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ELECTRIC VEHICLE LIMBO: THE NEED FOR CHARGING INCENTIVES

INTRODUCTION

A study published by AAA in 2018 shows, “20 percent or 50 million Americans, will likely go electric for their next vehicle purchase.”¹ This means that 1/5 Americans plan on moving on from their previous gasoline car to an electric vehicle. Fast forward to 2021, electric vehicle technology has vastly improved in the battery, range, and charging spheres which further popularizes this movement. It is evident that companies have taken note, as announcements of new electric vehicles coming to the market keeps increasing. There are many reasons for this shift and electric vehicles are set to become the future.

Ironically, electric vehicles were some of the first vehicles invented as early as the 1800s.² In the early 1900s these vehicles were more popular than gasoline powered cars due to their many advantages over gas cars.³ However, electrical vehicle technology was stalled as gasoline powered cars began using an electric starter that took away the need for manually starting the vehicle.⁴ Nevertheless, these electric vehicles have started to make a comeback as the technology is rapidly expanding. One of the reasons for this movement has been powered by the realization of the impacts of gasoline powered cars on the environment.

However, there are obstacles that must be overcome for electric vehicles to take over the road. Generally, two main concerns for consumers are running out of charge while driving and the poor electric vehicle charging infrastructure in the United States.⁵ On the other hand, there are not that many electric vehicle charging incentives for businesses like gas stations to warrant such a major investment.

Summarized, consumers do not want to buy electric vehicles without a better charging infrastructure and businesses do not have enough incentives to build that better charging infrastructure—hence, the electric vehicle “limbo”. This highlights the need to start developing the EV charging infrastructure now rather

¹ Ellen Edmonds, *AAA: 1-in-5 U.S. Drivers Want an Electric Vehicle*, AAA (May 8, 2018), <https://newsroom.aaa.com/2018/05/1-in-5-us-drivers-want-electric-vehicle/>.

² *The history of the electric car*, DEP’T OF ENERGY (Sep. 15, 2014), <https://www.energy.gov/articles/history-electric-car>.

³ *Id.*

⁴ *Id.*

⁵ Edmonds, *supra* note 1.

than later. To get out of this limbo, the federal government needs to further incentivize electric vehicle charging stations for gas stations.

I. BACKGROUND

The trend in the car industry is heading towards battery electric vehicles (“EVs”) that run on electricity. This trend is evident by the abundance of automakers like Audi, BMW, Ford, GM, Jaguar, Lucid Air, Mazda, Mercedes Benz, Nissan, Porsche, Tesla and many others that are looking to produce these cars.⁶ Electric cars function by taking power from a grid when plugged in and storing electric energy into rechargeable batteries which power the motor.⁷

The three main types of electric vehicles are plug-in electric (“PEV” or purely electric), plug-in hybrid (mainly electric but also fuel powered), and hybrid-electric (mainly fuel powered and some electric).⁸ A big advantage for EVs comes through regenerative braking, “in a traditional car, the kinetic energy caused usually goes to waste. However, in an electric car braking converts and stores thermal energy from brake pads and tyres’ heat friction and reuses it to power the car.”⁹ The main internal parts of a pure EV are the electric motor, inverter, drivetrain, batteries, and charging port which amount to 90% less moving parts than Internal Combustion Engine Vehicles (“ICE”).¹⁰ Due to this, the ride of an electric car is more quiet and smooth.

The most common cars you see on the road today are ICE cars which are powered by fuel. ICE car engines are made up of cylinders and pistons. These cars inject a mixture of fuel/oxygen into the engine and a spark ignites the fuel to make combustions that drive the crankshaft.¹¹ This energy is turned into rotational energy that allows movement of the vehicle.¹²

One of the biggest advantages of ICE vehicles are that gas stations are abundant. This means you can practically drive as far as you like as long as you fuel your vehicle. On the other hand, the same is not true for EVs that require

⁶ *Every Electric Vehicle That’s Expected in the Next Two Years*. CAR AND DRIVER (Aug. 31, 2020), <https://www.caranddriver.com/news/g29994375/future-electric-cars-trucks/>.

Electric Cars vs. Gas Cars: Everything You Need to Know

⁷ Marta Moses, *How do electric cars work?*. EDF (Jan. 8, 2020), <https://www.edfenergy.com/for-home/energywise/how-do-electric-cars-work>.

⁸ *Id.*

⁹ *Id.* (in the UK, they spell the rubber car tire as “tyre”).

¹⁰ *Id.*

¹¹ Suse Forrest, *The Interesting History of the Internal Combustion Engine*, MOTORBISCUIT (Sep 13, 2019), <https://www.motorbiscuit.com/the-interesting-history-of-the-internal-combustion-engine/>.

¹² *Id.*

charging stations that are not so plentiful. However, the biggest critique of ICE cars is the maintenance and the reliance on gasoline—a fossil fuel. The environmental impact of ICE vehicles is fueling the movement towards EVs.

A. *Electric Charging Stations and Companies*

Every EV needs the electricity to come from a charging station. There are three different levels of charging stations currently: Level 1, Level 2, and Level 3.¹³ Level 1 chargers are the slowest and can be used with a standard 120-volt AC plug that you use for common items around the house.¹⁴ According to the U.S. Dept of Energy’s Alternative Fuels Data Center, “...8 hours of charging at 120 V can replenish about 40 miles of electric range for a mid-size PEV. As of 2020, less than 5% of public charging outlets in the United States were Level 1.”¹⁵

Level 2 charging is the most popular which is installed in most residential and public charging stations making up about 80% of public outlets.¹⁶ These chargers provide 240 V and are usually relied upon to have EVs charged overnight at home or during work.¹⁷

Level 3 chargers are more commonly known as direct current fast chargers (“DC fast chargers”) because of their rapid charging which are 400 V or more.¹⁸ The Alternative Fuels Data Center reports, “as of 2020, over 15% of charging outlets in the United States were DC fast chargers. There are three types of DC fast charging systems, depending on the type of charge port on the vehicle: SAE Combined Charging System (CCS), CHAdeMO, or Tesla.”¹⁹ Tesla has its own network of DC fast chargers which they have termed Superchargers but their cars come with adapters to allow for the use of other types of chargers.²⁰ DC chargers can charge 80% of capacity in around 20-30 minutes²¹ and this technology only seems to be getting better. EV charging is more effective when

¹³ Patricia Valderrama, Madhur Bloor, Ada Statler, & Samuel Garcia, *Electric Vehicle Charging 101*, NRDC (July 10, 2019), <https://www.nrdc.org/experts/patricia-valderrama/electric-vehicle-charging-101>.

¹⁴ *Id.*

¹⁵ *Developing Infrastructure to Charge Plug-In Electric Vehicles*, U.S. DEP’T OF ENERGY, https://afdc.energy.gov/fuels/electricity_infrastructure.html (last visited Nov. 25, 2020).

