RESEARCH INSIGHTS

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Electrifying the World
From Fossil to Electric

With more and more electric vehicles(EV) taking to the roads around the world, will we see a complete shift in the automobile industry in the near future? In this editorial, we take a deeper dive into the world of the EV industry to understand its appeal.

What is an electric vehicle?

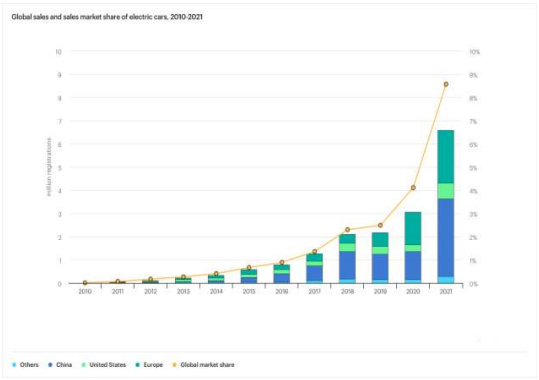
An EV uses a battery and an electric motor instead of a gasoline tank and an internal combustion engine(ICE). They produce no tailpipe emissions. In order to power and charge an EV, they are plugged into charging stations. In addition, the distance traveled by the average EV before it needs to be recharged is usually less than an ICE vehicle before it needs to be refueled. However, it is still enough to fulfill the average person's daily driving needs. Currently, there are also a number of EV models available on the market for consumers and businesses to purchase depending on their individual requirements.

A New Era

The market for electric cars is one of the most dynamic in the clean energy industry. About 130 000 electric vehicles were sold globally in 2012. Currently, that many are sold in a single week. Growth has been particularly strong in the last three years, despite the fact that the worldwide pandemic has shrunk the market for conventional vehicles and manufacturers have begun to grapple with supply chain constraints. The year 2020 did not see a significant increase in overall new automobile registrations. The global market for all sorts of automobiles was harmed by the COVID-19 epidemic and the ensuing economic collapse. In the midst of the epidemic, the picture for worldwide EV sales was extremely uncertain at the start of the year. However, as time passed, 2020 proved to be an unexpectedly good year, with worldwide EV sales increasing by 43% from 2019 and the global electric car industry market share reaching over 4%. 2021 followed, setting new records. Electric car sales more than quadrupled from 2021 to 6.75 million. In 2021, the number of EVs sold in a single week exceeded the number sold in the entire year of 2012. EVs are expected to play a key part in the lofty goal of zero-emission objectives set for 2050, and the industry is definitely preparing for it.

What Lies Ahead?

The rate of EV adoption is expected to pick up in the next few years, with China dominating the global EV industry, followed by Europe and the United States. With newer and more affordable EV models entering the markets, consumers have more options than never before. Regulatory pressures, incentives and shifts in consumer behaviors are also responsible for the move away from ICE vehicles.



China

In recent years, China's strong economic growth has enabled an increasing number of consumers to own their own vehicles in recent years. As a result, while there is more mobility and the world's largest car industry, there is also substantial urban pollution, excessive greenhouse gas emissions, and an increasing reliance on oil imports. This prompted the Chinese government to impose policies to encourage consumers to switch to EVs. From 2009 to 2020, they had included generous subsidies for EV purchases and had since reduced the rates as they had become too costly for the government. As a result, China's authorities decided to impose a requirement on automakers. Simply put, the mandate demands that a specific percentage of all vehicles sold each year by a manufacturer be battery-powered. To avoid financial penalties, manufacturers must earn a certain amount of points each year, which are granted for each EV manufactured based on a complex formula that considers range, energy efficiency, performance, and other factors. The standards get more stringent over time, with the objective of having EVs account for 40% of all automobile sales by 2030.

