

# Lessons learnt from FEED studies of FOWT Demonstration Projects

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# About speaker

- Senior Naval Architect - 9 years
- Ship Science - University of Southampton (2009-2013)
- Participated in OTC 2012, OTC Asia 2014, 2016
- Speaker at YoungGastech 2017, 2018, 2019, SUT+ 2020, FOW 2020

	Offshore Wind	Oil & Gas
LOC (2013-2019)	Offshore Wind Mobilisation Support Cable Lay Analysis	FPSO/FSRU mooring analysis Transportation Analysis Marine Warranty Services
Atkins (2019- 2021)	Offshore Wind Roadmap for Vietnam FOWT Concept Design FOWT Lessons Learnt Workshops Facilitator Floating Wind Engineering Management Advisory (a demonstration project in USA)	Subsea Storage Tank FEED
Worley (2021-now)	Assistant Engineering Manager for a Floating Wind project (a demonstration project in Norway)	



# Discussion Points

## Lessons

- It's not a ship .....
- Turbine data
- Model tank testing
- Computing resource

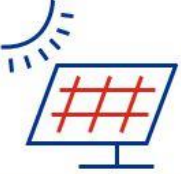





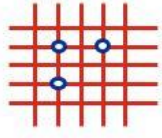


## Assumption of audience

- Mainly come from O&G industry
- Mainly working on bottom-fixed offshore wind projects

# Energy Transition: Worley is the leader

**2417+**

**Project experiences**

								
Solar power	Wind power	Geothermal, hydro & ocean power	Nuclear power	Renewable fuels & waste-to-energy	Hydrogen	Distributed energy, EV & storage	Electrification, energy efficiency & grid transformation	Carbon capture utilization & storage
<b>350+</b> Solar power projects	<b>707+</b> Wind power projects	<b>295+</b> Geothermal, hydro and ocean power projects	<b>221+</b> Nuclear power projects	<b>130+</b> Renewable fuels & waste-to-energy projects	<b>72+</b> Hydrogen projects	<b>224+</b> Distributed energy, EV & storage projects	<b>210+</b> Electrification, energy efficiency and grid transformation projects	<b>208+</b> Carbon capture utilization and storage projects
<b>950 MW</b> World's largest CSP/PV hybrid project	<b>310 MW</b> Largest onshore wind farm (and largest in Africa)  <b>2600 MW</b> Largest offshore wind farm	<b>20 GW</b> Largest hydropower project	<b>30+ GW</b> Nuclear projects over 55+ years, in 40 countries on 4 continents	<b>280,000+</b> Barrels per day (4.29 billion gallons/year) of renewable fuels from 34+ projects	<b>36 GW</b> Largest green hydrogen electrolyzer studied, combined with offshore wind	<b>30 MW</b> Largest battery energy storage project	<b>\$20m/yr</b> Savings achieved through energy efficiency and electrification for a single industry client	<b>100 MT</b> Million tons of CO <sub>2</sub> expected to be captured and stored on world's largest CCS project

**We are a safe pair of hands with over 30 years of experience in all types of floating systems**



**Horizon 2020  
Pivot Buoy**

Hull Type	Project	Location
Semi	Enterprise Southern Green Canyon	GoM
Semi	Hardy Oil PY 3 FPU	India
Semi	Hess Equus	Australia
Semi	Chevron BSM	GoM
Semi	BP Thunderhorse	GoM
Semi	Shell Gumusut FPU	Malaysia
Semi	Shell NaKika FPU	GoM
Semi	Shell Appomattox	GoM
Semi	Shell Vito	GoM
Semi	Shell Whale	GoM
Semi	Total North Platte	GoM

