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Written Statement of Ajay Chawan

Prepared for the United States Senate Committee on Environment and Public Works

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Good morning, Chairman Barrasso, Ranking Member Carper, and members of the committee. Thank you for the opportunity to be here with you today. My name is Ajay Chawan and I am here to provide the Committee testimony regarding the benefits, challenges, and opportunities associated with electrified transportation.

I have worked in the electric vehicle field since 2012 and have led efforts to bring three electrified vehicles to market. Currently, I am a member of the transportation-to-grid team at Navigant Consulting where I help organizations, including municipalities and utilities, transition to using electric vehicles.

The movement toward the development and production of electric vehicles (EVs) represents a revolution in how people and goods will move and has the potential to impact numerous portions of our lives. Three areas I would like to touch on today include energy security, jobs, and health.

Electric vehicles provide a significant opportunity to reduce our dependence on foreign oil. The U.S. is a net importer of about 854 million barrels of oil annually.[1] For each consumer EV that gets put on the road, we can reduce our oil consumption by 25 barrels per year.[2] Those same EVs can be powered by electricity produced from a variety of domestic energy sources that employ American workers.

The transportation sector is a significant source of employment in America. The consumer automotive segment alone directly employs more than 7 million people, and indirectly impacts millions of others who live in these communities.[3] As transportation technology advances, the nature of these jobs will continue to evolve. The need for workers who are skilled in computer programming, advanced manufacturing, and chemistry will continue to increase. American students who have benefitted from an emphasis on Science, Technology, Engineering, and Math, or STEM, curriculums will be well-equipped to enter these technology-focused spaces.

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[1] U.S. Energy Information Administration, https://www.eia.gov/tools/faqs/faq.php?id=727&t=6

[2] Alternate Fuels Data Center https://afdc.energy.gov/data/ , U.S. Department of Transportation Bureau of Transportation Statistics https://www.bts.gov/content/average-fuel-efficiency-us-light-duty-vehicles, U.S. Energy Information Administration https://www.eia.gov/tools/faqs/faq.php?id=327&t=9, Internal analysis.

[3] Alliance of Automobile Manufacturers, https://autoalliance.org/

Finally, eliminating the tailpipes on cars and trucks will result in cleaner air due to a reduction in particulates, including carbon monoxide and nitrogen oxide, from engine exhaust. These and other exhaust components are known to contribute to costly diseases including asthma, heart disease, and cancer. One 2010 study found that, if clean air standards were met in California, 30,000 emergency room visits would have been avoided, saving $193 million in hospital expenses for that state alone[4]. EVs will help achieve those clean air standards.

EVs have been growing in popularity since they entered the market on a mass scale in the beginning of this decade. In 2012, there were approximately 14,000 units sold across six models. In 2018, more than 225,000 vehicles were sold across 16 models – an increase of 1500%.[5] Next year, consumers will have at least 40 EV models to choose from. For reference, total annual vehicles sales in the U.S. is about 15 to 16 million units over about 500 models. In 2030, Navigant projects there will be about 3 million EVs purchased that year and 13 million EVs will be on the road in the U.S.[6]

Figure 1 below illustrates the growth of EVs globally during the period 2010 to 2018. It is important to note that, while the sales of EVs in the U.S. grew by 1,500% between 2012 and 2018, EV sales in China increased by almost 8,000% during this same period. According to Navigant Research, EV sales are expected to continue growing globally at a compounded annual growth rate (CAGR) of 26.1%; this growth is illustrated below in Figure 2.

[4] Romley, John. "The Impact of Air Quality on Hospital Spending." *Rand Corporation.* https://www.rand.org/pubs/technical_reports/TR777.html

[5] InsideEVs https://insideevs.com/news/344007/monthly-plug-in-ev-sales-scorecard-historical-charts/, Internal analysis.

[6] *Market Data: Global EV Market Forecasts; Global Forecasts for Light Duty Plug-In Hybrid and Battery EV Sales and Populations: 2018 – 2030*. Published 1Q 2019. Navigant Research.

