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Insights

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The future of electric vehicles is more promising than ever with technological innovation in hardware and software solutions.

Innovation will fuel e-mobility adoption

Key takeaways

1. The e-mobility movement is driven by policy as well as consumer demand. U.S. President Joe Biden set a target for 50% of new car sales to be EVs by 2030, and EV registrations in Europe increased from 3.5% in 2019 to almost 18% in 2021.

2. The top challenges facing manufacturers are expanding a vehicle's range and the availability of charging stations. This will require innovations in battery technology as well as expanded charging infrastructures that will provide rapid charging, so the driver experience is more akin to fueling gas-powered vehicles.

3. Electrical-grid power is another hurdle for EV adoption. Addressing this issue will require partnerships across industries and governments to develop the required technological advances and standards to support an EV market ecosystem.

The e-mobility revolution is in high gear. Automakers are promising to launch **dozens** of electric models over the next decade. In August 2021, U.S. President Joe Biden set a **target for 50%** of new car sales to be electric vehicles (EVs) by 2030. And electric car registrations in Europe increased from 3.5% in 2019 to almost 18% in 2021, according to the **European Environment Agency**.

Policy changes are driving the increasing popularity of e-mobility – the use of electric vehicles, such as cars, trucks, and buses, that obtain energy from a power grid. New policies include California's Advanced Clean Trucks (ACT) regulation, which requires manufacturers to sell increasing percentages of zero-emission heavy-duty trucks.

Evolving consumer demands are also helping e-mobility gain mainstream traction. In fact, automotive consulting firm AutoPacific **reports** that consumer demand in the U.S. increased to 5.6% of total light vehicle sales in 2022. This number was 3.3% in 2021. One reason for this uptick is that consumers are looking for eco-friendly alternatives to traditional transportation vehicles, which contribute approximately **one-quarter** of all energy-related carbon dioxide emissions to the atmosphere.

These shifts in policy and consumer sentiment not only herald a new era for e-mobility, but highlight the need for continued technological advancement. "Scaling e-mobility technologies more efficiently is critical to speeding widespread adoption of electric vehicles and reducing carbon emissions across the globe," said Jeff Harris, vice president of corporate and portfolio marketing at Keysight Technologies, a U.S.-based provider of design, emulation, and test equipment for electronics. He continues, "There are immediate opportunities for innovation across the e-mobility ecosystem that will help make EVs more affordable, convenient, and desirable to consumers."

As organizations rise to this challenge, innovations are emerging, from new battery designs to EV charging and EV supply equipment (EVSE) or charging infrastructures that, together, promise to push the envelope on electric vehicle adoption and contribute to a cleaner planet.

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Overcoming obstacles to an electric future

Among the top challenges facing manufacturers is expanding a vehicle's range and the availability of charging infrastructure.

"While consumer incentives and education have made a positive impact on electric vehicle adoption, we can boost it even more by addressing consumer needs through technology innovation," said Harris. "For electric vehicles to become mainstream, we need to make the driver experience more like what people are used to, which means delivering on comparable range and convenience."

