Asia Wind Energy Association

IN PARTNERSHIP WITH

Wind Pioneers · Anemos Solutions · Siemens Gamesa Renewable Energy

AWEA WEBINAR SERIES 2020 - TECHNICAL SESSION

Developing onshore wind farms for the next generation of huge turbines

SPEAKERS:

JERRY RANDALL
Wind Pioneers

BJARKE R NIELSEN
Anemos

SCOTT POWERS
Siemens Gamesa

TUESDAY, 22 SEPTEMBER 2020 - 3 PM SGT

Asia Wind Energy Association

The Asia Wind Energy Association was established in December 2016 to become the leading trade association for the wind energy sector in Asia Pacific.

The association acts as the regional platform for all wind power industry stakeholders to collectively promote the best interests of the wind power sector.

The Asia Wind Energy Association is supported by a wide variety of stakeholders from the offshore and onshore wind industry.

Information

Asia Wind Energy Association

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Asia Wind Energy Association

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Asia Wind Energy Association Corporate Partners

Asia Wind Energy Association Corporate Members

Asia Wind Energy Association Partner Organizations

Scott Powers

Sales Director - Siemens Gamesa

With experience from the North and Central America to Asia Pacific, Scott has been in the energy sector with a primary concentration on wind for nearly 10 years. Focusing on Business Development, WTG Sales, WTG Service as well as Project Development and Acquisition, he has witnessed the industry grow first hand from mature to emerging markets. Latest experience places Scott as the Sales Director of Southeast Asia for Siemens Gamesa, with a primary focus on the booming Vietnamese market. The adoption of newer (larger) WTG technology in emerging markets such as Southeast Asia will greatly help to accelerate the clean energy transition on a profitable basis for all windfarm stakeholders. With that said this upside is not without risk that must be mitigated through proper planning.

Siemens Gamesa Onshore

Reaching new heights

September 2020

Onshore Global Marketing Department

SIEMENS Gamesa
RENEWABLE ENERGY

Key facts*

105 GW
Globally installed

26,000
Employees

€10.2 B
Annual revenue**

€10.7 B
Market capitalization

€31.5 B
Order book

True global, modern and scalable footprint

Advanced digital capabilities

Portfolio covering all requirements

** Figures as end of June 2020.*
*** Figures as end of September 2019.*

Activity

Onshore

88.8 GW installed in 75 countries.
12.2 GW of wind farms developed in 14 countries.
The perfect technology partner for your wind projects.

Offshore

16.1 GW installed worldwide since 1991.
Most experienced offshore wind company with the most reliable product portfolio in the market.

Service

72.1 GW maintained.
Commitment beyond the supply of the Wind Turbine Generator (WTG) to achieve the profitability objectives of each project.

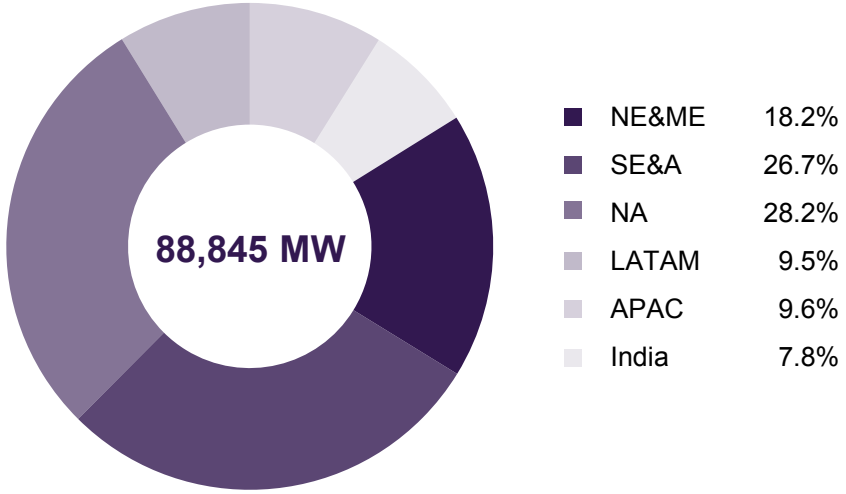
Three business units strongly positioned in the market

SIEMENS Gamesa
RENEWABLE ENERGY

Geographic diversification allowing growth in emerging and mature markets

Commercial offices in 35 countries across the world.

Accumulated track record – CY2Q2020



SGRE Vietnam
>1000MWs in <4 years

PROJECTS REFERENCES

- **Dam Nai 1 & 2** – 40 MWs - Ninh Thuan
- **Phuong Mai 3** – 21 MWs - Binh Dinh
- **Thanh Hai 1 & 2** – 63 MWs - Ben Tre **- Nearshore**
- **Binh Dai** – 35 MWs - Ben Tre **- Nearshore**
- **Hoa Thang 1.2** – 112.5 MWs - Binh Thuan
- **Soc Trang Power Plant #3** – 35 MWs - Soc Trang
- **Thai Hoa** – 90 MWs - Binh Thuan
- **Tan Thuan** – 75MW MWs - Ca Mau **- Nearshore**
- **Hiep Thanh** – 78MWs - Tra Vinh **- Nearshore**
- **Project XXX**
- **Project YYY**
- **Project ZZZ**

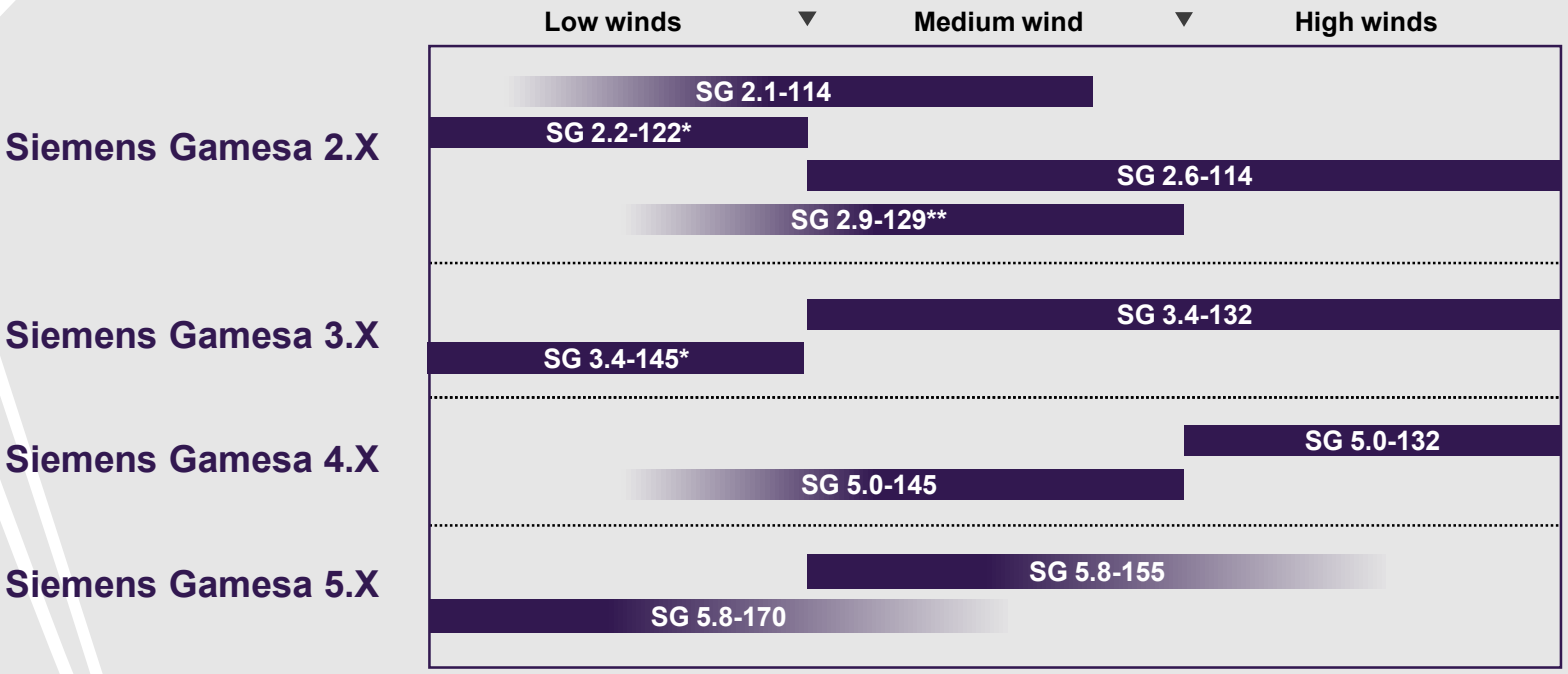
12 Projects	**20 Phases**
1,086 MWs	**226 WTGs**

