# Comparison of Various Logistic Configurations

University of Applied Sciences

HOCHSCHULE EMDEN · LEER

Interreg

North Sea Region

Decom Tools

European Regional Development Fund

EUROPEAN UNION

# Discussed Topics

1) Devised an algorithm to calculate the duration, cost and CO2 Emission of the offshore Operation

2) Select a case study to evaluate and verify the algorithms of calculations

3) Review installation fleet and actual duration of case study

4) Calculation of decommissioning reverse to installation (Pendulum config./Base Scenario)

5) Calculation with  Different logistic configuration ( Switch from Pendulum to Feeder)

6) Calculation with Different Logistic Configuration and Different type of Vessel (Feeder and HLV)

7) New Generation of vessels in the offshore wind industry

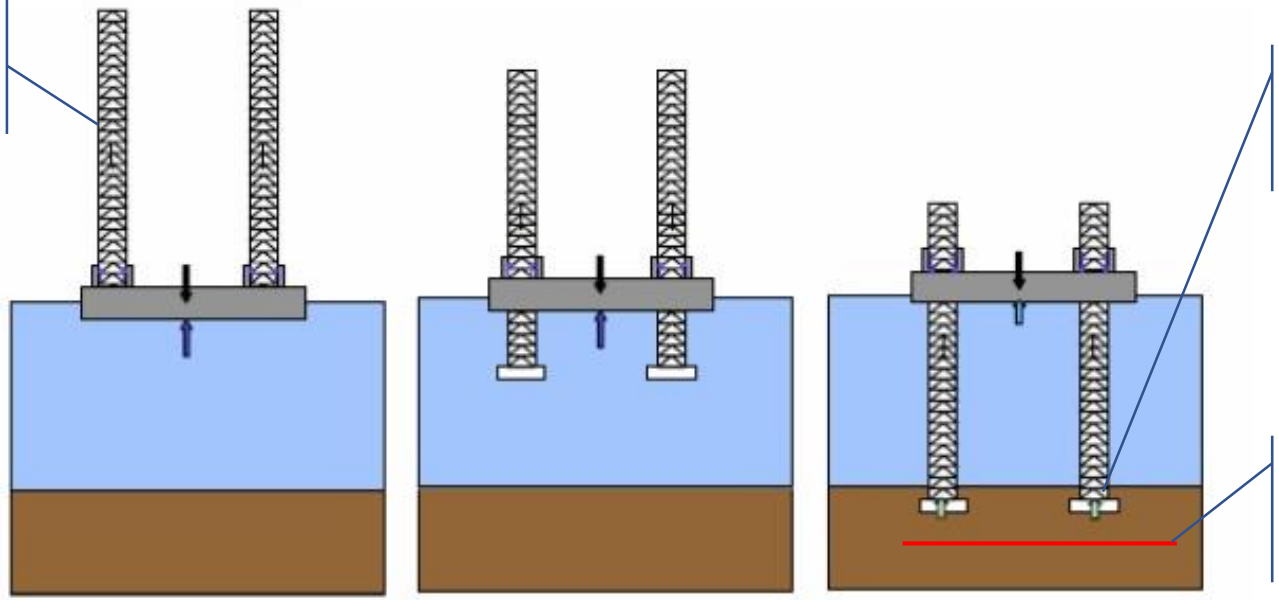
University of Applied Sciences
HOCHSCHULE EMDEN·LEER

# Transition modes of Jack up Vessel

Interreg North Sea Region Decom Tools
European Regional Development Fund

EUROPEAN UNION

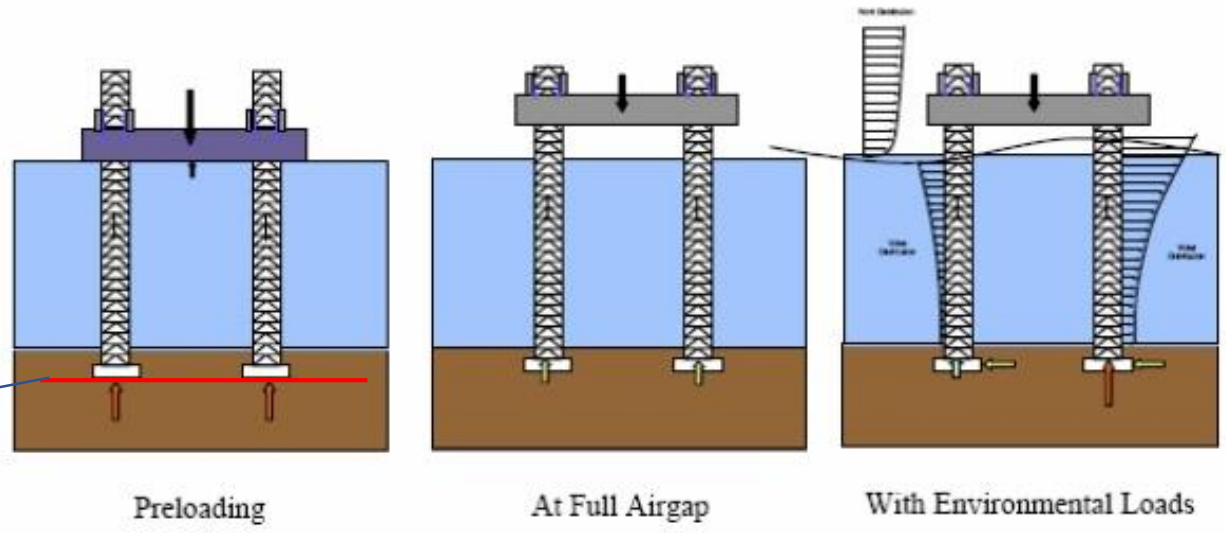
Legs in the raised position

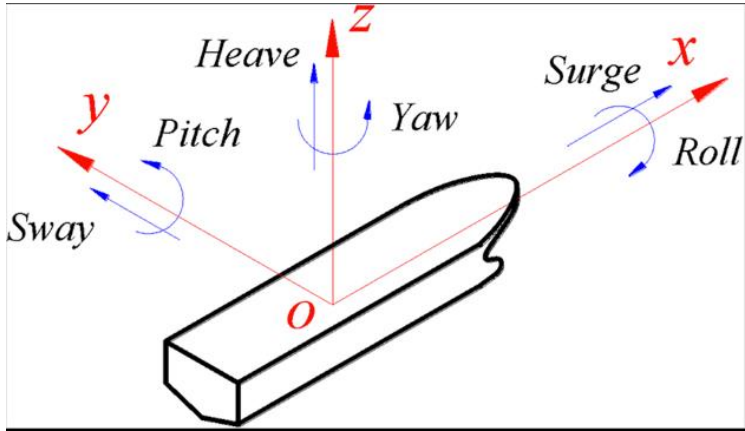



Soft pin

Final penetration

Final penetration



University of Applied Sciences
HOCHSCHULE EMDEN·LEER

# Hornsea 1 Facts and Figures

Interreg North Sea Region Decom Tools
European Regional Development Fund
EUROPEAN UNION

**Table 1**

| OWP: Hornsea 1 | Location: England | North Sea |
|---|---|---|
| **Wind Farm Specification** | | |
| Number of Turbine | 91 | Number |
| Turbine Rating | 7 | MW |
| Rotor Diameter | 154 | Meter |
| WT Distance | 6 | Times |
| Distance from Port | 120 | Km |
| Average Water Depth | 47.5 | m |

