Electric Vehicles are a Platform Business: What Firms Need to Know

Edward G. Anderson Jr., Hemant K. Bhargava, Jonas Boehm, Geoffrey G. Parker

~~~~~~~

SUMMARY

Many of the most successful firms in the world are platforms: Airbnb, Alibaba, Amazon, Facebook, Google and Uber to name a few. Electric vehicles are too, even if they don’t realize it. True value for the customer comes not just from the cars themselves, but also from the functionality they get from complementary providers. For example, for electric vehicles to drive long distances across the country—or often even across the county—they need a network of charging stations. Tesla has a commanding lead in this area. Competitors will have a hard time challenging it, because they face a chicken-and-egg effect. They can’t sell in volume without the charging stations, yet charging-station providers can’t profit without a large number of electric vehicles. If they combine forces or somehow get regulators to intervene, they may be able to beat this advantage. There are also potentially other complementary sides to the market, such as 3rd-party body makers or software developers, that competitors could harness, particularly the traditional automotive firms with their advantage in quality manufacturing at scale. Either way, Tesla’s competitors will only survive if they adopt the sophisticated strategies needed for a platform market.

~~~~~~~~~

KEYWORDS: vehicles, electric vehicles, battery electric vehicles, BEVs, Tesla, automobiles, platforms, platform markets, multi-sided platforms

~~~~~~~~~~~

Electric vehicles are a platform business, even if some industry members don’t yet know it. Companies in a platform business depend on other ecosystem partners to create components (complementary goods) of a complete system. This system delivers enhanced value to end users when they employ the platform to interact and exchange with these components or complementors\(^1\). This value also depends on the number of
users; the more affiliated users, and the greater the number of complements, the more valuable the service².

Over the last decade, many of the most successful companies in a wide range of industries have been platform businesses. These companies include Airbnb, Alibaba, Amazon, Facebook, Google and Uber. Amazon’s Marketplace, for example, manages a large number of buyers and sellers who come to the market to transact with one another. Similarly, Airbnb matches hosts with lodging to guests looking for somewhere to stay. If one side were missing, then the other side would not come to the Airbnb platform.

Platform Strategy in the Electric Car Business

But platform thinking extends beyond the often-cited digital platforms. In fact, companies can create a platform business without recognizing it as such. That’s happening right now in the auto industry as companies develop electric vehicles. Electric cars are a (digital) platform architecture good. The vehicle itself is only one side of a multisided market. For example, a crucial side of the market is a widespread charging network for recharging batteries³. The presence of a large number of supercharging stations makes an electric car more attractive to car buyers; conversely, a huge installed base of electric cars provides the motivation to build this supercharging network. However, not all carmakers seem to realize the importance of the supercharging station network. This oversight could become a serious issue, because platform markets are fundamentally different from traditional markets, and these differences must lead to distinctive business tactics and strategies.

More specifically, managers at electric car companies today face three key issues:

- **A Multisided Business**: Can managers of these companies actively work all of the platform—the vehicle on one side, its complementors, such as charging infrastructure, on the other? If so, they should be able to pursue additional strategic options.

- **Open vs. Closed**: Openness is a critical decision variable. Managers must decide whether to create their own closed systems, including both the vehicle and the charging infrastructure — as Tesla has done — or work with open systems that instead rely on ecosystems.

- **Making Money**: The revenue models of platform businesses are not straightforward; in fact, they can be counterintuitive. Optimal design, and even overcoming initial barriers, can require substantial subsidization on one or more sides. To truly cross-subsidize, though, companies will need to participate in more than one side of a multisided platform. Those that participate in only one side will find themselves constrained in their choice of business models.
All of the above issues can be addressed by building business strategy on a solid theory of multi-sided platforms. Tesla is a prime example of a company that understands it’s in a platform business. Despite early problems with vehicle quality, Tesla is unique in offering both electric vehicles and a complementary charging infrastructure. The company now has the best products and best options to monetize either side of this two-sided platform. It’s also being rewarded by consumers. Tesla now accounts for nearly 80 percent of all battery electronic vehicles (BEVs) sold in the United States.

Aside from Tesla, most other automakers, including those now producing BEVs, remain stuck in older thinking. They mistakenly believe that with electric cars, they are still in a product business, and that electric vehicles simply replace gasoline stored in a tank with electricity stored in a battery.

