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OFFSHORE WIND TOWARD 2020

ON THE PATHWAY TO COST COMPETITIVENESS

April 2013

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A. Offshore market volume of EUR 130 bn by 2020

Agenda 2020 – Market – Trends – Competition

A. Offshore market volume of EUR 130 bn by 2020

Offshore wind energy is an essential element in meeting ambitious European climate and energy targets

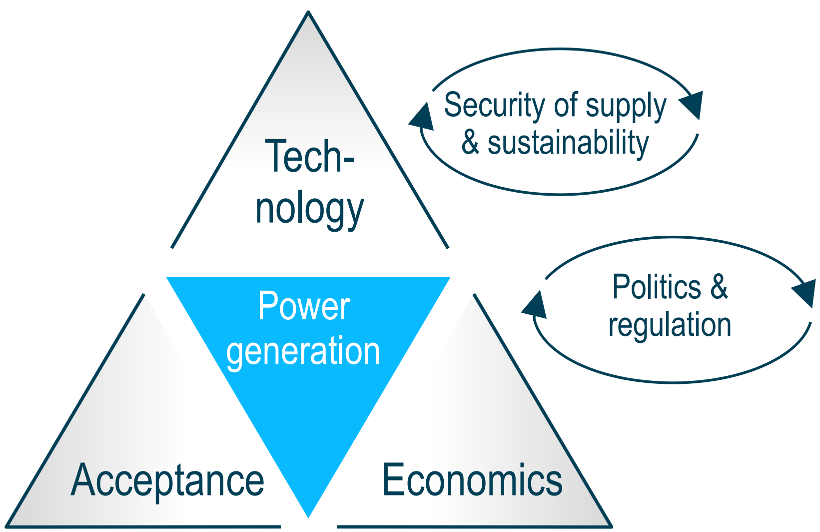
Renewables agenda

EUROPEAN TARGETS 2020

35% of electricity from renewables

12% of electricity from wind energy

40GW installed offshore capacity



ADVANTAGES OF OFFSHORE WIND

- Wind energy is the most mature renewable energy technology in operation
- There is limited growth potential for onshore wind due to high population density in Europe
- Offshore wind provides higher and steadier energy yields – on average about 4,000 full load hours
- Offshore wind is a very young technology that offers further potential for substantial cost reductions
- Several European countries rely strongly on offshore wind to fulfill their energy and climate targets

OFFSHORE WIND IS A KEY PILLAR OF THE EUROPEAN ENERGY TRANSITION

Source: European Commission; EWEA; BWE; Roland Berger

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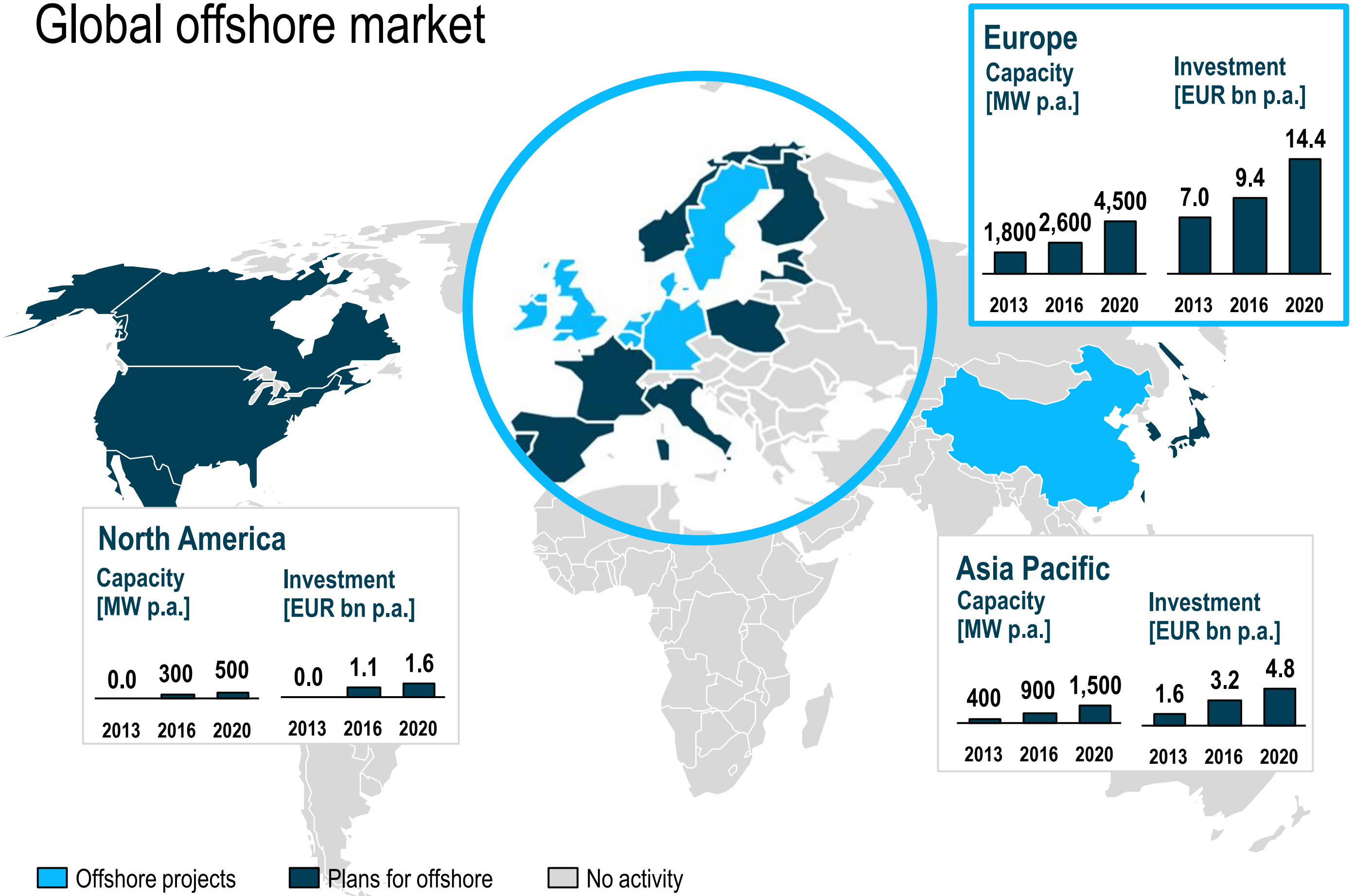
Offshore wind energy will soon become a large sector – Global investments of EUR 130 bn by 2020

