Hull Trim System

Maximize value for floating wind projects

Inês Serras Pereira,
LCOE and Business Intelligence Lead

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Principle Power

A planet powered by floating offshore wind

Principle Power: proven technology and experience for a planet powered by floating offshore wind

Founded in 2007, Principle Power has grown to be a global leader in the floating offshore wind industry

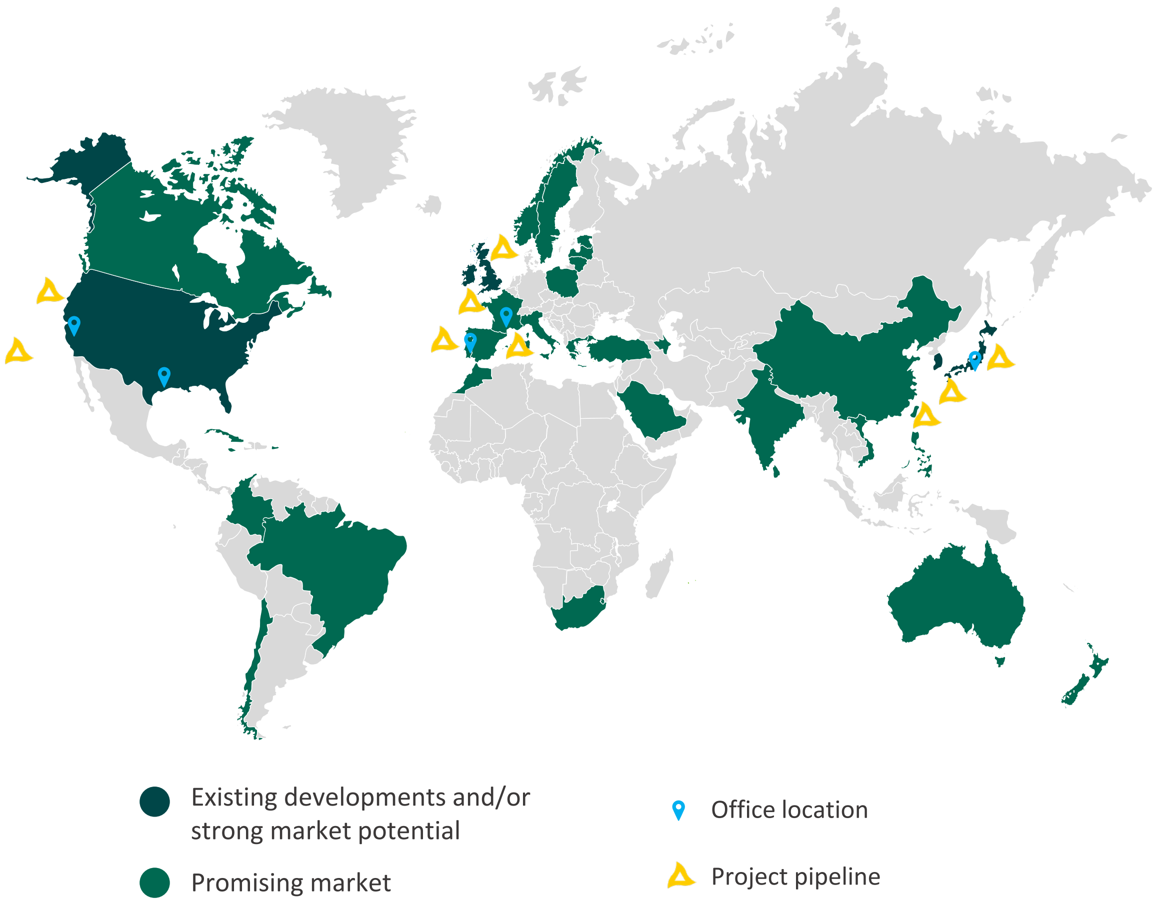
Globally patented and proven floating platform technology with 75MW in operation and 30MW under construction (over 630GWh energy produced)

>5GW global project pipeline secured & serving clients in all key floating offshore wind markets (10 GW under design contract)

Guided by the "300x30" vision, enabling local and regional supply chain ecosystems with deep experience and proven technology

Expert services across the product life cycle, from structuring early-stage opportunities to O&M support services

Learn more at principlepower.com



The WindFloat® product portfolio expands the fabrication capacity to fulfil high demands as FOW industry enters the GW-scale era

