

# INNOVATION IN THE AUTO INDUSTRY: THE ROLE OF THE U.S. ENVIRONMENTAL PROTECTION AGENCY

SANYA CARLEY, NATALIE MESSER BETTS, JOHN D. GRAHAM\*

## I. INTRODUCTION

Rapid innovation is occurring in the design of propulsion systems for the cars, light passenger trucks, and heavier commercial trucks that dominate the modern transportation systems in both the developed world and in emerging economies.<sup>1</sup> A common theme in these innovations is diminished use of petroleum to power the movement of people and goods.

The desire to reduce petroleum use is rooted in both energy security and environmental concerns. Although some scholars question the severity of the security risks<sup>2</sup> or the environmental risks<sup>3</sup> of petroleum dependence, few scholars deny the significance of both risks. Since there is a large literature on the risks of petroleum dependence, we summarize here only some of the key concerns.

From a security perspective, a national economy that depends on petroleum for transportation is vulnerable to unexpected supply disruptions and to the unpredictable behavior of the Organization of Petroleum Exporting Countries (OPEC), the coalition of oil-exporting nations that restricts global oil supplies and holds the price of oil above the level that would be observed in a highly competitive

---

\* School of Public and Environmental Affairs, Indiana University.

1. Passengers traveled 4.871 trillion miles on highways in 2008, over 8 times as many miles as were traveled by air, 90 times that of public transit, and nearly 800 times more than were traveled on intercity rail. See U.S. BUREAU OF TRANSP. STATISTICS, NATIONAL TRANSPORTATION STATISTICS 71 tbl.1-40 (2010).

2. Philip E. Auerswald, *The Myth of Energy Insecurity*, ISSUES SCI. & TECH., Summer 2006, available at <http://www.issues.org/22.4/auerswald.html> (summarized in Philip E. Auerswald, *Let's Call an End to Oil Alarmism*, N.Y. TIMES, Jan. 23, 2007, <http://www.nytimes.com/2007/01/23/opinion/23iht-edauers.4307288.html> (arguing that oil insecurity is a myth and that high and rising oil prices are good because they help combat global climate change)).

3. See, e.g., C.R. de Freitas, *Are Observed Changes in the Concentration of Carbon Dioxide in the Atmosphere Really Dangerous?*, 50 BULL. CANADIAN PETROLEUM GEOLOGY 297, 297 (2002) (arguing that carbon dioxide, which is emitted when petroleum is burned, is "not a pollutant").

market.<sup>4</sup> Inflated world oil prices are also believed to play a perverse, indirect role in international affairs. For example, the inflated flow of oil dollars from oil-importing to oil-exporting countries is believed to sustain a future for autocratic regimes that violate human rights, condone terrorism, and oppose pro-democracy efforts around the world.<sup>5</sup>

From an environmental perspective, oil use causes environmental damage throughout the supply chain, from the oil spills that occur during exploration, extraction, and transport of crude oil, to the vehicle tailpipe emissions that contribute to the unhealthy levels of smog and soot in urban air.<sup>6</sup> More recently, the dominant environmental concern has been climate change resulting from an increase in greenhouse gas emissions such as carbon dioxide, which is exacerbated by the heavy use of petroleum to power vehicles.<sup>7</sup>

In this article, prepared on the occasion of the fortieth anniversary of the creation of the U.S. Environmental Protection Agency (EPA), our primary objective is to highlight the influential role that EPA is playing in the rapid innovation that is underway in the transport sector of the U.S. economy. Although we acknowledge that EPA is not the only governmental actor influencing the innovation process, we argue that EPA—through a variety of older and newer regulatory authorities created by Congress and judicial interpretation—is a key player in the public policy debate surrounding emerging transportation technologies. EPA is making significant decisions that will change the future of propulsion systems used in the United States and around the world.

---

4. For further information on OPEC's pricing strategy see JOINT ECON. COMM., U.S. CONG. RESEARCH REPORT #110-2, OPEC STRATEGY AND OIL PRICE VOLATILITY (2007), available at <http://www.house.gov/jec/publications/110/r110-2.pdf>.

5. See Michael L. Ross, *Does Oil Hinder Democracy?*, 53 WORLD POL. 325 (2001); Thomas Friedman, *The First Law of Petropolitics*, FOREIGN POL'Y, May 2006, at 28.

6. CTR. FOR HEALTH & THE GLOBAL ENV'T, OIL: A LIFE CYCLE ANALYSIS OF ITS HEALTH AND ENVIRONMENTAL IMPACTS (Paul R. Epstein & Jesse Selber eds., 2002), available at <http://chge.med.harvard.edu/publications/documents/oilfullreport.pdf>.

7. See INT'L GOVERNMENTAL PANEL ON CLIMATE CHANGE, CLIMATE CHANGE 2007: THE PHYSICAL SCIENCE BASIS 23 (Susan Solomon et al. eds., 2007), available at [http://www.ipcc.ch/publications\\_and\\_data/publications\\_ipcc\\_fourth\\_assessment\\_report\\_wg1\\_report\\_the\\_physical\\_science\\_basis.htm](http://www.ipcc.ch/publications_and_data/publications_ipcc_fourth_assessment_report_wg1_report_the_physical_science_basis.htm) (noting the impact of greenhouse gases on climate change); see also U.S. ENVTL. PROT. AGENCY, EPA 430-R-11-005, INVENTORY OF U.S. GREENHOUSE GAS EMISSIONS AND SINKS: 1990–2009, at ES-14 to ES-15 tbl.ES-7 (2011), available at [http://epa.gov/climatechange/emissions/downloads11/US-GHG-Inventory-2011-Complete\\_Report.pdf](http://epa.gov/climatechange/emissions/downloads11/US-GHG-Inventory-2011-Complete_Report.pdf) (reporting that the transportation sector was responsible in 2009 for approximately 27% of greenhouse gas emissions attributable to economic sectors).

Our objective is not to make a normative argument as to whether EPA's influence has been—or will be—beneficial or harmful to the public interest, or to second guess whether EPA is making the most prudent decisions given the current state of knowledge regarding the viability of alternative transport technologies. Instead, we make a positive claim that we live in a world where agencies such as EPA have a meaningful degree of discretion to influence market decisions and technological futures and that EPA is likely to play a significant role in the future of automotive propulsion systems in the United States. We acknowledge that EPA shares responsibility for transport alternatives with a number of other agencies—including the California Air Resources Board (CARB), the Department of Energy (DOE), the Department of Transportation (DOT), the United States Department of Agriculture (USDA), and the Internal Revenue Service (IRS)—but we conclude that EPA plays a unique and influential role. Since we conclude that EPA decisions are significant in this arena, we encourage talented students of law, policy, economics, science, and engineering to consider making a professional contribution to this important federal agency.

This article is organized in five sections. Part I describes three alternative technologies (or classes of technologies) that are competing to replace the internal combustion engine and liquid petroleum fuels—the propulsion system that is now used extensively in the United States. Parts III, IV, and V examine the three alternative technologies: biofuels, refinements to the internal combustion engine (e.g., advanced diesel engines and conventional hybrid powertrains), and electrification (so-called “plug in” vehicles). In these three sections we describe the promise and limitations of each technological alternative and how current and future EPA policies may influence technology penetration in the marketplace. In Part VI we summarize our basic argument and acknowledge the non-EPA forces that are also likely to play important roles.

## II. ALTERNATIVE TECHNOLOGICAL VISIONS

In order to illustrate EPA's significant role, we examine three—somewhat competing—technological strategies for reducing petroleum use in the transport sector. We have chosen to focus on those technologies that are ripe for mass commercialization now; therefore, hydrogen fuel-cell technology and compressed natural gas vehicles are excluded from this discussion. For each strategy, we

pinpoint the specific policymaking authorities and roles of the EPA in relation to other federal and state agencies.

The first technological alternative is a substitute liquid fuel. The basic idea is to retain the internal combustion engine but power it with a petroleum substitute that can be produced in the United States and accomplish a more acceptable profile of environmental effects. We argue that biofuels appear to be the most important petroleum substitute in the United States, at least for the foreseeable future, and that EPA policies are crucial to the market's adoption of biofuels as a sustainable substitute. We consider not only corn-based ethanol but a variety of alternative ways of making ethanol, including cellulosic ethanol. We find that the U.S. Departments of Energy and Agriculture play important roles on biofuels policy, but the significance of EPA's regulatory role is indisputable.

The second technological alternative is a variety of refinements to the internal combustion engine that reduce the amount of gasoline necessary to travel a given distance. Since auto consumers value vehicle size and engine performance, the challenge for engineers is to reduce fuel consumption while preserving these valued vehicle features. An example of such an innovation is the conventional gas-electric "hybrid" engine, which is exemplified by the propulsion system in the popular Toyota Prius. Although there are few EPA policies that directly mandate any of these refinements to the internal combustion engine, we argue that EPA's regulatory policies—as devised jointly with the U.S. Department of Transportation and the California Air Resources Board—have a significant influence on market penetration of these refinements.

Finally, the third alternative—and a far more ambitious one—is electrification of the transport sector of the U.S. economy. Instead of powering vehicles with petroleum, these vehicles could be powered with electricity, as they were in the 1920s, when U.S. sales of electric cars actually outnumbered the sales of gasoline powered vehicles.<sup>8</sup> By "electric cars" we mean vehicles that are powered primarily or exclusively by plugging them in to the electrical grid. The Nissan Leaf and the Chevrolet Volt are illustrations of electric cars now being marketed in the United States. Although the DOE is the primary player in this realm, we discuss how EPA policies are already influencing the future of electric vehicles in the United States.

---

8. See GJIS MOM, THE ELECTRIC VEHICLE: TECHNOLOGY AND EXPECTATIONS IN THE AUTOMOBILE AGE 31 (2004).

### III. BIOFUELS

A biofuel is a source of energy, typically a liquid fuel, made from biomass, a biological material such as plant matter. The most common biofuels used in transportation are bioethanol (“ethanol”), which is typically made from corn or sugar feedstock, and biodiesel, which is typically made from vegetable oils, animal fats, or recycled greases.<sup>9</sup> Biofuels made from these products are generally referred to as “first-generation biofuels.”<sup>10</sup> Looking to the future, there is also tremendous interest in various forms of “cellulosic” ethanol—“second-generation biofuels”—that are produced from corn stalks or cobs, switchgrass, forest residue or even municipal wastes.<sup>11</sup>

Proponents of biofuels as a substitute for petroleum-based liquid fuels make a variety of claims about the advantages of biofuels. Many argue that biofuels contribute to U.S. energy security because they can be produced domestically.<sup>12</sup> They also point to some environmental advantages relative to petroleum (e.g., fewer carbon monoxide, benzene, and smog-related emissions from the vehicle tailpipe when biofuels are used).<sup>13</sup> Biofuels also are considered to be more sustainable than oil because the inputs to biofuel production are

---

9. See *Biofuels for the Transport Sector*, EUR. COMM’N STRATEGIC ENERGY TECHS. INFO. SYS., <http://setis.ec.europa.eu/newsroom-items-folder/biofuels-for-the-transport-sector> (last updated Sept. 12, 2011); U.S. DEP’T OF AGRIC., THE ECONOMIC FEASIBILITY OF ETHANOL PRODUCTION FROM SUGAR IN THE UNITED STATES, at iii (2006), available at <http://www.usda.gov/oce/reports/energy/EthanolSugarFeasibilityReport3.pdf>; MD. CLEAN CITIES, STRAIGHT ANSWERS ON ALTERNATIVE FUELS (2006), available at <http://energy.maryland.gov/incentives/transportation/factsheets/Biodiesel.pdf>.

