

# Best Electric Machine (BEM)

“Higher Purpose” Summary

*Innovation For A Clean, Efficient, and Sustainable Energy Future*

# BEM's "Higher Purpose" Products

- **A *verified & patented* electric motor system (EMS), called **SYNCHRO-SYM**, with a *new EMS circuit and control technology*:**
  - ✓ **Eliminates** the environmental & geopolitically harm of rare-earth, permanent magnets (RE-PM) and **reduces** copper & electrical steel usage!
  - ✓ **Substantially multiplies** the “performance/price” of any other EMS!
  - ✓ **Substantially multiplies** the “performance/price” *results* from applying enabling packaging techniques, such as emerging WBG semiconductor technologies!
- **A *verified & patented* EMS 3D Printer Method, called **MOTORPRINTER**, with **the only SYNCHRO-SYM CAD tool, called **BEM-CAD****:**
- ✓ **Eliminates the need for Offshoring** (*to unethically exploit low-cost labor*)
- ✓ **Protects IP** (*with secure inhouse manufacturing*)!
- ✓ **Solves** unforeseen and costly manufacturing bottlenecks by re-programmable, JIT, additive manufacturing!
- ✓ **Solves** material handling, such as emerging nano-materials!

# BEM's "Higher Purpose" Approach

- **A *unique* EMS** that is the most efficient, lightest, smallest, and lowest cost possible <sup>1</sup>: ***Driving higher profits & redefining technology***
- **A *unique* EMS without rare-earth minerals: *Best addresses climate-friendly objectives and associated harm by a global adversary's monopoly***
- **A *unique* EMS 3D Printing Method with reprogrammable BEM-CAD for secure, inhouse, JIT manufacturing:<sup>2</sup> *Quickly & Locally serving customer prototyping and production needs***

<sup>1</sup> An **EMS** is an electric motor (or generator) "system," which should include the *compounding* loss, cost, and size of all enabling components for practical application, such as the motor, gearbox, and electronic controller entities.

<sup>2</sup> Uniquely 3D Prints a superior thermal management & System of System (SoS) Integration

# BEM's "Higher Purpose" Outcome

- ✓ EMS manufacturing will become democratized!
- ✓ The U.S. will again become the leading global EMS manufacturer with a superior *RE-PM free* EMS and an additive EMS manufacturing method!
- ✓ The Global harm being caused by RE-PMs will be greatly reduced!<sup>1</sup>
- ✓ The U.S. will play a greater role in fighting against human rights abuses, improving climate circumstances, and transforming electricity!<sup>2</sup>

***BEM will be the go-to manufacturer of electric motor propulsion and regeneration systems!***

<sup>1</sup> By [unethically ignoring its monopolization by a global adversary](#), the **RE-PM EMS** is anecdotally considered the most efficient! But with higher performance/price and without RE-PMs, BEM's EMS would dominate while re-allocating RE-PMs to other strategic applications without a solution

<sup>2</sup> As the backbone of the electricity infrastructure, the EMS has a significant impact on global warming, carbon footprint, electricity efficiency & cost

# BEM's "Higher Purpose" TAM (>\$370B) <sup>1</sup>

- Automobile \$100B+
- Wind Turbines \$45B+
- Industrial & Commercial Motors \$220B+
- Others
  - Aircraft, including drone fleets, Boats and Ships, Rail and Trucks, Recreational Vehicles (e.g., scooters, golf carts, go-carts), Construction Machines (e.g. forklifts, power drills/hammers, backhoes)

**<sup>1</sup> Always served by the "Asymmetric" EMS (A-EMS) with the *non-optimal electromagnetic asymmetry* of a "passive rotor" of RE-PMs, slip-induction windings, reluctance saliencies, or DC Field Windings!**

# BEM's “Higher Purpose” *Immediate* TAM

- **BEM will help producers** of (i) EVs; (ii) land, rail, air and sea craft; and (iii) generators and wind turbines achieve their goals of:
  - ✓ Greater profitability with greater impact on achieving climate friendly objectives, greater efficiency, lighter weight, smaller size, lower cost, and greater range!
  - ✓ Avoiding the cost-driving need for offshoring with exploited labor and lost IP by *cost-effective, inhouse, additive* EMS manufacturing!
  - ✓ Providing best performance/price ratio over creative branding of another “me-too” product!
- **BEM's immediate global TAM** is expected to exceed **\$145B**