¹⁶ *Id.*

¹⁷ *Id.*

¹⁸ *Id.*

¹⁹ *Id.*

²⁰ *Id.*

²¹ *Driver’s Checklist: A Quick Guide to Fast Charging*, CHARGEPOINT, https://www.chargepoint.com/files/Quick_Guide_to_Fast_Charging.pdf (last visited February 5, 2021).

stopping the charge at a DC fast charger at about 80% because the charging slows down dramatically after that.²²

There are many different private companies, local governments, and public-private partnerships for these charging stations.²³ Other than Tesla, whose superchargers are only available to Tesla drivers, the three largest networks belong to ChargePoint, Electrify America, and EVgo.²⁴ Many consumers download apps such as ChargeHub, PlugShare, and OpenCharge Map to see all of the EV chargers near them or on their route.²⁵ Some apps even show you if the chargers are available at the moment or in use which makes the process a whole lot easier.²⁶

B. Graphs and Data

1. Charging Stations and Charging Outlets in the US

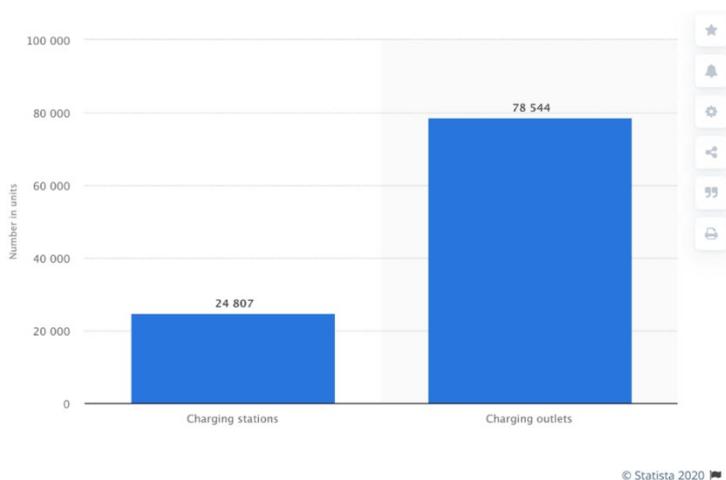


Figure 1: The number of public EV charging stations/outlets in the US as of March 3, 2020.²⁷

²² *Id.*

²³ Valderrama, *supra* note 13.

²⁴ Sebastian Blanco & Beth Nichols, *EV Charging Stations: Where to Find Them, What Type You Need, How to Pay*, CAR AND DRIVER (Dec. 3, 2019), <https://www.caranddriver.com/news/a30031153/ev-charging-guide/>.

²⁵ *Id.*

²⁶ *Id.*

²⁷ I. Wagner, *Number of public electric vehicle charging stations and charging outlets in the U.S. as of March 3, 2020*, STATISTA (Mar. 3, 2020), <https://www.statista.com/statistics/416750/number-of-electric-vehicle-charging-stations-outlets-united-states/>.

According to Statista, EV sales improved from around 115,000 in 2015 to 358,000 in 2018 because of the rise in the number of plug-in power stations and charging outlets.²⁸ Statista claims, “With faster charging and cheaper, more efficient batteries, long distance travel becomes possible with plug-in EVs.”²⁹ Due to this, California EV fleet size is expected to grow to four million by 2030.³⁰ To make EVs more popular, expanding the charging station/outlet network is vital for the rest of the United States.

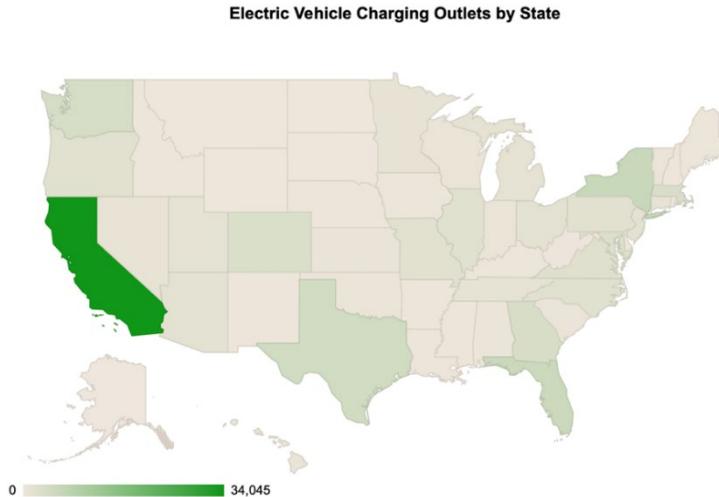


Figure 2: EV charging outlets by state.³¹

²⁸ *Id.*

²⁹ *Id.*

³⁰ *Id.*

³¹ *Maps and Data*, U.S. DEP'T OF ENERGY, <https://afdc.energy.gov/data/categories/alternative-fueling-stations> (last visited Nov. 26, 2020).

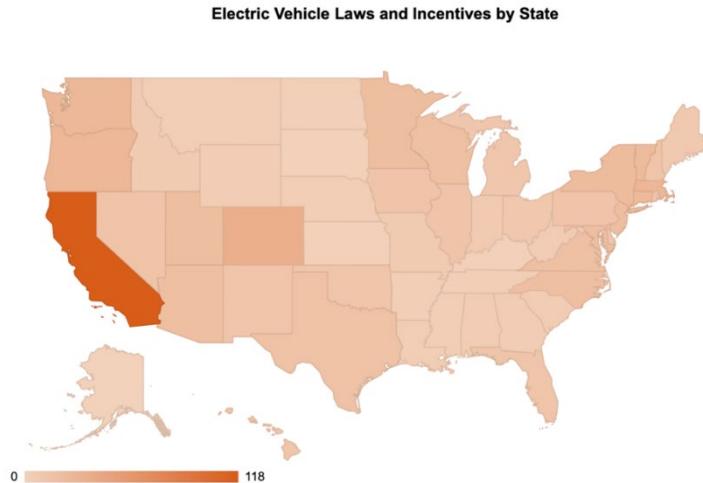


Figure 3: Incentives for EVs in the United States ranging from 0-118 laws and regulations.³²

Correlation does not necessarily mean causation. However, comparing Figures 2 and 3, it seems that there could be a relationship between incentives for EVs in a state and the amount of charging outlets. This comparison alludes to the fact that more incentives equal more charging outlets. If this were true, this shows how important government incentivization is to expanding an EV charging infrastructure.

