Union of Concerned Scientists

POLICY BRIEF

Accelerating US Leadership in Electric Vehicles

Incentives Boost Sales and Decrease Costs, Benefiting Consumers and Industry

HIGHLIGHTS

Leadership on vehicle electrification is critical to tackling climate change, protecting consumers from volatile oil prices, maintaining the competitiveness of US automakers, and creating 21st century manufacturing jobs. However, electric vehicles (EVs) currently cost more to manufacture than comparably sized gasoline-powered vehicles, which can mean higher prices and slower adoption. Today's incentives encourage EV sales while automakers scale up manufacturing and technology improves. It may make sense to reduce incentives after EVs become more price competitive, but removing them too soon would stall US leadership in a critical technology. The federal tax credit, in particular, is a vital investment in the transition to electric vehicles.

Electric vehicles (EVs) benefit their owners. In most cases, these vehicles are cheaper to fuel than gasoline cars. For example, in May 2017 the US Department of Energy estimated that refueling the average EV cost the equivalent of gasoline priced at only $1.17 per gallon—roughly half the price of gasoline (DOE 2017; EIA 2017).

EVs also benefit the environment and communities by reducing tailpipe air pollution and overall global warming emissions. The Union of Concerned Scientists (UCS) estimates that global warming emissions from the average EV in the United States are equal to those of a hypothetical gasoline vehicle achieving an astounding 73 miles per gallon, even when including emissions from generating the EV's electricity at power plants (Reichmuth 2017). And the gap between emissions from EVs and conventional cars will probably widen: EVs sold today will likely take advantage of future electricity supplies that include more renewable sources. The prospects for lowering emissions from gasoline are far less promising (Martin 2016).

Based on such benefits, plus regulatory and incentive efforts to encourage purchases, sales of EVs have increased greatly since their introduction in 2010. This is especially the case where strong state policies combine with federal incentives. In California, a leader among the states, plug-in EVs accounted for nearly 5 percent of all cars and trucks sold during the first quarter of 2017 (Nikolewski 2017).

It is essential to maintain policies supporting the adoption of EVs so that the technology reaches mass-market commercialization as quickly as possible. Incentives for EVs will translate into fewer global warming emissions in the near term, and enable even greater emissions reductions in the future. Earlier adoption of EVs also will enable drivers to realize fuel cost savings more quickly, thereby increasing demand for EVs, many of which are being built in the United States.

General Motors

Electric vehicle sales have increased significantly in recent years. With many of these cars being assembled in the United States, federal and state incentives that help spur EV sales also help make the vehicles more affordable—keeping the United States a leader in EV technology.

Government investments to encourage EV sales also support US-based R&D, manufacturing, and jobs. EV leader Tesla has established battery and vehicle production facilities in the United States, including a battery factory in Nevada that is slated to employ 10,000 workers when complete in 2020 (della Cava 2017). Other leading EV models also come off domestic assembly lines, such as Chevrolet's Bolt EV and Volt, produced in Michigan, and Nissan's Leaf EV, produced in Tennessee.

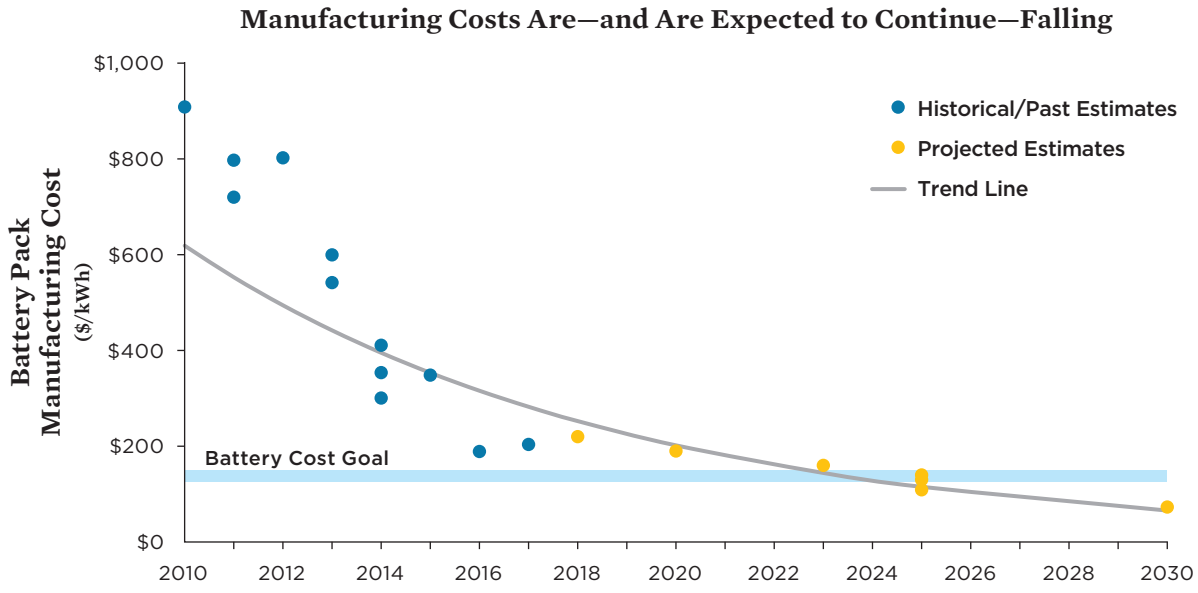
> ***Incentives for EVs today will translate into fewer global warming emissions in the near term, and enable even greater emissions reductions in the future.***