Global offshore market



Rationale: Investment costs per MW: 2013: EUR 3.9 m, 2016: EUR 3.6 m, 2020: EUR 3.2 m

COMMENTS

> **Europe** has ambitious growth rates and annual additions of 4.5 GW or EUR 14.4 bn in 2020

> **Asia Pacific** will catch up, with annual additions of 1.5 GW or EUR 4.8 bn in 2020

> **North America** follows, with lower levels

> **ROW** shows no relevant investment in offshore through 2020

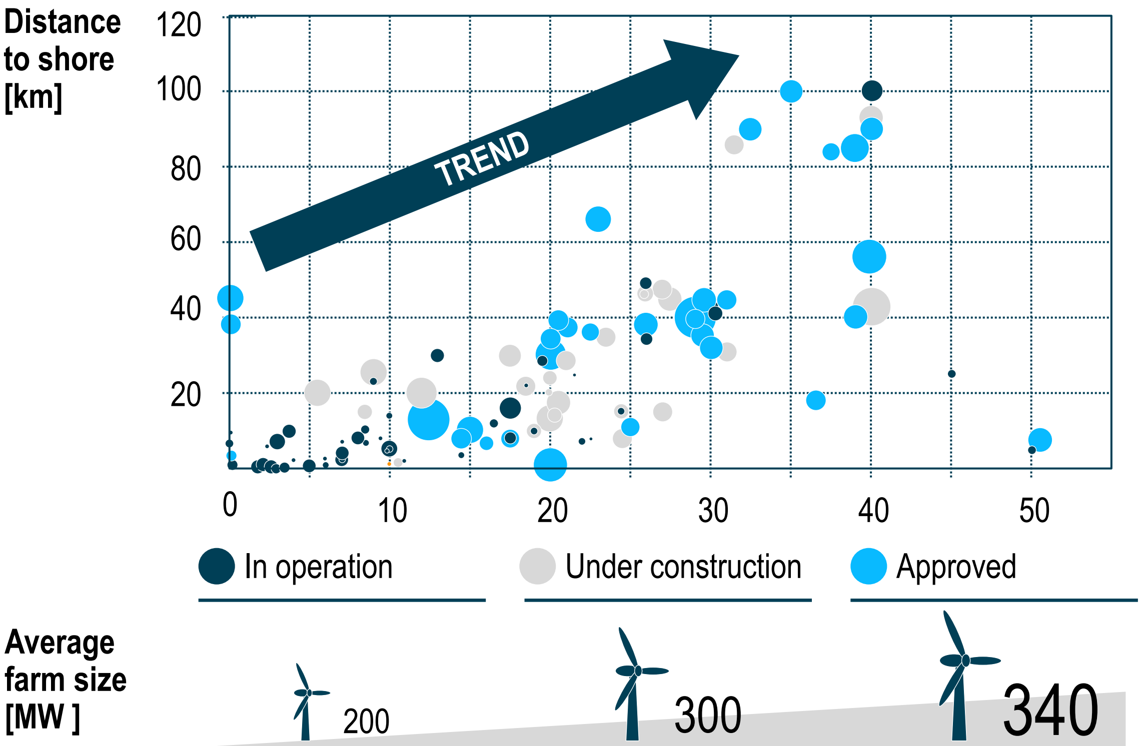
> Risks to global development arise from challenges such as a lack of grid connections and the need to reduce the cost of energy

Source: EER; BTM; Global Data; Roland Berger

The next generation of offshore wind farms will be constructed further away from the shore in deeper water

Trends in offshore

OFFSHORE WIND FARMS



TRENDS

I FURTHER

> Trend toward building wind farms further from shore

> Environmental laws (GER) and limited space close to shore are a driver for greater distance

II DEEPER

> Greater distance to shore usually leads to deeper water at site

> Deeper water requires new foundation solutions

III LARGER

> Larger wind farms allow improved fixed cost allocation

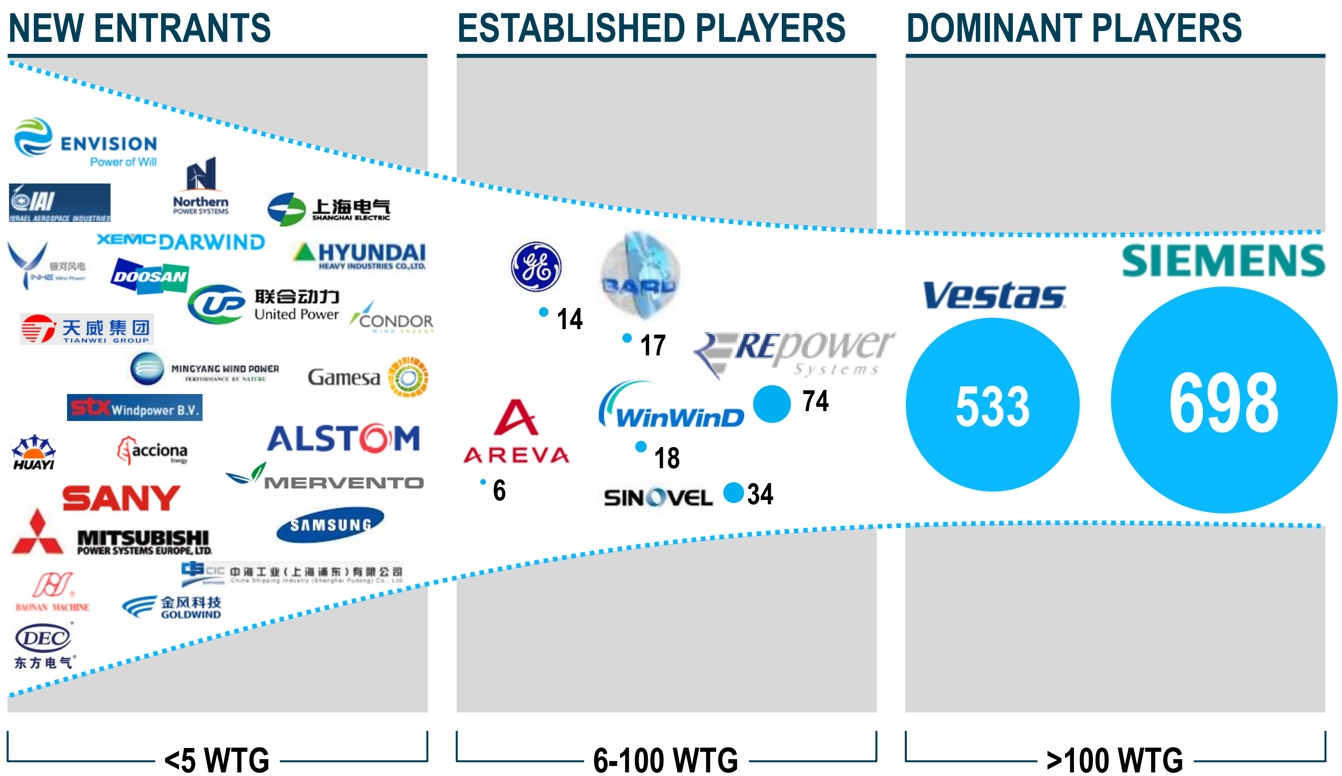
> Average size of approved projects is at 340 MW

