Overview of challenges associated with offshore wind farms in cold climates

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Winterwind INTERNATIONAL WIND ENERGY CONFERENCE FEB 6-8 2017

Quick Introduction

- **Sirris - collective technology centre in Belgium**

sirris

driving industry by technology

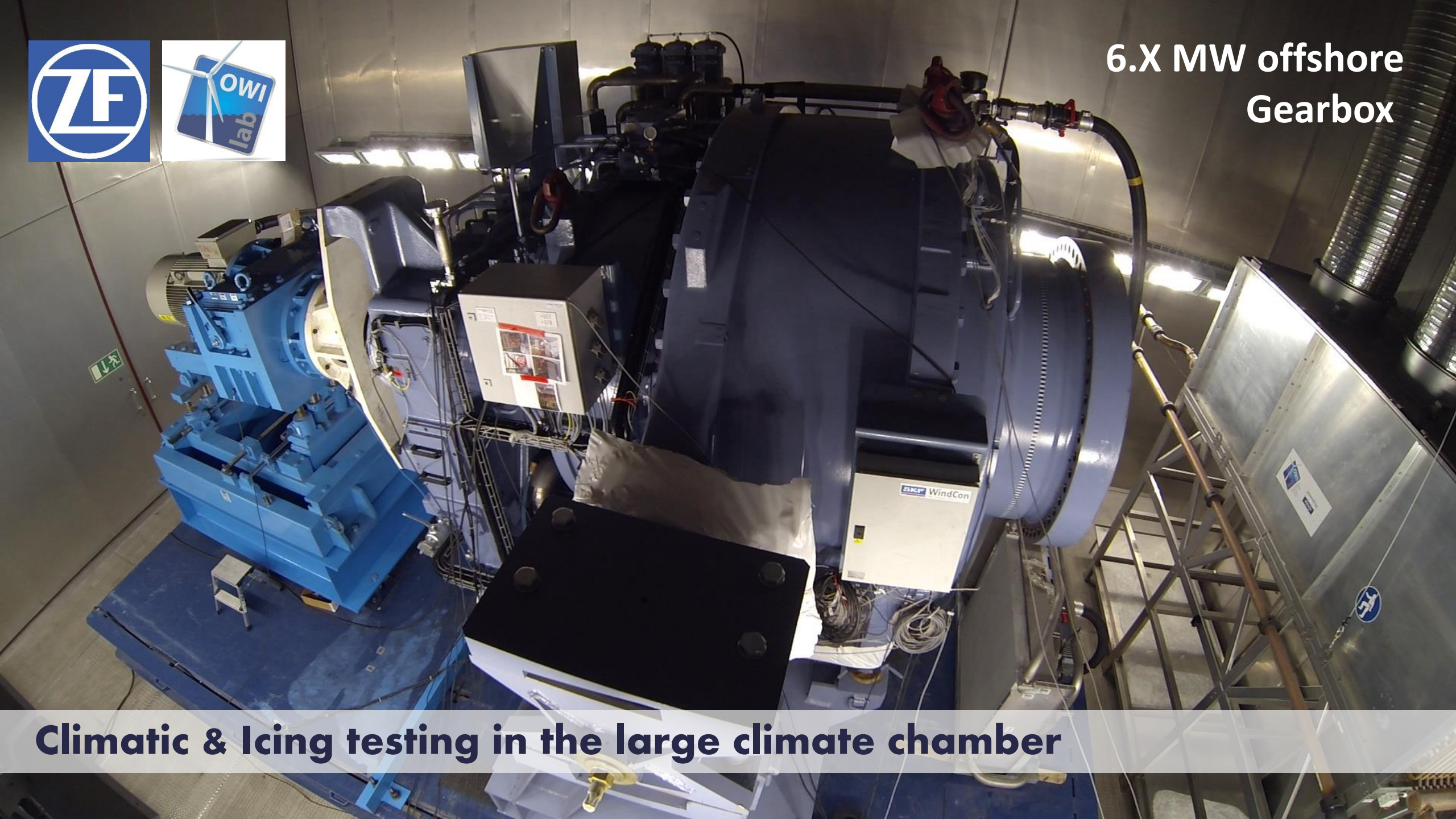
  - Supporting companies with implementing technology innovations
  - Multidisciplinary R&D and innovation projects in technology industry
  - Different technology sectors: Automotive, Energy, Aerospace, ICT, …
  - Different key expertise: ICT, Manufacturing, Mechatronics, Materials
  - High-tech test and R&D infrastructure

