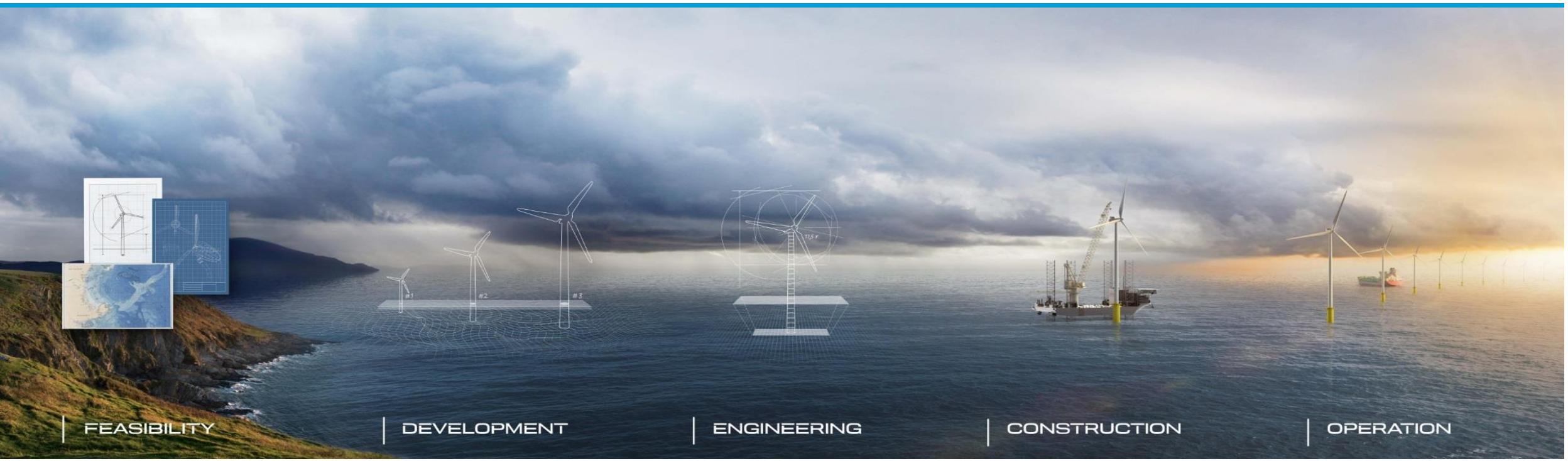
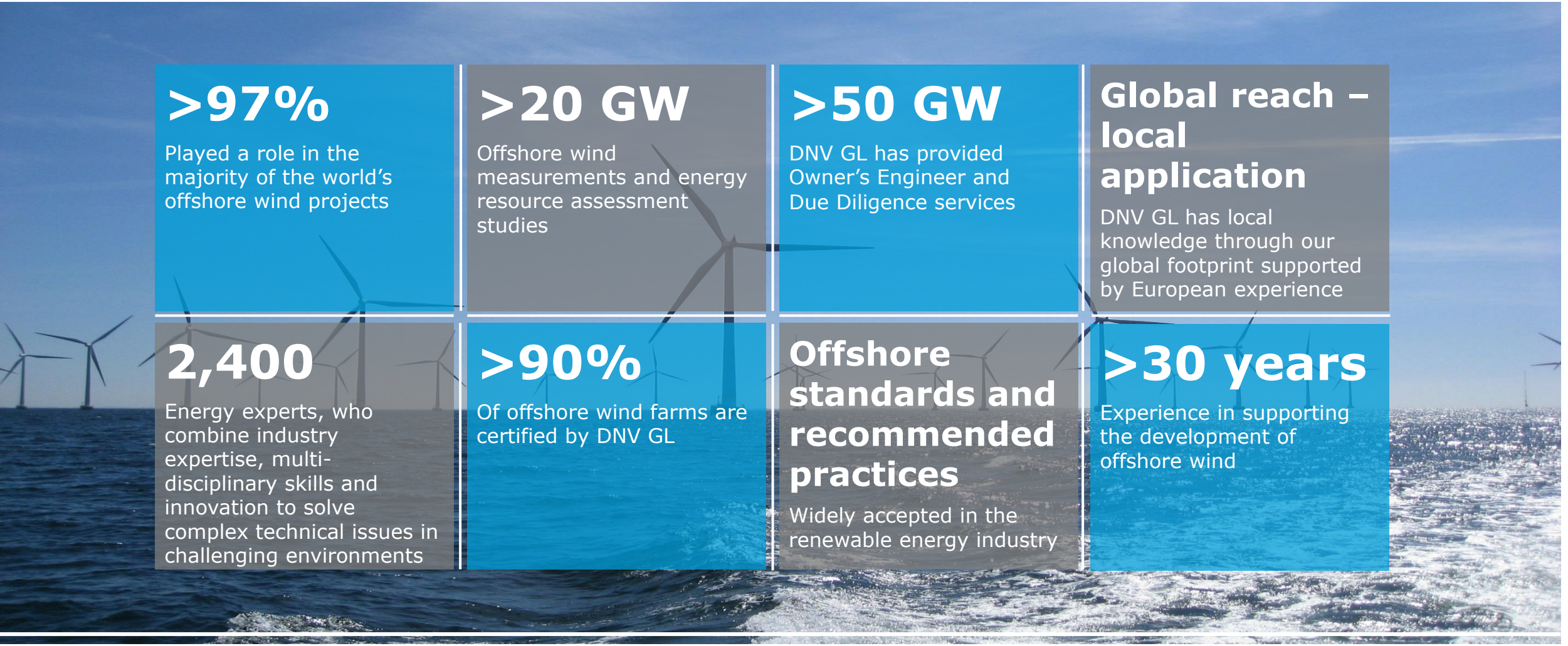


Presentation of DNV GL at Vietnam Wind Power 2019 – Offshore wind day

How to Develop a Robust Offshore Sector: Policies and Planning Needs, Infrastructure Needs and What are the Right Policies to Make sure it Happens? Nine steps to take !

11th June 2019, Hanoi, Vietnam

Value proposition: DNV GL has extensive global footprint in offshore wind



>97%

Played a role in the majority of the world's offshore wind projects

>20 GW

Offshore wind measurements and energy resource assessment studies

>50 GW

DNV GL has provided Owner's Engineer and Due Diligence services

Global reach – local application

DNV GL has local knowledge through our global footprint supported by European experience

2,400

Energy experts, who combine industry expertise, multi-disciplinary skills and innovation to solve complex technical issues in challenging environments

