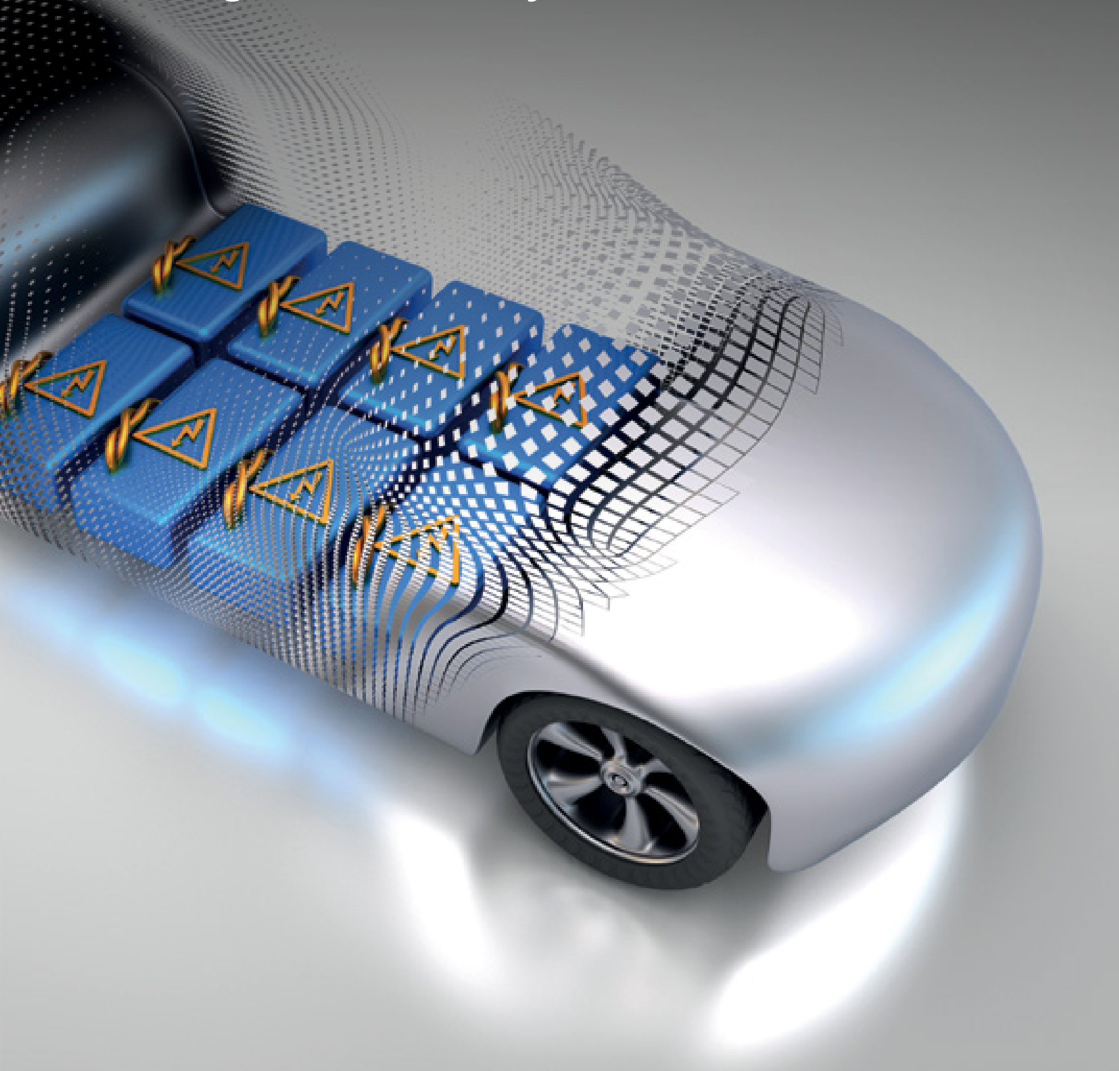
Capgemini engineering

E-MOBILITY ACCELERATING TOWARD MATURITY

Challenges in a new ecosystem



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$480 billion

Is the global electric mobility market forecasted in 2025

36 million units

Is the sales forecast of electric vehicles (EV) in 2025 vs. 6.4 million in 2019

7.3 million

chargers worldwide in 2019, demonstrating the rapid expansion of infrastructure for EV charging

52.5%

Is the market share of China in 2019 for EVs, remaining the market leader followed by Europe (26%) and the United States (14%)

35 million units

Is the projection of EV car production in 2030, dominated by BEVs

Introduction

Electric vehicles are nearing a turning point as changing consumer attitudes, improved battery economics, broader access to charging infrastructure, and stricter regulatory policies all present growth opportunities. However, the transition to electric propulsion will transform mobility industries and the transport sector globally.