Falling EV Battery Costs Make EVs More Price Competitive

Continuing government commitments to support EVs are important for maintaining US leadership and competitiveness in automotive manufacturing. Currently, EVs are relatively expensive to produce, in large part due to the batteries and associated electronics. Today's battery packs make the cost to manufacture EVs 1.5 to 2.5 times that for manufacturing similarly sized gasoline vehicles. However, such cost differences will decline significantly as the volume of battery production increases and manufacturers use lessons learned from prior vehicle and battery designs. One estimate anticipates a tipping point to occur with around 800,000 EVs sold annually in the United States, or about five times the current figure (Slowik, Pavlenko, and Lutsey 2016).

Indeed, the costs of battery packs already have fallen a great deal over the past seven years as the scale of production has increased (see the figure) and manufacturers have developed more cost-effective methods. Estimates of the price tag on the battery packs for the first mass-market EVs produced

EV Battery Pack Manufacturing Costs Predicted to Fall over Time



If battery costs continue to decline as EV production increases, within several years they will reach the $125–$150 target that makes EVs competitive with conventional gasoline vehicles.

Note: Battery cost estimates include both academic analysis and statements from automakers. Multiple data points in a given year represent estimates from multiple analyses. Trend line represents exponential best fit of battery cost data.

SOURCES: ARB 2017; SOULOPOULOS 2017; VOELCKER 2017; SLOWIK, PAVLENKO, AND LUTSEY 2016; VOELCKER 2016; NYKVIST AND NILSSON 2015.

US Air Force photo/Linda LaBonte Britt

Electric vehicles are cheaper to operate and produce less global warming emissions compared with today's gasoline-powered vehicles. Incentives for EVs today mean fewer emissions in the near term, and enable even greater emissions reductions in the future.

in 2010 reached $1,000 per kilowatt-hour (kWh) (Nykvist and Nilsson 2015). In contrast, Tesla reported that the battery pack for the new Model 3 battery-powered EV would cost $190 per kWh, and an analysis of General Motors' 2017 Chevrolet Bolt EV calculated a cost of about $205 per kWh (Voelcker 2017; Voelcker 2016).

Analysts have posited that EVs will effectively compete with conventional gasoline vehicles when the price of battery packs falls to between $125 and $150 per kWh (Howell et al. 2016; Nykvist and Nilsson 2015). A recent analysis of the Chevrolet Bolt EV concluded that its battery pack currently costs $12,500 per vehicle to produce (Voelcker 2017). If battery pack cost reductions predicted for 2025 are realized, that amount would fall to about $8,000, a $4,500 per-vehicle reduction or about 12 percent of today's suggested sales price for the Bolt EV.

Research and development will reduce costs significantly, yet the increasing scale of EV production may be more important to lowering the price tag on battery packs. To achieve the battery cost-reduction goals, it is estimated that global EV sales would need to reach about 4 million vehicles a year (Slowik, Pavlenko, and Lutsey 2016). In 2016, more than 750,000 EVs were sold worldwide, with US sales (159,000 EVs) accounting for more than 20 percent of the total (Rapier 2017). If the global sales distribution remains constant, reaching the target of 4 million would include US deliveries of about 800,000 EVs annually.

Several factors make the US and global levels of EV sales attainable. Perhaps most important for the US goal, American consumers soon will have more than twice as many EV models to choose from. All major automakers have announced plans to increase the number of EV models offered, from today's 30 models to more than 70 in the next five years (ARB 2017). Outside the United States, governments are also pushing for higher EV sales, with China alone forecast to hit 800,000 EV sales in 2017 (Reuters 2017). Several countries, including France, India, Norway, and the United Kingdom, are considering phasing out conventional vehicles altogether by 2040 or sooner (Castle 2017; Ewing 2017).

