A NEW PRESCRIPTION FOR ELECTRIC CARS

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Synopsis: The electric car revolution is here, or so the headlines would have one think. Cars like the Chevy Volt, the Nissan Leaf, and the Tesla Model S tout their environmental benefits and herald a new age of electric vehicles. Yet despite their allure, only with government subsidies do these cars of the future survive. What does the future really hold for electric cars and what role, if any, should the government take in encouraging them? In order to answer these questions and shape a recommendation for the United States, this article examines the electric car industry, and the laws foreign countries and the United States have adopted to promote it. Ultimately, the article finds that plug-in hybrid electric vehicles (PHEVs) do stand a chance in the United States, while battery electric vehicles (BEVs) have better potential in other countries. The article also finds that hybrid electric vehicles (HEVs) already achieve emission and oil reductions similar to PHEVs and BEVs. Considering these findings and other countries' policies for electric cars, the article recommends a six-part prescription for the U.S. federal government: (1) repeal the current $7,500 tax credit for PHEVs and BEVs and redirect it to HEVs; (2) invest in research and development for electric car technology through Advanced Research Projects Agency-Energy (ARPA-E); (3) do not renew the conversion and at-home charger tax credits for plug-ins; (4) do not renew the Advanced Technology Vehicles Manufacturing Loan Program; (5) leave any charging infrastructure investments to state and local governments; and (6) consider creating incentives for retrofitting heavy-duty trucks for natural gas.

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I. INTRODUCTION

Reading the headlines, it seems that an electric car revolution is already underway. Announcements of new vehicles like the Chevy Volt, Nissan Leaf, and Tesla Model S hitting the streets beg the question of what the future of electric cars will be.[1] This paper aims in Part II to explore the background of electric vehicles, in Parts III and IV to examine the electric vehicle (EV) laws that different countries and the United States have enacted, and in Part V to craft a recommendation for what the U.S. government should do about EVs.

II. BACKGROUND

Although veiled with a futuristic mystique, the electric car is far from new. In 1835, Thomas Davenport built the first practical electric vehicle in the United States, followed by William Morris, who in 1891 built the first successful electric automobile in Des Moines, Iowa.[2] By 1900, 28% of the 4,192 cars produced in the United States were powered by electricity.[3] However after Charles Kettering invented the electric automobile starter in 1912, eliminating the need for a hand crank, gasoline-powered automobiles accelerated in popularity.[4] With their long-distance capability, greater horsepower, and the ready availability of gasoline, gas-powered cars became more attractive than their electric counterparts.[5] Not until the soaring oil prices of the 1973 Arab Oil Embargo and growing environmental concerns of the 1970s did electric cars reemerge.[6]

1. *The Electric Car Revolution Starts Now!*, GREEN CHIP STOCKS, http://www.greenchipstocks.com/report/the-electric-car-revolution-starts-now/479 (last visited Mar. 22, 2014) [hereinafter *Electric Car Revolution*].

2. *Timeline: History of the Electric Car*, PBS (Oct. 30, 2009), www.pbs.org/now/shows/223/electric-car-timeline.html [hereinafter *Timeline*].

3. *Id.*

4. *Id.*

5. *Id.*

6. Seth Fletcher, *40 Years Later: Electric Cars and the OPEC Oil Embargo*, SCI. AM. (Oct. 8, 2013), http://blogs.scientificamerican.com/observations/2013/10/08/40-years-later-electric-cars-and-the-opec-oil-embargo/.

There exists a long, intricate history of electric cars. From Victor Wouk's first full-powered, full-size Buick Skylark hybrid in 1972, Vanguard-Sebring's CitiCar in 1974, G.M.'s creation of the EV1 in 1988, and Toyota's Prius in 1997, electric cars have taken many shapes and sizes.[7] Most recently, hybrid electric cars have attracted the most attention and have sold the most among electric cars; however, they still only account for approximately 3% of new car sales.[8]

On the outside EVs appear indistinguishable from internal combustion engine (ICE) cars; however, on the inside they are quite different. There are three main components that power EVs: the batteries, controller, and electric motor.[9] The rechargeable batteries store electricity, similar to an ICE car's gas tank.[10] The electricity stored in the batteries is regulated by a controller, which as its name suggests controls how much electricity is sent to the electric motor.[11] And finally, the electric motor powers the car.[12]

Returning to the batteries that store the car's power, battery technology has also taken different forms. There are three different kinds of rechargeable batteries—lead acid, nickel-metal hydride,[13] and lithium-ion—but lithium-ion batteries have become the most popular.[14] Lithium-ion batteries possess the best performance and range, although they are the most expensive.[15] They are also the same batteries used in laptop computers and cell phones.[16]

While EVs are often spoken about in general terms, there are in fact a handful of different kinds of EVs. Recognizing their differences is crucial to understanding the current landscape of the EV industry. The different EVs are:

- Hybrid Electric Vehicles,

7. *Timeline*, *supra* note 2.

8. *Electric Drive Sales Dashboard*, ELEC. DRIVE TRANSP. ASS'N, http://electricdrive.org/index.php?ht=d/sp/i/20952/pid/20952 (last visited Mar. 22, 2014) [hereinafter *Sales Dashboard*].

9. Marshall Brain, *How Electric Cars Work*, HOW STUFF WORKS, http://auto.howstuffworks.com/electric-car.htm (last visited Mar. 22, 2014).

10. *Id.*

11. *Id.*

12. *Id.*

13. Brad Berman, *The Hybrid Car Battery: A Definitive Guide*, HYBRID CARS (Nov. 6, 2008), http://www.hybridcars.com/hybrid-car-battery. Some of the cars that use nickel metal hydride batteries are the Toyota Prius Hybrid, Toyota Highlander Hybrid, Ford Escape Hybrid, Honda Insight Hybrid, and Saturn Vue Hybrid. *Id.*

14. *Id*. Lithium-ion (or Li-ion) batteries have been the most popular because of their "higher energy density—the amount of energy they hold by weight, or by volume." They hold "roughly twice as much energy per pound as do the previous generation of advanced batteries, nickel-metal-hydride (NiMH). NiMH batteries "in turn, hold[] about twice the energy per pound of the conventional lead-acid . . . 12-Volt battery that powers [a] car's starter motor. It's Li-ion's ability to carry so much energy that makes electric cars possible." *Id.* There are also many different kinds of lithium-ion batteries. What makes one lithium-ion battery different from another is the material of which the cathode is made. *Id.* The anode (negative electrode) is typically made of graphite, but the cathode (positive electrode) material varies. *Id.* There are five different types: cobalt dioxide, nickel-cobalt-manganese (NCM), nickel-cobalt-aluminum (NCA), manganese oxide spinel (MnO), and iron phosphate. *Id.* Each material offers a different "rate at which the cathode can absorb and emit free lithium ions, [and] [e]ach of several competing cathode materials offers a different mix of cost, durability, performance, and safety." *Id.* Cobalt dioxide has the highest energy density, and iron phosphate, the newest of the two materials used, is inexpensive, does not overheat, but works at a lower voltage. *Id.*

15. *Id.*

16. *Id.* Depending on the type of battery, it may need to be replaced every three to five years. MICHAEL BOXWELL, THE 2011 ELECTRIC CAR GUIDE (2011).

- Plug-In Hybrid Electric Vehicles,
- Battery Electric Vehicles, and
- Fuel Cell Electric Vehicles.[17]

This section will address each of these design types. After that, this section will investigate the two major benefits of EVs—reduced global warming emissions and oil consumption—to see how well EVs deliver.

A. Different Kinds of EVs

1. Hybrid Electric Vehicles (HEV)

An HEV uses an ICE, just like a conventional car, but also has an electric motor that captures energy that is normally lost through braking and coasting.[18] HEVs use the energy released from the wheels during braking to turn the motor, "converting energy normally wasted during coasting and braking into electricity, which is stored in a battery until needed by the electric motor."[19] By capturing this otherwise lost energy, HEVs can travel more miles on the same tank of gas than before. Many car companies like BMW, Cadillac, Chevrolet, GMC, Honda, Hyundai, Kia, Lexus, Mercedes, and Toyota make HEVs; however, the Toyota Prius is the most well-known.[20]

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17. *Vehicle Technology Basics*, ELEC. DRIVE TRANSP. ASS'N, http://www.electricdrive.org/index.php?ht=d/sp/i/2446/pid/2446 (last visited Mar. 22. 12, 2014). There is an additional category of electric vehicles called Neighborhood Electric Vehicles (NEVs), but these by design are meant for short range and not for mass appeal. Nikki Gordon-Bloomfield, *Neighborhood Electric Vehicles: A Marginal Option*, PLUGIN CARS (May 15, 2013), http://www.plugincars.com/neighborhood-electric-vehicle-margins-127231.html.

18. *Vehicle Technology Basics*, *supra* note 17.

> Since EVs use an electric motor, you can take advantage of the motor's momentum when you apply the brakes. Instead of converting all the potential energy in the motor into heat like a gas-powered car does, an electric car uses the forward momentum of the motor to recharge the batteries. This process is called regenerative braking. Although this process can only recover a fraction on the energy used to accelerate the car, it can increase the vehicle's range as much as 15%. You can still use a normal braking system on an EV, but the regenerative braking is worth the extra cost.

Electric Cars: How They Work, THINK QUEST, http://library.thinkquest.org/20463/howtheywork.html (last visited Mar. 22, 2014); *see also* Christopher Lampton, *How Regenerative Braking Works*, HOW STUFF WORKS (Jan. 23, 2009), http://auto.howstuffworks.com/auto-parts/brakes/brake-types/regenerative-braking.htm.

19. *How Hybrids Work*, U.S. DEP'T ENERGY, https://www.fueleconomy.gov/feg/hybridtech.shtml (last updated Mar. 21, 2014).

20. *Electric Car Revolution*, *supra* note 1; Alexander E. M. Hess & Michael B. Sauter, *The 10 Best-Selling Hybrid Cars*, FOX BUS. (Sept. 28, 2012), http://www.foxbusiness.com/personal-finance/2012/09/28/10-best-selling-hybrid-cars/ (naming the Prius as the most popular hybrid vehicle).

HEVs operate very similarly to ICE cars and do not require drivers to change their driving habits.[21] Although the inner workings of the car may be different, HEVs drive the same as ICE cars while enjoying an extended driving range.[22] The largest difference between HEVs and ICEs, apart from the electric motor, is their price tag. HEVs are more expensive than conventional ICE cars.[23] Many car companies that make HEVs offer them as a counterpart to an existing ICE model.[24] For example, Toyota makes the Toyota Camry as well as the Toyota Camry Hybrid.[25] However, for the 2012 models, the hybrid version was $3,945 more expensive.[26] This price difference is on the low end compared to other vehicles: Other HEVs are $5,000 to $17,000 more expensive than their ICE twins, as shown in Table 1 below.[27]

ICE vs. HEV Car Comparisons

Car	ICE Price	HEV Price	Price Premium	ICE Annual Fuel Cost	HEV Annual Fuel Cost	HEV Annual Fuel Savings	Years to Recoup HEV Premium
2012 BMW 750i	$84,300	$97,000	$12,700	$3,650	$3,100	$550	23.1
2012 BMW 750Li	88,200	101,000	12,800	3,650	3,100	550	23.3
2012 Cadillac Escalade 2WD	65,770	73,850	8,080	3,650	2,750	900	9.0
2012 Cadillac Escalade 4WD	65,720	76,400	10,680	4,150	2,750	1,400	7.6
2012 Chevrolet Silverado 2WD	22,195	39,640	17,445	3,400	2,750	650	26.8
2012 Chevrolet Tahoe 2WD	38,530	51,745	13,215	3,400	2,750	650	20.3
2012 Ford Escape AWD	23,190	32,320	9,130	2,500	2,000	500	18.3
2012 Ford Fusion FWD	22,975	28,775	5,800	2,300	1,500	800	7.3
2012 GMC Sierra C15 2WD	22,195	40,010	17,815	3,400	2,750	650	27.4
2012 GMC Yukon 1500 2WD	39,860	52,165	12,305	3,400	2,750	650	18.9
2012 Honda Civic	15,605	24,050	8,445	1,800	1,300	500	16.9
2012 Hyundai Sonata	19,795	25,850	6,055	2,050	1,550	500	12.1
2012 Kia Optima	19,500	25,700	6,200	2,050	1,550	500	12.4
2012 Lexus RX	39,075	45,235	6,160	2,750	2,050	700	8.8
2012 Lexus LS	73,175	112,750	39,575	3,250	3,100	150	263.8
2012 Lincoln MKZ FWD	34,755	34,755	0	2,750	1,500	1,250	0
2012 Toyota Camry	21,955	25,900	3,945	2,050	1,400	650	6.1
2012 Toyota Highlander	30,845	38,540	7,695	3,050	2,050	1,000	7.7
2012 Volkswagen Touareg	43,375	61,110	17,735	3,250	2,950	300	59.1

Source: U.S. Department of Energy, Energy Efficiency & Renewable Energy, *www.fueleconomy.gov*.

Table 1: Price premiums for hybrid models over their conventional model counterpart.

Although HEVs do save their owners money in fuel costs, it takes years before the fuel cost savings outweigh the initial premium consumers pay.[28]

21. *See, e.g.*, *How Hybrid Cars and Trucks Work*, UNION CONCERNED SCIENTISTS, http://www.ucsusa.org/clean_vehicles/smart-transportation-solutions/advanced-vehicle-technologies/hybrid-cars/how-hybrids-work.html (last updated Oct. 28, 2013).

22. *Id*.

23. Jamie Page Deaton, *Is Going Green Worth It? Hybrids vs. Conventional Models*, U.S. NEWS (May 28, 2011, 8:00 AM), http://usnews.rankingsandreviews.com/cars-trucks/best-cars-blog/2011/05/Is_Going_Green_Worth_It_Hybrids_vs_Conventional_Models/.

24. *E.g.*, *id*.

25. Mark Clotheir, *Toyota to Offer Sport Hybrid Version of Top-Selling Camry Sedan*, BLOOMBERG (Feb. 6, 2014, 12:43 PM), http://www.bloomberg.com/news/2014-02-06/toyota-to-offer-sport-hybrid-version-of-top-selling-camry-sedan.html.

26. *See* table 1; *see also* Wayne Cunningham, *The Hybrid Premium: How Much More Does a Hybrid Cost?*, CNET REV. (Apr. 30, 2012, 4:21 PM), http://reviews.cnet.com/8301-13746_7-57424518-48/the-hybrid-premium-how-much-more-does-a-hybrid-car-cost/. Honda's Civic Hybrid has a sticker price of $3,545 higher than its conventional counterpart. *Id.*

27. *Id*.

28. Deaton, *supra* note 23.

Depending on the car, it takes around six to twenty years for consumers to recoup their loss.[29] For example, the Toyota Camry Hybrid would take 6.2 years to recoup the initial premium.[30] This likely explains why HEVs have still only managed to capture around 3% of the new vehicle sales every year since 2007.[31]

Some car companies, however, are taking different sales approaches. Toyota, for example, does not offer both an ICE and HEV version of its Prius, the most successful HEV.[32] Rather, the Prius is a completely separate model.[33] Furthermore, the Toyota Prius is the least expensive of all HEVs, at only \$18,950, with the next expensive HEV being the Honda Civic at \$24,050.[34]

Toyota Cars by Price

ICE	HEV	PHEV	Price	Annual Fuel Cost	Relative Time to Recoup Prius c Premium
Yaris			$14,115	$1,800	7.44
Corolla			16,130	2,000	3.32
Matrix			18,845	2,400	0.08
	Prius c		18,950	1,150	N/A
Camry			21,955	2,050	N/A
	3rd Generation Prius		24,000	1,150	N/A
	Camry Hybrid		25,900	1,400	N/A
	Prius v		26,400	1,400	N/A
		Prius Plug-in Hybrid	32,000	N/A	N/A
Avalon			33,195	2,500	N/A

Source: Toyota, *www.toyota.com*; U.S. Department of Energy, Energy Efficiency & Renewable Energy, *www.fueleconomy.gov*.

Table 2: Comparison of various Toyota models

2. Plug-In Hybrid Vehicles (PHEV)

A PHEV combines the features of the battery electric vehicle (BEV) and HEV.[35] It uses an electric motor typically for the first forty miles or less and then switches into an HEV.[36] The electric motor can be recharged by plugging

29. *Compare Hybrids Side-by-Side*, U.S. Dep't Energy, http://www.fueleconomy.gov/feg/hybrids.jsp (last visited Mar. 22, 2014).

30. *Can a Hybrid Save Me Money?*, U.S. Dep't Energy, http://www.fueleconomy.gov/feg/hybrids.jsp (last visited Mar. 22, 2014).

31. From 2007 to 2011, HEVs have made up between 2.1% and 2.9% of the U.S. vehicle fleet. *Sales Dashboard*, *supra* note 8; *see also* Brad Tuttle, *Even with \$4 Gas, Few Drivers Choose Electric Cars—Or Even Hybrids*, Time (Mar. 14, 2012), http://business.time.com/2012/03/14/even-with-4-gas-few-drivers-choose-electric-cars-or-even-hybrids/. One anomaly is the 2012 Lincoln MKX FWD whose ICE and HEV prices are the same, and the HEV version saves the buyer \$1,250 annually in fuel. *Vehicle Cost Calculator*, U.S. Dep't Energy, http://www.afdc.energy.gov/calc/ (last visited Mar. 22, 2014). It is unclear why anyone would opt to buy the conventional ICE version under these circumstances.

32. Cunningham, *supra* note 26; *Toyota Prius Research All Models & Prices*, MSN, http://autos.msn.com/research/vip/default.aspx?make=Toyota&model=Prius (last visited Mar. 22, 2014).

33. Cunningham, *supra* note 26.

34. The 2014 models now start at \$19,080 and \$24,635, respectively. *Prius* c *2014*, Toyota, http://www.toyota.com/priusc/#!/Welcome (last visited Mar. 22, 2014); *Civic Hybrid*, Honda, http://automobiles.honda.com/shop/civic-hybrid.aspx?Group=civics (last visited Mar. 22, 2014).

35. *What is a Plug-In Hybrid (PHEV)?*, Plug In Am., http://www.pluginamerica.org/faq/what-plug-hybrid-phev (last visited Mar. 22, 2014).

36. *Plug-In Hybrid Electric Vehicles*, U.S. Dep't Energy, http://www.afdc.energy.gov/vehicles/electric_basics_phev.html (last updated Feb. 7, 2013).

the car into an electrical outlet.[37] Once the electricity in the electric battery is depleted, the car automatically switches from electricity to gasoline to power the car, operating at that point just like an HEV.[38]

One asset of PHEVs is that they allow drivers to use electricity to power their cars, which is cheaper and cleaner than gasoline, while still offering drivers the flexibility to go on long trips because of their back up hybrid engine.[39] The most talked about PHEVs in the United States are the Chevy Volt,[40] the Fisker Karma S Plug-In Hybrid[41] (although Fisker Automotive filed for bankruptcy in November 2013), the 2012 Ford Escape Plug-In Hybrid,[42] the Mercedes S500 Plug-In Hybrid,[43] and the Toyota Prius Plug-In Hybrid.[44]

37. *Id*.

38. *Id*.

39. *Id*.

40. The Chevy Volt is also being sold by GM as the Opel Ampera in Europe and the Holden Volt in Australia. Jason Fogelson, *2013 Chevrolet Volt—Not Quite Electrifying*, FORBES (Nov. 19, 2012, 6:57 PM), http://www.forbes.com/sites/jasonfogelson/2012/11/19/2013-chevrolet-volt-not-quite-electrifying/. There seems to be some confusion about whether the Chevy Volt is a PHEV or an extended range electric vehicle (EREV). Benji Jerew, *General Motors' Future Chevy Volt Taking a Shot at the Tesla Model E?*, GREEN OPTIMISTIC (Dec. 19, 2013), http://www.greenoptimistic.com/2013/12/19/general-motors-chevy-volt-taking-shot-tesla-model-e/#.Uy5406hdXHU. Like a PHEV, an EREV has an electric motor that can be plugged-in and charged to run for usually less than forty miles, as well as an internal combustion engine that provides extended driving range. *Plug-In Hybrid Electric Vehicles*, *supra* note 36. Once the car has depleted the electric battery the car switches from a pure electric car to an ICE car and uses gasoline. *Id.* While it is not completely clear, the difference between EREVs and PHEVs appears to be that when PHEVs switch from electric to gasoline, they use a hybrid system that still captures energy from regenerative braking and coasting. An EREV does not necessarily possess a hybrid system, but rather the term EREV appears to only connote that the vehicle can run on both electricity and gasoline, which extends its range. *Cadillac Introduces the 2014 ELR Extended Range Electric Vehicle*, GREEN CAR CONGRESS (Jan. 15, 2013), http://www.greencarcongress.com/2013/01/elr-20130115.html. The EPA lists the Volt as a PHEV, and it appears that the Volt does use regenerative braking, yet at the same time the Electric Drive Transportation Association (EDTA) lists the Chevy Volt and the 2014 Cadillac ELR as EREVs. Joann Muller, *What's Not to Love About the Chevy Volt? Here Are a Few Things*, FORBES (Nov. 29, 2012, 3:53 PM), http://www.forbes.com/sites/joannmuller/2012/11/29/whats-not-to-love-about-the-chevy-volt-here-are-a-few-things/.

