

The Electrification of Mobility

Disruptive Forces in Investing

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Anu Rajakumar: Since Ford's invention of the assembly line in the early 1900s, vehicle production and transportation methods have come a long way. Recent U.S. consumer reports find that a majority of drivers are interested in getting an electric vehicle in the future, with overall cost savings being a key reason cited. What are the implications behind consumers making the switch to electric vehicles, and how prepared is the auto industry in meeting consumer demand? My name is Anu Rajakumar, and to help me answer those questions and more, I'm pleased to be joined by John Hirt, Research Analyst covering mobility here at Neuberger Berman, to share more about electric vehicles and more. John, thank you for joining me today.

John Hirt: Thank you for having me.

Anu: Now, John, the concept of electric vehicles isn't particularly new, but it seems like it's getting a little traction, for lack of a better term, now more than ever. Could you tell us a bit more about what's the latest electrification of vehicles today?

John: Sure. First, let's define what we mean by electrification, and broadly speaking, there are two types. There's the battery-electric vehicle, which is 100 percent powered by the battery; and there are also hybrid vehicles, which typically has a smaller battery, as well as an internal combustion engine. And of course, as some folks would know, some of these hybrids are plugged in, and some are not. So then, let's talk about some of the types of vehicles that are being electrified. So the average car that someone buys, for example, the personal car, we're really seeing that acceleration happening today; and we've seen that happen over the last 12 to 15 months in particular. And this is something, honestly, that we wondered about, as COVID was impacting the global economy and the global automotive industry last year.

But in fact, what we've seen is a continued acceleration. And when we look at the percentage of new car sales that are either battery-electric or plug-in hybrid, year to date, has been approximately 10 percent. And if I compare that back to 2019, it was maybe three or four percent. So we've seen a robust acceleration over the last 12 to 18 months, and that's despite a very severe downturn in the context of COVID. So the question is, why is this happening? And part of this is policy driven; and there are strong incentives in place for EVs across Europe, across China, and then now, possibly, in the U.S. as well, given the aspirations of the Biden administration. And part of this is also consumer driven. So this is a generational shift that we're seeing, where the younger generation generally tends to be a little bit more environmentally conscious. And one recent automaker mentioned, in a study that they did, that 64 percent of their customers are willing to actually pay more for a product that is environmentally friendlier. That same automaker also found that three-quarters of millennials are willing to change brands based on sustainability criteria. And you might say, well, how does that compare to other generations. And if you look at baby boomers, for example, only approximately one-third of baby boomers would, would suggest that they would change brands based on sustainability criteria.

Anu: You know, John, as you were talking about that generational shift with personal cars, it was making me think of how I'm increasingly seeing, you know, electrified scooters, you know, all over different cities and even electric bikes. So clearly this adoption is going beyond cars to other vehicles. Can you touch on what's happening in different types of modes of transport, beyond cars?

John: Sure, and that's exactly right. We're seeing that across New York City in the case of bikes and scooters. We're seeing that in other cities. Another end market that we're seeing incremental interest in electrification is the truck market. When we think about commercial vehicles, for example – and this is a market that, honestly, is a little bit more bifurcated. The last-mile delivery space tends to be a little bit more intriguing from an electrification perspective. The U.S. Postal Service, for example, is increasingly electrifying their fleet. General Motors is getting involved in the space by launching their BrightDrop brand. Amazon is working with some companies, as well, on this. So there's the use case where we would say the electrification potential is much greater than it is in other places. If you look at the other end of the spectrum, the long-haul trucking market is likely to take longer. Uh, that's not to say it's not applicable when we think about electrification, but the heavy-truck space is much more difficult, at least in the near term. Batteries are heavy. Payloads are heavy, and the bigger the battery, the less cargo that you could haul. So there's also a revenue-loss component to that; but, that being said, companies are thinking about it. And so this is something where, over time, as battery costs come down, strategies evolve, you could see some

applicability of a lithium-ion battery, for example, being used in a relatively longer-haul market. But that's something that is probably further off than, uh, as compared to some of the other, shorter-haul markets. So the timing, in terms of how long it's going to take a fleet to convert to a pure battery-electric, or a fleet that has the majority of the vehicles as battery-electric, is going to take relatively longer for the long-haul truck market as compared to the last-mile delivery space, as an example. So there may be other elements to, uh, use cases that apply as it relates to electrification, but those are a few that the industry is working towards today.

