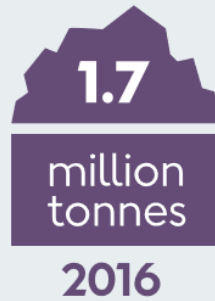


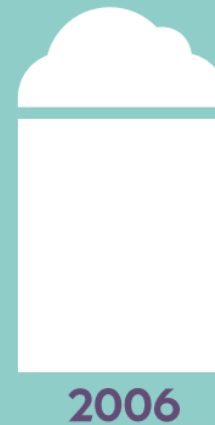
The Suction Bucket Jacket

Dansk Ståldag 2017



We're bidding
farewell to
coal in 2023

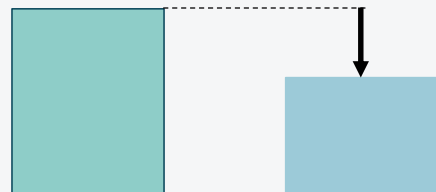
...and saying
goodbye to CO₂



Rationale for the suction bucket jacket

Why develop the suction bucket jacket?

Contribute to reduce CoE

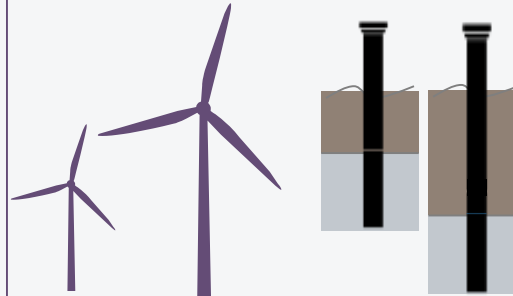


2012

2020

- New technologies must be developed to meet the CoE target

Increased requirements



Increased WTC's

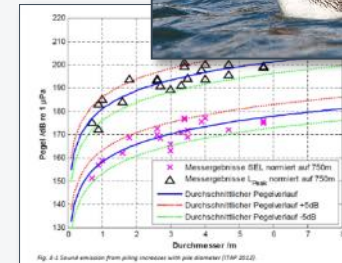
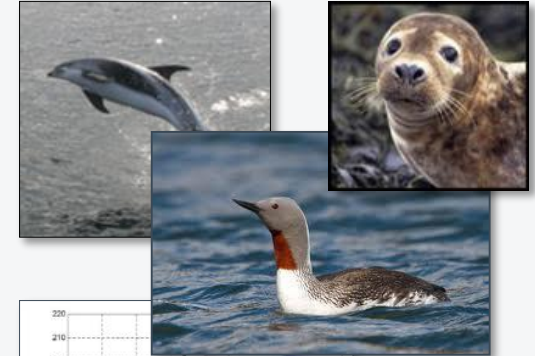
Deeper waters



