Green Giraffe
The renewable energy financial advisors

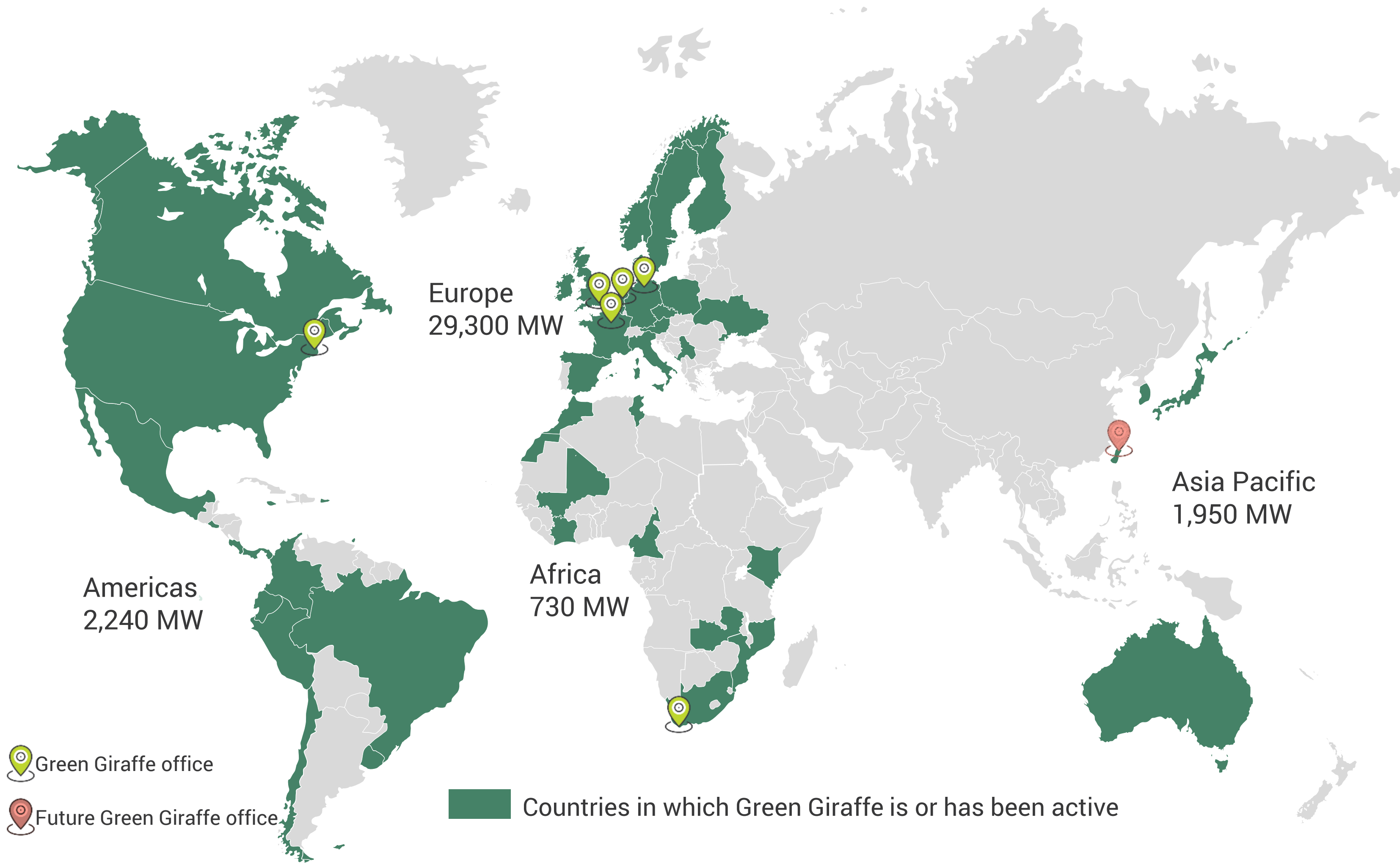
Financing floating offshore wind projects

Floating Offshore Wind Seminar – 6 June 2019

Clément Weber

We have a worldwide presence

Green Giraffe has been involved in circa 35 GW of renewable energy projects globally



Capacity shown corresponds to renewable energy projects we have worked on, as of Q1 2019

Green Giraffe – The renewable energy finance specialist

We get deals done

Deep roots in renewable energy finance

- Launched in 2010 by experienced finance specialists with a **strong and proven track record** in renewable energy
- 85+ professionals with offices in Boston (USA), Cape Town (South Africa), Hamburg (Germany), London (UK), Paris (France), and Utrecht (the Netherlands)
- Multi-disciplinary skillset including **project & corporate finance, M&A, tendering, contracting, and legal** expertise

High-quality, specialised advisory services

- Focus on projects where we can actually add value
- We can provide a holistic approach and are able to include sector-specific tasks in addition to traditional debt or M&A advisory (such as contracting, tender advice, strategic advisory, and development services)
- Widening geographical reach beyond Europe, with a growing presence in the Americas, Africa, and Asia
- Priority given to **getting the deal done!**

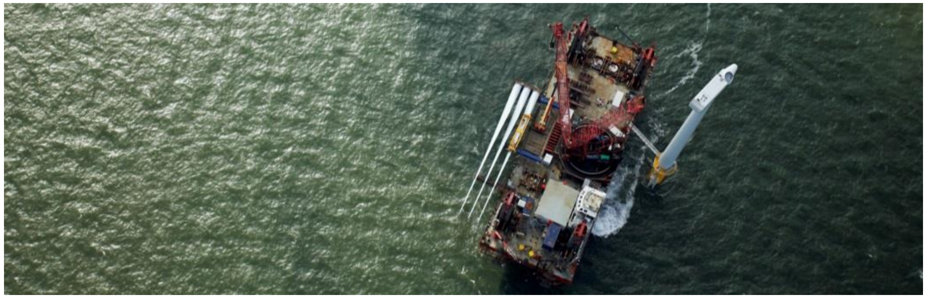
Close to **EUR 25 billion** funding raised for renewable energy projects in **9 years**

