WinDS3000/3300/5500 & WinDS8000+

Doosan has accumulated extensive know-how as a specialist in power generation facilities over the past 30 years, and has leveraged these competencies to develop the WinDS3000/3300 and WinDS5500. These models offer strong reliability and availability, ease of maintenance and service, and low cost of electricity production. Through system optimization, we have achieved both outstanding reliability and excellence in operational and maintenance efficiency.

NEW PARADIGM OF WIND POWER SYSTEM FOR OFFSHORE & ONSHORE

- Optimal aerodynamic design for both performance increase and load reduction
- Advanced blade materials for minimum weight
- Turbine design together with thorough component testing to prove machine life
- Innovative drive train design to improve reliability
- Low maintenance with permanent magnet generator
- Grid-friendly characteristics with full power converter

TECHNICAL INFORMATION

Power Curve

<table>
<thead>
<tr>
<th>Wind Speed (m/s)</th>
<th>WinDS3000</th>
<th>WinDS5500</th>
<th>WinDS8000+</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0,000</td>
<td>0,000</td>
<td>0,000</td>
</tr>
<tr>
<td>5</td>
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<td>7</td>
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<tr>
<td>9</td>
<td>0,000</td>
<td>0,000</td>
<td>0,000</td>
</tr>
<tr>
<td>11</td>
<td>0,000</td>
<td>0,000</td>
<td>0,000</td>
</tr>
<tr>
<td>13</td>
<td>0,000</td>
<td>0,000</td>
<td>0,000</td>
</tr>
<tr>
<td>15</td>
<td>0,000</td>
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<tr>
<td>17</td>
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</tr>
<tr>
<td>19</td>
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<td>0,000</td>
</tr>
<tr>
<td>21</td>
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</tr>
<tr>
<td>23</td>
<td>0,000</td>
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</tr>
<tr>
<td>25</td>
<td>0,000</td>
<td>0,000</td>
<td>0,000</td>
</tr>
</tbody>
</table>

* Estimated

WIN TURBINE LINE-UP

BENEFITS

- WinDS3000/3300 are more suitable for the areas of low wind and applicable to both on/offshore
- WinDS5500 is more efficient for the areas of strong wind and specialized in offshore
- WinDS8000+ is specialized in low wind areas of offshore wind farm
- Doosan’s Standard Quality Program can be applied with accumulated experiences in power sector
Wind Power Total Solution Provider

As a leader in EPC, Doosan designs and manufactures complete wind turbine generator systems for offshore and onshore wind farms, and also offers comprehensive operation and maintenance (O&M) services, from setting up a wind power project to O&M throughout the project’s entire life cycle.

<table>
<thead>
<tr>
<th>Operational Data</th>
<th>WinDS3000</th>
<th>WinDS3300</th>
<th>WinDS5500</th>
<th>WinDS8000*+</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td>(on/offshore)</td>
<td>(on/offshore)</td>
<td>(offshore)</td>
<td></td>
</tr>
<tr>
<td>Rated Power</td>
<td>3,000kW</td>
<td>3,300kW</td>
<td>5,560kW</td>
<td>8,000kW</td>
</tr>
<tr>
<td>Class</td>
<td>S</td>
<td>S</td>
<td>IB</td>
<td>IB</td>
</tr>
<tr>
<td>Cut-in Wind Speed</td>
<td>3m/s</td>
<td>3m/s</td>
<td>3.5m/s</td>
<td>3.5m/s</td>
</tr>
<tr>
<td>Rated Wind Speed</td>
<td>11m/s</td>
<td>11m/s</td>
<td>13m/s</td>
<td>13m/s</td>
</tr>
<tr>
<td>Cut-out Wind Speed</td>
<td>20m/s</td>
<td>20m/s</td>
<td>25m/s</td>
<td>25m/s</td>
</tr>
<tr>
<td>Rotor Diameter</td>
<td>134m</td>
<td>134m</td>
<td>140m</td>
<td>190m+</td>
</tr>
<tr>
<td>Rated Rotor Speed</td>
<td>10.7rpm</td>
<td>10.7rpm</td>
<td>12.2rpm</td>
<td>TBD</td>
</tr>
<tr>
<td>Extreme Survival Wind Speed</td>
<td>59.5m/s</td>
<td>59.5m/s</td>
<td>70m/s</td>
<td>70m/s</td>
</tr>
<tr>
<td>Blade Length</td>
<td>65.5m</td>
<td>65.5m</td>
<td>68m</td>
<td>90m+</td>
</tr>
<tr>
<td>Tower Hub Height</td>
<td>90,120m (Site-specific)</td>
<td>90,120m (Site-specific)</td>
<td>Site-specific</td>
<td>Site-specific</td>
</tr>
</tbody>
</table>

* Estimated
Doosan Wind Turbine Operation & Maintenance

Doosan uses its own technologies to offer information and communication technology (ICT) solutions which maximize capacity and optimize both wind turbine farm operations and resource management.

