Improving Energy Security With the Great Green Fleet: The Case for Transitioning From Ethanol to Drop-In Renewable Fuels

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"The United States requires freedom of action in the global commons and strategic access to important regions of the world to meet our national security needs. The well-being of the global economy is contingent on ready access to energy resources. Notwithstanding national efforts to reduce dependence on oil, current trends indicate an increasing reliance on petroleum products from areas of instability in the coming years, not reduced reliance. The United States will continue to foster access to and flow of energy resources vital to the world economy."

— Secretary of Defense Robert M. Gates, June 2008[1]

"In my opinion, any future defense secretary who advises the president to again send a big American land army into Asia or into the Middle East or Africa should 'have his head examined,' as General MacArthur so delicately put it."

— Secretary of Defense Robert M. Gates, February 25, 2011[2]

In an era of constrained oil supplies and ever-increasing demand, renewable fuels present a promising pathway for the United States to improve long-term energy security. Renewable fuels will allow the United States to diversify its energy portfolio, decrease reliance on foreign oil, and alleviate the pressure to utilize military action to ensure the free flow of oil throughout the world market.[3] To appreciate the magnitude of our nation's long-term energy challenge, and how renewable fuels may serve as a potential solution,[4] it is important to first recognize the underlying problem. In 2011, the United States consumed 18.8 million barrels of petroleum products per day, with net imports accounting for approximately 45% of the total amount.[5] In comparison, the world economy consumed just over 88 million barrels per day of petroleum products.[6] The United States, therefore, accounted for approximately 20.5% of total global consumption.[7] Looking towards the future, by 2035, the U.S. Energy

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1. U.S. Dep't of Defense, National Defense Strategy 16 (2008), *available at* http://www.defense.gov/news/2008%20national%20defense%20strategy.pdf.
2. Robert M. Gates, U.S. Sec'y of Defense, Address at the West Point United States Military Academy (Feb. 25, 2011), *available at* http://www.defense.gov/speeches/speech.aspx?speechid=1539.
3. *See* U.S. Dep't of Defense, *supra* note 1.
4. *See generally*, U.S. Energy Info. Admin., DOE/EIA-0384(2011), Annual Energy Review 2010, at 134 (2011) [hereinafter, U.S. Energy Info Admin., Annual Energy Review 2010], *available at* http://www.eia.gov/totalenergy/data/annual/pdf/aer.pdf.
5. U.S. Energy Info. Admin., *How Dependent Are We on Foreign Oil?*, Energy in Brief, http://www.eia.gov/energy_in_brief/foreign_oil_dependence.cfm (last updated July 13, 2012).
6. BP, Statistical Review of World Energy June 2012, at 9 (2012) [hereinafter BP, Statistical Review], *available at* http://www.bp.com/assets/bp_internet/globalbp/globalbp_uk_english/reports_and_publications/statistical_energy_review_2011/STAGING/local_assets/pdf/statistical_review_of_world_energy_full_report_2012.pdf.
7. *Id.*

Information Administration ("EIA") predicts that the world economy will consume 112.2 million barrels of liquid fuels and other petroleum products per day, with more than 75% of the increase coming from developing countries in Asia and the Middle East.[8] Given that the Middle East held almost 48% of the world's total proven oil reserves at the end of 2011 while the United States only held 1.9%, the potential for further conflict over this finite energy resource is significant.[9]

The future of renewable fuels, however, remains deeply debated within Congress due to an array of special interest groups that often lobby for their particular niche industry at the expense of others.[10] At the forefront of this debate is ethanol—a form of grain alcohol that only contains about two-thirds the energy density of gasoline.[11] Following decades of political support in the form of subsidies and tax breaks from federal and state governments,[12] corn-based ethanol accounted for over ninety percent of biofuel production in the United States in 2010.[13] Much of the controversy over ethanol focuses on (1) its compatibility with the existing fossil fuel infrastructure;[14] (2) the food versus fuel debate;[15] and (3) the environmental impacts of industrial agriculture.[16] First, concerns about infrastructure stem from the fact that ethanol "is corrosive and can degrade plastic, rubber or even metal parts in the fuel system that weren't engineered to use alcohol-bearing fuel."[17] As a consequence, ethanol may adversely affect engine performance, gas pumps, storage tanks, and pipelines.[18] Second, the food versus fuel debate focuses on the dilemma of diverting agricultural resources from food production to energy production.[19] Third, although the environmental impacts of industrialized agriculture are widespread, the most severe impact involves the overuse and degradation of limited fresh-water supplies.[20] As will be discussed below, improving energy security often requires consideration of the dynamic relationships between energy security, food security, and water security.

Recognizing the strategic vulnerabilities of our reliance on fossil fuels and seeking to "foster a culture in which energy awareness is part of everyday actions and decision-making,"[21] the U.S. Navy has pursued an energy strategy to develop alternative fuels that do not compete with food crops and that match "the characteristics and performance of conventional petroleum-based fuels."[22] The U.S. Navy expects these "drop-in" renewable fuels to require no modifications to existing platforms (i.e., ships and aircraft) and to perform interchangeably with petroleum-based fuels.[23] After several years of testing and certifying these alternative fuels, which are derived from renewable sources such as algae, camelina, and cooking oil waste,[24] the U.S. Navy formally introduced the Great Green Fleet during the 2012 Rim of the Pacific ("RIMPAC"), the world's largest multinational maritime exercises.[25]

The Great Green Fleet is a strike group composed of nuclear-powered carriers and submarines, hybrid-electric and conventional ships powered by a fifty-fifty blend of alternative and petroleum-based naval propulsion fuel, and aircraft flying on a fifty-fifty blend of alternative and petroleum-based naval aviation fuel.[26] The fleet also features several prototype, energy-efficient technologies designed to enhance combat capability. They include "solid state lighting, which is more efficient and lasts longer than incandescent or fluorescent fixtures; stern flaps designed to help reduce hull resistance when underway; a shipboard energy dashboard that displays energy usage to the operators in real

8. U.S. Energy Info. Admin., Doe/EIA-0484 (2011), International Outlook 2011, at 25 (2011) [hereinafter U.S. Energy Info. Admin., International Outlook 2011], *available at* http://www.eia.gov/forecasts/ieo/pdf/0484(2011).pdf.
9. BP Statistical Review 2012, *supra* note 6, at 6. "Proven reserves are classified as oil in the ground that is likely to be economically producible at expected oil prices and given expected technologies." U.S. Gov't Accountability Office, GAO 07-283, Crude Oil: Uncertainty About Future Oil Supply Makes It Important to Develop a Strategy for Addressing a Peak and Decline in Oil Production 14, n.10 (2007).
10. *See* Melissa Powers, *King Corn: Will the Renewable Fuel Standard Eventually End Corn Ethanol's Reign?*, 11 Vt. J. Envtl. L. 667, 707–08 (2010).
11. Hal Bernton, William Kovarik & Scott Sklar, The Forbidden Fuel, A History of Power Alcohol 219 (2d ed. 2010); *see also* Arnold W. Reitze Jr., *Biofuels–Snake Oil for the Twenty-First Century*, 87 Or. L. Rev. 1183, 1186 (2008).
12. Bernton et al., *supra* note 11, at xi.
13. Patricia Koshel et al., Nat'l Research Council, Expanding Biofuel Production: Sustainability and the Transition to Advanced Biofuels 29 (2010), http://www.nap.edu/catalog/12806.html.
14. Bernton et al., *supra* note 11, at 161–62.
15. *Id.* at 113.
16. *Id.* at 179.
17. Mike Allen, *Can E15 Gasoline Really Damage Your Engine?*, Popular Mechanics, (Dec. 21, 2010), http://www.popularmechanics.com/cars/alternative-fuel/biofuels/e15-gasoline-damage-engine-2.
18. Shelia Karpf, Envtl. Working Grp., Locking in Ethanol Locks Out Alternatives 1, 9 (2011), *available at* http://www.ewg.org/agmag/wp-content/uploads/2011/04/Final-ethanol-infrastructure-report2.pdf.
19. Bernton et al., *supra* note 11, at 113.
20. *See id.* at 116–17.
21. *See* U.S. Navy, A Navy Energy Vision for the 21st Century 1 (2010) [hereinafter A Navy Energy Vision], *available at* http://greenfleet.dodlive.mil/files/2010/10/Navy-Energy-Vision-Oct-2010.pdf (noting that the Navy "will pursue public-private partnerships where possible" to support its agenda).
22. *See id.* at 5. This endeavor is part of larger effort of the Department of Defense to achieve greater energy security throughout all of the military branches.
23. *See Alternative Fuels for the Military Need to Be "Drop-in": Navy Sec'y*, Platts (July 3, 2011, 11:28 AM), http://www.platts.com/RSSFeedDetailedNews/RSSFeed/Oil/6245497.
24. The U.S. Navy successfully tested a naval aviation fuel blend made from camelina, a rotation crop generally grown intermittently with wheat, for two fighter jets, the F/A-18 in 2009 and the F/A-18 Super Hornet in 2010. A Navy Energy Vision, *supra* note 21, at 6. In 2011, the U.S.S. Paul H. Foster, a decommissioned Spruance-class destroyer used for testing, completed a trial run off the coast of California during which it was powered by about 20,000 gallons of algae-based fuel. Alyce Moncourtois, *NSWC Port Hueneme's Test Ship Demos Alternative Fuel,* Worldwide Algae News (Nov. 18, 2011), http://algaenews.blogspot.com/2011/11/nswc-port-huenemes-test-ship-demos.html.
25. Suzanne Roig, *U.S. Navy's "Great Green Fleet" Debuts in Pacific,* Reuters (July 19, 2012, 2:09 PM), http://uk.reuters.com/article/2012/07/19/us-usa-navy-greenfleet-idUKBRE86I0B220120719.
26. A Navy Energy Vision, *supra* note 21, at 6; *see also* Tina Casey, *House Committee Torpedoes Military Biofuel Programs,* TPM Idea Lab, http://idealab.talkingpointsmemo.com/2012/05/house-committee-torpedoes-military-biofuel-programs.php (last visited Dec. 18, 2012).

time and informs energy efficient decisions; and gas turbine online water wash that improves engine efficiency."[27] The namesake of the fleet pays homage to President Theodore Roosevelt's Great White Fleet, which "traveled around the world on steam generated by the combustion of coal," effectively releasing "the Navy from the vagaries of wind."[28] Following this naval tradition of energy innovation, the Great Green Fleet reflects "the Navy's commitment to achieving energy security, enhancing combat capability, and reducing greenhouse gases."[29] Assuming alternative fuels become cost competitive with petroleum-based fuels, the U.S. Navy plans to operationally deploy the Great Green Fleet in 2016.[30] Ultimately, the U.S. Navy aims to obtain half of its energy requirements for both the afloat fleet and ashore installations from alternative sources by 2020.[31]

Thomas L. Friedman, New York Times columnist and noted "green" author, praised the U.S. Navy's effort to drive the development of the alternative fuels market and predicted a green revolution in the military so long as Congress continues to "refrain from forcing the Navy to use corn ethanol or liquid coal—neither of which are clean or efficient, but are located in many Congressional districts" throughout the United States.[32] His comments proved nearly prescient. In response to the high cost of testing these fifty-fifty blends of alternative and petroleum fuels, which amount to just over fifteen dollars per blended gallon, some members of Congress have sought to curtail the U.S. Navy's ability to test alternative fuels that cost more than petroleum-based fuel.[33] These critics argue that the U.S. Navy's alternative energy strategy does not make economic sense when federal budgets are strained and while energy companies are finding large quantities of oil and natural gas in the United States.[34] These arguments fail to consider, however, the vulnerability posed by our reliance on foreign oil, the impact of volatile oil prices on military budgets, and the need to invest in emerging technologies in order to help them become cost-competitive with petroleum-based fuel.[35]

More than simply refraining from meddling with the military's new energy strategy, this Article argues that Congress should follow the U.S. Navy's lead by phasing out legislative preferences for ethanol and encouraging the accelerated development of drop-in renewable fuels that match the performance characteristics of petroleum-based fuel. Part I provides a primer on the global oil economy followed by a brief history explaining how the United States has sought to improve energy security in the transportation fuels sector. Part II begins by arguing that the policy preferences for ethanol actually harm America's long-term energy security. It then compares the benefits of drop-in renewable fuels and briefly reviews the challenges that remain for reaching commercialization. It concludes with recommendations for fostering a new renewable fuel policy that provides the United States with the greatest amount of energy security in a cost effective and market oriented manner.

I. Striving for Energy Security in an Oil Addicted World

A. *The Fundamentals of the Global Oil Economy*

Refined oil products, including gasoline, diesel, and jet fuel, are the lifeblood of the global economy, powering industry, transportation, and shipping.[36] Like most commodities in the global market, oil is subject to the law of supply and demand.[37] When supplies are plentiful and accessible, oil is inexpensive.[38] When supplies are disrupted or outstripped by demand, the price of oil rises.[39] In addition, both the consumption and the production of oil are slow to respond to changes in price, which in economic parlance means that "both the demand for and supply of oil are inelastic."[40] On the demand side, "estimates of the elasticity of motor-fuel demand in the United States and other developed countries run about -0.1," meaning that a 10% increase in the price of gasoline would trigger a 1% decrease in consumption.[41] Faced with sustained higher oil prices, however, consumers will eventually change their consumption patterns by purchasing more efficient vehicles, using public transportation, and taking fewer trips.[42] On the supply side, estimates of the elasticity of oil production range from 0.3 to 0.5, which means that a 10% increase in long-term prices would be expected to trigger a 3% to 5% increase in global supply.[43]

This inelasticity in both supply and demand is a primary factor contributing to the volatility of oil prices.[44] For example, the price of oil rose from a low of twenty dollars per

27. Jeanette Steele, *Navy Shows Off "Great Green Fleet,"* San Diego Union Trib. (July 18, 2012), http://www.utsandiego.com/news/2012/jul/18/navy-shows-off-great-green-fleet/.
28. A Navy Energy Vision, *supra* note 21, at 3.
29. *Navy Fuels* Great Green Fleet Vision*: Latest Milestone on the Road to Energy Security*, Currents 18, 18 (Winter 2011), *available at* http://greenfleet.dodlive.mil/files/2011/01/Win11_Great_Green_Fleet_Vision.pdf.
30. Tom Hicks, *Navy: We'll Never, Ever Overpay for Biofuels,* Wired (July 27, 2012 6:30 AM), http://www.wired.com/dangerroom/2012/07/biofuel-pushback/.
31. A Navy Energy Vision, *supra* note 21, at 5–6.
32. Thomas Friedman, Op-Ed., *The U.S.S. Prius*, N.Y. Times, Dec. 19, 2010, at WK9, *available at* http://www.nytimes.com/2010/12/19/opinion/19friedman.html.
33. Roig, *supra* note 25.
34. *Id.*
35. Hicks, *supra note* 30.
36. Keith Crane et al., Imported Oil and U.S. National Security 5–6 (2009), *available at* http://www.rand.org/pubs/monographs/2009/RAND_MG838.pdf. Processing a forty-two gallon barrel of oil will produce forty-four gallons of petroleum products, including nineteen gallons of gasoline, ten gallons of diesel, and almost four gallons of jet fuel. *See also* U.S. Energy Info. Admin., *What Fuels Are Made From Crude Oil?*, Energy Kids, http://www.eia.doe.gov/kids/energy.cfm?page=oil_home-basics (last visited Dec. 18, 2012).
37. Nathaniel Popper, *Traders Say Supply, Demand Drive Oil Price,* Chi. Trib. (Mar. 12, 2012), http://articles.chicagotribune.com/2012-03-30/business/sc-cons-0329-money-consumer-watch-20120330_1_crude-oil-pressure-on-gasoline-prices-higher-gas-prices.
38. *Id.*
39. *Id.*
40. Crane et al., *supra* note 36, at 14.
41. *Id.* at 15.
42. *Id.*
43. *Id.*
44. *Id.* at 14.

barrel in 2001 to triple that amount by the middle of 2007.[45] On July 3, 2008, the price of oil reached an all-time high of $145 per barrel before precipitously crashing down to $45 per barrel 5 months later as the global recession took hold and demand plummeted along with the slowing economy.[46] The Brookings Institution ultimately concluded that the increase in oil prices "was caused by strong demand confronting stagnating world production."[47] Accordingly, the precipitous drop in oil prices demonstrated that oil producers failed to accurately anticipate and respond in a timely manner to the significant decrease in the demand for oil.[48] Another factor contributing to price volatility is the political instability found in oil producing nations in the Middle East and Africa, which were responsible for forty-two percent of the world's oil production in 2011.[49] With the uprisings across these regions in 2011 and the military intervention in Libya, oil prices increased significantly.[50]

Unlike other commodities traded in the global market, oil is not completely driven by the free market because of the pervasive influence of National Oil Companies ("NOCs"), which are responsible for over half of the world's oil production.[51] The NOCs, which include state controlled oil companies such as Saudi Aramco (Saudi Arabia), Pemex (Mexico), and Petróleos de Venezuela, S.A. (Venezuela), operate as an extension of their governments, with "corporate goals driven by political rather than commercial" concerns.[52] This mode of operation often results in hiring more workers than needed for each unit of output, rapid depletion of existing reserves, and insufficient investment in equipment, maintenance, research, and development.[53] As a consequence, NOCs "tend to be less efficient than privately owned oil companies" and less responsive to demand signals from the market.[54]

In contrast, International Oil Companies ("IOCs"), which include publicly owned oil companies such as Exxon, Chevron, and BP (formerly British Petroleum), are primarily concerned with maximizing profit for their shareholders.[55] As a consequence, IOCs tend to operate at peak efficiency. They are also more responsive to the demands of the market, and they generally invest heavily in equipment, development, and exploration.[56] In 2009, IOCs had full access to only eight percent of the world's proven oil reserves compared to NOCs, including Russian companies, which controlled over ninety-two percent.[57] As a historical note, in 1970, IOCs had unrestricted access to over eighty-five percent of the world's oil reserves in comparison to NOCs and the Soviet Union, which only controlled fifteen percent.[58]

The precipitous decline in IOCs' access to the world's oil reserves is directly attributable to the rise of the Organization of Petroleum Exporting Countries ("OPEC").[59] Formed in 1960, OPEC seeks to "protect the collective bargaining power of oil-producing nations from protectionism and the coordinated operations of the world's largest oil corporations."[60] As of 2012, there were twelve member countries in OPEC: Algeria, Angola, Ecuador, Iran, Iraq, Kuwait, Libya, Nigeria, Qatar, Saudi Arabia, the United Arab Emirates, and Venezuela.[61] Altogether, in 2011, these twelve countries controlled 72.2% of the world's proven oil reserves and were responsible for 42.5% of world oil production.[62]

OPEC ultimately aims to maintain an appropriately high price for oil "by determining how much of the gap between world demand and non-OPEC supply is filled by their production."[63] It accomplishes this objective "by discouraging competition among its members for market share and by determining target oil prices, which are achieved through coordinated supply control measures, including quotas on oil production."[64] The net result of these efforts, in conjunction with our demand for imported oil, is the transfer of vast sums of wealth from the United States to OPEC countries that often do not have our best national interests in mind.[65] In fact, some of these countries are openly hostile towards the United States.[66] For example, increased oil revenues have allowed Iran to provide funding and munitions to several terrorist and insurgent organizations that have carried out attacks against the United States military in Iraq and Afghanistan.[67]

