POLICY BRIEF

Electric Vehicle Adoption Potential in the United States

Carnegie Mellon University
Engineering & Public Policy

Electric vehicles can only make impact to the extent that consumers adopt them.

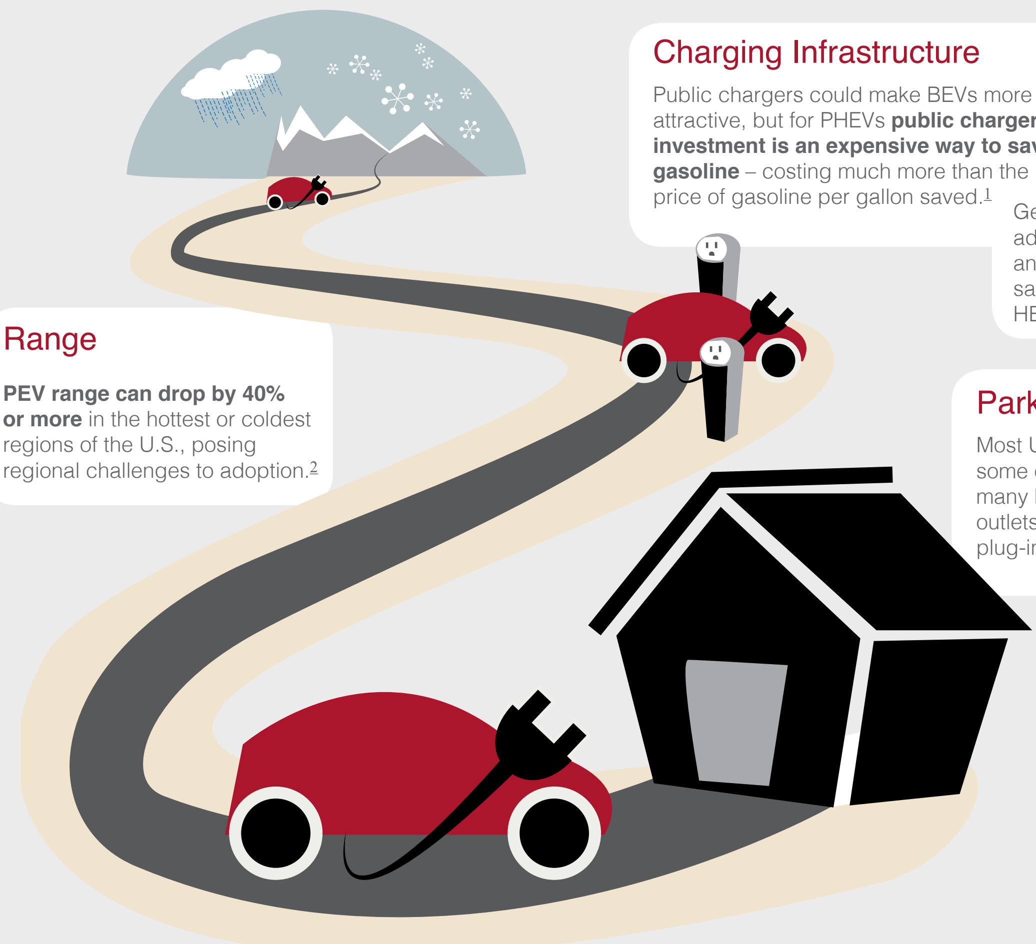
Vehicle Electrification Comparison

Plug-in Electric Vehicles (PEVs): PHEV, BEV

increasing electrification →

		CV (*Conventional*)	HEV (*Hybrid Electric*)	PHEV (*Plug-in Hybrid Electric*)	BEV (*Battery Electric*)
DRIVETRAIN	battery	-	SMALL	MEDIUM	LARGE
	power converter	ENGINE	ENGINE & MOTOR	ENGINE & MOTOR	MOTOR
SOURCE	electricity	-	-	Y	Y
	gasoline	Y	Y	Y	-

Key Factors in PEV Adoption



Charging Infrastructure

Public chargers could make BEVs more attractive, but for PHEVs **public charger investment is an expensive way to save gasoline** – costing much more than the price of gasoline per gallon saved.[1]

Generally, it is less expensive to add battery capacity to PHEVs, and it is even cheaper per gallon saved if more consumers adopt HEVs or low-range PHEVs.

Range

PEV range can drop by 40% or more in the hottest or coldest regions of the U.S., posing regional challenges to adoption.[2]

Parking

Most U.S. households have some off-street parking, and many have nearby electrical outlets, helping to enable plug-in vehicle adoption.