**Table 2**

| Installation Vessel Specification (Jack up DP2) | | |
|---|---|---|
| Installation Vessel Name | Bold Tern | Name |
| Installation Vessel Type | Jack Up DP2 | Propulsion |
| Vessel Max Speed | 12 | Knots |
| Vessel In-Field Speed | 1 | Knot |
| Vessel Jacking Speed | 0.5 | m/min |
| Spudcan Penetration | 76 | Meter |
| Transported Set Per Voyage | 4 | Set |
| Vessel Day Rate | $ 200,000.00 | $ |
| Stand-by Consumption | 6 | Tones |
| Installation Consumption | 8 | Tones |
| Sailing Consumption | 45 | Tones |
| Positioning Consumption | 22.5 | Tones |

**Table 5**

| Timetable of Installation and Unplanned Activities | | |
|---|---|---|
| Commencement of Installation | February 4, 2019 | Time |
| End of Installation | September 25, 2019 | Time |
| Duration of Installation | 234 | Day |
| Waiting on Weather (WOW) | 15% | % |
| Mechanical Break Down & WOC | 2% | % |

**Table 6**

| Timing of Positioning and Sailing | | |
|---|---|---|
| Duration of Jacking | 0.42 | Day/WT |
| Duration of Ballasting & Deballasting | 0.33 | Day/WT |
| Duration of Positioning | 0.75 | Day/WT |
| Number of Load Out | 23.00 | Times |
| | | |
| | | |
| | | |

University of Applied Sciences
HOCHSCHULE EMDEN·LEER

# Case Study: Hornsea 1

Interreg North Sea Region Decom Tools
European Regional Development Fund
EUROPEAN UNION

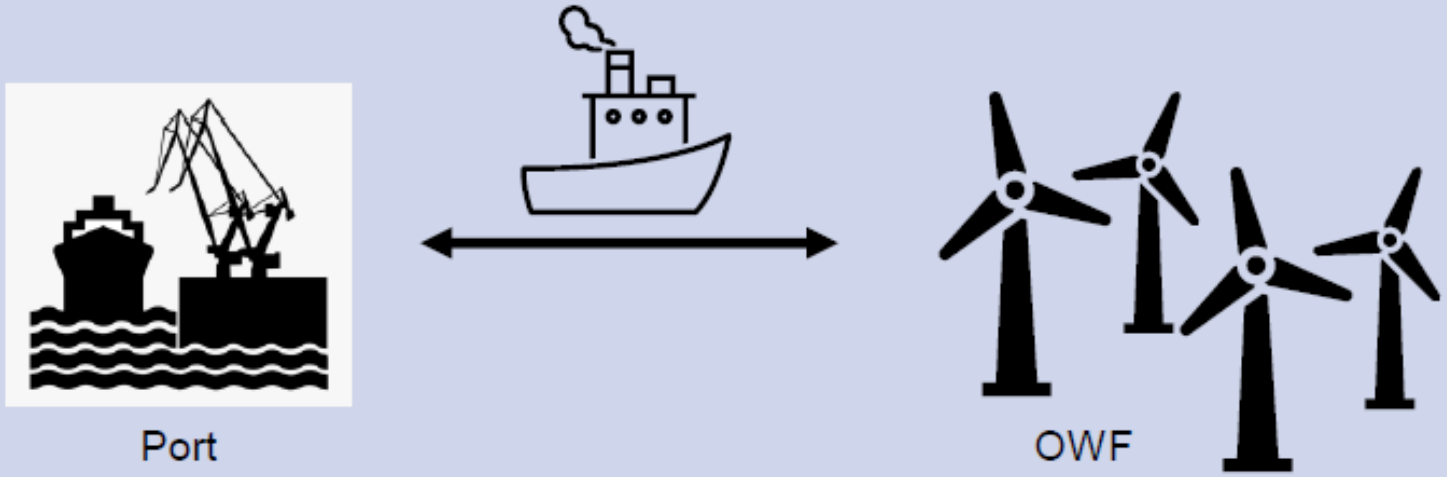

Source: https://www.youtube.com/watch?v=txhZUXlqj-4&t=92s

University of Applied Sciences
HOCHSCHULE EMDEN·LEER

# Pendulum Configuration

Interreg North Sea Region Decom Tools
European Regional Development Fund
EUROPEAN UNION

Ship shuttles between Port and OWF




University of Applied Sciences
HOCHSCHULE EMDEN·LEER

# Pendulum Configuration Results

Interreg North Sea Region Decom Tools
European Regional Development Fund
EUROPEAN UNION

| Statistics of Jack Up Vessel | OWP: Hornsea 1 | North Sea | Location: England | DP2 Jack Up | Bold Tern |
|---|---|---|---|---|---|
| Operations Description | Quantity | Unit | Time (Day) | Daily Fuel Consumption | Overall Fuel Consumption |
| Details of Positioning | 0.75 | Day/Turbine | 68.45 | 22.5 | 1540.18 |
| | | | | | |
| Details of In-Field Transit | 84.08 | Km | 1.91 | 22.5 | 42.94 |
| | | | | | |
| Details of Sailing (Site <--> Shore) | 5520.0 | km | 20.88 | 45 | 939.54 |
| | | | | | |
| Details of Assembly of Tower, Nacelle & Rotor | 0.90 | Set/Day | 81.52 | 8 | 652.17 |
| | | | | | |
| Details of Load Out | 0.31 | Set/Day | 28.44 | 8 | 227.50 |
| | | | | | |
| Details of Waiting On Weather (WOW) | 15% | %Project | 30.18 | 8 | 241.44 |
| | | | | | |
| Mechanical Break Down + Waiting On Client (WOC) | 2% | % Project | 4.02 | 6 | 24.14 |
| | | | | | |
| Overall Duration of Positioining+In-Field Sailing+ Construction+Load Out+Unplanned | | | 235.40 | | 3667.90 |

University of Applied Sciences
HOCHSCHULE EMDEN·LEER

# Pendulum Configuration Results

Interreg North Sea Region Decom Tools
European Regional Development Fund

EUROPEAN UNION

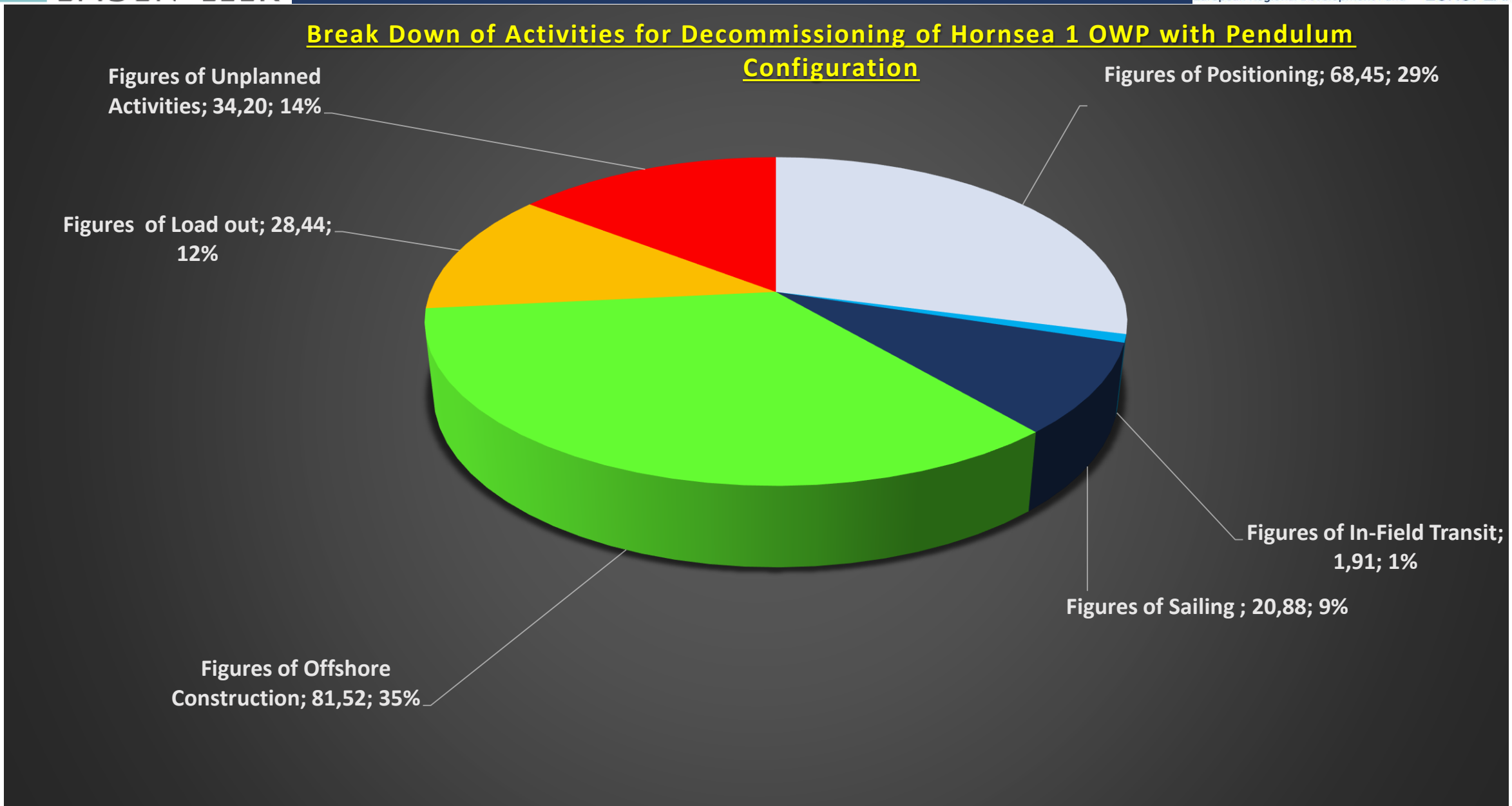
| Results of Pendulum Configuration in Decommissioning of | OWP: Hornsea 1 | DP2 Jack Up | Bold Tern |
|---|---|---|---|

