CIP
COPENHAGEN INFRASTRUCTURE PARTNERS

Lessons Learnt from Danish Experience

Presentation for meeting

14 June 2019

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Contents






David Taeseung Yoo

- 10+ years in energy & infrastructure

COP DAELIM KETEP

- US, Korea
- Ph.D. in Mechanical Engineering
- Univ. of Pennsylvania

- **Project development in Korea (Floating and Bottom fixed offshore wind power PJTs)**
- **Previously headed team for Jeju Hanlim (100MW) and foreign offshore wind power PJTs**
- **Previously implemented Government South West 2.5 GW offshore wind power program (and rolling plans) and managed offshore wind R&D PJTs**

CIP COPENHAGEN INFRASTRUCTURE PARTNERS	**Founded in 2012**	**By 5 senior offshore wind executives**
Investment Strategy	**Long-term investment**	**Buy & hold**
Partnership Approach		**Active Investor Local partners**
Dedicated Team	• **M&A** • **Asset Management** • **Technical capability**	COP
Fund Size	**€ ~7bn**	**42 investors**

PensionDanmark
Taiwanese life insurance company*
SEB SE
Pension scheme of British local government council*
SEB DK
MN
DIP
Danish family office*
TOWNSEND GROUP (On behalf of a UK pension fund)
Danish investment foundation*
Arbejdernes Landsbank
W&W
Nordea LIV & PENSION
WIDEX
LB FORSIKRING
LÆRERNES pension
Nykredit
Nykredit Alpha
PENSIONSKASSEN Magistre & Psykologer
jøp
Norwegian life insurance*
Taiwanese life insurance company*
Australian fund*
Länsförsäkringar Skåne
PBU
PFA PENSION
Norwegian pension scheme*
PKH Pensjonskassen for helseforetakene i hovedstadsområdet
Zhinfra K/S (Danish family office)
LÆGERNES PENSION
Swiss pension scheme*
German insurance company*
European Investment Bank The EU bank
VILLUM FONDEN
MIRAE ASSET 미래에셋대우
AP Pension
klp
Danish investor*
Taiwanese life insurance company*
MIGDAL
iSP
NNF
German pension scheme*

The most experienced offshore wind senior team worldwide

- More than 230 years of combined energy and M&A experience

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Overview of selected senior level profiles within CIP and COP

Senior management's years of experience in the energy sector

CIP

Extensive technical expertise

Mr. Poulsen	Mr. Smed	Ms. Sørensen	Mr. Hannibal	Mr. Skakkebæk	Mr. Poulsen	Mr. Pahl	Mr. Tordrup	Mr. Skovgaard	Mr. Roin
24Y	14Y	12Y	25Y	17Y	11Y	11Y	11Y	8Y	15Y

***+148** years of combined energy sector experience*

COP

The team has been involved in construction of offshore wind since construction of one of the first offshore wind farms globally, Tunø Knob, in 1995

Mr. Scheinemann	Mr. Thaaning	Mr. Holst	Mr. Møller	Mr. Hjortkjær	Mr. Jørgensen
15Y	12Y	16Y	10Y	10Y	23Y

***+86** years of combined energy sector experience*

Experience from some of the largest offshore wind projects in the world

- The combined experience from CIP and COP within offshore wind is unparalleled

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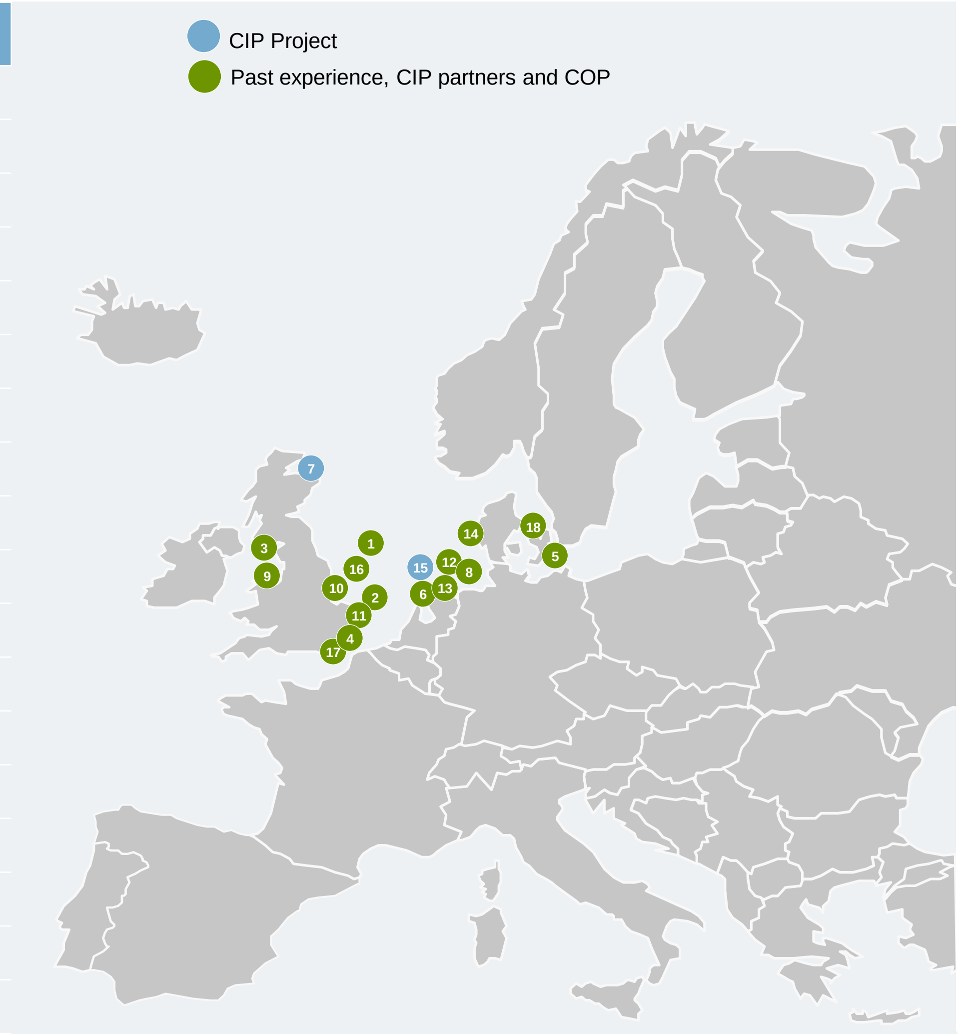
Overview of involvement in construction and operation stage projects[1]

