Danish Nearshore Windfams

Introduction to results from seabed investigations

01 Introduction and Overview

Danish Energy Agency
2014-11-27
Seminar → Agenda

1. Welcome by the Danish Energy Agency (Energistyrelsen)

2. Activities and scope of investigations
   - Common to all six sites

3. Results from the individual sites
   - Vesterhav Syd
   - Vesterhav Nord
   - Sæby

4. UXO conditions

5. End of meeting
Seminar → Objectives

1. Introduction to results from seabed investigations 2013 – 2014
2. Aim to give an overview – focus on wind farm sites
3. Dialogue and Questions
1. Welcome by the Danish Energy Agency (Energistyrelsen)

2. Activities and scope of investigations
   - Common to all six sites

3. Results from the individual sites
   - Vesterhav Syd
   - Vesterhav Nord
   - Sæby
   - Sejerø Bugt
   - Smålandfarvandet
   - Rønne Banke

4. UXO conditions

TOPICS
   a. Bathymetry and surface geology
   b. Boulders, Seabed dynamics, Man-made objects
   c. Seabed geology, seismic results
   d. Geotechnical investigations: Boreholes, CPT, pressuremeter tests
   e. Geotechnical results: Geology, in situ tests, laboratory tests
   f. Experiences with jack-up
The Nearshore Windfarm sites

- Smålandsfarvandet
- Sæby
- Sejerø Bugt
- Vesterhav Nord
- Vesterhav Syd
- Rønne Banke
Seabed investigations for offshore wind farms

1. Geological Desk Study
2. Geophysical seabed survey
3. Preliminary 3D ground model
4. Preliminary Geotechnical Investigations
5. 3D Geological ground model
6. Main Geotechnical Investigations
7. Local engineering surveys (archaeology, benthic, UXO)
# Seabed investigations for offshore wind farms

1. Geological Desk Study  
   29/01/2013 Instruction to Energinet.dk
2. Geophysical seabed survey  
   22/05/2014 Results published
3. Preliminary 3D ground model

---

4. Preliminary Geotechnical Investigations  
   12/11/2013 Instruction to Energinet.dk  
   01/11/2014 Results published

---

5. 3D Geological ground model
6. Main Geotechnical Investigations  
   To be clarified by Licensee
7. Local engineering surveys  
   (archaeology, benthic, UXO)
Geophysical seabed survey

- **Purpose**
  - Ensure a basis for EIA and for archaeological assessments
  - Delimit the geographical extensions of the wind farm areas

- **Methods**
  - Bathymetric mapping
  - Seafloor mapping
  - Geological investigations
  - Ferrous and Man-made-objects

- **Contract**
  - EGS International (UK)
Geophysical seabed survey

- EGS Pioneer (24 hour)
  - Length = 24.4m
  - Draught = 3.5m

- Føniks Miljø (12 hour)
  - Length = 18.3m
  - Draught = 1.8m
Geophysical seabed survey

- Bathymetric mapping
  - Kongsberg EM2040 multi-beam echo-sounding
  - Full coverage → DTM with 25cm cellsize
  - Backscatter

- Side Scan Sonar
  - Klein 3000, dual frequency 445kHz and 125kHz
  - 100% overlap → 0.5m x 0.5m x 0.1m (height)

- Magnetometer
  - Geometrics G-882, Screening of ferrous targets in all survey lines
Geophysical seabed survey

- Sub-bottom profiling
  - Single channel system:
    - Knudsen Pinger/Chirp (EGS Pioneer)
    - C-Boom system (Føniks Miljø)
    - All survey lines
  - Multi channel system:
    - Geospark 1000, 24 channel streamer (EGS Pioneer)
Preliminary geotechnical investigations

Purpose:
Establish initial geotechnical data

General scope of investigations in each area:
- 2 sample boreholes and adjacent CPT to 70m
- 5 – 10 seabed CPT to refusal
- pressuremeter tests
- laboratory tests

Performed by:
Fugro Seacore

Period:
April – October 2014
Preliminary geotechnical investigations
Jack up Excalibur
Boreholes and CPT

Fugro Seacore, Excalibur:
• Drilling of sample boreholes
• Pressuremeter tests in sample boreholes
• 20t Top push CPT adjacent to sample borehole, including drillout (locally down the hole CPT)
• 20t single Top push CPT to refusal at CPT-positions in shallow water
Preliminary geotechnical investigations
Fugro Commander
Seabed CPT

Fugro Commander:
• Seabed CPT to refusal
  - 20t Frame
Preliminary geotechnical investigations

Laboratory tests

Classification tests:
• Moisture Content
• Bulk Density
• Dry Density
• Atterberg Limits
• Particle Density
• Particle Size Distribution
• Maximum/Minimum Density
• Saturated Moisture Content

Advanced tests:
• Oedometer Test - Incremental Loading
• Undrained Triaxial Compression Tests without measurement of porewater pressure (UU)
• Anisotropically Consolidated Undrained Triaxial Compression with measurement of porewater pressure (CAUc)
• Isotropically Consolidated Drained Triaxial Compression with measurement of Volume Change (CID)

Chemical tests, etc.:
• Organic Content
• Sulphate Content
• Chloride Content
• Carbonate Content
• Thermal Resistivity

Cyclic tests:
• Cyclic Triaxial Tests
• Static DSS Tests (Direct Simple Shear)
• Cyclic CSS Tests (Cyclic Simple Shear)
Preliminary geotechnical investigations
Reporting structure and digital deliverables

Digital deliverables:
- AGS data
- CSV files
- Photos of samples
All results published