Electric Vehicles May Not Be The Environmental Savior We Imagine

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Electric Vehicles (EVs) are an innovation transforming car manufacturing and design. They offer consumers transportation that is environmentally conscientious and emission free. The sale of EVs has been steadily increasing in the US with one million electric vehicles on the roads by the end of 2018. Projections estimate that by early 2021 there will be two million EVs on US roads, illustrating industry's high expectations for the growing EV market. Concern regarding climate change is increasingly salient for the American public with 62% stating that climate change is impacting their local community. Electric vehicles can remove the need for emissions emitting automobiles.

Electric vehicles can reduce and even eliminate emissions from automobiles, working to reduce the impacts of climate change. Climate change is linked with greenhouse gas emissions, which are predominantly produced by human activity and industry. Greenhouse gas emissions lead to increasing temperatures across the globe by trapping heat from the sun within earth's atmosphere. Climate change has had devastating effects on global temperatures with the world meteorological organization determining that the 20 hottest years on record have occurred in the past 22 years. Transportation is the largest source of greenhouse gas emissions according to the Environmental Protection Agency making up 29% of total carbon emissions from the US. Climate change is linked with increases in natural disasters, water shortages and rising sea levels — real impacts that have grabbed the attention of many Americans. Electrifying vehicles can remove emissions from the transportation sector and is an important step in fighting climate change.

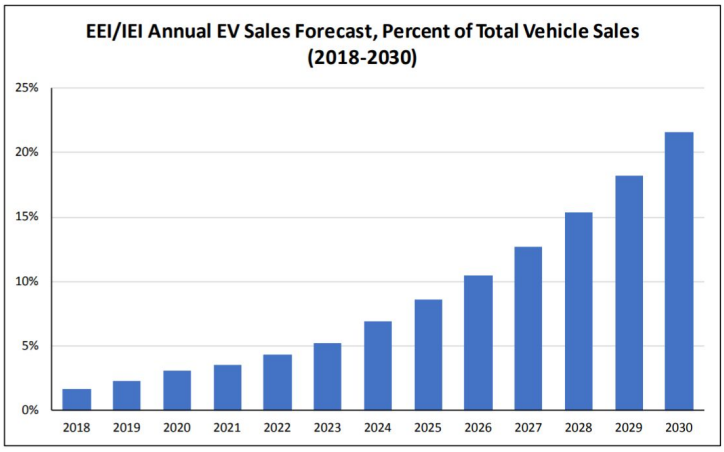
With interest in EVs gowing can transportation emissions be curtailed? EVs may not be the environmental savior we imagine. With more and more EVs being added to US roads each vehicle creates more strain on our electric grids and increases demand for electricity. As more

people begin plugging in their cars over going to the pump, electric utilities have to provide the energy for EVs. If there are too many cars charging then the utility is forced to burn fossil fuels, such as coal or natural gas to power EV charging and avoid blackouts. Burning coal to power our cars isn't the future many Americans have imagined when they think of an electric vehicle with zero emissions. Without the proper infrastructural planning to meet the significant energy demands of EV mass adoption, we risk speciously believing that EVs will benefit the environment.

What is the future for automobile production?

US consumer values have shifted to be more environmentally conscientious and these values are reflected in the growing popularity of electric vehicles. A joint report from Consumer Reports and The Union of Concerned Scientists determined that 63% of potential car buyers in the US are interested in EVs. This dawn of electrified automobiles is imminent and auto manufacturers are working to promote their new electric models. The recent 2020 superbowl had four adverts that introduced new electric vehicle models by Porsche, Ford, Audi, and GMC Hummer. The superbowl's popularity among Americans indicates that auto manufacturers are trying to reach the general populace to inform them of new electric vehicle options that are continually being developed. Change in the auto industry is imminent and with vehicles such as the Hummer moving to becoming electric and emission-free, the image of gas-guzzling cars is under attack. Now Tesla will not be the only provider of EVs opening up the market to more consumers. With strong advertising and multiple new entrants the EV Market is poised to continue expanding as more individuals decide to adopt electric cars.

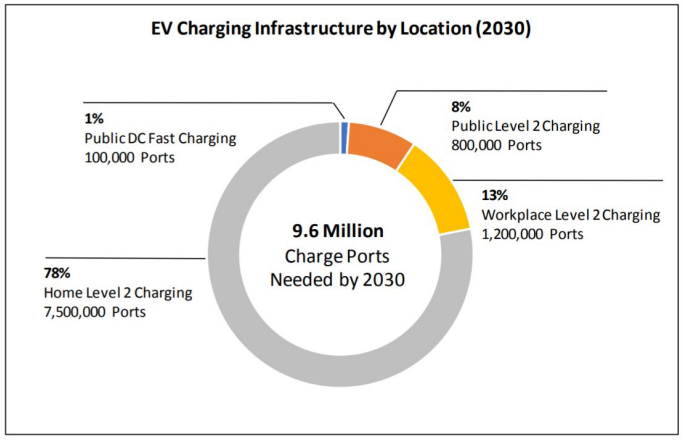
Electric vehicles will continue to make gains in the market share of automobile sales and auto makers are entering the EV market continually. The Edison Electrical Institute (EEI), a utility trade-association representing all major utilities in the US, predicts that by 2030 EV sales will make up more than 20% of all automotive sales. Most major auto manufacturers are bringing electric models to market or are developing them currently: Nissan, Porsche, BMW, Volkswagen, Audi, Ford, GMC, Mercedes, Volvo, Mini Cooper, Jaguar, Kia, Hyundai, Honda, Chevrolet. Even some new manufacturers are entering the market with their electric vehicle models such as Chinese SUV company Canoo. As manufacturers compete in a new market for dominance the spotlight on EVs will increase, informing more customers of the benefits and possibility of going electric. Continuing adoption of EVs is a step in the right direction for reducing the emissions of the transportation sector but lacking infrastructure may pose a serious challenge for EV users and mass adoption by consumers.



