

GE Renewable Energy Onshore Wind

2019 Business & Product Overview



Imagination at work.

**24 Internet-connected GE 2.85-103 wind turbines
Lake Huron, Ontario, Canada**

GE Renewable Energy

US\$10B Revenue, 13k Employees, 55 Countries



Jérôme Péresse, CEO
Paris, France



Onshore Wind

Delivering low cost energy solutions with differentiated products & services

2 & 3MW wind turbine platforms
Optimizing hardware to get the most out of the wind resource

Wind Services

Focus on customer outcomes, realizing
↑ AEP & profit over the lifetime of the fleet

Digital Wind Farm

A farm level solution- dynamic, connected
& adaptable wind energy ecosystem



Offshore Wind

Setting the benchmark for the marine energies industry

Fixed bottom offshore wind turbines:
Haliade* 150-6MW

Floating offshore wind turbines
Haliade* 150-6MW

Wind services

(preventive and corrective maintenance)

Tidal turbines

Oceade* tidal turbines platform,
including Oceade* 18 - 1.4MW, electrical
subsea hub



Hydro

Collaborating with customers as the #1 player in the hydropower market

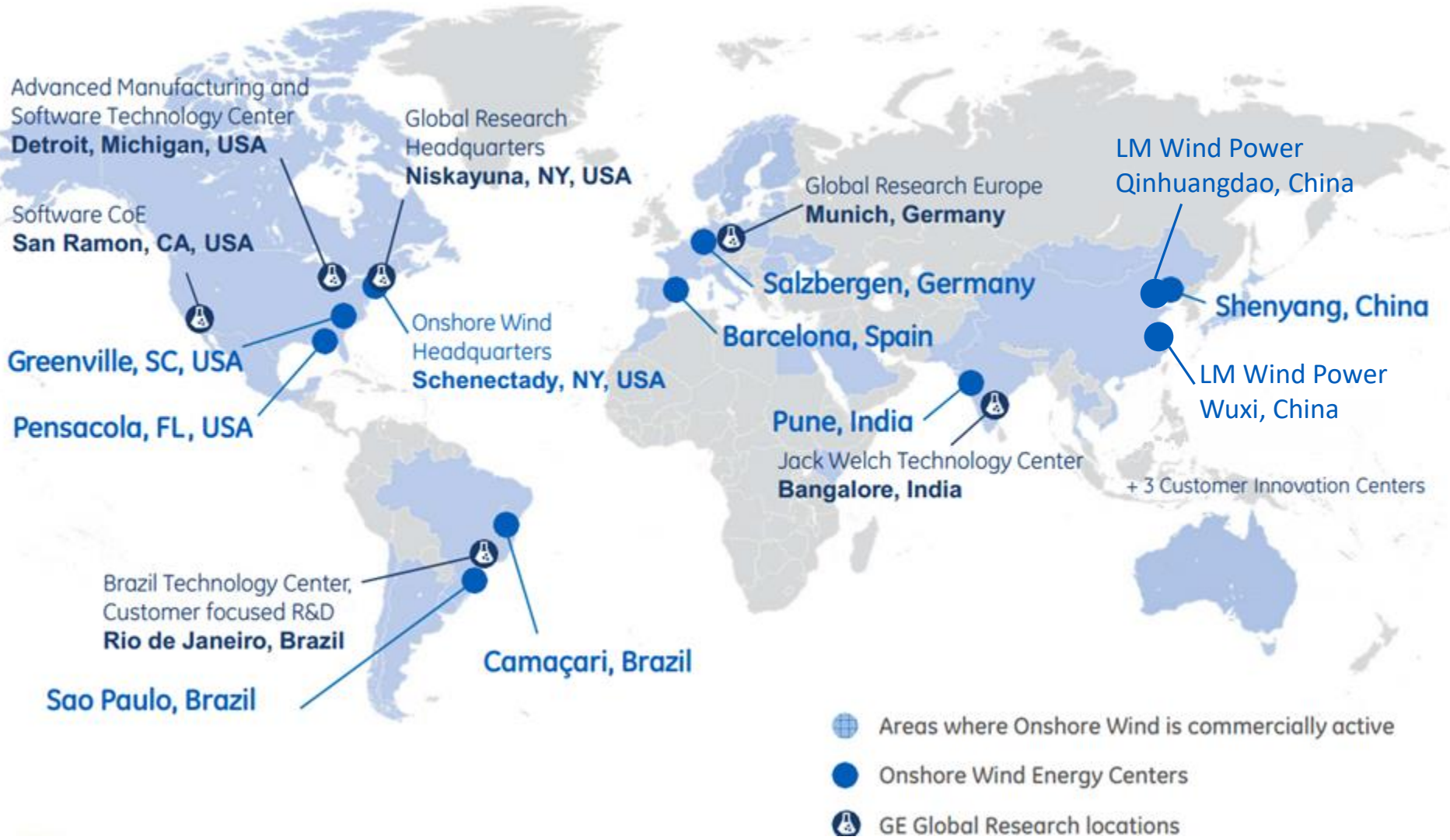
Hydropower solutions, products and services for:

