



Floating wind - Risk analysis towards bankability

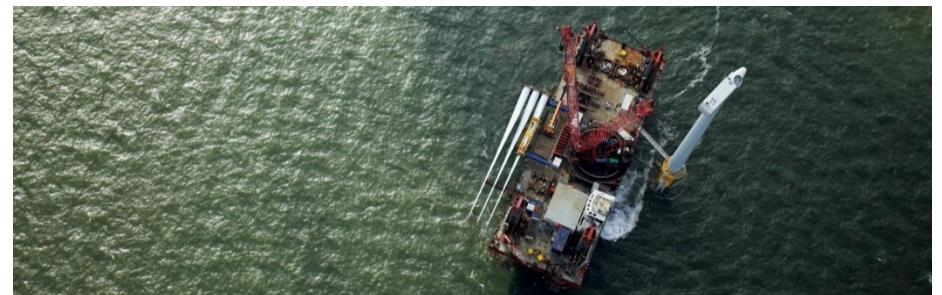
Seminar - 6 February 2018

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1. 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
- 70+ professionals with offices in Paris (France), Utrecht (the Netherlands), London (UK), Hamburg (Germany), and Cape Town (South Africa)
- Multi-disciplinary skillset including **project & structured finance, contract management, M&A, and legal** expertise



Close to **EUR 20 billion** funding raised for renewable energy projects in **8 years**



70+ professionals in **5 countries**

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 equity advisory (such as contracting, strategic advisory and development services)
- Widening geographical reach with a burgeoning presence in the Americas and Africa in addition to Europe
- Priority given to **getting the deal done!**



Involved in over **100 renewable energy projects** with a total capacity of ca. **25 GW**

1. Green Giraffe – What we can do for you

Proven track record in closing deals and maximising value for our clients and their projects

What Green Giraffe brings to the table

- Specialised expertise in **fund raising and financial structuring**, project development and contracting for complex transactions
- **Credibility in the equity markets** through a strong and proven track record in buy/sell-side advisory and brokerage in the wind and solar industry
- An **extensive and first class network with investors, contractors, banks, advisors and intermediaries** in the renewable energy market
- The lessons we have already learned will enable you to optimize the development process and **avoid costly mistakes and delays**
- We are deeply **committed** to the success of our clients and we offer you **highly competitive fee structures** including **success-based mandates**

Strategic advisory

- Corporate strategy advisory and market intelligence
- Technology and project bankability assessment
- Business plan analysis, financial modelling and valuation

Debt and equity raising and structuring

- Detailed financial analysis and valuation
- Fully structured packages to banks or potential investors
- Commercial negotiations with investors or banks
- For greenfield or brownfield projects

Assistance in project development and contracting

- Support in early project development (business plan, tariff tenders, permit process)
- Project- and sponsor-specific contracting services
- Support in negotiation (or review) of commercial terms, e.g. EPC warranties, availability levels, etc.

1. Principle Power – Globalizing offshore wind

An innovative technology and services provider to the offshore wind industry

Presence worldwide

- All disciplines in house: engineering, operations, development and construction
- Offices in California, France and Portugal

Strong industry backing

Shareholders



Partners



A proven technology

Successful 5 years full lifecycle demonstration

- 2 MW Vestas turbine injected 17 GWh into the grid
- Operational until 12 m waves, survived 17 m waves

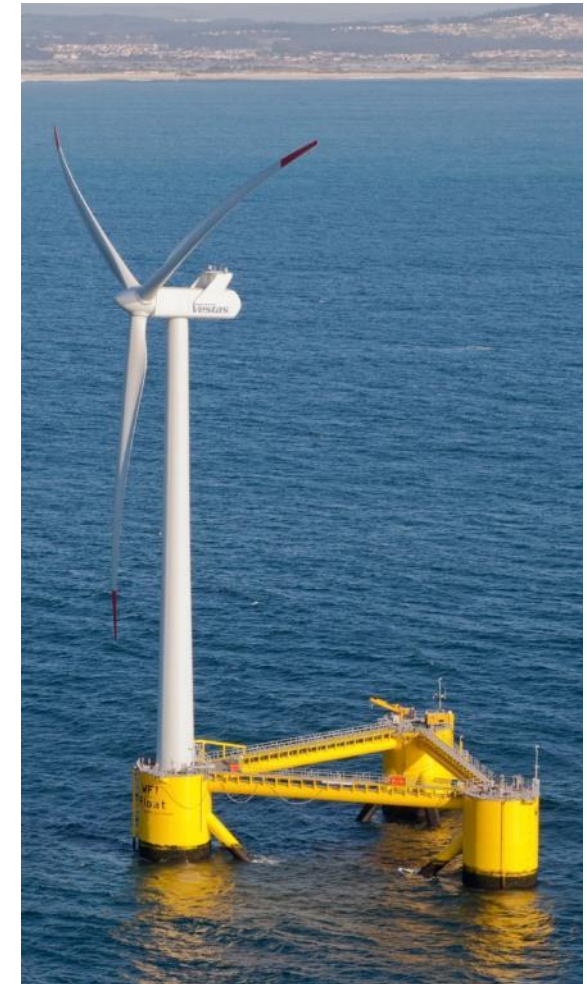
Pre-commercial projects

In progress

- Portugal: WindFloat Atlantic (2019)
- France: Gulf of Lion (2020)