| Summary of Major Activities | Duration | Portion (%) | Daily Charter Rate | Overall Charter |
|---|---|---|---|---|
| Figures of Positioning | 68.45 | 29.1% | $ 200,000.00 | $ 13,690,444.44 |
| Figures of In-Field Transit | 1.91 | 0.8% | $ 200,000.00 | $ 381,644.88 |
| Figures of Sailing | 20.88 | 8.9% | $ 200,000.00 | $ 4,175,744.37 |
| Figures of Offshore Construction | 81.52 | 34.6% | $ 200,000.00 | $ 16,304,166.67 |
| Figures of Load out | 28.44 | 12.1% | $ 200,000.00 | $ 5,687,500.00 |
| Figures of Unplanned Activities | 34.20 | 14.5% | $ 200,000.00 | $ 6,840,715.06 |
| Grand Total | 235.40 | 100.0% | | $ 47,080,215.42 |

University of Applied Sciences
HOCHSCHULE EMDEN·LEER

# Pendulum Configuration Results

Interreg North Sea Region Decom Tools
European Regional Development Fund
EUROPEAN UNION

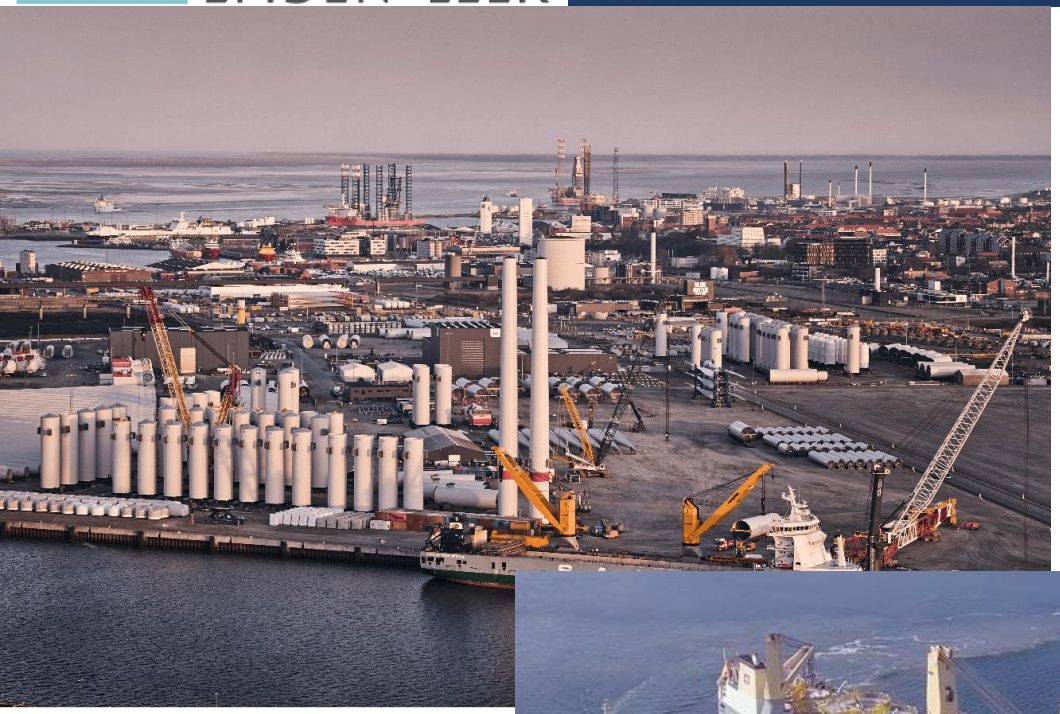


University of Applied Sciences
HOCHSCHULE EMDEN·LEER

# Feeder Configuration

Interreg North Sea Region Decom Tools
European Regional Development Fund

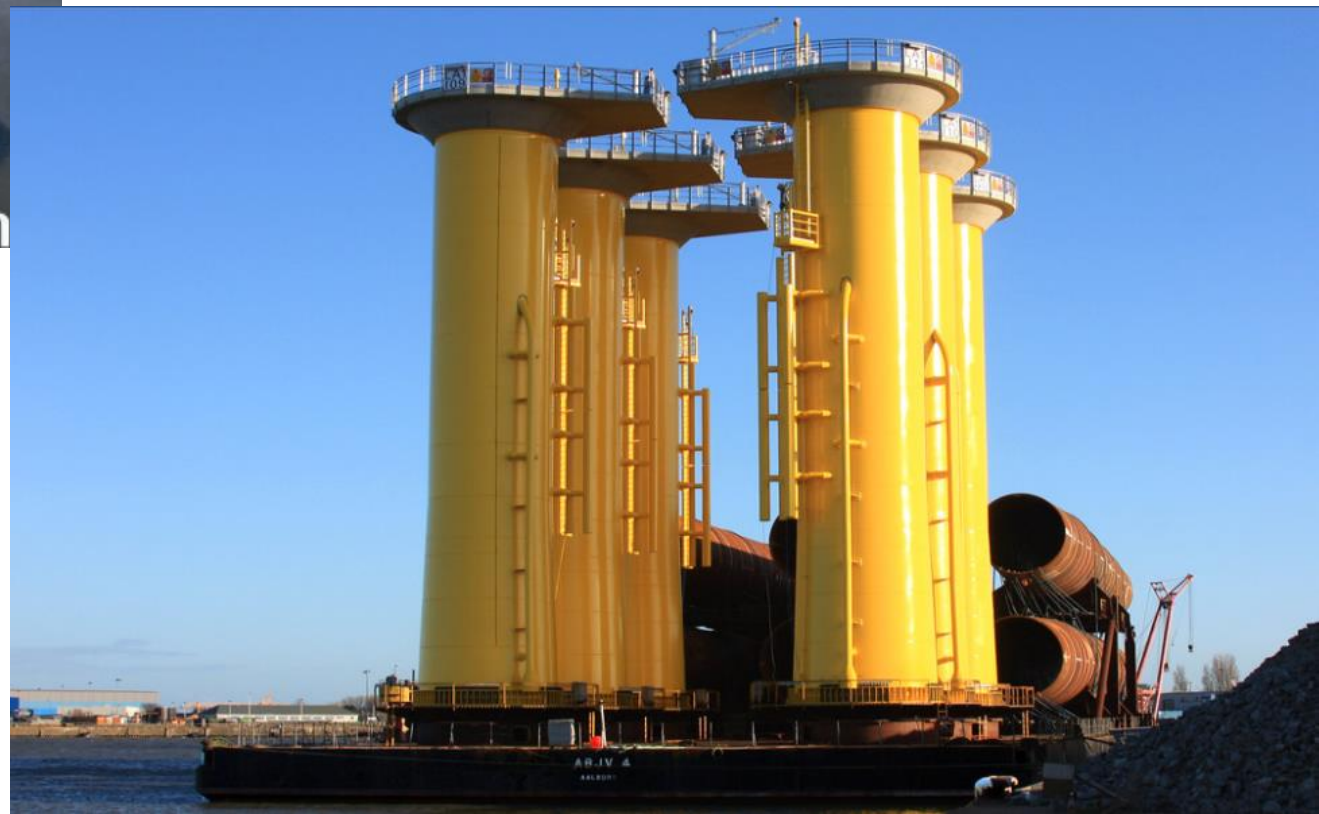
EUROPEAN UNION



University of Applied Sciences
HOCHSCHULE EMDEN·LEER

# Feeder Configuration

Interreg North Sea Region Decom Tools
European Regional Development Fund
EUROPEAN UNION

University of Applied Sciences
HOCHSCHULE EMDEN·LEER

# Installation of Fryslân OWP Commenced September 7, 2020

Interreg North Sea Region Decom Tools
European Regional Development Fund
EUROPEAN UNION


https://ocean-energyresources.com/2020/09/08/wind-farm-fryslan-starts-construction-with-first-mp-installation/

University of Applied Sciences
HOCHSCHULE EMDEN·LEER

# Installation of Fryslân OWP will be completed in Summer 2021

Interreg North Sea Region Decom Tools
European Regional Development Fund

EUROPEAN UNION

https://ocean-energyresources.com/2020/09/08/wind-farm-fryslan-starts-construction-with-first-mp-installation/

University of Applied Sciences
HOCHSCHULE EMDEN·LEER

# Feeder Configuration
# Jack up + Heavy Load Carrier (HLC)

Interreg North Sea Region Decom Tools
European Regional Development Fund

EUROPEAN UNION

**Table 1**

| OWP: Hornsea 1 | Location: England | North Sea |
|---|---|---|
| **Wind Farm Specification** | | |
| Number of Turbine | 91 | Number |
| Turbine Rating | 7 | MW |
| Rotor Diameter | 154 | Meter |
| WT Distance | 6 | Times |
| Distance from Port | 120 | Km |
| Average Water Depth | 47.5 | m |

**Table 2**

| Installation Vessel Specification (Jack up DP2) | | |
|---|---|---|
| Installation Vessel Name | Bold Tern | Name |
| Installation Vessel Type | Jack Up DP2 | Propulsion |
| Vessel Max Speed | 12 | Knots |
| Vessel In-Field Speed | 1 | Knot |
| Vessel Jacking Speed | 0.5 | m/min |
| Spudcan Penetration | 76 | Meter |
| Transported Set Per Voyage | 4 | Set |
| Vessel Day Rate | $ 200,000.00 | $ |
| Stand-by Consumption | 6 | Tones |
