

Comparison of Various Logistic Configurations



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Interreg
North Sea Region
Decom Tools

European Regional Development Fund

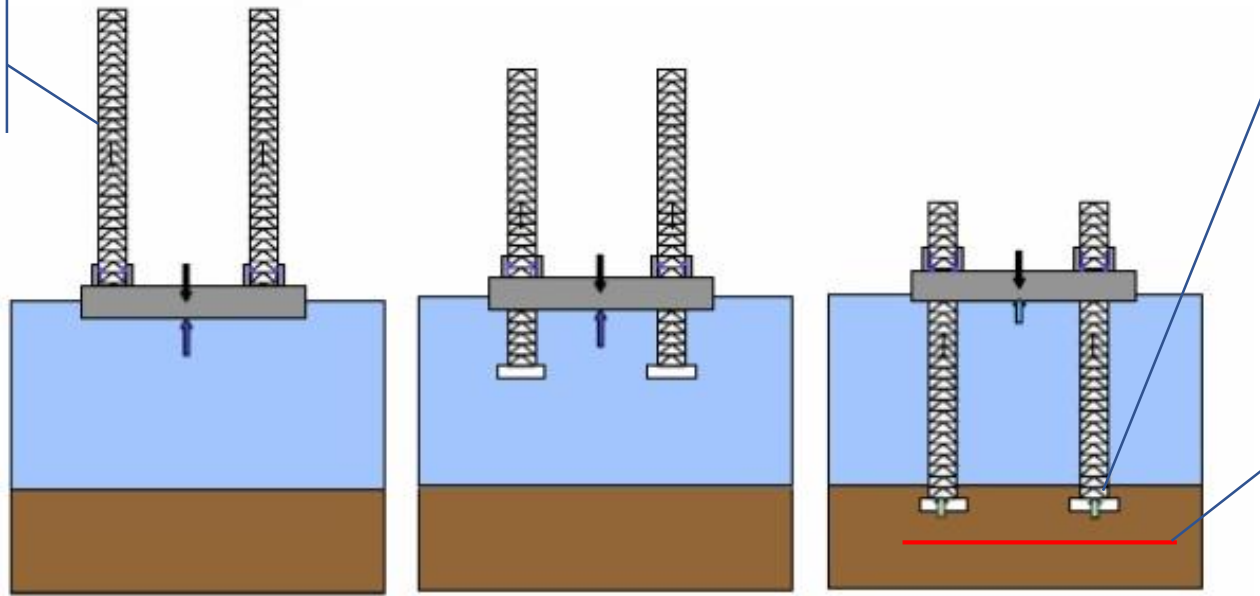


EUROPEAN UNION

- 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

Transition modes of Jack up Vessel

Legs in the raised position



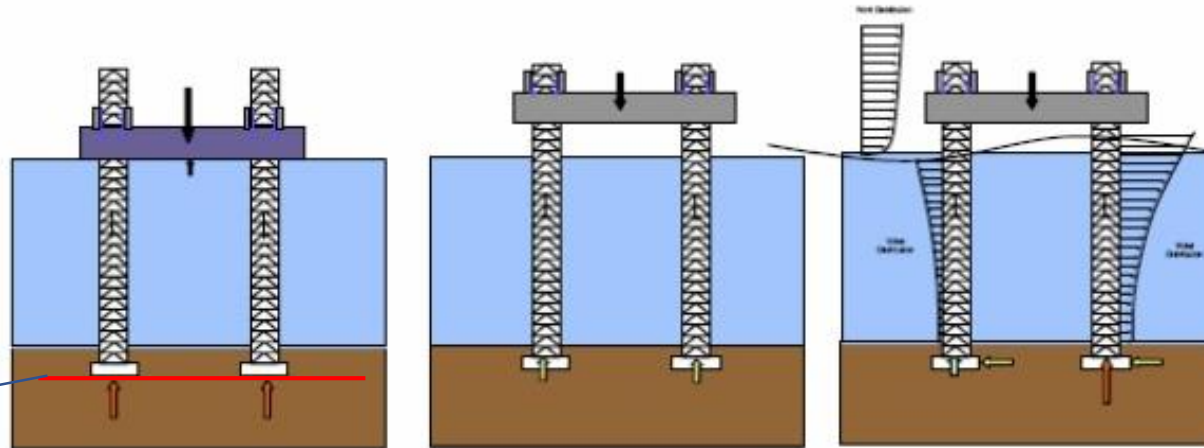
Soft pin

Final penetration

Arriving on Location

Lowering Legs

Coming Out of the Water

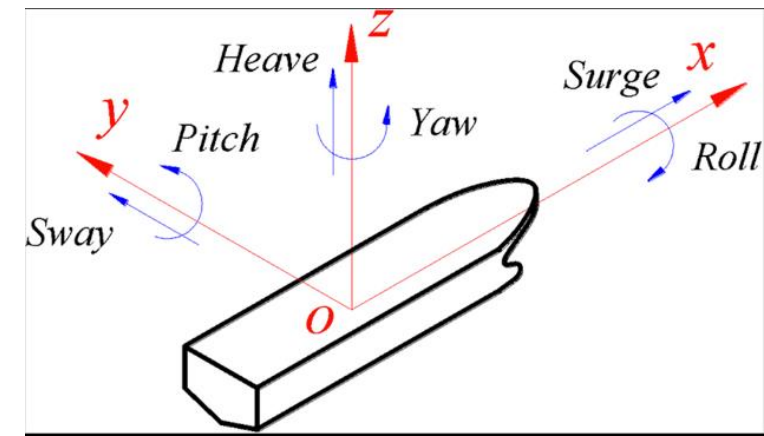


Final penetration

Preloading

At Full Airgap

With Environmental Loads



Hornsea 1 Facts and Figures

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