Figure 1: Global EV sales 2010 – 2018

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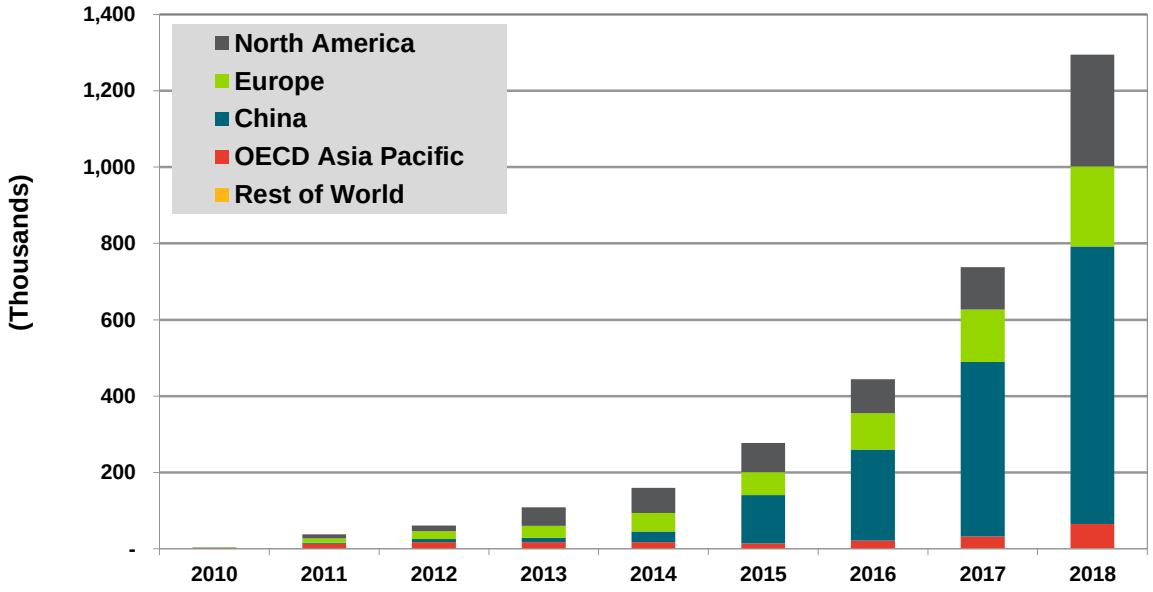
Chart 3-4
BEV Sales by Region, World Markets: 2010-2018



Source: Navigant Research

Figure 2: Projected Global EV sales, 2019 – 2030

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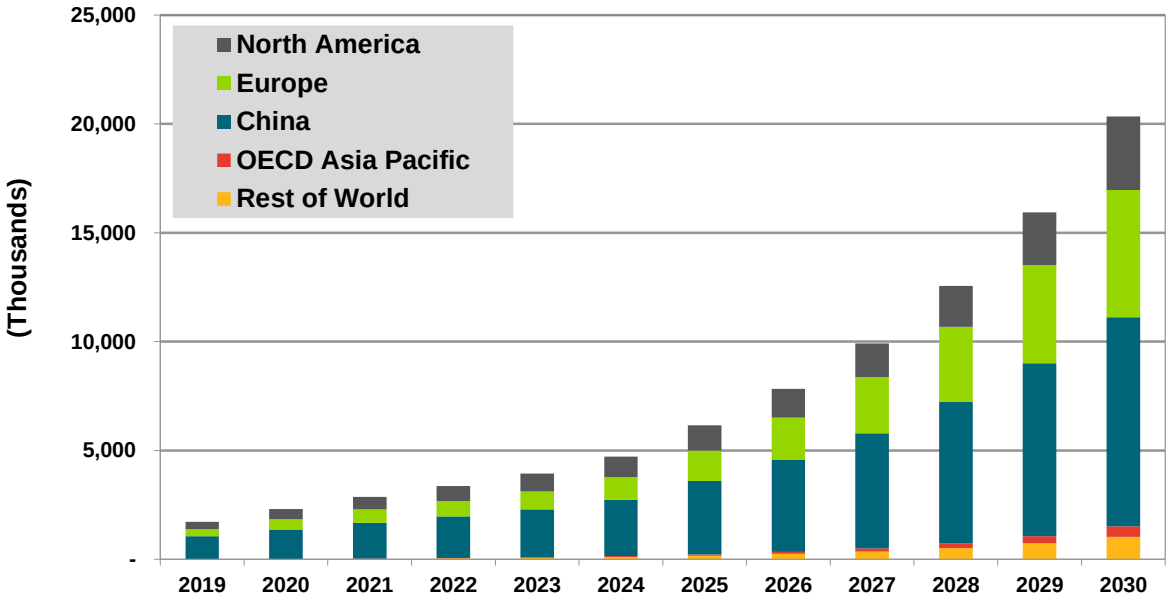
Chart 3-4
BEV Sales by Region, World Markets: 2019-2030



