SAE NITK

SOCIETY OF AUTOMOTIVE ENGINEERS

VOL 2.0 | JUNE 2021

TECHBUZZ

SAE-NITK ANNUAL MAGAZINE

ELECTRIC VEHICLES

#drivenbypassion

EXERGIC

Message from the editorial team

We at **SAE-NITK** are exultant and exuberant to publish the second issue of our annual magazine Techbuzz. As the saying goes: "The mind, like a parachute, works best when opened". This initiative sets the budding minds free, allowing them to roam free in the realm of imagination and make magic out of the term "**Electric Vehicles**".
The ambitious write-ups of our writers are indisputably ample to maintain the curiosity and admiration of the readers. We believe that our success depends upon our endowment to perceive, the capacity to discern and the power to traverse.

"Alone we can do so little; together we can do so much." – Helen Keller.

The above quote is the core of our magazine. Like a team, we all have contributed to developing the articles present within our latest attempt.
This strenuous task of editing the magazine would not have been possible without the sincere support of the Media Team members. They painstakingly edited all the articles given and presented them in the best way possible.

"Success consists of going from failure to failure without loss of enthusiasm." - Winston Churchill.

Not to forget, we are obliged to our Faculty Advisor, **Dr. Poornesh Kumar Koorata**, who helped steer our boat from the ocean of instability to the shores of steadfast progress. We are indebted to our Convenor of 2020-21, **Mr Rajat Shukla,** for guiding us throughout the making of the magazine and giving his solid support. We take this opportunity to thank our sponsor Exergic India for helping our club explore new fields and increase its reach.
Lastly, we wish all the readers prosperity and pray for their well-being in the era of Covid. We hope they are ever enthusiastic and always endeavour to learn and explore new things with aplomb.

Stay safe, and keep learning!
SAE-NITK Editorial Team
Mihir Mali
Ankit Gupta
K E S Srinivas

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TESLA FIRST EV : THE TESLA ROADSTER

Electric vehicles : From past to present

MANOJ GS
KUSHAL GOWDA

Electric vehicles have been described as a key technology in the mobility sector for reducing future pollution and energy consumption. The electric vehicle (EV) revolution is accelerating, but without the requisite infrastructure and technology, it can only go so far. Visions of a brighter, more optimistic future emerge as thought moves from fossil fuels to all-electric. The UK government's pledge to ban the selling of all new non-electric cars, including gasoline, diesel, and hybrid vehicles, beginning in 2035, demonstrates the country's commitment to reducing its carbon footprint by 2050.

The Birth of Electric Vehicles

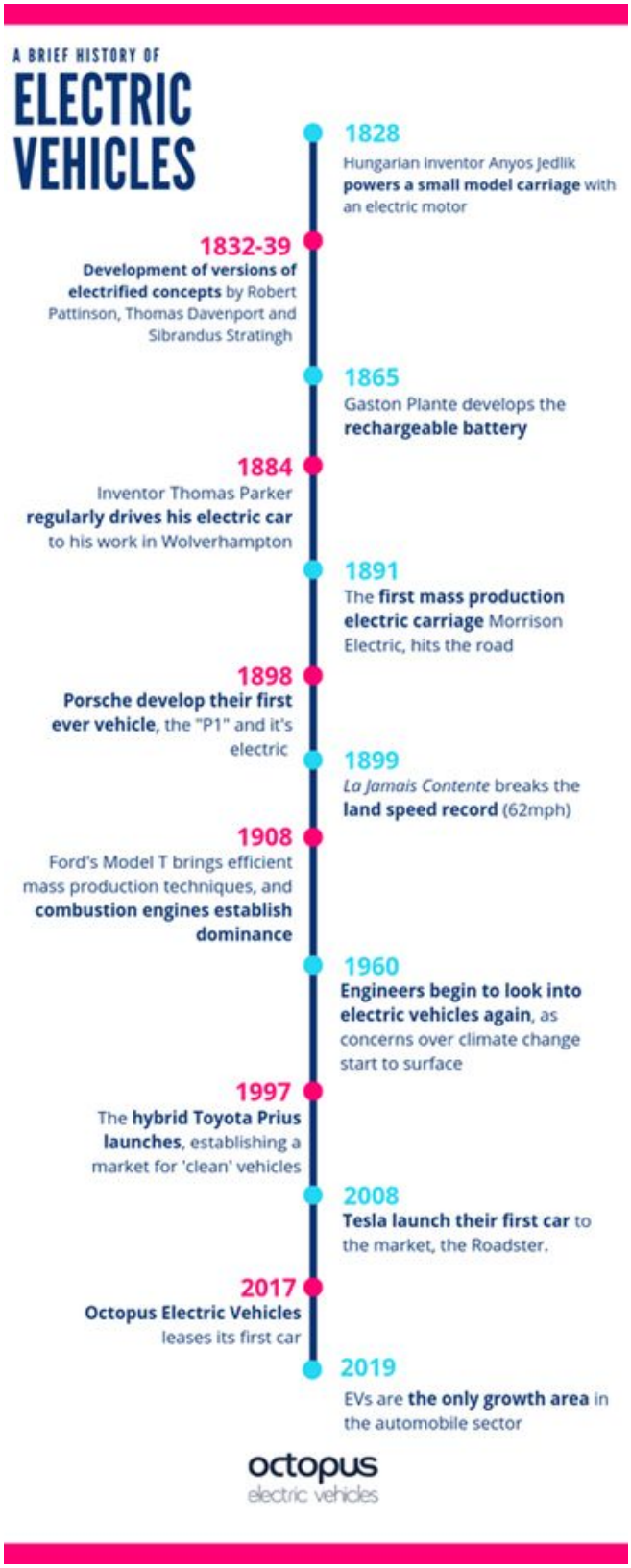
The First ever Electric Vehicle:Developed by:
Thomas Davenport

On a global scale, transportation consumes 26% of primary oil, and energy-related emissions account for 23% of greenhouse gas emissions. Today's propulsion technologies must be replaced by more effective and environmentally sustainable alternatives in order to fulfil potential mobility needs, minimise climate and health-related pollution, and phase out reliance on oil ('peak oil'). Globally, especially efficient mobility technologies are needed for the transition to a sustainable society. Such a technology has been identified as electric vehicles.People have dreamed of electric powered transportation since the invention of the first electric motor powerful enough to do work in 1834. Many people are unaware that electric vehicles, trains, and trolleys are older than they thought We will concentrate on the electric car on this list, but we will also mention trains and trolleys since their origins are intertwined

There were two major contrasting approaches to engine-driven automobiles at the start of the automobile's history: one with an internal combustion engine (ICE) and the other with an electric drivetrain. Thomas Davenport, an American inventor, designed the first electric car in 1834. Benz and Daimler in Germany produced the first ICEV in 1886.In 1904, Henry Ford introduced his line of low-cost, light-weight petrol-powered vehicles, which later included the Model T, and the Electric Vehicle Company went bankrupt within a few years. The mass-produced Model T by Henry Ford in the 1920s dealt a blow to the electric car. The Model T, which debuted in 1908, made gasoline-powered automobiles easily available and affordable.

Transition from Electric cars to hybrid electric cars

The hybrid concept made sense from the beginning of motor vehicles because it combined the low speed torque and easy control of electric traction motors with the lightweight energy storage of petroleum. A clutch and several different gear ratios made a gasoline engine workable in a lightweight automobile. Clutches on a heavy truck or locomotive are a concern because they must be wide and need a lot of pressure to avoid burning out. Early trucks and buses were frequently electric or series hybrid vehicles as a result of this. Since the engine is directly coupled to a dynamo, which is connected to one or more drive motors via a controller in a pure series hybrid, the engine will turn at the most efficient speed. As with most gasoline cars after 1912, a battery is used for starting and lighting, or a larger battery may store energy to make the most of a smaller engine by adding power where it is needed. The interest in electric cars is rekindled after the price of fuel reaches new highs in the 1970s. The US Department of Energy supports attempts to develop a low-cost electric vehicle.Cities in the early twentieth century were densely packed, clustered along trolley lines or within walking distance of work and downtown. For these short distances, the early electric cars worked well.Cities had exploded in size by the late twentieth century, with commutes of 30 miles or more becoming popular, especially in North America.



This energy-intensive lifestyle has made mass-market adoption of electric vehicles extremely difficult. The year 1982 was a watershed moment in the development of electric vehicles. GE Research Lab produces the world's first modern hybrid vehicle. It's computer-controlled, and it's the forerunner to today's commercial hybrid vehicles. The engine and power system were controlled by a computer in the 1982 car. The engine and power system of the 1982 vehicle were regulated by a computer, which resulted in significant cost savings. The breaking device also assisted in the recharging of the batteries. All of this was made possible by the machine eventually being small and strong enough to operate in a car.

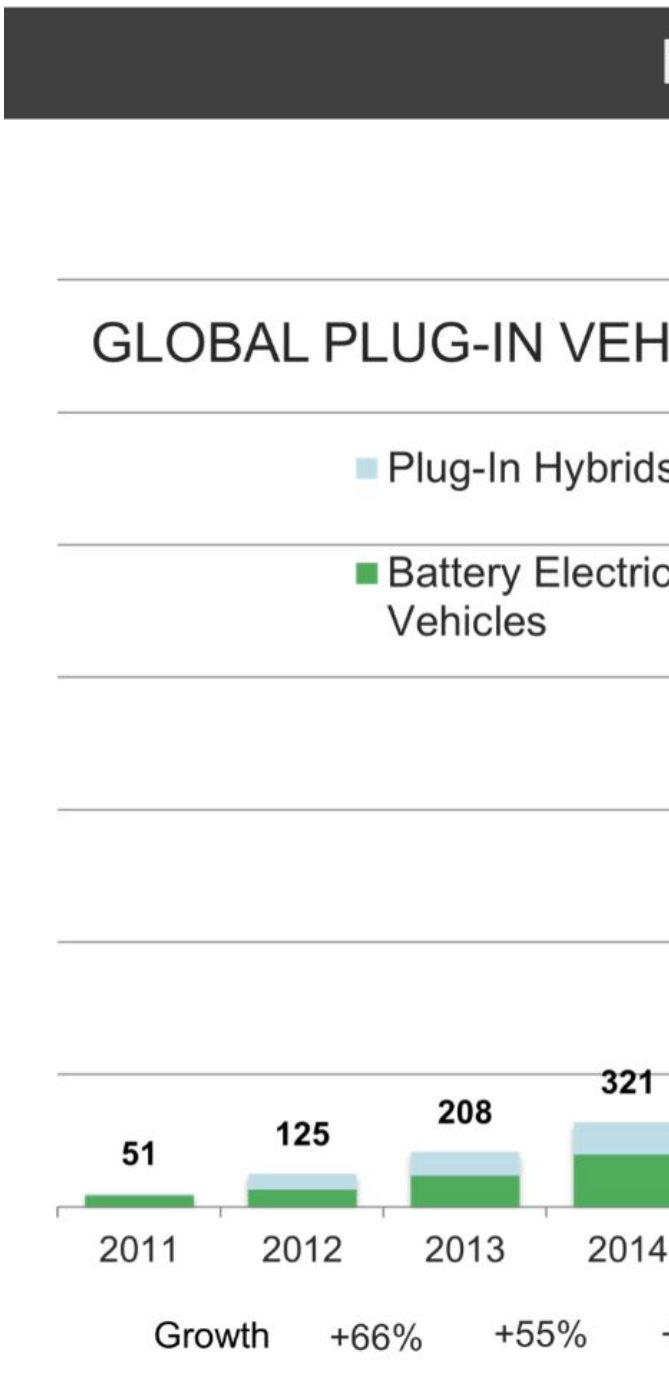
The emergence of Toyota and Tesla

The emergence of Toyota and Tesla

Toyota Prius:

After General Electric struggled to find enough traction in the American car market in the 1980s, Toyota secured patents for the new hybrid electric car.

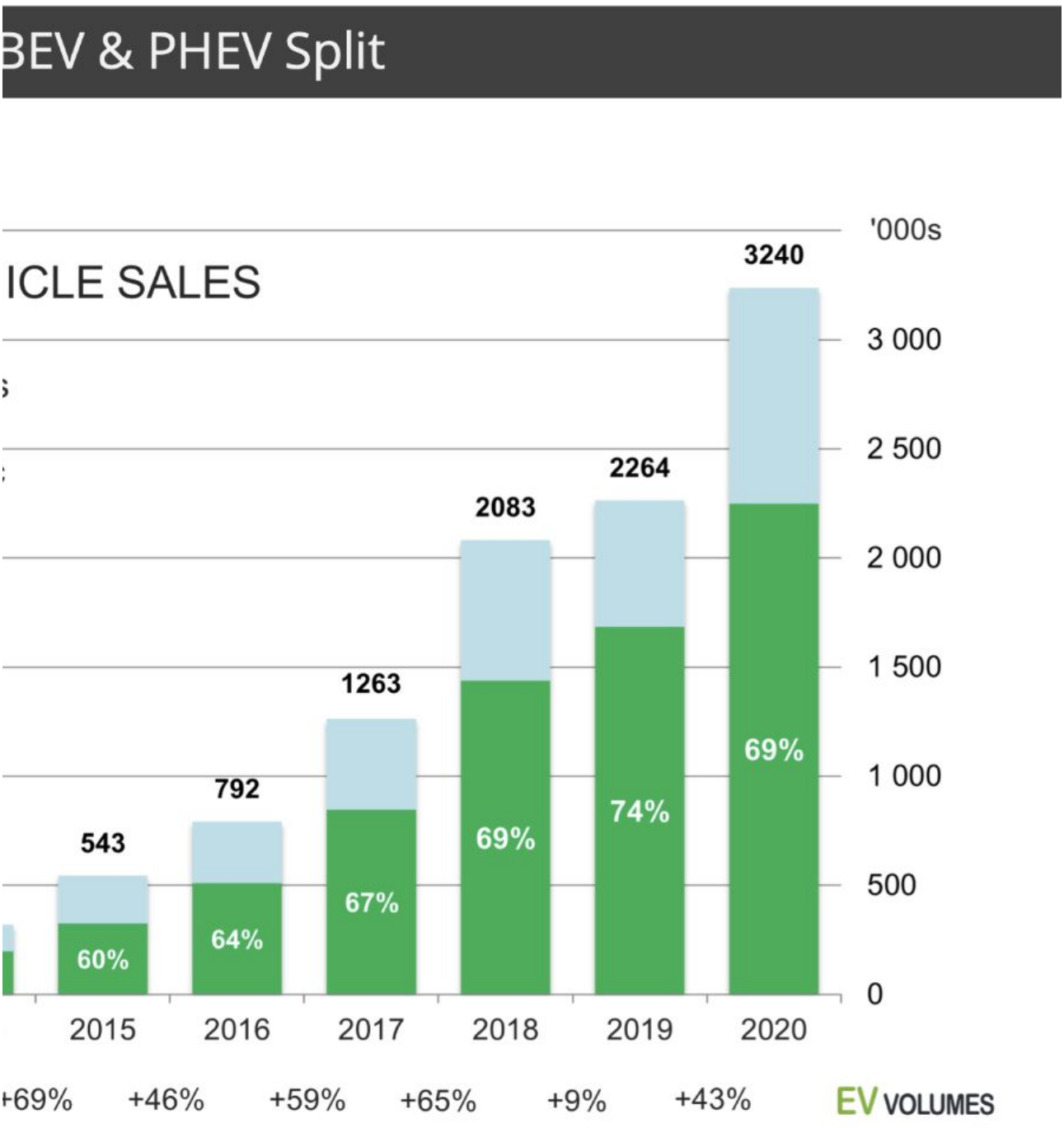
Toyota improved on the design and development of the Toyota Prius, which went on to become the world's first successful electric vehicle. The car allowed modern users to travel long distances on gasoline while commuting in town on electricity. This was important because urban design has changed dramatically since the turn of the century.



Tesla Motor Company: Tesla Roadster and Model S:

Tesla Motors was founded in the late 2000s and produces high-performance, high-cost electric vehicles. The Roadster was based on the Lotus and had a sporty appearance. Despite the fact that it was not cost efficient, Tesla Motors' Model S was a success. With its basic four-door sedan configuration and ease of use, the Model S appealed to the masses. The Model S is currently the best-performing electric vehicle ever, outperforming internal combustion engines in its class. In terms of acceleration and stability, the single-gear, high-torque Tesla outperformed powerful Mercedes and BMWs. In 2008, Tesla Motors released the Roadster, the company's first electric vehicle. This car, which featured cutting-edge battery technology and an electric powertrain, was a breakthrough in the new era of the electric vehicle.

Google's self-driving car projects could aid the production of grid-powered personal vehicles. Allowing cars to be managed and spaced equally on a road would allow for highways that function as rail lines between cities. Cars could connect to a "third rail" and travel the majority of the distance without recharging their batteries or using any fuel. As batteries become smaller, super/ultracapacitors can become a viable alternative to batteries altogether.History repeats itself, and hybrid cars are making a comeback in the mass market. The Nissan Leaf, Honda Insight, and Chevrolet Volt are all middle-market vehicles that have proven to be popular. With - fuel rates, many consumers are seeing significant cost savings. The high cost of replacement batteries and the disposal of highly radioactive waste are two disadvantages of electric vehicles. The long-term solution is to supply electricity to the EV through the grid. The most energy efficient solution will be to provide grid power to vehicles. Current overhead tram/bus lines in Europe have shown that the cost of operation and energy usage are worth it.



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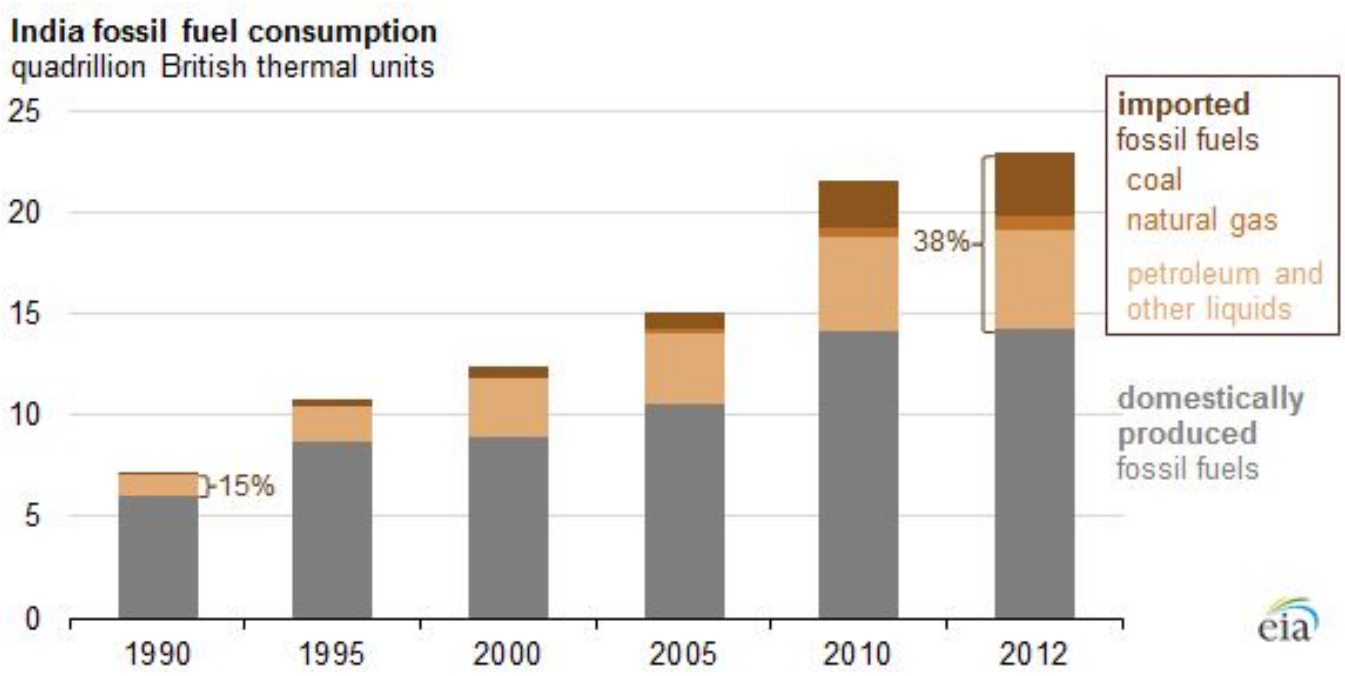
The Future of Transportation

VEDIKA PATRIKE
PRADEEP SINGH SOLANKI

Future is a word that always comes with anxiety, prediction,and innovation. This article is our attempt to take you a bit closer to an electric autonomous future where travel will no more be limited, but there will be many hurdles to this future that need to be tackle. Along the way hyperloop, airbus, autonomous ship, electric battery car are waiting for you. India's over-dependence on petrol and diesel with importing its 82% need from outside has raised the potential for clean and sustainable sources of energy. Let see how Indian transport will be transforming in the future, what are its major hurdle and how India should plan to reach there.