300 X 30

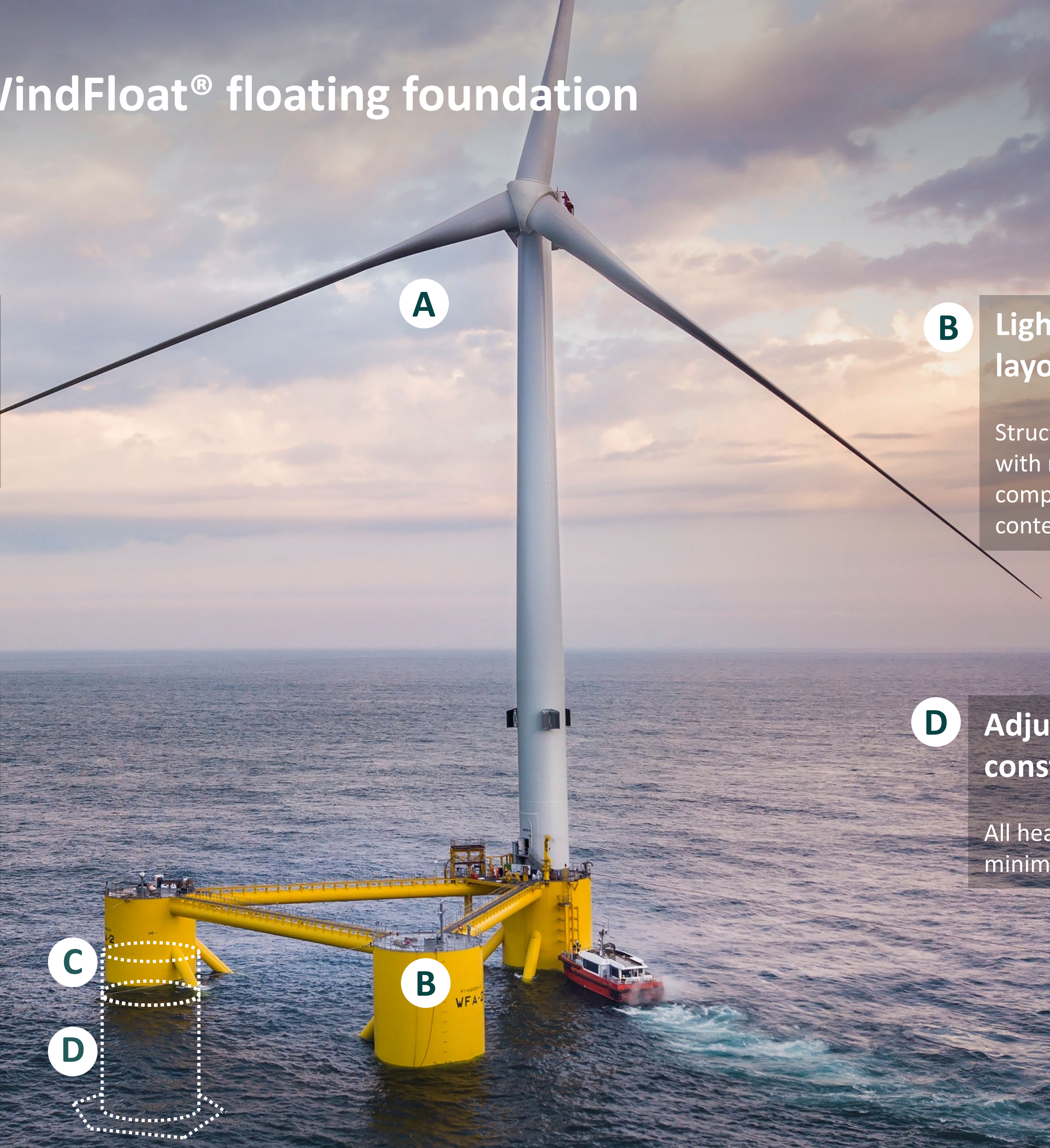
WindFloat T | WindFloat Tubular

A steel semi-submersible in the WindFloat® product line with *<u>columns suitable for tubular construction</u> and water entrapment plates*

WindFloat F | WindFloat Flat Panel

A steel semisubmersible in the WindFloat® product line with *<u>columns suitable for flat panel construction</u> and with pontoons*

Our solution: WindFloat® floating foundation



A **WindFloat® works with any commercial WTG**

Iterative design approach to achieve optimal system performance

B **Light weight and modular layout**

Structurally efficient, 3 column semi-sub with modular design to enable flexible, competitive supply chains and local content

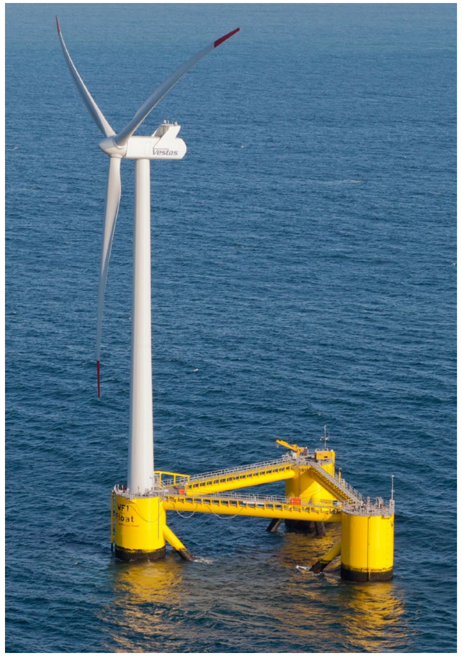
C **Hull Trim System (HTS)**

Boosts energy production by 2-3% vs passive systems by shifting water ballast between columns to keep WTG vertical

D **Adjustable draft for construction in port**

All heavy lifting conducted at port, minimizing cost, financial, and HSE risks

15-year track record proving technology from proof of concept to industrial scale

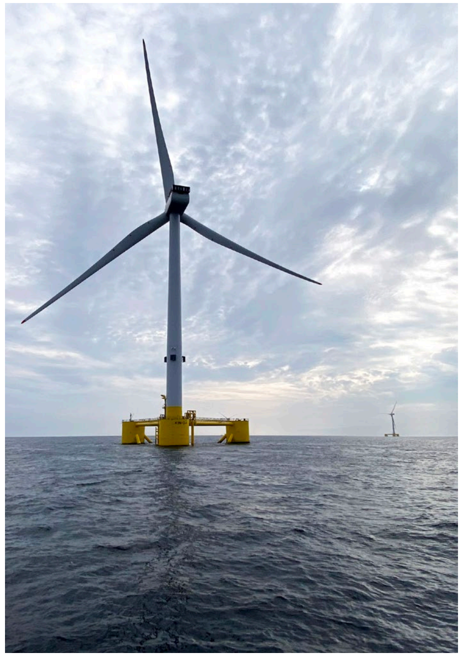


2 MW WindFloat 1

- Proof of concept
- 5 years in operation
- Retrofitted and relocated to Scotland

25 MW WindFloat Atlantic (2020)

- First technology to achieve bank financing
- +4 years in operation
- Withstanding waves up to 20 meters and wind gusts reaching 139 Km/h

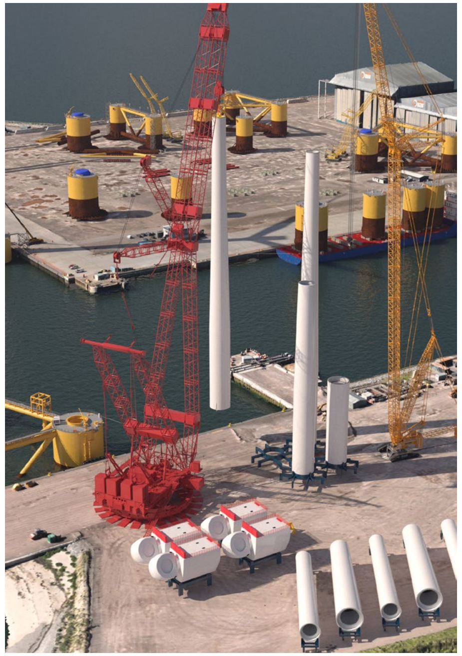


50 MW Kincardine (2021)

- 3 years in operation
- Modular design, mobilizing industrialized supply chain
- Successfully concluded the industry first tow-to-shore for turbine large correctives

30 MW EFGL (Under Construction)

- Non-recourse financing
- Certified by Bureau Veritas
- Deployed in a marine reserve with high focus on nature inclusive design and monitoring

