Clipper Windpower is a rapidly growing company engaged in wind energy technology, turbine manufacturing, and wind project development. With offices in the USA (California, Colorado, Iowa and Maryland), Mexico, Denmark and the United Kingdom, and a ISO 9001:2000 QMS Certified, 330,000 square foot manufacturing and assembly facility located in Cedar Rapids, Iowa, the company designs advanced wind turbines, manufactures its 2.5-MW Liberty wind turbine and actively develops wind power generating projects in the Americas and Europe. Clipper is a public company listed on the London Stock Exchange’s Alternative Investment Market (AIM). Clipper’s ticker symbol is CWP.

The ordinary shares of Clipper Windpower Plc are traded on the Alternative Investment Market of the London Stock Exchange and are not registered under the U.S. Securities Act of 1933 as amended. Such shares may not be offered or sold to residents of the United States or to persons acting on their behalf, or to other persons who are “United States Persons” within the meaning of Regulation S as promulgated under the Securities Act of 1933, unless such shares have been registered under the Securities Act or there is an available exemption from registration.
The Liberty 2.5 MW wind turbine brings the wind industry’s most valued design standards together with Clipper’s purpose-engineered technologies to tackle the industry’s most critical technology limitations – namely, the recognized drivers of unscheduled maintenance expense – downtime associated with gearbox stresses, large component change-outs and unscheduled crane call-outs.

Beginning with a horizontal-axis, 3-blade, upwind, pitch-regulated, variable-speed architecture, Clipper integrated its Quantum Drive® distributed drive train, a two-stage, helical load-splitting gearbox, four separate MegaFlux® permanent magnet synchronous generators, and controls optimized for variable-speed operation with full power conversion.

A number of innovative features were also added to increase worker safety, and provide ease of machine serviceability.

The Liberty turbine was designed by Clipper in partnership with the U.S. Department of Energy ("DOE") and its National Renewable Energy Laboratory ("NREL"), which provided funding for development as well as facilities and support for extensive drivetrain and blade testing. As a result, an ‘Outstanding Research and Development Partnership Award’ was issued to Clipper by DOE in 2007, highlighting Clipper’s “outstanding contribution toward industry advancements,” and recognizing “the Liberty wind turbine, which attained unparalleled levels of efficiency and reliability and reduced cost of energy.”

In March 2009, an independent due diligence review of the Liberty wind turbine technology was conducted by Garrad Hassan America, Inc. ("GH") on behalf of Clipper. The GH Report concluded: “Overall, GH considers the Clipper turbine design to be reasonable though novel, and the technology to be sound.”
GH notes that even some established gearbox manufacturers have struggled to meet the stringent design and manufacturing quality standards required for wind turbine applications. GH takes comfort in the fact Clipper is subjecting 100% of its production gearboxes to full load testing.

**LIBERTY 2.5 MW WIND TURBINE – KEY FEATURES**

- Quantum Drive® distributed powertrain
- Four MegaFlux® permanent magnet generators
- Variable speed technology
- IEEE 519 power quality, exceeds standards
- Extended low voltage ride-through capability
- Design architecture accommodates 50 or 60 Hz
- SCADA monitoring & control system
- CBMS predictive maintenance system
- Multiple gear inspection ports in powertrain
- Two-person service lift
- Service platform with safe and ample work area
- Internal 2-ton hoist
- Hub accessibility from inside the nacelle
- Comprehensive lightning protection
- Crane size requirement for installation similar to 1.5 MW unit
- GL certified cold weather capability
- Rotor diameter choices for optimized power generation
- Full Power Conversion
- Generator cooling: Water-to-air or air-to-air configurations

"GH notes that even some established gearbox manufacturers have struggled to meet the stringent design and manufacturing quality standards required for wind turbine applications. GH takes comfort in the fact Clipper is subjecting 100% of its production gearboxes to full load testing."
# JUST THE FACTS

## FEATURE DETAIL BENEFIT

### Quantum Drive™

**Distributed Powertrain**

Liberty utilizes a compact, two-stage helical, distributed load path powertrain.

- Four smaller high speed shafts distribute the output to four generators, reducing the potential for premature bearing failures and decreasing time and cost associated with generator service and repair.
- Two pre-loaded, low-speed taper roller main bearings absorb thrust loads and mitigate problematic axial motion and mainshaft misalignment associated with low speed bearing failures.
- High-speed gear sets are in “cartridge” form. Replacement is conducted by way of an onboard hoist without removal of the gearbox, eliminating the need for expensive crane mobilization.
- Multiple inspection ports facilitate simple access for visual observation of the gears, enabling a more rigorous operations and maintenance protocol and earlier detection of abnormal wear.