	Wind farm	Country	Capacity (MW)	Current Status	Turbine Supplier
1	Hornsea Project 1	🇬🇧	1,218	Under construction	Siemens
2	East Anglia 1	🇬🇧	714	Pre-construction	Siemens
3	Walney Extension	🇬🇧	659	Under construction	Siemens/Vestas
4	London Array	🇬🇧	630	Fully commissioned	Siemens
5	Kriegers Flak	🇩🇰	605	Under construction	Siemens
6	Gemini	🇳🇱	600	Fully commissioned	Siemens
7	Beatrice	🇬🇧	588	Under construction	Siemens
8	Gode Wind 1 & 2	🇩🇪	582	Fully commissioned	Siemens
9	Gwynt y Môr	🇬🇧	576	Fully commissioned	Siemens
10	Race Bank	🇬🇧	573	Fully commissioned	Siemens
11	Greater Gabbard	🇬🇧	504	Fully commissioned	Siemens
12	Hohe See	🇩🇪	497	Pre-construction	Siemens
13	Borkum Riffgrund 2	🇩🇪	450	Under construction	Vestas
14	Horns Rev 3	🇩🇰	407	Under construction	Vestas
15	Veja Mate	🇩🇪	402	Fully commissioned	Siemens
16	Dudgeon	🇬🇧	402	Fully commissioned	Siemens
17	Rampion	🇬🇧	400	Under construction	Vestas
18	Anholt	🇩🇰	400	Fully commissioned	Siemens



Notes: 1) Very early stage development projects are not included
Source: 4C Offshore

CIP has a large and diversified portfolio of energy infrastructure assets

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CIP's investment portfolio

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Offshore wind

- The CIP offshore wind portfolio currently consists of 10 operational, under construction and development projects in US, Canada, Germany, UK, Taiwan and Australia
- Total operational/under construction capacity of **~1GW**
- Under development offshore wind capacity of ~**4GW**

Onshore wind

- The CIP onshore wind portfolio consists of 12 operational, under construction and under development projects in UK and US
- Total operational/under construction capacity of ~**1GW**
- Under development onshore wind projects of ~**2GW**

Solar PV

- The CIP solar PV portfolio currently consists of 9 under construction and under development projects in the US and Spain
- Total under construction capacity of **0.3GWac**
- Total under development capacity of **1.7GWac**

Thermal

- The CIP thermal portfolio consists of 8 operational, under construction and under development projects in the UK and Germany
- Total operational, under construction and under development capacity of **~1GW** thermal projects

Other

- Other CIP investments include offshore wind transmission assets in Germany
- Total transmission capacity of **~1GW**

CIP is an experienced infrastructure fund with combined total assets under management of EUR ~6.8bn

Note 1: CHP = Combined Heat and Power
Note 2: Fund raising still ongoing in the CI III fund
Note 3: Including projects under development

CIP is active within offshore wind globally

- CIP is looking to leverage offshore wind competences globally

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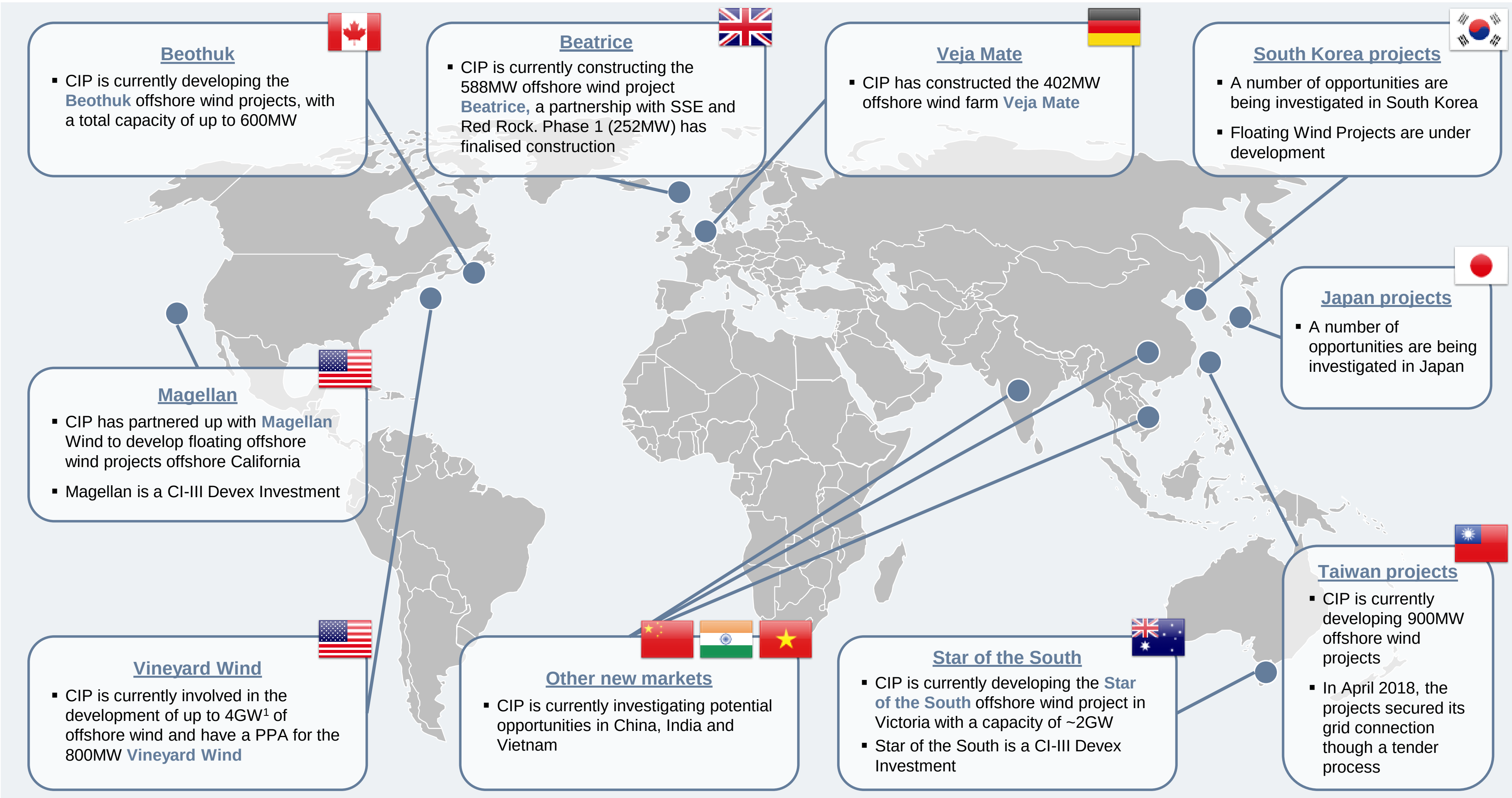
World map of current CIP offshore wind activities



Beothuk

- CIP is currently developing the **Beothuk** offshore wind projects, with a total capacity of up to 600MW

Beatrice

- CIP is currently constructing the 588MW offshore wind project **Beatrice,** a partnership with SSE and Red Rock. Phase 1 (252MW) has finalised construction

Veja Mate

- CIP has constructed the 402MW offshore wind farm **Veja Mate**

South Korea projects

- A number of opportunities are being investigated in South Korea
- Floating Wind Projects are under development

Japan projects

- A number of opportunities are being investigated in Japan

Magellan

- CIP has partnered up with **Magellan** Wind to develop floating offshore wind projects offshore California
- Magellan is a CI-III Devex Investment

Vineyard Wind

- CIP is currently involved in the development of up to 4GW[1] of offshore wind and have a PPA for the 800MW **Vineyard Wind**

Other new markets

- CIP is currently investigating potential opportunities in China, India and Vietnam