Dam Nai 1&2, Ninh Thuan →

← Phuong Mai 3, Binh Dinh

SIEMENS Gamesa RENEWABLE ENERGY

An optimized, streamlined product portfolio

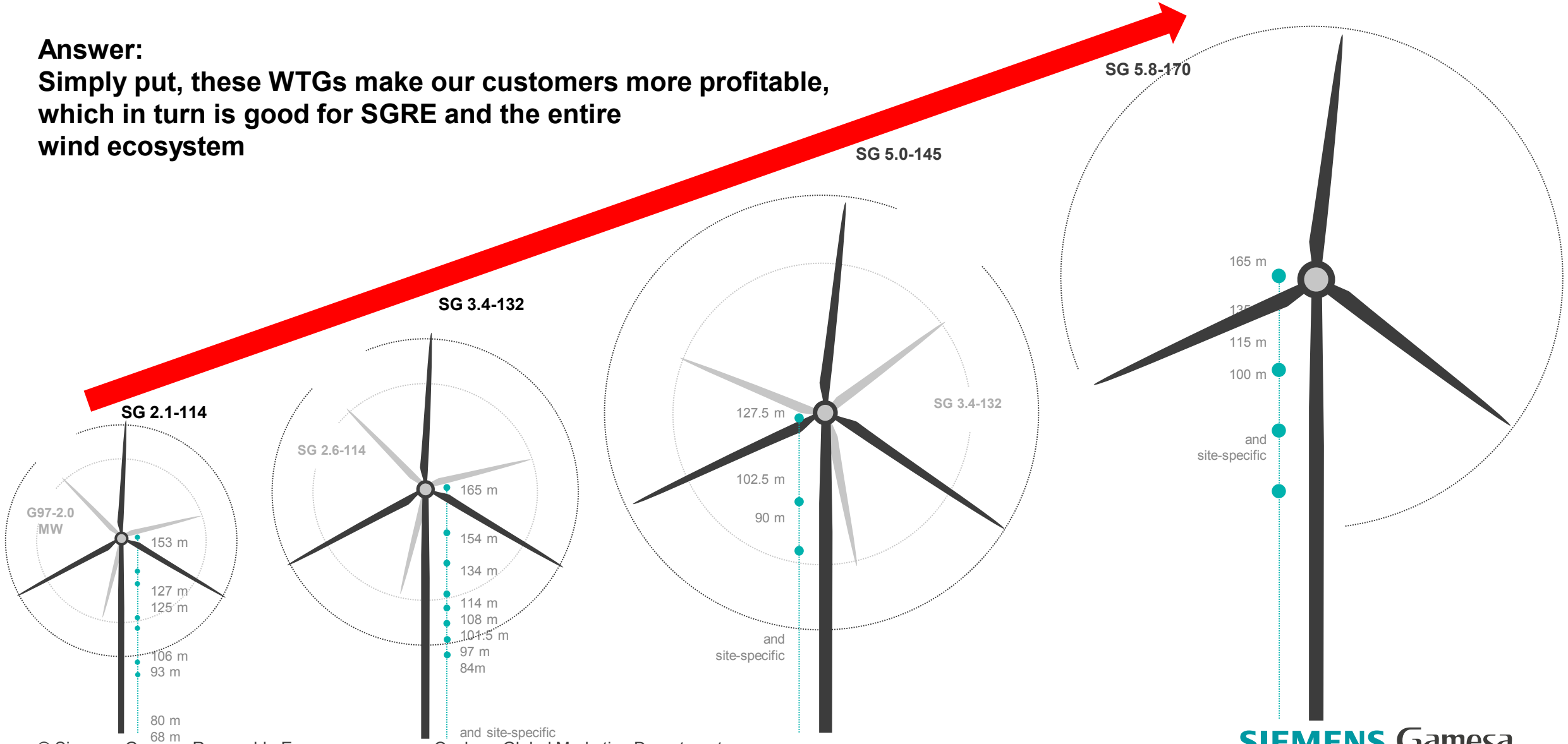


** Designed for the Indian market, but available worldwide.*
*** Designed for the North American market, but available worldwide.*

Siemens Gamesa long-term reference portfolio entirely based on geared technology.

Why is bigger better?

Answer:
Simply put, these WTGs make our customers more profitable, which in turn is good for SGRE and the entire wind ecosystem

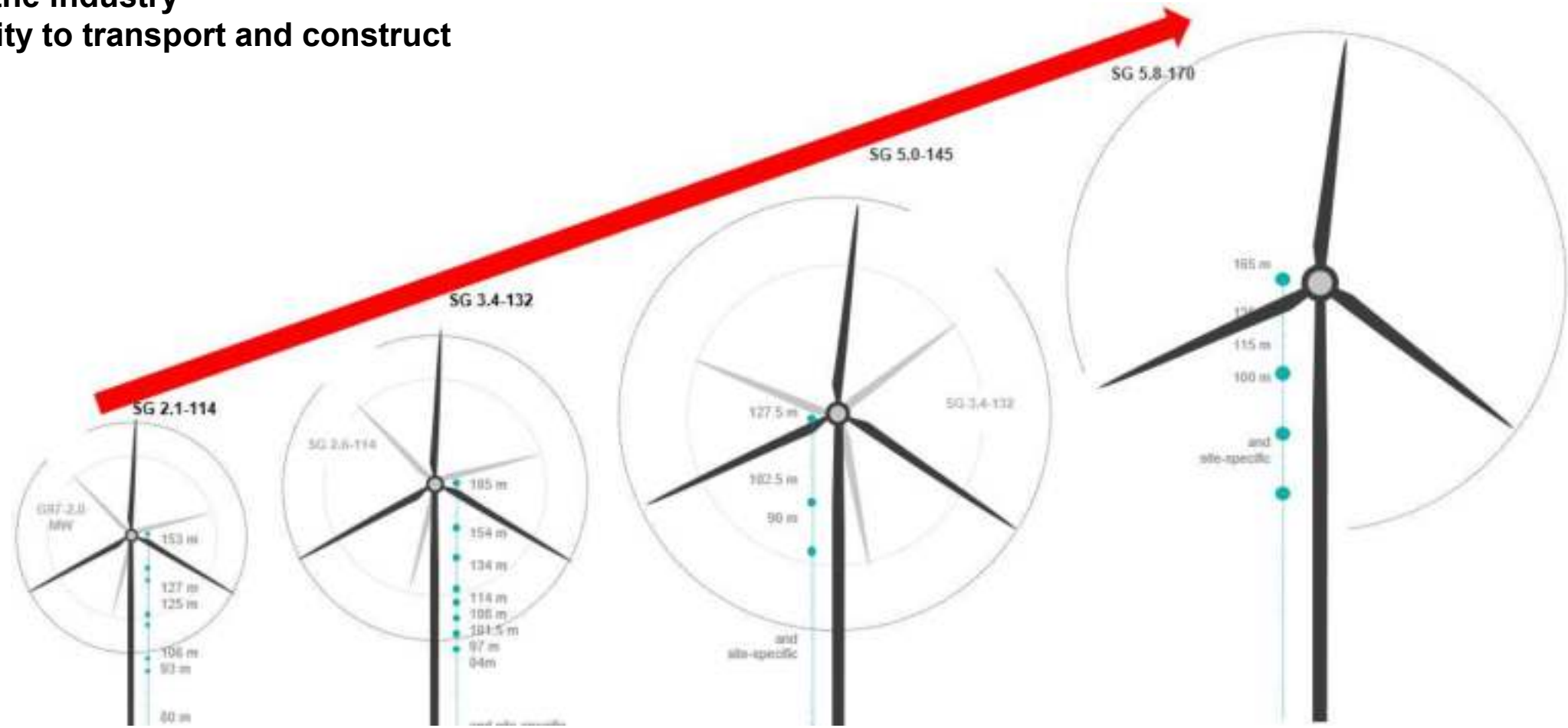


SIEMENS Gamesa
RENEWABLE ENERGY

Why has the market gone to larger WTGs?

Answer:

- **Pressure from customers to make their projects (more) profitable**
- **Competition in the industry**
- **Comfort on ability to transport and construct**