- **OWI-Lab - RD&I center for wind energy in Belgium**

  - Set-up in 2010 as a new application lab at Sirris to support wind energy R&D
  - Scope: wind energy in general - focus on '**offshore wind'** and '**cold climate'**
  - Range of new and unique test & monitoring infrastructures
  - Partnership with 3 Belgian universities for wind energy research (VUB, KU Leuven, UGent)

  - Member of EERA JP Cold climate
  - Member of IEA Wind Task19 Wind Energy in Cold Climates

Task 19

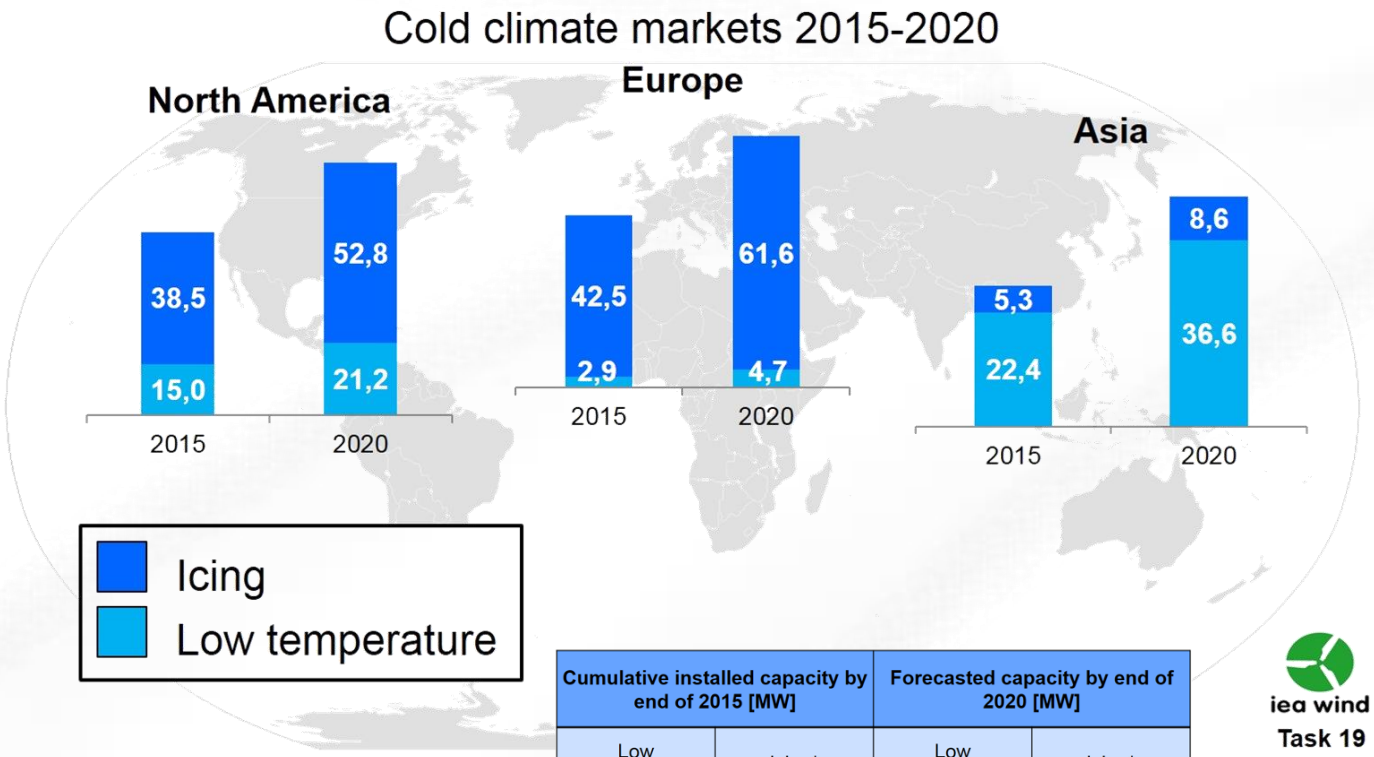

6.X MW offshore
Gearbox
SKF WindCon
Climatic & Icing testing in the large climate chamber