But many households lack enough dedicated off-street parking spaces for all of their vehicles. We estimate that **half of U.S. vehicles lack dedicated off-street parking at an owned residence where a charger could be installed**. So, electrifying the entire vehicle fleet is likely unrealistic without major infrastructure changes.[3]

Key Factors in PEV Adoption

Consumer Preferences

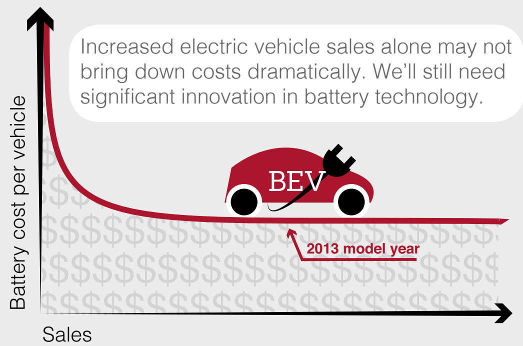
In one study, we estimate that mainstream American consumers are willing to adopt BEVs at similar rates to otherwise-equivalent gasoline vehicles only if they are $10,000 to $20,000 cheaper, on average.

In contrast, Chinese consumers are willing to pay equally for BEVs if they have sufficient range. So, China could potentially adopt BEVs at mainstream levels before the U.S. China's vehicle market is already larger than the U.S. market, so what happens in China has the potential to affect markets globally.[4]

Cost

Battery cost is the largest economic barrier to electric vehicle adoption.

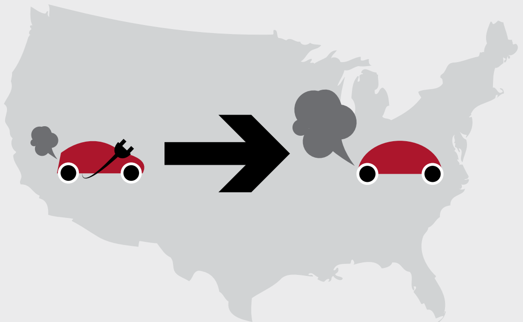
Economies of scale in large battery factories can cut costs somewhat, but we estimate that the cost savings of high-volume manufacturing are nearly exhausted at the production volumes of today's Nissan Leaf, Chevy Volt, and Tesla Model S.[5]



Policy

Under federal fuel economy standards, states that mandate electric vehicle sales enable other states to shift to higher-emitting vehicle fleets.

This could result in greater polarization in the types of vehicles purchased in different states without reducing overall emissions or gasoline consumption.[6]



Implications

So, a variety of factors will affect adoption patterns for electrified vehicles: Mainstream U.S. consumers will need costs to come way down, and high volume production alone isn't likely to get us there. Limited residential parking suitable for electric vehicle charging may pose a long term limit to mainstream adoption, and public charger investment is an expensive way to save gasoline. Loss of vehicle range in extreme weather regions may also affect regional adoption, and adoption in some regions can lead to higher-polluting fleets in other regions.

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1 Peterson, S. and J.J. Michalek (2013) "Cost effectiveness of plug-in hybrid electric vehicle battery capacity and charging infrastructure investment for reducing US gasoline consumption," *Energy Policy*, v52 p429-438.

2 Yuksel, T. and J.J. Michalek (2015) "Effects of regional temperature on electric vehicle efficiency, range, and emissions in the United States," *Environmental Science & Technology*, v49 n6 p3974-3980.

3 Traut, E., C. Cherng, C. Hendrickson, and J.J. Michalek (2013) "U.S. residential charging potential for electric vehicles," *Transportation Research Part D: Transport and Environment* v25 p139-145.

4 Helveston, J.P., Y. Liu, E. Feit, E. Fuchs, E. Klampfl, and J.J. Michalek (2015) "Will subsidies drive electric vehicle adoption? Measuring consumer preferences in the U.S. and China," *Transportation Research Part A: Policy and Practice* v73 p96-112.

5 Sakti, A., J.J. Michalek, E.R.H. Fuchs, and J.F. Whitacre (2015) "A techno-economic analysis and optimization of Li-ion batteries for light-duty passenger vehicle electrification," *Journal of Power Sources* v273 p966-980.

6 Jenn, A., I.L. Azevedo and J.J. Michalek (2015) "Unintended consequences: why U.S. alternative fuel vehicle adoption increases gasoline consumption and greenhouse gas emissions," in review.

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