

Installation Example



Offshore wind farm design OE5662

DUWIND

Royal Boskalis Westminster NV

- Largest Dredging Company in the World



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Royal Boskalis Westminster NV



Offshore wind farm design OE5662

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Royal Boskalis Westminster NV

- Largest Dredging Company in the World
- “We move the Earth to a Better Place”

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Royal Boskalis Westminster NV

- Largest Dredging Company in the World
- “We move the Earth to a Better Place”
- Boskalis Offshore

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Boskalis Offshore



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Boskalis Offshore



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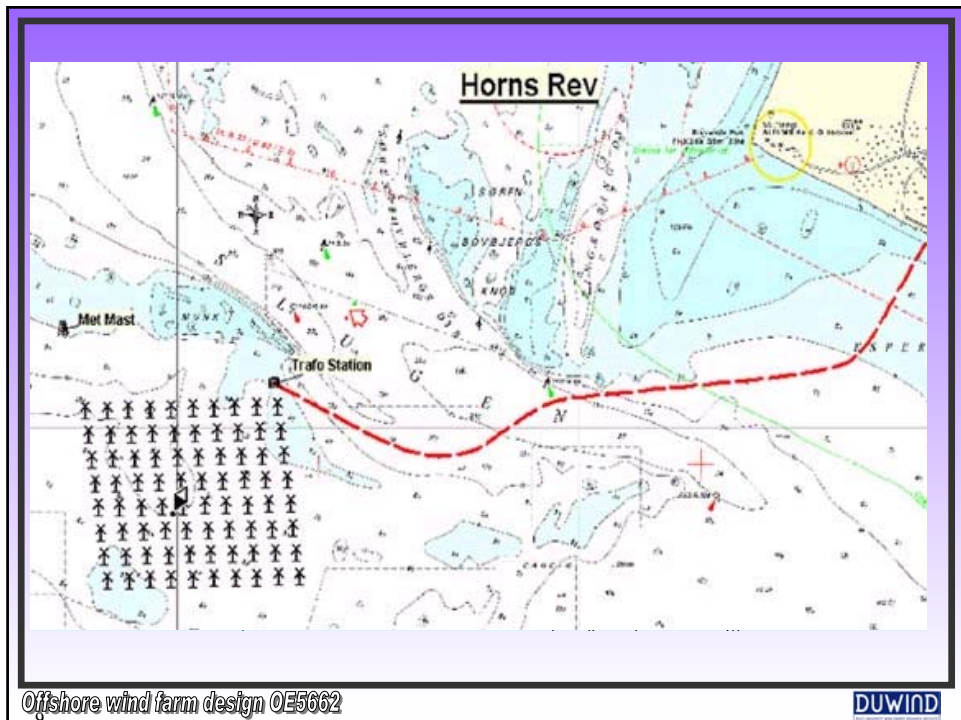
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Don't miss the boat:
Offshore Wind



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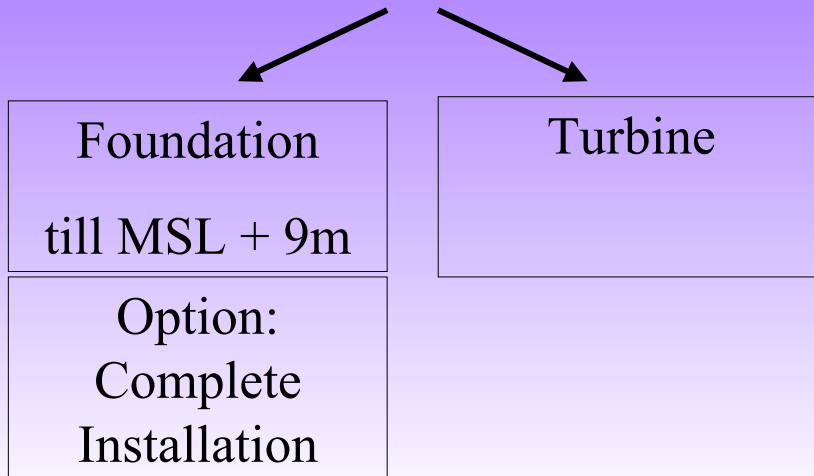
Denmark's Targets

