Steinmetz

Hyper-Efficient Power Electronics

Owen Brake

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1 Executive Summary

Steinmetz is a company creating a generic platform for all EV platforms from aerospace to automobiles to robotics.

The first vertical the company is tackling is EV motor controllers. There currently exists a large gap across the entire market where existing offerings are overpriced with poor performance metrics. The industry agrees that the path to lower overall EV system costs is through better, motor controller systems[1]. The founder Owen Brake has created a prototype GaN EV motor controller which has demonstrated feasibility. The potential market on this 1 vertical is over $100B/yr within the next decade.

The company is raising $1M preseed to package the prototype into a finished product and deliver product to customers within 12 months. The company plans to rapidly expand and penetrate the market, given that the finished product will deliver superior performance metrics at a component cost-competitive price.

The existing competitors on the market are bloated and slow, product innovation in this sector has ceased. The existing teams are not prepared to rapidly improve their systems as they have been mostly shuttered. The company plans to rapidly expand, deliver superior product to market driving down EV system cost and improving performance. This will create a competitive pressure for vertically integrated companies to disintegrate their motor controller and power electronics teams as they won't be able to keep up.

2 Company Overview

Steinmetz is a company which produces highly-performant and cost-effective power electronics for EV applications.

Steinmetz is composed of small engineering teams which cycle between potential verticals in the generic EV space. Various techniques are modelled, prototyped and validated. Then the team works on rapidly scaling this composition of ideas into production to deliver value to customers.

For the customer Steinmetz acts as a platform company.

When a customer goes to design their own EV product whether it be an automobile or a plane they can save tremendous engineering time by using the commercial off the shelf solution provided by Steinmetz. They will understand the engineering time and resources to produce a comparable component would be tremendous and not possible in the early stages of design.

For mature customers (Ford, Tesla, Stellantis, etc.) the value add is in increased scale, engineering validation and performance. For a mature EV company like Ford or Tesla they have to ship new vehicles every 1-2 years at scales of 100k-1M+ vehicles per year. Taking risks on new technologies or ideas is incredibly risky and involves significant engineering resources with potential for delays. Steinmetz offloads that burden by iterating on ideas continuously in the background and validating at scale through all the other customers.

The goal of the company is to be the generic platform for all future transportation. Electrified powertrains are from a physics perspective the most efficient practical form of power delivery we have. Everything that moves will eventually be driven by electric motors, to provide a platform for this future is a $1T+ industry.

2.1 Company Thesis

The company thesis is that the complete vertical integration of EVs is inefficient and unsustainable over the next 10-15 years. As the electrification of all transportation continues the competition will only become more fierce and as with the previous generation of vehicles, the best, most reliable, most efficient vehicles will succeed.

To produce great vehicles for the customer, manufacturers require great components. To produce future generations of EV components require non-trivial engineering investment and it’s infeasible for every EV company to in-house vertically integration this design and fabrication for every system [1].

> *"The cost needs to be cut and size reduced by an order of magnitude ..., and reliability need to be doubled to meet the 2025 targets"*
> *— Department of Energy U.S Drive Report [1]*

To remain competitive EV companies of various verticals will have to out-source this design to remain cost and performance competitive. This is an inevitability, not a bet.

Automotive manufacturers do not make their own: brake calipers, wheels, tires, suspension components, etc because these are highly specialized components [2]. To produce cost-effective, reliable, performant, competitive brake calipers requires significant in-house engineering resources.

There currently exists a gap in the market for the powertrain and power electronics in EVs as it is still a competitive approach to vertically integrate most systems. The COTS (commercial off the shelf) options are worse or on par with what is produced in house at the major EV companies, the product offerings are poor and there is no disruptive push for innovation.

When we push the envelope with a significantly better performance option at a cost competitive price we will disrupt the industry.

2.2 Team

2.2.1 Owen Brake (Founder)

Currently the team is composed by the company founder Owen Brake.

Figure 1: Owen Brake - Founder

Owen is a graduate from Mechatronics Engineering at the University of Waterloo. He’s worked at high profile tech companies working on teams designing, testing, fabricating and shipping products with millions of users. Owen has developed multidisciplinary experience working on Software, Firmware, Mechanical and Electrical engineering in the workplace.