- Low head hydropower plants
- Medium head hydropower plants
- High head hydropower plants
- Pumped storage hydropower plants
- Small hydropower plants
- Concentrated solar power plants
- Geothermal power plants
- Biomass power plants

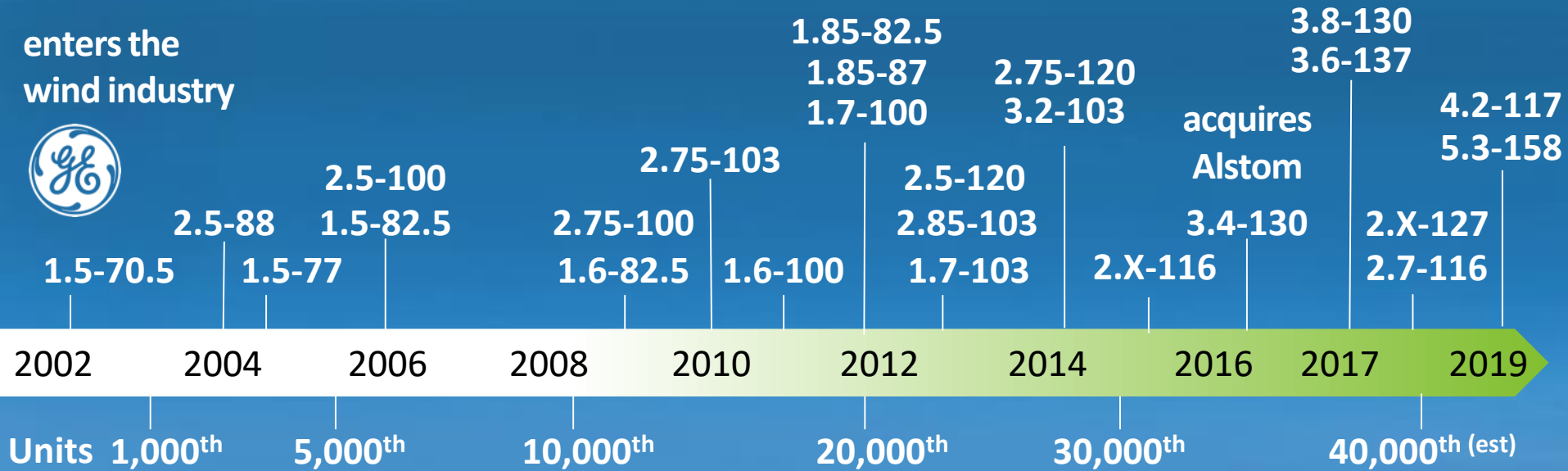
Powering our customers with the world's largest clean energy footprint