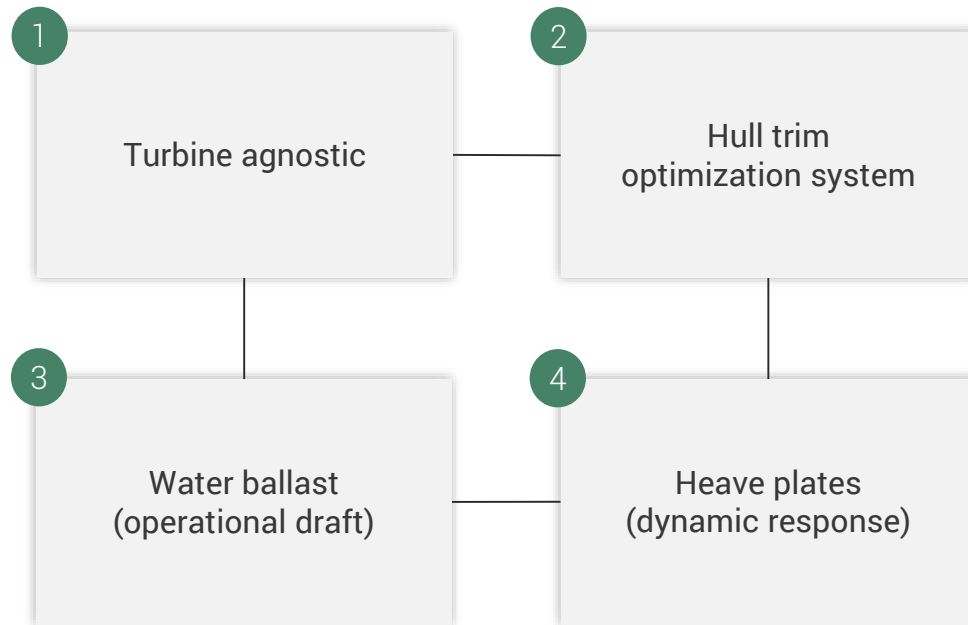
Commercial developments

- USA: CA, HI, North East
- Asia: Taiwan, Korea, Japan
- EU: France, UK, Portugal



1. The WindFloat technology

Risk analysis considers unique features of the WindFloat



Cost

- Light structure
- Serial production
- Onshore commissioning
- Low cost vessels

Risk

- Widely available vessels
- Limited offshore work
- Onshore large correctives
- Lower weather risk



1. The WindFloat Atlantic project

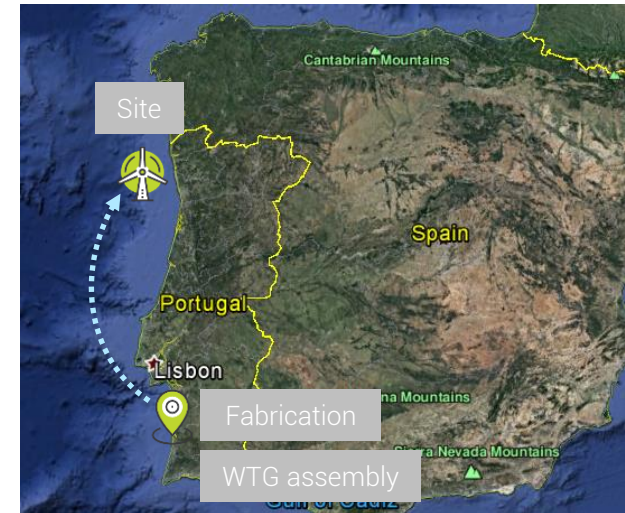
Risk analysis leverages WindFloat Atlantic project experience

Overview

- Location: 20 km off the coast of Viana do Castelo (PT) in 100 m water depth
- Turbines: 3 x MHI Vestas V164
- Construction: same shipyards as for WF1, WTG installation at quayside in Sines
- ABS Certification: design (25-year life), construction and installation

First non-recourse financed floating offshore wind project

- Equity closed at end of 2015 with major international players
- The WindFloat Atlantic project in Portugal (25 MW) delivered under a traditional non-recourse financing structure
 - EIB: InnovFin program
 - EKF: Denmark's export credit agency
 - Commercial banks
- Term sheets approved and due diligence completed, pending final FID



1. Collaboration between Green Giraffe and Principle Power

Risk analysis of the WindFloat technology

Background of the collaboration

- The parties shared a mutual interest in assessing development, construction and operational risks associated with the WindFloat technology
- Technology providers need funds to advance the deployment of their technologies, thus the interaction with the financiers is crucial for the floating offshore wind sector to reach commercial utility scale
- A key aspect of commercialisation of floating offshore wind is to ensure that investors and lenders understand the risks involved with this technology and obtain comfort that such risks can be managed

