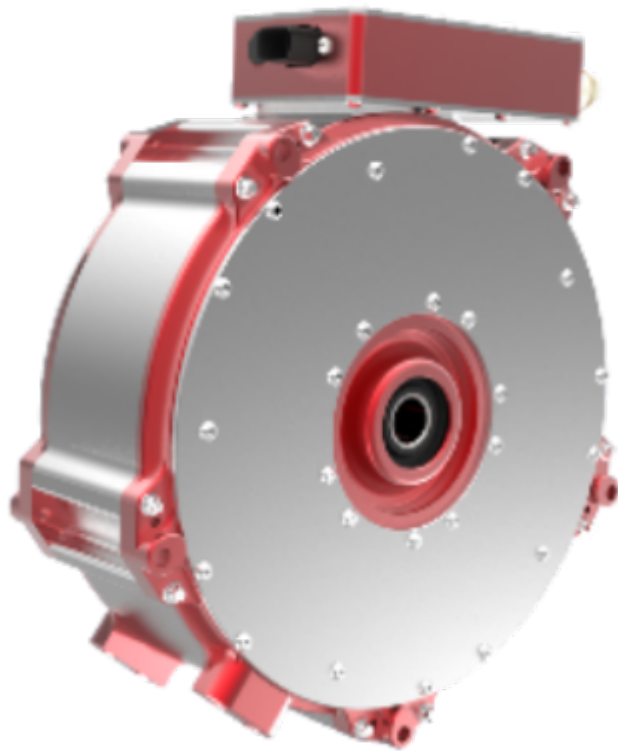


Who We Are



SYNCHRO-SYM Technologies

– BEM Portfolio of Patented Technologies for Transforming the Electricity Infrastructure –

Our Mission:

Real Innovation For Our Clean, Efficient, and Sustainable Energy Future!

SYNCHRO-SYM TECHNOLOGIES

PRODUCT → SHAPING OUR ENERGY FUTURE:

In accordance with **Our Mission** to “Innovate For Our Clean, Efficient, and Sustainable Energy Future,” Best Electric Machine (**BEM**) offers a portfolio of **patented**, straightforward-ready technologies, branded [**SYNCHRO-SYM Technologies**](#), that exclusively approach the theoretical limit in performance/price for *reimagining*: a) *smart electric motor and generator systems*, such as for electric transportation, b) *smart 3D printing method of high performance axial-flux electric motors, generators, and transformers*, c) *smart electric power conditioning and transfer*, such as wireless power transfer, and d) *smart electric polyphase micro-distribution*, which will *significantly* magnify the expected gain from applying performance enhancing technologies, such as emerging wideband gap (WBG) power semiconductor switches, and will *ethically* mitigate today’s stifling dependency on rare-

earth materials that are insidiously controlled by [a global adversary seeking world dominance](#) with harmful exploited labor, human rights, environmental, innovation, and geopolitical consequences.

PRODUCT → OFFERINGS:

SYNCHRO-SYM *reimagined* the electric motor and generator (i.e., electric machine) system with the *only “Symmetric” Synchronous Electric Motor or Generator Circuit and Control Architecture* comprising the *optimal electromagnetic symmetry* of an “active rotor assembly” that independently contributes an additional increment of working power (*or active power*) to the electromechanical energy conversion process *along* with the universally essential power and torque producing “active stator assembly” found in all electric motor systems, which is *only* possible with the *breakthrough invention* of *automatically precise, Brushless, Sensor-less, Multiphase Real Time Emulation Control (BRTEC)* for enabling *contiguously* stable “synchronous” operation from sub-synchronous to super-synchronous speed, including at or about synchronous and zero speeds, by its built-in runtime digital twin.

All other electric machine systems implement the me-too “Asymmetric” *Electric Motor or Generator Circuit and Control Architecture* with the *non-optimal electromagnetic asymmetry* of a “passive rotor assembly” of either slip-induction dependent windings, reluctance saliencies, [rare-earth permanent magnets \(RE-PM\)](#), or DC field windings that effectively wastes half of the total electric motor real-estate, loss, and cost by not independently contributing additional working (*or active*) power to the electromechanical energy conversion process along

with its active stator assembly, which is always controlled by an *estimating* derivative of off-line, field-oriented control (FOC), such as direct-torque control (DTC), for contiguously stable operation to only synchronous speed.