41. *Fisker Karma Review*, PLUGIN CARS, http://www.plugincars.com/fisker-karma (last visited Mar. 23, 2014). Fisker Automotive filed for Chapter 11 bankruptcy on November 22, 2013. Angela G. Keane, *Fisker to Sell Assets in Bankruptcy at $139 Million Loss*, BLOOMBERG (Nov. 22, 2013, 11:00 PM), http://www.bloomberg.com/news/2013-11-22/fisker-to-sell-assets-in-bankruptcy-at-139-million-loss.html. It halted production in 2012 after its car quit running during a Consumer Report road test and its battery supplier, A123 Systems, also filed for bankruptcy. *Id.*

42. *Ford Escape Plug-in Hybrid Review*, PLUGIN CARS, http://www.plugincars.com/ford-escape-plug-hybrid (last visited Mar. 23, 2014).

43. Danny King, *Mercedes-Benz S500 Plug-in Hybrid Ready for 'Major Role' in Urban Areas*, GREEN AUTO BLOG (Jan. 17, 2014, 7:56 AM), http://green.autoblog.com/2014/01/17/mercedes-benz-s500-plug-in-hybrid-ready-urban-areas/.

44. *Prius Plug-In 2014*, TOYOTA, http://www.toyota.com/prius-plug-in/ (last visited Mar. 23, 2014). The 2012 Bright Automotive IDEA plug-in hybrid van was also once on the list of PHEVs, but the company went bankrupt after failing to receive a DOE loan. James O'Toole, *Hybrid Maker Bright Automotive Goes Bust*, CNN MONEY (Feb. 29, 2012, 3:02 PM), http://money.cnn.com/2012/02/29/autos/bright_automotive/index.htm.

PHEV			
Car	**Price (-tax credit)**	**Range**	**Charge Time**
2012 Chevy Volt	$39,145 (-$7,500)	35 miles electric + 260-310 miles gasoline	• 120V – 10 hrs • 240V – 4 hrs
2012 Fisker Karma S Plug-in Hybrid	$103,000 - $116,000 (-$7,500)	32-50 electric + 200 gasoline	• 120V – 14 hrs • 240V – 6 hrs
2012 Toyota Prius Plug-in Hybrid	$32,000 (-$2,500)	11 electric + 530 gasoline	• 120V – 3 hrs • 240V – 1.5 hrs
Volvo V60 Plug-In Hybrid	$72,000	31 electric + 715 gasoline	• 6A – 7.5 hrs • 16A – 3.5 hrs
2013 BMW i8	>$150,000	22 electric + 430 gasoline	• 220V – <2hrs
2013 Ford C-MAX Energi	$32,950 (-$3,750)	21 electric + 600 gasoline	• 120V – 7 hrs • 240V – 2.5 hrs
2014 Mitsubishi Outlander	Not for sale yet	34 electric + 547 gasoline	N/A
2014 Cadillac ELR	Not for sale yet	35 electric + 300+ gasoline	• 240V – 5 hrs
2014 Mercedes S-500 Plug-in Hybrid	Not for sale yet	18 electric + N/A gasoline	• 120V – 4.5 hrs • 240V – 1 hr

Source: Various articles and websites.

Table 3: Price, range, and charge time of various PHEVs.

PHEVs' greatest drawback, like the HEV, is their high price tag.[45] For example, the 2013 Chevy Volt costs $31,645 after the $7,500 federal tax credit and travels 38 miles on an electric battery, with a total range of approximately 380 miles.[46] This driving range is in line with comparable ICE cars like the 2012 Honda Civic's 380-mile range and the 2012 Chevy Cruze's 379-mile range.[47]

As for fueling costs, PHEVs make comparing price savings difficult because the savings depend so heavily on each owner's driving habits. The EPA, however, officially estimates annual fuel cost at $950 for the Chevy Volt, taking into account both electricity and gasoline cost and average driving distances.[48] As can be seen in the HEV chart, other comparable ICE cars have a $2,000 to $3,000 annual fuel cost.

There is also the question of charging PHEVs. The Chevy Volt may be charged using a regular 120-volt (V) outlet, which takes ten to sixteen hours to fully recharge the battery, or an installed 240V outlet, which takes four hours.[49] The 120V outlets are the common outlets found inside homes, but a 240V outlet must be installed by a professional.[50] These 240V outlets are the same as those used by clothes dryers. Chevrolet and other car companies have partnered with

45. LYNETTE CHEAH & JOHN HEYWOOD, MASS. INST. OF TECH., THE COST OF VEHICLE ELECTRIFICATION: A LITERATURE REVIEW (2010), *available at* http://web.mit.edu/sloan-auto-lab/research/beforeh2/files/PHEV%20costs.pdf.

46. *Compare Side-by-Side*, U.S. DEP'T ENERGY, http://www.fueleconomy.gov/feg/Find.do?action=sbs&id=31186&id=31371&id=32655 (last visited Mar. 23, 2014).

47. *Id.*

48. *Compare Side-by-Side*, U.S. DEP'T ENERGY, http://www.fueleconomy.gov/feg/Find.do?action=sbs&id=32655&id=33900 (last visited Mar. 23, 2014).

49. *2014 Volt*, CHEVROLET, http://www.chevrolet.com/volt-electric-car.html (last visited Mar. 23, 2014); *see also* Muller, *supra* note 40.

50. Muller, *supra* note 40.

Bosch, which installs 240V charging stations.[51] On its website, Bosch states that while each installation is unique, "the national average ranges from $1,200-$1,500."[52] Some states also offer tax credits to mitigate the cost of installing a 240V outlet.[53] The cost of installing a 240V outlet is therefore an additional cost of these vehicles.

As illustrated by the description of the Volt, there are several general criticisms of the PHEVs. First, PHEVs are significantly more expensive than ICE cars.[54] Of the PHEVs that will soon be available, the least expensive, the Toyota Prius Plug-In Hybrid, is just under $30,000.[55] After that, prices quickly jump to nearly $40,000, $70,000, and over $100,000.[56] Second, the electric range of PHEVs is short.[57] All the cars listed above fall within an eleven to fifty mile electric range. However, PHEVs also have a gasoline engine that enables them to meet or surpass the range of ICE cars.[58] This is the greatest asset of PHEVs. It allows drivers to use electricity and save fuel costs for their everyday commutes and errands that seldom exceed fifty miles while still offering them the ability to travel long distances comfortably. The third criticism centers on the long charging time.[59] For the cars listed above using a 120V outlet, the cars require three to sixteen hours to charge, and using a 240V outlet, the cars require one to six hours to charge. Although EV advocates argue that drivers will just charge their cars at night, these are still significant time spans especially considering the limited eleven to fifty mile all-electric driving range they offer.

3. Battery Electric Vehicles (BEV)

A BEV is a pure electric car. It only operates using an electric battery and motor.[60] Some of the most well-known BEVs available are the Nissan LEAF

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51. Chevrolet originally partnered with SPX, but SPX was later purchased by Bosch in December 2012. *SPX Selected by Chevrolet As Home Charging Installation Partner for the New Volt*, PR NEWS WIRE (Oct. 6, 2014), http://www.prnewswire.com/news-releases/spx-selected-by-chevrolet-as-home-charging-installation-partner-for-the-new-volt-104406998.html; Alysha Webb, *Bosch Tries to Undercut Cost of Home Electric Car Chargers*, PLUGIN CARS (May 11, 2013), http://www.plugincars.com/bosch-tries-undercut-cost-home-electric-car-chargers-127196.html.

52. *Bosch Frequently Asked Questions*, BOSCH, http://www.pluginnow.com/bosch-frequently-asked-questions (last visited Mar. 23, 2014).

53. *State Laws and Incentives*, U.S. DEP'T ENERGY, http://www.afdc.energy.gov/afdc/laws/state (last updated Nov. 12, 2013).

54. *Benefits and Considerations of Electricity as a Vehicle Fuel*, U.S. DEP'T ENERGY, http://www.afdc.energy.gov/fuels/electricity_benefits.html (last updated Oct. 1, 2013).

55. Press Release, Toyota, 2014 Toyota Prius Plug-In to Start Under $30,000 (Oct. 9, 2013), http://toyotanews.pressroom.toyota.com/toyota/prius-family/prius-plug-in/2014+toyota+prius+plug+in+starts+under+30k.htm.

56. *Plug-In Vehicle Tracker*, PLUG IN AM., http://www.pluginamerica.org/vehicles (last visited Mar. 23, 2014).

57. Press Release, Honda, All-New Honda Accord Plug-In Hybrid Sedan Melds Power, Luxury and Efficiency with Electric-Only Driving Mode (Sept. 5, 2012, 9:04 AM), http://www.honda.com/newsandviews/article.aspx?id=6824-en.

58. *Id.*

59. Muller, *supra* note 40.

60. Christopher Lampton, *How Electric Car Batteries Work*, HOWSTUFFWORKS (Aug. 18, 2008) [hereinafter Lampton, *Car Batteries*], http://auto.howstuffworks.com/fuel-efficiency/vehicles/electric-car-battery.htm.

and the Tesla Roadster and Model S.[61] A majority, if not all, current BEVs and most planned ones are listed in the Table 4 below along with their prices, driving ranges, and charging times. Today's BEV market is quite varied. All the cars listed enjoy a federal $7,500 tax credit.[62] Car prices begin at around $20,000, but can run to hundreds of thousands depending on style, name brand, range, and charge time.[63]

Most BEVs travel less than 100 miles on a full charge, although there are a number of exceptions.[64] Most cars that surpass the 100 mile threshold are significantly more expensive (e.g., the Tesla Roadster and Model S, Audi e-tron, and Mercedes SLS E-Cell AMG).[65] One exception to this trend is BYD's e6 that claims to go 186 miles while costing $27,500.[66] According to BYD, it has advanced battery technology (a lithium-ion iron phosphate battery) that enables its e6 to perform so well.[67] Nonetheless all of these driving ranges, even among the most expensive BEVs, are well below the 300 to 500 mile driving ranges ICE cars and PHEVs feature.[68] Furthermore, all BEVs require long charging times compared to the few minutes it takes to fill a gas tank.[69]

61. *Electric Cars: The Top Ten*, AUTOSAUR (Oct. 21, 2013), http://www.autosaur.com/electric-cars-top-ten/.

62. *Federal Tax Credits for Electric Vehicles*, U.S. DEP'T ENERGY, http://www.fueleconomy.gov/feg/taxevb.shtml (last updated Mar. 21, 2014).

63. *All-Electric Vehicles: Compare Side-by-Side*, U.S. DEP'T ENERGY, http://www.fueleconomy.gov/feg/evsbs.shtml (last updated Mar. 21, 2014); *see also 2012 Mitsubishi i*, U.S. NEWS, http://usnews.rankingsandreviews.com/cars-trucks/Mitsubishi_i/2012/ (last updated Jan. 17, 2014); John Voelcker, *New & Used Tesla Roadster: In Depth*, CAR CONNECTION (Mar. 11, 2012), http://www.thecarconnection.com/cars/tesla_roadster.

64. Phillip Reed, *Electric Car Battery Basics: Capacity, Charging and Range*, EDMUNDS (Jan. 25, 2011), http://www.edmunds.com/car-technology/electric-car-battery-basics-capacity-charging-and-range.html.

65. *Electric Cars: The Top Ten*, *supra* note 61.

66. This is the cost after the $7,500 tax credit. John Voelcker, *2012 BYD e6 Electric Crossover to Cost $35,000, 200-Mile Range*, GREEN CAR REPORTS (Jan. 10, 2011), http://www.greencarreports.com/news/1053395_2012-byd-e6-electric-crossover-to-cost-35000-200-mile-range; *e6 Introduction*, BYD, http://www.byd.com/na/auto/e6.html (last visited Mar. 23, 2014).

67. *e6 Introduction*, *supra* note 66. After significant delays BYD's e6 has yet to come to market in the United States. Alysha Webb, Years After Unveiling, BYD All-Electric e6 Still Not Ready for U.S. Market (July 29, 2013), http://www.plugincars.com/years-after-debut-byd-all-electric-e6-still-not-ready-us-market-127844.html.

68. Reed, *supra* note 64.

69. *Id.*

BEV			
Car	**Price (after $7,500 tax credit)**	**Range**	**Charging**
2011 BYD e6	$27,500	186.4 miles	• 3.3 kW – 6 hours • 60 kW – 1.5 hours • 100kw – 40 min
2011 Tesla Motors Roadster	$101,500 - $121,000	245	• 120V – 30 hours • 120-240V – 6 hours • 208-240V – 4 hours • DC stations – 45 minutes
2011 Ford TRANSIT connect electric	$46,500	80	• 120 – 16 hours • 240V – 6-8 hours
2011 Nissan LEAF	$27,700	73-100	• 120V – 20 hours • 240V – 7 hours • 480V – 30 minutes
2011 Smart Fortwo electric drive	Lease only	63	• 110V – less than 8 hours • 220V – 3.5 hours from 20& to 80%
2011 TH!NK City	$28,995	99-126	• 20-80% – 4 hours • 230V – 9.5-10 hours
2011 BMW ActiveE	Lease only	100 (160km)	• 230V (32A) – 4-5 hours • 230V (16A) – 8-10 hours
2012 Coda Automotive Sedan	$32,400	125	• 220V (30 AMP) – 6 hours
2012 Mitsubishi i	$21,625	62	• 120V – 22.5 hours • 240V – 7 hours • 480V – 40 minutes
2012 Audi e-tron	$160,000	154	• 110V – 16 hours
2012 Ford Focus electric	$32,495	100	• 240V – 3-4 hours
2012 Honda Fit EV	$36,625	123 city/95 highway	• 240V – 3 hours
2012 Tesla Motors Model S	$50,400 - $69,900	160-300	• 62 miles per hour charge time • 50% in 30 min. with Supercharger
2012 Toyota FT-EV	N/A	50	N/A
2012 Toyota RAV4 EV	N/A	80-100	N/A
2012 Volvo C30 Electric	N/A	93	• 120V – 7 hours
2013 BMW i3 (Megacity)	$35,000	100	• 240V – 4 hours • High-speed charger – 1 hour
2013 Mercedes SLS E-Cell AMG	$183,000	90-130	• Fast charging station – 1 hour
2013 Nissan ESFLOW	$33,000	149	N/A
2014 BMW i3	N/A	93	• Slow charge – 6 hours • Quick charge to 80% – 1 hour
2014 Infiniti EV	+$40,000	80	N/A
2014 Volkswagen Golf Blue-e-motion	£14,230-£22,300	60-95	• 120V - 7 hours • 240V – 3.5 hours
Pininfarina Bluecar (B0 or B Zero)	Lease Only	160 (250 km)	• 230V – 4 hours
Subaru R1E	$17,500	50	• 120V – 8 hours • Special charger – 15 minutes

Source: Various articles and websites.

Table 4: Price, range, and charge time of various BEVs.

The criticisms against BEVs are generally the same as those for PHEVs. BEVs are expensive, have a short driving range, and take a long time to charge.[70] The latter two criticisms are especially important for BEVs as they do not have an ICE to grant them additional miles like PHEVs.[71] A fourth concern that is less often heard is the question of battery life. According to at least one car

70. Andrea Kissack, *Will Electric Cars Work for the Everyday Driver?*, NPR (Oct. 11, 2010, 12:01 AM), http://www.npr.org/templates/story/story.php?storyId=130362812. There are currently two methods to charging an EV—conductive and inductive charging. Conductive charging requires metal on metal contact and uses electric current to charge the batteries. Joachim G. Taiber, Wirelessly Charge Electric Vehicles by Induction While Driving, IEEE (Feb. 4, 2014), http://electricvehicle.ieee.org/2014/02/04/wirelessly-charge-electric-vehicles-by-induction-while-driving/. Inductive charging on the other hand uses a safer paddle that creates a magnetic field that charges the batteries. *Id.*; *see also* Murray Slovick, *Wireless Charging of Electric Vehicles: The Next Big Thing?*, TTI (May 11, 2011), http://www.ttiinc.com/object/me-slovick-20110511.html. Depending on the type of battery, it may need to be replaced every three to five years. BOXWELL, *supra* note 16.

71. *Vehicle Technology Basics*, *supra* note 17.

manufacturer the batteries last fewer than ten years, depending on use,[72] creating a considerable extra expense.[73]

The fifth and final criticism of BEVs, which also applies to PHEVs, is that they are not really clean.[74] This criticism cuts at the heart of one of EVs' main benefits, which is that they offer a cleaner, less polluting alternative to ICE cars. This criticism will be explored further in the following section. It suffices here to say that BEVs emit 30% to 40% less carbon dioxide compared to ICE cars.[75] There, however, is more to the story than that.

4. Fuel Cell Electric Vehicles (FCEV)

The last EV type is a fuel cell electric vehicle (FCEV), which combines hydrogen fuel and oxygen to produce electricity and power an electric motor.[76] Hydrogen is pumped into the FCEV, combined with oxygen, and converted into electricity and water.[77] As shown in the Table 5 below, although car manufacturers have produced FCEVs for some years now, they are still only available for lease and even then only for a small group of lessees.

FCEV		
Car	Availability/Price	Range
2007 BMW Hydrogen 7	Lease only	125 miles hydrogen + 300 miles gasoline
2008 Chevy Equinox Fuel Cell	Lease only	200 miles
2010 Hyundai Tucson ix35 Fuel Cell	Lease only	404 miles
2011 Honda FCX Clarity	Lease only, $600/month	240 miles
2011 Mercedes-Benz B-Class F-Cell	Lease only, $800-$1,000 per month	250 miles (for sale by 2015)

Source: Various articles and websites.

Table 5: Price and range of various FCEVs.

Although FCEVs exhibit a number of great benefits compared to PHEVs and BEVs—such as long range and quick fueling time, requiring mere minutes versus hours—the downfalls likely outweigh the benefits. First, although FCEVs themselves do not emit pollutants, liquefying and even compressing

72. Lampton, *Car Batteries*, *supra* note 60. However, to help reduce the sticker shock of total replacement, at least one car manufacturer offers a ten-year battery leasing program which covers the cost of maintenance and repair. *Frequently Asked Questions: Battery*, SMART USA, http://www.smartusa.com/models/electric-drive/faq.aspx (last visited Mar. 23, 2014).

73. Team Planet Green, *Top 10 Electric Car Frequently Asked Questions*, HOW STUFF WORKS (Dec. 6, 2011), http://auto.howstuffworks.com/top-10-electric-car-frequently-asked-questions10.htm (stating "you'll have to eventually replace the batteries in your car, which can cost thousands of dollars").

74. *E.g.*, Dave Chameides, *12 Myths About Electric Vehicles*, HOW STUFF WORKS, (Dec. 6, 2011), http://auto.howstuffworks.com/myths-electic-cars-vehicles.htm#page=3.

75. KIMBERLY AGUIRRE, ET AL., UNIV. CAL. L.A., LIFECYCLE ANALYSIS COMPARISON OF A BATTERY ELECTRIC VEHICLE AND A CONVENTIONAL GASOLINE VEHICLE (2012), *available at* http://www.environment.ucla.edu/media_IOE/files/BatteryElectricVehicleLCA2012-rh-ptd.pdf.

76. *E.g.*, Karim Nice & Jonathan Strickland, *How Fuel Cells Work*, HOWSTUFFWORKS (Sept. 18, 2000), http://auto.howstuffworks.com/fuel-efficiency/alternative-fuels/fuel-cell.htm. However, not all FCEV use liquefied hydrogen but instead use compressed hydrogen gas. Bill Howard, *First Production Hydrogen Fuel Cars Hit the Market, from Hyundai*, EXTREME TECH (Mar. 7, 2013), http://www.extremetech.com/extreme/150202-first-production-hydrogen-fuel-cell-cars-hit-the-market-from-hyundai.

77. *E.g.*, *How FCX Clarity FCEV Works*, HONDA, http://automobiles.honda.com/fcx-clarity/how-fcx-works.aspx (last visited Mar. 23, 2014).

hydrogen requires a large amount of electricity.[78] If that electricity is generated by coal-fired power plants, then pollution associated with that process is created.[79] Although the same could be said about PHEVs and BEVs, which also use electricity stemming from polluting sources, FCEVs operate less efficiently than PHEVs and BEVs and may in fact generate more pollution than ICE cars.[80] Second, some of the liquefied hydrogen stored in an FCEV or stored for distribution "must be allowed to evaporate for safety reasons."[81] This means that hydrogen is lost and detracts from FCEV's efficiency. Third, keeping hydrogen in a liquefied state at 420 degrees below zero is expensive and difficult.[82] Fourth, an expensive infrastructure would need to be created to distribute liquefied hydrogen for refueling.[83] It is likely that FCEVs have not gained wide acceptance because of these shortcomings.