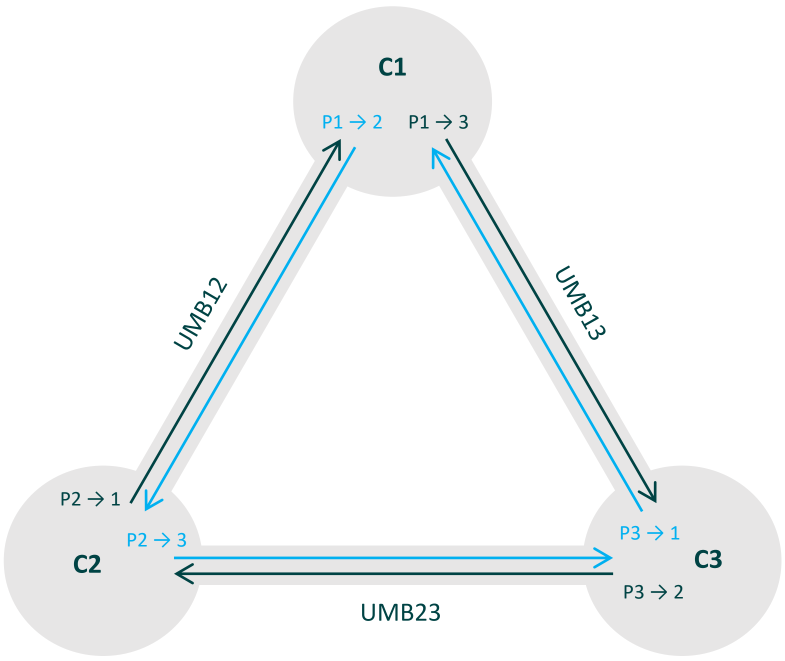


Industrialized WindFloat®

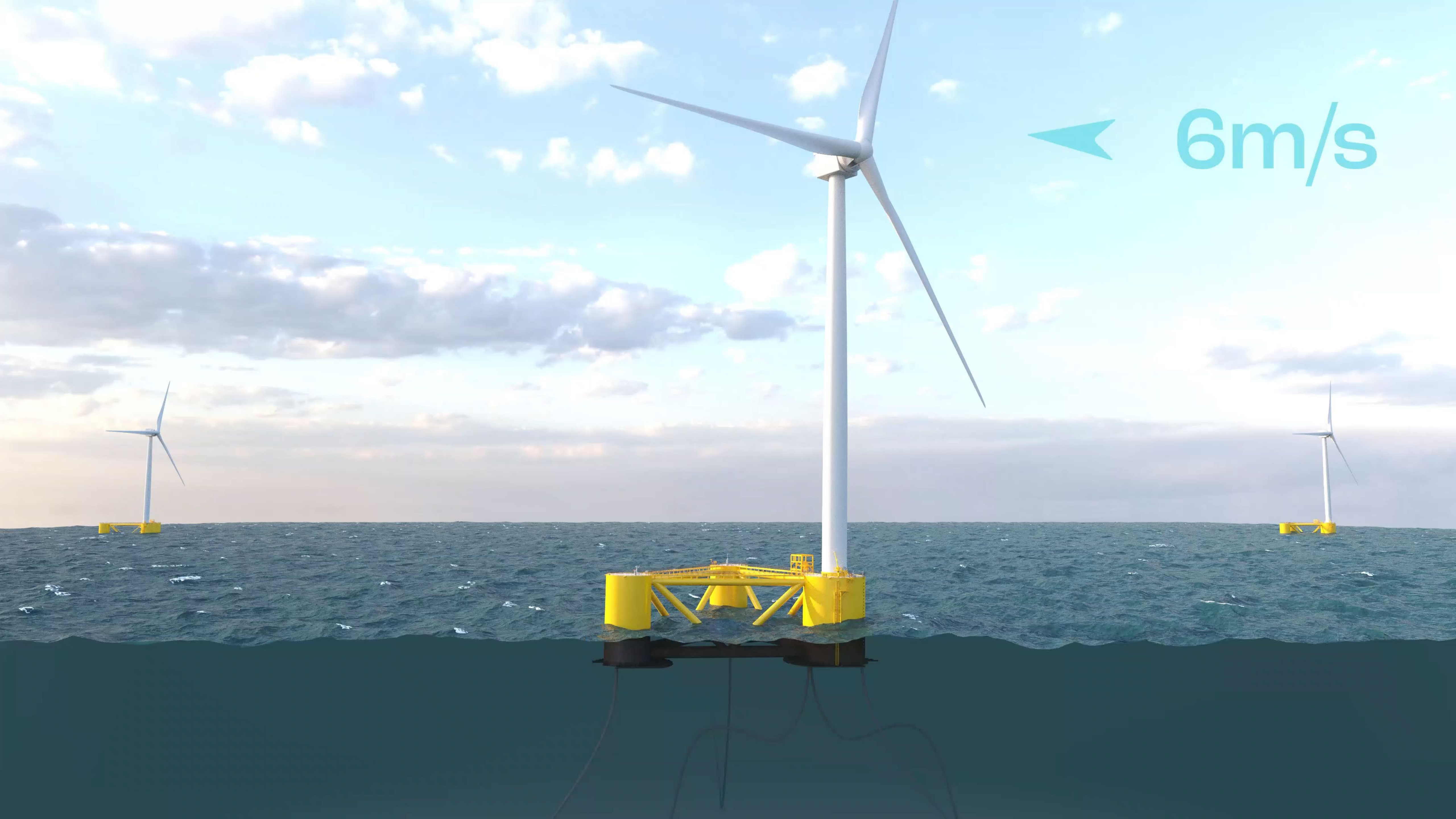
- Modular designs, suitable for mass manufacturing
- Laser focus on schedule reductions
- Proactive collaboration with supply chain to unlock cost reductions

The HTS's 6-pump can either be integrated onto Column 1 or integrated in sets of 2 across the three Columns