To date, the other sides of the business have been neglected by most BEV makers. For example, the platform’s charging network side has not received enough investment from BEV makers other than Tesla. This oversight is risky, as examples from another platform business — mobile phones — demonstrates. As powerful as mobile phones are, their true value became evident only with the widespread availability of high-speed mobile data networks and ecosystems of third-party mobile apps. Prior to that, mobile phones remained a standalone product. To push the analogy further, consider how today’s smartphones can be recharged anywhere there is electric power. However, if the phones could be charged only in a home or other static location, then users would be better off with laptop PCs. Similarly, if BEVs could be charged only at home, then most drivers would be better off with a traditional fuel-based vehicle. Complicating the issue, the relatively small number of BEV rapid-charging stations is highly fragmented due to their lack of interoperability. For example, Tesla operates more than 2,000 supercharger stations in the United States. But these charge only Tesla vehicles; owners of other-make BEVs cannot use these Tesla stations, and across the entire country they have access to only a few hundred interoperable charging stations. As of today, the interoperable stations also offer lower performance than Tesla’s. To use the smartphone analogy again, it’s as if some plugs in some buildings could only charge iPhones, and others could only charge Androids; only very, very few plugs could charge both.

<< INSERT FIGURE 1 HERE >>

A Multisided Platform Emerges

On top of this two-sided structure, the BEV platform market is likely to become even more complicated, adding at least four additional sides:

- **Third-Party Digital Apps**: BEVs are closely controlled by their embedded software. 3rd party firms are leveraging this, offering after-market add-ons to enhance functionality. Some of these apps provide additional control over vehicle functions, including warming up batteries, scheduling climate control and delivering remote notifications. Other apps provide vital statistics and readouts on
battery performance, charging and draining. Still others enhance the media capabilities of the automobile by connecting new sources of content. Most of these third-party apps are available on Google Play and Apple’s App Store, meaning the companies that operate these stores can earn royalties from these sales, or perhaps more importantly, aggregate and sell usage data.

- **“Skateboard” Makers:** Where traditional fuel-powered cars are built on chassis, BEVs are increasingly being built around what’s known as a skateboard. It’s a modular architecture that combines the chassis with the motor, wheels and all components needed for mobility (see Figure 2). Once built, these modular skateboards can be used by other providers, such as auto-body manufacturers, making them a true platform. As a result, it’s likely that the total number of skateboard makers needed will be smaller than the number of assemblers, and each supplier might be able to offer as few as one to three models. Notably, Tesla is behind the curve in skateboard design compared with disruptors as Rivian, whose skateboard-based truck is featured in Ewan McGregor’s recent streaming TV series, “Long Way Up.”

- **Auto Body Makers:** Another result of the BEV skateboard architecture is that it makes designing auto bodies increasingly simple and inexpensive. This allows partners to easily customize bodies for many different consumer markets. It’s already happening. Rivian’s skateboard was until recently being used by both Ford for Lincoln luxury vehicles and Amazon for delivery trucks. Although Ford has since cancelled its effort due to COVID-related cost-control measures, the principle is still applicable and is being actively pursued by REE Automotive, an electric platform provider. Israeli startup, REE, is pursuing a similar strategy, courting multiple car companies, including Mahindra. In the future, the converse might also occur, a single auto body could be made compatible with several skateboards.

- **Consumers:** The modular nature of BEV designs should enable consumers to mix and match components. For example, a consumer might first select the skateboard they prefer, next choose one of the many auto bodies that work with that platform, and finally add third-party apps. The result would be a semi-custom vehicle that increases customer satisfaction, similar to the way that mix-and-match personal computer (PC) architecture made mass customization possible in the 1990s.

One result of the modularization described above is that a whole industry is likely to turn into a business of platforms.

While not always recognized as such, traditional fuel-based vehicles are also platforms because they rely on a network of 3rd-party fueling stations. However, platform effects have not been strategically relevant in the case of fuel-based vehicles for many years.
There are three reasons for this difference in the importance of network effects for fuel-based vs. electric vehicles:

- **Range**: Most BEVs have a relatively low range. They can drive roughly 70 to 350 miles, depending on manufacturer, before needing a charge, compared with the more than 550 miles a gasoline-powered vehicle can go without refueling. Range matters, especially in countries such as the U.S., because Americans routinely drive long distances. This lack of range would be less consequential if BEV owners had reliable access to a network of rapid-charging stations that could recharge BEV batteries as quickly as one fills up a gasoline tank. But as of now, this is far from reality.