85+ professionals in **6 countries** on 3 continents

Involved in over **150 renewable energy transactions or projects** with a total capacity of circa **35 GW**

Financing floating offshore wind projects

Table of contents



1. FOW at a turning point

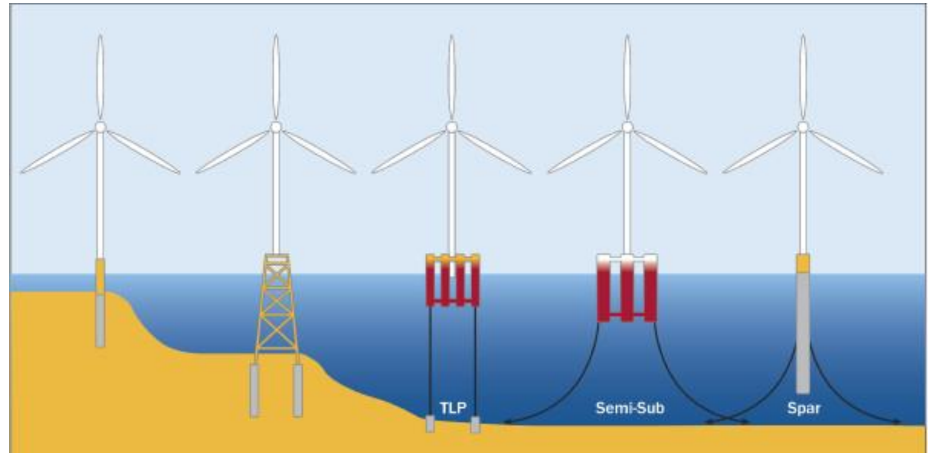
The history and potential of floating offshore wind

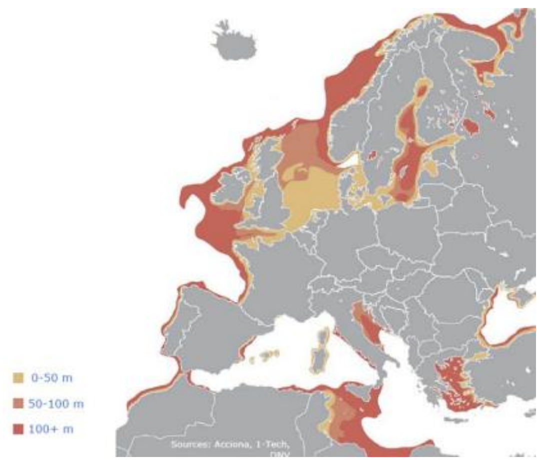
Floating offshore wind (FOW) as a concept exists since the 70s, whereas industry researching started in the mid 90s

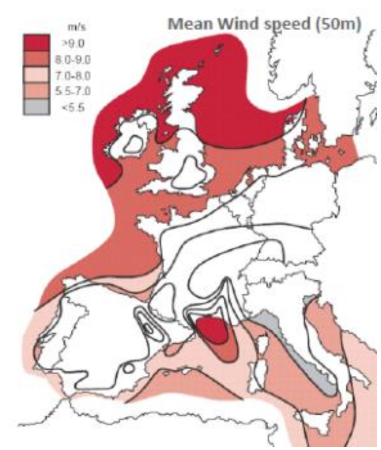
- In 2008, Blue H technologies installed the first test floating wind turbine (80 kW) off the Italian coast and decommissioned it after a year of testing

The potential for deep offshore wind energy is vast

- Europe has a potential floating offshore wind capacity of 4,000 GW (Carbon Trust) - 66% of the North Sea has a water depth between 50 m and 220 m (WindEurope)
- The estimated US offshore wind resource is around 4,150 GW, more than half of this capacity is in waters deeper than 60 m (US Department of Energy)
- Japan has the world's 6th largest Exclusive Economic Zone and very good wind resource, of which more than 80% is located in deep waters (WindEurope)
- South-America (BR, CL), Asia (CN, KR, IN, TW) and Oceania (AU) have also an enormous prospective







Illustrations by Carbon Trust

There is a potential for more than 7,000 GW of FOW in Europe, US and Asia

1. FOW at a turning point

Floating offshore technologies are building a track record

Status of the technology

- There are three main concepts behind a floating offshore wind foundation
- Full scale prototypes of semi-submersible and spar buoy have been in operation for several years
- One full scale prototype was successfully decommissioned in 2016 (WindFloat 1)
- Variants of the three main concepts exist (e.g. multi turbines and hybrid), although no full scale prototypes
- First pilot wind farm commissioned in 2017 (Hywind Scotland) and 2 others under construction (UK, PT)

Upcoming years

- More pilot farms shall be connected to the grid and more floating offshore wind demonstrators installed
- Several technology providers shall compete over the diverse concepts with the chance of smaller players becoming redundant in case of the more mature technologies prevailing