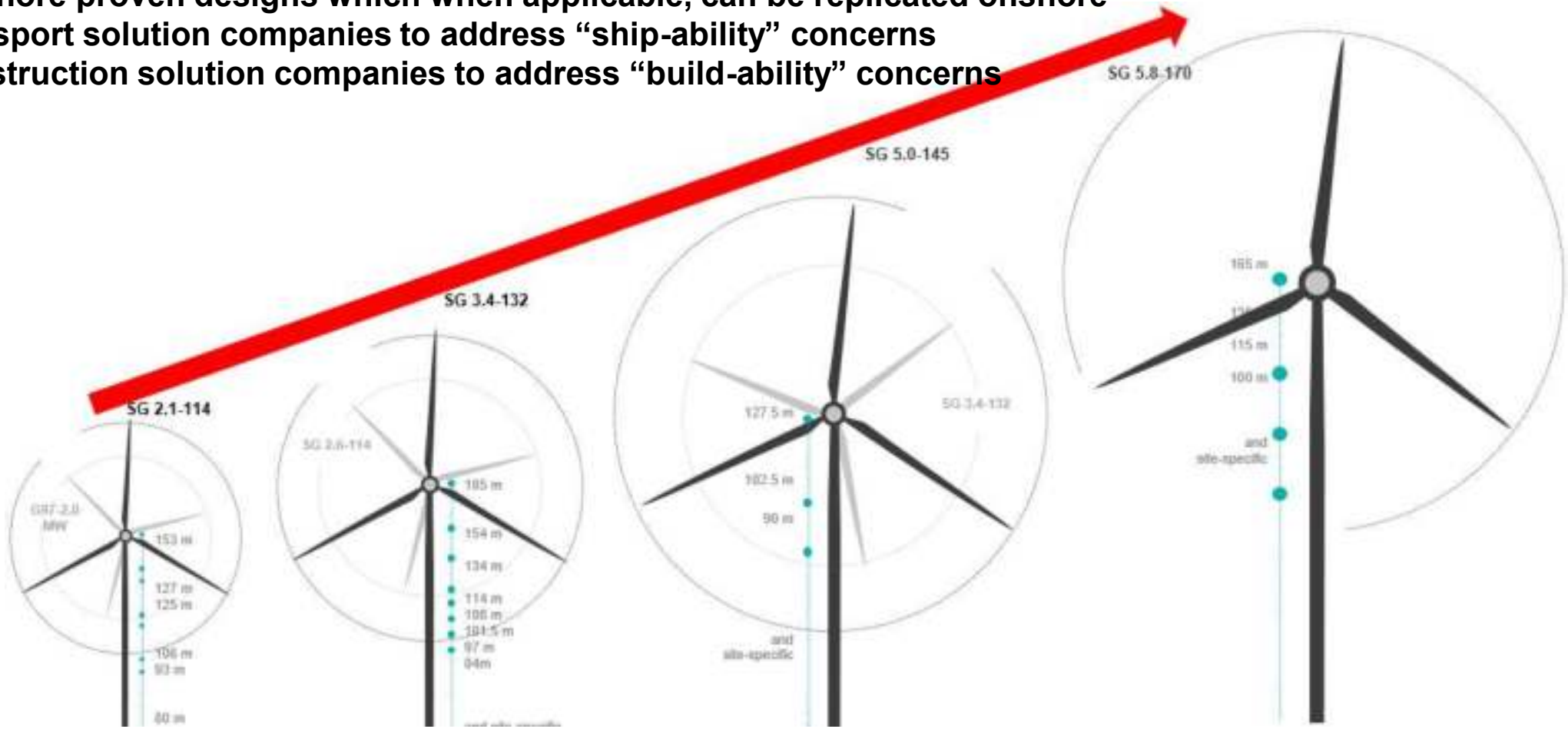


SIEMENS Gamesa
RENEWABLE ENERGY

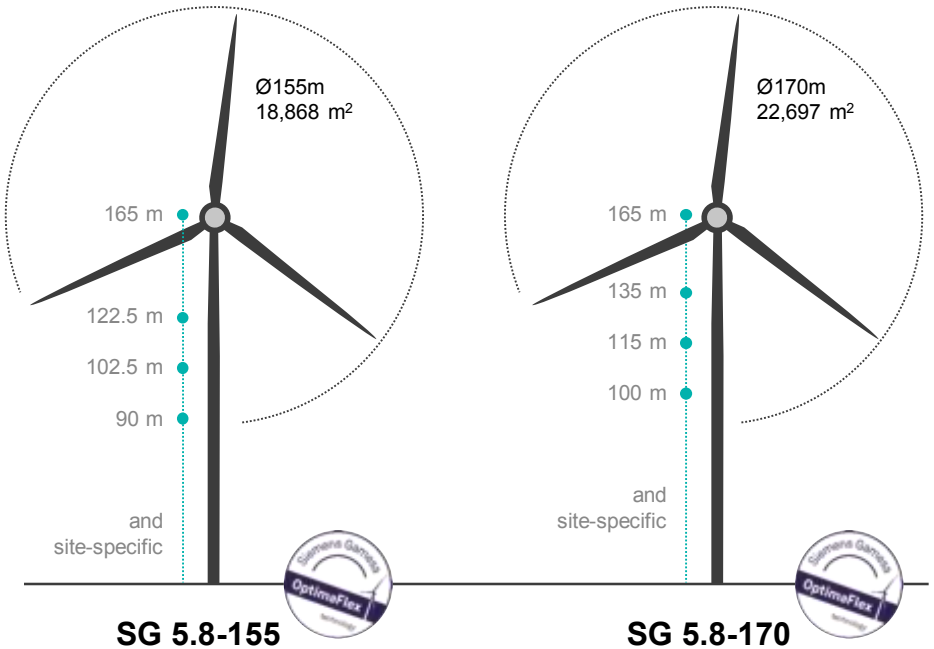
How have we gone larger?

Answer:

- **Leaning on Onshore proven designs which can be scaled larger**
- **Leaning on Offshore proven designs which when applicable, can be replicated onshore**
- **Leaning on transport solution companies to address “ship-ability” concerns**
- **Leaning on construction solution companies to address “build-ability” concerns**



Reaching new heights



Wind class	Medium and high	Low and medium

- **In performance, cost efficiency and reliability**.
- **In power output and rotor size** for the most competitive LCoE.
- **In technology**, based on Siemens Gamesa know-how and expertise.
- **In versatility**, with a highly flexible design for logistics, construction and service.
- **In site adaptability**, to configure the optimal solution for each project.
- **In value** for our customers.

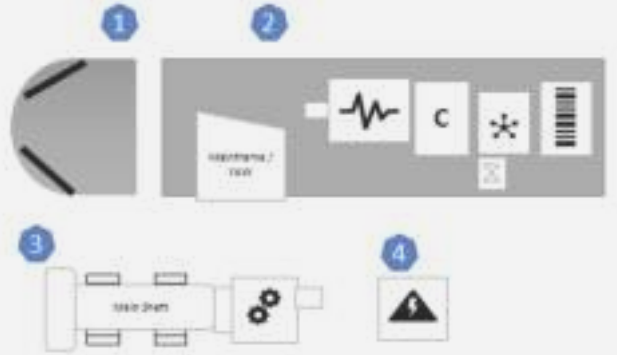
Next generation Siemens Gamesa onshore platform

SIEMENS Gamesa
RENEWABLE ENERGY

Transport and turbine dimensions

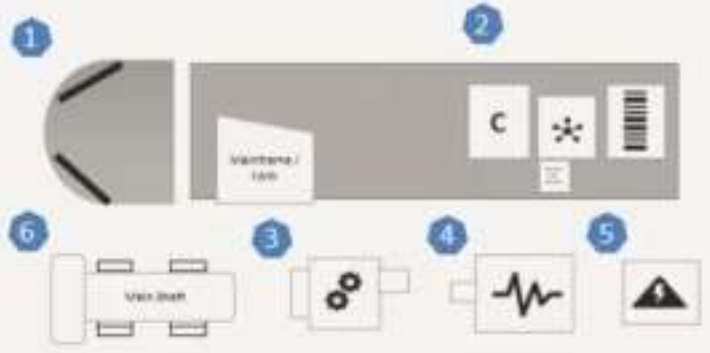
3 modules (max weight 96 t)

- Hub + nacelle housing & transformer + drive train



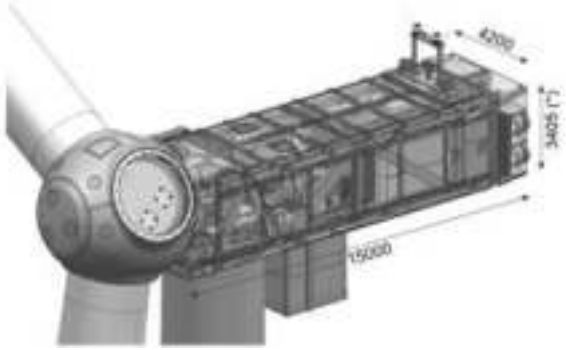
4 modules (max weight 81 t)

- Hub + nacelle housing + drive train + transformer



6 modules (max weight 64 t)

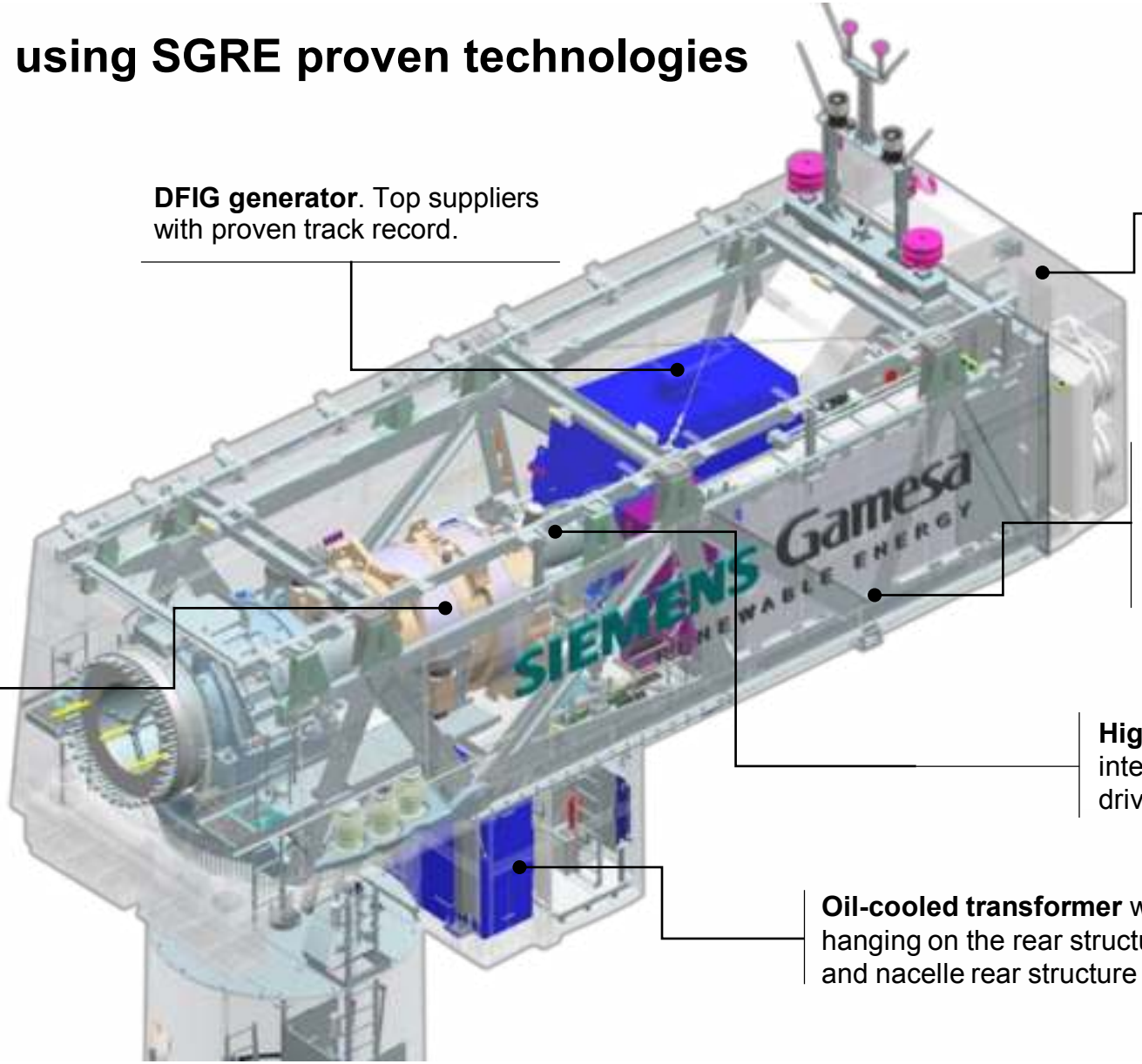
- Hub + nacelle housing + low speed shaft + gearbox + generator + transformer