>90%

Of offshore wind farms are certified by DNV GL

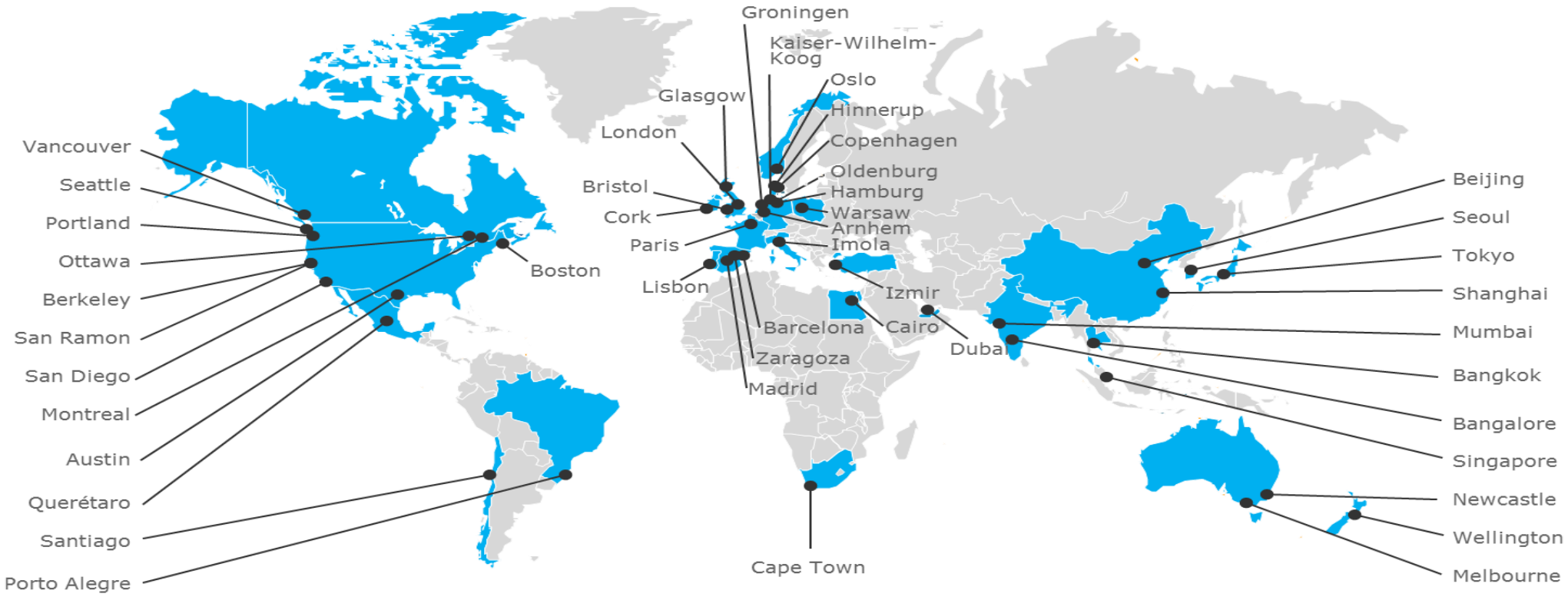
Offshore standards and recommended practices