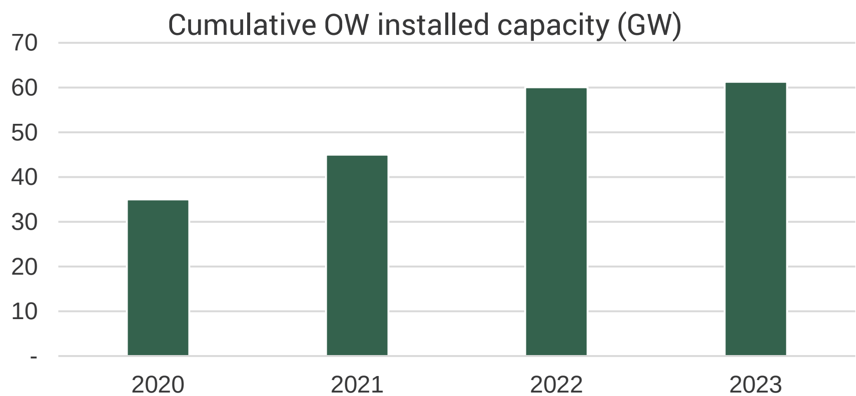
Illustrations by NREL (US Department of Energy)

1. FOW at a turning point

Global offshore wind has great potential but technology advancements are needed

Global offshore wind market

- Projected installed capacity in excess of 60 GW by 2023
- Globally offshore wind has the potential to achieve more than 500 GW of installed capacity by 2050
- To date most offshore wind development has occurred in Europe, however new deployment is much wider
- An estimated 80% of the offshore wind resource, is in water depths of over 60 meters
- Fixed-bottom designs are not capable of capturing the all of the global potential for offshore wind



Floating offshore wind technology can open up new markets

Capturing of considerable wind resources inaccessible with fixed-bottom foundations

- Access to deeper water sites
- Flexibility to choose sites with the largest and steadiest wind energy density
- Conventional mooring and anchor systems are suitable for all soil conditions

Lessening the impact on the surrounding environment

- Absence of piling and drilling processes during the construction phase

Helping to reduce permitting risk

- Farms can be built further from shore and then lowering the visual impact

Sources : IRENA's 2050 transformation roadmap, BVG Associates 2018, International Energy Agency, World Energy Outlook Series

1. FOW at a turning point

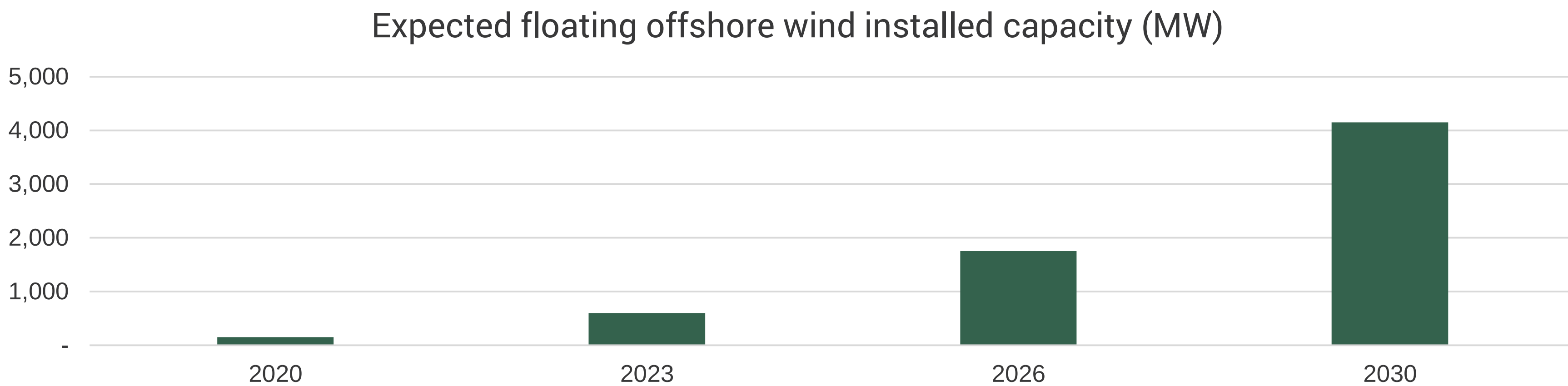
Floating offshore wind will capture an extensive part of the overall offshore wind market

Floating offshore wind has a highly promising future

- Technology advancement has brought floating wind to the start of the large scale commercialisation process
- Current market projections show a growth curve for floating offshore wind market from 2020 due to several projects that are already under development and many more to be added in the future
- Improved general competitiveness of offshore wind will provide further upside

Market share will be taken by cost-effective technologies

- Many technologies are at an early-stage and looking at building a full scale demonstration project
- Fast-followers will not replicate first movers' mistakes and will focus on key cost items including installation and compatibility of the floater with various wind turbines



Source: WindEurope, Floating offshore wind energy "A policy blueprint for Europe" October 2018