Anu: Great. That's terrific and very comprehensive, John. Thank you very much. Now I'd like to focus on a couple of the vehicle types that you mentioned, um, in your opening. You talked about cars and trucks. Um, what are the auto and truck companies doing to meet the demand for electric vehicles? And I'm particularly interested in affordability, as well as addressing the competition.

John: Sure. So, the auto industry has been, essentially, pushed very extensively by Tesla, so the industry, I think, broadly defined, is trying to catch up. And then, for those that do catch up, the onus is going to be on them to try to, essentially, keep pace with Tesla. And this is in relation to battery capacity, battery cost, and other features of the vehicle; whether it's in relation to over-the-air updates, autonomy. Think about highway autopilot, and then also just volumes. You know, Tesla produced 500,000 vehicles last year and has ambitions to grow meaningfully off of that base. So to do this, global automakers – and start-ups, to be fair – are spending billions and billions of dollars to do so. Uh, they're launching many new models. They – a lot of the, these companies have targets, by 2025 or 2030, to have a certain number of vehicles available, a certain number of models that are available. And for some companies, this is a complete 180-degree change. If I think about the Hummer as an example, which is an interesting development in what used to be a brand that was really the epitome of a gas guzzler. You know it would get five to 10 miles per gallon, and GM has effectively rebranded that vehicle, and now it's being dubbed as the Hummer EV. It's pure battery-electric. The plan is for the pickup truck variant of that particular vehicle to get 350 miles of range when that version comes out in a matter of a few months. So it's a complete, 180-degree shift for the Hummer brand, and it's really one example of how the industry is trying to evolve and strive for differentiation as well, within the context of the EV space. And really, it's, in some ways, reflective of that broader shift across the industry, which is a more, keen awareness of climate change and ESG considerations, as well as the policy landscape and evolving consumer preferences. But if we zoom back out for a moment, bigger picture, as a function of some of those investments that we're seeing, we're seeing more capability as well. So take GM for example, as it relates to highway autonomy. GM is increasingly rolling out a feature called Super Cruise to its vehicles. And think about that as something akin to Tesla's autopilot. And other OEMs have similar plans; because, at the end of the day, they're also trying to catch up with the features and functionalities that Tesla has. You also mentioned affordability, and I think this is something that the industry is also trying to strive for, because it also refers back to the competitiveness of the vehicles that a given OEM is putting out into the marketplace. And while the Hummer EV, as an example, starts at \$80,000, and goes all the way up to \$113,000, clearly is not exactly a mass-market price point, but overall the industry is pushing hard to make EVs more affordable. I think Tesla, in particular, has gone on record saying that they want to have a \$25,000 vehicle. GM has said they want to have an EV for everyone. So the key point here is that the industry is trying to make its vehicles more affordable; and to do that, they're having to drive down the battery cost. And as EV adoption grows, that will drive more volumes across those batteries. Those battery costs will come down and, ultimately, make those EVs much more affordable to the end consumer. So just one example on that front: Tesla said, at its Battery Day last year, that they want to reduce their battery cost by over 50 percent in just a few years' time. Now, we'll see whether or not they are successful in that regard; but that gives you a sense of what the industry is attempting to accomplish.

Anu: Terrific. I didn't know that Tesla had a Battery Day. That sounds very interesting. Um, so what does electrification mean from a policy perspective? It's something that you've touched on in some of your opening comments, but as you said, President Biden and his administration has dedicated, you know, a huge amount of resources to electrification initiatives. What are some of your thoughts there, in the U.S., as well as maybe policy outside of the U.S.?

