Developments in wind power turbine technology: Taiwan and typhoons
Innovation and performance improvement.
From an on-shore turbine to a purpose build offshore turbine
9 MW Platform
Controlled product development based on initial platform development and incremental steps

- We are **building on the experience** from our V164-8.0/8.4 MW WTG since 2014
- Product optimisations are introduced in **incremental steps**, enabling us, our customers, banks and advisors to **benefit from the Type Certification** of the V164-8.0 MW
- The **track record and field experience** makes the V164-9.5/10.0 MW WTG a low risk choice
- V164-9.5/10.0 MW 60 Hz and **IEC T**
- V174-9.5 MW 50/60 Hz is a **new variant based on same platform design, also IEC T**
9 MW Platform development history
From 8.0 MW to 10.0 MW in 4 years – proven concept, commercially available

Jan 2014
Installation of 8 MW prototype at Oesterild, DK

May 2014
Prototype runs in unattended mode. Start of test and verification

Nov 2014
Provisional Type Certificate received

Jun 2014
Start production of 0-series turbines

Mar 2015
Type Certificate received

Dec 2014
Completed load and Power Curve measurements

Sep 2016
First installation: Burbo Bank Extension, UK

Oct 2015
Start serial production

Jan 2016
Two onshore pilot turbines installed in Maade, DK

Dec 2016
24 hour power record as 9 MW wind turbine is launched (216 MWh in 24hrs)

Feb 2017
Launch of the V164-9.5 MW

Jun 2017
Final component Certificate for V164-9.5 MW

June 2018
Provisional Type Certificate for V164-9.5 MW

Dec 2018
Received Provisional Type Certificate for V164-9.5 MW

May 2018
9 MW Platform turbine # 100 installed at BRII

September 2018
Launch of the V164-10.0 MW

Feb 2019
Launch of the V174-9.5 MW
The first double digit commercial offshore wind turbine
The V164-10.0 MW™ is commercially available, and ready for installation from 2021

- Built on **proven technology** with a strong track record from the 9 MW Platform family
- More than **200 V164 turbines have already been installed**
- **Minor upgrades** required:
  - a stronger gearbox
  - minor mechanical upgrades
  - a small design change to enhance air flow and increase cooling in the converter
- Upgrades ensure the V164-10.0 MW can run at full power, at a site with wind speeds of 10 m/s, for 25 years
Our largest rotor and IEC T class turbine introduced
The V174-9.5 MW™ is commercially proven

- Built on **proven technology** with a strong track record from the 9 MW Platform family
- **Minimal design changes** required
- Configured for **worldwide application**, engineered for **IEC T**
- New 85-meter blade design profile, engineered to maximise **annual energy production**
  - Minimising structural loads, the advanced pre-bend blades are aerodynamically efficient
  - Each blade weighs 35 tonnes, same as the V164-9.5 MW 80-meter blade
**Dimensions of the V174-9.5 MW™**

Nearly 3 times the height of the Miramar Ferris Wheel

<table>
<thead>
<tr>
<th>Dimensions</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Swept area</td>
<td>23,779 m²</td>
</tr>
<tr>
<td>Power</td>
<td>9.5 MW</td>
</tr>
<tr>
<td>Blade length</td>
<td>85 m</td>
</tr>
<tr>
<td>Approx. hub height</td>
<td>110 m</td>
</tr>
<tr>
<td>Rotor diameter</td>
<td>174 m</td>
</tr>
<tr>
<td>Approx. tip height</td>
<td>197 m</td>
</tr>
<tr>
<td>Weight (excl. tower)</td>
<td>~ 500 t</td>
</tr>
</tbody>
</table>

V174-9.5 MW

197 m high

Miramar Ferris Wheel

70 m high
Readiness for the Taiwanese market
Demanding conditions to be considered

- Taiwanese market sees some **pronounced environmental conditions**
- Typhoon wind conditions are the most critical and need to be **carefully considered**
- We have worked **closely with customers** to understand these conditions
- The conditions are input into the **design and development process**
Readiness for the Taiwanese market
Work with certifying body and order pipeline support the introduction of a mature product

- MHI Vestas has worked closely with DNV GL as certifying body to ensure that the 9 MW platform variants can be **certified** for the demanding Taiwanese site conditions, making the WTG ready for typhoon conditions.

- This **early alignment** with DNV GL confirms to customers, banks and advisors that MHI Vestas is **fully prepared for and committed** to the Taiwanese market.
Readiness for the Taiwanese market
9 MW Platform, 60 Hz Class T ready for projects from 2020

- Manufacturing of 9 MW Platform turbine ready to commence early 2020 with the following configuration:
  - Configured to 60 Hz operation
  - Operation in extreme wind

- Designed to operate in areas prone to tropical storms with **extreme wind speeds**

- Accommodating **local legislation and design standards**
Let’s move the horizon.