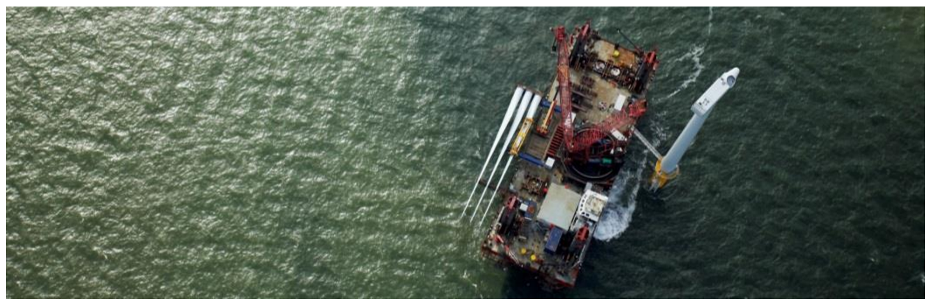
1. FOW at a turning point

Pilot farms up to 75 MW shall be connected by the end of 2020

Status	Project	Site	Year	Capacity	Type	Technology	Developer	Turbine
Construction	Windfloat Atlantic	PT	2019	25 MW	Semi	PPI	EDPR/others	MHIV 8.4 MW
Construction	Kincardine	UK	2020	50 MW	Semi	PPI	ACS Cobra	MHIV 9.5 MW
Development	Groix	FR	2021	24 MW	Semi	Naval	Eolfi/CGN	Haliade 6.0 MW
Development	Gruissan	FR	2021	25 MW	Semi	Ideol	Quadran	Senvion 6.2 MW
Development	Provence Grand Large	FR	2021	24 MW	TLP	SBM-IFPEN	EDF EN	Siemens 8.4 MW
Development	Leucate	FR	2021	24 MW	Semi	PPI	EDPR/Engie	Haliade 6.0 MW
Development	Maine Aqua Ventus	US	TBD	12 MW	Semi	VolturnUS	UMaine/others	Haliade 6.0 MW
Development	Dongbu	KR	TBD	100 MW	Semi	GustoMSC	Halla Wind En.	TBD
Development	Ulsan city	KR	TBD	1 GW	N.A	Multi	CIP / Macquarie / EDPr and Aker / Shell / Equinor	TBD
Development	Hawaii	US	TBD	400 MW	Semi	PPI	Progression En.	MHIV 8.3 MW
Development	Hywind Tampen	NO	TBD	88 MW	Spar	Hywind	Equinor	11.0 MW
Development	Kitakyushu-Hyosung	JP	TBD	4 MW	Semi	Ideol	NEDO/Glocal	Hyosung 4.4 MW
Development	Morro Bay	US	TBD	1 GW	TBD	TBD	Trident Winds	TBD

Financing floating offshore wind projects

Table of contents

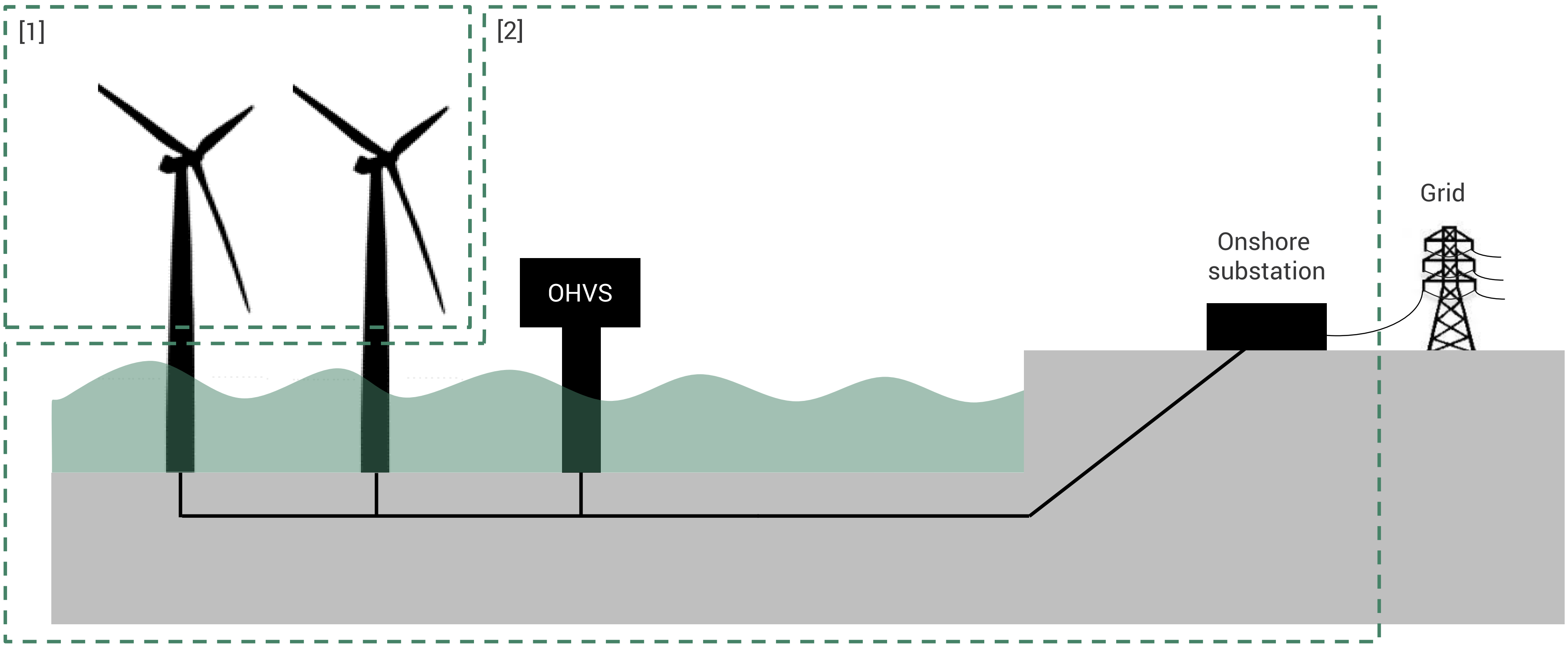


2. Risk analysis

Contractual structuring of fixed-bottom projects

The traditional offshore wind contracting strategies with fixed-bottom farms

- Current preference for very low number of contracts (3 of fewer) : [1]. WTGs, [2]. balance of plant
- With pricing based on lump sum contracts