Source: EWEA; Roland Berger

A. Offshore market volume of EUR 130 bn by 2020

Offshore turbine manufacturing will enter a phase of intense competition – Threat of future overcapacity

Competition between wind turbine manufacturers



= Number of installed offshore wind turbine generators (WTG)

COMMENTS

> Large number of new **market entrants** in the last two years

> **Big industrial players** such as Alstom, Hyundai, Mitsubishi and Samsung see offshore wind as attractive

> **Competition will increase** significantly due to the large number of new entrants

> **Siemens and Vestas** are the dominant players, with more than 500 turbines installed

> **Production overcapacity** expected in the years to come

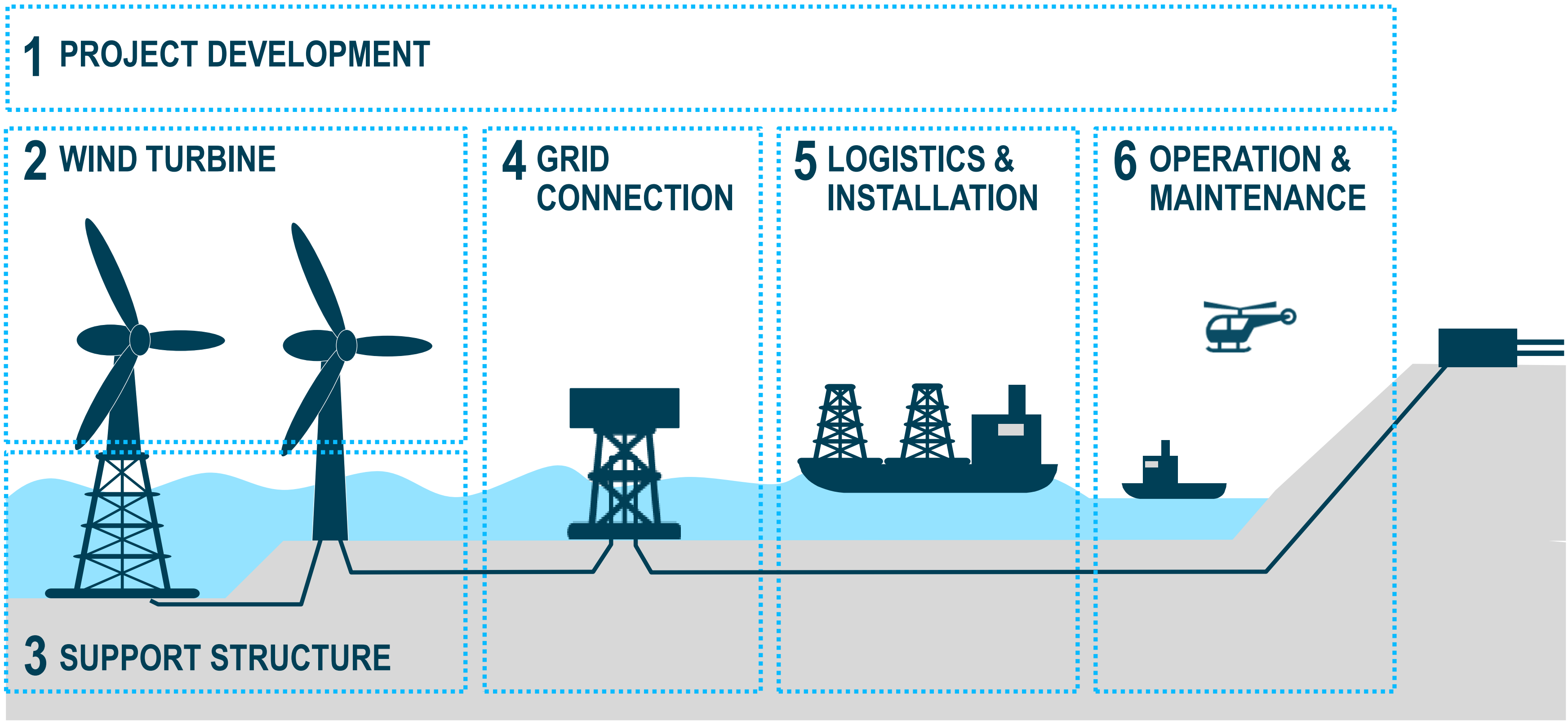
Source: EWEA; EER; manufacturers; press; Roland Berger

B. Value chain evaluation for offshore

Project development – Turbines – Foundation – Grid – Vessels – O&M

Offshore projects show significant potential for improvement across the entire project value chain

Value chain for offshore projects



Source: Roland Berger

Offshore project development takes 7-10 years – Growing professionalism expected to reduce delays

