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India Mutual Fund

INVESTMENT PERSPECTIVES | PGIM JENNISON

**ROBOTICS & AUTONOMY
IN THE NEXT ECONOMY**

ELECTRIC VEHICLES: THE BOOM IS JUST BEGINNING

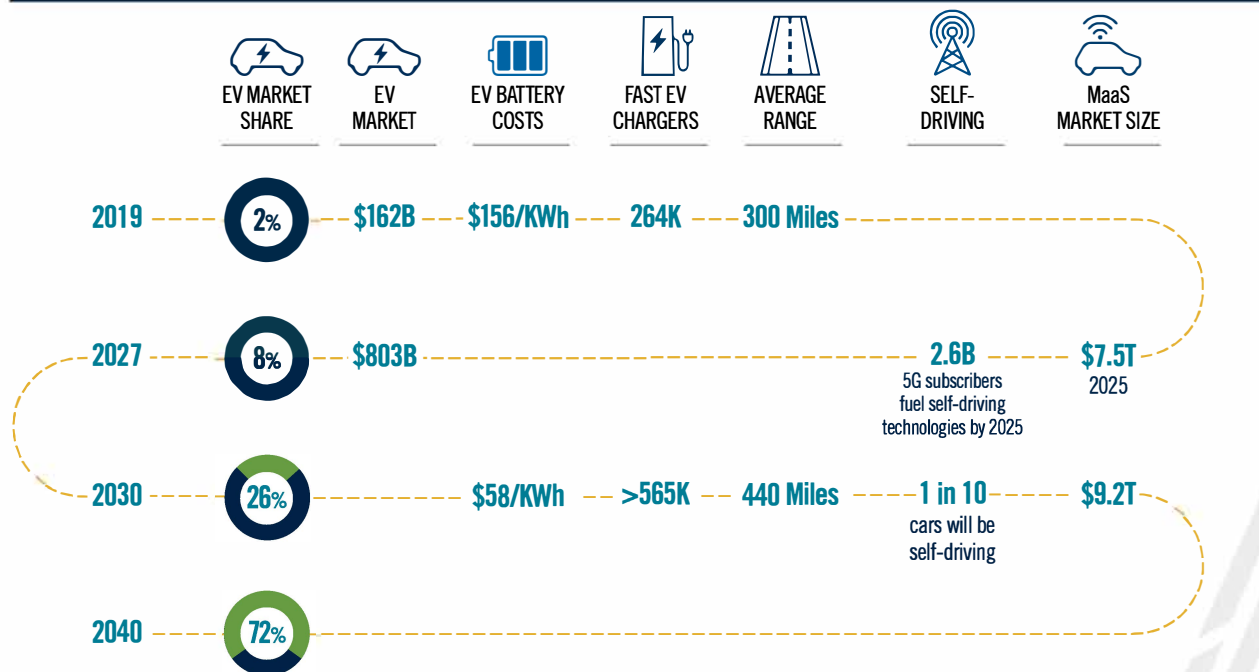
How a niche market is transforming into a multi-trillion-dollar industry

When the COVID-19 pandemic drastically restricted mobility worldwide last year, few industry analysts predicted strong growth for electric vehicles. Yet it turned out to be a banner year. Even while overall car sales fell 15%, automakers sold 3 million electric vehicles in 2020, a 40+% increase over the previous year.¹

A combination of trends converged to drive this dramatic growth: lower-cost batteries that can hold a charge longer, more charging stations, supportive government policies, and improvements in autonomous driving technology. Traditional auto manufacturers were also determined to expand their electric vehicle fleets to compete with industry leader Tesla.

With an industry projected compound annual growth rate of over 20% from 2019 to 2027, Jennison Associates' Global Equity team believes the electric vehicle boom is just beginning and will evolve into an engine for larger disruptions in the transportation industry.² "As disruptive mobility trends collide with clean energy initiatives and evolving consumer preferences, we're seeing an acceleration in the radical transformation of century-old automobile business models," said Thomas Davis, CFA, global equity portfolio manager at Jennison Associates. "Electric vehicles, electric batteries, and smarter semiconductor chips with artificial intelligence that enable parallel thinking are interesting ways to play the theme right now. But once the proper infrastructure is built and autonomous driving capabilities have improved, we expect disruptive mobility trends such as ride sharing, robo-taxis, and in-car monetization services to shift into overdrive."