Icing test
Shipping Industry

Climatic & Icing testing in the large climate chamber

MARKET OPPORTUNITY

Cold climate market



Cumulative installed capacity by end of 2015 [MW]		Forecasted capacity by end of 2020 [MW]	
Low temperature	Icing*	Low temperature	Icing*
40 500	86 500	62 500	123 000
Total 127 000		**Total 185 500**	

*: IEA Ice Classification ≥ 2 meaning > 44h/a of meteorological (in-cloud) icing

iea wind Task 19

Not taking into account the offshore projects in 'cold climate' – low temp / icing

Source: Windpower Monthly – 19/01/2017

Source: Offshore Wind Biz– 01/02/2017

Source: Offshore Wind Biz– 01/06/2016

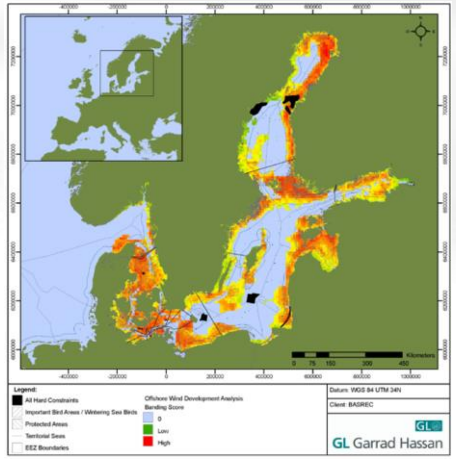
Source: Windpower Monthly – 09/02/2016

Source: Windpower Monthly – 29/02/2016

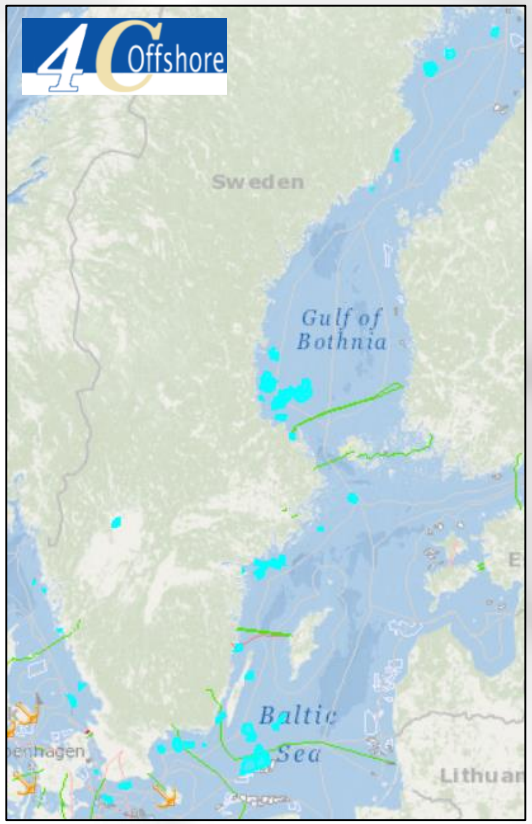
Source: Windpower Monthly – 14/12/2016

Offshore Cold climate market – niche market?

- **Baltic Sea - huge potential (130GW) – ongoing large scale projects**
- Bothnian Sea – demo projects
- USA: Great lakes & East coast – demo projects
- White Sea Russia – demo projects
- Caspian Sea Azerbaijan – demo projects
- Canada: lakes & East coast – planned demo projects
- …