Hull Trim System piping arrangement



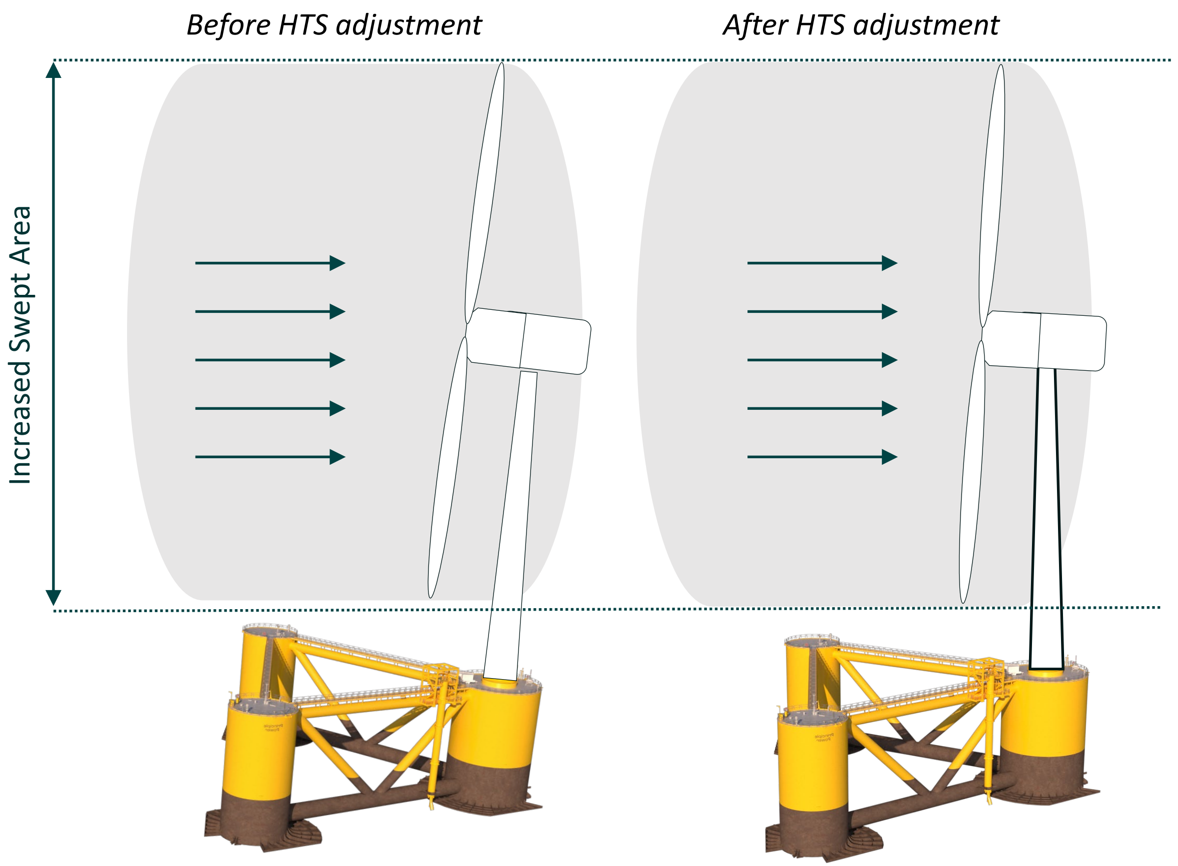
UMB – Upper Main Beam
C – Column
P 2 → 1 – Pumps water from Column 2 to Column 1 (example)


6m/s

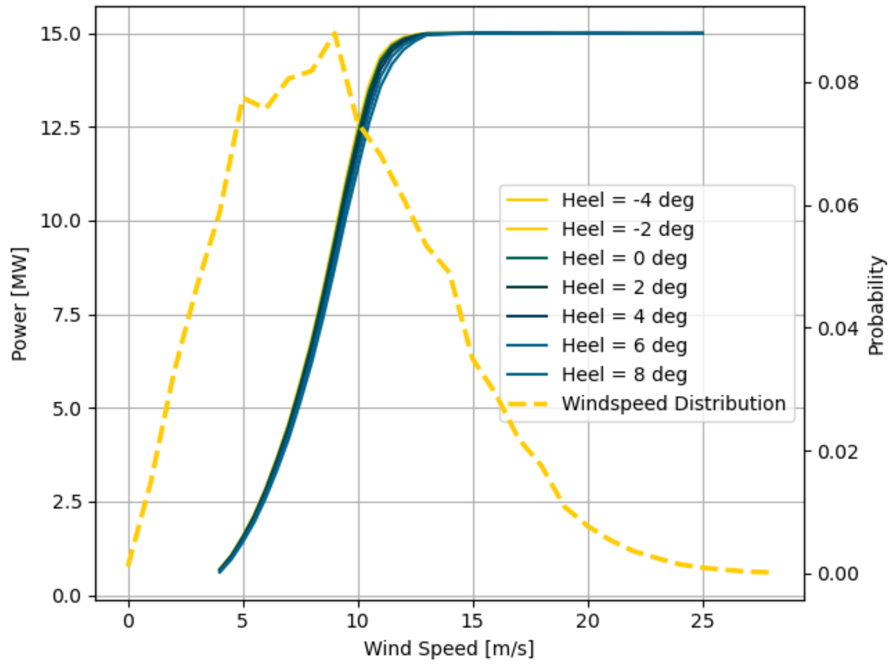
The WindFloat® Hull Trim System (HTS) maximizes AEP by offsetting WTG thrust force to keep platform operating angle within a 0-2º range

OPEX	AEP
CAPEX	CAPEX (STEEL)
COSTS	BENEFITS

Definition: Design Heel Angle (DHA): The static heel angle at maximum thrust of a FOWT platform without HTS system on.



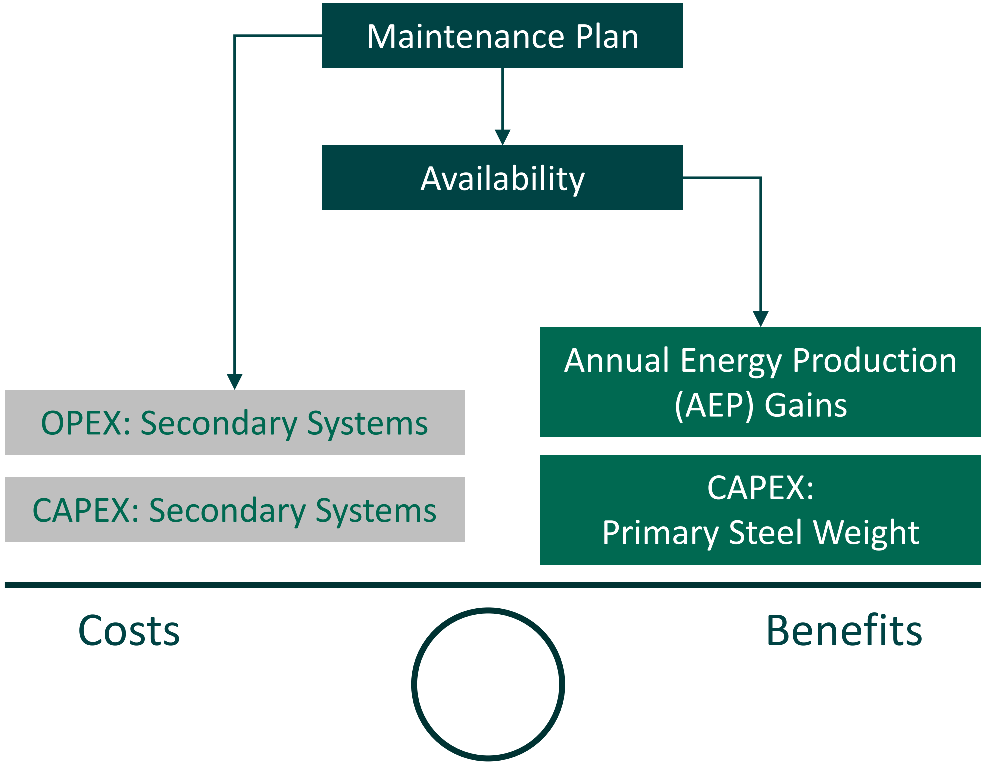
Effect of the operating heel angle on the power curve



Example Korean site: 76% of the wind speeds are below Vrated

The HTS reduces loads on WTG components versus passive platforms by allowing the WTG to operate near vertical.