- Flexibility by means of modularity in nacelle & hub to enable optimal distribution of weights, and thus the **utilization of more economical & widely available means of transport**.
- **Transport nacelle height set at 3.5 meters**, to enable transportation by train and the avoidance of obstacles in the route such as tunnels or signals.
- **Maximum blade chord of 4.5 meters,** dimensioned to not exceed onshore transport limits. Limited blade pre-bend of 2.6 meters.

SIEMENS Gamesa RENEWABLE ENERGY

Nacelle architecture using SGRE proven technologies



DFIG generator. Top suppliers with proven track record.

Cooling room located at the rear-end of the nacelle, designed for all thermal options.

Lattice rear-end structure for optimized structural weight.

Gearbox with two planetary stages and one helical for increased capacity. Top suppliers with proven track record.

High speed shaft coupling with integrated torque limiter to protect drive train components.

Oil-cooled transformer with proven reliability, hanging on the rear structure to reduce vibrations and nacelle rear structure weight.

SIEMENS Gamesa
RENEWABLE ENERGY

Main milestones

Platform ready for start of production during the first half of 2021.

SG 5.8-155

- **Q2 2019** — Official market launch (WindEurope 2019, Bilbao)
- **Q4 2020** — First prototype
- **Q1 2021** — Start of production
- **Q2 2021** — Type Certificate (B)
- **Q4 2021** — Type Certificate (A)

SG 5.8-170

- **Q2 2019** — Official market launch (WindEurope 2019, Bilbao)
- **Q1 2021** — First prototype
- **Q2 2021** — Start of production
- **Q3 2021** — Type Certificate (B)
- **Q1 2022** — Type Certificate (A)

OptimaFlex – Optimization through flexibility

WTGs can be precisely configured to adapt perfectly to site conditions, thus offering our customers the best product for their projects.

Beyond the traditional off-the-shelf approach, which results in products that more or less fit all the sites, but are sub-optimal for many, **OptimaFlex** delivers a uniquely tailored solution that is perfect for our customers' specific needs.

Optimized site design combined with a customizable product platform, based on flexible power rating, site specific towers and optimized BoP solutions, allow Siemens Gamesa to deliver reduced LCoE by increasing AEP and optimizing cost.

Maximized profitability

Conclusion: Bigger is in fact better, so long as…

- Our customers reliably profit from it (SGRE has ensured this by proper design)
- The WTGs can be successfully constructed at site (economically)
- The WTGs can be successfully shipped to site (economically)

Thank you!

Scott Powers
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SIEMENS Gamesa
RENEWABLE ENERGY

Bjarke Nielsen

Managing Director - Anemos

With nearly 20 years' experience related to logistics for onshore wind sector, Bjarke has seen turbine blades grow to more than twice their length, increasing the complexity of both seafreight and domestic transport. After 10 years in Singapore with Blue Water Shipping, in various operational and sales roles related to the wind sector in Asia, he started Anemos Solutions in 2017, to focus on pre-feasibility planning and development of logistics concepts for new challenging wind projects across Asia. The continued trend towards ever larger turbines is creating significant logistics challenges and needs to be addressed early in a projects development cycle.

ANEMOS SOLUTIONS

- Founded 2017 in Singapore
- Transportation consultancy for wind projects in APAC

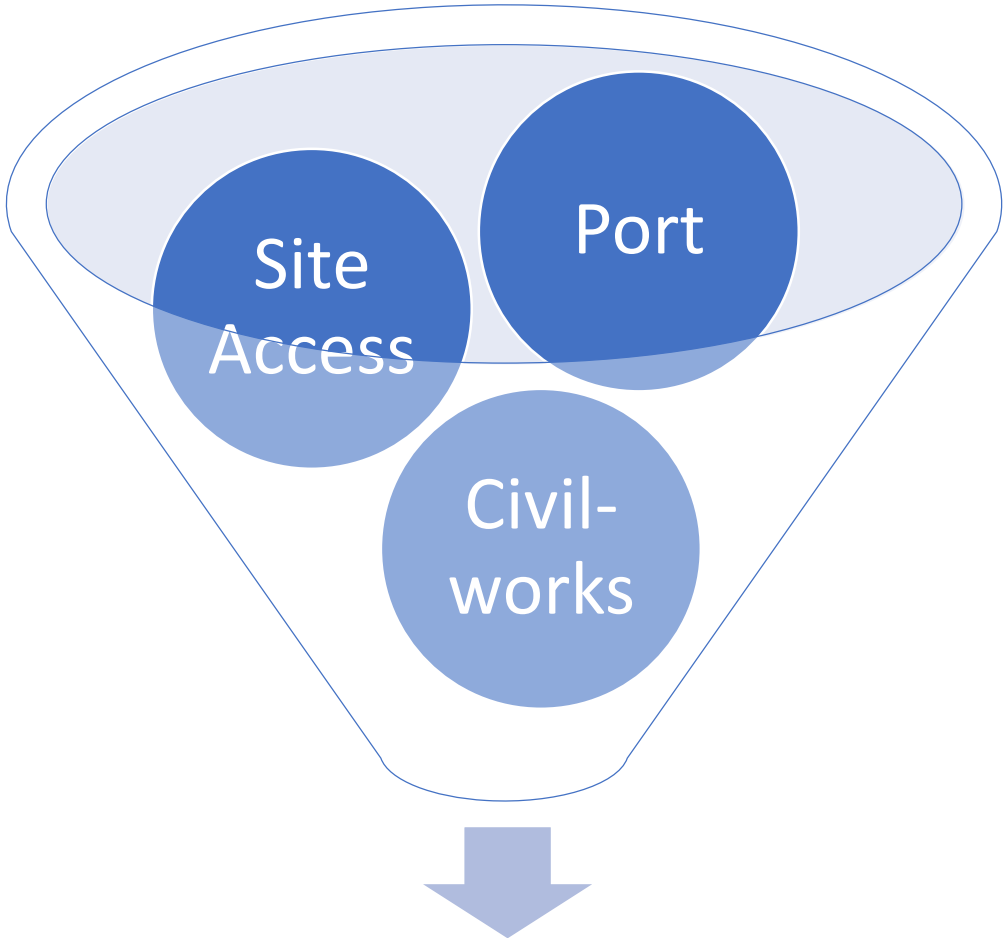
ANEMOS Solutions Pte. Ltd.
www.anemos.com.sg
brn@anemos.com.sg
Telephone: +65 9071 0404

BIG is Best / How big can it get

- Developers prefer EPC approach
- Logistics focus in Pre-FEED stage

- Suitable port for importation
- Infrastructure constraints between port and site
- Develop specific logistics strategy for each project

- Desktop study → ALWAYS first step



Multiple transport surveys

Community engagement

No obvious discharge port

No storage area in port

Engineering assessment of port

Bathymetric survey

www.anemos.com.sg

75MW Sidrap Windfarm, South Sulawesi, Indonesia

Specialized transport solutions

- Blade lifters
- Blade adapter units
- Tower adapter trailers
- Nacelle adapter trailers
- Roll on – Roll off barges