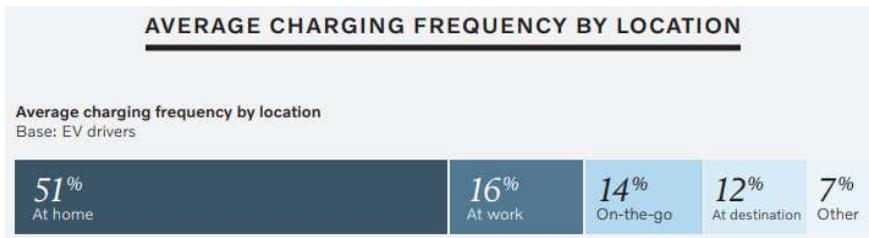


Figure 4: Volvo study shows EV charging location frequency in 2019.³³

³² *Maps and Data*, U.S. DEP'T OF ENERGY, <https://afdc.energy.gov/data/10373> (last visited Nov. 26, 2020).

³³ Rob Stumpf, *Americans Cite Range Anxiety, Cost as Largest Barriers for New EV Purchases: Study*, THE DRIVE (Feb. 26, 2019), <https://www.thedrive.com/news/26637/americans-cite-range-anxiety-cost-as-largest-barriers-for-new-ev-purchases-study>.

This 2019 study by Volvo shows that a majority of their EV's charging is done at home. There is an argument to be made that most EV charging happens at the home rather than at a public charger so why incentivize gas stations. Although this might be true now, this notion can be very misguided when looking towards the future. As of right now, the average cost of an EV in the U.S. is about \$55,600 whereas the average cost of a new car is around \$36,600.³⁴

Because the average cost of a new EV is about \$20,000 more than a new car, more affluent people could be buying EVs. A study performed by CarMax in 2017 reports that 70% of EV owners make over \$75,000 per year.³⁵ Coincidentally, according to Statista, the average income of a homeowner in 2017 was \$75,000.³⁶ This could mean that these more affluent people that are buying EVs right now have houses where level 2 EV chargers can be installed. However, as companies continue to focus on making EVs less expensive, a greater amount of Americans without houses will become buyers. This means all of these new EV drivers without houses would need places to charge their EVs—enter gas stations.

C. Cost of EV Charging – Tesla

EVs have a vast range of cost depending on model, location, and how much a consumer drives. Ultimately the costs vary depending on charging at charging stations versus home. At home costs also depend on your utility company. Because Tesla cars are the most popular EVs, it might help to use these as an example.

In the United States, the national average cost for power is 13 cents per kilowatt-hour (“kWh”) with an 85% charging efficiency for level 2 home chargers.³⁷ Based on these numbers, a Tesla Model X would take around \$15.29 for a full charge at 5 cents per mile providing 305 miles of driving range.³⁸ Whereas, the less expensive Tesla Model 3 would be fully charged at \$7.65 at \$0.03 cents per mile.³⁹

³⁴ Hearst Auto Research, *How much is an electric car?*, CAR AND DRIVER, <https://www.caranddriver.com/research/a31544842/how-much-is-an-electric-car/> (last visited February 7, 2021).

³⁵ Jason Hayes, *Taxing the poor to pay for your electric car*, MACKINAC CENTER (Jan. 28, 2019), <https://www.mackinac.org/taxing-the-poor-to-pay-for-your-electric-car>.

³⁶ *Median income of homeowners in the United States from 2005 to 2017*, STATISTA (Nov. 6, 2020), <https://www.statista.com/statistics/974721/median-income-homeowners-usa/>.

³⁷ Andrew Sendy, *The cost of charging a Tesla—and how it compares to gas vehicles*, SOLARREVIEWS (Nov. 7, 2020), <https://www.solarreviews.com/blog/how-much-does-it-cost-to-charge-a-tesla-is-it-the-same-as-the-cost-to-charge-other-electric-vehicles>.

³⁸ *Id.*

³⁹ *Id.*

According to SolarReviews, “this is almost 64% less than the cost per mile to drive the most popular gas-powered cars, which is approximately 13 cents per mile.”⁴⁰ One of the flaws pointed out in this article is that charging networks are tricky, making the consumers plan to account for slower charging stops.⁴¹ This leads to a phenomenon known as Range Anxiety.

D. Range Anxiety

Range Anxiety is one of the main reasons that consumers struggle to switch over to an electric car. Range Anxiety is “the fear that the electric vehicle won’t have sufficient charge to complete its duty, and it’s still perceived to be one of the greatest barriers preventing fleets from going electric.”⁴² Consumers are concerned that the car will run out of charge and they will be stranded. Also, the fact that consumers have to plan ahead of time for longer trips makes them uneasy about buying an EV. The study conducted by Volvo below reiterates the range anxiety problem that results in consumers struggling to make this switch to EVs. Furthermore, the low availability of charging stations adds to this uncertainty and fear. This is why creating a firm EV charging infrastructure needs to be important now rather than later.

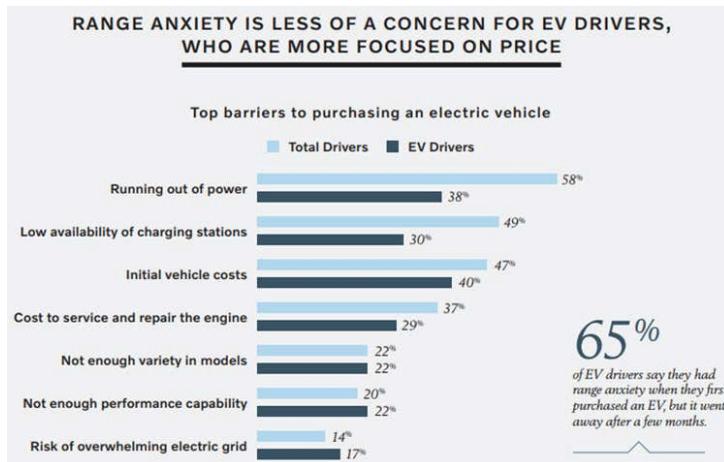


Figure 5: Volvo study citing the reasons of concern for purchasing EV vehicles.⁴³

⁴⁰ *Id.*

⁴¹ *Id.*

⁴² Lindsey Hall, *Overcoming EV range anxiety with electric vehicles*, GEOTAB (Nov. 6, 2019), <https://www.geotab.com/blog/range-anxiety/>.

⁴³ Stumpf, *supra* note 33.

E. Gas Stations

The evolution of gas stations has been remarkable in our history. Over time, these gas stations have gone from just providing gasoline to becoming convenience hotspots. The total number of gas stations in the United States has severely declined in the past two decades to around 115,000 total gas stations.⁴⁴ According to MarketWatch, “the reasons are primarily a fall off in the margins owners get, and more fuel efficient cars. And, while there are only a few hundred thousand electric cars in America, that figure is likely to surge. Gas stations, in many areas, will slowly disappear.”⁴⁵

When we think about companies like Subway or McDonalds, immediately two to three locations around you come to mind. Now to put the number of gas stations into perspective, in 2019, there were around 13,800 McDonalds⁴⁶ and 23,800 Subways.⁴⁷ Together, these two companies have around 37,600 locations. Imagine if all of the McDonalds and Subways were to close down and the jobs that would be lost. Now if you multiply that number by three (112,800), you get near the amount of Gas Stations in the United States. To think of the number of gas stations that could disappear and the jobs that would be lost from the economy is frightening.