For various, and obvious, reasons, e-mobility will gain major relevance in the upcoming years. Growing concerns about the environment are leading governments to encourage innovation and ownership of EVs, as well as emission rules for conventional internal combustion engines. With rapid urbanization posing new challenges to keep metropolitan areas livable, zero-emission and low-noise vehicles might be the only way to enter sustainable cities in the near future.

Developing and producing EVs on a large scale is complex, as an EV is not just another vehicle.

The challenge is to develop an attractive, cost-efficient package. Electrifying existing platforms or designing clean-sheet pure electric platforms mean a profound system change. With many new parts and technologies to integrate, no single automotive manufacturer can do it alone with the pace the market requires. With automotive supply chains already among the most complex in the world and facing multiple disruptions, adding a new technology domain like e-mobility involves a significant transformation.

Why e-mobility is unstoppable

Global challenges such as climate change, urbanization, and the energy transition toward renewables are driving electrification.

The Paris climate conference COP21 witnessed the first ever legally binding climate deal. Additional governments are now increasing pressure to make electric vehicles a more important part of the mobility landscape. The plan includes a joint effort toward sustainable e-mobility. The global e-mobility market size is expected to reach around USD 490 billion by 2025[1].

Climate change

Global warming is a fact, and CO^2 values have never been higher. Despite the withdrawal of the US, which represents a large part of global emissions, nearly 200 parties have signed the Paris Climate Agreement as a global response to the threat of climate change. Under the Paris Agreement, each country must determine, plan, and regularly report on the contribution it undertakes to mitigate global warming.

One of its key objectives is to keep the global temperature rise in this century well below 2^0C from pre-industrial levels and to pursue efforts to limit the temperature increase even further to 1.5^0C. The International Energy Agency analysis finds that to achieve this climate objective, a profound transformation of energy production and consumption needs to occur by 2050:

- Nearly 95% of electricity would need to be low-carbon by then, compared with about a third today, led by renewables
- 7 out of every 10 new cars would need to be electric, compared with 1 in 100 today
- The entire existing building stock would need to be retrofitted and the CO^2 intensity of the industrial sector would need to drop by 80% below today's levels
- Fossil fuels, in particular natural gas, would still be needed in 2050, but would account for 40% of energy demand, around half of today's level
- $3.5 trillion per year in energy-sector investments would be needed on average until 2050, which is around twice the current levels of investment

1. Grand View Research, 'Electric Mobility Market Size, Share & Trends Analysis Report By Product (Electric Scooter, Electric Bicycle, Electric Skateboard, Electric Motorcycle, Electric Car, Electric Wheelchair), By Battery, By Voltage, By Region, And Segment Forecasts, 2019 - 2025', 2019, available from: https://www.grandviewresearch.com/industry-analysis/electric-mobility-market

Increased urbanization

Today, cities already account for 50% of the world's population. An additional 2.5 billion people will live in cities by 2050, increasing energy demand and the need for transportation of people and goods. As a result, cities and suburbs will be noisy, congested, and prone to smog. This is even more the case in densely-populated metropolitan areas in emerging countries such as Beijing, New Delhi, and Mexico City. They all suffer from congestion and poor air quality.

In the nearly 10 million-strong city of New Delhi, the number of cars has increased from 180,000 to 3.5 million in the last 30 years. Still, it's the city's coal powered plants that are causing the biggest problem. They account for around 80% of total air pollution in the city. Urbanized areas will have to undergo significant transformations to create sustainable living conditions for their residents. The future of mobility is shared, electrified, and powered by renewable energy.

Energy transition toward renewables

According to the International Renewable Energy Agency, cities are responsible for 70% of man-made CO^2 emissions. Cars, heating, cooling, and lighting systems work around the clock, consuming energy and causing emissions. According to the 2019 renewables global status report, the power sector is driving rapid change toward a renewable energy future, but the overall transition is not advancing with the speed required.

At current consumption levels and known fossil fuel sources, we could run out of oil by 2052, gas by 2060, and coal by 2088.