Case Study: Hornsea 1



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

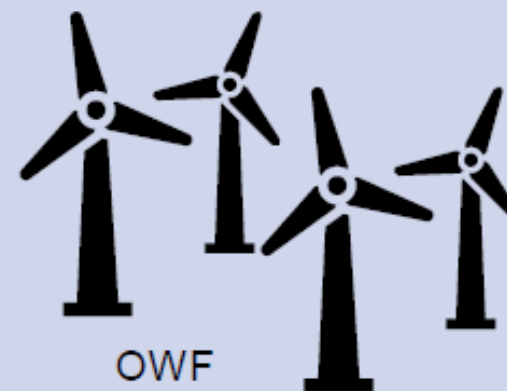


Pendulum Configuration

Ship shuttles
between Port and
OWF



Port



OWF

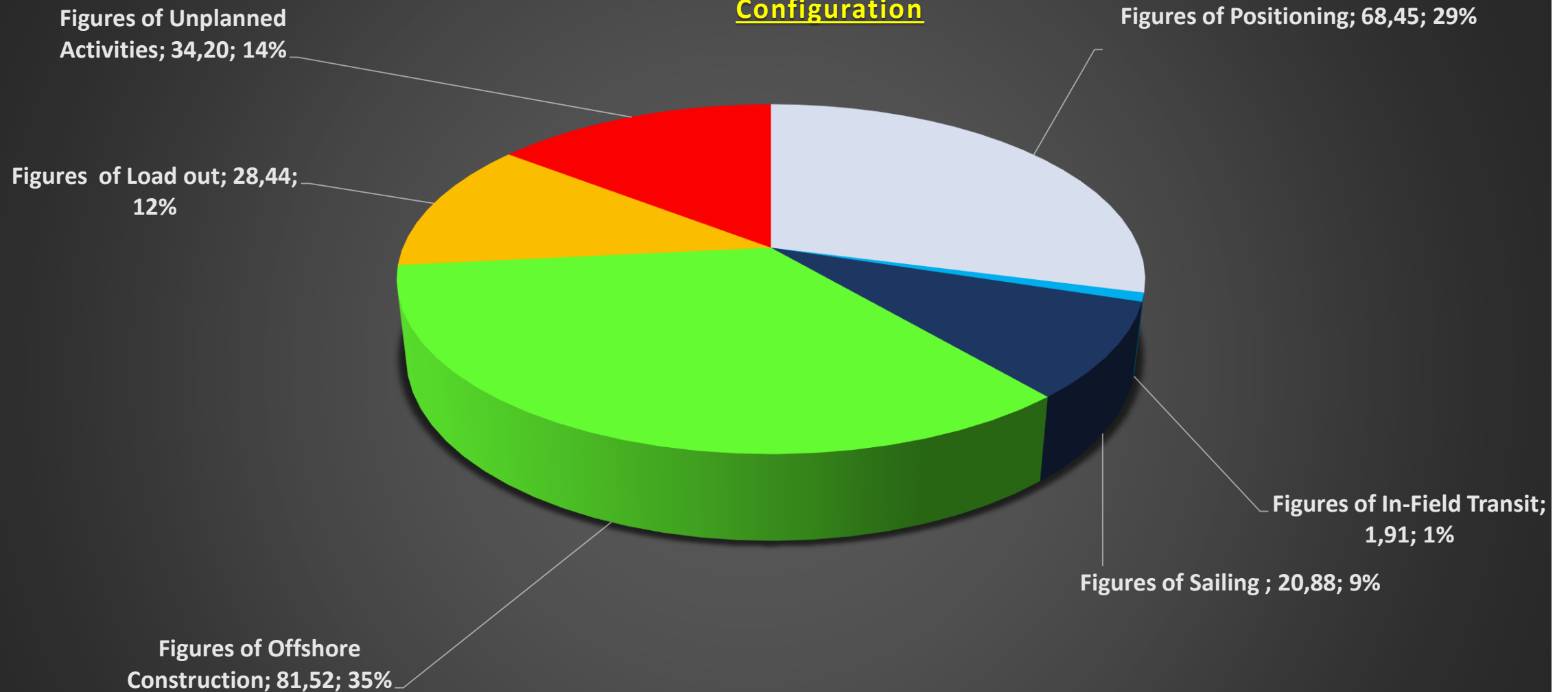


Statistics of Jack Up Vessel		OWP: Hornsea 1	North Sea	Location: England	DP2 Jack Up	Bold Tern
Operations Description	Quantity	Unit	Time (Day)	Daily Fuel Consumption	Overall Fuel Consumption	
Details of Positioning	0.75	Day/Turbine	68.45	22.5	1540.18	
Details of In-Field Transit	84.08	Km	1.91	22.5	42.94	
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	

Pendulum Configuration Results

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

Break Down of Activities for Decommissioning of Hornsea 1 OWP with Pendulum Configuration



Feeder Configuration



Hornsea One
the world's largest offshore wind farm
with a capacity of 1.2GW



Feeder Configuration





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Installation of Fryslân OWP Commenced September 7, 2020

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89 x 4.3 MW
1 X OHVS



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



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Installation of Fryslân OWP will be completed in Summer 2021

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

Feeder Configuration

Jack up + Heavy Load Carrier (HLC)