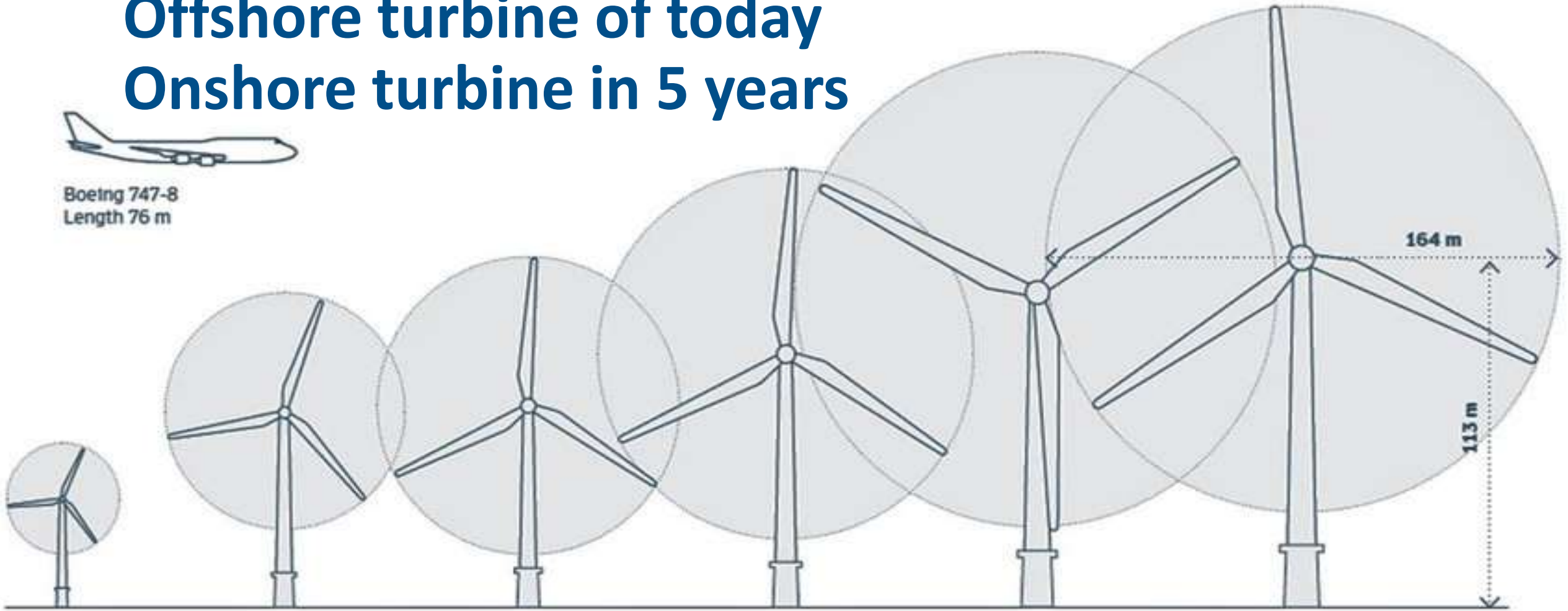
Barging in SE Asia

- Good for extreme cargo component size & Severe infrastructure limitations

- Archipelago areas
- River deltas
- Near coast projects

- Roll off vs. Lift off
- Calm beachhead for jetty
- Permanent or temporary jetty

Offshore turbine of today
Onshore turbine in 5 years



Vindeby		Middelgrunden		Horns Rev 2		Anholt		Westermost Rough		Burbo Bank Extension	
Year:	1991	Year:	2001	Year:	2010	Year:	2013	Year:	2015	Year:	2017
Diameter:	35 m	Diameter:	76 m	Diameter:	93 m	Diameter:	120 m	Diameter:	154 m	Diameter:	164 m
Height:	35 m	Height:	64 m	Height:	65 m	Height:	82 m	Height:	102 m	Height:	113 m
Capacity:	0.45 MW	Capacity:	2.00 MW	Capacity:	2.30 MW	Capacity:	3.60 MW	Capacity:	6.00 MW	Capacity:	8.00 MW

THANK YOU FOR YOUR ATTENTION

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Jerry Randall

Founder - Wind Pioneers

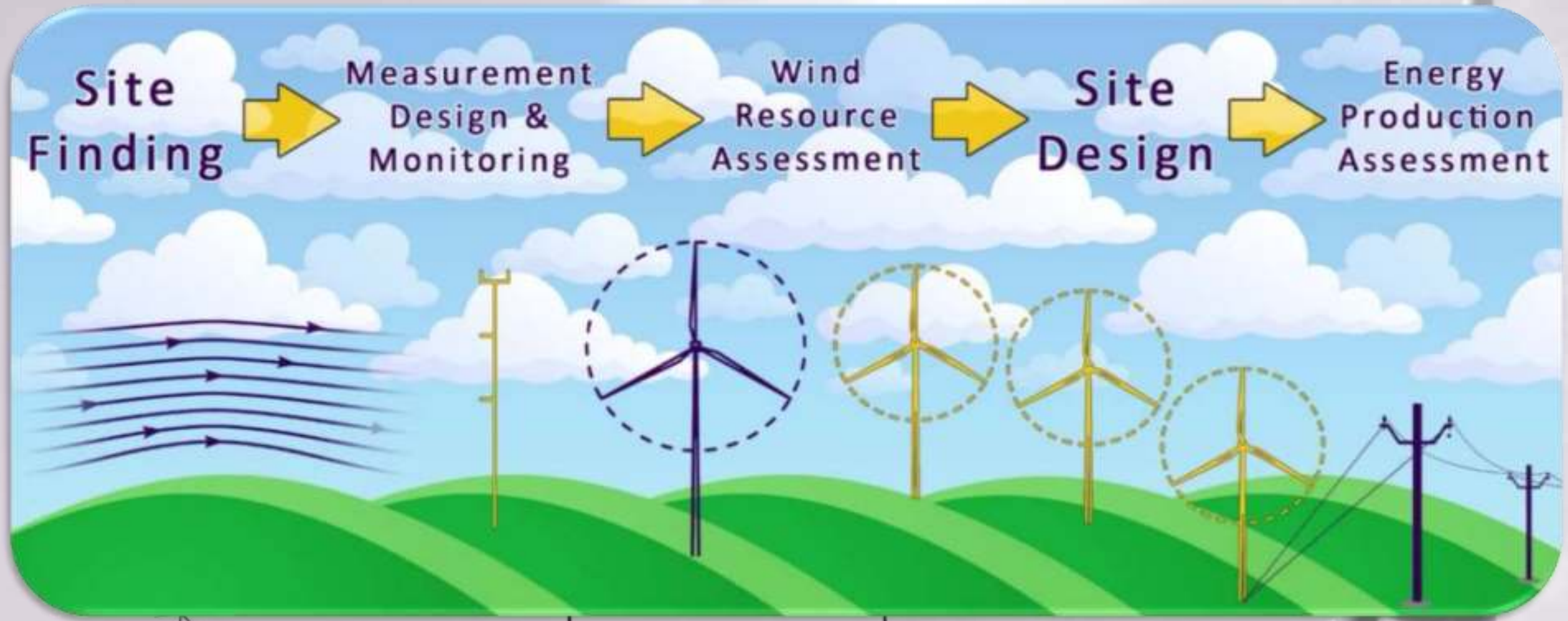
Jerry has a decade of experience working across wind markets in Asia. After a stint at Goldwind in Beijing he joined DNV GL and undertook bankable energy assessments across South and Southeast Asia. In 2016 he founded Wind Pioneers to serve emerging markets with access to flexible and powerful wind development engineering, from site prospecting through to bankable energy assessments. Wind Pioneers are now a team of 17 specialists and operating from their base in Bangalore have found 40GW of new sites and analysed more than 20GW of projects across more than 20 countries.

Developing onshore wind farms for the next generation of huge turbines

Asia WEA - *22nd September 2020*

Jerry Randall – jerry@wind-pioneers.com

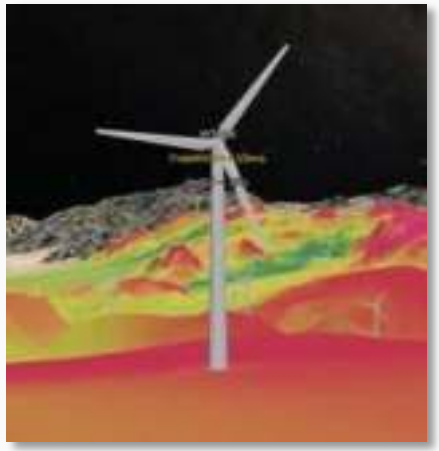
Wind Pioneers – Wind Farm Designers

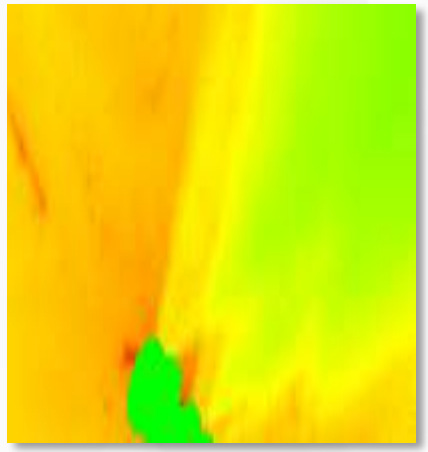


Huge Turbines For the Wind Farm Designer

Bigger Turbines Don't Just Reduce $/MW Capital Costs:

1) Concentrate Capacity on Best Areas of Site
2) Create More Efficient Layouts
3) Increase Net Capacity Factor