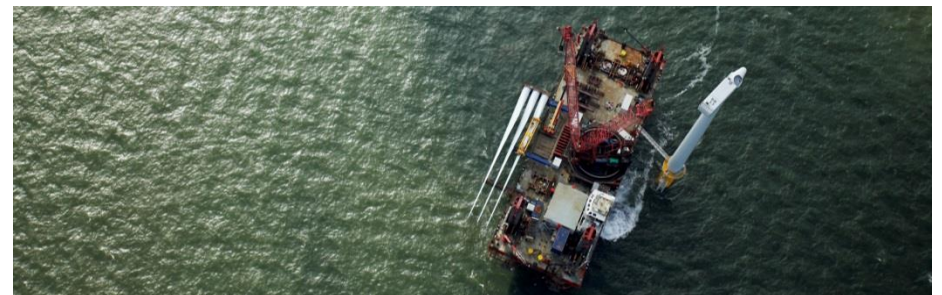
A risk assessment case study to serve as a functional model and with the following objectives

- Model a hypothetical commercial floating offshore wind farm (same technology as WFA project)
- Produce a project risk register that considers development and technology risks specific of the floating technology
- For each risk, estimate the probability of occurrence and cost impact
- Assess the mitigation solutions which can be adept to control the project risks
- Estimate feasible requirements for contingency funding

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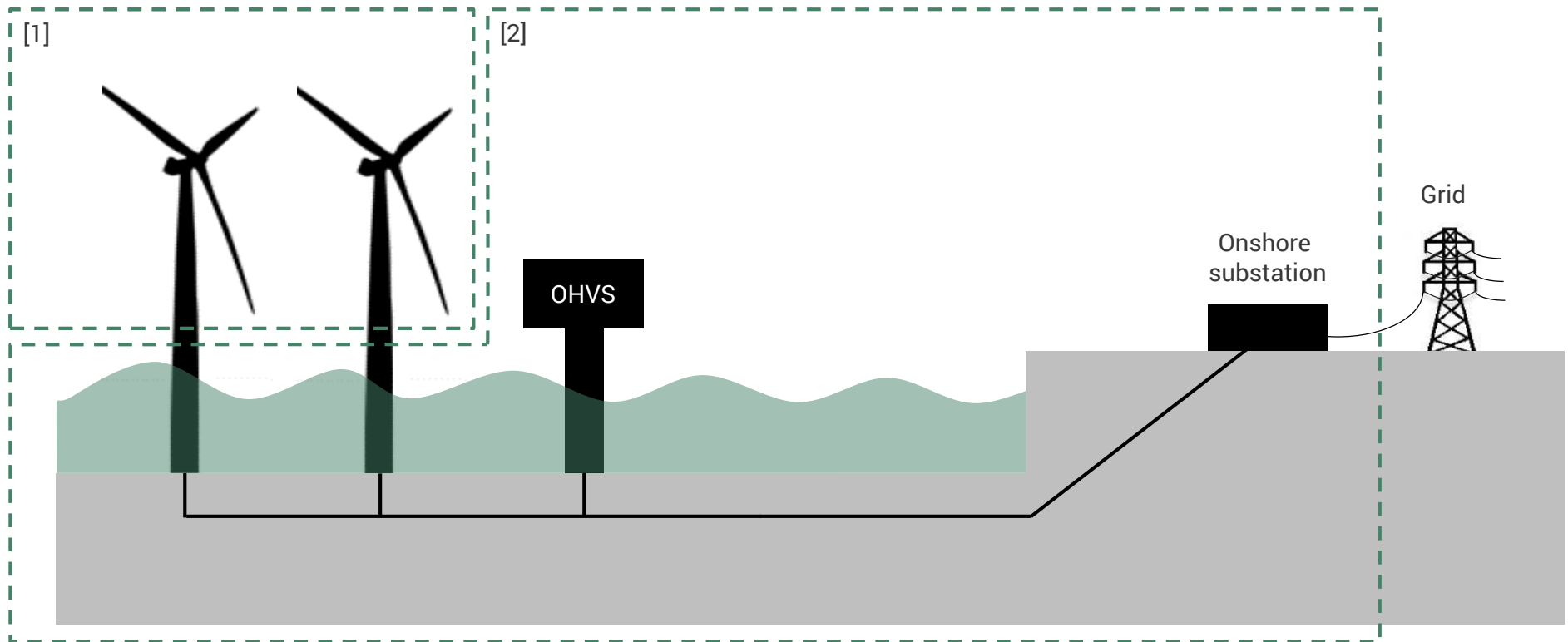


2. Approach to risk management

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 or fewer) : [1]. WTGs, [2]. balance of plant
- With pricing based on lump sum contracts