By simply *retrofitting* the “passive rotor assembly” of the “me-too” or asymmetric circuit and control architecture of *any other* electric motor or generator system with the “active rotor assembly” of the only *symmetric* circuit and control architecture of SYNCHRO-SYM, [a century of classic electric motor and generator study, research, and publication](#) and a regimen of BEM prototyping and invention have verified: a) the power density of the *original* retrofitted asymmetric electric machine “system” package would double, b) the loss would halve, c) the cost would halve, and d) the peak torque would octuple (*per unit of continuous power rating*).

Our Distinctive Value Proposition: SYNCHRO-SYM is the only electric motor system (EMS) with the optimal electromagnetic symmetry of an “active rotor” that stably contributes an additional increment of working power to the electromechanical energy conversion process along with the active stator. All other electric motor systems, including so-called “breakthrough airplane propulsion electric motor systems,” have the non-optimal electromagnetic asymmetry of a “passive rotor” of rare-earth permanent magnets, reluctance saliencies, conventional or superconductor field windings, or slip-induction windings that effectively wastes half of the EMS real-estate, loss, and cost without stably and independently contributing additional “working power” to the electromechanical energy conversion process!! When considering the rotor reasonably consumes half of the total EMS loss, cost, and size with compounding effects of stator, electronic control, etc. included, SYNCHRO-SYM immediately delivers at least twice the power density, half the loss, and half the costs per unit of package power rating of any other EMS and

without considering the additional performance enabling as only possible with the 3D Printing method of MOTORPRINTER!!

Today: Only SYNCHRO-SYM "Total System" Power Density reaches over 66 KW/L, Specific Power reaches over 16 KW/Kg, Efficiency reaches over 96%, and Cost is halved per unit of power rating with the same design specification (e.g., 800 volts DC, 4000 RPM, and 1.25T flux density), with the same electric machine package and performance enhancing techniques, with the compounding size, loss, and cost of the electronic controller "extraordinarily" included, and without precious rare-earth permanent magnets or superconductor electromagnets!

Tomorrow: Only SYNCHRO-SYM will continue to effectively double the advertised performance gain with half the cost and amount of material, such as [copper](#), per unit of power rating of any present or future electric machine packaging and performance enhancing techniques available to all electric machine systems, such as the performance and cost of emerging wide-bandgap semiconductor (WBG) switches, by "uniquely" enabling the rotor to be an additional "working power" contributor to the electromechanical energy conversion process along with the universally essential active stator for primary torque and working-power production! When superconductors become a practical reality, the fully electromagnetic SYNCHRO-SYM will be the only electric motor system of choice!

[More on SYNCHRO-SYM](#)

MOTORPRINTER *reimagined* electric motor manufacture with the only 3D Printer Method for the low cost, rapid, just-in-time, additive manufacture of low or high frequency, high power, [axial-flux](#) electric motor, generator, and transformer cores: 1) re-programmable shape, 2) with integral frame and winding assemblies, 3) with off-the-shelf, highly optimized feedstock

layering materials that are electromagnetically, structurally, and thermally compatible with the electric machine product being additively manufactured, such as highest performing, ultrathin electrical steel, amorphous metal, or nanocrystalline metal ribbons, structural material, and magnet wire, instead of being compatible with the 3D Printer itself, such as the typical 3D Printer feedstock powders, filaments, etc., 4) within a compact self-contained, remotely monitored and controlled footprint (*e.g., shipping container*) instead of the traditional century-old assembly line manufacturing with costly capital equipment inventory, large industrial power consuming smokestack facilities, and exploited offshored labor, and 5) with production scaling by simply adding or stacking another household powered, compact self-contained MOTORPRINTER footprint.