THE ROAD TO AN ELECTRIFIED FUTURE



Source: Statista as of March 2021. Any projections or forecasts presented herein are subject to change.



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WHAT'S DRIVING GROWTH?

1 CHANGING CONSUMER DEMAND

As technologies improve and safety increases, costs decline, and convenience and choices expand, consumers are increasingly gravitating to electric vehicles. The industry is now nearing an inflection point, moving from a relatively small group of early adopters toward mass adoption. Three big trends are helping to propel this growth:

Lower Battery Costs Enhance Affordability

While electric vehicles are more environmentally friendly than their internal combustion engine counterparts, the recent reduction in lithium-ion battery costs makes electric vehicle production more economically viable. Consider that a Tesla Model 3 battery (82 kWh) costs roughly \$12,000 today, compared to over \$90,000 a decade ago. The average volume-weighted cost of lithium-ion battery packs was \$1,160 per kilowatt hour (kWh) in 2010. Thanks to technological advances, the cost has dropped more than seven-fold to \$156/kWh over the last decade and is expected to fall below \$100/kWh by 2024.³

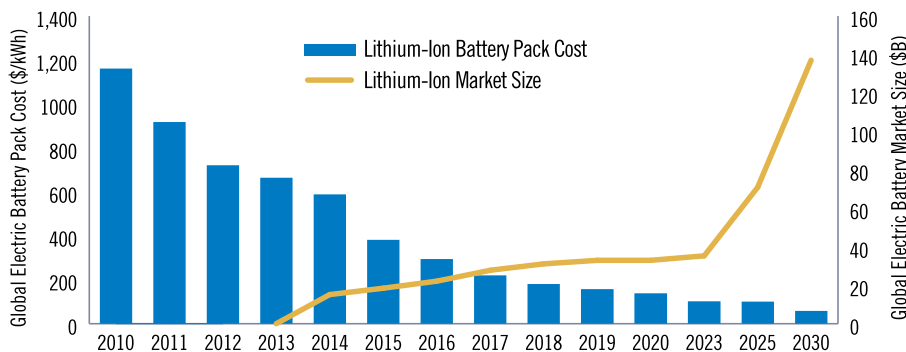
Higher Battery Capacity Extends Range

In 2020, electric vehicles traveled an average of 300 kilometers on a single charge, with the Tesla Model S Long Range Plus AWD offering the longest range of up to 390 miles. As battery technology improves, the average range is expected to reach 440 kilometers by 2030.⁴ The industry's ability to grow hinges on electric batteries, potentially making that market an even more exciting area for investors than electric vehicles themselves. Global battery demand for electric vehicles is predicted to grow 17-fold by 2030, with the lithium-ion battery cell market expected to nearly triple to \$137 billion by then. China's Contemporary Amperex Technology Co. is the world's top electric battery producer with a 14% global market share in 2018. It is expected to maintain that dominant position through 2028, when its estimated cumulative capacity will total 307 gigawatt hours (GWh). Tesla's capacity is expected to reach 135 GWh by then, ranking it third in the industry.⁵

More Charging Stations Improve Convenience

A large network of publicly available charging stations and outlets is critical for electric vehicles to go mainstream. New technologies that speed up lithium-ion battery charging time five-fold are driving growth in fast-charging stations that can fully charge passenger vehicles in a few hours. Globally, publicly available fast chargers topped 263,800 in 2019.³ China, the biggest electric vehicle market, has the largest network of chargers, including more than three-quarters of the world's fast chargers. The U.S. has almost 100,000 charging outlets, but less than 15% are fast chargers.⁵ The number of global electric vehicle fast-charging systems for light duty vehicles (i.e., passenger cars) is expected to reach 564,500 units by 2029.²

SURGING ELECTRIC BATTERY MARKET DEMAND AS BATTERY COSTS FALL



Source: Statista as of February 2021. Any projections or forecasts presented herein are subject to change.

\$137B
Lithium-ion battery cell market size by 2030⁴

440 kilometers
Average expected EV range on a single charge by 2030³

565,000
Global fast EV charging stations by 2029⁵

2 SUPPORTIVE GOVERNMENT POLICIES

To avoid the most devastating impacts of climate change, governments worldwide are rolling out infrastructure plans to reduce their carbon footprints. Because gasoline- and diesel-powered vehicles are key culprits for air pollutants, the electrification of the global transportation industry will be crucial for advancing these efforts. Broader adoption of electric vehicles hinges upon availability of more public charging stations and more power generation from cleaner sources. Innovations in battery storage and recharging efficiency, along with lower production costs, are also essential for widespread electric vehicle adoption.

