RADICAL CHANGE IN INSTALLING FLOATING WINDFARMS

RESULTING IN BIG COST SAVINGS

FWS

FLOATING WIND SOLUTIONS 2022

MARCH 1-3, HOUSTON

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Equipped for impact

HUISMAN SCHIEDAM

THE NETHERLANDS

MISSION EQUIPMENT FOR THE OFFSHORE WIND INDUSTRY

Heerema – Sleipnir
2x 10,000mt TMC

Boskalis – Bokalift 1
3,000mt OMC

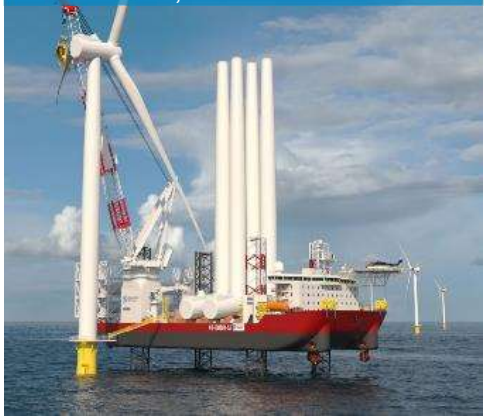
DEME – Flintstone
Deepwater Rock Dumping Unit

Jan de Nul – Vole Au Vent
Ø10m Monopile Gripper

Jumbo – Javelin
2x 900mt HLMC

Seajacks – Scylla
1,500mt LEC

Dominion Energy – Charybdis
2,200mt LEC



Van Oord – TBN
+3,000mt LEC

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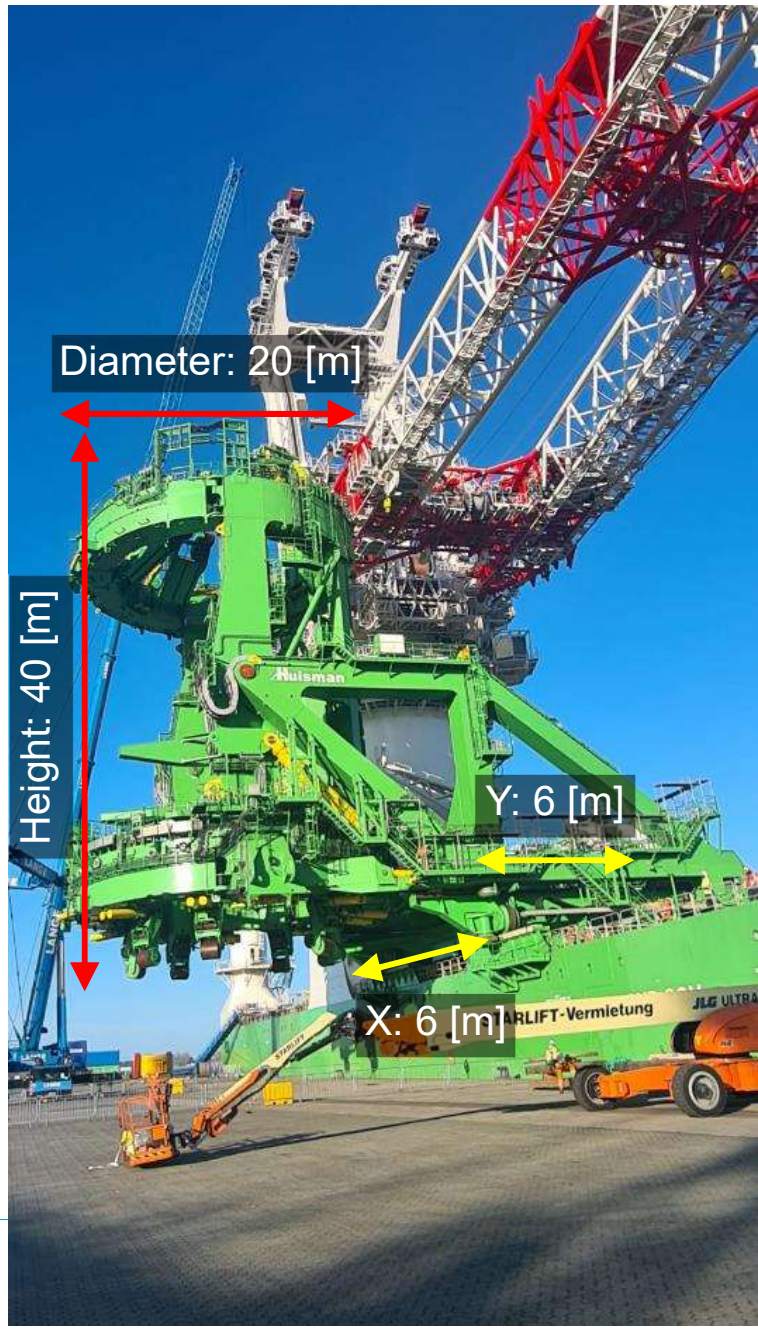
MOTION COMPENSATED PILE GRIPPER

