Nexans
ELECTRIFY THE FUTURE

Future Cable Systems for offshore floating wind

SUBSEA OPERATIONS CONFERENCE

JON ARNE HÄLL- 09/08/2023

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Nexans Subsea & Land Systems BG

- High voltage cable EPCI turn-key contractor
- 3 subsea plants (US, Norway, Japan) and 2 cable installation vessels
- Expert cables for offshore wind farms & Interconnectors

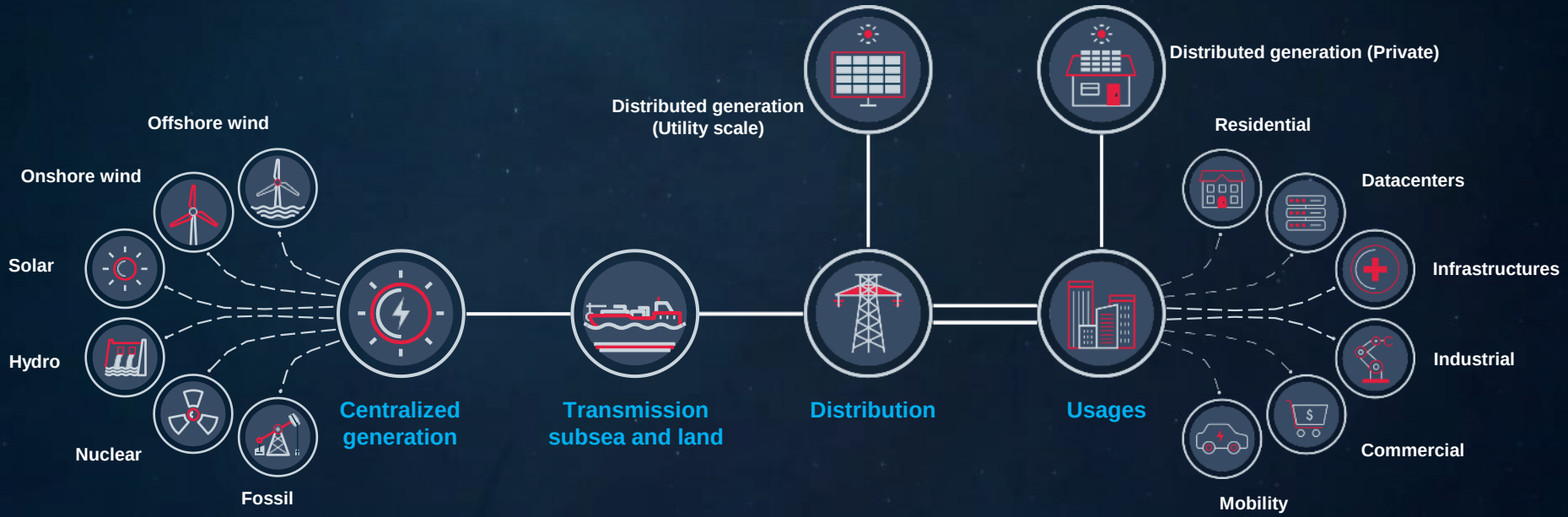
Halden Subsea cable plant
New tower in operation 2023

Nexans Aurora, 2021
....and one more on the way

Charleston subsea cable plant, SC, US

Simplify our business to amplify our impact

THE FIRST PURE ELECTRIFICATION PLAYER



Offshore Wind in 20 years.... (Nexans deliveries only)

Horns Rev Offshore Wind Farm	Denmark	2002
Barrow Offshore Wind Farm	England	2005
Horns Rev 2 Offshore Wind Farm	Denmark	2008
Lynn and Inner Dowsing Offshore Wind Farm	England	2008
Horns Rev 2 Offshore Wind Farm	Denmark	2008
Hywind Demo	Norway	2009
Belwind Offshore Wind Farm	Belgium	2010
Sheringham Shoal Offshore Wind Farm	England	2010
Lincs Offshore Wind Farm	England	2011
London Array Offshore Wind Farm	England	2012
Northwind Offshore Wind Farm	Belgium	2013
Hywind Scotland	Scotland	2017
Beatrice Offshore Wind Farm	Scotland	2018
East Anglia One Offshore Wind Farm	England	2019
Northwester 2 Offshore Wind Farm	Belgium	2019
Hornsea 2 Offshore Wind Farm	England	2021
DolWin 6 (320 kV DC)	Germany	2022
Seagreen 1 Offshore Wind Farm	Scotland	2022
Saint-Brieuc Offshore Wind Farm	France	2022
Sunrise	USA	Ongoing
Empire Wind	USA	Ongoing
Borwin	Germany	Ongoing
Tennet	Germany	Ongoing