10. ANSELM EISENTRAUT, SUSTAINABLE PRODUCTION OF SECOND-GENERATION BIOFUELS 7 (2010), available at [http://www.iea.org/papers/2010/second\\_generation\\_biofuels.pdf](http://www.iea.org/papers/2010/second_generation_biofuels.pdf).

11. EUR. COMM’N STRATEGIC ENERGY TECHS. INFO. SYS., *supra* note 9.

12. As biofuels reduce America’s growing appetite for oil, they exert downward influence on global demand for oil, which in turn slows the rate of growth of world oil prices and gasoline prices. U.S. DEP’T OF ENERGY, FACT SHEET: GAS PRICES AND OIL CONSUMPTION WOULD INCREASE WITHOUT BIOFUELS (2008), available at [http://www.in.gov/oed/files/DOE\\_Biofuels\\_Fact\\_Sheet\\_on\\_Oil\\_Prices\\_Gas\\_Consumption\\_and\\_Food\\_Prices\\_June08.pdf](http://www.in.gov/oed/files/DOE_Biofuels_Fact_Sheet_on_Oil_Prices_Gas_Consumption_and_Food_Prices_June08.pdf) (without ethanol, gasoline prices at the pump in the U.S. would be twenty to thirty-five cents per gallon higher than they are today).

13. ORG. FOR ECON. CO-OPERATION & DEV. [OECD], BIOFUEL SUPPORT POLICIES: AN ECONOMIC ASSESSMENT 50 (2008); GARETH BROWN, BIOETHANOL FOR SUSTAINABLE TRANSPORT, NO. D9.14, REVIEW OF FUEL ETHANOL IMPACTS ON LOCAL AIR QUALITY: A LITERATURE REVIEW OF AVAILABLE EVIDENCE FOR EFFECTS OF ETHANOL FUELS ON AIR POLLUTANT EMISSIONS FROM MOTOR VEHICLES 15–16 (2008), available at [http://www.best-europe.org/upload/BEST\\_documents/info\\_documents/Best%20reports%20etc/D9.14%20-%20Review%20of%20Ethanol%20Fuel%20Impacts%20on%20Local%20Air%20Quality\\_080516.pdf](http://www.best-europe.org/upload/BEST_documents/info_documents/Best%20reports%20etc/D9.14%20-%20Review%20of%20Ethanol%20Fuel%20Impacts%20on%20Local%20Air%20Quality_080516.pdf).

renewable. The opportunity for domestic production suggests another key rationale for biofuels: biofuel developments have the potential to increase employment and wages in the agricultural and transportation sectors of the U.S. economy.<sup>14</sup>

The United States has already obtained a strong position in the global ethanol industry. The United States and Brazil are the largest ethanol producers in the world, accounting for forty-eight and thirty-one percent of global production, respectively. The European Union accounts for sixty percent of global biodiesel production.<sup>15</sup>

Before considering EPA's role in advancing the biofuels industry, we mention the major drawbacks of biofuels compared to gasoline. First, the energy content of ethanol is approximately thirty-three percent less than the energy content of gasoline, which means that a vehicle will travel more miles on a tank of gasoline than on a tank of E10, E15, E85, or pure ethanol.<sup>16</sup> Second, as long as world oil prices remain below \$100 per barrel, making ethanol from corn will remain more expensive than refining gasoline from crude oil.<sup>17</sup> The economics of ethanol are favored by rising oil prices, but until very recently, the prices for inputs to ethanol production were growing faster than the price of oil.<sup>18</sup> Third, although potential environmental

14. For example, the growing use of ethanol, supported by more land for corn production, has boosted the market value of agricultural land throughout the United States. Monica Davey, *Ethanol is Feeding Hot Market for Farmland*, N.Y. TIMES, Aug. 8, 2007, <http://www.nytimes.com/2007/08/08/us/08farmers.html> (noting that prices of farmland have grown particularly around the nearly 200 then-existing or proposed ethanol plants, where the cost of transporting corn to ethanol refineries is the lowest).

15. OECD, *supra* note 13, at 9.

16. The terms E10, E15, and E85 refer to the percentage of ethanol blended with gasoline. For example, E10 is a blend of 10% ethanol and 90% gasoline. See *E15 (A Blend of Gasoline and Ethanol)*, U.S. ENVTL. PROT. AGENCY, OFFICE OF TRANSP. & AIR QUALITY, <http://www.epa.gov/otaq/regs/fuels/additive/e15/> (last updated Sept. 16, 2011). Despite its lower energy content, vehicles calibrated to run on pure (100%) ethanol can achieve close to the same mileage as the gasoline-powered version of the same vehicle since the engine can be optimized to run on ethanol alone; OECD, *supra* note 13, at 18. For a table comparing the energy content of fuel ethanol and gasoline, see U.S. ENERGY INFO. ADMIN., BIOFUELS IN THE U.S. TRANSPORTATION SECTOR tbl.12 (2007), available at <http://www.eia.doe.gov/oiaf/analysispaper/pdf/tbl12.pdf>.

17. NAT'L ACAD. OF SCIS. & NAT'L ACAD. OF ENG'G, AMERICA'S ENERGY FUTURE: TECHNOLOGY AND TRANSFORMATION: REPORT IN BRIEF 6 fig.5 (2009), available at <http://sites.nationalacademies.org/Energy/index.htm>.

18. Patrick Barta, *Biofuel Costs Hurt Effort to Curb Oil Price*, WALL ST. J., Nov. 5, 2007, available at ProQuest, Doc. No. 399049959 (stating that rising prices for grain and palm oil are boosting the cost of ethanol and biodiesel production, thereby protecting high-priced oil from market competition); see also OECD, *supra* note 13, at 22–23 (discussing connection between feedstock costs and biofuel costs and illustrating the relative prices of ethanol inputs and gasoline).

benefits have helped stimulate interest in biofuels, the comparative lifecycle environmental impacts of biofuels are not fully understood. The true environmental impacts almost certainly vary by the type of biofuel and may even be unfavorable under some plausible assumptions, especially if the impact of ethanol on water supplies and water quality is considered.<sup>19</sup>

Since significant amounts of energy are expended in growing corn, making ethanol from corn, and delivering the ethanol to blenders for use as a fuel additive, the lifecycle impacts of ethanol on petroleum consumption and greenhouse gas emissions need to be considered. One study found that ethanol from corn reduces use of petroleum by ninety-five percent, relative to conventional gasoline but reduces greenhouse gas emissions by only thirteen percent.<sup>20</sup> When ethanol is produced at plants fueled by natural gas instead of coal-fired electricity, the lifecycle GHG emissions of ethanol are significantly lower than gasoline.<sup>21</sup>

Cellulosic ethanol has the potential to reduce GHG emissions to a significantly greater degree.<sup>22</sup> Importation of Brazilian ethanol made from sugar cane is also believed to reduce lifecycle GHG emissions by eighty percent compared to gasoline.<sup>23</sup>

But these encouraging estimates of GHG reductions ignore potentially important factors: the indirect effects of ethanol on land use patterns, the impact of land use changes on GHGs, and other environmental impacts. Some environmental scientists are turning against a greater reliance on first-generation biofuels because modeling suggests that putting more land into production will create many adverse environmental impacts, including a large, one-time

---

19. See R. Dominguez-Faus et al., *The Water Footprint of Biofuels: A Drink or Drive Issue?*, 43 ENVTL. SCI. & TECH. 3005, 3005 (2009) (noting that increased agricultural production for biofuels will adversely impact the quality and quantity of water resources).

20. Alexander E. Farrell et al., *Ethanol Can Contribute to Energy and Environmental Goals*, 311 SCIENCE 306, 306 (2006).

21. Jeff Johnson, *EPA Gives Boost to Corn-Based Ethanol*, CHEMICAL & ENGINEERING NEWS, Feb. 8, 2010, at 40.

22. See Roel Hammerschlag, *Ethanol's Energy Return on Investment: A Survey of the Literature 1990–Present*, 40 ENVTL. SCI. & TECH. 1744 (2007); ALEXANDER E. FARRELL & DANIEL SPERLING, INST. OF TRANSP. STUDIES, UCD-ITS-RR-07-07, A LOW-CARBON FUEL STANDARD FOR CALIFORNIA, PART 1: TECHNICAL ANALYSIS (2007), available at [http://pubs.its.ucdavis.edu/publication\\_detail.php?id=1082](http://pubs.its.ucdavis.edu/publication_detail.php?id=1082).

23. OECD, *supra* note 13, at 10.

release of GHGs from the alteration of the landscape to expand cropland.<sup>24</sup>

Finally, since the first-generation biofuels are produced primarily with food-related crops, competition for scarce land to make crops for animal and human consumption is intensifying. Rising prices of corn and soybeans, and the concomitant rise in food prices, are believed to be aggravated by the rapidly growing size of the ethanol industry.<sup>25</sup> Since rising food prices have a devastating effect on low-income populations, especially in the developing world, there is growing interest in methods of ethanol production that do not use agricultural land or crops as an input.<sup>26</sup>

Despite the drawbacks of first-generation ethanol, the United States has rapidly expanded ethanol production.<sup>27</sup> Commercial interest in biofuels production has been driven primarily by public policy,<sup>28</sup> largely via the use of tax breaks, government grants, government-backed low-interest loans for construction of ethanol plants, and regulatory requirements for blending of biofuels with gasoline. Governmental support for the U.S. biofuels industry is projected to reach sixteen billion dollars annually by 2014.<sup>29</sup> Under

---

24. Timothy Searchinger et al., *Use of U.S. Croplands for Biofuels Increases GHGs through Emissions from Land-Use Change*, 319 SCIENCE 1238, 1238 (2008); Kent S. Hoekman, *Biofuels in the U.S.—Challenges and Opportunities*, 34 RENEWABLE ENERGY 12, 19–20 (2009). For an alternative view, suggesting that indirect land-use effects on GHGs are less than recent models predict, see Roman Keeney & Thomas W. Hertel, *Indirect Land Use Impacts of U.S. Biofuel Policies: The Importance of Acreage Yield and Bilateral Trade Response* (Global Trade Analysis Project, Working Paper No. 52, 2008), available at [http://www.gtap.agecon.purdue.edu/resources/res\\_display.asp?RecordID=2810](http://www.gtap.agecon.purdue.edu/resources/res_display.asp?RecordID=2810).

25. For a review of estimates of the impact of ethanol blending requirements on food prices, see U.S. GOV'T ACCOUNTABILITY OFFICE [GAO], GAO-09-446, BIOFUELS: POTENTIAL EFFECTS AND CHALLENGES OF REQUIRED INCREASES IN PRODUCTION AND USE 43–45 (2009). See also C. Ford Runge & Benjamin Senauer, *How Biofuels Could Starve the Poor*, FOREIGN AFF., May/June 2007, at 41.

26. See, e.g., RENEWABLE FUELS AGENCY, THE GALLAGHER REVIEW OF THE INDIRECT EFFECTS OF BIOFUELS PRODUCTION 41 (2008), available at [http://www.unido.org/fileadmin/user\\_media/UNIDO\\_Header\\_Site/Subsites/Green\\_Industry\\_Asia\\_Conference\\_Maanila/GC13/Gallagher\\_Report.pdf](http://www.unido.org/fileadmin/user_media/UNIDO_Header_Site/Subsites/Green_Industry_Asia_Conference_Maanila/GC13/Gallagher_Report.pdf).

27. See *International Energy Statistics: Fuel Ethanol Production (Thousand Barrels Per Day)*, U.S. ENERGY INFO. ADMIN., available at <http://www.eia.doe.gov/cfapps/ipdbproject/iedindex3.cfm?tid=79&pid=80&aid=1&cid=regions&syid=2005&eyid=2009&unit=TBDP> (last visited June 24, 2011) (showing that U.S. fuel ethanol production nearly tripled from 2005 to 2009).