- **Network Density**: Compared with fueling stations for gasoline-powered vehicles, BEV recharging stations are few and far between. In the United States, there are currently more than 168,000 public fueling stations, but only 1,500 to 3,000 rapid-charging stations for BEVs.

The result is that, while the presence or lack of supercharging stations is a crucial factor in the purchase of a BEV, one can make purchase decisions for fuel-based vehicles without active consideration of the fueling station network. Conversely, makers of fuel-based vehicles have for decades developed competitive strategy. However, this same disregard for the charging part of the platform can put firms at an extreme disadvantage when competing in the BEV segment.

**Important, Difficult Decisions Lie Ahead**

To overcome these obstacles, BEV industry players will need to make several important choices and decisions. We’ve found it useful to divide these decisions along three levels of consideration:

- **Firm**: Auto manufacturers, charging-network providers and others face choices around design issues, solving the chicken-and-egg problem (discussed below), specialization vs. integration, product quality and range, signaling and pre-announcements, and establishing/leveraging the advantages/disadvantages of being an incumbent/new entrant.

- **Industry**: Bodies including the CHAdeMo Association (a membership organization developing and promoting an electric-vehicle charging protocol) and the European Union will need to consider how they can establish standards, encourage the formation of consortia, and handle challenges related to platform coordination.

- **Policy**: Regulators and policy makers will need to consider whether — and how — to deploy subsidies, targets and other incentives to help coordinate the various sides of the platform market. They’ll also need to consider industry
standards, balancing those aspects that enable innovation and competition with those that constrain.

The BEV Chicken-and-Egg Problem

The chicken-and-egg problem is fundamental when companies launch platform products. The value of platform products is driven by the adoption of the platform by both users and complementors. This makes it essential to have a strategy to mobilize, with the right timing, additional sides of the platform.

Other industries have demonstrated that the chicken-and-egg problem can indeed be coordinated. These include video cassettes/video recorders, video games/video consoles, marketplaces such as eBay and Craig’s List, and payment systems including Visa and Mastercard.

To solve its own chicken-and-egg problems, the BEV industry can turn to both the literature and common practice for some general strategies. These could include:

- **Profitability**: Does the strategy ensure profitability for both sides, both in total and across time?
- **Growth**: Does the strategy enable balanced and sufficient growth, for example, through interoperability and standards?
- **Capital intensity**: Is the strategy suitable, given the capital endowments of a single player?
- **Innovation**: Does the strategy permit ongoing innovation?
- **Operational Efficiency**: Does the strategy favor operational efficiency? For example, are operations driven by a real-time data layer?

More specifically, the BEV industry can tackle its chicken-and-egg problem with any of four basic strategies:

- **Do It Yourself**: Organizations trying to build platform products can invest on both sides themselves, as Tesla has done. This typically requires extremely large investments, although a player can stage these investments by launching one side first, then adding the other side later. However, even with infinite capital, the DIY strategy bears a serious risk, namely, a delay in mobilizing a critical side of the market; building out a charging network takes time.

- **Form Consortia**: Players on one side can form multi- or bi-lateral cooperation agreements with suppliers from the other side. These agreements typically aim to reduce investment risks for all sides by letting each side build on the
other side's installed base. This approach offers both benefits and risks. The benefits include the ability to leverage multiple adjacent installed bases of vehicles to attract charging infrastructure suppliers. Members of a consortium can also benefit from the group’s larger, combined financial resources. As for the possible downsides, these include slow decision-making. Developing a consensus among a consortium’s members can take time. Another downside: the difficulty of figuring out cost mechanisms and revenue sharing, especially among members working from different business models. In addition, there is always the possibility of members who freeride. Consortia-based approaches often fail, a notable one being the failure of the JICRS (joint industry computerized reservation system) in the airline reservation industry, where the process was plagued by delay, inability to reach consensus on cost-sharing, freeriding, and even sabotage.

- **Rely on Regulators and Policy Makers:** Organizations on one side — say, vehicle makers — can wait for or even actively lobby governments to invest in the other side of the platform — in this case, a network of charging stations. This approach has high potential for innovation, but also carries a relatively high risk. On the plus side, different business models and technological standards can be tested. On the downside, these moves can be difficult to coordinate and deploy. Moreover, there is the possibility that a government might choose an inferior standard that will hamper some or perhaps all BEV makers.

- **Rely on Markets:** Finally, actors on one side of the market can rely on market mechanisms to supply the other side of the market. They can also use investment information signals to third parties as coordination mechanisms. For example, in the United States, several independent charging-infrastructure providers — including Better Place, Chargepoint and EVgo — have built charging networks. They hope to profit from the growing installed base of BEVs.