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

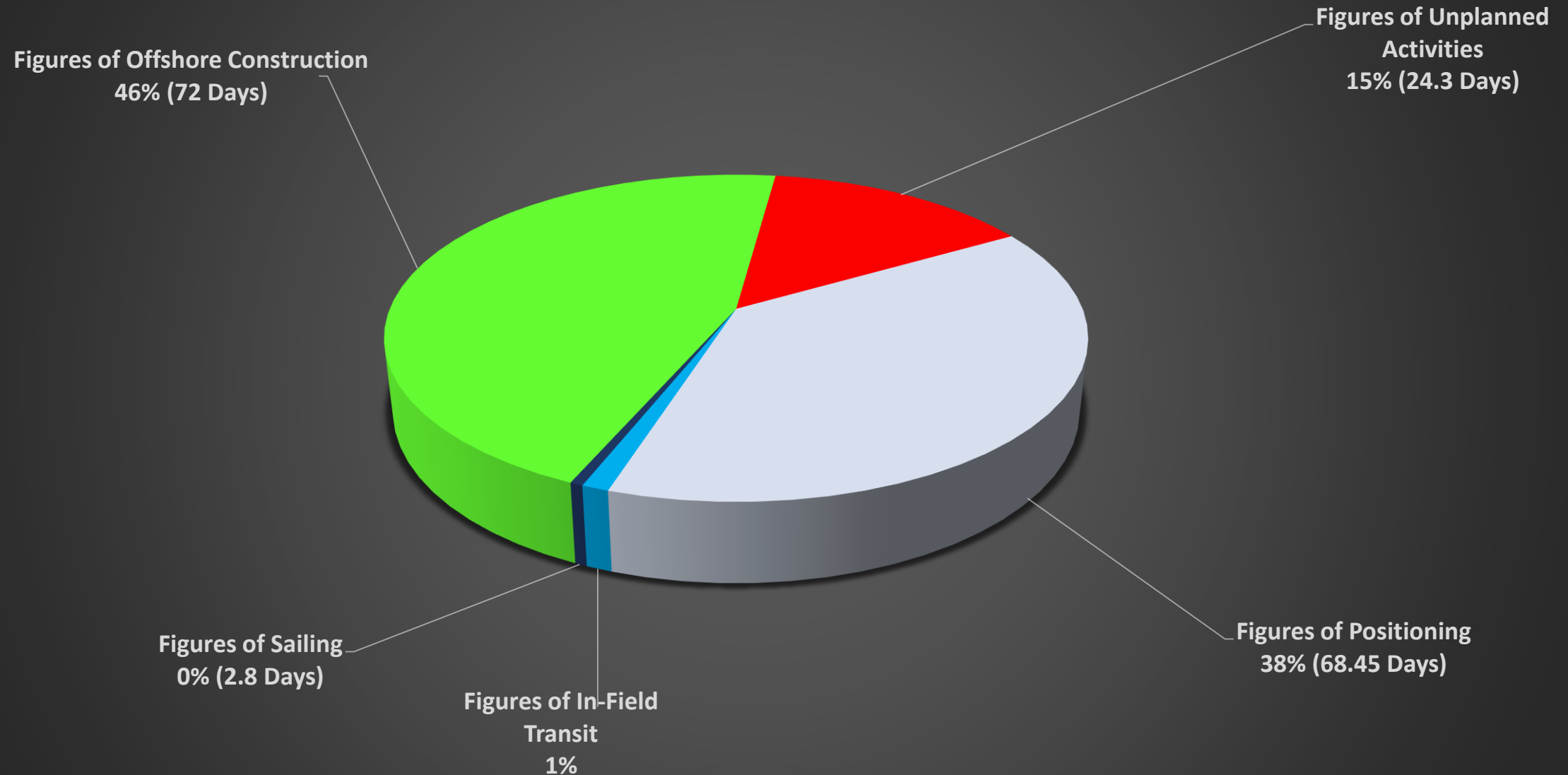
Table 7	Cargo Vessel		
	Sailing Speed	9.5	Knots
	In-field sailing Speed	1	Knots
	Transported Set Per Voyage	15	Set
	Number of Load Out	7.00	Times
	Duration of Load Out	18.96	Day/all set
	Duration of Sailing	8.03	Day
	Duration of In-Field Sailing	1.91	Day
	Vessel Day Rate	35000	\$
	Stand-by Consumption	1	Tones
	Operation Consumption	4	Tones
	Sailing Consumption	15	Tones

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	

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

Results of Feeder Configuration (Jack up + HLC)

Break Down of Activities for Decommissioning of Hornsea 1 OWP (Jack Up+ HLC)



Feeder Configuration (HLV+HLC)