Are we ready for mass-adoption of electric vehicles?

EVs require charging ports at home and in public and a network of chargers is needed for individuals to recharge their cars and promote wider consumer adoption. These charging stations function similar to a gas station but instead provide the electric car with electricity from the

energy grid to continue driving. The EEI predicts, that to meet the energy needs of an estimated 18 million EVs in the US by 2030, 9.6 million charging stations/ports will be needed. This is no small investment and without proper charging accessibility the EV market is likely to suffer. The National Renewable Energy Laboratory (NREL) found that a lack of accessibility to retail charging stations is a serious market barrier for consumers. This infrastructure deficit requires adequate incentives to promote the construction of public charging stations. NREL recommended the possibility of government incentives for EV charging stations that could entice investors to create the necessary infrastructure. Without incentives the EV market will see minimized growth, especially since gasoline infrastructure is already established across the US. Despite this market barrier, a lack of charging stations won't ruin prospects of success for the electric vehicle market, as many of these chargers will be located in consumers' homes. The EEI estimates that of the 9.6 million chargers needed, 78% will be located in homes of EV owners. Home charging can providing convenience and remove the need to charge at remote locations, making it preferable to the traditional gas station model. Investments in charging infrastructure are necessary for EVs to be market competitive and ultimately mass-adopted.

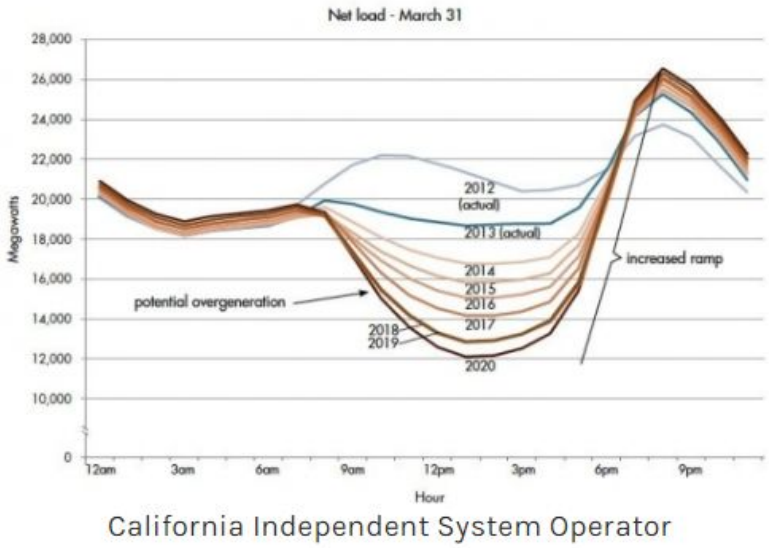


To reduce transportation emissions, mass-adoption of EVs is imperative, but electrical infrastructure may not be prepared to handle the demand of millions of EVs that require charging. Electric Vehicles represent the greatest growth in electrical load since the rise of air conditioning and if mishandled could result in rolling blackouts, expensive grid improvements, or the burning of fossil fuels to meet energy needs. As demand increases significantly at peak times such as when people return home from work, this can overload grid infrastructure that wasn't intended to support millions of charging vehicles. If utilities don't prepare for the adoption of EVs it could be a logistical nightmare that impedes access to either transportation or electricity. Additionally, if EVs become responsible for blackouts this could devastate the market and stop consumer adoption. Charging poses a serious threat to our current grid infrastructure, which was not designed for such a large additional electrical demand. EVs are the solution to reducing our transportation emissions but without proper infrastructural improvements and provisions EVs may result in grid blackouts and PR nightmares.

What is the duck curve and why does it matter for electric vehicles?

