ELECTRIC VEHICLES

OVERVIEW OF A HIGH-IMPACT DRAWDOWN SOLUTION

Electric vehicles are powered by electric batteries instead of conventional fuels such as gasoline and diesel. The emissions profile of these vehicles is lower; however, the exact emissions vary depending on the generation mix providing the electricity

TECHNOLOGY AND MARKET READINESS

Electric vehicles are available in the marketplace in LDV applications (Note: there are electric vehicles for other transportation solutions that are not included under this solution). Over the last decade, Georgia provided state subsidies (in the form of a tax credit on new EVs) that led to significant new EV sales yet allowed those subsidies to expire in 2016. Adoption rates during the subsidy period demonstrate a huge potential for EVs in the Georgia market. In 2018, about 14,000 electric vehicles were registered in Georgia [1]. The projected percentage share of new vehicle sales for EVs range from anywhere from around 20% [2] to nearly 50% [3] of total LDV sales in 2030. We assume that Georgia's adoption will fall within this national range, depending on future technology and policy scenarios.

LOCAL EXPERIENCE AND DATA AVAILABILITY

From 2017-2018, Georgia had 122.64% year-on-year share percentage increase and was a leader in EV adoption [4]. Consequently data is readily available and local markets have experienced high rates of adoption.

TECHNICALLY ACHIEVABLE CO_2 REDUCTION POTENTIAL

EVs are readily capable of achieving significant CO_2 reductions when the electricity generated comes from renewable or net-neutral carbon energy sources (Cox, et al., 2018). CO_2 reductions are still possible compared to conventional internal combustion vehicles when the electricity derives from natural gas generation. Reduction potential is heavily contingent on grid portfolio and emissions associated with manufacturing and resource extraction. Large potential reductions are possible in the 2050 timeframe, in particular under high renewable penetration scenarios (Cox, 2018). Current EV technology can reduce CO_2 emissions (including upstream) by 50gCO_2e/km for a small, light duty passenger vehicle using weighted average for the CO_2 emissions intensity of the Georgia grid [5]. As technology and efficiency continues to improve, these CO_2 reductions are expected to be even greater (by up to 50% more) by 2030 [6]. Even with modest penetration, electrification of Georgia's light duty personal & commercial vehicles shows significant potential for reduction. Additional carbon emissions associated with increased electricity demand warrants further study.

COST COMPETITIVENESS

As reflected by sales projections, the cost of a new EV is expected to be comparable to that of internal combustion engine vehicles (ICEVs) over the next decade. Cost competitiveness will increase as manufacturing economies of scale are realized and adoption rates grow. Costs and benefits vary with regard to usage patterns but are broadly positive as technology becomes cheaper and more commonplace (Simmons, 2015). Reduced operation and maintenance costs should offer significant savings to consumers over vehicle lifetimes [7]. More study is likely needed to determine the impact of charging infrastructure costs and electricity generation/rates and how these should be allocated to users or society as a whole.

BEYOND CARBON ATTRIBUTES

Co-benefits: The solution offers benefits to environmental and public health from localized air quality improvements (Smit, et al., 2018), recognizing that such benefits may not exist or may be limited in energy generation/producing locations. Other benefits include the creation of jobs associated with selling, installing, and maintaining batteries for electric vehicles [8]. Another positive consideration emerges from research that highlights the storage locations of commercial trucks in low income communities – with electrification and movement in/out of these facilities offering localized public health/air quality benefits (versus emission vehicles).

Co-costs: Potential adverse impacts include disposition of end-of-life of batteries (Ai, et al., 2019). Also, large scale EV adoption will necessitate charging/related infrastructure investments that have the potential to increase electricity rates. As with other solutions such as solar, the higher costs of EV vehicles may make access to this solution challenging for low-income communities [9].

References:
Ai, Ning, Junjun Zheng, and Wei-Qiang Chen. (2019). "U.S. End-of-Life Electric Vehicle Batteries: Dynamic Inventory Modeling and Spatial Analysis for Regional Solutions." Resources, Conservation & Recycling 145: 208–19.
Brian Cox, Christopher L Mutel, Christian Bauer, Angelica Mendoza Beltran, and Detlef P. van Vuuren. Environmental Science & Technology 2018 52 (8), 4989-4995
Simmons, Richard A., et al. (2015). "A benefit-cost assessment of new vehicle technologies and fuel economy in the US market." Applied Energy 157: 940-952.
Simmons, Richard A. (2015). "A techno-economic investigation of advanced vehicle technologies and their impacts on fuel economy, emissions, and the future fleet."
Smit, R., Whitehead, J., Washington, S. (2018). Where Are We Heading with Electric Vehicles?, Air Quality & Climate Change, 52 (3): 18–27. http://search.ebscohost.com.prx.library.gatech.edu/login.aspx?direct=true&db=eih&AN=133036244&site=ehost-live.

Endnotes:
1. https://afdc.energy.gov/data/10962
2. https://www.eei.org/resourcesandmedia/newsroom/Pages/Press%20Releases/EEI%20Celebrates%201%20Million%20Electric%20Vehicles%20on%20U-S-%20Roads.aspx ; https://www.eia.gov/outlooks/aeo/data/browser/#/?id=48-AEO2019&region=1-0&cases=ref2019&start=2017&end=2030&f=A&linechart=ref2019-d111618a.4-48-AEO2019.1-0&map=ref2019-d111618a.5-48-AEO2019.1-0&sourcekey=0
3. https://about.bnef.com/electric-vehicle-outlook/
4. https://evadoption.com/ev-market-share/ev-market-share-state/
5. https://www.epa.gov/energy/greenhouse-gases-equivalencies-calculator-calculations-and-references
6. https://www.mdpi.com/2032-6653/8/4/987/pdf
7. https://www.energy.gov/eere/electricvehicles/electric-vehicles https://www.bls.gov/careeroutlook/2012/summer/art02.pdf
8. https://www.transformca.org/sites/default/files/3R.Equity.Indesign.Final_.pdf

Corresponding Author:

Dr. Richard A. Simmons, PE
Director, Energy, Policy, and Innovation Center, Strategic Energy Institute
Instructor, Woodruff School of Mechanical Engineering
Georgia Institute of Technology
495 Tech Way NW Atlanta, GA 30332-0362