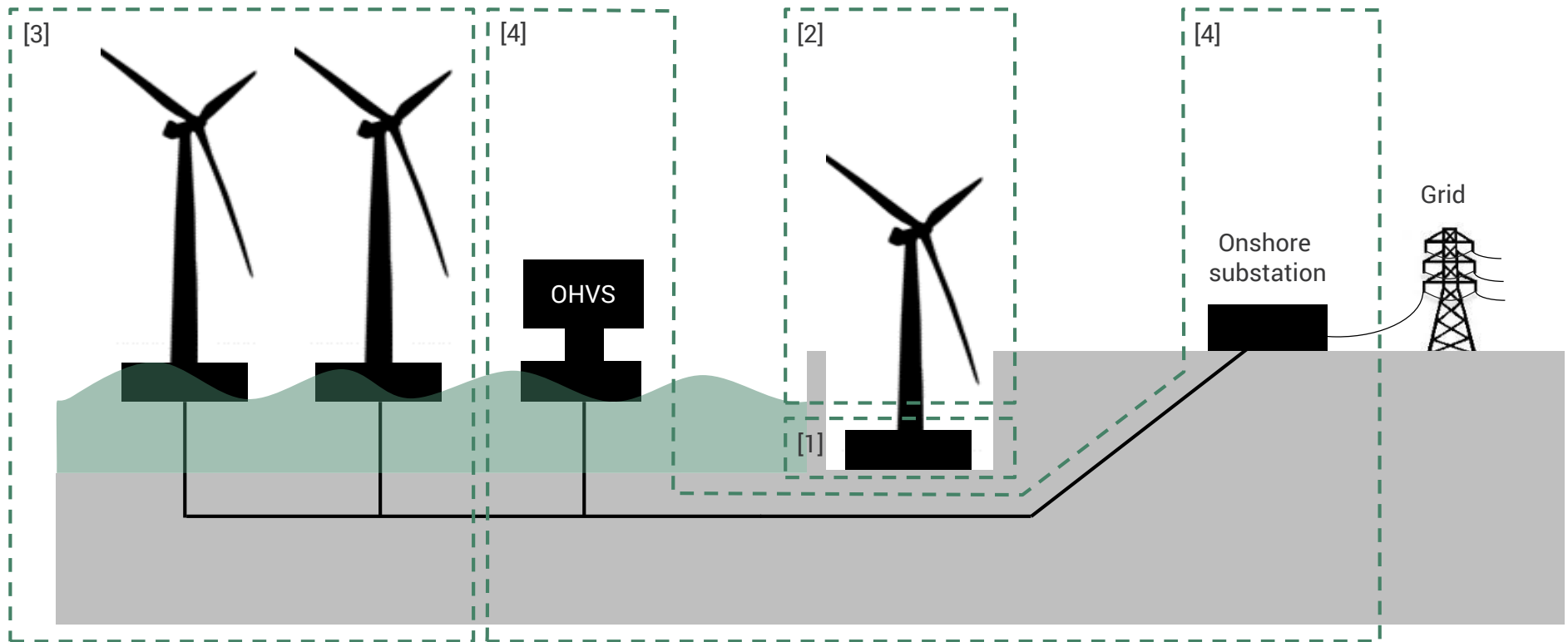


2. Approach to risk management

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. Approach to risk management

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 realization
- 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. Approach to risk management

Model a hypothetical commercial floating offshore wind farm

Assumptions

- Permitting in place
- Environmental Impact Assessment (EIA) approved
- Grid access (onshore substation, corridor for export cable, PPA)
- Support mechanism awarded (Contract for Difference)
- Pre-completion revenues considered (i.e. 3 arrays = 3 CfD starting dates)
- Conservative construction schedule based on P90 weather scenario
- Regulation of works via industry standards for health and safety assessment and environmental management system
- Insurance package: construction and operations all risks, delay in start up, third party liability and business interruption (to cover for external events, not internal ones such as a flaw in design, etc.)

Uncertainties

- Wind measurement and extrapolation (FLiDAR plus correlation with met mast)
- Interannually wind variation
- Wake modelling (both general and specific to floating)
- Power curve uncertainty, including floating motion
- Plant availabilities (WTG, floating foundation, offshore substation, grid)

The project contingency funding is defined on the basis of

- Qualitative and quantitative risk register (full detailing)
- Project uncertainties (estimate)
- Major delay scenarios (preliminary analysis)

2. Risk analysis

Risks have been captured for each package via sector experts and group workshops

The risk register allows for listing and reporting, providing a complete overview of the project exposure

- Each risk has been assessed in terms of
 - Causes and consequences
 - Probability of occurrence (min, max)
 - Present cost impact (min, most likely, max)
 - Mitigation solution and target cost impact (post mitigation)
- The risk register includes a Quantitative Risk Assessment (QRA) that facilitates the calculation of project contingency funding

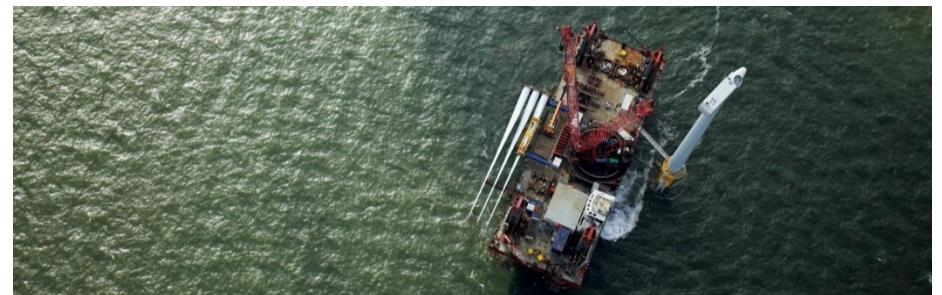
Monte Carlo simulation methodology to size contingency funding

- The Monte Carlo simulation is considered the best practice approach to quantify the cost of risks associated with complex projects and to estimate contingency funding
- Multiple iterations are generated, each being a unique and deterministic scenario, characterised by the same risks defined in the risk register and representing a potential outcome of the project
- These multiple resolutions are then used to generate a single probabilistic function that defines the project total risk exposure
- From this function probability levels (i.e. P50, P75, P90, P99) can be determined