But the world is not completely on track to meet international climate and sustainable development goals. Renewable energy sources offer us a way to avoid this (fossil-fueled) energy time bomb. Around a fifth of the world's primary energy supply already comes from renewable sources such as wind, solar, hydro, and geothermal. This sector is expected to continue growing by 2.6% each year until 2040.

Reducing emissions and going electric

Decarbonization of the transport sector is an important transition as the sector generates 23% of global energy-related CO^2 emissions. According to the International Energy Agency, this transition will require continued electrification of global rail transport infrastructure as well as electric propulsion for at least 20% of all road transport vehicles (cars, 2 and 3-wheelers, trucks, buses, and others) by 2030.

The Paris declaration on electro-mobility and climate change calls upon governments at all levels as well as businesses, cooperative initiatives, and others to take action, overcome challenges, and advance global momentum for electro-mobility. The key challenges range from the need for technological developments to greater availability of renewable energy to be ensured by energy companies, not to mention government regulations supporting e-mobility, availability of durable and easy-to-use charging solution infrastructure in line with automotive sector cost guidelines, and bringing a range of efficient and attractive electric vehicle models to the market.

Focusing on the automotive sector, we see major e-mobility investments with global automakers already announcing investments exceeding $90 billion in electric vehicles. The electric vehicle market has reached a new high with 1.2 million units sold in 2017 and more than 165 models on offer. China is currently leading the market with a 49.5% market share, followed by Europe with 25.6%. The full e-mobility ecosystem (automakers, infrastructure, suppliers, etc.) is expected to become a $390 billion global market and the total electric vehicles stock is soaring to 548 million by 2040, about 32% of the world's passenger vehicles.

Countries such as the UK and France announced that they will not allow ICE sales by 2040. China runs ahead and sets hard targets starting in 2019. These targets are based on a credit rating system for so-called new energy vehicles that include battery electric vehicles and plug-in hybrids. By 2020, car makers need to have a new energy credit rating of 12% of their annual sales. All companies selling more than 30,000 cars annually have to comply, by credits from other companies exceeding the quota or be subject to penalties.

Challenges in a new automotive ecosystem

The challenge to develop and produce EVs quickly, cost effectively, and on a large scale is complex, as an EV is not just another vehicle.

Requirements are different, new vehicle architectures are needed, and novel components and technologies have to be selected, tested, and integrated. As all of these aspects are new, a high level of co-creation will be expected of system integrators. OEMs, tier 1s, and new entrants are fighting for their positions in the future ecosystem. They all need partners to fulfill their goals in time, quality, and cost.

Challenges from an automotive perspective

Just think of autonomous vehicles, electric vehicles, digitization, and new mobility concepts, and it becomes clear the automotive industry faces more challenges than ever before. All of these challenges will not be solved with a single innovation. Moreover, with e-mobility, the market is not only dependent on the excellence of the underlying technology, but also on the societal, infrastructural, regulatory, and political landscape.

The auto industry has specialized in creating a plethora of vehicle variants on standardized, well engineered, and tested platforms, leveraging huge economies of scale. This is basically why the complex and customized vehicles of today are affordable. In order to make e-mobility accessible to the masses, specific platforms are needed to be developed. In addition, new components such as batteries, charging systems, e-motors, and inverters, to name but a few, have to be selected and integrated to work together as a smooth system.

A new ecosystem emerges

With e-mobility technology rapidly advancing, the value chain is in constant motion, making it complex to integrate the latest evolutions during the design process. Taking these agile considerations into account, a high level of interaction and collaboration among a range of ecosystem partners is required. Because OEMs want to focus on their core activities and no single player wants to do it all by itself, the role of independent engineering, research, and development partners, as connecting factors in the ecosystem, will be critical for success.

Accelerating toward maturity

As e-mobility technology is maturing, existing barriers for widespread adoption such as battery costs, range, charging time, and infrastructure are overcome.

E-mobility technology is advancing

The huge development spendings in the recent years have dramatically advanced the available technology for electrification. Hand-in-hand with this progress, the potential field of application has also grown (passenger cars, trucks, buses, shuttles, tractors, etc.). The real complexity of electrification emerges in the system integration of high-performance, high-voltage components, especially batteries with drivetrain and charging systems. It requires system architectures that are compliant to safety standards of ISO-26262 and beyond. Safety must be guaranteed in every scenario, as milliseconds in power shut-off influence system behavior and therefore, ultimately, passenger safety.