28. See Giovanni Sorda et al., *An Overview of Biofuel Policies Across the World*, 38 ENERGY POL'Y 6977, 6977 (2010).

29. DOUG KOPLOW, BIOFUELS—AT WHAT COST? GOVERNMENT SUPPORT FOR ETHANOL AND BIODIESEL IN THE UNITED STATES: 2007 UPDATE 1 (2007), available at [http://www.globalsubsidies.org/files/assets/Brochure\\_-\\_US\\_Update.pdf](http://www.globalsubsidies.org/files/assets/Brochure_-_US_Update.pdf). Another group of



current EPA rules, most refiners, blenders, and importers are required to displace about ten percent of their gasoline with biofuels.<sup>30</sup>

Pro-ethanol policies in the United States evolved from an intriguing bipartisan compromise. Facing persistent opposition to its 2001 national energy proposal, the George W. Bush administration, agreed to a major compromise that led to passage of the 2005 national energy bill.<sup>31</sup> In order to secure enough support from Senate Democrats to pass a bill that promoted nuclear power, clean coal, and expanded oil and gas exploration, President Bush agreed to a mandatory increase in the use of renewable fuels as a petroleum substitute.<sup>32</sup> The resulting boost to corn-based ethanol production was sufficient to attract the critical support of Democratic Senators from the Midwest.<sup>33</sup> Later in his term, President Bush secured additional energy legislation from a Democratic Congress, again using pro-ethanol provisions to help defuse opposition to other aspects of his energy policies.<sup>34</sup>

Since assuming office in 2009, President Barack Obama has reaffirmed the pro-ethanol policies agreed to by the Bush administration and Senate Democrats from the Midwestern states. Although early U.S. policies focused on expanding production of corn-based ethanol, policymakers have recently sought to accelerate the production of cellulosic ethanol.<sup>35</sup>

Federal biofuels policy and programming is handled jointly by an alphabet soup of departments and agencies: EPA, USDA, DOE, DOT, Customs and Border Protection, and the IRS.<sup>36</sup> The IRS

---

analysts projects that total tax and other subsidies for biofuels could rise as high as \$30 billion with current legislation. John Ohlrogge et al., *Driving on Biomass*, 324 *SCIENCE* 1019 (2009).

30. GAO, *supra* note 25, at 26–27 (in order to achieve the federal renewable fuel standard for an applicable year, EPA sets a blending standard for refiners, importers and blenders; it was set at 10.21% in 2009 to achieve the national mandate of 11.1 billion gallons of renewable fuel).

31. The Energy Policy Act of 2005, Pub. L. 109-58, 119 Stat. 594.

32. JOHN D. GRAHAM, *BUSH ON THE HOME FRONT: DOMESTIC POLICY TRIUMPHS AND SETBACKS* 118–24 (2010).

33. The Senate roll call vote for this bill is available at *U.S. Senate Roll Call Votes 109th Congress – 1st Session: H.R. 6, Energy Policy Act of 2005*, U.S. SENATE, [http://www.senate.gov/legislative/LIS/roll\\_call\\_lists/roll\\_call\\_vote\\_cfm.cfm?congress=109&session=1&vote=00212](http://www.senate.gov/legislative/LIS/roll_call_lists/roll_call_vote_cfm.cfm?congress=109&session=1&vote=00212) (last visited June 28, 2011).

34. For a more detailed account of how Bush's energy policies were spurred by the compromise on ethanol, see GRAHAM, *supra* note 32, at 115–62.

35. Sorda et al., *supra* note 28, at 6987.

36. See BRENT YACOBUCCI, CONG. RESEARCH SERV., R40110, *BIOFUELS INCENTIVES: A SUMMARY OF FEDERAL PROGRAMS* 2 (2011), available at <http://www.fas.org/sgp/crs/misc/R40110.pdf>.

oversees the implementation of eight tax credits available to the biofuels industry.<sup>37</sup> Customs and Border Protection enforces an import duty on fuel ethanol.<sup>38</sup> The USDA administers several grant, loan, and subsidy programs including a grant program for biomass research and development. The DOT handles a manufacturing tax credit for flexible fuel vehicles.<sup>39</sup> The DOE manages loan guarantees for biofuel production facilities and funding for biomass research and development; the DOE also provides per-gallon incentives for cellulosic ethanol through a reserve auction.<sup>40</sup>

In addition to federal biofuels policy, more than four-fifths of the states have adopted some form of an incentive to encourage the production or use of biofuels.<sup>41</sup> Some states focus on incentives for retailers to offer biofuels, some provide incentives to ethanol producers, and some go so far as to mandate the use of ethanol-blended fuels.<sup>42</sup>

---

37. The Volumetric Ethanol Excise Tax Credit (VEETC) was first established in the American Jobs Creation Act of 2004. This tax credit offers forty-five cents per gallon for E10. The Small Ethanol Producer Tax Credit was originally established by the Omnibus Budget Reconciliation Act of 1990 and provides small ethanol producers with a credit of ten cents per gallon on the first fifteen million gallons produced in a year. The Biodiesel Tax Credit provides a credit of one dollar per gallon to biodiesel producers. It was established by the American Jobs Creation Act of 2004. The Energy Policy Act of 2005 (EPAct 2005) created the Small Agri-Biodiesel Producer Credit which is a ten-cents-per-gallon credit for biodiesel produced from virgin agricultural products for small producers on the first fifteen million gallons produced in a year. EPAct 2005 also established the Renewable Diesel Tax Credit which provides one dollar per gallon to producers of biomass-based diesel fuel or diesel-renewable biodiesel blends, and the Alternative Fuel Station Credit which allows for a fifty percent credit for the installation of alternative fuel infrastructure. The Credit for Production of Cellulosic Biofuel gives cellulosic biofuel producers a \$1.01 per gallon credit, which for cellulosic ethanol is reduced by the amount of credit received by the VEETC and Small Ethanol Producer Tax Credit. This credit was established by the Food, Conservation, and Energy Act of 2008. The Tax Relief and Health Care Act of 2006 provided a depreciation deduction of fifty percent of the adjusted basis of a new cellulosic biofuel plant. *Id.* at CRS-2 to CRS-5.

38. Established in “1980 by the Omnibus Reconciliation Act of 1980 (P.L. 96-499); amended by the Tax Reform Act of 1986, §423 (P.L. 99-514) extended by the Tax Relief and Health Care Act of 2006, §302 (P.L. 109-432); further extended by the Food, Conservation, and Energy Act of 2008, §15333 (P.L. 110-246) and the Tax Relief, Unemployment Insurance Reauthorization, and Job Creation Act of 2010 (P.L. 111-312), §708.” *Id.* at CRS-11.

39. *Id.* at CRS-11.

40. *Id.* at CRS-9 to CRS-10.

41. *Biofuels: Incentives and Mandates*, PEW CTR. ON GLOBAL CLIMATE CHANGE, [http://www.pewclimate.org/what\\_s\\_being\\_done/in\\_the\\_states/map\\_ethanol.cfm](http://www.pewclimate.org/what_s_being_done/in_the_states/map_ethanol.cfm) (last updated Aug 10, 2011). A variety of other state and local policies support biofuels, generally ethanol in particular, as well, including grants, tax breaks, lending programs, mandates, and R&D funding. KOPLOW, *supra* note 28.

42. GAO, *supra* note 25, at 29.

EPA's role in biofuels policy is regulatory in nature, and the EPA's rules affect the fuels industry in four distinct ways. First, EPA is able to waive Clean Air Act prohibitions against fuel blends with an ethanol content greater than ten percent.<sup>43</sup> Imposing a blend limit is necessary because some vehicles are not designed to operate with blends of fuel dominated by ethanol. Second, EPA administers the Renewable Fuels Standard (RFS) program, which currently compels a rapid increase in the use of biofuels in the United States from at least 15.2 billion gallons in 2012 to at least thirty-six billion gallons in 2022.<sup>44</sup> Third, EPA rules constrain the amount of conventional biofuels (e.g., corn-based ethanol) that can be used to comply with the RFS (a maximum of fifteen billion gallons in 2022) and how much cellulosic biofuels must be used (a minimum of sixteen billion gallons in 2022). Finally, EPA limits the amount of greenhouse gases that are associated with the entire lifecycle of biofuels production and use. The greenhouse gas reductions required for cellulosic biofuels are more stringent than those for conventional ethanol.<sup>45</sup> Corn-based ethanol plants started before 2007 are not subject to the lifecycle GHG restrictions.<sup>46</sup> Since many of the details of biofuels regulation were specified by Congress in statute, the case for legislative determinism in biofuels policy is strong. The EPA, however, retains important technical discretion in several aspects of federal biofuels policy.

In regulations limiting the amount of ethanol that may be blended with gasoline, EPA historically permitted ten percent ethanol or less for sale at refueling stations. EPA's limit was designed to protect against corrosive damage to engines that were not designed for more significant ethanol blends. Following a petition in March 2009 by Grown Energy and fifty-four ethanol manufacturers, however, the EPA recently raised the ethanol blend limit from ten percent (E10) to fifteen percent (E15) for use in model year 2007 and newer light-duty motor vehicles.<sup>47</sup> The EPA did not grant the waiver

---

43. 42 U.S.C. § 7545(f)(4) (2006).

44. Energy Independence and Security Act of 2007 [EISA], Pub. L. 110-140, § 202, 121 Stat. 1493, 1522 (2007).

45. *See infra* Appendix A.

46. *See* Regulation of Fuels and Fuel Additives: Modifications to Renewable Fuel Standard Program, 75 Fed. Reg. 79,964, 79,973 (Dec. 21, 2010).

47. U.S. ENVTL. PROT. AGENCY, OFFICE OF TRANSP. & AIR QUALITY, EPA-420-F-10-540, EPA ANNOUNCES E15 PARTIAL WAIVER DECISION AND FUEL PUMP LABELING PROPOSAL 4 (2010), *available at* <http://www.epa.gov/oms/regs/fuels/additive/e15/420f10054.pdf>;

request that would allow light-duty and other vehicles from the year 2000 or older to use E15. The EPA also deferred the decision for all light-duty vehicles made between 2001 and 2006, until earlier this year, when it raised the limit to E15 for these vehicles as well.<sup>48</sup>

EPA also exercises considerable technical discretion in determining the lifecycle GHG emissions from various biofuels. The Energy Independence and Security Act of 2007 (EISA) specified in its revised renewable fuel standard (referred to as “RFS2”) that all biofuels must have lower lifecycle GHG emissions than a 2005 baseline of average gasoline and diesel fuel.<sup>49</sup> In order to determine whether fuels pass this 2005 threshold, Congress required EPA to set lifecycle GHG performance threshold standards for each fuel category. To comply with an RFS2 benchmark requirement, a company must use feedstock that meets the definition of “renewable biomass,” as outlined in the original EISA legislation and refined based on the EPA’s GHG lifecycle calculations for each feedstock.<sup>50</sup> The EISA legislation set the different fuel categories and the desired GHG lifecycle threshold for each; the EPA then identified which resources fit under each category and the methodology for GHG thresholds that are calculated for each fuel.<sup>51</sup> Refer to Appendix A for details on the RFS2 biofuels mandates and to Appendix B for a visual depiction of RFS2 induced biofuels growth over time.

---

see also Matthew L. Wald, *EPA Approves Use of More Ethanol in Gasoline*, N.Y. TIMES, Jan. 21, 2011, <http://www.nytimes.com/2011/01/22/business/energy-environment/22ethanol.html>.