Shell boss sees offshore wind value amid 'unstoppable' shift



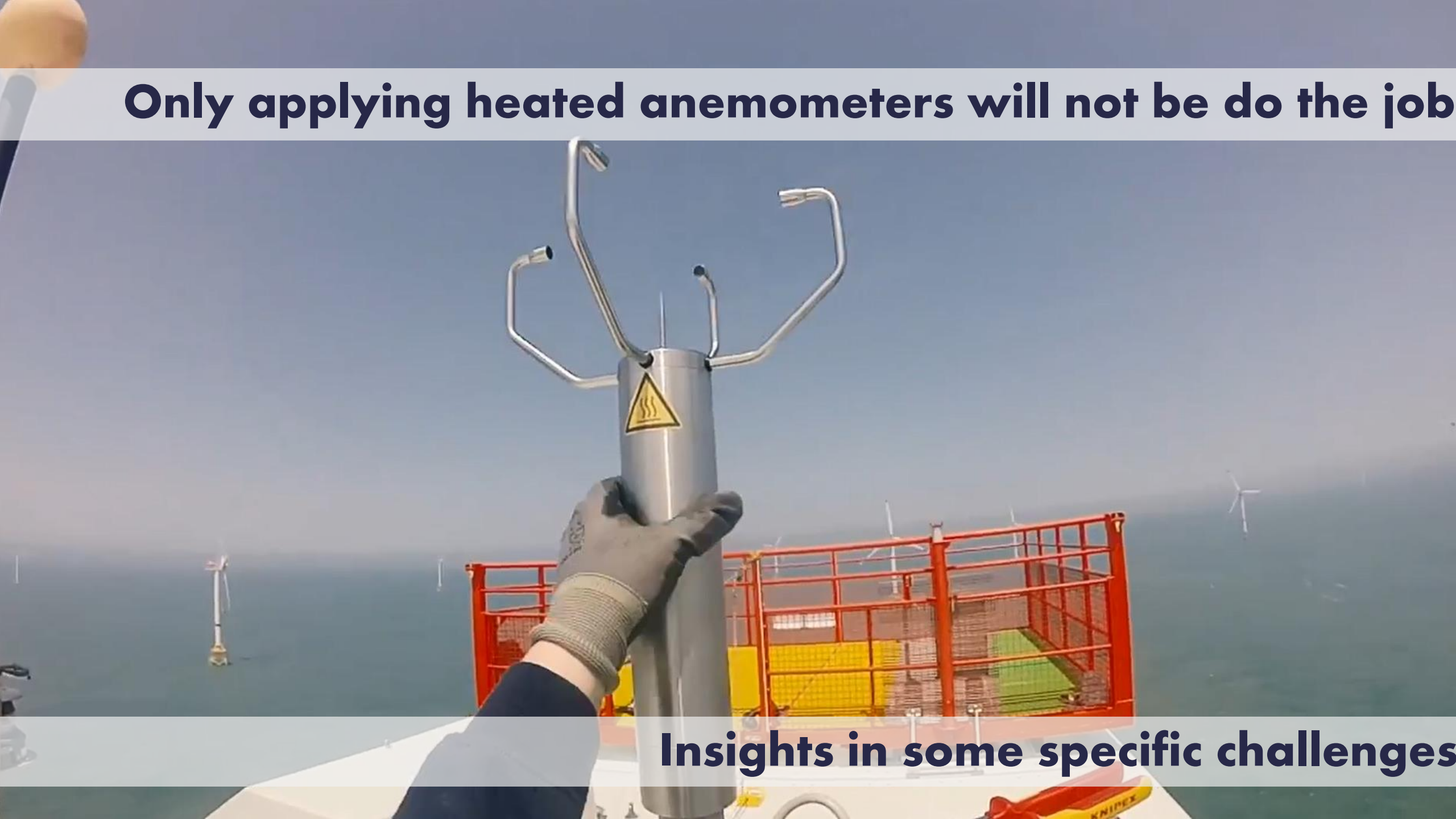
Source: BASREC – Study 'Conditions for deployment of wind power in the Baltic Sea Region' + 4C Offshore

- **Advantage Baltic Sea VS North Sea offshore wind farms**
  - Near-shore solutions (depth) : 30% cost reduction to far-shore North Sea
  - Low significant wave height
  - Lower salt levels
  - Good wind speeds – wintertime: air density advantage
  - Grid connection advantages
  - O&M: short distance to shore

- **But also some challenges to tackle due to site specific environmental conditions**

CHALLENGES & SOLUTIONS

Only applying heated anemometers will not be do the job



Insights in some specific challenges

The Great Lakes Could Be Getting Its First Offshore Wind Farm

ELIZABETH MILLER × JANUARY 20, 2017 × ENERGY × TECHNOLOGY

Source: US Coast Guard

Source Joshua Nowicki

Stunning pictures of Michigan's St Joseph Lighthouse transformed into giant icicles as arctic blast continues to sweep across the US