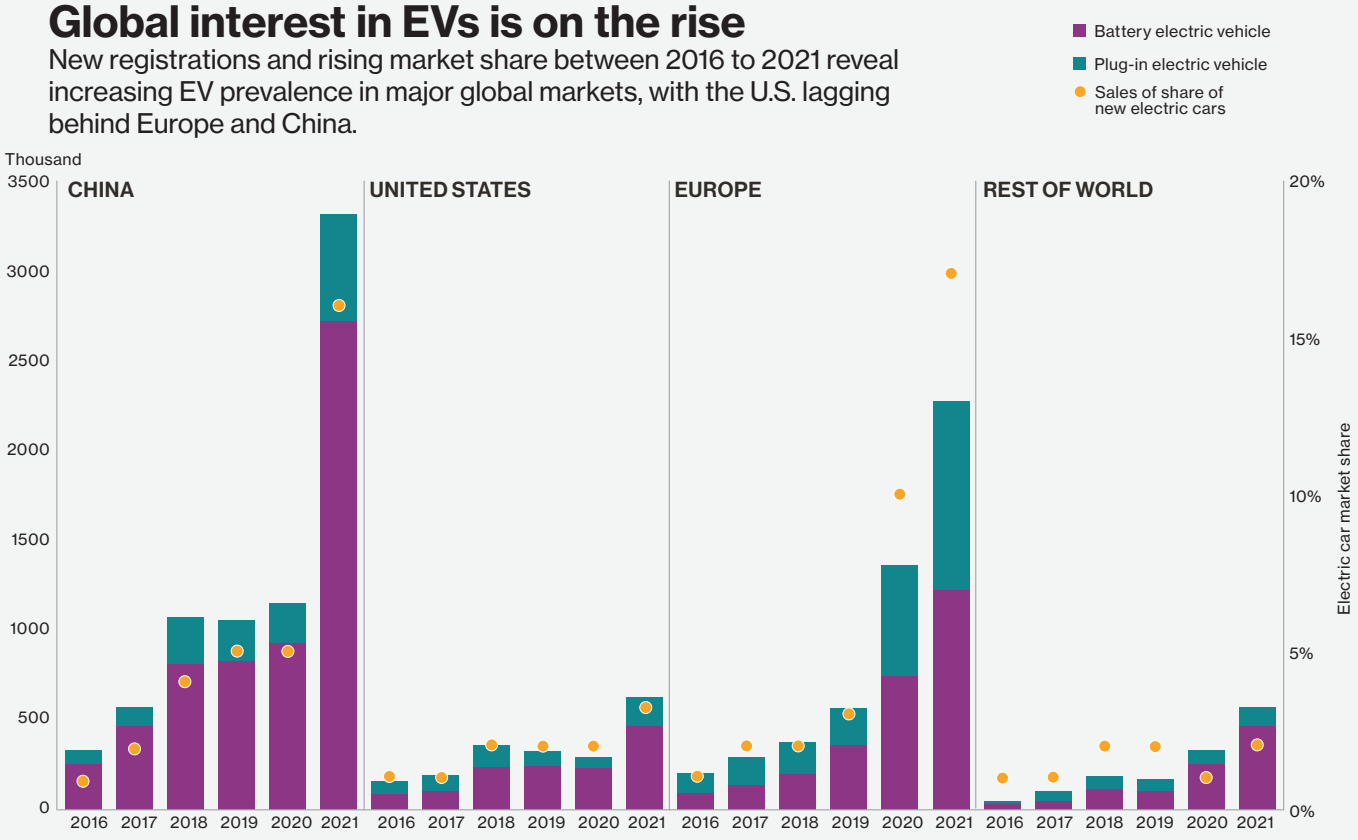
A vehicle's range depends on the size of its battery, and how efficiently the car uses that energy. However, "to build a car with sufficient range that can be recharged quickly at a lower cost, you need better batteries with more capacity," says Harris.

Building the necessary charging infrastructure is an obstacle that must be overcome to encourage consumer adoption. Today, most electric vehicles can travel between 150 and 250 miles on a charge, depending on the model. But unlike gas-powered cars that rely on traditional gas stations, EVs need to charge at electrical outlets. A recent study by the International Council on Clean Transportation **reveals** that 10,000 more charging stations will be required to support electric vehicles traveling between major U.S. cities by 2025.

Governments are supporting the e-mobility movement by rolling out high-power, fast-charging networks. "Many governments are creating an infrastructure of charging stations so that people can make longer trips and are better able to charge their vehicles," says Hwee Yng Yeo, automotive solutions manager for electric vehicles at Keysight Technologies. "This is a critical part of enabling e-mobility."

Global interest in EVs is on the rise

New registrations and rising market share between 2016 to 2021 reveal increasing EV prevalence in major global markets, with the U.S. lagging behind Europe and China.



Source: International Energy Agency (IEA), 2021, Trends and developments in electric vehicle markets.

Even then, though, Yeo explains, "it can still take a long time to recharge an electric vehicle in comparison to fueling an internal combustion engine. The majority of drivers won't accept that, at least in the near term. We need to get to the point that refueling or recharging your EV is at least comparable."

As it is, manufacturers are working feverishly to even the playing field between combustion engine-powered vehicles and their electric counterparts. Doing so, however, requires increased battery testing, according to Michael Cummings, chief operating officer at SparkCharge, an EV charging company. "Battery cells are still too expensive to undercut engines burning fossil fuels to propel cars," he says. "Affordable and available energy test labs help companies like SparkCharge move faster to optimize cell technology, pack technology, and source-to-EV charging technology."