Star of the South

- CIP is currently developing the **Star of the South** offshore wind project in Victoria with a capacity of ~2GW
- Star of the South is a CI-III Devex Investment

Taiwan projects

- CIP is currently developing 900MW offshore wind projects
- In April 2018, the projects secured its grid connection though a tender process

Note 1: Including Vineyard wind (800MW), Rest of Zone (up to ~1.6GW) and a new lease area in MA with a potential capacity up to ~2GW

World energy demand is growing and so is the share of renewables

- Politicians around the globe set increasingly ambitious climate goals to reduce carbon footprint

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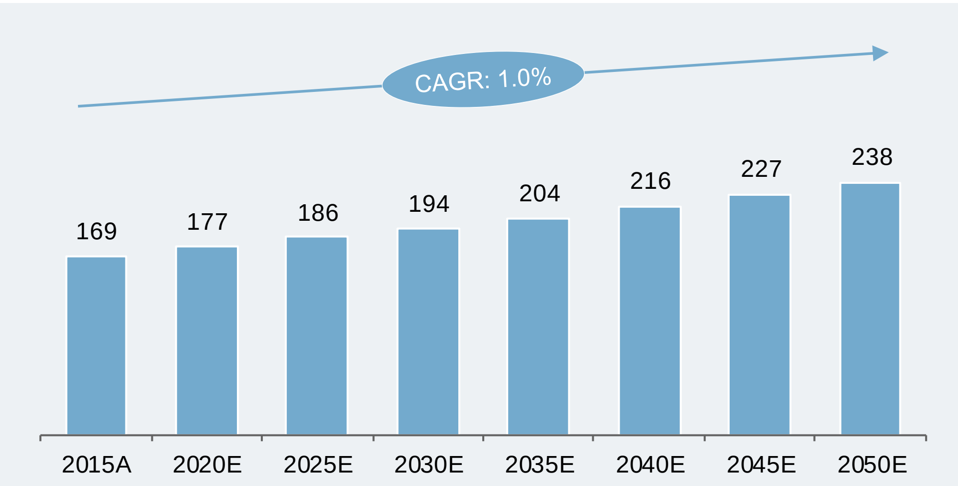
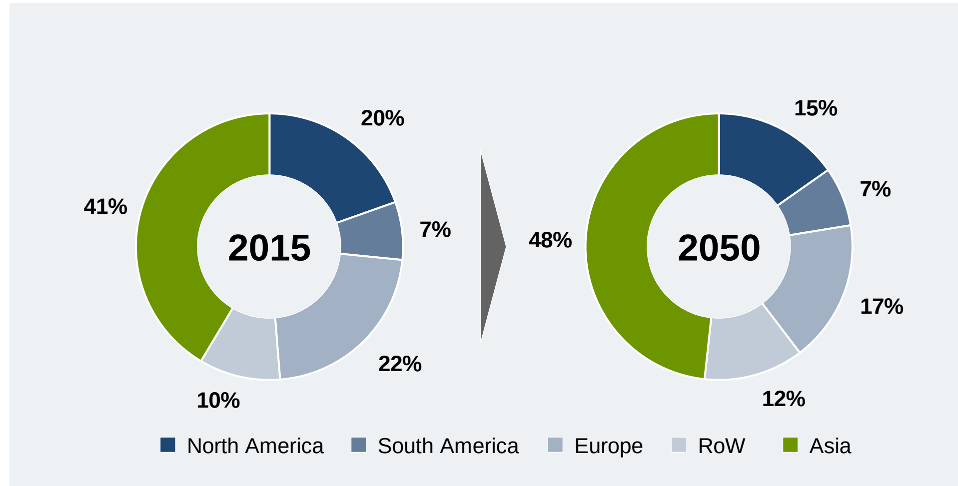
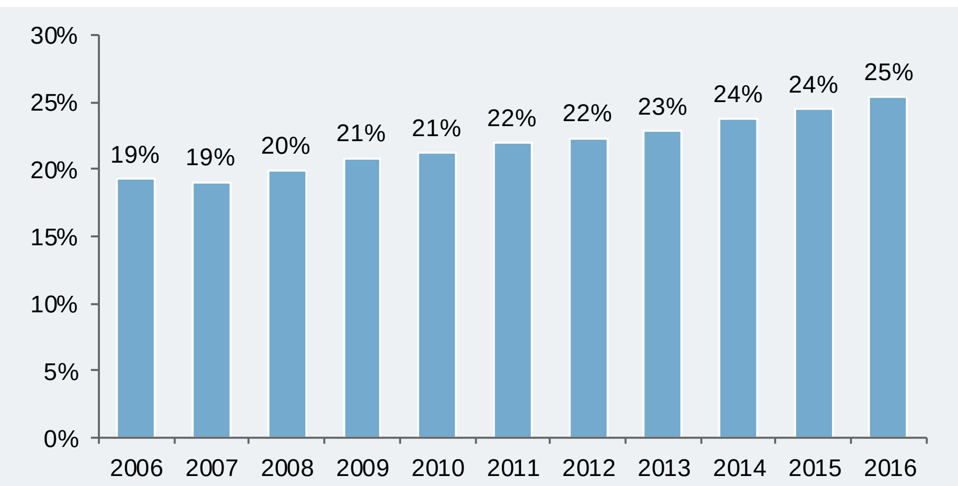
World primary energy consumption (PWh[1])



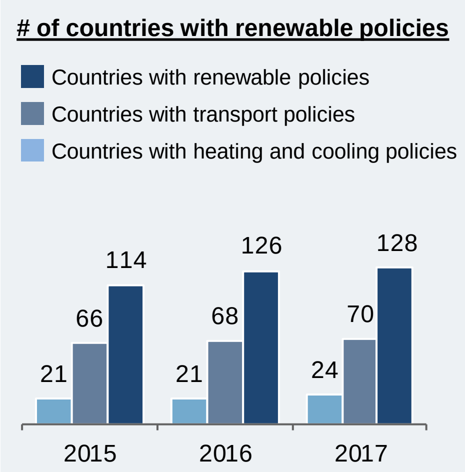
Percentage of world primary energy consumption (%)



Global renewable electricity generation as share of total generation (%)



Political incentives for renewable energy



Selected political targets

In 2017, the Korean government announced an energy transformation plan with an official target to reach 20% renewable energy generation by 2030

China's most recent Five-Year Plan sets an overall goal of increasing renewable capacity to 680 GW by 2020, making up 27% of total power generation

Notes: 1) Petrawatt-hour = 1,000 TWh

Source: The U.S. Energy Information Administration, REN21, Bloomberg New Energy Finance

Offshore wind capacity is expected to continue growth trajectory

- Asia is expected to account for an increasing share of installed offshore wind capacity in the future