To get more information from an insider, I interviewed Akshar Patel who fully or partially owns around 70 gas stations. He has been in the industry for over fifteen years and has built up his gas station network from scratch. When asked about how gas stations make money, Akshar responded,

the convenience store is where we make the most money. In certain markets selling gas is profitable but in other markets gas is used only to drive customer to the site. The sales of merchandise and fresh foods in a gas station is where the profitability is. As the industry is changing and evolving there is more emphasis on food, convenience and one stop shop for daily needs.⁴⁸

This seems to be true with most gas stations, as NBC reports that the “bread and butter” of gas stations is the convenience store aspect that generates higher

⁴⁴ *How Many Gas Stations Are In U.S.? How Many Will There Be In 10 Years?*, MARKETWATCH (Feb. 16, 2020), <https://www.marketwatch.com/story/how-many-gas-stations-are-in-us-how-many-will-there-be-in-10-years-2020-02-16>.

⁴⁵ *Id.*

⁴⁶ *Number of McDonald's restaurants in North America from 2012 to 2019, by country*, STATISTA (April, 2020), <https://www.statista.com/statistics/256040/mcdonalds-restaurants-in-north-america/>.

⁴⁷ *Number of Subway stores in the United States from 2015 to 2019*, STATISTA (April, 2020), <https://www.statista.com/statistics/469341/number-of-subway-restaurants-us/>.

⁴⁸ Telephone Interview with Akshar Patel, Businessman (10/01/2020).

profit margins than gasoline.⁴⁹ This shows that gas stations just need to attract customers to the site to be profitable and do not need to make most of their money through selling gasoline or charging for EVs.

Next, I asked what would happen to gas stations with this shift towards electric. Akshar said, “what will happen is we will have more sites converting from selling gas to selling electric charging for electric cars. I think the industry will evolve and adapt to the new demand. I will say we will see less gas stations as switching to electric will cost a lot.”⁵⁰ He emphasized the cost of switching to electric will lead to a decline in gas stations.

In Maryland, one gas station has already taken this step to fully switch to electric.⁵¹ The owner, Depeswar Dooley, does not expect to be rich overnight but he felt like this was the right thing to do for the environment and the community.⁵² Electric Vehicle Institute (“EVI”) and the Maryland Energy Administration jointly funded the conversion by providing \$786,000 and the CEO of EVI claims, “the area has had issues with the supply of charging stations not meeting the demand of EVs.”⁵³ The station allows up to four vehicles to charge at once and reach 80% capacity in 20-30 minutes.⁵⁴ EV owners can sit inside the convenience store which has screens that show the charging progress.⁵⁵ EVI takes 33% of the revenue from a charging session and Depeswar takes 66%.⁵⁶

⁴⁹ Darron Cummings, *Stations hope you will fill up with more than gas*, NBC (Apr. 1, 2008), <https://www.nbcnews.com/id/wbna23904590>.

⁵⁰ Patel, *supra* note 48.

⁵¹ Jacob Douglas, *First gas station in America to ditch oil for 100% electric vehicle charging opens in Maryland*, CNBC (Sep. 26, 2019), <https://www.cnbc.com/2019/09/26/first-gas-station-to-ditch-oil-for-electric-vehicle-charging-now-open.html>.

⁵² *Id.*

⁵³ *Id.*

⁵⁴ *Id.*

⁵⁵ *Id.*

⁵⁶ Hannah Hagemann, *Gas Station Converts To Electric Charging Station And Speeds Ahead Of Curve*, NPR (Oct. 26, 2019), <https://www.npr.org/2019/10/26/773446805/gas-station-converts-to-electric-charging-station-and-speeds-ahead-of-curve>.



Figure 6: Picture of Depeswar Dooley’s gas station in Tahoma Park, Maryland.⁵⁷

II. WHY NOW?

A. Domestic Outlook

In the United States, the shift to electric vehicles has become more than evident. On September 23, 2020, California Governor Gavin Newsom signed an executive order that requires all new cars sold in California to be zero-emission vehicles by 2035.⁵⁸ Speaking about one of the main reasons for the executive order, Governor Newsom stated, “this is the most impactful step our state can take to fight climate change. . . . For too many decades, we have allowed cars to pollute the air that our children and families breathe.”⁵⁹ California has been a national leader in EV technology and now they have backed it up with this executive order.

I asked Akshar Patel about his thoughts on this future ban and he responded, “I think overall if other states jump on this it will impact gas station owners. Currently the ban in California has already started creating stress over the

⁵⁷ *Id.*

⁵⁸ *Governor Newsom Announces California Will Phase Out Gasoline-Powered Cars & Drastically Reduce Demand for Fossil Fuel in California’s Fight Against Climate Change*, OFF. OF GOVERNOR GAVIN NEWSOM (Sep. 23, 2020), <https://www.gov.ca.gov/2020/09/23/governor-newsom-announces-california-will-phase-out-gasoline-powered-cars-drastically-reduce-demand-for-fossil-fuel-in-californias-fight-against-climate-change/>.

⁵⁹ *Id.*

future.”⁶⁰ This shift in California has clearly led to stressful situations for gas station owners. However, California has or will have incentives to help out these gas station owners.⁶¹ However, a cause for concern would be a major shift in other states that do not currently have incentives in place to help gas stations.

B. International Outlook

Internationally, many countries have also begun this switch into the future of EVs. In Germany, all gas stations will soon have to include an EV charging station at their location as part of its economic recovery package which includes 2.8 Billion for charging infrastructure.⁶² Talking about the German plan, Chairman of Quercus Real Assets, Diego Biasi, noted, “we know that 97% of the reason why they’re not buying electric cars is range anxiety. The German move is a way to try and fix this range anxiety since it means you know a petrol station is always open.”⁶³ Germany hopes that a more stable EV charging infrastructure will lead to a decline in range anxiety and an increase in EV sales.

Electrek reports that South Korea is making progress towards thousands of charging stations at gas stations.⁶⁴ South Korean car giant Hyundai is renovating big gas stations into EV charging stations. Hyundai has not finalized if their new charging network will be exclusive like Tesla’s supercharger network.⁶⁵ South Korea recognizes the importance of charging infrastructure that is needed to support the increasing number of EVs in the future.⁶⁶

Looking internationally, the common theme seems to be taking on the EV charging infrastructure at the start of this emerging EV movement. Solidifying a charging infrastructure will drive sales and ultimately lead to the ease for consumers to make the switch to EVs.

⁶⁰ Patel, *supra* note 48.