Widely accepted in the renewable energy industry

>30 years

Experience in supporting the development of offshore wind

Value proposition: DNV GL has broad - Global-Local Reach & Scale



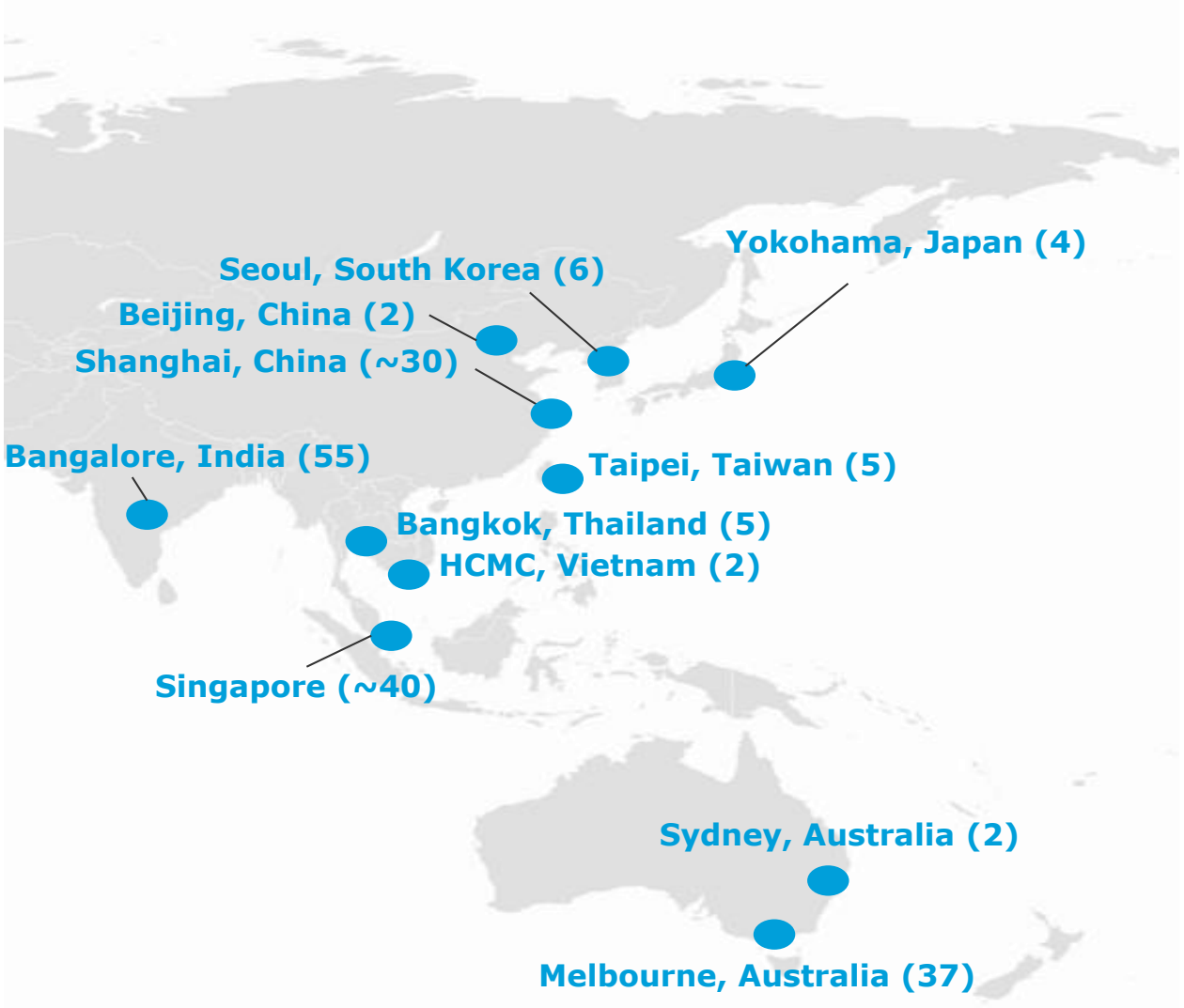
150+ years

350 offices

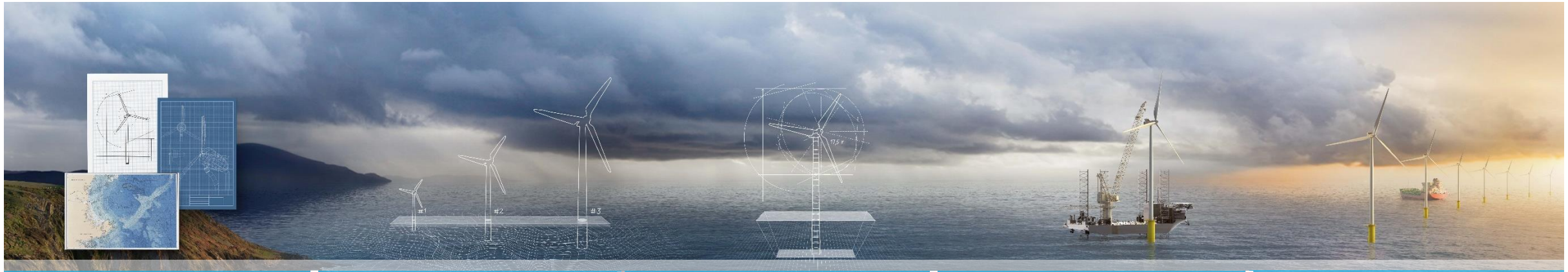
100+ countries

12500 employees

Zooming in on DNV GL Energy in APAC: 185 professionals across 11 offices



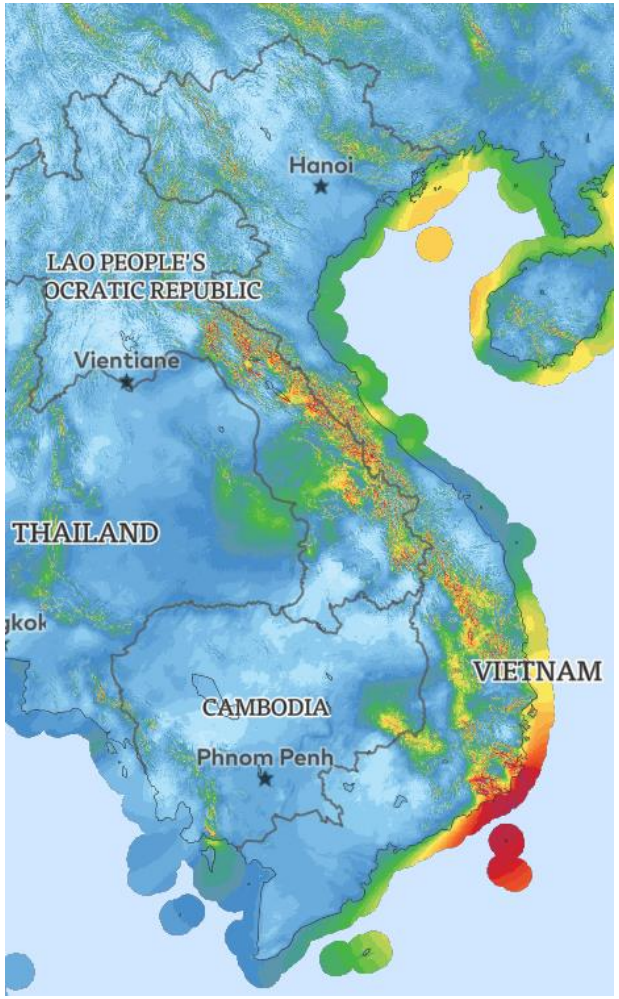
Broad and deep expertise across the entire offshore wind value chain



FEASIBILITY	DEVELOPMENT	ENGINEERING	CONSTRUCTION	OPERATION
Site & concept selection	Project optimisation	Tender support	Construction monitoring	Operations & maintenance
Technology evaluation			Technical due diligence	
Wind mapping	Measurements	Energy assessment	Operational assessment	
Market intelligence		Cost modelling	Market forecasts	
Digitalisation, Software & training				
Project management			Marine warranty	Inspections
Technology certification			Project certification	
Installation vessel classification			Operation & maintenance vessel classification	

Where are we in offshore wind in Vietnam ?

Opportunity in Vietnam – lots of potential and interest- but …..



Source: Global Wind Atlas

Implementing the Vietnam offshore wind power project

08:48 |19/12/2017

VIETNAM ENERGY - In Vung Tau city has been held the signing ceremony on comprehensive cooperation between the Singapore Enterprize Energy & RE Global Solution and the associate of PetroVietnam Construction Joint (VSP) to develop an offshore wind power projec from Binh Thuan sea coast and has a capacity billion. The investment of the project will be dive and 600 MW

The associate cooperation t tranformer sta of the project.

The sides ha finance. const

Doosan 'goes offshore in Vietnam'

Koreans to work with state-owned utility on wind project, says local media

MHI Vestas and DNV GL Enter Vietnamese Offshore Wind Alliance

MHI Vestas Offshore Wind and DNV GL have formed an alliance with Singapore- artners to develop scale wind projects etnam.

MEM to oversee development of Vietnamese wind farm

By Michelle Froese | October 23, 2017

Modern Energy Management (MEM), a specialist in delivering pr developers, financiers, and investors, has announced that it is t the development of the intertidal Tra Vinh wind farm.