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45. James Hamilton, *Causes and Consequences of the Oil Shock of 2007–08*, in Brookings Papers on Economic Activity 215, 215 (David H. Romer & Justin Wolfers, eds. Spring 2009), *available at* http://www.brookings.edu/~/media/Files/Programs/ES/BPEA/2009_spring_bpea_papers/2009a_bpea_hamilton.pdf.
46. *Id.*
47. *Id.*
48. Crane et al., *supra* note 36, at 15–16.
49. *Id.* at 17–18; Neela Banerjee & Ronald D. White, *Turmoil in OPEC Nation Drives Oil Prices Up Sharply*, L.A. Times (Feb. 22, 2011), http://articles.latimes.com/2011/feb/22/business/la-fi-oil-20110222; BP Statistical Review 2012, *supra* note 6, at 8.
50. Associated Press, *Oil Prices Jump Amid Crisis in Libya*, MSNBC (Mar. 21, 2011, 12:56 PM), http://www.msnbc.msn.com/id/42191519/ns/business-oil_and_energy/; *see also* Banerjee & White, *supra* note 49.
51. U.S. Energy Info. Admin., *Who Are the Major Players Supplying the World Oil Market?*, Energy in Brief, http://www.eia.doe.gov/energy_in_brief/world_oil_market.cfm (last updated Mar. 15, 2012).
52. Crane et al., *supra* note 36, at 16.
53. *Id.*
54. *Id.*
55. *See* U.S. Energy Info. Admin., *Who Are the Major Players Supplying the World Oil Market?*, *supra* note 51.
56. Nat'l Intelligence Council, Global Trends 2025: A Transformed World 42 (2008), *available at* http://www.aicpa.org/research/cpahorizons2025/globalforces/downloadabledocuments/globaltrends.pdf; *see also* Robert Pirog, Cong. Research Serv., RL34137, The Role of National Oil Companies in the International Market 5 (2007), *available at* http://www.fas.org/sgp/crs/misc/RL34137.pdf.
57. *See* Glen Sweetnam, Dir., Int'l, Econ., & Greenhouse Gases Div., U.S. Energy Info. Admin., Meeting the World's Demand for Liquid Fuels 6, Presentation at EIA 2009 Energy Conference: A New Climate for Energy? (Apr. 7, 2009), *available at* http://www.eia.gov/conference/2009/session3/Sweetnam.pdf.
58. *See id.*
59. Tim Carey, Comment, *Cartel Price Controls vs. Free Trade: A Study of Proposals to Challenge OPEC's Influence in the Oil Market Through WTO Dispute Settlement*, 24 Am. U. Int'l L. Rev. 783, 788–89 (2009).
60. *Id.* at 788.
61. Org. of Petroleum Exporting Countries, *Member Countries*, http://www.opec.org/opec_web/en/about_us/25.htm (last visited Dec. 18, 2012).
62. BP Statistical Review 2012, *supra* note 6, at 6, 8.
63. U.S. Energy Info. Admin., *Who Are the Major Players Supplying the World Oil Market?, supra* note 51.
64. Carey, *supra* note 59, at 789.
65. *See* Ctr. for Naval Analysis, Powering America's Defense: Energy and the Risks to National Security 3–4 (2009), *available at* http://www.cna.org/sites/default/files/Powering%20Americas%20Defense.pdf.
66. *See id.* at 1.
67. *Id.* at 4; *see also* Clay Wilson, Cong. Research Serv., RS22330, Improvised Explosive Devices (IEDs) in Iraq and Afghanistan: Effects and

In light of this anti-competitive behavior, some members of Congress have labeled OPEC an oil peddling cartel and have argued that the United States should bring a complaint against an OPEC member country to the World Trade Organization ("WTO").[68] Senator Frank Lautenberg argues that OPEC's quota policies systematically violate Article XI of the General Agreement on Tariffs and Trade ("GATT"), which prohibits quantitative restrictions on exports.[69] OPEC's policies, however, likely pass legal muster under the GATT framework for two reasons. First, OPEC places limits on oil production, not oil exports.[70] GATT only applies to exports, not domestic production. Second, GATT Article XX(g) exempts measures that are related "to the conservation of exhaustible natural resources [so long as] such measures are made effective in conjunction with restrictions on domestic production or consumption."[71] Although not explicitly listed under GATT Article XX(g), oil is an exhaustible natural resource and any quota would necessarily result in a restriction on domestic production.[72] Thus, the WTO provides limited mechanisms for curtailing OPEC's influence on the world oil market.

The finite nature of the oil supply also raises the important question as to when the world will reach peak oil production.[73] A 2007 report by the U.S. Government Accountability Office ("GAO") found that "[m]ost studies estimate that oil production will peak sometime between now and 2040, [but that] many of these projections cover a wide range of time, including two studies for which the range extends into the next century."[74] Peak oil production depends on a variety of factors, including the remaining amount of oil in the ground, the amount of oil that can be economically extracted, and the rate the world continues to consume oil.[75] Of these factors, there is a significant amount of uncertainty regarding the remaining amount of oil for three primary reasons.[76] First, "many parts of the world have not been fully explored for oil."[77] For example, after the publication of the GAO report cited above, the U.S. Geologic Survey concluded in 2008 that the Arctic may hold up to ninety billion barrels of oil and forty-four billion barrels of natural gas liquids.[78] Second, OPEC controls most of the world's oil, "but its estimates of reserves are not verified by independent auditors" and there is concern that some OPEC members have greatly exaggerated their oil reserves.[79] Third, new technologies and drilling techniques allow companies to reach previously inaccessible sources of oil.[80] For example, companies have started to use controversial hydraulic fracturing techniques on oil shale deposits, a process that involves blasting water into shale to dislodge previously inaccessible hydrocarbons.[81]

Despite the uncertainty surrounding proven reserves, the EIA predicts that global liquid fuel production will increase "by 26.6 million barrels per day from 2008 to 2035, including the production of both conventional liquid supplies (crude oil and lease condensate, natural gas plant liquids, and refinery gain) and unconventional supplies (biofuels, oil sands, extra-heavy oil, coal-to-liquids [("CTL")], gas-to-liquids [("GTL")], and shale oil)."[82] Given this prediction, it is likely that the world's production capacity will keep pace with world demand for the foreseeable future.[83] Nevertheless, when peak oil production for the world eventually comes to pass, as it already did for the United States in 1970,[84] the world must be prepared to respond with an economically feasible alternative or face the consequences of a significant disruption in the global economy.

B. *Energy Security Through Efficiency, Diversification, and Military Action*

Navigating the way through and beyond peak oil production is at the heart of achieving greater energy security, which is an admittedly amorphous concept given that energy security varies from the perspective of one nation or organization to the next.[85] For the United States, "energy security is assured when the nation can deliver energy economically, reliably, environmentally soundly and safely, and in quantities sufficient to support our growing economy and defense needs."[86] For the U.S. Navy, energy security means having "assured access to reliable supplies of energy and the ability to protect and deliver sufficient energy to meet operational needs afloat and ashore."[87] In contrast, for developing countries with abundant supplies of oil, such as Saudi Arabia and other OPEC members, energy security may focus on obtaining "unfettered access to the downstream petroleum sectors of the United States and other major industrial coun-

Countermeasures 3 (2007), *available at* http://www.fas.org/sgp/crs/weapons/RS22330.pdf; Joint Improvised Explosive Device Organization, Pub. No. 09032009-010, Iranian Weapons Smuggling Activities in Afghanistan (2009), *available at* http://info.publicintelligence.net/JIEDDO-IranWeaponsSmuggling.pdf.

68. *See* Office of Sen. Frank R. Lautenberg, Busting Up the Cartel: The WTO Case Against OPEC 12 (2004), *available at* http://lautenberg.senate.gov/documents/foreign/OPEC%20Memo.pdf.
69. *Id.* at 2.
70. *See* Carey, *supra* note 59, at 795.
71. General Agreement on Tariffs and Trade, art. XX(g), Oct. 30, 1947, 61 Stat. A-11, 55 U.N.T.S. 262.
72. *See* Carey, *supra* note 59, at 799–801.
73. *See* U.S. Gov't Accountability Office, *supra* note 9, at 4.
74. *Id.*
75. *Id.*
76. *Id.*
77. *Id.*
78. U.S. Geological Survey, Circum-Arctic Resource Appraisal: Estimates of Undiscovered Oil and Gas North of the Arctic Circle 4 (2008), *available at* http://pubs.usgs.gov/fs/2008/3049/fs2008-3049.pdf.
79. U.S. Gov't Accountability Office, *supra* note 9, at 4; *see also* Rowena Mason, *Oil Reserves "Exaggerated by One Third,"* The Telegraph (Mar. 22, 2010, 9:51 PM), http://www.telegraph.co.uk/finance/newsbysector/energy/oilandgas/7500669/Oil-reserves-exaggerated-by-one-third.html.
80. *See, e.g.*, Clifford Krauss, *Shale Boom in Texas Could Increase U.S. Output*, N.Y. Times, May 28, 2011, at A1, *available at* http://www.nytimes.com/2011/05/28/business/energy-environment/28shale.html?_r=1; Jason Lange, Analysis: *Shale Energy Boom Dangles Prospect of Leap in Economic Growth*, Reuters (May 24, 2012 11:30 AM), http://www.reuters.com/article/2012/05/24/us-usa-economy-energy-idUSBRE84N10O20120524.
81. *See* Lange, *supra* note 80. The process is also commonly referred to as "fracking."
82. U.S. Energy Info. Admin., International Outlook 2011, *supra* note 8, at 25.
83. *Id.* at 1–2.
84. U.S. Gov't Accountability Office, *supra* note 9, at 2.
85. Wen-Chen Shih, *Energy Security, GATT/WTO, and Regional Agreements*, 49 Nat. Res. J. 433, 435–36 (2009).
86. U.S. Energy Assoc., National Energy Security Post 9/11, at 7 (2002).
87. A Navy Energy Vision, *supra* note 21, at 4.

tries via exports of crude oil, products, and capital for further investment in refining and product marketing."[88] Providing a broader definition, the United Nations Development Program defines energy security as "a term that applies to the availability of energy at all times in various forms, in sufficient quantities, and at affordable prices, without unacceptable or irreversible impact on the environment."[89]

Tracing its routes to the Arab oil embargo in the early 1970s, "the current model" for energy security in the United States "focuses primarily on how to handle any disruption of oil supplies from producing countries."[90] In October 1973, the Organization of Arab Petroleum Exporting Countries ("OAPEC") initiated an oil embargo on the United States, the Netherlands, Portugal, and South Africa for supporting Israel during the Yom Kippur War.[91] Concurrently, OPEC announced a 25% cut in overall production.[92] As a result, oil prices skyrocketed from $3 per barrel in 1972 to $11.65 per barrel in early 1974.[93] The principal aims of the embargo action "were to compel Israel to withdraw from the territories it had occupied following the 1967 war and to weaken Western support for Israel in its ongoing conflict with Syria and Egypt."[94] In January 1974, following several rounds of back and forth diplomatic engagements between the United States, Israel, Egypt, and Syria, the parties settled on an "agreement for Israel to pull back from newly occupied areas of Egypt."[95] By March 1974, OAPEC lifted the oil embargo and OPEC resumed normal oil production.[96] Ultimately, our dependence on foreign oil proved to be an Achilles heel that OAPEC and OPEC successfully exploited to damage the economy and to influence foreign affairs.[97]

In response to the crisis created by the embargo, Congress enacted the Energy Policy and Conservation Act of 1975[98] in order to reduce foreign oil dependence. The Energy Policy and Conservation Act pursued this goal, in part, by requiring greater fuel efficiency for the automotive fleet in the United States through mandated increases in Corporate Average Fuel Economy ("CAFE") standards.[99] These new standards signaled the start of intermittent legislative endeavors to promote greater efficiency and conservation.[100] From the National Energy Conservation Policy Act of 1978[101] to the more recent Energy Independence and Security Act of 2007 ("EISA 2007"),[102] Congress has promulgated legislation that steered power plants away from using oil as an input for power generation, imposed steeper excise taxes on gasoline to reduce demand, and required more stringent CAFE standards.[103] For example, the EISA 2007 removed the CAFE exemption for light trucks (e.g., vans and sport utility vehicles) and raised the CAFE standard from 27.5 miles per gallon to 35 miles per gallon for all new passenger vehicles by 2020.[104] Additionally, touting the benefits of greater fuel efficiency, President Obama declared that his administration was "going to continue to work with the automakers, with the autoworkers, with states, to ensure the high-quality, fuel-efficient cars and trucks of tomorrow are built right here in the United States of America."[105] The benefits of efficiency are clearly demonstrated through the United States' ability to achieve greater economic output from fewer energy inputs.[106] A potential downside of these measures, however, is the rebound effect, an economic theory that posits greater efficiency may actually lead to greater energy consumption over time.[107]

The oil industry, with some assistance from the federal government, responded to the oil embargo by taking steps to diversify sources of imported oil away from the Persian Gulf and OPEC members.[108] IOCs began investing heavily in non-OPEC countries to develop and exploit new sources of oil.[109] In addition, the federal government helped by opening markets and ensuring access to energy through various free trade agreements.[110] For example, in the North American Free Trade Agreement ("NAFTA"), the United States secured unfettered access to Canada's oil market.[111] More recently, President Obama announced an agreement with Brazil "to work as strategic energy partners to the benefit of both countries, including in the safe development of the vast

88. Shih, *supra* note 85, at 436.
89. United Nations Dev. Programme, World Energy Assessment: Overview 2004 Update 42 (2004), *available at* http://www.undp.org/content/dam/aplaws/publication/en/publications/environment-energy/www-ee-library/sustainable-energy/world-energy-assessment-overview-2004-update/World%20Energy%20Assessment%20Overview-2004%20Update.pdf.
90. Daniel Yergin, *Ensuring Energy Security*, 85 Foreign Aff. 69, 78 (2006).
91. Crane et al., *supra* note 36, at 27.
92. *Id*.
93. *Id*.
94. *Id*.
95. *Id*.
96. *Id*.
97. *See generally* Dermot Gately, Nat'l Energy Policy Inst., OPEC at 50: Looking Back and Looking Ahead (2011), *available at* http://www.econ.nyu.edu/dept/courses/gately/Gately_NEPI_August2011.pdf.
98. Energy Policy and Conservation Act, Pub. L. No. 94-163, 89 Stat. 871 (1975) (codified as amended in scattered sections of 42 U.S.C.).
99. *Id*.
100. *See* Salvatore Lazzari, Cong. Research Serv., RL33578, Energy Tax Policy: History and Current Issues 3–6 (2008).
101. National Energy Conservation Policy Act, Pub. L. No. 95-619, 92 Stat. 3206 (1978) (codified as amended at 42 U.S.C. §§ 8251–8262k).
102. Energy Independence and Security Act, Pub. L. No. 110-140, 121 Stat. 1492 (2007) (codified as amended at 42 U.S.C. §§ 17001–17386).
103. *See, e.g.*, Lazzari, *supra* note 100.
104. Evan Turgeon, *Triple-Dividends: Toward Pigovian Gasoline Taxation*, 30 J. Land Res. & Envtl. L. 145, 152 (2010).
105. Barrack Obama, President of the United States, Address at Georgetown University on America's Energy Security (Mar. 30, 2011, 11:36 AM), *transcript available at* http://www.whitehouse.gov/the-press-office/2011/03/30/remarks-president-americas-energy-security.
106. U.S. Dep't of Energy, *Energy Intensity Indicators in the U.S.*, Energy Efficiency & Renewable Energy, http://www1.eere.energy.gov/ba/pba/intensityindicators/total_energy.html (last updated July 20, 2012).
107. *See* Jesse Jenkins et al., Energy Emergence: Rebound & Backfire as Emergent Phenomena 8 (Breakthrough Inst. 2011), *available at* http://thebreakthrough.org/blog/Energy_Emergence.pdf.
108. *See* U.S. Energy Info. Admin., Annual Energy Review 2010, *supra* note 4, at 140.
109. Amy Myers Jaffe & Ronald Soligo, James A. Baker III Inst. for Pub. Pol'y, The International Oil Companies 12–13 (2007), *available at* http://bakerinstitute.netfu.rice.edu/publications/NOC_IOCs_Jaffe-Soligo.pdf; *see also* Bassam Fattouh & Coby van der Linde, Twenty Years of Producer-Consumer Dialogue in a Changing World 54 (Int'l Energy Forum, 2011), *available at* http://www.clingendael.nl/publications/2011/2011_IEF_History_of_IEF_Clinde_BFattouh.pdf.
110. *See* Jaffe & Soligo, *supra* note 109, at 42–43.
111. North American Free Trade Agreement, U.S.-Can.-Mex., Dec. 17, 1992, 32 I.L.M. 296.

oil and gas resources in pre-salt prospects in Brazil's Outer Continental Shelf."[112]

Through such efforts, the United States reduced the Persian Gulf's and OPEC's respective market shares of imported oil from a peak of 27.8% and 70.3%, respectively, in 1977 to 14.5% and 41.6%, respectively, by 2010.[113] Just over half of the oil imported into the United States now comes from sources in the Western hemisphere, with Canada serving as our leading supplier with a twenty-nine percent market share of total oil imports.[114] Diversifying sources of oil supplies, however, only goes so far for improving energy security. Because oil is a global commodity, supply disruptions or "jumps in demand anywhere in the world will be distributed across the world market,"[115] resulting in relatively equal price increases for both domestic and foreign sources of oil.[116]

Partly due to the limitations of energy efficiency and diversification, the United States has also taken a special interest, which traces back to the Second World War, in ensuring the free flow of oil from the Middle East to the rest of the world.[117] In February 1945, President Franklin Roosevelt met with King Ibn Saud aboard the USS *Quincy* and agreed to guarantee the security of Saudi Arabia in exchange for access to its oil.[118] In response to the Soviet Union's invasion of Afghanistan,[119] President Carter warned in his 1980 State of the Union address that any "attempt by any outside force to gain control of the Persian Gulf region will be regarded as an assault on the vital interests of the United States of America."[120] Extending the Carter Doctrine to cover intraregional threats, President Reagan stated in a press conference that "there is no way . . . that we could stand by and see [Saudi Arabia] taken over by anyone that would shut off the oil."[121] Formalizing this stance during the first year of his presidency, President George H.W. Bush issued National Security Directive 26,[122] which began with a frank acknowledgement that "[a]ccess to Persian Gulf oil and the security of key friendly states in the area are vital to U.S. national security."[123] Under President Clinton, the United States Security Strategy for the Middle East reiterated that "[o]ur paramount national security interest in the Middle East is maintaining the unhindered flow of oil from the Persian Gulf to world markets at stable prices."[124] To this day, as highlighted in the National Defense Strategy, the U.S. Military continues to ensure energy security by maintaining "access to and flow of energy resources vital to the world economy."[125]