⁶¹ *Electric Vehicle Charging Incentives*, CHARGEPOINT, <https://www.chargepoint.com/index.php/incentives/commercial?type=15&state=19> (last visited February 6, 2021).

⁶² Roberto Baldwin, *In Germany, All Gas Stations Will Be Required to Provide EV Charging*, CAR AND DRIVER (June 5, 2020), <https://www.caranddriver.com/news/a32773392/germany-gas-stations-provide-ev-charging/>.

⁶³ Christopher Steitz & Edward Taylor, *Germany will require all petrol stations to provide electric car charging*, REUTERS (June 4, 2020), <https://www.reuters.com/article/us-health-coronavirus-germany-autos/germany-will-require-all-petrol-stations-to-provide-electric-car-charging-idUSKBN23B1WU>.

⁶⁴ Bradley Berman, *Korea plans thousands of fast EV charging at gas stations, now 76 and counting*, ELECTREK (Apr. 3, 2020), <https://electrek.co/2020/04/03/korea-plans-thousands-of-fast-ev-charging-at-gas-stations-now-76-and-counting/>.

⁶⁵ *Id.*

⁶⁶ Carrie Hampel, *South Korea expands electric and H2 stations for cars*, ELECTRIVE (Nov. 1, 2020), <https://www.electrive.com/2020/11/01/south-korea-expands-electric-and-h2-stations-for-cars/>.

C. *Emergence of Tesla and Automation*

On July 1, 2020, Tesla became the world's most valuable car company after a \$208 Billion dollar valuation.⁶⁷ To put that into perspective, Tesla is valued more than GM, BMW, Ford, and Honda combined.⁶⁸ Because Tesla cars are all EVs, this means that the market sees EVs becoming the new norm with that big of a valuation.

On the other hand, Tesla's supercharger network has a lot of growing to do. Tesla's superchargers are exclusive to Tesla owners and offer a competitive advantage by reducing range anxiety.⁶⁹ Forbes believes that the growth of the network is too slow compared to its vehicle deliveries.⁷⁰ Forbes reports, "Tesla's Cumulative deliveries have grown from 320k in Q1'19 to 790k in Q3'19, driven by the launch of the Model 3 sedan, its Supercharger connectors have grown from 9.3k to 14.7k in the same period."⁷¹ Forbes estimates that the number of cars per connector went from 35 to 54.⁷² This shows that the supercharger network along with the general EV charging network must expand at a faster pace to keep up with demand.

Autonomous driving by vehicles is another steadily growing concept in the industry that is linked directly to EVs. Tesla, a leader in this forefront is racing to make its vehicles fully autonomous. This would mean that the car would completely drive itself from Point A to Point B without ever having to touch the wheel. At the moment, Tesla's vehicles allow for autonomous driving on cruise control on the highway but not local. Musk believes that level 5 autonomous driving (basically fully autonomous) is "very close".⁷³ Another EV car company, Lucid Air, plans on releasing their fully autonomous technology for their EVs in the future as well.⁷⁴

⁶⁷ Sergie Klebnikov, *Tesla Is Now The World's Most Valuable Car Company With A \$208 Billion Valuation*, FORBES (July 1, 2020), <https://www.forbes.com/sites/sergieklebnikov/2020/07/01/tesla-is-now-the-worlds-most-valuable-car-company-with-a-valuation-of-208-billion/?sh=35430c9b5334>.

⁶⁸ *Id.*

⁶⁹ *A Closer Look at Tesla's Supercharger Network*, FORBES (Jan. 21, 2020), <https://www.forbes.com/sites/greatspeculations/2020/01/21/a-closer-look-at-teslas-supercharger-network/?sh=107d4d557193>.

⁷⁰ *Id.*

⁷¹ *Id.*

⁷² *Id.*

⁷³ Brenda Goh & Yilei Sun, *Tesla 'very close' to level 5 autonomous driving technology, Musk says*, REUTERS (July 8, 2020), <https://www.reuters.com/article/us-tesla-autonomous/tesla-very-close-to-level-5-autonomous-driving-technology-musk-says-idUSKBN24A0HE>.

⁷⁴ See Sebastian Blanco, *Lucid Air EV Introduces DreamDrive Autonomous Tech With OTA Updates*, FORBES (Jul. 28, 2020), <https://www.forbes.com/sites/sebastianblanco/2020/07/28/lucid-air-ev-introduces-dreamdrive-autonomous-tech-with-ota-updates/?sh=7f9732769b52>.

Since this movement is associated with EVs, this shows the need for an expansive EV charging network. A better EV charging network will not only lead to the ease of buying EVs but will also be beneficial to fully autonomous driving cars in the future.

D. Climate Change

Electric Vehicles help our climate change problem is one of the most popular reasons why enthusiasts stress the importance of switching to EVs. The U.S. Department of Energy notes, “In general, EVs produce fewer emissions that contribute to climate change and smog than conventional vehicles.”⁷⁵ On the other hand, while criticizing Governor Newsom’s executive order for new ICE vehicles, David Kreutzer, an economist at the Institute for Energy Research, said, “Electric cars might not have emissions at a tailpipe, but they do have emissions at the power plant.”⁷⁶ This outlines one issue of electric vehicles but misses the overall benefits that come from driving an EV when compared to an ICE vehicles.

Direct and life cycle emissions are the two general categories of vehicle emissions.⁷⁷ The tailpipe on a car produces the direct emissions through evaporation and the fueling process.⁷⁸ These direct emissions, “include smog-forming pollutants (such as nitrogen oxides), other pollutants harmful to human health, and greenhouse gases (GHGs), primarily carbon dioxide.”⁷⁹ Because EVs do not have tailpipes or even an engine, they produce zero direct emissions.

Zero direct emissions is what separates EVs from ICE vehicles. In the United States, transportation such as cars, trucks and other forms are the largest contributors to air pollution.⁸⁰ According to Sciencing.com, “Car exhausts emit a wide range of gasses and solid matter, causing global warming, acid rain, and harming the environment and human health.”⁸¹ This points out the major advantage that EVs have because they do not have exhausts. Furthermore,

⁷⁵ *Reducing Pollution with Electric Vehicles*, U.S. DEP’T OF ENERGY, <https://www.energy.gov/eere/electricvehicles/reducing-pollution-electric-vehicles> (last visited Nov. 26, 2020).

⁷⁶ *California Governor Signs Order Banning Sales of New Gasoline Cars by 2035*, NPR (Sep. 23, 2020), <https://www.npr.org/2020/09/23/916209659/california-governor-signs-order-banning-sales-of-new-gasoline-cars-by-2035>.

⁷⁷ U.S. DEP’T OF ENERGY, *supra* note 75.

⁷⁸ *Id.*

⁷⁹ *Id.*

⁸⁰ Jenny Green, *Effects of Car Pollutants on the Environment*, SCIENCING (Mar. 13, 2018), <https://sciencing.com/difference-between-human-natural-air-pollution-23687.html>.

