

Electric Vehicle Primer

This primer provides an overview of market trends, vehicle and charging infrastructure technology, policies and incentives, the VW settlement, as well as benefits, challenges, and concerns associated with electric vehicles (EVs).

I. Electric Vehicle Terminology

The following are definitions for common EV technology:

- **Battery electric vehicles (BEVs)** – Powered by battery only, also referred to as plug-in electric vehicles (PEVs).
- **Plug-in hybrid electric vehicles (PHEVs)** – Powered by battery and gasoline combination.
- **Electric vehicle supply equipment (EVSE)** – Charging equipment and electrical infrastructure required for EVs.
- **Zero emissions vehicle (ZEV)** – All vehicles running off alternative fuels which includes hydrogen fuel cells.
- **Internal combustion engine vehicle (ICE)** – Vehicle powered by gasoline.

II. Electric Vehicle Charging Infrastructure

There are four types of charging capacity:

	<i>Charger</i>	<i>Common Locations</i>	<i>Charging Time for 80 Miles</i>	<i>Vehicle Types</i>
Level 1	120V AC	Homes	16 Hours	All EVs
Level 2	240V AC	Homes and Public Stations	8 Hours	All EVs
DC Fast Charge	480V DC	Public Stations	30 minutes	Only BEVs
Tesla	480V DC	Tesla Charging Stations	15 minutes	Only Tesla Vehicles

III. Growth Trends

- Over 360,000 EVs have been sold in 2018; more than 1.1 million have been sold since 2008. For a detailed state breakdown, see the [auto alliance dashboard](#). Californians have purchased 88,513 EVs, 47.5% of all purchases.
- The most expensive part of an EV is the battery. However, lithium-ion battery prices have fallen from \$1,000/kWh in 2010 to \$190-205/kWh in 2018 with forecasts to fall further.¹
- Electrify America is investing \$2 billion on a national EV charging network. State Appendix “D” funds have a \$435 million infrastructure component. Utilities have approved \$1 billion so far to spend on 560 DC fast chargers and 88,000 Level 2 chargers.

IV. Existing Incentives

Numerous entities have implemented incentives to encourage EV adoption. Some examples include:

- **Federal Tax Credits** – The federal government offers a tax credit of \$2,500 to \$7,500 for EV purchases. Tesla and GM vehicles will be phased out of the credit starting in 2019.²
- **State Incentives** – Various states offer purchase incentives such as rebates, sales tax exemptions, or discounts. For a state-by-state breakdown, [Plug In America](#) has detailed descriptions on the various incentives.
- **Utility Incentives** – Utilities may offer rebates and credits for customers purchasing EVs or EVSE. A full list of state and utility incentives can be found in the [DOE EERE website](#).
- **HOV Lanes** – Certain states like New York and Maryland offer preferential HOV lane access to EVs.

V. Benefits

EVs offer health, economic, and energy benefits including:

- **Lowering emissions** – In 2018, the transportation sector accounted for 36% of U.S. CO2 emissions, the nation’s single largest source of emissions.³ Due to their high efficiency, EVs typically consume half the energy of an ICE vehicle. Decreased emissions reduce adverse health effects such as respiratory diseases caused by air pollution.⁴

¹ Chediak, M. (2017, December 5). The Latest Bull Case for Electric Cars. Retrieved November 19, 2018, from <https://www.bloomberg.com/news/articles/2017-12-05/latest-bull-case-for-electric-cars-the-cheapest-batteries-ever>

² Electric Vehicles: Tax Credits and Other Incentives. (n.d.). Retrieved November 19, 2018, from <https://www.energy.gov/eere/electricvehicles/electric-vehicles-tax-credits-and-other-incentives>

³ Lindstrom, P. (2019). *Monthly Energy Review - February 2019* (pp. 203-208, Rep. No. 0035). Washington, DC: DOE/EIA.

- **Minimizing household expenses** – Over the vehicle lifecycle, EVs are becoming cost competitive with ICE vehicles. Due to reduced fueling and maintenance costs the vehicles offer a clean alternative to ICE vehicles.⁵
- **Electricity market benefits** – Utilizing EVs as distributed energy resources can help smooth effects on electricity demand. It can capture excess generation from renewables and curb peak demands on the grid.⁶

VI. Concerns

While EVs have various benefits, it is important to remember the concerns associated with the technology:

- **Equity issues** – Due to the continued high costs for EVs, many individuals cannot afford an EV.⁷
- **Obsolescence risk** – Current EVSE may not be the right type to meet future vehicle charging needs.
- **Oil markets impact** – Increased EV usage may weaken downstream oil demand, potentially disrupting oil jobs.
- **Revenue depletion** – A shift to EVs may decrease gas tax revenue, requiring new transportation funding sources.
- **Resource constraints** – There is a limited global supply of resources required for lithium-ion batteries.⁸