Graph depicting percentage dependency on petrol

Major Factors leading to change

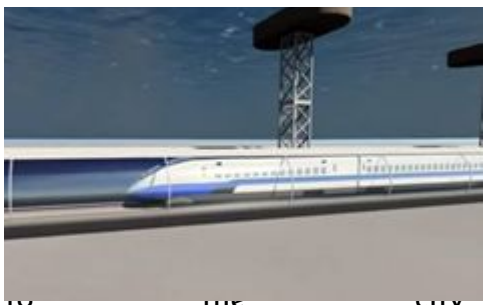
Changes come out of necessity and Technologies are advanced for the safer, fast, and comfort of humans. Transforming and adopting electrified, autonomous vehicle is an alternative to our dependency on petrol and diesel as India's 82% of its oil is imported from different parts of the world, secondly, pollution from cars and automotive vehicles has been increasing day by day. Thirdly we can't stick to petrol, diesel as they are limited and they can get extinct. finally, the population is demanding more spaces and for that Transportation is switching to air, underground, and undersea with projects like Kolkata underwater metro project on Hubli river and Mumbai to Fujairah (UAE) undersea bullet train is cutting travel time to only 2 hours are few examples.

Future Vehicles in India

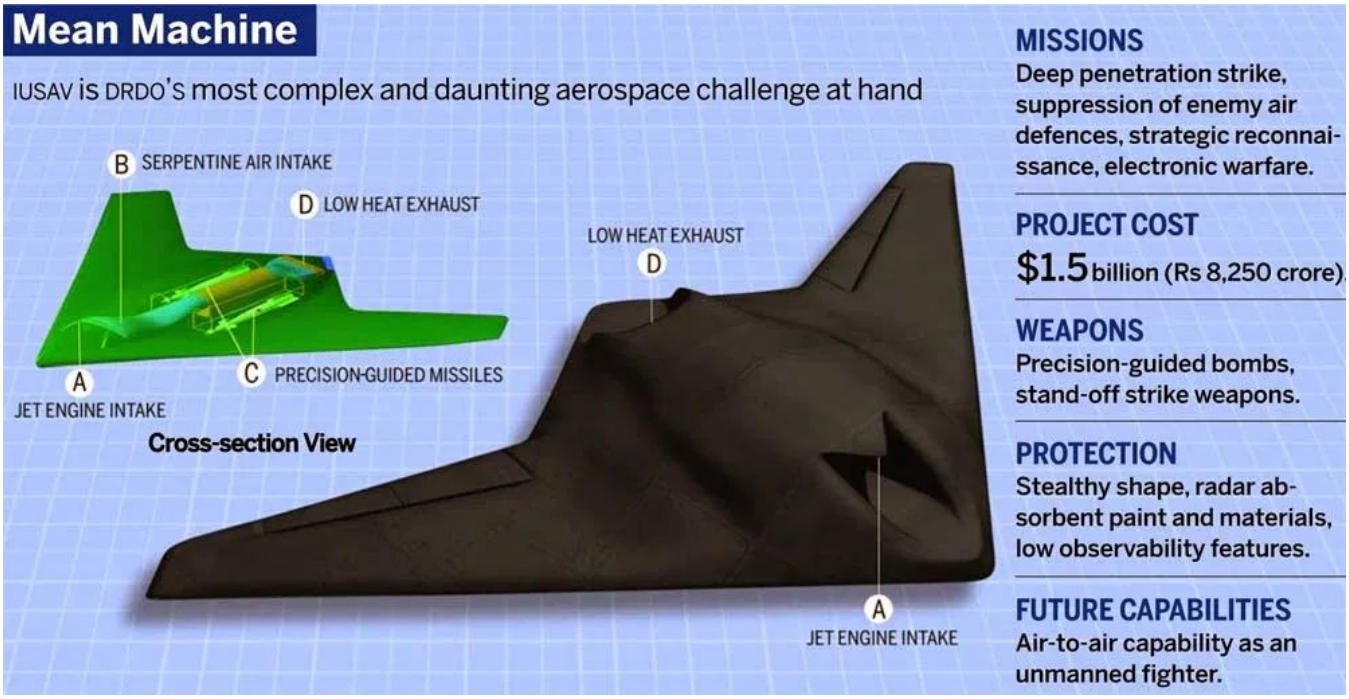
Since the time SpaceX CEO Elon Musk proposed the possibility of hyperloop design, the Maharashtra government has declared designs to make the first hyperloop transportation framework on the planet, this framework could connect central Pune with Mumbai in under 35 minutes. At present, voyaging this distance dominates 3.5 hours by the street.

Nonetheless, researchers and specialists from the Indian Institute of Science (IISc) and IT major Wipro Ltd have held hands to make a driverless vehicle for Indian conditions with a focus on the rollout date of March 2020.

In method transport, department taking a the interfacing Mumbai of Fujairah in the UAE through a submerged rail organization.



Bullet Train Undersea



DRDO Autonomous Drone

In transportation in air mode, Ghatak is an independent secretive automated battle air vehicle (UCAV), being created by the Defense Research and Development Organization for the Indian Air Force. The planned work on the UCAV is to be completed by the Aeronautical Development Agency (ADA). Self-ruling Unmanned Research Aircraft (AURA) was a provisional name for the UCAV.

Form of energy in future vehicle

While seeing the need for developing a new form of energy it is stand out chances for research in renewable sectors of energy like wind, solar, electric, magnetic, and a combination of two or more. India has been blessed with solar energy and we have also seen the effect from the government in exploiting solar energy with having 3 out of the top five world's largest solar farm like Kurnool Ultra Mega Solar Park, India Shakti Sthala, Pavagada, Karnataka, India, and Kamuthi, Tamil Nadu. Mounting solar panels on bodies of vehicles to store energy with the electrified systems on the concept of batteries has gained attention with the Indian automotive sector like Mahindra eKUV 100, Nissan Leaf, Porsche Taycan, and Tesla Model 3 establishing their feet in the Indian market. New and innovative use of magnets and vacuum to compensate for air and friction resistance is used in the hyperloop technology.

A model of interior of autonomous car

"If we are to better the future, we must disturb the present"

Problems with the Solution

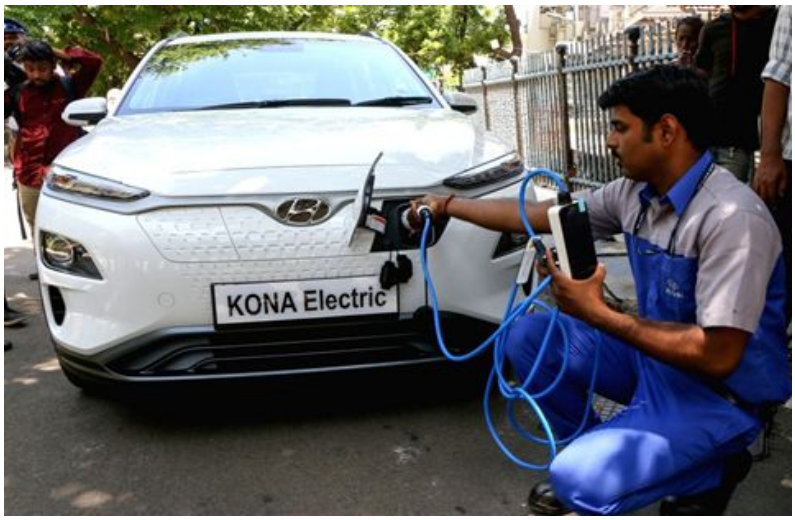
The government's active participation and smart move are key to a better future and getting in touch with the latest technology. Giving sufficient opportunity to start-up to grow and work on the latest tech, whereas developing an Entrepreneurial environment for school and colleges student to come up with a solution to deep-rooted problems. India must focus on infrastructure and customization of tax to keep the cost of production low in-country, training labor to a good level to provide companies with skilled workers to work on their firm. The government of India has shown an active part with the Skill India initiative and KABIL.

KABIL is a joint venture of National Aluminium Company Limited, Hindustan Copper Limited and Mineral Exploration Company limited for mineral security of India. Their only goal is ensuring supplies of mineral-like cobalt and lithium which are important for battery companies. They will do by exploring resources in India and establishing a deal with countries having resources in abounded.

The most compelling motivation for electric vehicles not being famous in India is the manner in which India creates its power. The majority of the world is playing electric vehicles to control contamination however the vast majority of electric force in India is created utilizing coal and other petroleum products.

The fundamental explanation behind electric vehicles not being mainstream is the accessibility of less expensive other options. For example, take the instance of e-bicycles, Electrotherm India Limited which creates the famous yo-bicycles had revealed incomes of 200 million in July-Sept in 2011 and detailed a 54% expansion in deals.

One of the principal explanations for purchasers not going for an electric vehicle is the high possession cost. For purchasers of EVs, the all-out expense of possession (TCO), which incorporates the expense for securing, running, and support is the main factor deciding the practicality of the vehicle, as per a white paper on electric versatility delivered by a procedure expert firm Kearney.



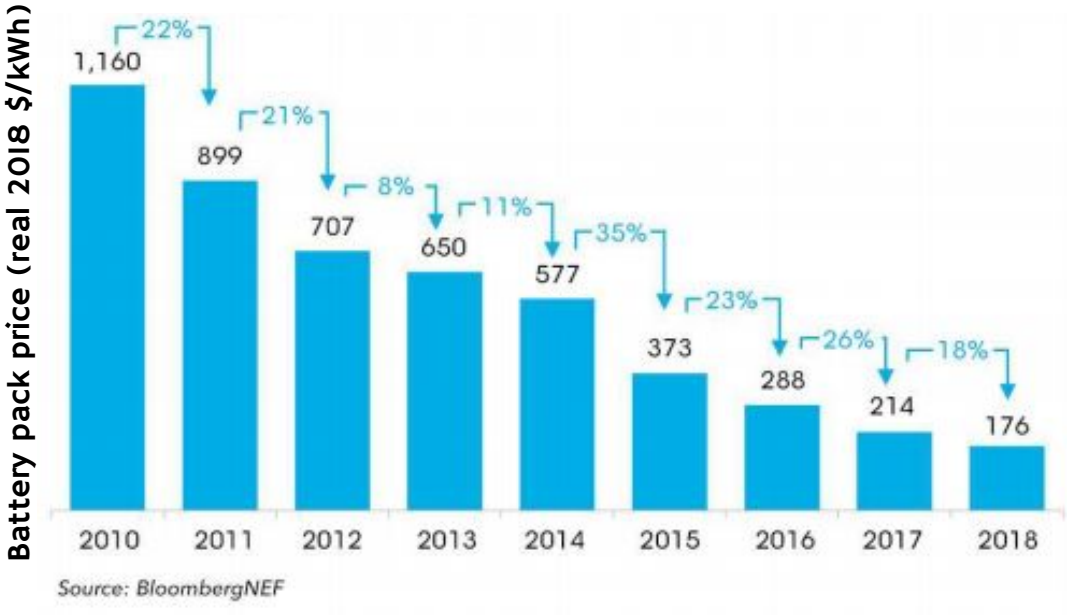
A worker demonstrates the usage of electrical vehicle (EV) charging cable at the flagging off ceremony of the Hyundai Motor India Ltd's electric sports utility vehicle (SUV) KONA Electric at the Tamil Nadu secretariat, in Chennai.

IS INDIA READY FOR EV's?

Electric vehicles are one of the fastest-growing technologies in today's world and have various desirable features as compared to gasoline vehicles such as compact size, lesser noise, better fuel efficiency, etc., It is a very surprising fact that despite the successful employment of electric locomotives by the Indian Railways, the electric vehicles industry is yet to stamp its authority in the Indian market. There are a lot of technological, business, and government policy aspects to consider to understand whether India is ready for EVs. There exists a bright ray of hope that EVs would successfully be integrated into the Indian market and change the fortunes of this wonderful nation.

SHRIVATSA HEGDE
GUHAN SIDHARTH

Lithium-ion battery price survey results: volume-weighted average



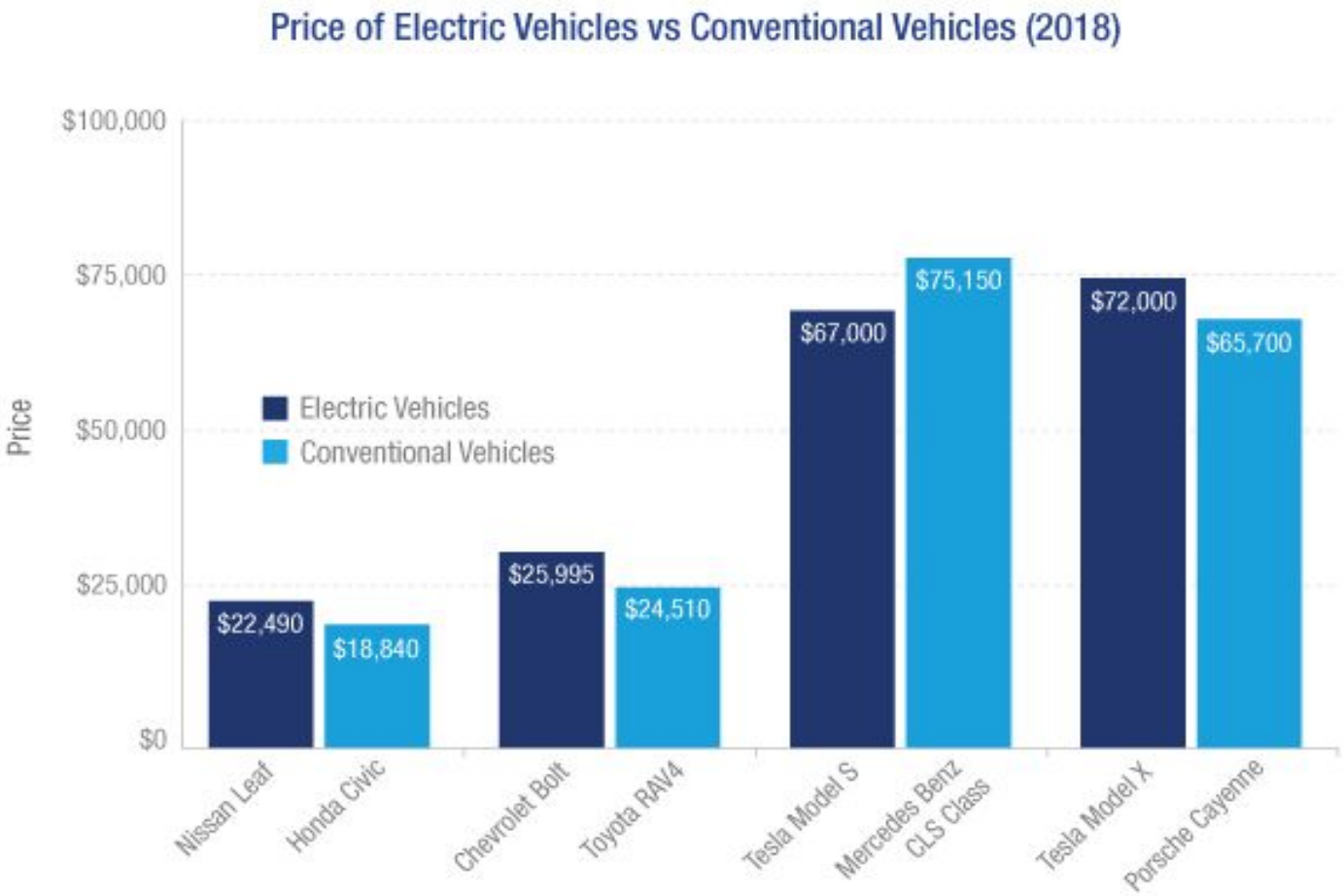
Pollution, noise, etc., are among many other problems associated with the transportation sector in India. This pollution in turn creates a lot of health hazards to the public. India has signed the Paris Agreement and is proactively working towards achieving the climate change goals. The reduction of emissions from vehicles is key to achieving these goals. One of the solutions available is "Switching to EVs". But before we switch to EVs it is important to ask "Is India ready for EVs?". There are a lot of factors to consider.

Though the total cost of ownership of EVs is lesser than that of fossil fuel vehicles, the cost of purchase of the former is greater than that of the latter. The cost of EVs is high mainly due to the cost of Li-ion batteries, which are imported and cost about $275/kWh in India. This combined with the GST of 28% and the lack of lithium in India, further increase the cost of batteries. Most EVs in India provide a range of 110 km and cost between Rs 6-8 lakhs which does not give a cost advantage compared to higher range cars in the same price range.

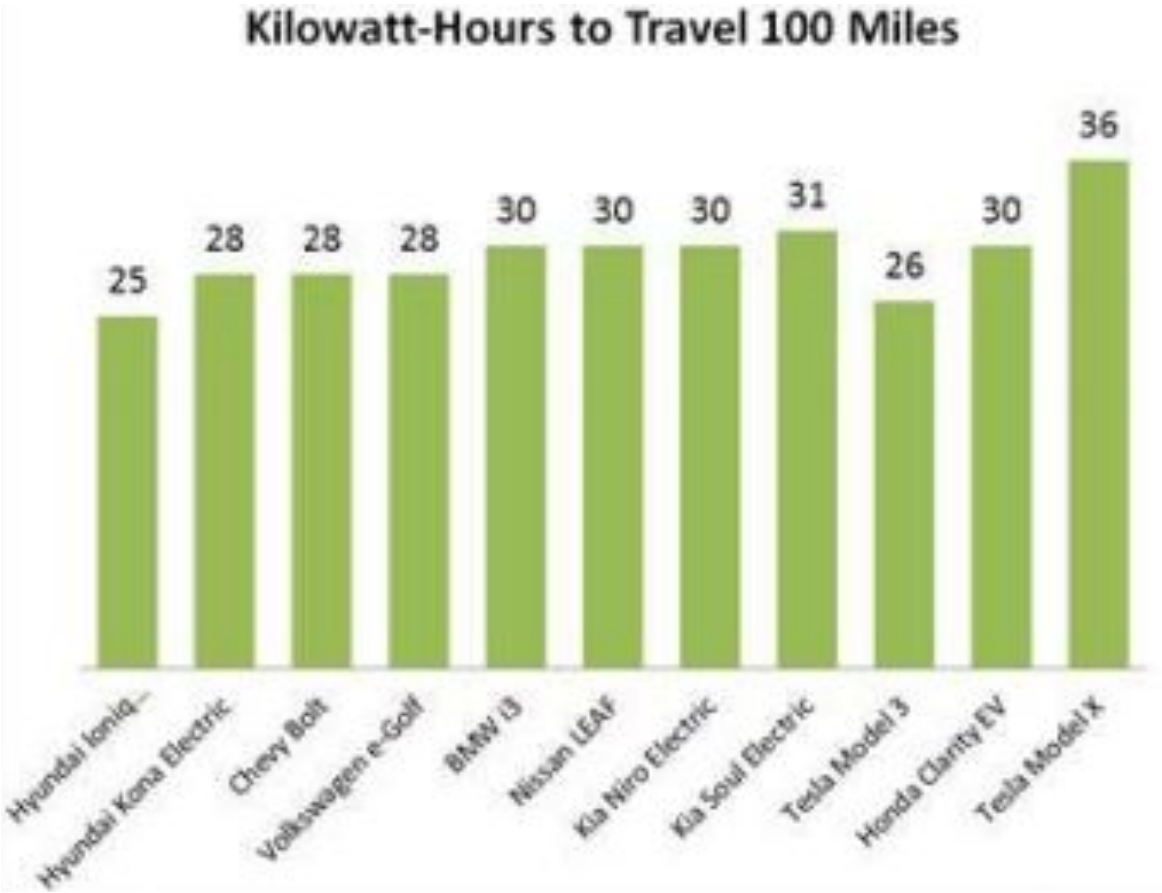
The government has been actively taking measures to introduce electric mobility in India. The govt. aims to make India a hub of EV manufacturing as suggested by the Manufacturing Policy of the National Electric Mobility Mission Plan 2020, and expects the contribution of EV manufacturing to reach 25% of the GDP by 2022. The government offers subsidies worth $1.4 billion for purchasing EVs and has hiked import tariffs to encourage the manufacturing of EVs in India. Various state governments have started adopting electric buses for public transportation. However, there are many more factors to be considered.