# BEM's Competitors' "Lower Purpose" A-EMS

<b>Funded Company <sup>a</sup></b>	<b>Market</b>	<b>Funding <sup>b</sup></b>	<b>TAM</b>
<a href="#"><u>Infinitum Electric</u></a>	<a href="#"><u>Industrial RE-PM PCB</u></a>	\$350M since 2014	\$186B
<a href="#"><u>TurnTide Technology <sup>c</sup></u></a>	Industrial Synchronous Reluctance	\$491M since 2013	\$186B
<a href="#"><u>Magnix</u></a>	Electric Airplane	\$74M since 2022	\$13B
<a href="#"><u>H3X</u></a>	Electric Airplane	\$9M since 2023	\$13B
<a href="#"><u>BMW's 5<sup>th</sup> Generation E-Drive <sup>c</sup></u></a>	Electric Vehicle	\$?	\$100B
<a href="#"><u>DeepDrive</u></a>	Electric Vehicle	\$34M since Sept. 2024	\$100B

  

<b>Emerging Company <sup>d</sup></b>	<b>Market</b>	<b>Funding <sup>b</sup></b>	<b>TAM</b>
<a href="#"><u>Best Electric Machine (BEM) <sup>c</sup></u></a>	<b>Electric Vehicles, etc.</b>	Seeking \$10M by 2025	\$370B

**Notes:**

- a. All are another "me-too" Asymmetric EMS (A-EMS) with a "performance-robbing passive rotor" and a remotely placed, estimating field-oriented controller derivative that is generally from different manufacturers
- b. Funding is for "validation and commercialization" of an EMS packaging technique
- c. Only EMS manufacturers with the "higher purpose" of eliminating the environmental, human exploitation, and geopolitical harm of RE-PMs.
- d. Only BEM's SYNCHRO-SYM has a "performance-contributing active rotor" and "integral" brushless real time emulation control (BRTEC) and with lower funding, only BEM's Validation Plan is faster to market with a game changing S-EMS and 3D Printing Manufacturing

# BEM's "Higher Purpose" Product Brief

- **SYNCHRO-SYM** is a *new* EMS "Circuit and Control Technology" with "*two unique*" performance-contributing features:
  1. **Optimal electromagnetic symmetry** of a "performance-contributing active rotor" (S-EMS) [*without delicate rare-earth permanent magnets*]: <sup>1</sup>
    - "Any other EMS" has the *non-optimal asymmetry* of a "performance-robbing passive rotor" (A-EMS) <sup>2</sup>
  2. **No performance-robbing Core Saturation or Core Loss due to Torque MMF**

***Retrofitting any A-EMS package footprint* <sup>3</sup> with **SYNCHRO-SYM Technology** will *at least double* the original performance/price**

<sup>3</sup>The performance/price ratio of any **A-EMS** package footprint is *limited* to available "design specification," such as voltage, air-gap flux density, and maximum load speed, and "packaging techniques," such as material science, winding arrangements, electronic components, package style, and thermal management, with *similar results*, if equally applied, but a SYNCHRO-SYM *retrofit* will at least *double the expected results!*



# BEM's SYNCHRO-SYM Vs EMS (or All Others)

Category	Continuous Power <sup>1</sup>	Peak Torque (Power) <sup>1</sup>	cost <sup>1</sup>	Loss <sup>1</sup>	Size <sup>1</sup>	weight <sup>1</sup>	Material Amount <sup>1</sup>	Strategic Rare-Earth Materials <sup>1,4</sup>	Inductance (Torque) <sup>5</sup>	Core Saturation (Torque) <sup>6</sup>	Compounding rotor Loss, Cost, and Size <sup>9</sup>	Magnetizing MMF Sharing <sup>10</sup>
<b>S-EMS<sup>2</sup></b>	2x	8x <sup>7</sup>	1/2x	1/2x	1/2x	1/2x	1/2x	No	No	No	No	Yes
<b>A-EMS<sup>3</sup></b>	1x	1x	1x	1x	1x	1x	1x	Yes <sup>8</sup>	Yes	Yes	Yes	No

<sup>1</sup> Per Unit of Power Rating with the same port voltage, air-gap flux density, and packaging and footprint

<sup>2</sup> The Symmetric EMS (S-EMS) [as only possible with SYNCHRO-SYM with a power producing “active rotor” as only possible with BRTEC] reaches the theoretical limit in EMS performance/price ratio