BEM-CAD *reimagined* electric motor design with the *only* computer-aided-design (**CAD**) tool that simultaneously designs axial-flux SYNCHRO-SYMs, RE-PM electric machine systems, and Induction electric machine systems to the same *continuous* torque, air-gap flux density, maximum load speed (**MLS**), frequency of excitation, and port voltage design and with the same material, winding, thermal management, electronic component, and packaging performance enhancing techniques for truly equitable cross-comparative analysis. Interfaced to BEM-CAD, MOTORPRINTER is programmed to additively manufacture (*or 3D Print*) axial-flux SYNCHRO-SYMs of virtually any power rating with duplicate rotor and stator assemblies by conveniently 3D Printing its unique BRTEC electromagnetic computer within the otherwise wasted annulus space of the low frequency symmetric synchronous doubly-fed axial-flux electric machine entity, all of which provide another level of system power density and component inventory reduction.

Complemented with its superior performance, simpler electronic power condition, and the straight-forward *additive* manufacture of MOTORPRINTER (*under the design control of BEM-CAD*), only

the optimum electromagnetic circuit and control symmetry of SYNCHRO-SYM inherently facilitates: a) a unique high capacity thermal management system that provides continuous operation at ultrahigh power densities and the designed-in convenience of incrementally stacking a multiplicity of SYNCHRO-SYM E-Motors lengthwise (*i.e., power stacking*) to provide incrementally higher power rating and fault tolerant redundancy (within smaller effective diameter and without affecting power density or specific power).

Only MOTORPRINTER under the programmable control of BEM-CAD will revolutionize and democratize the manufacture of superior performing low and high frequency, axial-flux electric motors, generators, and transformers with seamlessly scaled, inhouse or distributed, field programmable, just-in-time additive manufacturing and as a result, will neutralize the unethical advantage of offshoring for exploited labor manufacturing.

[More on MOTORPRINTER](#)

BMSCC reimagined bi-directional electronic power conditioning with the *only Brushless Bidirectional Multiphase Self-Commutated Controller* that provides a unique, compact, high power, isolated, common mode rejecting, *fault tolerant, high frequency zero-crossing fault detection and fusing, inherent resonant switching, automatically exact*, electromagnetically symmetrical magnetic sharing circuit and control architecture (*i.e., high power [gyrator](#)*) that provides the most versatile Smart Power Converter products with automatic frequency translation, direct AC(1ph,2ph,...)/DC-to-AC(1ph,2ph,...)/DC conversion, and wireless power transfer with the lowest cost, highest efficiency, highest power density, and lowest distortion possible.

BMSCC is unbeatably essential for implementing synchronous or asynchronous [grid forming \(GFM\)](#), [inverter based resources \(IBR\)](#), such as Bidirectional Multiphase Inductive (Wireless) Power and frequency Transfer Systems (M-IPTS), fast electric vehicle chargers, static synchronous compensators ([STATCOM](#)) for enabling the flexible AC transmission system ([FACTS](#)), compact high power phase shifting transformer, etc.

[More on BMSCC](#)

BM-HFMDB reimagined electric power micro-distribution with the only Bidirectional, Multiphase, High Frequency, Electricity Micro-Distribution Bus that provides a unique, isolated, common mode rejecting, high power, fault tolerant, high frequency zero-crossing fault detection and fusing, inherent resonant switching, automatically exact, electromagnetically symmetrical magnetic sharing circuit and control architecture (i.e., high power [gyrator](#)) that halves the cost, halves the number of active electronic stages, halves the loss, halves the harmonic content, and halves the complexity of the entire system of systems (SoS) application, such as electric vehicles, electric airplanes, wind turbine farms, etc.

BM-HFDFB is unbeatably essential for lowering the cost, reducing the size, and improving the efficiency of any electric transportation SoS, such as electric vehicles.

[More on BM-HFMB](#)

PRODUCT → FOCUS:

A dramatic decline of the traditional mechanically geared powertrain vehicle, which is typically driven by an internal combustion engine (ICE), is anticipated with the rapid adoption of the more universally efficient, reliable, low maintenance, energy recovery (e.g., regeneration) electric propulsion motor powertrain (e.g., E-mobility) for any type of vehicle, such as battery, fossil or hydrogen fuel cell, or fossil or hydrogen ICE powered vehicles, which leaves the electric motor/generator (and micro-distribution) system as a major consumer of the vehicle's loss, cost, and size. Efficient, high power density electric propulsion is needed for environmentally friendly short distance passenger airplanes or for autonomous unmanned, long duration, high altitude, solar powered (e.g., *no fuel for launch, landing, or sustainment*), maintenance returnable, self-adaptable flying platforms, such as for the broadest, low delay, most reliable communication network coverage possible (e.g., 5G) that is impractical with traditional or clustered, and expendable satellites with associated infrastructure provisioning. Modular, lightweight, high power electric generator systems are being explored to reduce delivery, field installation, and sustainment costs of large wind-turbines. As the backbone of the entire electricity infrastructure, electric machine system innovation provides enormous opportunities: a) for the efficiency, cost, power density, and future of our commercial or industrial energy infrastructure, b) for net zero carbon emission, and c) for combating global warming. Without considering commercial and industrial applications, the electric propulsion motor system market, alone, is expected to reach \$100B by 2030 (BB) with a CAGR of 26.6%.

Ironically, the entire electric motor/generator system industry is approaching this electricity infrastructure transformation with the same century old, me-too or “asymmetric” electric motor or generator circuit and control architecture with the *non-optimal asymmetry* of the universally essential “active” stator assembly comprising a directly excited (e.g., *bidirectional*) multiphase winding set (or *active winding set*) for torque and power production but a “passive” rotor assembly comprising either rare-earth permanent magnets (**RE-PM**), slip-induction dependent windings, reluctance saliencies, or DC field windings (e.g., *conventional or superconductor electromagnets*) with associated provisioning, such as brushes, sliprings, RE-PM structural and thermal reinforcements, cryogenics, etc., and an offline, *estimating* FOC or DTC controller derivative for contiguously stable operation to synchronous speed or the maximum load speed (**MLS**). Unlike the “active stator assembly,” which always determines the overall torque rating of the asymmetric electric motor system by independently contributing working power to the electromechanical energy conversion process, the “passive rotor assembly” effectively *wastes* the other half of the total electric motor and generator system loss, cost, and real-estate *by not independently contributing any working power* to the electromechanical energy conversion process along with the “active stator assembly.” In consideration, today’s performance marketing distinction between “me-too” asymmetric electric machine systems from different manufacturers is always: a) [hiding the pertinent technical details of the electric motor system from the electric vehicle \(EV\) specifications to avoid exposing “me-too” similarity](#), b) enhancing performance by *empirically* applying a different selection of available materials, winding, packaging, manufacturing, thermal management, electronic component, and design techniques, such as the [axial-flux formfactor](#), that would always result in the same stable *constant-torque speed range* to synchronous speed (or *maximum load speed (MLS)*) and associated performance, if equally applied between asymmetric

electric motor systems with the same *continuous* torque, excitation frequency, synchronous speed, and voltage, and air-gap flux density specifications, c) forming alliances with leading innovators to mutually leverage verified performance enhancing techniques, or d) investing in creative cost-reducing manufacturing after recognizing electric vehicle OEMs are cunningly marketing virtually the same performing, century-old, asymmetric electric propulsion motor system, such as [NIDEC's \\$billion investment in high volume electric vehicle motor manufacturing with a global adversary seeking world dominance](#).

Today's anecdotally best solution for mitigating the environmental consequences of "consuming fossil fuels" is to [rapidly adopt the "me-too" RE-PM electric motor system](#), which ironically, is monopolized by a global adversary seeking world dominance with unethical disregard to the harmful geopolitical, exploited labor, human rights, environmental, electric machine system innovation, and pricing consequences, including significant price increases [as expected from past experience when future RE-PM shortages occur!](#)

Demonstrating the global adversary's insidious control on electric motor innovation and manufacture, today's best solution to the harmful geopolitical, exploited labor, human rights, environmental, innovation, and pricing consequences of producing RE-PM electric machine systems is limited to only reducing the amount of deliberately pricier RE-PM materials by mating a high speed (and therefore smaller) RE-PM electric motor system with an unusual, high frequency electronic excitation controller and an extraneous, speed-reduction gearbox to match the high speed of the motor to the speed of the load, which ironically "compounds" the overall complexity, cost, reliability, maintenance, noise, size, and loss of the entire propulsion drivetrain! Similarly, moving to prevalent but very low energy product ferrite permanent magnets only

exasperates this problem by requiring even higher operating speeds and larger gearboxes for the same power density but lower efficiency and reliability as the RE-PM or Induction electric motor systems!