To assess the trade-offs of the Hull Trim System at floating wind projects, Principle Power uses a comprehensive Net Present Value method

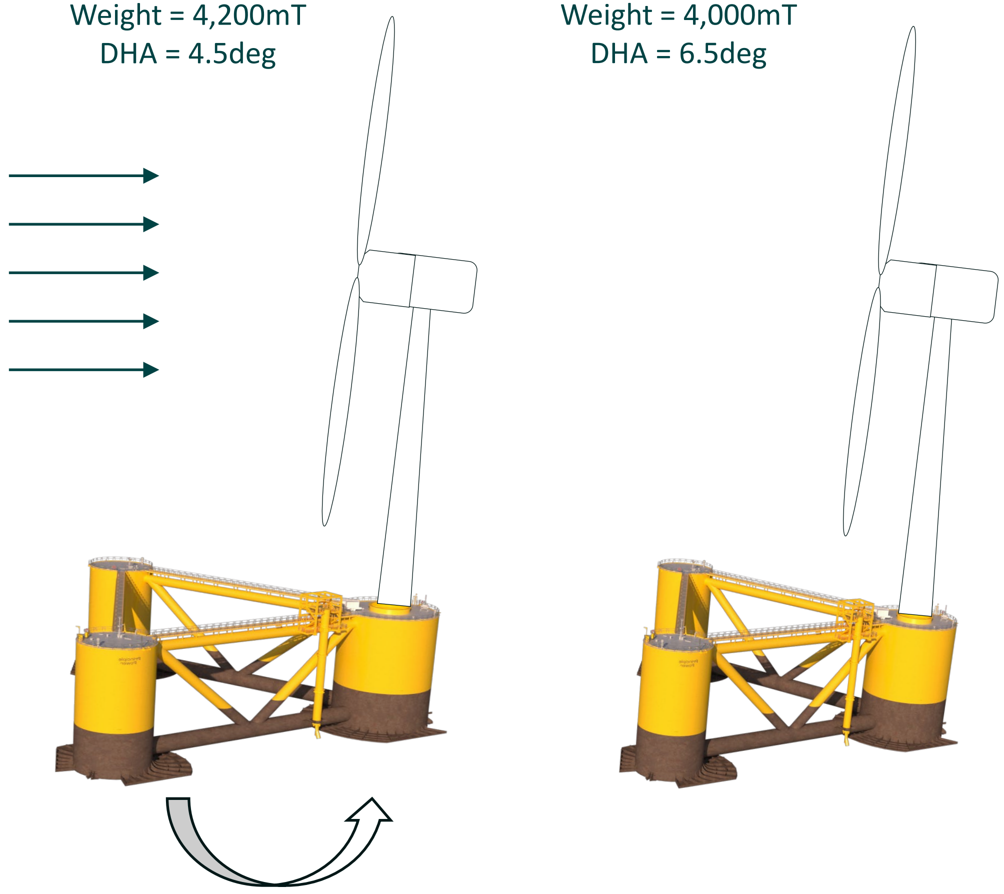


By enabling a more aggressive Design Heal Angle, the Hull Trim System can save steel (est. 200 mT), depending on WTG and site conditions