OWF located further from shore

- Future offshore foundation must adapt to the increased requirements

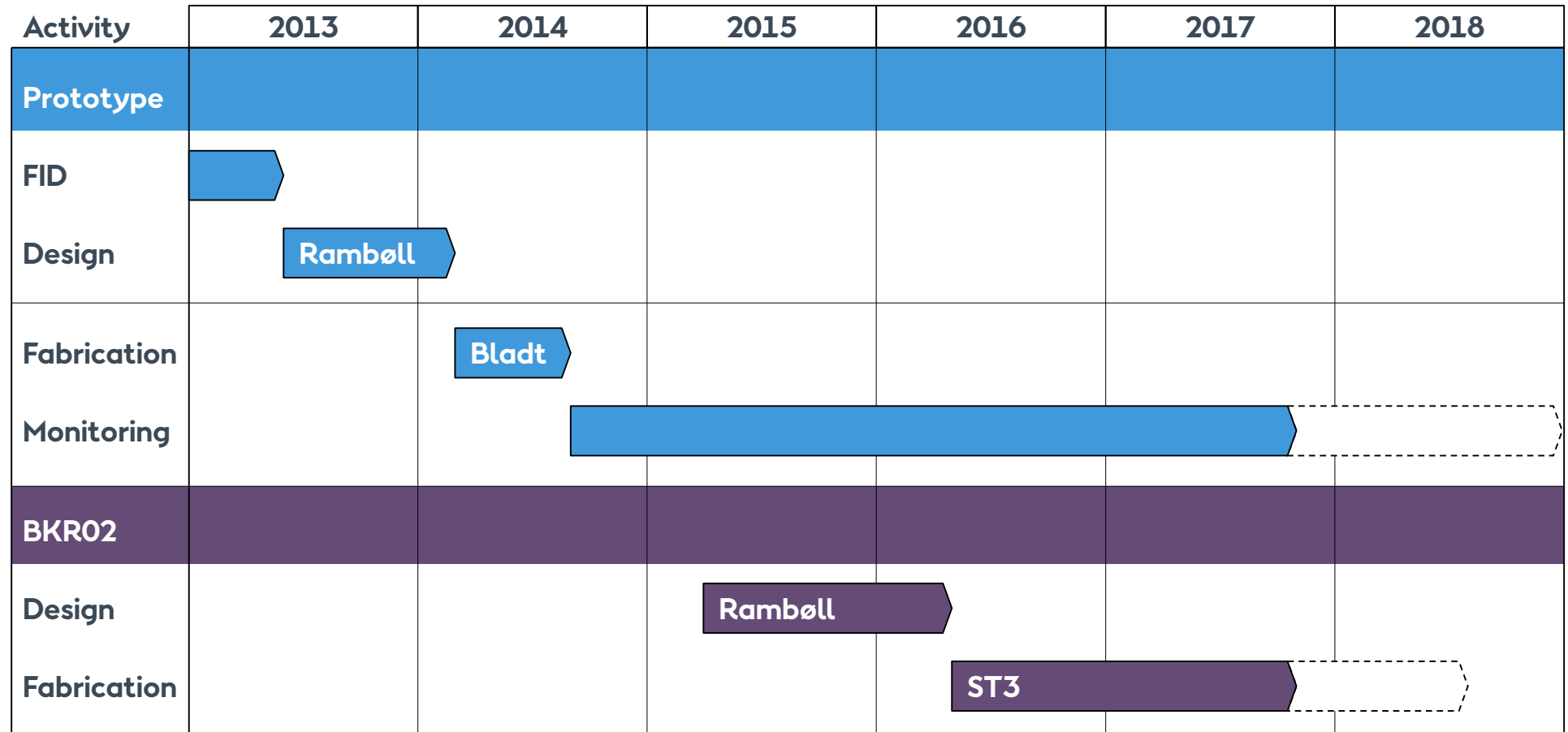
Environmental impact



Underwater noise emission challenge pile installations

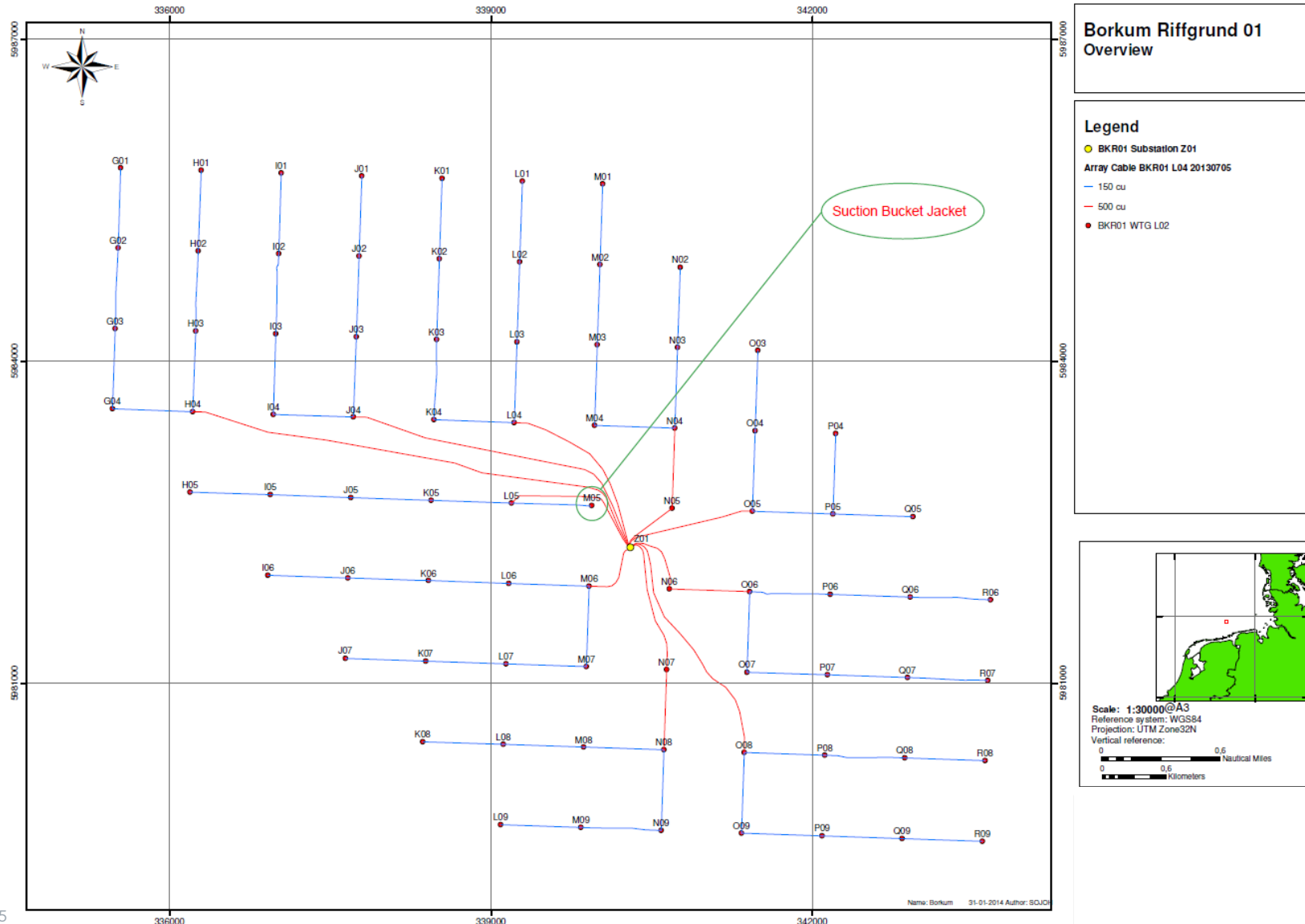
- German noise requirements

Ørsted Suction Bucket Timeline



Suction Bucket Jacket prototype project

Location of the SBJ on Borkum Riffgrund



Introduction to the suction bucket jacket

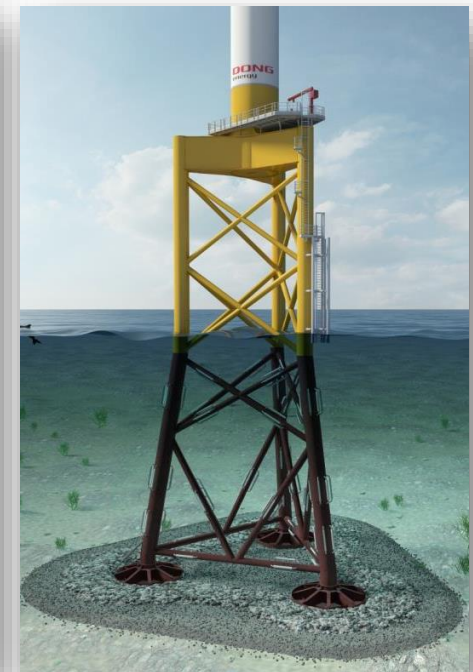
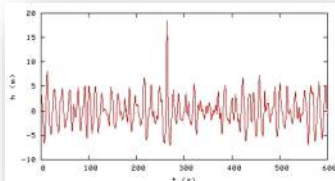
Jackets on suction buckets in brief

- A jacket is a welded tubular space frame with three (or more) legs with a bracing system between the legs
- The jacket is normally anchored by 40-60 m long piles driven into the seabed
- Inspired by the offshore oil and gas industry, DONG Energy has developed a jacket anchored by suction buckets
- The installation method is simple and generate only negligible noise level from the suction pumps