John: Sure. So, the Biden administration has proposed allocating approximately \$174 billion on electrification here in the U.S. And what's important here is that this would be a very notable shift in the U.S. landscape, because on a relative basis, the U.S. has actually been a laggard, relative to other parts of the world, like Europe and China in terms of electric vehicle adoption, hybrid adoption, et cetera. And the \$174 billion is notable, in part, because of its size; but then also because of the nature in which that money would be spent. And it really addresses a number of different areas. It addresses consumer subsidies to make those EVs more affordable up front. It involves direct government purchases of EVs, charging infrastructure. It also has certain funds available for R&D across a number of areas. And one of those areas happens to be battery research, so thinking about changing the complexity and the composition of the battery to make it more capable, to make it more affordable. And so this is something that could be a really important shift, because if the U.S., in fact, becomes more environmentally friendly, and pushes EVs in a more substantive way, it would, effectively, join what we're seeing in Europe and what we're seeing China, which are two very, very important markets in the context of the global economy, and obviously, as it relates to

automotive specifically. And so far, we've seen Europe as a leader, or one of the leaders. And really, this dates back to the Dieselgate scandal, where certain European OEMs were caught essentially cheating on the degree to which their vehicles were emitting, harmful chemicals into the atmosphere. So accordingly, that essentially put the European Union on a course of action to meaningfully reduce their CO2 emissions. And we're seeing the manifestation of that groundwork, implementing these CO2 targets, which will become increasingly onerous over time. Those targets started last year, in what we would deem a phase-in. And then they kicked in, in full force, in 2021. There's another hurdle in 2025 that OEMs in Europe have to clear, another target in 2030 that they have to clear. So these targets, increasingly, will cause new vehicles in Europe to be electrified. So we'll see even more EVs, even more hybrids. And so this is not something that's going to be going away anytime soon. And then, of course, in China, they've been a leader in electrification as well; and they've been incentivizing electric vehicles for some time, demonstrating that they are, they're prioritizing the climate. There are license plate restrictions in place. There are incentives in place. So, so there's really a wide variety of different features and different tools that the Chinese economy and, and various powers across China are using to try to incentivize EVs. So in the grand scheme of things, if the U.S. starts to become more serious, you also have Europe. You also have China. That's really a big portion of the global automotive industry.

Anu: Yeah, absolutely. Very helpful. Thank you. Um, now what about the Mobility-as-a-Service space? Um, you know we, we spoke a while ago on this podcast, um, I think when we were getting started, about how these companies were beginning to pilot automated vehicles. Um, but what's the latest there in terms of fleets starting to use electrification?

John: Sure. So, I would bifurcate this a little bit into the traditional ride-hail service that many folks may use, and I think about Uber and the network that they have, Lyft, and their network as well. Both of those companies have announced a commitment to transition towards 100 percent EVs in their fleet by 2030. And Uber, it's, it's more specifically as it releases to U.S. and Canadian cities and also in major global cities by 2030. And there are different incentives that they put in place as well. There's a green option, for example, Uber Green, as they call it; where, if you drive an EV, you earn an extra 50 cents from the passenger. So as a passenger, you can opt for that green ride. In the case of autonomous ride hail, this is something where I think the industry has gone through a correction of sorts, where expectations several years ago were very optimistic. And I think the industry realized it was much more difficult, um, or certainly certain portions of the investment community realized it was much more difficult, than a lot of companies were espousing. But, that being said, over the last year or two, there's been a lot of progress. So many of these platforms intend to use electric vehicles, the GM Cruise, for example. Um, and if you think about it, the use of electric vehicles could really extend the lifespan of that vehicle that's put in place. There are fewer moving parts. The internal combustion engine has more parts to it, more stuff that can go wrong. It shortens the lifespan of the vehicle, so if you think about the economics of deploying an EV in an autonomous ride-hail setting, the EV has the potential to last longer; which has implications for the economics and, therefore, the affordability of that service to the end consumer. Meanwhile, Waymo has also made progress; both in Phoenix, where they've been testing for some time, and they have recently announced that they're planning to start, uh, testing more substantively in California, as well. And so there has been a fair bit of progress. GM Cruise, for example, plans to start mass producing its electric Origin vehicle, as they call it, which would be dedicated to the robo-taxi efforts. They intend to start that in 2023. So it seems likely to us, or plausible to us, that a more meaningful commercial deployment could happen sometime in the not-too-distant future. And I think that's something that just may surprise some people.