Source: NTNU

Standard North Sea offshore VS cold climate offshore (Baltic sea / Bothnian sea)

$$COE = \frac{CAPEX + OPEX}{AEP}$$

Higher reliability and better maintenance

↓

Lower downtime

↓

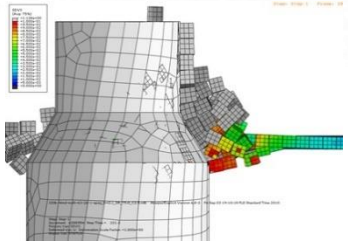
Lower OPEX and higher AEP

↓

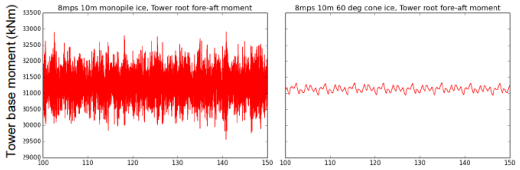
Lower COE

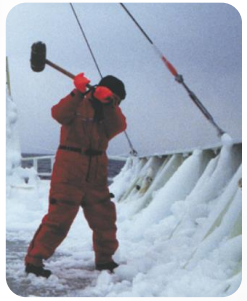
Factors that affect the offshore wind power price	North sea	Baltic sea
Distance from the shore	Long	Medium/ near shore
Depth	20 – 40 m	5 – 25 m
Tidal	Yes	No
Waves	High, up to 6,5m	Low, average near Vilsandi 0,6 m, 6 m wave possible once in 40 years
Wind class	IECI	IEC I/II
Saltiness	High	Low
Temperature	-10 ... +30 C	-30 .... +30 C
Ice (Drift Ice / Pack Ice)	No	Yes
Wind turbine design	Offshore turbine	Semi-offshore, cold climate version

Potential challenges in the value chain of ‘offshore cold climate’