Owen has an acute understanding of the customer needs and requirements having worked at multiple EV companies on both the in-housed design powertrain and power electronics as well as experience working with the COTS options.

Owen also performed complete design and fabrication of the prototype GaN motor controller.

2.2.2 First Hires / Cofounders

Currently the team consists of 1 person. For the company to scale it will require more employees/cofounders.

There are a few options for these people, but the decision has been made to remain solo and lean until major company roadblocks emerge. It's currently unclear which direction the first hirings should focus on, whether it's mainly a sales challenge or engineering challenge or manufacturing challenge, etc.

Table 1: Potential cofounders and first-hires.

Name	Specialty	Experience
Omar Abuabah	Electrical Engineer	Figure Robotics EE, Waterloo Mechatronics
Leah McClure	Mechanical Engineer	Tesla + Neuralink ME, Waterloo Mechanical
Justin Vuong	Firmware Engineer	Tesla FW, Waterloo ECE
Hewitt McGaughey	Firmware Engineer	Tesla + Applied Intuition FW, Waterloo Mechatronics
Ethan Childerhose	ASIC + Electrical Engineer	Tesla EE + NVIDIA, Neuralink ASIC, Waterloo Mechatronics
Sehajpreet Lubana	Sales	Waterloo Mechatronics
Redacted for Confidentiality	Sales	Microsoft + U of T

Listed above are people where a potential role has already been discussed. There are many other potential candidates that are not listed as they have not been contacted. Engineering talent acquisition will not be an issue in the early stages of the company.

2.2.3 Why this Team?

With a diverse experience set Owen has a unique insight into the design and manufacturing process of EV electronics as well as the customer experience. He also has a very broad set of engineering and leadership skills allowing him to manage cross-functional teams, recruit high-quality talent and direct engineering focus.

The truth is there aren't really truly multidisciplinary engineers out there in the world, people are incredibly focused and siloed.

Additionally, at large, bloated EV companies and automotive OEMs the teams grow to be quite large and very divided. As an example the people who might work on the motor controller will span 3 different departments, requirements are passed between each other to create a compromise product. This can be productive when you're working on a large system, but fundamentally is a flawed approach to engineering for these component level items.

The resulting product is a mess of trade-offs that yield a poor product on a long timeline. In this company a major focus will be to create small agile, multidisciplinary teams where cross-domain tradeoffs and discussions can be had with rapid iterations. This is a strategy which has been witnessed to be highly effective, in particular this is how Apple is able to rapidly produce new, innovative products, the product development teams are small, agile and multidisciplinary. A stark contrast to the slow automotive field.

2.2.4 Company Culture and Philosophy

The best engineers are not driven by TC or benefits, they are driven by mission and passion. The strategy at Apple, Tesla and Parallel Systems for attracting talent was very much no frills, and a promise that you will work on great projects. To an extent Tesla on the vehicle systems side has lost this aura as the cool projects have moved to Optimus and Autonomy.

Regardless, this will be the company culture at Steinmetz, the best engineers will work here on very cool projects and they will work hard. This is why it's important to create the small team culture, tight innovating teams which keep each other in check and iterate quickly on interesting engineering problems.

That is the strategy to remain lean and attract the best talent.

2.3 Product

2.3.1 General EV Architecture and Potential Verticals

Presented below is the generic EV architecture for most EVs spanning aerospace, automotive and naval.

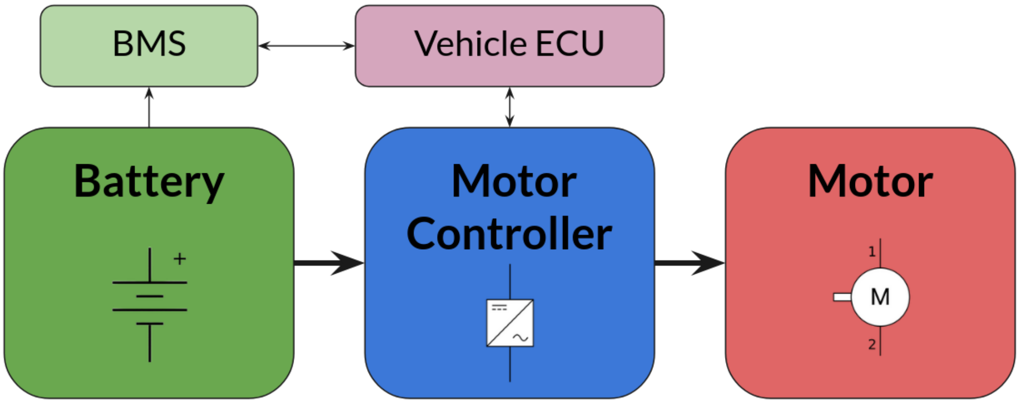

Figure 2: General EV Architecture.