Historically, the U.S. Military has shouldered the lion's share of the burden in enforcing these policies by patrolling the sea lanes of the Persian Gulf,[126] leading the charge to liberate Kuwait in Operation Desert Storm, and maintaining security in Operation Iraqi Freedom ("OIF").[127] In Operation Earnest Will during the Iran-Iraq War, the U.S. Navy escorted Kuwaiti oil tankers carrying Iraqi oil and cleared Iranian mines from the Straits of Hormuz.[128] When Saddam Hussein invaded Kuwait, President George H.W. Bush issued National Security Directive 45, which ordered the U.S. Military to defend the national integrity of Saudi Arabia, including its oil fields, from further Iraqi aggression.[129] In Operation Desert Storm, the U.S. Military eventually led a multinational force to remove Iraqi forces from Kuwait and to secure the Kuwaiti oil fields.[130] In 1995, the U.S. Navy reactivated the Fifth Fleet in Bahrain and took a more active role in securing the sea lanes for shipping oil in and out of the Persian Gulf.[131] At the outset of OIF, the U.S. Military secured the Iraqi Oil Ministry and various oil infrastructure assets throughout the country, including oil wells and two key oil terminals where almost 90% of Iraqi oil flowed through to awaiting tankers.[132] This increased security allowed Iraq, which has the third largest share of proven oil reserves at 8.7%,[133] to seek competitive bids for the development of several major oils fields, with the ultimate goal of increasing oil production capacity from 2.5 million barrels per day to 12 million barrels per day by 2017.[134]

Unfortunately, these oil security operations exact a heavy toll on the American taxpayer.[135] A 2009 monograph by the RAND Corporation, which reviewed several different studies, estimated that the U.S. Department of Defense spent up

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112. The White House, Blue Print for a Secure Energy Future 16 (2011), *available at* http://www.whitehouse.gov/sites/default/files/blueprint_secure_energy_future.pdf.
113. U.S. Energy Info. Admin., Annual Energy Review 2010, *supra* note 4, at 141.
114. U.S. Energy Info. Admin., *How Dependent Are We on Foreign Oil?*, *supra* note 5.
115. Crane et al., *supra* note 36, at 14.
116. *See* U.S. Energy Assoc., National Energy Security Post 9/11, *supra* note 86, at 15.
117. Alex Mills, *World Interests Rely on Free Flow of Oil From the Middle East*, m.TimesRecordNews (Jan. 1 2012), http://m.timesrecordnews.com/news/2012/jan/01/world-interests-rely-on-free-flow-of-oil-from/.
118. Christopher Blanchard, Cong. Research Serv., RL33533, Saudi Arabia: Background and U.S. Relations 4 (2009), *available at* http://assets.opencrs.com/rpts/RL33533_20091116.pdf.
119. *See* Crane et al., *supra* note 36, at 60.
120. *Id.*
121. *Id.* at 61.
122. The White House, National Security Directive 26 (Oct. 2, 1989), *available at* http://bushlibrary.tamu.edu/research/pdfs/nsd/nsd26.pdf.
123. *Id.* at 1.
124. Office of Int'l Security Affairs, U.S. Dep't of Defense, United States Security Strategy for the Middle East 6 (1995).
125. U.S. Dep't of Defense, National Defense Strategy, *supra* note 1.
126. Crane et al., *supra* note 36, at 73.
127. *See id.*
128. *See id.*
129. The White House, National Security Directive 45 (Aug. 20, 1990), *available at* http://bushlibrary.tamu.edu/research/pdfs/nsd/nsd45.pdf.
130. *See* Crane et al., *supra* note 36, at 61–62.
131. *Id.* at 70.
132. *See* Douglas Jehl & Elizabeth Becker, *A Nation at War: The Looting; Experts' Pleas to Pentagon Didn't Save Museum*, N.Y. Times, Apr. 16, 2003, http://www.nytimes.com/2003/04/16/world/a-nation-at-war-the-looting-experts-pleas-to-pentagon-didn-t-save-museum.html; *see also Clean Energy Policies That Reduce Our Dependence on Oil: Hearing Before the Subcomm. on Energy & Env't of the H. Comm. on Energy & Commerce*, 111th Cong. (2010) (statement of Robert Diamond, Lieutenant (Ret), U.S. Navy & Security Fellow, Truman National Security Project).
133. BP Statistical Review 2012, *supra* note 6, at 6.
134. United Nations Dev. Programme, UNDP and Ministry of Oil Agree on New Long Term Partnership to Support Skills Development in the Oil and Gas Sector in Iraq 1 (2011), *available at* http://www.iq.undp.org/Publications_View.aspx?q=SUQ9Mzkm-jzRdOm35ecg%3D.
135. *See e.g.*, Crane et al., *supra* note 36, at 63–65.

to $143 billion per year for maintaining oil security in the Middle East, of which $89 billion were attributed to OIF operations related to oil security.[136] These expenditures, however, fail to capture the more salient costs of the American soldiers, sailors, and airmen that have died or have sustained life altering injuries to secure our national security interest in the flow of oil from the Middle East.[137] Far removed from Iraq and the sea lanes of the Persian Gulf, these casualties are the hidden cost of gasoline that many Americans do not realize or fully appreciate when they fill up their tank at the local gas station.[138] Any endeavor to improve energy security must consider these very real humans costs.

C. Energy Security Through Renewable Fuels

In addition to its efforts to reduce demand for oil through efficiency and increase or maintain an adequate oil supply through diversification and military action, the United States has sought to supplant petroleum with renewable fuels.[139] The history of renewable fuels in the United States, much like the contemporary renewable fuels marketplace, revolves around ethanol.[140] Although touted as a fuel of the future, ethanol is really a fuel from the past.[141] From serving as an energy source for the first American prototype of an internal combustion engine in 1826 to powering Henry Ford's Model T in 1908,[142] ethanol promised to serve as a homegrown solution for reinvigorating America's struggling agriculture sector in the early part of the twentieth century.[143] The Prohibition era and the petroleum industry's campaign against alcohol blended gasoline in the 1930s, however, effectively stymied the ethanol fuel industry for the next several decades.[144] With the onset of the Arab Oil Embargo, however, the ethanol industry found new life.[145] Addressing the nation during the immediate aftermath of the energy crisis, President Nixon bound together renewable fuels and the vaunted notion of energy independence by proclaiming[146]

> [l]et us set as our national goal, in the spirit of Apollo, with the determination of the Manhattan Project, that by the end of this decade we will have developed the potential to meet our energy needs without depending on any foreign energy sources.[147]

Shortly thereafter, Congress passed the Geothermal Energy Research, Development, and Demonstration Act of 1974,[148] which was the first of many legislative proposals to promote ethanol as a fuel source and led to the "research and development of the conversion of cellulose and other organic materials (including wastes) into useful energy or fuels."[149]

1. Ethanol Subsidies and Tariffs

Elevating the rhetoric of energy independence, President Carter declared the need to meet the national demand for energy with domestic resources as the "moral equivalent of war."[150] With the National Energy Conservation Policy Act of 1978,[151] Congress responded to this figurative call to war by providing a $.40 per gallon tax exemption for every gallon of ethanol blended with gasoline.[152] In 1980, Congress implemented "the twin policy of [granting] ethanol tax [exemptions] and offsetting import tariffs designed to deny importers the benefit of those subsidies and protect home producers from lower-cost foreign competitors."[153] The impact of the U.S. tariff, however, was significantly limited by an exception in the agreement of the Caribbean Basin Initiative ("CBI") that allowed CBI countries to export ethanol to the United States duty-free so long as it was comprised of at least fifty percent locally grown feedstock.[154] Although the exception was limited to seven percent of total U.S. ethanol consumption, non-CBI countries, namely Brazil,[155] avoided the tariff by routing exported ethanol through CBI countries, where it was blended and subsequently shipped duty-free to the United States.[156]

In addition to foreign competitors, crashing oil prices in the mid-1980s also threatened the economic viability of the domestic ethanol industry.[157] Congress responded by mandating the addition of oxygenates, such as ethanol and methyl tertiary butyl ether ("MTBE"), to gasoline to allow the fuel "to burn more completely and thus release fewer pollutants."[158] Ethanol eventually dominated the oxygenate market because "MTBE turned out to be a toxic, carcinogenic chemical that readily leached into and contaminated

136. *Id.*
137. *See Clean Energy Policies That Reduce Our Dependence on Oil*, *supra* note 132, at 1 (discussing the death of two U.S. Navy Sailors and one U.S. Coast Guardsman in defending an oil terminal during an insurgent attack).
138. *See id.*
139. *See, e.g.*, Crane et al., *supra* note 36, at 84.
140. *See generally* Bernton et al., *supra* note 11, at 12–27.
141. *See id.* at 7–9.
142. *Id.*
143. *Id.* at 10–12.
144. *See id.* at 12–27.
145. Antoine Halff, *Energy Nationalism, Consumer Style: How the Quest for "Energy Independence" Undermines U.S. Ethanol Policy and Energy Security*, 19 Stan. L. & Pol'y Rev. 402, 406 (2008). This call to action also applied to the need to increase domestic production of petroleum-based fuels. *Id.*
146. *Id.*
147. *Id.*
148. Geothermal Energy Research, Development, and Demonstration Act of 1974, Pub. L. No. 93-410, 88 Stat 1080 (1974) (codified as amended in scattered sections of 30 U.S.C.).
149. U.S. Energy Info. Admin., *Energy Timelines: Ethanol*, Energy Kids, http://www.eia.gov/KIDS/energy.cfm?page=tl_ethanol (last updated June 2008).
150. Halff, *supra* note 145, at 406.
151. National Energy Conservation Policy Act of 1978, Pub. L. No. 95-619, 92 Stat. 3206 (1978) (adopted as amended in scattered sections of 42 U.S.C.).
152. Powers, *supra* note 10, at 680.
153. Halff, *supra* note 145, at 406.
154. *See* Madhu Khanna et al., *Land Use and Greenhouse Gas Mitigation Effects of Biofuel Policies*, 2011 U. Ill. L. Rev. 549, 558 (2011).
155. Brazil is the second largest producer of ethanol and enjoys a significant comparative cost advantage over the United States in producing ethanol from sugar cane. James A. Baker III Inst. for Pub. Pol'y of Rice Univ., No. 43, Fundamentals of a Sustainable U.S. Biofuels Policy 6 (2010) [hereinafter Baker Inst., Biofuels Policy Report], *available at* http://bakerinstitute.org/publications/EF-pub-PolicyReport43-121809.pdf.
156. Khanna et al., *supra* note 154. In 2007, total imports accounted for six percent of U.S. consumption with about forty percent imported directly from Brazil and sixty percent routed through CBI countries. *Id.*
157. *See* Powers, *supra* note 10, at 680.
158. *Id.*

groundwater supplies" near storage tanks.[159] Furthermore, under the American Jobs Creation Act of 2004,[160] Congress changed the ethanol tax exemption to a blending tax credit, which was officially referred to as the Volumetric Ethanol Excise Tax Credit ("VEETC").[161] These measures proved successful in raising domestic corn-based ethanol production from 175 million gallons in 1980 to 3.9 billion gallons in 2005.[162]

At the end of 2011, the ethanol tariff and subsidy, which had existed in one form or another for over three decades, finally expired through legislative inaction.[163] Prior to its expiration, the tariff consisted of a $0.54 per gallon duty and a 2.5% tax, while the ethanol subsidy amounted to a $0.45 per gallon tax credit for blending ethanol into gasoline.[164] Foreshadowing the demise of these protectionist measures, Congressional support for the domestic ethanol industry appeared to finally reach a zenith near the close of the 111th Congress.[165] In dueling letters to Senate Majority Leader Harry Reid, two bipartisan coalitions of Senators sparred over the fate of the ethanol subsidy and the ethanol import tariff, both of which were originally set to expire at the end of 2010.[166] Led by Senator Dianne Feinstein, seventeen senators argued that the continuation of the ethanol subsidy and import tariff was "fiscally irresponsible and environmentally unwise, and their extension would make our country more dependent on foreign oil."[167] In contrast, fifteen senators led by Senator Kent Conrad asserted that allowing the provisions to expire "would threaten jobs, harm the environment, weaken our renewable fuel industries, and increase our dependence on foreign oil."[168]

The Center for Responsive Politics provided an illuminating analysis of these very different and, in part, mutually exclusive propositions. The analysis showed that the first group of Senators drew significant contributions from the oil and gas industry and groups lobbying on behalf of industries impacted by the rising price of corn, such as the Grocery Manufacturers Association, the American Meat Institute, and the National Chicken Council.[169] In comparison, the second group of Senators shared geographic ties with the Corn Belt and received notable campaign contributions from pro-ethanol companies and lobbying groups, such as Monsanto, Archer Daniels Midland, POET, and the National Corn Growers Association.[170] Ultimately, Congress extended the tariff and the subsidy until the end of 2011 as part of a broader compromise in the Tax Relief, Unemployment Insurance Reauthorization, and Job Creation Act of 2010.[171]

Despite this compromise, the controversy over ethanol spilled into the 112th Congress.[172] On May 3, 2011, Senators Dianne Feinstein and Tom Coburn introduced a bipartisan bill that sought to completely eliminate the ethanol subsidy and the tariff on ethanol imports by July 1, 2011.[173] The bill's sponsors concluded that ending the subsidy at the midyear point instead of waiting to allow the provision to expire at the end of 2011 would save approximately $3 billion.[174] The very next day, Senators Chuck Grassley and Kent Conrad introduced their own bipartisan bill, the Domestic Energy Promotion Act of 2011 ("DEPA"), which sought to reduce and extend the ethanol subsidies and tariff through 2016.[175] The bill would have reduced the blending credit to $0.20 in 2012 and to $0.15 in 2013.[176] For the remaining three years, the subsidy would convert to a variable tax incentive based on the average three-month futures price for light sweet crude on the New York Mercantile Exchange.[177] The credit would have ranged anywhere from $0.30 per gallon if the price of oil fell below $50 per barrel to no credit whatsoever if the price of oil remained above $90 per barrel.[178] Although ethanol proponents continued to push for the subsidy to be phased out, on June 16, 2011, the Senate voted to end the subsidy at the midyear point by a vote of 73 to 27 based on geographic, rather than political, affiliations.[179] With no corresponding action in the

159. *Id.*
160. American Jobs Creation Act of 2004, Pub. L. No. 108-357, 118 Stat. 1418 (2004) (codified as amended in scattered sections of 26 U.S.C.).
161. *Id.* at §§ 301–03.
162. *See* Powers, *supra* note 10, at 668.
163. Robert Pear, *After Three Decades: Tax Credit for Ethanol Expires*, N.Y. Times, Jan. 2, 2012, at A11, *available at* http://www.nytimes.com/2012/01/02/business/energy-environment/after-three-decades-federal-tax-credit-for-ethanol-expires.html.
164. Cong. Budget Office, Pub. No. 4044, Using Biofuel Tax Credits to Achieve Energy and Environmental Policy Goals 6–7 (2010) [hereinafter Cong. Budget Office, Using Biofuel Tax Credits], *available at* http://www.cbo.gov/sites/default/files/cbofiles/ftpdocs/114xx/doc11477/07-14-biofuels.pdf.
165. *See, e.g.*, Letter from Sen. Dianne Feinstein (and 16 other Senators) to Senate Majority Leader Harry Reid (Nov. 30, 2010) [hereinafter Sen. Feinstein Letter], *available at* http://voices.washingtonpost.com/plum-line/Letter%20to%20Reid%20%26%20McConnell%20re%20ethanol.pdf; *but see* Letter from Sen. Kent Conrad (and 14 other Senators) to Senate Majority Leader Harry Reid (Nov. 30, 2011) [hereinafter Sen. Conrad Letter], *available at* http://grassley.senate.gov/about/upload/Biofuels-Support-Letter-to-Leaders-Reid-and-McConnell-signed.pdf.
166. *See* Sen. Feinstein Letter, *supra* note 165; *see also* Sen. Conrad Letter, *supra* note 165.
167. Sen. Feinstein Letter, *supra* note 165.
168. Sen. Conrad Letter, *supra* note 165.
169. *See* Michael Beckel, *Senators Supporting Ethanol Subsidies Reap Riches From Corn Interests*, OpenSecrets.org (Jan. 3, 2011, 1:07 AM), http://www.opensecrets.org/news/2011/01/ethanol-lobby-finds-friends-foes.html.
170. *See id.*
171. *See* Tax Relief, Unemployment Insurance Reauthorization, and Job Creation Act of 2010, Pub. L. No. 111-312, § 708, 123 Stat. 444 (2010), *available at* http://www.gpo.gov/fdsys/pkg/BILLS-111hr4853enr/pdf/BILLS-111hr4853enr.pdf.
172. *See* Ethanol Subsidy and Tariff Repeal Act, S. 493, 112th Cong. (2011), *available at* http://www.coburn.senate.gov/public//index.cfm?a=Files.Serve&File_id=782611c3-3ec4-4535-8416-8af1dd1e20ba.
173. *See* Press Release, Senators Coburn, Feinstein, Introduce Bill to Eliminate Ethanol Subsidy and Tariff (May 3, 2011), *available at* http://coburn.senate.gov/public/index.cfm/pressreleases?ContentRecord_id=d814a8d6-32bd-46d8-89bc-c61d65373f45.
174. *Id.*
175. *See* Press Release, Introduction of the Domestic Energy Promotion Act of 2011 (May 4, 2011), *available at* http://grassley.senate.gov/news/Article.cfm?customel_dataPageID_1502=34203.
176. *See* Domestic Energy Promotion Act of 2011, S. 884, 112th Cong. § 2 (2011), *available at* http://www.opencongress.org/bill/112-s884/text.
177. See *id.*
178. *Id.*
179. *See* Steven Mufson & Lori Montgomery, *Senate Approves Cut in Ethanol Subsidies*, Wash. Post, June 16, 2011, at http://www.washingtonpost.com/business/economy/senate-approves-cut-in-ethanol-subsidies-votes-for-feinstein-amendment/2011/06/16/AGwrfhXH_story.html.