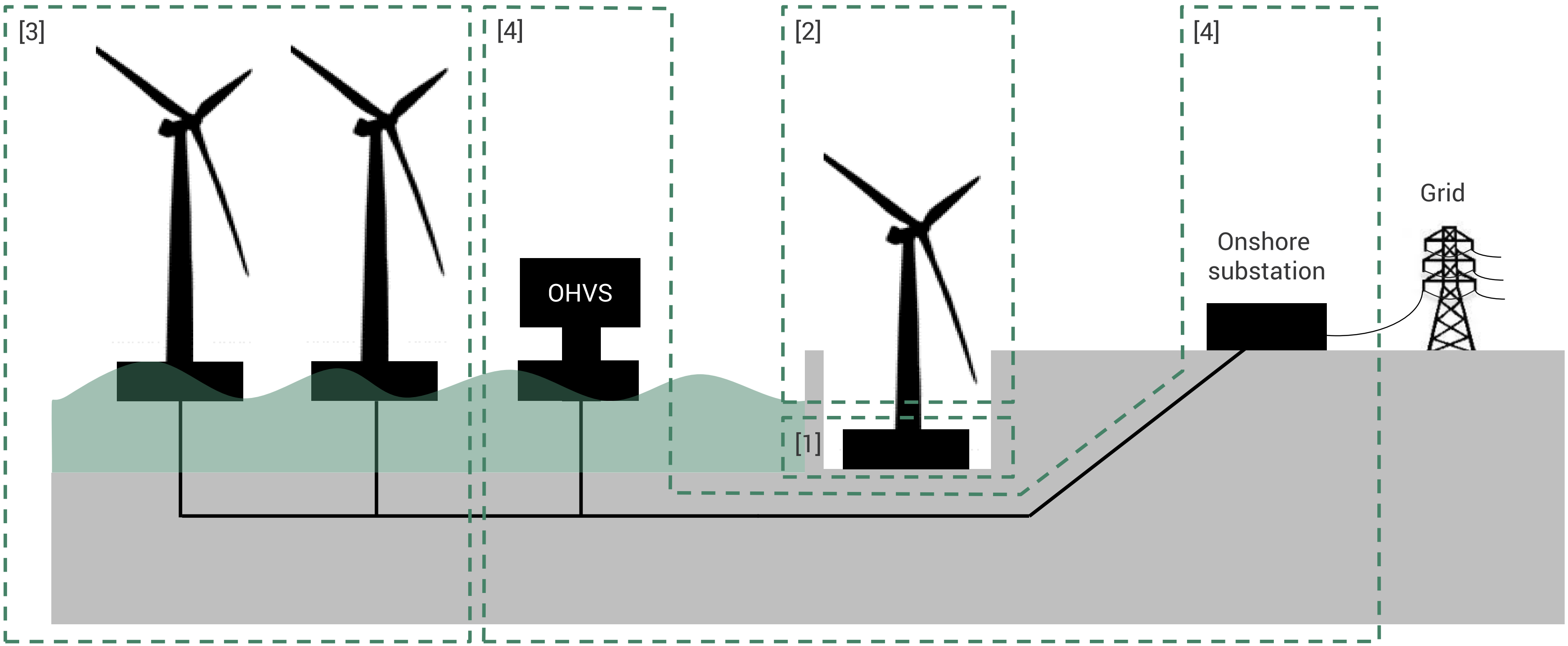


2. Risk analysis

Contractual structuring of floating offshore wind

Built on the fixed-bottom offshore wind experience with technology specific adjustments

- Scope can be divided between other contract lots: [1]. foundations, [2]. WTGs, [3]. offshore services, [4]. export system
- With pricing based on lump sum contracts



2. Risk analysis

Risk allocation and interfaces are key

Interaction between floating technology and turbine to be developed in an integrated way

- Design certified by a reputable classification society
- Project acquires a license from the floating technology provider and fabricator takes responsibility for its realisation
- Weather risk borne by the contractors or priced into the base case contingency funding
- Liquidated damages high enough to compensate for the losses of the project as a consequence of being delayed
- Liability caps high enough in total to cover for liquidated damages that compensate for the losses of the project as a consequence of being sued

Turbines and foundations service agreements (long term), lease agreements with Marshalling and service harbours (lifetime)

- Maintenance of floating foundations synchronized with WTGs (minor repairs on site), with large correctives (major up tower repairs) to be performed at quay side with land based crane
- Turbine supplier to warrant availability of turbines excluding carve outs (e.g. accessibility due to adverse weather, turbine out of operational envelope in heel angle and accelerations - floating motion dissimilar to design)
- Turbine supplier to warrant the power curve minus the uncertainty of the measured power output during the DNP and the impact of the floating motion (being detrimental or beneficial to the power curve)

Technical and contract interfaces need to be clearly identified and managed carefully

2. Risk analysis

Design and certification

Risk control starts with design process

- Design standards are adapted from Oil & Gas and fixed-bottom offshore wind
- Turbine supplier states performance criteria (e.g. accelerations, heel angle) of the turbine
- Floating technology provider designs the foundation to keep the turbine within its operational & extremes envelope – the collaboration from the turbine supplier is central to define requirements and confirm acceptability of performance
- Floating technology adapted to turbine specifications and site conditions
- Full system simulation according to standards with software validated with performance data from the demonstrator
- Classification society (e.g. DNV GL, ABS, BV, ClassNK) reviews and confirms that design process complies with all performance objectives

Risks

- Certification delay (design interface WTG-FOU)
- Operational underperformance (defective design)
- Component damage / excessive wear / catastrophic failure

Mitigation solutions

- FID after design approved for construction
- Early and full involvement of WTG supplier
- Certification of entire design process

