RADICAL CHANGE IN INSTALLING FLOATING WINDFARMS
RESULTING IN BIG COST SAVINGS

FLOATING WIND SOLUTIONS 2022
MARCH 1-3, HOUSTON

Huisman
Equipped for impact
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
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]

Diameter: 20 [m]
Height: 40 [m]
**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)

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**INNOVATIONS TAKE TIME, PERSEVERANCE AND MARKET INPUT**
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
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
HIGHLY EFFICIENT ON BOARD ASSEMBLY OF NEXT GEN. WTG’S

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

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 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

ENABLES ON-SITE FLOATING WINDFARM INSTALLATION

- 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
WORKABILITY DURING WIND TURBINE INSTALLATION
COMPARISON

Towing & mooring operation
- Max. wave height: $H_{sig} = 2.5m$
- Average workability: 60-70%
- Required window for operation: 5-10 days

Windfarm Installation Vessel
- Max. wave height: $H_{sig} = 3.5m$
- Average workability: >85%
- Required window for operation: 6-8 hours
WINDFARM INSTALLATION VESSEL
MODEL TESTING

- Model testing of WIV with floating foundation being performed at TU Delft
# Windfarm Installation Vessel

## High Level Comparison Between Tow-Out and WIV: Time & Cost

### Installation Cost and Time per Turbine | Assuming ~10MW Turbines

<table>
<thead>
<tr>
<th>Process Steps</th>
<th>Tow-out</th>
<th>WIV</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Time (days)</td>
<td>Costs (in EURk)</td>
</tr>
<tr>
<td>Transport of WTG components from OEM to port or WIV</td>
<td>idem</td>
<td>idem</td>
</tr>
<tr>
<td>WTG tower produced in one piece, savings manufacturing cost</td>
<td>-</td>
<td>1,000</td>
</tr>
<tr>
<td>Pick-up, transport and deliver floater foundation to sheltered waters</td>
<td>idem</td>
<td>idem</td>
</tr>
<tr>
<td>Towing of floater to quay side</td>
<td>1</td>
<td>50</td>
</tr>
<tr>
<td>Port WTG assembly cost (port, crane, personnel)</td>
<td>-</td>
<td>1,000</td>
</tr>
<tr>
<td>Towing &amp; mooring of floater/WTG to offshore location (for towing case)</td>
<td>9</td>
<td>450</td>
</tr>
<tr>
<td>Towing &amp; mooring of floater to offshore location (for WIV case)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Assembly of WTG on WIV + installation on floater</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Waiting on Weather total</td>
<td>4</td>
<td>200</td>
</tr>
<tr>
<td>Earlier delivery of electricity</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

**Time and cost difference (per turbine)**

- **Tow-out**: 14 days, EUR 1.7m
- **WIV**: 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)

**Note:** high level estimations based on market input and own estimations
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!
Equipped for impact.