| Installation Consumption | 8 | Tones |
| Sailing Consumption | 45 | Tones |
| Positioning Consumption | 22.5 | Tones |

**Table 7**

| Cargo Vessel | | |
|---|---|---|
| Sailing Speed | 9.5 | Knots |
| In-field sailing Speed | 1 | Knots |
| Transported Set Per Voyage | 15 | Set |
| Number of Load Out | 7.00 | Times |
| Duration of Load Out | 18.96 | Day/all set |
| Duration of Sailing | 8.03 | Day |
| Duration of In-Field Sailing | 1.91 | Day |
| Vessel Day Rate | 35000 | $ |
| Stand-by Consumption | 1 | Tones |
| Operation Consumption | 4 | Tones |
| Sailing Consumption | 15 | Tones |

University of Applied Sciences
HOCHSCHULE EMDEN·LEER

# Feeder Configuration (Jack up + HLC)

Interreg North Sea Region Decom Tools
European Regional Development Fund
EUROPEAN UNION

| Statistics of Jack Up Vessel | OWP: Hornsea 1 | North Sea | Location: England | DP2 Jack up + HLC | Bold Tern |
|---|---|---|---|---|---|
| Operations Description | Quantity | Unit | Time (Day) | Daily Fuel Consumption (Tones) | Overall Fuel Consumption (Tones) |
| Details of Positioning | 0.75 | Turbine/Day | 68.45 | 22.5 | 1540.18 |
| | | | | | |
| Details of In-Field Transit | 84.08 | Km | 1.91 | 22.50 | 42.94 |
| | | | | | |
| Details of Sailing (Site <--> Shore) | 240.00 | km | 0.91 | 45.00 | 40.85 |
| | | | | | |
| Details of Assembly of Tower,Nacelle & Rotor | 0.90 | Set/Day | 81.52 | 8.00 | 652.17 |
| | | | | | |
| Details of Waiting On Weather (WOW) | 15% | % Project | 22.92 | 6.00 | 137.51 |
| | | | | | |
| Mechanical Break Down + Waiting On Client (WOC) | 2% | % Project | 3.06 | 6.00 | 18.33 |
| | | | | | |
| Overall Duration of Positioining+In-Field Transit+ Sailing+Constrcution+Unplanned Activities | | | 178.76 | | 2431.97 |

University of Applied Sciences
HOCHSCHULE EMDEN·LEER

# Results of Feeder Configuration (Jack up + HLC)

Interreg North Sea Region Decom Tools
European Regional Development Fund
EUROPEAN UNION

| Statistics of HLC | OWP: Hornsea 1 | North Sea | Location: England | DP2 Jack up + HLC | Bold Tern |
|---|---|---|---|---|---|
| Operations Description | Quantity | Unit | Time (Day) | Daily Fuel Consumption (Tones) | Overall Fuel Consumption (Tones) |
| Details of In-Field Transit | 84.08 | Km | 1.91 | 7.5 | 14.31 |
| | | | | | |
| Details of Sailing (Site <--> Shore) | 1680.00 | km | 8.0 | 15 | 120.40 |
| | | | | | |
| Details of Load Out | 0.31 | Per Set | 28.44 | 4 | 113.75 |
| | | | | | |
| Details of Waiting On Weather (WOW) | 15% | % Project | 5.76 | 1 | 5.76 |
| | | | | | |
| Mechanical Break Down + Waiting On Client (WOC) | 2% | % Project | 0.77 | 1 | 0.77 |
| | | | | | |
| | | | 39.14 | Overall Fuel Consumption | 1282.41 |

University of Applied Sciences
HOCHSCHULE EMDEN·LEER

# Results of Feeder Configuration (Jack up + HLC)

Interreg North Sea Region Decom Tools
European Regional Development Fund
EUROPEAN UNION