OPEX | AEP
CAPEX | CAPEX (STEEL)
COSTS | BENEFITS

Platform without HTS
Weight = 4,200mT
DHA = 4.5deg

Platform with HTS
Weight = 4,000mT
DHA = 6.5deg

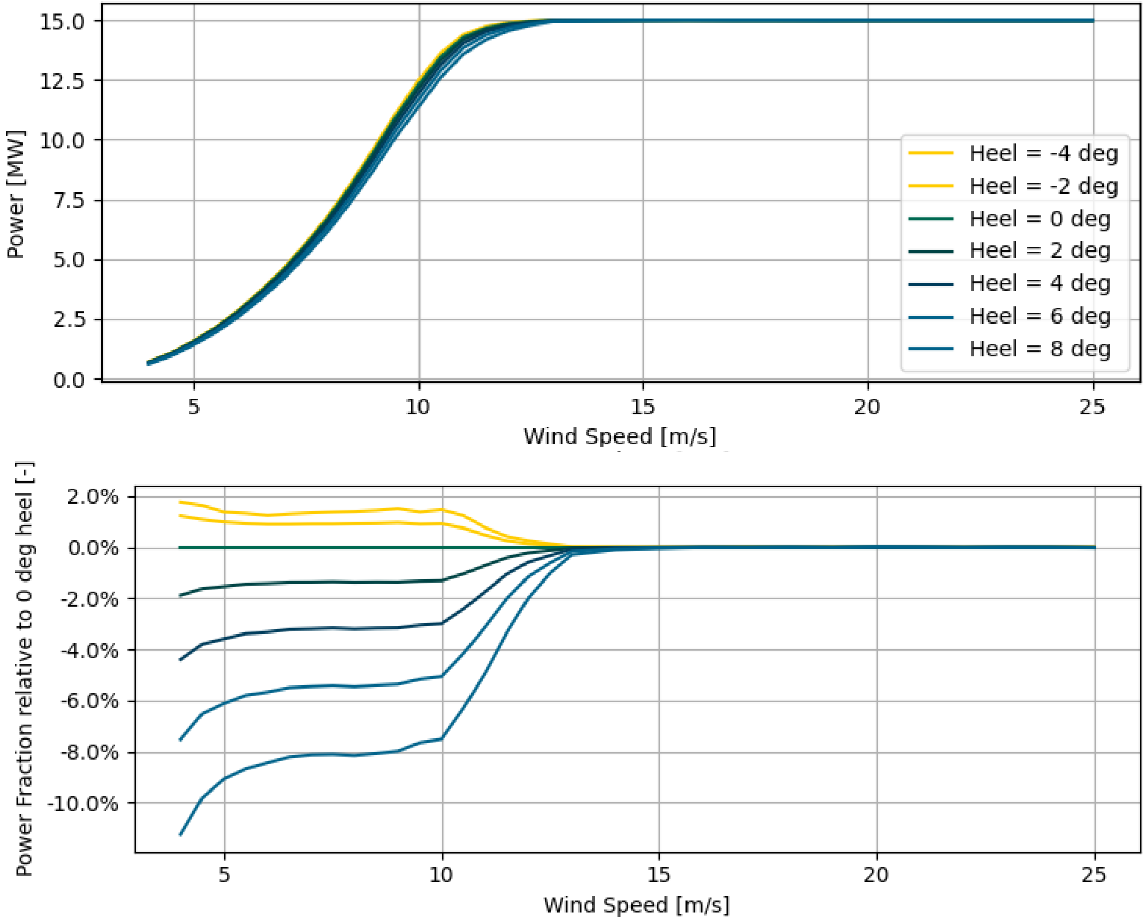


Design Options

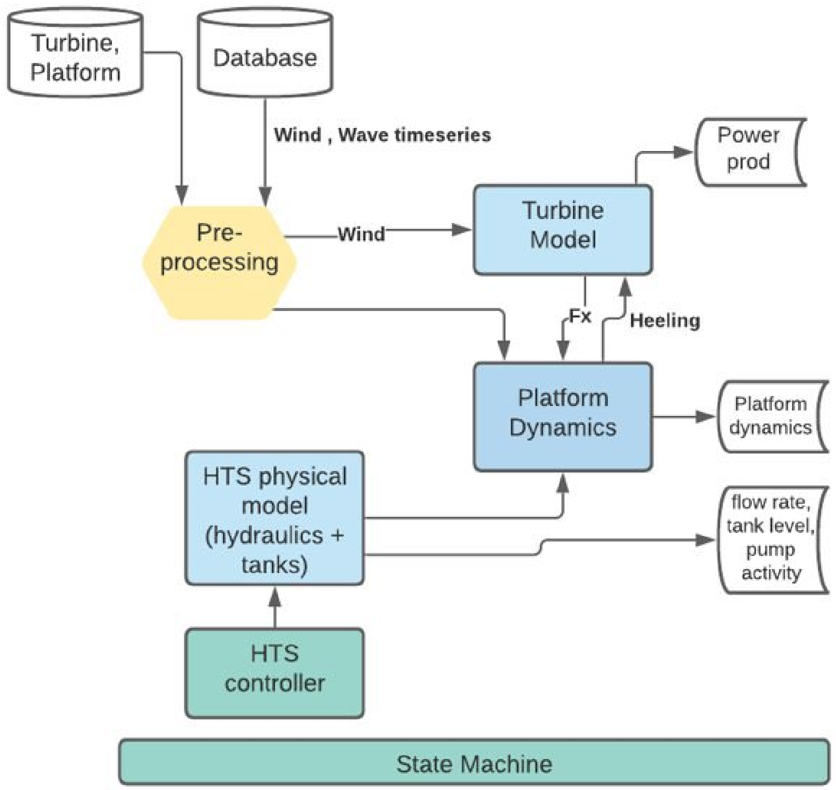
- **Option 1: Design a passive platform with higher AEP losses compared to fixed-bottom WTGs**
- **Option 2: Design a larger passive platform with a lower Design Heel Angle with moderate AEP losses compared to fixed bottom WTGs.**
  - Increase Column spacing (Footprint) → Increase restoring moment
  - Increase Columns' size → Increase buoyancy
- **Option 3: Design a platform with Hull Trim System that minimizes platform size and AEP Losses compared to fixed bottom WTGs.**
  - Achieve optimum balance of weight, dimensions, and revenue generation

The HTS actively minimizes heel angle during operations, maximizing AEP for all wind speeds below rated wind speed

OrcaFlex to model the WTG generation in different heel angles



PumpedHydro to model the platform behavior



HTS CAPEX and OPEX: deltas between Platforms with and without Hull Trim Systems are limited

CAPEX

- HTS CAPEX is estimated to be **~760k EUR** per platform for a Commercial project, including Engineering costs. This amount is expected to be offset by steel savings resulting in net CAPEX savings of **~40k EUR** per platform.
- Logistical benefits during WTG integration, where the HTS is used to stabilize the platform during transfer of components from crane to platform, further reduces net CAPEX.

OPEX

Additional Hull Trim System Maintenance

	[hours/year/platform]
Preventive Maintenance	10
Corrective Maintenance	7

- Simulation of operations show minimal deltas between passive and HTS platforms:
  - OPEX delta ranges from **+0.2-1.0 EUR/kW/year**
  - Production Based Availability deltas range from **-0.03% to -0.27%**

The Net Present Value of the Hull Trim System for 1GW Project in the Ulsan Area in South Korea is between 1.3-1.5 mEUR per platform and 88-102 mEUR for the entire project

Platform without HTS

WTG Rating = 15MW
Weight = 4,200mT
DHA = 4.5deg

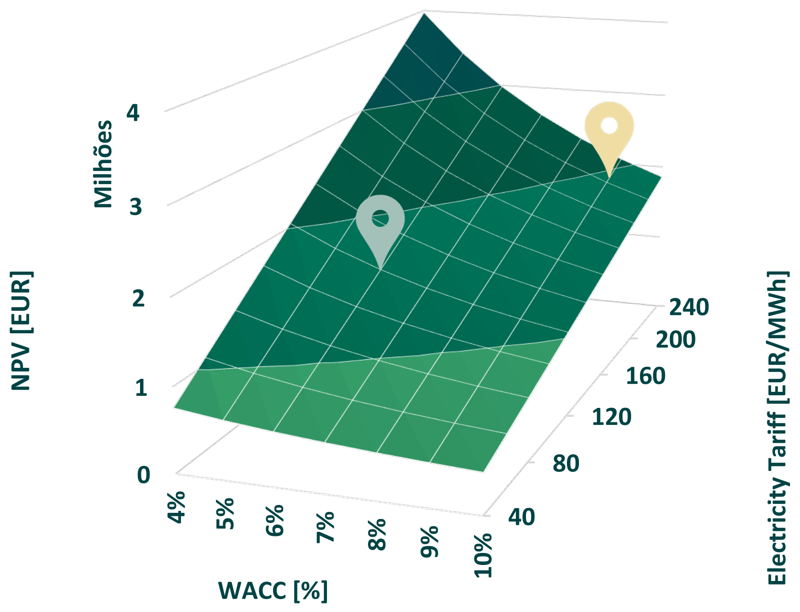
Platform with HTS

WTG Rating = 15MW
Weight = 4,000mT
DHA = 6.5deg
AEP (gross) = **+1.30%**

	68 units x 15MW	Project NPV [mEUR]	Platfofm NPV [mEUR]
	First Commercial	102	1.5
	Mature Commercial	88	1.3

Notes: CAPEX, OPEX, and Electricity tariff indexed to 2% escalation per year.

Net Present Value of the Hull Trim System



- For a range of expected WACCs and electricity tariffs, the Hull Trim System has an NPV above 1M EUR per platform
- **Similar conclusions were found in a range of project sites, with gross AEP benefits ranging from 1.0-2.5%**

Thank you!