Elsam: park owner

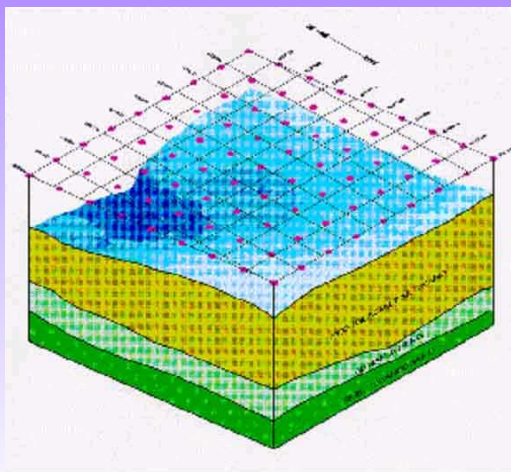
Eltra: distribution



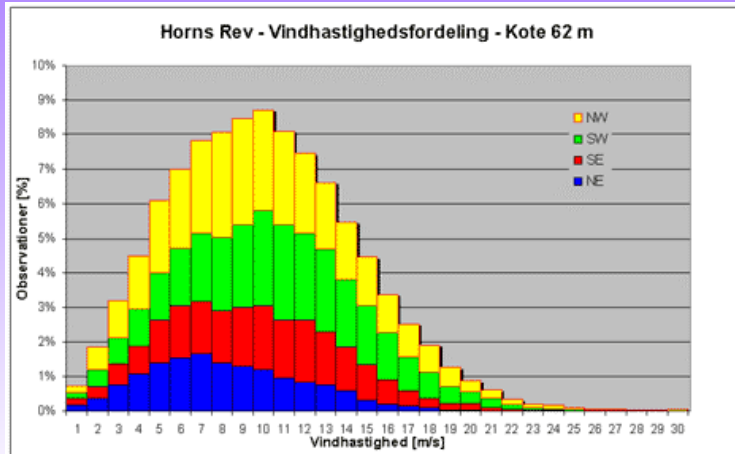
Tender



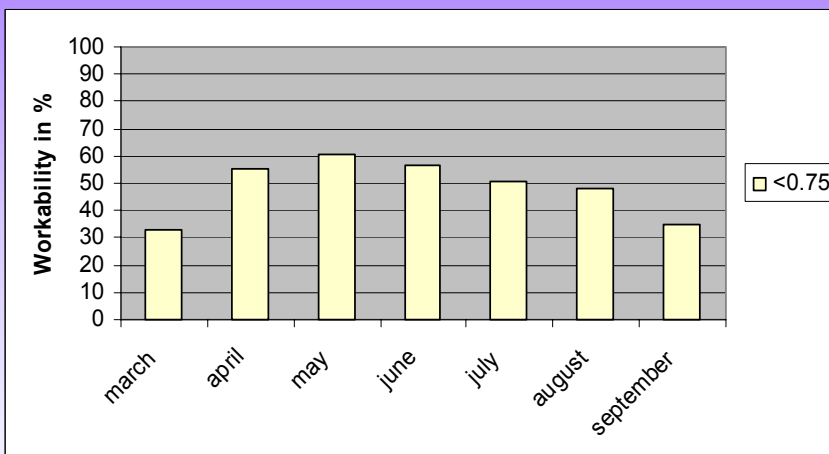
Site Information



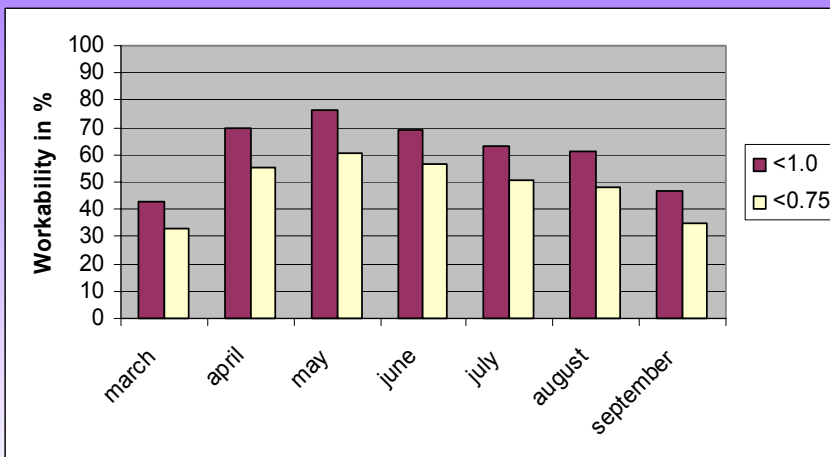
Site Information



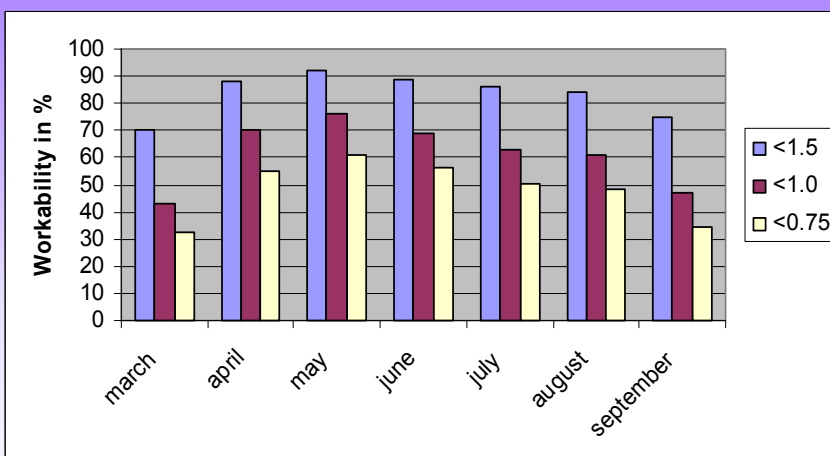
Site Information



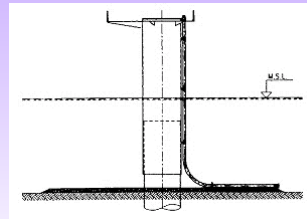
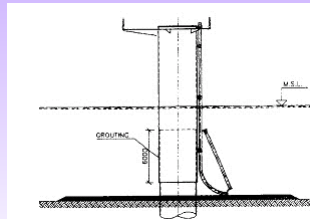
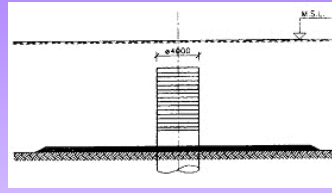
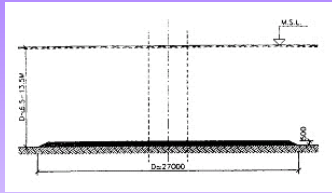
Site Information



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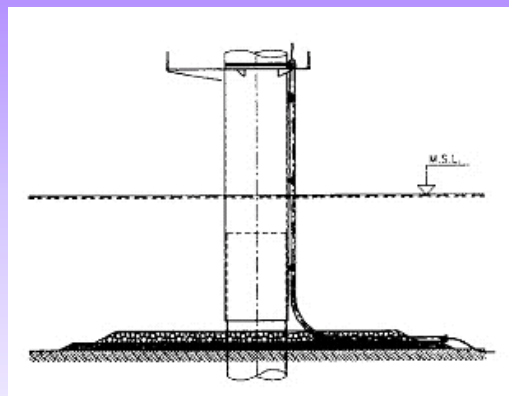