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3. Risk register highlights

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
- WindFloat technology adapted to turbine specifications and site conditions
- Full system simulation according to standards with software validated with performance data from the demonstrator (WF1)
- 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

3. Risk register highlights

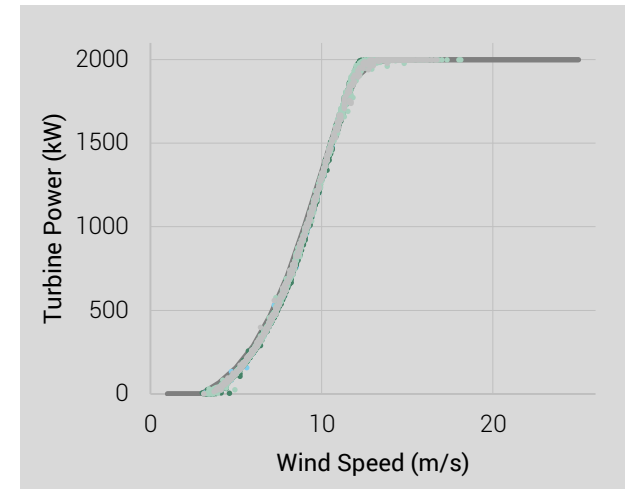
Turbine performance

Demonstrator (WF1) track record confirms turbine performance

- Full scale 2 MW turbine for 5 years in operation
- No power losses or negative effect on turbine performance
- High system availability (excluding grid issues)
- Inspection at decommissioning confirmed healthy turbine, sold for re-use

Contracting of supply and servicing of turbines influences risk exposure

- Choice of an experienced turbine supplier (WFA project: MHI Vestas V164)
- Essential TSA and SAA/SMA items critical to bankability



— Power Curve
● $H_s = 0-1$ m ● $H_s = 1-2$ m
● $H_s = 2-3$ m ● $H_s = 3-4$ m

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

3. Risk register highlights

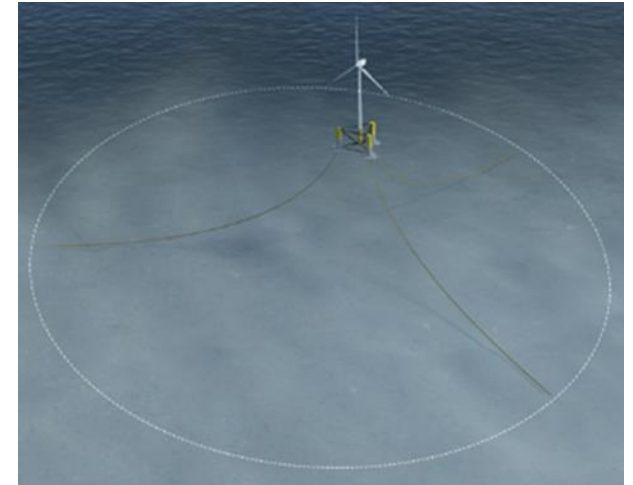
Mooring scheme and seabed interface

Provides interface between floating wind turbine and seabed

- Function to provide station keeping (not stability) - Windfloat technology
- 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

- Seabed geotechnical conditions not as expected
- Mooring system deficiency
- Component damage / excessive wear / catastrophic failure

Mitigation solutions

- Effective project management and planning, due diligence
- Seabed campaigns according to best practices
- Certification of mooring design, fabrication, installation

3. Risk register highlights

Foundation fabrication and launching

Design robustness tested in extreme met-ocean conditions

- 5-year inspection of demonstrator (WF1) showed 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 serialize 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

3. Risk register highlights

Electrical infrastructure

Inter-array and export cables

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

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)

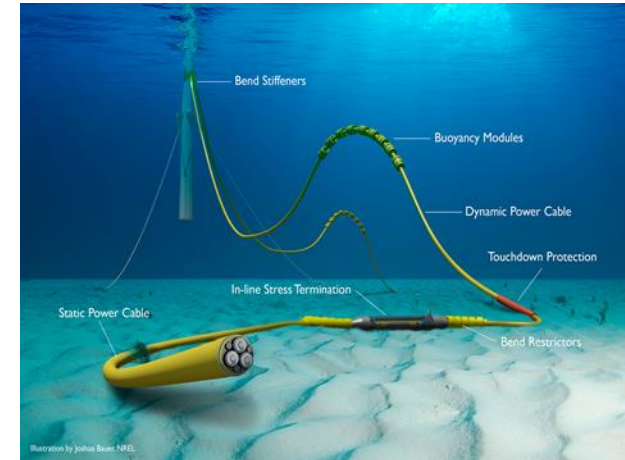


Illustration by NREL (US Department of Energy)

Risks

- Performance of dynamic cables
- Interface issues between IAC / EXC and WTG
- Floating substation performance and cost overruns

Mitigation solutions

- Effective project management and planning, due diligence
- Counter party analysis and early engagement of suppliers
- Extra cable sections and spare ancillary equipment

3. Risk register highlights

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 ($H_s < 2.5$ 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