Project development

Initial planning	Permission	Supplier management	Financing	Installation & construction	Operations & maintenance
> Identify suitable area > Evaluate wind potential > Evaluate ground surface > Develop wind farm layout	> Apply to the responsible public authority > Conduct required environmental studies	> Identify suppliers > Negotiate terms > Allocate interface risks > Develop installation and logistics concepts > Develop O&M concept	> Optimize project structure > Prepare info memo and financial model for investors and banks > Approach banks and investors > Financial close	> Align suppliers' timeframes with logistics concept > Manage and mitigate interface risks > Ensure timely commissioning	> Assure high level of turbine availability > Regular service and quick troubleshooting > Enable component change > Ensure cost effectiveness of O&M concept
1-3 years	**2-4 years**	**2-3 years**	**1-3 years**	**1-2 years**	**20+ years**

Avg. of 7-10 years[1)] (Initial planning through Installation & construction)

COMMENTS

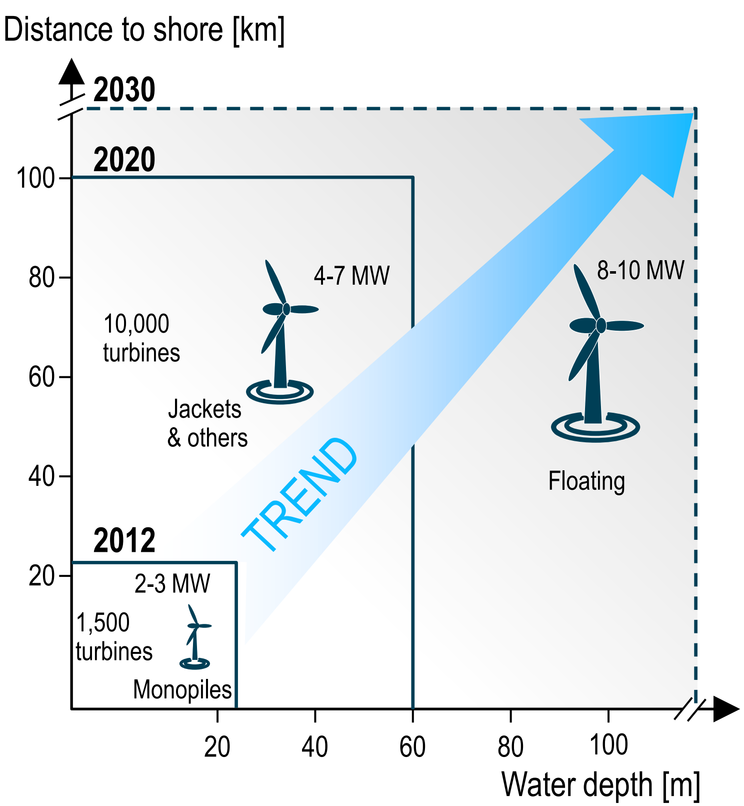
- **Interface risks for investors**
  - EPC contracts for offshore wind projects are not available
  - Multi-contracting has major interface risks for investors
- **Improvement methods**
  - Build strategic partnerships with a small number of partners
  - Strengthen controls
  - Hire experienced personnel from developers
- **Growing professionalism**
  - Market entry by large players such as construction companies and utilities leads to growing professionalism in project development

1) Years per phase not strictly cumulative as some phases overlap

Source: Roland Berger

Larger turbines will improve total CAPEX, capacity factors and O&M costs – "Big is beautiful" as LCoE falls

Wind turbines – Size and LCoE



LEVELIZED COST OF ENERGY (LCoE), OFFSHORE WIND

DRIVER		3 MW turbines	6 MW turbine	IMPROVEMENT
CAPEX [EUR m/MW]	Turbine	1.35	1.55	+15% (-6%)
	Balance of plant	2.55	2.10	-18%
Capacity factor [%]		43	48	+12%
O&M costs [EUR '000/MW/year]		140	120	-14%
LCoE[1)] [EUR ct/kwh]		**13.4**	**11.1**	**-17%**

1) Idealized model calculation for newly installed turbines on global average

Source: Expert interviews; Roland Berger

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Monopiles remain the dominant foundation concept, but trend toward deeper water is shifting growth to jackets

Foundation concepts

WATER DEPTH

FOUNDATION	DEPTH [m]	MARKET SHARE: CUM 2012	MARKET SHARE: TREND 2020	COMMENTS
Gravity-based foundations (GBF)	<20[1]	21%	↘	Currently only used in shallow water; however, new GBF concepts could have potential for renewed future application up to 40 meters
Monopile	10-30[1]	75%	→	Remains most widespread foundation type. Limitations in water depth and weight are increasingly being overcome with new concepts
Tripod/-pile	25-50	2%	↘	High production costs due to complex structure and great weight are likely to limit use of both concepts
Jacket	20-60	2%	↗	Jackets will increase their share due their flexibility and low weight (40-50% less steel than monopiles), commercially worthwhile >35 m
Floating	> 50	<1%	↗	Currently at R&D stage, but could become relevant for countries with steep shores. No commercial use expected before 2020