B. Benefit #1: Reduced Emissions

All of the types of EVs described above share two major purported benefits compared to ICE cars—reduced global warming emissions and reduced oil consumption.[84] These benefits aim to combat climate change by decreasing greenhouse gas emissions and enhance energy security by diminishing the country's dependence on oil.[85] While these benefits may seem obvious, there are nuances to the emissions and oil consumption profiles of the different kinds of EVs. For example, recent studies have found that while BEVs emit less global warming pollutants and consume less oil than ICE cars, HEVs achieve similar reductions.[86] In shaping a recommendation for U.S. EV policy, it is imperative to assess how all EVs compare on emissions and oil consumption in order to determine whether pursuing EVs is worthwhile.

Many critics complain that EVs still generate greenhouse gases because the electricity they use derives from fossil fuel burning sources, mostly coal and natural gas.[87] Does this mean that EVs are just moving pollution from the tailpipe to the smokestack? In analyzing whether EVs are eco-friendly, it is

78. *Hydrogen*, WINDOW ST. GOV'T, http://www.window.state.tx.us/specialrpt/energy/renewable/h2.php (last visited Mar. 23, 2014).

79. *2007 BMW Hydrogen 7*, CAR & DRIVER BUYER'S GUIDE (Sept. 2006), *available at* http://www.caranddriver.com/news/2007-bmw-hydrogen-7-car-news-but-does-it-really-help-the-environment-page-2 (stating that "getting a pound of hydrogen into its liquid form takes roughly six kilowatt hours of electricity. If that electricity comes from a coal-fired plant, it creates as much carbon dioxide as burning half a gallon of gasoline."). "Using hydrogen in a fuel cell to produce electricity extracts far more performance from the fuel than do internal-combustion engines." *Id.*

80. *Id.*

81. *Why a Hydrogen Economy Doesn't Make Sense*, PHYS.ORG (Dec. 11, 2006), http://www.physorg.com/news85074285.html.

82. *2007 BMW Hydrogen 7*, *supra* note 79.

83. Nichola Groom, *Fuel-Cell Vehicles Face Roadblock in Infrastructure, Not Technology*, CHI. TRIB. (Nov. 21, 2013, 9:48 AM), http://cars.chicagotribune.com/fuel-efficient/news/chi-fuelcell-vehicles-future-20131121.

84. *UK Study Finds Electric Cars Can Reduce Urban Population*, EV WORLD (June 14, 2013), http://evworld.com/news.cfm?newsid=30499.

85. Pew Charitable Trusts, *Electric Vehicles Can Help Reduce U.S. Oil Dependence*, CARE2 (Aug. 2, 2012, 7:30 AM), http://www.care2.com/causes/electric-vehicles-can-help-reduce-u-s-oil-dependence.html.

86. *Infra* note 90.

87. Chameides, *supra* note 74.

imperative to discuss PHEVs and BEVs separately. PHEVs use both an electric battery and gasoline, while BEVs use only an electric battery, creating different emissions profiles for each.[88]

To begin with PHEVs, the utility industry-sponsored Electric Power Research Institute (EPRI) and the Natural Resources Defense Council (NRDC), an environmental advocacy group, conducted a study in 2007 analyzing the emissions created by PHEVs.[89] This study found that "plug-in electrics are responsible for about 30% fewer climate-changing greenhouse gases than conventional gasoline-powered cars, even if the electric vehicle is charged with a coal-fired power plant."[90] According to this study, even in regions that use coal for electricity, PHEVs reduce greenhouse gases by 25-30% compared to ICE cars, and even more if the region uses other cleaner forms of energy, such as hydroelectric, wind, or solar power.[91] Using the values shown in the study, if the electricity powering PHEVs came from coal only, an average grid mix, or renewables only, the emissions reductions would be 30%, 45%, 68% respectively.[92] Thus PHEVs do reduce greenhouse gases, and the cleaner the electricity generating source, the greater the emissions reduction.[93]

Moving to BEVs, a report by the Union of Concerned Scientists in 2012 instead analyzes the emissions created by BEVs.[94] Similar to the EPRI-NRDC study, this study found that BEVs also reduce global warming emissions by 19% to 77% compared to ICE cars, depending on whether the source of the electricity is only coal, a mix (coal, natural gas, nuclear, renewables, etc.), or entirely renewables.[95] Once again, the cleaner the electricity source, the greater the emissions reduction. The findings of both studies are shown in the chart below.

88. *Emissions from Hybrid and Plug-In Electric Vehicles*, U.S. DEP'T ENERGY, http://www.afdc.energy.gov/vehicles/electric_emissions.php (last updated July 30, 2012).

89. NATURAL RES. DEF. COUNCIL, THE NEXT GENERATION OF HYBRID CARS: PLUG-IN HYBRIDS CAN HELP REDUCE GLOBAL WARMING AND SLASH OIL DEPENDENCY (2007) [hereinafter NRDC 2007 REPORT], *available at* http://www.nrdc.org/energy/plugin.pdf.

90. Jerry Edgerton, *Electric Cars: How Green Are They Really?*, CBS NEWS (July 21, 2010, 1:40 PM), http://www.cbsnews.com/8301-505145_162-40541064/electric-cars-how-green-are-they-really/ (discussing the 2007 NRDC report).

91. *Environmental Benefits*, GO ELEC. DRIVE, http://www.goelectricdrive.com/index.php/drive-electric/environmental-benefits (last visited Mar. 23, 2014).

92. NRDC 2007 REPORT, *supra* note 89, at 3.

93. Edgerton, *supra* note 90.

94. DON ANAIR & AMINE MAHMASSANI, UNION OF CONCERNED SCIENTISTS, STATE OF CHARGE: ELECTRIC VEHICLES' GLOBAL WARMING EMISSIONS AND FUEL-COST SAVINGS ACROSS THE UNITED STATES, (2012) [hereinafter UCS REPORT], *available at* http://www.ucsusa.org/assets/documents/clean_vehicles/electric-car-global-warming-emissions-report.pdf.

95. *Id.* executive summary at 15, *available at* http://www.ucsusa.org/assets/documents/clean_vehicles/electric-car-global-warming-emissions-exec-summary.pdf.

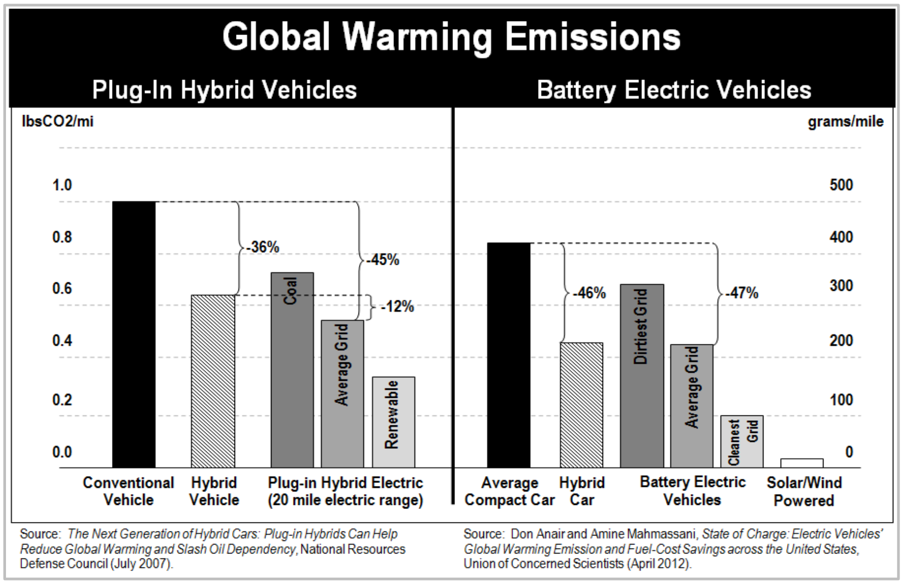

Figure 1: GHG emission comparisons of different types of electric vehicles.

Both studies also offer some surprising and illuminating information on HEV (e.g. Toyota Prius) greenhouse gas emissions savings as compared to PHEVs (e.g. Chevy Volt) and BEVs (e.g. Nissan Leaf). With an average grid mix of generating sources, HEVs would cut about as much greenhouse gases as PHEVs and BEVs. As illustrated in the graphs above, the reports found that PHEVs and BEVs may actually emit more greenhouse gases than HEVs if the source of their electricity is only or mostly coal. While greenhouse gas emissions would be substantially lower for PHEVs and BEVs compared to HEVs when the electricity powering them is all renewable, this is simply not a reality in the United States nor will it be anytime in the foreseeable future.[96] In 2012, only 3% of the electricity in the United States is generated by wind and solar energy.[97] It appears that HEVs may be more worthwhile than PHEVs and BEVs since these reports show that PHEVs and BEVs do not generate large greenhouse gas savings unless powered exclusively by renewable energy.[98] Also considering the other shortcomings of PHEVs and BEVs—the high price tags, short range, long charge times, battery replacement, and necessary charging station infrastructure—versus the ease of switching to HEVs, which enjoy long driving ranges, minute-long refueling, and no new infrastructure, the case for HEVs is even stronger. Although HEVs also carry higher price tags than ICE cars, that is the only major hurdle compared to the many sundry ones of PHEVs

96. *What Is U.S. Electricity Generation by Energy Source?*, U.S. ENERGY INFO. ADMIN., http://www.eia.gov/tools/faqs/faq.cfm?id=427&t=3 (last updated May 9, 2013) [hereinafter *U.S. Electricity by Energy Source*].

97. *Energy in Brief*, U.S. ENERGY INFO. ADMIN., http://www.eia.gov/energy_in_brief/article/renewable_electricity.cfm (last updated May 7, 2013). Twelve percent of U.S. electricity generation in 2012 came from renewable sources. *Id.* The breakdown of that 12% is: 56% hydropower, 28% wind, 8% biomass wood, 4% biomass waste, 3% geothermal, 1% solar. *Id.*

98. NRDC 2007 REPORT, *supra* note 89, at 3; UCS REPORT, *supra* note 94, at 5.

and BEVs. But does this mean that it is no longer worth pursing PHEVs and BEVs?

While these studies evince the superior benefits that HEVs offer, they do not vitiate the need to pursue PHEVs and BEVs for a number of reasons. First, considering an average grid mix, PHEVs and BEVs are still cleaner than HEVs and certainly cleaner than ICE cars.[99] Second, the EPRI-NRDC study assumes that PHEVs have a 20-mile all-electric range, which as seen in the previous section is on the low end of the spectrum.[100] While the new Toyota PHEV has a 15-mile all-electric range, the Chevy Volt can go 38 miles on its battery, and other PHEVs already can exceed all-electric 20 miles.[101] As the all-electric range of PHEVs grows, their greenhouse gas emissions will decrease. Third, the grid is becoming greener every year. As more natural gas and renewable energy sources are integrated into the grid, electricity and hence PHEVs and BEVs will become cleaner. Fourth, it may be easier and more efficient to clean smokestacks than tailpipes. By moving to PHEVs and BEVs, the source of pollution will be power plants instead of millions of individual cars. It may be easier to tighten emissions restrictions at power plants than for millions of cars, and thus make the powering of PHEVs and BEVs cleaner.[102] These power plants would likewise be easier to monitor to ensure compliance. Fifth, while renewables will not comprise 100% of the electric grid anytime soon, there is the potential for rooftop photovoltaic panels on households.[103] Should this technology become more economically viable, houses could install rooftop solar panels to power PHEVs and BEVs and make the electricity source 100% clean.[104] In this way, the electricity powering PHEVs and BEVs would come from completely renewable sources and generate significant greenhouse gas emission reductions, even compared to HEVs. Sixth, reducing greenhouse gas emissions is not the only benefit of PHEVs and BEVs.[105] As will be discussed in the next section, PHEVs and BEVs reduce oil consumption, which is an entirely separate reason to encourage their development.

99. NRDC 2007 REPORT, *supra* note 89, at 3.

100. *Id.*; *supra* Part II.A.2.

101. Colum Wood, *2013 Toyota Prius Plug-in Review*, AUTOGUIDE (May 22, 2013), http://www.autoguide.com/manufacturer/toyota/2013-toyota-prius-phev-plugin-review-video-2632.html; Robert Duffer, *2013 Chevy Volt Review: Extending Range in Style*, CHI. TRIB. (Sept. 25, 2013, 12:43 PM); *Compare Side-by-Side*, U.S. DEP'T ENERGY, http://www.fueleconomy.gov/feg/Find.do?action=sbs&id=33336&id=33398 (last visited Mar. 23, 2014) (showing both the 2013 Ford C-Max Energi Plug-In Hybrid and the Fusion Energi Plug-In Hybrid with an electric range of 21 miles).

102. UCS REPORT, *supra* note 94, at 2 ("[T]he U.S. electric vehicle fleet will only be as clean and sustainable as the power grid it ultimately plugs into.").

103. *See, e.g.*, Kiley Kroh, *California Installed More Rooftop Solar in 2013 Than Previous 30 Years Combined*, THINK PROGRESS (Jan. 2, 2014, 12:37 PM), http://thinkprogress.org/climate/2014/01/02/3110731/california-rooftop-solar-2013/.

104. Chip Gaul, *Why Use Rooftop Solar Panels to Power Your Electric Vehicle?*, ENERGY COLLECTIVE (June 28, 2012), http://theenergycollective.com/chipgaul/88254/complexities-and-payoffs-using-rooftop-solar-panels-power-your-electric-vehicle.

105. *Cummins, GM, Nissan and Shorepower Recognized for Reducing U.S. Oil Dependence*, TRUCKING INFO (Oct. 4, 2013), http://www.truckinginfo.com/channel/fuel-smarts/news/story/2013/10/cummins-gm-nissan-and-shorepower-recognized-for-reducing-u-s-oil-dependence.aspx.

C. Benefit #2: Reduced Oil Consumption

EVs also reduce oil consumption, thus diminishing the nation's dependence on oil. This second benefit was also examined in the EPRI-NRDC study.[106] This study found that PHEVs consume approximately 67% less oil than ICE cars and about 45% less oil than HEVs, as seen in the graph below.[107] BEVs on the other hand, by definition, consume no oil.[108] Thus, both PHEVs and BEVs if widely adopted could significantly decrease the dependence of the United States on oil and enhance the country's energy security. Moreover the EPRI-NRDC study also shows that HEVs consume approximately 36% less oil than ICE cars.[109] Although this reduction is not as large as that for PHEVs and BEVs, similar to the reduction of global warming emissions, it is still significant and readily augmented because of the ease by which more HEVs can be integrated into the marketplace as compared to PHEVs and BEVs.[110]

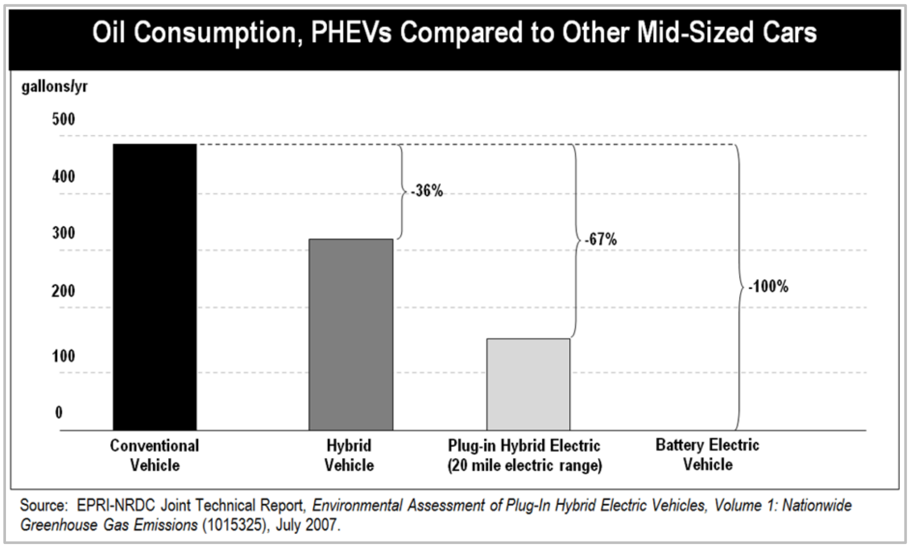

Figure 2: Oil consumption based on electric vehicle type.

On the subject of oil, it is worth clarifying a common misconception about the United States' dependence on oil. Many advocates of cutting the nation's dependence on oil highlight that the United States imports most of its oil and that this oil comes from hostile countries, most often focusing on the Middle East and the specter of the Organization of the Petroleum Exporting Countries (OPEC).[111] Although the United States does import 57% of its crude oil,[112] these

106. NRDC 2007 REPORT, *supra* note 89.

107. *Id.* at 3.

108. *Id.* Only 1% of electricity in the United States is generated by oil. *U.S. Electricity by Energy Source*, *supra* note 96.

109. NRDC 2007 REPORT, *supra* note 89, at 3.

110. *Electric Drive Sales Dashboard*, *supra* note 8.

111. *See, e.g.*, Rebecca Lefton & Daniel J. Weiss, *Oil Dependence Is a Dangerous Habit*, CTR. FOR AM. PROGRESS (Jan. 13, 2010), http://www.americanprogress.org/issues/green/report/2010/01/13/7200/oil-dependence-is-a-dangerous-habit/.

fears are misleading. Most of the oil that the United States imports does not come from the Middle East, nor does the majority of it come from hostile countries.[113] In fact, in 2011, most of the oil the United States imported came from Canada, Mexico, Saudi Arabia, Venezuela, and Nigeria.[114] While Saudi Arabia and Venezuela have ideologies that tend to conflict with those of the United States, they are not actively hostile countries. Nor can it be said that most of the oil the United States imports comes from OPEC.[115] In 2011, only 27% of the total U.S. oil supply, or about 40% of the oil the United States imported, came from OPEC countries.[116]

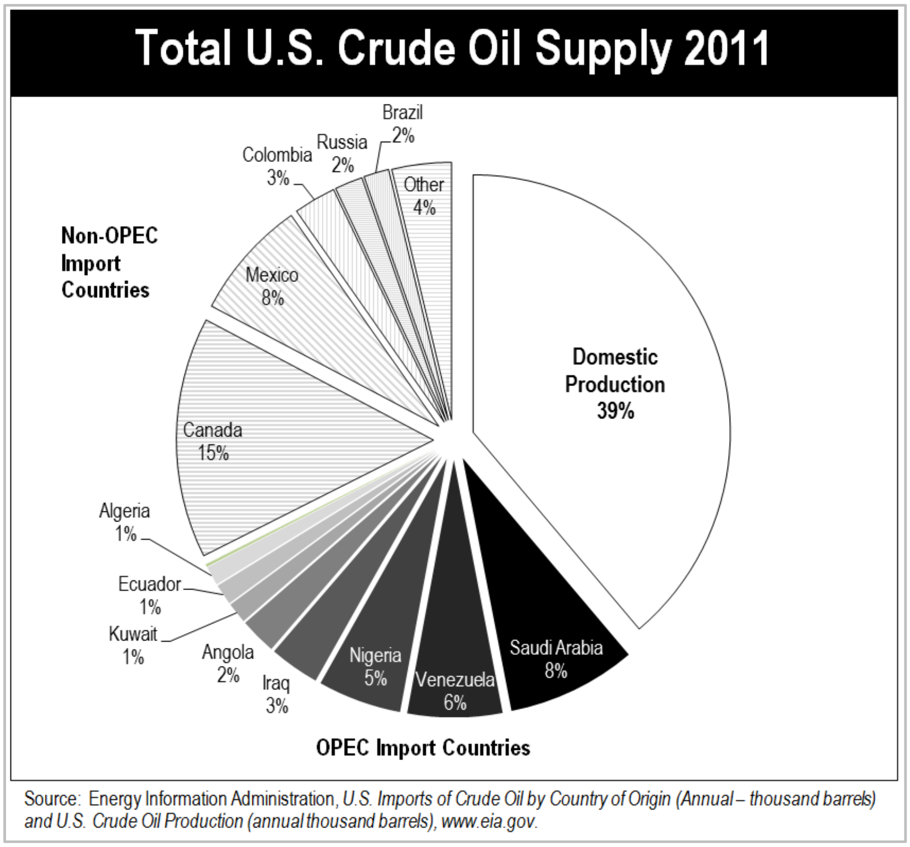

Figure 3: Countries contributing to U.S. crude oil supply

112. *How Dependent Is the United States on Foreign Oil?*, U.S. ENERGY INFO. ADMIN. (May 10, 2013), http://www.eia.gov/energy_in_brief/article/foreign_oil_dependence.cfm.

113. *How Dependent Are We on Foreign Oil?*, U.S. ENERGY INFO. ADMIN., http://www.eia.gov/energy_in_brief/article/foreign_oil_dependence.cfm (last updated May 10, 2013).

114. *Nearly 69% of U.S. Crude Oil Imports Originated from Five Countries in 2011*, U.S. ENERGY INFO. ADMIN. (Mar. 27, 2012), http://www.eia.gov/todayinenergy/detail.cfm?id=5570.

115. *How Dependent Are We on Foreign Oil?*, *supra* note 113.

116. NEELESH NERURKAR, CONG. RESEARCH SERV., U.S. OIL IMPORTS & EXPORTS 1 (2012), *available at* https://www.fas.org/sgp/crs/misc/R42465.pdf.