3. Risk register highlights

Operations, maintenance and decommissioning

Scheduled maintenance and minor corrective repairs

- Same approach as for fixed-bottom offshore wind
- Access through CTV, SOV or helicopter – proved with demonstrator (WF1)
- 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 - procedure validated through successful decommissioning of demo (WF1)
- Large correctives (major up tower repairs) to be performed at quay side with land based crane



Risks

- WTG & FOU availabilities, adverse weather (accessibility)
- Failure predictability (e.g. damage, wear, corrosion)
- Port and equipment unavailability for large correctives

Mitigation solutions

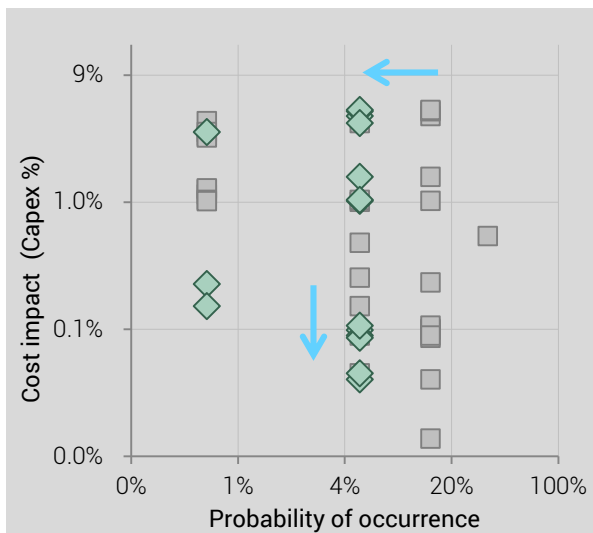
- WTG & FOU long term service agreements, incl. spare parts
- Farm access control to protect cables and mooring lines
- Stand by port and equipment for large correctives

3. Further risk analysis outcomes

The qualitative and quantitative evaluation of risks

Risk mapping

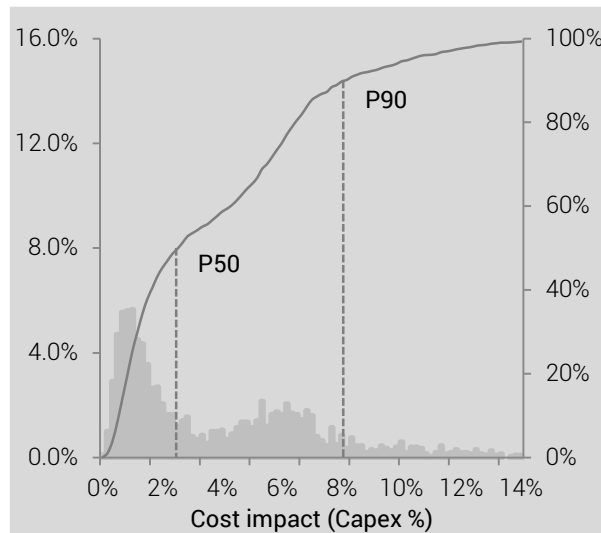
Risks mitigated through technical and contractual solutions



◆ Target scenario ■ Present scenario

Project risk exposure (initial)

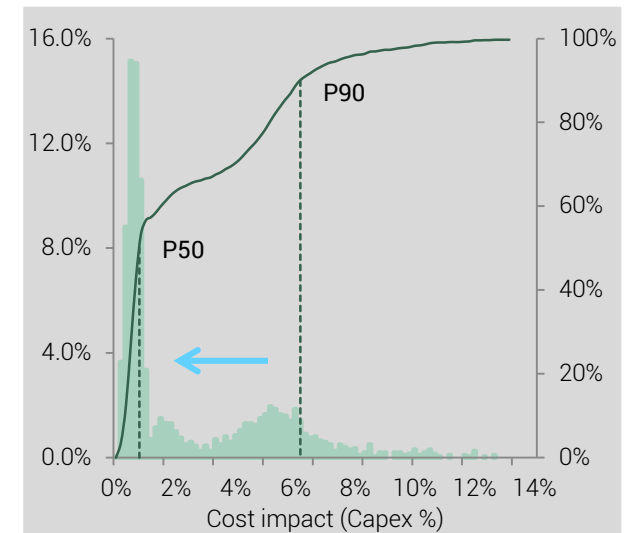
Most likely contingency 2% of Capex, 8% of Capex in P90 scenario



— Relative occurrence — Cumulative occurrence

Project risk exposure (target)

The mitigation solutions optimize the total project risk exposure



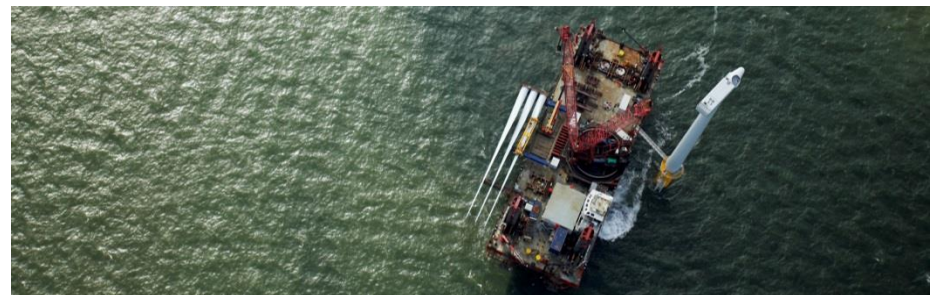
— Relative occurrence — Cumulative occurrence