MCPG WITH UPENDING FUNCTION

- Controlled upending of monopile
- Secures monopile in vertical position, installed from floating vessel
- X&Y compensation to compensate for vessel motions
  - X compensation 6 [m]
  - Y compensation 6 [m]



INNOVATIONS TAKE TIME, PERSEVERANCE AND MARKET INPUT

Wind Turbine Shuttle (WTS)

- Designed a decade ago (2009)
- Fast sailing SWATH vessel
- 3D motion compensation technology
- WTG is assembled in harbour
- Able to transport and install two complete WTG's (**Max. 10MW**)

Picking up WTGs in harbour

INDUSTRY CHALLENGES

CALL FOR FUNDAMENTAL CHANGE IN INSTALLING WINDFARMS

- ✓ **Amount of offshore WTG's** to be installed is growing exponentially
- ✓ WTG's are **increasing in size**: today 15MW, near future up to 20MW
  - ✓ Hub heights up to 170m
  - ✓ Nacelle mass up to 1,000-1,200mt
  - ✓ Blade length up to 126m
- ✓ **Floating wind** expected to ramp up to ~1GW by 2025 and ~30GW by 2035
  - ✓ From prototypes projects to full size windfarms
- ✓ **Workability** current installation method
- ✓ Certain foundations need to be **installed offshore** (TLP/SPAR)
- ✓ Limited capable and available **Marshalling ports**
- ✓ Current offshore **safety challenges**

FLOATING OFFSHORE WIND NEEDS A NEW APPROACH

Current way of installing floating wind turbines

- Transport floating foundation to port
- Transport WTG components to port
- Assemble WTG on floater in port
- Tow out to offshore location

Windfarm Installation Vessel (WIV)

- Transport floating foundation directly to offshore location
- Transport WTG components to WIV
- Assemble WTG on board of WIV
- Install WTG offshore on floater in single motion compensated lift

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NEW WINDFARM INSTALLATION SOLUTION

INSTALLATION OF WTG'S ON BOTTOM FIXED OR FLOATING FOUNDATIONS

- ✓ **Efficient, cost effective, solution for WTG (and MP) installation**
- ✓ **High year around workability (>85%)**
- ✓ **Increased safety by applying robotics**
- ✓ **Depending on location, Marshalling ports are not required**

Result:

- ✓ **Potential installation capacity: 300 WTG's (~4.5GW) per year**
- ✓ **Significant cost reduction per installed wind turbine**

WINDFARM INSTALLATION VESSEL (WIV)

WHAT IS IT?

- Stable, large, semi submersible floating vessel
- Length overall: 240 [m]
- Beam: 88 [m]
- (Light) transit speed: 12 [kn]
- Installed power: 50 [MW]
- Methanol fueled
- Accommodation for 200 people
- 3,000 [mt] rotating, 3D motion compensated installation tower
- 3,000 [mt], 3D motion compensated, Hybrid Boom Crane

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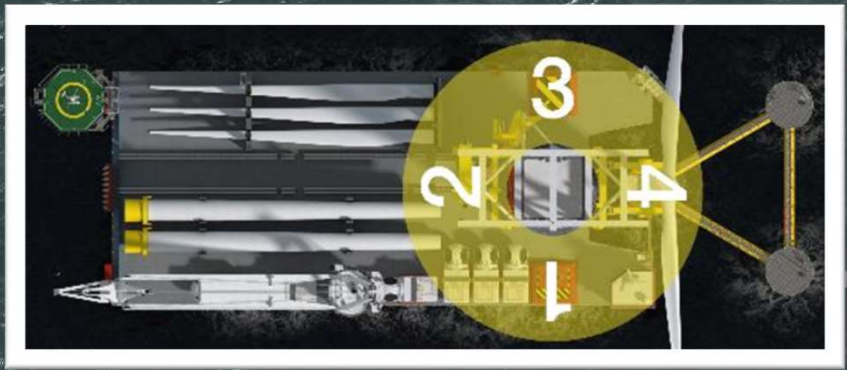
HIGHLY EFFICIENT ON BOARD ASSEMBLY OF NEXT GEN. WTG'S