House of Representatives, the ethanol tariff and subsidy finally expired at the end of 2011.[180]

2. The Renewable Fuel Standard

Taking a significantly different approach towards the development of renewable fuels, President George W. Bush signed into law the first federal Renewable Fuel Standard ("RFS") with the Energy Policy Act of 2005 ("EPACT 2005").[181] The RFS required producers, refiners, and importers of oil to blend a minimum amount of biofuels into gasoline for automotive vehicles starting with 4 billion gallons in 2005 and rising to 7.5 billion gallons by 2012.[182] The passage of EPACT 2005 also signaled Congress' intent to promote the development of advanced biofuels, including cellulosic biofuels and other non-food crop biofuels.[183] For example, EPACT 2005 established a credit trading program that assigned equivalency values to various biofuels based on their assessed environmental benefits and energy content (e.g., cellulosic biofuels were worth 2.5 times more than corn ethanol).[184] In practice, "an oil producer, importer, or refiner would need to purchase only one gallon of waste-derived fuel for every 2.5 gallons of corn ethanol to meet its RFS."[185] In spite of these measures, corn ethanol continued to dominate the market because targeted subsidies made it significantly cheaper than other biofuels.[186]

Two years later, with the passage of the Energy Independence and Security Act of 2007 ("EISA 2007"),[187] Congress substantially revised the RFS, which EPA rechristened as RFS2, by expanding its applicability to all transportation fuels except for jet fuel and fuels for ocean going vessels,[188] increasing the amount of biofuel required for blending and establishing limits for the lifecycle greenhouse gas emissions for renewable fuels.[189] With EISA 2007, Congress also repealed certain equivalency values mandated by EPACT 2005 and established new volumetric standards for renewable fuel, which included specific standards for advanced biofuel, cellulosic biofuel, and biomass-based diesel.[190] The new standard required increasing the amount of blended renewable fuel from nine billion gallons in 2008 to thirty-six billion gallons by 2022.[191] Renewable fuel is broadly defined as "fuel that is produced from renewable biomass and that is used to replace or reduce the quantity of fossil fuel present in a transportation fuel."[192] Renewable biomass, however, encompasses a smaller universe of materials, including algae, various kinds of animal, yard, and food waste, and specified crops, trees, and their respective residues.[193] The concept of renewability under EISA 2007 "focuses on land conversion prohibitions, limits on biomass sourcing from nonfederal forests, and absolute bars against harvests from old growth or late succession forests and forests with ecological communities with certain global or state ranking."[194]

The portion of the RFS2 comprising advanced biofuel will increase from 0.6 billion gallons in 2009 to 21 billion gallons in 2022.[195] Although the advanced biofuel category specifically excludes ethanol derived from corn starch, it may include other types of ethanol, such as that derived from vegetative waste, animal waste, cellulose, hemicellulose, lignin, sugar, or any other starch.[196] Advanced biofuel may also include biomass-based diesel, biogas produced through the conversion of organic matter from renewable biomass, butanol, and any other fuel derived from cellulosic biomass.[197] Under RFS2, advanced biofuel includes the volumetric standards for cellulosic biofuel, which reaches its maximum level at sixteen billion gallons in 2022, and biomass-based diesel, which reaches its maximum level at one billion gallons in 2012.[198] Although there is no volumetric standard for corn ethanol, the "remaining portion of total renewable fuel not met with advanced biofuels is allowed to be corn-based ethanol."[199] This was not an unanticipated result.[200] EISA 2007's "year-by-year targets for 2008 to 2015 so closely matched the ethanol industry's own construction schedule as to effectively lock in a market for plants already planned or under construction, while raising the barrier for new entrants."[201] Incidentally, EPA projects that the remaining fifteen billion gallons of RFS2 (i.e., those gallons not constituting advanced biofuel) by 2022 will be satisfied entirely with corn-based ethanol.[202]

To limit any unintended economic impacts, Congress empowered EPA to make adjustments to the vari-

180. *See Ethanol Tax Break Quietly Expires, Industry Moves on to Gas Pumps*, SustainableBusiness.Com (Jan. 5, 2012, 3:16 PM), http://www.sustainablebusiness.com/index.cfm/go/news.display/id/23286.
181. Energy Policy Act of 2005, Pub. L. No. 109-58, 119 Stat. 594 (codified as amended at 42 U.S.C. § 15801).
182. Powers, *supra* note 10, at 681.
183. *See id.* at 707.
184. *Id.* at 670–71.
185. *Id.* at 671.
186. *Id.*
187. Energy Independence and Security Act of 2007, Pub. L. No. 110-140, § 202, 121 Stat. 1492 (2007) (amending Clean Air Act ("CAA") § 211, 42 U.S.C. § 7545 (1990)).
188. CAA § 211(o)(1)(L), 42 U.S.C. § 7545(o)(1)(L) (Supp. III, vol. 4 2010). *See generally Questions and Answers on Changes to the Renewable Fuel Standard Program (RFS2)*, U.S. Envtl. Prot. Agency, http://www.epa.gov/oms/fuels/renewablefuels/compliancehelp/rfs2-aq.htm (last updated Aug. 10, 2012).
189. CAA § 211(o)(1)(H), 42 U.S.C. § 7545(o)(1)(H) (Supp. III, vol. 4 2010).
190. *See* Regulation of Fuels and Fuel Additives: Changes to Renewable Fuel Standard Program, 75 Fed. Reg. 14670, 14709 (Mar. 26, 2010) (codified at 40 C.F.R. pt. 80).
191. Fred Sissine, Cong. Research Serv., RL34294, Energy Independence and Security Act of 2007: A Summary of Major Provisions 5 (2007), *available at* http://www.seco.noaa.gov/Energy/2007_Dec_21_Summary_Security_Act_2007.pdf.
192. CAA § 211(o)(1)(J), 42 U.S.C. § 7545(o)(1)(J) (Supp. III, vol. 4 2010).
193. *See* CAA § 211(o)(1)(I), 42 U.S.C. § 7545(o)(1)(I) (Supp. III, vol. 4 2010).
194. Jody M. Endres, *Agriculture at a Crossroads: Energy Biomass Standards and a New Sustainability Paradigm?*, 2011 U. Ill. L. Rev. 503, 511 (2011) (internal citations omitted).
195. CAA § 211(o)(2)(B)(i)(II), 42 U.S.C. § 7545(o)(2)(B)(i)(II) (Supp. III, vol. 4 2010).
196. CAA § 211(o)(1)(B), 42 U.S.C. § 7545(o)(1)(B).
197. *Id.*
198. CAA § 211(o)(2)(B)(i)(III)–(IV), 42 U.S.C. § 7545(o)(2)(B)(i)(III)–(IV).
199. Khanna et al., *supra* note 154, at 556.
200. *See* Halff, *supra* note 145, at 410.
201. *Id.*
202. Regulation of Fuels and Fuel Additives: Changes to Renewable Fuel Standard Program, 75 Fed. Reg. 14670, 14746 (Mar. 26, 2010) (codified at 40 C.F.R. pt. 80).

ous renewable fuel production quotas in case the market cannot produce the statutorily mandated quantities.[203] In other words, if industry is unable to produce sufficient quantities of cellulosic biofuel, then EPA may reduce the amount required for blending below the statutorily prescribed standard.[204] This effectively prevents a situation where a limited supply of cellulosic biofuel causes a spike in fuel prices at the pump.[205] For 2011, EPA reduced the statutorily required mandated amount by ninety-seven percent from 250 million gallons to 6.6 million gallons because the cellulosic biofuel industry was still in the early phases of development and was unable to produce enough cellulosic biofuel to meet the amount originally prescribed by Congress.[206]

EISA 2007 also makes an attempt to address climate change.[207] As part of the mandate to quantify the lifecycle greenhouse gas emissions for each type of renewable fuel, Congress directed EPA to consider both "direct and significant indirect emissions."[208] These emissions include those from land use changes that are related to "all stages of fuel and feedstock production and distribution, from feedstock generation or extraction through the distribution and delivery and use of the finished fuel to the ultimate consumer . . . ."[209] Each type of renewable biofuel is compared to a baseline, which is defined as "the average lifecycle greenhouse gas emissions . . . for gasoline or diesel (whichever is being replaced by the renewable fuel) sold or distributed as transportation fuel in 2005."[210] Additionally, all renewable fuel from facilities that commence construction after December 19, 2007, must achieve at least a twenty percent reduction below the baseline lifecycle greenhouse gas emissions for the applicable petroleum product.[211] Advanced biofuel must generally obtain at least a fifty percent reduction below the applicable baseline for petroleum fuels.[212] However, renewable fuels produced from facilities that were in service or that had commenced construction prior to December 19, 2007, are exempt from the requirement to reduce lifecycle greenhouse gas emissions.[213] This exemption primarily benefits corn ethanol production facilities because they dominated the biofuels market when President Bush signed EISA 2007 into law.[214]

3. Other Legislative Efforts to Promote Ethanol

To further encourage the development of advanced biofuels, Congress enacted several additional subsidies in the Food, Conservation, and Energy Act of 2008 ("2008 Farm Bill").[215] First, Congress created a credit, which is set to expire on December 31, 2013, for the production of cellulosic biofuel amounting to $1.01 per gallon.[216] Second, Congress created the Biomass Crop Assistance Program ("BCAP") in an effort to address the "classic chicken-or-egg challenge around the startup of commercial scale bioenergy activities."[217] In a fact sheet discussing BCAP, the U.S. Department of Agriculture ("USDA") succinctly described the challenge as follows:

> If commercial-scale biomass facilities are to have sufficient feedstocks, then a large-scale energy crop must exist. Conversely, if profitable crop production is to occur, then viable consumers must exist to purchase the crop. The federal [RFS] requires 21 billion gallons of non-corn-starch [sic] biofuels in the national fuel supply by 2022 and new types of biomass feedstocks must be available to meet this requirement. Many bioenergy crops need several years to become established. Many bioenergy facilities need several years to reach commercial scale. BCAP serves as catalyst to unite these dynamics by reducing the financial risk for landowners who decide to grow unconventional crops for these new markets.[218]

The actual subsidy reimburses farmers up to seventy-five percent of the cost to establish an eligible bioenergy perennial crop, which entails a five-year annual payment limit for herbaceous crops and a fifteen-year limit for woody crops.[219] In addition, for a two-year period, producers are eligible for a matching payment of up to forty-five dollars per ton for the delivery of crops, including corn stover, to cellulosic biorefinieries.[220] In an effort to steer clear of the food versus fuel debate, eligible crops under BCAP do not include crops that are eligible to receive payments under Title I of the 2008 Farm Bill such as wheat, corn, grain sorghum, barley, oats, upland cotton, long grain rice, medium grain rice, pulse crops, soybeans, and other oilseeds.[221] Despite this prohibition, it is worth noting that the federal government still provided over $3.5 billion in subsidies for growing corn in 2010 alone, which indirectly benefited the corn ethanol industry.[222]

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203. CAA § 211(o)(2)(B)(ii)–(v), 42 U.S.C. § 7545(o)(2)(B)(ii)–(v) (Supp. III, vol. 4 2010).
204. *Id.*
205. *See* Regulation of Fuels and Fuel Additives: 2011 Renewable Fuel Standards, 75 Fed. Reg. 76790, 76792 (Dec. 9, 2010) (codified at 40 C.F.R. pt. 80).
206. *Id.*
207. *See* CAA § 211(o)(1)(H), 42 U.S.C. § 7545(o)(1)(H).
208. *Id.*
209. *Id.*
210. *Id.* § 211(o)(1)(C), 42 U.S.C. § 7545(o)(1)(C).
211. Regulation of Fuels and Fuel Additives: Changes to Renewable Fuel Standard Program, 75 Fed. Reg. 14670, 14677 (Mar. 26, 2010) (codified at 40 C.F.R. pt. 80).
212. CAA § 211(o)(1)(D)–(E), 42 U.S.C. § 7545(o)(1)(D)–(E) (Supp. III, vol. 4 2010). Cellulosic fuel, a type of advanced biofuel, must achieve at least a sixty percent reduction in comparison to the baseline. *Id.* § 211(o)(1)(E), 42 U.S.C. § 7545(o)(1)(E).
213. *Id.*
214. *See* Powers, *supra* note 10, at 672.
215. *See* Food, Conservation and Energy Act of 2008, Pub. L. No. 110-234, 122 Stat. 923 (2008) [hereinafter 2008 Farm Bill].
216. *Id.* § 15321; American Taxpayer Relief Act of 2012, Pub. L. No. 112-240, § 404, 126 Stat. 2313, 2338–39.
217. U.S. Dep't of Agric., Fact Sheet: Biomass Crop Assistance Program (2011) [hereinafter Fact Sheet: Biomass Crop Assistance Program], *available at* http://www.fsa.usda.gov/Internet/FSA_File/bcap_update_may2011.pdf.
218. *Id.*
219. *Id.*
220. *Id.*
221. U.S. Dep't of Agric., *supra* note 217 at 2; Food, Conservation and Energy Act of 2008 § 1001 (definition of covered commodities).
222. Corn Subsidies, EWG Farm Subsidies, http://farm.ewg.org/progdetail.php?fips=00000&progcode=corn (last visited Oct. 29, 2012).

Altogether, government support helped the industry produce almost fourteen billion gallons of ethanol in 2011.[223] But in reaching this milestone,[224] the American taxpayer paid an exorbitant price.[225] From 2005 through 2011, the VEETC cost approximately $30.5 billion in lost tax revenue.[226] Focusing on how much ethanol production is solely attributable to subsidies, the Congressional Budget Office ("CBO") estimated taxpayers paid $1.78 for "displacing a gallon of gasoline with a quantity of ethanol that provides the same amount of energy as a gallon of gasoline."[227] Likewise, the CBO estimated "that the costs to taxpayers of displacing gasoline with cellulosic ethanol will total $3.00 per gallon and the costs of displacing petroleum diesel with biodiesel will total approximately $2.55 for an equivalent amount of biodiesel."[228] Despite these costly measures to promote renewable fuels, oil will still continue to play a dominant role in our nation's energy future for decades to come.[229] Based on current standards mandated by EISA 2007, the EIA predicts that biofuel will only increase from four percent in 2009 to eleven percent in 2035 of the total amount of liquid fuels consumed in the United States.[230] From a trading perspective, this growth in the biofuels market will help the United States significantly reduce its net imports in petroleum products from fifty-two percent in 2009 to approximately forty-two percent in 2035.[231] Nevertheless, because the United States will still heavily rely on foreign sources of petroleum in 2035,[232] the goal of energy independence through renewable fuels appears increasingly unrealistic in an interconnected world where energy commodities are traded in a global marketplace.[233]

II. Moving Beyond Ethanol to Drop-In Replacement Fuels

A. *The Need to Move Beyond Ethanol*

In 2010, Secretary Stephen Chu of the U.S. Department of Energy ("DOE") candidly acknowledged that "ethanol is not an ideal transportation fuel."[234] Rather, Secretary Chu emphasized that DOE is much more focused on using biomass to create synthetic versions of gasoline, diesel, and jet fuel because such fuels do not require the special infrastructure that is necessary to increase the utilization of ethanol.[235] As discussed in the introduction, the U.S Military is bypassing ethanol altogether in favor of drop-in renewable fuels that are compatible with the existing fossil fuel infrastructure and that do not directly compete with food crops.[236] The drive behind these efforts stems from some very basic problems involving the production and use of ethanol as a transportation fuel.[237] These problems cast significant doubt as to whether ethanol—particularly the corn-based variety—actually improves or enhances America's energy security.[238] As discussed above in Part I.B., energy security is assessed on the ability to "deliver energy economically, reliably, environmentally soundly and safely, and in quantities sufficient to support our growing economy and defense needs."[239] Using this measure, the current legislative focus on promoting ethanol and protecting the domestic corn ethanol industry fails to actually improve energy security due to infrastructure constraints, limits on production capacity, and adverse environmental impacts.[240]

1. Infrastructure Constraints

Infrastructure constraints concerning the use of ethanol extend to both the automotive fleet and the network for distributing ethanol throughout the country.[241] As mentioned previously in the Introduction, the unique chemical properties of ethanol make it fairly corrosive to engines that were not designed to run on alcohol-bearing fuels as well as to pumps, storage tanks, and pipelines.[242] Until 2010, EPA had authorized ten percent ethanol to gasoline blends ("E10") for all vehicles and eighty-five percent ethanol to gasoline blends ("E85") for all flex fuel vehicles ("FFV"), which constituted just over three percent of the U.S. automotive market.[243] In November 2010 and January 2011, under two successive orders, EPA partially granted a petition that ultimately authorized an increase in the blended amount of ethanol in gasoline to fifteen percent ("E15") for certain classes of vehicles.[244] EPA approved the use

223. Julianne Johnston, *2011 Ethanol Production Nears 14 Billion Gallons,* AgWeb.com (Mar. 1, 2012), http://www.agweb.com/article/2011_ethanol_production_nears_14_billion_gallons/.
224. Sen. Tom Coburn, *Amendment 309–Repeal the Volumetric Ethanol Excise Tax Credit (VEETC) and Save Over $3 Billion* 1 (2011), *available at* http://coburn.senate.gov/public//index.cfm?a=Files.Serve&File_id=ff76d919-1234-4e07-add8-d14925cd5524.
225. *Id.*
226. *Id.*
227. Cong. Budget Office, Using Biofuel Tax Credits, *supra* note 164, at 10.
228. *Id.*
229. *See* U.S. Energy Info. Admin., DOE/EIA-0383(2011), Annual Energy Outlook 2011 With Projections to 2035, at 81 (2011) [hereinafter U.S. Energy Info. Admin., Annual Energy Outlook 2011].
230. *Id.* at 2.
231. *Id.* at 83.
232. *See id.* at 81–83.
233. *See* United Nations Dev. Programme, *supra* note 89, at 42–43.
234. Phillip Brasher, *Chu: Ethanol Not the Best Biofuel*, Des Moines Reg. (Nov. 29, 2010, 1:20 PM), http://blogs.desmoinesregister.com/dmr/index.php/2010/11/29/chu-ethanol-not-the-best-biofuel/.
235. Robin Bravender & Darren Samuelsohn, *EPA: More Renewable Fuels Required*, Politico (Nov. 30, 2010, 9:13 AM), http://www.politico.com/news/stories/1110/45691.html#ixzz1M9m3n9Bw.
236. *See Alternative Fuels for the Military Need to Be "Drop-In," supra* note 23.
237. *See* Brasher et al., *supra* note 234.
238. Halff, *supra* note 145, at 410.
239. U.S. Energy Assoc., National Energy Security Post 9/11, *supra* note 86, at 7.
240. *See* Baker Inst., Biofuels Policy Report, *supra* note 155, at 3.
241. James A. Baker III Inst. for Pub. Pol'y of Rice Univ., Fundamentals of a Sustainable U.S. Biofuels Policy 28 (2010) [hereinafter Baker Inst., Sustainable Biofuels Policy], *available at* http://bakerinstitute.org/publications/EF-pub-BioFuelsWhitePaper-010510.pdf.
242. *Id.*
243. U.S. Dep't of Agric., A USDA Regional Roadmap to Meeting the Biofuels Goals of the Renewable Fuels Standard by 2022, at 13 (2010) [hereinafter U.S. Dep't of Agric., A USDA Regional Roadmap], *available at* http://www.usda.gov/documents/USDA_Biofuels_Report_6232010.pdf.
244. Office of Transp. & Air Quality, U.S. Envtl. Prot. Agency, EPA Announces E15 Partial Waiver Decision 1 (2011), *available at* http://www.epa.gov/otaq/regs/fuels/additive/e15/420f11003.pdf. E15 is a blend of gasoline and ethanol. *Id.*

of E15 for model year 2001 and newer cars, light duty trucks, and SUVs.[245] EPA, however, specifically prohibited the use of E15 in all motorcycles, all vehicles with heavy duty engines such as buses and delivery trucks, all off-road vehicles such as boats and snowmobiles, and all model year 2000 or older vehicles.[246] Several industry groups, including the American Petroleum Institute and the Alliance of Automobile Manufacturers, condemned EPA's decision, arguing that testing was incomplete and that the higher concentrations of ethanol would impair engine performance and cause safety problems.[247] Even with the potential to use higher ethanol blends, according to the USDA, the "limited number of FFVs, their relatively low utilization of bio-based fuels instead of gasoline, and the inability of the rest of the vehicle fleet to utilize higher blends, restricts the amount of ethanol that can actually be consumed."[248]