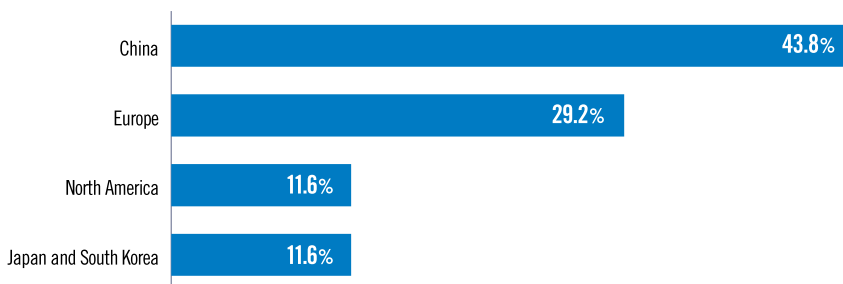
Financial Incentives & Restriction Exemptions

To entice consumers to buy cleaner-energy electric vehicles, governments have been offering rebates, discounts, and/or income tax credits to reduce the total cost—in some cases by roughly \$10,000 per vehicle.⁶ However, as battery costs decline and electric vehicles reach pricing parity with combustion engine vehicles, governments are gradually phasing out subsidies and replacing them with other incentives. For example, megacities around the world are excluding electric vehicles from driving bans and/or punitive taxes imposed on combustion engine vehicles.

Tighter Emission Standards

On the product side, regulators are forcing automakers to accelerate their electric vehicle launch plans by aggressively tightening emission standards. While fossil fuels may be abundant, raw materials like nickel, cobalt, and lithium that are used to build electric batteries and vehicles are more scarce. Countries and companies investing heavily to electrify their transportation sector early are well positioned for success, since they are likeliest to have secured an adequate supply of these raw materials. China and Europe are currently leading the electrification race with their robust subsidy policies and tight restrictions on fossil fuel emissions. As a result, these regions have led the world in electric vehicle production, which is a trend likely to continue for the next decade. Despite its late arrival, the U.S. is expected to make major investments in clean energy to help achieve net-zero emissions by 2050.

PROJECTED EV PRODUCTION IN 2027



Source: Statista as of March 2021. Any projections or forecasts presented herein are subject to change.

36.4 billion
metric tons global CO₂ emissions in 2019¹

12%
Road transportation share of total greenhouse emissions worldwide³

\$10,000
EV purchase incentives in Germany⁶

3 MORE MODELS ON THE MARKET

The global automotive industry is expected to grow into a \$9 trillion market by 2030, although it will look starkly different from today, with a slew of new electric vehicles set to upend the status quo.⁷ Globally, automakers have pledged to invest billions in electric vehicles and are planning to debut a deluge of models, including cars, transit buses, trucks of all sizes, and even big-rig tractor trailers.

Global EV Fleet Expansion

Jennison’s equity research analyst for industrial and consumer sectors, Owuraka Koney, CFA, notes that “Tesla’s game-changing impact on mobility continues to strengthen. Not only is Tesla the breakaway EV leader, but is positioned to disrupt the overall automotive industry.” It is the only major automaker with a fully electric fleet, a convenient direct-to-consumer sales model, and its own supercharger network. It is a pioneer in battery technology and vehicle software, with industry-leading full self-driving capabilities built into its vehicles which can be turned on through subscription models and upgraded through software updates. Its vertical integration across the entire value chain and lack of unionized labor enables it to innovate faster than the competition, giving it more EV capacity coming online than any other automaker over the next 18 months. While the company could maintain its significant lead over newcomers if it continues to innovate and adapt faster than its rivals, the competition isn’t backing down. Almost every automaker is expanding its lineup to include electric vehicles. By 2030, the global electric vehicle fleet size is expected to grow 14-fold to 116 million units.

