Responding to "An Uphill Battle for EVs vs ICEs": setting the record straight on the status and future of EV adoption

BY MATTEO MURATORI, CATHERINE LEDNA, CHRIS GEARHART, JOHN FARRELL, AND DAVID GREENE

In its Fourth Quarter 2020 edition, the IAEE Energy Forum published a perspective article authored by Mamdouh Salameh in which he asserts that "...while electric vehicles (EVs) are bound to get a share of the global transport system, they will never prevail over internal combustion engine vehicles (ICEVs). As a result, ICEVs will continue to be the dominant means of transport throughout the 21st century and far beyond." In that article Mr. Salameh makes several assertions to support his conclusions: 1) EV adoption has been negligible as of today; 2) massive investments are required to expand the global electricity generation capacity; 3) EVs have prohibitive purchase costs and higher operational costs relative to ICEVs; 4) EVs have poor charging speeds and availability; and 5) there is a lack of global support for transitioning to EVs, especially from industry. All these assertions, however, are not based on the most recent data and possibly misleading. In this response, we offer up-to-date data and statistics on the state of the global EV market and EV technologies. While we cannot predict the future success of different technologies, we argue that with respect to EVs, Mr. Salameh's outlook is outdated, factually inconsistent and overly pessimistic of the ingenuity displayed in solving seemingly intransigent problems.

EV adoption is growing globally, with more than 7 million passenger electric vehicles on the road

Mr. Salameh claims that EVs and hybrids together make up a negligible share of the global vehicle market, citing 4 million EVs and hybrids globally compared to 1.5 billion ICEVs. Looking only at EVs,[1] and excluding hybrids (which should not be conflated), we find that these numbers are out of date. As of December 2019, there were over 7.2 million electric passenger cars globally (and many more electric 2- or 3-wheelers and buses).[2] Globally, EVs have grown exponentially in the last decade, increasing from 0.23 million in 2013 to more than 7 million in 2019.[3] This is about a 78% increase year over year, on average. Regionally, the growth has been more variable with the U.S. seeing a slowdown in 2019-2020 as model availability has dropped. Yet, all regions are expected to grow dramatically through this decade based on almost every forecast by industry experts who study these markets and gather data from auto companies and their suppliers[4] Sales shares are a better indicator of technology success, and global EV sales in 2019 reached 2.6%. In some regional markets, EVs have already made significant inroads, comprising more than 50% of new sales in Norway in 2019 and approximately 8% in California.[5,6] While one could debate whether 2.6% of global share is consequential or not, vehicle original equipment manufacturers (OEMs) are expecting significant growth in the next decade as they are planning to launch an additional 400 models by 2023 across all light-duty vehicle market segments and more models planned in the medium and heavy duty market.[7,8] For example, on November 19, 2020, General Motors announced it will spend $27 billion on all-electric and autonomous vehicles through 2025, an increase of $7 billion, or 35%, from initial plans announced in March.[9] This increase in spending on EVs is reflected in many projections for EV adoption, with many government, industry, and research sources projecting EV to become the predominant light-duty technology by 2050.[10] Moreover, projections of EV adoption have been consistently revised upwards over the last decade and great optimism is publicly shown by many stakeholders.[11,12]

Matteo Muratori, Catherine Ledna, Chris Gearhart, and **John Farrell** are with the National Renewable Energy Laboratory. Matteo Muratori can be reached at: Matteo.Muratori@nrel.gov **David Greene** is with The University of Tennessee.

EVs offer opportunities to support and complement electricity infrastructure investments