Turning to distribution, the ethanol industry faces significant hurdles in constructing "a vast ethanol pipeline network comparable to the existing gasoline transportation system" to achieve these blends on a national basis.[249] Gasoline is "transported very cheaply around the United States via pipeline from refineries to local distribution centers (where trucks are loaded for short-range delivery to local distribution centers) or directly to major industry consumers."[250] The United States contains approximately 160,868 miles of liquid petroleum pipelines for transporting crude oil and refined petroleum products, which allows gasoline to "be transported across the country for pennies per barrel."[251] In contrast, ethanol is distributed from distilleries in the Midwest via rail, truck, or barge with costs ranging from $.05 to $.20 per gallon depending on the mode of transportation.[252] The limited options for ethanol distribution stem from the corrosive water-carrying properties of ethanol, which "can cause pipeline scouring (which could result in perforation) and stress corrosion cracking, particularly at weld joints in pipelines, as well as storage and transportation tanks."[253] Consequently, petroleum pipeline owners are generally reluctant to share their facilities with ethanol because of the potentially damaging effects.[254] As an exception, Kinder Morgan, a company specializing in transporting energy commodities, operates an ethanol pipeline from Tampa to Orlando, which it batches with petroleum shipments to prevent corrosion.[255] Even if pipeline owners were willing to use methods like those employed by Kinder Morgan for reducing corrosion, "the geography of pipelines in the United States works against batching ethanol into existing pipeline infrastructure."[256] Most petroleum product pipelines flow from states on the southern coast of the United States toward the Midwest, but not in the opposite direction.[257] Ultimately, the failure to develop a "large-scale ethanol pipeline infrastructure increases distribution costs for ethanol to be used as either an additive to gasoline or as a substitute fuel, especially in the main gasoline consumption regions along the U.S. coasts."[258]

To lower these costs, several ethanol companies and trade groups have sought to construct an ethanol dedicated pipeline from Iowa to New Jersey with federally guaranteed loans.[259] In a 2010 report assessing the economic viability of the proposed pipeline, DOE found that "it would need to transport approximately 4.1 billion gallons of ethanol per year—a volume that exceeds projected demand in the target East Coast service area by 1.3 [billion gallons per year]."[260] DOE speculated that this level of throughput "could be achieved in this region with a significant increase in demand for E85 and/or the widespread use of ethanol blends greater than [ten] percent if an increase in the percent ethanol allowed for blending in motor gasoline is approved" by EPA.[261]

Although EPA approved higher percentage ethanol blends, E15 must still overcome several hurdles to attain sufficient market penetration.[262] As the Environmental Working Group highlighted, it is highly uncertain "how many service stations will even offer E15 because of its potentially damaging effects on small, off-road and older vehicles engines, higher emissions of certain air pollutants, uncertainty over warranties and liability protection, safety and environmental hazards, and concerns over potential misfueling."[263] Echoing these concerns, the National Association of Convenience Stores also expressed doubt as to whether the return on equity for selling E15 justifies the costs in upgrading fuel dispenser pumps, which costs approximately $20,000 per unit, and replacing storage tanks and pipes, which could increase upgrade costs to beyond $100,000 per gas station.[264] Most importantly, DOE concluded that the removal of the subsidies and tariff protections for domestic ethanol "would pose

245. Id. at 2.
246. *Id.*
247. Carlton Caroll, API: EPA is premature in E15 decision, puts more consumers at risk, Am. Petroleum Inst. (Jan. 21, 2011), *available at* http://www.api.org/Newsroom/e15-decision.cfm; *see also* Press Release, Auto Alliance, Alliance Statement Regarding EPA Decision on E15 Fuel Use (Jan. 21, 2011), *available at* http://www.autoalliance.org/index.cfm?objectid=3C21853A-2586-11E0-A62C000C296BA163.
248. U.S. Dep't of Agric., A USDA Regional Roadmap, *supra* note 243.
249. Baker Inst., Biofuels Policy Report, *supra* note 155, at 4.
250. *Id.*
251. *Id.*
252. Baker Inst., Sustainable Biofuels Policy, *supra* note 241, at 32.
253. *Id.* at 28.
254. *Id.*
255. *Id.* at 29. Ethanol is currently transported by rail (sixty-six percent), truck (twenty-nine percent), and barge (five percent) with less than one percent now moving via the Florida pipeline. Dep't of energy, Report to Congress: Dedicated Ethanol Pipeline Feasibility Study 4 (2010) [hereinafter Dep't of Energy, Report to Congress], *available at* http://www1.eere.energy.gov/biomass/pdfs/report_to_congress_ethanol_pipeline.pdf.
256. Baker Inst., Biofuels Policy Report, *supra* note 155, at 4.
257. *Id.*
258. *Id.* at 5.
259. Karpf, *supra* note 18.
260. Dep't of energy, Report to Congress, *supra* note 255, at iv.
261. *Id.*
262. *Id.* at 16–17.
263. Karpf, *supra* note 18.
264. *The American Energy Initiative: Hearing Before the Subcomm. on Energy & Power of the H. Comm. on Energy & Commerce*, 112th Cong. 4 (2011) (statement of Jeffrey Miller on behalf of the Nat'l Assoc. of Convenience Stores), *available at* http://democrats.energycommerce.house.gov/sites/default/files/image_uploads/Testimony_Miller_05.05.11_AmericanEnergyInitiative.pdf.

serious consequences for the feasibility of a dedicated ethanol pipeline."[265] With the tariff now removed, depending on respective feedstock surpluses, it potentially allows blenders to use more ethanol made from Brazilian sugar cane than from Midwestern corn.[266] Regardless, Brazil is an ally with a democratically elected government and such an outcome would likely enhance, rather than diminish, our nation's energy security.[267]

2. Limitations on Production Capacity

The second reason that protecting the domestic ethanol industry fails to improve energy security stems from the inherent limitation on production capacity. Given the amount of petroleum products consumed on a daily basis by Americans and the lower energy content of ethanol, "corn-derived ethanol can never supply anything more than a relatively small part of the overall demand for fuel in the United States."[268] It would take an immense amount of corn production to supplant domestic oil consumption.[269] For example, if the entire 2005 corn harvest were converted to ethanol using the most efficient conversion process, it would have only produced enough fuel to supply thirteen percent of the total domestic gasoline consumption.[270] Satisfying all of America's gasoline demand with corn-based ethanol would require the crop "to be grown on some 220 million hectares of arable land, or on an area roughly 20 percent larger than the country's total arable land."[271] Despite increasing yields of crop per acre over the past several decades, an acre of corn yields just over 354 gallons of ethanol, and an acre of soybeans only produces 56 gallons of diesel.[272] These limitations, in part, spurred Congress to encourage the development of advanced biofuels, including cellulosic biofuels, which would be able to take advantage of different feedstock options such as corn stover and other agricultural wastes.[273] Cellulosic biofuels, however, are still in the early phase of development and have a focus on producing ethanol, which does little to address the infrastructure constraints discussed above.[274] Due to the slower than expected development of the cellulosic biofuel industry, EIA projects that the United States will be unable to meet the thirty-six billion gallon renewable fuel standard until 2030—a full eight years behind the target date established by Congress.[275] Moreover, even when the final RFS is actually achieved, renewable fuels will account for just eleven percent of the total domestic liquid fuel supply by 2035.[276]

The production capacity for corn-based ethanol also raises the specter of the food versus fuel debate. Ethanol advocates argue that "opponents of biofuels have propagated the false notion that increased use of grain for ethanol is somehow causing a food crisis and driving retail food prices higher."[277] The reality, however, is much more complex given that "crops tend to compete for the same inputs, land, fertilizers and water (where irrigation is necessary), to find the best return on investment."[278] Additionally, a multitude of factors can impact food prices, including inclement weather, crop failures, government import and export controls, and energy costs for transportation and fertilizer.[279] When there is a greater demand for biofuels, the market will meet that demand by diverting some agricultural crops from the food supply to the production of ethanol and biodiesel in order to maximize profit.[280] An increase in demand for a particular crop will result in a corresponding price increase,[281] which also has a ripple effect on "the price of meat and dairy products because grain is used as feed."[282] For example, corn provides the largest source of livestock feed for cattle, hogs, and poultry in the United States.[283] The extent of the price increase in food that is attributable to biofuels, however, is subject to debate.[284] A report by the World Bank, which attempted to explain a 130% increase in the international food commodity price index from January 2002 to June 2008, attributed up to 75% of the increase "to biofuels and the related consequences of low grain stocks, large land use shifts, speculative activity and export bans."[285] Examining a shorter time period, the Federal Reserve Bank provided a more conservative estimate, indicating that global biofuel

265. Dep't Of Energy, Report to Congress, *supra* note 255, at 13.
266. Khanna et al, *supra* note 154; *see also* Baker Inst., Biofuels Policy Report, *supra* note 155, at 4.
267. Sean Charles Starr, *Sweet Rewards: How U.S. Trade Liberalization and Penetration of Brazilian Ethanol Into the U.S. Market Can Stimulate America's Domestic Economy and Strengthen America's International Influence*, 8 DePaul Bus. & Comm. L. J. 275, 285 (2010).
268. Vaclav Smil, Energy Myths and Realities: Bring Science to the Energy Policy Debate 101 (2010).
269. *See id.*
270. *Id.*
271. *Id.* Similar constraints are found in the production of biodiesel from soybeans. Joshua Fershee, *Struggling Past Oil: The Infrastructure Impediments to Adopting Next Generation Transportation Fuel Sources*, 40 Cumb. L. Rev. 87, 94 (2009). If the entire domestic soybean crop were converted to biofuel, it would only replace approximately six percent of total diesel consumption in the United States. *Id.* at 94, n.50.
272. Lester R. Brown, Plan B 2.0: Rescuing a Planet Under Stress and a Civilization in Trouble 34 (2006), *available at* http://www.earth-policy.org/books/pb2.
273. *Id.* at 34–35.
274. *See* U.S. Energy Info. Admin., Annual Energy Outlook 2011, *supra* note 229, at 83.
275. *Id.*
276. *See id.* at 2.
277. *The American Energy Initiative: Hearing Before the Subcomm. on Energy & Power of the H. Comm. on Energy & Commerce*, 112th Cong. 3 (2011) (statement of Bob Dinneen, Pres. & CEO, Renewable Fuels Asso.), *available at* http://democrats.energycommerce.house.gov/sites/default/files/image_uploads/Testimony_Dinneen_05.05.11_AmericanEnergyInitiative.pdf. Corn is technically a grain, although it popularly known as a vegetable.
278. Richard Doornbosch & Ronald Steenblik, Org. for Econ. Co-operation & Dev. ("OECD") Roundtable on Sustainable Development Biofuels: Is The Cure Worse Than The Disease? 33 (2007), *available at* http://www.ft.com/intl/cms/fb8b5078-5fdb-11dc-b0fe-0000779fd2ac.pdf.
279. *See* OECD, *Food Price Volatility–OECD-FAO Agricultural Outlook 2011–2020,* http://www.oecd.org/site/oecd-faoagriculturaloutlook/foodpricevolatility-oecd-faoagriculturaloutlook2011-2020.htm (last visited Dec. 18, 2012).
280. Scott Baier et al., Bd. of Governors of the Fed. Reserve Sys., No. 967, Biofuels Impact on Crop and Food Prices: Using an Interactive Spreadsheet 4 (2009), *available at* http://www.federalreserve.gov/pubs/ifdp/2009/967/ifdp967.pdf.
281. *See id.* at 2.
282. *Id.* at 6.
283. *Id.*
284. *See id.* at 17–18.
285. Donald Mitchell, *A Note on Rising Food Prices* 16–17 (The World Bank, Policy Working Paper 4682, 2008), *available at* http://www-wds.worldbank.org/external/default/WDSContentServer/IW3P/IB/2008/07/28/000020439_20080728103002/Rendered/PDF/WP4682.pdf.

production accounted for just over 12% of the rise for the two-year period ending in June 2008.[286] Domestically, the CBO estimated that the diversion of corn to ethanol production accounted for ten to fifteen percent of the rise in food prices from April 2007 to April 2008.[287]

Regardless of the actual contribution from the demand for biofuels, the price increases for food have real world impacts that reverberate through society, particularly for the more impoverished and vulnerable segments.[288] Domestically, as of 2010, the USDA classified 14.5% of U.S. households (17.2 million households) as food insecure households, meaning that they "had difficulty at some time during the year providing enough food for all their members due to a lack of resources."[289] Approximately 6.4 million households, or 5.4% of all U.S. households, had very low food security, a severe range of food insecurity in which "the food intake of some household members was reduced and normal eating patterns were disrupted due to limited resources."[290] The government often assists these households through the Supplemental Nutrition Assistance Program and the Women, Infants, and Children program.[291] The increasing demand for corn-based ethanol, however, ultimately makes these programs more expensive.[292] In 2009, the CBO found that the "increased production of ethanol most likely accounts for an estimated $600 million to $900 million, or roughly 10 percent to 15 percent of the change in federal spending for those programs as a result of higher food prices."[293] With constrained budgets and immense budget deficits, these food assistance programs are often the first to be targeted for cuts in funding.[294]

Turning to the international arena, it is much harder to absorb food price increases in developing nations where a greater share of family income goes towards purchasing food.[295] As a consequence, soaring food prices in developing countries often lead to riots and political instability.[296] Although the underlying causes of the Arab Spring are varied and complex,[297] the lack of food security and the thirty-two percent spike in international food prices during the second half of 2010 served as prime catalysts for triggering the revolts in Tunisia and Egypt.[298] Acknowledging that it was not simply politics that led to the protests in the Middle East and North Africa, President Obama observed that the "tipping point for so many people is the more constant concern of putting food on the table and providing for a family."[299]

The tension between biofuel and food will only increase in the future. The World Bank projects "that demand for food will rise by 50 percent by 2030, as a result of growing world population, rising affluence, and shifts to Western dietary preferences by a larger middle class."[300] This trend calls into question the continued use of corn as a biofuel feedstock given that the "amount of corn necessary to make enough ethanol to fill an SUV fuel tank—once—contains enough calories to feed a person for an entire year."[301] The United States may eventually need to imitate China, which "banned the use of grain-based feedstocks for biofuel production and reoriented the country's bioenergy plans toward perennial crops grown on marginal land."[302] Given these challenges over production capacity, corn-based ethanol is not a viable solution for improving our long-term energy security.

3. Adverse Environmental Impacts

Lastly, corn-based ethanol fails a key measure of energy security—the ability to obtain energy supplies in an environmentally sound manner.[303] Growing corn through industrialized agriculture causes a wide array of adverse environmental impacts on water quality, air quality, public health, and wild-

286. Baier et al., *supra* note 280, at 2.
287. Cong. Budget Office, Pub. No. 3155, The Impact of Ethanol Use on Food Prices and Greenhouse-Gas Emissions 6 (2009) [hereinafter Cong. Budget Office, Impact of Ethanol Use], *available at* http://www.cbo.gov/sites/default/files/cbofiles/ftpdocs/100xx/doc10057/04-08-ethanol.pdf.
288. *See* Elisabeth Rosenthal, *Food Prices Stir Concern About Biofuels Mandates*, N.Y. Times, Apr. 8, 2011, at A1, *available at* http://www.nytimes.com/2011/04/07/science/earth/07cassava.html.
289. Alisha Coleman-Jensen et. al., U.S. Dep't of Agric., Economic Research Report No. 125, Household Food Security in the United States in 2010, at v (2011), *available at* http://www.ers.usda.gov/media/121076/err125_2_.pdf.
290. *Id.*
291. U.S. Dep't of Agric., Nutrition Assistance Programs, *available at* http://www.fns.usda.gov/fns/ (last updated Dec. 10, 2012).
292. *See* Cong. Budget Office, Impact of Ethanol Use, *supra* note 287, at 11–12.
293. *Id.*
294. *See, e.g.*, *id.* at 11.
295. Food & Agric. Org. of the United Nations, Price Volatility in Agric. Markets: Evidence, Impact on Food Security and Policy Responses 1–2 (2010) *available at* http://www.fao.org/docrep/013/am053e/am053e00.pdf.
296. Rabah Arezki & Markus Brückner, *Food Prices, Conflict, and Democratic Change* 2–3 (The Univ. of Adelaide Sch. of Econ., Research Paper No. 2011-04, 2011), *available at* http://www.economics.adelaide.edu.au/research/papers/doc/wp2011-04.pdf.
297. Hamze Abbas Jamoul, *The Arab Spring: The Root Causes?*, Almanar News, http://www.almanar.com.lb/english/adetails.php?fromval=1&cid=31&frid=31&eid=45439 (last visited Dec. 18, 2012).
298. Ariana Eunjung Cha, *Spike in Global Food Prices Contributes to Tunisian Violence*, Wash. Post (Jan. 14, 2011, 11:14 AM), http://voices.washingtonpost.com/political-economy/2011/01/spike_in_global_food_prices_tr.html; *see also* Debora Mackenzie, *Egypt and Tunisia: Rocked by the Global Food Crisis*, New Scientist (Feb. 8, 2011, 4:42 AM), http://www.newscientist.com/article/dn20100-egypt-and-tunisia-rocked-by-the-global-food-crisis.html; Ambrose Evans-Pritchard, *Egypt and Tunisia Usher in the New Era of Global Food Revolutions*, Telegraph (Jan. 30, 2011, 1:30 PM), http://www.telegraph.co.uk/finance/comment/ambroseevans_pritchard/8291470/Egypt-and-Tunisia-usher-in-the-new-era-of-global-food-revolutions.html.
299. Barack Obama, President of the United States, Remarks on the Middle East and North Africa (May 19, 2011, 12:15 PM), *available at* http://www.whitehouse.gov/the-press-office/2011/05/19/remarks-president-middle-east-and-north-africa.
300. Nat'l Intelligence Council, *supra* note 56, at viii; *see generally* The World Bank, Reengaging in Agricultural Water Management: Challenges and Options (2006), *available at* http://siteresources.worldbank.org/INTARD/Resources/DID_AWM.pdf.
301. Roberta F. Mann, *Like Water for Energy: The Water-Energy Nexus Through the Lens of Tax Policy*, 82 U. Colo. L. Rev. 505, 521 (2011).
302. Horst Weyerhaeuser et al., *Biofuels in China: An Analysis of the Opportunities and Challenges of Jatropha Curcas in Southwest China* i (World Agroforestry Centre, Working Paper No. 53, 2007), *available at* https://jatropha.uni-hohenheim.de/fileadmin/einrichtungen/jatropha/Biofuels_in_China-An_Analysis_of_the_Opportunities_and_Challenges_of_Jatropha_Curcas_in_Southwest.pdf.
303. *See, e.g.*, United Nations Dev. Programme, *supra* note 89, at 33–34.