It’s important to note that these four strategies are not mutually exclusive. They can be mixed and matched. What’s more, a company may adopt one strategy, then change it over time. For example, when Apple first introduced the iPhone, the company offered the device as a closed system, with Apple establishing itself as the only supplier of both the smartphone’s hardware and underlying operating system. While this is still the case, over time Apple has opened the iPhone ecosystem, allowing the business to become increasingly reliant on App Store offerings from third parties. Not incidentally, this also helped Apple transform the iPhone into a multibillion-dollar ecosystem.

**Tesla’s DIY Advantage**

In the BEV industry, Tesla offers a clear example of the Do-It-Yourself strategy and its benefits. By building the installed base of both cars and charging infrastructure, Tesla has been able to make quicker and better decisions on both sides of the market, which
has been critical during the company’s early growth phase. This DIY strategy has also endowed Tesla with three other advantages:

- **Reduced Friction**: Tesla can mix and match revenue models for its vehicles and charging stations as needed. By comparison, independent providers need to develop business models based purely on offering the charging infrastructure.

- **Higher Levels of Freedom to Incentivize One Side**: Having no strategic partners, Tesla can change tactics with relative ease. For example, the company currently offers charging to owners of its vehicles for free. Once Tesla’s installed base is large enough, it could change this policy and begin offering vehicle charging for a fee. (Note: We can observe a side-switching strategy as Tesla starts to increase prices for its charging station network.)

- **Greater Choice of Openness**: Tesla is free to decide how open or closed it wants its network to be. Currently, it has closed the network to all but Tesla vehicle owners. But the company could certainly change that strategy in the future. And without any strategic partners, Tesla could make that decision easily.

However, Tesla’s DIY strategy also reveals the approach’s risks. These include the need for massive investment, the possibility of being outperformed by consortia, and the risk of settling on an inferior standard. Another danger is that a government might impose a standard different from Tesla’s for antitrust or other reasons, stranding much of Tesla’s investment.

**Selecting the Right Strategy for Growth**

Once the BEV industry gets past its initial chicken-and-egg problem in charging, the platform’s players will vie to grow the platform on both sides. They know from the literature that markets with network effects often end in a winner-takes-all situation as users congregate on a single platform.

However, it’s important to note that not all platform markets are winner-takes-all. Multiple networks can co-exist and share the market. For example, Microsoft Windows is by far the dominant PC operating system, yet it continues to share the market with others, notably macOS, Linux and Chrome. Similarly, Android and iOS share the mobile-phone system software market.

We do not assume that the BEV market will end with a winner-takes-all situation. In large part, that’s because the market is likely to depend heavily on the car side. Here, a wide range of different firms can be expected to thrive, just as they do in the traditional fuel-powered car market. However, we expect there to be a dominant network for some time. What’s more, this dominant position can be exploited.
Growth Options

One key strategy for growth is signaling. Here, to attract complementors, a company will signal to one particular side that joining its system will make more sense than joining the others. However, signaling in a multisided market can be a challenge. For example, if a company signals only at the product level, as many BEV makers are now doing, it may miss opportunities; for example, charging stations will increase the utility of a firm’s car to potential customers.

Another risk of signaling is that it can cannibalize products. This happened when Tesla introduced its Model 3 car as an affordable BEV with an anticipated price in the range of $35,000. This announcement helped attract charging infrastructure complementors, but it also cannibalized Tesla’s more expensive and higher-margin BEVs while creating a false anchor in consumers’ minds. When the Model 3 finally shipped, the car’s actual price tag was in the much higher range of $55,000 to $60,000, rendering the level of cannibalization needlessly high.

Another approach for growth is building on an installed base or fixed-cost assets. Consumers are naturally attracted to the largest platforms, and they are also reluctant to join small ones. Companies with an installed base on one side of the market will enjoy a natural advantage over market newcomers.

In the case of charging, building on an installed base is an obvious choice for three classes of actors: utilities and electric service providers; fueling stations; and manufacturers, dealers and employers. However, as these companies try to grow with their installed bases, they risk finding themselves trapped in a new chicken-and-egg problem. Utilities and electric service providers, as well as fueling stations, must wait for demand from car owners. To date, Tesla has built the industry’s strongest installed base. This enables Tesla to profit from its strong position.