Offshore Oil & gas example: The Draupner platforms



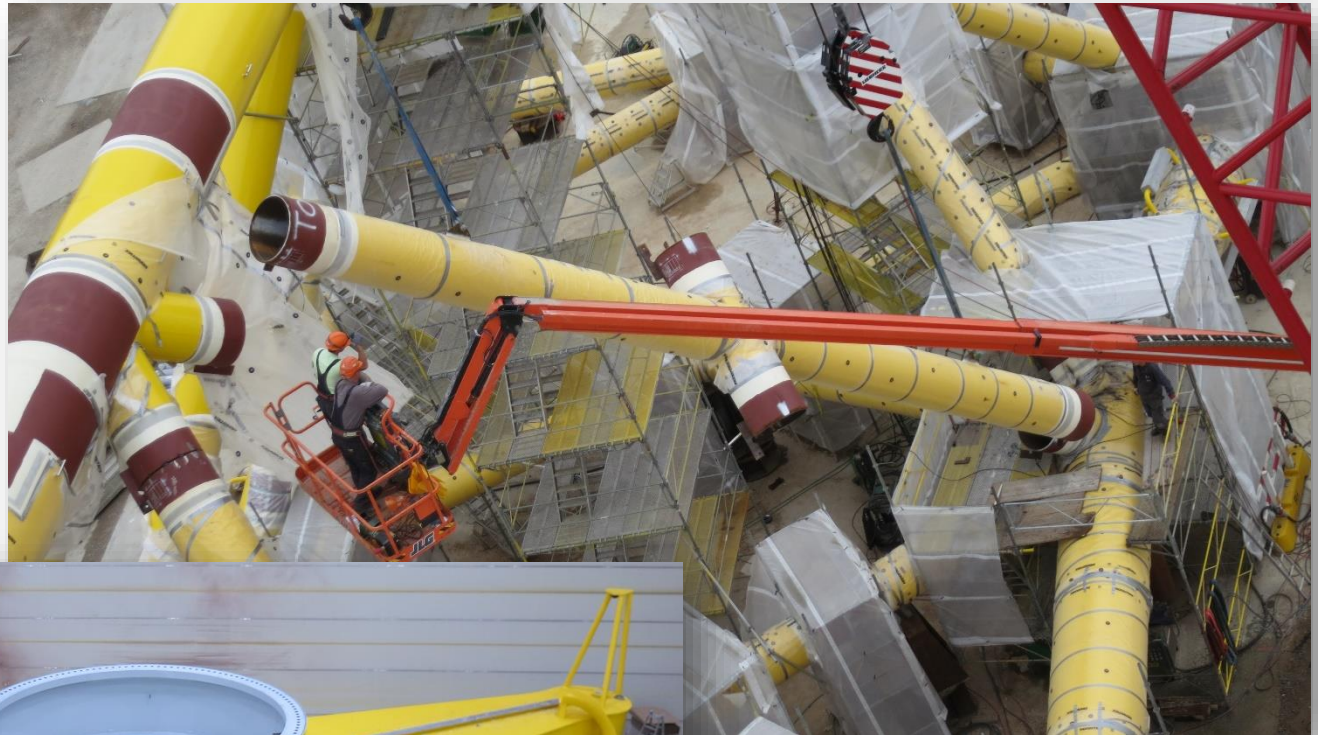
1 January 1995: 25.7m monster wave hits the Draupner platforms