- The market for offshore wind has matured over the last 20 years.
- Nexans entered into this market in 2002
- From 36 kV – 245 kV AC/320 kVDC Export Cables

Whats next

VALUE CREATION THROUGH LEADERSHIP IN TECHNOLOGY

INCREASING POWER, DISTANCE AND WATER DEPTH

- Cost efficient HVDC XLPE 525kV and beyond
- Industrialize Powerboost HVDC
- Deep Water Products and Installation
- Monitoring Solutions

FLOATING OFFSHORE WIND

- Dynamic HV/EHV AC and DC cable systems

ENVIRONMENTAL REQUIREMENTS

- SF6 free terminations (g3 or dry)
- Lead free accessories
- Replace lead sheath in subsea cables
- Life Cycle Assessment

HVDC / HVAC qualification status today

Qualifications for cable systems (cable + accessories) involve successful type tests (TT) and pre-qualification tests (PQ)

HVDC

Qualified cable systems

- 320 kV HVDC XLPE subsea and land cable system
- 400 kV HVDC XLPE subsea cable system
- 525 kV HVDC XLPE subsea and land cable system 2 GW
- 525 kV HVDC MI subsea cable system
- 600 kV HVDC MI land cable system

HVAC

Qualified cable systems

- 420 kV HVAC XLPE subsea cable system
  - Three core and single core cables

First system of 420 kV subsea cables with XLPE insulation qualified and installed in 2006.

Dynamic Power

Technology developed for the oil & gas market since 1983

Pioneer in floating offshore wind

- **2009: Hywind Demo** (Norway)
  - World's first floating wind turbine
- **2017: Hywind Scotland**

145 kV, 3 core prototype manufactured with metallic sheath

Successful qualification for 1,500 m water depth

Turnkey contract for Jansz-Io Compression project ongoing:

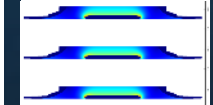
- 135 km of XLPE 145 kV dynamic and static cables
- Max water depth: 1400 m

Typical OWF export cables

- Voltage class 245 kV
- Size up to 3x1x1800 mm²
- Up to Ø = 260 mm

Technology Readiness Level - Dynamic

FEASIBILITY SCREENING | QUALIFICATION | PRODUCTION

1 Desktop studies	2 Physical models	3 Small scale prototypes	4 Full scale R&D tests	5 System qualified	6 System installed	7 Field proven
						
Idea formulated, basic research	Analytical and FEM simulations	Plates, models	Thermal tests, performance tests	PQ and TT Cigré TB 490 / IEC	Offshore laying, onshore installation	>3 years after installation

Standards eq.							
API 17	0/1	2	3	4/5		6	7
EU - CLOUDWATCH	0/1	2/3	4	5	6	7/8/9	

52 kV AC wet, Dynamic	2006	2007	2008-2011
145 kV AC Dry, Dynamic	2018	2019	2025-2028
145 kV AC Wet, Dynamic	Sometime before 2022	2025	**(1983)** 2026-2029
245/300 kV AC Dry, Dynamic	2024	2025	2026-2029
320 kV DC Dry, Dynamic	2024/2025	2026	2030-2033