Reference Design



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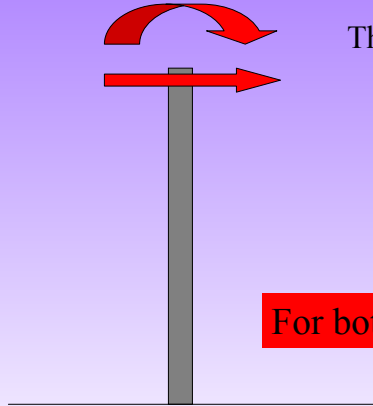
Reference Design



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Reference Design



The only interaction between support structure and turbine:

Force $F = \dots$ kN

Moment $M = \dots$ kNm

For both: 2 different values!!!

Options

Installation - Structure

Reference design: not an option



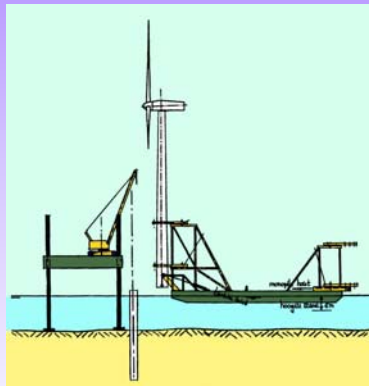
Options Installation - Structure

Design Drivers:

- use own equipment
- most assembly onshore
- the structure should fit the installation procedure