Fabrication – Prototype – Bladt in Aalborg



Fabrication – Prototype – Bladt in Aalborg

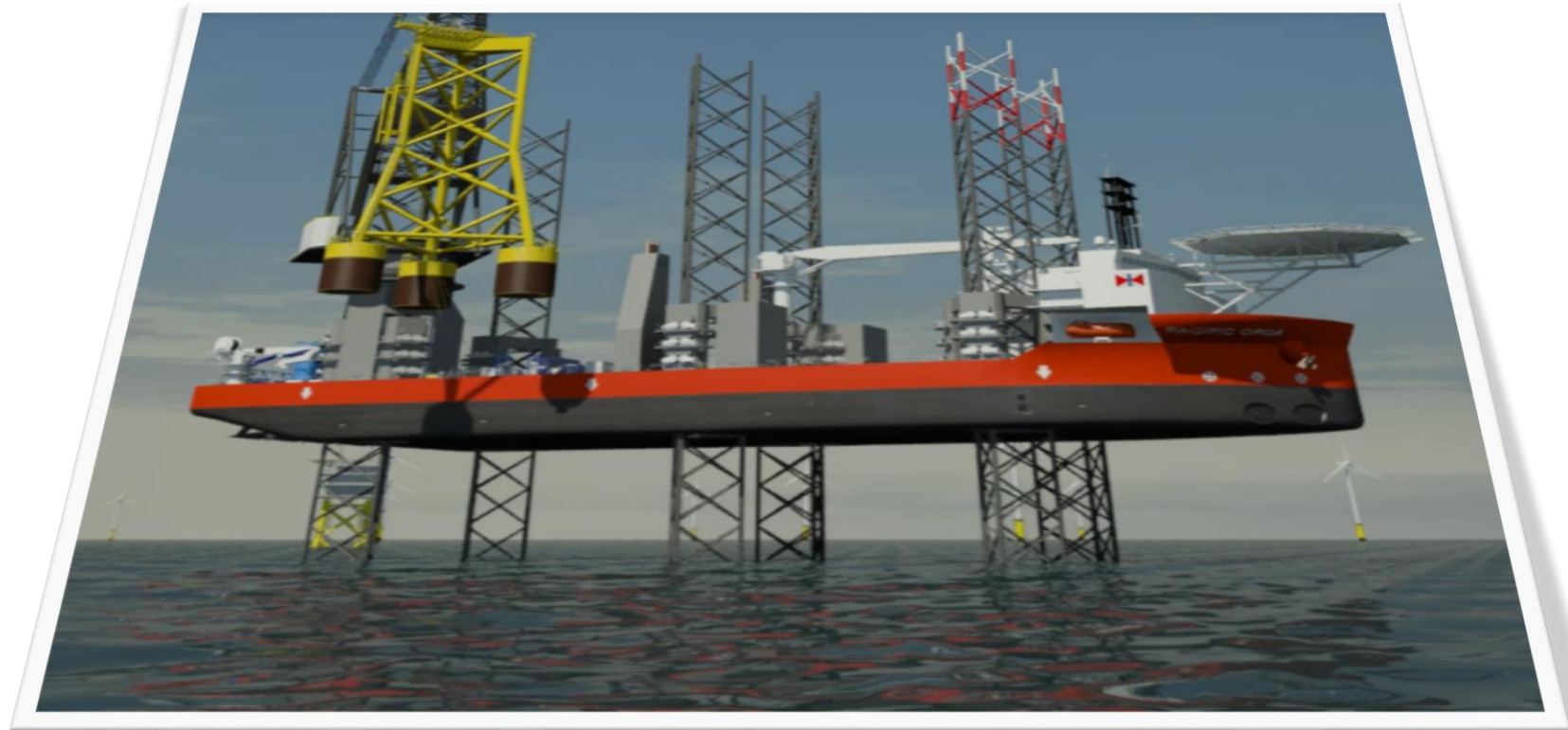


Upending of Jacket – 12 August 2014

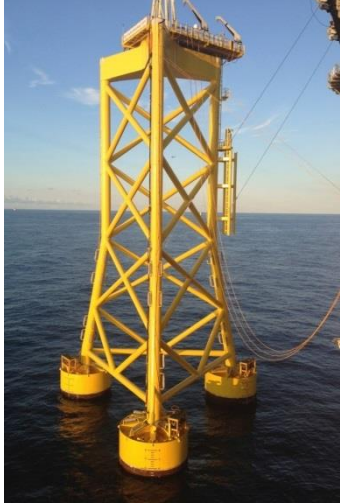


Suction Bucket Jacket

3D animation film – Installation process



Suction Bucket Jacket Installation



Low Noise Installation Method

Offshore-Windpark „Borkum Riffgrund 1“

Hydroschallmessungen während der Installation einer OWEA Gründungsstruktur mittels eines Suction Buckets

Messbericht

Version 1

Projektnummer: 2381-14

Bearbeitung: Patrick Remmers, B. Eng.
Dr. Michael A. Bellmann

15. Dezember 2014

Umfang: 22 Seiten Bericht

itap
INSTITUT FÜR TECHNISCHE ACOUSTIK UND ANGEWANDTE PHYSIK GMBH

Messstelle nach ISO 9001:2008
für Geräusche und Erschütterungen
Akreditiertes Prüfaboratorium nach
ISO/IEC 17025
Akreditiert durch:

DAKKS
Deutsche
Akreditierungsstelle
D-PL 34102-01-00

Telefon
(0441) 57061-22
(0441) 57061-0

Fax
(0441) 57061-10

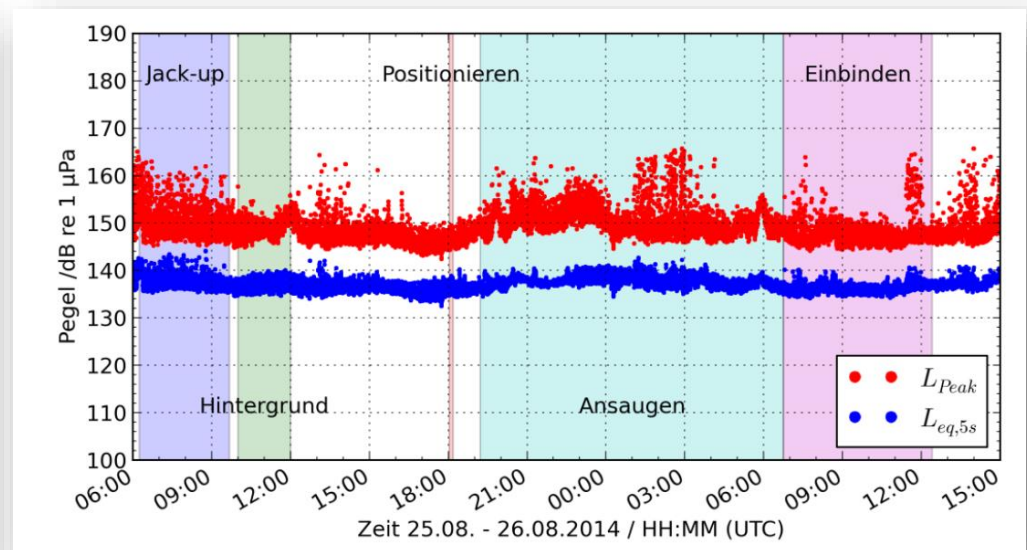
Email
info@itap.de

Postanschrift
Marie-Curie-Strasse 8
29129 Oldenburg

Geschäftsführer
Dr. Manfred Schulz-von-Glahn
Dipl. Phys. Hermann Remmers

Büro
Marie-Curie-Strasse 8
29129 Oldenburg
Angelegend Oldenburg
HRS: 120 607

Bankverbindung
Raiffeisenbank Oldenburg
Hitz- Nr. 60 088 000
BLZ: 250 602 28



Kontinuierliche Pegelerhöhungen bedingt durch den eigentlichen Installationsprozess der Suction Bucket Jacket Konstruktion konnten nicht registriert werden. Zeitweise wurden Schallimpulse registriert, die vermutlich durch Erschütterungen der Jacket-Konstruktion während des Einbindens entstanden sind. Diese unterscheiden sich jedoch kaum von denen, die durch Arbeiten auf dem Errichterschiff z. B. während des Jack-up Vorgangs ins Wasser eingetragen werden. Es handelt sich somit im vorliegenden Fall um eine lärmarme Installationsvariante.

Suction Bucket Jacket prototype project

Verification – Monitoring system

Measuring areas

Buckets

- Pore pressure sensors
- Inclinometers
- Accelerometers
- Strain gauge sensors

Structure

- Strain gauge sensors
- Wave radar
- Inclinometers
- Accelerometers

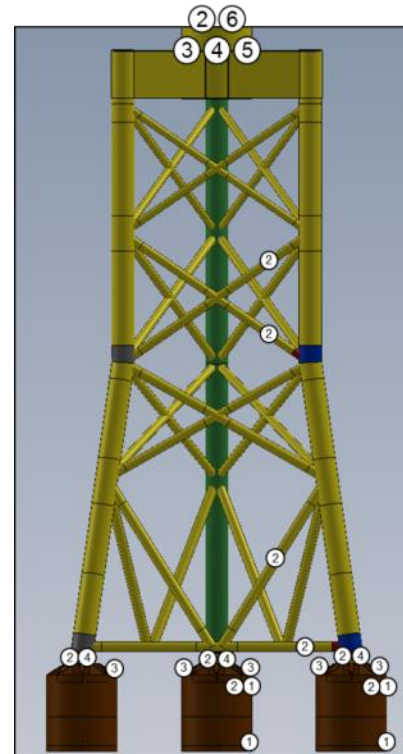
Wind turbine SCADA

- Power, pitch, wind speed, rotor speed, yaw angle, wind direction

Others

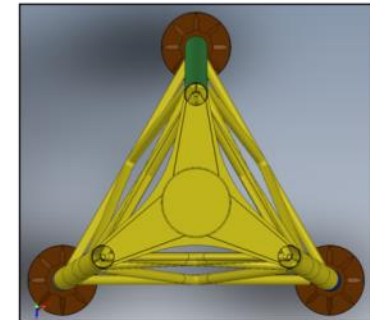
- Water sound pressure measurements during installation
- Scour Protection surveys

Monitoring system



Sensors in the Monitoring system

Measurement	No.
Pore Pressure	1
Strain	2
Inclination	3
Dynamic motion	4
Wave radar (air gap)	5
Signals from turbine	6



Suction Bucket Jacket prototype project

Key learnings from monitoring system

- The monitoring system is performing as desired
- Analysis of measurements will benefit to develop and validate calculation methods

