Pushing Offshore Wind Energy Regions (POWER)

POWER Offshore Summer School 2006

INSTALLATION and LOGISTICS of OFFSHORE WIND FARMS

Gerard van Bussel

TU Delft

The Netherlands

Pushing Offshore Wind Energy Regions (POWER)

Offshore transport and installation vessels

- Semi Submersible
- Sheer leg crane
- Ship type with rotating crane
- Jack up barge with land crane
- Self propelled Jack up platform with crane
- Towed floating barges

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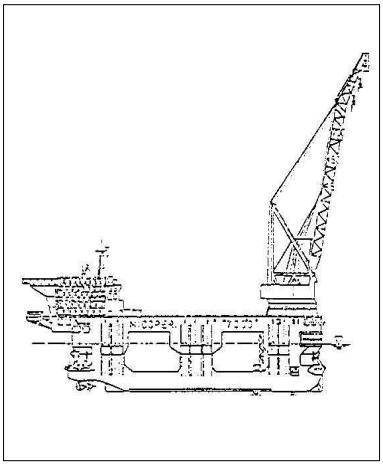
Semi submersible crane vessel



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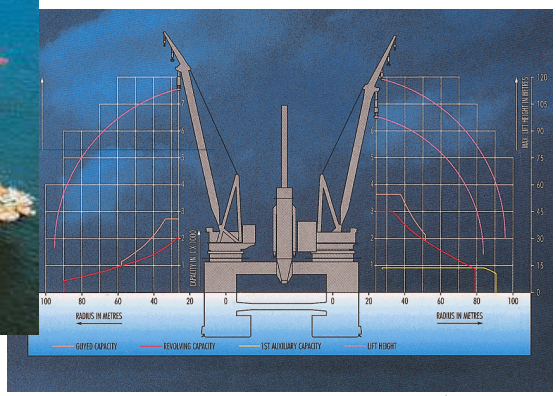
Semi submersible crane vessel



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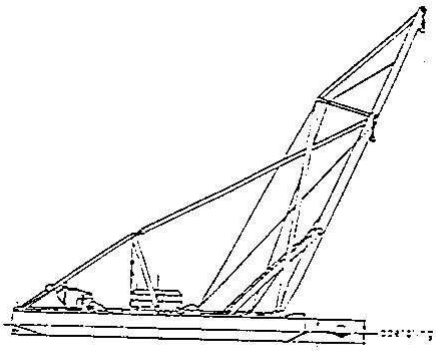
Flat bottom sheer leg crane



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Ship with rotating crane

Arklow bank

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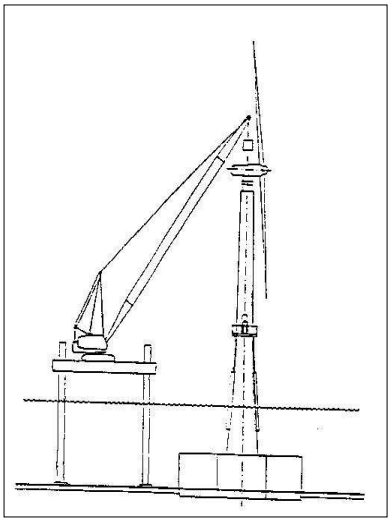
Jack up barge with land crane



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Jack-Up platform (self propelled)

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Installing Gravity Base Structures

Installation:

- Construction in dock
- Float out
- Seabed preparation required

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Gravity Base Structures 2

Construction in dock

Middelgrunden Dk

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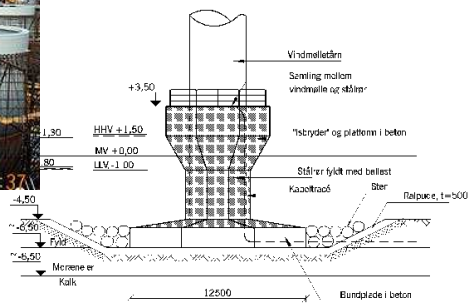
Gravity Base Structures 3

Dock construction



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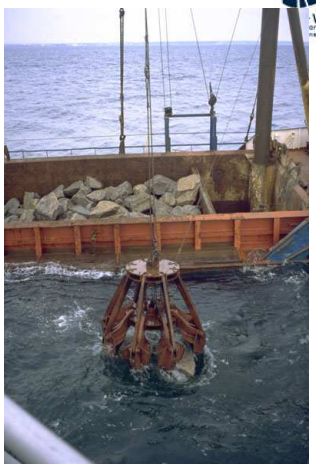
Gravity Base Structures 4

Soil preparation and completion



Gravity Base Structures 5

GBS floating from dock to site

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Installing Monopiles

Installation:

- Drilling or driving of pile
- Option of transition piece
- Tower sections bolted

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Monopile transport

Blyth (UK)

Yttre Stengrunden (SE)

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Monopile installation

Blyth offshore U.K.

