# SYNCHRO-SYM Wind Turbine Electric Generator Systems

Best Electric Machine (BEM) is entering the Computer-Aided-Design (CAD) phase of developing a family of lightweight electric generator systems for large wind turbines that is based on its patented electric motor technology called SYNCHRO-SYM, which is a symmetrical wound-rotor "synchronous" doubly-fed electric motor system circuit and control architecture as only provided by the highly integrated Brushless Real Time Emulation Controller (**BRTEC**), starting with the SYNCHRO-SYM Wind Turbine 500 (or SSWT-500) lightweight electric generator product.

The SSWT-500 specification:

- Provides a componentized Wind Turbine Generator System with a superior operating performance specification that always includes the efficiency, weight, and dimensions of the essential electronic controller, which for SYNCHRO-SYM is the highly integrated BRTEC, frame, axle, and bearing assembly;
- Provides a componentized Wind Turbine Generator system without rare-earth permanent magnets (*such as neo permanent magnets*) and their associated issues of field assembly, cogging (*or torque ripple*), cost, reliability, safety, life expectancy, and pollution;
- Provides a compact, small diameter, stackable, low speed direct drive capability that is without the compounding complexity, loss, maintenance, reliability, and size issues of a gearbox;
- Provides a compact, low speed direct drive capability that can be field replaceable by a small internal nacelle crane, lengthwise stackable to 16 MW, small diameter and shippable by conventional means, starting with 500 KW or 1 MW standalone or componentized lengthwise increments;
- Provides failsafe operation until field replacement of any failed generator in the stack (*without the mitigating effects of permanent magnet torque ripple*).

The following table provides the SSWT-500 specification:

| **SSWT-500 PERFORMANCE SPECIFICATIONS**<br>*(compared to the GE Haliade-X Wind Turbine Generator)* | | |
|---|---|---|
| | **SYNCHRO-SYM**<br>(Axial-Flux) | **GE Haliade-X**<br>(Radial-Flux) |
| Total Power | 1-16 MW | 12-14 MW |
| Stackable Power Increments | 1 MW<br><br>(***Each SSWT-500 includes Dual BRTEC and Frame, Axle & Bearings)*** | Large, non-stackable self-contained unit.<br><br>(Permanent Magnet Electric Machines must be fully assembled at the factory) |
| Speed | 0-10 RPM<br>(*Higher RPM without overvoltage concerns*) | 0-10 RPM |
| Length<br>(shippable Length) | 21 in<br>(*530 mm*)<br>(*Includes the integrated BRTEC*) | 9.8 ft?<br>(*3 M?*)<br>(*Does not include the electronic controller*) |

| | | |
|---|---|---|
| Diameter | **12 ft**<br>(*3.7 M*)<br>(*Includes the integrated BRTEC*) | **36 ft**<br>(*11 M*)<br>(*Does not include the electronic controller*) |
| Total System Efficiency<br>(*Turbine Hub to AC/DC Power Grid*) | > 91% @ 12' Dia.<br>(*Includes the integrated BRTEC)* | ? |
| Rotor or Stator Component Weight<br>(shippable weight) | **16,413 lbs. (2)**<br>(*8,125 kgs*)<br>(*Includes the integrated BRTEC*) | ?<br><br>(*Permanent Magnet Electric Machines must be fully assembled at the factory and for safe transport*) |
| Total Increment Weight<br>(shippable weight) | **35,000 lbs. (3)**<br>(17,371 *kgs*)<br>(*Includes the integrated BRTEC*) | ? |
| Volume<br>(*(Dia./2)$^2$ * π * Length*) | **5.7 M$^3$**<br>(*Include the BRTEC*) | **285 M$^3$** (1)<br>(*Does not include the electronic controller*) |
| Total Stackable Units | 16x<br>(Frames, Bearings, and Axles provide structure strength) | ? |
| Total Stackable Length (16x) | **28 ft**<br>(*8.54 M*)<br>(*Includes the integrated BRTEC*) | N.A.<br><br>(***Nacelle is 67.5ft/20.6M long***) |
| Stackable Volume | **91 M$^3$** (1)<br>(*Includes the integrated BRTEC*) | **285 M$^3$** (1)<br>(*Does not include the electronic controller* and for 13 MW) |
| Total Stackable Weight | **280 tons** (1)<br>(*254 tonnes*)<br><br>(*Includes the integrated BRTEC*) | **600 tons?** (1), (4)<br>(*Nacelle total is 660 tons, including electronic controller,* for 13 MW) |

(1) Consistent with the wound-rotor doubly-fed [synchronous] electric machine circuit and control architecture, *as only possible by the enabling technology of brushless real time emulation control or* ***BRTEC***, SYNCHRO-SYM shows half the size, half cost, and half loss as all other electric machine systems, such as the RE-PM generator system.
(2) **15 ton internal nacelle crane**
(3) 25 ton internal nacelle crane
(4) 700 ton, 150 meter, external mobile crane