

# DECOMMISSIONING OF VINDEBY – THE WORLDS FIRST OFFSHORE WIND FARM



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# Agenda

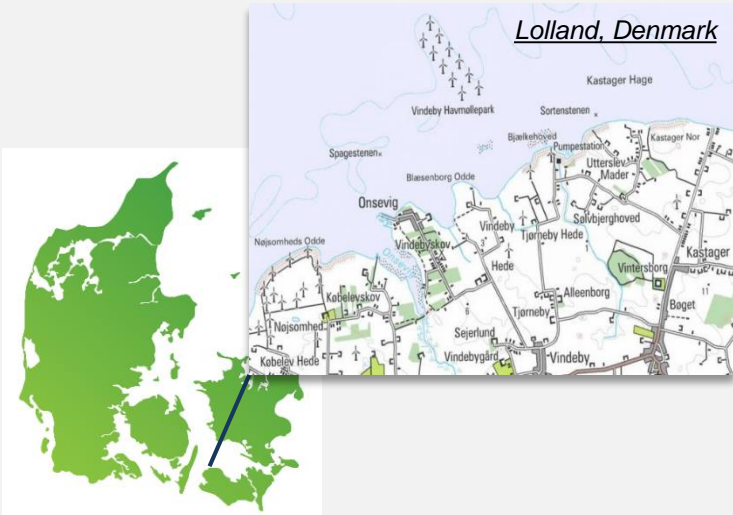
- **Vindeby – the worlds first offshore wind farm**
- **Why decommission Vindeby?**
- **Project timeline**
- **Tender process**
- **The actual decommissioning project**
- **Handling of scrap**
- **Learnings from the project so far**

# Offshore wind started 25 years ago with Vindeby in 1991

- Vindeby was the world's first offshore windfarm
- Key milestone marking the beginning of the offshore wind industry

## Vindeby

- 4.95 MW installed capacity
- Inaugurated September 1991
- Lifetime production: ~ 243 GWh
- Built by Elkraft/SEAS
- Located ~1.5 km offshore near Vindeby Lolland



## Wind turbines

- 11 Bonus 450 kW
- Installed in one piece
- Hub height 35 m
- Blade length 17 m
- Service harbour: Onsevig, Lolland

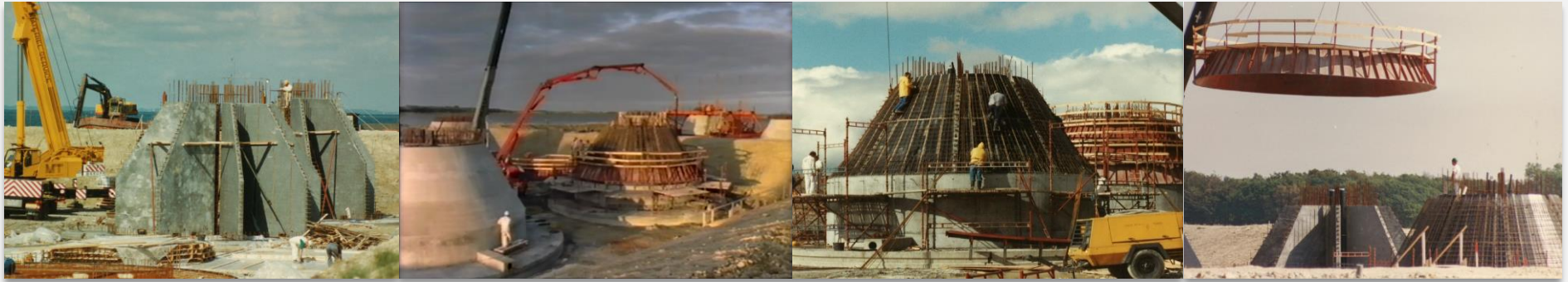


## Foundations

- Gravity based
- 5 m water depth
- Reinforced concrete shell filled with sand
- Weight ~1.500 t (filled) & ~ 500 t (dry)
- Built locally at Onsevig harbour