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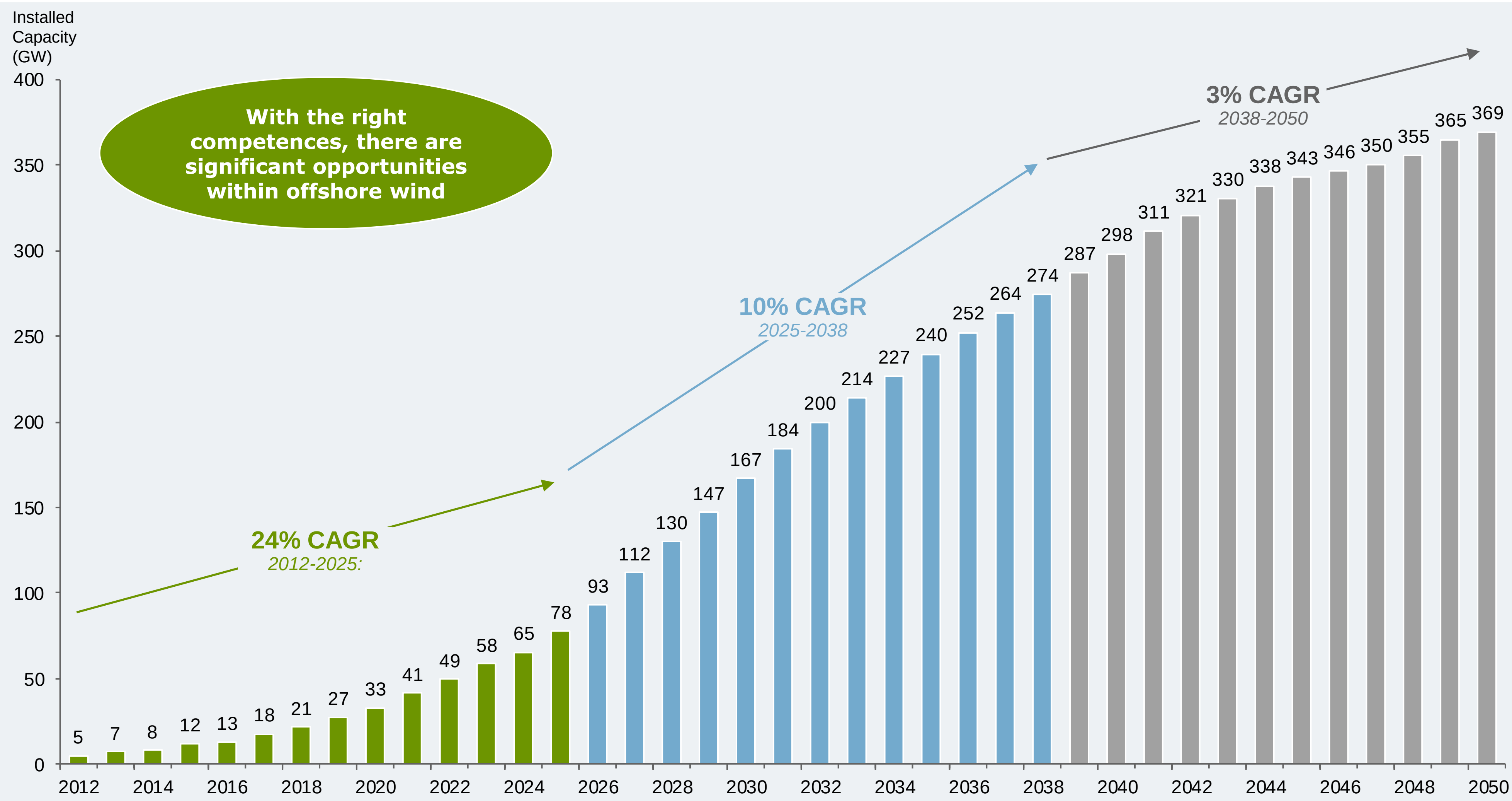
Expected development in offshore wind capacity towards 2030 (GW)



Source: "New Energy Outlook 2018", Bloomberg New Energy Finance

Several Asian markets are expected to be key growth markets

- Offshore wind markets in Korea, Japan, India and China are expected to grow at the highest pace

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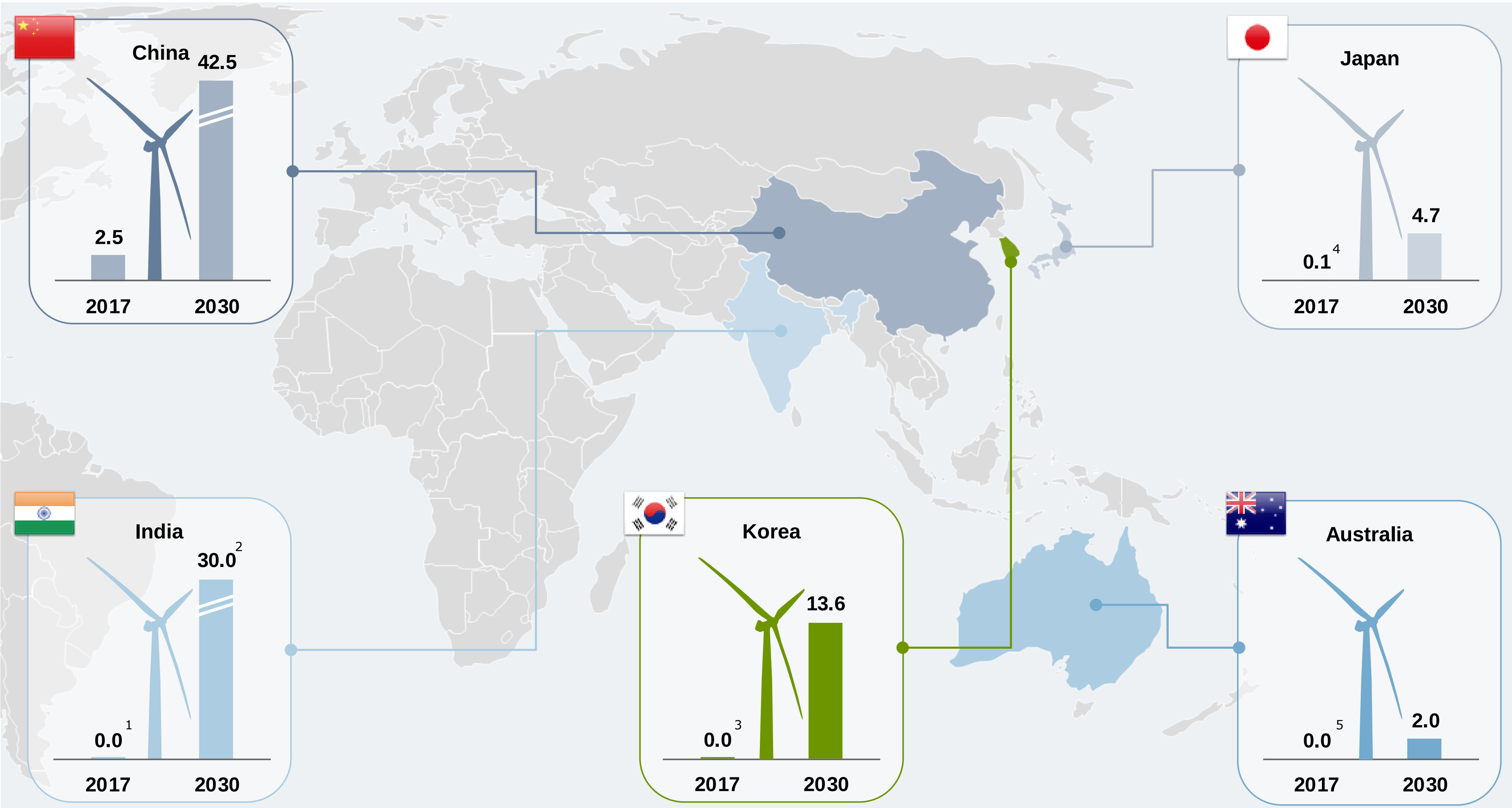
Development in installed offshore wind capacity in key growth markets (GW)