2. Risk analysis

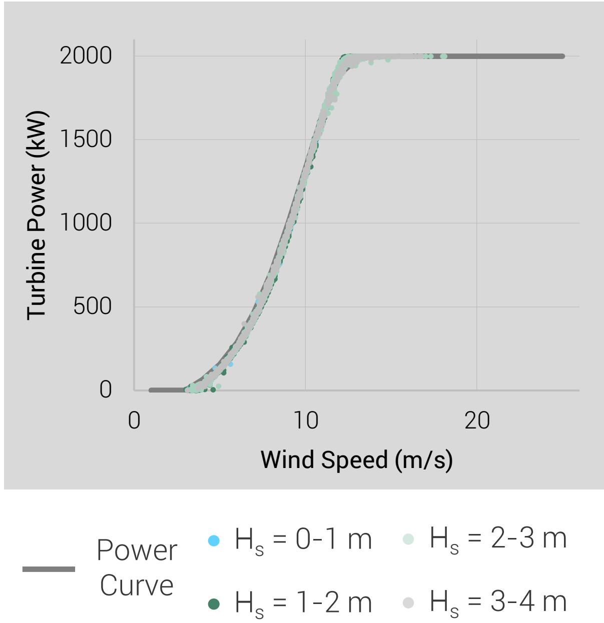
Turbine performance

Demonstrator track record should confirm turbine performance

- At least 2 MW demonstrators for a few years in operation
- No power losses or negative effect on turbine performance
- High system availability
- Technical inspection confirming healthy turbine, sold for re-use

Contracting of supply and servicing of turbines influences risk exposure

- Choice of an experienced turbine supplier
- Essential TSA and SAA/SMA items critical to bankability



Power curve – Example of Windfloat prototype

Risks

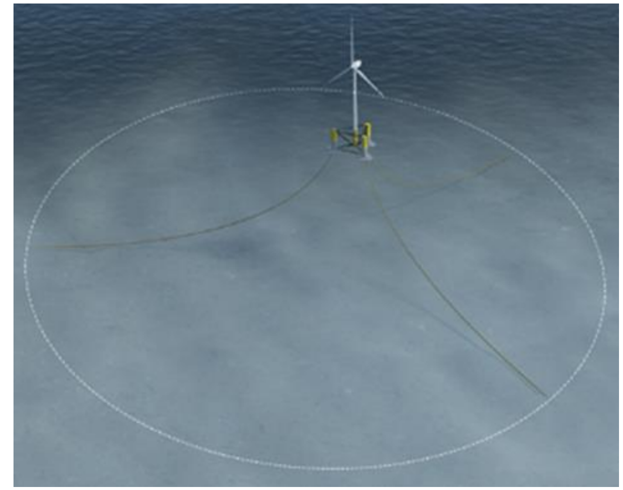
- Turbine-floating foundation contractual interface
- Availability and/or production penalties
- Component damage / excessive wear

Mitigation solutions

- WTG & FOU long term service agreements
- WTG & FOU component warranties, availability guarantees
- WTG power curve guarantee

2. Risk analysis

Mooring scheme and seabed interface



Provides interface between floating wind turbine and seabed

- Function to provide station keeping (not stability)
- Designed according to standards with safety factors, in conjunction with geophysical and geotechnical campaign
- Catenary configuration with low pre-tension to reduce vessel requirements
- Anchors embedded in advance, mooring lines pre-tensioned before hook up of floating wind turbine

Off the shelf components with proven track record

- Drag embedment anchors from maritime industry, mooring lines from Oil & Gas
- Proven connectors allow simple hook-up and dis-reconnection

Risks	Mitigation solutions
• Seabed geotechnical conditions not as expected	• Effective project management and planning, due diligence
• Mooring system deficiency	• Seabed campaigns according to best practices
• Component damage / excessive wear / catastrophic failure	• Certification of mooring design, fabrication, installation

2. Risk analysis

Foundation fabrication and launching

Design robustness to be tested in extreme met-ocean conditions

- Inspection of demonstrator showing no structural damage
- Significant track record in use of steel floating Oil & Gas platforms
- Fabrication quality enforced through monitoring by classification society, strict acceptance criteria and long term platform warranty

Commercial project requires serial production

- Investment needed to serialise aspects of fabrication
- Leverage on existing supply chain for sub-components fabrication
- Careful planning and conservative scheduling to reach target volumes

Risks

- Construction delay, schedule activities knock on effect
- Cost overruns (e.g. steel price, exchange rate, loss in PCR)
- Component damage / excessive wear / catastrophic failure

Mitigation solutions

- Effective project management and planning, due diligence
- Counter party analysis of suppliers and contractors
- Certification of foundation design, fabrication, installation

2. Risk analysis

Electrical infrastructure

Inter-array and export cables

- Dynamic cables available (e.g. 66 kV inter-array cables)
- Proven track record in the Oil & Gas sector at medium & high voltages
- Dis/re-connection of individual turbines from array and export cables to enable large correctives maintenance at quay side

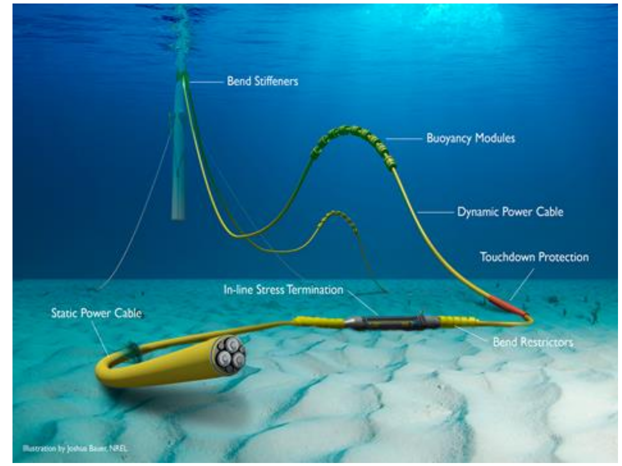


Illustration by NREL (US Department of Energy)