Yet another strategy for growth is attracting complementors. It’s important because only with complementors do BEV products really make sense. Yet to date, most BEV makers have failed to attract complementors. In part, that’s because many important choices have been left undecided. For example, where should charging stations be located and what levels of charging speed should be offered? The industry’s failure to coordinate on these and other decisions has discouraged complementors from investing. In addition to charging networks decisions, consumer benefit can be added by complementors who can fine-tune automobile performance, add to the multimedia entertainment experience, or provide enhanced value in other ways such as customized bodies.

In this area as in others, Tesla has taken an entirely different approach. Rather than trying to attract complementors, Tesla has built its own complementary products. Now Tesla faces a new strategic question: When and to what extent should the company open its platform to others?
Another strategy for growth is a focus on product quality\textsuperscript{14}, range\textsuperscript{15} (whether broad or narrow) and timing. In a networked market such as BEVs, decisions on these factors can differ dramatically from those made for a standalone market\textsuperscript{16}. That’s because a company’s network’s size determines the network benefit for users. BEV manufacturers have focused mainly on the quality of their cars rather than complements such as charging systems. We assume these companies plan to make money with their cars only. Also, their product mix is limited, leaving space for newcomers.

One way for BEV manufacturers to combat Tesla is to recognize that BEV’s are a multisided platform and attack platform sides other than charging. They could even follow the IBM PC’s Windows strategy. That would mean creating an open standard with respect to bodies and software, particularly if the BEV makers can level the playing field by convincing regulators to enforce openness in charging stations. This would also be similar to how the Android standard competed with the iPhone. It offered customizability of an open system to unseat a closed, less flexible system. Despite the risk of commoditization with this strategy, the BEV firms could at least achieve scale and remain in business. Traditional automotive firms would especially benefit from this strategy because their capability to manufacture highly reliable, low-defect products at scale requires significant institutional knowledge that newer firms, including Tesla, lack. A few might move into the platform business of skateboards, probably in conjunction with extant skateboard startups. However, skateboards are likely become a scale business, which does not provide much differentiation to the customer. Instead, most of these companies will probably move into the body and interior industry. A side effect of this is that the advantage of bundling would erode, so that few would try to do both modular skateboards and bodies. Hence, we predict that the current vertically integrated body and engine firm, which has dominated the landscape for over a century, will disappear in the face of platforms.

Time is running out. If the traditional auto makers do not leverage their quality and potential scale advantages in making vehicles immediately, they will leave Tesla two overwhelming competitive advantages. First, Tesla will have produced the most BEV’s to date, meaning it will reach scale relatively soon. Second, Tesla has a well-developed, second platform side--its extensive charging network--which will be difficult to duplicate. These two factors will soon enable Tesla to lock out competitors, leaving the company in the driver’s seat for the near term.

**New Management Approaches Required**

As part of the BEV industry’s evolution, its leaders will need to abandon decades-old management “wisdom” and instead adopt new management strategies. This need for rethinking is due to five key characteristics of the BEV industry as a platform business:

- *Platform Product Utility*: As stated above, while standalone products have only standalone value, platform products rely on the combined utility of multiple sides. For example, Tesla’s product is both a “car” and “charging,” which forms the platform product of electric mobility. By contrast, other BEV makers are
producing beautifully engineered cars at minimized production costs, but are still leaving the customers mostly on their own to figure out the charging aspect of the product.

- **Economics**: For standalone products, the product itself incurs costs and realizes profits. Ultimately, the production costs of the product need to be lower than the realized revenues. By contrast, in platform products, both sides can incur costs and accumulate revenue. For example, Tesla offers free charging to owners of its cars. Given that the BEV industry is a platform market, this is a viable option. In standalone markets, offering a service for free is not viable. However, this raises another issue: Tesla’s revenue needs to come from somewhere, and if not from the charging network, then from the car. Here, Tesla could face serious competition, as its main competitors — traditional automakers — are focused on vehicle quality.

**Usage**: Where standalone products depreciate in value through use, platform products can appreciate in value through use. While this is especially true for products that are digital, it also applies to the BEV industry. Again, Tesla offers a clear example. The more cars Tesla has on the road, the more incentive there is to deploy Tesla charging, and the better the charging network will become. This also positions Tesla to benefit from a network effect: The company can use data from Tesla cars to optimize the performance of its charging network.

- **External Benefits**: While product firms mainly create value internally, network effects — and value creation — typically scale better outside of a firm. This can happen in either of two main ways: by valuing interactions in addition to assets; or by shifting emphasis from employees to external contractors, and from internal experts to external crowds. While Tesla has led the industry in its use of remote diagnostics and software updates, the company may choose to further open its system to third-party complementors that could provide additional applications and functionality.