Project financing is about risk analysis: making risks visible & measurable and mitigating them

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4. How projects are financed

“Balance sheet” (equity) vs “non-recourse” (debt)

Large projects are typically developed through a standalone project company

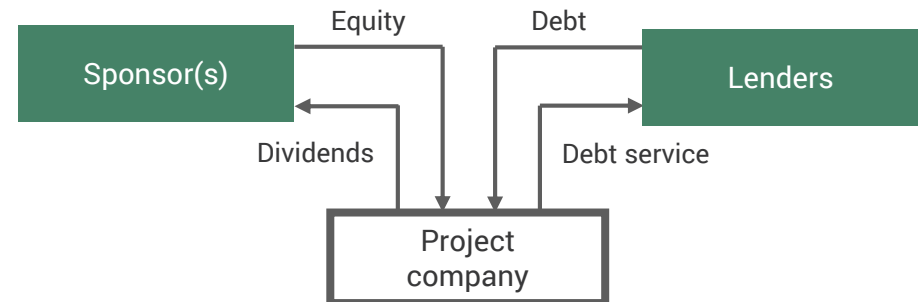
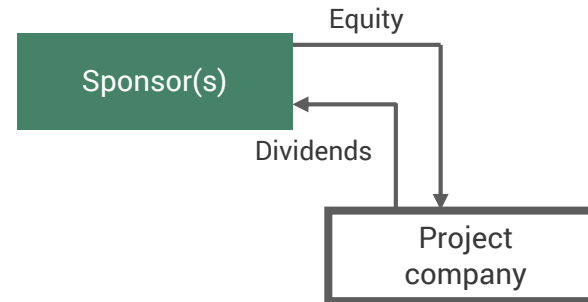
- Owned by the project investors
- With its own revenues & balance sheet and thus the ability to raise debt on its own merits

There are only two discrete sources of funding

- By the owners (directly via equity or shareholder loans, or indirectly via guarantees)
- By banks without recourse to the equity investors – this is “project finance”

The way a project is funded will have a material impact on how it deals with contractors

- In a project finance deal, you need to deal with the senior lenders' requirements!
- Tax, accounting, consolidation and rating issues



All parties have a direct incentive to understand who will be funding the project

4. Equity providers for floating wind – the different profiles

Investors and appetite for risk

Investor	Perm.	Dev.	Constr.	Ops.	Notes	PF
Utility / Oil & Gas	Yes	Yes	Yes	Yes	Several actively involved, sensing large scale potential. Want active role. Conservative assumptions, but long term plans	If possible
IPP	Yes	Yes	Yes	Yes	Several actively involved, including at early stage, as it offers potentially higher returns. Flexible & pragmatic investors & co-dev.	Yes
Trading house	Yes	Yes	Yes	Yes	Some actively involved. Others considering investing. In alignment with the Japanese government strategy for floating offshore wind	Yes
Private equity	Yes	Some	Some	No	Like the potentially high returns, but time scales are an issue. Active involvement in dev. phase with likely early exit	Yes
Financial (aggressive)	No	Maybe	Yes	Yes	Looking for higher returns, so could be interested, but will need comfort with the technology, so will likely seek partners	Probably
Financial (conservative)	No	No	Maybe	Yes	Will come in at a later stage, first on operational projects, then, once the technology is proven, may take construction risk	Not necessarily
Corporations	No	No	Maybe	Yes	Can invest to hedge power price risk or for strategic/marketing reasons. Happy (or require) to be junior partner. FOW new to them	Not necessarily
Contractors / Naval yards	Maybe	Yes	Yes	No	Can provide funding to secure / make projects viable (in FOW, FOU can be great part of capex). Want perspective on exit after COD	Not necessarily

4. Equity providers for floating wind

Some degree of appetite for early deals

Industrial investors will dominate the early projects

- Utilities interested to test a new market segment
- Oil & Gas companies looking to enter into renewables, making use of their competence in floating offshore structures
- IPPs looking for the “next new thing” – some private equity players might have the same approach
- Small developers – if they can find the early development equity

Strong political support required

- Outright funding required for early projects (demonstrators and pilot projects), in addition to a specific tariff for power
- EU programmes (via EIB or otherwise) can contribute
- Lateral investments (which require public support or at least encouragement) to
 - Foster technology advancement
 - Improve the coastal infrastructure capacity, and
 - 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