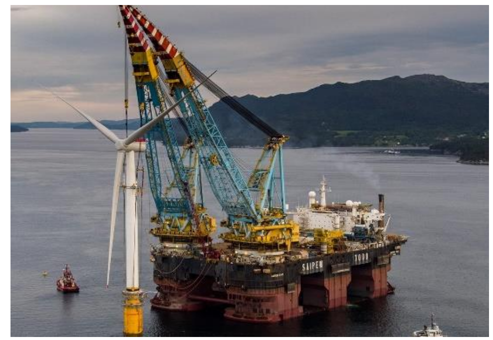
Floating offshore substation

- No technical barriers to locate high voltage equipment on a floating platform (long history of powering applications in the Oil & Gas sector)
- Engineering required to achieve design for commercial scale substation
- Several certified suppliers available for top side, platform to follow principles of floating foundation for turbine (i.e. meet top side requirements)

Risks	Mitigation solutions
• Performance of dynamic cables • Interface issues between IAC / EXC and WTG • Floating substation performance and cost overruns	• Effective project management and planning, due diligence • Counter party analysis and early engagement of suppliers • Extra cable sections and spare ancillary equipment

2. Risk analysis

Turbine assembly and offshore installation



Straightforward sequencing of activities

1. Pre-laying: anchors embedded and proof tested, mooring lines wet stored
2. Turbines installed on floating foundations at quayside by land based crane
3. Floating wind turbine towed to site by standard offshore tug boats and hooked up to pre-installed mooring lines
4. Inter-array cables laid and connected to floating wind turbines

Low sensitivity to weather – all assembly activities land based (including lifting)

- Only commissioning done offshore, hook up most sensitive activity (Hs < 2.5 m)
- Low commercial implications if adverse weather (vessels EUR 15-30 k/day)

Risks

- Construction delay (e.g. late delivery, adverse weather)
- Contractors interfacing (WTG, fabricator, offshore party)
- Cost overruns (e.g. fuel cost, exchange rate, loss in PCR)

Mitigation solutions

- Effective project management and planning, due diligence
- Counter party analysis of contractors
- Conservative schedule, including delay scenario analysis

2. Risk analysis

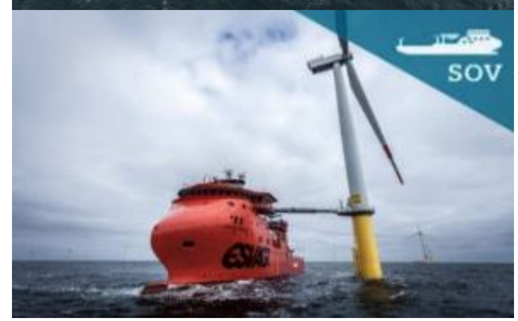
Operations, maintenance and decommissioning

Scheduled maintenance and minor corrective repairs

- Same approach as for fixed-bottom offshore wind
- Access through CTV, SOV or helicopter
- Turbine minor repairs on site with on board crane

Large correctives maintenance

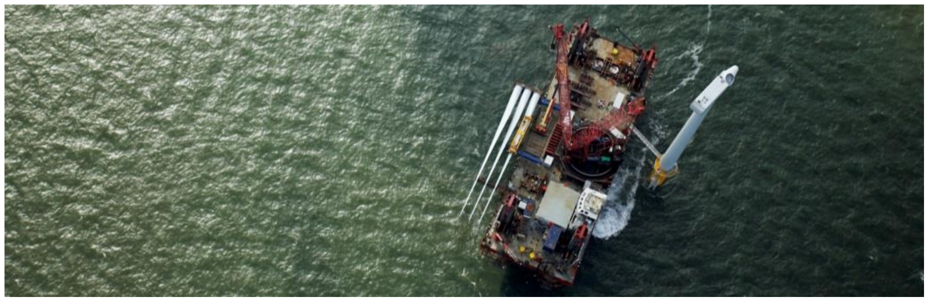
- Mooring scheme and inter-array cables designed for dis/re-connection of individual turbines while keeping the array energized
- Floating wind turbines to be towed with standard offshore tug boats
- Large correctives (major up tower repairs) to be performed at quay side with land based crane



Risks	Mitigation solutions
WTG & FOU availabilities, adverse weather (accessibility)	WTG & FOU long term service agreements, incl. spare parts
Failure predictability (e.g. damage, wear, corrosion)	Farm access control to protect cables and mooring lines
Port and equipment unavailability for large correctives	Stand by port and equipment for large correctives

Financing floating offshore wind projects

Table of contents



3. The equity market

Valuation of FOW projects

Projects with development risk generally see lower transaction value

- Projects at early development stage can not be valued on the basis of future cash flows as this would be viewed as highly speculative. Instead, such projects are valued on a flat price per unit of capacity
- The same principle applies with current FOW projects as they lack a track record and economics are considered uncertain
- Investors will valuate FOW projects by taking a view on the 4 major development risks:
  - Offtake. PPA secured and/or contract for difference (CfD) allocated?
  - Grid connection secured?
  - Permitting free from any claims?
  - Technology/design certified and/or with track record?