Table 8	Heavy Lift Vessel			Table 7	Cargo Vessel		
	WOW	20%	%		Sailing Speed	9.5	Knots
	Mechanical break Down & WOC	2%	%		In-field sailing Speed	1	Knots
	Sailing Speed	12	Knots		Transported Set Per Voyage	15	Set
	Vessel Day Rate	\$ 200,000	\$		Number of Load Out	7.00	Times
	Stand-by Consumption (DP Mode)	15	Tones		Duration of Load Out	28.44	Day/all set
	Lifting Consumption (DP Mode)	20	Tones		Duration of Sailing	8.03	Day
	Sailing Consumption	25	Tones		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

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		

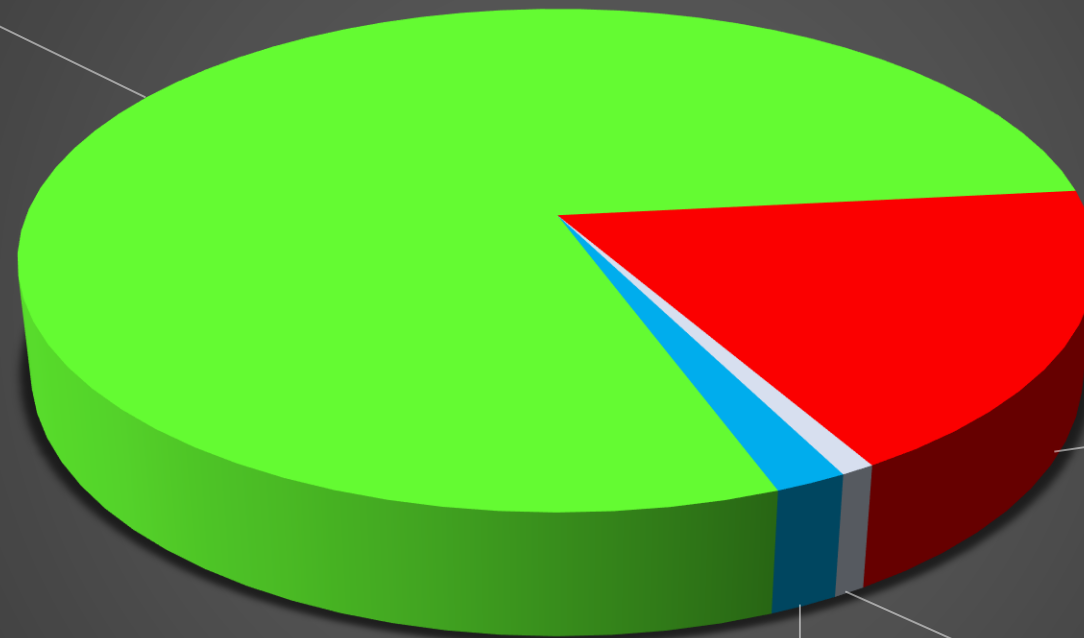
Statistics of HLC		OWP: Hornsea 1	North Sea	Location: England	HLV+ HLC	
Operations Description	Quantity	Units	Time (Day)	Daily Fuel Consumption (Tones)	Overall Fuel Consumption (Tones)	
Details of In-Field Transit	84.08	Km	1.91	7.5	14.31	
Details of Sailing (Site <--> Shore)	1680.00	km	0.91	15.00	13.62	
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

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)

Break Down of Activities for Decommissioning of Hornsea 1 OWP (HLV+HLC)