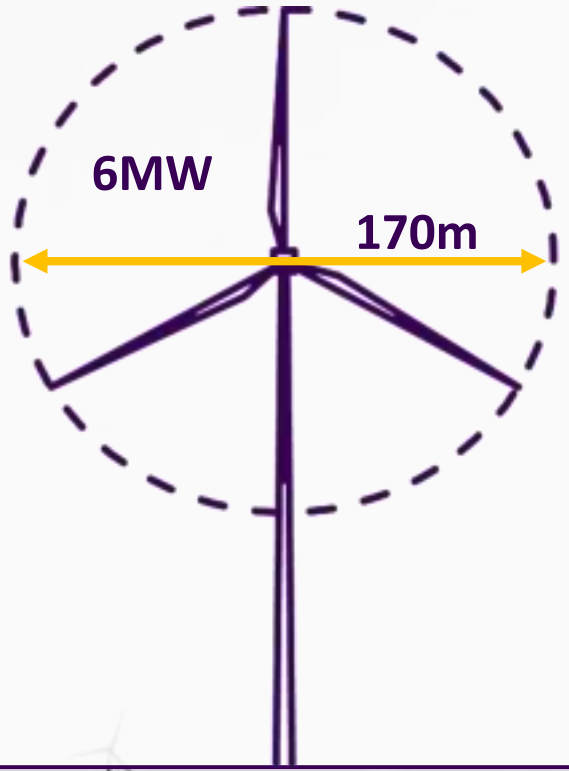




Turbines: Next Generation vs. Previous

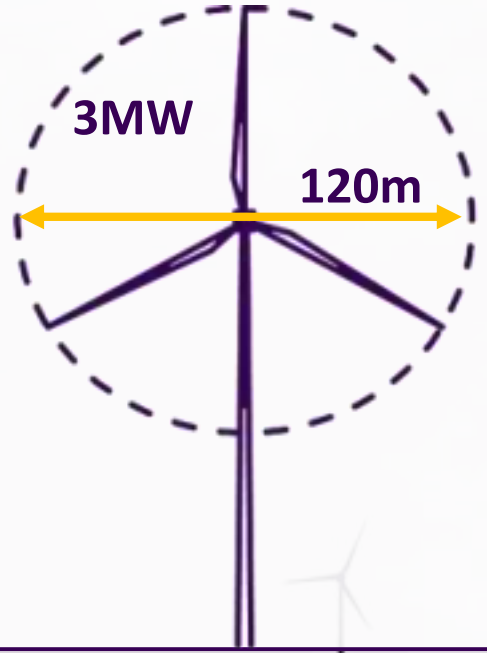
Next Generation 6MW Machine

SGRE170-6.0MW



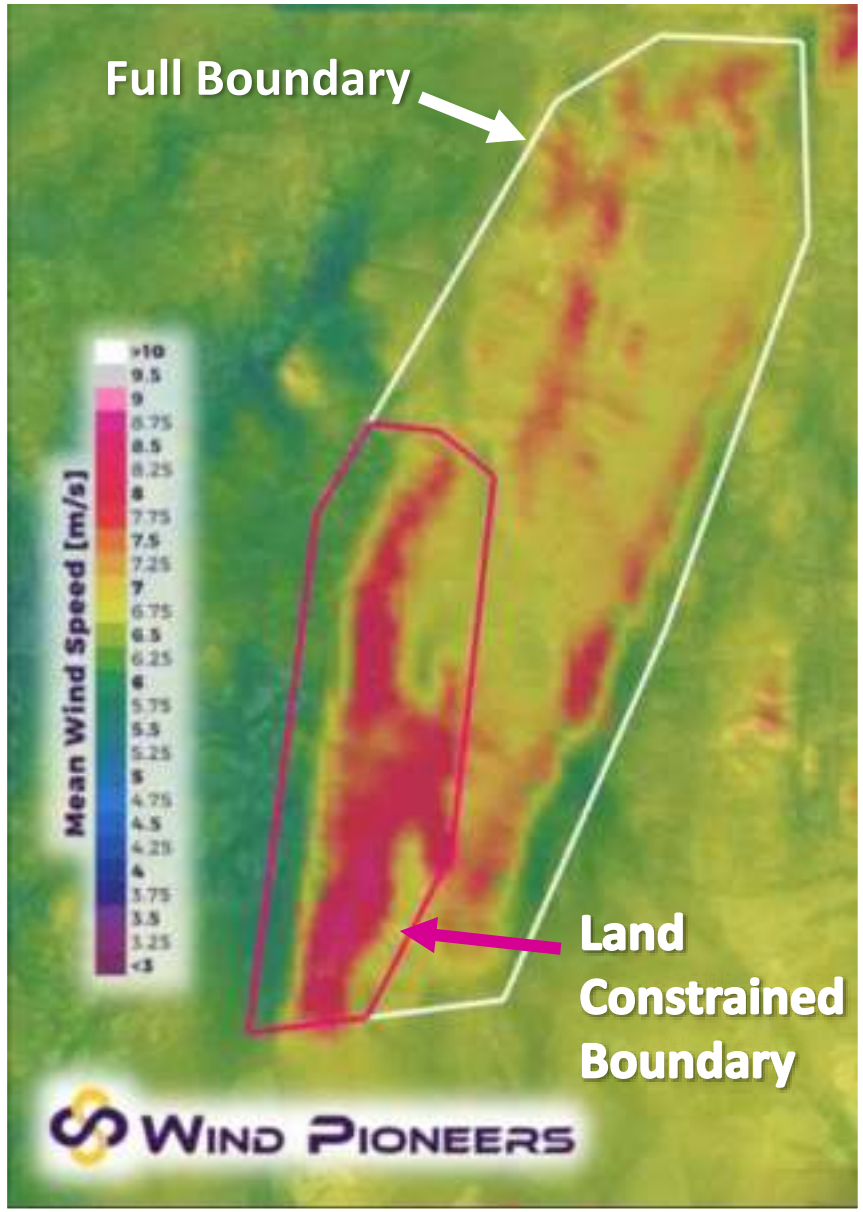
Imagined 3MW Machine

SGRE120-3.0MW
120m Rotor – half the swept area
Same power density



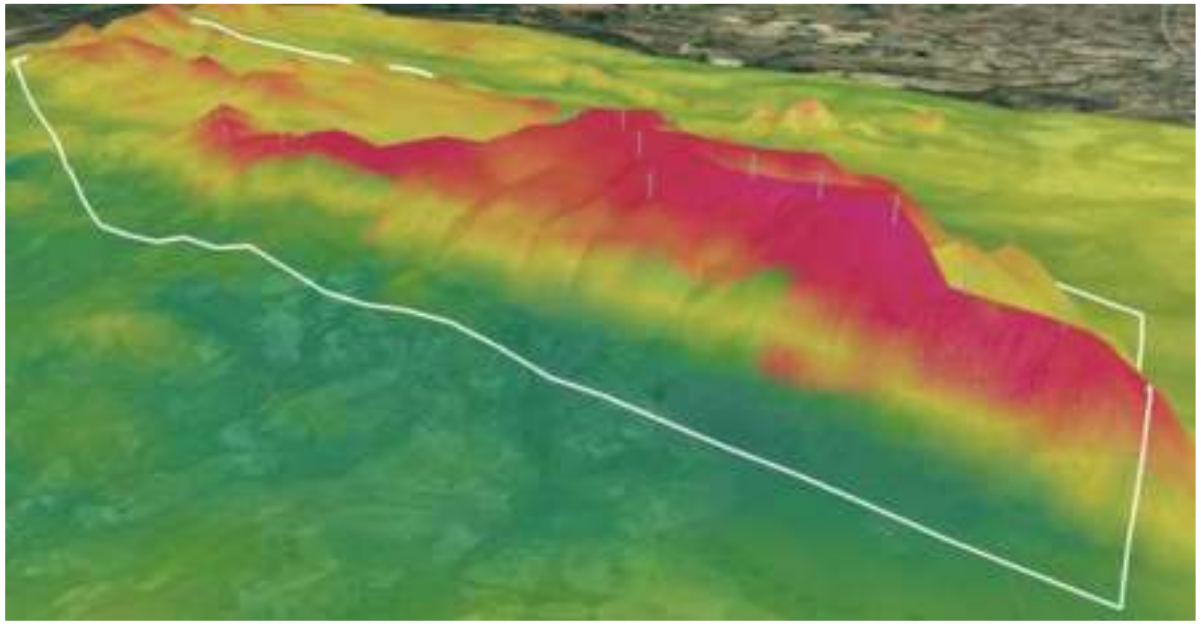
Both machines will have the same capacity factor at the same wind speed

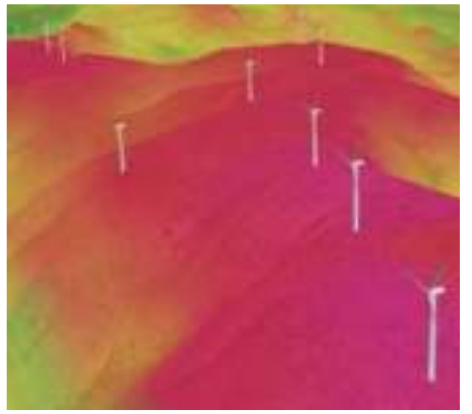
Test Site – What's the impact of BIG?

