MCEDD

DEEPWATER DEVELOPMENT

28 - 30 March 2023 | Millennium Gloucester Hotel | London, UK

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ENERGY SERVICES INC

Mobile FOWTs to Power Oil & Gas Facilities to Reduce CO_2 Emissions

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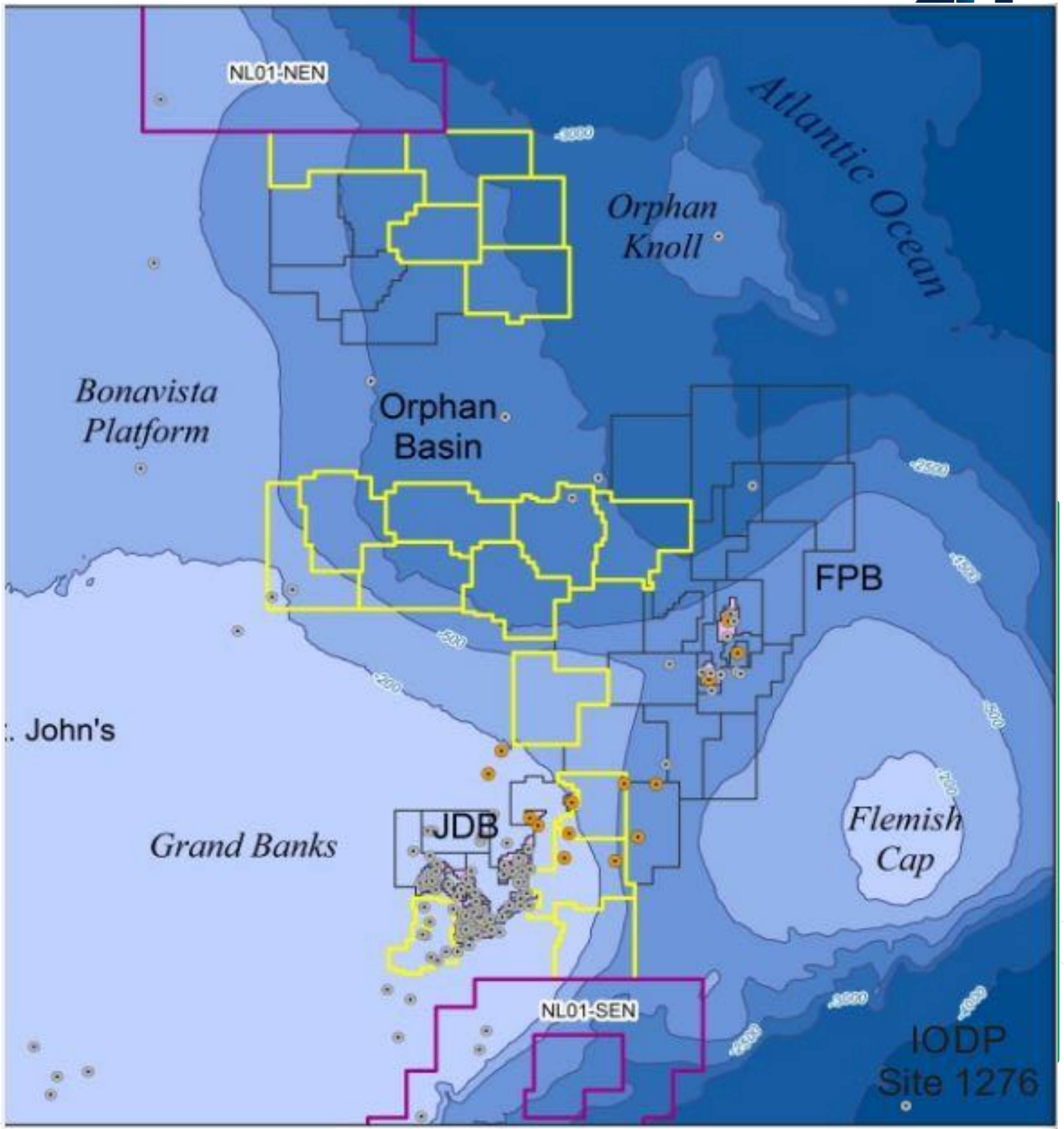
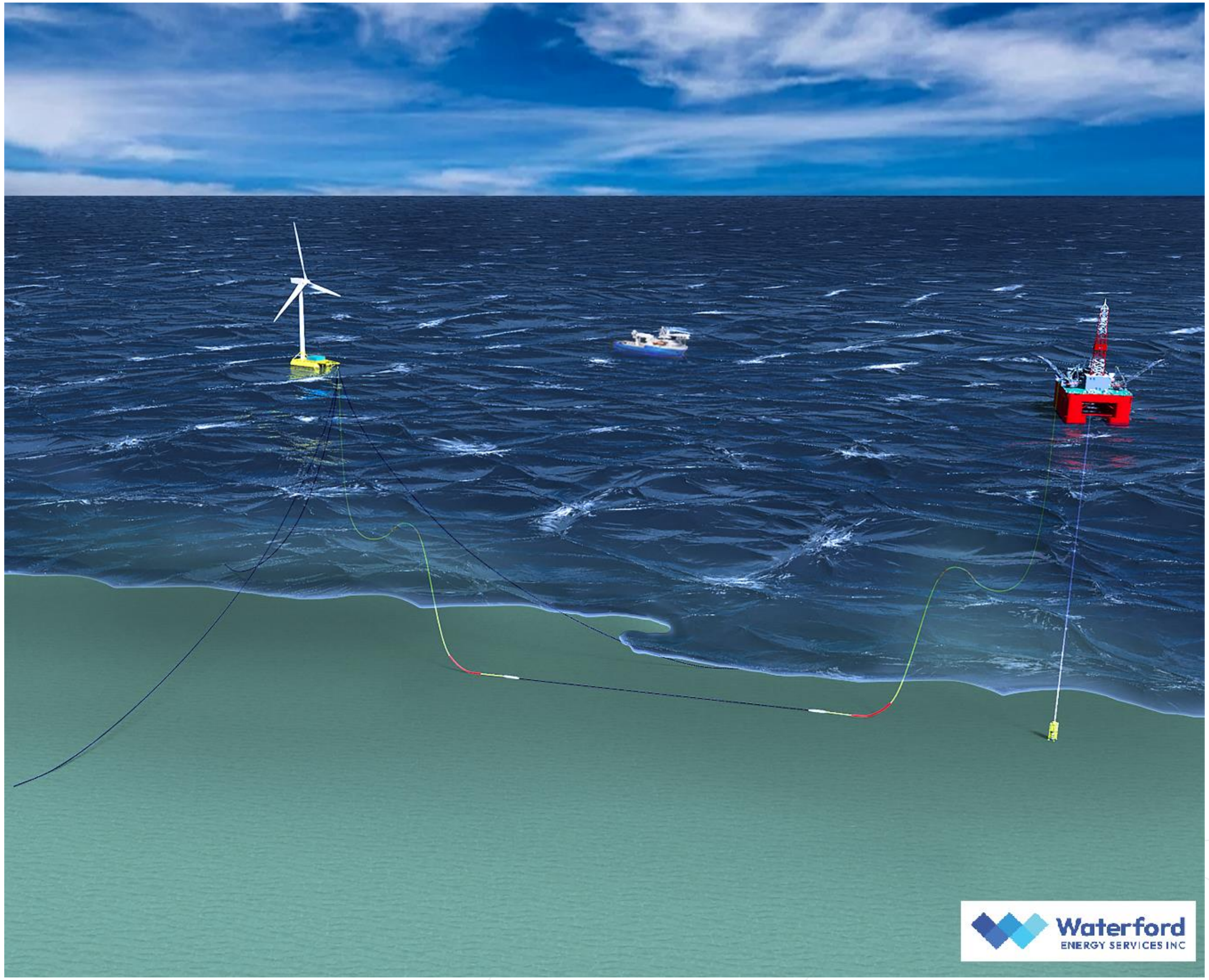
Background