**Increased reliability and durability. Higher efficiency in comparison to three-stage powertrain designs.**

### MegaFlux™

**Permanent Magnet Generators**

- Permanent magnet generators offer advantages over induction generators in terms of increased power density, increased efficiencies at lower wind speeds, improved low-voltage ride-through capability when combined with full power conversion, and simplicity of design.
- Does not utilize slip rings or brushes. Historically, slip rings have been a maintenance issue requiring replacement more frequently than anticipated.
- Stray current-induced pitting and bearing failures inherent in doubly-fed generators is eliminated, substantially extending bearing life.

**Nearly maintenance-free operation with higher efficiency, increased energy production, and a lower VAR requirement.**

### Variable Speed System

- System is based on larger capacity IGBT’s and proprietary permanent magnet generator technology which provides simpler, more reliable, more cost effective variable speed operation.

**Higher energy capture. Increased productivity.**

### Full Power Conversion

- Grid Isolation. Clipper’s variable speed generator and inverter system completely decouples the generator from the grid, eliminating grid induced drivetrain torque excursions.
- Power Factor Control. Enables the operation with selectable power factor to near unity and as low as five percent load which minimizes or eliminates the need for VAR correction.
- Passive Rectifier. Conversion of the generator alternator output to direct current for the input to the variable speed inverter offers a simpler variable speed system compared to other wind turbine designs.
- Unidirectional Power Flow. Clipper’s variable speed inverter system is simpler, utilizes fewer parts, and delivers power exclusively from the generator’s rotor requiring high-power slip rings and brushes.
- Meets or exceeds IEEE 519 high quality power requirements worldwide now common in all major electricity power markets.

**Lower operating and maintenance costs. Siting versatility. Improved gearbox reliability.**

### Low Voltage Ride-Thru

- The Clipper system stays online, helping to stabilize weak grid systems. The system provides low voltage ride-through capability of up to 3 seconds down to 10% of nominal voltage and for 150 msec down to zero percent, exceeding all low voltage ride-through requirements. Clipper’s system exceeds the most stringent grid requirements now in planning, enabling integration into the strictest regulatory environments.

**Provides siting versatility and enables greater wind penetration on a given grid system.**

### JUST THE FACTS

**TM**

- Increased productivity.
- Increased reliability.
- Reduced downtime, and greater energy capture.
- Lower operating and maintenance costs.
- Improved gearbox reliability.
- Siting versatility.
- Increased reliability and productivity.
- Reduced downtime and long-term operating costs.
- Increased reliability and productivity and decreased downtime.
- Higher energy capture. Increased productivity.
- Improved gearbox reliability.
- Lower operating and maintenance costs.
- Siting versatility. Increased productivity.
- Provides siting versatility and enables greater wind penetration on a given grid system.
Liberty gearbox assembly at Clipper’s facility in Cedar Rapids, Iowa.

**FEATURE**

**Blades**
- Rotor sizes available for all wind regimes, including 89m, 93m, 96m and 99m.
- Blade pitch system
  - Each blade has an independent electromechanical pitch system with battery back-up for power control and primary braking.
- Lightning Protection
  - Blade tip lightning receptors connect through brushes on the blade pitch bearings and main shaft, transmitting lightning strike current down the tower to ground. A steel mesh Faraday Cage is embedded within the structure of the nacelle providing an added lightning protection for service crews and machine safety, and immunity to radio frequency interference.
- Advanced Cold Weather Package
  - Operates at temperatures down to -30 degrees Centigrade, survives to -40 degrees.
- Installation Requirements
  - Crane size and duration requirements for the installation of the Liberty turbine are similar to that of a typical 15 MW machine.
- Service Lift
  - A two-person service lift facilitates timely and efficient service calls enabling crews to service more turbines per day. In addition, experienced service personnel can extend their careers without the limitation of stringent climbing requirements.
- Interior Work Platform
  - Provides full stand-up workspace for several technicians as well as near-obstacle-free walkways, facilitating ergonomic comfort, safety and ease of service for organized, efficient work performance.
- EHS Equipment
  - Personnel evacuation equipment, including a rescue system.
- Containment Deck
  - The nacelle includes a 125-gallon containment deck below the powertrain, preventing tower contamination and providing increased service crew safety.
- Hub Access
  - The hub can be accessed through three entry ports from inside the nacelle, eliminating the need to exit to the nacelle topside to enter the hub, facilitating quick, simple and safe hub access, particularly in extreme weather conditions.
- Blade Pitch System
  - Blade tip lightning receptors connect through brushes on the blade pitch bearings and main shaft, transmitting lightning strike current down the tower to ground. A steel mesh Faraday Cage is embedded within the structure of the nacelle providing an added lightning protection for service crews and machine safety, and immunity to radio frequency interference.