Does this then mean that oil and OPEC do not threaten our energy security? No. The threat to America's energy security remains real. Why? That is made clear in the graph below. While the United States may not import most of its oil from OPEC, OPEC countries control the *grand* majority of the world's crude oil reserves. OPEC claims that it controls 81% of the world's crude oil reserves[117] while the Energy Information Administration claims in 2011 OPEC controlled 72%.[118] In either case, OPEC controls a clear majority of crude oil reserves, and therefore has the power to collectively dictate the global price of oil.[119] This is important because oil is a world commodity that is traded on a global market. There is a global price of oil that the market dictates, and countries that control the majority of oil reserves control the price of oil by releasing or withholding their supply.[120] This fact matters to the United States because while it may purchase oil from Canada, the price of that Canadian oil is set by OPEC countries. Thus countries like Iran, with whom the United States has open tensions, have indirect control over the price of oil the United States imports, even though the United States does not buy oil directly from Iran.[121] This indirect control that OPEC countries exert over the United States creates a real threat to U.S. energy security and makes reducing the nation's oil consumption a worthwhile endeavor.

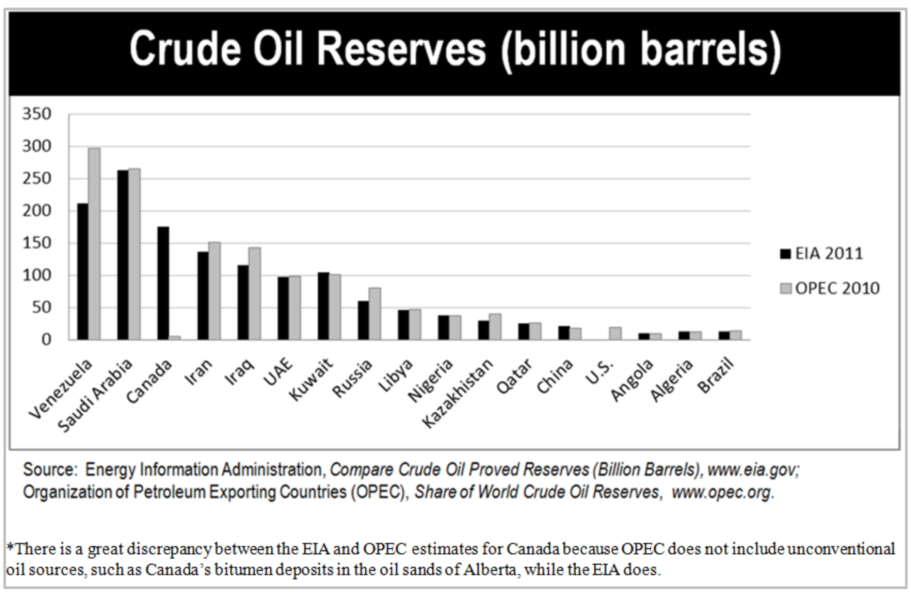

Figure 4: Crude oil reserves, by country.

117. *OPEC Share of World Crude Oil Reserves 2012*, OPEC, http://www.opec.org/opec_web/en/data_graphs/330.htm (last visited Mar. 24, 2014).

118. *International Energy Statistics: Crude Oil Reserves*, U.S. ENERGY INFO. ADMIN., http://www.eia.gov/cfapps/ipdbproject/iedindex3.cfm?tid=5&pid=57&aid=6&cid=ww,CG9,&syid=2000&eyid=2011&unit=BB (last visited Mar. 24, 2014). According to this data, in 2011, OPEC controlled 1,064.790 billion barrels of crude oil reserves out of the world's 1,473.761 billion barrels. *Id.*

119. *See generally What Drives Crude Oil Prices?*, U.S. ENERGY INFO. ADMIN., http://www.eia.gov/finance/markets/supply-opec.cfm (last visited Mar. 24, 2014).

120. *Id.*

121. *See, e.g.*, Wenqian Zhu, *U.S. Oil Boom Helps Thwart OPEC*, CNN MONEY (June 19, 2013, 5:30 AM), http://money.cnn.com/2013/06/19/news/economy/us-oil-price-opec/.

This section provided a background of EVs, highlighting their history, characteristics, and benefits. While PHEVs and BEVs are commonly heralded as the necessary panacea for reducing our emissions and oil dependency, all things considered HEVs appear to better deliver on emissions reductions. And while PHEVs and BEVs outperform HEVs in reduced oil consumption, HEVs nonetheless reduce oil consumption significantly.[122] Furthermore, without widespread adoption, none of EVs' purported benefits will be meaningful, so it is important to promote EVs that will be widely adopted. Already HEV sales are increasing and dwarf those of PHEVs and BEVs. This suggests that perhaps HEVs should be the EVs the United States encourages right now. Next, this article examines the EV laws of other countries to help inform its recommendation for the United States.

III. FOREIGN EV LAWS

Having established a foundation of the history, types, and benefits of EVs, now we can examine the EV policies of other countries in order to inform U.S. policy. This section explores the EV laws of several different countries to see how other governments around the world are encouraging EVs. First, it examines China because of China's growing population, increasing automobile demand, and robust government support of EVs. Next it moves to Denmark and Israel, countries that have served as test sites for EV deployment. Lastly, the section examines Germany, which is taking a staunch but different stance on EVs, and concludes by sampling some other European countries' EV laws.

A. China

China is an important country to look at when discussing EVs or even automobiles in general. With China's growing population comes a burgeoning middle class, a bourgeoisie that wants cars.[123] Even conservative reports forecast that China's vehicle stock will double by 2020 and match the number of vehicles in the United States around 2027.[124] This growing number of cars creates three major problems.

First, these millions of new cars will need millions more gallons of oil.[125] Because China does not have large oil reserves,[126] this means that it will depend

122. NRDC 2007 REPORT, *supra* note 89, at 3.

123. Karl Vick & Ramat Hasharon, *Will Israel's Electric Cars Change the World?*, TIME (Apr. 26, 2011), http://www.time.com/time/world/article/0,8599,2066975,00.html. "Beijing's next five-year plan foresees at least 170 million new vehicles, or perhaps twice that," which almost equals all the cars in Germany, France, Spain, Italy, and Britain combined. *Id.*

124. M. WANG ET AL., U.S. DEP'T OF ENERGY, ARGONNE NAT'L LAB., PROJECTION OF CHINESE MOTOR VEHICLE GROWTH, OIL DEMAND, AND CO_2 EMISSIONS THROUGH 2050, at 35 (2006) [hereinafter ARGONNE REPORT], *available at* http://www.transportation.anl.gov/pdfs/TA/398.pdf. Another study projects an even higher vehicle stock in China forecasting a 13% to 17% annual growth rather than the 6% to 11% annual growth widely forecasted. Yunshi Wang et al., *China's Soaring Vehicle Population: Even Greater Than Forecasted?*, 39 ENERGY POL'Y 3296 (2011).

125. Vick & Hasharon, *supra* note 123. To fuel just the 170 million new vehicles expected in China's latest five-year plan would require 8 million barrels of oil every day, which is about as much as the United States imports every day. *Id.*

126. In 2010, China already "relie[d] on imported oil for 55% of its supplies" (4.2 million barrels per day out of the 8 million barrels per day total), according to the National Development and Reform Commission.

more on foreign countries for its oil, jeopardizing its energy security. Second, this increase in oil demand will likely increase the price of oil,[127] further endangering China's (and other oil dependent countries') energy security. Third, this growing number of cars will compound China's environmental problems, emitting carbon dioxide, degrading local air quality, and contributing to global warming.[128] This problematic trifecta gives China cause to worry about the future of automobiles.

A report by the Argonne National Laboratory, a U.S. Department of Energy and University of Chicago research laboratory, expects the number of highway vehicles in China to match that of the United States before 2030 and double by 2040.[129] This same report also finds that China's carbon dioxide (CO_2) emissions from cars will match that of the United States around 2035 and may even be double that by 2050.[130] In addition to the threat to global warming and climate change that this poses, this increase in cars also means an increase in oil demand. The Argonne report finds that China will consume as much oil as the United States between 2030 and 2040, and that consumption will only continue to increase after that.[131]

David Biello, *Driving to the Future: Can China—And the World—Afford 2 Billion Cars?*, SCI. AM. (Jan. 3, 2011), http://www.scientificamerican.com/article/china-driving-to-the-future-of-two-billon-cars/. That same year, China placed fourteenth compared to all other countries in crude oil reserves with 20.35 billion barrels, according to the U.S. Energy Information Administration, and 18 billion barrels, according to OPEC. *International Energy Statistics*, U.S. ENERGY INFO. ADMIN, http://www.eia.gov/cfapps/ipdbproject/IEDIndex3.cfm?tid=5&pid=57&aid=6 (last visited Mar. 25, 2014); ORG. OF THE PETROLEUM EXPORTING COUNTRIES, ANNUAL STATISTICAL BULLETIN 2010/2011, at 22 tbl3.1, *available at* www.opec.org/opec_web/static_files_project/media/downloads/publications/asb2010_2011.pdf.

127. Not only will the increase in vehicles in China create a heavy reliance on imported oil, since China imports two-thirds of its oil from the Persian Gulf region, but this will likely also increase the price of oil. Biello, *supra* note 126. Right now gasoline prices in China are comparable to those in the United States, though there are already some signs of them rising. *Id.*

> In Shenyang and Beijing, gas costs roughly 6.72 renminbi per liter ($3.85 per gallon) [in the autumn of 2011]. But that price is [increasing as] a result of rising global oil prices and ongoing billions of renminbi losses at the quasi-governmental Chinese oil companies . . . . [T]he NDRC raised fuel prices on December 21, 2011, adding roughly 0.23 renminbi [($0.04)] to the retail price per liter in a bid to spur conservation.

Id.

128. China is the world's largest carbon emitter with many of the world's most polluted cities. Christina Larson, *China Confronts Global Warming Dilemma*, CHRISTIAN SCI. MONITOR (Nov. 12, 2009), http://www.csmonitor.com/Environment/Global-Warming/2009/1112/china-confronts-global-warming-dilemma. The World Bank claims that "[a]ir pollution is costing China 3.8% of its gross domestic product [GDP]." *WB: Air Pollution Costs 3.8% of China's GDP*, CHINA DAILY (Nov. 19, 2007, 7:16 PM), http://www.chinadaily.com.cn/china/2007-11/19/content_6264621.htm. Beijing's smog and traffic have become infamous, some ranking it third in the world on the "Commuter Pain Index" after Mexico City and Shenzen. *See generally* Michael Wines, *Multiplying Drivers Run over Beijing Traffic Plan*, N.Y. TIMES (Dec. 22, 2010), http://www.nytimes.com/2010/12/23/world/asia/23beijing.html?_r=1&ref=world; Lauren McCarthy, *Has Beijing's Traffic Actually Improved?*, BEIJINGER (Sept. 10, 2011, 10:00 AM), http://www.thebeijinger.com/blog/2011/09/10/Has-Beijing-s-Traffic-Actually-Improved. The Argonne National Laboratory study predicts that China's carbon dioxide (CO_2) emissions of motor vehicles will double between 2010 and the early 2020's, reaching the United States' 2004 level between 2028 and 2037. ARGONNE REPORT, *supra* note 124, at 47.

129. ARGONNE REPORT, *supra* note 124, at 35.

130. *Id.*

131. *Id.*

A solution to China's worries may be EVs. EVs would stave off the heightened demand for oil and the greater energy dependence, high oil prices, and environmental degradation that would follow. China is also hoping to be a leader in the manufacturing of EVs.[132] If successful, China may solve its growing energy and environmental problems through EVs while also opening new economic opportunities.[133]

For these reasons China has enacted several laws to spur the development and use of EVs, aiming for half a million EVs by 2015 and five million by 2020.[134] But developing EVs comes with its share of difficulties. To overcome the obstacles of high price, low range, and long charge time, China is employing national and municipal efforts to promote EVs.[135] While its national efforts have focused on targets, funding, tax exemptions, and subsidies, China's municipal efforts have concentrated on deploying EVs, providing additional subsidies, and offering city specific incentives.[136] These heavy plans lead some, like Chen Qingquan, chairman of the World Electric Vehicle Association, to expect that China will lead the EV sector with hybrid and pure-electric vehicle sales taking an estimated 15% market share in China, the world's biggest automobile market, by 2020.[137] Others however, like JPMorgan Chase & Co., remain skeptical and

132. "The Chinese really want to stimulate their industry. . . . The government is very much pushing in that direction, but it will take a long time." Jim Motavalli, *China to Subsidize Electric Cars and Hybrids*, N.Y. TIMES, (June 2, 2010, 7:30 AM), http://wheels.blogs.nytimes.com/2010/06/02/china-to-start-pilot-program-providing-subsidies-for-electric-cars-and-hybrids/#. "The Chinese government's focus on pure-electric and plug-in hybrid vehicles is strategic and quite reasonable to make the nation's auto industry competitive in the global market, as Western countries have dominated the traditional auto technologies." Li Fangfang, *China Plans to Take Lead in New-Energy Vehicles*, CHINA DAILY (Apr. 8, 2011), http://www.chinadaily.com.cn/china/2011-04/08/content_12289591.htm. China also enjoys a competitive advantage in batteries, electric motors, and rare-earth resources to help it to become a leader in the electric-vehicle industry. *Id.* Sixteen of the largest state-owned companies formed an alliance to invest 100 billion yuan (US $14.7 billion) on EVs by 2012. Wan Zhihong & Li Fangfang, *Alliance Drives Promotion of Electric Cars*, CHINA DAILY (Aug. 19, 2010, 11:54 AM), http://www.chinadaily.com.cn/bizchina/2010-08/19/content_11173784.htm. This alliance was guided by the state-owned Assets Supervision and Administration Commission of the State Council (SASAC) and includes China's top three oil companies, top two power grid operators, and two major automakers (China FAW Group Corp. and Dongfeng Auto Corp.). *Id.*

133. A study by the World Bank estimates "that global sales of plug-in vehicles will likely comprise 10[%] of new vehicle sales by 2020. This rapid growth is expected to usher in a new global electric vehicle era estimated to be worth *US $250 billion* worldwide in ten years creating unprecedented opportunities across the transport sector." Press Release, World Bank, China to Benefit from Emerging Global Electric Vehicle Demand, Though Challenges Remain (Apr. 20, 2011), http://www.worldbank.org/en/news/2011/04/20/china-to-benefit-from-emerging-global-electric-vehicle-demand (emphasis added).

134. Christopher Marquis, Hongyu Zhang & Lixuan Zhou, *China's Quest to Adopt Electric Vehicles*, STANFORD SOCIAL INNOVATION R., Spring 2013, at 52; *China to Extend Subsidies on Electric Cars Past 2015*, REUTERS (Feb. 6, 2014, 3:57 AM), http://www.reuters.com/article/2014/02/08/us-china-autos-subsidies-idUSBREA1707220140208.

135. *China Waives Sales Tax on Locally Made EVs, Fuel Cell Cars*, CHINA DAILY (Jan. 9, 2012, 9:59 AM), http://www.chinadaily.com.cn/bizchina/2012-01/09/content_14404771.htm [hereinafter *China Waives Sales Tax*]. "Demand for electric cars remains weak in China because of their high cost, limited range, and the lack of charging facilities." *Id.*

136. Patrick Whiteley & Wang Chao, *China Wants to be Global Leader in Electric Vehicles*, CHINA DAILY (May 19, 2011), http://usa.chinadaily.com.cn/epaper/2011-05/19/content_12539963.htm.

137. *Id.*

estimate that EVs will still only account for 1% to 2% of global vehicle sales by 2020.[138]

On the national scale China has set targets, pledged funding, created tax incentives, and designed tariffs and domestic participation requirements to further EVs. In its 12th Year Plan (2011 to 2015), China designated Clean-Energy Vehicles as one of the "New Magic 7" important sectors for China.[139] In the new plan, China set an annual production capacity target of one million "new-energy vehicles" by 2015, 50% of which will be pure-electric and plug-in hybrid machines.[140] Subsequently, the Ministry of Industry and Information Technology (MIIT), the Ministry of Science and Technology, the Ministry of Finance, and the National Development and Reform Commission jointly submitted a draft plan to the State Council for final approval by April 2011, which aims for sales volumes of five million EVs by 2020.[141]

To effectuate these targets, the central government pledged to pump roughly 100 billion yuan (US $15.67 billion) into the EV sector from 2011 to 2021.[142] Around 50% is earmarked for technological research and development (R&D) while the other half will be used for subsidies.[143] "'The Chinese government has clearly stated its commitment, and now it is putting in place critical elements of policy to make it a reality,' said Mr. Giffi, who leads Deloitte's automotive practice in the United States."[144] It appears that the half earmarked for R&D will go towards projects that advance "critical" technologies such as batteries, electric motors, and electric control systems, with a focus on light-duty BEVs.[145]

138. *Id.*

139. Liu Yuanyuan, *China Begins Implementation of "12th Five-Year" Plan for EVs*, RENEWABLE ENERGY WORLD (June 10, 2011), http://www.renewableenergyworld.com/rea/news/article/2011/06/china-begins-implementation-of-the-12th-five-year-plan-for-evs. "Electric vehicle industry insiders recently revealed that China's Ministry of Science and Technology has no plan to publicly release the "12th five-year" (2012-2016) plan for electric vehicles." *Id.* Seventy-seven projects aimed at reducing production costs for batteries, increasing the number of EVs, expanding annual production capacity of power batteries, establishing a system standard for EVs, increasing the number of model EV cities, and installing thousands of charging stations have won funding from the Ministry of Science and Technology totaling 780 million yuan (US $120 million). *Id.*

140. Laurenz Awater, *China's New-Energy Vehicle Plan Submitted for Final Approval*, CHINESE BUS. CLUB (Apr. 22, 2011, 2:37 AM), http://www.xing.com/net/chinesebusinessclub/investment-103350/china-s-new-energy-vehicle-plan-submitted-for-final-approval-36513974/. Some recent resources state that China is channeling its effort through a New Energy Vehicle (NEV) Program, under which "China aims to become the largest EV market by 2020, with annual sales of over 5 million vehicles, which can only be achieved by selling an annual average of 500,000 battery vehicles and plug-in hybrids along with 1.5 million conventional hybrids between 2011 and 2020." Michelle Hsu, *New Energy Vehicle Plan to Drive China to Lead EV Market by 2020*, CENS.com (Apr. 5, 2012), http://cens.com/cens/html/en/news/news_inner_39802.html.

141. *China Aims to Sell 5 Million Alternative-Energy Vehicles by 2020*, BLOOMBERG (Nov. 24, 2011, 6:57 PM), http://www.bloomberg.com/news/2011-11-24/china-aims-to-sell-5-million-alternative-energy-vehicles-by-2020.html.

142. *China's SAIC Motors and GM Complete Electric Car JV*, CHINA BRIEFING (Sept. 27, 2011), http://www.china-briefing.com/news/2011/09/27/chinas-saic-motors-and-u-s-gm-complete-electric-car-joint-venture.html [hereinafter *SAIC and GM JV*]. "Beijing has declared the electric vehicle industry a top priority, earmarking $1.5 billion a year for the next 10 years to transform the country into one of the leading producers of clean vehicles." *China Waives Sales Tax*, *supra* note 135.

143. Hsu, *supra* note 140.

144. Motavalli, *supra* note 132.

145. Hsu, *supra* note 140. Additionally, the China Daily reports that China's central government will "establish as many as five businesses to produce batteries and electric motors by 2015" to ensure the

According to a draft regulation by China's State Council, beginning January 1, 2012, China's national government also waived sales taxes on BEVs and FCEVs made domestically.[146] Forty-nine Chinese-made car models will be exempted from sales taxes.[147] This will effectively cut prices by 9% for those vehicles.[148] HEVs will also be eligible for a 50% cut in sales tax.[149]

In addition to cutting taxes for EVs, the new regulation also decreases a tax for engines with smaller displacement, which also benefits EVs.[150] This tax was formerly the same for all vehicles.[151] On top of the tax decrease for cars with smaller engines, China's national government is also offering a small-engine subsidy.[152] China's central government will offer a nationwide subsidy of 3,000 yuan (US $439) for cars with engines smaller than 1.6 liters and that consume 20% less fuel than current standards.[153] Seventy-one cars have been approved for this subsidy, twenty-six Chinese models (e.g. Jianghuai Automobile, Chang'an Automobile, Chery Automobile, BYD, Great Wall Auto, Brilliance Auto, Geely), eighteen U.S. models (e.g. Shanghal GM), twelve South Korean models (e.g. Beijing Hyundai, Dongfeng Yueda Kia), eight Japanese models (e.g. Chang'an Suzuki, Guangqi Honda), and seven German models (e.g. Shanghai Volkswagen).[154]

development of core technologies for the EV sector. Fangfang, *supra* note 132. It is not clear if these "five businesses" will be new state-owned enterprises or what shape they will take. Anecdotally, a research fellow at the Industrial Economics Research Department of the Development Research Center of the State Council, Wang Xiaoming said "the nation aims to lower the price of batteries used for electric vehicles to 2 yuan [(US $0.30)] for each watt-hour by 2015 and 1.5 yuan a watt-hour by 2020 as part of a stimulus plan for the new-energy vehicle industry." *Id.*

146. *China Waives Sales Tax*, *supra* note 135.