- Like most developed countries, in 2019, the government of Canada set a price on carbon pollution across the country.
- CO_2 emission costs $50/tonne with prices increasing $15 per year until 2030 when it hits $170/tonne
- There is significant Oil & Gas exploration and production activity on the east coast of Canada
- Oil & Gas facilities use generators that consume hydrocarbons and release CO_2 for electricity



Background

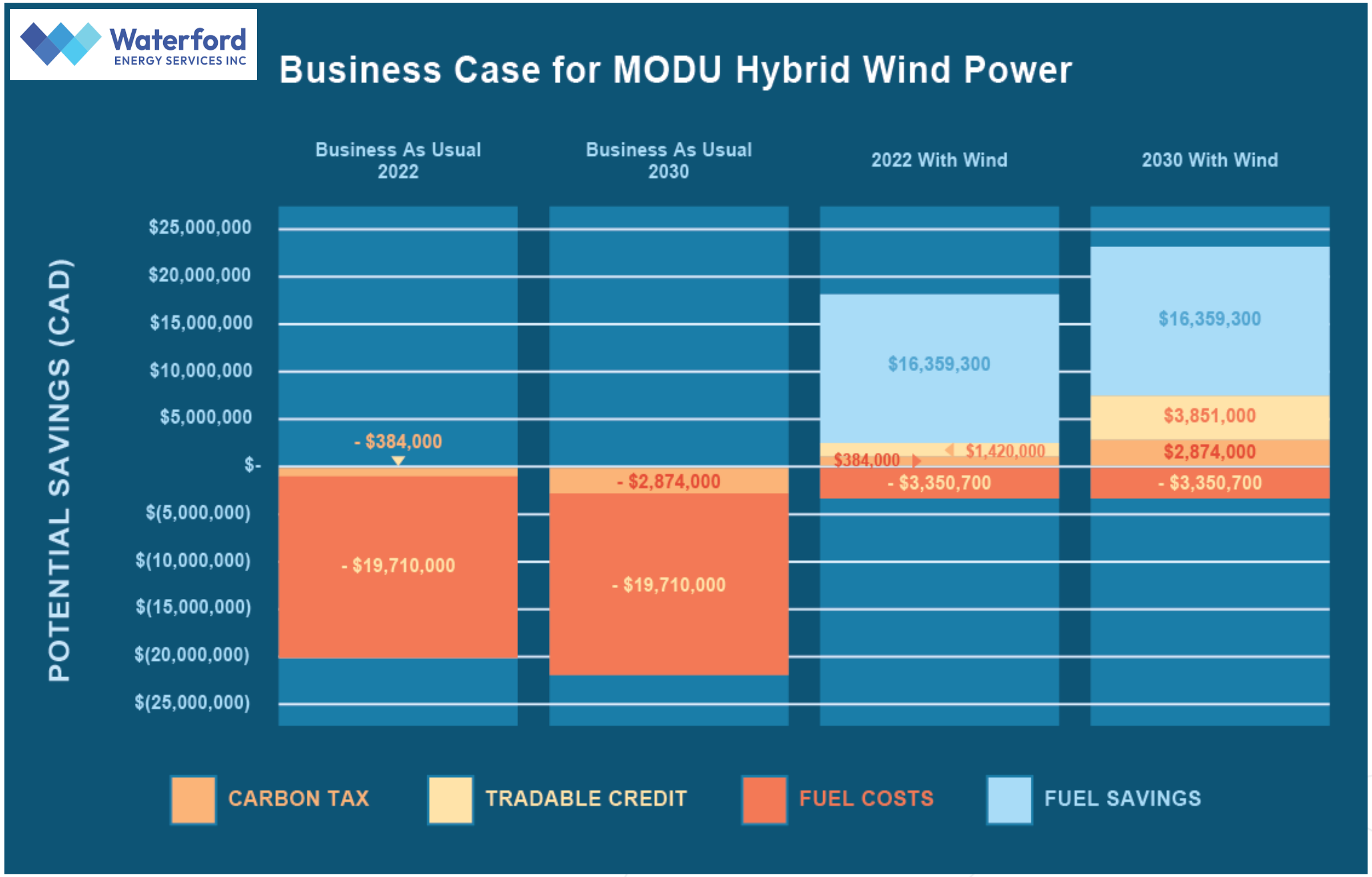
- Canadian Carbon Tax
  - Carbon tax on all combusted fossil fuels
  - 30% reduction of GHG emissions below 2005 levels by 2030
- MODU (mobile drilling units) produce approximately 40,000 tonnes of CO_2 annually
- Floating Offshore Wind Turbines (FOWTs) can reduce CO2 emissions to 7,000 tonnes, an 83% reduction in emission and fuel costs