Beyond sales, Mr. Salameh cites the challenges of expanding global electricity infrastructure to accommodate demand from EVs, which he estimates to require trillions of dollars of investment. This argument frames these investments as negative for the electricity sector. EVs can actually reverse trends of stagnating electricity demand in countries such as the US, which has seen near-zero growth in the past decade. Even under high growth scenarios, the government-industry US DRIVE partnership assessed that sufficient generation capacity will be available in the US to accommodate large-scale EV adoption, noting that the growth in generation required will be lower than past periods of growth seen historically.[13] Furthermore, with managed charging and vehicle to grid solutions, EVs may serve as a resource to support grid planning and operations and facilitate the integration of intermittent renewables such as solar and wind.[14] Studies have shown that flexible EV charging enables better utilization of electricity assets and could decrease electricity cost for all electricity consumers, not just EV users.[15] Overall, while investments will be necessary to expand generation capacity and update grid infrastructure, these are well in-line with traditional utility growth.[16] Grid investment will be required even in the absence of EV growth as a part of routine maintenance and grid modernization[17], and EVs offer a unique opportunity to synergistically improve

the efficiency and economics of mobility and electric power systems.[18] Lastly, it should also be noted that the investments in oil and gas required under an ICEV-dominated future are substantial as well (averaging $500 billion per year for upstream investments alone between 2015 and 2019).[19]

EV purchase price are decreasing with battery costs, and operational cost is already lower compared to ICEVs

Mr. Salameh also argues that high purchase price and operational costs are additional barriers to the adoption of EVs. He cites a cost of $70,000 to $100,000 for an EV with a range of 250-300 miles; but in fact, five of the 11 battery electric vehicles with ranges above 250 miles currently available on the U.S. market have a retail price below $50,000 (without considering incentives). Before incentives, a Chevy Bolt (259 miles of range) costs less than $40,000 in the U.S., and a Tesla Model 3 (290 miles) sells for a base price of around $40,000 in the U.S. and in China.[20] If prices were to stay at this level, we might agree that vehicle cost will limit EV adoption. But battery prices are dropping rapidly along with other key EV components. Battery electric vehicles (BEVs) are expected to reach purchase price parity with ICEVs when battery prices reach ~$80 -100/kWh.[21,22] Battery pack prices are expected to fall below $100/kWh by 2024 and below $80/kWh by 2030 according to projections made by BNEF and others.[23,24] At the same time, ICEVs capable of meeting increasingly stringent fuel economy and criteria emissions regulations are becoming more complex and expensive,[25] and automakers including Daimler, Volkswagen, and General Motors have announced an intent to end research and development on new ICEV platforms in favor of EVs.[26,27,28]

In addition to reductions in upfront purchase cost, EV operational costs are already lower than those of ICEVs, making total cost of ownership cheaper for EVs in some cases.[29] Recent data show that maintenance costs for EVs in the US are up to 50% lower than ICEVs, and differences in fuel prices also offer substantial savings.[30,31] Mr. Salameh argues that savings from maintenance costs will be outweighed by increasing electricity prices. Energy prices, especially for petroleum, have been volatile and heavily influenced by global macroeconomic and geopolitical conditions.[32] While gasoline and electricity prices vary widely across regions and their future trajectory is uncertain, recent US-focused research indicates slightly falling electricity prices over the next decades as a result of declining generation costs.[33] Including charging equipment costs and using current retail electricity prices and future escalation, the cost of charging an EV in the US is estimated to range between $0.08 and $0.27/kWh, resulting in lifetime fuel savings of $3,000 relative to an ICEV under the worst case scenario and over $10,000 in the best-case scenario (considering electricity price escalation).[34] The combination of more expensive ICEVs and cheaper EVs due to continued battery and other technology cost reductions suggest that the lifetime cost of EVs will continue to grow more competitive with ICEVs even in the absence of subsidies.

Charging infrastructure availability and charging speeds are increasing

EV charging speed and public charging availability have also rapidly improved. Far from Mr. Salameh's estimate of 30 miles of range per hour of charging, today's standard commercial DC fast chargers can deliver 60 to 80 miles of range in 20 minutes of charging.[35] Faster charging speeds (150 kW–350kW per car or 600–1400 miles of range per hour) are commercially available and becoming increasingly common.[36] A 2019 Tesla Model 3 Long Range vehicle operating at peak efficiency can recover up to 75 miles of charge in just 5 minutes.[37] Globally, public charging availability has grown rapidly, with the number of chargers increasing by 60% between 2018 and 2019 to reach 862,000 globally—with 263,000 being fast chargers.[38] In the U.S. alone over 75,000 public chargers were available at the end of 2019, with 13,000 being fast chargers.[39] The IEA projects that by 2030 public chargers will expand to 11 million worldwide assuming that existing government policies are fully implemented (supporting 140 million EVs).[40]