life habitat, all of which have been extensively documented.[304] This article focuses on water impacts because they are perhaps the most important factor in assessing whether biofuels are a viable long-term energy source.[305] Growing feedstock for biofuels may currently work for Brazil and the United States,[306] but it is simply not a realistic option for the 36 countries, home to approximately 1.4 billion people, that the National Intelligence Council ("NIC") projects will be either cropland or freshwater scarce by 2025.[307] Moreover, the NIC reports the lack of access to stable water supplies "will worsen because of rapid urbanization worldwide and the roughly 1.2 billion persons to be added over the next 20 years."[308] Countries facing water shortages are more likely to rely on petroleum-based fuels, instead of agriculturally grown biofuels, for meeting their growing energy needs.[309] Even for the United States, freshwater supplies are becoming scarcer in farming states that have been subject to more severe and prolonged droughts.[310] In those states, growing corn for ethanol simply uses too much water[311] and degrades the quality of the water that it does use.[312]

In contrast to petroleum-based fuels, ethanol derived from corn starch consumes a substantial amount of water.[313] A 2009 study by the Argonne National Laboratory found that producing gasoline from conventional U.S. crude oil consumes 3.4 to 6.6 gallons of water for every gallon of gasoline depending on the age of the oil well and the utilization rate of recycled water.[314] In comparison, producing a single gallon of ethanol from corn consumes 10 to 324 gallons of water.[315] Although the actual distillation process only consumes three gallons of water for every gallon of ethanol produced, the overall water consumption rate is heavily dependent on the extent that irrigation is used to grow corn.[316] On the low end of the range, USDA Region V—which encompasses Iowa, Indiana, Illinois, Ohio, and Missouri—consumes 7 gallons of irrigation water for every gallon of ethanol produced.[317] For the upper range, USDA Region VII—which encompasses North Dakota, South Dakota, Nebraska, and Kansas—consumes 320.6 gallons of irrigation water for every gallon of ethanol produced.[318]

Addressing the differences in energy content between gasoline and ethanol, another study examined how many gallons of water are consumed per mile driven depending on the fuel source.[319] For a typical light duty vehicle, driving a mile on petroleum-based gasoline will consume between 0.07 to 0.14 gallons of water.[320] Depending on the amount of irrigation, driving a mile using ethanol-based fuel consumes between 1.3 to 62 gallons of water, with an average of 28 gallons of water per mile,[321] which is "almost 200 times as much as petroleum gasoline."[322] Even EPA acknowledges that "the water requirements for both increased corn farming and ethanol production could lead to future water constraints that may in some regions limit yield growth potential."[323]

In addition to these water consumption challenges, industrialized agriculture negatively impacts the public water supply, which is already facing growing demand signals across the United States.[324] Industrialized agriculture involves "practices such as conversion of undeveloped land into agricultural fields, intensive water use for irrigation, fertilizer use, pesticide use, growing crops in monocultures, and tilling soils," all of which can lead to greater erosion and deteriorated water quality.[325] With increased erosion, agricultural runoff carries fertilizers and pesticides into the ground water, local streams, and rivers, resulting in varying effects on the water.[326]

Fertilizers, which contain nutrients such as phosphorous and ammonium nitrate, are a direct contributor to eutrophication, a process that leads to increased algal growth, oxygen depletion in the water table, and hypoxic areas or dead zones that are incapable of sustaining phytoplankton and other forms of life, including fish and shrimp.[327] For example, at the mouth of the Mississippi River lies the Gulf of Mexico Dead Zone, an area that "is now longer than the distance between Washington, D.C., and Hartford, Connecticut."[328] This expansive dead zone "is largely the result of commodity crop production and fertilizer application in the Corn Belt of the United States near the Mississippi River and other rivers that ultimately discharge into the Gulf of Mexico."[329]

Pesticides, including both herbicides and insecticides, also present a significant danger to both public health and

304. William S. Eubanks II, *A Rotten System: Subsidizing Environmental Degradation and Poor Public Health With Our Nation's Tax Dollars*, 28 Stan. Envtl. L.J. 213, 255–57 (2009); Mary Jane Angelo, *Corn, Carbon and Conservation: Rethinking U.S. Agricultural Policy in a Changing Global Environment*, 17 Geo. Mason L. Rev. 593, 603 (2010).
305. *See* Angelo, *supra* note 304, at 604.
306. Baker Inst., Sustainable Biofuels Policy, *supra* note 241.
307. Nat'l Intelligence Council, *supra* note 56, at 51.
308. *Id*. at viii.
309. *Id*. at 51–52.
310. Karl Plume, *Drought Worsens in U.S. Farm Srates-Climatologists*, Reuters (Aug 2, 2012, 1:07 PM), http://www.reuters.com/article/2012/08/02/us-drought-idUSBRE87110A20120802.
311. *See* M. Wu et al., Argonne Nat'l Lab., ANL/ESD/09-1, Consumptive Water Use in the Production of Ethanol and Petroleum Gasoline 6 (2009), available at http://www.transportation.anl.gov/pdfs/AF/557.pdf (comparing corn ethanol to petroleum gas production to show that even the most efficient corn ethanol production uses more water than the most water intensive ethanol or gasoline production methods).
312. Angelo, *supra* note 304, at 605.
313. Wu et al., *supra* note 311, at 6.
314. Wu et al., *supra* note 311, at 6.
315. *Id*.
316. *Id*.
317. *Id*. at 1–3. Region V accounted for fifty-one percent of ethanol production in 2006. *Id*. at 3.
318. *Id*. at 1–3.
319. *See* Mann, *supra* note 301.
320. Carey W. King & Michael E. Webber, *Water Intensity of Transportation*, 42 Envtl. Sci. & Tech. 7,866, 7,867 (2008), *available at* http://pubs.acs.org/doi/abs/10.1021/es800367m.
321. *Id*. at 7,869.
322. Mann, *supra* note 301.
323. Regulation of Fuels and Fuel Additives: Changes to Renewable Fuel Standard Program, 75 Fed. Reg. 14670, 14769 (Mar. 26, 2010) (codified at 40 C.F.R. pt. 80).
324. Angelo, *supra* note 304, at 604–05.
325. *Id*. at 603.
326. *See, e.g.,* Eubanks II, *supra* note 304, at 255–56.
327. *Id*.
328. *Id*.
329. *Id*.

aquatic life.[330] A ten-year study by the U.S. Geological Survey found that 1.2% of shallow ground water wells and 9.6% of streams in agricultural areas contain levels of pesticides that pose a threat to human health.[331] This same study found that the aquatic life benchmarks[332] were exceeded in fifty-seven percent of streams and thirty-one percent of sediment beds in agricultural areas.[333] The highest concentrations of atrazine, a prevalent pesticide and known endocrine disruptor that can adversely affect hormone levels in animals and humans, "were observed in streams within the Corn Belt and other areas where corn is a primary crop and where the herbicide is most heavily used."[334] Additionally, increased soil erosion from industrial agriculture not only depletes the topsoil necessary for future farm productivity, but it also leads to sedimentation, which "can clog streams and fill in shallow areas in water bodies, thereby reducing habitat and light availability to submersed plants."[335] Meeting the mandates established by EISA 2007 with corn-based ethanol will only encourage greater corn production, exacerbating these adverse environmental impacts.[336]

B. The Promise of Drop-In Renewable Fuels

Drop-in renewable fuels promise to provide greater energy security by overcoming many of ethanol's drawbacks. In general, drop-in renewable fuels match the performance characteristics of petroleum-based fuels and are capable of using existing petroleum-based fuel distribution networks.[337] The platforms for producing these drop-in renewable fuels have the potential to produce thousands of gallons of fuel per acre in contrast to the hundreds of gallons of conventional renewable fuels, such as corn-based ethanol and soy-based biodiesel, produced per acre.[338] Moreover, drop-in renewable fuels generally do not directly compete with agricultural food products,[339] and they do not necessarily require the conversion of forest, prairie, and other arable land to grow feedstock materials.[340] Lastly, some of these fuels do not require any freshwater for production; brackish, saline, and waste water will suffice.[341]

Not all drop-in renewable fuels, however, are created equal.[342] Each type must overcome distinct limitations and challenges to successfully attain a significant market share in the transportation fuels market.[343] But once industry achieves full scale commercialization, these drop-in renewable fuels offer an important path for transitioning away from petroleum as the demand for liquid fuel outstrips the production capacity of oil producing nations.[344] Although certainly not an exhaustive list, the most promising drop-in renewable fuels include isobutanol,[345] algae-based fuel,[346] and diesel produced from microorganisms.[347]

1. Isobutanol

Categorically classified as an advanced biofuel by EISA 2007,[348] isobutanol is a four-carbon alcohol that "can be shipped in existing pipelines and blended with a variety of fossil fuel-based material to produce greener versions of jet fuel, rubber, polyethylene or diesel."[349] Possessing two more carbon atoms than ethanol, isobutanol contains almost thirty percent more energy and has a lower water solubility, which means that it lacks the corrosive properties associated with ethanol. It is, therefore, more "compatible with the current gasoline distribution infrastructure and would not require new or modified pipelines, blending facilities, storage tanks, or retail station pumps."[350] Although current EPA regulations permit blending isobutanol with gasoline in concentrations up to 11.5% by volume, limited testing has shown that gasoline-powered vehicles can be fueled with isobutonol blends of 85% or greater with little to no modification.[351] Given these advantages, the industry asserts that isobutanol could easily overcome ethanol's 15% blend limitation.[352] More importantly, the industry has developed the technology to modify existing ethanol production facilities to produce isobutanol.[353] This means that the market could produce significant quantities of isobutanol without having to start a completely new industrial base from the ground up.[354] Despite these benefits, transitioning facilities from ethanol to isobutanol production is somewhat stymied by legislative preferences for ethanol. Isobutanol, for instance,

330. Baker Inst., Sustainable Biofuels Policy, *supra* note 241, at 64.
331. U.S. Geological Survey, The Quality of Our Nation's Waters: Pesticides in the Nation's Streams and Ground Water, 1992–2001, at 6 (2006), *available at* http://pubs.usgs.gov/circ/2005/1291/pdf/circ1291.pdf.
332. Aquatic life benchmarks "are estimates of the concentrations below which pesticides are not expected to harm aquatic life." *Office of Pesticide Programs' Aquatic Life Benchmark,* U.S. Envtl. Prot. Agency, http://www.epa.gov/oppefed1/ecorisk_ders/aquatic_life_benchmark.htm (last updated May 30, 2012).
333. U.S. Geological Survey, *supra* 331, at 8.
334. *Id.* at 12.
335. Angelo, *supra* note 304, at 606.
336. *See, e.g.*, Khanna et al., *supra* note 154, at 569–570.
337. *See infra* text accompanying notes 349 and 372.
338. *See, e.g.*, Press Release, Joule, Joule Secures First of Multiple Sites to Host Solar Fuel Production (May 5, 2011) [hereinafter Joule Press Release], *available at* http://www.jouleunlimited.com/news/2011/joule-secures-first-multiple-sites-host-solar-fuel-production.
339. *See infra* text accompanying notes 361–363 and 370–371.
340. *See infra* text accompanying note 370.
341. *See* Biomass Prog., U.S. Dep't of Energy, National Algal Biofuels Technology Roadmap 3 (2010) [hereinafter National Algal Biofuels Technology Roadmap], *available at* http://www1.eere.energy.gov/biomass/pdfs/algal_biofuels_roadmap.pdf.
342. *See infra* Part II.B.1–3.
343. *See infra* Part II.B.1–3.
344. *See infra* pp. 104–05.
345. *See infra* Part II.B.1.
346. *See infra* Part II.B.2.
347. *See infra* Part II.B.3.
348. *See* CAA § 211(o)(1)(B), 42 U.S.C. § 7545(o)(1)(B) (Supp. III, vol. 4 2010).
349. Michael Kannellos, *Can Isobutanol Replace Ethanol?*, Greentechmedia.com (June 1, 2011), http://www.greentechmedia.com/articles/read/can-isobutanol-replace-ethanol/.
350. U.S. Dep't of Energy, *Biobutanol,* Alternative Fuel Data Center, http://www.afdc.energy.gov/fuels/emerging_biobutanol.html (last updated July 30, 2012).
351. *Id.*
352. *Id.*
353. *See* Kannellos *supra* note 349.
354. *See* Transp. Fuels, GEVO, Renewable Solution: Isobutanol—A Renewable Solution for the Transportation Fuels Value Chain 7 (2011), *available at* http://www.gevo.com/wp-content/uploads/2011/05/GEVO-wp-iso-ftf.pdf.

was not eligible for the ethanol blending credit, and ethanol, which currently costs less to produce, still currently enjoys a de facto carve out under RFS2.[355]

Two companies, Gevo and Butamax, are at the forefront of developing the technology to drive down the costs for producing isobutanol from biomass.[356] Gevo has developed a patented fermentation technology using genetically modified yeast that "was designed to enable the low cost retrofit of existing ethanol capacity for isobutanol production."[357] The company recently purchased an ethanol plant in Minnesota, which was expected to produce eighteen million gallons of isobutanol in 2012.[358] By converting isobutanol into isobutylene and paraffinic kerosene, "Gevo has already produced renewable gasoline and jet fuel that meet or exceed all [American Society for Testing and Materials International ("ASTM")] specifications."[359]

Butamax, a joint venture by DuPont and BP, utilizes a similar technology that uses sugarcane and corn to produce isobutanol.[360] Aiming to bypass the food versus fuel debate, both Gevo and Butamax ultimately seek to produce isobutanol from higher yielding cellulosic biomass, "including fast-growing energy crops (e.g., energy grasses) or agricultural by-products (e.g., corn stalks)."[361] A potential boon for both companies in meeting this goal, researchers at the Oak Ridge National Laboratory recently developed a genetically modified microorganism that combines several steps—pretreatment, enzyme treatment, and fermentation—into a single process for converting cellulosic biomass into isobutanol.[362] Nevertheless, until the production of isobutanol shifts away from corn as a feedstock, this particular fuel will be plagued by the same drawbacks as ethanol, including limited production capacity, competition with agricultural food commodities, and adverse environmental impacts.[363]

2. Algae-Based Fuel

Listed as a potential source of advanced biofuel under EISA 2007,[364] algae are photosynthetic organisms that convert solar energy, carbon dioxide, and water into oxygen and macromolecules such as carbohydrates and lipids.[365] Many of these macromolecules are potential biofuels or biofuel precursors for producing diesel, gasoline, and alcohol fuels.[366] Compared to ethanol-based fuels, algae-based fuels possess several distinct advantages.[367] First, algal productivity offers "high biomass yields per acre of cultivation," with the DOE projecting annual yields of anywhere from 1,000 to 6,500 gallons of oil per acre.[368] Some "algae strains are projected to be at least sixty times higher than from soybeans, approximately fifteen times more productive than jatropha, and approximately five times that of oil palm per acre of land on an annual basis."[369] Second, algae can be cultivated in photo-bioreactors and open ponds, thereby avoiding the need to use arable land best saved for food production, grazing, or conservation.[370] Third, algae can be cultivated using "waste water, produced water, and saline water, thereby reducing competition for limited freshwater supplies."[371] Fourth, fuels produced from algae "have the potential to be more compatible than other biomass-based fuels with the existing fuel-distribution infrastructure."[372]

For these reasons, the private sector and the government have taken a keen interest in the development of algae-based fuels.[373] Exxon, in collaboration with Synthetic Genomics, has already committed to investing over $600 million in research and development to eventually incorporate algae-based fuels into the petroleum production pipeline.[374] The U.S. Navy has already purchased significant quantities of algae-based fuel from Solazyme, a publicly traded company that utilizes a heterotrophic process to grow algae in the dark by "consuming sugars derived from plants that have already harnessed the sun's energy."[375]

Algae-based fuel, however, faces a myriad of challenges in reaching full-scale commercialization.[376] A 2009 study by Accenture reported that a significant long-term commitment to algae-based fuels is needed to reduce "current cost estimates—ranging from approximately $2 to $8 per liter ($8 to $30 per gallon)—and to scale-up the production of strains and processes that are company-specific, environment-specific (i.e., location and conditions), and have

355. *See* Powers, *supra* note 10, at 672–73.
356. *See* Kannellos *supra* note 349.
357. *Company Overview*, Gevo, http://www.gevo.com/about/company-overview/ (last visited Oct. 30, 2012).
358. David Shaffer, *In Luverne, Corn Based Fuel Takes a New Turn*, Star Trib. (June 1, 2011, 9:10 AM), http://www.startribune.com/business/122743589.html.
359. *Gevo Produces Isobutanol, Hydrocarbons and Renewable Jet Fuel From Cellulosic Biomass*, Green Car Congress (July 29, 2010), http://www.greencarcongress.com/2010/07/gevo-produces-isobutanol-hydrocarbons-and-renewable-jet-fuel-from-cellulosic-biomassgevo-20100729.html.
360. Butamax Advanced Biofuels, LLC, Global Agricultural Fact Sheet 2 (n.d.), *available at* http://www.butamax.com/_assets/pdf/global_agriculture_fact_sheet.pdf.
361. *Id*.
362. *BESC Scores a First With Isobutanol Directly From Cellulose*, Oak Ridge Nat'l Lab. (Mar. 7, 2011), http://www.ornl.gov/info/press_releases/get_press_release.cfm?ReleaseNumber=mr20110307-00.
363. *See supra* Part II.A.2–3.
364. Sissine, *supra* note 191, at 6.
365. National Algal Biofuels Technology Roadmap, *supra* note 341, at 11.
366. *Id*. at 48.
367. *Id*. at 2.
368. *Id*. at 3. Algae encompass a diverse group of organisms that "include microalgae (unicellular eukaryotic organisms), macroalgae (seaweeds), and cyanobacteria (historically known as blue-green algae)." *Id*. at 8.
369. *Id*. at 2.
370. *See id*. at 29.
371. *Id*. at 3.
372. *Id*. at 48.
373. *See, e.g.*, Exxon Mobil, ExxonMobil Algae Biofuels Research and Development Program (2011), *available at* http://www.exxonmobil.com/Corporate/Files/news_pub_algae_brochure.pdf; *see also* Katie Howell, *Exxon Sinks $600M Into Algae-Based Biofuels in Major Strategy Shift*, N.Y. Times (July 14, 2009), http://www.nytimes.com/gwire/2009/07/14/14greenwire-exxon-sinks-600m-into-algae-based-biofuels-in-33562.html; *see also Biotechnology That Creates Renewable Oils From Microalgae*, Solazyme, http://www.solazyme.com/technology (last visited Dec. 18, 2012); *Solazyme Completes World's Largest Microbial Advanced Biofuel Delivery to U.S. Military*, Solazyme (Sept. 15, 2010), http://www.solazyme.com/media/2010-09-15.
374. ExxonMobil, *supra* note 373; Howell, *supra* note 373.
375. *Biotechnology That Creates Renewable Oils*, *supra* note 373; *Solazyme Completes World's Largest Microbial Advanced Biofuel Delivery to U.S. Military*, *supra* note 373.
376. *See* National Algal Biofuels Technology Roadmap, *supra* note 341, at 6.