Background

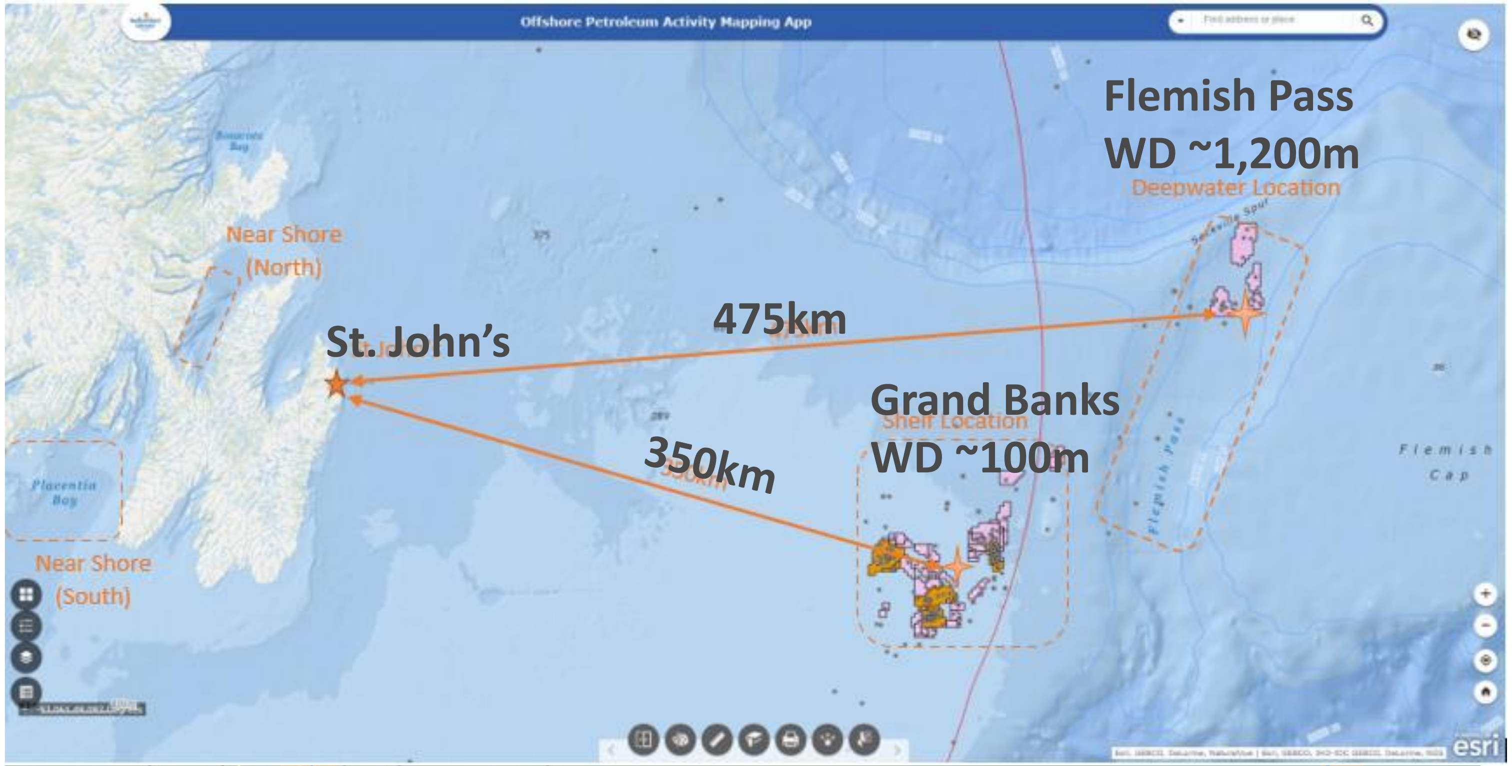
- Annual Savings with FOWT - 2030
  - $2.8 million on carbon tax
  - $3.8 million tradable credits
  - $16.3 million fuel savings

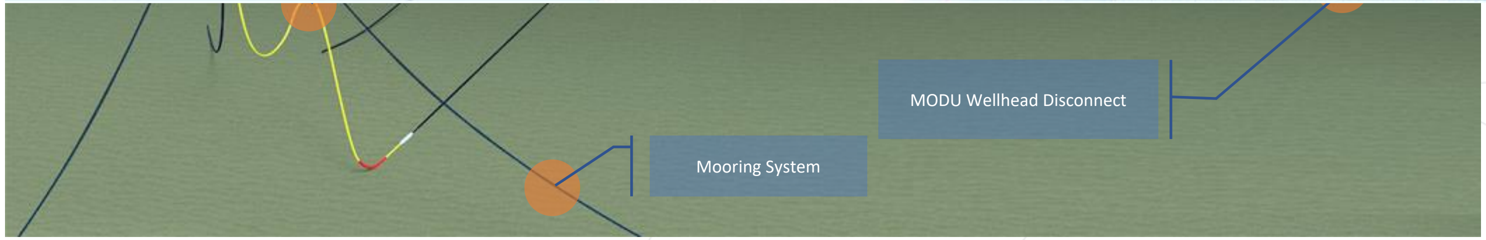
- The fuel savings for MODUs vary based on the BESS capacity, As BESS increases, the generator loads decrease and create additional cost savings on fuel and emissions tax.