The exact figures change depending on the vehicle design, but overall the major subsystems of the system are the Battery, Motor Controller and Motor.

Not included are the various smaller power electronic subsystems in an EV including: OBC (on-board charger), DC-DC units (high-voltage to low-voltage) and LV power distribution.

One day Steinmetz will create a modular platform for EV design such that one can build a complete integrated system using Steinmetz's custom subsystems.

2.3.2 Motor Controller

As stated the company has multiple potential verticals and aims to be a general hardware platform for all EVs. However, the first product is a very efficient and power dense motor controller.

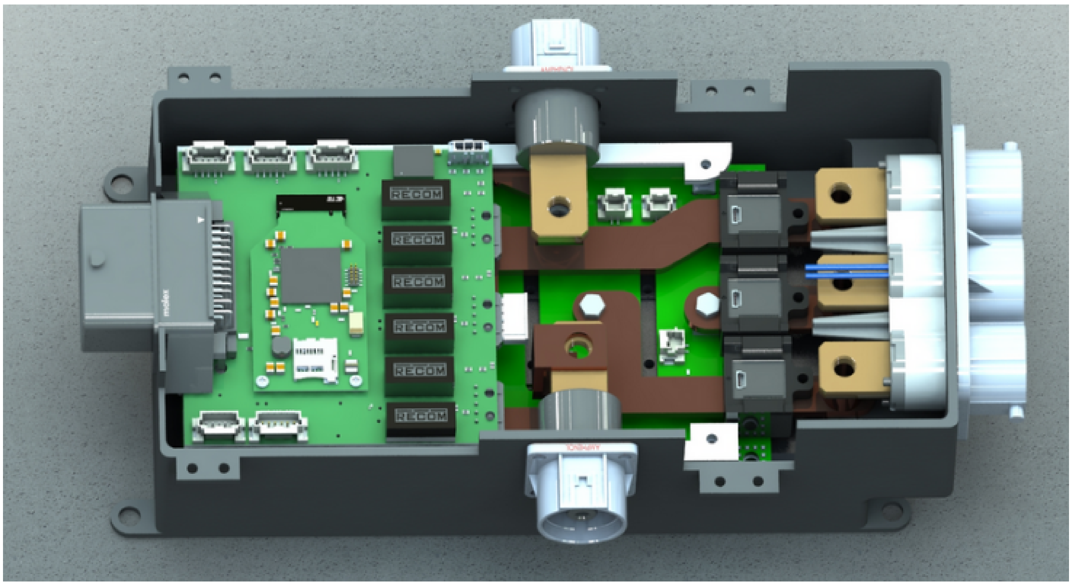

Figure 3: Prototype Render with lid removed.

The first product to market is a very lightweight efficient motor controller using GaN technology and numerous power electronic optimizations. A prototype to validate many of these techniques has already been fabricated and tested at the University of Waterloo. A render of the full assembly is shown above.

The next step for the product is to take these lessons, perform a quick design turnaround to bring down cost, improve assembly process and get a ready for market product. The same general techniques will be utilized as in the prototype, a small amount of engineering work is required to make this a product ready for small-scale production.

It's difficult to provide completely accurate figures on performance as this design turnaround must be performed and rigorous testing of the final product will be done to get complete statistics on this.

The conservative floor estimate for power density would be $60\frac{kW}{kg}$, the goal would be to be approaching $100\frac{kW}{kg}$ which is very possible. Within the near future the team would be pushing well ahead of that utilizing multi-physics integrations [1]. Additionally the cost would be incredibly competitive likely aiming for $60\frac{W}{\$}$ for early low volume production with direct paths to significant cost reductions at scale. The existing market is discussed in the Market Analysis section, but for reference this product entering the market would be quite disruptive on cost/performance.