48. Partial Grant of Clean Air Act Waiver Application Submitted by Growth Energy to Increase the Allowable Ethanol Content of Gasoline to 15 Percent: Decision of the Administrator, 76 Fed. Reg. 4662, 4662 (Jan. 26, 2011).

49. Energy Independence and Security Act of 2007 § 202(a)(1).

50. U.S. ENVTL. PROT. AGENCY, OFFICE OF TRANSP. & AIR QUALITY, EPA-420-F-10-007, EPA FINALIZES REGULATIONS FOR THE NATIONAL RENEWABLE FUEL STANDARD PROGRAM FOR 2010 AND BEYOND 6 (2010), available at <http://www.epa.gov/otaq/renewablefuels/420f10007.pdf>.

51. The EPA held a workshop and solicited peer reviewers’ comments and suggestions in the process to devise a method for calculating GHG threshold estimates. The EPA describes their approach to devising lifecycle GHG analysis as “a collaborative, transparent, and science-based approach.” OFFICE OF TRANSP. & AIR QUALITY, U.S. ENVTL. PROT. AGENCY, EPA-420-F-10-006, EPA LIFECYCLE ANALYSIS OF GREENHOUSE GAS EMISSIONS FROM RENEWABLE FUELS 3 (2010), available at <http://www.epa.gov/otaq/renewablefuels/420f10006.pdf>. For additional information, see generally *Workshop on Lifecycle Greenhouse Gas Analysis for the Proposed Revisions to the National Renewable Fuels Standard Program*, U.S. ENVTL. PROT. AGENCY, <http://client-ross.com/lifecycle-workshop/index.asp> (last visited June 28, 2011). See also U.S. ENVTL. PROT. AGENCY, OFFICE OF TRANSP. & AIR QUALITY, EPA-420-F-09-032, PEER REVIEW OF RENEWABLE FUELS LIFECYCLE ANALYSIS UNDER EISA: QUESTIONS AND ANSWERS (2009), available at <http://epa.gov/otaq/renewablefuels/420f09032.htm>.

Congress recognized that the pace of technological progress toward cellulosic biofuels is difficult to predict. As a result, EISA required that EPA estimate the volume of cellulosic ethanol that will be commercially available each year and adjust the requirement for the fuel, if necessary.<sup>52</sup> In 2010, the first benchmark year for cellulosic ethanol,<sup>53</sup> the EPA dramatically adjusted the total amount of required cellulosic ethanol from 100 million gallons down to 6.5 million gallons, including the option to purchase cellulosic credits. The EPA notes, however, that this 2010 adjustment should not affect the total fuel mandate in 2022.<sup>54</sup>

Congress also granted EPA discretion to revise their calculations as well as the procedure for calculating lifecycle GHG emissions for compliance with RFS2 when necessary to do so.<sup>55</sup> The EPA recently exercised this ability when it modified its calculation of lifecycle GHG emissions for corn ethanol, with the assumption that corn ethanol does not have as large of an indirect land-use impact as originally estimated. These changes resulted in a lower GHG emissions projection for corn ethanol.<sup>56</sup>

The legislative changes to the RFS over time have generally sought to constrain the growth of conventional biofuels and enhance the market share of advanced biofuels and cellulosic biofuels. This legislative trend is consistent with the concern that growing use of biofuels in the United States is exerting upward pressure on food prices around the world.<sup>57</sup> Moreover, Congress is responding to scientific concerns that the proliferation of land use for biofuels production is causing carbon dioxide to be released from the soil into the atmosphere.

As important as EPA biofuels rules are, it is a mistake to ignore the influential role of California and other states in biofuels policy. In the same year that the EISA called for updating the RFS program to emphasize cellulosic fuels and incorporate GHG emissions standards,

---

52. Energy Independence and Security Act of 2007 § 202.

53. All other fuel types had a benchmark value in 2009: 500 million gallons of biomass-based diesel, 600 million gallons of advanced biofuel, and 11.1 billion gallons of total renewable fuel. Regulation of Fuels and Fuel Additives: Changes to Renewable Fuel Standard Program; Final Rule, 75 Fed. Reg. 14,670 (Mar. 26, 2010).

54. *Id.*

55. Energy Independence and Security Act of 2007 § 202.

56. Stacy Morford, *EPA Recalculates Land Use Changes, Gives Corn Ethanol Thumbs Up*, SOLVE CLIMATE NEWS (Feb. 3, 2010), <http://solveclimatenews.com/news/20100203/epa-recalculates-land-use-changes-gives-corn-ethanol-thumbs?page=show>.

57. Sorda et al., *supra* note 28, at 6977.

the state of California enacted its own renewable fuels program with the signing of Governor's Executive Order S-01-07.<sup>58</sup> The order, following up on a 2005 executive order setting GHG reduction goals for the state, mandates that fuel suppliers and distributors reduce the lifecycle carbon intensity of fuel by ten percent by 2020.<sup>59</sup> Most of the regulations were finalized between April 2008 and April 2009, and the program began in January 2010.<sup>60</sup> In contrast to the volume-based requirements in the RFS2 program, California's Low Carbon Fuel Standard (LCFS) is based on the average carbon intensity of the fuel mix. Preceding EISA by nearly a year, California's standard is recognized as the first policy initiative in the world to include lifecycle GHG emission concepts in the legislation.<sup>61</sup> Following California's lead, thirteen states now have an LCFS either in effect or under consideration.<sup>62</sup>

In summary, EPA is an important player in biofuels policy, particularly in regulatory promulgation and interpretation. Without the market guaranteed by EPA regulation, it is doubtful that the U.S. biofuels industry would have grown as rapidly as it did. Congress did specify much of the regulatory framework for biofuels, but, as mentioned above, EPA retains considerable authority in the making of lifecycle emissions estimates for different biofuels and the discretion to adjust volume requirements based on its assessment of the ethanol market.

#### IV. REFINEMENTS TO THE INTERNAL COMBUSTION ENGINE

Engineers at vehicle manufacturers and suppliers across the country are working to identify creative ways to reduce the amount of fuel consumed when a vehicle is used. Rather than completely replace the gasoline-powered internal combustion engine, engineers are implementing a wide range of practical refinements to the design of current engines. This incremental approach to fuel economy performance improvement is attractive for a variety of reasons: 1)

---

58. State of Cal., Office of the Governor, *Executive Order S-01-07* (Jan. 18, 2007), <http://www.arb.ca.gov/fuels/lcfs/eos0107.pdf>.

59. *Id.*; State of Cal., Office of the Governor, *Executive Order S-03-05* (June 1, 2005), <http://www.dot.ca.gov/hq/energy/ExecOrderS-3-05.htm>.

60. Sonia Yeh & Daniel Sperling, *Low Carbon Fuel Standards: Implementation Scenarios and Challenges*, 38 ENERGY POL'Y 6955, 6957 (2010).

61. *Id.*

62. *Low Carbon Fuel Standard*, PEW CTR. ON GLOBAL CLIMATE CHANGE, [http://www.pewclimate.org/what\\_s\\_being\\_done/in\\_the\\_states/low\\_carbon\\_fuel\\_standard](http://www.pewclimate.org/what_s_being_done/in_the_states/low_carbon_fuel_standard) (last updated Aug. 16, 2011).

many of the refinements are already proven on cars in Europe, where fuel prices have exceeded five dollars per gallon for many years;<sup>63</sup> 2) some refinements can be implemented quickly on existing models, instead of waiting for the model to be redesigned; 3) such refinements have low capital and retooling costs compared to replacing the internal combustion engine entirely; and 4) some or all of the modest costs of these measures can be recaptured by the consumer in the form of fuel savings over the useful life of the vehicle.<sup>64</sup> The effectiveness of these adjustments is typically measured by the change in the vehicle's mileage rating—the average number of miles the vehicle can be driven on one gallon of gasoline.

In 1975, Congress made EPA's existing voluntary fuel economy rating program mandatory with the Energy Policy and Conservation Act.<sup>65</sup> A vehicle's mileage rating serves two purposes: to guide consumers who are comparing the mileage of different vehicles and to determine whether a manufacturer's vehicles have earned credits or penalties under the Corporate Average Fuel Economy (CAFE) program. Over time, the consumer ratings have been modernized while the ratings used for CAFE compliance have been unchanged due to statutory restrictions, and thus the two sets of ratings are not equivalent. For the consumer information program, EPA recently revised their test method procedures for all vehicles to account for more accurate driving conditions than previous methods, including rapid acceleration driving, the use of air conditioning, and operation of a vehicle in cold weather.<sup>66</sup>

Currently, each new vehicle in the United States is assigned three mileage ratings by EPA: a rating for highway travel, a rating for city travel, and a combined rating, which is a weighted average of the highway and city ratings. The EPA also determines which test methods must be performed to calculate a vehicle's fuel economy, although Congress constrained which vehicle categories would be

---

63. U.S. ENERGY INFO ADMIN, WEEKLY RETAIL GAS PRICES (INCLUDING TAXES) (2011), available at <http://www.eia.gov/emeu/international/Gas1.xls>.

64. See Ben Knight, *Better Mileage Now*, SCI. AM., Feb. 2010, at 50.

65. CLIFFORD TYREE, U.S. ENVTL. PROT. AGENCY, EPA-AA-CPSB-82-02, HISTORY AND DESCRIPTION OF THE EPA MOTOR VEHICLE FUEL ECONOMY PROGRAM 3 (1982).

66. OFFICE OF TRANSP. & AIR QUALITY, U.S. ENVTL. PROT. AGENCY, EPA-420-F-06-069, EPA ISSUES NEW TEST METHODS FOR FUEL ECONOMY WINDOW STICKERS 2 (2010), available at <http://www.epa.gov/fueleconomy/420f06069.pdf>; see also Joseph B. White, *Eyes on the Road: New Bout of Sticker Shock?*; *EPA Updates Mileage Estimates and Vehicle Window Stickers*, WALL ST. J., Sept. 10, 2007, available at ProQuest, Doc. No. 399098559 (noting that EPA's new test procedures caused the mileage ratings for the Toyota Camry to decline from 24 and 33 miles per gallon to 21 and 31 miles per gallon in city and highway driving, respectively).

subjected to the ratings—for example, large pickup trucks were not included in the fuel economy labeling program for consumers.

EPA's mileage ratings are so prominent in the marketplace for new cars that they exert significant pressure on automakers to improve fuel economy. Virtually every published review of a new car model includes information on the model's EPA fuel economy ratings. For model year 2011, the car with the highest overall EPA mileage rating was the Toyota Prius, with a rating of fifty miles per gallon (mpg).<sup>67</sup>

From an engineering perspective, the most obvious way to improve a vehicle's mileage rating is to downsize the vehicle by reducing its exterior dimensions, including height, length, and width. Smaller vehicles tend to have better mileage ratings because they are lighter and have less aerodynamic drag during operation. Between 1975 and 1985, when the federal government compelled vehicle manufacturers to double average new car mileage ratings, from 14 to 27.5 miles per gallon (mpg), the exterior dimensions and weight of many new car models were reduced by twenty percent or more.<sup>68</sup> But this approach is no longer a preferred strategy because manufacturers have learned that many consumers value the safety, comfort and utility that a larger vehicle provides. In today's auto market, the creative automotive engineer is looking for fuel-saving methods that preserve vehicle size because size allows more seating positions, more leg room, more crush space, more trunk or cargo space, and the ride height that many drivers have come to prefer.