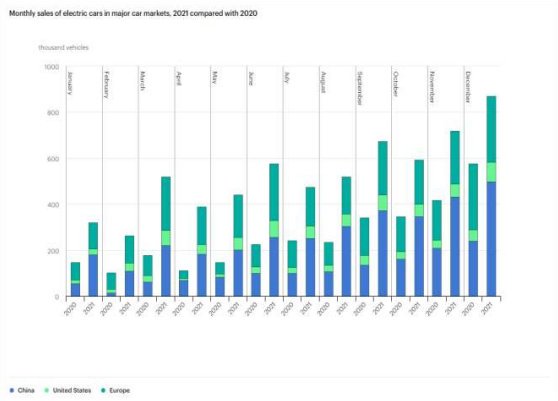
Europe

EV adoption in Europe has mostly been driven by consumer demand and government stimulus. The urge to lessen one's carbon footprint drives environmentally aware people to purchase EVs. Some are even ready to pay a premium for ICE alternatives that are zero- or low-emission. For example, "environment" is cited as the key motivation for purchasing by 29% of Norwegian EV consumers. Drivers of EVs have additional perks as well. Numerous governments and towns are attempting to increase EV sales. These advantages may include preferred parking permits in densely populated regions (for example, the City of Amsterdam) or the opportunity to drive in bus and taxi lanes and save significant time during peak hours (e.g., City of Oslo).

In general, EVs are much more costly than ICE vehicles without subsidies. However, in certain circumstances, due to government subsidies, EV cars are less expensive than their ICE equivalents. Consumers seeking to profit from these sorts of rules are driven to EVs because they provide a low-cost mobility alternative during Europe's recent time of high gasoline costs. In Norway, for example, EVs are more cost-effective than ICEs due to incentives such as exemption from purchase tax, VAT, toll road costs, registration tax, and yearly circulation tax. The EU plans to have 30 million electric cars by 2030.

United States

President Biden's auto vision and leadership have positioned the United States to lead the EV future to generate employment, produce more in America, combat climate change, and advance environmental justice. The President rallied automakers and autoworkers around the audacious goal of electrifying 50% of all vehicles sold in the United States by 2030. Since President Biden took office, aggressive policies have been implemented to advance the EV industry. In order to build a nationwide network of 500,000 EV chargers to make charging EVs predictable, reliable, and accessible the Bipartisan Infrastructure Act invested more than $7 billion; and over $7 billion to ensure domestic producers have the key minerals and other components needed to make batteries; and more than $10 billion for clean transit. The Inflation Reduction Act creates an incentive for consumers of EVs, credits to help producers retool existing facilities and create new production in the United States, and subsidies to deploy zero-emission heavy-duty vehicles. Lastly, the CHIPS and Science Act also makes crucial investments in increasing domestic capacity for semiconductors used in electric cars. All these policies have since tripled the number of electric vehicles sold in the United States since President Biden took office.



Cost of Ownership?

Electric and gas vehicles have always had a compromise. Fully electric cars are usually more expensive to purchase, but they are generally less expensive to own since they are less expensive to fuel and maintain. ICE cars are less expensive up front, but they cost more in the long term due to the high cost of gas. That dynamic is still commonly accepted, but compelling new evidence shows a disconnect between the metrics used to assess gasoline expenses and the realities that EV drivers confront on the road. So, are EVs truly less expensive to fuel than ICE vehicles?

There are various cost aspects to consider before buying an EV. As more countries strive for cleaner energy cars to combat climate change, several are giving incentives with the purchase of an EV, lowering the vehicle's overall cost. Some countries may even provide unique financing options or other extra incentives for electric and fuel-efficient automobiles, such as reduced interest rates and longer payback terms, making the monthly payments more affordable. Another area to consider is the upkeep of the vehicle. This mostly includes fueling and maintaining the vehicle. The cost of fueling an EV is not as straightforward as an ICE vehicle. Factors such as the cost of installing an EV charger in residential homes, electricity cost per kilowatt during peak and non-peak hours, using different levels of public charging services can influence the amount spent on fueling the EV. Vehicle maintenance cost is also a challenge to calculate. This is because EVs have fewer moving parts compared to ICE vehicles and do not require regular tune-ups or oil changes. They also have regenerative braking systems which can help the brakes last longer. However, despite having these benefits, one of the largest costs is the replacement of the battery. Unlike a gas vehicle, EVs do not have a fixed capacity in the fuel tank, the battery capacity of an EV slowly deteriorates over the course of its operating life. This will lead to the eventual replacement of the battery which could cost between US$5000 to US$15000 depending on the model.