⁸¹ *Id.*

because EVs do not use gas that means that less gasoline needs to be produced overall which leads to less life cycle emissions.

Life cycle emissions are associated with fuel and vehicle production, processing, and distribution.⁸² In 2019, only 17% of energy produced in the U.S came from renewable energy and 61% was produced through burning fossil fuels which leads to a negative impact on the environment.⁸³ Life cycle emissions can be reduced by generating electricity from non-polluting renewable resources like wind and solar.⁸⁴ U.S. Dep't of Energy points out "However, EVs typically produce fewer life cycle emissions than conventional vehicles because most emissions are lower for electricity generation than burning gasoline or diesel."⁸⁵

First, manufacturing seems to be a big concern for opponents of EVs who question if EVs really help the environment. However, the more common EVs become, battery recycling will become more popular which will ultimately lead to less reliance on the production on new batteries.⁸⁶

Second, the source of the electricity used to charge EVs is another key concern. However, electric grids are focusing on relying less on fossil fuels and more on renewable energy.⁸⁷ In 2019, 15% of the electricity generated in the U.S. came from renewable sources, which is a 6% jump from the previous decade.⁸⁸ These wind and solar farms directly feed energy to the grid and the grid is being updated to accommodate renewable sources contributing to electricity.⁸⁹

On January 27, 2021, President Joe Biden signed an executive order to spend \$400 billion to support commercialization of clean energy technologies, accelerate clean energy generation and shift the federal fleet to EVs.⁹⁰ The main

⁸² U.S. DEP'T OF ENERGY, *supra* note 75.

⁸³ *Electricity Explained*, U.S. ENERGY INFORMATION ADMIN. (Mar. 20, 2020), <https://www.eia.gov/energyexplained/electricity/electricity-in-the-us.php>.

⁸⁴ U.S. DEP'T OF ENERGY, *supra* note 75.

⁸⁵ *Id.*

⁸⁶ James Ellsmoor, *Are electric vehicles really better for the environment?*, FORBES (Mar. 20, 2019), <https://www.forbes.com/sites/jamesellsmoor/2019/05/20/are-electric-vehicles-really-better-for-the-environment/?sh=71311d1d76d2>.

⁸⁷ *Id.*

⁸⁸ Nate Berg, *How the US power grid is evolving to handle solar and wind*, ENSIA (Oct. 3, 2019), <https://ensia.com/features/us-power-grid-renewables-wind-solar/>.

⁸⁹ *Id.*

⁹⁰ Jeff John, *Biden Executive Orders Set Broad Federal Role in Clean Energy and Climate Change Mitigation*, GTM (Jan. 27, 2021), <https://www.greentechmedia.com/articles/read/biden-executive-orders-set-broad-federal-role-in-climate-change-and-clean-energy>.

goal is to shift the country from its reliance on fossil fuels to sources of low-no carbon energy.⁹¹ Federal agencies have also been directed to focus on improving the grid infrastructure to accommodate the growth in renewable energy as a source of electricity.⁹² Finally, the plan is to switch the 645,000 federally owned cars to electric vehicles.⁹³ This move by President Biden shows that as EVs become more popular, the push for renewable energy as the source to charge batteries becomes stronger.

Biden administration's focus on renewable energy will further lower the life cycle emissions of EVs which will ultimately lead to less impact on global warming. EVs already produce zero emissions when compared to ICE vehicles. In conclusion, EVs clearly help the fight against climate change when compared to ICE vehicles as EVs produce zero direct emissions and its life cycle emissions are being reduced as technology advances.

III. THE PRESENT LANDSCAPE

A. *The Cost of EV Charging*

The higher the level of EV chargers, the higher the cost. These charger's costs depend on a variety of factors such as level, location, installation.⁹⁴ According to the U.S. Dep't of Energy, "[s]ingle connector unit costs range from \$300 to \$1,500 for Level 1, \$400 to \$6500 for Level 2, and \$10,000 to \$40,000 for DC fast charging."⁹⁵ Chargers can also be connected to the internet to send data such as charging progress.⁹⁶ Installation for these chargers can also be very costly, varying from \$600 to \$12,700 for Level 2 and \$4,000 to \$51,000 for DC fast charging.⁹⁷

For gas stations, DC fast chargers would be the appropriate level to install. By taking both the low costs and high costs for purchase and installation, one station can cost anywhere from \$14,000 to \$91,000! That is without other associated costs such as maintenance, permitting, compliance, signage and markings.⁹⁸ Looking to Depeswar Dooley's fully converted gas station to

⁹¹ *Id.*

⁹² *Id.*

⁹³ *Id.*

⁹⁴ *Developing Infrastructure Procurement and Installation*, U.S. DEP'T OF ENERGY, https://afdc.energy.gov/fuels/electricity_infrastructure_development.html (last visited Feb. 3, 2020).

⁹⁵ *Id.*

⁹⁶ *Id.*

⁹⁷ *Id.*

⁹⁸ *Id.*

charging station, the full costs for that conversion were uncertain but he needed a \$786,000 grant to help fund this venture.⁹⁹ This type of money is not easy to come by for a gas station owner. Depeswar received a gracious grant but all in all this stresses the importance of much needed financial aid to make this conversion.

B. Incentives

In general, there are many incentives going in and out when it comes to the EV industry. These incentives go from the initial consumer purchase of a car to installation of charging stations. For consumers, state and federal government have used tax cuts as the major incentive to buy an EV. The federal government will give a federal income tax credit up to \$7,500 for electrical vehicles purchased after 2010.¹⁰⁰ However, this federal tax credit only applies to companies that have not sold more than 200,000 total EVs already.¹⁰¹ This would mean that a consumer buying from Tesla, the most successful EV company, would not be applicable for this federal tax cut.

The Alternative Fuel Infrastructure Tax Credit gives a credit for 30% of the cost up to \$30,000 for buying and installing an EV charger.¹⁰² This tax credit can also be used for each charging station that a business installs but only for installation and equipment and will expire at the end of 2021.¹⁰³ It is concerning that the tax credit will expire at the end of 2021, however with Biden becoming president, this credit will likely be extended. The fact that there is an existing incentive to private businesses in these states, shows that there is no current federal encroachment on state rights or duties.

However, this incentive is not close to enough for a gas station to make a conversion from gas to EV charging. Evbox, an EV charging station company, compared this credit with their pricing.¹⁰⁴ For a DC fast charger the hardware cost is \$43,250 and installation is \$21,000 which brings the total to \$64,250.¹⁰⁵

⁹⁹ Douglas, *supra* note 51.