Figures of Offshore
Construction; 81,52; 79%



Figures of Unplanned
Activities; 18,89; 18%

Figures of Sailing ; 0,91; 1%

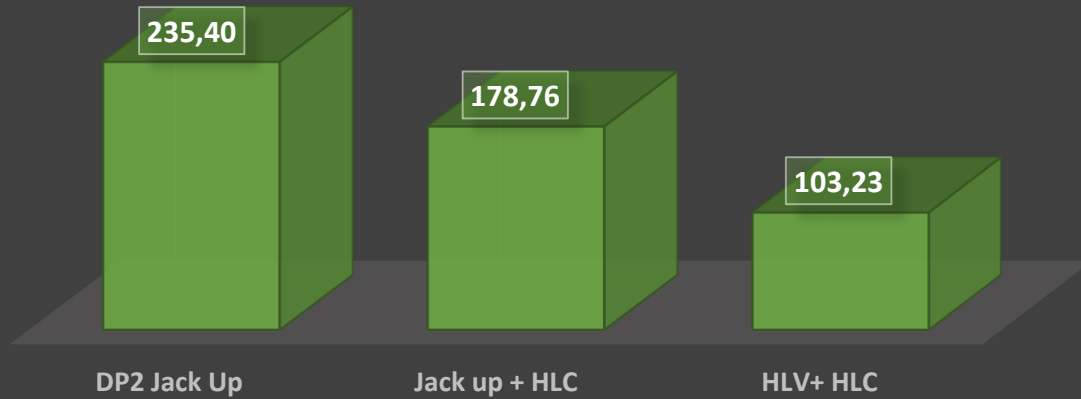
Figures of In-Field Transit;
1,91; 2%

Comparison Table

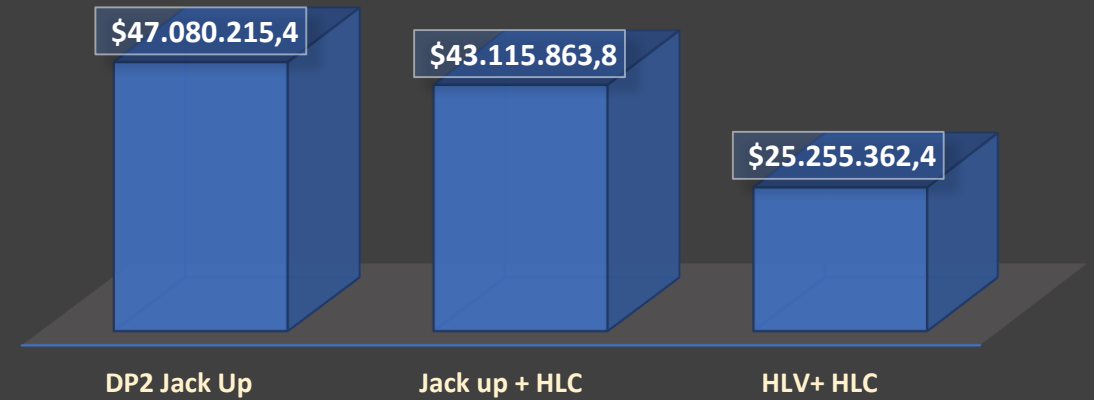
OWP: Hornsea 1		Logistic Configuration Comparison Table		Location: England	
Configuration	Pendulum	Feeder			
Parameters	DP2 Jack Up	Jack up + HLC		HLV+ HLC	
Time (Day)	235.40	178.76		103.23	
	Base Scenario	-57		-132	
		24%		56%	
Cost (\$)	\$ 47,080,215.4	\$ 43,115,863.8		\$ 25,255,362.4	
	Base Scenario	\$ (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%	