# Construction of Vindeby 25 years ago



# Why decommission Vindeby ?

## Considerations started early 2015

- The consent was running out 2016 – extension could be applied for
- Most turbines were operational but needing increasing maintenance
- Blades, towers, foundations, cables could continue to produce, but maintenance of i.e. corroding bolts at flange was needed
- Inspection showed need to refurbish gearboxes to continue operation – not feasible given turbine size, power prices and cost of overhaul



# Project timeline

## 2015

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- Jan – First strategic considerations as consent expires Sept 2016
- March – Technical report shows necessity to refurbish gearboxes to continue operation
- September – First talks to Danish Energy Agency on regulatory process
- October – Decision to decommission Vindeby is taken

## 2016

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- January – Contract with NIRAS re. tender material, decom method and scrap/waste management
- April – Invitation to tender
- July – Environmental surveys (flora/fauna)
- August – Contract award
- September – Decommissioning plan and Environmental Statement sent to Danish Energy Agency

## 2017

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- Jan – Approval from Danish Energy Agency (2 rounds)
- March – Start of decom. works
- May – Expected end of works
- June/July – Environmental surveys (flora/fauna/sediment)
- December – Final reporting to Danish Energy Agency

## 2020

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- June/July – Environmental surveys (flora/fauna)

# Tender process

- Attention from many bidders
- 10 suppliers were invited to bid – 6 submitted a bid
- Different technical approaches to this special project due to technology and water depth
- Site visit was offered to introduce suppliers to the site etc.
- Scrap required to be handled by certified contractors
- SSE was awarded the contract in August 2016



# Decommissioning method proposed by SSE

- SSE – Turn key contractor
- Subcontractors to SSE:
  - BMS (Krangården) – Lifting services
  - Connected Wind – Turbine decommissioning
  - Barslund – Foundation decommissioning

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- Decommissioning method

**Turbines:** *Take down one blade first, then nacelle with 2 blades and finally the tower*

**Foundations:** *Open from the top, pump up ballast consisting of marine sand onto a barge and sail to position where it can be discharged into the ocean again.*

*Foundations will be cut into smaller pieces and lifted onto barge and sailed to Nyborg harbour for further treatment using known procedures for scrapping concrete as bridges etc.*

**Cables:** *To be pulled directly up from seabed and rolled onto a hydraulic cable drum or cut to smaller pieces*

**Handling:** *All parts will be placed on a barge and sailed to Nyborg for further treatment*

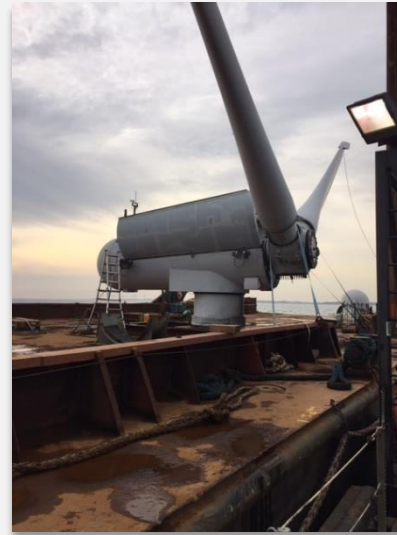


# Removal of onshore facilities by SEAS-NVE\* - February 2017

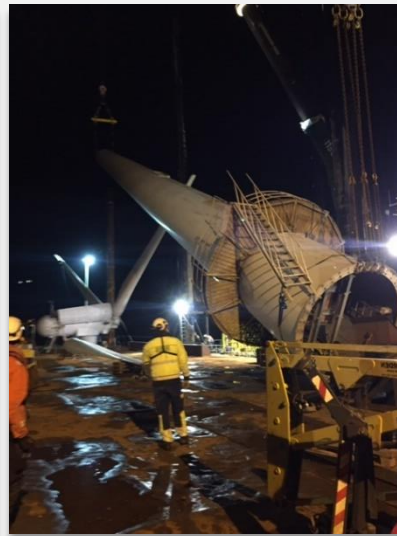


\*Offshore and onshore cables property of SEAS-NVE

# Dismantling of turbines



- Blade length: 17 m
- Blade weight: 2.2 t
- Hub height: 37.5 m
- Nacelle weight: 27.6 t
- Tower weight: 20 t