Charging Infrastructure

In order to power an EV, it would need to be plugged into a charging station. Currently there are 4 levels of charging available for users. Each level allows for different charging speeds and higher level charging usually costs more.

Level 1

This is the slowest way to charge an EV. It uses a common 120-volt alternating current (AC) outlet which can be found on any regular wall outlet in a residential household. Level 1 chargers take around 40-50 hours to fully charge an EV from empty. These are good for charging plug-in hybrids (PHEV) due to them having smaller batteries but are too slow for EVs for most daily charging.

Level 2

These are more commonly used for daily EV charging. Level 2 chargers use 208V-240V with an AC outlet and are frequently found in workplaces, shopping malls and other public locations. Most EV owners will opt to install a level 2 charger in their residence as they can fully charge an empty EV in 4-10 hours and empty PHEV in 1-2 hours.

Level 3

Level 3 charging uses direct current(DC) instead of AC which provides a much higher voltage and fully charges an EV from empty in around 1 hour. As it requires a 400V-500V circuit, most residential locations will not be able to support them. In addition, they are expensive and cost tens of thousands of dollars to implement. Therefore, most level 3 chargers are only offered at charging networks installed by auto manufacturers as part of their charging services.

Level 4

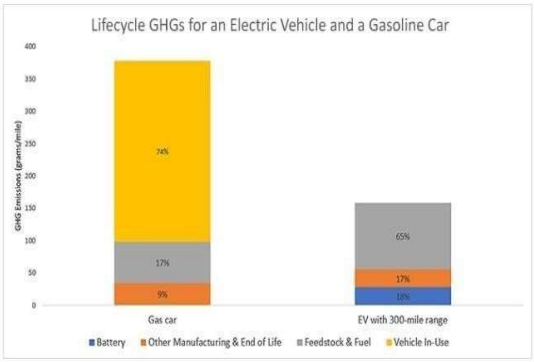
Level 4 chargers are relatively new and are the highest level of charging currently available on the market. They can fully charge an EV in 30 minutes producing up to 1000V. There are few level 4 chargers on the market as they have to be connected to a power grid in order to generate such a high voltage. Similar to a level 3 charger, they are usually too extensive to be installed for residential use and are most commonly found offered by auto manufacturers.

Pollution Concerns

Many people have expressed concern about the carbon footprint and greenhouse gas emissions associated with the production and use of electric vehicles. Even after accounting for the electricity used for charging, EVs have a lower carbon footprint than ICE vehicles. The electricity used to charge EVs may emit carbon emissions, but the amount varies depending on how the power is generated . For example using renewables like solar or wind, versus coal or natural gas which emits carbon pollutants. Research has also shown that EVs produce less greenhouse gasses compared to a new ICE vehicle.

What about the carbon pollution from manufacturing the batteries? While it is true that the process of constructing the batteries for EVs creates more pollution than making an ICE vehicle. The total greenhouse gas(GHG) produced over the lifetime of an EV is still much lower than that of a gasoline car. This is due to the fact that EVs produce close to zero GHG during operations. Another factor many fail to take into account is that EVs produce much less noise compared to ICE vehicles, this would lower noise pollution in densely polluted cities.

With that being said, lithium mining is the main contributor of pollution in the process of manufacturing EVs. Lithium extraction usually harms the soil and causes air pollution. On top of that, an estimated 2.2 million litres of water is required to produce 1 ton of lithium so even though there's no carbon pollution, environmental damage is still being done.



An Engineering Marvel

The heart of any EV. Much like the lithium-ion (Li-ion) battery in a mobile phone, many EVs nowadays use a battery pack consisting of thousands of Li-ion cells packed closely together. Compared to normal lead-acid or nickel-cadmium rechargeable batteries, they have a higher energy density. As a result, the size of the battery pack as a whole can be decreased by battery makers.