The catch: properly testing batteries takes time and requires the construction of complex battery and EV component factories. In fact, McKinsey reports that Europe will have to build an estimated 24 new battery factories just to meet local battery demand.

50%

increase in worldwide electricity consumption by 2050, mostly due to a proliferation of electric vehicles.

Source: The U.S. Energy Information Administration

Then there are the costs of purchasing an electric vehicle. "We're making progress in the entry costs of an electric vehicle, but they're still significantly more expensive [than their gas-powered counterparts], even though the total cost of ownership is approaching that of an internal combustion engine," says Yeo.

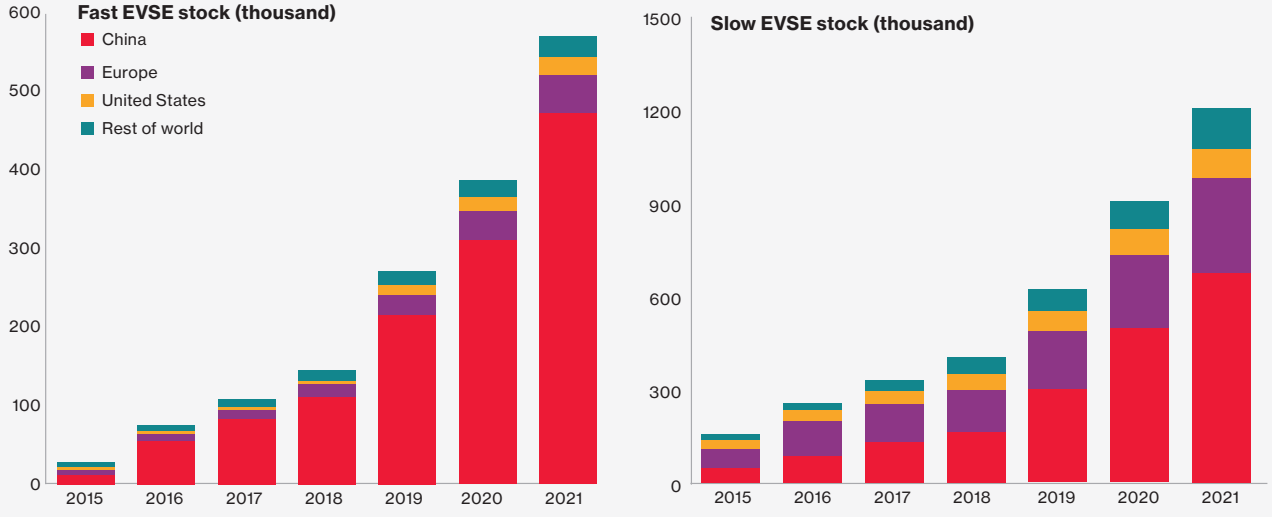
Innovations to deliver speed

These days, it's critical for engineers who design battery-powered devices to know a cell's expected self-discharge – the rate at which a lithium-ion cell's open-circuit voltage will decrease over time when nothing is connected to it. Armed with this information, engineers can more accurately calculate an EV's maximum range.

However, in the past, measuring a cell's self-discharge involved the painstaking process of placing a battery on a shelf and simply waiting for it to completely discharge. Part of the problem, says Renee Morad, automotive solutions manager for batteries, Keysight Technologies, is that "lithium cells take a long time to discharge on their own." As a result, she adds, "trying to find a defective cell by looking at how much it discharges can take days or weeks."

Global publicly accessible EV charging station infrastructure data shows accelerated growth between 2015 and 2021

Although the EV charging infrastructure is growing, the stock of slow chargers continues to outpace fast chargers.



Source: U.S. International Energy Agency, 2022, Global EV Data Explorer

However, that's changing as engineers increasingly rely on direct self-discharge measurement systems, such as **self-discharge analyzers**. These devices can accurately measure the self-discharge current of lithium-ion cells in minutes or hours instead of taking weeks or months to assess the loss of charge through open-circuit measurements.

Charging problems, such as poor interoperability, are another impediment to adoption that is leading to the creation of new and innovative tools. For instance, the failure of an electric vehicle to properly communicate with a particular charging station can negatively impact a driver's experience, especially when compared to how easily drivers can gain access to traditional gas stations. For years, evaluating interoperability required connecting a physical vehicle with a physical charging station. Not only was this approach time-consuming, but it made it difficult for engineers to troubleshoot the causes of errors.