Significant current and planned support from industry and governments globally

Mr. Salameh states that "…any mandatory transition to renewable energy and EVs will not achieve the desired outcome without individuals, businesses and governments getting on board." We agree with this sentiment and believe there is strong evidence that such buy-in is occurring. With respect to individuals, in addition to increasing sales growth, surveys in the US have found that the number of consumers intending to purchase an EV has grown over time due to increased experience with the technology and greater appreciation of the financial and environmental advantages to ownership.[41,42] In addition, governments and industry alike have signaled continuing and increasing commitment to EVs. While purchase subsidies declined in some regions in 2019, regulatory measures such as China's New Energy Vehicle mandate, zero emission vehicle mandates in regions of the US and Canada, and European fuel economy and CO_2 standards continue to incentivize EV sales, with existing policies set to grow stricter over time.[43] As of 2020, seventeen countries, including France, the UK, and Norway, have signaled an intent to increase these commitments in the future, with zero emission vehicle targets and goals of phasing out ICEVs by 2050.[44] As a recent example, in 2020 the state of California announced that by 2035 all new cars and passenger trucks sold in the state must be zero emissions vehicles, a category that is dominated by EVs.[45] Automakers have also voiced their support for this transition. Speaking at the Automotive Press Association, Mary Barra, CEO of General Motors, stated "We believe in an all-electric future, and we're

moving aggressively," and expressed the belief that electric vehicles will help the company to grow.[46] These sentiments have been echoed by other manufacturers, including Volkswagen and Ford, and supported by expanded EV offerings and R&D.[47,48,49] This support reflects not only recognition of increasing consumer demand for EVs, but also industry engagement and broad actions in response to concerns surrounding local air pollution and CO_2 emissions, which are priorities globally.

Conclusions

Projecting future technology adoption is a daunting task, and no one can know with certainty the future role of EVs and ICEVs. However, in this article we tried to inform this discussion with current facts. Over the last decade, EVs have made rapid progress, including major cost reductions, great expansion of charging infrastructure, and improvements in batteries and other technologies—in many cases outpacing expectations. With a wider variety of EVs coming to market, including medium- and heavy-duty models, as well as strong commitments made by governments and industry, there are reasons to expect that the next decade will see further accelerations in growth, as anticipated by many leading experts, industry leaders, and governments. Still, Mr. Salameh asserts that apart from technological barriers, "…the real challenge facing a deeper penetration of EVs into the global transport system is the realization that oil is irreplaceable now or ever." This assertion rests on the premise that the advantages of petroleum as a transportation fuel are so great that there is no reason for further sectoral transformations to occur. Advantages that EVs provide over ICEVs offer a compelling motivation for such a transformation. These include zero tailpipe emissions (greatly benefiting local air quality) and, if coupled with clean electricity, significant CO_2 emissions reductions. While EVs are part of a larger set of possible solutions to the problems of energy, air quality, and emissions, the commitments to their development made by both governments and industry leaders suggest that the recognition of their advantages is widespread and will be sustained through the coming decades. Moreover, fast acceleration, low noise, and the opportunity of convenient home-based charging also contribute to an overall improved driving experience for EVs compared to the incumbent technology. The biggest customer barrier often cited for EVs, has been range, but even this is being addressed with new models having over 300 miles range and charging infrastructure being expanded. The facts and references reported in this article show that providing affordable and convenient mobility solutions for on-road transportation is indeed feasible without relying predominantly on ICEVs. Electric vehicles are a competitive technology that has seen major technological progress over the last decade and is already seeing significant adoption today. In light of this, and of the massive investments and commitments from multiple stakeholders, EVs are well-positioned to achieve widespread adoption in the coming decades.

Footnotes

[1] EVs are vehicles that are powered with an on-board battery that can be charged from an external source of electricity. This definition includes plug-in hybrid electric vehicles (PHEVs) and battery electric vehicles (BEVs).

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