Although the common understanding amongst electric motor manufacturers is directed towards reducing the dependency on precious, costly, environmentally destructive, and geopolitically sensitive rare-earth permanent magnet (RE-PM) materials by higher speed operation, manufacturers of so-called yokeless, coreless, air core, or printed circuit board electric motor systems with lengthy airgaps, such as [Infinitum Electrics](#), are ironically increasing the amount of RE-PM materials per unit of power rating, which can only be artificially sustained by the RE-PM cartel of the global adversary!

*Only BEM is introducing a patented “synchronous” electric motor or generator system, called **SYNCHRO-SYM**, with the optimal “symmetric” circuit and control architecture that brushlessly, synchronously, and stably combines the working power production of two similarly rated “active” winding sets that are symmetrically placed on the rotor and stator, respectively, to inherently maintain the same electric motor package footprint of material (less RE-PMs), construction, cost, and loss as any other electric motor system, while simultaneously doubling the continuous power with octuple the peak torque of any other. [Proven by at least a half century of basic electric machine study, research, and publication](#) that were reimaged to practical reality by a regimen of BEM prototyping and invention, the symmetric multiphase wound-rotor “synchronous” doubly-fed circuit and control architecture of SYNCHRO-SYM is known to be only possible with the breakthrough invention of *automatically exact*, brushless, sensor-less, and multiphase real time emulation control (**BRTEC**) for guaranteeing *contiguously* stable operation,*

regardless of random rotor or line destabilizing perturbations, from sub-synchronous to super-synchronous speeds, including at or about zero and synchronous speeds. Effectively, the patented BRTEC is the only control technology with the “digital twin” embedded in the runtime control hardware and software (i.e., real time emulation) instead of applied as a onetime design tool for research and development. Therefore, under the same MLS design for a given *continuous* torque, frequency and voltage of excitation, and air-gap flux density, all while reasonably assuming the rotor or stator consumes half of the loss, cost, and size of any electric machine system with the associated *compounding* effects of rotor friction, induced harmonics, electronic control, stator support, stator power through, and extraneous enabling components for consistently maintaining the rotating air-gap flux density, **SYNCHRO-SYM** is a drop-in replacement to the asymmetric electric machine system of all others but provides at least *double the continuous power with virtually unlimited peak torque density at half the size (e.g., twice the continuous power density), half the amount of material, such as [copper](#), half the cost, and half the loss ([per unit of continuous power rating](#))* by the combined performance of two active winding sets (i.e., *doubly-fed*) in the same package of material (less RE-PMs), winding, electronic component, thermal management, and manufacturing techniques of any “asymmetric” electric motor circuit and control architecture with only a single active winding set (i.e., *singly-fed*), particularly in an [axial-flux](#) format with inherently similar adjacent rotor and stator disks assemblies,.

Our flagship product, SYNCHRO-SYM, as only possible with the practical invention of brushless, real-time, emulation control (BRTEC), provides at least six uniquely superior attributes:

- 1. The only electric motor or generator system with an***

“active rotor” assembly that is without passive RE-PMs but instead, stably contributes another increment of “active power” to the electromechanical energy conversion process while reasonably consuming the other half of the total electric motor system package loss, cost, and size along with the universally essential power producing active stator assembly. For example, RE-PMs do not have an electrical port for directly providing multiphase (active) electrical power to the electromechanical energy conversion process and like slip-induction windings, reluctance saliencies, or DC field windings, a rotor of RE-PMs is a “passive rotor.”

- 2. The only electric motor or generator system that doubles the power density at half the cost, half the amount of material, such as copper, and half the loss per unit of power rating of the typical electric machine footprint or packaging techniques with the size, loss, and cost of the integrally embedded BRTEC extraordinarily included in the calculations. For example, only SYNCHRO-SYM delivers twice the continuous constant-torque speed range with the same air-gap flux density, torque, voltage, synchronous speed, and excitation frequency design and packaging (less RE-PMs), such as 7200 RPM @ 60Hz for SYNCHRO-SYM with one pole-pair versus 3600 RPM for the asymmetric electric machine system, which is tantamount to twice the continuous power density at half the amount of material, such as [copper](#) & electrical steel, half the cost, and half the loss per unit of power rating of asymmetric electric machine systems.***
- 3. The only electric motor or generator system that provides octuple the typical peak torque at the same maximum load speed, voltage, frequency of excitation, and air-gap flux density by eliminating core saturation with increasing torque current, which is essential for direct drive or gearless electric motor propulsion systems.***
- 4. The only electric motor or generator system with***

electric machine circuit and electronic controller symbiosis, which inherently doubles the expected performance gain of emerging wide bandgap semiconductor while halving their expected cost per unit of power rating.