2.4 What is the Business?

To put it succinctly, Steinmetz is a HW platform company. Eventually everything that moves will be built on the Steinmetz platform.

Just as NVIDIA is the platform from which AI models are trained, Steinmetz is the platform on which everything artificial that moves is built. Just as with NVIDIA, it's too costly and requires talent concentration to create a competitive product through vertical integration.

In the not too distant future, when a company like Apple or Tesla decides they want to build a plane or a robot or a car they will begin their design by using Steinmetz off the shelf motors, controllers and DCDCs.

3 Strategy

3.1 Sales Strategy

Once the company has scaled the company will focus on 3 main categories of sales: COTS, OEM and ODM.

3.1.1 COTS (Commercial Off the Shelf)

For the very small volume customers (<25 units/year) there will an online store where customers can purchase off the shelf options. The company will have a plethora of product options for the customer to meet whatever their needs may be.

There will be excellent documentation and open source software to allow these end users to integrate their product easily into their own systems, alleviating the support requirement for these small customers.

In the early days this will likely be the predominant form of customer sales. The COTS market is important to keep in mind as it helps establish the engineering reputation of the company.

3.1.2 OEM (Original Equipment Manufacturer)

For medium volume customers (>$100k/yr, <$10M sales) the company will act as an OEM. Customers will still order existing product offerings with little to no modifications on design to product. Customers will sign production contracts to ensure supply demands are met.

3.1.3 ODM (Original Design Manufacturer)

For large volume customers (>$10M/yr sales) a contracted design agreement may be desired. A company like Tesla might desire a tightly integrated and optimized design for their exact use case, they might have very specific requirements. In this case a small group of engineers would work with the customer to tailor a design to meet their needs. Manufacturing would still remain in house.

3.2 Near Term Plan

Plans are always subject to change in very early days but it’s important to plot a course to adequately prepare for the future.

The initial plan is to go to market with this product, scale it rapidly and deeply penetrate the market. There’s sufficient appetite from customers for this product in the present and very near term. It’s important we move quickly and leanly to get the product in as many hands as possible, develop a strong reputation and iterate on feedback rapidly to stay ahead of potential competitors.

Large customers will likely wish to see the product validated in the field by smaller customers, so it’s important we push rigorously in the early days to get the product in the hands of many small customers to get this validation evidence and reputation.

3.2.1 Year 1 (2025)

In 2025 the main goal is to establish the company, bring up the testing infrastructure and finish the production ready version of the first product, the motor controller. The goal is within 8-10 months of year 1 a system is ready to go out to first customers. This will require only a small number of employees at most 3-4.

The rest of 2025 will be spent selling the device to various customers, iterating quickly on customer feedback and preparing for a seed round raise. The goal is to achieve 100 purchase product orders by the end of the year which should yield $500k+ in revenue.

Table 2: Estimated Team Composition and Progress.

Role	Count
Electrical Engineers	1
Software Engineers	1
Mechanical Engineers	1
Sales/Operating	1
Units Produced Yearly	50-100
ARR	$500k
Annual Gross Profit	$200k

3.2.2 Year 2 (2026)

The start of year 2 will be characterized by the raising of the seed round to scale the company using the market validation of year 1. This seed round will be used to hire on a few more engineers as well as a strong sales group to bring the team to about 10-15. The goal would be $5M, enough to grow the team, invest in company infrastructure and scale manufacturing.

A group of the engineers will work on supporting the motor controller product as well as preparing the device for mass production in the 10k+ range, that is bringing unit costs down, collecting more validation evidence and iterating on methods to improve device performance even more.

Another small group of engineers will be working on rapidly bringing up 2nd vertical. The 2nd vertical is subject to change based on customer feedback, but it is likely an integrated motor system. The plan would be deploying this 2nd vertical within the calendar year of year 2.

The sales team will be working aggressively to get the product in the hands of the low-hanging fruit, low volume customers but more importantly aiming to acquire those large volume customers, i.e Ford, Rivian, Lucid, Tesla, Stellantis, etc.

Table 3: Estimated Team Composition and Progress.

Role	Count
Electrical Engineers	2
Software Engineers	4
Mechanical Engineers	1
Manufacturing Engineers	1
Sales/Operating	4
Units Produced Yearly	500-1000
ARR	$5M
Annual Gross Profit	$2M

3.2.3 Year 3 (2027)

Year 3 will mark a rapid acceleration of the team. By year 3 the goal is to have substantial production contracts and multiple recurring customers. The company at this point is preparing for a Series A raise to begin mass production of devices and continue to expand into other verticals.