Another obvious approach to increasing a vehicle's mileage rating is to reduce the power of the engine, since less powerful engines consume less fuel. For example, some vehicle manufacturers are considering replacing a standard V-8 engine with a standard V-6, in part to improve a vehicle's mileage rating. Yet this strategy is commercially risky because many new car buyers select models based to some extent on the power of the vehicle's engine. The more horsepower and torque that an engine can deliver, the easier it is for a vehicle to accelerate quickly from a starting position, to enable quick passing on a highway, to haul cargo or tow recreational boats, and to perform occasional off-road functions. In consideration of consumer

---

67. U.S. DEP'T OF ENERGY [USDOE], DOE/EE-0333, FUEL ECONOMY GUIDE MODEL YEAR 2011, at 5 (2010), available at <http://www.fueleconomy.gov/feg/pdfs/guides/FEG2011.pdf>.

68. John D. Graham, *Saving Gasoline and Lives*, in *RISK VS. RISK: TRADEOFFS IN PROTECTING HEALTH AND THE ENVIRONMENT* 87, 88 (John D. Graham & Jonathan Baert Wiener eds., 1995).



preferences but also the pursuit of better mileage ratings, automotive engineers are seeking to preserve as much engine power as possible, as well as vehicle size. Although the new Ford F-150 pickup truck—the best-selling vehicle in the United States—now has a standard V-6 instead of a V-8 engine, the V-6 has been buttressed with turbochargers and other refinements to deliver almost as much power as the more expensive V-8 engine.<sup>69</sup>

As a result of the Supreme Court's 2007 decision under the Clean Air Act,<sup>70</sup> EPA has expanded its participation in the CAFE process from its previous technical role of providing fuel economy ratings to a regulatory role—collaborating with DOT and CARB in setting the national regulatory mileage targets that each vehicle manufacturer must meet. While EPA sets carbon emissions standards for vehicles and DOT sets mileage standards, the two are closely related from an engineering perspective. Federal mileage regulations, as well as carbon regulations, constrain the average mileage rating—and carbon emissions—across a manufacturer's fleet of vehicles. If a manufacturer decides to sell some vehicles with low mileage ratings, those vehicles must be offset by enough sales of vehicles with high mileage ratings. In the determination of whether a company has complied with EPA, DOT, and CARB regulations, separate standards must be met for passenger cars (domestic and imports), light trucks, and heavy commercial trucks.

More recently, the Obama administration has used its executive authority to build on the Bush program and require all passenger vehicles to achieve an average of 35.5 mpg by model year 2016. When compared to the average composite mileage below 20 mpg that prevailed in model year 2004,<sup>71</sup> the Bush and Obama administrations

---

69. *2011 F-150 Specifications: Engine*, FORD MOTOR CO., <http://www.ford.com/trucks/f150/specifications/engine/> (last visited June 25, 2011); Jerry Hirsch, *Truck Models Still Make up the Best-Selling Vehicles*, L.A. TIMES MONEY & COMPANY (Sept. 9, 2011, 11:25 AM), [http://latimesblogs.latimes.com/money\\_co/2011/09/trucks-sales-autodata.html](http://latimesblogs.latimes.com/money_co/2011/09/trucks-sales-autodata.html).

70. In *Massachusetts v. EPA*, 549 U.S. 497 (2007), the Supreme Court held in favor of Massachusetts, requiring the EPA to treat greenhouse gas emissions as air pollutants under the Clean Air Act. In 2009, EPA found that greenhouse gases do “endanger public health or welfare,” enabling the agency to regulate GHG emissions. For more information on the EPA's authority to regulate greenhouse gases, see U.S. ENVTL. PROT. AGENCY, EPA'S ENDANGERMENT FINDING (2009), *available at* [http://www.epa.gov/climatechange/endangerment/downloads/EndangermentFinding\\_LegalBasis.pdf](http://www.epa.gov/climatechange/endangerment/downloads/EndangermentFinding_LegalBasis.pdf).

71. U.S. ENVTL. PROT. AGENCY, EPA-420-R-10-023, LIGHT-DUTY AUTOMOTIVE TECHNOLOGY, CARBON DIOXIDE EMISSIONS, AND FUEL ECONOMY TRENDS: 1975 THROUGH 2010, at 8 tbl.1 (2010), *available at* <http://www.epa.gov/oms/cert/mpg/fetrends/420r10023.pdf>.

have clearly placed an ambitious regulatory mandate on the automotive industry. Looking forward, the Obama administration, through EPA and DOT action, has announced plans to raise the average federal mileage standards to somewhere between forty-seven and sixty-two mpg by 2025.<sup>72</sup> Some opposition is already developing to these targets within the automotive industry, and the changing partisan composition in Congress may cause new legislation to be passed that interferes with the 2017 to 2025 mileage targets planned by DOT and EPA.

Vehicle manufacturers and suppliers are now engaged in a competitive race to find the most cost-effective ways to meet the rising federal mileage targets. The model year 2009 cars and light trucks sold in the United States showed the largest single-year increase in fuel economy, seven percent, in average mileage since the Arab oil embargo of 1973 and 1974.<sup>73</sup> Between now and 2016, the following measures are expected to account for much of the anticipated mileage improvement: light-weight materials,<sup>74</sup> low-rolling resistance tires,<sup>75</sup> electric power steering,<sup>76</sup> improved aerodynamics,<sup>77</sup> transmission refinements,<sup>78</sup> idle shutdown systems,<sup>79</sup> cylinder

---

72. *EPA Mulls Fuel Efficiency Rules: 62 mpg by 2025?*, CBSNEWS (Oct. 1, 2010, 1:36 PM), <http://www.cbsnews.com/stories/2010/10/01/tech/main6918784.shtml>.

73. Matthew L. Wald, *EPA Finds Gas Mileage Improved in '09 Fleet*, N.Y. TIMES, Nov. 17, 2010, <http://www.nytimes.com/2010/11/18/business/energy-environment/18fuel.html> (average new car and light truck fuel economy rose from 21.0 miles per gallon in model year 2008 to 22.4 miles per gallon in model year 2009).

74. Chris Woodyard, *Auto Components Lighten Up to Improve Mileage*, USA TODAY, Oct. 15, 2007, [http://www.usatoday.com/money/autos/2007-10-07-lighter-weight\\_N.htm](http://www.usatoday.com/money/autos/2007-10-07-lighter-weight_N.htm) (noting that Chrysler engineers estimate that each 120 pound reduction in vehicle weight yields a 1% gain in gasoline mileage, and that auto makers are exploring more use of plastics, aluminum, and higher quality grades of steel that are lighter and stronger).

75. *Low-Rolling Resistance Tires*, U.S. DEP'T OF ENERGY, ALTERNATIVE FUELS & ADVANCED VEHICLES DATA CTR., [http://www.afdc.energy.gov/afdc/vehicles/fuel\\_economy\\_tires\\_light.html](http://www.afdc.energy.gov/afdc/vehicles/fuel_economy_tires_light.html) (last updated Jan 12, 2011).

76. Jennifer LaForce, *Electric Power Steering Improves Product Lineup*, FCN ONLINE (Mar. 31, 2008), [http://media.ford.com/article\\_display.cfm?article\\_id=27976](http://media.ford.com/article_display.cfm?article_id=27976).

77. *Improving Aerodynamics to Boost Fuel Economy*, EDMUNDS.COM, <http://www.edmunds.com/fuel-economy/improving-aerodynamics-to-boost-fuel-economy.html> (last updated May 5, 2009).

78. *Transmission Technologies*, U.S. DEP'T OF ENERGY, [http://www.fueleconomy.gov/feg/tech\\_transmission.shtml](http://www.fueleconomy.gov/feg/tech_transmission.shtml) (last updated Sept 23, 2011).

79. Also called "start-stop systems," the engine turns off when the vehicle comes to a stop and restarts when the driver presses the gas pedal. Tim Moran, *The Low-Hanging Fruit of Saving Fuel*, N.Y. TIMES, Mar. 21, 2010, <http://www.nytimes.com/2010/03/21/automobiles/21IDLE.html>.

deactivation systems,<sup>80</sup> turbochargers,<sup>81</sup> and direct fuel-injection systems.<sup>82</sup> Ford has recently announced that it will soon equip all of its gasoline-powered vehicles with “start/stop” technology that shuts off the engine at stoplights and restarts it when the driver presses on the accelerator. By itself, this technology is projected to reduce fuel use by ten percent in crowded cities and four percent overall.<sup>83</sup>

For 2017 to 2025, vehicle manufacturers are looking into more widespread use of advanced diesel technology and considering wider implementation of gas-electric and diesel-electric hybrid propulsion systems. Both diesels and hybrids are attractive because they promise substantial improvements in mileage, they do not compromise vehicle size, and they can deliver more engine power—horsepower and torque—than a gasoline engine. Although diesel fuel is usually refined from crude oil, diesel fuel has more energy content than gasoline, and the diesel engine operates at higher temperatures and achieves greater fuel efficiency than the gasoline engine. Compared to a similar-sized car or light truck with a gasoline engine, diesel propulsion will typically achieve thirty to thirty-five percent better fuel economy.<sup>84</sup> Moreover, there is less energy consumed in converting oil into diesel fuel at the refinery than in converting oil into gasoline. From a lifecycle perspective, replacing a gasoline engine with a diesel engine can be expected to reduce oil consumption. The primary drawback of the advanced diesel engine is that it carries a \$2,000 to \$5,000 cost premium, depending on whether it is used in a small car or a large pick-up truck.

---

80. Also known as “variable displacement,” cylinder deactivation turns off combustion in several cylinders during low-revving conditions. Bradford Wernle, *Fuel-Saving Cylinder Deactivation Takes Hold*, AUTOMOTIVE NEWS, Nov. 2, 2009, at 16, available at ProQuest, Doc. No. 219491960.

81. Turbochargers are high-velocity fans that use exhaust gases to drive a compressor that injects pressurized air back into the motor’s cylinders, increasing an engine’s mileage and power output at the same time. Ken Bensinger, *Race for Greener Engines Goes Turbo*, L.A. TIMES, Nov. 24, 2007, at C1, available at ProQuest, Doc. No. 422132524.

82. With direct injection, fuel is directed into each cylinder of the engine to increase power and torque without hurting performance or emissions, allowing automakers to produce smaller engines while achieving the same power output. Robert Sherefkin, *Direct Injection for Gasoline, Not Just Diesel, Sees Growth Spurt*, AUTOMOTIVE NEWS, Nov. 2, 2009, at 16D, available at ProQuest, Doc. No. 219531033.

83. Chris Woodyard, *Ford to Add Automatic Engine Shut-off to All Vehicles*, USA TODAY, Dec. 27, 2010, <http://content.usatoday.com/communities/driveon/post/2010/12/ford-to-add-automatic-engine-shutoff-to-all-vehicles/1>.

84. *Diesel Vehicles*, U.S. DEP’T OF ENERGY, [http://www.fueleconomy.gov/feg/di\\_diesels.shtml](http://www.fueleconomy.gov/feg/di_diesels.shtml) (last visited June 25, 2011).

Although diesel engines were once considered dirtier than a gasoline engine, both DOE engineers and EPA specialists in Ann Arbor, Michigan have helped automakers and their suppliers develop advanced emission control strategies for diesel engines. EPA has issued specific regulatory guidance concerning steps diesel-engine suppliers and vehicle manufacturers can take to better ensure compliance with EPA tailpipe emission standards.<sup>85</sup> Emissions of both particulates and nitrogen dioxide—a smog-forming pollutant—are now controlled to extremely low levels. As a result, the modern diesel engines that now account for fifty percent of passenger vehicle sales in Europe can, with only modest refinement, meet the same tailpipe emissions standards as gasoline engines, including the most stringent particulate and nitrogen standards issued by CARB.