GE Onshore Wind



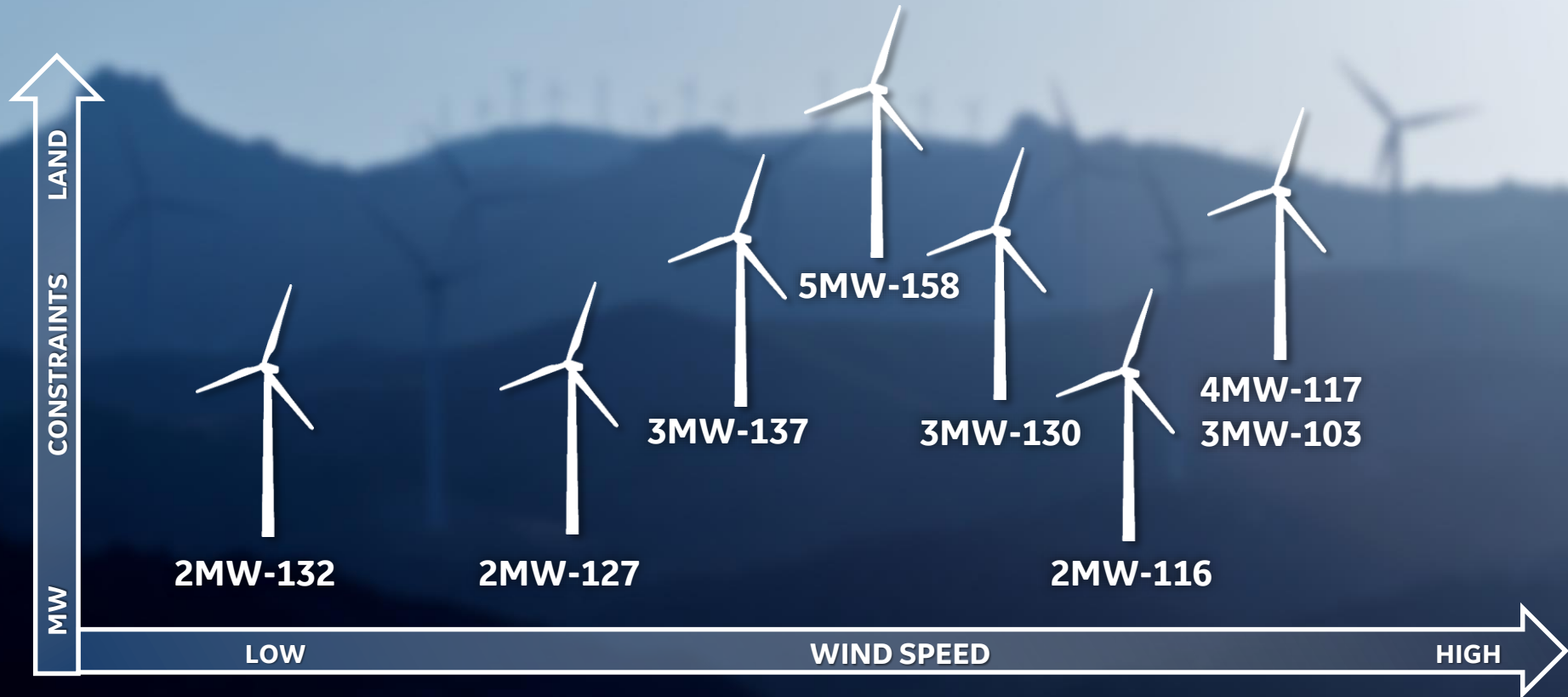
Evolution of the GE Portfolio



Nearing 40,000 deployed units and 20 years in wind



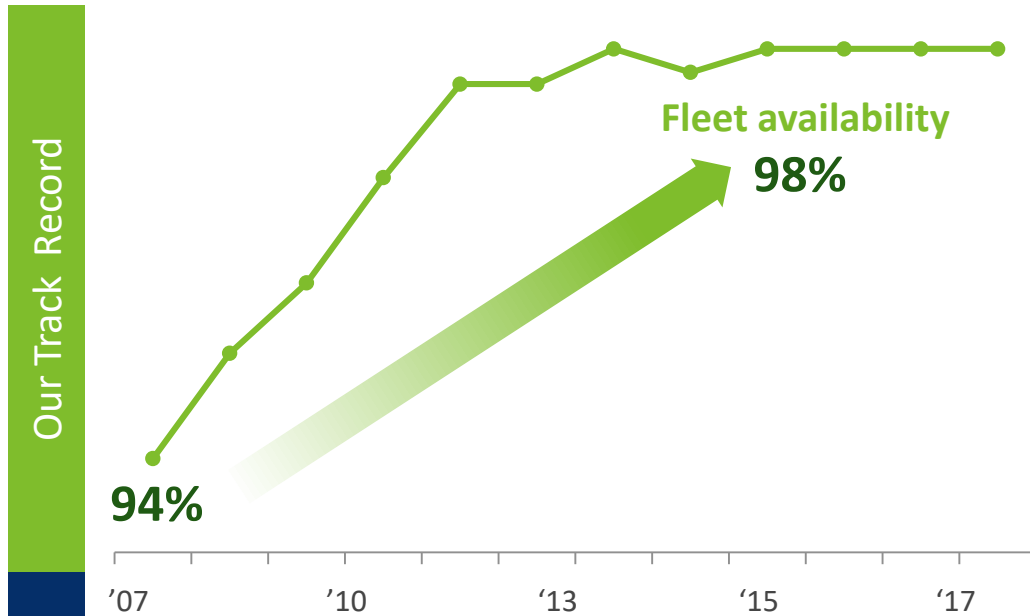
GE's diversified wind product portfolio



Enhancing farm economics for a broad range of site conditions



Industry leading fleet availability



2 Remote Operations Centers

11k turbines monitored 24/7/365

2 Repair Development Centers

Reduced downtime

120+ engineers

Committed to fleet reliability

150+ rules and algorithms

Early anomaly detection

6 minute

Remote Return to Service rate

325+ suppliers

Right parts right away

Time Based

Timely delivery of maintenance with laser focus on uptime

Production Based

More production with strategic maintenance during low wind periods

Our Guarantee



4.2-117

High power & strength ... for high wind and Typhoons

What's
NEW?

Advanced
aero blade

+

Electrical
upgrades

+

Typhoon
strengthening

3.2-103

>

3.8-130

>

4.2-117

4.2-117

IEC ed3 Wind Class

1S, 10 m/s