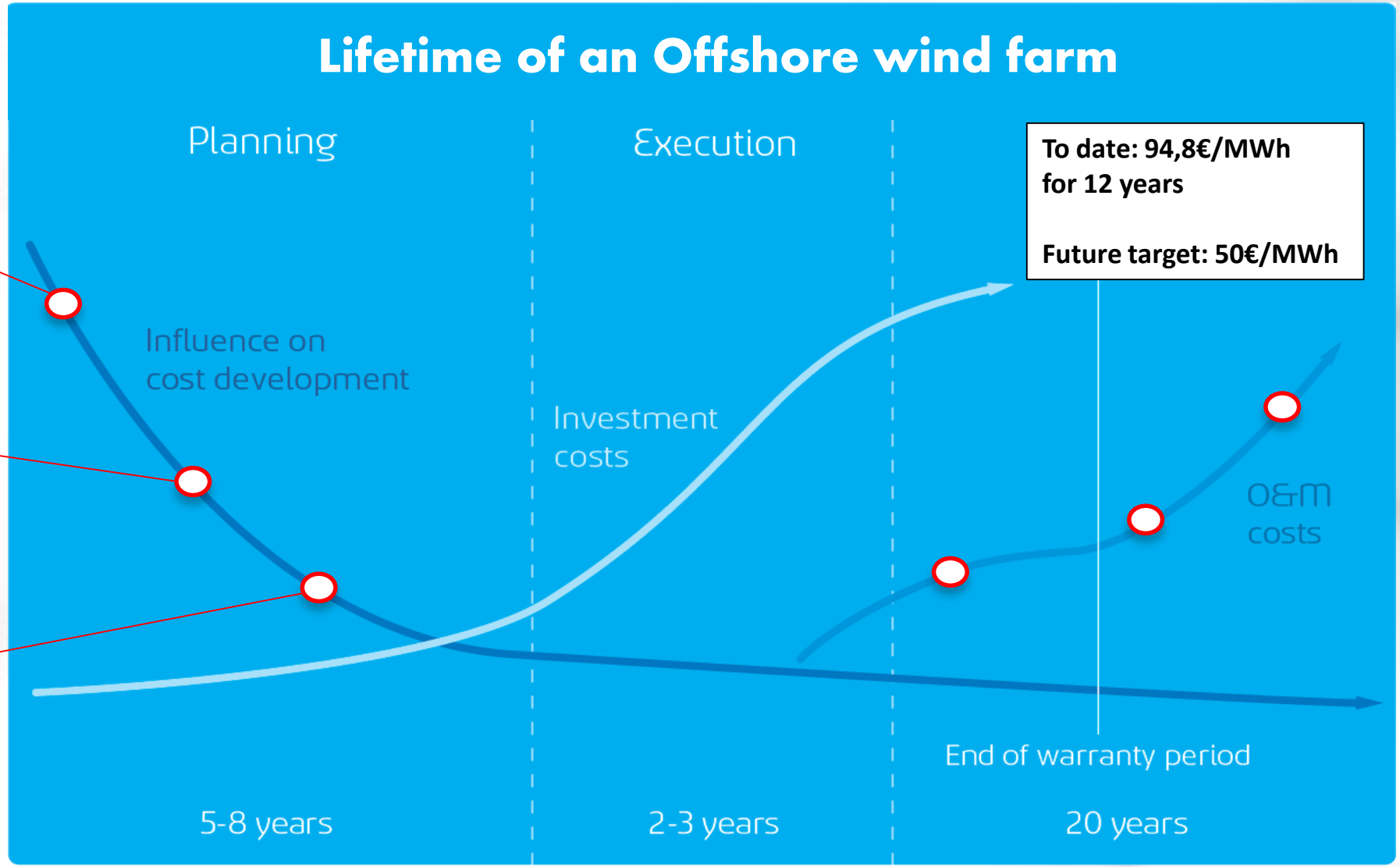
Source: VTT & Suomen Hyötytuuli Oy





Source: Demag

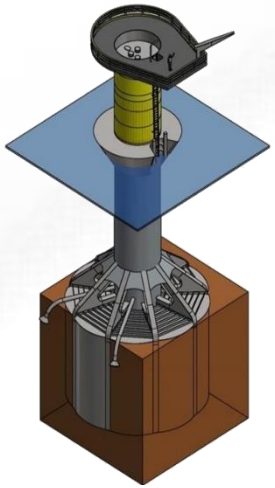
Source: STRABAG OW EVS

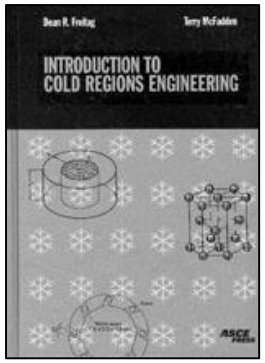


Overview of challenges to overcome in the lifetime of an ‘offshore cold climate’ WF

Predevelopement & Consenting → Production & Acquisition → Installation & Commissioning → Operation & Maintenance → Decommissioning & Disposal

Example: ice removal on floating lidar buoy
Source: Offshore wind biz





- Good understanding of site specific conditions
  - Temperature specification / cold climate package needs
  - Sea ice loads / ice induced vibrations
  - Wave / soils conditions (sand, rock, chalk)
  - Icing scour (foundation & cabling)
  - Weather window (installation phase)
- Uncertainties & risk assessment
- Design for O&M (procurement VS O&M team)
  - Condition monitoring
  - Structural Health Monitoring
- Health & Safety topics
- Reliable resource assessment tools
  - Data quality
  - Battery life / Electronics
  - Power production
  - H&S topics
- Certain choices have impact on the full chain !