Study – Feasibility of FOWTs to Power Oil & Gas Facilities to Reduce CO2 Emissions

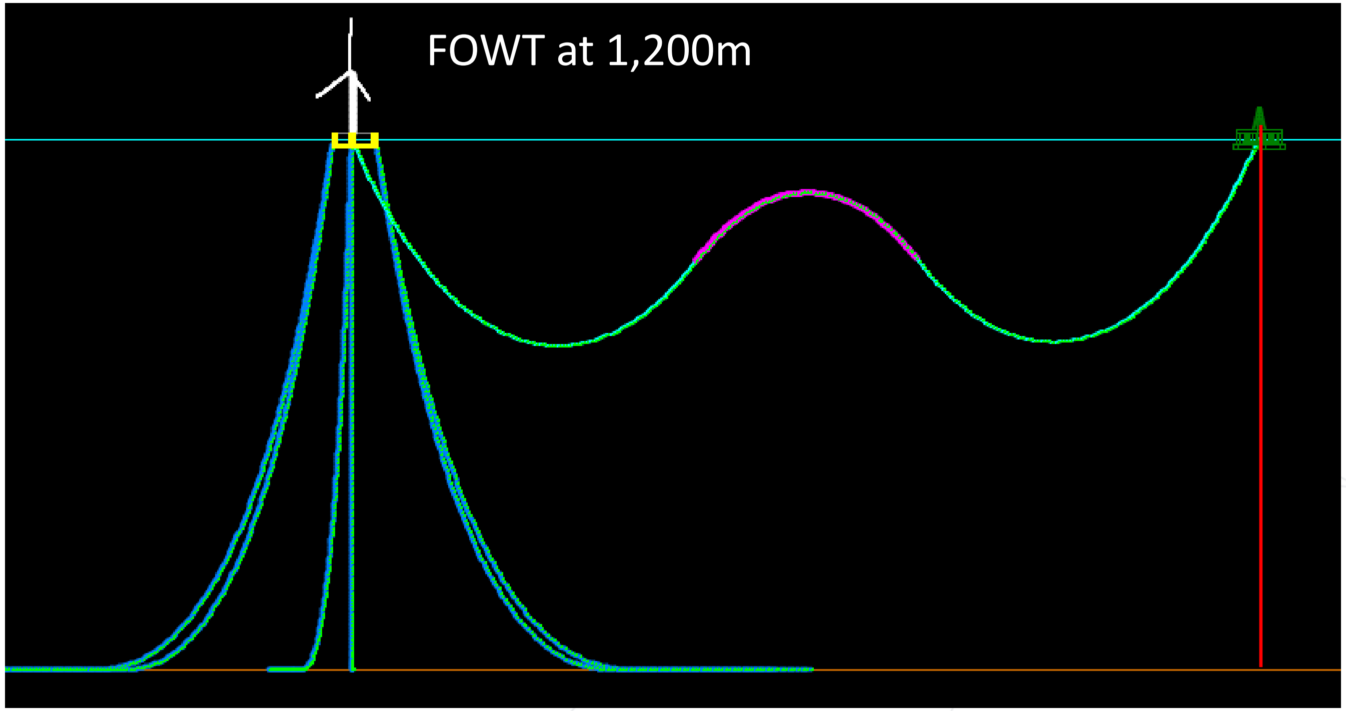
- Funded by Canadian government
- Led by Waterford Energy Services Inc. (WESI)
  - Economic and logistical feasibility
- 2H Offshore
  - FOWT mooring Design
- 2 Target Oil& Gas Fields
  - Grand Banks (100m)
  - Flemish Pass (1,200m)





Mobile FOWT Design Challenges

- Drillship is to relocate to a new well location at every 6 to 12 months
- The water depth can change anywhere from 100m to 1,200m in the field
- Mooring design should work at every possible water depth in the field
- Mooring and anchor component sizes are to remain unchanged regardless of water depth
- Modular mooring segments to facilitate mooring length adjustment based on water depth



Mooring Design Premise

- Design Load Cases
  - 50yr extreme storm (DnV DLC 6.2 - Parked)
  - Operational at rated and cut-out wind speeds with severe sea state (DnV DLC 1.6)
  - Packed ice condition (DnV DLC 9.1)
    - 1,000kN in Surge
    - 300kN in Sway