Four workstations

For simultaneous assembly :

- Station 1 Nacelle
- Station 2 Tower and Nacelle assembly
- Station 3 Blade installation
- Station 4 Single lifting and installation of one fully assembled wind turbine

WTG assembly

- Designed for 20 MW wind turbines
- 3,000t knuckle boom crane (3D compensated) for offloading vessels
- Fast & safe on board assembly

WINDFARM INSTALLATION VESSEL (WIV)

ANIMATION

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ENABLES ON-SITE FLOATING WINDFARM INSTALLATION

WTG installation on foundation

- 3D motion compensation (XYZ) technology during installation (coloured arrows)
- Able to install on fixed (MP, jacket) & floating foundations (SPAR, semi, TLP)
- Offshore installation of WTG in the field instead of assembly in ports

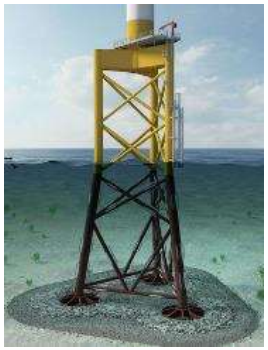
- Minimizes the requirement for onshore port logistics
- WTG installation takes on avg. 1 day

WINDFARM INSTALLATION VESSEL (WIV)

COMPATIBLE FOUNDATION TYPES

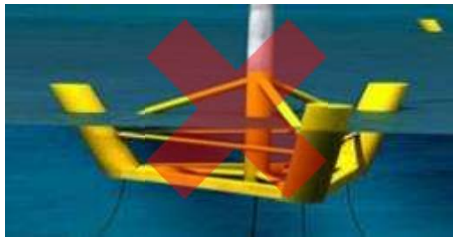
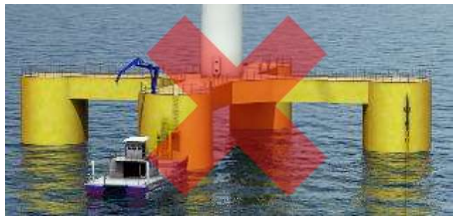
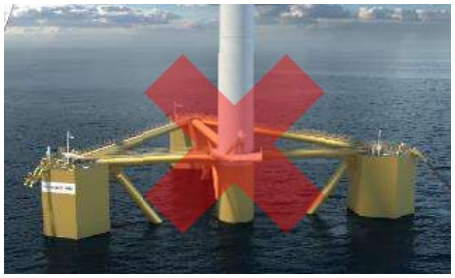
- Installation slot dimensions allow for the majority of floating foundation designs

Compatible types




Non compatible types

*Note *: When WTG mounted on corner of barge*

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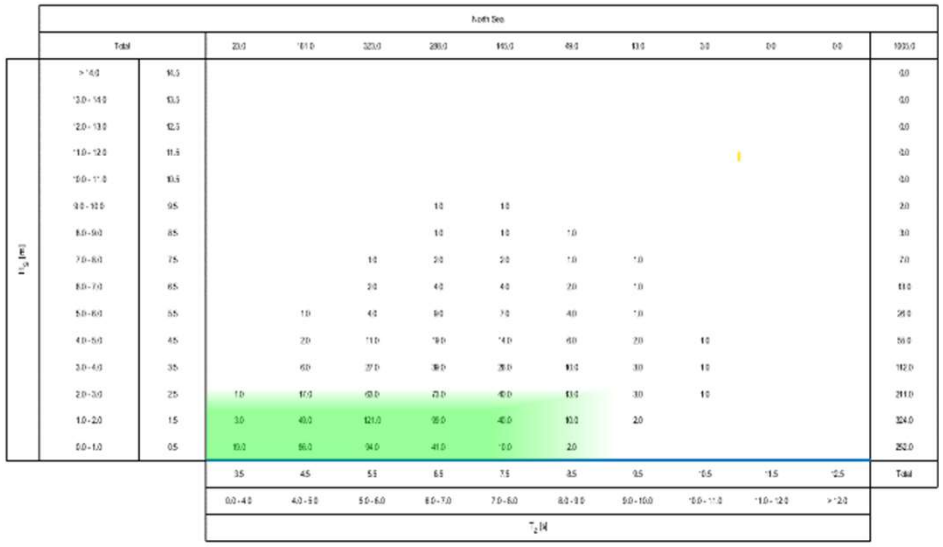
WORKABILITY DURING WIND TURBINE INSTALLATION