147. *Id.* Some of these companies are SAIC, BYD, SAIC-GM, Volkswagen, BYD, Chery Automobile, Geely Automobile Holdings, and the FAW Group.

148. Mike Sandru, *China Increases Locally-Produced Electric Car Subsidies, Puts Huge Taxes on Imported Ones*, GREEN OPTIMIST (Jan. 23, 2012), http://www.greenoptimistic.com/2012/01/23/china-electric-vehicles-subsidies/#.UzOJXPlSZgg.

149. *Id.*

150. Esther Tanquintic-Misa, *China to Impose Higher Taxes for Vehicles and Vessels Starting Jan. 1*, INT'L BUS. TIMES (Dec. 20, 2011, 10:40 AM), http://au.ibtimes.com/articles/269780/20111219/china-impose-higher-taxes-vehicles-vessels-starting.htm.

151. Reports however differ on the size of the tax decrease. "The tax on cars with a 1.6-liter engine or below will range from 60 to 540 yuan a year, while autos with engines bigger than 3.0 liters will pay from 2,400 to 5,400 yuan." Han Tianyang, *Taxes Slashed to Cut Emissions*, CHINA DAILY (June 20, 2011, 8:00 AM), http://www.chinadaily.com.cn/cndy/2011-06/20/content_12731970.htm. This report however only cites a "draft regulation." *Id.* A more recent source claims that effective January 1, 2012, China will implement a "modified Vehicle and Vessel Tax Law that imposes a corresponding higher tax levy for vehicles with an engine size of 2 liters and above." Tanquintic-Misa, *supra* note 150. It claims that tax rates for vehicles with a 2 liter engine or lower will not be changed, while moderate taxes will be levied on vehicles with a 2 to 2.5 liter engine, and much higher taxes will be imposed on vehicles with an engine size above 2.5 liters. *Id.* At the same time the article also points to a "second draft copy of the law earlier this year," which states that "taxes on 1.0 liter to 1.6 liters engine-capacity vehicles fell from 360 to 660 yuan ($57 to $104) to 300 to 540 yuan," and "[l]evies on vehicles with 1.6 liters to 2.0 liters capacities likewise slid from 660 to 960 yuan to 360 to 660 yuan." *Id.* Thus the precise numbers of the tax change are unclear.

152. *Buyers of Energy Efficient Cars to Get Subsidies*, CHINA DAILY (June 3, 2010), http://www.chinadaily.com.cn/bizchina/2010-06/03/content_9931391.htm.

153. *Id.*

154. Li Fangfang, *Subsidies Set to Spur Green Car Development*, CHINA DAILY (July 2, 2010), http://www.chinadaily.com.cn/bizchina/2010-07/02/content_10049850.htm.

In general, in order to qualify for subsidies in China, a car company must have an annual production of 50,000 cars or more, and if it is a joint venture with a foreign company, the Chinese partner must control at least 51% of the company.[155] As for EVs made outside of China, not only do they *not* qualify for any subsidies, but they must also pay a 25% customs duty on top of the 9% sales tax.[156] In total the national government has enacted targets, provided R&D funding, placed tax exemptions, and created subsidies to help develop and deploy EVs in China.

Moving from the national to the local stage, China is also using municipalities to spur the development of EVs. China's first municipal EV foray involved the creation of the "Ten Cities, Thousand Vehicles Program."[157] Then it began a five-city pilot subsidy program, with some of those five cities taking even further measures on their own to spur EVs.[158]

The Government of China initiated the "Ten Cities, Thousand Vehicles Program" in 2009.[159] This program planned to roll out 1,000 EVs in ten cities: Beijing, Shenzhen, Shanghai, Jinan, Chongqing, Wuhan, Changchun, Hefei, Dalian, and Hangzhou.[160] The program mostly focused on "government fleet vehicles with predictable driving patterns such as buses, garbage trucks, and taxis," and was aimed at answering questions about EV driving range and infrastructure.[161] After the initial rollout in the ten cities, "the program was expanded twice, first to Changsha, Kunming, and Nanchang, and then to Tianjin, Haikou, Zhengzhou, Xiamen, Suzhou, Tangshan, and Guangzhou," bringing it to a total of twenty cities.[162]

Additionally, on June 1, 2010, the Ministry of Finance announced a pilot program in five cities to subsidize the purchase of EVs, particularly PHEVs and BEVs.[163] For PHEVs the subsidy is 3,000 yuan ($400) per kilowatt hour of battery power, with a maximum of 50,000 yuan (US $7,320).[164] BEVs enjoy a maximum subsidy of 60,000 yuan (US $8,784).[165] These subsidies are paid *directly to carmakers*, who are then supposed to lower the price of their cars

155. Jacob Alexander, *China Wants Foreign Companies to Disclose EV Secrets*, PAULTAN.ORG (Sept. 22, 2010, 5:20 PM), http://paultan.org/2010/09/22/china-wants-foreign-companies-to-disclose-ev-secrets/; Mack Chrysler, *China Pushes Ambitious Plan to Become a World Leader*, WARDS AUTO (Nov. 10, 2011), http://wardsauto.com/print/ar/china_pushes_plan_101110.

156. USHA C.V. HALEY, ECON. POLICY INST., PUTTING THE PEDAL TO THE METAL 28 (2012).

157. WORLD BANK & PRTM MGMT. CONSULTANTS, INC., THE CHINA NEW ENERGY VEHICLES PROGRAM 1 (2011), *available at* https://archive.org/details/231369-the-china-new-energy-vehicles-program-challenges.

158. *Id.* at 13.

159. *Id.*

160. *Id.*

161. *Id.*

162. *Id.*

163. *Id.* The five cities are Shanghai, Shenzhen, Hangzhou, Hefei and Changchun. *China to Subsidize Electric, Hybrid Car Purchases in Five Cities*, ENGLISH.NEWS.CN (June 1, 2010, 7:41 PM), http://news.xinhuanet.com/english2010/china/2010-06/01/c_13327814.htm.

164. Fred Meier, *China Will Pay Electric Car Subsidies to Makers, Rather Than Buyers*, USA TODAY, (June 1, 2010, 10:04 AM), http://content.usatoday.com/communities/driveon/post/2010/06/china-will-pay-electric-car-subsidies-to-makers-rather-than-buyers-/1#.T38359lra9s. Although some sources state that the 50,000 subsidy is for "hybrids," most sources state PHEVs. *E.g.*, *id.*

165. *Id.*

accordingly.[166] A USA Today article claimed that "[p]aying most of the money behind the scenes to manufacturers is aimed to make the subsidies more politically palatable."[167] The subsidies however will be reduced once 50,000 green cars are sold.[168] Interestingly, the five cities in which these subsidies are offered also "just happen to be the homes of five major Chinese automakers."[169] The five city program also "requires the local governments to supply charging stations and systems to recycle potentially highly polluting used batteries," called battery-recovery networks.[170]

In addition to the 50,000 and 60,000 yuan subsidies, the cities of Shanghai and Shenzhen also offer additional subsidies. In Shenzhen, PHEV carmakers can qualify for a subsidy of up to 30,000 yuan ($4,412) for each sale, and BEV carmakers can qualify for up to 60,000 yuan ($8,823) per sale.[171] This fact means that after combining national and regional subsidies, a PHEV like BYD's F3DM can receive an 80,000 yuan (US $12,681) subsidy and a BEV like BYD's e6 can receive a 120,000 yuan (US $19,022) subsidy.[172] To paint a picture of what this has meant for EV prices in China, in July 2010, BYD priced its F3DM at 89,800 yuan (US $14,234) after subsidies, meaning that its unsubsidized price was 168,800 yuan (US $26,757).[173]

Lastly, in 2011 Beijing's municipal government exempted buyers of new energy vehicles from its license plate lottery.[174] Although this exemption is no longer in effect, Beijing started this lottery in January 2011 to cut new car sales in the congested city.[175] Beijing is also establishing a smart battery recharging and replacement network, and subsidizing up to 30% of the construction cost of charging stations and poles with an aim of having 100,000 BEVs on its roads by 2015.[176] Similarly, Shanghai has waived the license fee for EVs.[177]

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166. *Id.*

167. *Id.*

168. Motavalli, *supra* note 132.

169. Meier, *supra* note 164.

170. *Id.*

171. *More Sops for Green Cars*, CHINA DAILY (July 7, 2010, 9:44 AM), http://www.chinadaily.com.cn/business/2010-07/07/content_10074864.htm.

172. *Id.*

173. *Id.* BYD's CEO Wang Chuanfu said that he hopes to reduce EV costs to a range similar to ICE cars within two years. *Id.* Shenzhen's Mayor Xu also estimated that by 2012 Shenzhen would have 25,000 EVs on its streets. *Id.*

174. *Beijing Waives License Plate Lottery for Electric Vehicles*, ENV'T NEWS SERVICE (Oct. 26, 2011), http://ens-newswire.com/2011/10/27/beijing-waives-license-plate-lottery-for-electric-vehicles/. Beginning in 2013, Beijing no longer exempts electric vehicles from the license plate lottery; however, they are still effectively exempt as there are more plates available than EV buyers applying for the plates. *Beijing Auto-License Lottery Sees Few Electric-Car Takers*, BLOOMBERG (Feb. 26, 2014, 4:15 AM), http://www.bloomberg.com/news/2014-02-26/beijing-license-plate-lottery-sees-few-takers-for-electric-cars.html; Carmen Lee, *EV Buyers in Beijing No Longer Exempt from License Plate Lottery*, AUTOMOTIVE NEWS (June 24, 2013), http://autonews.gasgoo.com/china-news/ev-buyers-in-beijing-no-longer-exempt-from-license-130624.shtml.

175. *Beijing License Plate Lottery to Get Harder*, GLOBAL TIMES (Sept. 3, 2013), http://www.globaltimes.cn/content/808412.shtml#.UxUBmFHZfww.

176. Liu Yuanyuan, *Beijing Sets Plan for Massive EV Adoption*, RENEWABLE ENERGY WORLD (May 20, 2011), http://www.renewableenergyworld.com/rea/news/article/2011/05/beijing-set-to-launch-subsidy-scheme-for-new-energy-cars-purchased-for-personal-use.

All of these EV incentives beg the question: Have these programs actually spurred EV development in China? The unsatisfying answer is that it is likely too soon to tell. On the one hand there is a host of EV cars, companies, and joint ventures emerging in China. For example, Dongfeng Motor Corp., one of China's largest automakers, announced in 2010 that it will invest 3 billion yuan (US $440.76 million) until 2015 to develop EVs, naming sixteen key projects and setting a goal to produce 100,000 HEVs and 50,000 BEVs by 2015.[178] Similarly, Volkswagen, along with its Chinese partner SAIC, planned to introduce its HEV Touareg to China and produce Golf and Lavida EVs in 2013.[179] Other car companies and joint-ventures with EV projects are SAIC (Roewe 750 selling at 236,800 yuan/US $37,260), SAIC-Volkswagen, SAIC-GM, FAW-Group-Volkswagen (Kaili, 150 km range, 93 miles, selling in 2013), Dongfeng-Nissan (VENUCIA), Dongfeng-Honda (HEV and BEV), Wanxiang-Ener1, Coloumb Technologies, BYD-Daimler (BEV DENZA), BYD (BEV e6, PHEV F6DM, PHEV F3DM), Brilliance-BMW (BMW 5-Series PHEV).[180]

On the other hand, most actual EV sales have been lackluster. Few EVs have been sold and most of them have been to government or taxi fleets.[181] The reasons behind this slow growth mirrors many of those in the United States—high price, long charge time, undeveloped infrastructure, short battery lifespan, incomplete industry standards, and safety risks.[182] There are two other potential reasons for China's slow EV evolution. First, there seems to be some ambivalence on the part of the government with different ministries advocating disparate approaches leading to unclear policy.[183] Second, China may have delayed announcing EV subsidies to make sure that Chinese companies, not

177. Liu Yuanyuan, *Shanghai to Provide Free License Plates for Elec. Vehicles Through Auctions*, RENEWABLE ENERGY WORLD (Dec. 7, 2011), http://www.renewableenergyworld.com/rea/news/article/2011/12/shanghai-to-provide-free-license-plates-for-electric-vehicles-through-auctions.

178. Gong Zhengzheng & Xiao Han, *Dongfeng Drives New Energy Strategy*, CHINA DAILY (Aug. 16, 2010), http://www.chinadaily.com.cn/bizchina/2010-08/16/content_11158588.htm.

179. *Id*.

180. *E.g.*, *Chinese-Made Electric Cars*, CHINA AUTO WEB, http://chinaautoweb.com/electric-cars/ (last visited Mar. 27, 2014).

181. Meier, *supra* note 164; Damien Ma, *Who Killed China's Electric Car?*, ATLANTIC, http://www.theatlantic.com/business/archive/2011/11/who-killed-chinas-electric-car/247990/ (last visited Feb. 12, 2014).

182. Ma, *supra* note 181 ("Even with limited consumer subsidies, the E6 [sic] all-electric model will still cost around 250,000 yuan, or nearly $40,000—sticker shock for the average Chinese consumer in the market for a car that gets you from point A to B."). "The lack of battery core technologies, vehicle self-ignition security problems, the lack of charging stations, and the lack of integrated standards for the pure electric vehicle sector" all contribute to the cool EV market. *New-Energy Vehicles Industry Needs to Refocus*, CHINA DAILY (Apr. 11, 2012), http://www.china.org.cn/environment/2012-04/11/content_25112296.htm.

183. There appears to be at least some ambivalence on the plan for EVs in China's national government. Premier Wen Jiabao suggested that China's leadership is unsure about the direction of the EV industry at a national science conference, and the ten-year plan for EVs that was intended to be released in 2010 has yet to surface. Ma, *supra* note 181. Other accounts describe a tug of war between the Ministry of Industry and Information Technology, which is pushing for the simultaneous development of fuel efficient cars and EVs; the Ministry of Science and Technology, which wants to promote EVs "from a narrow technological standpoint;" and the National Development and Reform Commission, which seems to support hybrids only as a transitional tool towards BEVs. *Id*.

foreign companies, were poised to produce the EVs and receive the subsidies.[184] Whatever the case, only time will tell what will happen with EVs in China.

A final thought on China: EVs may not be the panacea to China's mounting environmental problems as they may seem. China derives 75% of its electricity from coal and China has more lenient emissions requirements than the United States.[185] Thus, a switch to EVs does not necessarily mean a step towards a cleaner China, though it would be a step towards a less oil dependent China.

B. Denmark

Denmark is also using its tax system to foster EV growth. Denmark taxes cars very heavily at 180%.[186] No, that is not a typo. That means that a car with a $10,000 price tag would actually cost the buyer $28,000 with $18,000 paid towards the normal vehicle-registration tax. While Denmark exempts EV purchases from this tax, it applies to HEVs.[187] Reports suggest that the tax exemption will save EV buyers at least $40,000.[188]

There is also $2.8 million in public funding coming from the European Commission "for a program in Denmark that would provide incentives for the purchase of electric vehicles."[189] This funding was given because Denmark's effort will assist the European Union in reaching its objective of cutting

184. G.E. Anderson, *Will China Subsidize Electric Vehicles?*, FORBES (Apr. 28, 2010, 1:33 AM), http://www.forbes.com/sites/china/2010/04/28/will-china-subsidize-electric-vehicles/ (quoting a Chinese auto executive who commented, "Who is selling these vehicles in China right now? Toyota? Why would the government want to subsidize the purchase of foreign brands? You will not see an announcement on subsidies until the government can be sure most of the money will support domestic brands."). This article points out another recent example—beginning in early 2009 the central government also gave a tax break to small cars with engines of 1.6 liters or less. *Id.* This was unusual since the traditional categorization of engine sizes broke at whole numbers and halves (e.g. 1.0-1.5 liters, 1.5-2.0 liters, 2.0-2.5 liters, etc.). It appears that "1.6 liters was exactly the cutoff point at which domestic Chinese manufacturers would most benefit from the tax break." *Id.*

185. Jason Koebler, *Chinese Electric Car Pollution More Harmful to Humans Than Gas Cars*, U.S. NEWS (Feb. 13, 2012), http://www.usnews.com/news/articles/2012/02/13/chinese-electric-car-pollution-more-harmful-to-humans-than-gas-cars; Whitney Heins, *UT Researchers Find China's Pollution Related to E-Cars May Be More Harmful Than Gasoline Cars*, U. TENN. KNOXVILLE (Feb. 13, 2012), http://www.eurekalert.org/pub_releases/2012-02/uota-urf021012.php (highlighting that 85% of electricity production is from fossil fuels and 90% of that is from coal). EVs may be bad for China where 75% of electric comes from coal, and coal power plant emission requirements are not as strict as in United States. Koebler, *supra*.

186. *E.g.*, Justin Bergman, *Denmark Leads Europe's Electric-Car Race*, TIME (Feb. 14, 2010), http://www.time.com/time/world/article/0,8599,1960423,00.html.

187. EUROPEAN AUTO. MFRS. ASS'N, OVERVIEW OF PURCHASE AND TAX INCENTIVES FOR ELECTRIC VEHICLES IN THE EU, (2013), *available at* http://www.acea.be/images/uploads/files/Electric_vehicles_overview_2013.pdf.

188. Nelson D. Schwartz, *In Denmark, Ambitious Plan for Electric Cars*, N.Y. TIMES, (Dec. 1, 2009, 5:32 AM), http://www.nytimes.com/2009/12/02/business/energy-environment/02electric.html?dbk. Problems over Denmark's promised tax exemptions have already occurred. Bergman, *supra* note 186. In 2009, "the former Climate and Energy Minister, Connie Hedegaard, suggested the government might extend the tax break until 2015, but months later, a decision on that [had] yet to be made. . . . Denmark's new Climate and Energy Minister has promised to resolve the issue quickly." *Id.*

189. *Denmark Gets OK for Electric Car Program*, UPI, (Mar. 9, 2011, 8:40 AM), http://www.upi.com/Business_News/Energy-Resources/2011/03/09/Denmark-gets-OK-for-electric-car-program/UPI-97451299678053/.

emissions by 20% of the 1990s levels by 2020.[190] As a further incentive, EV drivers will enjoy free parking in downtown Copenhagen.[191] Thus, tax exemptions, public funding, and free parking are the mechanisms the government of Denmark is using to encourage EVs.

The Danish government also had planned to use Danish Oil & Natural Gas (DONG) Energy, of which it owns a majority share, to spur EV development.[192] DONG Energy made plans to launch 500,000 EVs in Denmark by 2020, signing deals with carmakers and a venture startup company called Better Place.[193] However, Better Place filed for bankruptcy on May 26, 2013.[194] Originally founded by Israeli investors, Better Place was formally based in the United States and envisioned circumventing the problem of long charge times in EVs by replacing depleted electric batteries with fully-charged batteries at battery switching stations. It was working with Denmark and Renault SA to install its battery switching stations in Denmark, Israel, and Australia.[195] Better Place had also brokered a deal with Renault to supply 100,000 of Renault's new Fluence ZEs (BEV) to Denmark and Israel by 2016.[196] The bankruptcy of Better Place has scuttled Denmark's EV plans, leaving no clear answers about the future of EVs in Denmark.[197] The lofty ambitions and projections of just a year ago seem mostly abandoned.[198] E.ON, a German holding company and large electric

190. *Id.*

191. Schwartz, *supra* note 188.

192. *Id.*

193. *Denmark to Extend Tax Breaks for Electric Cars*, FÉDÉRATION INTERNATIONALE DE L'AUTOMOBILE REGION 1 (May 29, 2009), http://www.fiaregion1.com/en/fia_european_bureau/news/archive/denmark_to_extend_tax_breaks_for_electric_cars.htm. For a look at different economic strategies used to encourage certain environmental policies, see generally STEFAN SPECK ET AL., NAT'L ENVTL. RESEARCH INST., DENMARK, THE USE OF ECONOMIC INSTRUMENTS IN NORDIC AND BALTIC ENVIRONMENTAL POLICY 2001-2005 (2006), *available at* http://www.norden.org/en/publications/publikationer/2006-525.

194. Brad Plumer, *What Better Place's Bankruptcy Tells Us About the Future of Electric Cars*, WASH. POST (May 27, 2013, 1:23PM), http://www.washingtonpost.com/blogs/wonkblog/wp/2013/05/27/what-better-places-bankruptcy-tells-us-about-the-future-of-electric-cars/; David Pearson & Sara T. Stub, *Better Place's Failure Is Blow to Renault*, WALL ST. J. (May 29, 2013, 5:08 AM), http://online.wsj.com/news/articles/SB10001424127887323855804578507263247107312.

195. Gwen Ackerman & Jonathan Ferziger, *Better Place Plans Electric-Car IPO Within 2 Years, Agassi Says*, BLOOMBERG (Jan. 25, 2012, 9:34 AM), http://www.bloomberg.com/news/2012-01-25/better-place-plans-electric-car-ipo-within-2-years-agassi-says.html.