Notes: 1) 24MW (Arichamunai); 2) Official target as of June 2018; 3) 38MW (Tamra, Gunsan Demonstration, Jeju Demonstration); 4) 65MW (Kamisu and Sakata Port (40MW) and 8 demonstrations (25MW); 5) 0MW
Source: "New Energy Outlook 2018", Bloomberg New Energy Finance, MAKE Consulting

Offshore wind power project does include challenges and risks

- Ability to mitigate risks effectively through risk management system is crucial

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Examples of offshore wind disaster stories in Europe

Grouting issues

RENEWABLE ENERGY MAGAZINE
wind
Grouting still a major issue for offshore wind
Wednesday, 04 January 2012

WIND ENERGY update
Monopile worries mount: Grouted joint doubts linger
Apr 10, 2012

WTG development and technology

RENEWABLE TECHNOLOGY
Horns Rev reveals the real hazards of offshore wind
1 October 2004

WINDPOWER OFFSHORE
Borkum Riffgrund 1 turbine installation delayed
20 August 2014 by David Weston, Be the first to comment

Substation and transformer issues

WINDPOWER
Horns Rev I offshore wind farm is shut down
3 June 2010 by James Quilter

WINDPOWER
Major Transformer Failure at Nysted, Denmark
Windpower Monthly - Torgny Moller - July 1, 2007

Installation vessels

BBC
Windfarm cranes sink in Atlantic

Health and safety

WINDPOWER
Diver killed on Riffgat offshore wind farm

Grid connection

SUN&WIND ENERGY
Riffgat: Inauguration without grid connection

Examples of potential new challenges in Asia

Natural disaster

THE STRAITS TIMES
Taiwan hit by second storm after Typhoon Nesat injures 111

CNN
China evacuates millions after Typhoon Mangkhut leaves Hong Kong in tatters

BBC
Deadly earthquake hits Japan

THE TIMES
Huge earthquake hits South Asia

Significant experience mitigating risk in relation to development and construction of offshore wind is a must.

A well-established and tested framework for handling risks, which can effectively be applied to offshore wind projects in new markets regardless that the risks there are of a different nature

Multiple examples of offshore wind disasters in Europe

- Developers who have failed to handle risks appropriate have suffered extensive financial losses

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Greater Gabbard

Disaster: **Cracking discovered on some of the 140 monopile foundations**

Illustration:

Details:

- 504MW UK offshore wind project
- **Server quality issues with the monopile foundations (cracking)**
- The issue was largely a result of various failures by the inexperienced foundation supplier
- Issues could potentially have been detected through quality control and inspections by the developer during fabrication
- Led to lawsuit and **claim against the supplier of ~GBP 250m**
- The project owner eventually won the lawsuit after several years of legal battle with the supplier

Bard offshore

Disaster: **Series of outages resulting from transmission problems**

Illustration:

Details:

- 400MW offshore wind project in the German North Sea
- **Construction heavily delayed** due to several setbacks such as (1) overvoltage and harmonics between BARD and its respective grid links, (2) a fire at a transmission station and (3) a fatal accident leading to the passing of a diver and a construction worker
- **BARD (the developer) went bankrupt** in November 2013 and as of January 2015, most of the turbines were still not operating

Robin Rigg

Disaster: **Monopile supply design issue**

Illustration:

Details:

- 174MW offshore wind project in the UK
- Shortly after completion of the wind farm, **grouted connections incorporated within the foundation structures failed**
- Led to lawsuit and claim regarding **necessary remedial works of EUR 26m**
- After years of legal process, the Danish Supreme Court determined that the supplier, MT Højgaard, was liable for the issue as the design of the foundations was not fit for purpose

Trianel

Disaster: **2 years delay of grid connection**

Illustration:

Details:

- 200MW offshore wind project in the German North Sea
- The project is owned by Trianel, EWE and Fontavis
- Commissioning of the wind farm was **delayed close to 2 years** due to problems with grid connection
- After 3 years of law suit, projects owners' **EUR 144m claim againt transmission company TenneT was rejected**

Source: Wind Power Offshore

Excellent construction execution must be secured

- Several German offshore wind farms have encountered quality and technology issues

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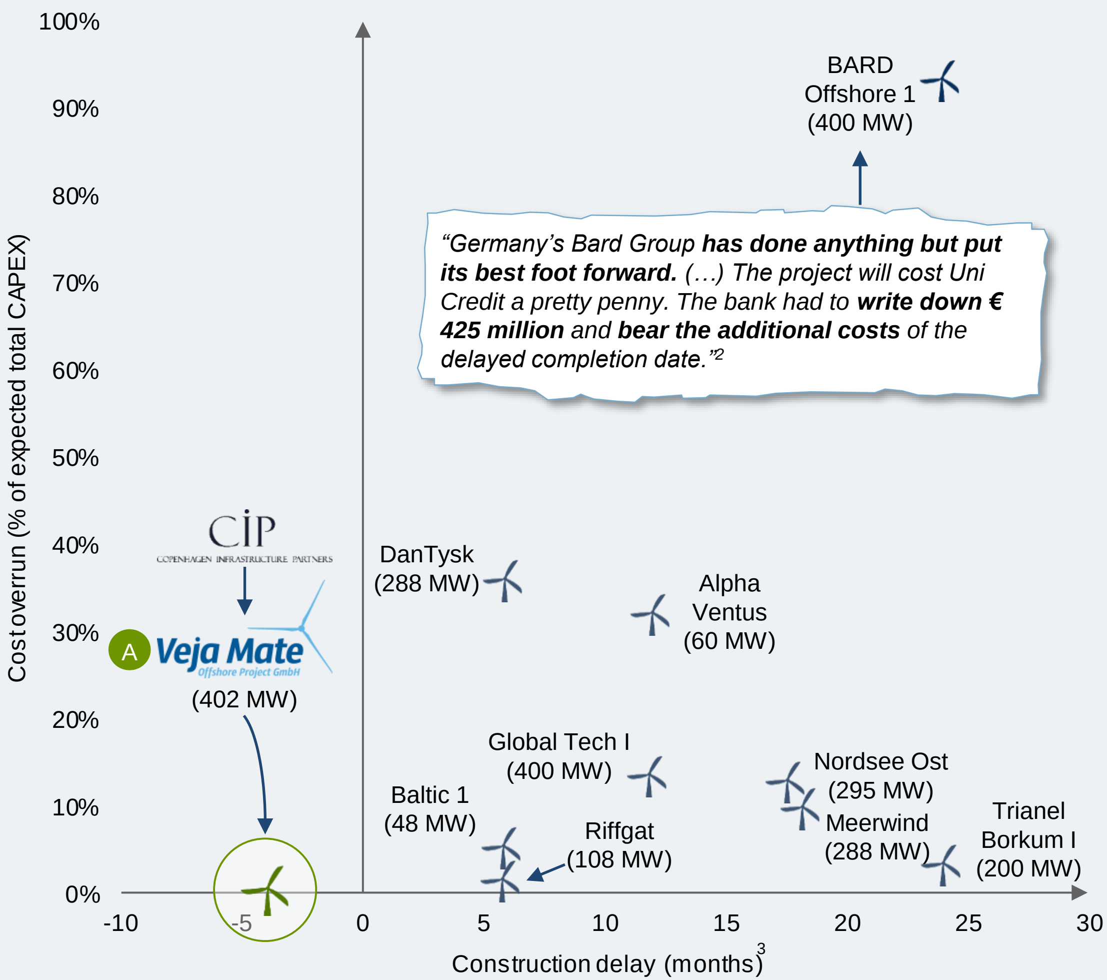
Several German projects have experienced challenges during construction[1]…