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Financial Incentives for EVs Are Critical

The EV market, while rapidly growing, is in its infancy, accounting for less than 1 percent of US new vehicle sales in 2016. With the higher manufacturing costs of EVs, federal and state financial incentives are instrumental to driving early EV adoption and for EVs to gain a significant share of the US auto market. Policies that help offset an EV's higher upfront cost should continue until battery costs decline to the point at which these vehicles become cost-competitive with gasoline-powered vehicles.

Today's federal tax credit of up to $7,500 for a qualifying EV, a key factor in EV sales to date, has enabled hundreds of thousands of car buyers to choose an EV that they might not have been able to afford otherwise. With that incentive, the cost of EVs compares roughly to their gasoline counterparts (see the table, p. 4). Moreover, the credit can apply to leases, expanding the potential market by enabling auto dealers to offer attractive lease rates for many EVs.

Conversely, EV sales suffer in the absence of policies to make EVs more affordable. Georgia offered a tax credit of up to $5,000 for EVs sold in the state. It also posted some of the nation's highest EV sales—until state lawmakers abruptly ended the tax credit in 2015. EV sales in Georgia plummeted from 1,338 in June 2015 to only 148 two months later, and they have yet to recover (Edelstein 2015).

The federal tax credit, similar state financial incentives, and other policies to offset higher EV purchase prices are

The Impact of the Federal Tax Credit on Pricing for Electric Vehicles and Comparable Gasoline Vehicles

	Ford Focus EV	Ford Focus Titanium	Toyota Prius Prime Plus	Toyota Prius One	VW eGolf	VW Golf S
Powertrain	**Plug-in EV**	**Gasoline**	**Plug-in EV**	**Hybrid**	**Plug-in EV**	**Gasoline**
MSRP	$31,075	$24,075	$27,100	$23,475	$28,995	$19,895
Federal Incentive	$7,500		$4,502		$7,500	
Price after federal incentive	**$23,575**	**$24,075**	**$22,598**	**$23,475**	**$21,495**	**$19,895**

Note: The federal incentive for the Toyota Prius Prime Plus is lower than the other EVs shown above because it has a smaller battery.

SOURCE: MANUFACTURERS' SUGGESTED RETAIL PRICES (MSRP) FROM MANUFACTURERS' WEBSITES.

critical to expanding the EV market in the United States. Removing federal and other supports prematurely will hamper automaker competitiveness, decrease opportunities for consumers to save at the pump, and diminish the impact of previous investments in EVs and underlying battery technologies.

At the same time, it will be important to address a major drawback to the federal tax credit: the legislation comes with a 200,000 EV cap per manufacturer, and some automakers are likely to hit that cap in 2018. At that point, the size of the incentive scales down for any EV sold by that manufacturer, disappearing completely after one and a half years. EV purchasers could take full advantage of the tax credit only if they bought from a company that had not hit the cap. In other words, the incentive will not be available if purchasers want an EV from today's market leaders, including General Motors, Nissan, and Tesla. In effect, the cap as currently designed penalizes the very companies that are in the forefront of developing and selling EVs.

Conclusion

Electric vehicles are central to reducing oil consumption and transportation-related emissions in the United States. Purchase incentives for plug-in EVs have been a critical policy tool, accelerating the manufacture and adoption of EVs and making them accessible to car buyers. These investments in EV technologies are helping automakers transition to new technologies and enabling Americans to drive cleaner and cheaper.

In particular, the federal EV tax credit is essential. Now is not the time to end a policy that works. Instead, the federal government should extend the credit to ensure continued progress, build upon success, and keep the United States in the lead with 21st century automotive technology.

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REFERENCES

Air Resources Board (ARB). 2017. *California's Advanced Clean Cars midterm review*. Sacramento CA: California Environmental Protection Agency. Online at *www.arb.ca.gov/msprog/acc/mtr/acc_mtr_finalreport_full.pdf*, accessed July 18, 2017.

Bloomberg New Energy Finance (BNEF). 2016. Electric vehicles to be 35% of global new car sales by 2040. Blog, February 25. Online at *http://about.bnef.com/blog/electric-vehicles-to-be-35-of-global-new-car-sales-by-2040*, accessed June 26, 2017.