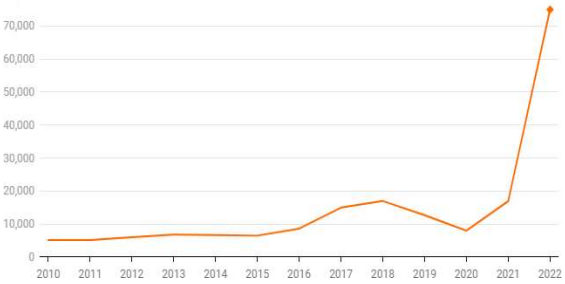
While driving, EV batteries go through cycles of "discharge," and they "charge," when the car is plugged in. The battery's ability to keep a charge is affected by how often you repeat this process. As a result, the length between charges and the time between trips are reduced. The majority of manufacturers provide a battery guarantee of five to eight years. A battery for an electric vehicle, however, is expected to last between 1-2 decades before needing to be replaced. Electric motors can also function as generators. When the throttle is released, the vehicle starts to slow down by converting its forward momentum back into electricity. This happens more powerfully if you apply the brakes. The braking will then recover energy that would have been lost and then store them in the battery thus improving the vehicle's range.

Bottleneck of Production

Battery metals, specifically lithium, is poised to be the bottleneck for the EV industry. Demand has far outpaced supply, this along with supply chain issues has caused the prices of lithium to skyrocket. Unfortunately, this is not due to the scarcity of the metal but rather the challenging process of refining lithium . While it's relatively easy to build a battery factory, the process of converting the raw materials into a finished product would take a much longer time. This process would involve heavy machinery that's difficult to scale and several rounds of vigorous testing to make sure the lithium is safe to be utilized in vehicles. Many Investors and producers have been reluctant to spend much on new refineries and mines to increase capacity for fear of a demand swamped that led to a years-long price drop until late 2020. According to Joe Lowry, an expert who's known as "Mr. Lithium" this issue will continue to persist throughout this decade.

Lithium prices have spiked sky-high

Price of battery-grade lithium carbonate per metric ton in U.S. dollars



Dead Batteries

As mentioned previously, the lifespan of a lithium battery is around 10-20 years so what happens at the end of the it's life? Instead of ending up in a landfill, they are first reused and repurposed then finally recycled. Once the battery performance decreases to 70% or less in the vehicle, it is given a 'second life'. They can be converted to stationary energy storages. For the average consumer, this can be done by using the battery to power a renewable energy source like solar panels. For commercial use, the individual batteries could be connected together to create a larger sized battery and used to power manufacturing plants and streets. In a virtuous energy cycle, the very same batteries that were produced by the factories could be used to power them.
The batteries will be recycled at the end of their life cycle in order to reduce environmental pollution.

There are two main methods used in the recycling process.

Pyrometallurgy: this technique exposes the metal components (cobalt, nickel, copper) by destroying the organic and plastic components using high heat . The metals will be separated through a chemical process.

Hydrometallurgy: this method uses leaching to form a solvent containing all the critical metals. The metals are then individually separated using solvent extraction, precipitation and purification with a material recovery rate of close to 100%.

After the recycling process, the materials can be used for other purposes including the manufacturing of new lithium-ion batteries.

Writer's Opinions

The path to decarbonization of the streets will likely accelerate very soon. With all the financial aid and government policies catering towards the EV industry, there is no denying that they are not only here to stay but also expected to progress much further in the coming years. While it may take a few decades before most vehicles on the roads become fully electric, I believe that this future is inevitable. Consumers looking to switch to an EV might also want to consider doing it earlier as these incentives and unique financing loans may get reduced or removed in the future as EV sales increase.

Even though EVs run on electricity, many fail to take into account how this electricity is created in the first place. It is true that they can be produced through more sustainable methods such as using renewables or nuclear energy but we still cannot completely avoid the use of fossil fuels. At the end of the day, fossil fuel is still indirectly required to power EVs. The process of manufacturing EVs is also not as green as many people think. There is huge environmental damage done in the process of extracting lithium to create batteries in the vehicles. In a nutshell, EVs may reduce the carbon pollution in the longer term, but in the shorter term they might possibly cause more harm to the environment. The dependency of fossil fuels might be reduced in the future as more EVs replace ICE vehicles, but I believe they will never truly be eliminated entirely.

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