Options Installation - Structure

Jack-up + Barge



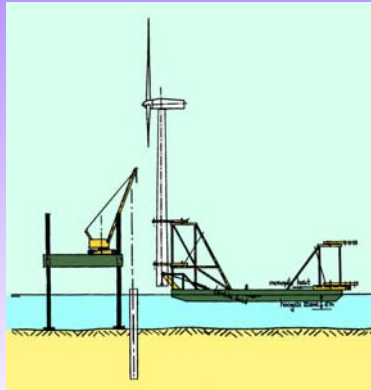
Own equipment

Installation onshore

Structure fit procedure

Options Installation - Structure

Jack-up + Barge



Own equipment

Installation onshore

Structure fit procedure

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Options Installation - Structure

Seahorse



Own equipment

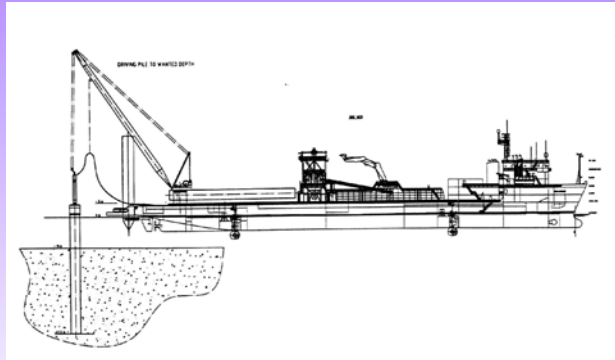
Installation onshore

Structure fit procedure

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Options Installation - Structure Seahorse



Own equipment

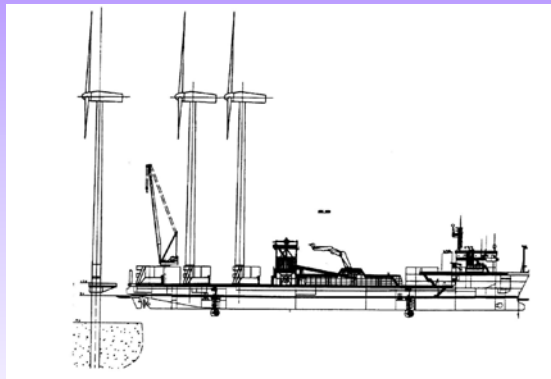
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Options Installation - Structure Seahorse



Own equipment

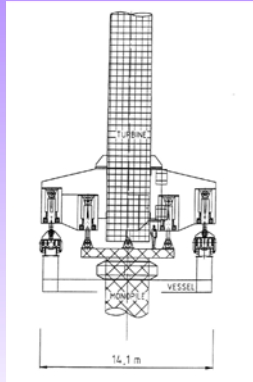
Installation onshore

Structure fit procedure

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Options Installation - Structure Seahorse



Own equipment

Installation onshore

Structure fit procedure

Options Installation - Structure Problems

Going from the floating world to the fixed world

Own equipment

Installation onshore

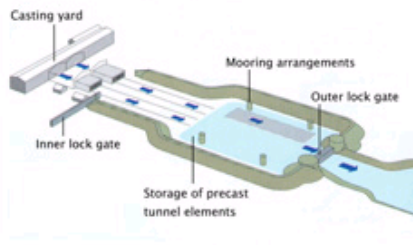
Structure fit procedure



Øresund



Construction Site Øresund Immersed Tunnel



Options Installation - Structure The Sub

Codename: “Gebakje” (piece of cake)

- Pickup entire structure,
- sink the pontoon on site,
- hammer piles,
- sail away.

Own equipment

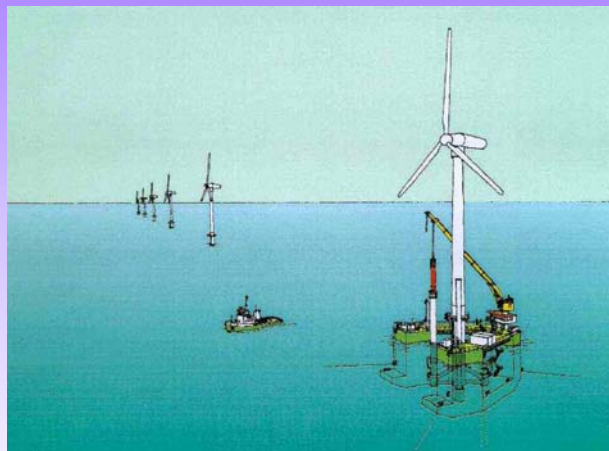
Installation onshore

Structure fit procedure

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Options Installation - Structure