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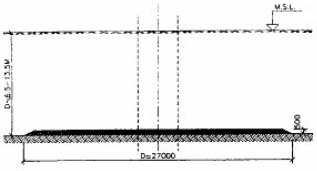
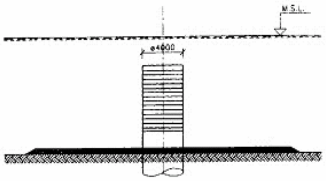
…and completion

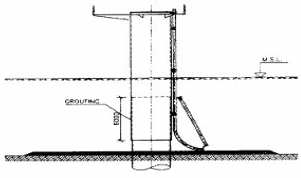
Horns Rev monopile installation sequence



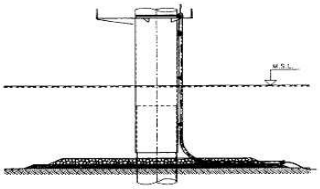
Scour Protection Installation



Driving the Pile



Grouting Transition Piece



Connecting the cable, Armour Rock Layer

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Monopile installation Horns Rev

pile

transition piece

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…and completion

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Suction piles 2

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Wind turbine suction pile foundation

- Single pile
- Shallow water
- Proof of principle (unique so far)

Frederikshaven (DK)

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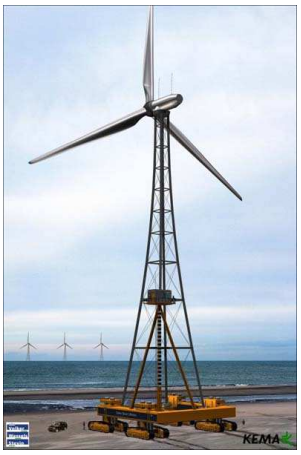
Novel specialties



Smart tower

Hydraulic tower

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Wind turbine installation

The quest for a stable working platform

- no motion relative to the “fixed world”
- high workability
- fast repositioning
- large deck for transport of several turbines

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Wind turbine installation

Floating cranes:

Weather windows

or sheltered waters

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Wind turbine installation 2

Small jack up

with land based crane

Yttre Stengrunden SE

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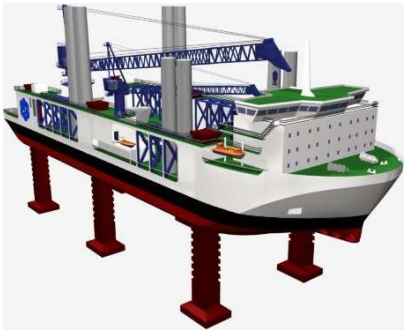
Purpose built vessels



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Purpose built vessel

Small “jack up boat” with crane

Horns Rev DK

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Purpose built Jack up with crane

Arklow Bank (IRL)

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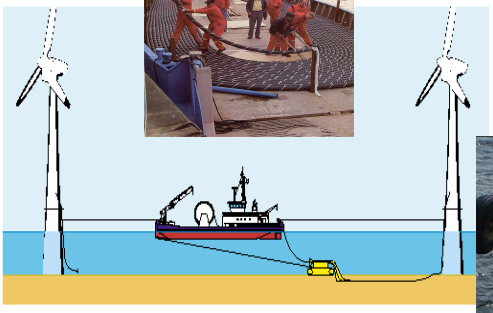
Installation of cables



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Installation of transformer platform

Horns Rev (DK)

Traditional offshore equipment

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Logistics ahead of installation

- Both land and sea transport
- Different solutions for different parts of wind farm (may lead to use of different harbours)
- Large harbour space and manoeuvring space needed for components

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Logistics ahead of installation

Egmond aan Zee (NL)

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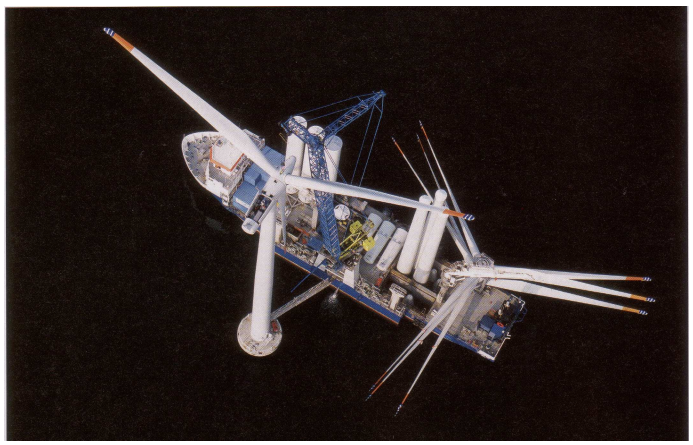
Logistics in installation

Efficiency in sea transport



Nysted (Dk))

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Construction and installation approaches