"Germany's Bard Group ***has done anything but put its best foot forward.*** *(…) The project will cost Uni Credit a pretty penny. The bank had to* ***write down € 425 million*** *and* ***bear the additional costs*** *of the delayed completion date."[2]*

… however, execution of Veja Mate was highly successful

A

Fully operational large scale offshore wind farm

- 4 months ahead of schedule
- On budget delivery of asset
- High-quality asset

"Veja Mate's technology selections present ***no material risks****, having been subject to* ***extensive design development, testing and certification.*** *K2 sees no reason why Veja Mate should not be capable of ongoing* ***safe and reliable operation for up to a total lifespan of 30 years.****"*

Statement from technical advisor

"Veja Mate is ***only offshore wind project that has not had a single insurance claim*** *following successful construction"*

Statement from Codan

Notes: 1) According to two studies; "Large infrastructure projects in Germany" (Hertie School of Governance, May 2015), "Cost performance and risk in the construction of offshore and onshore wind farms" (Wind Energy, November 2016); 2) www.sunwindenergy.com; 3) From date when all WTGs are installed, connected to the grid and producing electricity

An integrated development, construction and operations approach is key for delivering most profitable wind farms

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Critical decisions across whole asset lifecycle needs to be considered already in the development-phase

	Development	*Financial Close*	Construction	*Operations handover*	Operations	*End of Life Decision*	Decommissioning
Critical decisions required during Development phase	▪ Transaction structure and securing financing ▪ Foundation technology ▪ Soil conditions ▪ Wind resource ▪ Site-optimal wind turbine ▪ Site layout & transmission system (layout) ▪ Time plan & activity planning ▪ Permitting ▪ Stakeholder management ▪ …		▪ Construction Harbour ▪ Weather risks during installation ▪ Contract and claim management ▪ Installation vessels ▪ Organisation ▪ CAPEX ▪ Supplier Selection & follow-up ▪ …		▪ Long-term performance ▪ Jack-up vessel and strategic spare parts ▪ Project-specific organisation capability built-up ▪ OPEX & AEP (Annual Energy Production) ▪ Asset Integrity and warranty utilisation ▪ …		▪ Optimal asset lifetime ▪ Decommissioning strategy ▪ Repowering options ▪ …
IRR-range @ Risk *(Well-developed vs. poor-developed project)*	**Biggest Risk**		**Risk**		**Risk**		

Foundation technology & supply

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Foundation technologies available & soil condition suitability

Upper soil[1] / Lower soil[1]	Weak soil / Weak soil	Weak soil / Strong soil	Strong soil / Strong soil	Strong soil / Very strong	Very strong soil / Very strong soil
Typical encountered soil	TAIWAN		EUROPE US2)	ATLANTIC CANADA	
 **Monopile**	✓	✓	(✓)		
 **Piled jacket**	✓	✓	(✓)		
 **Gravity-based**			✓	✓	✓
 **Suction bucket**		(✓)	(✓)	(✓)	