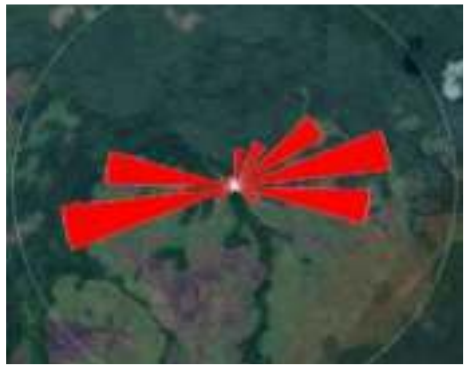


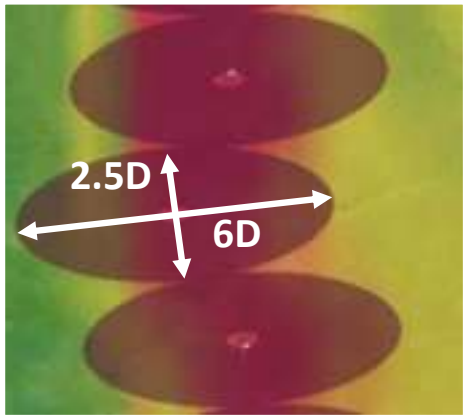
Test Site:

- Site on series of ridges
- Ridges perpendicular to prevailing winds
- Assume elliptical turbine spacing 6D x 2.5D
- Two scenarios – Capacity Constrained
  Land Constrained Boundary

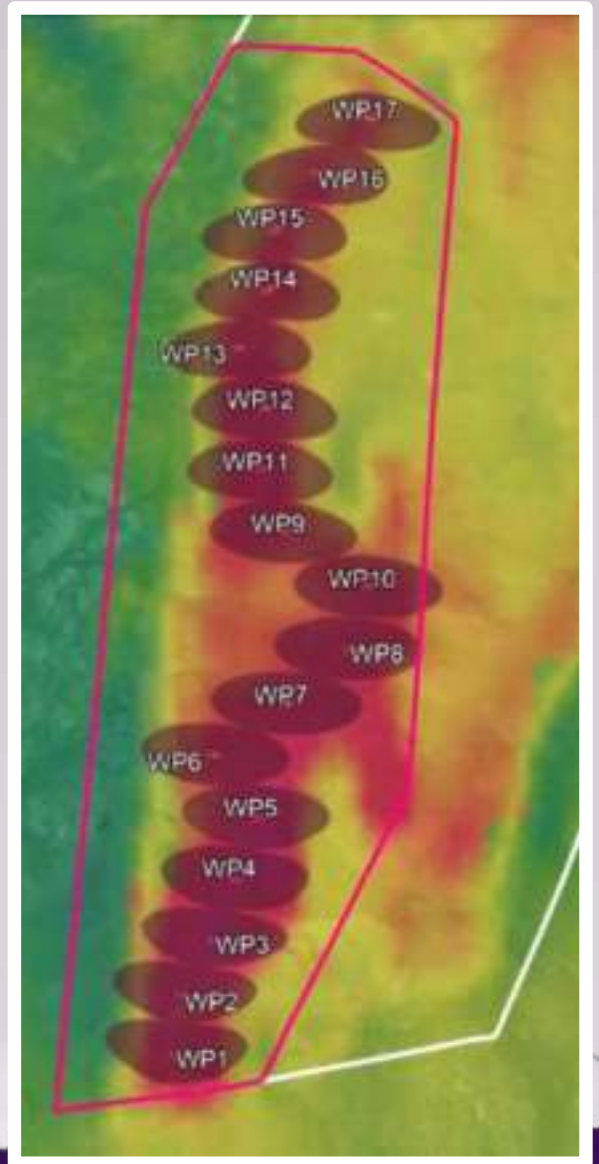








Case Study 1 – Land Constrained Site



BASE CASE – 6MW

17 WTG = 102MW

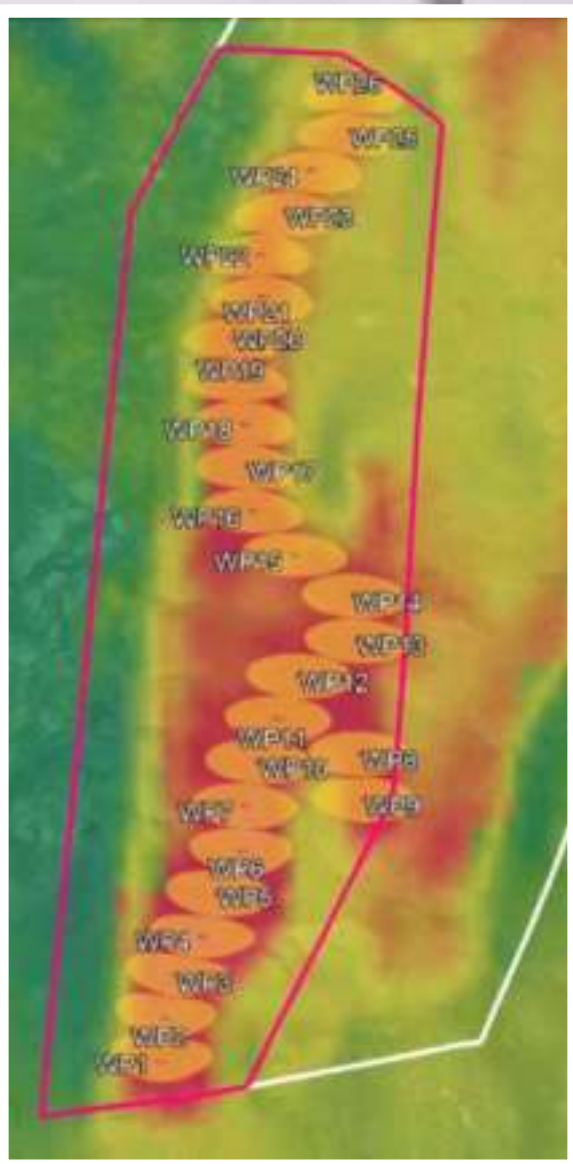
Bigger turbines
= concentrated capacity
= 30% bigger project

COMPARISON – 3MW

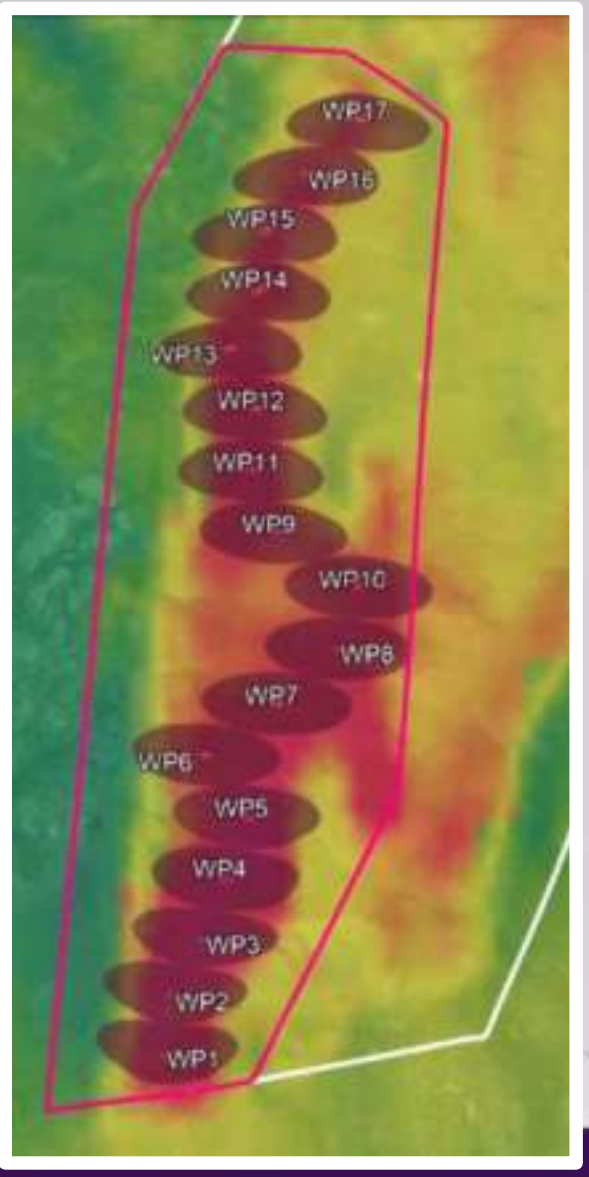
26 WTG = 78MW

More turbines
= higher wake losses
= Lower capacity factor

120	Hub Height [m]	120
6	Turbine Rated Power [MW]	3
17	Turbine Locations	26
102	Wind Farm Rated Power [MW]	78
8.13	Average HH Wind Speed [m/s]	8.08
449	Gross Output [GWh/a]	340
50.2	Gross Capacity Factor [%]	49.8
99.1	Wake Losses [%]	98.4
90.0	Non Wake Losses [%]	90.0
398	Net Output [GWh/a]	299
44.5	Net Capacity Factor [%]	43.8