4. Debt for offshore wind

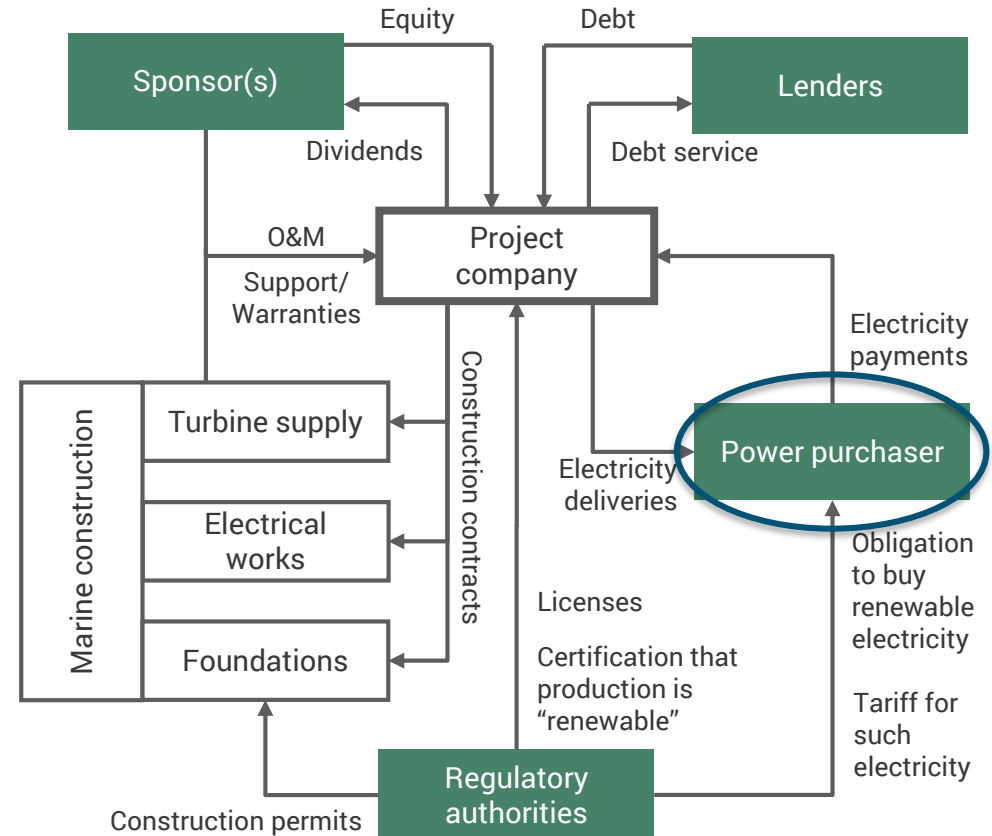
Large-scale wind transactions are always heavily contracted...

...and a power purchase agreement (PPA) is always an important aspect of the contractual package

- The PPA provides a route to the market for the project's produced electricity
- Together with revenues from the applicable support regime, PPAs typically provide the bulk of a project's income
- As such, lenders will have specific demands on the structure of a PPA and will scrutinise the actual contract in great detail

Even under contract for difference (CfD) mechanisms, lenders scrutinize the PPA

- Management of sales on the wholesale power market with no volume or balancing risk
- Price index to match with CfD



PPAs are crucial elements in the contractual structure of wind projects

4. Debt for floating – what will be possible

Debt could be raised for the first commercial projects

The players

- By necessity, 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 key requirement will be to have lower leverage – we would expect 50:50 or 60:40 to be a reasonable target for early projects
- Pricing will be above offshore wind, but likely not by that much (50-100 bps premium)

The other requirements

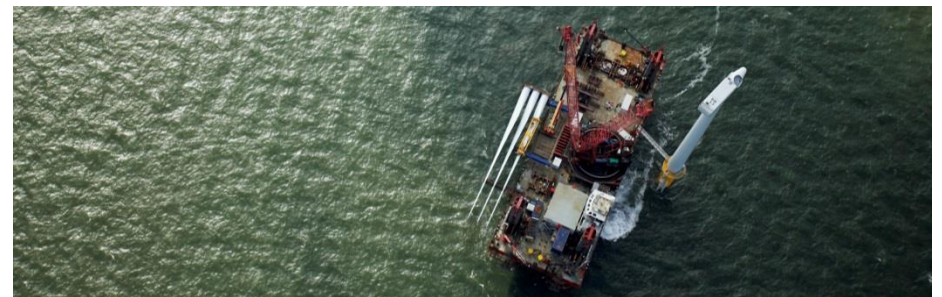
- Specific due diligence will be required on the items which are new to lenders (e.g. interaction turbine-floater, dynamicity and dis/connectivity of electrical cabling, mooring and ballast systems, floating offshore substation, tow-to-shore maintenance)
- Availability guarantees (for both the turbine 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

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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

You can raise financing if you target the right providers and meet their requirements



Debt



Equity



Strategic



Contracting

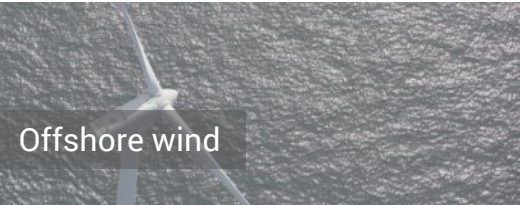


Green Giraffe

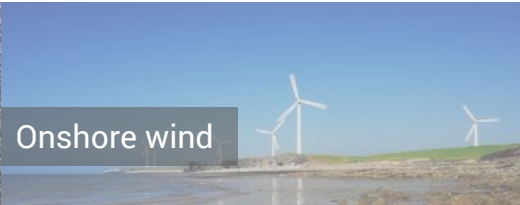
The renewable energy financial advisors

PARIS • UTRECHT • LONDON • HAMBURG • CAPE TOWN

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Offshore wind



Onshore wind



Solar power



Other renewables