Based on the recent offerings of vehicle manufacturers, there appears to be even more optimism about the promise of a “hybrid” propulsion system than the advanced diesel engine. A hybrid combines a gasoline or diesel engine with battery power. Honda and Toyota have been the pioneers of this technology, though Toyota has had the most commercial success with hybrids in the United States. Although hybrids vary in how they work, a common engineering practice is to design the system so that battery power does the work at low speeds while a combination of battery power and liquid fuel do the work at higher speeds. Estimates vary, but conventional hybrid technology can boost a vehicle’s mileage rating by anywhere from thirty to fifty percent. Over the last decade, the number of vehicles offered with a hybrid engine grew from two in 2000, the Prius and the Honda Insight, to more than fifteen in 2011. Although hybrids accounted for less than three percent of new passenger-vehicle sales in the U.S. in 2009, many forecasters believe that hybrids will account for ten to twenty percent of new vehicle sales in 2020.<sup>86</sup> In 2010

---

85. Press Release, U.S. Env’tl. Prot. Agency, EPA Spurs Clean Diesel Technology (Mar. 30, 2007), *available at* <http://yosemite.epa.gov/opa/admpress.nsf/b853d6fe004acebf852572a000656840/335a7e701ef6253c852572ae0050e746!OpenDocument>.

86. See Scott Evans, *Study: Hybrids to Command 20% of Total Car Market by 2020*, MOTOR TREND (May 28, 2009, 1:36 PM), <http://wot.motortrend.com/study-hybrids-to-command-20-of-total-car-market-by-2020-5026.html#ixzz1Icefn7l3> (discussing a JPMorgan Chase annual report forecasting hybrid vehicles being 20% of new sales); *EIA Projects Rapid Growth in Unconventional Vehicle Sales*, U.S. ENERGY INFO ADMIN. (Feb. 10, 2011), <http://www.eia.gov/todayinenergy/detail.cfm?id=70> (forecasting a 13.9% market share for mild-hybrids and hybrids in 2020); INT’L COUNCIL ON CLEAN TRANSP., ICCT HYBRID VEHICLE HANDOUT 3 *fig.2, available at* [http://www.unep.org/transport/gfei/autotool/approaches/technology/ICCT\\_hybrid\\_handout.pdf](http://www.unep.org/transport/gfei/autotool/approaches/technology/ICCT_hybrid_handout.pdf)

Toyota sold over 300,000 units of the Toyota Prius, a small car rated at forty-eight mpg due to its hybrid engine, unique aerodynamics, and use of light-weight materials.

If EPA, DOT, and CARB continue to tighten fuel economy—and carbon—regulations through 2025, a majority of new vehicles sold in the U.S. may be equipped with a diesel or hybrid engine. Diesels may dominate the light-truck market while hybrids dominate the passenger car market. However, it would be a mistake to rule out the possibility that cars without a hybrid or diesel engine will achieve a mileage rating above forty mpg. For example, the 2011 Chevrolet Cruze Eco is a midsize car that achieves the highest mileage of any non-hybrid and non-diesel car in the U.S.; EPA rates the manual transmission Cruze at twenty-eight mpg in the city and forty-two mpg on the highway.<sup>87</sup> Both Ford and Hyundai are planning to offer new car models that will achieve more than forty miles per gallon without a hybrid or diesel engine.<sup>88</sup>

In summary, EPA is involved in regulatory efforts to improve the fuel efficiency of the internal combustion engine through three primary roles: EPA sets carbon emissions standards for vehicles, it determines which tests to perform to estimate a car's fuel economy and carbon emissions, and it provides regulatory guidance for diesel-engine suppliers and vehicle manufacturers to ensure compliance with EPA tailpipe emission standards.<sup>89</sup>

## V. ELECTRIFICATION OF THE TRANSPORT SYSTEM

Given the success of conventional hybrids, such as the Toyota Prius, it has been suggested that cars and light trucks should be powered by electricity instead of petroleum-based fuels. Although the conventional hybrid does use an electric-drive system coupled with a gasoline or diesel engine, here we focus on “plug-in electric vehicles” (PEVs), which means vehicles that derive their power primarily by owners plugging them into the electric grid. The term PEV includes both those vehicles that use only battery power, called a “battery-

---

(showing a range of forecasts of U.S. hybrid sales for 2010–2025, with four forecasts projecting between 10 and 20% hybrid sales, and one projecting approximately 30% hybrid sales in 2020).

87. USDOE, *supra* note 67, at 5.

88. Chris Woodyard, *More New Cars Get 40 mpg, but 'Cheap' Gas Keeps Buyers Away*, USA TODAY, Dec. 9, 2010, [http://www.usatoday.com/money/autos/2010-12-09-40mpg09\\_ST\\_N.htm](http://www.usatoday.com/money/autos/2010-12-09-40mpg09_ST_N.htm) (noting that new versions of Hyundai Elantra and Ford Fiesta are both expected to be rated at greater than forty miles per gallon).

89. Many of these responsibilities are shared in various ways with the U.S. Department of Transportation.

electric vehicle” (BEV), and those that also have an internal combustion engine that can be used for power, called a “plug-in hybrid electric vehicle” (PHEV).

As of 2008, less than 60,000 PEVs were on the road in the United States,<sup>90</sup> but in 2010 a resurgence of electric vehicle offerings by auto manufacturers began with the introduction of the GM Volt and the Nissan Leaf. With significant policy interest in promotion of the technology, including an official federal goal of one million PEVs by 2015,<sup>91</sup> the market share of PEVs is expected to increase. Although estimates of the future market penetration of PEVs vary widely,<sup>92</sup> the prediction of the U.S. Energy Information Administration is that by 2035 just over two million PHEVs will be sold in the United States, representing about eleven percent of total sales.<sup>93</sup> J.D. Power and Associates predicts 100,000 BEV sales in the U.S. in 2020.<sup>94</sup>

The emissions profile of PEVs is fundamentally different than gasoline or diesel-powered vehicles. When operating on battery power, a PEV emits no pollution. Instead, the emissions occur when the battery is recharged through the increased electricity generation that is required. While PEVs are clearly a highly effective method of reducing oil use, their ultimate impact on GHGs is more uncertain. Some regions of the U.S. rely primarily on coal for their electricity production, while other regions rely more heavily on renewable sources (e.g., wind and hydropower), natural gas, and nuclear power. The GHG emissions during the process of electricity production vary enormously depending on how the power is produced, given the variation in carbon intensity across different energy sources.<sup>95</sup>

---

90. See U.S. ENERGY INFO. ADMIN., ESTIMATED NUMBER OF ALTERNATIVE FUELED VEHICLES IN USE IN THE UNITED STATES BY FUEL TYPE (2010), *available at* [http://www.eia.gov/cneaf/alternate/page/atftables/attf\\_v1.html](http://www.eia.gov/cneaf/alternate/page/atftables/attf_v1.html).

91. U.S. DEP'T OF ENERGY [USDOE], ONE MILLION ELECTRIC VEHICLES BY 2015: FEBRUARY 2011 STATUS REPORT (2011), *available at* [http://www1.eere.energy.gov/vehiclesandfuels/pdfs/1\\_million\\_electric\\_vehicles\\_rpt.pdf](http://www1.eere.energy.gov/vehiclesandfuels/pdfs/1_million_electric_vehicles_rpt.pdf).

92. SCH. OF PUB. & ENVTL. AFFAIRS AT IND. UNIV., PLUG-IN ELECTRIC VEHICLES: A PRACTICAL PLAN FOR PROGRESS 27 tbl.3 (2011), *available at* [http://www.indiana.edu/~spea/pubs/TEP\\_combined.pdf](http://www.indiana.edu/~spea/pubs/TEP_combined.pdf).

93. U.S. ENERGY INFO. ADMIN., ANNUAL ENERGY OUTLOOK 2010, at 65 fig.58 (2010), *available at* [http://www.eia.doe.gov/oiaf/aeo/pdf/0383\(2010\).pdf](http://www.eia.doe.gov/oiaf/aeo/pdf/0383(2010).pdf).

94. See J.D. POWER & ASSOCS., DRIVE GREEN 2020: MORE HOPE THAN REALITY 12 (2010).

95. For further information on GHG emissions from electricity generation, see generally U.S. ENERGY INFO. ADMIN., CARBON DIOXIDE EMISSIONS FROM THE GENERATION OF ELECTRIC POWER IN THE UNITED STATES (2000), *available at* [http://www.eia.gov/cneaf/electricity/page/co2\\_report/co2emiss.pdf](http://www.eia.gov/cneaf/electricity/page/co2_report/co2emiss.pdf).

If PEVs are recharged with highly-efficient, non-emitting, or renewable generation technologies, their emissions are projected to be significantly less than that of a conventional hybrid or internal combustion engine.<sup>96</sup> This relative improvement does not hold true if they are recharged with more carbon-intensive sources of electricity. Under one carbon-intensive electricity scenario, a PHEV-30 (a PHEV with a battery pack that can go thirty miles), was found to decrease CO<sub>2</sub>-equivalent emissions per kilometer compared to a gasoline-powered vehicle, but caused a perverse nine percent increase in emissions compared to a conventional hybrid electric vehicle that does not plug into the grid. PHEV-60s and PHEV-90s fared even worse compared to the hybrid, using this same method of comparing lifecycle GHG emissions.<sup>97</sup>

The promotion of plug-in electric vehicles by the federal government is not new, but it has received special attention during the Obama administration. In 2008, then-Presidential-candidate and Senator Barack Obama campaigned on a national goal of one million plug-in cars by 2015.<sup>98</sup> President Obama reaffirmed this goal in his 2011 State of the Union address.<sup>99</sup>

The federal agency at the forefront of national PEV policy is the Department of Energy. DOE performs research crucial to the development of PEV technology, administers grants to the electric vehicle industry, and oversees programs to encourage local government promotion of cleaner vehicle technologies.<sup>100</sup> The latter responsibility encompasses the Clean Cities Program, a government-industry partnership that brings stakeholders together in local coalitions to reduce the transport sector's consumption of petroleum.<sup>101</sup> Although not a program targeted at PEVs specifically,

---

96. See ELEC. POWER RESEARCH GROUP & NAT'L RES. DEF. COUNCIL, ENVIRONMENTAL ASSESSMENT OF PLUG-IN HYBRID ELECTRIC VEHICLES, VOLUME 1: NATIONWIDE GREENHOUSE GAS EMISSIONS 7-8 (2007), available at [http://projectgetready.com/wp-content/uploads/2010/09/EPRI\\_NRDC\\_Volume1.pdf](http://projectgetready.com/wp-content/uploads/2010/09/EPRI_NRDC_Volume1.pdf).

97. See Constantine Samaras & Kyle Meisterling, *Life Cycle Assessment of Greenhouse Gas Emissions from Plug-in Hybrid Vehicles: Implications for Policy*, 42 ENVTL. SCI. & TECH. 3170, 3174 (2008).

98. OBAMA FOR AMERICA, BARACK OBAMA AND JOE BIDEN: NEW ENERGY FOR AMERICA 1 (2008), available at [http://www.sustaincommworld.com/pdfs/Obama\\_Biden\\_on\\_Energy.pdf](http://www.sustaincommworld.com/pdfs/Obama_Biden_on_Energy.pdf).

99. Barack Obama, President, State of the Union Address 2011 (Jan. 25, 2011), available at <http://www.whitehouse.gov/the-press-office/2011/01/25/remarks-president-state-union-address>.

100. USDOE, *supra* note 91.

101. *Clean Cities*, U.S. DEP'T OF ENERGY, ENERGY EFFICIENCY & RENEWABLE ENERGY, <http://www1.eere.energy.gov/cleancities/> (last updated Sept 13, 2011).