50-yr Vref

45 m/s

Gross AEP

20.3 GWh

Gross CF

54%

Hub Height

76.5, 85 m tube

Noise

107 dBA

Technology

- Model based controls
- Low noise trailing edge
- Typhoon strengthening
- Lightning enhanced blade
- Weak grid support



5.3-158

A new era in onshore wind

What's
NEW?

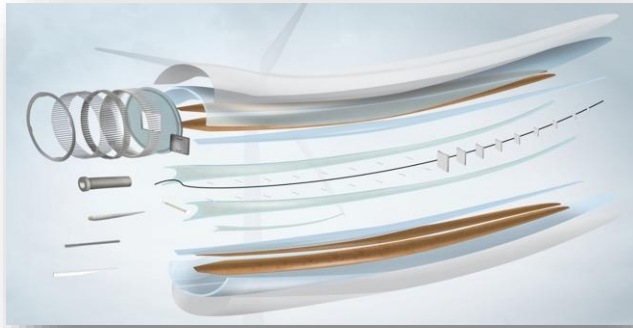
**NEW PLATFORM BUILT ON
PROVEN ARCHITECTURE**

5.3-158

Wind Class	IEC Class 3S
Gross AEP	~20 GWh @ 7.5 m/s
Hub Height	101 or 121 m tube, up to 161 m hybrid
Noise	106 dB, NRO modes down to 98dB
Design Life	25 years
Amb Temp	-15 to +40 deg C
DECS	Prov: Available, Full: Aug '19
Type Cert	Prov: Oct '19, Full: 2Q'20
Key Technology Changes	<ul style="list-style-type: none">• Carbon blade• Up-tower DFIG MV electrical• Loads management & control• AC pitch system



LM 77.4 P blade overview



Blade architecture & structure – LM design

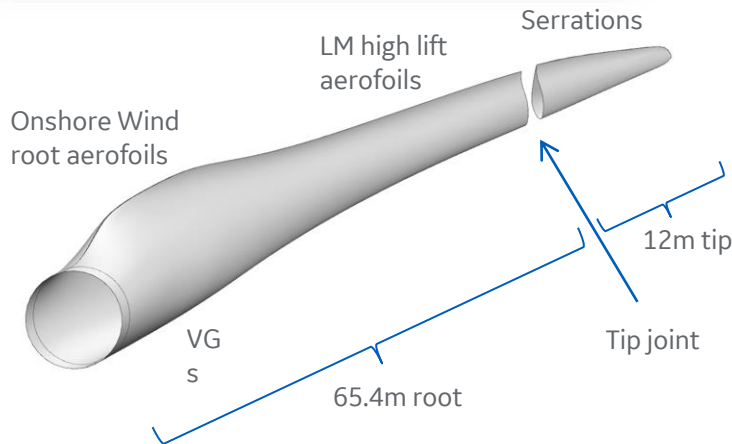
- Gelcoating
- UW & DW shells
- Carbon main spar
- Two shear webs
- LM root inserts
- Lightning system IEC 61400-24 Level 1