5. *The only electric motor or generator system that doubles the expected performance gain while halving the cost per unit of power rating from applying the same performance enhancing techniques to any other electric machine system, such materials, winding, thermal management, packaging, and electronic component techniques, including emerging wide-bandgap (WBG) semiconductors.*
6. *The only electric motor or generator system that provides a practical, ethical, and superior but lower cost alternative to the cartel-controlled RE-PM electric motor system, which is anecdotally considered the best performing electric motor system but is cartel-controlled and therefore monopolized by a global adversary seeking world dominance with harmful exploited labor, human rights, environmental, and geopolitical consequences.*

Only BEM is introducing a portfolio of patented enabling technologies, branded SYNCHRO-SYM Technologies, that reduces overall size, improves overall efficiency, and lowers overall cost of an electrical System of Systems (SoS) application, such as wind turbine farms and electrically propelled ships, airplanes, and land vehicles. SYNCHRO-SYM Technologies include: a) *a patented (and only) electric machine 3D Printing technology, called MOTORPRINTER, for revolutionizing and democratizing the rapid just-in-time additive manufacture of superior performing axial-flux low frequency electric motor and generator systems, such as SYNCHRO-SYM, and high frequency, high power electronic transformers, such as BRTEC, which are essential for lowering*

the cost, size and loss of the smart electricity infrastructure, b) a *patented (and only) Brushless Bidirectional Multiphase Self-Commutated Controller*, which is essential for successfully implementing the smart electricity infrastructure, and c) a *patented (and only) Bidirectional, Balanced Multiphase, High Frequency, Electricity Micro-Distribution Bus*, which is essential for lowering the cost and improving the efficiency of the electric vehicle SoS.

PRODUCT → SHOW ME:

Comprising the asymmetry of a “passive rotor assembly” of rare-earth permanent magnets (**RE-PM**) and a *state-of-art* but offline, *estimating* control derivative of FOC, [MAGNAX](#) shows some of the highest performance metrics for the century old, me-too asymmetric electric motor system by *empirically* applying an engineered selection of commonly understood [RE-PM yokeless and segmented armature \(YASA\) performance enhancing techniques to leverage its advantages while mitigating the manufacturing and thermal management challenges of the dual-airgap axial-flux \(i.e., adjacent stator and dual rotor disks\) asymmetric synchronous electric motor system](#) with the *compounding* structural, permeability, and flux saturation constraints of YASA’s soft magnetic material.

By simply *retrofitting* the same asymmetric circuit and control technology of MAGNAX with the *patented brushless and symmetric multiphase wound-rotor synchronous doubly-fed electric machine circuit and control technology* of **SYNCHRO-SYM**, which keeps the loss, cost, and size of the original MAGNAX active stator

assembly with the same continuous torque, frequency & voltage excitation, and air-gap flux density ratings but *replaces* the size, loss, and cost of the MAGNAX “passive rotor assembly” (i.e., dual air-gap disks) and offline *estimating* control derivative of FOC with the optimal symmetry of a working power contributing “active rotor assembly,” as only possible with contiguous synchronous stabilization by an automatically exact, brushless, sensor-less, and multiphase real time emulation controller (BRTEC™), the *power density* of the *original* MAGNAX electric machine system package would comparably *double* per unit of continuous power rating (i.e., twice the constant-torque speed range), the *cost* would comparably *halve*, the *efficiency* would comparably *double*, and the *peak torque* would comparably *octuple*, as was [proven by at least a half-century of electric motor study, research, and publication](#) that were reimagined to practical reality by a regimen of BEM prototyping and invention. Also, the non-optimal asymmetry of RE-PMs with known safety, handling, limited operational life expectancy, wasteful cogging drag, unfriendly environmental, exploited labor, human rights, and geopolitical consequences would be ethically eliminated with the optimal electromagnetic symmetry of *another* active winding set.