¹⁰⁰ Brian Normile, *Which Electric Cars Are Still Eligible for the \$7,500 Federal Tax Credit?*, CARS.COM (Dec. 1, 2020), <https://www.cars.com/articles/which-electric-cars-are-still-eligible-for-the-7500-federal-tax-credit-429824/>

¹⁰¹ *Id.*

¹⁰² *Alternative Fuel Infrastructure Tax Credit*, U.S. DEP'T OF ENERGY, <https://afdc.energy.gov/laws/10513> (last visited February 6, 2021).

¹⁰³ *Id.*

¹⁰⁴ *Save 30% on EVBox Stations*, EVBOX, <https://evbox.com/us-en/learn/rebates/federal-tax-credit-30> (last visited February 6, 2021).

¹⁰⁵ *Id.*

Applying the 30% tax credit this would save \$19,275, for a grand total of \$44,975.

Keep in mind, this price would be for just installing one charging station and not all of the other associated costs. To name a couple big expenses, the underground storage tanks at gas stations must be removed and power lines to support charging must be added. While this tax credit is very generous, Depeswar Dooley received a \$786,000 grant to help him fund the conversion of four gas pumps to charging stations.¹⁰⁶ This is the only major federal incentive to help owners pay for an EV charging station, but it is not nearly enough.

In California, there are a lot of private, state, and local incentives to buy or lease an EV. The California Air Resources Board has set up the Clean Vehicle Rebate Project which promotes clean vehicles by offering rebates up to \$7,000 for the purchase or lease of EVs.¹⁰⁷ The project offers increased incentives for some public entities that operate in more vulnerable and polluted areas.¹⁰⁸ There are plenty of private incentives through electric companies as well.¹⁰⁹

Anaheim Public Utilities Public Access Electric Vehicle Charging Station Rebate Program is a local incentive in California that provides up to \$5,000 to install up to four DC charging stations for public access.¹¹⁰ The Sacramento County Incentive Project has a total of about \$6.3 million dollars in funds available to incentivize DC chargers in the county.¹¹¹ There are many other local and private incentives for charger installation in California as well¹¹² to promote EV growth by expanding the EV charging infrastructure.

Across the US, multiple cities and states are adopting new laws and regulations to help transition to the new EV economy.¹¹³ In Arizona, the Tuscan Electric Power Smart EV Charging Program will cover up to \$24,000 or up to 75% of the costs to purchase and install a DC fast charger for a business.¹¹⁴ This is a very big but also rare incentive program from a private company that helps

¹⁰⁶ Douglas, *supra* note 51.

¹⁰⁷ *About CVRP*, CENTER FOR SUSTAINABLE ENERGY, <https://cleanvehiclerebate.org/eng/about-cvrp> (last visited February 6, 2021).

¹⁰⁸ *Id.*

¹⁰⁹ *Electric Vehicle Charging Incentives*, CHARGEPOINT, <https://www.chargepoint.com/index.php/incentives/commercial?type=15&state=19> (last visited February 6, 2021).

¹¹⁰ *Id.*

¹¹¹ *Id.*

¹¹² *Id.*

¹¹³ Bradley Berman, *Cities and states lead the way on new electric vehicle incentives*, ELECTREK (May 5, 2020), <https://electrek.co/2020/05/05/cities-and-states-lead-the-way-on-new-electric-vehicle-incentives/>.

¹¹⁴ *Id.*

in a big way. Connecticut announced that they want ten times the amount of EVs to be on the road by 2025 and provide \$1,500 for the purchase of EVs with a range of 200+ miles.¹¹⁵

In New Jersey, Governor Murphy signed Senate Bill 2252 into law that allows up to \$5,000 in rebates for EV purchases.¹¹⁶ The governor has also stated, “By establishing aggressive goals and strong incentives for electric vehicles, we are repositioning our economy and state for a clean future.”¹¹⁷ Governor Murphy explains the importance of governmental incentives to help promote this leap into a clean future powered by more EVs in the market.

In Georgia, the story is a bit different. For consumers, there are currently no state tax credits for the purchase or lease of EVs.¹¹⁸ However, EVs are allowed to use the interstate HOV lanes regardless of the number of passengers and the time.¹¹⁹ This is a drastic change in incentives that California has to offer and shows Georgia’s minimal interest in expanding into EVs.

Surprisingly, Georgia does have the Electric Vehicle Supply Equipment Tax Credit which offers up to 10% or \$2,500 of EV charging costs.¹²⁰ When realizing that the \$30,000 federal tax credit is not enough, this does not go far in helping the burden of buying and installing EV charging stations. For Georgia, the limited amount of EV incentives pushes potential EV buyers away from making the switch from ICE vehicles.

However, there are many states such as Georgia that have little to no incentives to purchase an EV or charging station. Looking at Picture 4, it is clear that most southern states such as Tennessee, Alabama, South Carolina, and Mississippi offer just as little incentives and laws relating to EVs.¹²¹ The overall trend for states that do offer EV incentives, seems to be incentives for the initial purchase of an EV. Although there is nothing wrong with that, there needs to be more of a push for incentives for EV charging stations. As noted earlier, most consumers have EV range anxiety, and this could be diminished by more EV chargers on the road.

¹¹⁵ *Id.*

¹¹⁶ *Id.*

¹¹⁷ *Id.*

¹¹⁸ *Georgia laws and Incentives*, U.S. DEP’T OF ENERGY, <https://afdc.energy.gov/laws/all?state=GA> (last visited February 6, 2021).

¹¹⁹ *Id.*

¹²⁰ *Id.*

¹²¹ *Maps and Data*, U.S. DEP’T OF ENERGY, <https://afdc.energy.gov/data/10373> (last visited Nov. 26, 2020).

In the legislature, Congresswoman Alexandria Ocasio-Cortez (D-NY) and Congressman Andy Levin (D-MI) took note of the importance of EV chargers for the expanding EV market.¹²² In the 116th Congress, they introduced H.R. 5770: EV Freedom Act which aims to establish a national network of EV charging stations.¹²³ The focus of the bill is to develop an EV charging network along the interstate highway system to where anyone can drive from any point A to point B along the national interstate system in the United States.¹²⁴

The bill states, “failure to access to publicly accessible electric vehicle chargers will prevent the wider adoption of electric vehicles and, therefore, hinder progress towards a more sustainable transportation system.”¹²⁵ The legislators realize that developing a larger EV charging infrastructure can lead to less EV range anxiety and more EV sales that will drive the transportation sector towards sustainability.

The action phase of the bill calls for a grant program that awards grants through the Secretary of Energy and Secretary of Transportation to eligible entities to implement this plan.¹²⁶ Some of the eligible entities include a state, a transit agency, port authority, Indian tribe, for-profit businesses, and non-profit organizations.¹²⁷ The bill also requires the Transportation Research Board of the National Academy of Sciences to study different options when it comes to financing the project and partnering with private companies such as gas stations.¹²⁸

Despite some holes with the EV Freedom Act, the bill shows the importance of the role the federal government can play in helping create an EV charging infrastructure. The bill ultimately died in the 116th congress as electric vehicle adoption was not towards the forefront of the Trump administration’s agenda.¹²⁹ However, this was an important first step to shed light on the poorly developed EV charging network in the United States today.