Anu: Well, it sounds like there are continuing to be lots of exciting developments in this space, John. You know, if we were fast forward and, you know, be having this chat again in 2030, where, where would you like to see the future of mobility in the next, you know, nine, 10 years, in the next decade? What are some of your takeaways for the longer term here?

John: Sure. I think there're a few key points, and to be fair, we're not quite at the Jetsons' level yet; but we've certainly come a long way in the last five years. When I think about EVs, certainly there's been a lot of excitement; but I think what's important to remember is that we're still relatively early in the longer-term evolution. So global adoption rates of new electric vehicles last year [were] maybe three or four percent, but the conditions are in place for a continued acceleration in EV adoption because of the policy support, the degree of industry investment, and also the evolution of consumer attitudes and preferences. So looking out five to 10 years, EV adoption is likely to be far higher. How much higher, it's anyone's guess; but I think the direction is clearly up and to the right as it relates to new EV adoption. And the second point that I would reference here is that electrification can have broad implications. It can have implications for how people are moved, how goods are moved, which is why I think the developments, as it relates to robo-taxi R&D efforts, and early signs of commercialization, could have implications of how people and, and goods move around a, a given city. And then, eventually, it's likely to be iterative; but a growing number of cities can start to have a more meaningful impact. Thirdly, electrification also, I think, has implications for other feature sets. So think about autonomy. Think about connectivity. The way that electric vehicles are being designed and architected, I think, has implications for the degree to which vehicle autonomy is deployed across vehicles; so not just robo-taxis, but also think about highway-autopilot functionality. New EVs, oftentimes, are architected from a clean sheet of paper.

They're just redesigned entirely from the ground up. They have a lot of new features and new connectivity, new architectures. And ultimately, what that enables is a much better consumer experience. So because of that, I think it's reasonable to expect that broader feature sets, like highway autopilot and other forms of connectivity – think about over-the-air updates – I think that'll be far more prevalent. And ultimately, what that can lead to is a business-model shift, of some degree, to the OEMs; where they're more connected to that consumer. So to sum it up, I think the future of mobility is likely to be increasingly electric, autonomous, and connected. And I think, in the grand scheme of things, these three attributes are in relatively early innings of adoption. So as much progress as we've made in the last five years, I think it's reasonable to expect just as much progress in the next five or 10.

Anu: All right, terrific. That is a great overview, John. Thank you very much. I do have one final question for you. This is a fun one, just to wrap things up. If you could electrify any car tomorrow, which car would you choose?

John: Ooh, that's a good question. I would probably electrify the – hm. Well this is a very good question. I would probably electrify my kids' school bus. So that way, when they get on, and they start asking me, why does this school bus still use gas, you know, they see the exhaust -- but again, this goes back to the generational shift that we're already starting to observe. You know, my son, for example, is far more excited when he sees a Tesla than when he sees any other vehicle when we're driving down the road. But when that happens across the school bus fleet, I think that's something that is, is likely to further shift how people think about electrification, its use cases, and what it could mean for the future.

Anu: That is a great answer. I like how you're planting the seeds there to the next generation. John, this has been a great conversation. Thank you so much for joining me today to share insights on a topic that, I'm sure, will affect many, many people and many of our listeners on this podcast. So thank you very much, again, for being here.

John: Thanks for having me.

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