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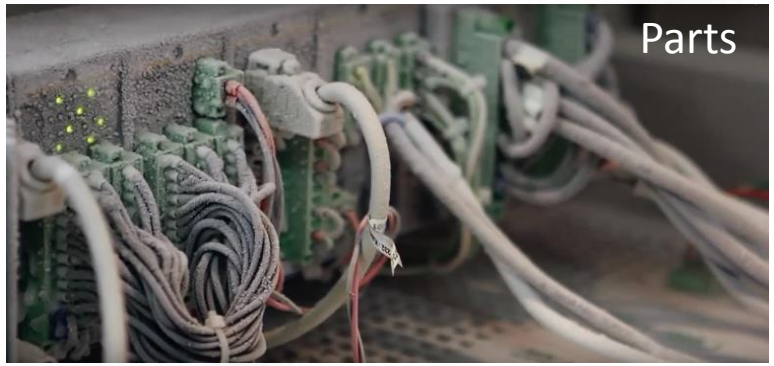
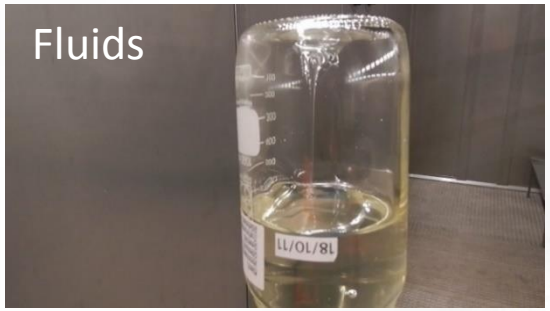
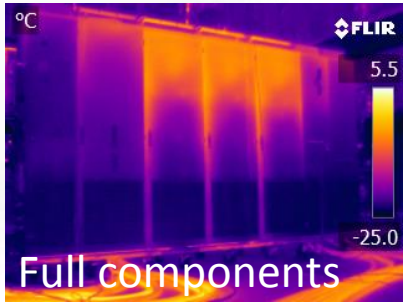






DNV·GL

RECOMMENDED PRACTICE

DNVGL-RP-0363 Edition April 2016

Extreme temperature conditions for wind turbines

DNV·GL

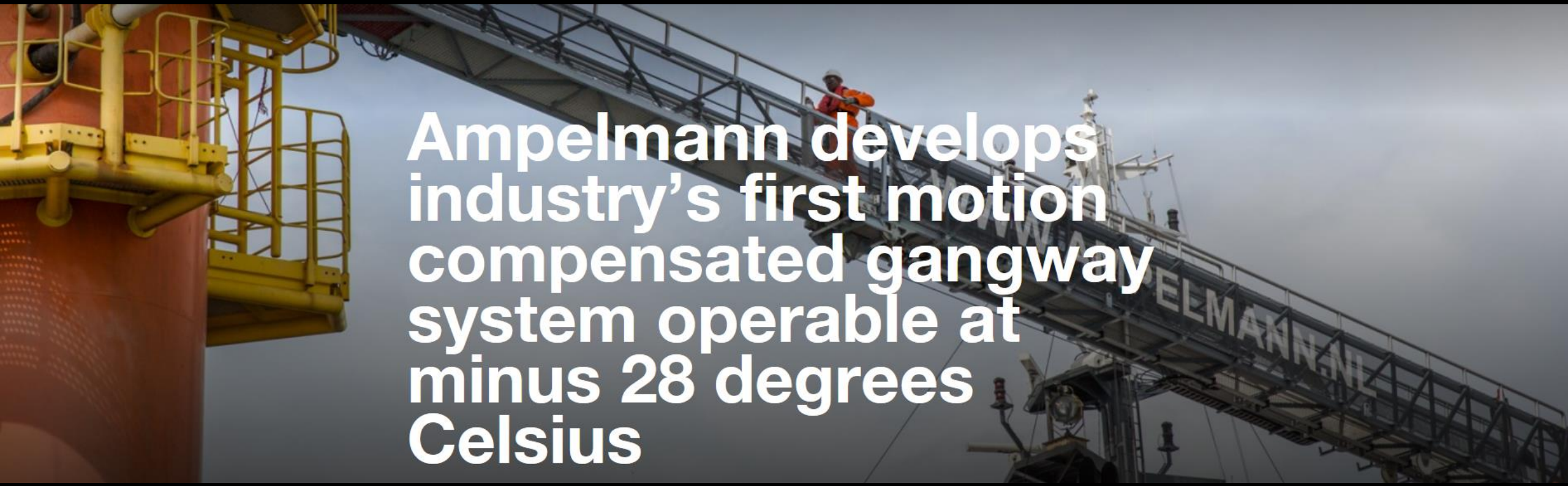
OFFSHORE STANDARD

DNVGL-OS-A201 Edition July 2015

Winterization for cold climate operations


winergy
8 MW offshore


B2 J3
B2J3
REDROCK



Ampelmann develops industry's first motion compensated gangway system operable at minus 28 degrees Celsius