Hull Type	Project	Location
TLP	Anadarko/El Paso Marco Polo	GoM
TLP	BHP Billiton Shenzi	GoM
TLP	Chevron Big Foot	GoM
TLP	El Paso Prince	GoM
TLP	Elf Matterhorn	GoM
TLP	Hess Okume and Oveng	Equatorial Guinea
TLP	Hess Pony	GoM
TLP	Kerr-McGee Boomvang	GoM
TLP	Murphy Kikeh	Malaysia
TLP	Petrobras Papa Terra	Brazil
TLP	Shell Malikai	Malaysia
TLP	Shell Malikai	Malaysia
TLP	Shell Mars B (Olympus)	GoM
TLP	Telemark Norsk Hydro	GoM
TLP	Total Moho Nord	Congo-Brazzaville
TLP	Unocal West Seno A	Indonesia
TLP	Unocal West Seno B	Indonesia
TLP	Woodside Browse	Western Australia

Hull Type	Project	Location
Spar	ATP Mirage	GoM
Spar	Chevron Genesis	GoM
Spar	ExxonMobil Diana	GoM
Spar	Kerr-McGee Red Hawk	GoM
Spar	Murphy Front Runner	GoM
Spar	Murphy Medusa	GoM
Spar	Murphy Devil's Tower	GoM
Spar	Shell Perdido	GoM

# It's not a ship ... not even a conventional O&G floating structure

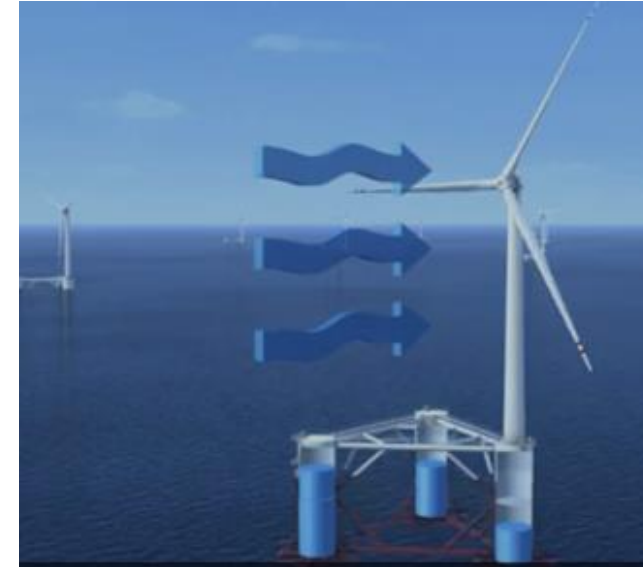
- GML (longitudinal stability)
- Heave/pitch/roll coupling
- Codes and Standards

DNV-RP-0286	Operational	Survival
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Maximum Tilt Angle	10 deg	15 deg
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Maximum Acc.	0.3g	0.6g
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It's a child of floating O&G with bottom-fixed offshore wind, inherits their personalities of both BUT have its own characters