Site	Storm Condition	Hs	Tp	y	Wind Speed	Surface Current	Seabed Current
		m	s		m/s	m/s	m/s
Grand Banks	1yr	8.04	12.37	2.08	10.59[1] 28[2]	0.25	0.1
	50yr	14.32	15.6	2.74	32.51	1.2	0.4
Flemish Pass	1yr	8.93	13	2.11	10.59[1] 28[2]	0.3	0.1
	50yr	15.2	16.04	2.77	34.73	1.4	0.3

1/ Max thrust wind speed
2/ Cut-out wind speed

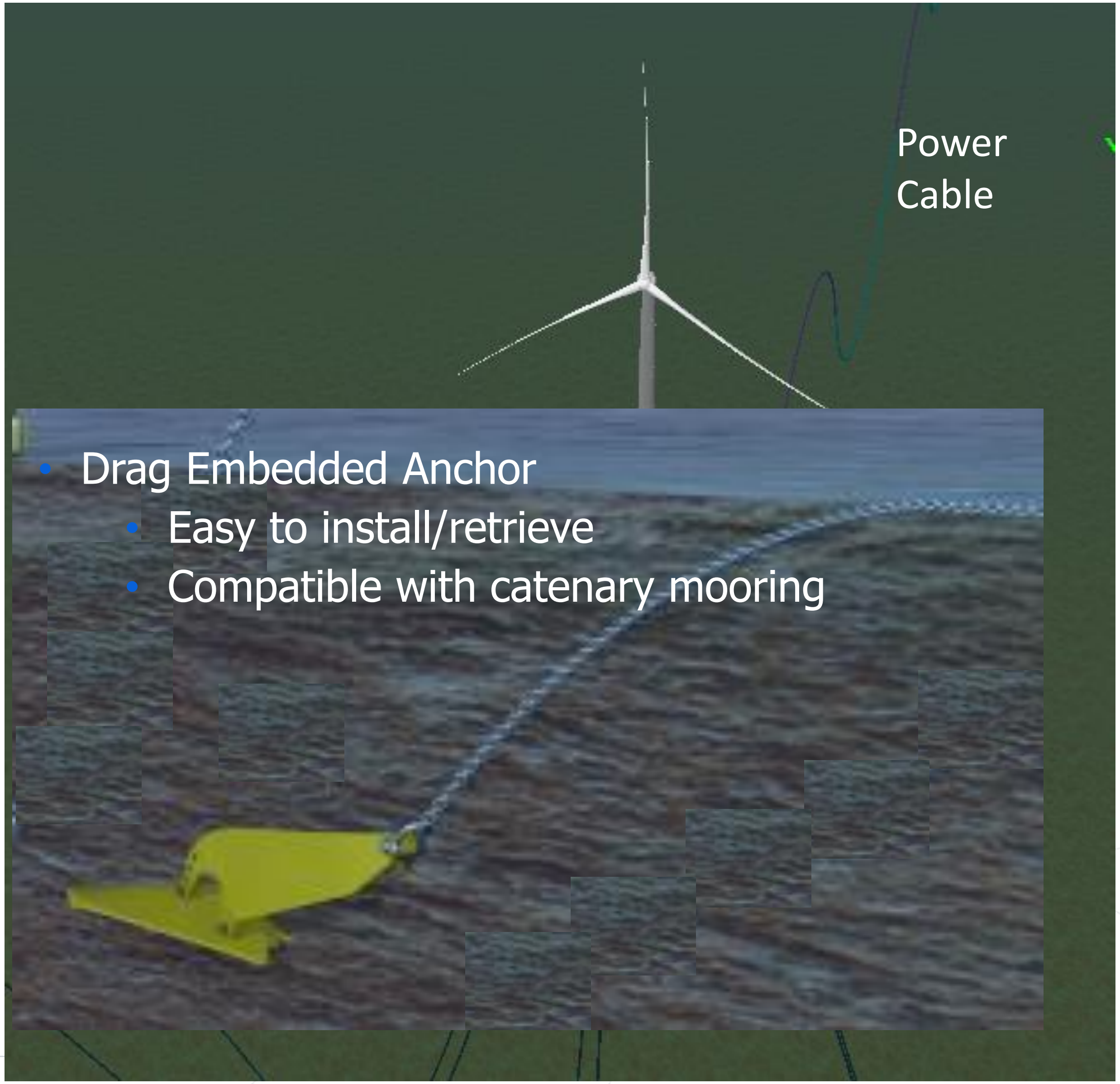
Mooring Design Premise

- NREL's 15MW WTG
- VolturnUS Concrete Floater by Unv of Maine

- 6-Line Chain Catenary Mooring
  - Redundancy in case of mooring failure due to oil & gas facilities
  - Robustness for handling and multiple installation and retrieval