For truly emission free transportation EVs must be powered by renewable generation sources such as wind, solar, hydroelectric, and geothermal. Renewable energy generation has doubled since 2000 and is projected to continue growing into the future. Green energy such as solar and wind could potentially meet our power needs and reduce emissions significantly, particularly when paired with EVs. Renewables are undoubtedly becoming a part of the US energy mix, with states like Texas, a large oil and gas producer, generating the most wind power in the US. These advancements in emission free energy aren't enough to meet the demands of

EV charging. Home EV charging presents a unique problem for renewables which are necessary for emission free transportation. Since people usually will charge their EVs when they arrive home from work, this will increase the electrical demand at 5 to 6 PM. The huge demand of people charging their EVs when they return from work doesn't coincide with renewable generation times. Industry professionals call this difference in timing is the duck-curve referring to the difference between renewable generation times and peak-demand times. Renewables generate the most power during the middle of the day around 1 to 2 PM, whereas the most energy is needed as the sun begins to set and people return home from work at 5 to 6 PM. Peak demand for electricity is coincidentally also when people would plug in their EVs adding to the already high energy demand. The duck-curve forces utilities to burn fossil fuels such as coal or natural gas to meet the energy needs during peak demand times and would be used to charge EVs plugged in at home. A coal powered Tesla isn't what consumers have in mind when they opt for an electric car and doesn't provide emission free transportation.



How do we prepare for an electric vehicle future?

Implementing emission free transportation won't be easy but to cut down on transportation emissions more action must be taken after consumers leave the dealership with a new EV. Three solutions have been circulated around the automotive and utility industry, that can resolve these potential issues. Government incentives or involvement for building retail charging stations would accelerate the implementation of a network of chargers for EVs. Utility grid planning to predict areas with high penetration of EVs can ease blackout concerns, while combining this with computer automated managed charging can control electrical loads and reduce peak-demand. Lastly, more storage for renewable generation can help consumers make better use of renewable energy for EVs, alleviating issues caused by the duck curve.

Government involvement in promoting and building infrastructure for charging networks is a necessity to overcome the market barrier of insufficient charging access. NREL a leading research institution on renewable energy and environmentally friendly technologies recommends the use of government incentives to promote charging infrastructure construction. The EV market has benefited from government subsidies in the past with federal tax credits of up to $7,500 for consumer purchases of electric vehicles. This tax credit helped offset the higher costs associated with EVs, since they are competing in an established market. Charging stations face the same competition from established business and government help would even the playing field. Democratic House representatives have also shown interest in putting government spending towards improved charging infrastructure networks. House representatives Alexandria Ocasio-Cortez and Andy Levin have proposed a bill that would build charging stations along the

national highways system for EVs. Both representatives have acknowledge that more chargers are needed for broad adoption of EVs to occur. Even democratic presidential nominees Bernie Sanders and Joe Biden have supported the use of government spending to create EV charging networks. Proper infrastructural investment will boost the adoption of EVs which is critically important for reducing emissions. Government leaders have begun to recognize their role in creating a greener future through policy that benefits the use of electric vehicles.

Utilities and automakers are aware of the challenges posed by more consumers opting for plug-in EVs and are working to preempt problems with grid upgrades and managed charging. Utility planning has developed significantly, becoming more granular and accurate in order to better account for the new electrical demand of EVs. These planning methods often called distribution system planning, are able to identify potential problem areas and make preemptive improvements to the electrical grid. This can prevent blackouts and ensure electrical reliability. It is important for utilities to seriously consider the new energy demands of EVs and prepare for improvements across their entire system. The expense of new infrastructure has drove some utilities to work with automakers to create systems of managed charging. Managed charging uses computers to remotely control the charging rates and times of electric vehicles that are plugged in. This allows for utility companies to divert electrical demand to later periods in the night. By alternating charging times utilities can avoid massive electrical demands at the same time, reducing the chances for blackouts. Managed charging can also make better use renewable energy by increasing charging rates or even starting charging when renewable generation is in excess. By managing charging times this would put less stress on utilities to meet energy demands and thus decrease the need for burning fossil fuels to supply charging vehicles with energy. Managed charging is a technology that if paired with EVs would make them smarter and more environmentally friendly. Utilities understand the challenges EVs pose to our electrical system and are planning for a future that is prepared for the energy demands of charging vehicles.

The duck-curve is a unique problem of renewable generation that indirectly affects EVs but can be resolved with the use of utility scale battery storage systems. The duck curve indicates that there is too much power generated by renewables during the day when electricity is least needed. Battery storage offers a way to keep this renewable energy for later when it is really needed. Battery storage on a utility scale can make renewables more reliable and provide clean energy during the night when renewable sources generate the least electricity. Batteries can help EVs make use of renewable generation by storing clean electricity until EVs return home to be plugged in. Battery systems are constantly being developed around the country and new technologies such as flow batteries are being deployed currently. Development in battery technology is essential to maximize the utility and benefit of renewable energy generation and alleviate the duck-curve issue.

EVs are the best way to cut transportation emissions and reduce the impact of climate change, but without public support for the development of the necessary infrastructure EVs won't have the environmental benefits envisioned by many. Investments in charging, the energy grid, and battery storage are some of the most practical ways to support the green transition to electrified transportation. The automotive market is changing but with popular support and informed advocacy we can accelerate the adoption of electric vehicles and the necessary supporting infrastructure for the betterment of our planet