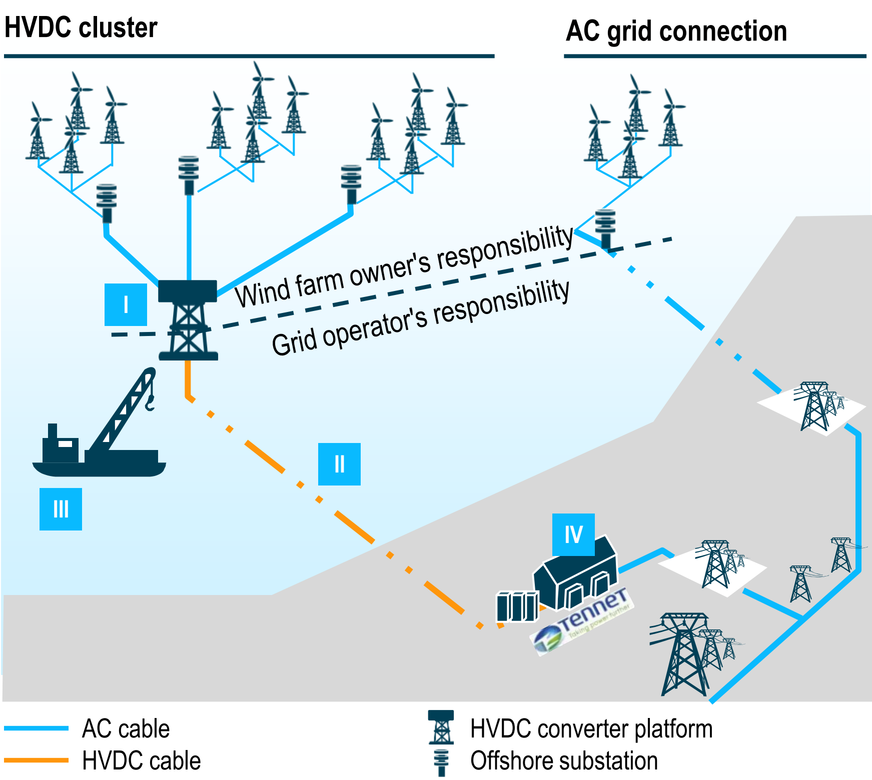
1) Up to 40 m with new concept

Source: EWEA; 4coffshore; Ramboll; Roland Berger

HVDC connections cause delays and cost overruns in Germany – Similar issues may occur in other markets

Grid connection – Example: Germany

HVDC GRID CLUSTER



BOTTLENECK

I Offshore converter stations
> Only three suppliers: ABB, Siemens, Alstom
> Delivery time up from 30 to 50 months

II Offshore HVDC cables and cable laying
> Only a few suppliers. Shortages may occur

III Installation vessels for converter stations
> Only a few vessels can install converter stations >10,000 t

IV Transmission system operator (TSO)
> TenneT to provide grid connection for all projects in the German North Sea (CAPEX approx. EUR 1 bn per GW)

SOLUTIONS IN GERMANY

> Distribution of liability costs to electricity customers
> Involvement of public institutions and financial investors
> Politically backed master plan for offshore grid infrastructure
> Standards for converter stations

Source: Wind-Kraft Journal; TenneT; Roland Berger

New vessels specifically designed for offshore wind will reduce installation times and costs – Bottleneck resolved

Installation vessels

JACK-UP VESSELS

Application

> Offshore wind farms are constructed by jack-up vessels
> Mostly, jack-ups load material in harbors, carry it to site and install it

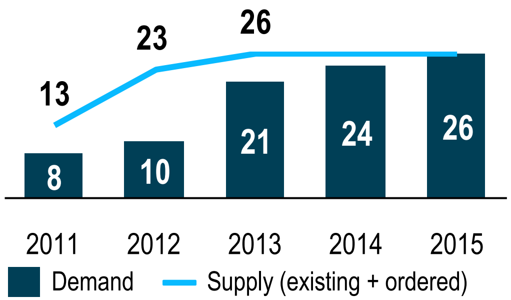
History

> Vessels from offshore oil & gas industry deployed for first wind farm installations
> Major bottleneck around 2008 for offshore wind installation vessels
> Some 15 new vessels are being built that are tailored to the needs of offshore wind energy

NEW GENERATION OF VESSELS

DEVELOPMENT

Vessel demand and supply



Vessel KPI	Trend	Benchmark
Deck space [m²]	↗	4,300
Capacity [tons]	↗	8,400
Speed [knots]	↗	13.5
Water depth [m]	↗	>45

IMPROVED VESSEL PERFORMANCE

EXAMPLE: NEW VESSEL

> **New generation** of installation vessels specifically **designed for offshore wind**
> New vessels such as the "Innovation"
  – Are larger in size (148 m x 42 m)
  – Have **greater deck space** and **storage capacity** (8,000 t; e.g. 7x6 MW WTG or 12x3 MW WTG, 4 jackets or 7 monopiles)
  – Are **faster**
  – Can work in **deeper water** (50 m)
  – Have improved **jacking speed**

> **Faster** wind turbine **installation** will **reduce the total cost of ownership**

REDUCED COSTS

Source: GeoSea; Roland Berger

B. Value chain evaluation for offshore

O&M concepts for the next generation of wind farms are not yet mature – O&M is a key value driver

Operation & maintenance (O&M)

IMPORTANCE OF O&M

- Efficient, proven O&M concepts are still not available
- Excellence in O&M is critical to a profitable offshore wind business
  - O&M approx. 28% of lifetime costs
  - 10% O&M cost reduction delivers +4% EBIT or +30 bps IRR[1)]
  - 1% increase in availability delivers +2% EBIT or +15 bps IRR[1)]
- O&M offers potential for continuous improvement over project lifetime

KEY O&M VARIABLES

I Location of service station

- Station for service personnel onshore or offshore on service platform

II Logistics to and on site

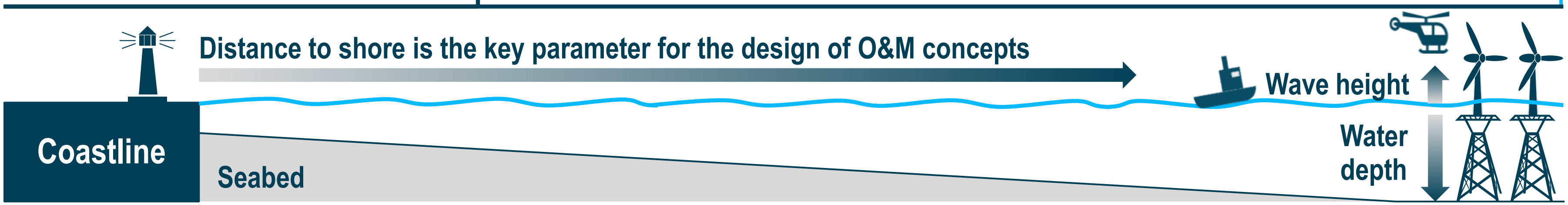
- Service vessel concept and potential use of helicopter

III Availability of crane or jack-up

- Adequate access to vessels for replacing large components

IMPROVEMENT LEVERS

- Increased rated power of WTGs reduces O&M costs per kWh
- Increased reliability of turbines and components reduces unplanned service activities
- Geographical clustering of offshore wind farms creates synergies
- Increased in-house O&M activity by utilities will partly or fully replace O&M turbine manufacturers