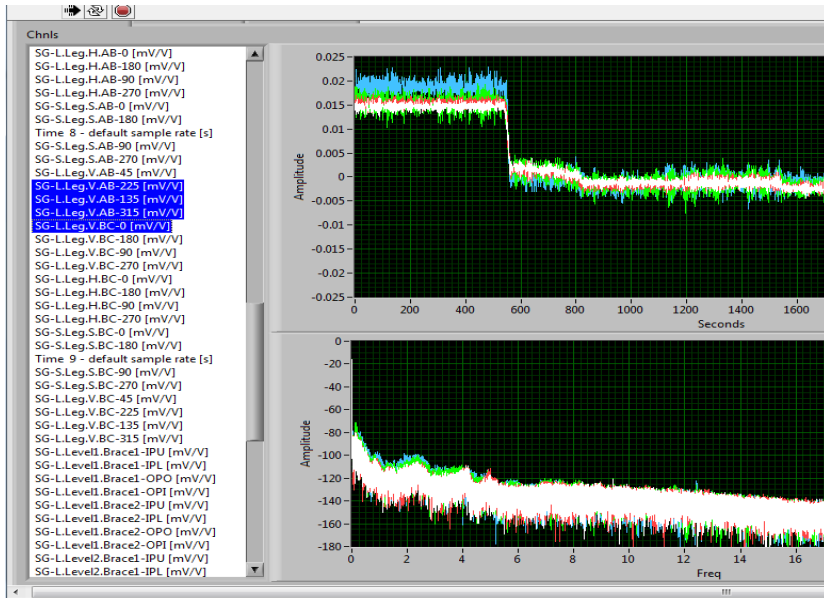


Figure 1, SG measurements from clean section (lower jacket legs), measuring strain in vertical direction during the WTG installation

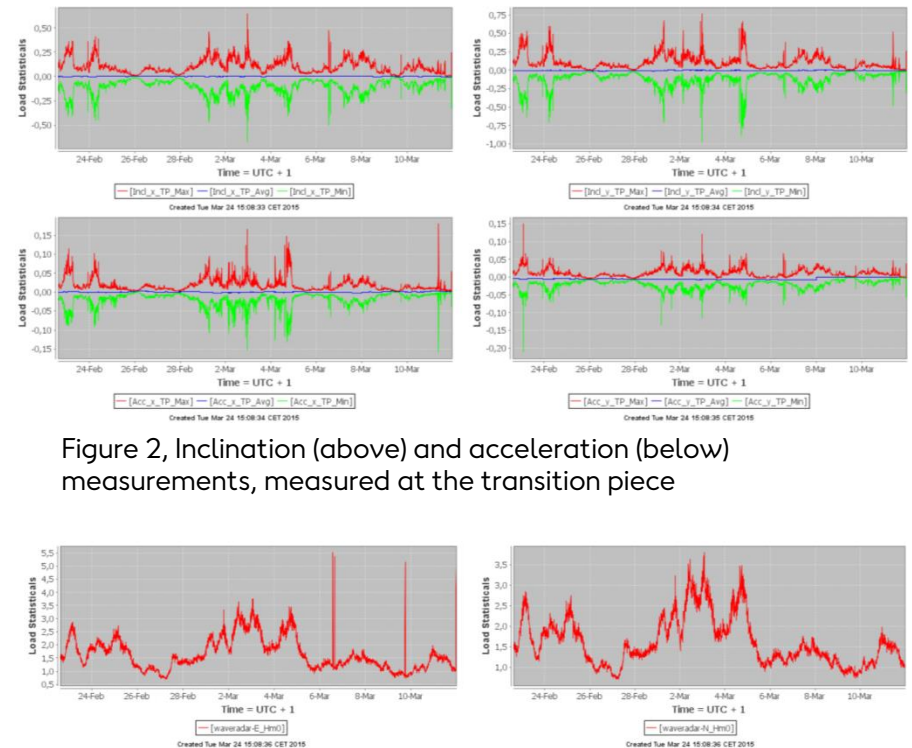


Figure 2, Inclination (above) and acceleration (below) measurements, measured at the transition piece