196. Ariel Schwartz, *Better Place, Renault Sign Mega-Deal for 100,000 EVs by 2016*, FAST CO. (Sept. 18, 2009, 5:05 AM), http://www.fastcompany.com/1363726/better-place-renault-sign-mega-deal-100000-evs-2016.

197. Brad Berman, *Better Place Pulled Down Israel and Denmark Electric Car Markets, Say Local Drivers*, PLUGIN CARS (Dec. 13, 2013), http://www.plugincars.com/better-place-pulled-down-israel-and-denmark-electric-car-market-say-local-drivers-129094.html.

198. On June 28, 2011, Better Place opened its first battery switching station just outside of Copenhagen with plans to open another twenty in the following nine months. Better Place Unveils Europe's First Battery Switch Station in Denmark, BUS. WIRE (June 28, 2011, 7:00 AM), http://www.businesswire.com/news/home/20110628005892/en/Place-Unveils-Europe%E2%80%99s-Battery-Switch-Station-Denmark#.UzS7gqhdXHU. Shai Agassi, Better Place's Founder and CEO, said that as many as 10,000 cars using Better Place stations would be on Denmark's, as well as Israel's roads by the end of the year. Ackerman & Ferziger, *supra* note 195; Neal Ungerleider, *Better Place and Renault Delivering 115,000 Electric Cars in 2011*, FAST CO. (Dec. 14, 2010, 6:31 AM), http://www.fastcompany.com/1709616/better-place-teams-up-with-renault (highlighting the importance of Better Place in 2011).

utility, has purchased Better Place's 770 charging stations in Denmark, which were closed after the bankruptcy.[199]

C. Israel

Whereas Denmark's sense of environmental concern seems to propel its heavy car tax and EV deployment efforts, Israel's geopolitical tensions appear to underlie its efforts to foster EVs. Like Demark, Israel also planned to serve as a key test country for Better Place's battery swapping vision.[200] Better Place began selling its Renault Fluence Z.E. in Israel in August 2011 for 157,500 NIS (€31,775) and planned to have 40 battery switching stations deployed across Israel by the end of 2011, as well as thousands of charge spots.[201] After Better Place's bankruptcy, Tzachi Merkur, an Israeli owner of various real estate investments and parking facilities, aimed to purchase Better Place, planning on resurrecting the company as DriiVZ—Better Place. DRiiVZ is an Israeli logistics company that "will be responsible for managing the charging systems, servicing and billing."[202] However, an Israeli judge voided the sale due to legal conflicts, leaving the future of Better Place uncertain.[203]

Again mirroring Denmark, Israel is also offering tax breaks for EVs.[204] It is also worthwhile to bear in mind that fuel in Israel costs 110% more than in the United States, meaning that Israelis are paying approximately $7.25 per gallon.[205] This automatically makes EVs a more attractive substitute for ICE cars in Israel than in the United States.

D. Germany

Germany is also seeking to develop EVs. Germany has set a target of 1 million EVs by 2020.[206] The question, however, is how it can accomplish this

199. *E.ON Enters Danish EV Market with Purchase of Better Place*, MINISTRY FOREIGN AFF. DEN. (Sept. 10, 2013), http://www.investindk.com/News-and-events/News/2013/EON-enters-Danish-EV-market-with-Purchase-of-Better-Place.

200. Ackerman & Ferziger, *supra* note 195.

201. Stacy Feldman, *Better Place Takes Big Leap Forward with Israel Electric-Car Pilot*, INSIDE CLIMATE NEWS (Feb. 9, 2010), http://insideclimatenews.org/news/20100209/better-place-takes-big-leap-forward-israel-electric-car-pilot; John Reed, *Electric Cars Are All the Rage in Israel*, FIN. TIMES MAG. (Sept. 17, 2010, 10:20 PM), http://www.ft.com/cms/s/2/c0ef35cc-c06a-11df-8a81-00144feab49a.html#axzz1rVMpq3VE; *Israel Electric Car Pioneer Unveils Annual Price Plans*, STAR (May 17, 2011), http://www.thestar.com/business/2011/05/17/israeli_electric_car_pioneer_unveils_annual_price_plans.html.

202. *Better Place Is Reborn As DRiiVZ—Better Place, and Is Expanding*, EV MARKETS (Sept. 30, 2013), http://evmarkets.com/better-place-reborn-driivz-better-place-expanding/. However, this sale was voided after a district court discovered Merkur's inadequate financial position. Jasmin Gueta, *Better Place Receivers Say Potential Buyer Is Deep in Debt*, HAARETZ (Oct. 14, 2013, 4:06 AM), http://www.haaretz.com/misc/article-print-page/.premium-1.552175?trailingPath=2.169%2C2.199%2C.

203. Gueta, *supra* note 202.

204. Because the Fluence will be "domestically produced" it will be taxed at 10% plus a 16% value-added tax (VAT) instead of the 89% tax plus 16% VAT that all new imported cars carry. Brian London, *Is Israel Making the Electric Car Work?*, PJ MEDIA (Jan. 27, 2012, 12:00 AM), http://pjmedia.com/blog/is-israel-making-the-electric-car-work/http://pjmedia.com/blog/is-israel-making-the-electric-car-work/. *See also* Maurice Picow, *Will Israel Be a Leader in Introducing Electric Cars? Ask the Tax Man!*, GREEN PROPHET (Oct. 22, 2010), http://www.greenprophet.com/2010/10/israel-electric-cars/.

205. London, *supra* note 204.

206. John Blau, *Berlin May Offer Tax Breaks for Electric Cars After All*, DEUTSCHE WELLE (May 5, 2011), http://www.dw.de/dw/article/0,,15051420,00.html.

goal. Right now, only 2,300 of the 42 million cars registered in Germany are EVs, and without any government intervention, this number will likely only reach 450,000 by 2020.[207] Much like the other countries discussed, the strategies discussed in Germany to encourage the use of EVs have been subsidies, tax cuts, R&D, and special incentives like special traffic lanes or dedicated parking lots.[208] Germany, however, has taken a different approach than the countries examined above.

It has eliminated subsidies. Despite intense lobbying from German carmakers, Chancellor Angela Merkel has rejected direct subsidies to consumers to promote EVs.[209] One of the reasons for this rejection is the fear that foreign companies that have made the most progress in the EV field would end up being the greatest beneficiaries of these subsidies.[210] However, Germany has adopted the tax cut option. EVs are now exempt from Germany's annual motor vehicle tax for ten years.[211] The government is also considering implementing special incentives, like allowing EVs to use bus lanes and creating parking zones where battery charging would be free.[212]

Germany's dominant strategy, however, seems to be funding EV research and development. The German government is adding another 1 billion euros (US $1.4 billion) to its already 1 billion euro 2013 EV R&D budget, bringing the total to 2 billion euros (US $2.8 billion).[213] One of the main focuses of this funding will be on battery technology.[214] This option seems to be the most attractive to the German government because it furthers the goal of creating products that are competitive rather than reducing the cost of products that the market will not independently sustain.[215]

While the German government may have chosen to focus on R&D rather than the deployment of EVs, German carmakers in the meantime have begun to introduce EVs. BMW launched its first BEV in 2013, Volkswagen followed with its two EVs shortly thereafter, and Daimler introduced its EV "Smart" car

207. Dirk Kaufmann, *Berlin Plans Powerful Spark for Electric Car Sector*, DEUTSCHE WELLE (May 17, 2011), http://www.dw.de/berlin-plans-powerful-spark-for-electric-car-sector/a-15082462.

208. Blau, *supra* note 206.

209. Kaufmann, *supra* note 207. The head of Germany's Monopolies Commission, "a body which advises the government on economic competition issues," Justus Haucap, echoes this sentiment stating that it is "completely unclear whether electric cars really have a future or will be replaced by another technology," he told the Euro am Sonntag newspaper. *Id.*

210. *See, e.g.*, *id.*

211. Paul Hockenos, *Europe's Incentive Plans for Spurring E.V. Sales*, N.Y. TIMES (July 29, 2011), http://www.nytimes.com/2011/07/31/automobiles/europes-incentive-plans-for-spurring-ev-sales.html?_r=1&emc=eta1; Blau, *supra* note 206. Another proposal from the German Electrical and Electronic Manufacturer's Association (ZVEI) is to lift Germany's 40% tax on electricity for drivers of electric cars. Blau, *supra* note 206.

212. Kaufmann, *supra* note 207.

213. *Id.*; Matthew Lynley, *Germany Readies $1.4B in Aid for Electric Cars*, VENTUREBEAT (May 16, 2011, 1:21 PM), http://venturebeat.com/2011/05/16/german-electric-car-aid/; Hockenos, *supra* note 211.

214. Kaufmann, *supra* note 207 ("The automobile industry has also pledged 17 billion euros in investments over the next few years.").

215. Blau, *supra* note 206 (As German auto expert Professor Ferdinand Dudenhöffer stated, "[w]hat we really need to do is build products that are competitive.").

and EV Mercedes A Class in 2011.[216] "On the whole, the [German] automobile industry has pledged 17 billion [e]uros in investments over the next few years."[217]

E. Other European Countries

Other European countries are also promulgating incentives to spur EV development. From building charging infrastructures and implementing driving privileges to enticing consumers with tax credits and subsidies, European countries are trying to bring EVs to their roads.[218] Much of these efforts are impelled by the European Union's target of cutting the number of ICE cars in cities in half within 20 years and phasing them out entirely by 2050.[219] Still the number of EVs in Europe now is small. In general, "17 of the 27 European Union countries levy carbon dioxide related taxes on passenger cars, and 15 nations offer tax incentives for plug-in vehicles, according to the European Automobile Manufacturers' Association."[220] Many European countries use the vehicle's level of carbon emissions as a metric when offering incentives, rather than distinguishing by the kind of car (HEV, PHEV, BEV) as the United States does.[221]

So what can the United States learn from other countries' EV laws? China has decided to vigorously support EVs, using subsidies and tax incentives on both the national and municipal level. Denmark and Israel have similarly lifted their car taxes and have tried to serve as test sites for new battery-switching technology. Germany on the other hand has chosen to focus on research and development for EVs rather than spurring technologies that are not market ready. While the markets and make-ups of these countries certainly differ from the United States, the reactions of other countries to EVs can help this country shape sensible EV policies. By learning from the successes and mistakes of others, the United States can craft its own path forward.

IV. U.S. EV LAWS

The United States has already taken several committed steps to promote EVs. President Barack Obama has set a target that the United States will have one million electric cars on the road by 2015.[222] To reach this goal, the federal government offers tax credits, provides loans, and invests in research and

216. Hannah Elliott, *The Electric BMW i3 Is Not Hot but It'll Sell*, FORBES (July 29, 2013, 2:40 PM), http://www.forbes.com/sites/hannahelliott/2013/07/29/the-electric-bmw-i3-is-not-hot-but-itll-sell/; Kaufmann, *supra* note 207; *Volkswagen's First Two Production Battery-Electric Vehicles Debut at Frankfurt*, GREEN CAR CONGRESS (Sept. 11, 2013), http://www.greencarcongress.com/2013/09/20130911-vw.html.

217. Itir Sonuparlak, *Germany Boosts Electric Vehicle Sector*, CITYFIX (May 25, 2011), http://thecityfix.com/blog/germany-boosts-electric-vehicle-sector/?utm_source=feedburner&utm_medium=feed&utm_campaign=Feed%3A+thecityfix%2Fposts+%28TheCityFix%29.

218. Hockenos, *supra* note 211.

219. *Id.*

220. *Id.*

221. *Id.*

222. U.S. DEP'T OF ENERGY, ONE MILLION ELECTRIC VEHICLES BY 2015: FEBRUARY 2011 STATUS REPORT (2011), *available at* https://www1.eere.energy.gov/vehiclesandfuels/pdfs/1_million_electric_vehicles_rpt.pdf.

development.[223] Congressmen are also proposing new measures for the federal government.[224] State governments have likewise taken an active role, offering similar tax credits, purchase rebates, and non-monetary benefits to incentivize drivers to purchase EVs.[225]

A. Federal Laws

1. Tax Credits

One of the strongest tools the federal government has used to foster EVs has been tax credits. The Energy Improvement and Extension Act of 2008 created a tax credit for new plug-in EVs called the Plug-in Electric Drive Vehicle Credit, which was amended by the American Recovery and Reinvestment Act of 2009 (ARRA).[226] Additionally, the ARRA authorized a tax credit for *converted* plug-in EVs and for at-home charging stations.[227] While the Plug-in Electric Drive Vehicle Credit continues, the other two created by the ARRA have expired.[228]

Under the Energy Improvement and Extension Act of 2008 the Plug-in Electric Drive Vehicle Credit was limited to "$2,500, plus $417 for each kilowatt hour of traction battery capacity in excess of 4 kilowatt hours."[229] The credit was capped at $7,500 for light-weight passenger vehicles and would begin to phase out when the number of new qualified plug-in electric drive motor vehicles sold in the United States after December 31, 2008, reached 250,000.[230] The ARRA slightly changed this tax credit. The ARRA increased the battery capacity requirement to five kilowatt hours, delayed the phaseout period one year to December 31, 2009, and decreased the phaseout threshold to 200,000 vehicles.[231] The $7,500 cap remains the same, and every plug-in EV on the market qualifies for the full $7,500.[232] Once the manufacturer sells 200,000 of its qualifying vehicles, the credit begins to phase out.[233] The phase-out period is

223. *Id.*

224. *E.g.*, Eric Evarts, *Michigan Congressmen Propose Extending $7,500 EV Tax Credits*, CONSUMER REP. NEWS (Jan. 28, 2011, 3:22 PM), http://www.consumerreports.org/cro/news/2011/01/michigan-congressment-propose-extending-7-500-ev-tax-credits/index.htm.

225. Kristy Hartman, *State Hybrid and Electric Vehicle Incentives*, NAT'L CONF. ST. LEGISLATURES, http://www.ncsl.org/research/energy/state-electric-vehicle-incentives-state-chart.aspx (last updated Nov. 2013).

226. Energy Improvement and Extension Act of 2008, Pub. L. No. 110-343, 122 Stat. 3765; American Recovery and Reinvestment Act of 2009, Pub. L. No. 111-5, 123 Stat. 115.

227. American Recovery and Reinvestment Act of 2009 §§ 1123, 1143.

228. *State & Federal Incentives*, PLUG IN AM., http://www.pluginamerica.org/incentives (last visited Mar. 30, 2014).

229. Energy Improvement and Extension Act of 2008 § 205 (codified at 26 U.S.C. § 30d).

230. *Id.*

231. American Recovery and Reinvestment Act of 2009 § 1141; *Plug-In Electric Vehicle Credit (IRC 30D)*, INTERNAL REVENUE SERV., http://www.irs.gov/businesses/article/0,,id=214841,00.html (last updated Feb. 13, 2014) [hereinafter *Plug-In IRC 30D*]; *Energy Incentives for Individuals in the American Recovery and Reinvestment Act*, INTERNAL REVENUE SERVICE, http://www.irs.gov/uac/Energy-Incentives-for-Individuals-in-the-American-Recovery-and-Reinvestment-Act (last updated Mar. 13, 2014).

232. LYNN J. CUNNINGHAM ET AL., CONG. RESEARCH SERV., ALTERNATIVE FUEL AND ADVANCED VEHICLE TECHNOLOGY INCENTIVES 7-8 (2013), *available at* http://www.fas.org/sgp/crs/misc/R42566.pdf; *Plug-In IRC 30D*, *supra* note 231.

233. American Recovery and Reinvestment Act of 2009 § 1141.

"the one-year period beginning with the second calendar quarter after the calendar quarter in which at least 200,000 qualifying vehicles manufactured by that manufacturer have been sold for use in the United States (determined on a cumulative basis for sales after December 31, 2009)."[234] During the phase-out period, vehicles manufactured "are eligible for 50 percent of the credit if acquired in the first two quarters of the phase-out period and 25 percent of the credit if acquired in the third or fourth quarter of the phase-out period."[235] In order to claim this tax credit, EV purchasers must fill out Form 8936 "Qualified Plug-in Electric Drive Motor Vehicle Credit" on their income tax return.[236] This means that consumers, not vehicle manufacturers, receive the credit. According to the Department of Energy (DOE), in 2009 alone, 2,226 light-duty EVs were made available, which means that the $7,500 per vehicle tax credit would have created $16,695,000 of foregone federal tax revenue.[237]

Two other federal tax credits have expired: the plug-in conversion and infrastructure tax credits. The ARRA created a federal tax credit for plug-in drive conversion kits that expired on December 31, 2011.[238] The credit equaled 10% of the cost of converting a vehicle into a qualified plug-in EV and was limited to $4,000.[239] The credit also required that the vehicle be placed in service after February 17, 2009.[240] Another tax credit that was set to expire on December 31, 2010 but was extended twice through 2013, was the Alternative Fuel Infrastructure Tax Credit.[241] This tax credit originally allowed for 50% of the "cost of installing a charging station on commercial or private property (up to $2,000 private, $50,000 commercial)."[242] That tax credit was set to expire on December 31, 2010, but was extended, although modified, for a year, until December 31, 2011, and then was extended again until December 31, 2013.[243] The latest version covered only 30% of the purchase and installation costs (up to

234. I.R.S. Notice 2009-89, 2009-48 I.R.B. 714 (Nov. 30, 2009).

235. *Id.*

236. *Qualified Plug-In Electric Drive Motor Vehicle Tax Credit*, U.S. DEP'T ENERGY, http://www.afdc.energy.gov/laws/law/US/409 (last updated Nov. 12, 2013).

237. *Alternative Fuel Vehicle Data*, ENERGY INFO. ADMIN. (Apr. 8, 2013), http://www.eia.gov/renewable/afv/supply.cfm?fs=a&uyear=2009&weightclass=Id&fueltype=evc.

238. *Energy Incentives for Individuals in the American Recovery and Reinvestment Act*, INTERNAL REVENUE SERVICE, http://www.irs.gov/uac/Energy-Incentives-for-Individuals-in-the-American-Recovery-and-Reinvestment-Act (last updated May 31, 2013).

239. *Id.*

240. *Id.*

241. Nick Chambers, *Extension of Electric Car Charging Station Incentives Snuck into Tax Cut Extension Bill*, PLUGIN CARS (Dec. 17, 2010) [hereinafter Chambers, *Charging Station Incentives*], http://www.plugincars.com/breaking-extension-electric-car-charging-station-incentives-snuck-tax-cut-extension-bill-106565.html; *Federal Laws and Incentives for Tax Incentives*, U.S. DEP'T ENERGY, http://www.afdc.energy.gov/laws/laws/US/incentive/3234 (last updated Nov. 11, 2013) [hereinafter *Federal Laws and Incentives*].

242. Chambers, *Charging Station Incentives*, *supra* note 241.

243. *Id.*; *Federal Laws and Incentives*, *supra* note 241.

$1,000 private, $30,000 commercial).[244] Thus, today there remains only the $7,500 federal tax credit.[245]

2. Loans

Another tool used by the U.S. federal government is the extension of loans to EV manufacturers. Section 136 of the Energy Independence and Security Act of 2007[246] also created the Advanced Technology Vehicles Manufacturing Loan Program (ATVMLP).[247] This program "arrange[s] loans from the U.S. Department of Treasury's Federal Financing Bank to eligible manufacturers of advanced technology vehicles (ATVs) and ATV components."[248] Its mission is to provide direct loans, rather than loan guarantees, to "eligible automobile manufacturers and component suppliers for projects that re-equip, expand, and establish manufacturing facilities in the [United States] to produce advanced technology vehicles and components for such vehicles."[249] The law allows the DOE to loan up to $25 billion, but so far it has only loaned $8.399 billion, leaving $16.6 billion still unused.[250] This has created some consternation as there have been hundreds of applicants who are still waiting for the DOE to respond.[251]

The ATVMLP has funded five programs thus far.[252] This funding has allowed the Ford Motor Company to upgrade factories with new technologies

244. Nick Chambers, *Electric Car Charging Station Tax Credit Extended, But at Lower 30% Pre-Stimulus Levels*, PLUGIN CARS, (Dec. 17, 2010), http://www.plugincars.com/breaking-electric-car-charging-station-tax-credit-extended-lower-30-pre-stimulus-levels-106580.html.

245. *Federal Laws and Incentives*, *supra* note 241.

246. Energy Independence and Security Act of 2007, Pub. L. No. 110-140, § 136, 121 Stat. 1492, 1514-16.

247. CUNNINGHAM ET AL., *supra* note 232, at 15-16.

248. U.S. DEP'T OF ENERGY, GUIDANCE FOR APPLICANTS TO ADVANCED TECHNOLOGY VEHICLES MANUFACTURING LOAN PROGRAM (2010), *available at* https://lpo.energy.gov/wp-content/uploads/2010/09/applicantguidance.pdf.

249. *The Financing Force Behind a Clean Energy Economy*, U.S. DEP'T ENERGY, https://lpo.energy.gov/about/our-mission (last visited Mar. 30, 2014).