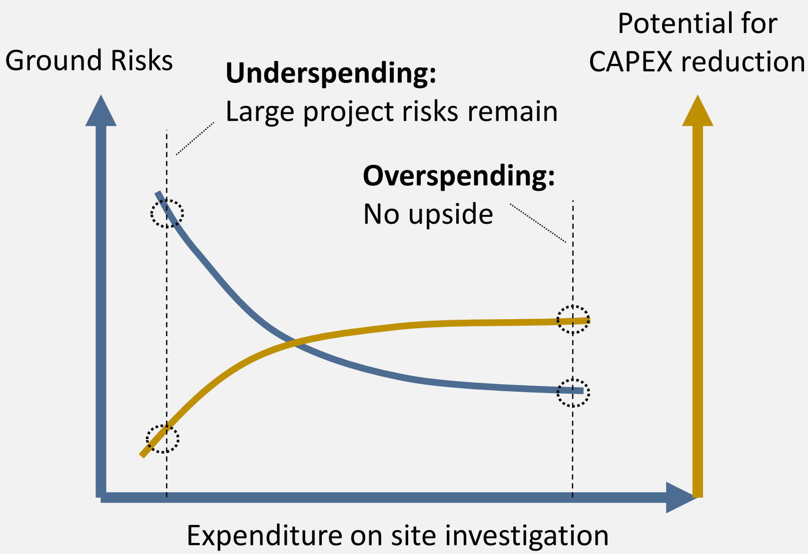
Applying optimised solution is key

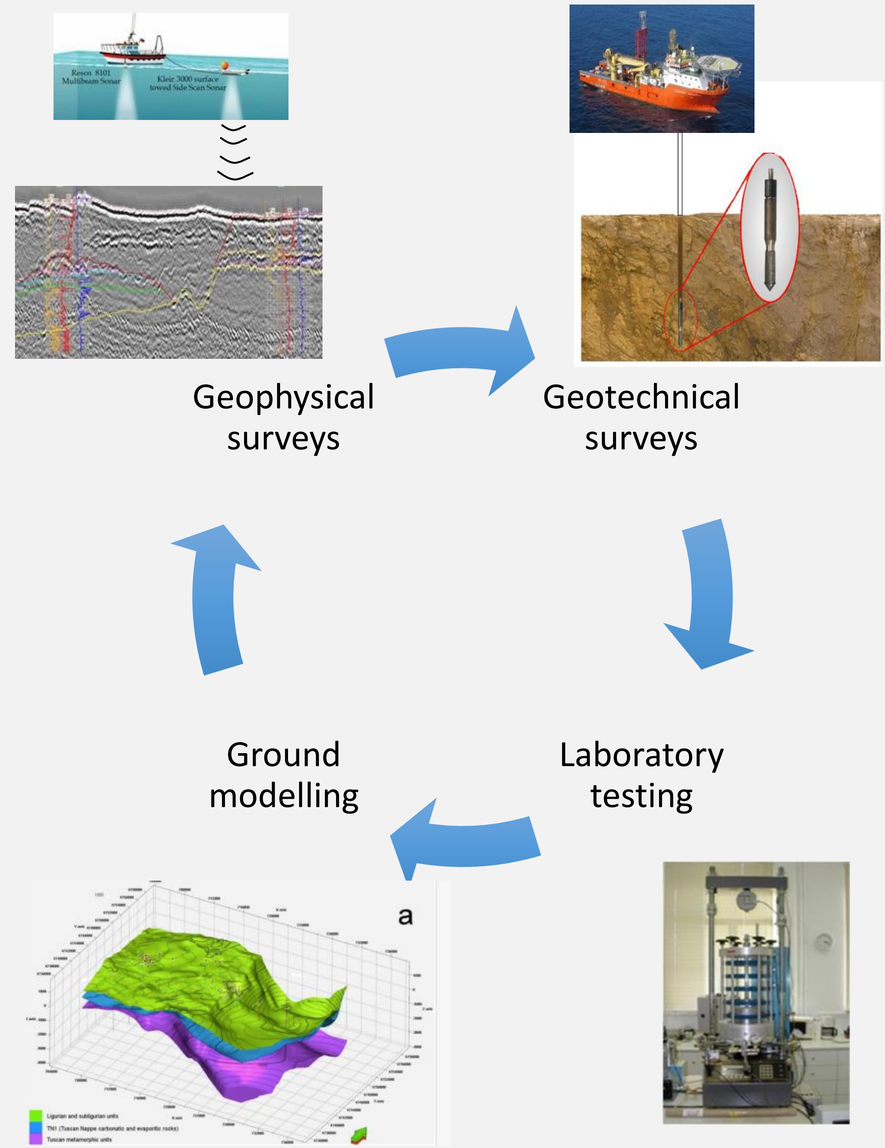
- Identifying and designing a site-suitable foundation is **among the most complex activities** for an offshore wind farm
- Thorough ground condition assessment (Geotechnical and Geophysical surveys) are critical
- CAPEX: There can be around EUR 3-5m per foundation in difference between a monopile- and a jacket-solution
- For a 400MW, this can imply **300-500EURm at risk** if choosing a sub-optimal solution

Notes: 1) WEAK SOIL: Weak clay/silt which provide very limited capacity to support structures. STRONG SOIL: Good strength clay/sand which provide good support for structures and allows for pile driving. VERY STRONG SOIL: Rock which provide good support for structures but does not allow for pile driving; 2) Massachusetts, US; 3) Assuming 100 x x4MW wind turbines

Ground investigations and modelling

Identification and mitigation of ground risks are of vital importance for offshore wind farm developments.



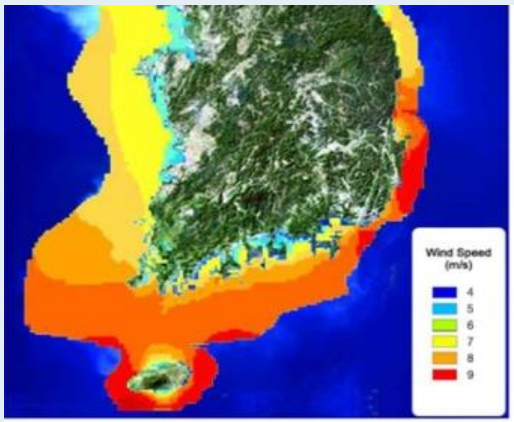


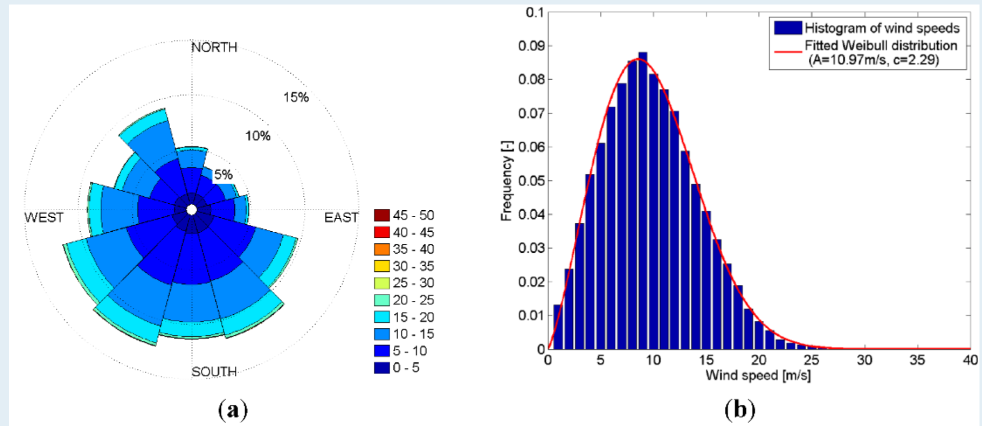
Improper Climatic Conditions Assessment can trigger wrong wind turbine or site layout decisions and reduce revenue by a lot

Wind, wave, temperature and pressure is pivotal when assessing turbine suitability and power generation potential

Normal Wind Conditions

- 'Normal wind conditions' is **main value driver** for a wind farm and requires high certainty when choosing wind turbines, getting project finance and taking investment decision

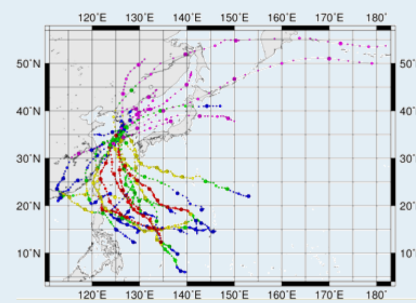




(a) (b)

Extreme Wind Conditions

- Extreme wind speeds is a main parameter when identifying optimal wind turbine (IEC-class).
- According to Korean Building Law and recently published studies, the basic design wind speed (with a 100 year return period) is in the range of 30-35 m/s.
- Converting this into a 50-year return period and at the desired hub height yields **basic design wind speed**.
- Typhoon occurrences should be considered in selecting wind turbine.