This simple retrofit comparison between SYNCHRO-SYM and the original MAGNAX (*or any other electric motor system*) conveniently shows:

1. Like MAGNAX, SYNCHRO-SYM follows the same material, winding, packaging, and electronic component enhancing techniques and as a result, is straight-forward ready,
2. Like MAGNAX, SYNCHRO-SYM follows the same operation, design, construction, and manufacture and as a result, is straight-forward ready,
3. Like MAGNAX, SYNCHRO-SYM uses off-the-shelf components (*but without RE-PMs*) and as a result, is straight-

forward ready,

4. Like MAGNAX, SYNCHRO-SYM is adaptable to legacy or future electric machine systems with customary engineering and manufacturing and as a result, is straight-forward ready,
5. Like MAGNAX, SYNCHRO-SYM easily leverages third party legacy or future electric machine design, packaging, material, winding, or construction enhancing techniques but with double the expected performance gain and as a result, is straight-forward ready,
6. But *unlike* MAGNAX, only the symmetric circuit and control architecture of SYNCHRO-SYM with two similarly rated active winding sets advantageously placed on the rotor and stator, respectively, *inherently* provides: i) the same packaging footprint and materials (less RE-PMs), ii) universal single AC, multiphase AC, or DC operation, iii) coveted field weakening for extended speed range, electronic control reliability, and *highest efficiency* at any speed, iv) efficient clogless motoring and generating (*i.e., no RE-PMs*), v) inherently indestructible without the fragility and limited life expectancy of RE-PM but with the precision control of BRTEC and the proprietary thermal management as only provided by the just-in-time, additive manufacture of MOTORPRINTER, vi) “comprehensive” leading, lagging, or unity power factor compensation over the entire speed range, vii) “comprehensive” regeneration over the entire speed range, viii) *best* utilization of emerging [wide bandgap electronic semiconductor switches](#) with a circuit and control technology [that doubles their expected performance with half their expected amount of material, such as copper, & cost per unit of power rating](#), ix) the reliability and resiliency of BRTEC with inherent resonant switching, x) the direct AC-to-AC power conversion of instantaneous, sensorless, multiphase, and automatic electromagnetic computing (*i.e., BRTEC*) with [inherent active filtering, which eliminates the DC Link](#)

Stage of FOC with banks of large, expensive, inefficient, and delicate low frequency, high power capacitors, xi) the unique power conditioning method of BRTEC inherently provides pure sinusoidal excitation, which minimizes electrical stress on electronic components, insulation, etc., xii) *best* utilization of the axial-flux form factor by conveniently and proportionally placing the compact electromagnetic computer of BRTEC within the otherwise wasted annulus of the electric motor axial flux core, which physically provides the same rotor and stator assemblies (*less software programming*), and xiii) a simple and highly effective demand based cooling method for another level of system power density and component inventory reduction, all of which are inherent to SYNCHRO-SYM under the additive manufacturing of MOTORPRINTER and the design control of BEM-CAD.

7. But unlike MAGNAX, the modularized, axial-flux SYNCHRO-SYM is: i) with the same rotor and stator disks with the exception of software configuration (as only provided by the symmetric circuit and control architecture and the additive manufacture of MOTORPRINTER under BEM-CAD), ii) is without the safety and handling issues of RE-PMs, iii) is without the componentized assembly logistics of the typical remotely mounted electronic controller, such as FOC, and iv) as a result, can be conveniently field assembled or field stackable lengthwise for incrementally higher power rating or smaller diameter, direct drive applications.