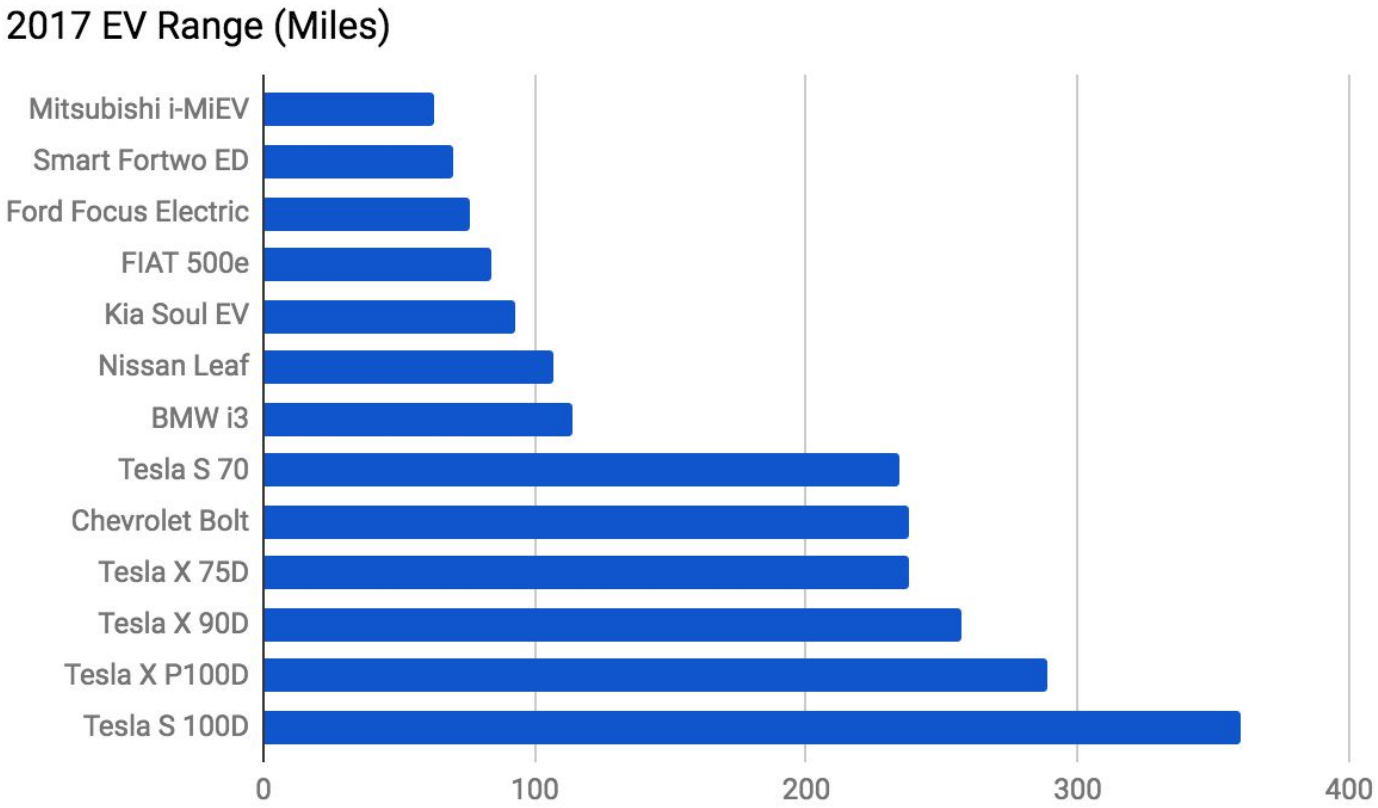
As the EV industry expands the government needs to ensure that there is no large-scale loss of jobs in the automobile sector and the fossil fuel industry. As the cost of purchase of EVs decreases, there would be an increase in demand which helps in creating more job opportunities in the EV industry.

Electric Vehicle Sales in India		
Segment	FY2019	FY2018
e-2-wheelers	126,000	54,800
e-3-wheelers	630,000	NA
e-4-wheelers	3,600	1,200
Total	759,600	56,000



One of the major challenges is to establish the necessary charging infrastructure. Large-scale charging infrastructure needs to be developed at different places within the cities, at highways, and in fastest-growing houses. The government plans to install at least one charging station in a grid of 3 km x 3 km in cities and one station every 25 km on highways. A large amount of electricity needs to be generated to meet the electricity requirements of the EVs.





Last but not least it is important to integrate the private sector companies into the EV industry and suitable policy measures are required for the same. Prominent manufacturers such as Maruti Suzuki India, Hero Electric Vehicles, Mahindra, and Mahindra are already registered EV manufacturers in India. Latest collaborations such as Suzuki and Toyota, are planning to launch EVs in India.

It is also important to consider the public response towards EVs.

- Indians are not inclined towards EVs due to their slow pickup, slow speed, short-range, and non-availability of charging centers.
- As per the data of the Society of Manufacturers of Electric Vehicles, only 22,000 units of EVs were sold in India by March 2016, of which 2,000
- were four-wheelers. At the same time, sales of electric cars grew at a rate of 94% from 2011 to 2015.
- Just after nine months of the launch of Ola's ambitious EV project in Nagpur, it faced a major roadblock with Ola drivers wanting to return their electric cars and switch back to petrol or diesel variants due to high operating expenses and long wait times at charging stations.
- Despite incentives as high as INR 140000 on some cars under the Faster Adoption and Manufacturing of Hybrid and Electric Vehicles scheme, there has been a lukewarm response.
- Sales of EVs contributed to only a fraction of the 3 million passenger vehicles sold in India in 2016.

Though the market in India has given a tepid response to EVs there exists an immense opportunity for the growth of EVs. Hence it is conclusive that though India is still not ready for a complete transition into electric mobility, it is the right time to take small but significant steps into a cleaner and greener future with a special focus on developing the necessary charging infrastructure. The government is set to play the most significant role in this historic transition.

Formula E : A new beginning

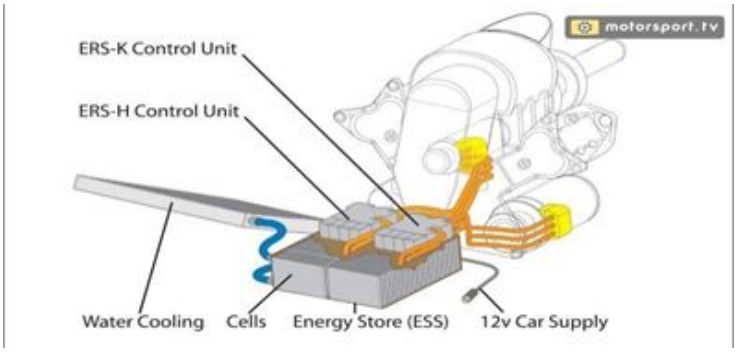
KAUSTUBH S
MANOHAR I

At a time when the automotive sector is moving from IC engine cars to Electric Vehicle, Motorsport follows the trend with the highly competitive and exciting FIA Formula E World Championship. Formula E is the new FIA competition which reinvents motorsport by combining the thrill and technology of Formula 1 with new exciting twists like fan-boosting and attack mode.

Formula E is an auto racing championship using completely electric single-seater cars. It started in 2014 in Beijing. Formula E stands for the FIA Formula E Championship. In 2014 it started its first season with single-seater cars for all 10 teams – it is designed and build by Spark Racing Technology with much top expertise from McLaren, Williams, Dallara, Renault, and Michelin. From the second season, it started allowing manufacturers and teams to participate. From then it started developing many new technologies in electric cars like new powertrain solutions, battery development, incorporating the e-motor, inverter, and transmission.

The Spark-Renault SRT_01E - the first car to be homologated by the FIA - has been built by French company Spark Racing Technology with some leading companies involved in it.

. Italian firm Dallara, who have been in motorsport for more than 40 years, have constructed the monocoque chassis, made entirely from aluminum and carbon fibre, the chassis is made to be super lightweight and incredibly strong and fully complying with the latest FIA crash tests - the same used to regulate Formula OneMcLaren Electronics Systems developed the electric powertrain and electronics, the company is the world leader in high-performance technology for motorsport, and the batteries developed by the world-famous Williams F1 team



The championships technical partner Renault, will oversee all the systems integration, as they are a leader of electric vehicles and also an expert in motorsports with their Renault Sport Technologies and Renault Sport F1 programs. Tires used in this series are 18" treaded tires which were designed for Formula E will be supplied by Official Tyre Partner Michelin, these tires are capable of providing the optimum performance in both dry and wet conditions. Formula E continuously develops its Design, Technology, Dimensions, Power, and Performance. We will see here, what optimized condition should be needed for this car while racing. For every season it is developing.

Design :

Aerodynamics optimized to facilitate overtaking, to tackle the city centered streets, high ride height sensitivity and wide range of suspension set ups are possible

Technology :

Using the latest technologies, pushing the boundaries for the future A compromise between performance and cost-effectiveness is done wherever possible. Extensive use of composite materials but the usage of the most expensive carbon fibers is limited

Power :

The maximum power is 200kw, which is equivalent to 270bhp. In race mode, which is the power-saving mode, power is restricted to 150kw, equivalent to 202.5bhp and FanBoost which can only be used during the race temporarily increases max power from 150 kw to 180kw. (Increase of 30kw / 40.5bhp)

Maximum power will be available during practice and qualifying sessions. During the championship races, a power saving mode will apply with the FanBoost system which allows maximum power for a short duration of five seconds per car.

Power Unit :

The power unit is a MGU by McLaren. Maximum of two MGU's are allowed. MGU can be only linked to the rear axle. The use of traction control is forbidden. It results in an acceleration from 0 - 100 km/h in less than 3 seconds and a top speed of 225 km/h

Traction Battery :

The traction battery is a Rechargeable Energy Storage System also called RESS which supplies electric energy to the Power Circuit and hence to the traction motor. Any such onboard battery which has been electrically connected to the Power Circuit is considered to be an integral part of the car's traction battery

A Rechargeable Energy Storage System (RESS) is a system which is designed to propel the vehicle via the electric motor. To comply they must be:

- FIA Standard

- The maximum weight of the Battery Cells and Capacitor of the rechargeable energy storage system should not be greater than 200 kgs

- All Battery Cells must be certified by the UN Transportation Standards which is a minimum requirement

Chassis :

Chassis / Survival cell are made of Carbon/aluminum honeycomb structure made by Dallara. Front and rear wing are Carbon structures and Aero styling is done by Dallara. Bodywork is Carbon - Kevlar honeycomb structures made by Dallara

Brakes and Gearbox :

Hewland paddle-shift five-speed sequential gearbox are used with fixed gear ratios to reduce costs. Brakes are standard two separate Hydraulic systems, operated by the same pedal. Brake material is a free choice and for the calipers, the section of each caliper piston should be circular

The body of the calipers must be made from aluminum alloy

Wheels and Tyres :

Tires are bespoke 18" treaded Michelin tires for use on both wet and dry conditions/surfaces
O.Z. Racing Magnesium rims. Max width front - 260mm / rear 305mm. Max Diameter - front 650mm / rear 690mm

Suspension and Steering system:

The Suspension system consists of double steel wishbones, pushrod operated, twin dampers and torsion bars suspension at the front and spring suspension at the rear It consists of an adjustable ride height, camber, and toe.
Two way at the front and four-way at the rear, adjustable Koni dampers

The steering system has to be a non assisted rack and pinion system with power assistance being allowed. The steering wheel has a dashboard, marshaling display, clutch paddles, and gear change

Safety :

FIA safety standards including front, side, rear, and steering column impact tests, Front and rear roll hoop, monocoque push tests and impact structures, Anti-intrusion survival cell protection panels, Wheel retainer safety cables and Extinguisher system (electronically operated)

HYDROGEN-TRAIN

The future of the railway sector

Hydrogen trains or hydrails are expected to be the rail sector's backbone in the emerging hydrogen economy. They have zero carbon footprint, self-sustainability, zero emissions and perfect passenger comfort theoretically. This dream has come true in European countries such as Germany, Scotland Etc. In this article we analyze how hydrail technology works and the risks associated with it.

GAUTHAMKRISHNA S
VISHLAVATH TARUN

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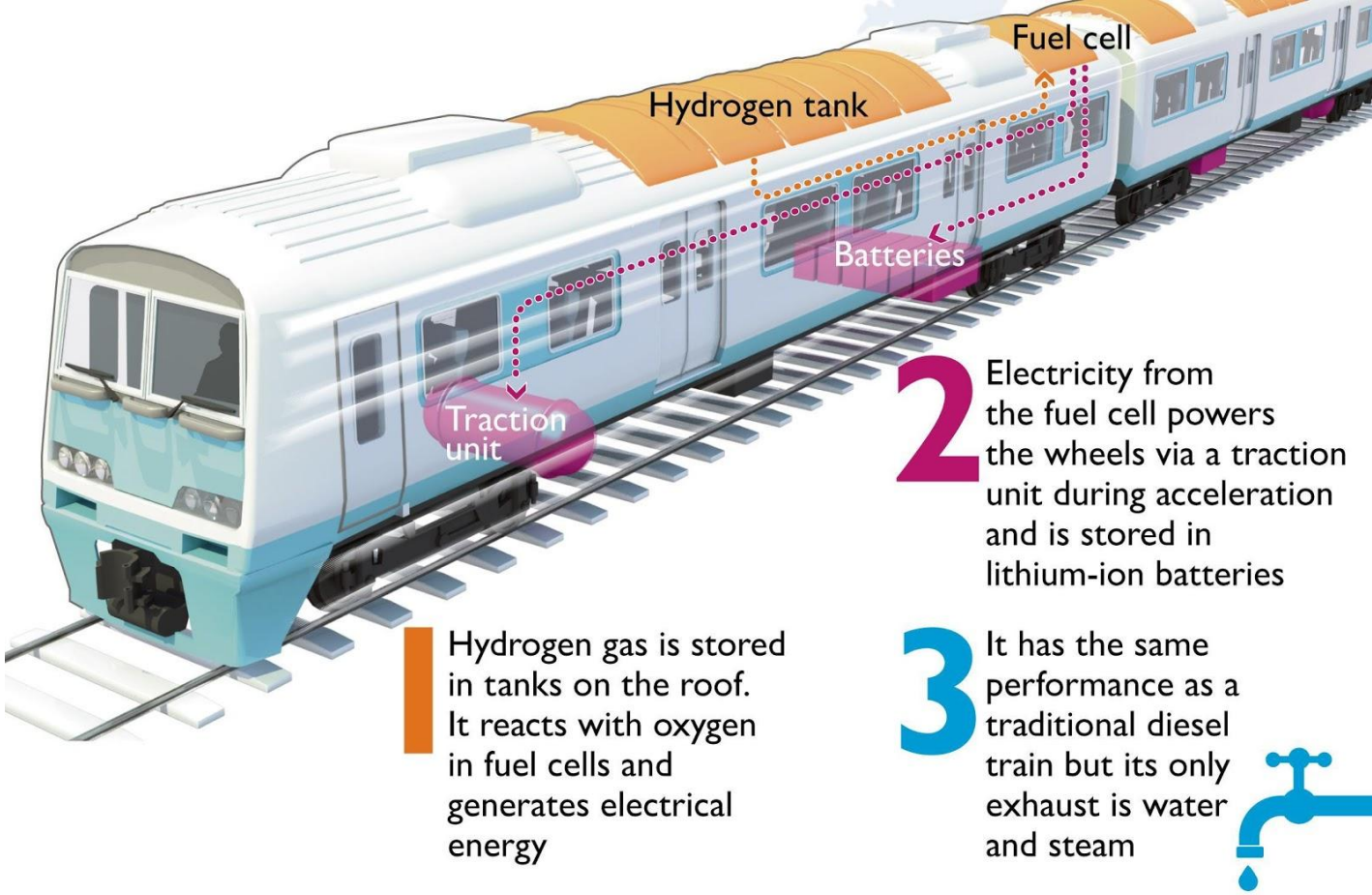
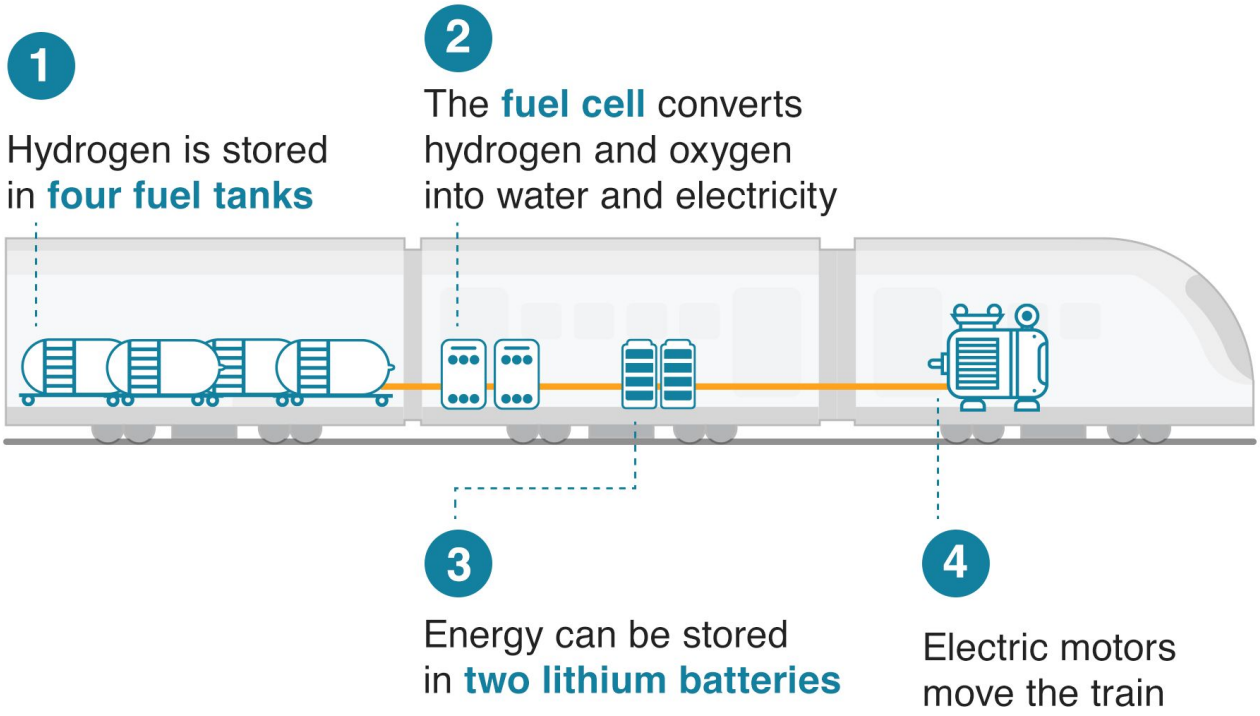


How zero emission trains work

Hydrogen trains, more popularly known as hydrails is the mode of railway transportation. The hydrogen fuel energy is used to power traction motors or the auxiliaries of the locomotive system. First practically accomplished in the United Kingdom by Alestorm in 2016, the technology is supposed to play a significant role in Hydrogen economy's actualization. The proposed economic system uses Hydrogen as the fuel component for al land every need to reduce carbon footprints and global warming. The hydrogen-trail base as all other hydrogen-fuelled systems produces Hydrogen from water using electricity and a fuel cell to generate power from it with water as the byproduct. Some of the existing hydraulic systems can reach up to 50-75 miles per hour and continuously run for 3/4 hours.

Hydrogen when reacts with oxygen creates energy; this is the principle used for running hydrogen train. Hydrogen train works with the help of a fuel cell. It contains Hydrogen at the anode and oxygen at the cathode, and the fuel cell also has a catalyst and electrolyte separating cathode and anode. The catalyst removes an electron from hydrogen molecule making it, hydrogen ion(H+). However, the electrons must be transported to the cathode to react with oxygen to form water. This transportation can be done with the help of a wire. Moreover, transportation of electrons means electricity this can be used for charging batteries. These batteries supply energy to electric motors which run the train.



The significant advantage of the hydrogen train is the zero-emission feature. Hydrogen as a fuel does not create any harmful emissions, and as water is the only byproduct, it is 100%self sufficient and has no carbon footprint. Compared to the existing alternative of eclectic trains, they are economically more suitable as it does not need extensive reconstructions of track systems. Compared to conventional rail systems they are much more silent and passenger-friendly. They are more energy-efficient than the IC engine due to the fuel cell technology used with efficiency reaching up to 80% with the counterpart of the IC engine only reaching up to 60% maximum. Another aspect is the abundance of the fuel, as the world's fossil resources are dwindling each day hydrogen is an easy alternative as it can be easily synthesized. The water needed for it could be partially recovered too.The main concern with hydrogen trains is regarding the storage and safety of the fuels. In the existing systems, an additional chamber is used for storing Hydrogen adjacent to passenger carts. Hydrogen needs to be stored in high-pressure systems due to the explosive nature of Hydrogen for safety concerns. The problem occurs in its capacity too. It is not practical to store Hydrogen more than that requires 4-5 hours of the journey, making it inconvenient for longer journeys.Another problem is the real environmental effects it has. The electricity used for hydrolysis is mostly produced and stored in conservative ways. For example, the lithium batteries used for this purpose causes severe after effects and environmental impact.

The first hydrail locomotive was developed and designed in the US in 2002. It was a Non-hybrid mining locomotive using PEM fuel cell and metal-hydride storage. Later it was replaced by a battery-powered version due to performance (higher power, more extended range, faster refueling). The International hydrail conference series started in 2005 where they created the term 'hydrail' to encourage hydrogen fuel technology development. Some of the current developments are Alstom Coradia iLINT (France/Germany), TIG/m streetcars (USA), CRRE streetcars/trams (China). Even manufacturers like Siemens, Stadler, JR East / Toyota are offering developments. Some railroads have to pay charges in Canada due to higher emissions than allowable to achieve air quality standards in urban areas.

Today pollution is a big problem we are facing in the present world. Hydrogen power is a clean source of power, without emitting any harmful gases(only emits water vapour). Electric powered and hydrogen-powered trains are one of the alternatives for diesel trains running at present. However, the electric train needs new infrastructure, and it is too expensive. Hydrogen trains are also expensive, but they can run on the same track as a diesel train. It is more appreciated where the population is more, as it benefits economic returns.