3.3 Why Now?

The ultimate question is why now?

3.3.1 Commoditization

The commoditization of EVs is rapidly progressing. The era of EVs being a luxury to own is rapidly waning. Mass market adoption has occurred and now companies are in a competition over who can create the best EV, it's no longer a toy.

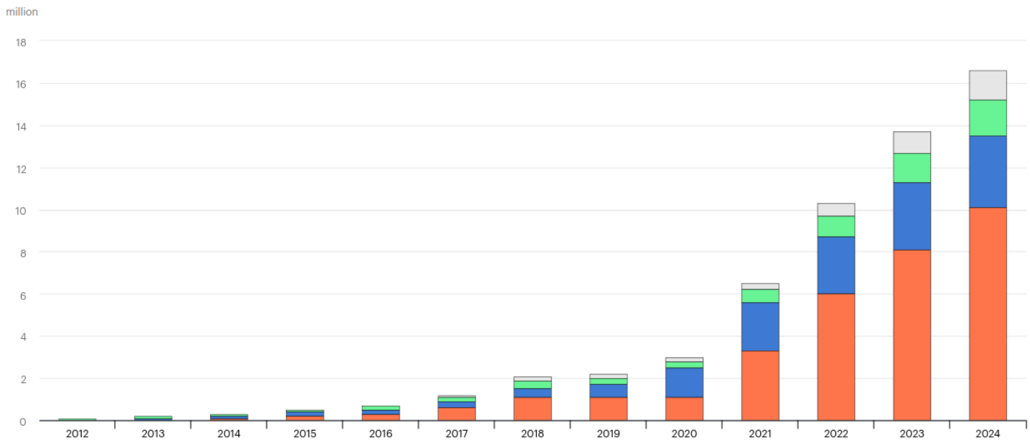

Figure 4: Global year over year EV sales.

This axiom lends itself to huge potential immediate market access and lower market risk. Additionally the next decade will see automotive manufacturers continue to try and drive down cost and prices for further mass market adoption. Per the US DRIVE report innovation along this path will "enable overall power electronics cost to decrease due to system cost reduction."[1]

3.3.2 SiC Catastrophe and WBG Hangover

This report coins the term "SiC Catastrophe", it's an ill discussed phenomenon in part due to the embarrassment of Tesla. The summary is from 2017-2022 the entire automotive industry invested heavily in attempting to move their high-power power electronics over to a new type of semiconductor SiC (Silicon Carbide)[3]. Tesla in particular invested heavily and attempted to move nearly all there power electronics onto this semiconductor platform[3].

Lots of engineering time and money was invested but by 2023 those in the automotive industry understood that there are significant issues with SiC and now players are attempting to divest[4].

There is now a "WBG (Wideband Gap) Hangover" in the industry, the major players have halted any innovation or work on R&D. Designs have reverted to old Si IGBT processes and the only engineering work being done is on tiny parts cost optimizations.

This offers a unique opportunity for market penetration. The big players are not working on improving their systems, there is no competitive pressure or moat by the big players.

3.3.3 GaN Market Maturity

Over the past few years the GaN semiconductor market has matured tremendously and reached significant market penetration in low-medium voltage devices[5]. This WBG semiconductor allows for tremendous power density and efficiency improvements and the process is sufficiently mature that it is extremely cost competitive with Si.