- **Competition**: In a traditional business, standalone products compete mainly with other standalone products, and supply-chain partners mainly compete only with other supply-chain partners. By contrast, in a platform business, competition can occur at three distinct layers: among platforms, among complementors (which are platforms’ supply chain partners), and among platforms and their complementors. As a result, competitive advantage in a platform business is more likely to be generated by seamless access than by classical entry barriers. For example, Tesla’s complete system — not just its cars — competes with other the complete systems — and not just cars — of other BEV manufacturers.

**How Open Do You Get?**

One of these new management decisions is openness. It’s a key characteristic of any platform business. One key to successful openness is governance, which aims to
avoid negative effects by setting boundaries for participant behavior while also seeking not to constrain their creativity\textsuperscript{18}. For example, Uber is a relatively open platform on both the passenger and driver side, but has governing mechanisms to ensure passenger safety and has rules for its drivers that aim to ensure clean cars, punctual rides and friendly drivers.

Governing openness is a balancing act. Too much openness can create new risks, but so can too little. For an example of too much openness, consider Google’s Android operating system, which today powers 85 percent of the world’s smartphones\textsuperscript{19}. Early on, Google had a problem as Samsung, Motorola and other phone makers fragmented Android with their own modified (“forked,” in industry parlance) versions. To regain control, Google restricted access to certain Android services and shifted some application programming interfaces (APIs) to its proprietary store. Conversely, too little openness can also be a risk, as Tesla has discovered. Because Tesla runs a closed network, the company lacks the generativity of a bigger ecosystem and hence does not reap the benefits of engineering innovation from outside partners.

Tesla in particular faces a scaling dilemma on its charging network: The more cars the company sells, the more charging stations it needs to build. Currently, Tesla’s charging stations are pure cost because the company now offers vehicle charging for free or at marginal cost. (Again, Tesla makes its money on the car side.) This raises three difficult questions on openness and regarding Tesla’s future: On which side should the company make money in the long run? How long should Tesla keep its network proprietary? And how rapidly should Tesla deploy its supercharger network?

More traditional automakers have played a different game. Typically, they turn a profit on their cars and service parts sales. They have also pushed for open and standardized charging systems, and then invited as many players as possible to build the charging-system infrastructure. However, this effort has not been well-coordinated. And as a result, it has run into several strategic and operational problems. Complexity and fragmentation have both been exacerbated. A high variety of charging systems networks (sometimes both hardware and software) has emerged, each with its own governing structure, leading to a fragmented market. Quality problems have arisen. The pace of investment in building charging stations hasn’t been fast enough to assure BEV buyers, and the lack of a sufficient installed base has led to low utilization levels and an unprofitable business model. One of the earliest and most ambitious efforts to build out a network of charging stations was launched by Better Place in 2008, but was bankrupt by 2013. Finally, automakers have failed to fully exploit all the options — such as subsidies and exclusivity agreements — made possible by a platform product.

**Electric Trucks: Dramatically Different**

This discussion so far has focused mainly on cars. The BEV category of electric trucks warrants an extended discussion because the market and its requirements are quite different, and in several important ways. The electric-truck market is more accurately considered as not one market, but instead two that are separate yet related:
• **Light- and Medium-Duty Electric Trucks**: These include both small and midsized trucks used mainly for daytime deliveries of lightweight packages to relatively compact physical areas as well as school buses and other similar types of vehicles. Examples include vehicles now used by Amazon, FedEx and UPS to make their consumer deliveries. In addition, this group of vehicles can also include school buses. These electric trucks are attracting heavy investment. For example, Amazon has reportedly invested $700 million in Rivian and, as part of the deal, received 100,000 of Rivian's electric delivery vans.²⁰

• **Heavy-Duty Electric Trucks**: These are the electric versions of the large 18-wheelers used today for hauling goods over long distances. Even though many are operated in practice for only 14 hours per day, many are also operated essentially 24/7. They must also be extremely sturdy, with some trucks carrying up to 80,000 pounds of cargo.

Keeping light- and medium-duty electric trucks charged is a relatively straightforward proposition. These vehicles are mainly driven only during the day, follow well-defined and optimized routes, and they usually return to their central locations at night. Because these vehicles can be charged each night at their depots, they do not need a network of charging stations out on the road.