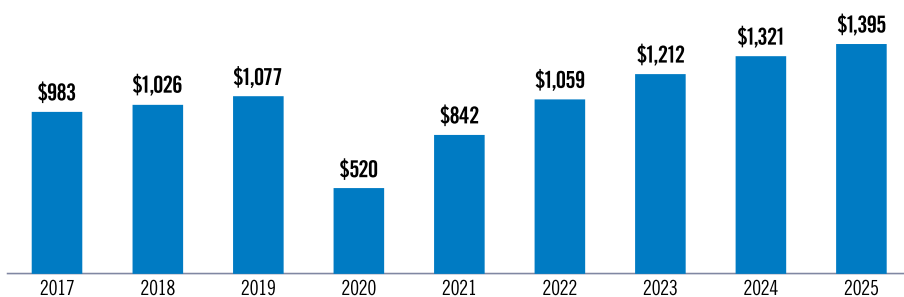
Enhanced Self-Driving Technology

Self-driving cars have not lived up to their hype. The biggest impediments over the years have involved inconsistent upload and download speeds, communication delays between self-driving cars on the road, and delays gathering information about driving conditions. But the rollout of 5G mobile technology should help overcome these challenges. As 5G becomes more widespread globally and autonomous driving technologies evolve, the global autonomous car market is expected to reach \$60 billion by 2030, a 10-fold increase over 2018, with 800,000 robo cars projected to be on the road.⁸

The Mobility Services Opportunity

With a compound annual growth rate of 18%, the global mobility services market (which excludes carpools, chauffeur services, ride-sharing agencies, ferries, and public transport) is expected to balloon to \$1.4 trillion by 2025.⁶ As artificial intelligence and autonomous vehicles make mobility more convenient, a concept known as mobility-as-a-service (MaaS), which includes public transportation, taxis, car- and ride-sharing/hailing services, and bike sharing, is emerging as a premier mobility option. MaaS is expected to become a \$9.2 trillion market by 2030 as shared cars and other transportation technologies transform urban mobility.²

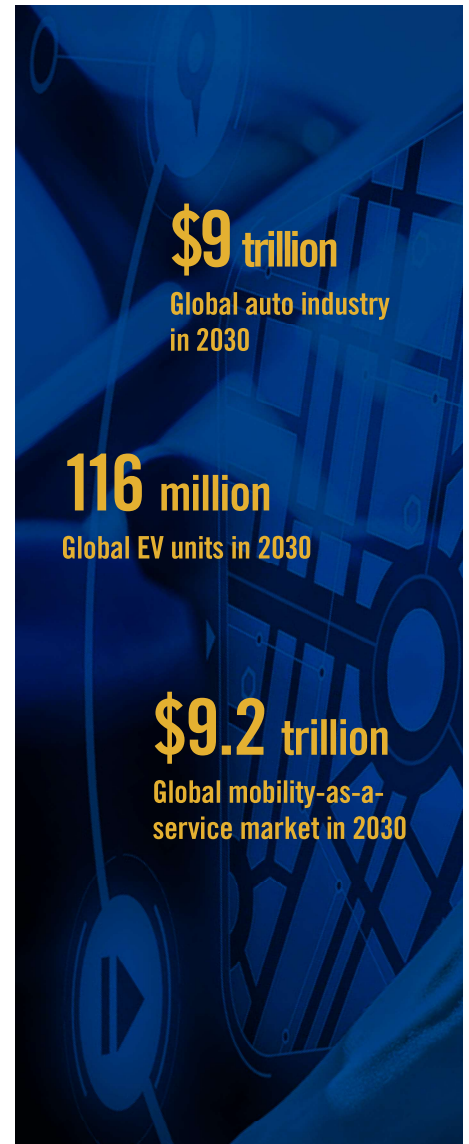
MOBILITY SERVICES TO SHIFT INTO OVERDRIVE (\$ BILLIONS)



Source: Statista as of October 2020; adjusted for the expected impact of COVID-19. Any projections or forecasts presented herein are subject to change.

INVESTING IN THE INDUSTRY

The transformation of the global auto industry will have vast implications for economies, societies, and investors. Adoption of electric vehicles and mobility services likely will be chaotic and confusing for investors. Capitalizing on the disruptive mobility opportunities in the NEXT—or new exceptional technologies—economy will require the vision to identify big secular themes and the ability to pick the future winners early. Active managers with intimate industry knowledge and the expertise to forecast the magnitude and duration of a company’s growth can help position investors to succeed.



¹ Source: Statista as of January 2021.

² Source: Statista as of March 2021.

³ Source: Statista as of December 2020.

⁴ Source: Statista as of June 2020.

⁵ Source: Statista as of February 2021.

⁶ Source: Statista as of October 2020.

⁷ Source: Statista as of September 2020.

⁸ Source: Statista as of March 2020.

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