Our integrated ICT monitoring system is an optimal solution for operating wind turbines. It facilitates the management of power generation, monitors the status of wind turbine operations, and diagnoses the status of major components, such as gearboxes and main bearings, in real time. In addition, it utilizes efficient inventory and fault history management to optimize operational efficiency, and thus maximize availability and capacity for wind turbine farms.

The ICT system uses wind turbine data to enhance operational efficiency, which in turn enhances customer profitability.

Benefits
- Real time prediction of defects and errors
- Optimized inventory management
- Lifetime extension of wind turbines
- Mobile monitoring and remote control
- Fast and immediate actions
- Maximization of availability and capacity factors

<table>
<thead>
<tr>
<th>Site</th>
<th>Name</th>
<th>Tamra Offshore</th>
<th>Jeonnam</th>
<th>Sangmyeong</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capacity</td>
<td>30MW</td>
<td>42MW</td>
<td>21MW</td>
<td></td>
</tr>
<tr>
<td>Average availability (%)</td>
<td>99.82</td>
<td>98.47</td>
<td>99.59</td>
<td></td>
</tr>
</tbody>
</table>

Average Availability: 99.1% (as of August 2018)

Doosan ESS Solution with Renewable Energy

Doosan delivers innovative, technology-based solutions to meet the challenges of the constantly-changing energy industry, and is embarking on initiatives to open new markets in partnership with its customers.

Output of electricity from renewable energy resources fluctuates significantly due to environmental factors such as the weather or seasonality. This makes it difficult for electric utilities to maintain a steady supply of high quality electric power. The intermittent nature of renewable energy also makes it difficult for ‘energy prosumers’ — end users who also produce energy themselves by capturing resources including solar energy — to save on electricity by producing and consuming electric power efficiently.

We therefore offer our customers total technology solutions that include platform-based control system software for energy storage system (ESS) and distributed generation, which helps customers turn obstacles into opportunities and also improve profitability.

ESS Configuration

```
Electric generation sources  End users
     ↓                       ↓
ESS control system software  PCS (AC-DC-AC)
     ↑                       ↑
Battery (Cell & BMS)
```
Doosan has developed the first 3MW class on/offshore wind turbine generator in Korea, the WinDS3000/134, and has won contracts using its own technologies totaling output of more than 200MW.

Doosan has extensive experiences in engineering, procurement and construction (EPC), as well as in operations for various on/offshore projects. Doosan recently launched a new model, the WinDS5500/D140, and is developing an 8MW+ model especially for offshore wind farm projects. The 8MW+ model will help to expand the market for wind energy by making it possible for wind energy to compete with other energy sources at low cost.

**DOOSAN’S CORE COMPETENCIES & BENEFITS**

As an original equipment manufacturer (OEM) for the wind power industry and an EPC player, Doosan is developing a full range of wind turbines that are more reliable and suitable for diverse and highly volatile environments.

**SUCCESSFUL EXPERIENCE IN OFFSHORE WIND FARM**
- Tamra offshore wind farm (30MW) — the first offshore wind farm EPC experience in Korea
- Total solution provider of wind farm including EPC, O&M and financing

**ORIGINAL EQUIPMENT MANUFACTURER OF OFFSHORE WIND POWER SYSTEMS**
- Wind turbine suitability assessment and analysis through wind source/environment
- Optimized components design including subsea foundation structure

**INHERENT TECHNOLOGY FOR CONTROL LOGIC AND SOURCE CODE**
- Fast trouble shooting and product reliability
- High availability ensured by differentiated O&M services

**CUSTOMIZED VALUE MAXIMIZATION PROVIDED BY AN EPC PLAYER**
- Flexible business solutions ranging from equipment to EPC
1. Yeongheung Phase I (D91) 6MW KOEN
2. Yeongheung Phase II (D91) 24MW KOEN
3. South-West Offshore Phase I (D100/D134) 60MW KOWP
4. Gunsan Offshore (D100) 3MW KEPRI
5. WinDS3000/134 Prototype 3MW DHI (R&D)
6. Yeonggwang (D100) 3MW EWP
7. Jeonnam (D100) 42MW SERVEONE
8. Shinan (D91) 9MW POSCO ICT
9. Jangheung (D134) 18MW KWP
10. Gyewol-ri (D100) 3MW LG CNS

**In operation** 158.5MW

**Under construction** 78MW

**TOTAL** 236.5MW

*As of July 2018

11. Jeju Hangwon Offshore (D91) 3MW Jeju Provincial Government
12. Woljeong Offshore (D91) 3MW DHI (R&D)
13. Woljeong Village (D100) 3MW LG CNS
14. Gimnyeong (D140) 5.5MW DHI
15. Tamra Offshore (D91) 30MW Tamra Offshore (SPC)
16. Sangmyeong (D91) 21MW KOMIPO

KOEN: Korea South-East Power Co.
KOWP: Korea Offshore Wind Power
EWP: Korea East-West Power Co.
KOMIPO: Korea Midland Power Co.
KEPRI: Korea Electric Power Research Institute
KWP: Korea Western Power

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**Doosan Heavy Industries & Construction**

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