Own equipment

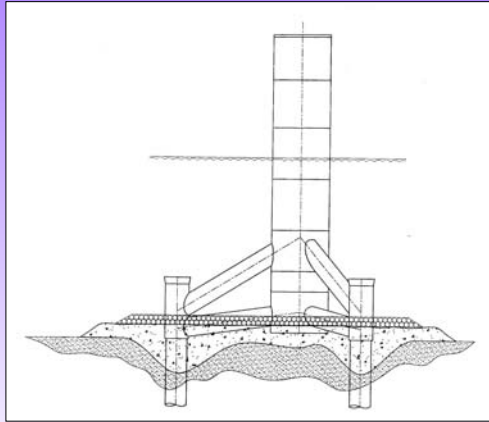
Installation onshore

Structure fit procedure

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Options Installation - Structure

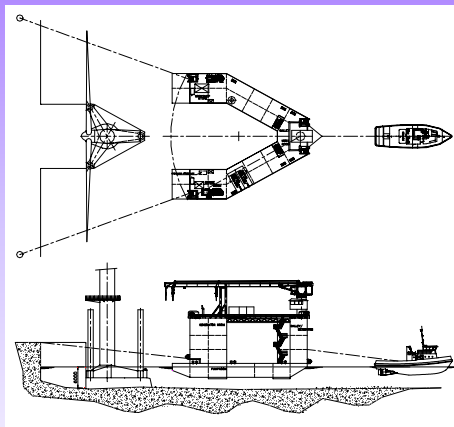


Own equipment

Installation onshore

Structure fit procedure

Options Installation - Structure

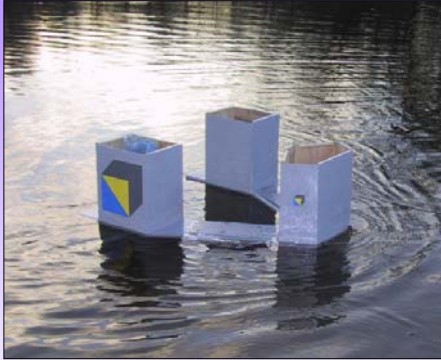


Own equipment

Installation onshore

Structure fit procedure

Options Installation - Structure



Own equipment



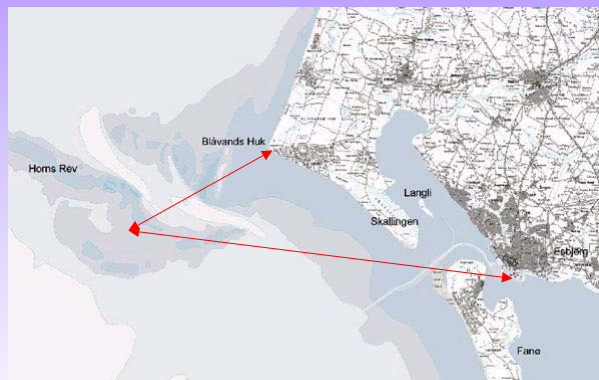
Installation onshore

Structure fit procedure

Installation Sequence

Sailing time?

Distance 10km to shore



Installation Sequence

45 km

dependent on tide?



Installation Sequence

- Impact at touchdown? (max 1.5m Hs)
- Survival at 3m Hs?
- Scour during storm?
- Sail away without collision?
- Vibrations due to hammering of piles?
- Tripod design?
- Pick-up system?

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Qualifications Possible

“Unsolvable”

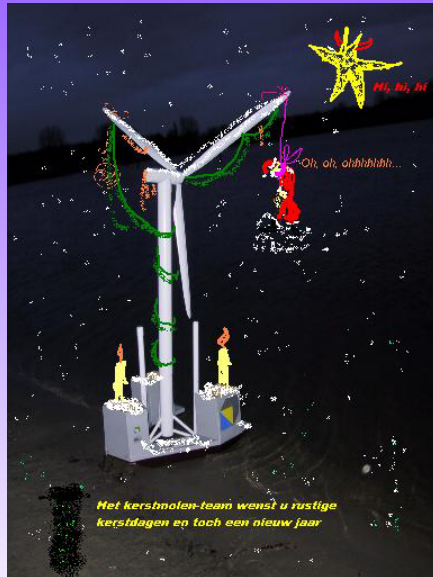
- Installation in 1 season not feasible
- Option was more expensive than monopile

(or was it?)

3 days before tender date

Boskalis decides: NO!

Too much steel
not enough blubber.



And Now?

- of 9 only 2 contractors remained
- they merged
- numerous subcontractors are added

Lessons

- buy a map
- think worst case
- but be optimistic
- strange problems require strange solutions
- cheap is not always best
- integrated design has to be integrated even more