Source: Navigant Research

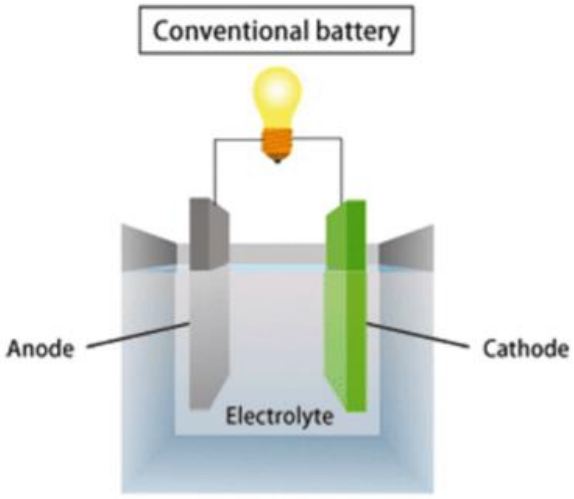
Given this projected strong growth in the EV market globally, automakers are making significant investments in electric vehicle technology firms. Between 2014 and today, private investment in the automotive and transportation sector has attracted $18.47 billion in private investment. It is worth noting that only about 13% of this investment came from traditional transportation companies. The rest of the investment has come from organizations from outside the industry. Outside investors include technology firms such as Alphabet and venture capital/private equity firms.[7]

One of the major areas of investment in the EV space is in battery technology. The batteries used in EVs today primarily use a combination of lithium, cobalt, and nickel (for the anode). Figure 3 below illustrates the common composition of a lithium-ion battery that is commonly used in EVs.[8]

[7] CB Insights, analyst interviews.

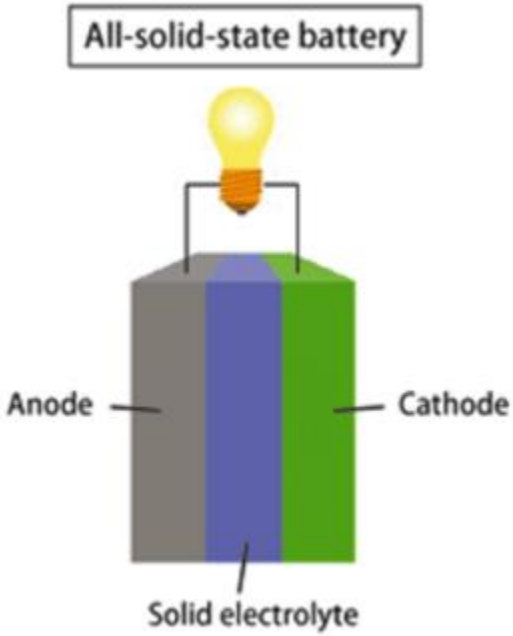
[8] Spring8. http://www.spring8.or.jp/en/news_publications/research_highlights/no_49/

Figure 3: Conventional EV battery configuration



One focus of battery research today is to replace the liquid electrolyte (which is commonly made from lithium salt), with a solid electrolyte. This revised configuration is shown below in Figure 4.[9]