Comparison Table

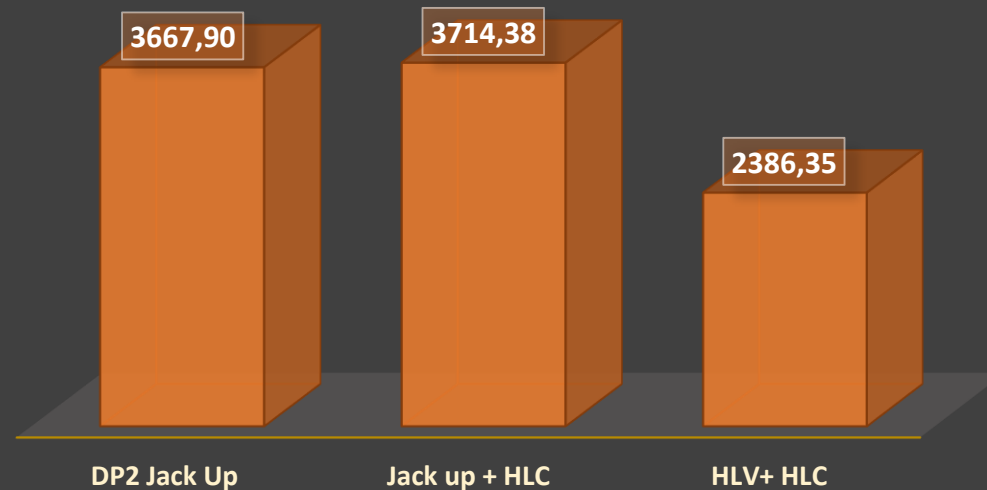
TIME (DAY)



COST (\$)

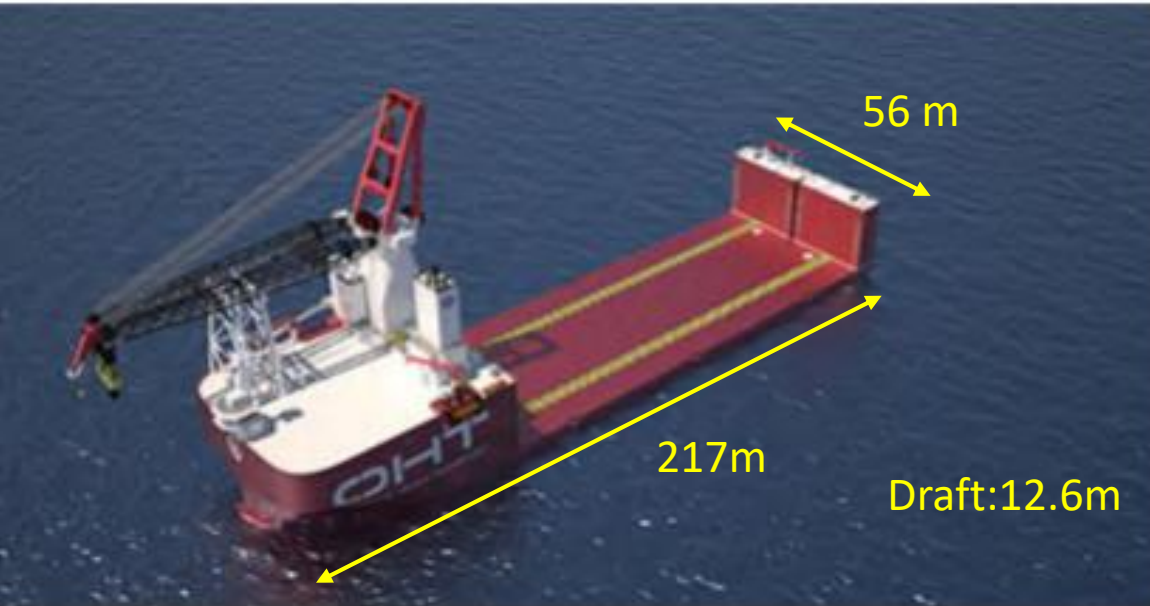


FUEL (TONES)