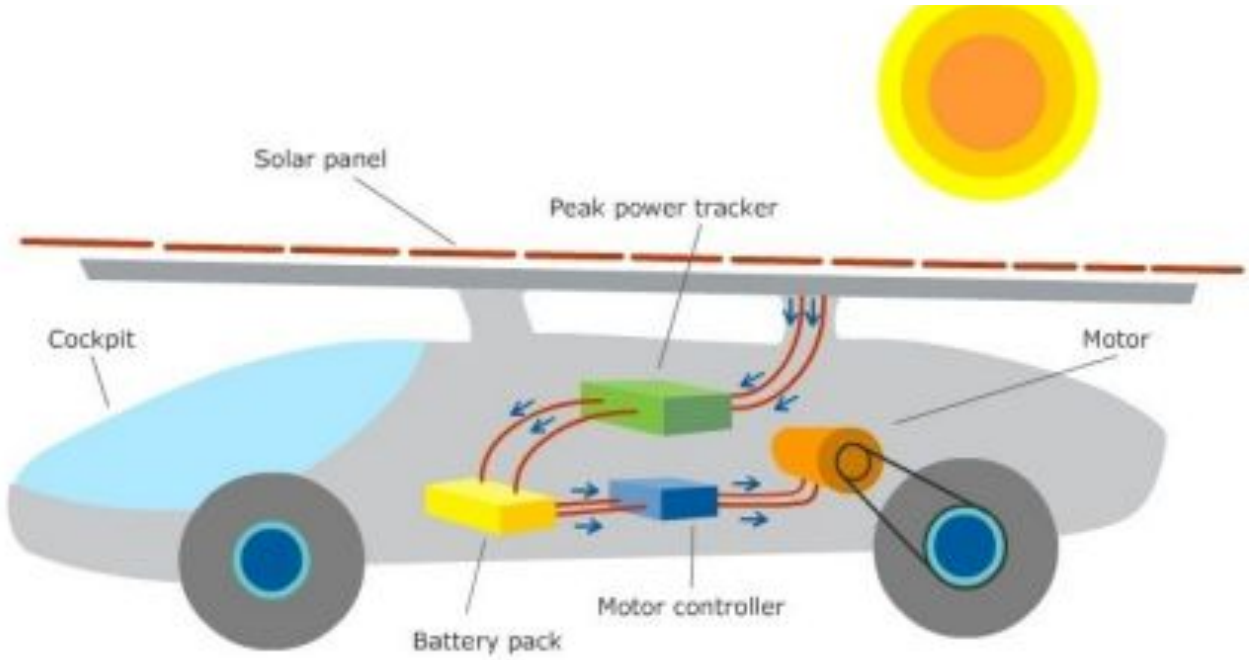
SOLAR CARS

Yes It's Possible!

One of the trickiest problems in the field of engineering is using clean energy sources. When talking about pollution caused by vehicles, there's a lot that CNG vehicles have changed. But what next?, Electric cars? Technology has upgraded even further. With the invention of solar electric cars where you can run your car without charging for months. Here is the technology that is taking humans to advancement without harming our planet. Solar energy is one such renewable energy source that has been extensively studied, developed and it's now incorporated in vehicles, thereby reducing pollution by almost 80%.
Most of us might be wondering if it would be possible to make such cars which can work efficiently as the electricity the car would need might not match the electricity generated through the solar panels. The answer is YES it's possible!!!

We have "Sunswift Ivy" as the fastest solar car on earth. A team of University Students made this car for the "world solar Challenge" and broke all the existing world records with a recorded speed of 88 km/h.

DIKSHA NEGI
LIKHITA J



The Working Flow Diagram of Solar Car

The recent 5 seater trending car in the market is Lightyear one which is 2 - 3 times more energy efficient than the current electric cars in the market. It is equipped with all the modern features along with its five square meters of solar panels adding an hourly 12 kilometres of range. A group of five students from Eindhoven school of technology brought this car into reality after winning 4 times world solar challenge by turning the winning race car into a real passenger car which runs on solar energy. Their mission is to make clean mobility available for everyone

Features of light Year One	
Range	400-800 km
Battery Capacity	60 KWh
Energy Consumption	69-148 KWh
Top Speed	150 km/h

Light Year One - Front View

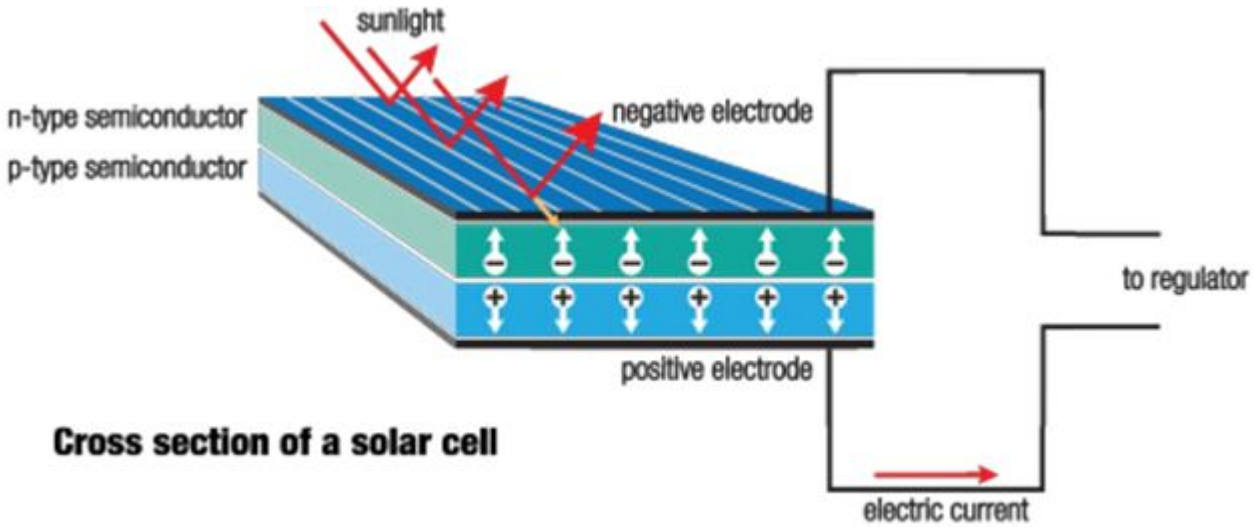
WORKING OF SOLAR ELECTRIC CARS

Solar cars have solar panels mounted onto the body of the car, the panels are usually made up of photovoltaic cells(PVCs) also known as solar cells which can transform solar energy to electric energy efficiently to drive electric motors. The solar cell is a PN semiconductor that is made up of silicone. These solar cells can retain light which in turn helps in the release of fast-moving electrons which generates the flow of electricity. This electricity which is generated by the solar cells is stored in batteries like lithium-ion batteries When the car is turned on the power is transferred to the electric motors which help the car to move.

THE BRIGHT SIDE OF SOLAR ENERGIZED CARS:

Basis of calculation	Petrol Car	Other electrical cars	Solar Car
Fuel	Petrol	Electricity	Solar electricity
Fuel unit rate	72 Rs/litre	INR 22.5/charge unit	INR 5/charge unit
Mileage	12 km/litre	75 km/charge	101 km/charge
Running cost	INR 6	INR 0.3	INR 0.05
Average spending on fuel/year	INR 64,800	INR 3,240	INR 540
Saving per year	-	INR 61,560	INR 64,260

Due to the pollution caused by classic petroleum cars, we are facing issues like climate change and Global Warming, but with the use of Solar cars, we can avoid burning fossil fuels which produce harmful gases. Sunlight is obtained for free and it's a renewable clean source of energy, which means that sunlight will still be there in the next millions of years too. Unlike solar energy, fossil fuels are the non-renewable source which takes many years to form. Solar-powered cars have no vibrations during the driving process making the drive smooth and comfortable, these cars are quiet and don't make any noise while driving. Classic cars and electric cars need regular filling of tanks or recharging of batteries, but the solar cars directly use energy from the sun hence we don't need to wait for the car to get recharged.



Cross section of a solar cell

DRAWBACKS OF SOLAR CARS:

On a sunny day, we might not face any problem, but during a rainy season, the efficiency of the car will drop because of the limited sunlight reaching the solar panels. The solar panels require a lot of space so that direct sunlight falls onto the solar panels. So, we need to accommodate the solar panels on to the body of car such that direct sunlight falls on to the panels. Manufacturing of solar panels causes pollution and is an expensive process.

7

Li-ion Batteries

An Initiative to the changed World

SHUNU P S
SARANSH BHADUKA

Lithium-ion batteries are presently standard in numerous gadget frameworks. They are light and littler batteries compared to other battery innovations. Moreover, Li-ion batteries have influenced nearly everybody within the world. The victory of commercial Li-ion batteries brought about serious inquire about and commitment by many great researchers over many decades. As of late, much exertion was put into encourage enhancement on the exhibitions of Li-ion batteries, accomplishing a certain level of victory. There are still exceptional issues. Escalates investigation is required to accomplish next-generation Li-ion batteries. Private companies contribute to the inquiry about and advancement of Li-ion batteries, which seem to lead to incrementally progressed items that accomplish critical coordinate impacts on our society. Scholastic segments might make commitments by generating out-of-the-box ideas and ideas, particularly those past Li-ion batteries that may well be commercialized within the following few decades. Battery safety and sustainable batteries should receive their deserved emphasis and attention in the future.

	Normal Batteries	Li-ion Batteries
Life Span	200 cylces or 100 cycles in 5 yrs	2000 yrs or 5 years
Efficiency	80-85%	>95%
Change Rate	After 85% the charging moderates down. (Overheating is often on rapid Charge)	Faster Charge rate and can handle higher amperage
Depth of Charge	the overall capacity in a single cycle should only be released up to 50 percent	Lithium-ion batteries have a higher capacity and can handle discharges of 80%

Comparison of Normal Batteries and Li-ion batteries

THE HISTORY

British chemist M. Stanley Whittingham proposed lithium batteries at Binghamton College, whereas working for Exxon within the 1970s. Whittingham utilized titanium(IV) sulfide and lithium metal as the anodes. In any case, this rechargeable lithium battery may never be made viable. Titanium disulfide was a bad choice since it needs to be synthesized beneath totally fixed conditions, too being quite expensive (~$1,000 per kilogram for titanium disulfide crude fabric within the 1970s). When uncovered to discuss, titanium disulfide responds to make hydrogen sulfide compounds, which have an unsavory odor and are harmful to most creatures. For this and other reasons, Exxon suspended the advancement of Whittingham's lithium-titanium disulfide battery. Batteries with metallic lithium terminals displayed security issues, as lithium metal responds with water, discharging combustible hydrogen gas.

TYPES

1. Lithium cobalt oxide:
They made from lithium carbonate and cobalt. Due to their exceptionally particular vitality, these batteries are utilized in cell phones, portable workstations, and electronic cameras. They have a cobalt oxide cathode and graphite carbon as their anode fabric.

2. Lithium manganese oxide:
These batteries are eminent for their high-temperature steadiness and are too more secure than other lithium-ion battery sorts. They are frequently utilized in therapeutic hardware and gadgets, but they may moreover be utilized in control instruments, electric bicycles, and more. They are also used to control tablets and electric powertrain cars.

3. Lithium iron phosphate (LiFePO4)
This is utilizing LiFePO4 as the cathode fabric and a graphitic carbon cathode. The energy density of LiFePO4 is lower than that of lithium cobalt oxide (LiCoO2) and incorporates a lower working voltage. The biggest disadvantage of LiFePO4 is its moo electrical conductivity. LiFePO4 is finding a number of parts in-vehicle utilize, utility-scale stationary applications, and reinforcement control. LFP batteries are cobalt-free.

	LITHIUM-ION	LEAD ACID
Cost		X
Capacity	X	
Depth of discharge	X	
Efficiency	X	
Lifespan	X	

Which is Better in various factors for EV's and Normal Lead Acid Batteries

ADVANTAGES:

Li-ion batteries have a place in the lesson of rechargeable batteries, making them an extraordinary source of transferable vitality which can be carried from put to put, making them exceptionally valuable whereas traveling. They can be revived once more and once more, decreasing the utilization of non-biodegradable cells and contributing to an eco-friendly environment. A few of the focal points of the li-ion batteries are recorded underneath:-

High energy density - Potential for however higher capacities

It does not require delayed preparation when unused. One customary charge is all that's required.

Low self-discharge - The self-discharge of li-ion is less than half that of nickel-based batteries.

Low Maintenance -No intermittent release is required; there's no memory.

DISADVANTAGES :
Sensitive to temperature:
They are greatly delicate to tall temperatures. Warm causes lithium-ion battery packs to debase much speedier than they as a rule would.
BMS is necessary:

A battery management system must be used to manage the Li-ion battery. It makes them even more expensive.

Chance of thermal runaway:

There is a slight chance of thermal runaway in Li-ion batteries.

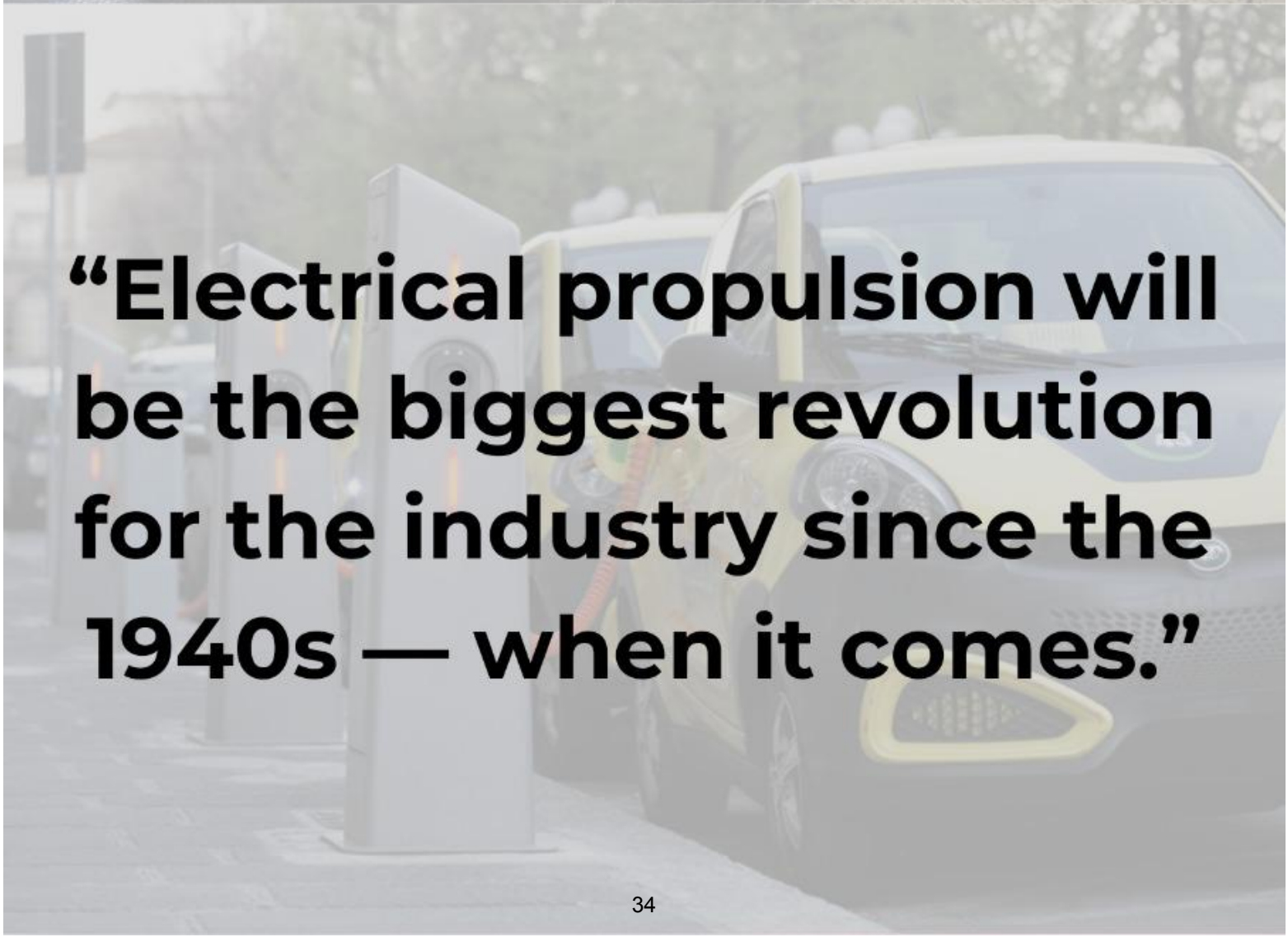
A short circuit of a cell generates large heat, and adjacent cells get damaged.

Electric Planes

Electric Aircrafts runs on electric motors. Different power sources used for electric planes are batteries, ground power cables, solar cells, ultracapacitors, fuel cells, and power beaming. Small electrical aircraft models have been flying since the 1970s. They have since got developed into small crewless aerial vehicles or drones. Drones, in the twenty-first century, have become widely used for many purposes.

SAGAR ROR
LUCKY PARMEET RAYI


“The industry is increasingly feeling the environmental pressures,


“Electrical propulsion will be the biggest revolution for the industry since the 1940s — when it comes.”

There has recently been a considerable and dramatic change in the system design of some future aircraft. Traditionally powered hydraulic, mechanical, or pneumatic power sources are now getting replaced with electrical systems. This increase in electrical energy use has led to a demand for rapid technology development, particularly in power electronics. Electrical systems are getting used for aircraft actuation systems, wing ice protection systems, environmental control systems, and fuel pumping. The usage and versatility of electrical energy ensure that these modern systems make it possible for future aircraft to be quieter and more fuel-efficient, improve the atmosphere for everyone, and reduce maintenance costs.

The primary source of power for subsystems on large aircraft is from the turbine engines, as shown in Figure 1. While the gas turbines are primarily wont to provide the thrust needed for the aircraft's flight, they need to be ready to give the facility sources required for all other loads on the plane. Figure 1 shows the facility sources and loads for a typical large aircraft power grid.

In a conventional sizeable civilian aircraft, there are typically four sources of power derived from the engines: electrical, pneumatic, hydraulic, and mechanical. The electrical system employs the power loads like avionics systems, lighting, and in-flight entertainment. The pneumatic system, taken as an air off-take from the engine, provides for loads like cabin pressurization and air-conditioning, and wing ice protection. The system is employed for fuel and oil pumping, mainly local to the engine. Many aircraft actuation systems, both for flight-control and auxiliary systems, uses a mechanism. The maximum power level of those systems is typically in more than 1 MW, an outsized power grid for a comparatively small platform

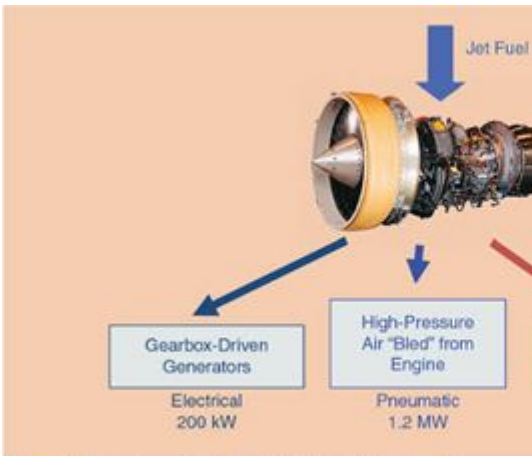
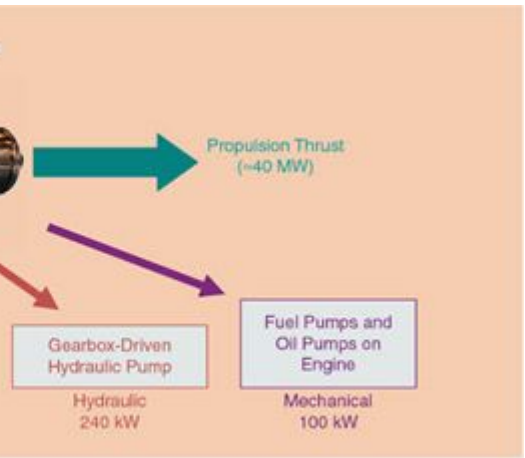


Figure 1. The power systems on a typical large civilian aircraft.

THE PRINCIPLE AND ADVANTAGES

Having four separate power systems on an aircraft may be a design that has evolved, each system being suitable for his or her dedicated loads. However, the aircraft as an entire show that efficiency and weight gains should be possible if only one power source employs all the systems. The chosen single source is electrical power because it features several benefits in flexibility and range of applications. This development of electric aircraft technology aims to scale back operating costs, fuel consumption, and, therefore, future aviation's environmental impact. The removal of a pneumatic system eliminates the necessity for a bleed air system on the turbine, resulting in a significant improvement within the turbine's efficiency. The removal of mechanical and hydraulic systems can also cause some reductions in the overall weight. However, more importantly, electrical systems offer much more options for reconfigurability than advanced prognostics and diagnostics. These prognostics and diagnostics systems could help improve aircraft availability and reduce the necessity for unscheduled maintenance .There is a possibility for equipment on an aircraft to watch its use and environmental conditions and use profiles of its failure mechanisms to predict the end of life, resulting in preventative maintenance supported usage instead of simply age or flying hours.

Example: Boeing claims that the electrical anti-icing system uses half the traditional bleed-air methods (as provided by the engines). Drag and noise decrease, and the efficiency of the turbine increases.



Several advantages claim electric motors in comparison with gas turbines.

· Noise is one benefit. An electric motor is quieter than a fuel-combustion motor. A propulsor, rotor, propeller, or fan must also be powered, creating noise on takeoff and climb-out. However, when flying and cruising, electric propulsion can be quieter. With many smaller, more silent rotors or fans, electric motors also allow distributed propulsion systems.

· Efficiency is another advantage. Electric drivetrains can be more than 90 percent effective, compared to 55 percent for today's large turbofans and 35 percent for small turboprops. The disparity in efficiency between large and small turbines is one reason why the electrification of propulsion begins with modifying regional aircraft powered by turboprops like the Pratt & Whitney PT6.