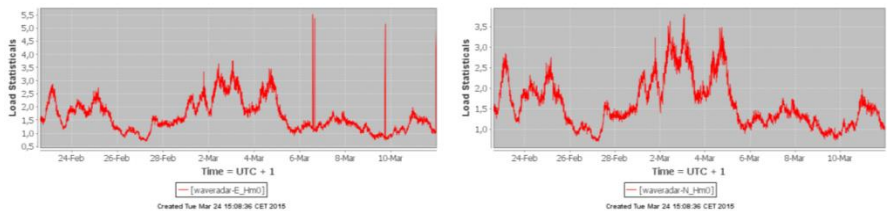
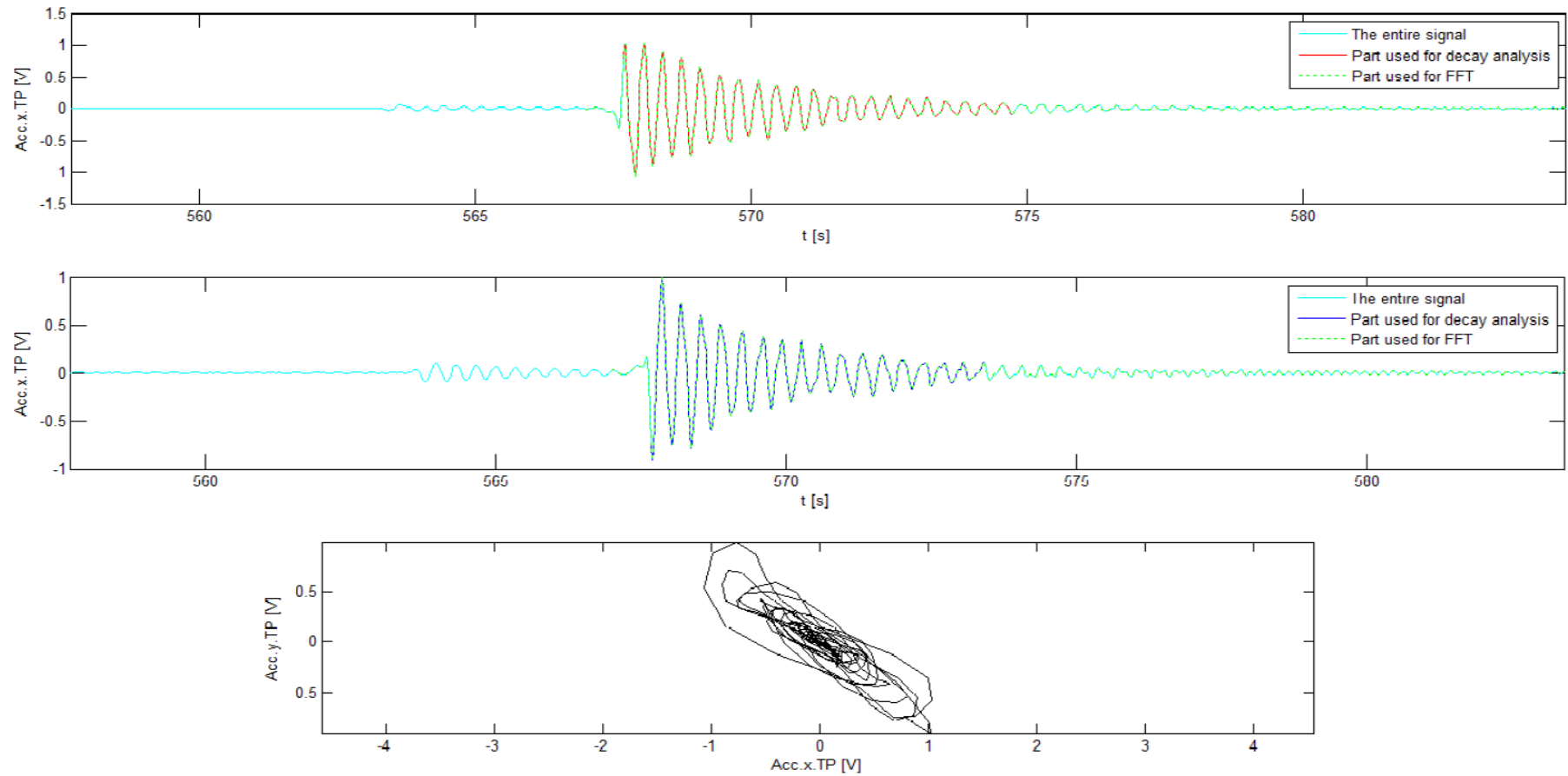


Figure 3, Wave radar measurements from the two wave radars mounted at the transition piece in Northern and Eastern direction

TP accelerations after Crew Vessel Impact



Serial Fabrication of Suction Bucket Jackets at ST3 in Szczecin



Serial Manufacturing - Jig for mounting TP on Jacket



Summary and Conclusions

- Ørsted have successfully installed the Worlds first Suction Bucket Jacket Foundation for a Wind Turbine Generator at the Borkum Riffgrund Offshore Windfarm.
- An extensive measurement system have been installed and data has been analysed and used for BKR02.
- The Suction Bucket Jacket installation was proved to be a "Low Noise Installation Method"
- 20 Suction Bucket Jackets are currently being fabricated in Poland and will be installed in 2018



Thank you

Ørsted