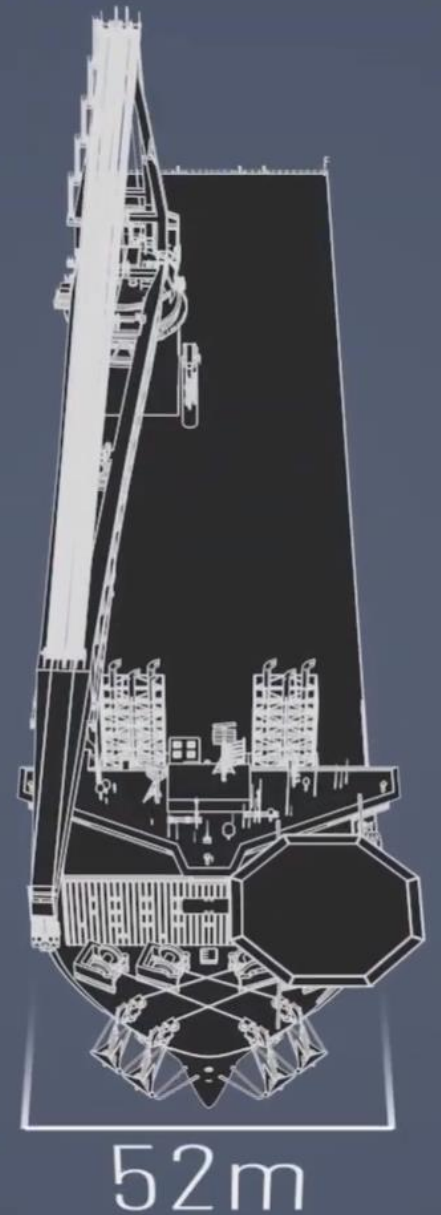
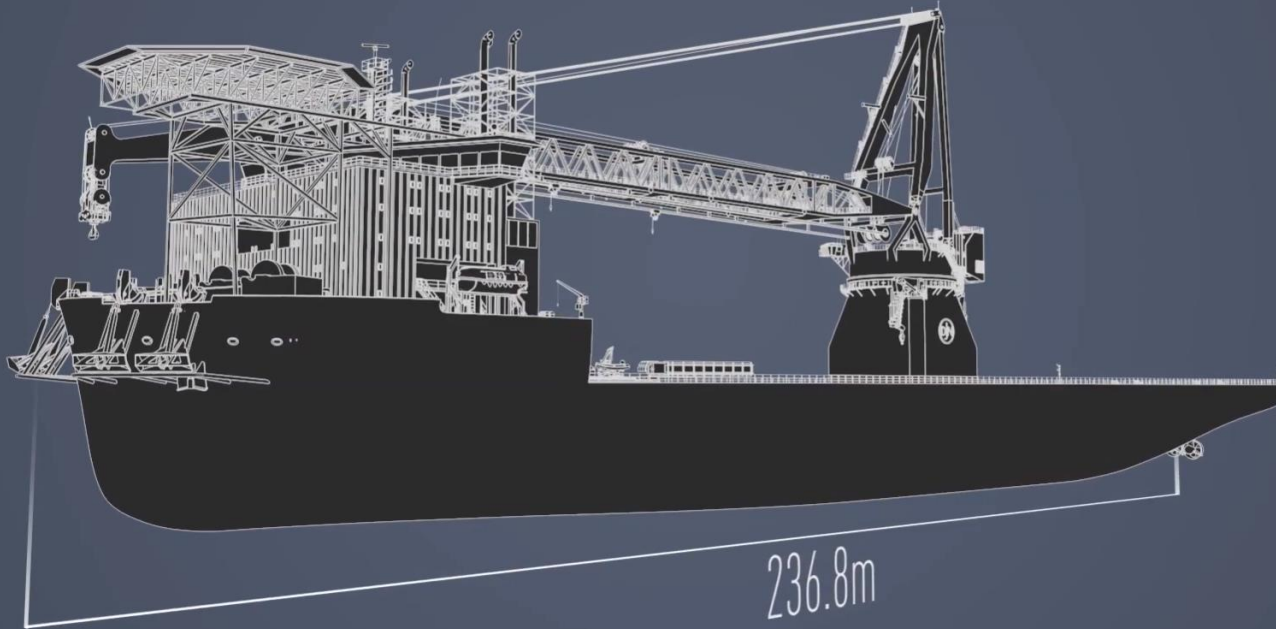


Heavy Lift Vessel (floating vessel)



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





JDN Fleet Development



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



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Current Heavy Load Carrier in the Wind Industry

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Heavy Load Carrier in the Shipping and Offshore Industry





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What is needed now?

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 .