development, and financing planning

GE to support 800-MW wind project in Vietnam

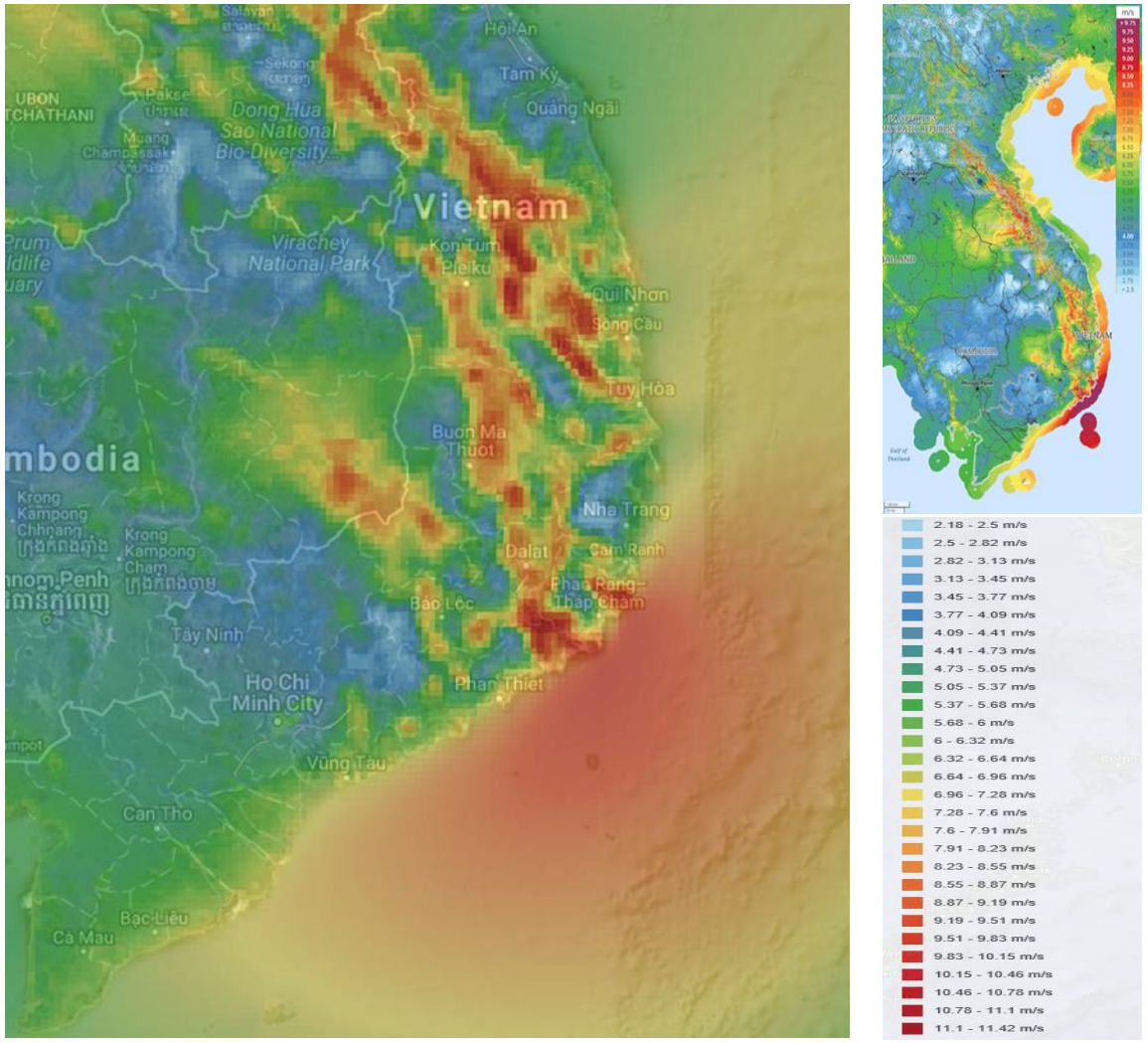
By Michelle Froese | June 2, 2017

GE Renewable Energy, global wind and solar company Mainstream Renewable Power, and local Vietnamese partner the Phu Cuong Group have agreed to a $2 billion Joint Development Agreement to develop, build, and operate the 800-MW Phu Cuong Wind Farm in the Soc Trang province of Vietnam.

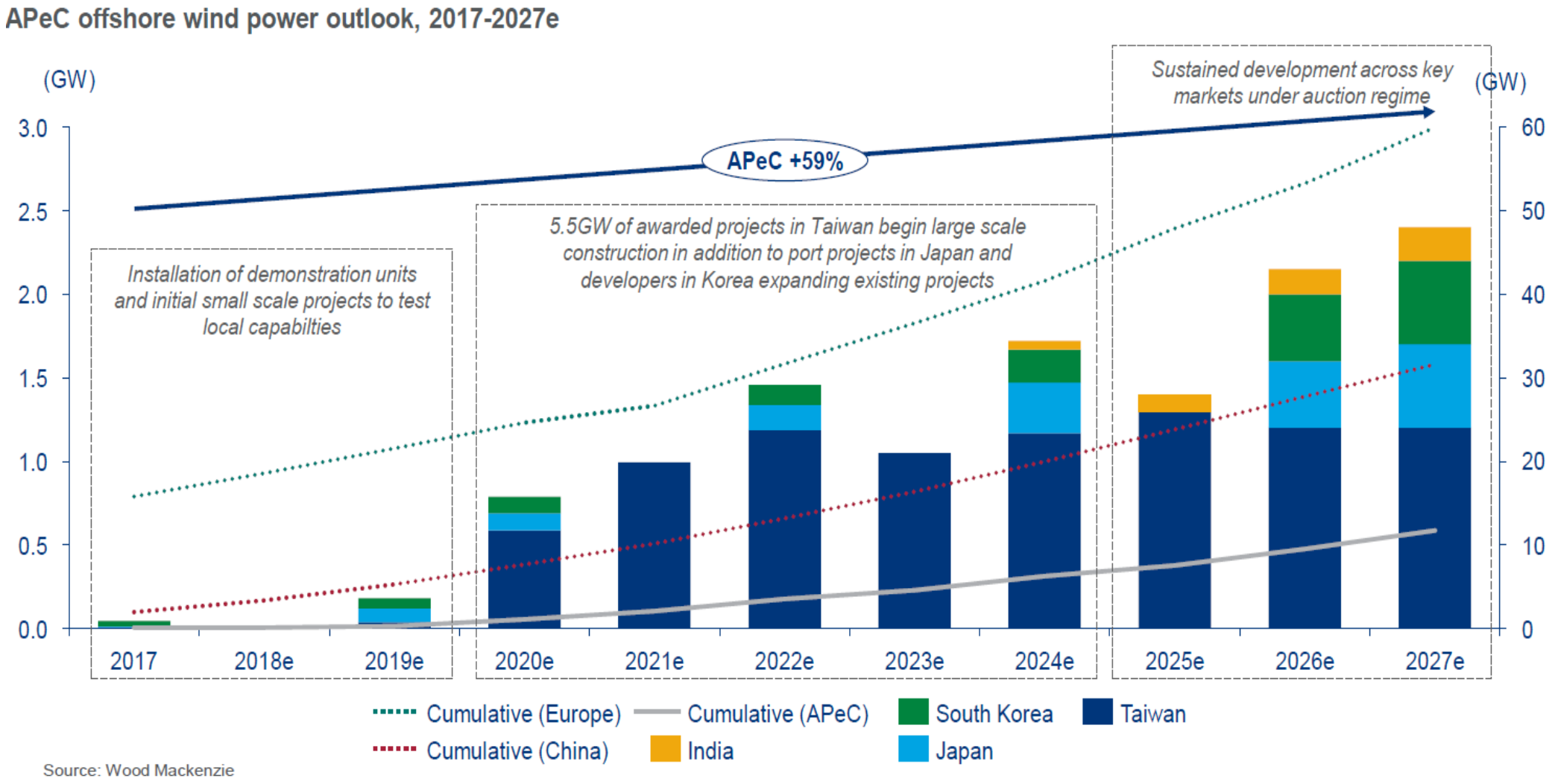
Lot's of ground work still must be undertaken before Vietnam is ready…..

Government don't have a full assessment of the offshore wind potential (asset) – and development process is so far "privatised" – i.e. sits with individual developers'.

- Wind resource:
  - Very large wind speed differences along the coast
  - Uncertainties from mesoscale wind flow models remain very large
  - High uncertainty
  - Not suitable for project finance
- Geotechnical data and sources are only very limited:
- No grid and transmission studies/plans for connecting to load centres (constituting offtake risk)
- Project finance is not available (not even for onshore wind)



Vietnam is not yet on the map of markets believed to be realized next 10 years. 2/3rd of APAC growth in Mainland China - followed by Taiwan, Japan and Korea



Source: Wood Mackenzie

Complexity of Offshore Wind and additional challenges in Vietnam

What to do next ?

How can we develop a robust offshore wind plan for Vietnam ?