By comparison, heavy-duty electric trucks present a much more complicated charging challenge. Unlike other trucks, 18-wheelers usually do not return to their depots each night. They are driven up to 14 or even 24 hours per day in one direction and do not return to central depots. Hence, these trucks need to recharge while out on the road.

This creates another chick-and-egg problem. To make electric heavy-duty trucks attractive to fleet buyers, the industry will need to create a far-reaching network of truck charging stations. What’s more, these stations will need to be quite large. Heavy-duty electric trucks need about 30 minutes to recharge if Tesla’s estimates are correct, compared with 10-15 minutes for a tank of diesel fuel. That means each electric station would need at least twice as many charging stations as it has fuel pumps, assuming electric trucks had the same range as fuel trucks. However, they do not. An electric heavy-duty truck has a range of approximately 500 miles, compared with approximately 2,000 miles for a conventional diesel truck. Hence, there will have to be more frequent stops, or the stops will have to be much bigger.

Heavy-duty trucks also present some challenges around batteries. Especially for the largest of these trucks, the power density of current battery technology appears to be insufficient. There’s also the question of whether today’s batteries are durable enough, as most heavy-duty trucks are driven more than a million miles over their working lifetime. Yet another unanswered question is whether today’s batteries are powerful enough to get heavily loaded trucks up and down steep hills and mountains. Currently, there’s a tradeoff between climbing power on the one hand and battery life on the other.
Here again, Tesla is pursuing a unique strategy: The company is thinking of building its own electric-truck stops. While that might seem straightforward given Tesla’s current network of supercharging stations, the reality could be more complex. Tesla’s stations are not designed for trucks. For one, they’re too small for 18-wheelers. For another, they lack the additional accommodations typically offered in truck stops, which include laundries, showers and driver lounges. In addition, Tesla’s stations lack both adequate space for overnight parking and auxiliary power for heaters, TVs and other devices that drivers use while sleeping in their vehicles overnight. A final and formidable problem is that, if there are the same number of electric truck charging stations as there are current fuel truck stops, each truck charging station would require on the order of 150 megawatts of electric power, which is the size of a small power station, as well as the transmission and distribution infrastructure to deliver that power to the station. In practice, there may need to be more truck charging stations than there are currently truck fuel stops, but the problem remains immense.

One possibility is that Tesla (or others) could partner with existing truck-stop chains, such as Pilot Flying J, which operates more than 750 “travel centers” in 44 U.S. states and six Canadian provinces. This could help Tesla meet some of its challenges, including overnight parking and amenities. However, because these truck stops are designed for trucks running on diesel fuel, Tesla would still need to build the electric chargers and solve the power-generation and distribution problem.

It’s also possible that all makers of electric heavy-duty trucks could form consortia to solve the truck-stop chicken-and-egg problem. However, the industry is even more fragmented than the consumer vehicle industry, making cooperation difficult. What’s more, the level of investment required to build a nationwide network of truck-charging stations is daunting.

**The Strategy for the Future**

Looking ahead, BEV companies need to choose a strategic direction. They have options, each with its own set of trade-offs. But at its core, the BEV industry must embrace platform thinking. In a platform business, different sides must grow in parallel. For investments in one side to profit, the other sides must also grow. So far, the BEV industry hasn’t done this well as illustrated by charging. To improve, they could do better on two main activities: One, coordinating through pricing; currently, there’s a deadlock. And two, coordinating either with technology standards or a market-coordination service. Open standards such as the Open Charge Point Protocol are a good step in this direction, although they often only coordinate one side of the market.

Automakers must also deal with Tesla’s lead in charging stations. So far, only Tesla is truly playing a platform game, taking the lead on two sides of the market. That puts the other companies in the position of second movers. To catch up with Tesla, OEMs have three main options:

---

1 Calculations are based on publicly available data and are available from the authors.
• Build their own complementary offerings
• Partner with other automakers to jointly challenge Tesla
• Partner with Tesla and pay for access to its network

Tesla will need to switch its game, too — but when? Eventually, the company, like any ongoing business, will need to make consistent profits. Currently, it plans to do this by monetizing the car side profitably while subsidizing the charging. But Tesla could eventually reverse this, trying instead to monetize charging while subsidizing its cars.

Several factors make Tesla’s strategy switch likely. First, as Tesla becomes a mass manufacturer, the company is likely to face increased competition and lower margins. Second, this competition will come from other automotive makers, many with better optimized production. Third, while Tesla currently holds a network knowledge advantage, the company could lose that advantage if it opens the network to others. And fourth, Tesla could be overtaken on both sides by new technological developments or the development of other sides of the platform. Other BEV players could be the ones to profit from Tesla’s innovations. History shows that infrastructure investments often pay off only for the second player, and often only after significant write-offs.