Despite remaining technology risks (5 floater designs being currently tested), we see a decent appetite from targeted investors

- Many players have missed the opportunity to be active in the fixed foundation offshore wind market. They view FOW as an opportunity to take part in a market with less restriction on the projects location
- First successful projects will attract cheap capital allowing sponsors to roll out their development pipeline

3. The equity market

Investors with different appetites for early stage projects

	Investor sub-type	Early stage	Notes	Examples
Pub.	Public agencies	Yes	• Took part in the financing of several floating pilot projects • Need another partner from the private sector	• ADEME • EIB
Strategic	Power utilities	Yes	• Provided development funding for most floating projects • Value early projects as an option to build and operate	• EDF • EnBW
	Oil & gas majors	Yes	• Build on their expertise from oil & gas floating platforms • Very active on technology finance as well as early projects	• Equinor • Shell
	Civil & offshore contractors	Yes	• Largest contractors can spend development money • Seek preferential rights for construction contracts	• ACS Cobra • Aker
Financial	Family offices	Maybe	• Family offices are flexible sources of capital with diverse investment objectives, that could fit with floating assets	• Creadev • Highland
	Traditional private equity	Maybe	• Typical private equity funds may be interested in floating investments, subject to project size	• Blackstone • Enbridge
	Infrastructure funds	Maybe	• Infrastructure funds are looking at floating wind projects in development that will reach FC in the coming years	• Meridiam • Marguerite • CDC

3. The equity market

Equity investors appetite on early FOW projects

Industrial investors will dominate the early deals

- Utilities interested to test a new market segment
- Oil & gas companies looking to enter the renewable energy sector, making use of their expertise in offshore structures
- IPPs looking for the "next new thing"
- Small developers – if they can find the early development equity
- A few private equity players who want to take advantage of projects which are first-movers

They will need a strong political support

- Outright funding on early projects (demonstrators/pilots) in addition to specific support on offtake power price
- EU programmes (via EIB or otherwise) can contribute

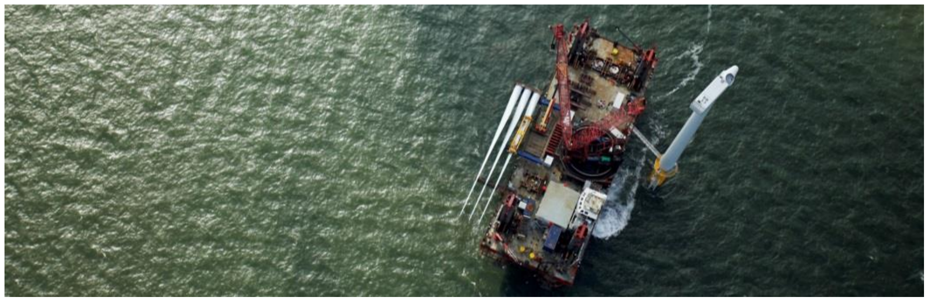
In parallel, number of ancillary investments will require public support

- To foster technology advancement
- To improve the coastal infrastructure capacity, and
- To support, where relevant, the necessary onshore grid upgrades and transmission extensions

With the 1st array in operation and more to be connected, investors are actively looking at FOW

Financing floating offshore wind projects

Table of contents



Green Giraffe

4. The debt market

Debt could be raised for the first commercial projects

The players

- Public financing institutions such as BPI, EIB and EKF will need to play a strong role
- Some commercial banks should be willing to finance early projects with the right parties and structure

The terms

- The early deals will naturally have conservative debt terms compared to traditional offshore wind
- A lower leverage will be a key requirement – we expect it to be closer to the first offshore projects (60-70% rather than 80%)
- Pricing will be above offshore wind but we expect moderate premium (50-100 bps)

The other requirements

- Specific due diligence will be required on the items which are new to lenders (e.g. interaction turbine-floater, dynamicity and dis/connectivity of electrical cabling, mooring and ballast systems, floating offshore substation, tow-to-shore maintenance)
- Availability guarantees (for both the turbine and the substructure), together with the power curve warranty, to be discussed extensively (with strong commitments from the floating technology provider)
- Ample contingency budget, both for construction and for maintenance
- Focus on transparency, availability of track record (when available), design certification and strength of counterparties

Debt terms will not be aggressive, but should still help investors

Financing floating offshore wind projects

Table of contents

5. Conclusion

Funding is available, but will be subject to strict conditions and realistic LCOE expectations

The most advanced technologies will be the first to be financed

- Those with full scale prototypes already installed, and with a satisfactory operating track-record
- Project sponsors will need to make the effort and take the time to educate financiers on this new technology
- Terms will be guided by market precedents, to the extent they are applicable

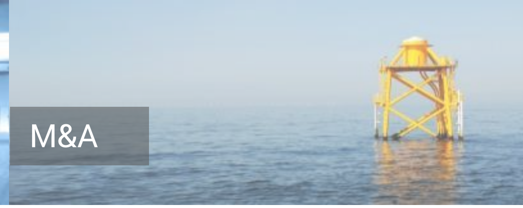
Extensive due diligence and contractual requirements

- Transparency regarding the technology is critical
- Technical advisors trusted by the financiers should be involved early
- Thorough risk assessment and management process are paramount
- The contractual structure should be adapted on the corporate strength of the technology providers
- Specific focus on the experience of the supply chain and development team

Different players for different stages

- Venture capital for technology development financing
- Private equity and developers for early projects
- Infrastructure funds and PF banks for larger projects

Financing is available for well-structured floating offshore wind projects



Green Giraffe

The renewable energy financial advisors

BOSTON • CAPE TOWN • HAMBURG • LONDON • PARIS • UTRECHT

green-giraffe.eu