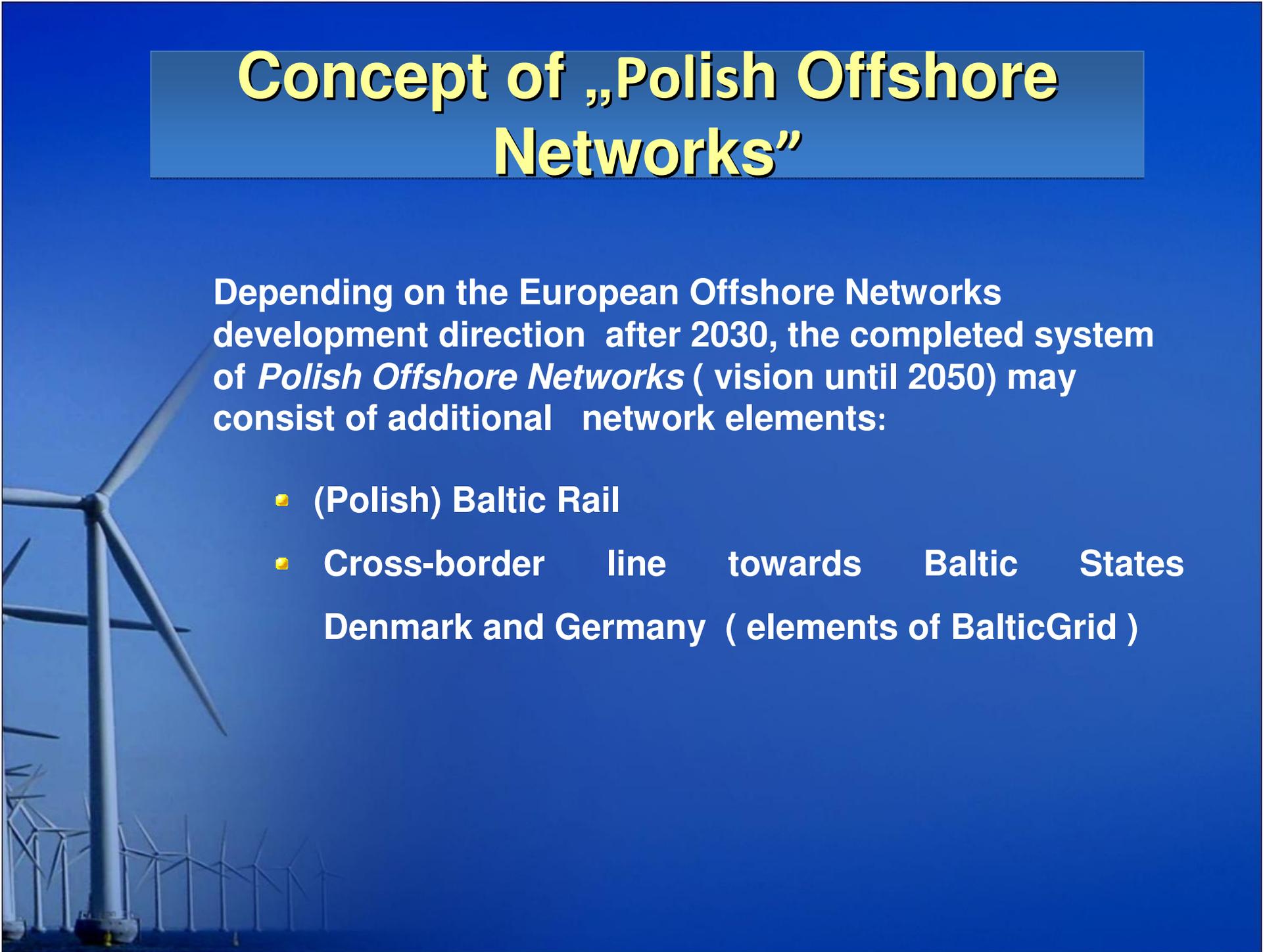
Concept of „Polish Offshore Networks”