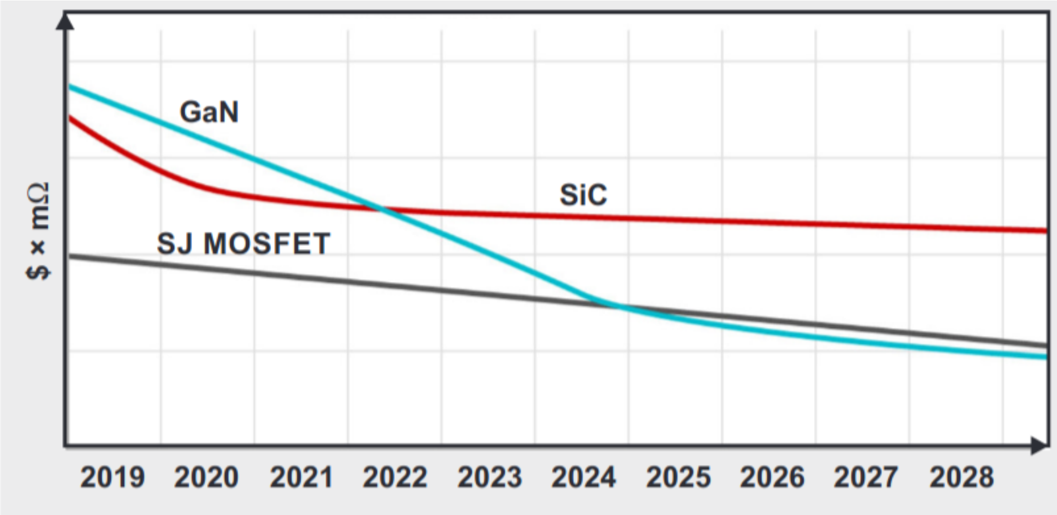

Figure 5: GaN vs Si vs SiC cost projection by Texas Instruments [6].

The GaN semiconductor market is now very cost-competitive, and has demonstrably higher performance. There are currently no GaN motor controllers in EVs. The GaN semiconductor process nodes are robust and cheap due to its application in other fields.

3.3.4 Emerging EV Markets

As is discussed in the Market Analysis section, today there is a rapidly growing electrification of other vehicle platforms. Robotics, eVTOL, EV planes, EV boats, drones, trucks, everything that moves is becoming electrified to yield these efficiency improvements. These markets are emerging rapidly, if we can offer them an easy-to-use, effective product we can achieve customer lock-in early on and grow with our customers while maintaining low risk.

3.4 Preseed

The goal of the preseed raise is to bring the product to market, achieve market validation and prepare to scale up after raising the seed round. The company is raising $1M which should provide ample runway for 12-18 months.

3.5 Why Venture?

Venture capital is required to scale this business rapidly and support the up-front engineering costs. The engineering cost of bringing a product like this to market is non-trivial. Perfecting design and collecting appropriate validation evidence on the design for the customer requires expensive test-equipment which is infeasible to bootstrap.

Additionally, the marketplace is dominated by high-value, large customers, there is some value in selling to startups, but there is significant alpha and great opportunity in scaling quickly to be able to compete with the major players in the space. If you don't have the capital to be able to scale manufacturing to 10k+ units then the market opportunity is more limited.

Finally, this is a venture scale business.

1. Potential TAM is in the $100B+
2. Quickly growing market (both automotive EVs + other types of EVs + other verticals)
3. Clear path to $1B company.
    a. Can reach $100M+ in revenue w/o majorly disintegrating vertical integration, just offering better product to existing customers.
    b. Ford -> 75k EVs/yr (2023) -> $1500/EV -> $100M revenue
4. Product is easily scalable, production is fairly simple and capital efficient, can scale to 100k+ units in <5 years (100M ARR).

3.6 How much R&D is Required?

A common question for those unfamiliar with the industry is how much R&D is required to be competitive and enter the market. It seems insane but practically no major R&D work is needed, there is no long timelines of R&D, the reason is we know how to produce better products today.

The knowledge and understanding is there, all that remains is the final piece of engineering execution and go-to-market.

4 Market Analysis

Performing a complete market analysis is somewhat difficult due to the vast number of customers and incredibly diverse use cases. Consider that about 50% of global energy is spent driving motors[7].