1) bps = basis points; IRR = internal rate of return
Source: E.ON; DONG; EnBW; Roland Berger

C. Offshore potential to meet LCoE targets

Utilities – Investors – Cost competitiveness – Saving potential – Costs of energy

Utilities are dominant in farm ownership and operation – Financial investors required to finance the pipelines

Utilities by capacity and investment model

Utility	OFFSHORE CAPACITY [MW]	PIPELINE [MW]	PIPELINE [EUR]
Vattenfall	840	4,700	17 bn
DONG energy	800	2,900	10 bn
e.on	470	3,400	12 bn
RWE	160	7,500	27 bn
centrica	140	6,000	22 bn
Scottish and Southern Energy plc	90	6,000	22 bn
EnBW	25	1,100	4 bn
EDF	3	1,000	4 bn
Iberdrola / ScottishPower	0	6,600	24 bn

INVESTMENT MODELS

1 STANDALONE

> One utility owns, develops and operates project
> Utility has full control, but bears all risks

Examples: RWE Innogy 1 (RWE), Amrumbank West (E.ON), Horns Rev2 (DONG)

2 LEAD INVESTOR

> Leading utility with one or more minority investors
> Utility shares risk and reduces equity requirements

Examples: DanTysk (Vattenfall, SWM), Baltic 1 (EnBW, municipal utilities)

3 JOINT VENTURE

> A group of equal players join forces
> Project development by joint venture company

Examples: Egmond aan Zee (Vattenfall, Shell), Borkum West II (Trainel), C-Power (RWE, EDF, others)

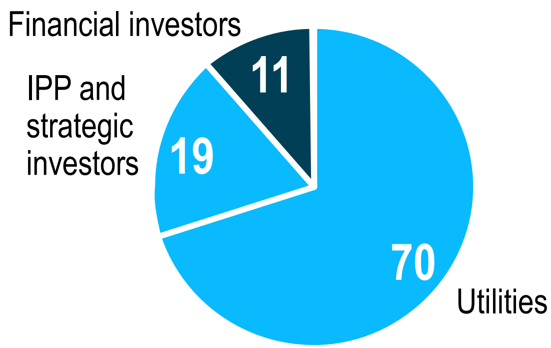
Status as of September 2012; estimated average investment volume for pipeline: EUR 3.6 m per MW

Source: Company websites; 4COffshore; Roland Berger

New investment models with better risk-return ratios required to attract more financial investors

Investors in offshore wind

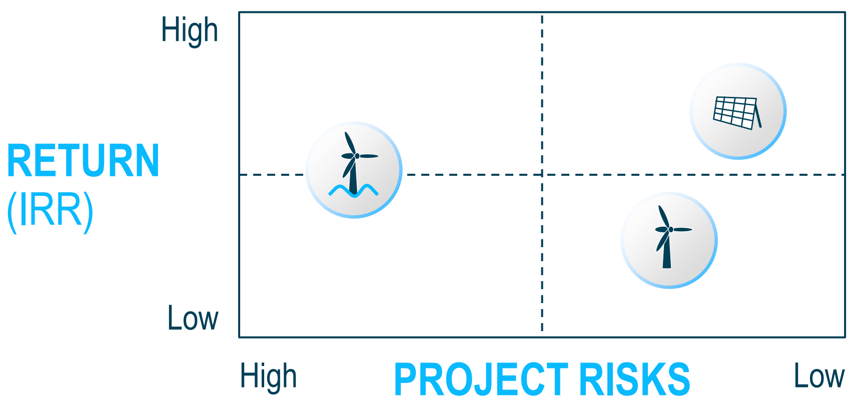
WINDFARM OWNERSHIP [%]



Approx. 3,600 MW

- Wind farms are owned by utilities, IPPs and strategic investors with a focus on wind energy – **only a few "pure" financial investors**
- Trend: **Utilities include financial investors** as minority investors to reduce their own capital expenditure (e.g. DONG). Interest also expressed by German investors such as Allianz and Munich Re

RISK-RETURN RATIO



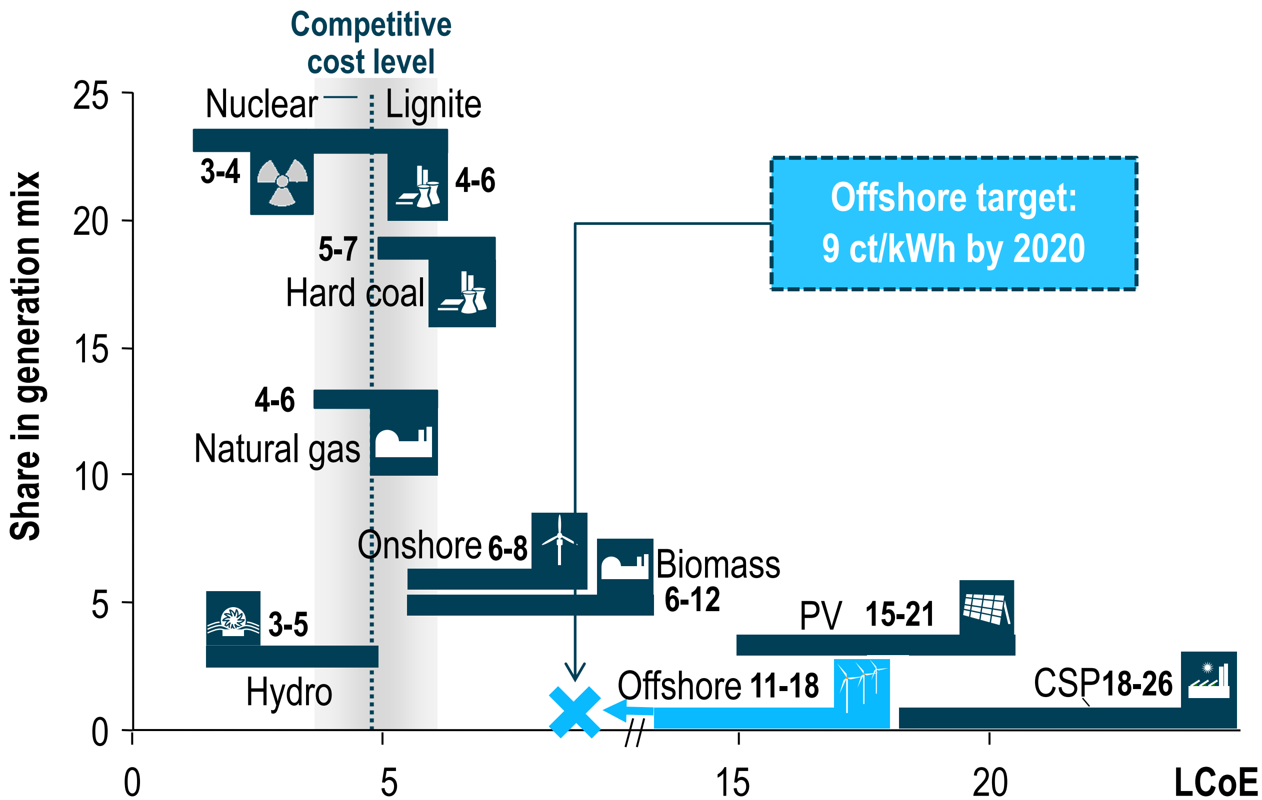
- **Risk-return ratio unfavorable**
  - > Compared to other options, offshore risks are not adequately covered by return potential
- Three actions to **improve attractiveness** of offshore
  - > Reduce risk by raising industry professionalism
  - > Increase profitability by lowering LCoE
  - > Introduce new investment models (e.g. utility & financial investor)