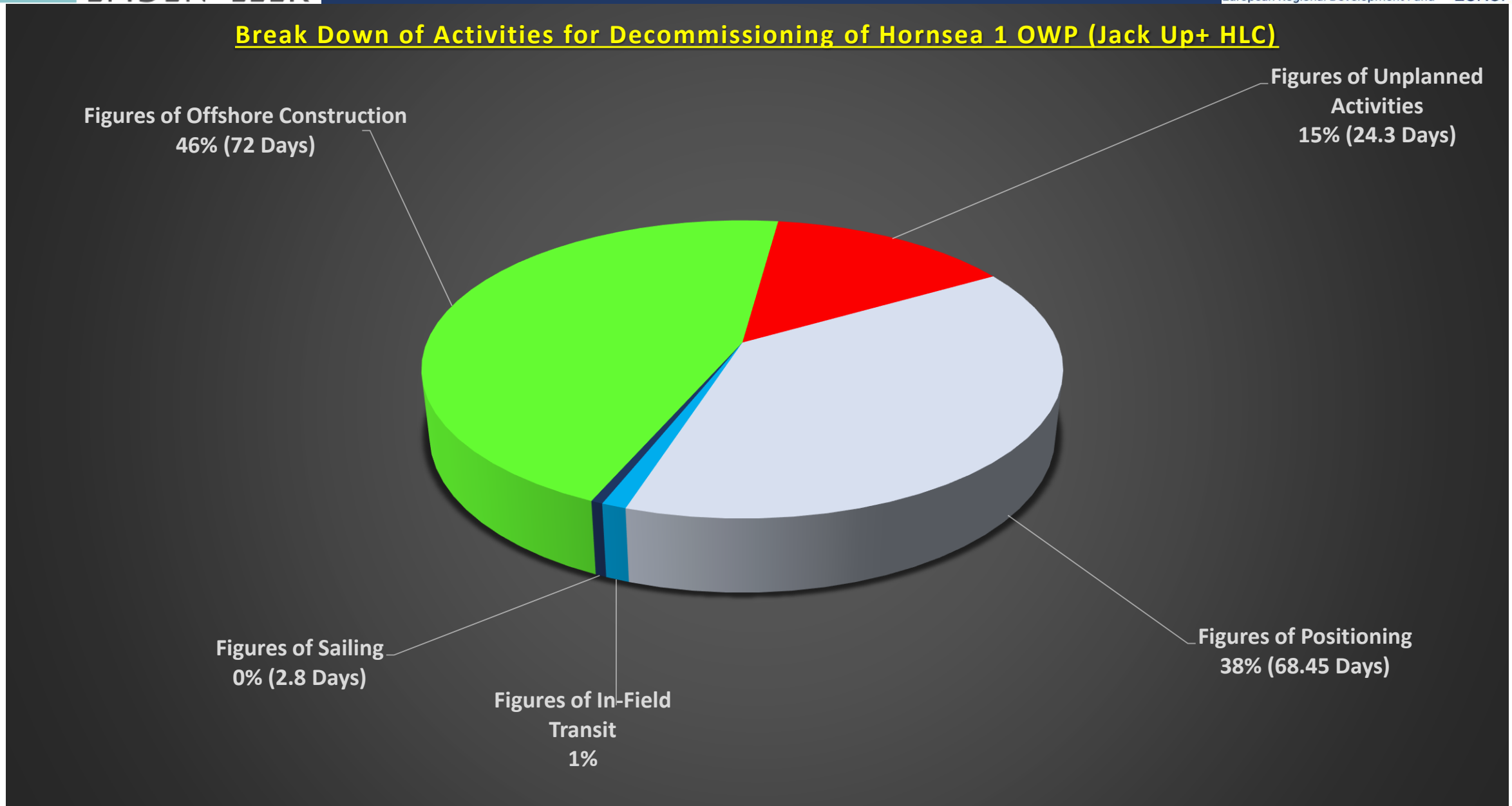
| Results of Feeder Configuration in Decommissioning of | OWP: Hornsea 1 | Jack up + HLC | Bold Tern |
|---|---|---|---|

| Summary of Major Activities | Duration | Portion | Daily Charter Rate | Overall Charter |
|---|---|---|---|---|
| Figures of Positioning | 68.45 | 38.3% | $ 200,000.00 | $ 13,690,444.44 |
| Figures of In-Field Transit | 1.91 | 1.1% | $ 200,000.00 | $ 381,644.88 |
| Figures of Sailing | 0.91 | 0.5% | $ 200,000.00 | $ 181,554.10 |
| Figures of Offshore Construction | 81.52 | 45.6% | $ 200,000.00 | $ 16,304,166.67 |
| Figures of Unplanned Activities | 25.97 | 14.5% | $ 200,000.00 | $ 5,194,827.72 |
| Figures of HLC | 210.38 | N/A | $ 35,000.00 | $ 7,363,226.00 |
| Grand Total | 178.76 | 100.0% | $ 635,000.00 | $ 43,115,863.82 |

University of Applied Sciences
HOCHSCHULE EMDEN·LEER

# Results of Feeder Configuration (Jack up + HLC)

Interreg North Sea Region Decom Tools
European Regional Development Fund
EUROPEAN UNION



University of Applied Sciences
HOCHSCHULE EMDEN·LEER

# Feeder Configuration (HLV+HLC)

Interreg North Sea Region Decom Tools
European Regional Development Fund

EUROPEAN UNION


University of Applied Sciences
HOCHSCHULE EMDEN·LEER

# Feeder Configuration (HLV+HLC)

Interreg North Sea Region Decom Tools
European Regional Development Fund
EUROPEAN UNION

**Table 8**

| Heavy Lift Vessel | | |
|---|---|---|
| WOW | 20% | % |
| Mechanical break Down & WOC | 2% | % |
| Sailing Speed | 12 | Knots |
| Vessel Day Rate | $ 200,000 | $ |
| Stand-by Consumption (DP Mode) | 15 | Tones |
| Lifting Consumption (DP Mode) | 20 | Tones |
| Sailing Consumption | 25 | Tones |
| | | |
| | | |
| | | |

**Table 7**

| Cargo Vessel | | |
|---|---|---|
| Sailing Speed | 9.5 | Knots |
| In-field sailing Speed | 1 | Knots |
| Transported Set Per Voyage | 15 | Set |
| Number of Load Out | 7.00 | Times |
| Duration of Load Out | 28.44 | Day/all set |
| Duration of Sailing | 8.03 | Day |
| Duration of In-Field Sailing | 1.91 | Day |
| Vessel Day Rate | $ 35,000 | $ |
| Stand-by Consumption | 1 | Tones |
| Operation Consumption | 4 | Tones |
| Sailing Consumption | 15 | Tones |

University of Applied Sciences
HOCHSCHULE EMDEN·LEER

# Feeder Configuration (Heavy Lift Vessel+ HLC)

Interreg North Sea Region Decom Tools
European Regional Development Fund
EUROPEAN UNION

| Statistics of Heavy Lift Vessel (HLV) | OWP: Hornsea 1 | North Sea | Location: England | HLV+ HLC | |
|---|---|---|---|---|---|
| Operations Description | Quantity | Units | Time (Day) | Daily Fuel Consumption (Tones) | Overall Fuel Consumption (Tones) |
| Details of In-Field Transit | 84.08 | Km | 1.91 | 12.5 | 23.85 |
| | | | | | |
| Details of Sailing (Site <--> Shore) | 240.00 | km | 0.91 | 25 | 22.69 |
| | | | | | |
| Details of Assembly of Tower,Nacelle & Rotor | 0.90 | Set/Day | 81.52 | 20 | 1630.42 |
| | | | | | |
| Details of Waiting On Weather (WOW) | 20% | % Project | 16.87 | 15 | 253.01 |
| | | | | | |
| Mechanical Break Down + Waiting On Client (WOC) | 2% | % Project | 2.02 | 15 | 30.36 |
| | | | | | |
| Overall Duration of In-Field Transit + Sailing + Constrcution + Unplanned Activities | | | 103.23 | | 1676.96 |