Integration and safety issues cause a high amount of (re)engineering in the components and high-voltage systems, in hardware and software alike. Unit and system test scenarios have to be developed to test crucial circumstances under new requirements for test equipment. Additionally, the development cycle of electric vehicles should be agile to adhere to the same deadlines and ultimately costs as conventional vehicles.

Barriers for widespread adoption are disappearing

Affordable battery capacity has been improved, which means that the range of the vehicles has changed. The typical range from available electric cars has increased from 150 km to 500 km with one charge under realistic conditions. The technical benchmark for existing vehicles is to reach a range of approximately 1,000 km as well as improve cell chemistry to drive down cost and make it more affordable (€/kwh).

Although the energy content of battery cells has been increasing over the years, smarter packages make it possible to put even more capacity (28Ah -> 63Ah) into the same volume, with a weight increase of only 25%. In the near future, we can expect batteries with an energy density increased by a factor of 2-3.

The lifetime of a battery is no longer a blocking point today. With 4,000 equivalent full charge cycles – before reaching 80% depth of discharge (DoD) compared to the rated capacity – the lifetime of the battery is already exceeding that of the vehicle. Batteries will get a second life as they are used as stationary storage.

In the last few years, technology has made significant developments toward better charging infrastructure. Charging time can be reduced from overnight (six to eight hours) to 20 minutes by using high power charging stations. Charging infrastructure is developing fast. At home, 22kW power – readily available at most single houses – is enough to fully charge the most powerful electric vehicle overnight. The urban infrastructure of fast chargers with 50kW power is growing rapidly, with parking providers, supermarkets, and shopping malls sometimes even offering free charging. Infrastructure of high-power charging points with a power range of 100kW to 450kW at strategic locations such as highways and defined urban locations is increasingly available for vehicles capable of fast charging.

An additional benefit will be bi-directional charging, allowing the power supplier to use the batteries in the vehicles for grid balancing and as an energy buffer. This requires new intelligence to be integrated into vehicles, to communicate with the grid and the grid power control.

Approach to electric vehicle development

From idea to product, several issues have to be solved. A detailed study is needed to identify the use case as the requirements applicable to an e-car are obviously different from the one for a city e-truck, an electric shuttle, or an e-tractor. After identifying the use case of the vehicle, it is very important to prove technical and commercial feasibility. As a first research step in the study, the energy needed for the specific use case needs to be calculated.

Different vehicles, different challenges

In the example of an autonomous shuttle for rapid group transit, the requirements were defined with the use case boundaries such as speed, availability, capacity of people per hour, range, and operating costs. The technical feasibility study answered questions regarding power class, battery capacity, charging power possibilities, charging time, etc. With this information, the infrastructure needed could be planned and matched with the environment.

Specific requirements in this project were battery cooling and an acclimatized transport vehicle capable of operating in a high-temperature environment at relatively low speeds. For 2getthere, Capgemini Engineering covered the design, engineering, and assembly of the vehicle. The challenge was to develop a thermal management system for the vehicle and to calculate the power needed to specify battery capacity, taking charging boundaries into consideration.

In multiple and highly complex projects to electrify heavy-duty vehicles such as trucks and buses, it is key to focus on re-engineering from conceptualization, prototyping, and testing up to homologation. These vehicles are the future of mobility in urban environments to operate with zero emission and low noise.

In the upcoming years, we will see more special-duty vehicles with combustion engines going green. One example is the agriculture market, where fuel consumption and emissions were the main drivers for developing an e-tractor. Electrification does not only electrify the drivetrain, but also makes for accurate control of the working machines behind the e-tractor. The challenges in the development of this kind of vehicle are the thermal management of high-voltage components and system integration of these components.

Considering the smaller production numbers and often limited development capacities of specialized vehicle manufacturers, it is often more economical for development partners to take complete system responsibility for the electrification of the vehicle – from concept over integration to homologation.

Source: 2getthere

Conclusion

The development and spread of e-mobility is bringing us much more than increased comfort and quality of life. It also has to be seen as a way to meet our responsibility to cut down CO^2 emissions in order to fight global warming and keep the world a habitable place.

The future of transport has to be electric and shared in order to adapt to increasing urbanization. The advancements in electrification have been huge. But to keep that pace and master the challenges of product, infrastructure, and economies at the same time, it is vital to work in ecosystems.

It will be key to strengthen cross-functional collaboration between OEMs, tier 1 suppliers, as well as energy suppliers and governments to continuously develop the charging infrastructure and hence prepare the cities of tomorrow for the continuously increasing number of e-vehicles on the road.

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