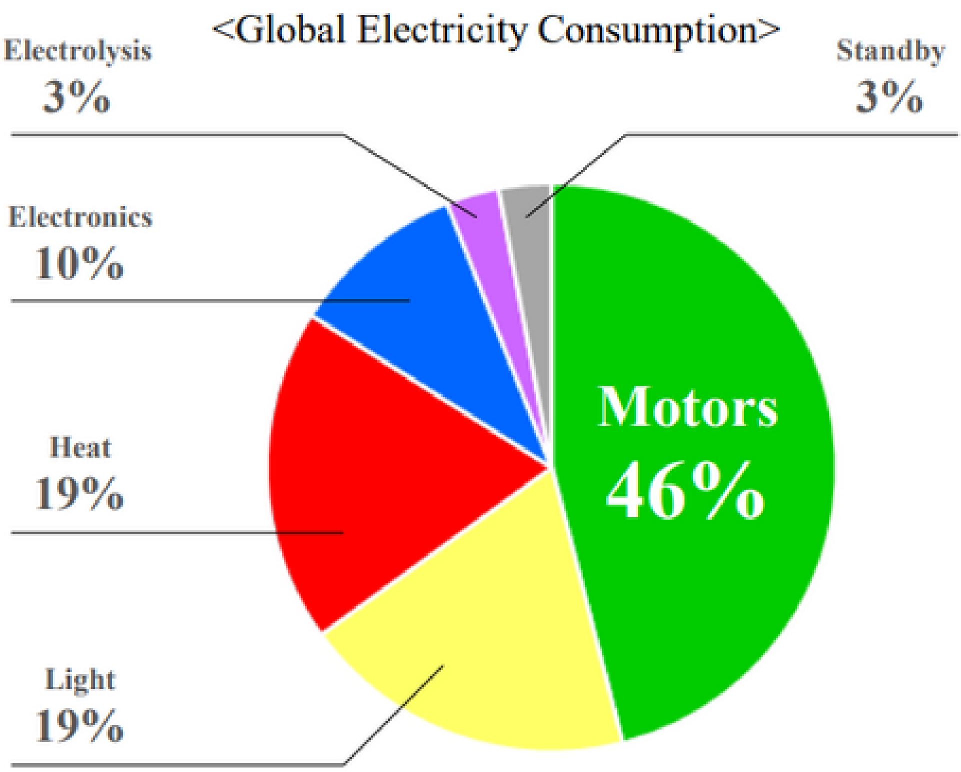

Figure 6: Global Electrical Consumption by generic use case (2011)[7]

This market analysis will solely look at the motor controller industry for EVs. There are further multiplicative verticals which substantially increase the potential market for the company but a full analysis in this direction would be exhaustive.

4.1 Customers

4.1.1 Automotive

The automotive industry is the market with the largest near-term market. Today there are approximately 17M electric cars sold per year[8]. At an average 2 motor controllers per vehicle and $1k per unit, that's a total addressable market today of $35B.

Figure 7: Tesla Roadster Mockup

The market is growing tremendously year over year, the total passenger car market is about 80M units/year [8]. Assuming the inevitable complete electrification of all cars that's about 80M EV cars per year. This would be a market of $160B/year.

4.1.2 Commercial Aviation

The commercial aviation industry is a tremendously large industry and one in particular where mass and efficiency are extremely valued. Currently the main players in the transportation space are eVTOL craft, there are numerous multi billion dollar eVTOL companies working to launch their vehicles in the near future. Research suggests there are about 1,000 eVTOL orders placed per year, with about 4 controllers per aircraft that's about a presently $20M/yr industry. There is potential for substantial growth in this area once regulatory approval has been acquired given these are multi-billion dollar companies.

Figure 8: Joby eVTOL craft

Aside from the eVTOL space there is Heart Aerospace which is attempting to electrify passenger aircraft. Currently the market is fairly small, they have not delivered any units but have substantial orders in place. Amortized over a few years the existing market is probably in the range of $10M/yr for this type of industry, today.

The potential market is incredibly high though. The commercial aircraft market is about $200B/yr. If you assume complete electrification of the powertrain of commercial aircraft in the future this is likely a $20B/yr business.

Figure 9: Heart Aerospace Plane Render

4.1.3 Boating

The recreational EV boating sector is currently a very small market. The primary blocking function is uncompetitive, high system costs as well as range anxiety exacerbated by a heavy system and slow charging infrastructure. These are issue which are in part remedied by the improved power electronics cost and efficiency gains of our product.

There are a few startups emerging to disrupt this industry, with currently fairly low volumes but strong backing. Arc boats for example has raised over $100M and is currently using an existing off the shelf solution with very poor performance[9].

Figure 10: Arc Electric Boat

Approximately 200-300k recreational boats are sold per year in the US alone[10]. Assuming 1 motor controller per vehicle at a cost of approximately $8k that's a potential market of $2B/year.