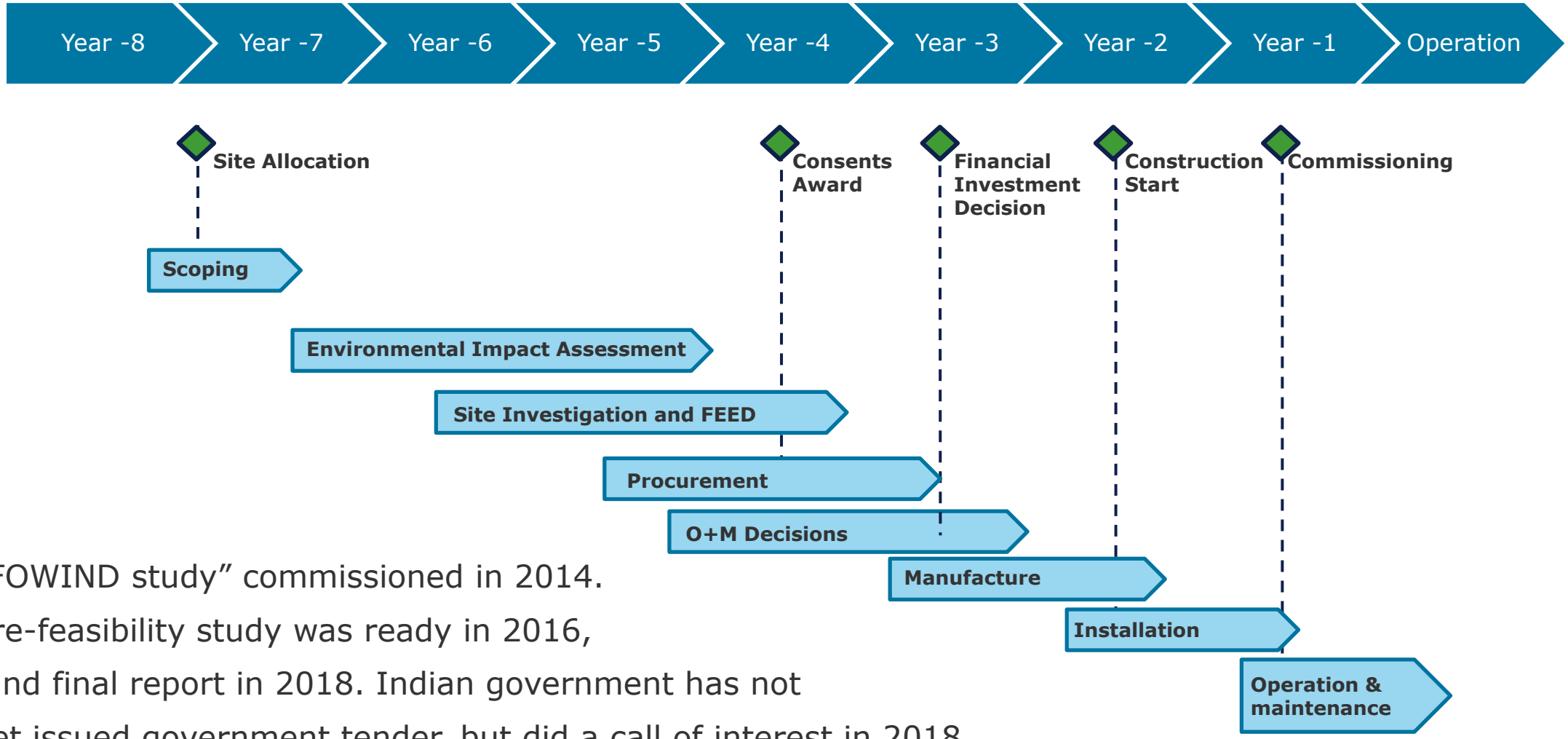
DNV GL suggest 9 steps to take……

First step: Accept complexity of Offshore Wind – many risk to manage ….

Second step: Assess the resource in a trustworthy way – so more players get attracted to be involved in developing the asset

- Government must declare its offshore wind plans
- Pre-feasibility should be initiated to access the potential and opportunity(ies) (and give guidance to FiT/PPA)
- Further wind resource measurements needed (Lidars)
- Transmission and geotechnical studies should be initiated
- Government tender should be initiated to secure international competition and secure transparent regulatory setup
- Commercial "risk management" will follow above mentioned actions i.e. Technical Due Diligence etc

Third step: From project conception to commissioning – It takes time to do it right



"FOWIND study" commissioned in 2014.
Pre-feasibility study was ready in 2016,
and final report in 2018. Indian government has not
yet issued government tender, but did a call of interest in 2018

Fourth step: Understand your Market Risk: Securing investor confidence – Offshore wind is more complex than onshore wind. Need to secure bankability of PPA !

In planning phase, modelling informs risk management (use Turbine Architect)

Look at probabilities of each risk

Identify where to focus effort

Government can ease risk burden by creating stable framework conditions:

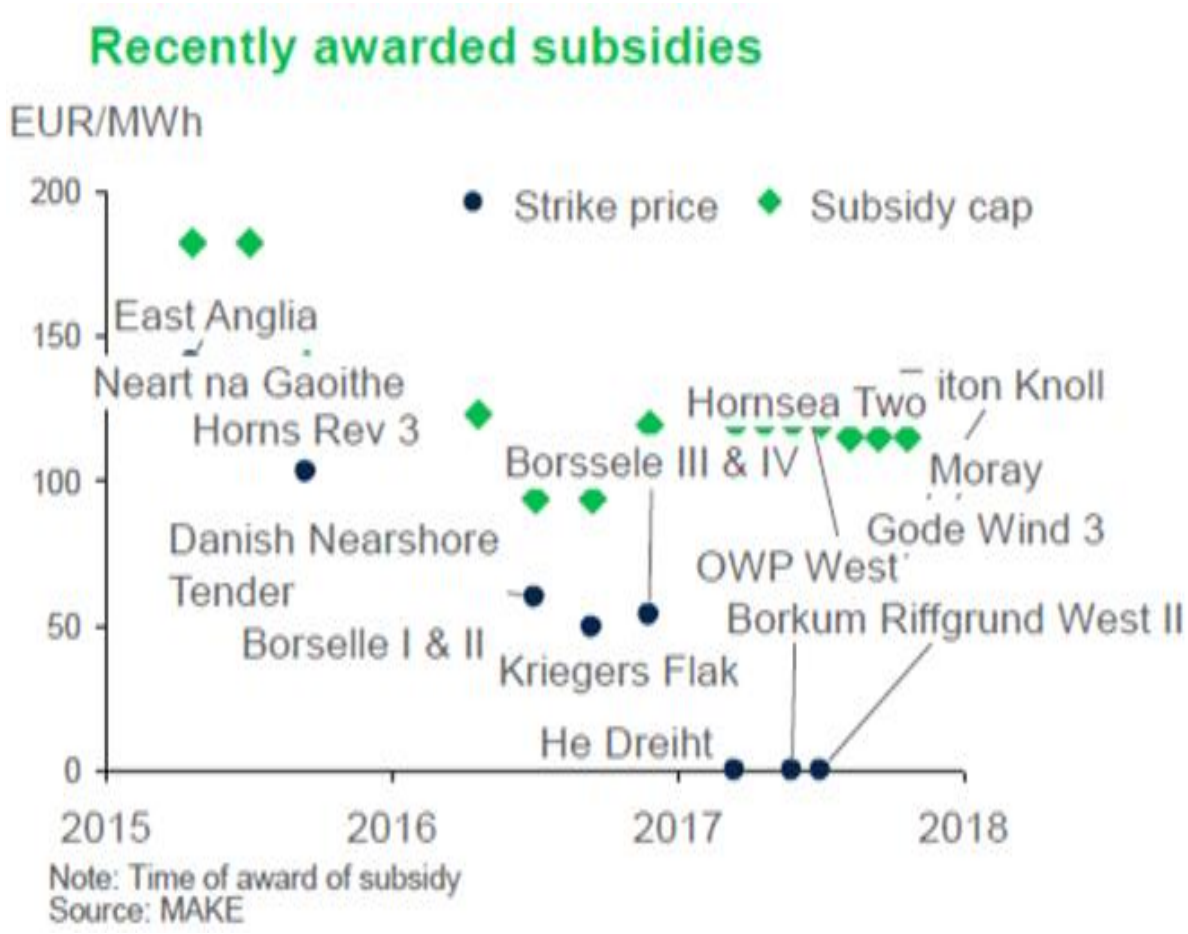
- Bankable PPA
- Grid analysis (limit offtake risk)
- (open) wind resource data
- Geotech data
- Develop supplier data

Fifth step: Realize Offshore wind is complex and huge. Government authorities must (also) play a supporting role in successful OW markets