Figure 4: Solid-state battery configuration

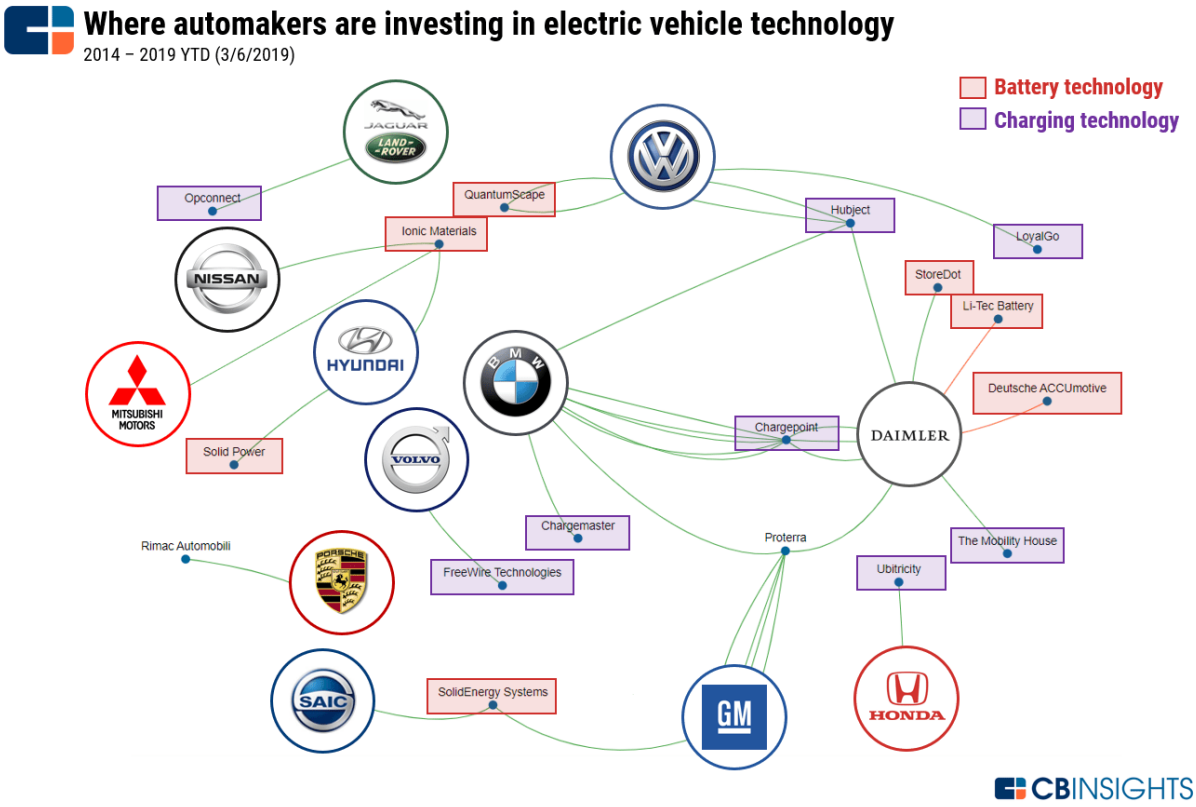


[9] Spring8. http://www.spring8.or.jp/en/news_publications/research_highlights/no_49/

A solid-state battery offers numerous advantages over a conventional lithium-ion battery, including easier handing, increased energy density (more EV miles per battery), and reduced quantity of elements required. This reduction of elements will alleviate the demand of elements that are particularly challenging to obtain, such as cobalt.[10] Battery manufacturers and EV manufacturers alike are working toward the reduction of these elements. This is of particular importance for U.S. manufacturers, as lithium, cobalt, and nickel are sourced internationally. The U.S. does not have sizeable deposits of these materials. According to the U.S. Geologic Survey (USGS), U.S. reserves for these materials is less than 1% of global reserves.[11]

Given numerous benefits offered by and projected growth of EVs, automakers are investing heavily in outside firms who are developing EV technology. Where automakers are making investments is illustrated below in Figure 5.

Figure 5: Where automakers are investing in electric vehicle technology



[10] *Interview with Caspar Rawles, Benchmark Mineral Intelligence.* https://www.theverge.com/2018/6/21/17488626/elon-musk-cobalt-electric-vehicle-battery-science

[11] U.S. Geologic Survey, https://www.usgs.gov/centers/nmic/lithium-statistics-and-information, https://www.usgs.gov/centers/nmic/cobalt-statistics-and-information, https://www.usgs.gov/centers/nmic/nickel-statistics-and-information

One automaker absent from Figure 5 is Toyota. Toyota has stated that it intends to introduce a solid-state battery by 2022, possibly sooner[12]. Amongst the firms pursuing solid-state technology, Toyota leads them all with 25 patent applications. Toyota is followed by Fujifilm Holding Corporation (18 patent applications), QuantumScape (10 patent applications), and Hyundai Motor Company (10 patent applications).[13]

One of the key opportunities to harness with the increase of EV proliferation is what to do with the battery when the vehicle comes off the road. The average life of a car or truck in the U.S. is about 11 years.[14] After this time, an EV's battery still has about 70% of its storage capacity left.[15] One option receiving significant consideration today is to use these batteries to provide backup power at critical locations, such as military facilities, hospitals, and data centers. Finding uses to give a second life to batteries is an area my team is very focused on.

As research and investment dollars continue to flow into the EV battery space, their characteristics will continue to evolve. This includes the very elements used to make batteries and methods by which they can be redeployed and later recycled. Our research and data have shown there are social, domestic energy security, economic, and societal benefits from electric transportation that are poised to increase in the coming years.

Thank you for the opportunity to share this testimony and for this Committee's important work.

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[12] "Toyota pushes ahead with solid-state batteries for future electric cars." *Digital Trends.* https://www.digitaltrends.com/cars/toyota-may-introduce-solid-state-batteries-for-electric-cars-by-2020/

[13] CB Insights, analyst interviews.

[14] U.S. Department of Transportation, Bureau of Transportation Statistics, https://www.bts.gov/content/average-age-automobiles-and-trucks-operation-united-states, Internal analysis

[15] Internal analysis