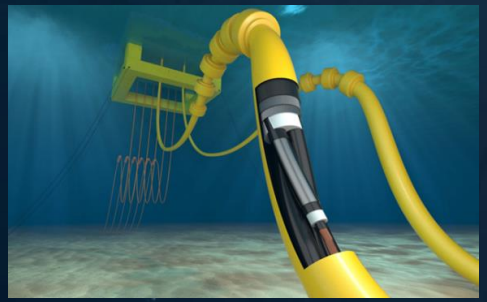
Dynamic cables

ELECTRIFICATION OF FLOATING STRUCTURES

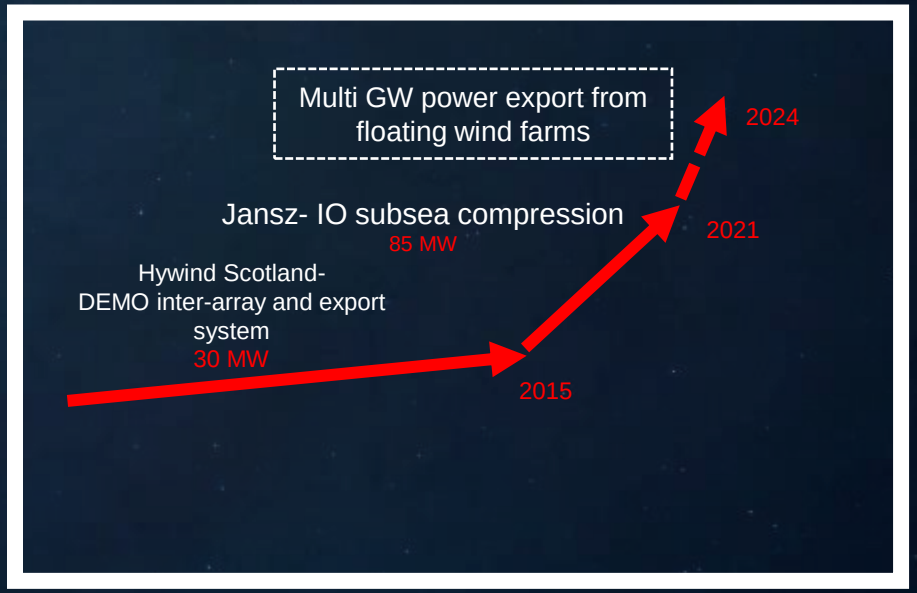
POWER- FROM- SHORE

FLOATING WIND:

- Inter-array
- Export



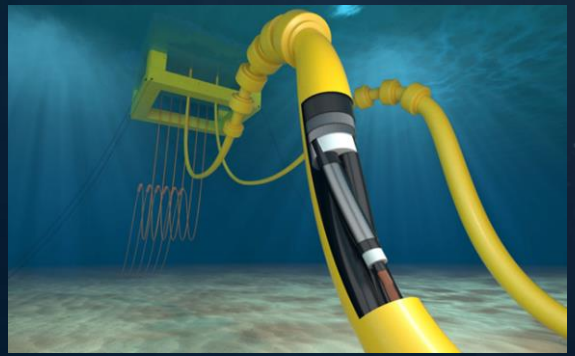
Trend- Qualified technology & outlook



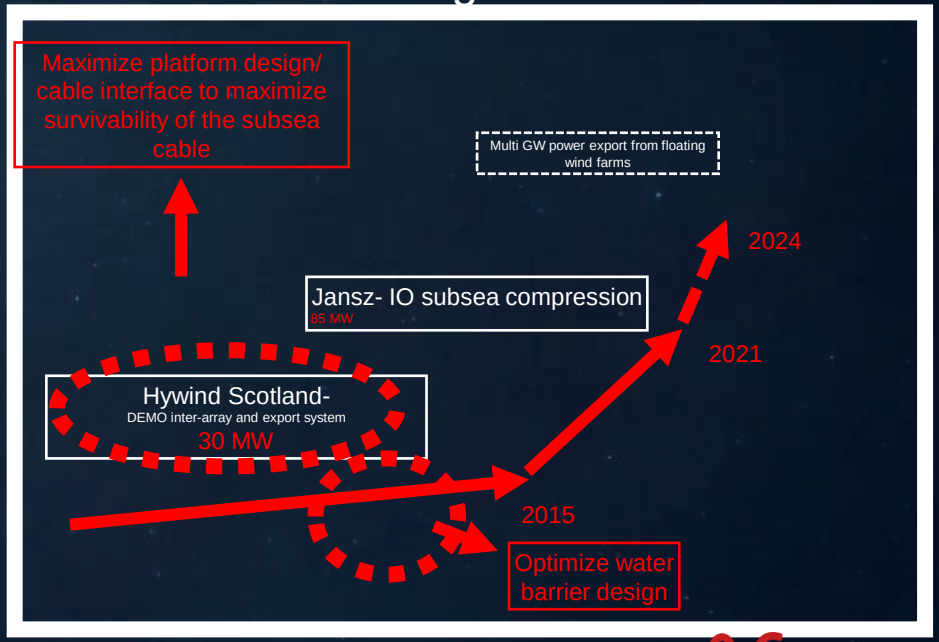
More transmission capasity

HOW TO ELEVATE TRANSMISSION CAPACITY

- 3-core 145 kV AC ~100 MW ✓
- 3-core 245 kV AC >300 MW ✓
- 1-core 320 kV DC > 1,000 MW ✓
- 1-core 525 kV DC > 2,000 MW ✓