University of Applied Sciences
HOCHSCHULE EMDEN·LEER

# Feeder Configuration (Heavy Lift Vessel+ HLC)

Interreg North Sea Region Decom Tools
European Regional Development Fund
EUROPEAN UNION

| Statistics of HLC | OWP: Hornsea 1 | North Sea | Location: England | HLV+ HLC | |
|---|---|---|---|---|---|
| Operations Description | Quantity | Units | Time (Day) | Daily Fuel Consumption (Tones) | Overall Fuel Consumption (Tones) |
| Details of In-Field Transit | 84.08 | Km | 1.91 | 7.5 | 14.31 |
| | | | | | |
| Details of Sailing (Site <--> Shore) | 1680.00 | km | 0.91 | 15.00 | 13.62 |
| | | | | | |
| Details of Load Out | 4.06 | Day | 28.44 | 4.00 | 113.75 |
| | | | | | |
| Waiting On Weather (WOW) | 20% | % Project | 6.25 | 1.00 | 6.25 |
| | | | | | |
| Mechanical Break Down and Waiting On Client (WOC) | 2% | % Project | 0.75 | 1.00 | 0.75 |
| | | | | | |
| | | | 38.25 | Overall Fuel Consumption | 709.39 |

University of Applied Sciences
HOCHSCHULE EMDEN·LEER

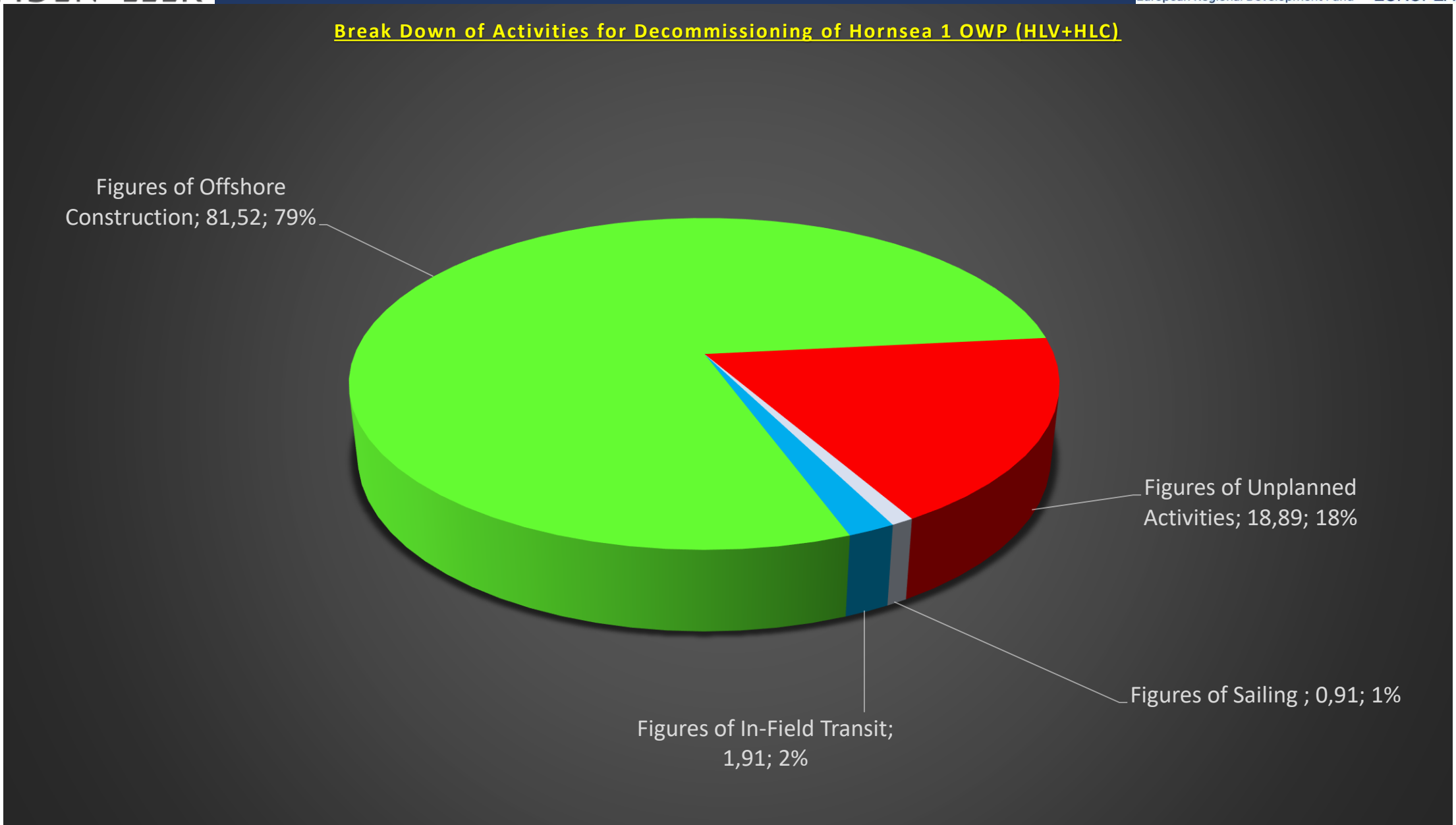
# Feeder Configuration (Heavy Lift Vessel+ HLC)

Interreg North Sea Region Decom Tools
European Regional Development Fund
EUROPEAN UNION

**Results of Feeder Configuration in Decommissioning of** **OWP: Hornsea 1** **HLV+ HLC**

| Summary of Major Activities | Duration | Portion | Daily Charter Rate | Overall Charter |
|---|---|---|---|---|
| Figures of Sailing | 0.91 | 0.9% | $ 200,000.00 | $ 181,554.10 |
| Figures of In-Field Transit | 1.91 | 1.8% | $ 200,000.00 | $ 381,644.88 |
| Figures of Offshore Construction | 81.52 | 79.0% | $ 200,000.00 | $ 16,304,166.67 |
| Figures of Unplanned Activities | 18.89 | 18.3% | $ 200,000.00 | $ 3,778,289.91 |
| Figures of HLC | 131.71 | N/A | $ 35,000.00 | $ 4,609,706.88 |
| Grand Total | 103.23 | 100.0% | | $ 25,255,362.43 |