The bill did point out that the existing rest areas along the national interstate highway system would be perfect starting points to add EV chargers.¹³⁰ In the

¹²² EV Freedom Act, H.R. 5770, 116th Cong. (2020).

¹²³ *Id.*

¹²⁴ Mark Kaufman, *What America’s epic electric vehicle charging system may look like*, MASHABLE (Feb. 11, 2020), <https://mashable.com/article/electric-vehicle-charging-network-us/>.

¹²⁵ EV Freedom Act, *supra* note 122.

¹²⁶ *Id.*

¹²⁷ *Id.*

¹²⁸ *Id.*

¹²⁹ *Id.*

¹³⁰ *Id.*

same way, there are plenty of gas stations in the United States that have the space ready to add EV charging stations but just need funds. If the government could create better incentives for these gas station owners, then the EV charging network could expand and get us out of this limbo.

C. Shopping Centers, Restaurants, & Office Spaces

Looking at the present landscape, there is a strong trend for charging while dining, shopping, or working.¹³¹ This seems like a very popular movement with EV charging stations because it is convenient for the consumer. As for the business, having an EV charging station attracts consumers to their location. The hope is that consumers will choose a restaurant with a charger versus one without so that the car can charge while they are dining instead of waiting around. Shopping centers and work areas use the same tactics to help consumers out.

This trend seems to work against the point that the government should incentivize EV charging stations at gas stations. However, this would be misguided because having EV chargers at these locations is convenient now but not for the future. This process works now because there are very little EVs on the road today,¹³² however that will not be the case in the future. Due to growth in EVs on the road, there will need to be EV chargers in more places than just restaurants, office buildings, and shopping centers. This is why incentivizing EV chargers for gas stations will help build the infrastructure needed to match the growth of EVs.

Another reason why this trend does not hinder gas station's from installing EV charging stations is charging speed. At the moment, DC fast chargers charge 80% in about 30 minutes¹³³ which is the perfect amount of time for a food stop. However, as EV technology progresses, through EV batteries and charging stations, this charge time will become faster. As charging times become faster, gas stations with convenience aspects become the perfect quick stops for a charge.

¹³¹ *Making the Most of the Trend of Eating and Charging*, BLINK, <https://blinkcharging.com/restaurants-making-the-most-of-the-trend-of-eating-and-charging/> (last visited February 6, 2021).

¹³² See Alex Kopestinsky, *Electric Car Statistics in the US and Abroad*, POLICYADVICE (Feb. 26, 2021), <https://policyadvice.net/insurance/insights/electric-car-statistics/>.

¹³³ CHARGEPOINT, *supra* note 21.

CONCLUSION

There is no perfect solution on how to build an EV charging infrastructure that will be able to support the upcoming growth of EVs. Again, consumers do not want to buy electric vehicles without a better charging infrastructure and businesses do not have enough incentives to build that better charging infrastructure. One way to get the United States out of this limbo is for the federal government to further incentivize EV charging stations for gas stations. This will create security for potential EV buyers to make the switch and not worry about Range Anxiety.

There are around 115,000 gas stations in the United States¹³⁴ today that face the realization that ICE vehicles will slowly become cars of the past. All of these gas stations employ many Americans and are situated on prime locations for car flow in and out. These factors make gas stations the perfect locations for EV charging stations.

However, making the switch from gas pumps to electric stations is not an easy task as the costs are immensely high. Gas stations would have to remove the underground gasoline storages and replace them with electric lines to support the charging stations. Factoring in the cost of the hardware and installation, a full conversion would cost a gas station a lot of money which is not reasonably practical. To put it into perspective, Depeswar Dooley received a \$786,000 grant just to help make this switch.¹³⁵ Gas stations could use funding to install these charging stations to stay relevant by attracting people to the location and making most of the sales inside the store through the convenience aspect.

The federal government needs to charge this movement by providing incentives to gas stations for EV charging stations. One of the main motivators for the federal government is the environmental benefits that come from U.S. drivers switching from ICE vehicles to EVs. EVs produce zero direct emissions and the life cycle emissions of an EV are being reduced as renewable energy becomes more central. Because the transportation sector is the largest contributor to air pollution that drives climate change,¹³⁶ a switch to EVs would vastly improve the environment.

Domestically, Governor Newsom has already announced that all new cars sold in California have to be zero-emission vehicles by 2035.¹³⁷ This already is

¹³⁴ MARKET WATCH, *supra* note 44.

¹³⁵ Douglas, *supra* note 51.

¹³⁶ Green, *supra* note 80.

¹³⁷ OFF. OF GOVERNOR GAVIN NEWSOM, *supra* note 58.

big step into phasing out ICE vehicles on the California roads and shows the emergence of EVs. Internationally, there are many countries that are developing their EV charging infrastructure to increase the amount of EVs on the road. Germany realizes that a successful EV charging network is vital to decrease range anxiety and grow their EV sales by requiring all gas stations to have a charging station.¹³⁸

Looking at the present landscape of the United States, some EV chargers are situated at restaurants, shopping centers, and office spaces. However, this can only support the EVs on the road now, and not a full-blown switch to EVs by all drivers. Furthermore, the last thing the United States wants is a bunch of private companies making exclusive charging networks for only their cars like Tesla's supercharging network. Having a bunch of different exclusive networks would make the choice of changing from ICE vehicles to EVs for consumers that much tougher. However, the government could prevent such a tragedy if it were to further incentivize gas stations to make an open network that supports all EVs.

The government can provide incentives that are contingent upon having the charging stations open to all brands of EVs. As noted earlier, there is interest in moving into the future of EVs in the legislature evident by the EV Freedom Act.¹³⁹ To avoid the government from choosing which gas stations to fund, the incentive would need to be available to all gas stations willing to install EV charging stations. This would allow the process of building up the charging station infrastructure to be fast and a lot more efficient. Even though the government currently provides the \$30,000 tax credit incentive,¹⁴⁰ that is not nearly enough for gas station owners to make the switch. The federal government could continue funding this endeavor by giving tax credits for these further incentives.

In the end, there will probably be a decline in the amount of gas stations in the United States. However, providing increased incentives for EV charging stations might be enough of a push to keep around as many gas stations as possible. These incentives could help avoid having these ideal gas station locations from having to repurpose or simply die off. Building a wide network of EV charging stations benefits more than just consumers but also the environment. Creating this EV charging infrastructure might just get potential

¹³⁸ Baldwin, *supra* note 62.

¹³⁹ EV Freedom Act, *supra* note 122.

¹⁴⁰ U.S. DEP'T OF ENERGY, *supra* note 102.

EV buyers to come out of the limbo and move on from ICE vehicles and into battery electric vehicles.

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