There is also the entire non-recreational boating industry. Cruise ships, container ships, transport ships, etc. The largest ships in the world are diesel-electric and thus already have existing power electronics inside them. This is a market not in the vision of the company for the near-future but a potential vertical for disruption long in the future and very lucrative due to the massive scale and desire for fuel savings.

4.1.4 Military, Space, Drones and Robotics

With the advent of new major hardware tech companies from Anduril to SpaceX to Figure robotics, there's tons of industries being unlocked every day. All these hardware tech companies require motors and motor controllers.

There is tremendous potential for growth in these industries but to speculate on exact market size is very difficult. If you take the aggressive estimates by some, of >10B humanoid robots in the future then the potential TAM is in the $1T+.

4.1.5 Summary

Table 4: Potential Customers and TAM.

Industry	Present TAM	Potential TAM
Passenger Car	**$35B**	**$160B+**
Commercial Aviation	$20M	$20B+
Recreational Boating	$10M	$2B+
Robotics	?	$1T+*

* See section on Military, Space, Drones and Robotics

4.2 Competitors

4.2.1 Existing Off the Shelf Solutions

Listed below are some off the shelf solutions one can use for EV motor controllers.

Table 5: Existing Off the Shelf Options.

Product	$\frac{kW}{kg}$ (higher is better)	$\frac{W}{\$}$ (higher is better)
Kelly Controller	3.8	30
NetGain AC-X1	9.5	17
BMW i3	14	?
Cascadia CM200DZ	15	14
Sevcon Gen5S9	18	15
Helix MCU1200	25	4.5
Steinmetz	**>65**	**>60**

The **Cascadia CM200DZ** is a very popular motor controller in industry. The Cascadia line of motor controllers is very popular in the startup industry as it is easily available off the shelf. The truth is the software support is terrible, and it's a fairly unreliable system, but it's common in industry and relatively cheap compared to the competition.

Figure 11: Cascadia CM200DZ.

For customers who are interested in the high-end offerings where weight matters they will go for the Helix line. The Helix line of motor controllers is very expensive but does offer superior power densities to the competition, but notably Steinmetz does beat this.

4.2.2 Where is the Competition?

The is very little competitive pressure in the industry. BorgWarner is a major quasi-monopoly player in the industry, which owns both Sevcon and Cascadia. Despite high prices and low performance metrics these controllers are still in wide utilization by industry especially startups.

Figure 12: BorgWarner

Legacy automotive manufacturers like GM, Ford and Stellantis out-source design and manufacturing to power electronics firms mainly BorgWarner.

The only other major competitors that exist in the arena either offer very low performance, low cost systems. Or they offer very high performance, high premium systems tackling the aerospace market where there is low cost sensitivity.

4.2.3 Vertical Integration

Due to the poor existing options on the market most cutting edge EV companies vertically integrate their systems. So Lucid, Rivian and Tesla design and fabricate their own motor controllers.

To win over these high-value customers, we must demonstrate we can deliver a cost-competitive, superior product. As stated previously this will have to be demonstrated with other smaller customers first.

A key value add to this customer relationship is a relaxation of risk and operating cost for the customer. The customer no longer needs to worry about maintaining a large motor controller team, worrying about deadlines and keeping up on R&D.

The main way to attract these customers is to deliver a superior product on the market for their competitors, force them to reckon with their inability to compete and then offer them the solution to maintain competition.

One may assume that these vertically integrated designers have highly performant systems, but this is a fallacy. The designs in these motor controllers are old, as stated previously the SiC Catastrophe has quenched any innovation in this field, so delivering a superior product then their in-housed option is not an issue.

4.3 What is the Moat?

The truth is the vertically integrated players don't have the engineering resources, risk appetite, skill or timeline to be able to produce a competitive product. It may appear that one could simply copy the designs, but in these complex multi-domain projects understanding the concepts is not the main moat it's the execution and design analysis performed that creates the moat.

Additionally, the design is patentable and once this fundraising period is over and the production product is ready a provisional patent will be filed.

Once the team is at scale the moat will continue to widen. The number of engineers with the skill to execute effectively on these types of projects is quite limited, and we will work hard to ensure they work with us. The capital requirement to improve on these designs will also grow as the industry progresses. Potential features like: custom ASICs, custom semiconductor modules, advanced PCB designs, etc, will mean that future players and innovators will have difficulty disrupting the market.

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