Sophisticated testing systems, on the other hand, can emulate either an electric vehicle or a charging station, or be used as a "person-in-the-middle" tester to verify communications between an EV and an EVSE. Essentially, charging discovery systems monitor the communication and power flow in a virtual or lab test environment. The ability to check the status of a charging station in real time allows engineers to assess charging quality, identify potential areas for errors, and analyze root causes.

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Michael Cummings,
Chief Operating Officer, SparkCharge

Innovation behind the wheel

Fortunately, many organizations are stepping up to meet these challenges with innovative hardware and software solutions that not only aim to reduce barriers to adoption but are better for the planet.

Chief among these solutions are advances in the chemistry, packaging, and size of battery cells. "One of the more recent innovations is that cells have become physically larger," says Renee Morad, automotive solutions manager for batteries at Keysight Technologies. "They've gone from being cylindrical cells to prismatic cell shapes that can store more energy because they're now bigger and more space efficient," she adds. The result is a battery capable of providing electric vehicles with greater range and capacity.

Manufacturers are also discovering new and innovative approaches to EV battery testing. Traditionally, nail penetration tests are used to assess the safety of lithium-ion cells – a process that involves driving a metallic nail through a charged cell at a prescribed speed. The rechargeable cell passes the test if no smoke or flame follows.

However, more sophisticated battery testing methods are emerging. For example, Morad says researchers are using data and data-modeling techniques to simulate how cells will behave under certain weather conditions, as well as how well they can accommodate faster charge times and higher voltage levels.

By modeling such responses using sophisticated computer algorithms, Morad says, "we can better understand how quickly we can push energy into cells without making them dangerous" and negatively impacting battery performance and durability.

Engineers can also set parameters, such as voltage and current, to conduct repeated tests on how effectively a vehicle and charging station communicate with one another. Such functionality significantly reduces the time, effort, and costs associated with conducting a variety of test combinations using a wide array of charger types. Moreover, a charging discovery system can recognize worldwide charging station protocols, enabling engineers to conduct hundreds of test cases to verify interoperability and conformity with devices around the world.

Beyond offering engineers more accessible and precise evaluations of interoperability, charging discovery systems provide electric vehicle manufacturers with keen competitive advantages, including "quicker time to market" with new products, says Yeo.

Another important innovation in the maturing industry comes from the power analyzer, which was developed to evaluate battery charging efficiency. Electric vehicle batteries are controlled by an inverter, a device that converts DC power to the AC power used in an electric vehicle, for efficient operation. As a result, Yeo says, these power converters "must be as efficient as possible; otherwise, they'll waste the energy that's stored in the battery." In response, many organizations are relying on innovative power analyzers to calculate the energy conversion efficiency of power converters by measuring the power between the battery and the inverter itself, and then analyzing the results.

As companies increasingly embrace new battery designs, self-discharge measurement systems, and power analyzers, many companies in the electric vehicle market are discovering the need for faster and more efficient data processing, sharing across teams, and analysis at every stage in the product development workflow. With the right scalable and predictive software platform in place, engineers and business leaders can take advantage of the operational improvements offered by innovative systems and solutions, while better managing increasing design, test, and measurement complexity.

The future is united

As the electric vehicle landscape evolves, organizations are forming mutually beneficial partnerships as part of a broader market ecosystem. For example, Harris says Keysight is partnering with testing laboratories in Europe, "where they're focused on certifying charging stations and electric vehicles so that they're interoperable. They're not only looking at the safety aspects but the actual communication and charging interface between EVs and charging stations."

Such partnerships will be critical to continued technological advancements as millions of vehicles increase the demand on electrical-grid power. In fact, the U.S. Energy Information Administration (EIA) **predicts** a worldwide increase of nearly 50% in electricity consumption by 2050, mostly due to a proliferation of electric vehicles.

"Even if we had all the charging stations that we need in the world, we still have to be able to generate the electricity to provide power to all of those charging stations," says Yeo. "Right now, adding that much capacity to the grid is very difficult, especially when you're trying to make it a sustainable method of generation."

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Hwee Yng Yeo, Automotive Solutions Manager for Electric Vehicles, Keysight Technologies

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