**DETAIL**

**Blades**

- Provides siting optimization benefits.
- Increased reliability, higher availability.

**Blade Pitch System**

- Greater energy capture and reduced downtime.
- Improved installation value on a cost-per-megawatt basis.
- Higher turbine operating availability.
- Increased worker safety.
- Reduced downtime, reduced cost, and greater productivity.

**Lightning Protection**

- Reduced downtime, reduced cost, and greater productivity.
- Lowered to the ground with a small, portable 2-ton hoist that attaches to lifting eyes inside the hub.

**Advanced Cold Weather Package**

- Improved installation value on a cost-per-megawatt basis.

**Installation Requirements**

- Provides full stand-up workspace for several technicians as well as near-obstacle-free walkways, facilitating ergonomic comfort, safety and ease of service for organized, efficient work performance.

**Service Lift**

- Ease of maintenance.
- Increased maintenance.
- Easier access.
- Increased worker safety.

**Interior Work Platform**

- Provides greater safety levels for service technicians.

**EHS Equipment**

- Reduced downtime associated with spills.

**Containment Deck**

- Increased worker safety.

**Hub Access**

- Reduced downtime for component change out.

**BENEFIT**

- Decreased downtime associated with performing hub maintenance in severe weather.
- Increased worker safety.

- Provides greater safety levels for service technicians.
- Increased worker safety.

- Provides greater safety levels for service technicians.

- Ease of maintenance.
- Increased maintenance.

- Easier access.
- Increased worker safety.

- Reduced downtime associated with spills.

- Increased worker safety.

- Reduced downtime for component change out.

- Ease of replacement and maintenance of components in the hub.

**JUST THE FACTS**

**MANUFACTURING**

**Quality**
- Clipper operates with Six Sigma quality assurance practices, including tools and training for manufacturing practices, personnel training and quality assurance of suppliers. Clipper’s ISO 9001:2000 compliant Quality Management System “QMS” manages the full life cycle of the product from design through ongoing operation and maintenance. Our fleet of professional On-site staff is on site at Clipper’s Iowa facility as well as at the plants of our key component suppliers to ensure production to the highest standards. This proactive hands-on approach includes mandatory hold and inspection points within all of our production processes.

**In-House Manufacturing**
- Cedar Rapids, Iowa
- Located in the middle of North America near major road, rail and river barge services.
- Clipper has invested significantly to ensure state-of-the-art operations. Affording over 300,000 square feet of manufacturing and assembly space, Clipper’s facility includes full-scale wind turbine machine base, hub and gearbox assembly lines for the highest level of quality control and supply security.

**In-House Testing**
- Clipper built and operates two fully rated gearbox test stands as well as a generator test stand. Gearboxes and generators undergo a rigorous fatigue testing protocol prior to final sign-off and shipment.

**Purpose-Engineered Component Manufacturing**
- Outsources to select, reliable, well-established companies with specialized industrial expertise, and precision-mate to Clipper’s strict specifications for quality assurance.
- Clipper’s component manufacturing is purpose engineered to the highest standards.

**Safety**
- At Clipper, we’re dedicated to the safe operation of our facilities and to the protection of our employees, the public and the environment. Our experienced staff includes a ratio of full-time EHS Officers to employees that is among the highest in the wind energy industry. Our practices meet or exceed local, state and federal agency standards.

**Operation, Maintenance & Remote Monitoring**
- Clipper provides service support, covering both scheduled and unscheduled maintenance and maintains a 24/7 Remote Monitoring and Diagnostics Center (RMDC) at its Cedar Rapids plant. The RMDC interfaces with project sites to shut down and bring online turbines that are going into or coming out of a maintenance cycle. The RMDC is also active throughout the turbine commissioning process. Clipper’s Fleet Service team is among the wind industry’s most skilled, with decades of experience providing a highly qualified professional base.