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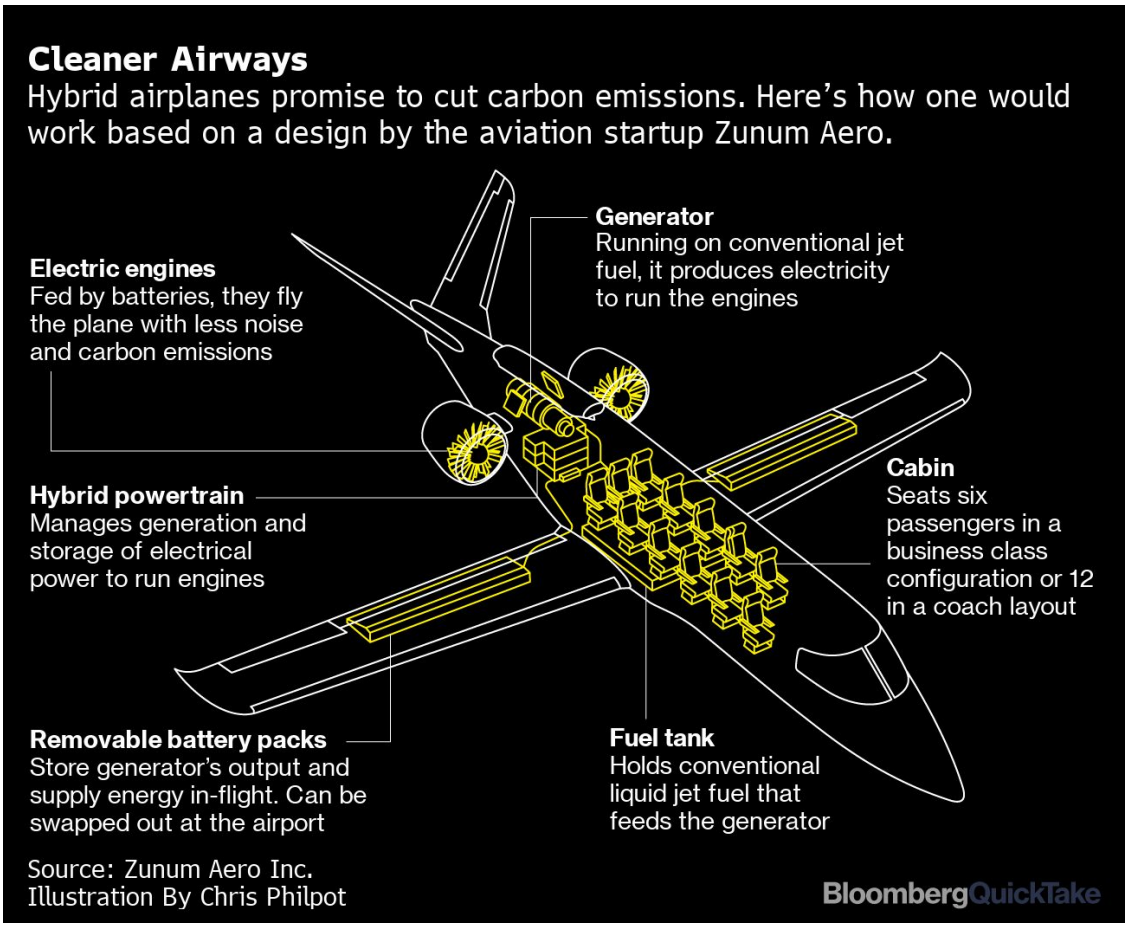
WHAT TO EXPECT IN THE FUTURE?

· The greatest challenge to electrify propulsion is power storage. Today's batteries account for only a fraction of the energy density of aviation fuels. For this reason, fully electric propulsion begins with small, short-range air taxis with a flight time of one hour in general. Even hybrid-electric airplanes start with short-range regional planes. There are battery chemicals that outperform the current lithium-ion models, but they are not yet on the market. New ways of storing energy are under development, such as the flux battery, that NASA adapts to aircraft propulsion as part of the Aquifer project.

Battery limitations are another reason why initial electric propulsion application is new to aviation than the road and rail transportation domain. It takes longer to electrify the short- and medium-range aircraft that make up the bulk of commercial aviation. In contrast, long-haul aircraft are considered likely to remain reliant on liquid fuels

As we see, an electric plane has many advantages over commercial aircraft, like an electric plane is quieter, more efficient, low cost, and more eco-friendly.

Also, we all know about Thermoacoustic Instability in a gas turbine engine which causes major failures in engines. Therefore, we concentrate more on electric aircraft; currently, battery-powered electric aircraft has a useful load, range, and endurance much more limited than those powered by combustion engines. Hence, it is only suitable for tiny aircraft (for large passenger aircraft, an improvement of the energy density by an element 20 compared to li-ion batteries would be required). So, it seems the future of the aerospace industry may depend entirely on the electric source.



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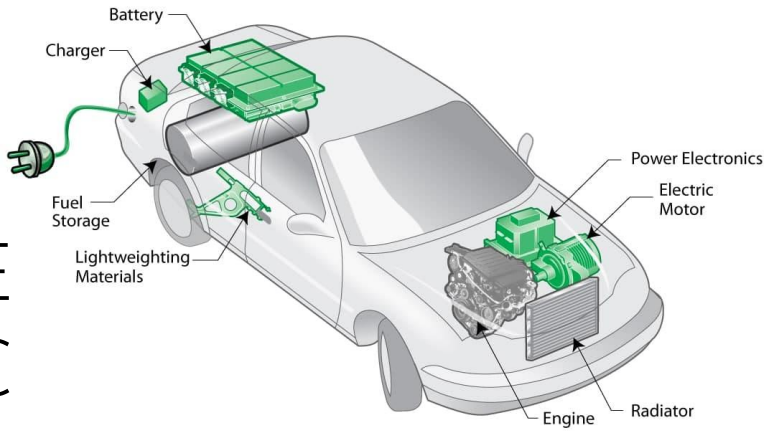
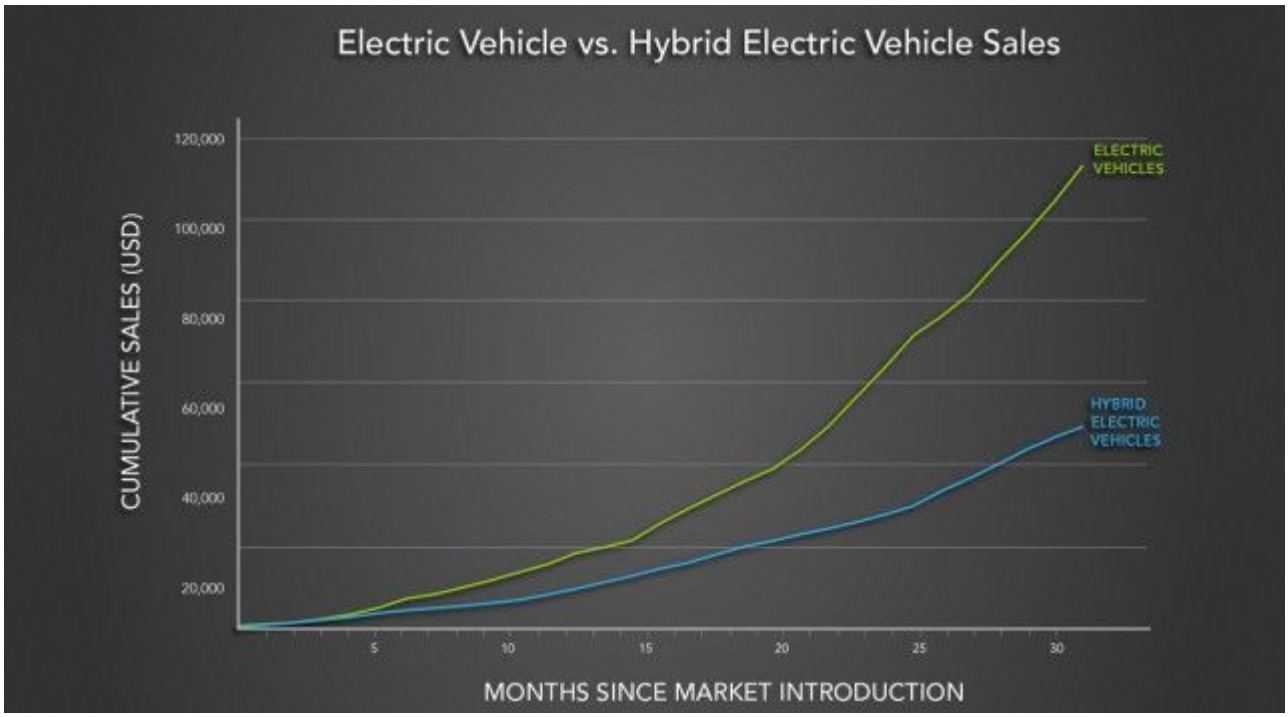


A PURE ELECTRIC VEHICLE OR A HYBRID ONE

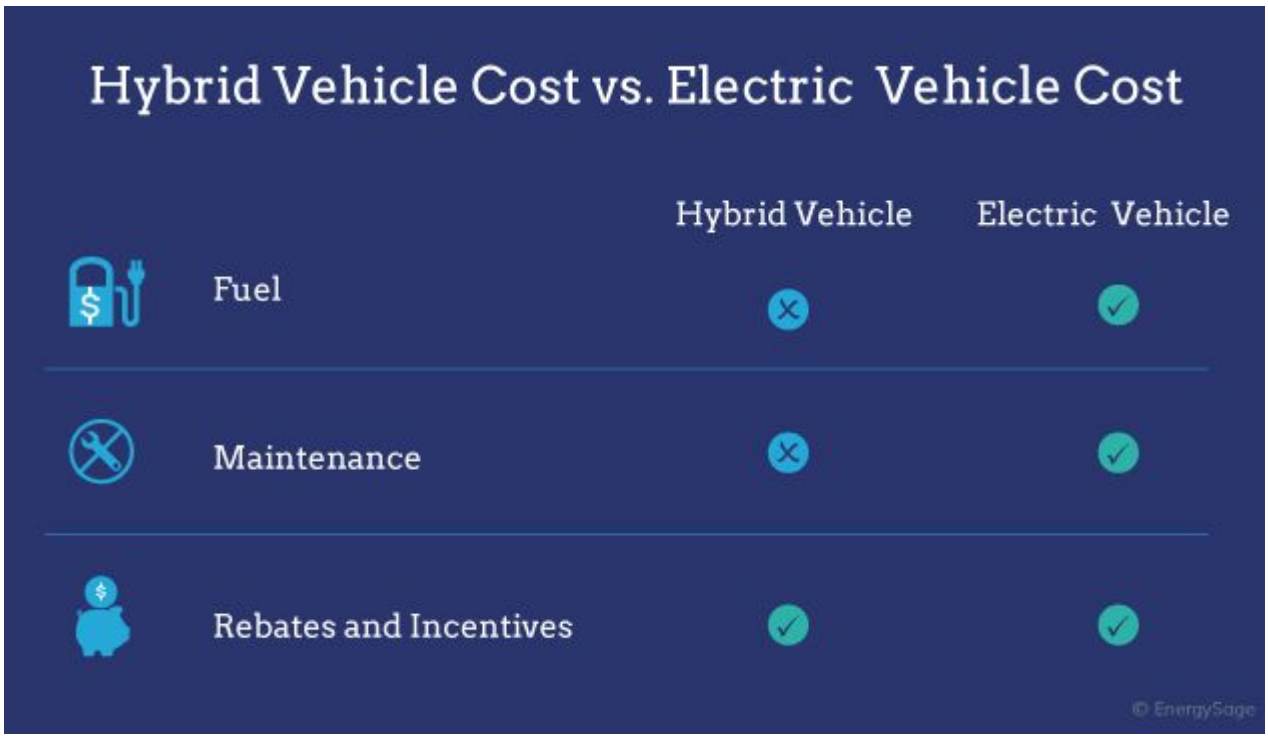
WHAT'S YOUR PICK?

SAKSHI BAGDE
RISHU KUMAR

Can you predict the future? The CEV says maybe. Electric Vehicles are the vehicles that use electric or traction motors for propulsion and are just becoming more and more exciting. What's more intriguing is the different types it offers to its users to cope up with its high prices. There are four types of electric vehicles: fully-electric, hybrid electric, plug-in hybrid electric, and fuel cell electric. How do they differ from each other? Let's find out more about them...



Electric Vehicles have outperformed Hybrid's in terms of Vehicle Sales after introduction to the market



The advantages of Electric Vehicles compared to Hybrids.

THE RACES OF AN EV- A CLASSIFICATION

There are a few different types of electric vehicles -

1. Plug-in Hybrid Electric Vehicles (PHEVs)
2. Battery Electric Vehicles (BEVs)
3. Hybrid Electric Vehicles (HEVs)
4. Battery-Assisted Hybrid Electric Vehicles (BHEVs)
5. Fully Electric Vehicles (FEVs)

Each has its advantages and disadvantages. They all save on fuel and emit fewer greenhouse gases, unlike the other vehicles. Their batteries are recharged through regenerative braking. In this process, the vehicle's electric motor helps to slow down the vehicle and recover some of the energy that is normally converted to heat by the brakes. Here, we will mainly focus on HEVs and FEVs.

An HEV has two compatible drive systems that include a gasoline engine and fuel tank and an electric motor and battery. The gasoline engine and the electric motor concomitantly turns the transmission, which powers the wheels. HEVs can't be recharged from the power grid.

As HEVs take turns in and out of the electric mode, these are cheaper to run than the IC engines. These are much more similar to gasoline cars than to electric vehicles as they do not require access to charging.

A pure-EV (FEV) is charged from an external electricity supply that includes, typically plugging in to an EV charge point. Whenever required, energy is drawn from the electric-cells and then converted to motion power by the use of the electric motors. Battery EVs have no combustion engine. It has only an on-board battery that provides energy to an electric motor. Plug-in hybrid EVs have an electric powertrain together with a small - to medium-sized combustion engine, which enables the operation in full-electric mode, using fossil fuel or a combination of both.

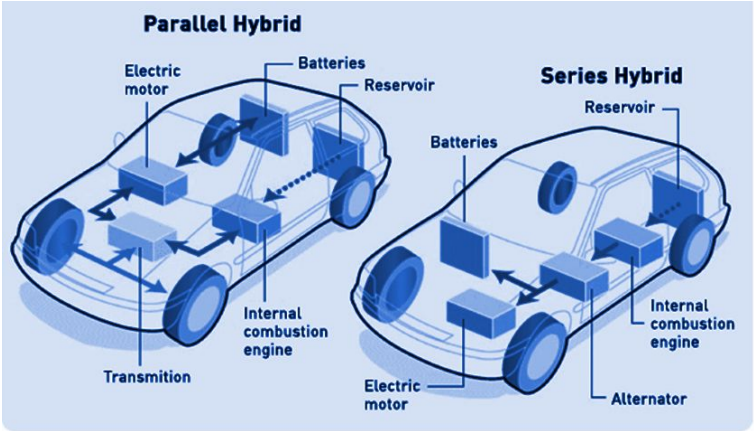


Figure Showing an internal view of a parallel and a series type of hybrid car

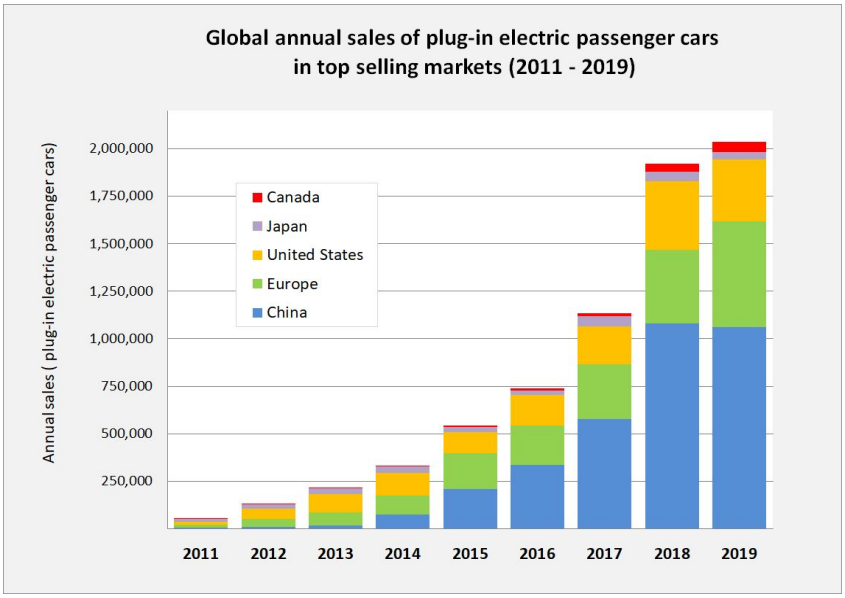
POWER SOURCE:

A hybrid car is powered by both an electric motor and an internal combustion engine(IC). The two systems work systematically with each other to generate power to run the vehicle.

When certain driving conditions favor the use of only the electric motor, such as sitting idle or driving below a specific speed, the engine remains off and thus burns no gasoline. When the battery level gets to some certain depletion level or if heavy throttle-loads are required, the gasoline motor automatically kicks in to work both in recharging the battery and propelling the wheels.

Talking about electric cars; it has got a battery pack and produces the energy (electricity) to rotate an electric motor. The motor is then joined with a transmission, and the transmission rotates the wheels since they are connected. Usually, an electric powered car needs to be recharged after a 100 miles drive.

THE STATISTICS



showing the global annual sales of EV in top-selling markets

Specifications	Hybrid Cars	Electric Cars
Power/Fuel Source	Electricity and Fossil Fuel (Petrol and Diesel)	Electricity Through Battery Pack (DC)
Engine	Internal Combustion Engine (ICE) and Electric Motor(s)	Electric Motor(s)
Fuel Efficiency	Combination of ICE and Battery Range	Depends on Battery Range
Emission Levels	Higher Compared to Electric Cars	Lower Compared to ICE and Hybrid Cars
Price Range	Similar to Conventional ICE Cars	High
Charging	Not Needed	Needed

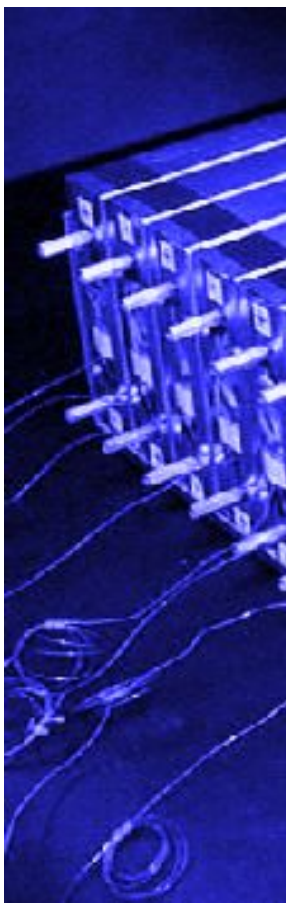
Shows the differences between a hybrid and a pure EV

BATTERY STORAGE AND CHARGING:

Lithium-ion-based batteries are majorly used as per their high power and energy density. Other batteries are cheaper, such as nickel-metal hydride (NiMH), but have a poorer power-to-weight ratio. Batteries with some different chemical compositions are developing such as zinc-air batteries that can be much lighter. The more powerful a battery is, the more the range of the vehicle will be.

One more factor that accounts for optimum battery utilization is its proper and regular charging and discharging.

Other than a fossil fuel car, an EV can be charged at home or at a battery station. An overnight charge of say 8 hours using a (120-volt AC) outlet will provide around 65 km of range, while a (240-volt AC) outlet will provide approximately 290 km. The speed of recharging depends on the charging station's charging speed and the vehicle's own capacity to get charged. Connecting a vehicle that can accommodate very fast charging to a charging station with a high charge rate can refill the vehicle's battery to 80% in 15 minutes.



FIRMS REVOLUTIONISING EV:

There are currently about forty different electric vehicles available, from about twenty different electric car manufacturers.

- Tesla - It is by far the most popular EV manufacturer. Its entire line-up involves plug-in electric vehicles only. Tesla is the worldwide leader in EV sales and has sold nearly half a million EVs so far.
- Chevrolet - It began the selling of the Volt (an extended-range electric vehicle), in late 2010. The Chevy Volt has been one of the top-selling electric cars in the US since its launch.
- BMW - It currently has 5 different electric cars.
- Nissan - Its only EV offering is the LEAF, a 5-passenger midsize hatchback

WHAT DOES TESLA SAY ABOUT THE COMPARISON:

"Hybrid cars are not Tesla's future" - it was stated by one of the officials of Tesla.The reason according to them was stated that a hybrid car is not an electric car. "You have the worst of both worlds in many cases, a gas engine and a battery, all the complexity, all the maintenance, all of the tradeoffs that occur in a hybrid car," Tesla board member Steve Jurvetson told a leading journal. That says it all about the view of Tesla on Hybrids.

CONCLUSIONS:

We know that many individuals, organizations, firms, and more have realized that it is time to do something that helps in energy conservation, economic fuel consumption, usage of renewable energy sources, and overall sustainable development.

For the same to take place Electric vehicles are foremost and revolutionized the way to save fossil fuels and reduce carbon footprints. This revolution of using better fuel-efficient cars may look stunning but again if we look into the roots of energy(electricity) production, it comes from fossil fuels and we need to consider a better way to produce electricity.

Talking about the Indian markets and if EV's can sustain the markets and fulfill the consumer needs, we need to consider various aspects in this growing economic country-

1.Can we have enough of a consumer market?

2.Can we open an open market for the production of EVs?

3.Can we have enough charging stations?

If these types of queries are resolved, then I think it will be a very viable option to use.