# Feeder Configuration (Heavy Lift Vessel+ HLC)



University of Applied Sciences
HOCHSCHULE EMDEN·LEER

# Comparison Table

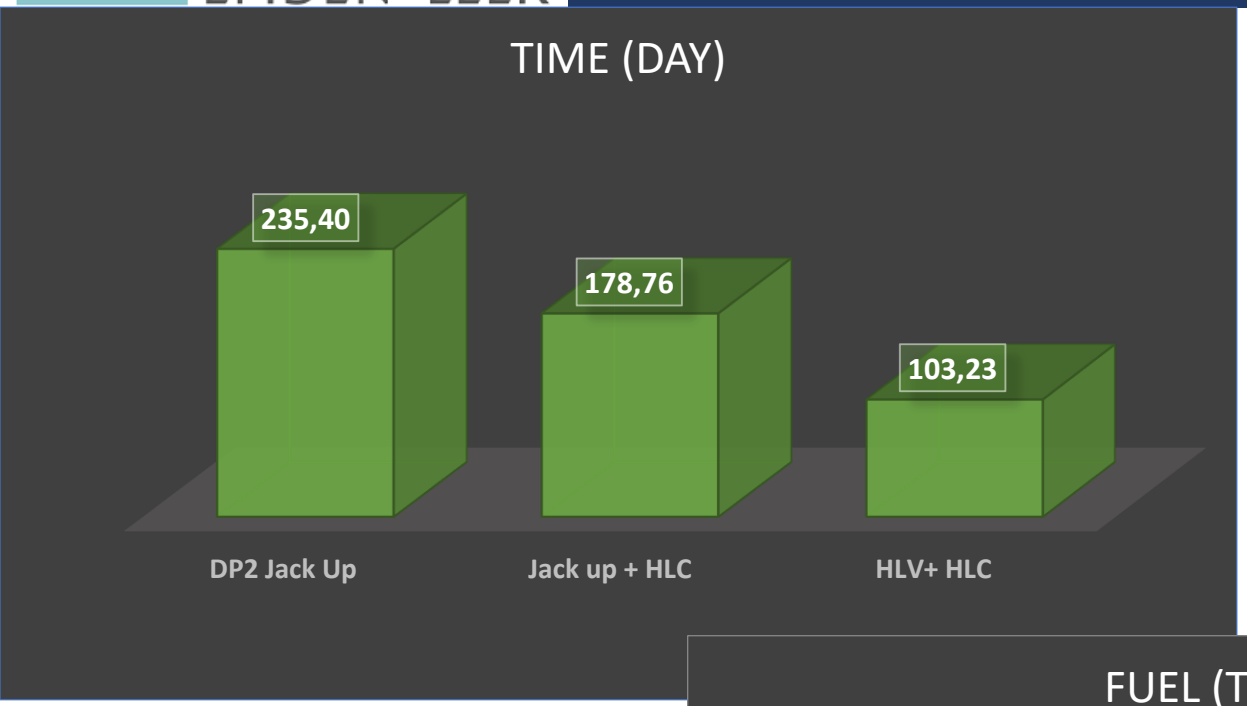
Interreg North Sea Region Decom Tools
European Regional Development Fund
EUROPEAN UNION

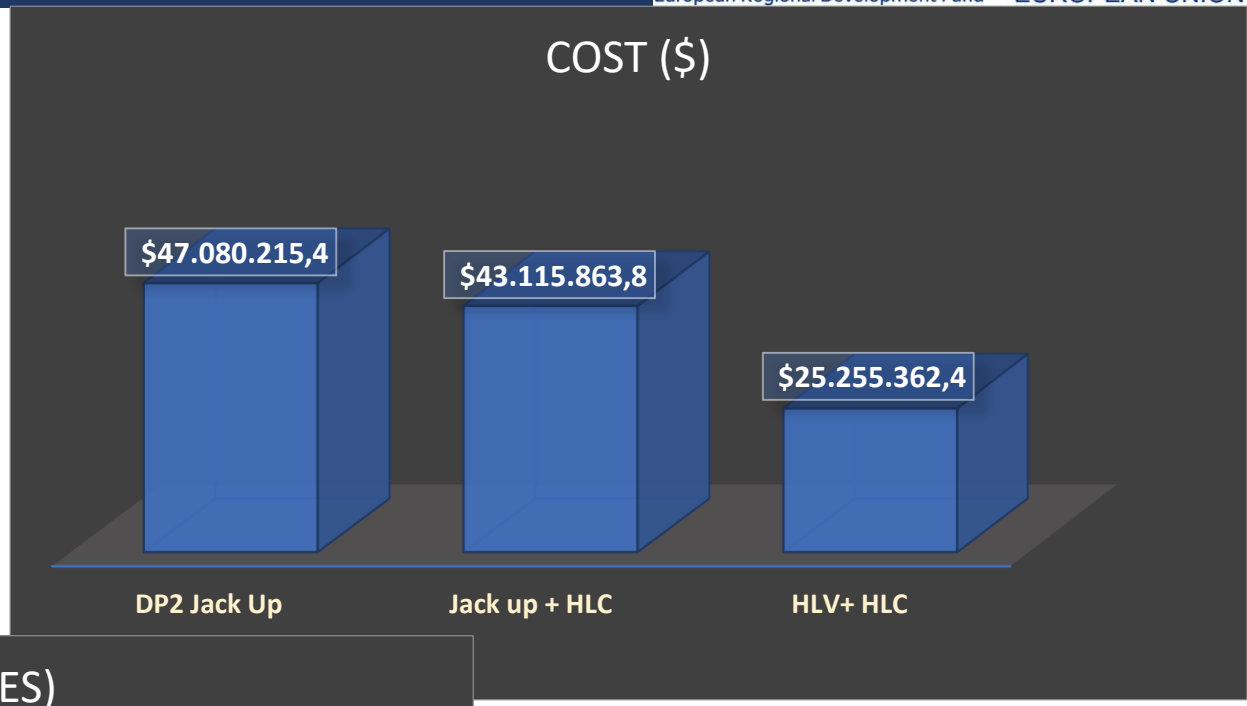
| OWP: Hornsea 1 | Logistic Configuration Comparison Table | | Location: England |
|---|---|---|---|
| **Configuration** | **Pendulum** | **Feeder** | |
| **Parameters** | **DP2 Jack Up** | **Jack up + HLC** | **HLV+ HLC** |
| **Time (Day)** | 235.40 | 178.76 | 103.23 |
| | Base Scenario | -57 | -132 |
| | | 24% | 56% |
| **Cost ($)** | $ 47,080,215.4 | $ 43,115,863.8 | $ 25,255,362.4 |
| | Base Scenario | $ (3,964,351.6) | $ (21,824,853.0) |
| | | 8.42% | 46.36% |
| **Fuel (Tones)** | 3667.90 | 3714.38 | 2386.35 |
| | Base Scenario | 46.48 | -1281.55 |
| | | -1% | 35% |
| **CO2 Emission (Tones)** | 1054.26 | 1067.62 | 685.91 |
| | Base Scenario | 13.36 | -368.35 |
| | | -1% | 35% |

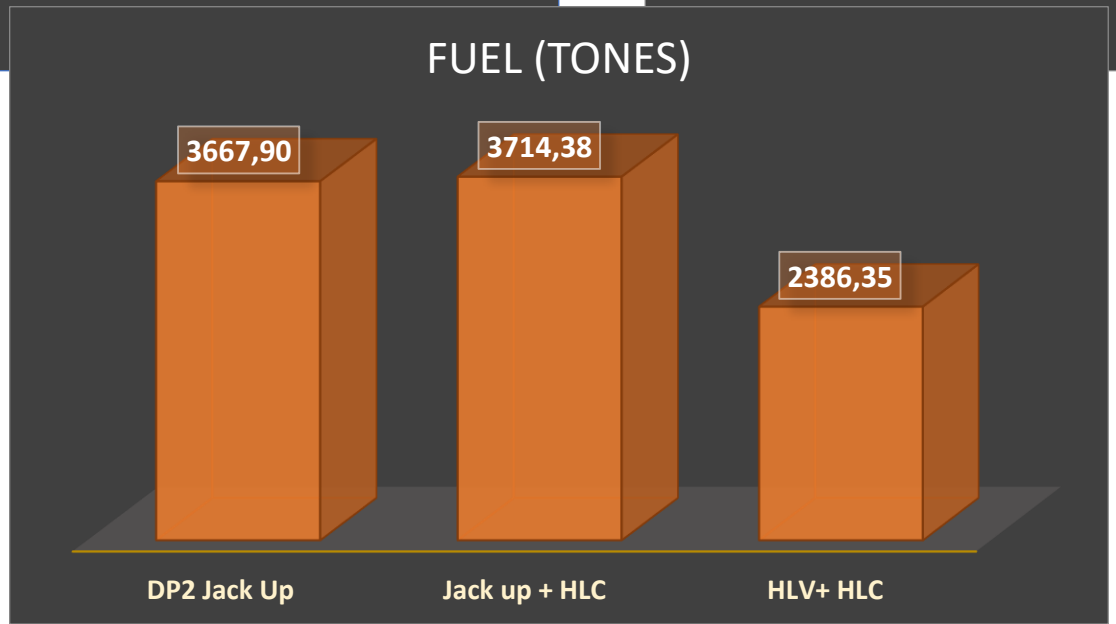
University of Applied Sciences
HOCHSCHULE EMDEN·LEER