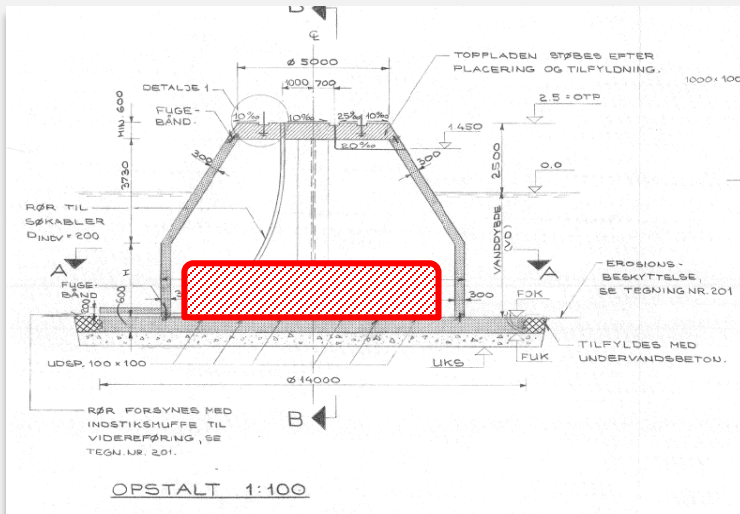


# Dismantling of turbines

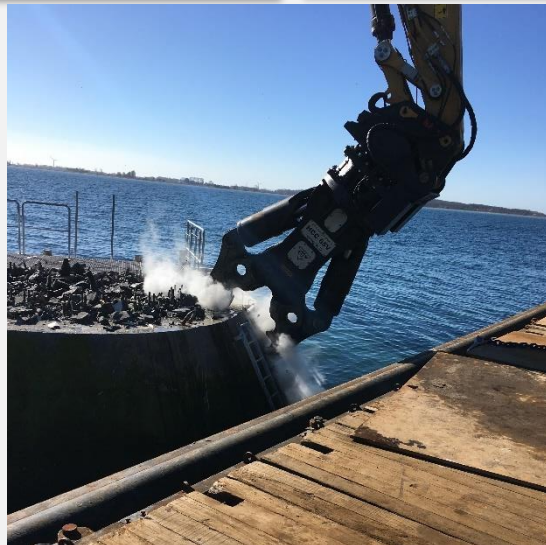


# VINDEBY DECOMMISSIONING

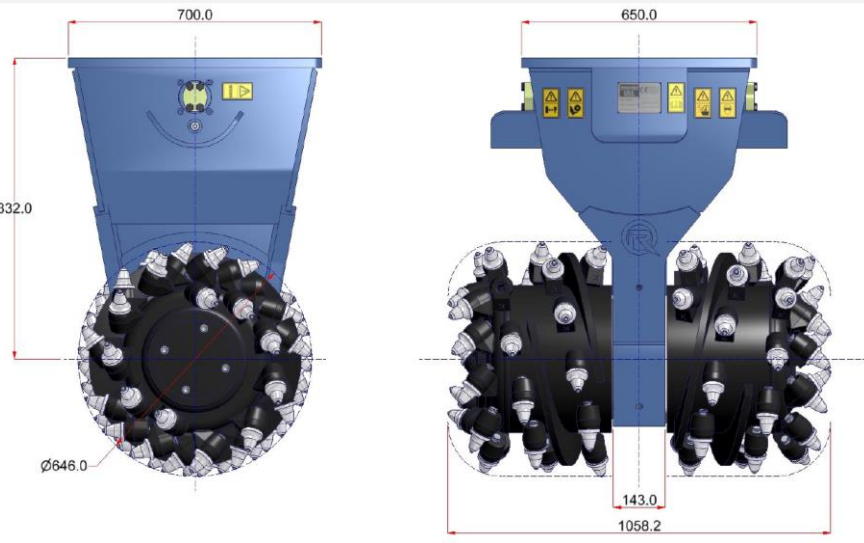
# Dismantling – Foundations (start week 14 2017)