Inês Serras Pereira

LCOE and Business Intelligence Lead

ipereira@principlepowerinc.com

Emeryville, US
- Global Performance
- Structures
- Design & Drafting
- People
- Office Management

Houston, US
- Global Performance
- Structures

Aberdeen, UK
- O&M

UK
- Commercial/Business Development

Viana do Castelo, PT
- O&M

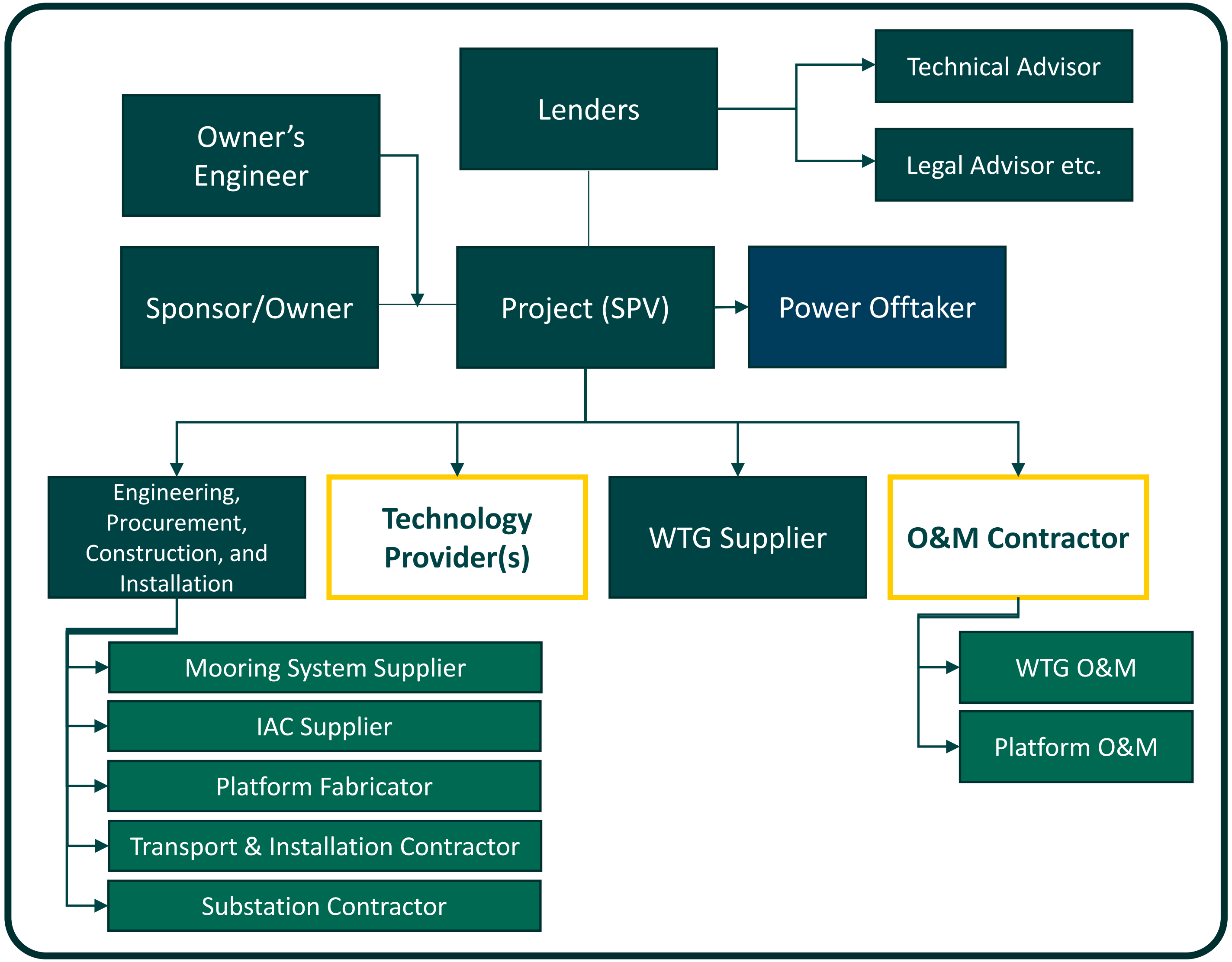
Aix-en-Provence, FR
- Global Performance/Mooring & Cable
- Structures
- Hull Systems
- Installation
- People
- Office Management

Tokyo, JA
- Business Development
- Project Management

Lisbon, PT
- Global Performance/Mooring & Cables
- Structures
- Fabrication
- Commercial & Innovation
- Quality, HSE
- Procurement
- Transformation
- People
- Finance
- IT
- Legal
- Office Management

Which types of companies exist in the Renewable Energy Sector?

Project Development World – Floating Offshore Wind Example



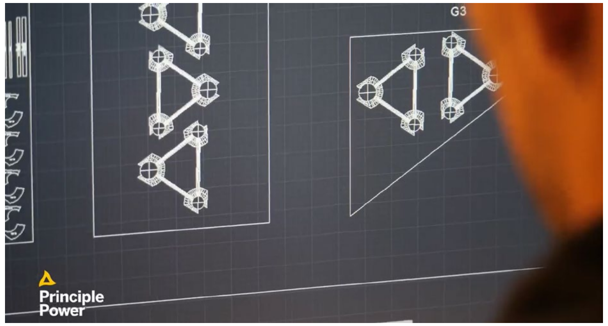
Opportunities in Principle Power

Disciplines in Principle Power

Principle Power milestones

Start of Engineering — Engineering complete — COD — Decommissioning

Beginning of Project Development	Engineering Phase	Execution Phase	Operations



- Naval Architecture
- Structural
- Mooring & Cable → Mooring & Cable Support
- Marine Systems
- Fabrication Eng. → Fabrication Support
- Installation Eng. → Installation Eng. Support
- Operations & Maintenance

Commercial, Strategy, Technology, Human Resources, Finance, Legal, Quality, Health and Safety

Scope of Work for a WindFloat® Engineer

Design Phases

- **Technical feasibility assessments**
- **Technical optimization/finalization**
- **Design deliverables:**
  - Design Basis
  - Design Methodology
  - Design Reports
  - Drawings
  - Specifications
- **Technical advisory towards class approval**