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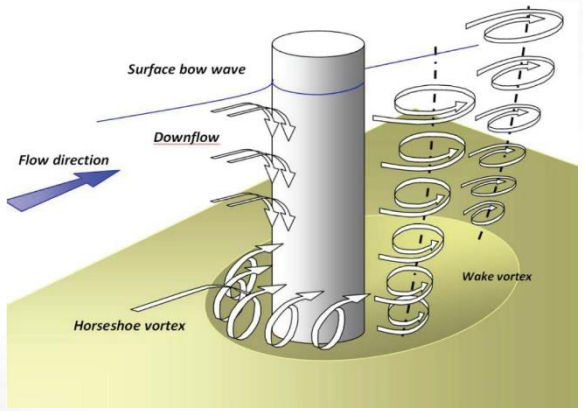

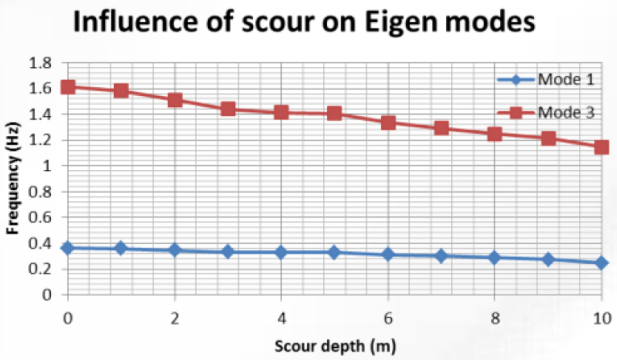

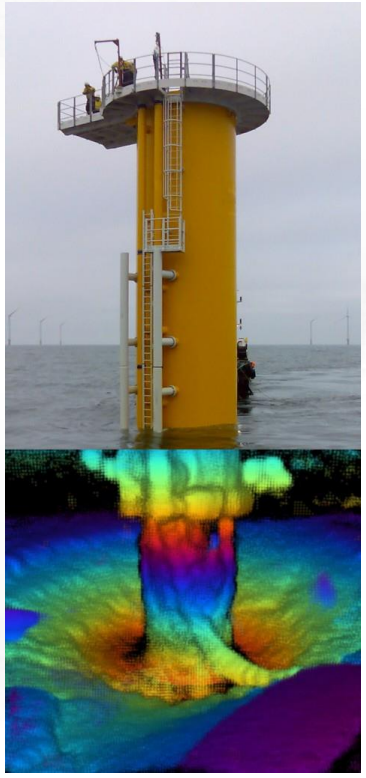

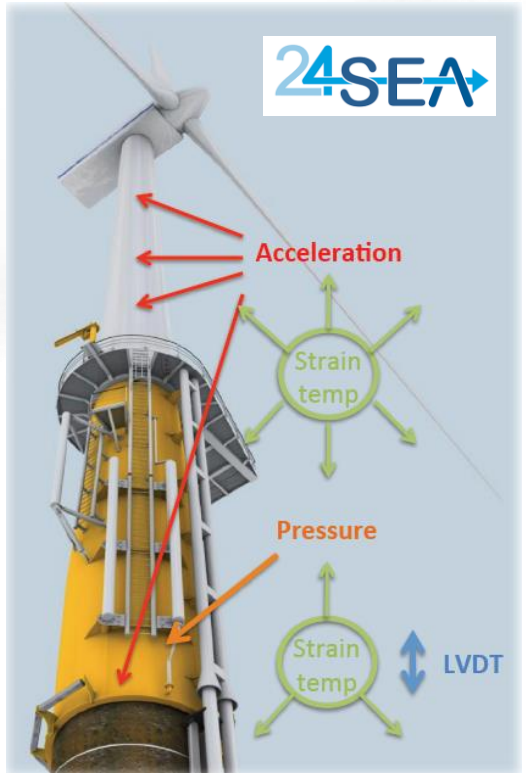

North Sea

- Ice induced vibrations a problem?
- Load data for design optimization
- Ice scouring a problem?

Offshore cold climate ?

Liberty ship - cargo ship US Army World War II – link
"well-known and dramatic example of the brittle fracture of steel that was thought to be ductile"

Contact person & more information

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