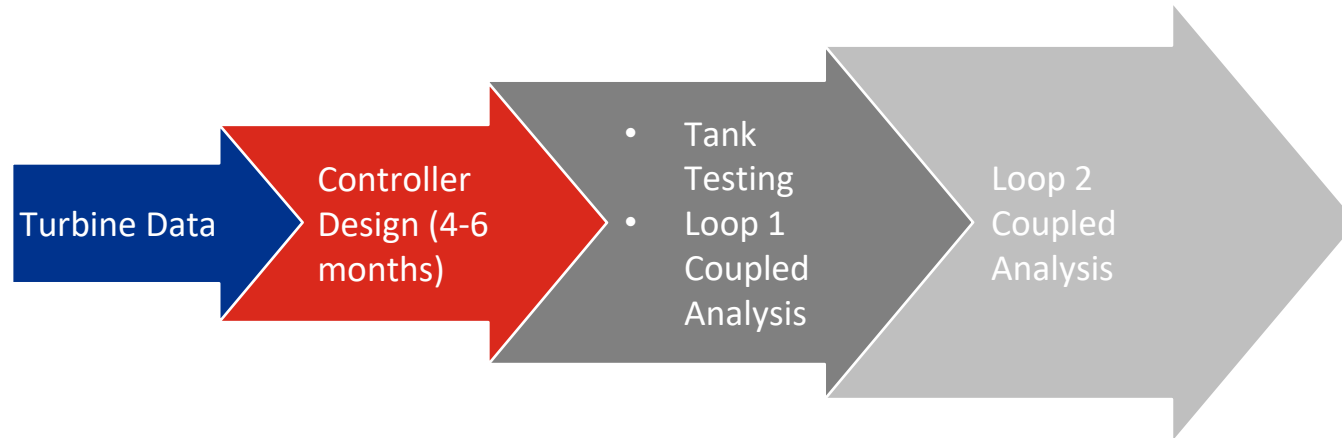


*Longitudinal Stability & Trim*



# Turbine Data

- Single most important long-lead item
- Turbine Manufacturer not accessible
- Second-hand turbine
- Scaled model acceptable for Pre-FEED but NOT in FEED