<sup>3</sup> The Asymmetric EMS (A-EMS) with a passive rotor of slip-induction windings, reluctance saliencies, DC field windings or permanent magnets, such as rare-earth permanent magnets (RE-PM), that wastes loss, cost, and size without any power production

<sup>4</sup> Rare Earth Materials, such as for RE-PMs, are monopolized by a global adversary seeking world dominance with harmful environmental, human exploitation, innovation, and geopolitical consequences

<sup>5</sup> The lower the inductance (due to “torque MMF cancellation” as a result of symmetrical transformer physics), the faster servo response time

<sup>6</sup> The lower the core saturation potential (due to Torque MMF cancellation), the higher the peak torque

<sup>7</sup> Due to Torque MMF cancellation, the air-gap flux density can be designed closer to the saturation limit of the core material and SYNCHRO-SYM uniquely has another degree of power density adjustment, which is torque current magnitude adjustment, over packaging techniques.

<sup>8</sup> Only RE-PM A-EMS

<sup>9</sup> The rotor loss, cost, and size of any A-EMS, including the RE-PM A-EMS, are compounded through the Stator. For instance, without a directly-excited (or passive) rotor, the loss of the rotor must be passed through the power producing active stator, which will compound the loss (size and cost) of the stator. In contrast, the rotor and stator of SYNCHRO-SYM are independently excited.

<sup>10</sup> With the symmetry of two independently excited winding sets on the rotor and stator of the S-EMS, as only possible with SYNCHRO-SYM, Magnetizing MMF is shared between the rotor and stator winding sets and as a result, the total winding  $I^2R$  loss (and core loss) is halved.

# BEM's "Higher Purpose" Technology Verification <sup>1</sup>

- **BEM's EMS (SYNCHRO-SYM)** is ½ the size, ½ the weight, ½ the cost, 8x the peak torque, and 2x as efficient with the same A-EMS packaging [*but without [the harm of RE-PMs](#)*]:
  - ✓ *Verified* by a century of [theoretical EMS study & R+D](#) <sup>2</sup>
  - ✓ *Verified* by *tangible* BEM R+D, Prototyping, and Domestic & International Patents
- **BEM's 3D Printer Method (MOTORPRINTER) for JIT SYNCHRO-SYM Manufacture:**
  - ✓ *Verified* by BEM orchestrating empirical studies with leading manufacturers of amorphous metal and fiber laser cutting [& now in [fabrication](#)]
- **BEM's EMS Computer Aided Design Tool (BEM-CAD) for JIT SYNCHRO-SYM design:**
  - ✓ *Verified* by BEM cross-comparing results with A-EMS published product specification
- **BEM's Team Developed [& Executing] "Validation & Commercialization" Plan:**
  - ✓ *Verified* by BEM cross-comparing with "[High Value Funded Contestants' A-EMS Validation Plan](#)"

**Technology & Market Verified! Low Technical or Market Risk!**

# “Higher Purpose” *Issues* To Overcome

- **Confusion:** EMS “Terminology” that evolved from a century of *applied A-EMS practice* must be accurately redefined to describe the *theoretical S-EMS practice* enabled by BRTEC!
- **Ignoring Facts:** SYNCHRO-SYM is the only stable “symmetric” EMS (S-EMS), which was verified by a century of *theoretical* EMS study & research and by *applied* BEM R+D, prototyping, & patents!
- **Conflicts of Interest:** Substantial investment in *validated* “me-too” A-EMS packaging practices, such as RE-PMs, ignores the new & *unvalidated* S-EMS of SYNCHRO-SYM!
- **Confusion:** SYNCHRO-SYM is a “newly invented” S-EMS circuit and control technology that easily retrofits any A-EMS package but IAW physics, greatly magnifies the performance/price!
- **Confusion:** SYNCHRO-SYM is *wrongly* confused with the *unstable* field-oriented controlled, doubly-fed, “induction” A-EMS (WRDF-EMS) with multiphase brush-slip-ring assembly!