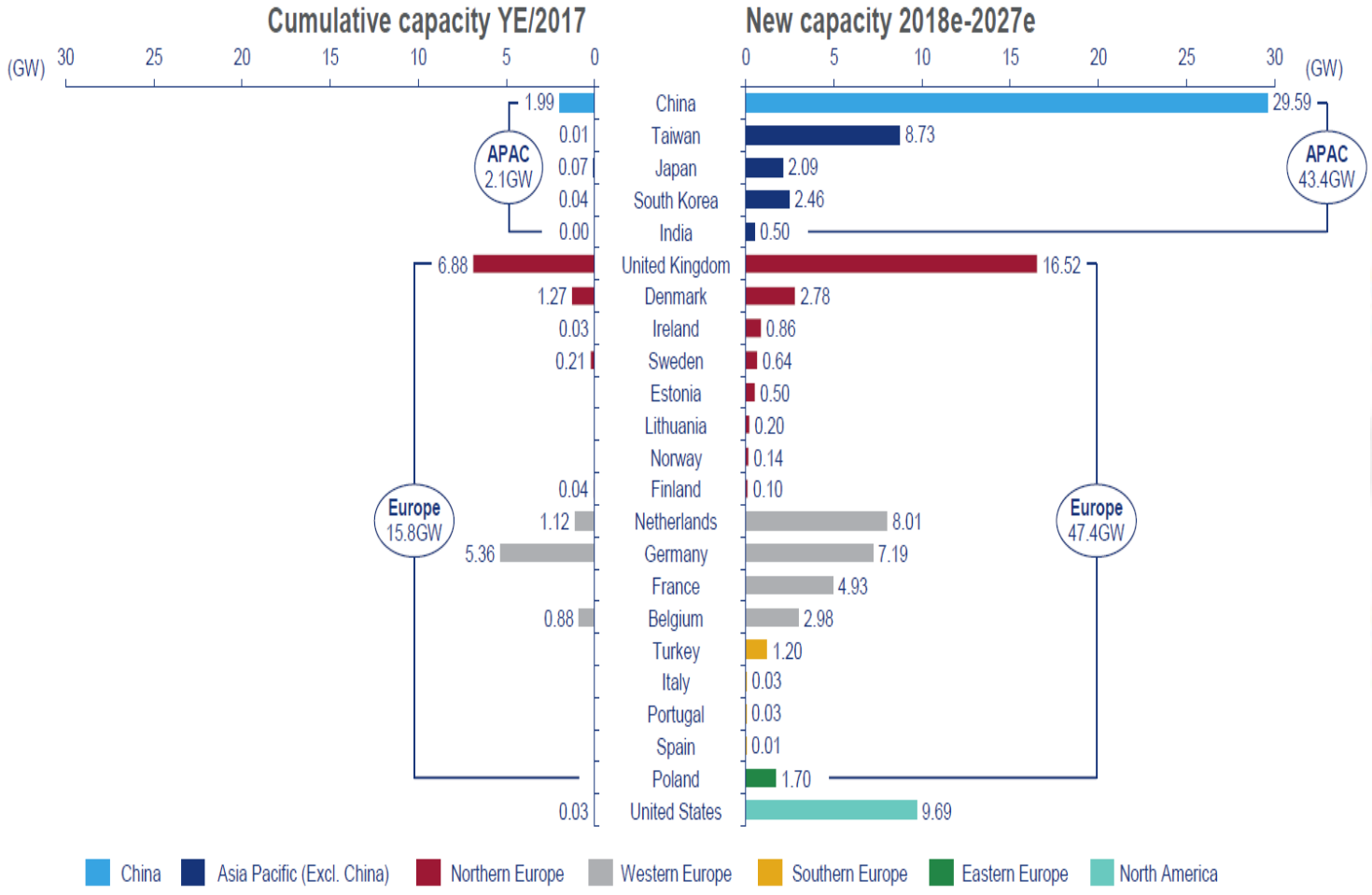
- Case of UK: Ministry of Industry and Business, Crown Estate, Carbon Trust, Universities and others. Developer is delivering both transmission and wind park

- Case of DK, NL and Germany: Central Ministries also play key role in location of sites – but here the State also delivers the transmission link to the wind farm. This limits project risk – and enable lover LCOE cost.

- In the USA – Federal body BOEM and DOE plays key role together with state governments in site locations, standards development, environmental assessment etc. Developer also delivers transmission to onshore grid (like in the UK).



Sixth step: Understand the complex regional industrial situation – and plan for it

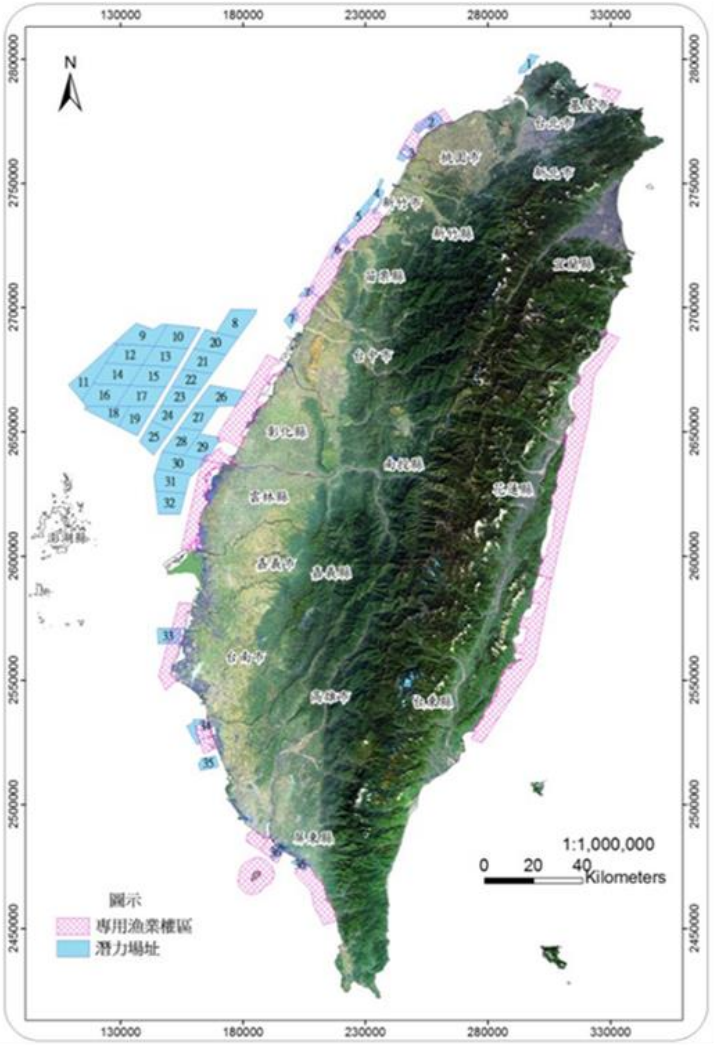


Note: Based on annual grid-connected capacity.
Source: Wood Mackenzie

Woodmac illustration

4

Seventh: Learn from other successful market (like UK, DK, Taiwan etc) – case Taiwan



Taiwan authorities have planned their government venture for more than 10 year

Taiwan authorities has planned site location and tender procedures

Taiwan authorities have invited International players to compete and play in Taiwan offshore wind market (with huge success)

Taiwan authorities respects international standards and invite for experience sharing and cooperation

Taiwan Offshore Wind Allocations

Owner	MW	CoD Year
Taipower	110	2019
Swancor - Macquarie - Orsted	120	2019
China Steel - CIP	300	2024
CIP	100	2021
CIP	452	2023
CIP (West Island)	48	2024
Northland - Yushan	300	2024
Orsted	605.2	2021
Orsted	294.8	2021
Swancor - Macquarie	378	2020
Taipower	300	2024
wpd	350	2021
wpd (Yunlin I)	360	2020
wpd (Yunlin II)	348	2021

Eighth: International standards are mandatory and key for successful new Offshore Wind projects

- **Standards for onshore construction and offshore O&G are not appropriate for offshore wind !**

- **Certification schemes for offshore wind are available**:
  - International: IEC(RE), DNV GL
  - National schemes are often based on IEC with local amendments (Germany, USA, The Netherlands, Denmark, Taiwan etc.)