DOE provides educational resources regarding PEVs to Clean Cities groups,<sup>102</sup> and Clean Cities coalitions have initiated local incentives for purchasing electric vehicles<sup>103</sup> and partnered with PEV manufacturers to promote recharging infrastructure.<sup>104</sup>

The federal stimulus package of 2009 provided DOE \$2.4 billion to establish electric vehicle and battery manufacturing plants.<sup>105</sup> Pursuant to the stimulus package, DOE also works with the IRS to determine the “eligibility and merit” of applications for the Advanced Energy Manufacturing Tax Credit.<sup>106</sup> In addition to stimulus programs, DOE provides loans to manufacturers of PEVs and PEV components through the Advanced Vehicle Technology Manufacturing Loan Program.<sup>107</sup> DOE also funds significant research and development in PEV technology through its Vehicle Technologies Program and by awarding Advanced Research Projects Agency-Energy (ARPA-E) grants.<sup>108</sup> In 2010, DOE issued guidance on federal fleet management in accordance with Executive Order 13415, which included recommendations to acquire PEVs in geographical areas where electricity generation has low carbon intensity.<sup>109</sup>

DOE’s role in PEV policy will grow if Congress grants President Obama’s 2012 budget request for DOE. The 2012 request includes increased funding for R&D investments in electric drive and battery

---

102. See generally *Clean Cities Coordinator Toolbox*, U.S. DEP’T OF ENERGY, [http://www1.eere.energy.gov/cleancities/toolbox/training\\_archives.html](http://www1.eere.energy.gov/cleancities/toolbox/training_archives.html) (last updated June 24, 2011).

103. See, e.g., *Alternative Fuel Incentives*, CITY OF AUSTIN, <http://www.ci.austin.tx.us/cleancities/electricvehiclerebate.htm> (last visited June 25, 2011).

104. Eric Loveday, *Nissan Partners with Clean Cities-Atlanta to Promote Electric Vehicles*, AUTOBLOG GREEN (Nov. 22, 2010, 8:56 AM), <http://green.autoblog.com/2010/11/22/nissan-partners-with-clean-cities-atlanta-to-promote-electric-ve/>.

105. U.S. DEP’T OF ENERGY [USDOE], THE RECOVERY ACT: TRANSFORMING AMERICA’S TRANSPORTATION SECTOR—BATTERIES AND ELECTRIC VEHICLES 3 (2010), available at <http://www.whitehouse.gov/files/documents/Battery-and-Electric-Vehicle-Report-FINAL.pdf>.

106. *President Obama Awards \$2.3 Billion for New Clean-Tech Manufacturing Jobs*, U.S. DEP’T OF ENERGY, <http://www.energy.gov/recovery/48C.htm> (last visited June 26, 2011) [hereinafter *President Obama Awards*].

107. USDOE, *supra* note 105, at 3.

108. See ARGONNE NAT’L LAB., *Plug-Ins: The Future for Hybrid Electric Vehicles?*, available at <http://www.transportation.anl.gov/pdfs/HV/376.pdf>; USDOE, *supra* note 105, at 3.

109. See U.S. DEP’T OF ENERGY, EXECUTIVE ORDER 13514: FEDERAL LEADERSHIP IN ENVIRONMENTAL, ENERGY, AND ECONOMIC PERFORMANCE—GUIDANCE FOR FEDERAL AGENCIES ON E.O. 13514 SECTION 12, FEDERAL FLEET MANAGEMENT 20 (2010), available at [http://www1.eere.energy.gov/femp/pdfs/fleetguidance\\_13514.pdf](http://www1.eere.energy.gov/femp/pdfs/fleetguidance_13514.pdf).



technology, as well as a new competitive grant program to reward communities that improve PEV recharging opportunities.<sup>110</sup>

More minor players in PEV policy at the federal level are the IRS and DOT. In addition to its role in the Advanced Energy Manufacturing Tax Credit mentioned above, the IRS oversees the implementation of the tax breaks available for purchasing electric vehicles and installing recharging infrastructure.<sup>111</sup> DOT has become involved in PEV policy through the Pedestrian Safety Enhancement Act of 2010, which calls for NHTSA to require that PEVs—which make very little noise while operating, especially at low speeds—make some noise to alert pedestrians of their presence.<sup>112</sup>

Although DOE has the dominant federal role in PEV policy making, the EPA exerts a subtle and significant influence on the PEV industry as well. When issuing clean-air regulations that affect the transportation sector, EPA must decide how to rate PEVs for fuel economy and how to calculate all emissions associated with the operation of PEVs. In recent years, EPA has begun to favor PEVs in regulatory policy. For example, consider a recent joint rulemaking between DOT/NHTSA and the EPA on corporate average fuel economy standards and GHG emissions requirements for light-duty vehicles for model years 2012 through 2016.<sup>113</sup> For the first time in the history of transportation regulations, vehicle manufacturers were required by the DOE and EPA to meet carbon emissions limitations in addition to fuel economy standards. With the emergence of PHEVs and BEVs in dealer showrooms, EPA had to determine both the fuel economy rating for these cars—since their mode of operation did not lend themselves easily to typical mpg ratings—and how to treat the indirect emissions from PEVs that occur at the power plant, when the vehicles are plugged into the electrical grid for recharging.

On the issue of GHG emissions, EPA decided to treat BEVs as well as fuel-cell vehicles as if they have zero emissions, despite the upstream emissions that they create at power plants, at least for the

---

110. OFFICE OF MGMT. & BUDGET, DEPARTMENT OF ENERGY BUDGET, FISCAL YEAR 2012, at 75 (2011), available at [http:// www.whitehouse.gov/sites/default/files/omb/budget/fy2012/assets/energy.pdf](http://www.whitehouse.gov/sites/default/files/omb/budget/fy2012/assets/energy.pdf).

111. See FS-2009-10, *Energy Provisions of the American Recovery and Reinvestment Act—FS-2009-10*, U.S. INTERNAL REVENUE SERV., <http://www.irs.gov/newsroom/article/0,,id=206871,00.html> (last updated June 3, 2009); *President Obama Awards*, *supra* note 106.

112. Pedestrian Safety Enhancement Act of 2010, Pub. L. 111-373, § 3, 124 Stat. 4086, 4086–87.

113. See Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards; Final Rule, 75 Fed. Reg. 25,324 (May 7, 2010).

first 200,000–300,000 of these vehicles produced per manufacturer. For PHEVs, the electric portion of the vehicle is treated as having zero emissions as well, with the same volume limit per manufacturer. Fuel-cell vehicles were given the same treatment. EPA explicitly states that this treatment was designed as a temporary incentive “to encourage the commercialization of advanced GHG/ fuel economy control technologies.”<sup>114</sup> Originally, EPA had planned to provide an even greater incentive: in the proposed rule, a multiplier was to be applied to these advanced vehicles so that each vehicle would be weighed more heavily than a conventional vehicle, making compliance easier for those manufacturers that offered an advanced vehicle.<sup>115</sup> In response to public comments, EPA opted not to include this multiplier in the final rule.

Even though 2010 marked the first time that DOT/NHTSA and EPA issued CAFE standards through a joint rulemaking, EPA has long played a key role in the measurement of each manufacturer’s CAFE compliance. EPA collects fuel economy data at its National Vehicle and Fuel Emissions Laboratory and provides these data to NHTSA to be used in determining compliance with CAFE standards.<sup>116</sup> Interestingly, when an electric vehicle is part of a manufacturer’s fleet, EPA is bound by statute to use calculations provided by DOE—consistent with DOE’s role as the primary arbiter of PEV policy.<sup>117</sup>

In addition, EPA has significant discretion over how this fuel economy rating information is presented to consumers. In 2007, recognizing the inherent complexity in equating the fuel costs or savings from a vehicle that runs on electricity versus one that runs on gasoline, Congress instructed the EPA to create labels with a ratings system that would “make it easy” for consumers to compare efficiency across vehicle types.<sup>118</sup> After the passage of their joint rulemaking on light duty vehicle standards, EPA and NHTSA worked together to propose alternatives to the traditional vehicle label to meet this tall order from EISA. One of these alternatives is a letter grade label, which would award high grades for highly efficient

---

114. *Id.* at 25,341.

115. *Id.*

116. *Data & Testing*, U.S. ENVTL. PROT. AGENCY, <http://www.epa.gov/fueleconomy/data.htm> (last updated Feb. 12, 2011).

117. 49 U.S.C. § 32904(a)(2) (2006).

118. Revisions and Additions to Motor Vehicle Fuel Economy Label Proposed Rule, 75 Fed. Reg. 58,078, 58,083 (Sept. 23, 2010).

vehicles and failing grades for “gas guzzlers.”<sup>119</sup> The other is similar to the existing label and uses a “miles per gallon-equivalent” figure for PEVs.<sup>120</sup> EPA computes this figure by converting kWh to mpg (based on a 33.4 kWh/gallon assumption), in contrast to the electric vehicle fuel economy rating calculated by DOE for CAFE compliance.<sup>121</sup> Both labels include an estimate of the monetary impacts—savings or losses—due to changes in fuel expenditures over the life of the vehicle, relative to the average vehicle.<sup>122</sup> Regardless of the final ruling on the label choices, the ratings system and design of consumer labels is a significant matter. EPA’s decisions about how to generate ratings and how to design labels dictates how information on fuel economy, comparative eco-friendliness, and potential fuel savings are presented to consumers on the showroom floor, where consumers often make their final purchasing decisions.

EPA also has the responsibility of establishing the official driving range estimates for PEVs (i.e., how far a vehicle can travel on battery power alone). This procedure is of enormous importance, since range anxiety is often cited as a key barrier to the commercialization of PEVs.<sup>123</sup> Nissan and GM both cite EPA test procedures as the basis of their range estimates for the Leaf and Volt, respectively.<sup>124</sup> With manufacturers using EPA procedures to estimate their vehicles’ all-electric range, implicitly relying on the credibility of EPA as validation of this estimate, EPA assumes an expanded role in PEV market compared to the conventional auto market, where range anxiety is a non-issue.

The stakes in the accuracy of EPA’s range figures are high. If the range estimates are too high, resulting in stranded drivers or disappointed buyers, consumer trust in PEVs could be irreparably

---

119. *Id.* at 58,114.

120. U.S. ENVTL. PROT. AGENCY [USEPA], EPA-420-F-10-048, EPA AND NHTSA PROPOSE CHANGES TO THE MOTOR VEHICLE FUEL ECONOMY LABEL 4 (2010), *available at* <http://www.epa.gov/fueleconomy/label/420f10048.pdf>.

121. *Id.* at 3–4.

122. *Id.* at 2.

123. *See* MASS. INST. OF TECH. ENERGY INITIATIVE, ELECTRIFICATION OF THE TRANSPORTATION SYSTEM 14 (2010), *available at* <http://web.mit.edu/mitei/docs/reports/electrification-transportation-system.pdf>; Larry Greenemeier, *The Great Electric Car Quandary: How to Build a Charging Infrastructure Before Demand Grows*, SCI. AM., Aug. 14, 2009, <http://www.scientificamerican.com/article.cfm?id=electric-car-quandary>; SCH. OF PUB. & ENVTL. AFFAIRS AT IND. UNIV., *supra* note 92, at 30.