The BEV industry must also figure out a way to work together effectively despite scarce capacity and fragmented markets. Currently, fast-charging infrastructure is a scarce good. This level of scarcity could be exploited through a reservation system. This would give drivers the security of having a charging spot when needed, for which they’d pay an additional fee or premium. Another possibility is that automakers and charging-network operators could consolidate their pricing and billing systems. This happened in aviation systems, where the SABRE system was developed to leverage joint routing, preferential access, pricing and bundling.

The BEV industry also needs to create and use good quality and dense data from different sides of the platform. In general, the industry — once again, with the exception of Tesla — hasn’t done this yet. This could be done with short-term, mid-level data platforms. These would offer services such as real-time information about charging-station availability and reservations.

Investors need to accept the platform game, too. This may require some education. Building and coordinating multiple sides of a market typically requires high upfront investments over extended periods of time. For example, after Amazon went public, the company reported quarterly losses for many years. Because Amazon had clearly explained its long-term strategy, investors knew to expect these losses, and they kept the company’s stock price high. By contrast, Wall Street analysts covering Tesla (and other OEMs for that matter) today do not seem to understand the dynamics of platform markets. And while venture capital firms generally do understand platform markets, they have so far been reluctant to invest in BEV complementary products.
While building out complementary networks, can BEV players (especially Tesla) make productivity gains and enjoy economies of scale? If Tesla can achieve these gains, then its advantages from its charging network is more likely to be defensible. However, it is unlikely that we will see significant gains, meaning Tesla’s network will be less defensible.

In the realm of charging networks specifically, companies should prepare for the eventual creation of a joint industrywide network because it is very unlikely that proprietary charging networks such as Tesla’s are defensible in the long run. While the development of open charging networks is likely, history shows it is not guaranteed. In the 1970s, attempts by U.S. airlines to create a standard passenger-reservation system failed. Later, airlines created their own competing systems, leading to a costly battle for market dominance.

How about policy makers? Should they promote competition? And if so, how? We believe they have two main options. One is to let the market’s competitive processes declare a winner. When a dominant position is associated with maximization of efficiency in production and value creation, it should be welcomed. However, letting market participants fight it out can be capital-intensive, time-consuming, inefficient and wasteful. That’s what happened, for example, in home entertainment as companies battled over the Blu-ray and HD-DVD disc formats. Second, policy makers could intervene with a focus on value creation. This could include a reduction in switching costs and ensuring data portability. Policy makers could also encourage the development and use of open standards.

As outlined in this paper, we believe that analyzing markets from a platform perspective will yield valuable insights about possible decisions and strategic directions in many other areas and industries such as electricity, the Internet of Things, Smart Cities and Healthcare. Entire industries can be observed to entail platform mechanics, and understanding the industries from this perspective can yield important insights.

~~~~~~~~~~~~~~~~

Author Biographies

Edward G. Anderson Jr. is the Mr. and Mrs. William Wright Jr. Centennial Professor for Innovative Technology at the University of Texas McCombs School of Business. (email: edanderson@utexas.edu)

Hemant K. Bhargava is the Jerome and Elsie Suran Chair in Technology Management Professor at the University of California, Davis, and Director of the Center for Analytics and Technology in Society. (email: hemantb@ucdavis.edu)

Dr. Jonas Boehm is Visiting Scholar at Dartmouth College (email: jonas.e.boehm@gmail.com)
Fast-Charging Stations by Standard in the U.S., Nov. 2020 (own illustration based on DOE)
many highly customized body and internal functionality by third-party providers can be easily fitted to it, contributing to the platformization of BEVs.

[Endnotes]

7 [Tesla has 2K+ U.S. charging stations:] https://www.tesla.com/supercharger
8 [168K public gas stations in USA:] www.fueleconomy.gov
9 [1,500 to 3,000 rapid charging stations:] https://afdc.energy.gov/fuels/electricity_locations.html#/find/nearest?fuel=ELEC
Also: https://www.theverge.com/2018/10/3/17933134/ev-charging-station-network-infrastructure-tesla
20 [Android on 85% of world’s smartphones:] https://www.idc.com/promo/smartphone-market-share/os
21 [Pilot truck-stop stats:] https://www.pilotflyingj.com/history/