**Need “Validation & Commercialization” To Overcome Issues!**

# “Higher Purpose” Validation & Commercialization

## 1) “Validate” MOTORPRINTER:<sup>1</sup>

- ✓ By MOTORPRINT’ing SYNCHRO-SYM samples just-in-time (JIT) for Alpha (Inhouse) and Beta (Customer) Validation

## 2) “Validate” SYNCHRO-SYM:<sup>1</sup>

- ✓ By Alpha & Beta Testing of MOTORPRINT’ed SYNCHRO-SYMs

## 3) Kickstart “Commercialization” with “Show Me”:

- ✓ Direct marketing by publishing the *validated* results of SYNCHRO-SYM’s *matchless* performance/price ratio and JIT MOTORPRINT’ed samples

**BEM seeks \$10M To “Validate and Commercialize”**

<sup>1</sup>Validation: “Does product meet cost-performance when applied?”;

# BEM's “Higher Purpose” Next Steps & Milestones

1. Partner with committed investors and champions to secure a path for executing BEM's “show me” **validation** and **commercialization Plan** (e.g., series A funding) <sup>1</sup>
2. Complete MOTORPRINTER and SYNCHRO-SYM engineering and fabrication <sup>2</sup>
3. Inhouse (i.e., **Alpha**) **Validation & Support** by MOTORPRINTing SYNCHRO-SYMs
4. Publish the Alpha Validated results for courting strategic partners, gov't labs, etc.
5. Orchestrate validation at customer sites (i.e., **Beta Validation & Support**)
6. Publish the Beta Validated results
7. Scale MOTORPRINTER's portable footprint to meet production for sales growth (i.e., **Commercialization**)

<sup>1</sup> With focus on protecting IP and Trade Secrets, BEM knows what it is doing, has the current team for the Next Steps/Milestones, and will grow the future team to deliver production!

<sup>2</sup> BEM sole keeper of SYNCHRO-SYM engineering knowledge base, *patented* IP, BEM-CAD, MOTORPRINTER, and program & cost plans!

# BEM's "Higher Purpose" Team <sup>1</sup>

## Today:

- Founder, Chief Technology Officer (Fred Klatt)
- Chief Executive Officer (Kaylyn)
- Chief Operating Officer (Garrett)
- VP Marketing (Carol)

## Tomorrow:

- Add Sales & Marketing
- Add CIO for SYNCHRO-SYM  
*Enabled Products:*
  - Compact, Light Weight Wind Turbines
  - Universal EV Power Train Cradle
  - Hydrogen Capture
  - Distributed Power Management

**IT'S THE MARKET *NEED* FOR BEM'S HIGHER PURPOSE TECHNOLOGY!**  
*[ITS NOT The Creative Market Plan or The Who's Who Marketing Team!]*

<sup>1</sup> BEM's "Show Me Plan" for "Validation and Commercialization" is straight-forward with a committed team of IP protection integrity, functional expertise, ethical resolve to compete against a global adversary, and mission centric flexibility but is not the who's who of creative marketing that is essential to sell another "me-too" A-EMS product

# BEM's "Higher Purpose" Validation NEED!

*[High-Risk R+D and Verification Successfully Completed!]*

- **Short-Term, Low-Risk Capitalization For:**
  - ✓ Quick SYNCHRO-SYM "Validation" to bootstrap sales <sup>1</sup>
  - ✓ Quick MOTORPRINTER "Fabrication" for *inhouse* Production & Sustainment <sup>1</sup>
- **Accomplished-Help with Capitalization For:**
  - ✓ Crowdfunding, Technology Collateral Loan, Commercialization Partnership,...
  - ✓ Series A, B,... (e.g., Liquid Piston, Infinitum, TurnTide, etc.)
  - ✓ Tapping into the \$Billions for *validating* (e.g., *capitalizing*) another "me-too" A-EMS packaging with *offshored* manufacturing but instead, for *validating* SYNCHRO-SYM with *inhouse* MOTORPRINTER manufacturing

<sup>1</sup> As we continue to execute our plan, BEM-CAD has already designed our [SYNCHRO-SYM E-Motor](#) to compete against [Koenigsegg Dark-E EMS](#) (as the gold standard of A-EMS packaging) with higher performance/price and with simple MOTORPRINTER just-in-time manufacturing;

# SYNCHRO-SYM Demonstration

<https://youtu.be/IZ8cxSLLCR8?t=5>



# THANK YOU

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# Backup Slides

# BEM's A-EMS Retrofit (AR) Example

Showing  $\frac{1}{2}$  the loss,  $\frac{1}{2}$  the cost,  $\frac{1}{2}$  the size, and 8x the peak torque of any other EMS (i.e., A-EMS) package:

- Engineer the replacement of the A-EMS “passive rotor and FOC” with the *active rotor* and stability enabling *BRTEC* of SYNCHRO-SYM but: <sup>1,2</sup>
  - ✓ Without changing the original A-EMS size, loss, and cost or packaging
  - ✓ Without RE-PMs, performance hindering core saturation, etc.
  - ✓ With Double the maximum load speed at the same excitation voltage or frequency
  - ✓ With Double the original A-EMS continuous power
  - ✓ With Octuple the original A-EMS Peak Torque Potential