- **Design and fabrication standards for offshore wind are available**
  - International: IEC(RE), ISO, DNV GL Standards
  - National standards are based on local requirements and often on standards for onshore construction or for offshore O&G
  - Standardization is the **process** of implementing and developing **technical standards** based on the *consensus* of different parties that include firms/developers, users, interest groups, standards organizations and governments
  - Standardization can help to **maximize** compatibility, interoperability, **safety**, **repeatability,** or **quality** (TDD or PC)

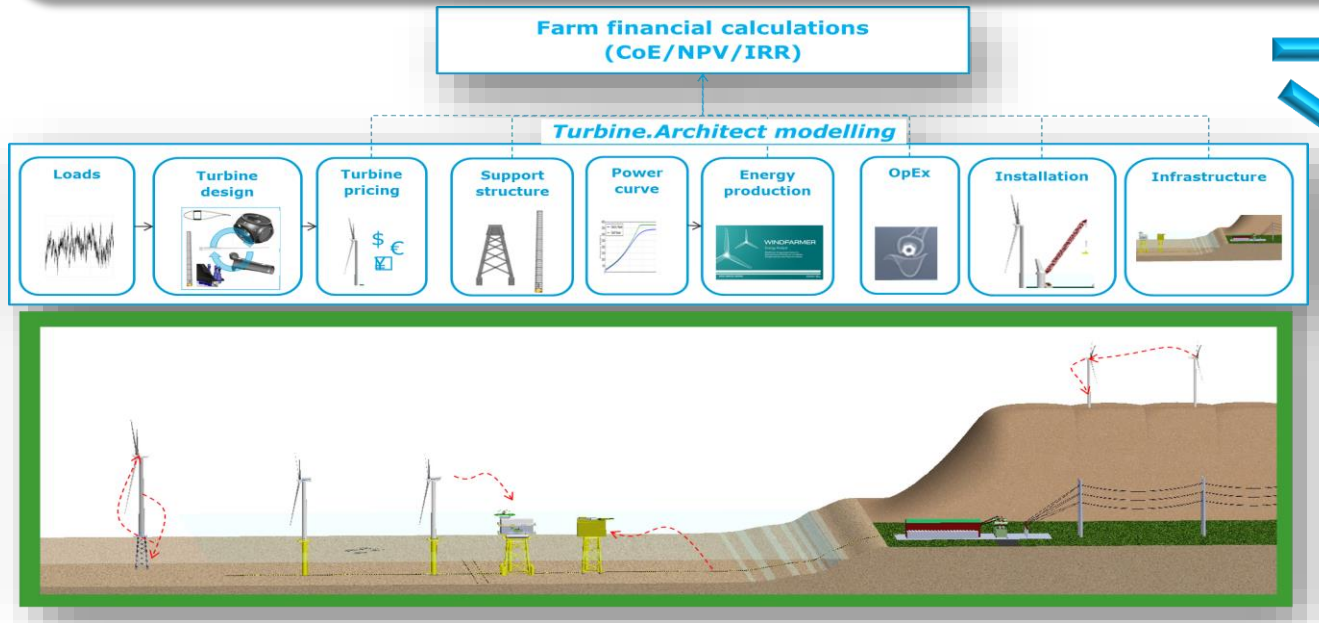
- **HSE requirements for working in wind is covered mainly by GWO**

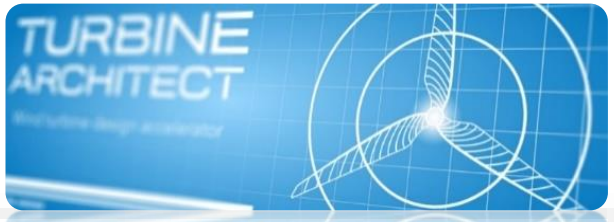
- **Use of international standards and certification will help facilitate international project financing**

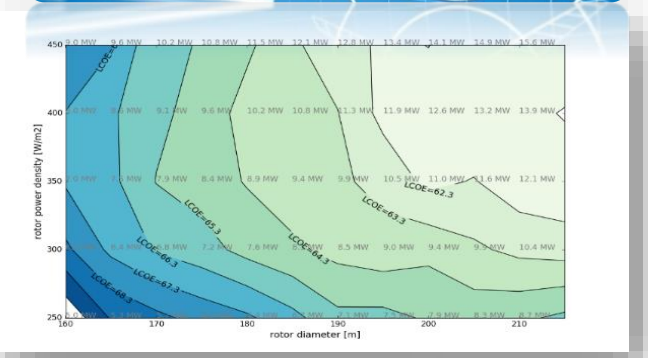
Ninth: Use proven digital modelling tools for both OW potential (government), site selection (government + developers) and potentially project optimization (developers and investors) – Fx. with "Turbine Architect"

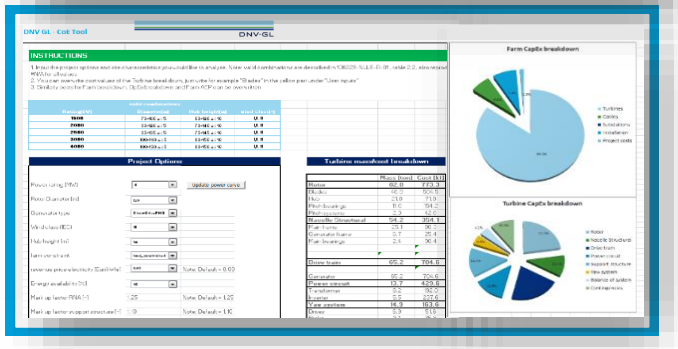
Our advanced cost of energy modelling tool, Turbine.Architect, allows engineering design decisions to be made on the bases of LCoE. It contains engineering models of the main components of the wind turbine and wind farm, including balance of plant, construction and O&M, and combines these with financial models to allow you to understand the complex relationships involved in the integrated system to optimise the overall design.

Turbine.Architect can also be used to aid wind turbine OEMs or support structure designers when bidding for wind farm development opportunities.