COMPARISON

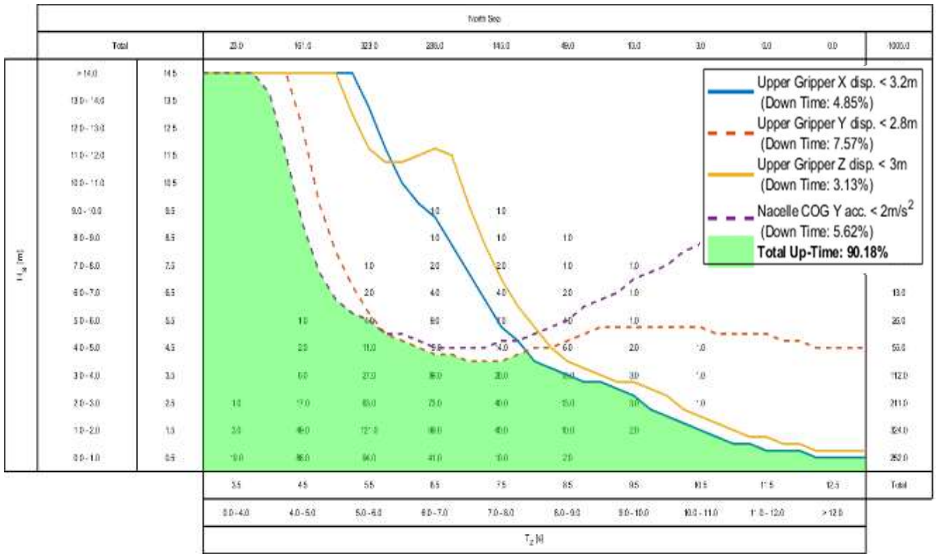
Towing & mooring operation

- Max. wave height: Hsig = 2.5m
- Average workability: 60-70%
- Required window for operation: 5-10 days



Windfarm Installation Vessel

- Max. wave height: Hsig = 3.5m
- Average workability: >85%
- Required window for operation: 6-8 hours