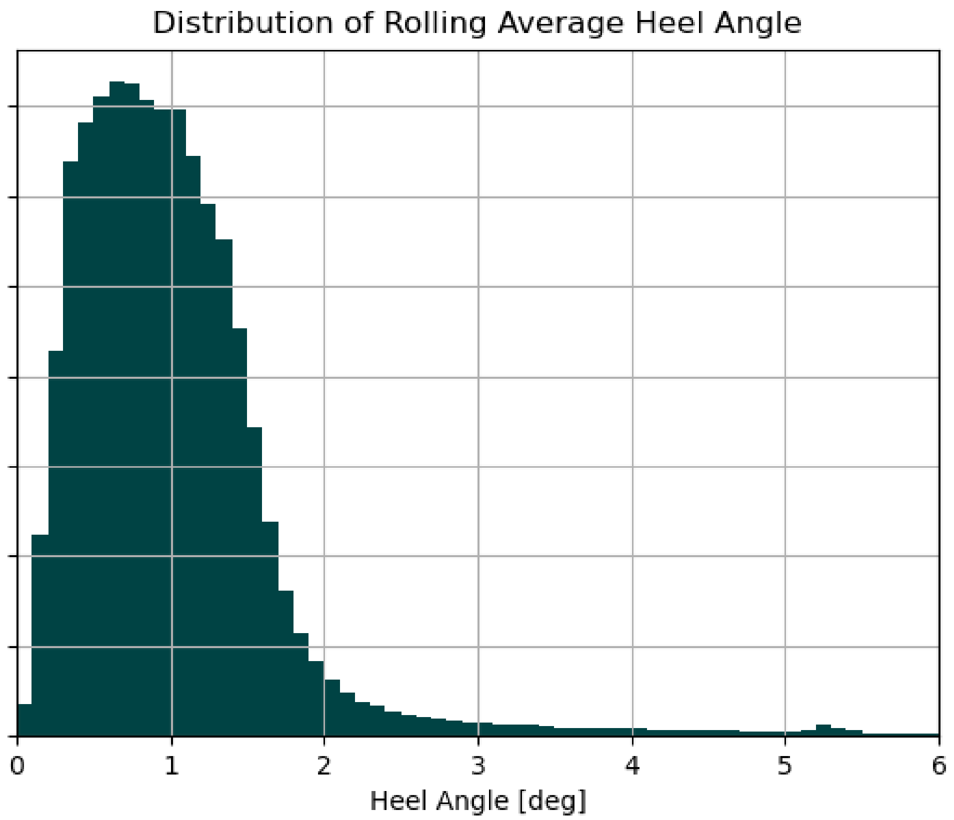
Execution Phases

- **Hardware procurement follow-up**
- **Fabrication follow-up**
- **Client technical advice before and during offshore operations**
  - WTG integration
  - Commissioning
  - Mooring Pre-lay
  - Hookup
  - Cable pull-in
  - Inspections/Operations
  - Decommissioning

Field data show the Hull Trim System keeps the platform at a heel angles lower than 2 deg 96% of the time

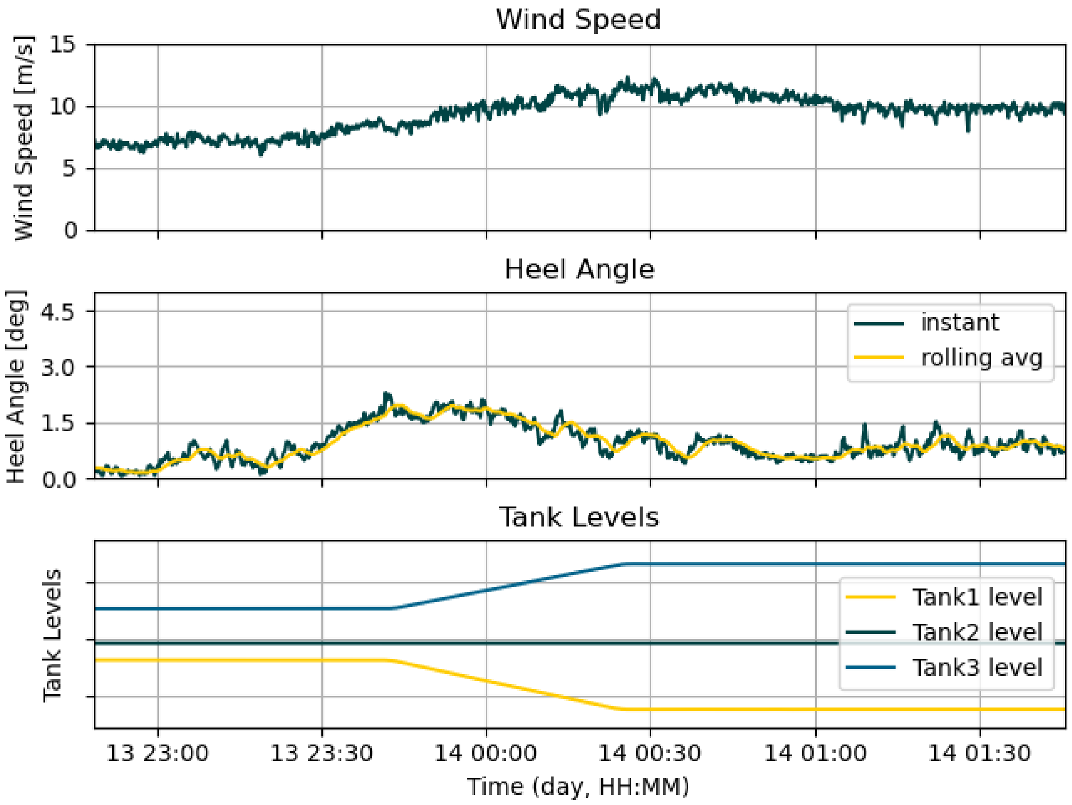
OPEX	AEP
CAPEX	CAPEX (STEEL)
COSTS	BENEFITS

1-Year WindFloat Atlantic Data - Heel Angle Distribution



NOTE: Heel Angle Distribution shows the absolute heel angle value.

The Hull Trim System returns the platform close to even keel in less than 30 minutes



NOTE: Wind speed increases from ~7 to ~11 m/s.

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8 WindFloats in operation worldwide (PT, UK)

>210k Global operational hours

630 GWh WindFloat power delivered to grid

9.5 MW Largest floating WTG operating

20 m Maximum wave height encountered

59.6 m/s Maximum wind speed encountered

The OPEX and Availability deltas are calculated using a Monte Carlo simulation software

OPEX	AEP
CAPEX	CAPEX (STEEL)
COSTS	BENEFITS

Model Inputs

Project-Specific Inputs

- Wind farm layout
- Accessibility Vessel (CTV or SOV)
- O&M and Large Correctives Port locations
- Offshore site and O&M port metocean
- WTG Details (Power Curve, Hub Height, etc.)
- WTG O&M requirements
- WTG Major Component Replacement Strategy
- Vessel parameters

Principle Power Inputs

Platform O&M requirements:

- Preventive Maintenance
- Corrective Maintenance
- Structural Periodical Inspections

→

Monte Carlo Simulations
(variable weather and stochastic failure modeling)

→

Model Outputs

- Wind Farm Availability
- Production Loss and Root Causes
- Lifetime and Annual OPEX