**Warranty**
- Warranties are available to suit our customer’s needs similar to other industry standard packages.

**Our People**
- Clipper’s team represents one of the broadest and deepest levels of experienced wind industry professionals. The global staff includes a strong ratio of professionals with 10 to 20 years of proven wind energy expertise throughout the full range of key staffing roles—a unique experience gained through prior employment within the industry’s top wind energy companies.
# TECHNICAL SPECIFICATIONS - LIBERTY 2.5 MW WIND TURBINE

<table>
<thead>
<tr>
<th>Specification</th>
<th>C89</th>
<th>C93</th>
<th>C96</th>
<th>C99</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Power Output</strong></td>
<td>2500 kW</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Operation</strong></td>
<td>Variable Speed: 9.6 - 15.5 rpm</td>
<td></td>
<td></td>
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</tr>
<tr>
<td><strong>Model</strong></td>
<td>C89</td>
<td>C93</td>
<td>C96</td>
<td>C99</td>
</tr>
<tr>
<td><strong>Wind Class</strong></td>
<td>Ia*</td>
<td>Ia</td>
<td>Ib</td>
<td>S</td>
</tr>
<tr>
<td><strong>Rotor Diameter</strong></td>
<td>89m</td>
<td>93m</td>
<td>96m</td>
<td>99m</td>
</tr>
<tr>
<td><strong>Swept Area</strong></td>
<td>6231m²</td>
<td>6739m²</td>
<td>7238m²</td>
<td>7698m²</td>
</tr>
<tr>
<td><strong>Blades</strong></td>
<td>43.2m</td>
<td>46.2m</td>
<td>46.7m</td>
<td>48.2m</td>
</tr>
<tr>
<td><strong>Cut-in Wind Velocity</strong></td>
<td>4 m/s - 10 min. Average</td>
<td></td>
<td></td>
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<tr>
<td><strong>Cut-out Wind Velocity</strong></td>
<td>25 m/s - 10 min. Average</td>
<td></td>
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<tr>
<td><strong>Pitch System</strong></td>
<td>3X DC Electric-Mechanical Gear-motor; Servo Drives and Batteries</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td><strong>Generator</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Type</strong></td>
<td>Synchronous Permanent Magnet</td>
<td></td>
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</tr>
<tr>
<td><strong>Rated Power Each</strong></td>
<td>660 kW at 1133 rpm</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td><strong>Number of Units</strong></td>
<td>4</td>
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<tr>
<td><strong>Voltage</strong></td>
<td>1330 VDC at Rated Power</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td><strong>Controller</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Type</strong></td>
<td>Embedded Motorola Power PC</td>
<td></td>
<td></td>
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<tr>
<td><strong>Voltage</strong></td>
<td>3 Phase 480 VAC</td>
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<tr>
<td><strong>Power Converter</strong></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td><strong>Type</strong></td>
<td>4X, Voltage Sourced, IGBT Based</td>
<td></td>
<td></td>
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<tr>
<td><strong>Voltage</strong></td>
<td>690 VAC, 50Hz or 60Hz + 3Hz</td>
<td></td>
<td></td>
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<tr>
<td><strong>Grid Compatibility</strong></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td><strong>Frequency-Continuous</strong></td>
<td>50Hz or 60Hz + 3Hz</td>
<td></td>
<td></td>
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</tr>
<tr>
<td><strong>Line Voltage</strong></td>
<td>690 VAC + 10% Continuous</td>
<td></td>
<td></td>
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<tr>
<td><strong>Line Fault Ride-Thru</strong></td>
<td>-90% of Nominal Line for 3 sec.</td>
<td></td>
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<tr>
<td><strong>Line Phase Imbalance</strong></td>
<td>Rated Power + 5%, Cut-in + 10%</td>
<td></td>
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<tr>
<td><strong>Yaw System</strong></td>
<td>4 Electro-Mechanical Motors with Planetary Drives</td>
<td></td>
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<tr>
<td><strong>Yaw Bearing</strong></td>
<td>Internal Gear, Ball Bearing</td>
<td></td>
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<tr>
<td><strong>Yaw Brake System</strong></td>
<td>Disc, 4 Active Hydraulic Brake Calipers</td>
<td></td>
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<tr>
<td><strong>Parking Brake System</strong></td>
<td>Dual Disc with Active Hydraulic Brake Calipers</td>
<td></td>
<td></td>
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</tr>
<tr>
<td><strong>Parking Brake Location</strong></td>
<td>Intermediate Stage of Gearbox</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Tower</strong></td>
<td>Partial Conical - Tubular Steel, 4 Steel Plate Sections</td>
<td></td>
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<tr>
<td><strong>Hub Height</strong></td>
<td>80m Standard / Other Options Available</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Service Hoist</strong></td>
<td>On-Board, 2 Metric-ton Hoist</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Maintenance</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Post Commissioning</strong></td>
<td>Once at 700 Hours, Every 6 Months Thereafter</td>
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</tbody>
</table>
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