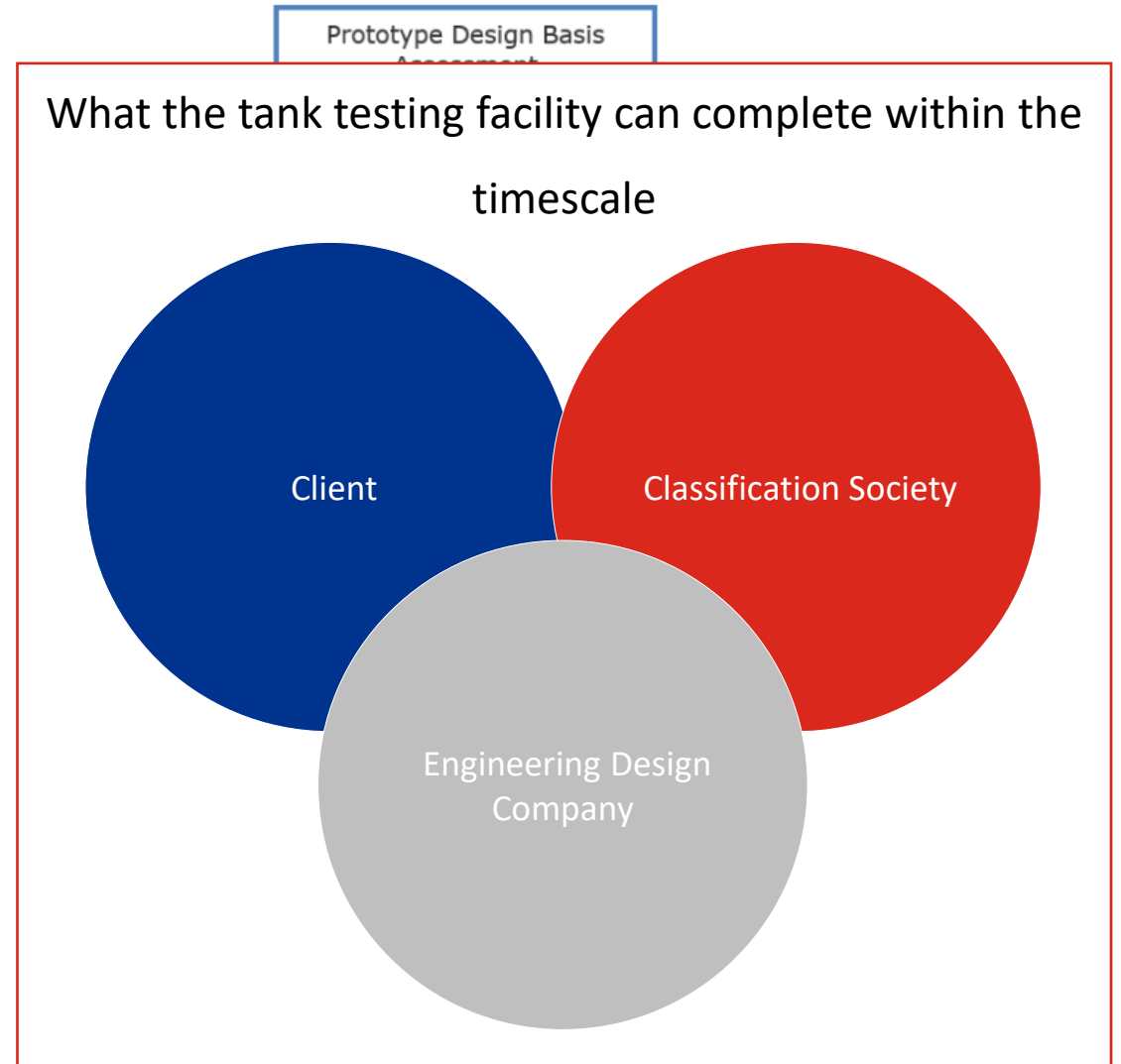


- ✓ Turbine Data needs to be available as early as possible, ideally before the start of FEED
- ✓ If the data is not available, then a plan to mitigate its impact

# Model tank test

- Necessity of modal tank test
- Availability of tank testing facility
- 4 stakeholders in a tank testing

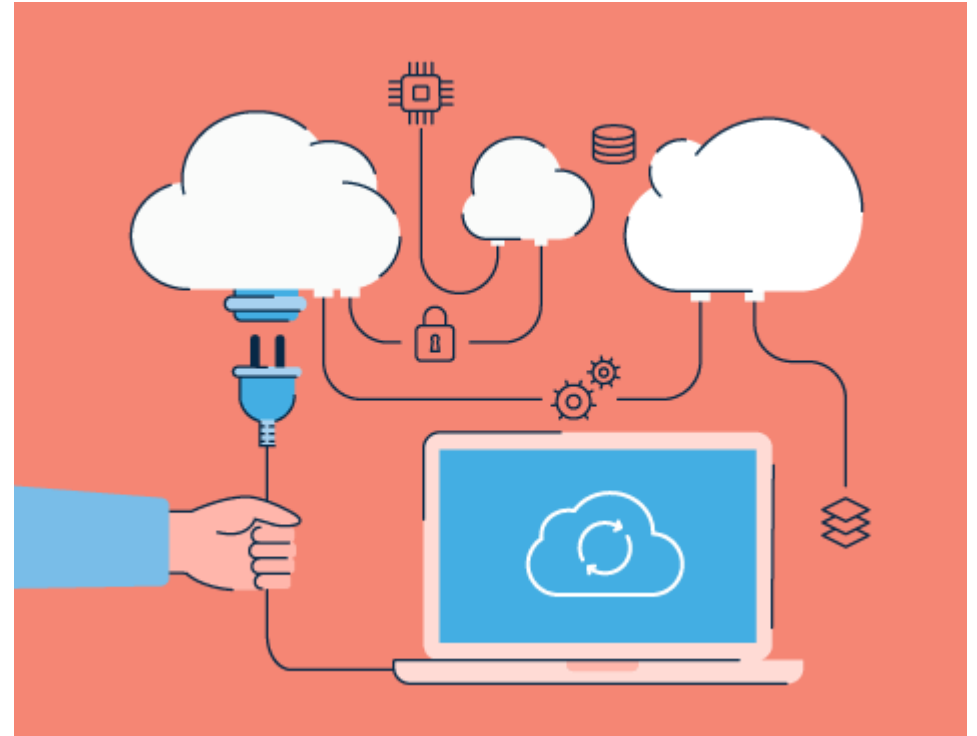
- ✓ Avoid if you can (for demonstration projects)
- ✓ Find your tank facility early, fit your schedule around the model test
- ✓ Align 4 stakeholders on the objectives of tank testing





# Flexible computing resources

- Resources needed for the final loop
  - 300 - 1000 Design Load Cases (6 seeds), each take 10 hours
  - Storage (a single 3-hour time-domain OrcaFlex coupled analysis simulation is 3GB)
- Resource intensity are peaks and troughs
- Cost of cloud computing (e.g. 48 cores cost \$3500/month)



- ✓ **Cloud computing is a must for Floating Wind FEED studies**
- ✓ **Need a cloud expert to minimize your cost**

# Summary

- FOWT is a child of floating O&G with bottom-fixed offshore wind BUT ...
- Importance of turbine data and implication of not having a turbine data ready
- Issues around model test
- Cloud computing is a must



I went to a  
Wind Conference



It blew me away

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**Worley**  
energy | chemicals | resources