Source: Company websites; Roland Berger

C. Offshore potential to meet LCoE targets

Offshore needs to raise its cost competitiveness to ensure sustainability – Substantial LCoE reduction expected

LCoE 2012 European generation mix [EUR ct/kWh]



Note: Competitive cost level as a non-weighted average of non-renewable energy sources is 4.9 ct/KWh

RECENT STATEMENTS

" A cost reduction of 20-30% in offshore by 2017 is realistic"
(DONG Energy)

" Our LCoE target for all wind energy is 5-9 EUR ct/kWh in the medium term"
(Siemens Wind Power)

" Our target: 40% reduction of offshore CAPEX by 2015"
(E.ON Climate & Renewables)

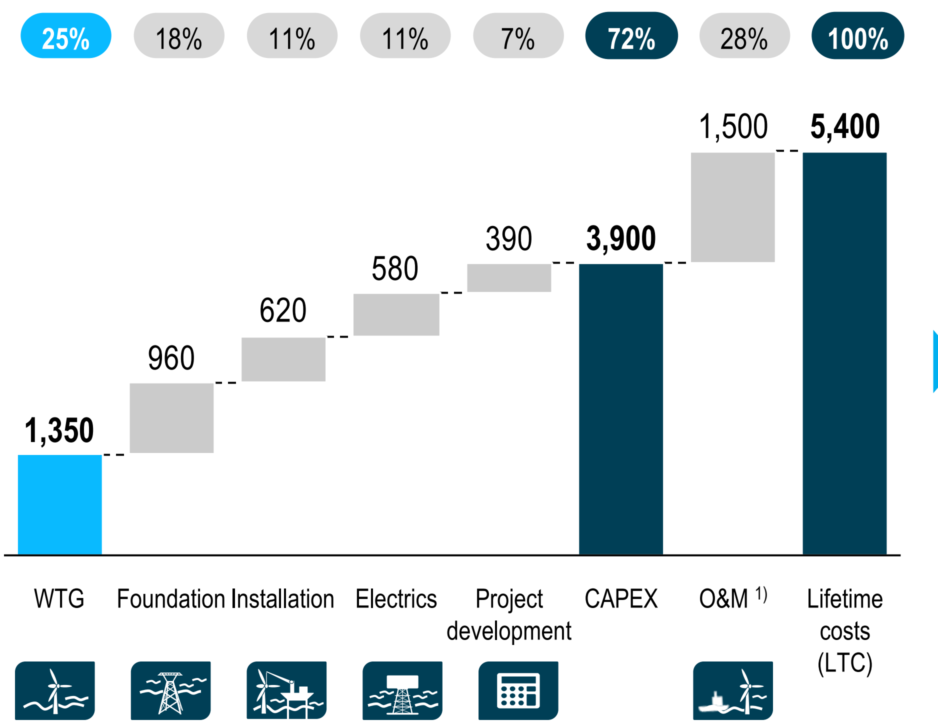
LCoE REDUCTION

Source: Bloomberg New Energy Finance; IEA; Roland Berger

WTG costs are 25% of lifetime costs – Project elements offer further potential to realize a sustainable cost out

Cost & saving potential

COST STRUCTURE ['000 EUR/MW]



SAVING POTENTIAL

- New turbine technology and innovative design options (e.g. 2 blade option, drive train solution, tower concepts)
- Innovative design concepts and use of standards for serial production (e.g. new jacket structures)
- Optimized logistics and new installation concepts (e.g. footprint optimization, new vessel concepts)
- Standards for converter platforms and inclusion of new investors for grid connection (e.g. Anbaric & TenneT)
- Increased control of project and reduction of interface risks (e.g. EPC models/partnership model)
- Innovative O&M concepts and joint use of offshore service stations (e.g. SLAs, asset management strategies)