Connect- Floating Offshore Wind



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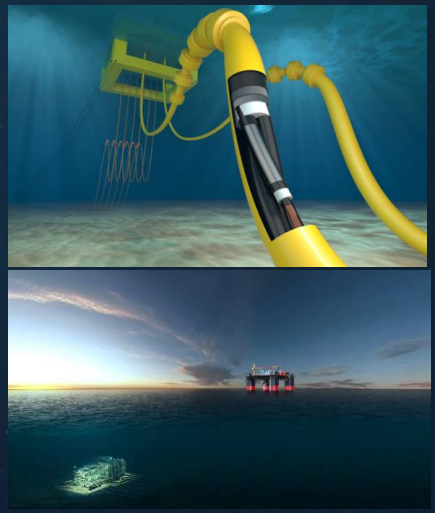
Technology

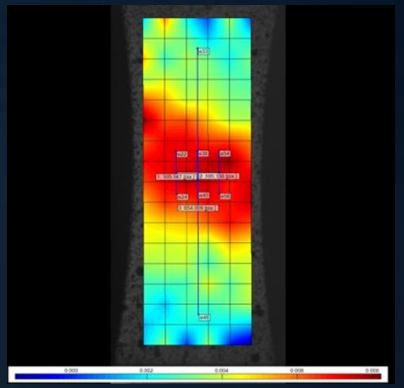
HOW TO ELEVATE TRANSMISSION CAPACITY

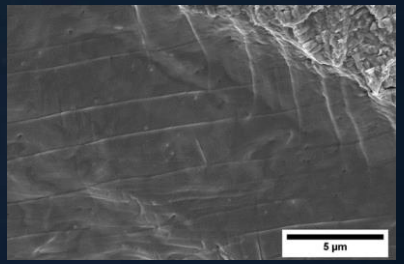
Legacy high voltage subsea cables beyond 36 (66) kV require a humidity barrier **of lead**

Remove lead | Replace lead



Jansz-IO compression:
~1,650 m water depth/
145 kV dynamic
(from : www.offshore-mag.com)





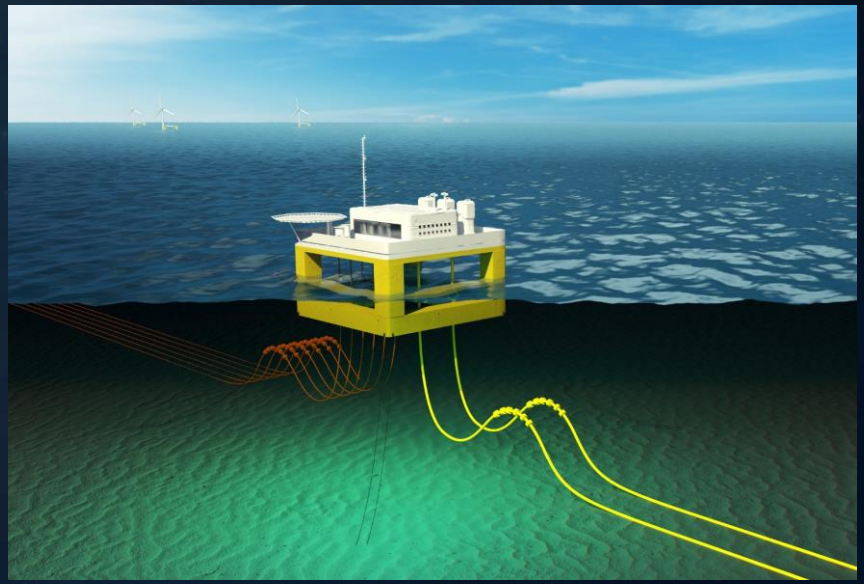
Transmission system for floating wind

- Floating substation/Direct Connection to shore → Dynamic cable

- Design for:
  - Shallow water (From ~70 m WD)
  - Deep water (> 2,000 m WD)

- Further from shore
- 250 MW – 2 GW
- Both AC and DC

- Dynamic 145 kV already qualified for 1500 m
- Desktop studies gives high confidence in dynamic 245 kV AC Systems and 320 kV DC Systems



Need for strong cooperation in execution

- Dynamic cables → Long & detailed Engineering needed upfront
  - Concept / Pre-FEED / FEED studies
- Strong impact between interfaces (floater, mooring, cables)
  - Iterative process
- Common practice for O&G operators
  - moving into floating wind
  - Early Engagement → FEED → Contract → Execution → IMR
  - EPCI contracts → risk reduction

CLV Nexans Aurora