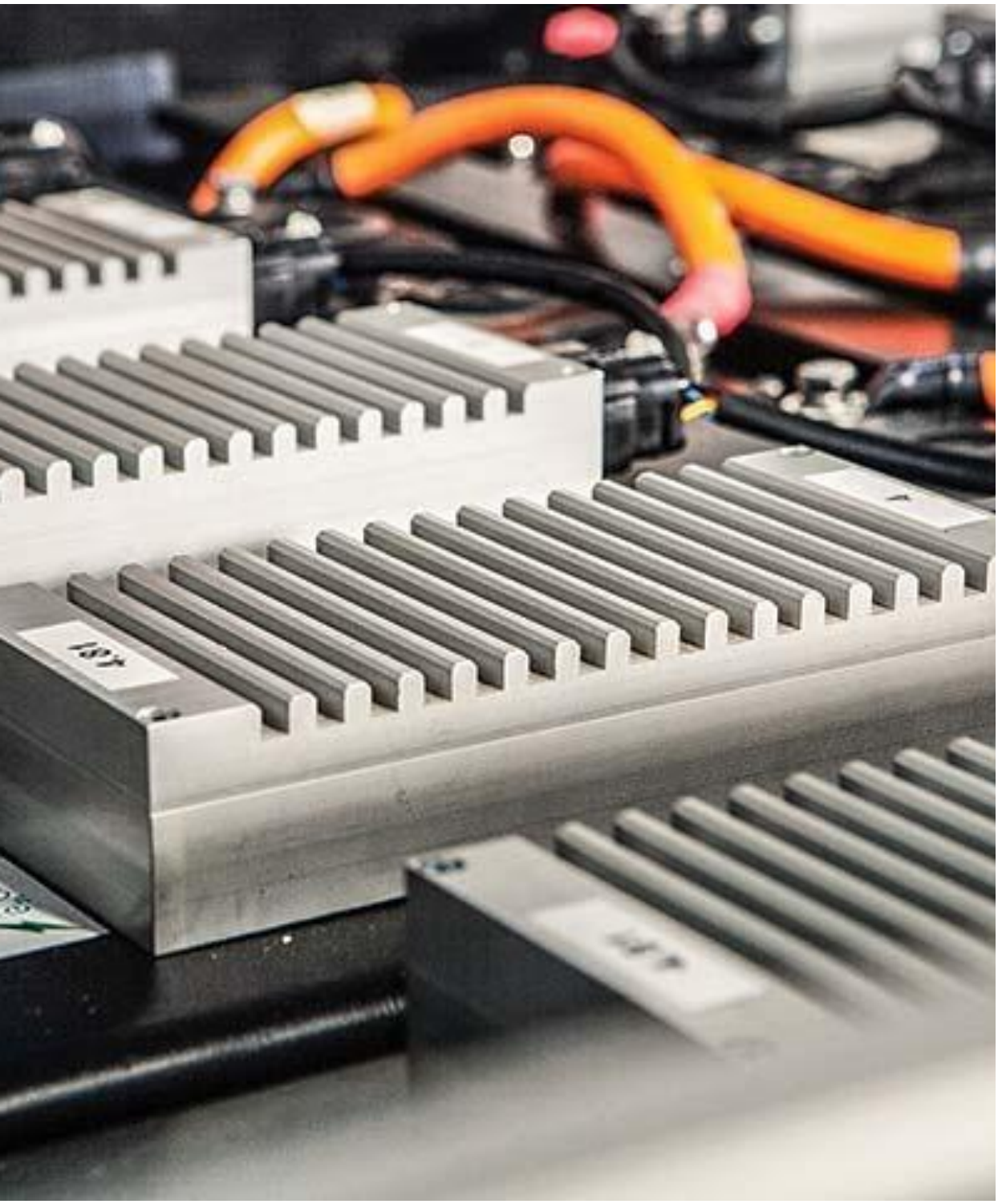
Weight of Normal Cars v/s Ev

The average weight of an electric car is 200 to 400 kilograms more than that of a normal car (i.e. fuel engine). This difference is usually due to the battery pack involved in electric cars. These packs are usually Lithium-Ion battery packs. Battery is very heavy mainly due to energy density. To give good range, energy storage should be high and so the weight increases. In a Tesla car the weight of battery is around 500 kgs.

The weight of any car affects its efficiency. Heavy cars require more torque to move it or simply put, the heavier the car, the more energy it takes to accelerate. Also, heavier cars result in shorter tyre life as the weight adds on to the wear and tear of tyres. Due to this many people speculated that electric vehicles would not be as eco-friendly as first thought. But heavy weight is not always a bad thing.

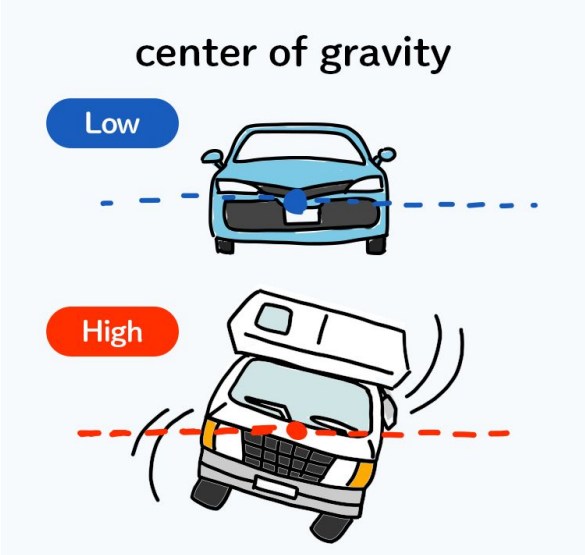
MEET SHAH
LAKSHMI ASHISH PRATEEK

Li-ion Batteries: The powerhouse of EV

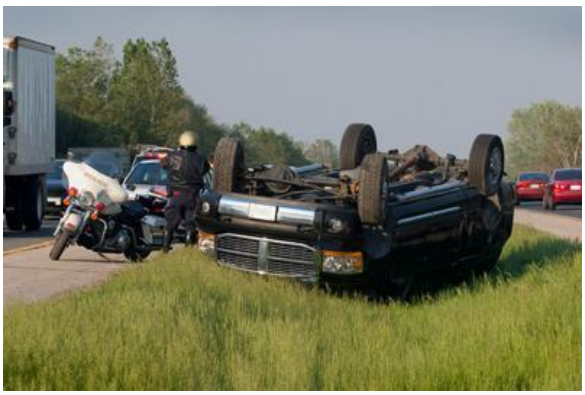


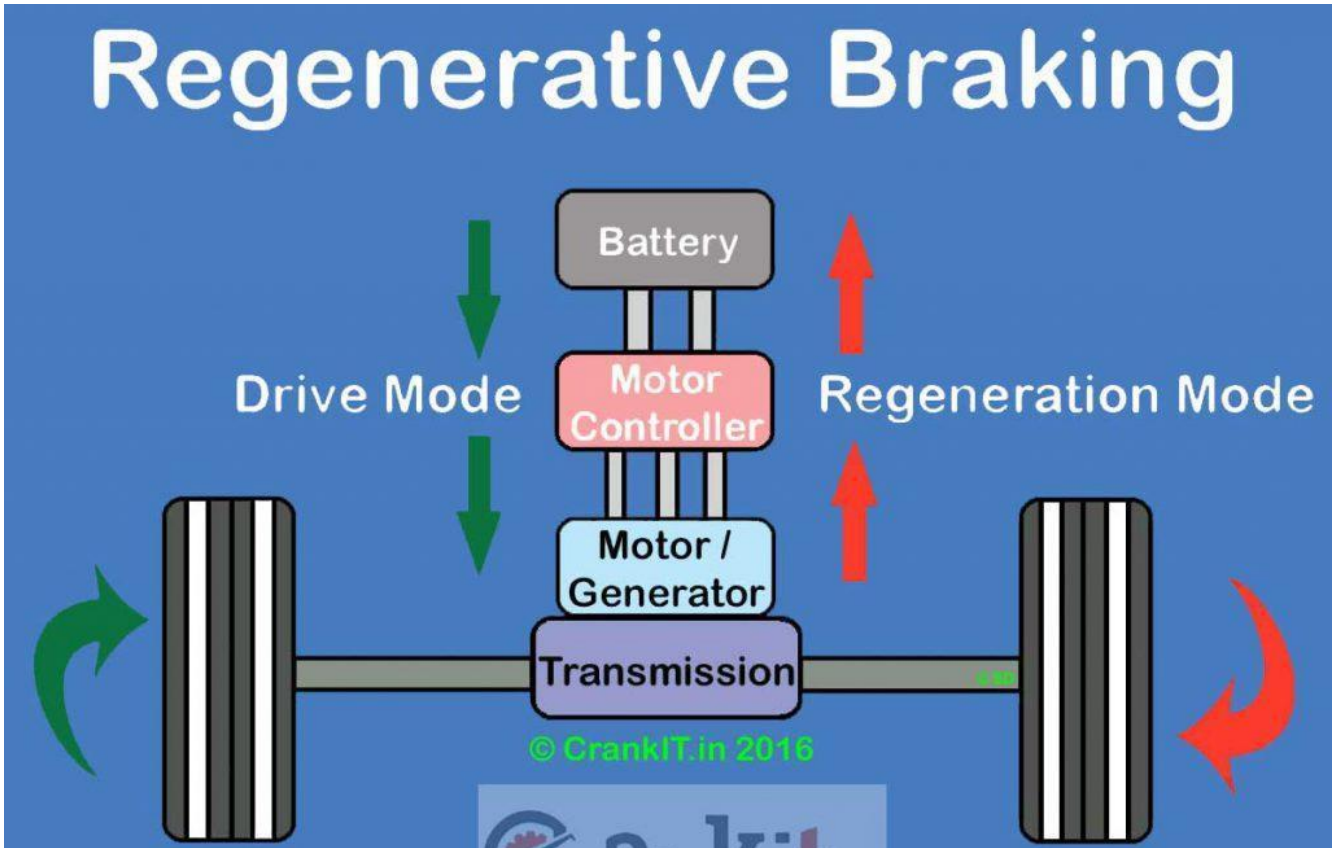
The weight of any car affects its efficiency. Heavy cars require more torque to move it or simply put, the heavier the car, the more energy it takes to accelerate. Also, heavier cars result in shorter tyre life as the weight adds on to the wear and tear of tyres. Due to this many people speculated that electric vehicles would not be as eco-friendly as first thought. But heavy weight is not always a bad thing.

The heavy weight of electric cars has a few benefits also. Electric cars usually have the regenerative braking feature. Regenerative braking is an energy recovery mechanism that slows down a moving vehicle by converting its kinetic energy into a form that can be stored until needed. In this mechanism, the electric traction motor uses the vehicle's momentum to recover energy that would otherwise be lost to the brake discs as heat. So, more momentum leads to more energy returned to the battery and momentum is directly proportional to weight also, so, heavy weight of electric cars is a beneficial feature in this way.



Design of any car is also very important. A great design makes the "flaws" of a car also beneficial. Tesla's Model X was first SUV to receive a perfect crash test rating. This was due to simple design decisions for the car. SUVs are notorious for having a high centre of gravity causing them to roll over when put into tight maneuvering situations, or a side impact. Rollovers can result in the partial or full ejection of passengers from the vehicle, increasing the chances of injury or death.

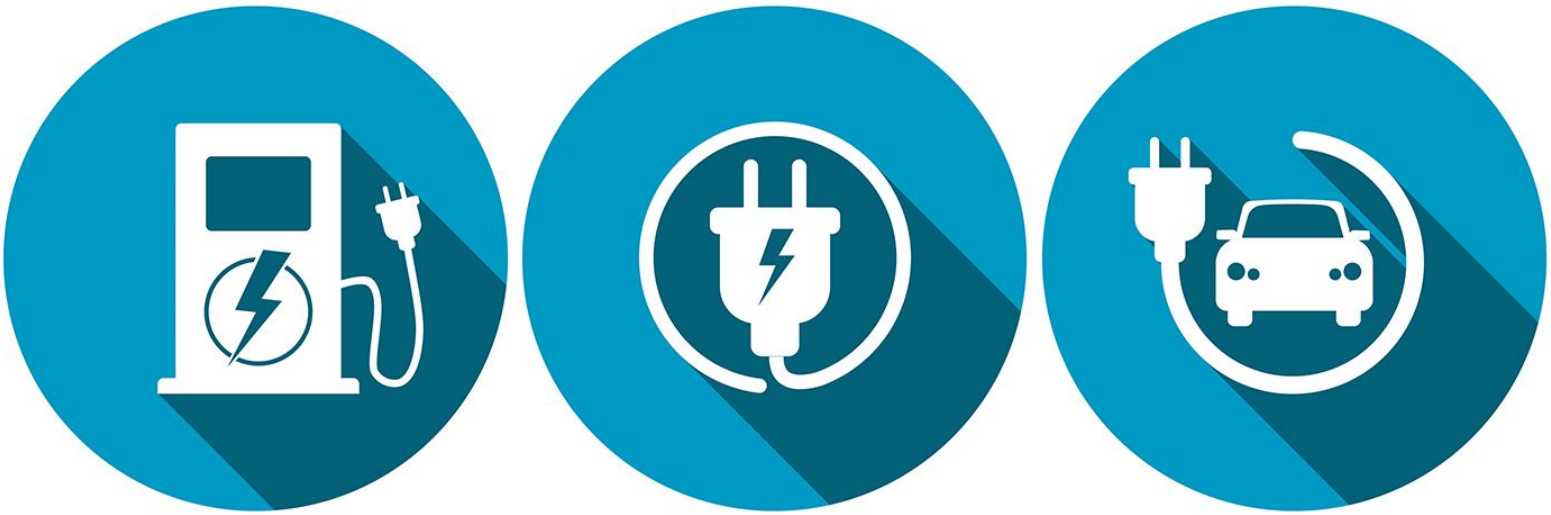




Powertrain of electric car and how regenerative braking in electric car works

Tesla Model X, like other Teslas, has a large, rigid battery pack located on the floor of the vehicle. This gives the Model X a much lower centre of gravity than your average SUV. Due to this in event of collision where normal SUVs would rollover, Model X stays put. It should also be noted that rollovers are just one aspect of the safety test. Since the Model X is an electric vehicle, there's no need for mechanical components in the hood of the car. This allows for a much larger crumple zone to absorb energy from a frontal crash, another reason why it is very safe.

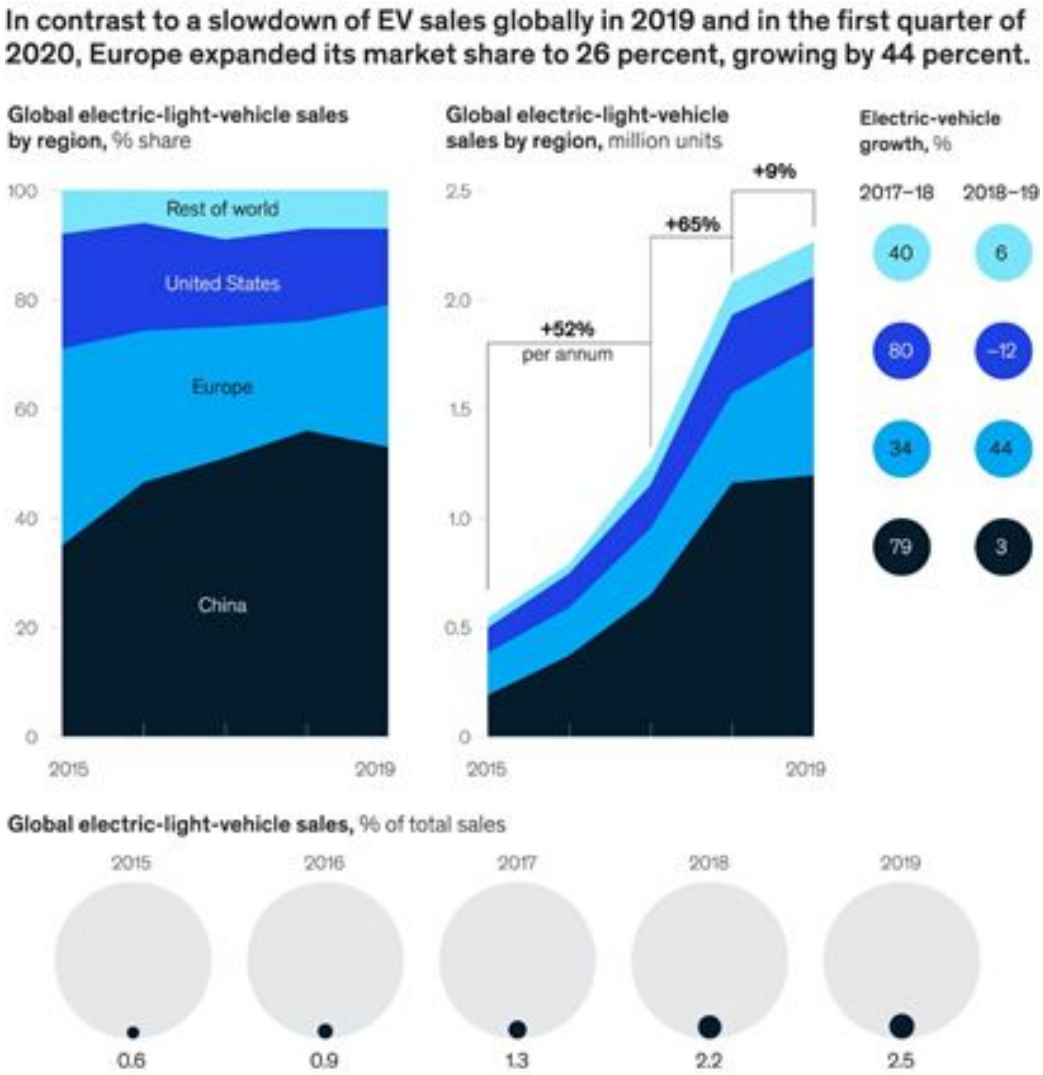
In conclusion, weight of a car is an important factor but heavy weight is not always a bad thing. It might mean that tyres need to be changed more frequently but heavy weight also saves the energy which would be wasted as heat while slowing down a car. Also, with better design even heavy weight leads to more safety for passengers. Also, EV batteries will get lighter over time as lithium-ion cell energy density increases at 7 percent a year.



MARKET ECONOMY OF EV'S

The Electric Vehicle Market is estimated to reach FROM **3.3M** in 2019 to upto **27M units** by 2030, at a CAGR of 21.1%. As per the report, the base year is 2018, and the expected period is from 2019 to 2030. The electric vehicles market has seen fast evolution with the present growth in automotive sector. The government policies and support in terms of subsidies and grants, tax rebates and other non-financial benefits in
carpool lane access, new car registration, increased vehicle range, proactive participation by automotive OEMs and better availability of charging infrastructure would drive the global electric vehicle sale

KRISHNA REDDY B V
K ESHWAR SAI SRINIVAS



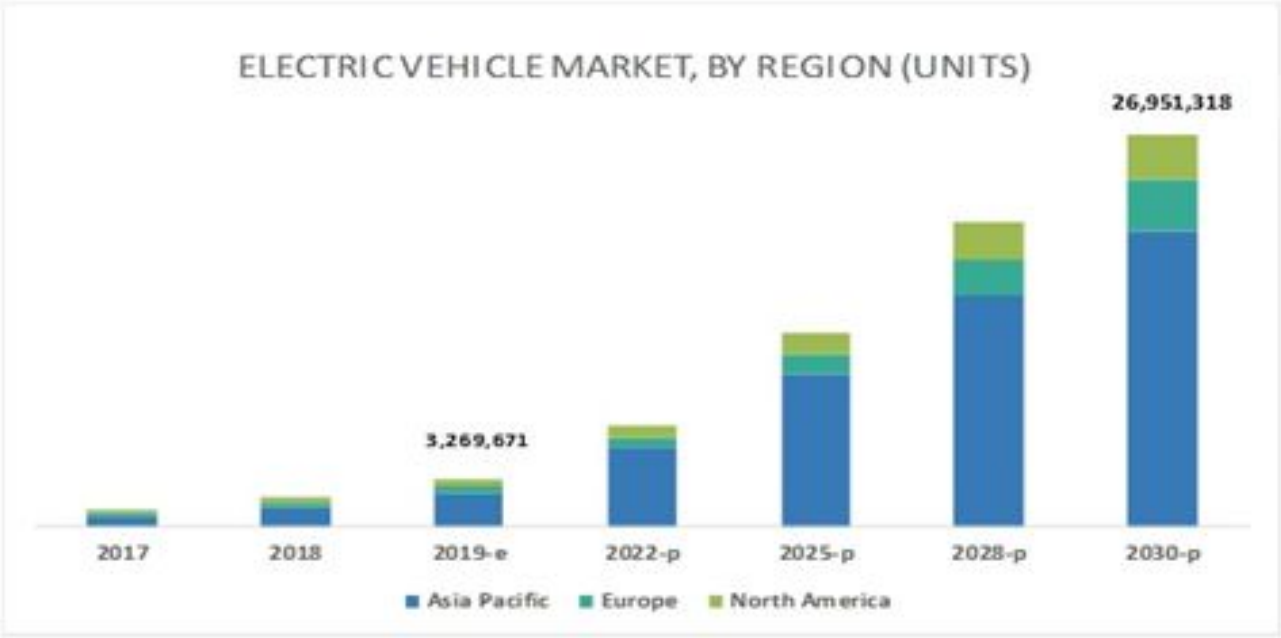
What is Market Economy:

Market economy is where individuals and businesses are consumers making up all of the decisions. The system decides the laws of supply and those of demand dictate the production of goods and services. The supply can include capital, Labour and natural resources too. Whereas, the market demand includes purchases by consumers, businesses and the government.