Castle, S. 2017. Britain to ban new diesel and gas cars by 2040. *New York Times*, July 26. Online at *www.nytimes.com/2017/07/26/world/europe/uk-diesel-petrol-emissions.html*, accessed July 26, 2017.

della Cava, M. 2017. Tesla giant desert Gigafactory rumbles to life. *USA Today,* January 4. Online at *www.usatoday.com/story/tech/news/2017/01/04/tesla-gigafactory-begins-battery-production/96133342*, accessed June 26, 2017.

Department of Energy (DOE). 2017. eGallon. Online at *www.energy.gov/maps/egallon,* accessed May 31, 2017.

Edelstein, S. 2015. Georgia electric-car sales plummet after incentive replaced by tax. *Green Car Reports,* November 4. Online at *www.greencarreports.com/news/1100751_georgia-electric-car-sales-plummet-after-incentive-replaced-by-tax*, accessed July 12, 2017.

Electric Drive Transportation Association (EDTA). 2017. Electric drive sales dashboard. Online at *http://electricdrive.org/index.php?ht=d/sp/i/20952/pid/20952*, accessed July 17, 2017.

Energy Information Administration (EIA). 2017. Weekly retail gasoline and diesel prices. Online at *www.eia.gov/dnav/pet/PET_PRI_GND_DCUS_NUS_W.htm*, accessed June 5, 2017.

Ewing, J. 2017. France plans to end sales of gas and diesel cars by 2040. *New York Times*, July 6. Online at *www.nytimes.com/2017/07/06/business/energy-environment/france-cars-ban-gas-diesel.html*, accessed July 12, 2017.

Howell D., B. Cunningham, T. Duong, and P. Faguy. 2016. Overview of the DOE VTO Advanced Battery R&D Program. June 6. Online at *www.energy.gov/sites/prod/files/2016/06/f32/es000_howell_2016_o_web.pdf*, accessed June 26, 2017.

Martin, J. 2016. *Fueling a clean transportation future: Smart fuel choices for a warming world.* Cambridge MA: Union of Concerned Scientists. Online at *www.ucsusa.org/clean-vehicles/clean-fuels/transportation-fuels-future*, accessed June 28, 2017.

Nikolewski, R. 2017. Electric vehicles see a boost in early year sales in California. *San Diego Union Tribune*, May 16. Online at *www.sandiegouniontribune.com/business/economy/sd-fi-california-cars-20170516-story.html*, accessed June 26, 2017.

Nykvist, B., and M. Nilsson. 2015. Rapidly falling costs of battery packs for electric vehicles. *Nature Climate Change* 5:329–332. Online at *www.nature.com/nclimate/journal/v5/n4/full/nclimate2564.html*, accessed July 3, 2017. doi:10.1038/nclimate2564.

Rapier, R. 2017. U.S. electric vehicle sales soared in 2016. *Forbes,* February 5. Online at *www.forbes.com/sites/rrapier/2017/02/05/u-s-electric-vehicle-sales-soared-in-2016*, accessed June 26, 2017.

Reichmuth, D. 2017. New numbers are in and EVs are cleaner than ever. *The Equation*. Cambridge, MA: Union of Concerned Scientists. Blog, May 31. Online at *http://blog.ucsusa.org/dave-reichmuth/new-numbers-are-in-and-evs-are-cleaner-than-ever,* accessed June 1, 2017.

Reuters. 2017. China forecasts 800,000 green vehicle sales in 2017: state media. February 8. Online at *www.reuters.com/article/us-china-autos-electric-idUSKBN15O0C7*, accessed August 22, 2017.

Slowik, P., N. Pavlenko, and N. Lutsey. 2016. *Assessment of next-generation electric vehicle technologies.* Washington, DC: International Council on Clean Transportation. Online at *www.theicct.org/sites/default/files/publications/Next%20Gen%20EV%20Tech_white-paper_ICCT_31102016.pdf*, accessed June 26, 2017.

Soulopoulos, N. 2017. *When will electric vehicles be cheaper than conventional vehicles?* Bloomberg New Energy Finance, April 12.

Voelcker, J. 2017. Chevy Bolt EV costs $28,700 to build, Tesla Model 3 a bit higher: Analysis. *Green Car Reports,* May 21. Online at *www.greencarreports.com/news/1110563_chevy-bolt-ev-costs-28700-to-build-tesla-model-3-a-bit-higher-analysis*, accessed June 26, 2017.

Voelcker, J. 2016. Electric-car battery costs: Tesla $190 per kwh for pack, GM $145 for cells. *Green Car Reports,* April 28. Online at *www.greencarreports.com/news/1103667_electric-car-battery-costs-tesla-190-per-kwh-for-pack-gm-145-for-cells*, accessed June 26, 2017.

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