- Traditional approach (copy of land based approach)
- Parallel construction and installation
- Integrated approach (wind turbine technology and offshore technology integrated)

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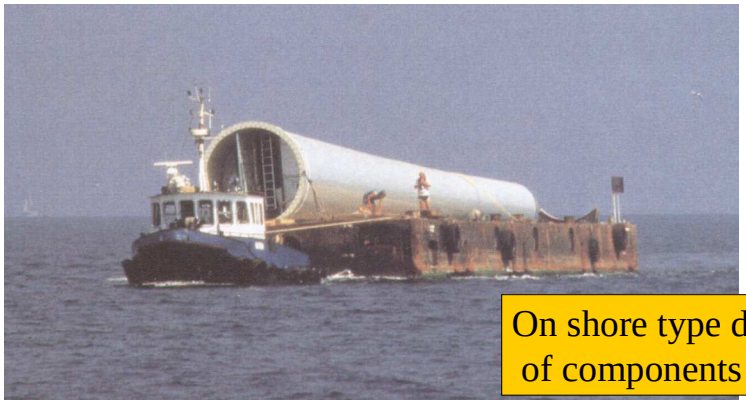
Traditional approach examples

Tunø Knob, DK - Transportation



On shore type delivery of components

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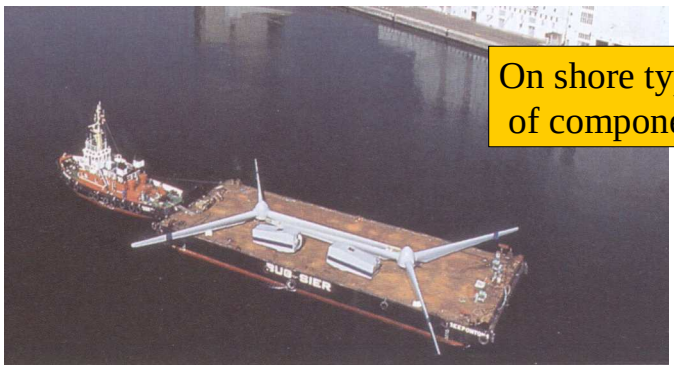
Traditional approach examples

Tunø Knob, DK - Transportation



On shore type delivery of components

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Traditional approach examples

Tunø Knob, DK - Installation

Onshore type installation of tower, …

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Traditional approach examples

Tunø Knob, DK - Installation

…
nacelle
and
rotor.

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Traditional approach examples

Arklow bank logistics

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Pushing Offshore Wind Energy Regions (POWER)

Traditional approach examples

Arklow bank installation

But purpose built jack up

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Traditional approach examples

Arklow bank

…and completion

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Parallel approach examples

Middelgrunden, DK – Installation

Special purpose installation hardware

Transformer + electrical system protected in tower

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Parallel approach examples

Middelgrunden, DK – Installation

But … Onshore type installation of wind turbines

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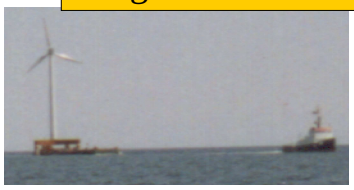
Integrated approach examples

Nogersund, SE – First offshore windturbine (1991)

Onshore commissioning

Integral offshore transport



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Integrated approach examples

Beatrice offshore wind farm (UK)

Offshore transport and installation of jacket

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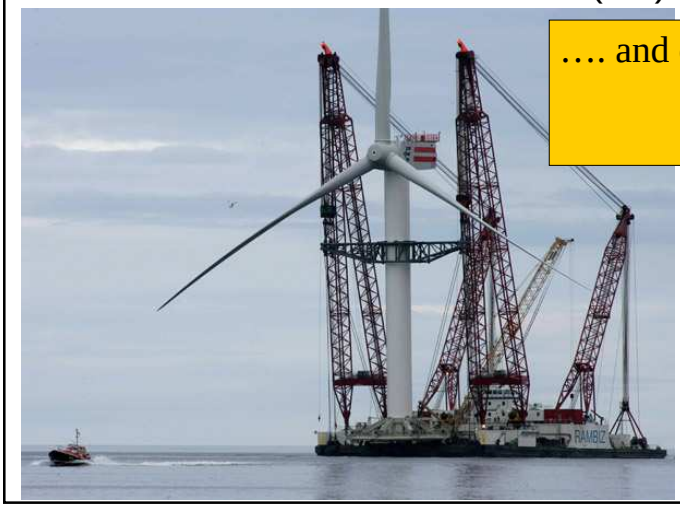
Integrated approach examples

Beatrice offshore wind farm (UK)



…. and offshore transport + installation of windturbine

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Installation and Logistics

- From traditional approach to (more) integrated approach (wind turbine and offshore technology integrated)
- Dedicated installation vessels on the market (water depth's <25 m)
- Logistics improve through experience with realised offshore windpower projects

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