Blade geometry – Onshore Wind (ONW) lead

- Mix of ONW & LM profiles, fully tested in wind tunnels
- Optimized for aero add-ons (e.g., vortex generators, serrations)

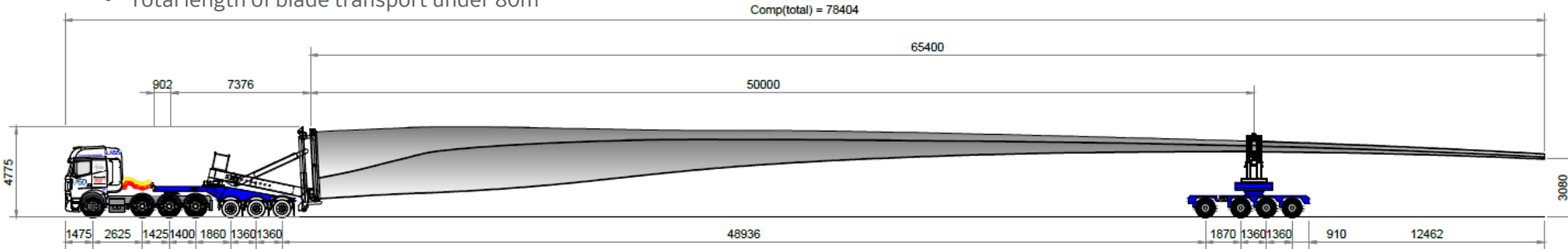
Tip joint

- Split line at 65.4m to allow for better site access & reduced transport cost
- Blade tip connection developed by ONW, LM, Blade Dynamics, GE Global Research
- Blade root and tip joint connected at site through simple mechanical assembly



Blade logistics to site

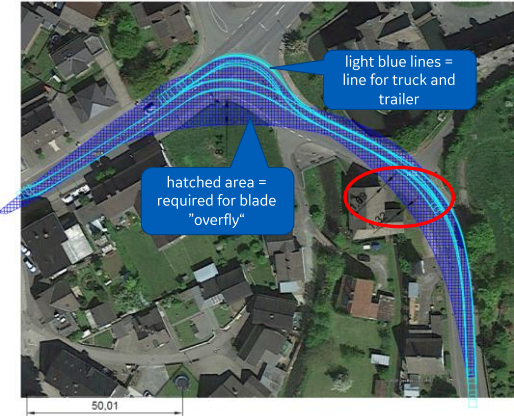
- Example of blade root end transported with Schnabel-Dolly system...depending on country and project, a super wind carrier may be possible
- Total length of blade transport under 80m



Sample road study for a project in Germany

65.4m split blade on 78m transporter can pass – longer transports fails

Flexibility with tip clamp positions at 45m, 50m, 54m, 57m



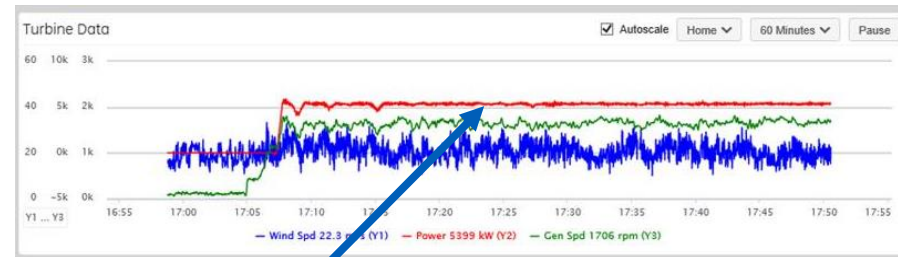
Cypress Validation Unit

Validation Unit #1 status:

- Site is located in ECN test field, Netherlands
- Validation machine Installation completed ✓
- First time online, 1st kWh Feb'19 ✓
- Rated power reached, 5.3MW, March '19 ✓
- Commissioning finalized: Early March '19 ✓
- Operability phase: March/April '19

Validation campaign:

- Installation of turbine power curve and load measurement systems ✓
- Power curve, noise & loads measurement starting in April'19
- Full blade static and fatigue tests at LM, expected complete 2Q'20
- 100+ tests of component, subsystem, operability, serviceability planned



Rated Power
5.3 MW