124. *See Leaf Range: How Far Can My Car Go?*, NISSAN USA, <http://www.nissanusa.com/leaf-electric-car/tags/show/range#/leaf-electric-car/range-disclaimer/index> (last visited June 26, 2011); *2011 Volt*, CHEVROLET, <http://www.chevrolet.com/volt> (last visited June 26, 2011).

damaged.<sup>125</sup> The heightened need for accuracy of estimates and ratings in advanced technologies was demonstrated in the early years of hybrid vehicles. Toyota Prius drivers were angered when they found that their vehicles were not achieving the fuel economy promised by EPA ratings.<sup>126</sup> EPA responded to complaints by modifying their algorithms, which had the effect of reducing the fuel economy estimates for future model years. As a Toyota spokesman at the time noted, EPA estimates had traditionally overstated fuel economy, but their margin of error was far more noticeable on a vehicle with 55 mpg versus one with 20 mpg<sup>127</sup>—and, presumably, for a vehicle whose main selling point was its high fuel economy.

In summary, although EPA does not have the direct involvement with PEV policy that is seen at DOE, the agency's strong involvement in transportation regulation at large gives EPA a significant role in federal PEV policy. By directly interacting with the consumer through vehicle ratings and labeling, and by incentivizing this technology by exempting the first generation of these vehicles from upstream emissions restrictions, EPA appears to be using the powers it has to promote a future for the PEV industry.

## VI. CONCLUSION

We have argued that EPA programs are influencing the rapid innovation in the auto sector that is now underway. EPA's influence is likely to grow as regulatory mandates and deadlines become binding and as consumers become even more interested in how different vehicles compare in their mileage ratings and GHG emissions. We have seen that EPA's policy footprint is evident in each of the three technological strategies we examined: biofuels, refinements to the internal combustion engine, and electrification. The growing EPA role was often not self-initiated but spurred by unexpected legislation, areas of discretion granted by Congress and novel judicial interpretations of existing statutes.

We conclude by considering three counterarguments that might cause one to minimize the role that EPA has played or will play in the auto sector. While we believe that each counterargument has some merit, and should serve as a qualification to our general argument, we

---

125. SCH. OF PUB. & ENVTL. AFFAIRS AT IND. UNIV., *supra* note 92, at 5.

126. James R. Healey, *Drivers Upset as Hybrids Fall Short on Fuel Economy*, USA TODAY, June 11, 2004, [http://www.usatoday.com/money/autos/2004-06-11-hybrids-fuel-economy\\_x.htm](http://www.usatoday.com/money/autos/2004-06-11-hybrids-fuel-economy_x.htm).

127. *Id.*

believe that in each case it is difficult to sustain a conclusion that EPA policies are not a factor in the innovations that are now occurring.

First, market forces—starting with the increasing and volatile price of oil but including the private investments in each of the three technologies—are certainly playing a significant role in the industrial innovation that we have reviewed. In the case of biofuels, EPA is constrained by market forces in administering the RFS, as evidenced by its dramatic reduction of the cellulosic ethanol requirements for 2010 due to insufficient availability in the market. However, it is hard to imagine that market penetration would have been nearly as fast or as significant without the benefit of the regulatory mandates that EPA is administering. In fact, one recent analysis found that, despite some reductions in the cost of producing corn-based ethanol, it remains economically uncompetitive with gasoline unless the world price of oil remains higher than \$100 per barrel.<sup>128</sup>

Some refinements to the internal combustion engine and alternative vehicle technologies are being offered by manufacturers in response to the consumer demand for fuel economy that has been stimulated by periodic spikes in fuel prices. Hybrid sales, for example, are quite sensitive to gasoline prices.<sup>129</sup> But it is crucial to remember that the central yardstick used by consumers to compare the fuel economy of vehicles is an official mileage rating system that has been designed and modernized by EPA. Looking to the future, the federal government—DOT and EPA, specifically—likely will be setting mileage and carbon standards for new vehicles that compel more fuel-saving technology than would be stimulated by market forces alone. Electric cars in particular do not yet have a strong market-value proposition and are dependent on the continuation—at least for a period—of favorable government policies.<sup>130</sup> Several of EPA's recent decisions, such as the compliance incentives for plug-in vehicles and the impressive mileage ratings for the Leaf and the Volt, appear to be assisting efforts to begin mass commercialization.

Second, in the executive branch of the federal government, EPA is only one of several White House offices and Cabinet agencies. It is difficult to discern, for example, which EPA decisions on the auto sector originated with EPA's career or political staff, which were dictated by White House offices (or even the President), and which

---

128. NAT'L ACAD. OF SCIS. & NAT'L ACAD. OF ENG'G, *supra* note 17, at 6 fig.5.

129. See Josee Valcourt, *Pricier Gasoline Makes Hybrids a Better Deal*, WALL ST. J., June 12, 2008, at D1, available at ProQuest, Doc. No. 399004314.

130. SCH. OF PUB. & ENVTL. AFFAIRS AT IND. UNIV., *supra* note 92, at 5–8.

represent a collaborative effort of EPA with the White House. More importantly, DOT has played a central role on Corporate Average Fuel Economy standards, and USDA and DOE have significant roles—especially in R&D policy—for biofuels and electrification, respectively.<sup>131</sup> But we have found that much of the technical information in support of regulatory decisions and compliance, as well as some of the key information for consumers, is coming from EPA.

Third, a case can be made that EPA has simply followed the more aggressive regulatory actions of CARB, and that it is policymakers in Sacramento, California, not those in Washington, D.C., who are driving the rapid innovation in the industry. We have noted that the State of California, in collaboration with a dozen or so (largely Northeastern) states, has clearly been at the forefront of these issues. Looking back at control of conventional tailpipe pollution, one study found that CARB was more effective than EPA in reducing pollution from passenger cars, while EPA was a more effective force than CARB in reducing pollution from commercial trucks.<sup>132</sup> In the case of electrification, some reluctant vehicle manufacturers (e.g., Honda and Volkswagen) have publicly acknowledged that they plan to offer plug-in vehicles only for the purpose of complying with CARB's Zero-Emission Vehicle Program, an initiative that has no twin sister at the national level.<sup>133</sup> Even in the case of federal mileage standards for cars, pressure from California regulators played a role in helping persuade the George W. Bush administration to rejuvenate and reform the DOT's Corporate Average Fuel Economy Program.<sup>134</sup> Indeed, the ultimate stringency of both the Bush and Obama auto mileage plans are in the same ballpark as proposed by the State of California about a decade ago. Looking forward, however, it seems apparent that EPA will, at minimum, be a collaborative player with DOT and CARB as the Obama administration sets the key mileage and carbon mandates for

---

131. On the roles of DOT, DOE and USDA in the George W. Bush years, see GRAHAM, *supra* note 32, at 149–60 (biofuels), and *id.* at 163–93 (CAFE standards).

132. See COMM. ON STATE PRACTICES IN SETTING MOBILE SOURCE EMISSION STANDARDS, NAT'L RESEARCH COUNCIL, STATE AND FEDERAL STANDARDS FOR MOBILE-SOURCE EMISSIONS 3–4 (2006), *available at* <http://www.nap.edu/catalog/11586.html>.

133. See Hans Greimel, *Rules Alter Honda's EV Attitude*, AUTOMOTIVE NEWS, Aug. 31, 2009, at 6, *available at* ProQuest, Doc. No. 219442939; Diana T Kurylko, *Europeans Pile on the Green Bandwagon*, AUTOMOTIVE NEWS, Oct. 5, 2009, at 14, *available at* ProQuest, Doc. No. 219494736.

134. See GRAHAM, *supra* note 32, at 167–81.

model years 2016 to 2025. In the case of biofuels, EPA—despite the reality of California’s renewable fuels standard—determines the maximum amount of ethanol that may be blended with gasoline and sold to vehicles of different vintages, and EPA determines the mandatory minimum rate at which the national biofuels industry is growing.

Finally, we acknowledge that the lawmaking and political powers of the United States Congress have guided, constrained, and influenced the decisions of the EPA on these issues. Indeed, we do not address a theoretical strain of the political science literature that contends that all decisions of regulatory agencies can be traced, directly or indirectly, to the wishes of legislators.<sup>135</sup> We documented that Congress specified important aspects of the biofuels mandate but also left some significant areas of discretion for EPA. Congress constrained how EPA’s fuel-economy ratings are used in determining manufacturer compliance with federal CAFE standards but Congress left significant technical discretion for EPA to modernize mileage ratings that are supplied to consumers. And, as mentioned above, EPA has made significant decisions to assist the emerging plug-in vehicle industry without any directive from Congress. In summary, although the EPA’s authority is determined by Congress and clarified by the judiciary, the tendency of legislatures and courts to defer to the technical expertise of the agency has created significant areas of EPA discretion. To conclude with just one example, EPA analysts are playing a significant role in determining how lifecycle GHG emissions are calculated in several regulatory programs.

If our central thesis is correct, that EPA is positioned as a key player in an industrial sector that is entering a period of rapid innovation, then EPA’s offices that work on the auto sector will be busy in the years ahead. We thus encourage students of engineering, science, law, economics, and public policy to consider how they can make a contribution to EPA’s activities.

---

135. See, e.g., Barry R Weingast & Mark J Moran, *Bureaucratic Discretion or Congressional Control? Regulatory Policymaking by the Federal Trade Commission*, 91 J. POL. ECON. 765 (1983).

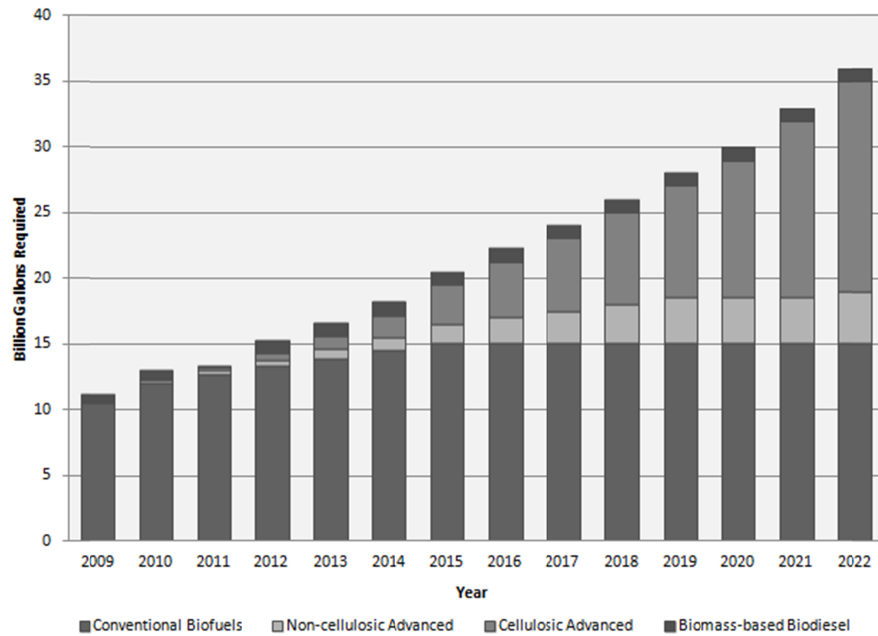
## APPENDIX A

## Treatment of Renewable Fuel Categories Under RFS2

Category	Definition	Volume Requirement	Lifecycle GHG Reduction Requirement
Biomass-based diesel	Renewable diesel, soy, wastes, algae	1 billion gallons by 2022	50%
Cellulosic biofuel	Ethanol, diesel, or gasoline produced from cellulose, hemicellulose, or lignin	16 billion gallons by 2022	60%
Advanced biofuel	Any non-fossil fuel made from non-edible plant material, including fuels in the biomass-based diesel and cellulosic biofuel categories.	21 billion gallons by 2022	50%
Renewable Biofuel	Any of the above fuels, but can include corn-based ethanol	36 billion gallons by 2022	20%



## APPENDIX B

Renewable Fuel Volume Requirement Under RFS2<sup>136</sup>

---

136. Adapted from Sorda et al., *supra* note 28