- Conical reinforced concrete gravitation foundations
- Concrete compressive strength 77,9 MPa Hub height: 37.5 m
- Cylindrical part on top of bottom plate with a diameter of 10 m
- Bottom plate with 14 m in diameter and a thickness of 60 cm
- Foundations divided into eight internal chambers filled with marine sand
- Weight ranges between 710 and 1105 t with ballast (366 and 559 t without)



# Dismantling – Foundations with Drum Cutter



# Dismantling - Cables

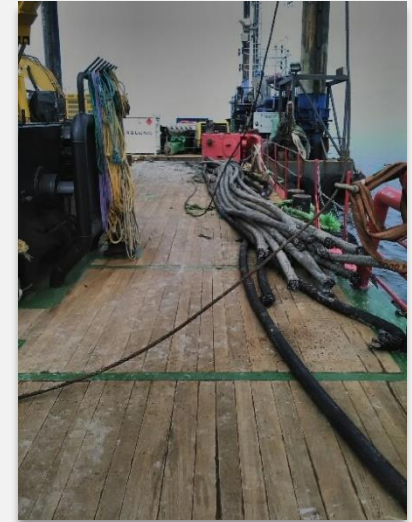
Cables to be pulled directly up from seabed and rolled onto a hydraulic cable drum or cut to smaller pieces



*Multicat vessel with a cable drum*



*Cable cutting*



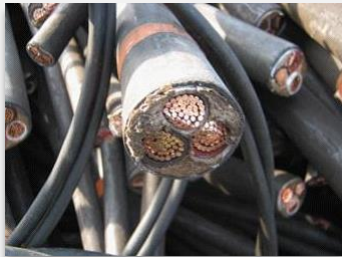
*Cables on deck*

- Array cables and export cable - 12 kV, 3x150mm<sup>2</sup> PEX-Cu-LRT subsea cable with 4 optical fibres
- Reinforced with zinc threads and asphalt
- 3 km array cables and 3 km export cable both buried to a depth of 1 m below sea level
- Export cable is from 1.5 m water depth and to shore covered by concrete slabs
- The array cables are at the cable entrances at the turbines covered with rocks and sandbags

# Handling of scrap

- All non-reusable components will be disposed of by certified companies that can handle the scrap fractions that will be present

Cables and Electrical components





Metal and Concrete





Blades



# Much effort has been put into influencing best practice in e.g. recycling & durability testing

- 1 **miljøservice**  
...en del af naturens kredsløb  
Marin fouling/macroalgae
- 2 **LM WIND POWER**  
Blades for testing
- 3 **SIEMENS**  
Siemens Wind Power  
2 piëcs gearboxes for test and exhibition
- 4 **ENERGI MUSEET**  
1 piece complete turbine for exhibition
- 5   
ØSTFYN GENVINDING APS  
Concrete
- EKOKEM**  
Saving natural resources  
Contaminated concrete
- Nyborg Jernhandel**  
v. Jesper H. Pedersen ApS  
Iron reinforcement
-   
**H.J.HANSEN**  
Udvikling gennem generationer  
Metal and steel



- 6 **Miljøskærm**  
Reuse of blades
-   
7 **CONNECTED**  
WIND SERVICES  
2 complete turbines for spare parts and recycling
- 8 **DTU** Technical University of Denmark  
Test of blades, gear boxes and concrete
- 9   
**HEMPEL**  
Inspection of paint and surface protection
- 10 **CLEMCO**  
DANMARK  
Inspection of paint and surface protection
- 11 **DONG energy**  
Examination of cable parts



# Learnings from the project so far

- Plan ahead – options close the closer to decommissioning you get
- New regulatory processes take time – close interaction was needed
- Decommissioning of offshore wind is an immature market
  - different approaches and prices  
*(Vindeby is a very special case due to technology and water depth)*
- Market innovation is needed within decommissioning
  - Dismantling methods and logistics – monopiles will become large market
  - Methods and market for resale, reuse, scrapping of turbines, towers, foundations
  - New solutions for fibreglass blades are needed – large quantities in big batches will be coming in the future

**Thank you**



**DONG**  
energy