multiple interdependent steps."[377] DOE came to the same conclusion in the 2010 National Algal Biofuels Technology Roadmap, where it found "that a great deal of [research, development, and demonstration] is still necessary to reduce the level of risk and uncertainty associated with the algae-to-biofuels process so it can be commercialized."[378] More recently, in a congressionally mandated report issued in 2011, the RAND Corporation provided a more blunt assessment of the military's focus on drop-in renewable fuels by opining that algae-based fuel is "a research topic, not an emerging option that the military can use to supply its operations."[379] In response, "several critics of the study suggested that its authors failed to engage a number of sectors that might have given them a better understanding of algae's potential as a liquid fuel, its overall state of development and its potential for ramping up to commercial scale at some point in the future."[380] Despite these challenges, the Navy continues to push forward with algae-based fuels, with the long-term goal to reduce dependence on unstable regimes for energy supplies and to limit the impact of volatility and price shocks in the oil market.[381] Providing a rationale for this effort, Secretary of the Navy Ray Mabus said that the military "can help get some of these smaller companies and some of these new technologies over the hurdle from being just a good idea to being commercially viable."[382] It will still take time, however, to reach commercialization. Even the head of the Algal Biomass Organization, who would be expected to provide an optimistic timetable, predicts that algae-based fuels will not be cost competitive with petroleum until at least 2017 or 2018.[383]

3. Diesel Produced From Microorganisms

Bioengineering microorganisms that can secrete hydrocarbons presents a very promising path to drop-in renewable fuels.[384] Although several companies are pursuing this strategy, two companies, Amyris and Joule, are leading the way with very different approaches for producing drop-in renewable diesel.[385] Amyris has developed a process that uses genetically modified yeast to convert sugar into isoprenoids,[386] a class of organic compounds composed of two or more units of hydrocarbons.[387] In particular, Amyris has focused on producing a fifteen carbon hydrocarbon, known as biofene, that may be used in a wide variety of products, including renewable diesel, cosmetics, and lubricants.[388] Independent testing has shown that renewable diesel produced by Amyris "performs as well as or better than both petroleum diesel and biodiesel on critical ASTM International certification metrics."[389] Moreover, in comparison to petroleum-based diesel, Amyris' renewable diesel offers several environmental benefits, including an eighty percent reduction of greenhouse gas emissions, zero sulfur emissions, lower nitrogen oxide emissions, lower particulate matter emissions, and lower carbon monoxide emissions.[390] Based on these factors and additional road testing, EPA increased the authorized blend level of Amyris' renewable diesel from twenty to thirty percent, the highest blend level authorized by EPA for the commercial sale of renewable fuel as of November 2010.[391] To jump start production, Amyris turned to Brazil, where it has formed a partnership with Santelisa Vale, the second-largest sugar company in the country, and where it has already started "refitting some of that firm's ethanol plants in order to make drop-in diesel."[392] Now operational, the company had anticipated producing over thirteen million gallons of biofene from its San Paolo production facility in 2012.[393]

Taking a radically different but simplistic approach, Joule has developed a patented system that converts sunlight and waste carbon dioxide directly into liquid fuels without the use of biomass feedstock, freshwater supply, or arable land.[394] Instead of relying on yeast or algae that synthesize fuel from plant sugars, Joule genetically engineered several strains of cyanobacteria that use photosynthesis to convert carbon dioxide into various chemical compounds, such as ethanol or hydrocarbons.[395] The process begins by pumping waste

377. Accenture, Betting on Science: Disruptive Technologies in Transport Fuels 9 (2009), *available at* http://home.accenture.com/SiteCollectionDocuments/PDF/Accenture_Betting_on_Science_Study_Overview.pdf.

378. National Algal Biofuels Technology Roadmap, *supra* note 341, at 5.

379. James T. Bartis & Lawrence Van Bibber, RAND Nat'l Def. Research Inst., Alternative Fuels for Military Applications xvi (2011), *available at* http://www.rand.org/content/dam/rand/pubs/monographs/2011/RAND_MG969.pdf.

380. Tom Zeller, Jr., *The Future of Algae Is . . . When?*, N.Y. Times (Jan. 25, 2011, 2:50 PM), http://green.blogs.nytimes.com/2011/01/25/the-future-of-algae-fuels-is-when/.

381. John Tomasic, *Navy Secretary Mabus Unabashed About "Choosing Winners" in Fuel Market,* Colo. Indep. (July 13, 2011, 6:55 AM), http://coloradoindependent.com/93805/navy-secretary-mabus-unabashed-about-%E2%80%98choosing-winners%E2%80%99-in-fuel-market.

382. *Id*.

383. Stacey Feldman, *Algae Fuel Inches Toward Price Parity With Oil*, Inside Climate News (Nov. 22, 2010), http://solveclimatenews.com/news/20101122/algae-fuel-inches-toward-price-parity-oil.

384. *See, e.g.*, Bryan Walsh, *Big Oil Invests in Small Renewables*, TIME (May 9, 2011), http://ecocentric.blogs.time.com/2011/05/09/big-oil-invests-in-small-renewables/.

385. *See Production Process*, Amyris, http://www.amyrisbiotech.com/en/science/production-process (last visited Dec. 18, 2012); *see also The Helioculture Platform*, Joule, http://www.jouleunlimited.com/why-solar-fuel/how-it-works (last visited Dec. 18, 2012).

386. *Production Process*, *supra* note 385.

387. Richard H. Eastman & Ronald H. Kluger, *Isoprenoid*, Encyclopedia Britannica, http://www.britannica.com/EBchecked/topic/296490/isoprenoid (last visited Dec. 18, 2012).

388. *Production Process*, *supra* note 385.

389. *Renewable Diesel Fuel*, Amyris, http://www.amyrisbiotech.com/en/markets/fuels/renewable-diesel-fuel (last visited Dec. 18, 2012).

390. *Id*.

391. Press Release, Amyris, No Compromise® Renewable Diesel Receives Highest EPA Blending Registration for Renewable Fuel (Nov. 1, 2010), *available at* http://www.amyrisbiotech.com/en/newsroom/186-amyris-no-compromiser-renewable-diesel-receives-highest-epa-blending-registration-for-renewable-fuel.

392. *The Future of Biofuels: The Post-Alcohol World,* Economist (Oct. 28, 2010), *available at* http://www.economist.com/node/17358802.

393. Todd Woody, *Amyris Opens Biochemical Factory in Brazil*, Forbes (Apr. 29, 2011, 10:14 AM), http://blogs.forbes.com/toddwoody/2011/04/29/amyris-opens-biochemical-factory-in-brazil/.

394. *Frequently Asked Questions*, Joule, http://www.jouleunlimited.com/faq (last visited Dec. 18, 2012).

395. Paul Voosen, *As Algae Bloom Fades, Photosynthesis Hopes Still Shine*, N.Y. Times (Mar. 29, 2011), *available at* http://www.nytimes.com/

carbon dioxide from an industrial emitter into a module consisting of flat translucent panels that house a circulating medium of non-potable water, micronutrients, and proprietary microorganisms.[396] Charged by sunlight, the cyanobacteria consume the carbon dioxide and continuously secrete, through carbon fixation, the desired end product into the medium.[397] A separator then extracts the product, leaving the microorganisms to continue production for approximately eight weeks before the panels must be cleaned and inoculated with new cyanobacteria.[398] Having already demonstrated the technology at a pilot plant in Texas,[399] Joule has taken the first steps to build a commercial production facility. Joule has entered into a lease agreement for 1,200 acres in Lea County, New Mexico and has the potential to expand the renewable fuel production project to 5,000 acres.[400] Dwarfing the production capacity of other renewable fuels that must rely on costly biomass as feedstock,[401] Joule anticipates that it will be able to achieve commercial "delivery of up to 15,000 gallons of diesel and 25,000 gallons of ethanol per acre per year" at full-scale production.[402] Given that Joule reports it can produce diesel at the cost of $50 per barrel without subsidies, this emerging technology platform for producing drop-in renewable fuel promises to significantly transform the transportation fuels market.[403]

C. *Fulfilling the Promise of Drop-In Renewable Fuels*

Politicians have historically and unrealistically touted homegrown biofuels as the key to achieving energy independence and greater energy security.[404] Real worldwide energy security, however, comes from the ability to develop an economically sustainable platform that is capable of producing a fungible energy commodity from almost anywhere in the world.[405] Drop-in renewable fuels, at least those engineered to have a minimal impact on agricultural and fresh water resources, show promise in actually achieving long-term energy security for a future marked by increasingly scarce resources. To fulfill this promise, Congress must recognize the problem, establish a new drop-in renewable fuel standard, and strive to achieve parity in promoting drop-in renewable fuels.

1. Recognize the Problem

The first step in addressing a problem is recognizing that there is one in the first place. The problem in this case is the mistaken belief that free-market capitalism alone will solve the challenge of achieving greater energy security. Recognizing this problem is especially important given that some members in Congress are already calling for the repeal of the renewable fuel standard based on the premise that the government should not pick winners and losers in the ostensibly free marketplace of transportation fuels.[406] This argument has merit, but the premise is faulty for at least three reasons. First, Congress has been intimately involved in shaping the transportation fuels market since at least 1916, when it first allowed the expensing of intangible drilling costs to promote oil exploration.[407] Even if Congress completely repealed the renewable fuel standard, Congress would still be effectively picking the petroleum industry as a net winner based on reduced royalty rates for oil obtained from federal lands and existing exemptions, deductions, and credits within the tax code for petroleum–based fuels.[408] Given the entrenched legislative preferences for the petroleum industry, promoting the development of drop-in renewable fuels at least provides a semblance of balance under the law.[409]

Second, the transportation fuels market is not entirely free given the coordinated effort by OPEC to manipulate prices in the global oil market.[410] This point sheds light on a primary justification for why Congress should encourage the development of renewable fuels.[411] When OPEC sets production quotas to raise the price of oil, IOCs, such as Exxon and BP, indirectly benefit through increased profit margins from their producing oil wells.[412] Although these increased profit margins benefit the shareholders of these private companies, the same cannot be said for the American people.[413] As such, our federal government has an independent interest in limiting the ability of OPEC, which is really a small collective of sovereign nations, to impact our nation's energy security, economic productivity, and foreign policy.[414]

Lastly, the U.S. Military has heavily subsidized the delivery of oil to world markets by enforcing variants of the Carter Doctrine in the Middle East for over the past three

gwire/2011/03/29/29greenwire-as-algae-bloom-fades-photosynthesis-hopes-stil-54180.html?pagewanted=all. Although cyanobacteria are commonly known as blue-green algae, Joule's microorganisms are not algae. *Frequently Asked Questions, supra* note 394. "Algae are defined as *eukaryotic* photosynthetic microorganisms, whereas Joule's engineered microorganisms are *prokaryotic* due to their lack of intracellular organelles, chloroplasts, nucleus and their use of prokaryotic ribosomes." *Id.*

396. *The Helioculture Platform*, *supra* note 385.
397. *Id.*
398. *Id.*
399. Voosen, *supra* note 395.
400. Joule Press Release, *supra* note 338.
401. *Id.*
402. *Why Joule?*, Joule, http://www.jouleunlimited.com/why-solar-fuel/overview (last visited Dec. 18, 2012).
403. Nathanial Gronewold, *Alt-Fuel Hopefuls Make Plays for Oil Companies' Cash*, N.Y. Times (Mar. 11, 2011), http://www.nytimes.com/gwire/2011/03/11/11greenwire-alt-fuel-hopefuls-make-plays-for-oil-companies-44218.html?scp=2&sq=joule&st=cse.
404. *See* Halff, *supra* note 145, at 408–09.
405. *See, e.g.*, United Nations Dev. Programme, *supra* note 89, at 33–34.
406. *See, e.g.*, Press Release, Sen. Jim DeMint, DeMint Supports Coburn Ethanol Amendment; Will Offer Separate Amendment to End Ethanol Mandates & Lower Taxes for Family Farms (June 10, 2011), *available at* http://demint.senate.gov/public/index.cfm?p=PressReleases&ContentRecord_id=d9db6fc4-ff8a-4cea-88e7-5ed98bf66d26.
407. Molly F. Sherlock, Cong. Research Serv., R41227, Energy Tax Policy: Historical Perspectives on and Current Status of Energy Tax Expenditures 2–3 (2010), *available at* http://www.cnie.org/NLE/CRSreports/10Jun/R41227.pdf.
408. *See* Robert Barkman James, *Oil and the Environment: Reducing Oil Dependency in the Automotive Sectors*, 15 U. Balt. J. Envtl. L. 1, 15–17 (2007).
409. *See id.* at 16–17.
410. Ronald E. Minsk et al., *Plugging Cars Into the Grid: Why the Government Should Make a Choice*, 30 Energy L. J. 317, 338 (2009).
411. *See, e.g.*, *id.* at 339; *see also* Gately, *supra* note 97, at 16.
412. *See* Jaffe & Soligo, *supra* note 109, at 26–27.
413. Minsk et al., *supra* note 410, at 339.
414. *See id.* at 339–40.

decades.[415] One study concludes that the United States spent approximately $7.6 trillion dollars from 1976 to 2007 (in 2008 dollars) on the cost of force projection in the Persian Gulf to deter conflict and to support ongoing military operations.[416] If these costs were directly passed on to consumers at the pump, then perhaps the free market would produce drop-in renewable fuels without the guiding hand of Congressional mandates.

A completely free market solution for ensuring greater energy security would entail removing subsidies and tax preferences for all types of energy (i.e., oil, gas, and renewable), breaking OPEC's pricing power in the oil market, and ending the U.S. Military's energy security mission in the Middle East. None of these courses of action are likely to happen, let alone all three. Thus, given the challenges associated with our reliance on foreign oil, it is appropriate for Congress to shape a renewable fuels policy based on a hybrid of free-market and government-managed capitalism. In shaping that policy, however, Congress has the responsibility to do so in a way that is economically sound and environmentally neutral.[417] With this guiding principle in mind, this article sets forth the following recommendations to transition our national renewable fuel policy away from ethanol and towards drop-in renewable fuels.

2. Establish a New Drop-In Renewable Fuel Standard

Achieving greater energy security with drop-in renewable fuels will require a long-term commitment from both private industry and the government given the time necessary for research, development, and commercialization.[418] Private industry is moving in the right direction, as evidenced by the investments of leading energy companies mentioned above.[419] Additionally, the U.S. Navy is certainly on the right path, sending a clear signal to the market that it is only interested in purchasing drop-in renewable fuels that do not directly compete with food crops.[420] Despite these positive steps, the current renewable fuel standard places little emphasis on developing fuels that are actually compatible with the existing petroleum-based infrastructure and fuel systems.[421] To the contrary, EISA 2007 protects the ethanol industry by establishing a de facto carve out for corn ethanol and by exempting existing ethanol facilities from the requirement to produce fuel that achieves a twenty percent reduction in greenhouse gases.[422] Moreover, EISA 2007 encourages the development of additional ethanol production facilities given that the first three examples under the definition of advanced biofuel all involve ethanol derived from a feedstock other than corn.[423] When EPA proposed the cellulosic fuel standard for 2012, it based the revised target on the anticipated output from individual facilities, more than half of which produced cellulosic ethanol.[424]

These measures ultimately hurt the development of drop-in renewable fuels because they artificially preserve ethanol's share of the renewable fuels market.[425] In a properly functioning market, a superior and competitively priced renewable fuel should eventually displace an inferior one through competition.[426] Under RFS2, if a company developed a competitively priced drop-in renewable fuel, it would struggle to gain market share in this overly regimented system.[427] To address this market failure, Congress should repeal the categorical production quotas of the current renewable fuel standard and establish a new drop-in renewable fuel standard.

This new drop-in renewable fuel standard would require all renewable fuels to closely match the performance characteristics of petroleum-based fuels and to be compatible with existing petroleum-based infrastructure and fuel systems. Although the Navy provides a good starting point for assessing compatibility by using a 50/50 blend of drop-in renewable fuels and petroleum fuels,[428] Congress and EPA may require greater flexibility—at least initially—in setting an appropriate blend to take advantage of fuel technologies that are already, or about to be, available in the market. In other words, so long as the drop-in renewable fuel is completely compatible with the existing distribution infrastructure, a 35/65 blend for engine use may be an appropriate starting point for assessing compatibility. Over time, however, the standard should increase to at least a 50/50 blend and perhaps even more as drop-in renewable fuel technology advances.[429]

With regard to limiting greenhouse gas emissions, setting different reduction targets for different types of renewable

415. Roger J. Stern, *United States Cost of Military Force Projection in the Persian Gulf, 1976-2007*, 38 Energy Pol'y 2816, 2825 (2010).

416. *Id.*

417. *See, e.g.*, Office of Speaker Pelosi et al., Building the Clean Energy Economy 30 (2009) ("The U.S. Congress can pass climate legislation that is both environmentally effective and economically sound . . . .") (quoting Charles O. Holliday, Chairman of the Board, DuPont, discussing the proposed Waxman-Markey American Clean Energy and Security Act), *available at* http://globalwarming.house.gov/files/WEB/ACESPacket/ACESCleanEnergyPlan.pdf.

418. *See* Office of Sci. & Tech. Pol'y, National Bioeconomy Blueprint 24–25 (2012), *available at* http://www.whitehouse.gov/sites/default/files/microsites/ostp/national_bioeconomy_blueprint_april_2012.pdf.

419. *See id.* at 50–57.

420. *See* A Navy Energy Vision, *supra* note 21, at 6 ("The first alternatives currently under evaluation are derived from hydroprocessed renewable non-food plant and algal feedstocks . . . .").

421. *See* Regulation of Fuels and Fuel Additives: 2011 Renewable Fuel Standards, 75 Fed. Reg. 76790, 76757 (Dec. 9, 2010) (codified at 40 C.F.R. pt. 80).

422. *See* Regulation of Fuels and Fuel Additives: Changes to Renewable Fuel Standard Program, 75 Fed. Reg. 14670, 14677 (Mar. 26, 2010) (codified at 40 C.F.R. pt. 80).

423. CAA § 211(o)(1)(B)(ii)(I)–(III), 42 U.S.C. § 7545(o)(1)(B)(ii)(I)–(III) (Supp. III, vol. 4 2010).

424. Regulation of Fuels and Fuel Additives: 2012 Renewable Fuel Standards, 76 Fed. Reg. 38844, 38846–47 (July 1, 2011) (codified at 40 C.F.R. pt. 80).

425. *See* Timothy A. Slating & Jay P. Kesan, *Making Regulatory Innovation Keep Pace With Technological Innovation*, 2011 Wis. L. Rev. 1109, 1145 (2011) (ethanol currently saturates the limited captive market for renewable fuels, preventing biobutanol's successful commercialization).

426. *See* Bryan Sims, *A Call for Statutory Clarity: Is the Current Regulatory Regime Hindering Commercialization of Advanced Biofuels?*, Biorefining Mag. (Sept. 20, 2011), http://www.biorefiningmagazine.com/articles/5796/a-call-for-statutory-clarity.