250. CUNNINGHAM ET AL., *supra* note 232, at 15-16; *Loan Programs Office: Our Projects*, U.S. DEP'T ENERGY, https://lpo.energy.gov/our-projects/ (last visited Mar. 30, 2014) [hereinafter *Our Projects*]. The ATVM Program has loaned Fisker Automotive $0.529 billion, Ford Motor Company $5.907 billion, Nissan North America, Inc. $1.448 billion, Tesla Motors $0.465 billion, and the Vehicles Production Group LLC $0.05 billion, for a total of $8.399 billion. *Id.*

251. Sebastian Blanco, *Most Advanced Technology Vehicles Manufacturing Loan Program (ATVMP) Money Delayed*, AUTOBLOG GREEN (Jan. 24, 2011, 2:55 PM), http://green.autoblog.com/2011/01/24/most-advanced-technology-vehicles-manufacturing-loan-program-at/ ("It's been a long time since we've heard anything about the many, many applications for funds (100 groups applied for over $42 billion), so what's up with the rest of the money?"). As the Detroit News stated,"[s]ome applications for the low-cost government loans have languished for more than two years. Projects have collapsed and some small companies are barely hanging on, hoping the money arrives in time. Some loans have taken another seven months to close after being approved." *Id.*

252. Chris Woodyard & James R. Healey, *$25 Billion Green-Car Fund Dodges Bullet*, USA TODAY (Sept. 26, 2011, 10:00 PM), http://abcnews.go.com/Business/25-billion-green-car-fund-dodges-bullet/story?id=14612731#.T6dB89mNOSo. USA Today reported that funds had been loaned to six companies; however, at the time the article was written, the $730 million loan to Severstal Dearborn had not yet closed. *Id.* The DOE later denied the company the loan. *Dept. of Energy Denies $730M Severstal Loan*, DEARBORN PATCH (Jan. 6, 2012, 11:14 PM), http://dearborn.patch.com/groups/politics-and-elections/p/dept-of-energy-denies-730m-severstal-loan.

that will allow it to raise fuel efficiency, enabled Tesla Motors and Fisker Automotive to create new plug-in EVs, empowered Nissan North America to retool its assembly plant to manufacture EVs and construct an advanced battery manufacturing facility, and supported the Vehicle Production Group LLC in developing a car that will run on compressed natural gas.[253] The DOE Loan Programs Office claims that all together these programs have created or saved 37,000 jobs.[254]

The ATVMLP certainly has evoked its share of controversy. Fisker Automotive, one of its recipients, filed for bankruptcy in November 2013.[255] This resulted in a loss of $139 million for U.S. taxpayers, as only $53 million of the $192 million borrowed will be repaid.[256] Another recent bankruptcy that hit the headlines is Solyndra, a solar-panel manufacturer that received a $535 million loan guarantee from the DOE.[257] While this loan guarantee is a different government program encouraging renewable energy rather than electric vehicles, critics point to both programs as failed attempts by the government to encourage particular businesses that the market does not support ("picking winners and losers").[258] Supporters answer that while these companies did fail, they are few among a list of winners. Tesla Motors, another ATVMLP recipient, repaid its $465 million loan in full in May 2013, nine years early.[259] "Ford Motor Co. and Nissan Motor Co. are [also] making regular payments on their loans."[260]

3. Research and Development

In addition to tax credits and loans for EVs, the federal government has also created an energy research and development department called the Advanced Research Projects Agency—Energy (ARPA-E) that in part undertakes R&D for EV technology.[261] Established by the America COMPETES Act of 2007 and authorized with $400 million by the ARRA, ARPA-E has funded R&D for various kinds of "disruptive" technologies.[262] To date it has funded more than

253. Woodyard & Healey, *supra* note 252.

254. *Our Projects*, *supra* note 250. The DOE's fiscal year (FY) 2012 Budget called for $6 million for the ATVMLP, compared to the $20 million it had in FY 2010. OFFICE OF CHIEF FIN. OFFICER, U.S. DEP'T OF ENERGY, FY 2012 CONGRESSIONAL BUDGET REQUEST: BUDGET HIGHLIGHTS 60-61 (2012), *available at* http://energy.gov/sites/prod/files/FY12Highlights.pdf.

255. Keane, *supra* note 41.

256. *Id.*

257. Michael Bathon, *Solyndra Wins Court Approval of Bankruptcy Exit Plan*, BLOOMBERG (Oct. 22, 2012, 11:01 PM), http://www.bloomberg.com/news/2012-10-22/solyndra-wins-court-approval-of-bankruptcy-exit-plan.html.

258. Paul Ryan, H. Comm. on the Budget, *Solyndra Deal Violates 'Fundamental Law of Economics,'* HOUSE.GOV (Sept. 22, 2011), http://budget.house.gov/news/documentsingle.aspx?DocumentID=261228.

259. *Tesla Pays Off Government Loan Nine Years Early*, ASSOCIATED PRESS (May 23, 2013), http://www.foxnews.com/leisure/2013/05/23/tesla-pays-off-government-loan-nine-years-early/.

260. Keane, *supra* note 41.

261. *BEEST: Batteries for Electrical Energy Storage in Transportation*, ARPA-E, http://arpa-e.energy.gov/?q=arpa-e-programs/beest (last visited Mar. 30, 2014) [hereinafter *BEEST*].

262. *ARPA-E History*, ARPA-E, http://arpa-e.energy.gov/?q=arpa-e-site-page/arpa-e-history (last visited Mar. 30, 2014).

$521.7 million to more than 180 projects.[263] ARPA-E has established twelve different programs aimed at different kinds of technologies.[264] One of these is Batteries for Electrical Energy Storage in Transportation (BEEST).[265] The program's goals are to create batteries that are (1) "cost-competitive with traditional cars," (2) "30% of today's cost" with two to five times today's batteries' energy storage capabilities, and (3) 300% to 500% longer in battery life and range.[266] This program funds ten different projects for a total investment of $36.3 million.[267] These projects are both university research projects as well as private company undertakings.[268]

Additionally, on April 11, 2012, ARPA-E announced that it will fund $43 million for two energy storage programs: $30 million for a program geared towards working with the Department of Defense on battery enhancement and $13 million for a program aimed at small businesses.[269]

4. Proposed Federal Laws

While the tax credits, loans, and R&D programs listed above have already been enacted, many new federal bills have been introduced in Congress concerning EVs.[270] In 2013 alone, congressmen introduced over a dozen bills regarding electric vehicles.[271] Two noteworthy bills are Senate Bill 488, the

263. *Department of Energy Awards $156 Million for Groundbreaking Energy Research Projects*, ARPA-E (Sept. 29, 2011), http://arpa-e.energy.gov/?q=arpa-e-news-item/department-energy-awards-156-million-groundbreaking-energy-research-projects.

264. *Id.*

265. *BEEST*, *supra* note 261.

266. ARPA-E, BEEST: ELECTRIC VEHICLE BATTERIES (2012), *available at* http://www.arpae-summit.com/paperclip/web_asset/403/original__BEEST_ProgramSheet_Final_OnePage.pdf.

267. *Id.*

268. *BEEST*, ARPA-E, http://arpa-e.energy.gov/?q=programs/beest (last visited Mar. 30, 2014).

269. *ARPA-E Issues $43 Million for Transformational Energy Storage Research Projects*, ARPA-E (Apr. 11, 2012), http://arpa-e.energy.gov/?q=arpa-e-news-item/arpa-e-issues-43-million-transformational-energy-storage-research-projects.

270. Here is a sampling of some 2011 Senate bills regarding EVs: New Alternative Transportation to Give Americans Solutions Act of 2011, S. 1863, 112th Cong. (2011); Make It in America Tax Credit Act of 2011, S. 1764, 112th Cong. (2011); Open Fuels Standard Act of 2011, S. 1603, 112th Cong. (2011); Changing How America Reduces Greenhouse Emissions (CHARGE) Act, S. 1602, 112th Cong. (2011); Fuel Cell Industrial Vehicle Jobs Act of 2011, S. 1417, 112th Cong. (2011); Battery Innovation Act of 2011, S. 1351, 112th Cong. (2011); Oil Independence for a Stronger America Act of 2011, S. 1294, 112th Cong. (2011); Hybrid and Electric Trucks and Infrastructure Act, S. 1285, 112th Cong. (2011); Fulfilling U.S. Energy Leadership Act, S. 1220, 112th Cong. (2011); Department of Defense Energy Security Act of 2011, S. 1204, 112th Cong. (2011); Alternative Fueled Vehicles Competitiveness and Energy Security Act of 2011, S. 1001, 112th Cong. (2011); Energy Savings and Industrial Competitiveness Act of 2011, S. 1000, 112th Cong. (2011); Promoting Electric Vehicles Act of 2011, S. 948, 112th Cong. (2011); Heavy Duty Hybrid Vehicle Research, Development, and Demonstration Act of 2011, S. 938 112th Cong. (2011); American Alternative Fuels Act of 2011, S. 937, 112th Cong. (2011); Advanced Vehicle Technology Act of 2011, S. 734, 112th Cong. (2011); Strategic Petroleum Demand Response Act of 2011, S. 612, 112th Cong. (2011); Charging America Forward Act, S. 298, 112th Cong. (2011); Dual Fuel Vehicle Act of 2011, S. 152, 112th Cong. (2011). Introduced in 2012 was the Energy Freedom and Economic Prosperity Act, S. 2064, 112th Cong. (2012).

271. Energy Security and Employment Act, H.R. 3033, 113th Cong. (2013); Electric Transportation Advancement Act of 2013, H.R. 2075, 113th Cong. (2013); Advanced Vehicle Technology Act of 2013, H.R. 1047, 113th Cong. (2013); Consortia-Led Energy and Advanced Manufacturing Networks Act, S. 1698, 113th Cong. (2013); Domestic Energy and Jobs Act, S. 1401, 113th Cong. (2013); Alternative Fueled Vehicles Competitiveness and Energy Security Act of 2013, S. 1230, 113th Cong. (2013); State Energy Race to the Top

Advanced Vehicle Technology Act of 2013, and House Resolution 1027, the Advanced Vehicle Technology Act of 2013, which mostly mirror each other and were both introduced and referred to committee on March 7, 2013, by Senator Debbie Stabenow (D-MI) and Representative Gary Peters (D-MI14), respectively.[272] Both bills focus on facilitating research, development, engineering, demonstration, and commercial application of advanced vehicles.[273]

B. State Laws

Switching from federal to state actions, many states have also enacted laws that incentivize the purchase and use of EVs. States like California, Colorado, Georgia, Hawaii, Illinois, Louisiana, New Jersey, Oklahoma, Oregon, Pennsylvania, and Tennessee have taken the strongest lead, creating purchase rebates and income or sales tax credits ranging from $2,500 to $6,000.[274] States also offer perks to EV drivers like lower licensing fees,[275] excise tax exemptions,[276] reduced registration fees,[277] high occupancy vehicle (HOV) lane access,[278] and reduced toll fares.[279] Many utilities also appear to have teamed up with states and offer reduced electricity rates for owners of plug-in EVs.[280] From federal to state government, the United States has taken serious steps to encourage EVs. The question remains, however, whether these steps are the best course of action and what future measures the United States should take.

V. RECOMMENDATION

A. Do EVs Stand a Chance?

It certainly seems like EVs have an uphill battle to fight in the United States. American drivers are accustomed to virtually unlimited range because of

Initiative Act of 2013, S. 1218, 113th Cong. (2013); Clean Energy Race to the Top Act of 2013, S. 570, 113th Cong. (2013) (intending "[t]o establish a competitive grant program in the Department of Energy to provide grants to States and units of local government to carry out clean energy and carbon reduction measures, to close big oil company tax loopholes to pay for the competitive grant program and reduce the deficit, and for other purposes"); Advanced Vehicle Technology Act of 2013, S. 488, 113th Cong. (2013).

272. S. 488; H.R. 1027.

273. S. 488; H.R. 1027.

274. Hartman, *supra* note 225.

275. *Reduced Alternative Fuel Vehicle (AFV) License Tax*, U.S. DEP'T ENERGY, http://www.afdc.energy.gov/afdc/laws/law/AZ/4179 (last updated Nov. 12, 2013) (referencing Arizona law).

276. *Alternative Fuel and Fuel-Efficient Vehicle Title Tax Exemption*, U.S. DEP'T ENERGY, http://www.afdc.energy.gov/afdc/laws/law/DC/5979 (last updated Nov. 12, 2013) (discussing Washington, D.C. law).

277. *Reduced Registration Fee for Fuel-Efficient Vehicles*, U.S. DEP'T ENERGY, http://www.afdc.energy.gov/afdc/laws/law/DC/6601 (last updated Nov. 12, 2013) (referencing Washington, D.C. law).

278. Hartman, *supra* note 225 (listing California, Virginia, New Jersey, and New York, among others, as states exempting qualifying EVs from HOV lane restrictions).

279. *Id.* (naming California, Florida, and New Jersey as states offering discounts or exemptions from toll fees for qualifying EVs).

280. *Plug-In Electric Vehicle Charging Rate Reduction—SMUD*, U.S. DEP'T ENERGY, http://www.afdc.energy.gov/afdc/laws/law/CA/4241 (last updated Nov. 12, 2013); *Plug-In Electric Vehicle (PEV) Charging Rate Reduction—Virginia Dominion Power*, U.S. DEP'T ENERGY, http://www.afdc.energy.gov/afdc/laws/law/VA/9213 (last updated Nov. 12, 2013).

ubiquitous gas stations and the mere minutes it takes to refuel. Therefore, U.S. car purchasers will likely not easily take to BEVs that can only drive about one hundred miles, need a three- to six-hour recharge, and cost many thousands of dollars more than conventional cars.[281] These impediments seem too high for most consumers to hurdle. Even optimistic estimates augur that BEVs will not garner a significant portion of the U.S. fleet any time soon.[282] Until BEVs can come close to matching the long range, short refueling time, and low price tag of ICE cars, they will likely not be widely adopted, and BEVs will likely meet these requirements only with major technological breakthroughs.

But that is not the whole story. Although BEVs require significant improvements, PHEVs may establish a hold in the United States much sooner. PHEVs solve the problem of range and only suffer from a high price tag.[283] That problem, however, will likely be mitigated as mass production increases, more carmakers enter into the space, and technology is improved. Already the Chevy Volt (PHEV) appears to be selling better than the Nissan Leaf (BEV), although not by much.[284] While the Chevy Volt has been heavily criticized for its slow sales, it is important to keep in mind that even viable new technologies and products often take time to garner momentum, as consumers are reluctant to change their habits.[285] As Secretary Chu shared at the New York Times' "Energy for Tomorrow" Conference, at the turn of the century pundits claimed that automobiles had reached their maximum engineering plateau and even Henry Ford's banker believed the Ford Motor Company was doomed to fail.[286] We too should not judge too soon. As more PHEVs like the Toyota Prius Plug-In Hybrid and the Ford Escape Plug-In Hybrid hit the roads, we shall see if PHEVs are in fact more attractive to consumers. In short, PHEVs may sell substantially in the United States while BEVs will likely not any time soon.

Another facet of EVs that is important to highlight is that although the prospects for BEVs do not seem especially good in the United States, there are other places in the world that offer much better odds. Smaller countries, whose people are neither accustomed to nor need to drive long distances, offer more fecund ground for BEV acceptance. Countries like Denmark seem to fit this bill. Denmark is the size of a small U.S. state and carries a very strong sense of environmental consciousness.[287] As explored earlier, Denmark already taxes ICE cars at 180%, making BEVs cost-competitive, and possibly making

281. Brad Berman, *Electric Cars Pros and Cons*, PLUGIN CARS (Oct. 24, 2013), http://www.plugincars.com/electric-cars-pros-cons-128637.html.

282. ELECTRIFICATION COAL., STATE OF THE PLUG-IN ELECTRIC VEHICLE MARKET 4 (2013) [hereinafter EV MARKET OUTLOOK], *available at* http://www.electrificationcoalition.org/sites/default/files/EC_State_of_PEV_Market_Final_1.pdf.

283. *Id.* at 3.

284. Eric Loveday, *Chevy Volt Sales Still Sizzling, Nissan LEAF Slumps in April 2012*, PLUGIN CARS (May 1, 2012), http://www.plugincars.com/chevy-volt-sales-still-sizzling-nissan-leaf-slumps-april-2012-120922.html. The 2012 year-to-date car sales of the Chevy Volt and Nissan Leaf are 5,377 units and 2,103 units, respectively. *Id.*

285. EV MARKET OUTLOOK, *supra* note 282, at 6.

286. Steven Chu, Sec'y, U.S. Dep't of Energy, Address at the New York Times Energy for Tomorrow Conference (Apr. 11, 2012).

287. *Supra* Part III.B.

Denmark a country in which BEVs could take off soon.[288] Other countries like Israel also share Denmark's size and have strong political reasons for adopting and spurring EVs.[289] These kinds of countries possess special characteristics that make BEVs much more attractive to them and enable BEVs to take hold in a way they would not in the United States.

So to answer the question "Do EVs stand a chance?" the answer appears to depend on what kind of EV one is asking about and where. In the United States, BEVs will likely not be widely adopted for quite some time while PHEVs hold more immediate promise. Other countries' politics and cultures make BEVs much more palatable there, meaning those countries may see significant numbers of BEVs on their roads soon.

B. Should the U.S. Government Be Involved?

Before addressing what measures the government should take to support EVs, it is first imperative to ask whether the government should do anything at all. Many argue that the U.S. government should not be in the business of subsidizing or promoting technologies, EVs or otherwise.[290] Governments, they argue, are inherently inefficient compared to the market, and having the government choose winners and losers leads to the wrong ones winning.[291] While this is a convincing argument for private goods, the most important benefits of EVs are *public* goods, meaning that the market fails to value them correctly, leading to market failure and necessitating government involvement for the benefit of the public.

Public goods are non rivalrous, meaning that the consumption or enjoyment of the good by one does not reduce the availability of the good for another, and non excludable, meaning that the costs of excluding nonpayers from enjoying the benefit of the good is prohibitive.[292] In the context of EVs, when a person chooses between buying an EV or an ICE car, that purchaser does not internalize all the benefits that the EV generates.[293] Two main public goods that EVs create are decreased pollution and increased energy security.[294] Both of these goods are enjoyed by the public at large. No one person fully internalizes these public goods' costs or benefits. Thus, without government intervention, no one would

288. Bergman, *supra* note 187.

289. *Supra* Part III.C.

290. *E.g.*, Ryan, *supra* note 258.

291. *Id.*

292. Paul A Samuelson, *The Pure Theory of Public Expenditure*, 36 REV. ECON. & STATS. 387, 387 (1954); *Private Goods v. Public Goods*, ECONPORT, http://www.econport.org/content/handbook/Market-Failure/Public-Goods/PRIV-V-PUB.html (last visited Mar. 30, 2014). This can be compared to private goods which are both rivalrous and excludable, common goods (fish stocks, timber, coal) which are rivalrous and non-excludable, and club goods (cinemas, private parks, satellite TV) which are non-rivalrous and excludable. *Id.*

293. *See generally* Hunt Allcott et al., *Energy Policy with Externalities and Internalities*, 112 J. PUB. ECON. 72 (2014).

294. *Benefits and Considerations of Electricity as a Vehicle Fuel*, U.S. DEP'T ENERGY, http://www.afdc.energy.gov/fuels/electricity_benefits.html (last updated Oct. 1, 2013).

step up to protect these goods.[295] Hence, the government must represent the nation's collective will and protect them.

Furthermore, while reduced pollution and increased energy security are the main public goods created by EVs, there are a host of others. The United States has spent and continues to spend billions of dollars in defense to protect our nation's oil interests abroad.[296] Although we may never know the exact price the government has paid, our dependence on oil and need to protect our foreign oil interests has, for example, led the United States to fight wars that otherwise may have been unnecessary. Spurring EVs to decrease our dependence on oil and to allow us to withdraw from hostile areas of the world also creates the benefits of decreased defense spending and increased national security. Decreasing defense spending, and hence the federal budget, would decrease the taxes Americans pay while also decreasing the national threats our citizens face abroad and at home. These are all public goods that EV purchasers generate but do not internalize.[297]

In addition to decreasing defense spending and increasing national security, the discovery of enhanced EV technology generates other public goods, such as preserving the United States' technological lead, increasing domestic manufacturing in a wide number of fields, such as batteries for EVs, electrical grid storage, cell phones, laptops, defense uses, and rural electrification,[298] and cutting the trade deficit. All of these consequences of enhanced battery discoveries elevate the nation in general. Just as the internet began as a government project and grew into a worldwide phenomenon, so could new battery technologies and EV developments lay the ground for new business and manufacturing opportunities for U.S. companies. This could augment U.S. technological leadership and cut our trade deficit by creating manufacturing opportunities here in the United States. In sum, because the benefits of EVs are public goods, and only the government by representing the collective interest of the people will protect those nation-enhancing benefits, the U.S. government is justified in supporting EVs.