- DnV-ST-0119 Consequence Class-1 (Redundant)
  - Target Strength Utilization <0.95

Limit State	Consequence Class 1 Load Factors	
	γ_{mean}	γ_{dyn}
Ultimate Limit State (ULS)	1.3	1.75
Accidental Limit State (ALS)	1.0	1.10

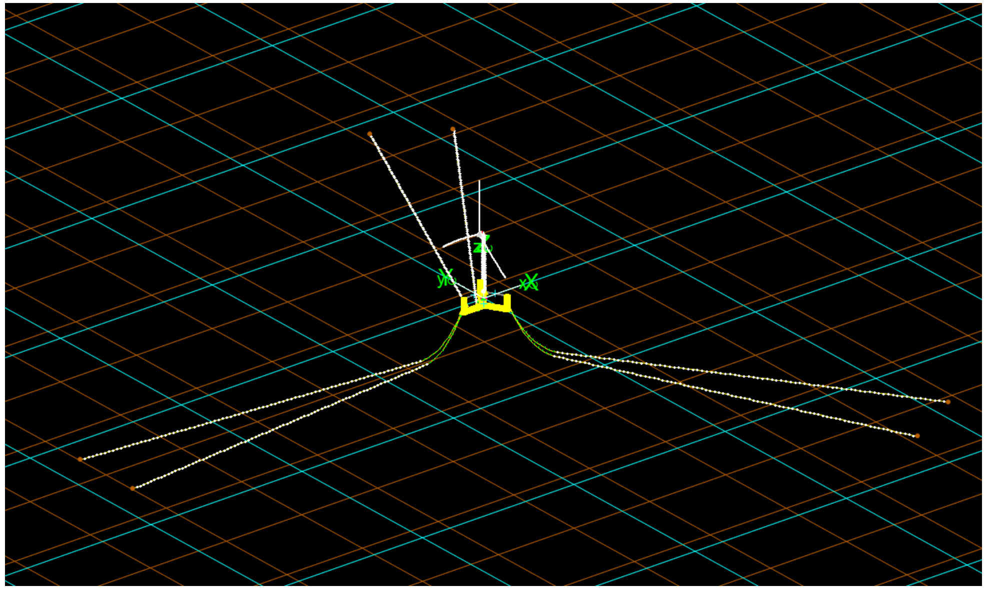


Mooring Configuration at Grand Banks (100m)

- 6 mooring line spread system:
  - 3 clusters at 120°, lines 10° apart within cluster

- 84mm R5 Chain
- MBL: 7,742kN (includes 4mm corrosion)