Growth in the electric-vehicle market has slowed…

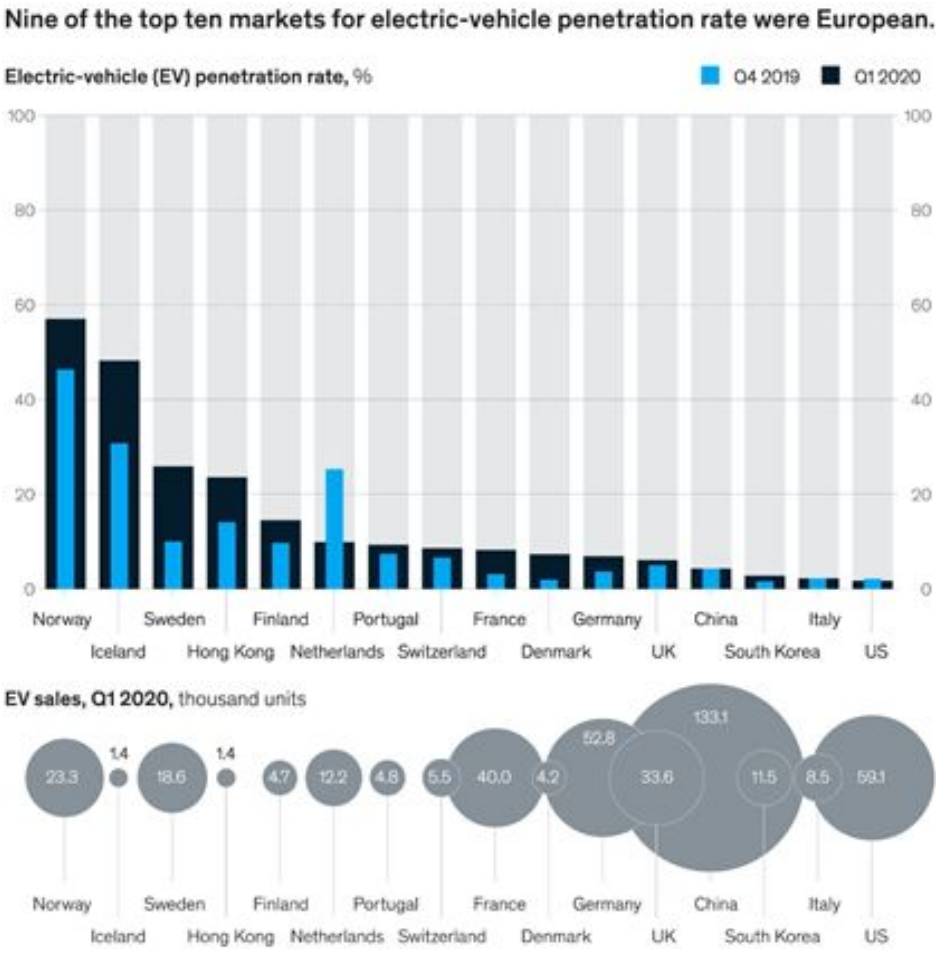
EV sales grew to 65% from 2017 to 2018. But in 2019, the sales increased only to 2.3M, from 2.1M in the previous year. Which implies a mere growth of 9%. In addition, EV sales declined by almost 25% during the first quarter of Beginning of the Pandemic i.e., The first quarter of 2020. Overall, Europe has seen the most robust growth in EVs. The days of rapidly expanding of EV market have ceased—or at least paused temporarily.

Though this growth and development of EV's are disappointing, they largely reflect the decline of the overall light-motor-vehicle market. The Light Vehicle market fell by 5% in 2019 and by 29% in the first quarter of 2020. Despite having the overall drop in sales, In 2018 to 2019 global EV market penetration increased by 0.3% points for a total share of 2.5%. Also, With additional growth in the Q1 of 2020, EV penetration is now at 2.8%.



Electric Vehicle Market, by Region (units)

The Asian market is expected to have the fastest growth, followed by Europe and North America. The automotive industry in countries such as China, Japan, and South Korea is inclined toward innovation, technology, and advanced electric vehicles. The rise in demand for reducing carbon emission and developing more advanced and fast-charging stations is expected to propel electric vehicles' growth. BYD, BAIC, Chery, and SAIC are some of the key players in the Asia Pacific electric vehicle market.

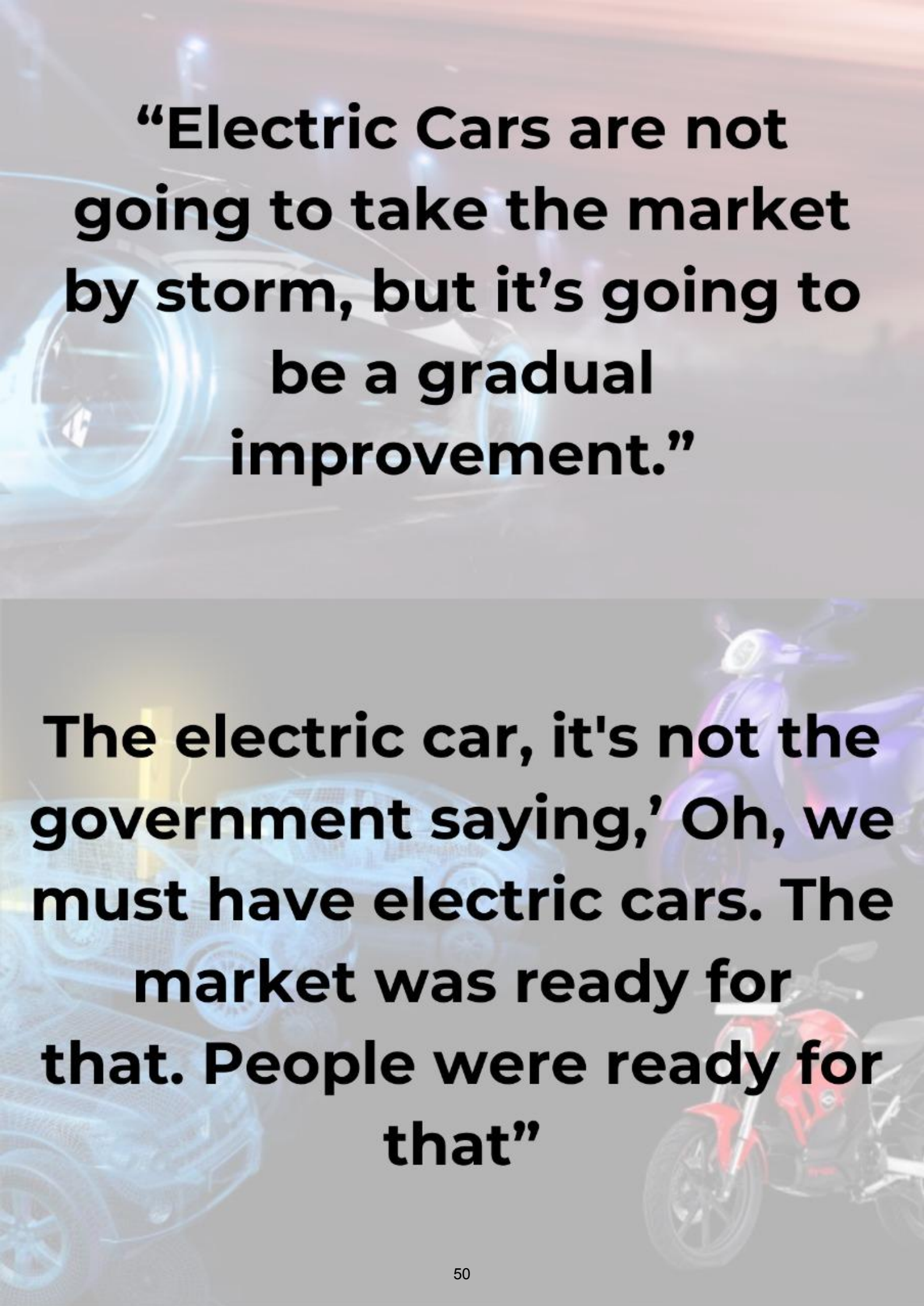


Source: Ev-volume.com; Light Vehicle Sales Forecast, May 2020, IHS Markit

McKinsey & Company

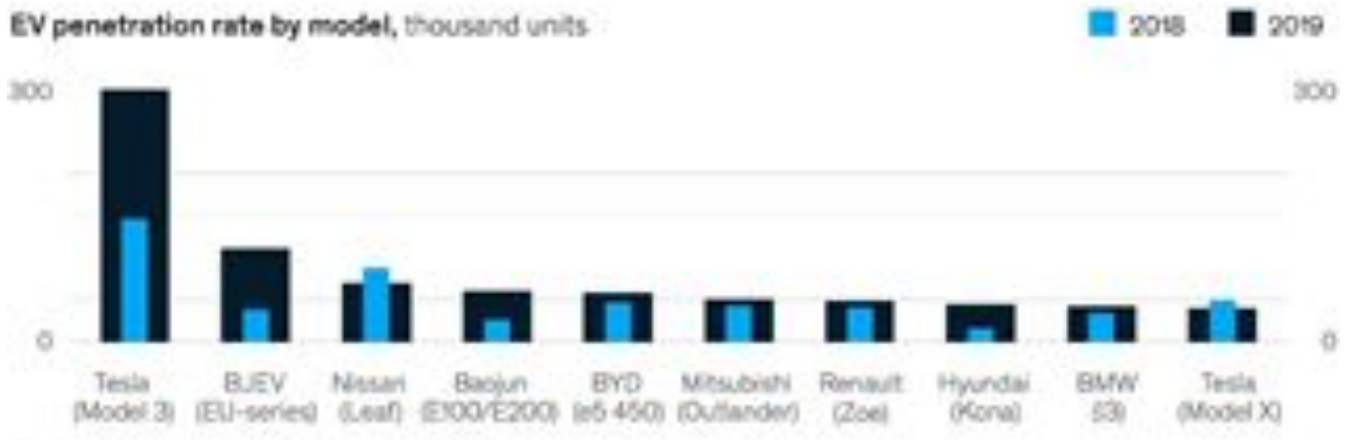
ELECTRIC VEHICLES MARKET

Advancements in battery technology with lower cost, improved charging speed, and government support in tax rebates and subsidies to promote eco-friendly vehicles are the key factors driving the adoption of electric vehicles. In addition, the market growth is also driven by the rising investment by automakers in EV development, decreasing prices of batteries. However, stringent rules for the installation of charging stations and the high cost of an electric vehicle pose challenges for the growth of the electric vehicle market.



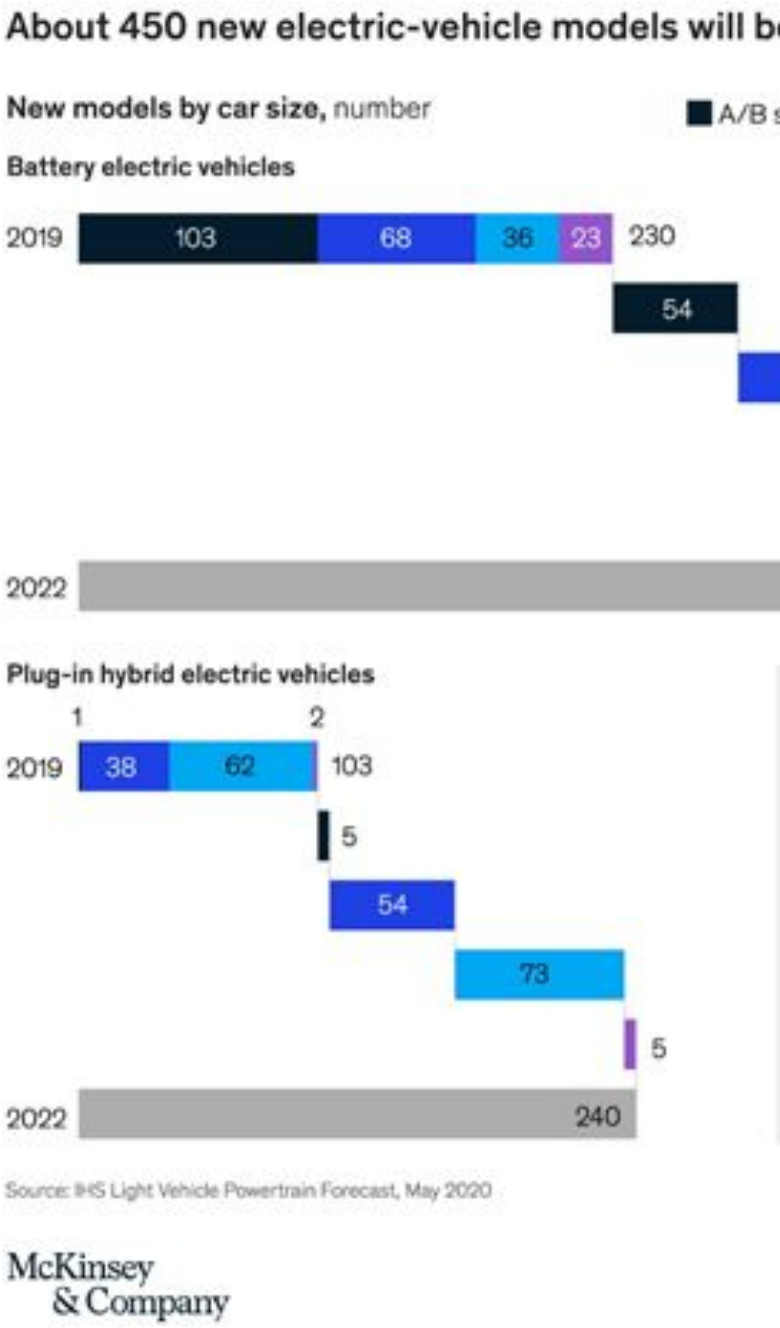
“Electric Cars are not going to take the market by storm, but it’s going to be a gradual improvement.”

The electric car, it's not the government saying,’ Oh, we must have electric cars. The market was ready for that. People were ready for that”



Mid-Priced vehicles shall grow at the highest CAGR rate

The future of EV's is expected to be bright, and with time the price of batteries, one of the most vital components in an EV, is reducing significantly, which would make EVs more affordable. The mid-Priced vehicle class has limited features, emphasizing features like infotainment, instrument cluster, and other expensive components. China is one of the prime countries in the mid-priced segment. Companies such as Great Wall Motors, BYD, and Smart are manufacturing less costly vehicles than others. In July 2018, To produce electric MINI vehicles in China, Great Wall Motors partnered with BMW Group. The company launched its new flagship electric vehicle brand: the ORA R1, in December 2018. The small urban car will cost only 8,680 US dollars after incentives with a range of almost 200 miles.



Key Drivers:

- Favourable government policies and subsidies
- Demand for increased vehicle range per charge
- Growing concerns over environmental pollution

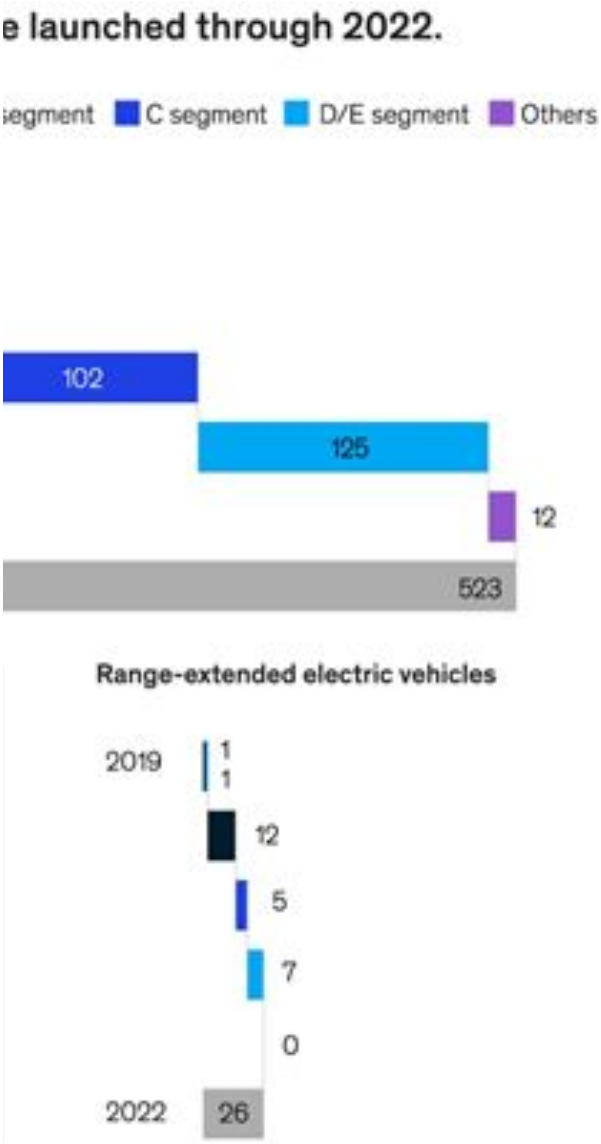
Heavy investments from automakers in EVs

Key Restraints:

- High cost of EVs compared to ICE ..
.....vehicles
- Lack of standardization of charging infrastructure

Electric-vehicle makers are debuting new models and boosting sales of existing ones

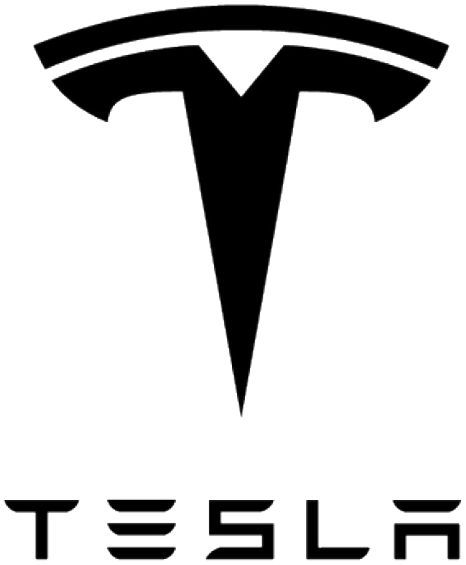
Automakers launched 143 new electric vehicles—105 BEVs and 38 plug-in hybrid electric vehicles (PHEVs)—in 2019. They plan to introduce around 450 additional models by 2022 (Exhibit 3). Most are midsize or large vehicles. Given the estimated production levels, German manufacturers, with an expected 856,000 EVs, could overtake Chinese players in 2020. That would boost Germany's global production share from 18% in 2019 to 27% in 2020.



Conclusion

The EV market has multiplied, but the dynamics vary by Region. In key markets, the transition from ICEs to electric powertrains reached a tipping point in 2019, fueled by more stringent emissions regulations, access restrictions in cities, advancing EV technologies that lengthen driving ranges and cut prices, and the expansion of the charging network. The same forces will further expand uptake over the coming years, but their evolution will vary by market.

To win, automakers and suppliers must develop a detailed view of what's happening in each market by monitoring the regulatory environment, customer preferences, infrastructure development, and competitors' moves—especially new entrants, including start-ups from outside the industry. Companies that match customer demand with suitable EV models and catch regulatory tailwinds may secure the most promising pockets of growth as we advance



TESLA'S IMPACT ON THE MARKET

Tesla is currently dominating the EV market in the West but its future in the rest of the world largely depends on the development of other countries as well as the economic feasibility of their vehicles in those countries. Given that Tesla is set to dominate the EV vehicle market in the West solely because of its superiority over other manufacturers when it comes to the quality of cars they make. Even though Tesla is set to enter the Indian market this year we can't predict if it will be able to dominate the market, especially when the more famous and financially feasible brands such as TATA and Mahindra have similar plans.