● High potential for cost reduction ○ Low potential for cost reduction

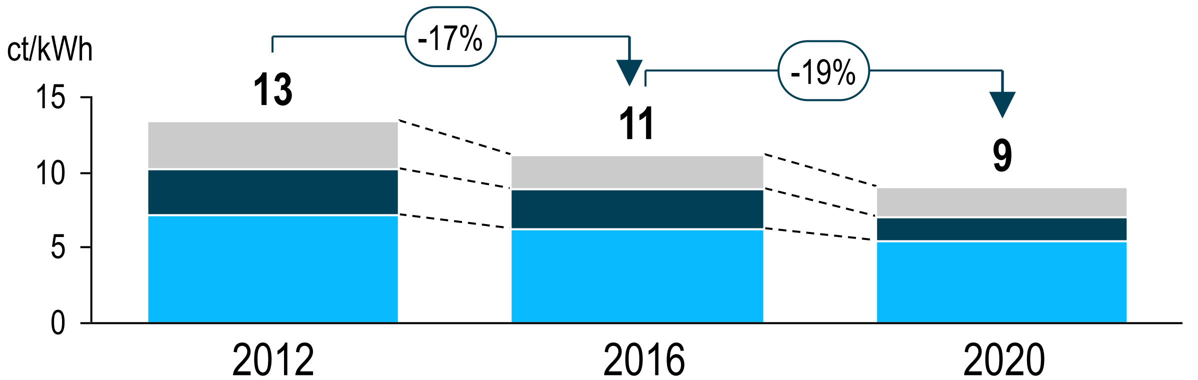
1) Discounted over 20 years

Source: IHS EER; Project Finance; Erneuerbare Energien; Handelsblatt; Roland Berger

LCoE target of 11 ct/kWh is achievable by 2016 and 9 ct/kWh are targeted by 2020

LCoE forecast

LCoE [1] offshore



Prerequisites

	2012	2016	2020
WTG SIZE	Average rated power of newly installed WTG: 3 MW	Average rated power of newly installed WTG: 6 MW	Average rated power of newly installed WTG: 8 MW
FOUNDATION	Currently available foundation types	Initial savings from improved foundation concepts	Serial production effects for selected foundation types
O&M	Limited experience with far-shore O&M	Far-shore experience leads to reduced O&M costs	Mature O&M concepts with minimized cost structures

Project development/other | OPEX: O&M, insurance, management | CAPEX: WTG, foundation, installation, electrics

COMMENTS

> Cost level of 9 ct/kWh should be reached for new additions in 2020

> Offshore will not match the competitive cost levels of conventional energy by 2020

> Offshore is on the pathway to cost competitiveness, but further time-consuming efforts are required

> Political support and a joint industry effort will be essential for offshore to meet the prerequisites and reach the targets

1) Idealized LCoE model calculation for newly installed WTGs on global average

Source: Roland Berger

D. Conclusion

Offshore on the pathway to cost competitiveness

D. Conclusion

Offshore is setting a course toward product and operational excellence – Targets are ambitious

Offshore – Conclusion

MARKET STABILITY

Offshore is a policy-driven market and depends on public support schemes

➡ **Ensure reliability of regulation and stability of political support**

LCoE COMPETITIVENESS

Offshore needs to become independent of public support mechanisms (e.g. Renewable Energy Act) to maintain political support

➡ **Reduce LCoE to 11 ct/kWh by 2016 and 9 ct/kWh by 2020**

TECHNOLOGY

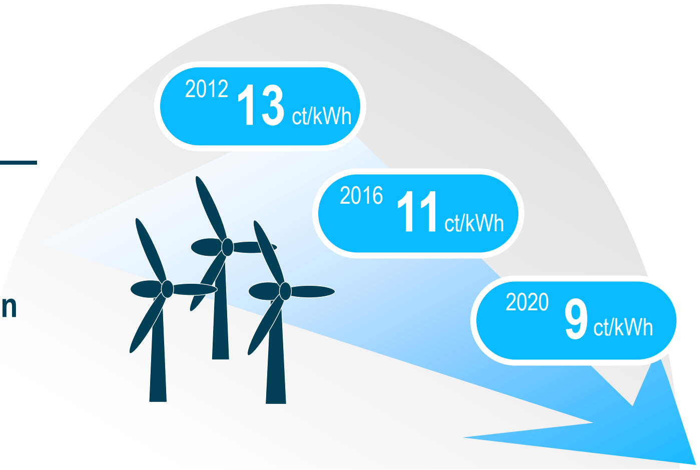
Offshore is still at an early stage and combines technologies from different industries – optimized integration possible

➡ **Maintain Europe's technology leadership and boost innovation**

OEM COMPETITION

New players are entering the market and competition will increase significantly

➡ **Achieve cost competitiveness driven by product excellence**



RISK-RETURN RATIO

Achievable margins do not yet compensate for potential risks

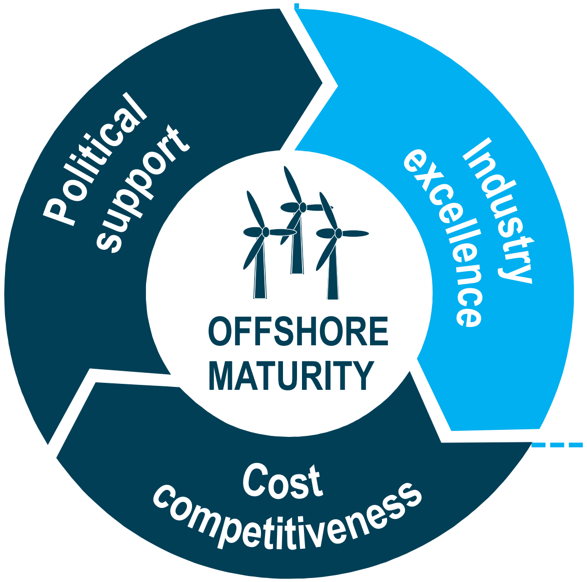
➡ **Improve risk-return ratio and develop new investment models**

Source: Roland Berger

Offshore is on the pathway to cost competitiveness – Joint efforts are required in this young industry sector

Offshore – The journey to maturity

Offshore maturity cycle



Joint efforts to achieve cost competitiveness

Turbine manufacturers
- > Focus on innovation to achieve product excellence
- > Optimize processes to enable a rigorous cost out

Foundation suppliers
- > Explore new technologies and foundation concepts
- > Drive standardization efforts to achieve scale effects

Grid suppliers
- > Develop solutions to guarantee timely grid connection
- > Include new investors on a project basis

Construction companies
- > Reduce interface risks through partnership models
- > Develop EPC models to offer turnkey solutions

Utilities/ operators
- > Increase control over project development
- > Incentivize OEMs and suppliers to drive out costs

Banks/ investors
- > Develop investment models with larger utilities
- > Attract new investor groups to the sector

Source: Roland Berger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It's character that creates impact