# Comparison Table

Interreg North Sea Region Decom Tools
European Regional Development Fund
EUROPEAN UNION



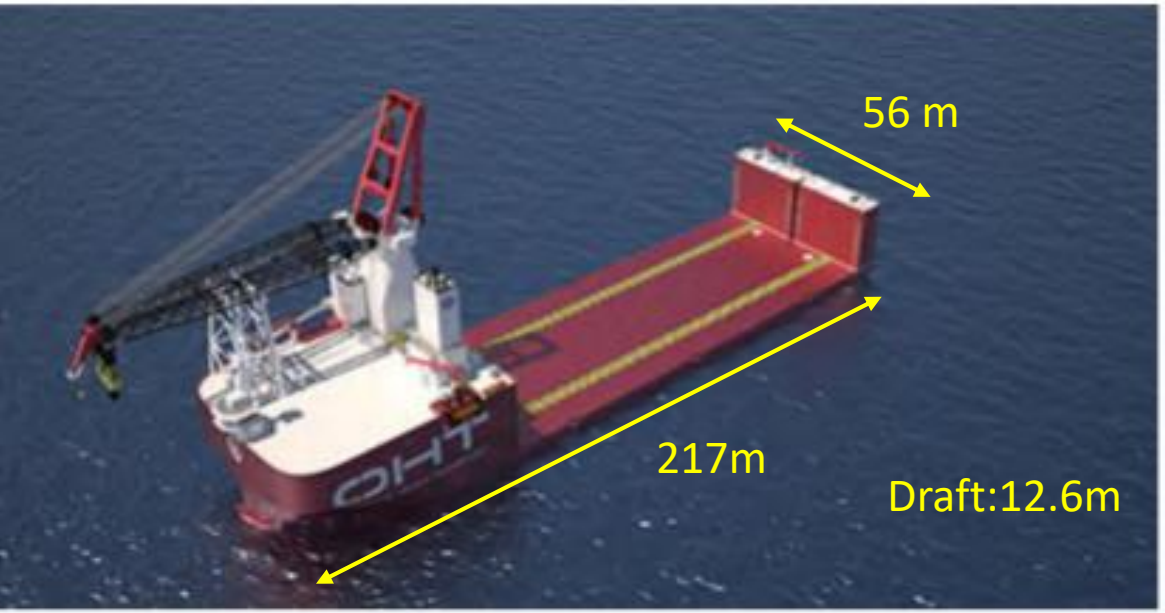



University of Applied Sciences
HOCHSCHULE EMDEN·LEER

# Heavy Lift Vessel (floating vessel)

Interreg North Sea Region Decom Tools
European Regional Development Fund

EUROPEAN UNION



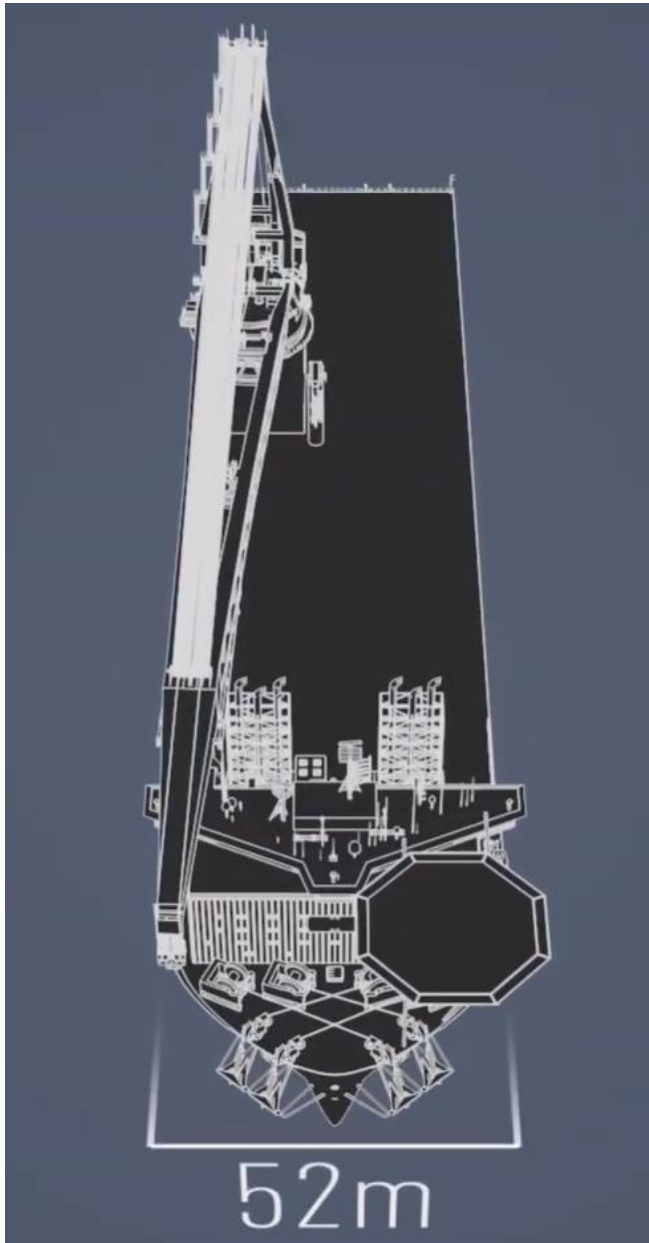



https://www.oht.no/wp-content/uploads/2020/09/OHT-AlfaLift-ProductSheet-R11.pdf

University of Applied Sciences
HOCHSCHULE EMDEN·LEER

# New Heavy Lift Vessel of Jan De Nul

Interreg North Sea Region Decom Tools
European Regional Development Fund
EUROPEAN UNION


Source: https://www.youtube.com/watch?v=eDSUfwvP0Vk

University of Applied Sciences
HOCHSCHULE EMDEN·LEER

# JDN Fleet Development

Interreg North Sea Region Decom Tools
European Regional Development Fund
EUROPEAN UNION

Source: https://www.youtube.com/watch?v=eDSUfwvP0Vk

University of Applied Sciences

HOCHSCHULE EMDEN·LEER

# Current Heavy Load Carrier in the Wind Industry

Interreg North Sea Region Decom Tools

European Regional Development Fund

EUROPEAN UNION

University of Applied Sciences

HOCHSCHULE EMDEN·LEER

# Current Heavy Load Carrier in the Wind Industry

Interreg North Sea Region Decom Tools

European Regional Development Fund

EUROPEAN UNION

University of Applied Sciences

HOCHSCHULE EMDEN·LEER

# Current Heavy Load Carrier in the Wind Industry

Interreg North Sea Region Decom Tools

European Regional Development Fund

EUROPEAN UNION

University of Applied Sciences

HOCHSCHULE EMDEN·LEER

# Current Heavy Load Carrier in the Wind Industry

Interreg North Sea Region Decom Tools

European Regional Development Fund

EUROPEAN UNION

University of Applied Sciences

HOCHSCHULE EMDEN·LEER

# Heavy Load Carrier in the Shipping and Offshore Industry

Interreg North Sea Region Decom Tools

European Regional Development Fund

EUROPEAN UNION

University of Applied Sciences

HOCHSCHULE EMDEN·LEER

# Heavy Load Carrier in the Shipping and Offshore Industry

Interreg North Sea Region Decom Tools

European Regional Development Fund

EUROPEAN UNION

University of Applied Sciences
HOCHSCHULE EMDEN·LEER

# What is needed now?

Interreg North Sea Region Decom Tools
European Regional Development Fund
EUROPEAN UNION

A suitable and efficient Cargo Vessel (C/V) or Heavy Load Carrier (HLC) for the transportation of large numbers of offshore wind turbines components in order to minimize the cost of transportation and reduction of fuel consumption .