ANKIT GUPTA
MIHIR MALI

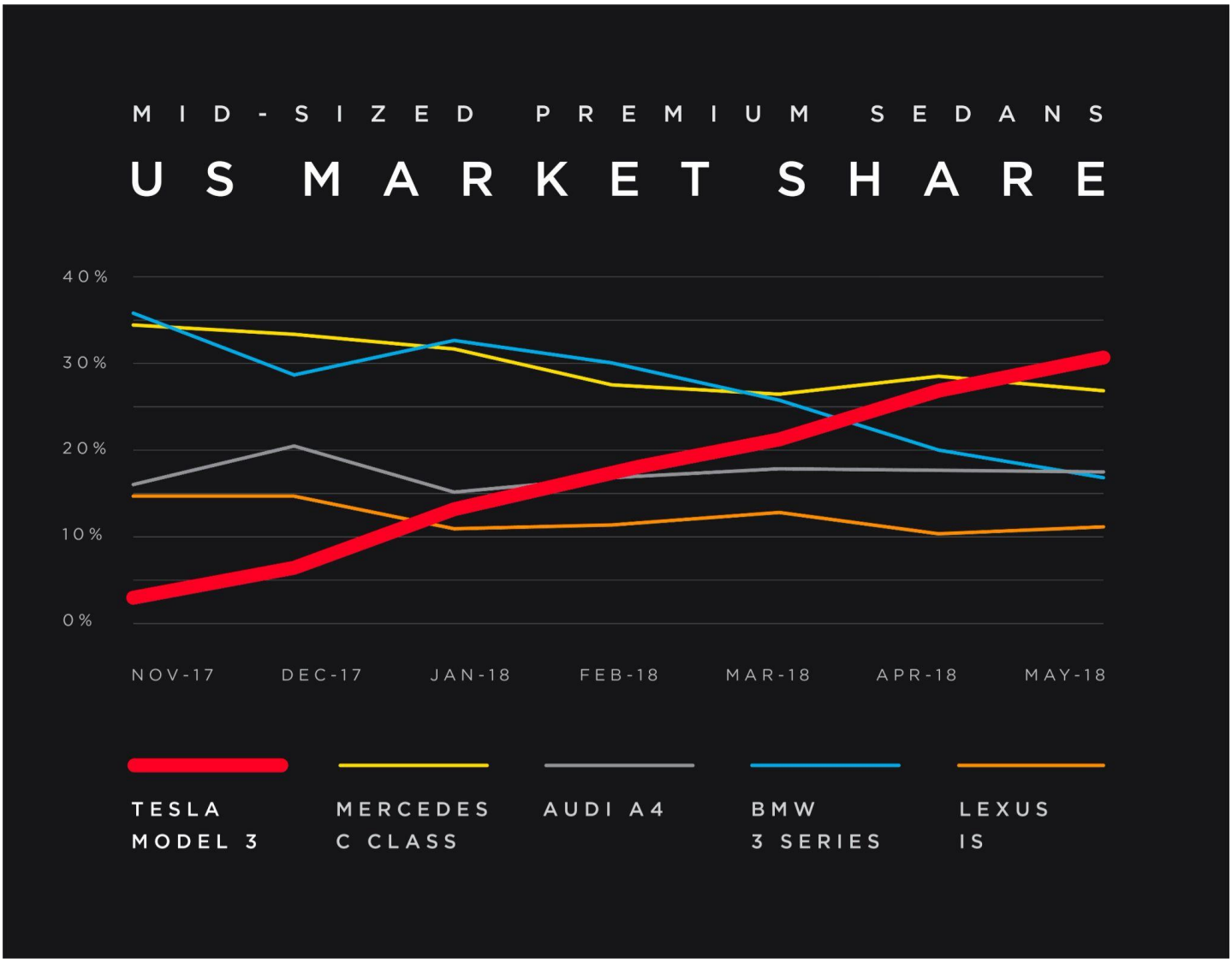
. Tesla, Inc, formerly (2003–17) Tesla Motor, is an American electric automobile manufacturer. It was founded in the year 2003 by American entrepreneurs Martin Eberhard and Marc Tarpenning. It was christened after the brilliant Serbian inventor and thinker Nikola Tesla.

It was founded in the year 2003 by American entrepreneurs Martin Eberhard and Marc Tarpenning. It was christened after the brilliant Serbian inventor and thinker Nikola Tesla.
Tesla Motor was traditionally formed to develop an electric sports car. Eberhard was Tesla's chief executive officer (CEO) and Tarpenning took position as its chief financial officer (CFO). Funding for the company was properly obtained from a variety of sources. Elon Musk, the then CEO of Paypal, contributed approximately 100m in dollars and took position as chairman of Tesla Inc, in 2004. In 2008 Tesla Motor released its first car, the completely electric Roadster.

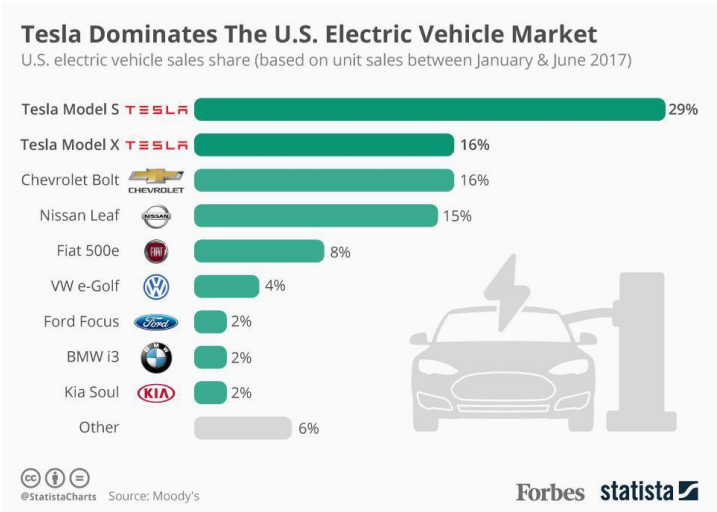
In subsequent company tests, it achieved 245 miles (394 km) on a sole charge, a range unremarkable for a production electric car. Other tests showed that its performance was comparable to that of many gasoline-powered cars: the Roadster went from 0 to 60 miles (96 km) per hour in less than 4 seconds and maxed at top speed of 125 miles (200 km) per hour. The vehicle's electric motor was powered by lithium-ion cells—frequently used in laptop-computer batteries— that could be recharged from a standard electric outlet. With a price tag of over $100,000 apiece, the Roadster remains a luxury product.

If EVs, especially the ones made at Tesla, could realistically challenge vehicles with conventional combustion engines, charging speeds would need to be reduced by a lot. This would come to be a matter of some urgency for the company over the following years. Tesla has begun to dominate the market even before the era of electric cars. While the electric vehicle market is tiny today, it's expected to explode in the coming years. According to Allied Market Research, the electric vehicle market was thought to be at around $118 billion in 2017 and is projected to grow to $567 billion by 2025, representing a CAGR of 22.3% from 2018 to 2025.

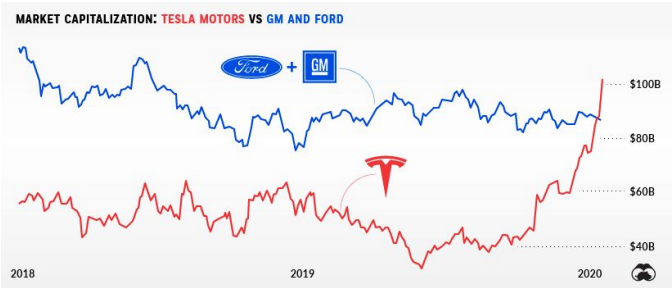
Moreover the company doesn't rely on electric cars as their only source of income. The company has also started investing in solar power and battery pack business along with their already existing subsidiary SpaceX which focuses on space exploration.In recent times the company announced that they will be bringing an electric vehicle under $25k which they expect will get people to move from normal cars to electric ones.While considering EV's people only think of Tesla because of the superiority of its vehicles over other EV manufacturers. Having had 650K pre-orders on their cybertruck the company is set to dominate the US electric vehicle market at least in the near future.



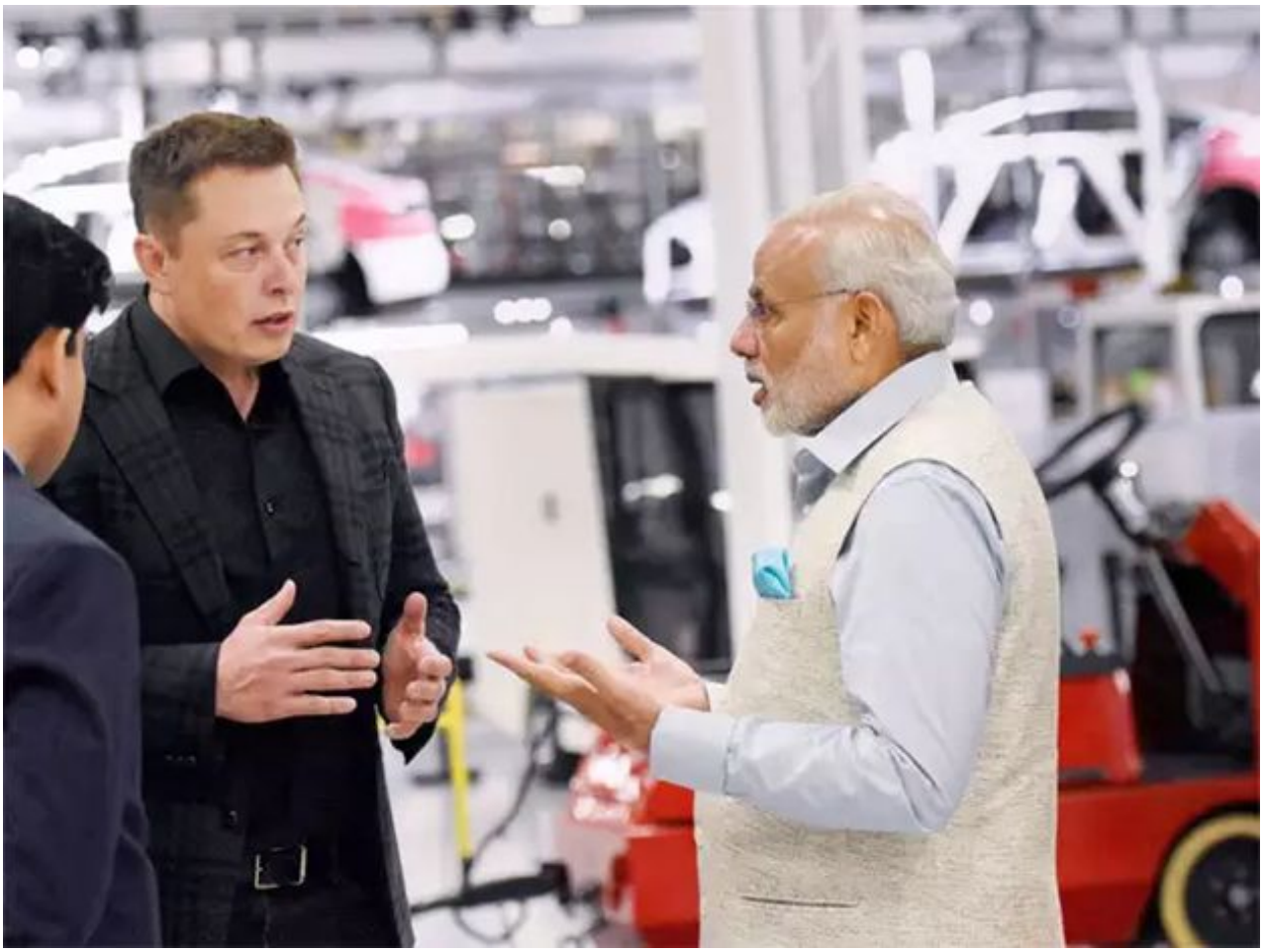
US Market share over the years for mid-sized premium sedans



Electric Vehicle sales shares in the first half of 2017



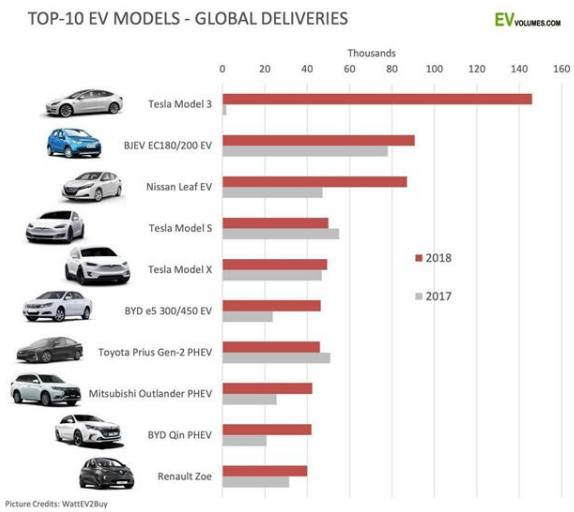
Market Capitalization of TESLA vs GM and FORD over the years



Prime Minister Modi meeting Tesla CEO Elon Musk

In recent times the Road Transport & Highways minister of India Nitin Gadkari announced that Tesla will be coming to India in early 2021. Whilst not having much competition in India the main constrain it will face will be in the pricing. Companies like Tata and Mahindra are offering their EV models at Rs 10 lakh while the cheapest Tesla Model 3 retails at Rs 35 lakhs in the US and will cost much more when taking into consideration factors like tax and shipping price.

Even though sitting in the High-end class of vehicles in India Tesla might be a good alternative for cars such as BMW or Mercedes-Benz which usually start at a price tag of Rs 30 lakh. Tesla with its luxurious interior while having the added benefit of being an electric car should easily replace the lower-end BMW and Mercedes-Benz models. But it's not as easy as it sounds. The main problem EV's will face in India is the scarcity of charging stations. Even though the government plans to set up 69,000 charging stations across the country by 2026, there are only 250 across the country right now. The Electric Vehicle market in India will highly depend on how fast the government is able to build these charging stations.



Global deliveries of EV's in 2017 and 2018

Tesla’s cybertruck : A new revolution

The Tesla Cyber Truck seems like it has been dropped from nowhere, but it has the potential to challenge all of the top-selling pickup trucks. Starting with a sharp-edged exterior that's made from scratch and dent resistant chrome steel, Tesla's all-electric truck is seriously tough. Along with available all- wheel drive, the Cybertruck can tow up to 14,000 pounds and has an estimated range of 500 plus miles. Other standard features include onboard power inverters for supplying both 120 and 240 volt electricity, allowing the use of power tools without a portable generator An air compressor for powering pneumatic tools is included. The exterior stainless steel sheet metal is also bullet resistant.

All vehicles will also accompany Tesla Autopilot and can also have the hardware capabilities for fully autonomous operation. Elon Musk indicated that there would be a solar roof option that might add 15 miles of range per day. As every coin has two sides, even though having that many features cybertruck has raised a lot doubts about safety standards of pedestrians and other vehicle’s when met an accident, headlight placement and about rear-view mirror etc.,

RAHUL N
SUMIT SAGAR

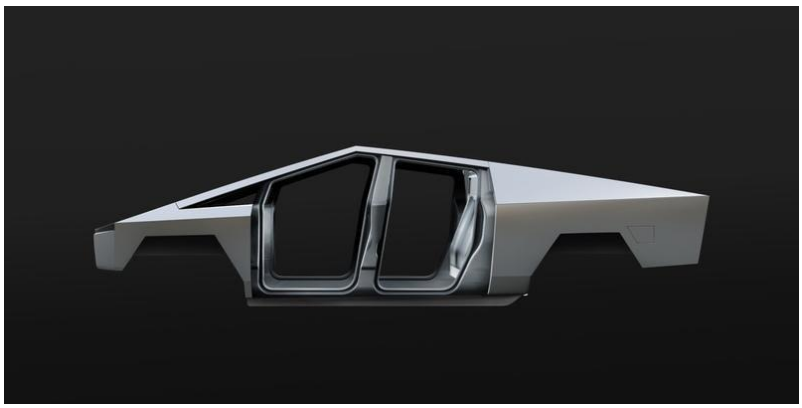
"Some folks love it, some folks hate it. It's even become a meme, with hilarious people all over the internet highlighting how much the angular truck looks like something ripped from a video game:"

A truck with very great features like as good picks up as sports car, fully electric, very less maintenance cost, weird design, strong body panel, etc., Why someone will refuse to buy it and launched by such a reputed 'Tesla' company, who are leading in EV vehicles and assures lot many promising features.
Not to forget the free publicity of popular news channels and in social media about Cyber truck, the name itself created some interest to hit such huge pre-order bookings.
Let's look into the details of what made to hit >650k pre-order bookings..

Cybertruck is made with an exterior outer shell made for ultimate durability and passenger protection. So, starting from a nearly almost impenetrable exoskeleton, every component is meant for superior strength and endurance, from Ultra Hard 30X Cold-Rolled stainless steel structural skin to Tesla armor glass. The Ultra-Hard 30X cold - Rolled skin helps

to eliminate dents, damage and long-term corrosion and provides the driver and the passengers maximum protection.

Cybertruck also has an additional feature of having an Ultra-strong glass and polymer layered composite that can absorb and redirect impact force for improved performance and damage tolerance.



With up to a payload capacity of 3500 pounds and adjustable air suspension, Cybertruck is the most powerful, engineered with 100 cubic feet of exterior, lockable storage including a magic tonneau cover that's strong enough to face on.

The Cybertruck allows you to raise and lower suspension four inches in either direction for easy and straightforward access to Cybertruck or the vault, while self-levelling capabilities adapt to any situation and assist with every job with greater simplicity.Six very comfortable seating with extra space to store things underneath of second row seats and its 6.4 -foot cargo bed offers 100 cubic feet of volume and this completes with an advanced 17" touchscreen with an all- new customized interface and features.

Tesla didn't currently reveal the size of the batteries that will power its electrified pickup. However, it has been confirmed that every model will have a 250-kW charging cable, and of course, it will also have access to Tesla's vast network of Superchargers. Its driving range will vary with the number of motors, but Tesla claims the single motor has a max range of 250-plus miles, the dual motors have a max range of 300-plus miles and the tri-motor setup has a max range of more than 500 miles on a single charge.

Talking about the strength of the cybertruck it has the power to tug near-infinite mass and a towing capability of over 14,000 pounds. With this Cybertruck can perform in almost any extreme situation with ease.

Model	Range -EPA est. in miles (km)	0-60 mph (0-97 km/h) in sec	Top Speed in mph (km/h)	Payload in lbs (kg)	Towing cap. in lbs (kg)	Price (USD)	Availability
Single Motor RWD	≥ 250 (400)	< 6.5	110 (175)	3,500 (1,600)	≥ 7,500 (3,400)	$39,900	Late 2022
Dual Motor AWD	≥ 300 (480)	< 4.5	120 (195)	3,500 (1,600)	≥ 10,000 (4,500)	$49,900	Late 2021
Tri Motor	≥ 500 (800)	< 2.9	130 (210)	3,500 (1,600)	≥ 14,000 (6,350)	$69,900	Late 2021

The Cybertruck is out there with not only one, not just two, but three electric motors. While the three- motor truck has all -wheel drive, the two- and one motor models have rear wheel drive. Now coming to the advanced class of strength that is speed and versatility and that is only possible with an all -electric design. The much needed lower centre of gravity and powerful drive-train provide the Cybertruck , an extraordinary traction control and torque enabling acceleration from 0-60 mph in as little as 2.9 seconds and up to 500 miles of range with much ease.

Cybertruck hasn't been crash-tested till now. However, every model will have Tesla's self-driving feature, and the company says it will offer a Full Self-Driving option for an additional amount of $7000.

The Cybertrucks are going to be available in three different configurations, which all support the number of electrical motors each has. While all¬wheel drive is standard on about the single¬motor version, each additional motor means quicker acceleration, longer driving range, and greater towing capacity

All models will have 100 cubic feet (2.8 m3) of space for storing, and a 6.5-foot-long (2.0 m) cargo deck. As on an offroad vehicle, 16 inches (40 cm) of ground clearance is provided, with a 35-degree approach angle and 28-degree departure angle

ARE EV's ECO-FRIENDLY?

DIWAKAR S GOUD
AKSHAY KUMAR R R

With the increase in pollution levels, everyone's focus is on the shift from conventional vehicles (CVs) to electric vehicles (EVs). But there are some questions that arise in our minds like "are EVs really 100% eco-friendly?", "Does manufacture of EVs lead to zero pollution?", "Does pollution levels of our planet decrease drastically once we shift to EVs?". In this article, we will explain answers to all these questions and also show the dark side of EVs. You will see how battery production, electricity generation, and battery disposal have raised concerns over the future of EVs

Does battery production creates pollution?

EVs or electric vehicles can be of different types like on-ground car, underwater vehicle or in-air aircraft. The only major difference between EVs and CVs is the way in which the power is generated to propel the vehicle. In CVs, fuel sourced from the fossils is burnt to produce the required kinetic energy.

Whereas in EVs, batteries are used to run the electric motor. EVs emit zero emissions during driving .Batteries are made up of rare earth elements like lithium, cobalt or nickel. Mining of these elements has several safety and environmental challenges to overcome like nickel mining in Russia has polluted rivers and lithium mining in Latin America has led to water shortages and toxic spills.

Even after collection of these elements, battery manufacturing requires large amount of water for charging electrode, removing impurities, washing finished cells and maintaining manufacturing plant. Hence,large amount of water is wasted which might lead to water scarcity.

Then what about battery disposal?

Mining Lithium pollutes the environment is many different ways

With the increase in the number of EVs, the demand for electricity will gradually increase. The important question is whether the electricity generated is from non renewable or renewable energy sources. Non-renewable way of energy generation like thermal power plants using coal leads to air and water pollution, thus leading to more pollution with increase in number of EVs. Whereas the use of renewable energies like wind, solar, nuclear, and hydroelectric produces less pollution, hence favorable for the usage of EVs.

When a large number of EVs flood the market, a large amount of battery waste will be generated. Since batteries consist of heavy metals and toxic elements, unprocessed battery disposal has raised concerns over soil contamination and water pollution. Battery recycling is one of the solutions to reduce battery waste but recycling requires disassembling of battery pack which is a time-consuming process. A study by Dr. Gavin Harper found that about 250,000 tonnes of unprocessed battery waste will be produced from a million electric cars sold in 2017.

The Solution to the problem

The one and only answer to all those questions raised in the beginning of this article is "definitely not!". EVs do not emit harmful gases from the tailpipe but processing,

Manufacturing and maintenance of batteries that power EVs leads to environmental pollution which has to be carefully monitored and controlled. Researchers are trying to find out ways to minimize the environmental impact by EVs, making them more efficient and eco-friendly. With shifting towards sustainable energy sources and continuous research on eco-friendly battery technologies EVs can develop the potential to get closer towards 100% eco-friendly goal. The debate between EVs and CVs is still on.

"Hence bigger the EV, larger the number of batteries required, larger the amount of rare earth elements required, greater the amount of electricity generated from the non-renewable energy sources, poorer the battery recycling technology, more the increase in pollution levels."

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