While solving the challenges of manufacturing production and thermal management of the *axial-flux or YASA* electric motor system with the structural, permeability, and flux saturation limits of soft magnetic composites, **MOTORPRINTER** revolutionizes and democratizes the manufacture of low and high frequency *axial-flux* electric motors, generators, and

transformers, such as SYNCHRO-SYM, with a rapid, just-in-time, compact, incrementally scalable, low waste, non-smokestack, remotely controlled, deployable, self-contained 3D Printing method that also exclusively provides a high capacity electric motor system thermal management system. Also, the circuit and control architecture of the automatically precise, Brushless, Sensor-less, and Multiphase Real Time Emulation Controller (BRTEC) with electromagnetic processing and inherent resonant switching provides several patented hybrid configurations. For instance, **BM-HFMDB** provides the power distribution to multiple SYNCHRO-SYMs in a system of system, such as electric vehicles, with half the number of active devices (*i.e.*, *power switches*), fault tolerance, and high frequency zero-crossing fault detection and conduction breaking for higher efficiency, lower cost and lower size and **BMSCC** allows compact and efficient solid-state power conditioning, gyration, and translation from any power, such as DC, single, and multiphase AC, to any voltage, frequency, or phase, such as an EV battery controller and an EV charger.

[Already proven by over a half century of independent electric motor study, research, and publication](#) and then, verified by BEM's prototyping and computer aided design tool (**BEM-CAD**), BEM hopes the reader takes the necessary time to understand the [SYNCHRO-SYM's concept of operation](#). It will become evident that any electricity infrastructure product can benefit from applying SYNCHRO-SYM Technologies.

[Eliminating the RE-PM Electric Motor System is Hot!](#)

PRODUCT → SYNCHRO-SYM E-MOTOR:

BEM's [E-mobility](#) market study verified the advertised [Koenigsegg Quark E-Motor](#) claims of best overall performance of any other "me-too" (or *asymmetric*) propulsion motor system with the typical componentized remote electronic controller, because unlike the creative marketing of most others, Koenigsegg provided proper specifications for fair analysis. As a result, the Quark E-Motor will be our initial competitive market focus of the **SYNCHRO-SYM E-Motor**. But without exotic materials, such as RE-PMs or superconductors, or packaging techniques, such as Halbach arranged RE-PMs, the **SYNCHRO-SYM E-Motor** shows "total system" Power Density of 66 KW/L (*versus Koenigsegg's 31.3 KW/L*), Specific Power of 16 KW/Kg (*versus Koenigsegg's 8.7 KW/Kg*), and total System Efficiency of 96% (*versus Koenigsegg's N.A.%*) at 800 volts, 4000 RPM and 1.25T airgap flux density, all while *uniquely including the compounding loss, cost, and size of the integrally embedded BRTEC*, which demonstrates SYNCHRO-SYM's double expected performance gain as [proven by at least a half-century of electric motor study, research, and publication](#) that were reimagined to practical reality by a regimen of BEM prototyping and invention. With ample funding, other "me-too" asymmetric RE-PM electric motor systems (*for electric airplane propulsion*), such as [MagniX](#), [H3X Technologies Motor](#), and [MIT's Megawatt Motor](#), are also struggling to reach the power density, specific power, and efficiency ratings of the Quark-E motor or Koenigsegg newest E-Motor introduction, called [Dark Matter](#). Also, with its superior performance and the inherent facilities provided by the straight-forward *additive* manufacture with MOTORPRINTER (*under the design control of BEM-CAD*), the SYNCHRO-SYM E-Motor product offers higher reliability and much lower cost.

[SYNCHRO-SYM versus Koenigsegg Quark E-Motor](#)

PRODUCT → OUR STORY:

BEM's story reveals our history and ethical mission, "Innovate for our clean, efficient, and sustainable energy future!"

[The Story Behind Best Electric Machine and SYNCHRO-SYM Technologies](#)

PRODUCT → COMPANY:

[Already proven by over a half century of independent electric motor study, research, and publication](#) and then, verified by BEM's prototyping and computer aided design tool (**BEM-CAD**), let BEM be your one-stop electricity infrastructure provider with SYNCHRO-SYM Technologies.

[Product Collaboration or Purchase](#)

PRODUCT → FUTURES:

An informal collage of future BEM products, which are uniquely enabled by the compact, low cost, high efficiency, and rare-earth material free SYNCHRO-SYM Technologies, uniquely enables a ubiquitous, autonomous, and sightless far offshore, green hydrogen capture sail ship method, a modular and programmable (SW) electric vehicle propulsion drivetrain method, an energy reciprocity management method, an ultra-high altitude, field repairable, autonomous swarming, meshed communication solar powered unmanned drone method, and etc.

[Potential Future Products](#)