Case Study 2 – Capacity Constrained Site



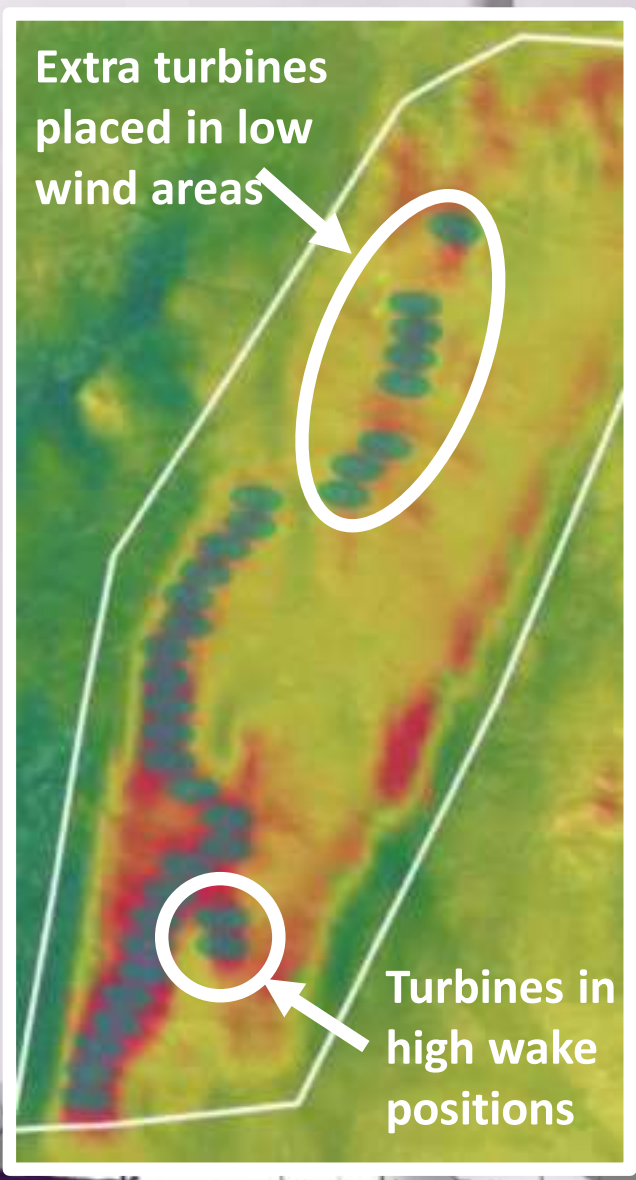
BASE CASE – 6MW
17 WTG = 102MW

Bigger turbines
= efficient use of ridge
= Higher capacity factor

COMPARISON – 3MW
26 WTG = 78MW

More turbines
= lower wind speed
= Lower capacity factor

120	**Hub Height [m]**	120
6	**Turbine Rated Power [MW]**	3
17	**Turbine Locations**	34
102	**Wind Farm Rated Power [MW]**	102
8.13	Average HH Wind Speed [m/s]	7.94
449	Gross Output [GWh/a]	435
50.2	**Gross Capacity Factor [%]**	48.6
99.1	Wake Losses [%]	98.3
90.0	Non Wake Losses [%]	90.0
398	Net Output [GWh/a]	382
44.5	**Net Capacity Factor [%]**	42.7



Designing for Huge Turbines

Prospecting
Finding sites suitable for huge machines

Early Studies
Are there red flags?

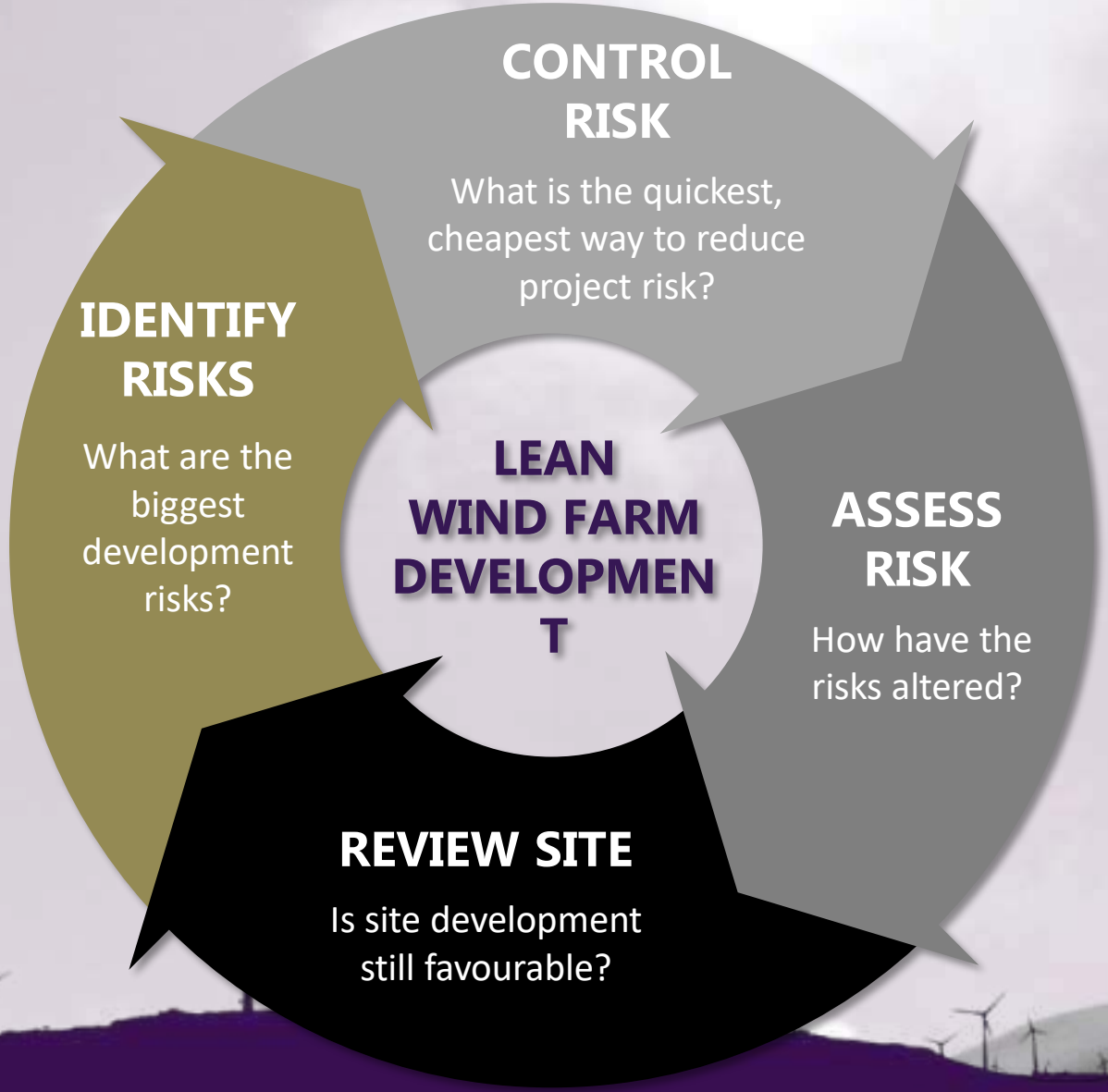
Measurements
Design measurement campaign for large turbines

Detailed Design
Technical studies inc. logistics & construction

Optimisation
Optimise site for huge machines

Success
A wind farm gets built!

The Importance of Being Lean



Conclusions

Two Major Advantages to Bigger Machines:

1) Cost reductions
2) Maximise site potential

Increasing viability and Net Present Value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AWEA WEBINAR SERIES 2020 - TECHNICAL SESSION
Developing onshore wind farms for the next generation of huge turbines
TUESDAY, 22 SEPTEMBER 2020 - 3 PM SGT

Q & A Session

Question 1

When do we see the 6+ MW onshore wind turbine?

Question 2

Is current transportation equipment on the market suitable for these big turbines and blades?

Question 3

Are they any new developments regarding installation and lifting for bigger turbines?

Question 4

What is the impact of bigger turbines on wind measurement and assessment?

Question 5

Do you expect that existing laws need to be changed for bigger turbines?

Question 6

What are the main challenges for projects in Vietnam?

Question 7

Will the offshore infrastructure need to be retooled to handle the larger machinery? Are there enough vessels?

Question 8

How was SG 5.8-170 tested before commercial operation ? Is it typhoon proof?

Question 9

Would like to know how leading-edge erosion (mainly due to monsoon rains and dust storms in India) is tackled. What's the latest technological advancements in LEE coatings/ tapes? How do you identify LEE just from SCADA data?

Question 10

When is SGRE coming up with >140m rotor diameter WTGs in India? Do you foresee any major challenges?

Question 11

Is the SG5.8-170 type-certified? If not, what is the expected date?

Question 12

A lot of the newer, larger designs deliver higher efficiency at lower/ medium windspeed. They are now increasingly proposed in more regions with typhoon/ cyclone exposure. Can you elaborate on if/how such an exposure is considered (windloads, etc), and the machines' resilience please?

Question 13

The picture on the OptimaFlex slide showed installation on a pretty rough terrain, including on a ridge line. What wind shear is allowed across these very large swept diameters?

Question 14

Are all the wheels on the multi-wheel specialized transport equipment, such as nacelle adaptors, individually steerable? If not, what would be the lateral load typically imposed on the road pavement?

Question 15

Where do you think the limit will be for turbine capacity and height?


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Closing

Information

Asia Wind Energy Association

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Asia Wind Energy Association

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CapitaGreen - Level 24
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Upcoming Webinars


Asia Wind Energy Association
IN PARTNERSHIP WITH
WIND PIONEERS
ANEMOS SOLUTIONS
SIEMENS Gamesa RENEWABLE ENERGY
AWEA WEBINAR SERIES 2020 - TECHNICAL SESSION
Developing onshore wind farms for the next generation of huge turbines
TUESDAY, 22 SEPTEMBER 2020 - 3 PM SGT

Thank You