Most severe typhoons near project area in the last 30 years

Identifying the site-optimal wind turbine

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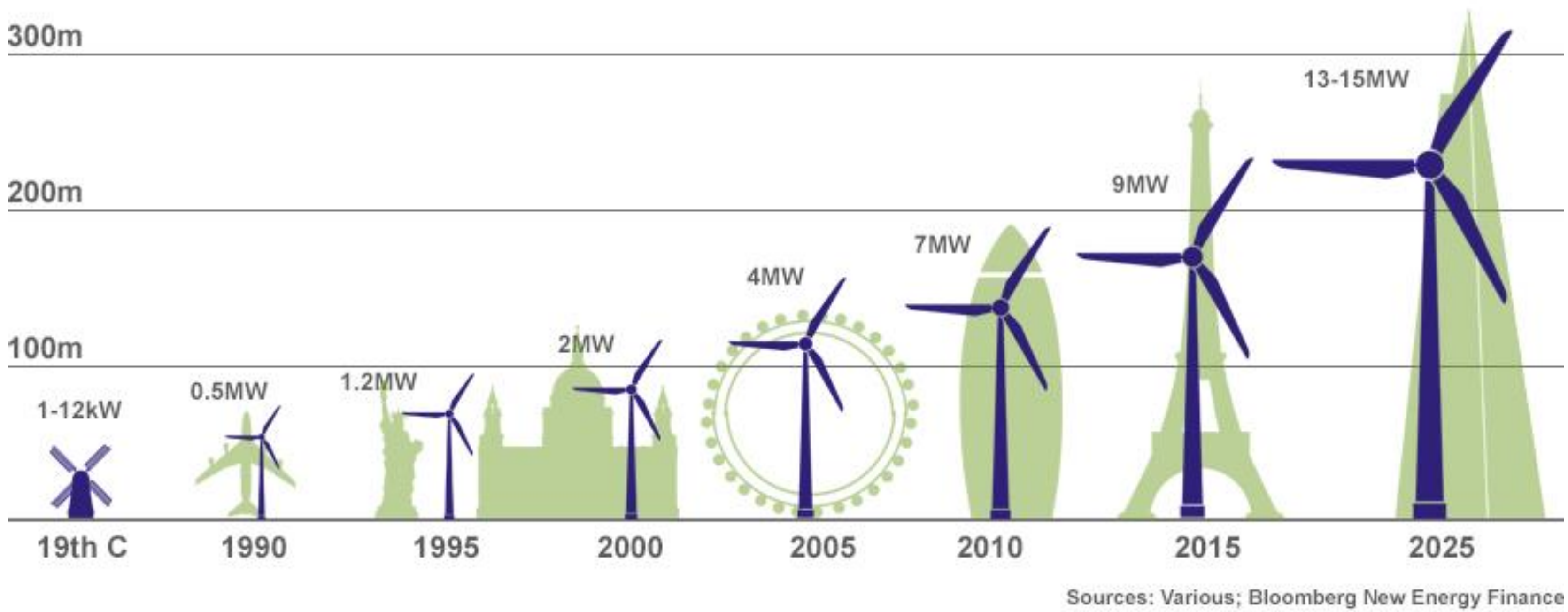
Identifying the site-optimal wind turbine has significant value impact

- Identifying the optimal wind turbine not only drives revenue, but also CAPEX (no. positions to be installed).
- **Significant revenue at risk** if choosing the sub-optimal wind turbine
- The Site Condition Assessment and the CAPEX per installed position is the main drivers in identifying the IRR-optimal wind turbine
- Due to typhoon extreme wind, a suitable **IEC class WTG for wind farm in Korea needs to be carefully identified.**



Notes: 1) IEC 61400

Cable route and transmission solution critical to optimise

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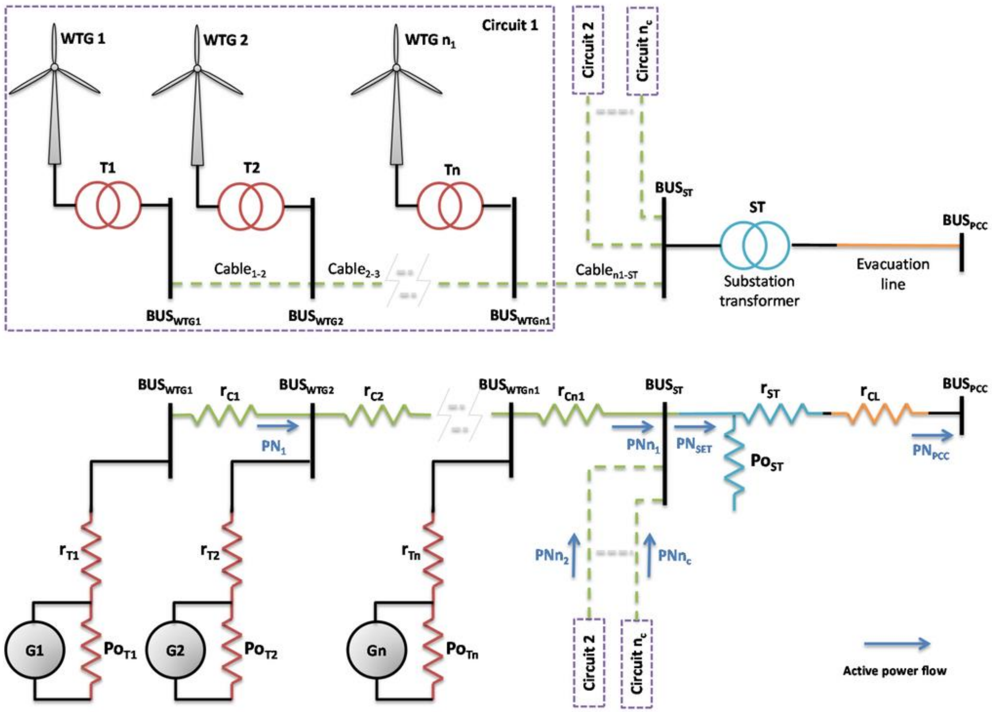
Design and optimization of electrical design

- Conceptual design and grid connection
- Optimization of concepts
- Development of suppliers and market
- In-house engineered



- With or without offshore substation

Establishing a business case suited for investment decisions and project finance

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Examples of key risks and opportunities to be realised during development (project IRR impact for 400mw project)

Choosing correct foundation technology	*Overengineered and expensive solution that require expensive installation vessels and equipment*
Optimising the site layout	*Identify the IRR-optimal site layout (optimised production, cable- & foundation CAPEX) based on wind, adjacent projects and shore line.*
Optimised foundation design	*Best-in-class foundation design with balanced contingency and design-to-fabricate mindset*
Site-optimal wind turbine	*Avoid choosing too conservative IEC-class wind turbine*
Choosing optimal transmission system	*Optimal inter-array and export cable-voltage and utilisation, combined with smart cable-routing and substation-strategy*
Negotiating market leading prices in supplier agreements	*Utilize industry experience to know pricing-levels and key value drivers*
Preparing a streamlined and lean time plan	*Avoid long and inefficient execution time with high running costs*
Managing local stakeholders	*Long-term business relations to be established with local government, fishermen, supply chain & NGOs to facilitate smooth cooperation*
IRR-range @ Risk	(Well-developed vs. poor-developed project)

Choice of EPC contracting strategy extremely important

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	EPC / Turnkey	Hybrid	Multi-contracting
Number of Contracts	▪ 1-3	▪ 4-8	▪ 8+
Price	▪ Relatively high	▪ Medium	▪ Relatively low
Risk Exposure	▪ Low, but with contractual caps (if contract has been sufficiently well-prepared and negotiated)	▪ Medium	▪ High
Control	▪ Low/indirect	▪ High	▪ High/direct
Conclusion	▪ Project financing is theoretically easier, as risk exposure is lower - if EPCI Contractor is experienced ▪ Employer may suffer lower transparency and influence into project deviations ▪ May be preferred by less experienced employer	▪ Proven contractual setup, allowing both project financing and high project control, while keeping the project team relatively small ▪ Smaller contract scopes enables local content	▪ High complexity in interfaces and risk exposure ▪ High returns if successful ▪ Experienced employer with large organization required

Summary/Suggestions

- **Plan early and thoroughly**
- **Develop right**
- **Build market first**
- **No need to invent wheel again**

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