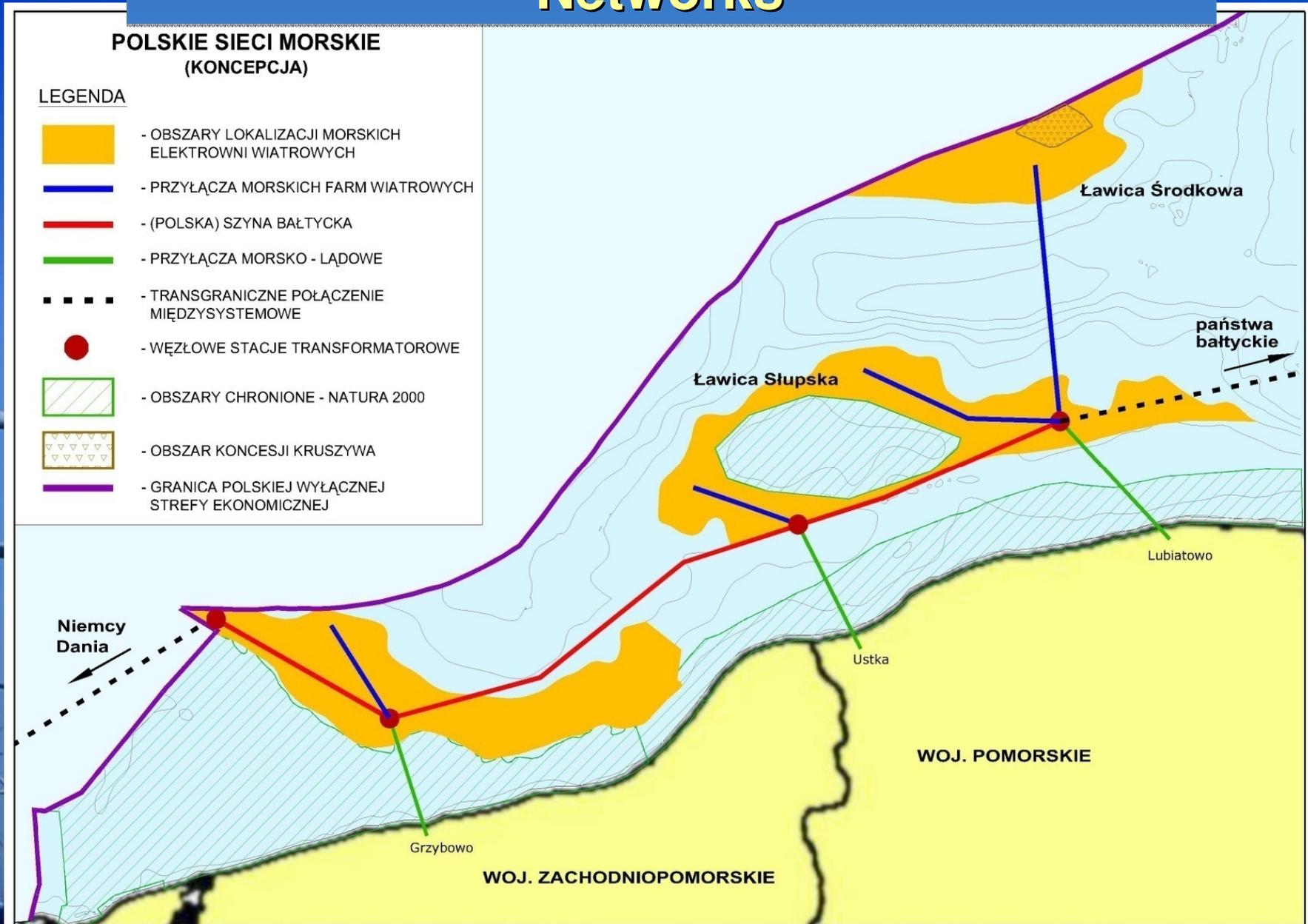
Concept of „Polish Offshore Networks”

Depending on the European Offshore Networks development direction after 2030, the completed system of *Polish Offshore Networks* (vision until 2050) may consist of additional network elements:

- (Polish) Baltic Rail
- Cross-border line towards Baltic States
Denmark and Germany (elements of BalticGrid)



Concept of „Polish Offshore Networks”



Thank you for your attention



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