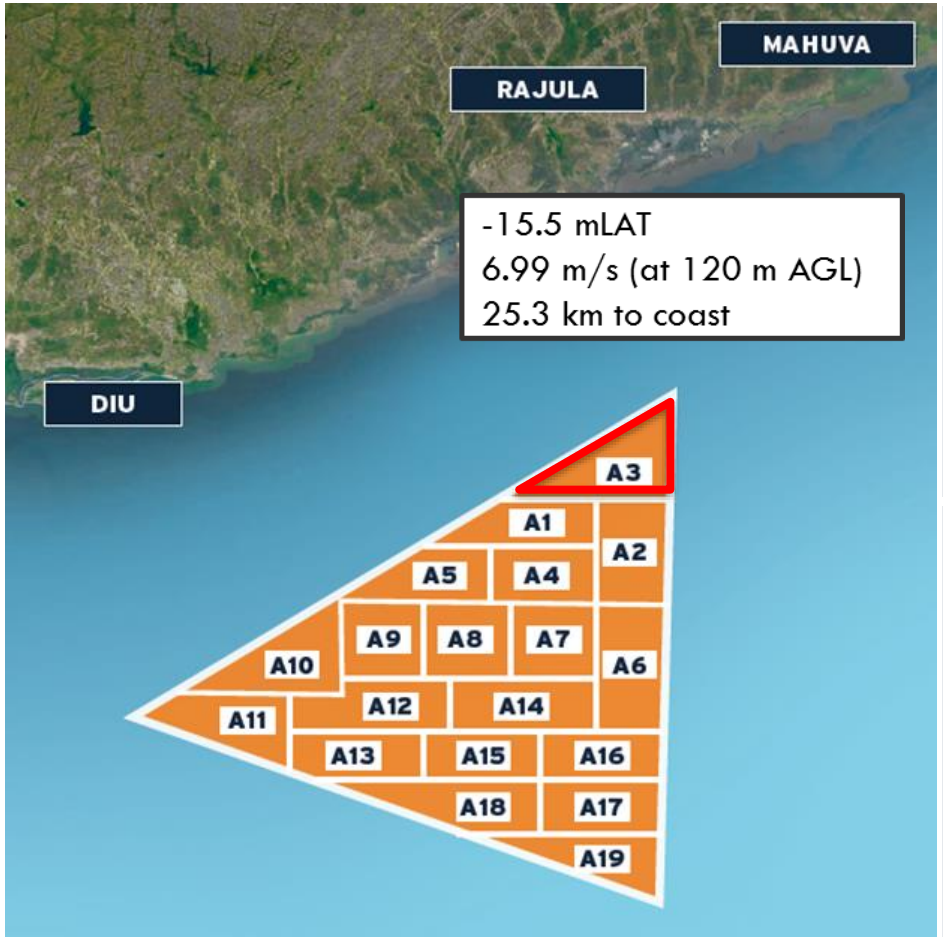


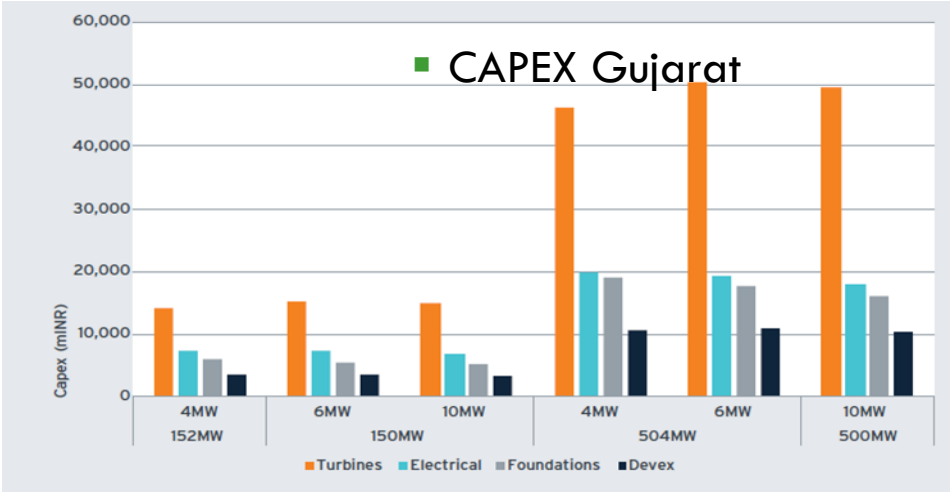


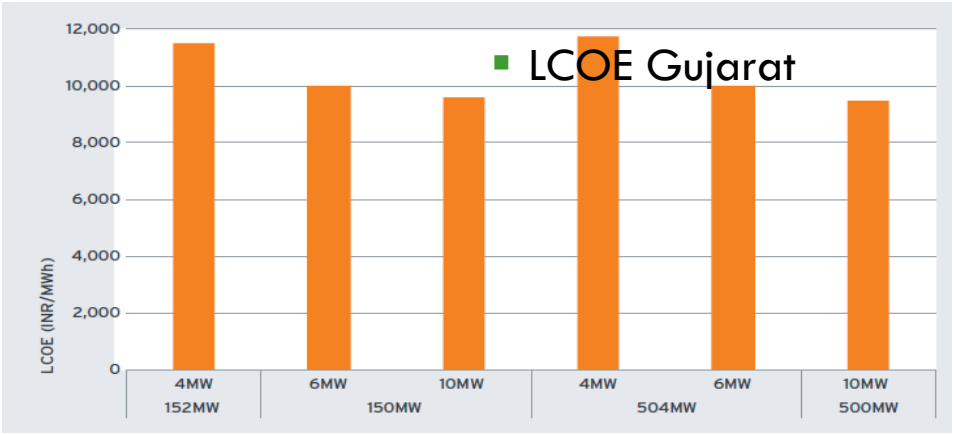


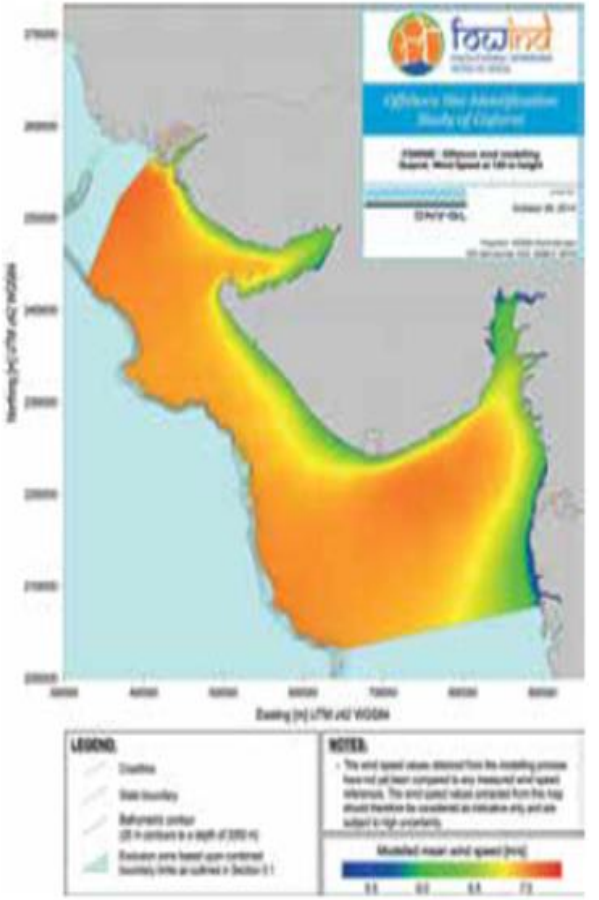
Example: Turbine Architect was used for India offshore site and turbine optimization selection (FOWIND). We can do the same for Vietnam….

Gujarat – zone A, 19 sub-zones









Thank you

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