High predictability

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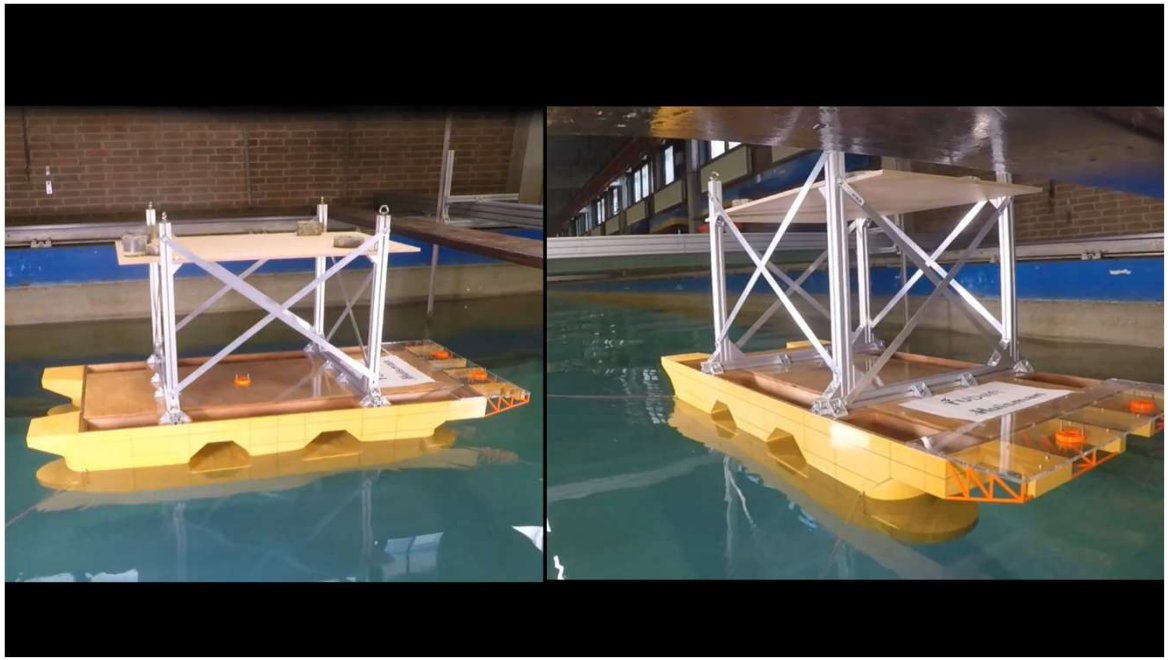
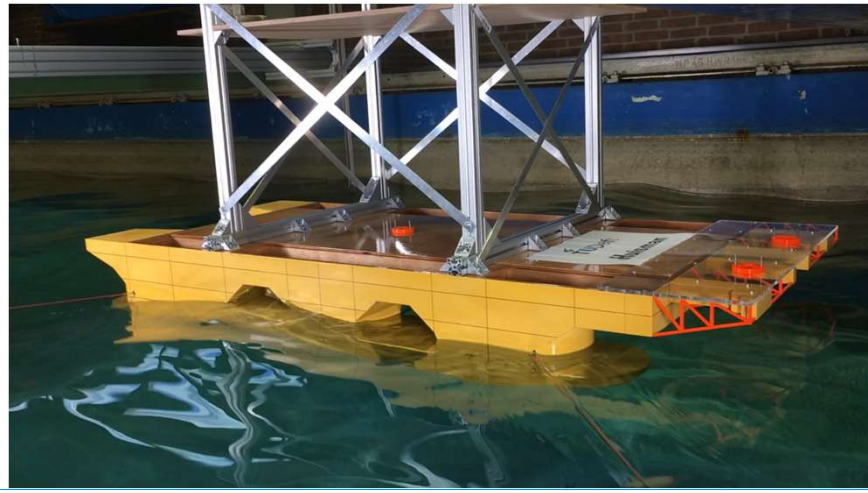
WINDFARM INSTALLATION VESSEL

MODEL TESTING

- Model testing of WIV with floating foundation being performed at TU Delft





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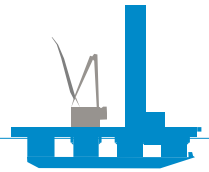
WINDFARM INSTALLATION VESSEL

HIGH LEVEL COMPARISON BETWEEN TOW-OUT AND WIV: TIME & COST



Installation cost and time per turbine I assuming ~10MW turbines	Tow-out		WIV	
Process steps	Time (days)	Costs (in EURk)	Time (days)	Costs (in EURk)
Transport of WTG components from OEM to port or WIV	idem	idem	idem	idem
WTG tower produced in one piece, savings manufacturing cost		-		-300
Pick-up, transport and deliver floater foundation to sheltered waters	idem	idem	idem	Idem
Towing of floater to quay side	1	50	-	-
Port WTG assembly cost (port, crane, personnel)	-	1,000	-	-
Towing & mooring of floater/WTG to offshore location (for towing case)	*9*	450	-	-
Towing & mooring of floater to offshore location (for WIV case)	-	-	3	150
Assembly of WTG on WIV + installation on floater	-	-	→ **1**	700
Waiting on Weather total	4	200	0.2	150
Earlier delivery of electricity		-		-300
Time and cost difference (per turbine)	**14 days**	**EUR 1,7m**	**4-5 days**	**EUR 0,4m**

- ✓ **Floater design** potentially can be **optimized** (smaller floater) as the floater is not limited by port draft
- ✓ Enabling **maintenance** (reversed installation)

10 days less per WTG

1.3mln Euro less per WTG

Note: high level estimations based on market input and own estimations

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INTEGRATED APPROACH TO WINDFARM INSTALLATION

To conclude:

- Currently no cost effective solution for large scale floating windfarms
- Calls for a fundamentally different approach:
  - Portfolio instead of project-to-project
  - Integration in the supply chain
  - Requires combining forces and boosting cooperation between key stakeholders:
    - Developers
    - OEM's
    - Installation contractors
    - Logistic partners
    - Solution providers

Together and with this integrated approach, we can take a giant step forward in windfarm installation!

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Equipped for impact.