<sup>1</sup> If an A-EMS wants to keep its proprietary packaging IP, such as [H3X](#), but gain 2-8x more performance with SYNCHRO-SYM circuit and control technology

<sup>2</sup> More cost-effective to provide design specs to BEM for additive manufacture with the inherent packaging improvements of MOTORPRINTER & BEM-CAD

# BEM's Electric Vehicle (EV) Example

Showing  $\frac{1}{2}$  the loss,  $\frac{1}{2}$  the cost,  $\frac{1}{2}$  the size, and 8x the peak torque of any other EMS (i.e., A-EMS) package:

- Four independent SYNCHRO-SYM directly driving each wheel can replace the dual RE-PM A-EMS driving the front and rear axles of the typical high-performance EV (see [BEM-UPM](#)) but:
  - ✓ Without increasing the “total propulsion system” size, loss, and cost
  - ✓ Without the *compounding* size, loss, cost, and unreliability of RE-PMs, gearboxes, differentials, and remotely mounted controllers
  - ✓ With Double the total EV power, double torque vectoring performance, and double redundancy and safety, while extending range and lowering system of systems (**SoS**) cost
  - ✓ With true electromagnetic braking (*by uniquely providing 8x peak torque potential*)

NOTE: With the direct EMS (electromagnetic) drivetrain as more efficient and reliable than the typical mechanical drivetrain, the same analysis follows for electric scooters, construction machines (fork lift, backhoe), hybrid electric, internal combustion engine, etc. vehicles.

# BEM's Electric Airplane (EA) Example

Showing  $\frac{1}{2}$  the loss,  $\frac{1}{2}$  the cost,  $\frac{1}{2}$  the size, and 8x the peak torque of any other EMS (i.e., A-EMS) package:

- Two independent SYNCHRO-SYM can replace the typical single RE-PM A-EMS of an EA but:
  - ✓ Without increasing the “total propulsion system” size, loss, and cost
  - ✓ With double the EA power and redundancy of [two cascaded SYNCHRO-SYMs](#) providing the propulsion efficiency of directly-driven [counter rotating propellers](#) to improve range
  - ✓ Without RE-PMs and the counter rotating gearbox with *compounding* size, loss, cost, and reliability consequences

NOTE: The same analysis is equally applicable to Electric Ships, unmanned air vehicles (UAV), etc.

NOTE: BEM-CAD already designed SYNCHRO-SYMs with continuous Power Density of over 66 KW/L, Specific Power of over 16 KW/Kg, and Efficiency of over 96% at 800 volts DC, 4000 RPM, and 1.25T air-gap flux density (as only possible with MOTORPRINT'ed SYNCHRO-SYMs) with the compounding size, loss, and cost of the only integral electronic controller extraordinarily included

# BEM's Wind Turbine Generator Example <sup>1</sup>

Showing ½ the loss, ½ the cost, ½ the size, and 8x the peak torque of any other EMS (i.e., A-EMS) package:

- The electromagnetic symmetry of SYNCHRO-SYM can replace the single, low speed, direct drive RE-PM A-EMS of a wind turbine but: <sup>2</sup>
  - ✓ With RE-PM free, stackable, small diameter, light weight SYNCHRO-SYMs <sup>3</sup>
  - ✓ With safely shippable, light-weight components (i.e., same rotor and stator without RE-PMs) that can be field assembled in the nacelle without the extraordinary logistics for the RE-PM A-EMS

<sup>1</sup> The typical high-speed Wind Turbine Generator Component is being quickly replaced with the direct-drive low-speed RE-PM A-EMS generator to eliminate the reliability and maintenance issues of a high-speed gearbox; but because of persistent magnetism, the RE-PM A-EMS must be fully assembled at the factory for safe handling.

<sup>2</sup> Low-speed, direct-drive RE-PM A-EMS are large and heavy (e.g., 10M Diameter, 600 Tonne Nacelle assembly), which require extraordinary transportation and terrain logistics means.

<sup>3</sup> BEM-CAD designed a low-speed, direct-drive, >10MW, RE-PM free SYNCHRO-SYM (e.g., 3.1M Diameter, 0.4M length, 8 Tonne rotor or stator component increments) for convenient transportation and field assembly without extraordinary means