C. What Should the U.S. Government Do?

Having established that the U.S. government should support EVs for the benefit of environmental protection and energy security, among others, the next question naturally is what exactly should the government do? Pundits would argue that there are two possible solutions. One option would be to create a market so that private forces can dictate the correct price for the good. In the context of environmental protection, this option would mean the government setting a cap on U.S. emissions and allowing polluting entities to purchase and

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295. *See generally* Garrett Hardin, *Tragedy of the Commons*, *in* THE CONCISE ENCYCLOPEDIA OF ECONOMICS (2d ed. 2007), *available at* http://www.econlib.org/library/Enc/TragedyoftheCommons.html.

296. *See, e.g.*, Peter Maass, *The Ministry of Oil Defense*, FOREIGN POLICY (Aug. 5, 2010), http://www.foreignpolicy.com/articles/2010/08/05/the_ministry_of_oil_defense (suggesting the spending over three decades exceeded $7 *trillion*).

297. The collective action problem is the inaction created when a benefit or harm is spread out amongst many people and therefore no one person has the incentive to protect or fight it. Hardin, *supra* note 295; Samuelson, *supra* note 292.

298. *See, e.g.*, Yuliya Chernova, *Battery Companies in Need of a Boost*, WALL ST. J. (Dec. 5, 2011), http://online.wsj.com/article/SB10001424052970204443404577051832763572816.html.

trade the right to pollute.[299] This is the "Cap and Trade" system, or emissions trading system, proposed in the American Clean Energy and Security Act of 2009 (ACES).[300] Although it passed the House by seven votes, the bill died in the Senate.[301] Thus the cap and trade strategy has not worked and shows no signs of resurrecting in the near future.

The second solution economists would argue is to impose a Pigouvian tax to combat the negative externalities that ICE cars are creating (i.e. global warming, energy security threat, etc.).[302] In the context of car emissions, a tax could be placed on oil so oil sellers would be taxed for every unit of oil they sold and pass this tax burden onto consumers through higher oil prices.[303] This tax could also be a general carbon tax so that any activity that creates greenhouse gases would incur a tax.[304] The effectiveness of this tax approach is debated. Economists, most notably William Nordhaus, argue that a tax would be more effective than a cap and trade market, especially in the international context.[305] Nordhaus argues that a tax provides clear signals to consumers, producers, inventors, and innovators and is easier to implement.[306] Conversely, opponents of a tax (often politicians) point to the inefficiency of a tax, claiming that the market should be left to set an efficient price for carbon, rather than the government setting an arbitrary tax.[307] In any case, there appears to be no appetite in the United States for the tax approach. Americans are so dependent on oil for their daily lives and so accustomed to buying it cheaply that a U.S. carbon or oil tax appears politically unpalatable.

Seeing as how the market and tax strategies are not viable, let us instead consider what may be the best realistic strategy. This paper recommends six steps the U.S. federal government should take in the arena of EVs. In the author's opinion, these recommendations offer the best realistic measures the federal government can take to use EVs to decrease greenhouse gas emissions, decrease our oil dependence, increase our energy security, and increase the industrial and business opportunities created by enhanced battery and EV technologies.

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299. *Why Emissions Trading Is More Effective Than Command and Control*, INT'L EMISSIONS TRADING ASS'N, http://www.ieta.org/index.php?option=com_content&view=article&id=418:why-emissions-trading-is-more-effective-than-command-and-control&catid=54:3-minute-briefing&Itemid=135 (last visited Mar. 30, 2014).

300. American Clean Energy and Security Act of 2009, H.R. 2454, 111th Cong. (2009).

301. *111th Congress Climate Change Legislation*, CTR. FOR CLIMATE & ENERGY SOLUTIONS, http://www.c2es.org/federal/congress/111 (last visited Mar. 30, 2014).

302. ARTHUR C. PIGOU, THE ECONOMICS OF WELFARE (4th ed. Macmillan & Co. 1932) (1920).

303. *See, e.g.*, Jonathan Williams, *Gasoline Taxes: User Fees or Pigouvian Levies?*, TAX FOUND. (Nov. 27, 2006), http://taxfoundation.org/article/gasoline-taxes-user-fees-or-pigouvian-levies.

304. *E.g.*, Robert H. Frank, *Heads, You Win. Tails, You Win, Too.*, N.Y. TIMES (Jan. 5, 2013), http://www.nytimes.com/2013/01/06/business/pigovian-taxes-may-offer-economic-hope.html?nl=todays headlines&emc=edit_th_20130106.

305. William D. Nordhaus, Keynote Address at Climate Change: Global Risks, Challenges, and Decisions: Economic Issues in a Designing a Global Agreement on Global Warming (Mar. 10, 2009), *available at* http://www.econ.yale.edu/~nordhaus/homepage/documents/Copenhagen_052909.pdf.

306. *Id.* at 3, 5-6.

307. William J. Baumol, *On Taxation and the Control of Externalities*, 62 AM. ECON. REV. 307, 307-08 (1972).

First, the U.S. federal government should repeal the $7,500 tax credit for PHEVs and BEVs and instead offer a $5,000 tax credit for HEVs. The current tax credit for PHEVs and BEVs supports a technology that will not be widely accepted. Until PHEVs and BEVs display characteristics similar to ICE cars, such as costing around $20,000, traveling around 300 miles on one charge, and charging in less than an hour, American consumers will most likely view them as inferior to the average ICE car and will not widely purchase them. Having a small handful of PHEVs and BEVs on the road does very little to solve the global warming and energy security problems that they are intended to address.[308] Only when EVs make up a substantial portion of new car sales will these goals be attainable. Because this tax credit is supporting technology that does not materially enhance the public goods it was intended to support, it should be repealed.

Conversely, HEVs can obtain similar emissions and oil reductions to PHEVs and BEVs without suffering their challenges and costs. As addressed earlier, PHEVs and BEVs can reduce greenhouse gas emissions compared to ICE cars by 25% to 45% on average.[309] However, it appears that HEVs can achieve similar environmental benefits with much less effort and cost.[310] Although PHEV and BEV emissions will decrease in time as the electrical grid becomes cleaner, for the near future HEVs appear to be the more practical solution to address climate change.

The government should, therefore, redirect the $7,500 tax credit for PHEVs and BEVs instead towards HEVs, cutting it to $5,000 or some similar amount. As evidenced in the EPRI-NRDC and UCS studies, HEVs reduce emissions by around 40%, about as much as PHEVs and BEVs do.[311] This means that HEVs already fulfill the same emission-reducing goal of PHEVs and BEVs while requiring no behavior change by consumers.[312] As current HEVs drivers can attest, HEVs are driven just like ICE cars, making them an easy choice. There are no range issues, in fact HEVs travel farther than ICE cars on the same amount of gas, do not require charging infrastructures, and do not have three to six hour long charge times.[313] Rather HEVs drive just as easily as any other car. These features are critically important because they mean that HEVs can be widely adopted by U.S. consumers and therefore stand a better chance of materially reducing greenhouse gas emissions and oil consumption. The only impediment for wide-scale adoption of HEVs, as evidenced in Part II of this paper, is their higher price.[314] This is where a tax credit can help.

As shown on the HEV table (Table 1) in Part II, many HEVs cost between $4,000 to $9,000 more compared to their ICE counterparts for compact and mid-

308. Brad Berman, *Drop in the Bucket*, HYBRID CARS (June 25, 2007), http://www.hybridcars.com/drop-bucket-062507/.

309. *Supra* Part II.B.

310. NRDC 2007 Report, *supra* note 89.

311. *Id.* at 3 (35.5%); UCS REPORT, *supra* note 94 (45.8%).

312. *Supra* notes 21-22, 24 and accompanying text.

313. *E.g.*, Hybrid Electric Vehicles, U.S. DEP'T ENERGY, http://www.afdc.energy.gov/vehicles/electric_basics_hev.html (last updated Feb. 7, 2013).

314. *Supra* notes 23-27 and accompanying text.

size cars.[315] For example, the Ford Fusion HEV costs $5,800 more than its ICE version, the Honda Civic HEV $8,445, the Hyundai Sonata $6,055, the Kia Optima $6,200, the Lexus RX $6,160, and the Toyota Camry $3,945 more.[316] If the federal government were to offer a $5,000 tax credit for these vehicles, the HEV versions would in many cases be interchangeable with their ICE counterpart. In fact, considering the $500 to $1,000 fuel cost savings that HEVs enjoy, the HEV version may be the more economically attractive option, giving consumers every reason to purchase the HEV.[317] Considering how commonplace HEVs are today (staving off hesitations consumers have of new technologies), how wide the selection of HEVs available is, how easy it is to transition from ICE to HEV cars, and how cost-neutral or cost-beneficial moving to HEVs is, such a tax credit has the potential to lead to large-scale adoption of HEVs—exactly what is needed to make meaningful cuts in emissions and oil dependency. While it is true that HEVs do not cut oil consumption as much as PHEVs and BEVs, they still provide significant oil reductions.[318] Considering the near identical reductions they have on emissions, HEVs seem like the most practical technology to support at this time. Unlike PHEVs and BEVs, they can create meaningful change now.

The federal government once had such a tax credit in place. President Bush signed the Energy Policy Act of 2005, which created a tax credit of up to $3,400 for the purchase of new HEVs.[319] Only HEVs purchased between December 31, 2005, and December 31, 2010, were eligible, and the tax credit phased out as the manufacturer reached 60,000 new HEVs.[320] While this tax credit was intended to help jumpstart the assimilation of HEVs into the U.S. automobile industry, left to its own, HEV sales have not reached significant numbers.[321] Despite a rise in HEV sales, in 2012 only 382,704 HEVs sold, meaning only 2.8% of the 13,340,000 total light duty vehicles sold that year.[322] Only 53,234 PHEVs and BEVs combined sold in 2012, a mere 0.4% of total light duty vehicles sold in 2012.[323] While the federal government should not offer an HEV tax credit indefinitely, it is appropriate for the government to intervene considering the significant and immediate public benefits that HEVs offer. With the ability to cut emissions by 40% and cut oil use by 37%, HEVs are an effective current solution that can make an immediate difference.

Second, the federal government should invest more in research and development of battery and EV technology through ARPA-E. While PHEVs and BEVs are not yet attractive enough for popular use, with the right technological breakthroughs, one day they might be. Instead of focusing on

315. *Supra* Part II.A.1, tbl. 1.

316. *Id.*

317. *Id.*

318. NRDC 2007 REPORT, *supra* note 89, at 3.

319. Mike Scott, *Strategies for Hybrid Vehicle Purchase Tax Incentives*, GOV'T FLEET (Nov. 2007), http://www.government-fleet.com/article/print/story/2007/11/strategies-for-hybird-vehicle-purchase-tax-incentives.aspx.

320. *Id.*

321. *U.S. HEV Sales by Model*, U.S. DEP'T ENERGY, http://www.afdc.energy.gov/data/ (last updated Apr. 2013).

322. *Id.*

323. *Id.*

deploying the current technology that is not viable, it is better to instead take an approach similar to Germany's and focus on creating the technologies that will work.[324] The Advanced Vehicle Technology Act of 2013 introduced in the House and Senate adopts this exact strategy.[325] This approach seems especially appropriate for the United States because the country is the global leader in innovation. Thanks to our world-class universities, research programs, and investment resources, the United States can best make the battery and EV technology breakthroughs needed for EVs to obtain the price, range, and charge-time trifecta required to become popularly accepted.[326] However, when compared to the $2.8 billion that Germany and the $15.67 billion that China are each investing in EV R&D, the few million that ARPA-E has invested in EV research seems paltry.[327]

The U.S. government should invest in R&D because of the public goods that will stem from these technologies. In addition to cleaning our air and protecting our energy security, these technological breakthroughs will also benefit the nation by preserving our technological lead and creating manufacturing, industrial, and business opportunities for U.S. companies.[328] If the government funds university and private research projects, those projects, if successful, will develop battery and other technologies that can be converted into products that can be manufactured in the United States and sold abroad.[329] Given the mechanized and low-labor intensive characteristics of batteries, these kinds of products can be made in the United States just as easily as they could anywhere else and can be sold abroad. This means revenue for American companies and jobs for American workers.[330]

These technologies hold the potential for massive change as better batteries can be used not only in EVs but also in improved HEV technology, grid electrical storage, energy solutions for the Defense Department, laptop batteries, cell phone batteries, and rural electrification. This wide application means that there is a great and diverse worldwide demand for these technologies. Breakthroughs could sprout new industries and reignite the American manufacturing sector. If successful, these breakthrough batteries could even be sold to countries like China, which is clamoring for solutions for its energy threats, and India, which needs to electrify massive rural parts of its population.[331] Right now the largest battery manufacturers are in China, Japan,

324. *Supra* Part III.D.

325. Advanced Vehicle Technology Act of 2013, H.R. 1027, 113th Cong. (2013).

326. *See generally* BILL CANIS, CONG. RESEARCH SERV., BATTERY MANUFACTURING FOR HYBRID AND ELECTRIC VEHICLES: POLICY ISSUES (2013), *available at* http://www.fas.org/sgp/crs/misc/R41709.pdf.

327. *US DOE Selects 43 Projects for $92M in ARPA-E Funding; 3 on Automotive Power Electronics*, GREEN CAR CONGRESS (July 13, 2012), http://www.greencarcongress.com/2010/07/arpae-20100713; *supra* notes 142, 213.

328. *See, e.g.*, CLEAN ENERGY MINISTERIAL ET AL., GLOBAL EV OUTLOOK: UNDERSTANDING THE ELECTRIC VEHICLE LANDSCAPE TO 2020 (2013) [hereinafter GLOBAL EV OUTLOOK], *available at* http://www.iea.org/publications/globalevoutlook_2013.pdf; Matthew Stepp, *DOE's High Impact Energy Innovation Incubator Program*, ENERGY COLLECTIVE (May 13, 2013), http://theenergycollective.com/mstepp/222291/doe-proposes-expanding-high-impact-energy-innovation-incubator-program.

329. GLOBAL EV OUTLOOK, *supra* note 328, at 16.

330. *See, e.g.*, *id.* at 17.

331. *See generally* G.D. Kamalapur & R.Y. Udaykumar, *Rural Electrification in India and Feasibility of Photovoltaic Solar Home Systems*, 33 ELEC. POWER & ENERGY SYS. 594 (2011).

and Korea.[332] But the United States could be the leader in this field, and government investment in battery and EV technology R&D can open the doors for it to take that lead.

Third, the U.S. federal government should not renew the conversion and at-home charger tax credits. The reasoning for this recommendation is the same as that for the first recommendation to remove the $7,500 plug-in EV tax credit. Because PHEVs and BEVs are not yet popularly viable, providing a tax credit that assists in deploying them does not do much good. Having a few thousand or even a few tens of thousands of PHEVs and BEVs on the road does not meaningfully help fulfill EVs' greater benefits. Thus, these expired credits should remain expired.

Fourth, the U.S. federal government should let the Advanced Technology Vehicles Manufacturing Loan Program run its course, but after the $25 billion has been loaned, it should not be funded again. Again, because PHEV and BEV technology is not yet viable, loaning money to lost causes is a waste of taxpayer dollars. Though it is true that this is a loan program and, therefore, the government plans to recoup its investment plus interest, there nonetheless are administrative expenses that this program creates as well as the possibility that companies will go bankrupt and lent money will be lost.[333] While it is true that this program has created American jobs,[334] which is laudable given the current economy, funding a product that will not bring the wide-scale public benefits intended should not be the business of the federal government.

Fifth, similar to the plug-in EV, conversion, and at-home charger tax credits, the federal government should not undertake any incentives to build charging infrastructure for EVs. This should instead be left to states.[335] While PHEVs and BEVs will likely need charging infrastructures in order to gain wide-use, their shortcomings argue against the federal government taking part in this kind of investment. Not only would such infrastructure require heavy investment and great government expense, but state governments are in a better position to undertake such efforts. The measures that cities in China, like Beijing, Shanghai and Shenzhen, have taken serve as examples for this approach.[336] Any infrastructure plans would have to be done on a city scale.[337] As such state governments, not the federal government, have a better purview of how best to structure such plans.[338] Like China's "Ten Cities, Thousand Vehicles Program,"[339] these small-scale infrastructure designs should be done by localized governments, in this case state or local governments, as the expense will come from and more directly benefit those consumers. The DOE appears to have already taken steps in this direction with its "Clean Cities" program in its

332. Steve Levine, *The Great Battery Race*, FOREIGN POL'Y (Oct. 12, 2010), http://www.foreignpolicy.com/articles/2010/10/11/the_great_battery_race.

333. Keane, *supra* note 41 (discussing the Fisker bankruptcy).

334. *Our Projects*, *supra* note 250.

335. For an example of one state's efforts, see generally Teresa Messmore, *EV Charging Station Expansion*, UNIV. DEL. (Feb. 19, 2014), http://www.udel.edu/udaily/2014/feb/ev-charging-stations-021914.html.

336. *Supra* Part III.A.

337. *See generally, e.g.*, Messmore, *supra* note 335.

338. *Id.* (discussing how the local level is able to identify areas where charging stations are needed).

339. *Supra* Part III.A.

Energy Efficiency & Renewable Energy branch.[340] This program should advise and provide information to state or local governments on charging infrastructure plans, as the DOE may be able to most efficiently educate state and local governments on best practices in this field, but should limit its role to that end.

Sixth, a final recommendation for the United States to cut greenhouse gases and dependence on foreign oil is to encourage changing the U.S. fleet of heavy-duty trucks from consuming diesel fuel to natural gas.[341] Although this paper aims to address EVs, and natural gas vehicles do not fall within its scope, it is worth highlighting a sector of vehicles that EVs will not be able to influence—heavy-duty trucks—and recognizing the potential natural gas solution to cutting emissions and oil consumption for this vehicle sector.[342] Heavy duty trucks (sixteen- and eighteen-wheelers) constitute a significant portion of the U.S. vehicle fleet and U.S. vehicle emissions.[343] Electric batteries will not be able to power these mammoth trucks in the foreseeable future, but natural gas can. Thanks to the extraction of shale gas using horizontal drilling and hydraulic fracturing, the U.S. supply of natural gas has recently increased dramatically.[344] Because natural gas releases approximately half as much greenhouse gases as diesel fuel, switching these trucks to natural gas can significantly reduce greenhouse gas emissions and oil dependency in a sector that EVs cannot affect.[345] This proposal is made all the more viable by the travel routes these trucks use. These large trucks drive preplanned distances, moving goods around the country and stopping at refueling stops along major highways. Only these large refueling stations would need to be retooled to offer natural gas. Nonetheless serious questions need to be answered first. The exact amount of the emissions and oil reduction, the costs of retrofitting trucks and refueling stations, and the cost to the government to encourage such change are paramount inquiries that must first be answered before enacting such a proposal. Nonetheless, it is important to recognize the disparate nature of the U.S. vehicle fleet and shape different energy strategies to create a holistic energy plan, which is something the United States has lacked for decades.

These six recommendations offer the best realistic strategy the U.S. federal government can take to use EVs to cut emissions and oil dependence. HEVs deserve a renewed federal tax credit, considering the substantial and immediate environmental and energy benefits they offer. Their sales the past few years indicate that additional support is needed and that the market left to itself is not reflecting the benefits they offer. While the tax credits for PHEVs and BEVs should be repealed, efforts should be refocused on investing in R&D to find the

340. *Building Partnerships to Reduce Petroleum Use in Transportation*, U.S. DEP'T ENERGY, http://www1.eere.energy.gov/cleancities/ (last updated Mar. 19, 2014).

341. *See, e.g.*, Christopher Helman, *Should Natural Gas-Powered Cars Run on CNG, LNG…Or Gasoline*, FORBES (June 5, 2013), http://www.forbes.com/sites/christopherhelman/2013/06/05/should-natural-gas-powered-cars-run-on-cng-lng-or-gasoline/.

342. *Id.*

343. *Cars, Trucks, Buses, and "Nonroad" Equipment*, ENVTL. PROTECTION AGENCY, http://www.epa.gov/air/caa/peg/carstrucks.html (last updated Mar. 6, 2012) (stating that heavy duty trucks account for one-third of nitrogen oxide emissions and one-fourth of particle emissions).

344. U.S. ENERGY INFO. ADMIN., AEO2014 EARLY RELEASE OVERVIEW (2014), *available at* http://www.eia.gov/forecasts/aeo/er/pdf/0383er(2014).pdf.

345. Helman, *supra* note 341.

technologies that will make these cars work and that may open new global industrial opportunities for American companies. Similarly, the ATVMLP and the conversion and at-home charging station tax credits should not be renewed. Also, any charging infrastructure investment for PHEVs and BEVs should be left to state and local governments, which are in the best position to plan for, pay for, and benefit from such programs. Lastly, the federal government should consider converting heavy-duty trucks from diesel to natural gas, as the United States' bolstered natural gas reserves have depressed prices and offer an opportunity for emissions and oil cuts in a sector that EVs cannot affect.

VII. CONCLUSION

Not all electric cars are created equal. Considering the high price tag, long charge times, and short electric drive ranges of PHEVs and BEVs versus the ease of switching to HEVs and their similar emissions and oil reductions, HEVs may be the best immediate bet for the United States. Nonetheless the United States should also keep its eye on the future and invest in research for PHEV and BEV technologies. While no one knows what the future holds for EVs, the United States should place itself in the best position to gain from their potentially vast environmental, political and economic benefits.