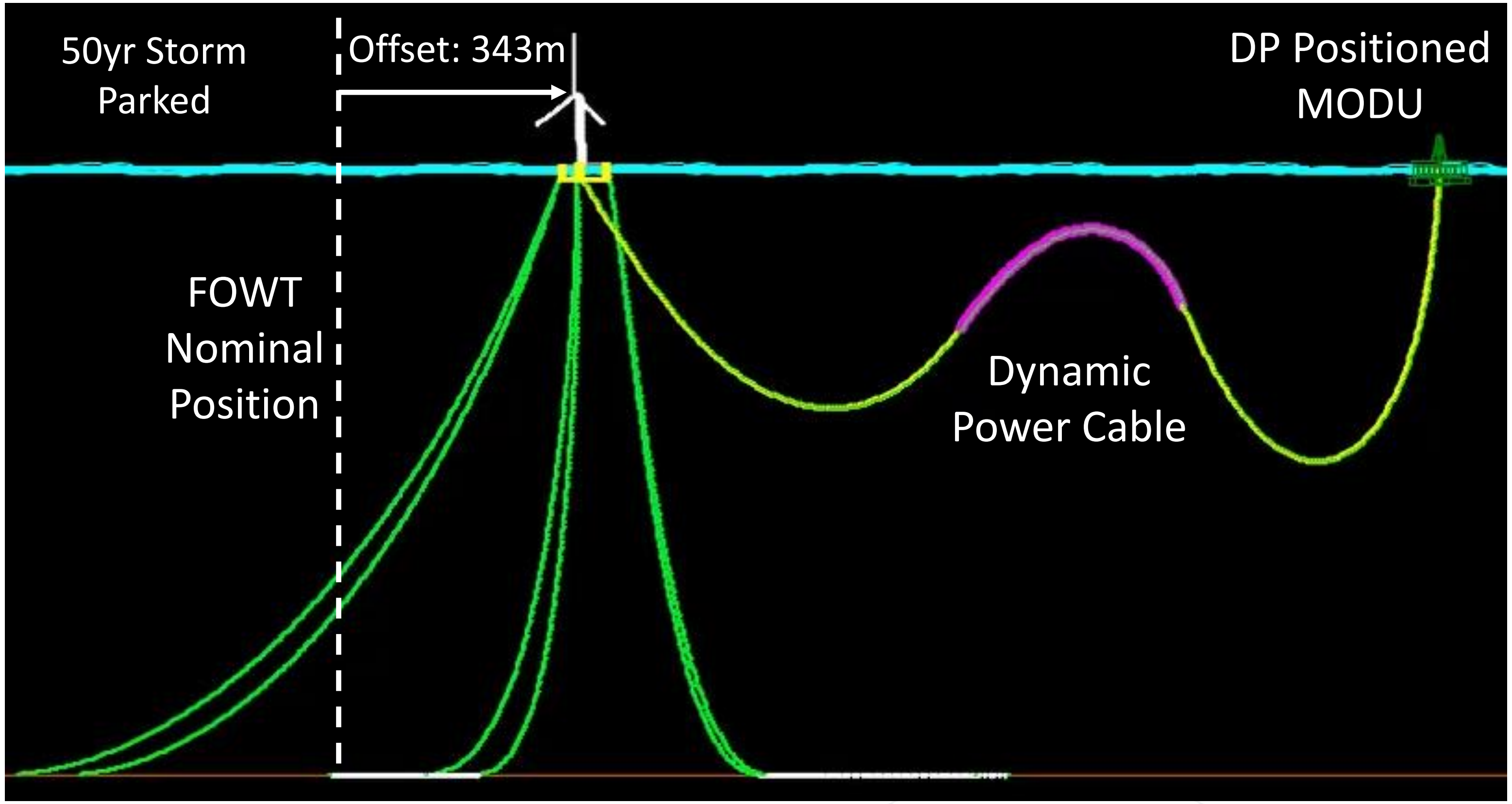
- Min Chain Length: 650m



Configuration	Chain Size	Top Angle	Pre-tension	Max Offset	Strength Utilization	Max Tension	Chain MBL	Required Chain Length
	mm	°	% MBL	m	-	kN	kN	m
6ML – Config 1	150	50	6%	15.3	42%	5,884.3	21,789.0	482.5
6ML – Config 2	124	50	6%	17.2	54%	5,433.2	15,852.0	552.9
6ML – Config 3	94	50	6%	20.4	81%	4,877.7	9,539.0	653.4
6ML – Config 4	84	50	6%	21.3	102%	4,996.3	7,742.0	683.5
6ML – Config 5	94	30	3%	34.9	72%	4,346.9	9,539.0	610.0
6ML – Config 6	**84**	**30**	**3%**	**35.9**	**90%**	**4,401.8**	**7,742.0**	**650.0**

Mooring Configuration at Flemish Pass (1,200m)

- 6 mooring line spread system:
  - 3 clusters at 120°, lines 10° apart within cluster
- 84mm R5 Chain
- MBL: 7,742kN (4mm corrosion)
- Anchor Radius: 1,250m
- Min Chain Length: 2,000m
- Chain Segments: 250m to 500m



Configuration	Chain Size	Top Angle	Pre-Tension	Strength Utilization	Max Tension	Chain MBL
	mm	°	% MBL		kN	kN
6ML - Config 1	124	10	26%	60%	6624.5	15483.0
6ML - Config 2	**84**	**10**	**26%**	**87%**	**4483.0**	**7537.0**
6ML - Config 3	74	10	26%	100%	4051.7	5927.6
6ML - Config 4	78	10	26%	95%	4247.2	6549.2

Key Takeaways

- The government of Canada set a price on carbon pollution (carbon tax) targeting GHG emission reduction of 30% below 2005 levels by 2030.
- FOWTs can reduce MODU's CO_2 emissions and fuel costs by 83% or more based on the BESS capacity providing annual savings of over $20 million.
- Robust and mobile mooring system can be designed for FOWTs considering local environmental conditions and water depths.
- Redundant mooring system can ensure the safety of oil & gas facilities even with failed mooring lines.
- Power cables can be suspended in water column for deep waters or laid on the seabed for shallow waters.
- The concept is being advanced for larger emitters in the offshore Oil and Gas industry. We expect this technology to be employed by 2030 in Atlantic Canada; Oil and Gas Production will exist beyond 2050 however, associated emissions will be curtailed significantly

Thank You

Questions

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