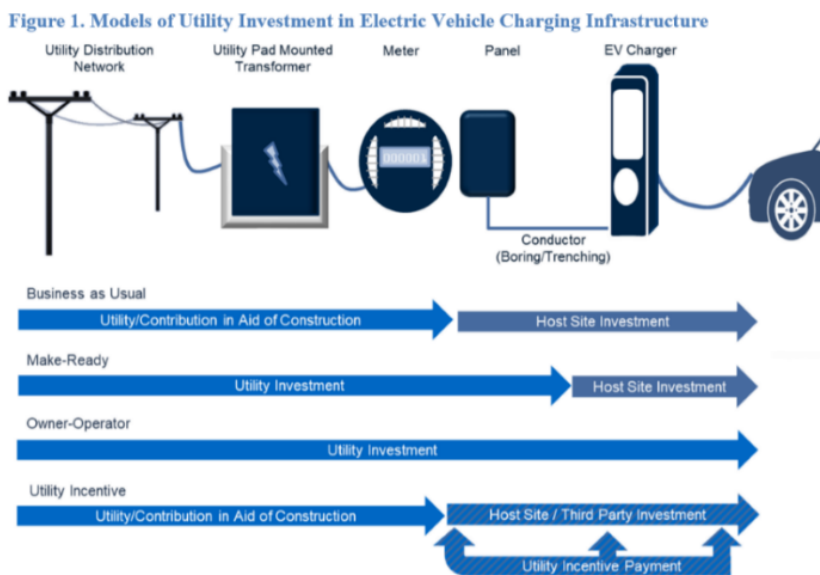
VII. Challenges

EVs face certain challenges that may need to be addressed to achieve wide-scale adoption:

- **Consumer Awareness** – Consumers are unaware of vehicle options or purchase incentives on the market today.⁹
- **System stress** – EVs could increase stress on distribution infrastructure and increase peak demand.¹⁰
- **Affordability** – Initial up-front costs remain high, creating an affordability gap. Battery costs will need to decrease further for EV prices to compete with ICE vehicles. Forecasters predict \$100 per kWh (now at \$200 per kWh) will be the tipping point for wide-scale EV adoption.¹¹
- **Range anxiety** – EVSE tend to cluster in urban areas. Outside these areas public charging infrastructure may be insufficient. Lack of consumer awareness about current EV ranges contributes to “range anxiety”.¹²
- **EV Fees** – An alternative method to offset revenue losses is for a state to charge an annual electric vehicle registration fee. Currently, 18 states have implemented some form of [fee](#).

VIII. Utilities Investments Model

Utilities can assist in EV adoption by (1) providing upgrades through “make-ready” installations, (2) fully owning and operating installations, or (3) providing financial incentives to host sites. See [Figure 1](#).



Source: M.J. Bradley & Associates

IX. Volkswagen Settlement

In 2016, Volkswagen agreed to a \$14.7 billion settlement for cheating on emission testing. \$2.7 billion was allocated to the Environmental Mitigation Trust to be divided up by the states, territories, DC, and tribes commensurate with vehicles in each jurisdiction. The funds can be used for diesel emissions reductions actions. That includes up to 15% for EVSE. See [NASEO & NACAA VW Settlement Clearinghouse](#).

⁴ Health Effects Institute Panel on the Health Effects of Traffic-Related Air Pollution. (2010). *Traffic-related air pollution: A critical review of the literature on emissions, exposure, and health effects*. Retrieved from the Health Effects Institute website: <https://www.healtheffects.org/publication/traffic-related-air-pollution-critical-review-literature-emissions-exposure-and-health>

⁵ *Total cost of ownership for current plug-in electric vehicles: Update to model 2013 and 2014 model year vehicles*. (2014). Retrieved from Electric Power Research Institute website: <https://www.epri.com/#/pages/product/000000003002004054>

⁶ Khan, S., & Vaidyanathan, S. (2018, February 13). *Strategies for integrating electric vehicles into the grid*. Retrieved from American Council for an Energy-Efficient Economy website: <http://aceee.org/research-report/t1801>

⁷ *Electric Vehicles for All: An Equity Toolkit*. (n.d.). Retrieved November 19, 2018, from <http://greenlining.org/publications-resources/electric-vehicles-for-all/>

⁸ *Metals & Mining - Global: Metal supply shortfall likely to slow battery electric vehicles near term*. (n.d.). Retrieved from Moody's website:

https://www.moodys.com/researchdocumentcontentpage.aspx?docid=PBC_1114731

⁹ Gerdes, J. (2018, February 26). *Consumers Lack EV Awareness, Even in the Nation's Largest Market*. Retrieved November 19, 2018, from <https://www.greentechmedia.com/articles/read/consumers-lack-ev-awareness-even-in-the-nations-largest-market>

¹⁰ Khan, S., & Vaidyanathan, S. *Strategies for integrating electric vehicles into the grid*.

¹¹ Chediak, M. *The Latest Bull Case for Electric Cars*.

¹² Baumhelfer, M., & Hwang, R. (2016, June 16). *Driving out pollution: How utilities can accelerate the market for electric vehicles*. Retrieved from Natural Resources Defense Council website: <https://www.nrdc.org/resources/driving-out-pollution-how-utilities-can-accelerate-market-electric-vehicles>