427. *See e.g.*, Christopher Helman, *How a Dumb Law Blocks a Great Way to Fuel America*, Forbes (Apr. 3, 2012, 3:38 PM), http://www.forbes.com/sites/christopherhelman/2012/04/03/ethanol-minus-the-corn-it-could-fuel-america-if-it-werent-illegal/.

428. *See* A Navy Energy Vision, *supra* note 21, at 6.

429. *See, e.g.*, A Navy Energy Vision, *supra* note 21, at 6.

fuels unfairly segments the market according to the comparative costs for achieving different emission standards.[430] The current renewable fuel standard effectively locks in ethanol's share of the market and provides no incentive for existing ethanol facilities to improve emission standards.[431] In contrast, the new drop-in renewable standard should establish the same greenhouse gas reduction target for all fuels, including those from existing plants. At first, a twenty percent reduction may suffice given that it is the minimum reduction required under the current renewable fuel standard.[432] Over time, with the appropriate rulemaking authority, EPA should increase the reduction target[433] while taking into consideration industry's ability to cost-effectively modify existing production plants.[434] As industry gains more experience, it will most likely become more efficient, which should mean less greenhouse gas emissions over time.[435]

Although a difficult proposition for politicians from the Corn Belt, adopting a drop-in renewable fuel standard simply makes more economic sense than continuing a policy that systematically favors ethanol.[436] In contrast to ethanol, drop-in renewable fuel would not have the same compatibility issues and would therefore find a more readily accepting market at refineries for eventual distribution to local gas stations.[437] Although these fuels may initially cost more than ethanol, and perhaps even more than petroleum fuel depending on the price of oil, costs will eventually decrease as industry gains more experience and production ramps up to large-scale commercialization to meet the growing demand for transportation fuels.[438] Additionally, Congress would no longer have to spur demand for an artificially inflated ethanol market by spending taxpayer money on special blending pumps at gas stations, ethanol only distribution pipelines, and flex-fuel engines.[439]

To limit the economic impacts of an abrupt change in policy, the new drop-in renewable fuel standard should fully go into effect several years after the date of enactment in order to provide industry sufficient lead time to prepare and adjust.[440] During this transition period, EPA should have the authority to gradually adjust and replace the production quotas under EISA 2007, with the overarching goal of having a single drop-in renewable fuel standard.[441] In practice, existing ethanol production facilities could be converted to produce isobutanol assuming that additional testing proves that it is actually compatible with petroleum-based fuel in higher concentrations.[442]

From a global perspective, establishing a drop-in renewable fuel standard may create a pathway that will allow other countries to improve their energy security as well.[443] Once companies develop the technology and production methods for large-scale commercialization, that technology can be licensed to other companies across the globe so that other countries can develop the capacity to produce drop-in renewable fuels.[444] In Southeast Asia, which expects to see significantly increased demand for transportation fuels through 2035, drop-in renewable fuels provide a mechanism for reducing tensions over competing oil claims in the South China Sea.[445] A 2010 U.S. Geological Survey estimated that this region of Southeast Asia contains over 21.6 billion barrels of undiscovered oil and 299 trillion cubic feet of undiscovered natural gas.[446] Without an alternative transportation energy source, the race for the oil beneath the South China Sea runs the risk of igniting a war on a body of water through which over half the world's sea-borne commerce transits every year.[447] It is no small coincidence that President Obama, as part of a national defense review, recently proclaimed that "as we end today's wars, we will focus on a broader range of challenges and opportunities, including the security and prosperity of the Asia Pacific."[448]

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430. *See* Assessment & Standards Div., U.S. Envtl. Prot. Agency, Renewable Fuel Standard Program (RFS2) Regulatory Impact Analysis 810 tbl. 4.4-4. (2010), *available at* http://www.epa.gov/otaq/renewablefuels/420r10006.pdf.
431. *See* Nat'l Research Council, *supra* note 13, at 30.
432. *See, e.g.*, Regulation of Fuels and Fuel Additives: Changes to Renewable Fuel Standard Program, 75 Fed. Reg. 14670, 14677 (Mar. 26, 2010) (codified at 40 C.F.R. pt. 80).
433. Caution should be taken in raising the reduction target too quickly; EPA may inadvertently increase the cost of drop-in renewable fuels to the point where they are more expensive than oil from Canadian tar sands, a commodity distilled through a process that produces significantly more greenhouse gases than conventional drilling methods. *See* Richard K. Lattanzio, Cong. Research Serv., R42537, Canadian Oil Sands: Lifecycle Assessments of Greenhouse Gas Emissions 20 fig.3 (2012), *available at* http://www.fas.org/sgp/crs/misc/R42537.pdf. The underlying aim of a drop-in renewable fuels policy is to capture greater market share in the transportation fuel sector, which requires a competitively priced product that can displace petroleum-based fuels. *See* James I. Hileman et al., Near-Term Feasibility of Alternative Jet Fuels 3 (2009), *available at* http://web.mit.edu/aeroastro/partner/reports/proj17/altfuelfeasrpt.pdf.
434. *See* Bryan Sims, *Fitting the Right Retrofit*, Biorefining Mag. (Oct. 7, 2010), http://www.biorefiningmagazine.com/articles/158/fitting-the-right-retrofit.
435. *See* Assessment & Standards Div., *supra* note 430, at 754 (noting that the renewable fuels industry typically proceeds up a learning curve, leading to more efficient plants over time).
436. *See supra* II.A.1–3.
437. *See* U.S. Dep't of Energy, *Drop-In Biofuels,* Alternative Fuels and Advanced Vehicle Data Center (May 16, 2012), http://www.afdc.energy.gov/afdc/fuels/emerging_dropin_biofuels.html.
438. *See, e.g.*, Jasvinder Singh & Sai Gu, *Commercialization Potential of Microalgae for Biofuels Production*, 14 Renewable & Sustainable Energy Revs. 2596, 2608 (2010) (concluding that more research and development will help algal biofuels become economically practicable).
439. *See* Assessment & Standards Div., *supra* note 430, at 771–72 tbl. 4.2-2 (total cost to distribute additional volume of ethanol required by RFS2 will be $5.5 billion by 2022).
440. *See* Sims, *A Call for Statutory Clarity, supra* note 426 ("While an industry-wide retrofit strategy for corn ethanol plants to integrate advanced biofuels technologies may not be feasible anytime soon . . . it certainly has replication potential for long-term success.").
441. *See supra* text accompanying note 429–430.
442. GEVO, Second-Generation Biofuel: Isobutanol Producing Biocatalyst 1 (2011), *available at* http://www.epa.gov/ncer/sbir/success/pdf/gevo010711.pdf.
443. *See, e.g.*, United Nations Dev. Programme, *supra* note 89, at 33–34.
444. *Cf.* Singh, *supra* note 438, at 2,608.
445. *Cf.* Daniel Ten Kate, *South China Sea Oil Rush Risks Clashes as U.S. Emboldens Vietnam on Claims*, Bloomberg News (May 27, 2011, 7:55 AM), *available at* http://www.bloomberg.com/news/2011-05-26/s-china-sea-oil-rush-risks-clashes-as-u-s-emboldens-vietnam.html.
446. U.S. Geological Survey, World Petroleum Resources Assessment Project, Assessment of Undiscovered Oil and Gas Resources of Southeast Asia 1 (2010), *available at* http://pubs.usgs.gov/fs/2010/3015/pdf/FS10-3015.pdf.
447. U.S. Energy Info. Admin., Country Analysis Briefs: South China Sea Region 1 (2003), *available at* http://apps.americanbar.org/intlaw/committees/industries/energy_natural_resources/schina.pdf.
448. Letter from Barrack Obama, President of the United States, Sustaining U.S. Global Leadership, Priorities for 21st Century Defense (Jan. 3, 2012), *avail-*

Moreover, drop-in renewable fuels also promise to diminish the ability of OPEC to manipulate world oil prices.[449] If OPEC decides to limit oil production, then non-OPEC nations can build additional capacity to produce more drop-in renewable fuel to fill the emergent gap between supply and demand.[450] There will still be a slight lag in responding to the production decrease from OPEC, but the overall volatility in the market should diminish with the knowledge that other nations can build capacity to produce more transportation fuels.[451] Another strategic benefit of drop-in renewable fuels is that once drop-in renewable fuels reach a critical mass in the transportation fuels market, the pressure to ensure the free flow of oil from the Middle East may eventually decrease to the point where it is no longer necessary to maintain a large military presence in the region.[452] Reaching this point may take several decades, but it is certainly achievable within a generation so long as Congress follows the U.S. Navy's lead by adopting a drop-in renewable fuel standard.[453]

3. Strive for Parity in Promoting Drop-In Renewable Fuels

Congress should aim to achieve parity among drop-in renewable fuels by establishing an even playing field where each type of fuel has the same opportunity to succeed or fail.[454] For some, such as the Algal Biomass Organization, this entails an endless cycle of lobbying efforts to ensure that their particular renewable fuel industry receives the same blending credit as others.[455] The most cost effective and simplest way to achieve parity, however, requires Congress to do nothing at all. The $1.01 credit for cellulosic fuels and the $1.00 credit for biodiesel are set to expire at the end of 2013.[456] Once all of these subsidies expire, they should remain expired.[457] Over thirty years of exemptions, credits, and tariffs failed to make corn ethanol a cost competitive transportation fuel that could actually improve the long-term energy security of the United States.[458] The lesson to be learned from the failure of ethanol is that Congress should not pick winners and losers among the various industries that produce renewable fuels.[459] Rather, Congress should first establish the new qualitative standard and then afford industry the opportunity to find the most cost effective drop-in renewable fuels.[460]

Besides the obvious reason that our nation can no longer afford subsidies in this period of austerity, the most important reason for ending subsidies is that they are no longer needed given the mechanism enacted to enforce the current renewable fuel standard. When a facility produces renewable fuel, it generates a renewable identification number ("RIN") that is transferred along with the fuel to an obligated party (i.e., a fuel company that must meet the blending requirements) for the purpose of tracking compliance.[461] Obligated parties satisfy their assigned renewable volume obligations ("RVO"), which are based on the annual volume of gasoline or diesel fuel they produce or import, by turning in the necessary amount of RINs two months after the calendar year.[462] An obligated party may sell excess RINs on a secondary market to other obligated parties that did not blend a sufficient amount of renewable fuel to meet their respective RVOs.[463] If an obligated party fails to turn in sufficient RINs, then EPA may assess civil penalties under the Clean Air Act and other fines designed to negate any economic benefit derived from failing to initially comply with the standard.[464] To avoid these penalties, obligated parties should direct investment and purchasing power towards the most efficient drop-in renewable fuel technologies.[465] The market participants, not Congress, would choose the winners among the competing drop-in renewable fuel sources.[466]

There are several other reasons for discontinuing subsidies directed towards renewable fuels. First, "technologies and goals can change quicker than fiscal policy, leading to outdated fiscal instruments, which then incentivize undesired behaviors or technologies."[467] In the past, even as new and objectively better fuel technologies emerged, Congress continued to spend billions in taxpayer money on corn ethanol, effectively insulating the ethanol industry from any competition.[468] Moreover, despite the promise of algae-based fuels, they were not eligible for many of the credits afforded to other advanced biofuels until President Obama signed the American Taxpayer Relief Act of 2012.[469] Continuing exist-

able at http://www.defense.gov/news/Defense_Strategic_Guidance.pdf.

449. *See, e.g.*, U.S. Energy Info. Admin., *Who Are the Major Players Supplying the World Oil Market?*, *supra* note 51.
450. *Cf.* Jaffe & Soligo, *supra* note 109, at 14. Instead of the traditional investment in oil production capacity by IOCs and smaller producers, firms would invest in drop-in fuels to make up for the decreased supply.
451. *See generally, id.*
452. *See, e.g.*, A Navy Energy Vision, *supra* note 21.
453. *See supra* p. 103.
454. *See* Sims, *Call for Statutory Clarity*, *supra* note 426.
455. *How Can Congress Support the U.S. Algae Industry,* Algal Biomass Org., http://www.algalbiomass.org/how-can-congress-support-algae/ (last visited Dec. 18, 2012).
456. Brent Yacobucci, Cong. Research Serv., R40110, Biofuels Incentives: A Summary of Federal Programs 2–3 (2012), *available at* http://www.fas.org/sgp/crs/misc/R40110.pdf; American Taxpayer Relief Act of 2012, Pub. L. No. 112-240, §§ 404–05, 126 Stat. 2313, 2338–40.
457. *See How Can Congress Support the U.S. Algae Industry, supra* note 455.
458. Craig Cox & Andrew Hug, Envtl. Working Grp., Driving Under the Influence: Corn Ethanol and Energy Security 1 (2010), *available at* http://www.ewg.org/files/EWG-corn-ethanol-energy-security.pdf.
459. Ideally, Congress should establish parity for all transportation fuels by eliminating all subsidies except for those related to research and development. *See* Sims, *Call for Statutory Clarity*, *supra* note 426.
460. *See supra* text accompanying note 454.
461. Regulation of Fuels and Fuel Additives: Renewable Fuel Standard Program 72 Fed. Reg. 23900, 23908–13 (May 1, 2007) (to be codified at 40 C.F.R. pt. 80).
462. *Id.*
463. *Id.*
464. *Id.* at 23,950.
465. *Id.* at 23,904.
466. *See How Can Congress Support the U.S. Algae Industry*, *supra* note 455.
467. Marilyn A. Brown & Sharon Chandler, *Governing Confusion: How Statutes, Fiscal Policy, and Regulations Impede Clean Energy Technologies*, 19 Stan. L. & Pol'y Rev 472, 474 (2008).
468. Joshua Kagan, *Congressional Budget Office Paints Dismal Portrait on Ethanol Subsidies*, Greentechmedia.com (July 19, 2010), https://www.greentechmedia.com/articles/read/congressional-budget-office-paints-dismal-portrait-on-ethanol-subsidies/ ("The U.S. taxpayer [spent] $7.6B subsidizing the corn ethanol industry in 2010 with a cumulative taxpayer cost of more than $41B since 1980.").
469. *See How Can Congress Support the U.S. Algae Industry*, *supra* note 455; American Taxpayer Relief Act of 2012, Pub. L. No. 112-240, § 404, 126 Stat. 2313, 2338– 39.

ing subsidies, or creating new ones, would only disrupt the market mechanisms implemented under the proposed standard, thereby hindering the development of cost effective drop-in renewable fuels.[470]

Second, subsidies create a culture of dependency, which makes it difficult to end them once established.[471] Even as political opposition mounted against the VEETC, the ethanol industry continued to push for even more subsidies after over thirty years of substantial government support.[472] This phenomenon is true even for legitimately mature energy technologies, which is demonstrated by the nuclear industry's reliance on loan guarantees for construction and the petroleum industry's professed need to claim an immediate business deduction for intangible drilling costs instead of depreciating them over time as capitalized costs.[473]

Third, "[f]luctuating and sporadic fiscal incentives lead to uncertainty as well as abandonment of initiatives before their potential can be realized," which, in other words, means investors prefer certainty over an extended time horizon.[474] Despite this maxim, Congress currently enacts targeted subsidies over relatively short time periods only to renew them at the last minute, as shown by the recent short-term extensions of VEETC and the cellulosic fuel credit.[475] In some cases, Congress extends subsidies even after they have expired, as was the case with the biodiesel credit, which was retroactively extended through 2013 after expiring at the end of 2009 and 2011.[476] It would not be unfathomable for Congress to revive the VEETC, as Senators Grassley and Conrad sought to do with their proposed legislation, if oil prices were to suddenly plummet.[477] This, however, is not the ideal scenario for creating certainty because a subsidy revival would only continue to foster an unfair competitive advantage for that technology.[478] Rather, ending subsidies for all renewable fuels is the best way to give investors and obligated parties the long-term certainty they need to invest in the most cost-effective technologies for meeting the proposed drop-in renewable fuel standard.[479]

Lastly, achieving parity means ending subsidies under the Biomass Crop Assistance Program ("BCAP") and refraining from placing an arbitrary ban on any renewable fuel feedstock that competes with food crops.[480] BCAP creates uncertainty. For example, Congress slashed funding for BCAP from $552 million in fiscal year 2010 to $17 million in fiscal year 2012.[481] The significant decrease in funding came about from a bicameral compromise that followed a House vote to terminate all funding.[482] This reduced funding level will also undoubtedly spawn more winners and losers as the USDA struggles to divvy up a smaller pot of money among competing applicants.[483] Moreover, BCAP creates a competitive disadvantage for drop-in renewable fuels that are not reliant on feedstock materials such as the fuel precursors produced directly from cyanobacteria.[484] As for a ban on using dual use feedstock, Congress should avoid this course of action. From a fundamental fairness standpoint, farmers should have the freedom to choose how they market their crops in order to maximize their return on investment.[485] From a practical perspective, banning dual use crops for energy production would likely create unnecessary administrative burdens and enforcement costs, and would very likely lead to unforeseen consequences.[486] Moreover, such a ban is not needed at this time. Given the increasing demand for food as the developing world acquires a taste for Western diets, industry is already beginning to shift away from the use of dual use crops, as evidenced by the investments in drop-in renewable fuels by Exxon[487] and Joule.[488] Even without government intervention, the technologies and production processes that avoid dual use crops, or that do away altogether with the need for feedstock, should be cheaper in the long run and will ultimately prevail under the new drop-in renewable fuel standard.[489]

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470. *See* Jeffrey Leonard, *Get the Energy Sector Off the Dole,* Wash. Monthly (Jan.–Feb. 2011), *available at* http://www.washingtonmonthly.com/features/2011/1101.leonard-2.html.
471. *See* Dane Muldoon, *Biofuels Conference Highlights Dependence on Subsidies,* AutoBlogGreen (Jan. 2, 2007, 3:18 PM), http://green.autoblog.com/2007/01/02/biofuels-conference-highlights-dependence-on-subsidies/ (indicating that the recent Biofuels Finance & Investment World conference indicates that "biofuels globally are completely dependent on government subsidies").
472. *See* Jeff Coombe, *Why Should VEETC Be Renewed?*, RenewableEnergyWorld.Com (July 27, 2010), http://www.renewableenergyworld.com/rea/news/article/2010/07/why-should-veetc-be-renewed.
473. Leonard, *supra* note 470.
474. Brown & Chandler, *supra* note 467, at 486.
475. Yacobucci, *supra* note 456; Jim Lane, *Bills Introduced for Ethanol Tax Credit, Tariff, Cellulosic Biofuels Tax Credit; Package Attracts Few Sponsors Outside Midwest*, Biofuels Dig. (Mar. 26, 2010), http://www.biofuelsdigest.com/bdigest/2010/03/26/bills-to-extend-ethanol-tax-credit-ethanol-tariff-cellulosic-biofuels-tax-credit-introduced-in-congress-by-30-members-of-congress-attracts-few-sponsors-outside-midwest/.
476. *Breaking News: Obama Signs Tax Pact; Ethanol, Biodiesel, Renewable Diesel Credits Restored*, Biofuels Dig. (Dec. 17, 2010), http://www.biofuelsdigest.com/bdigest/2010/12/17/obama-signs-tax-pact-ethanol-biodiesel-renewable-diesel-credits-restored/; *U.S. biodiesel tax credit extended through 2013 by Congress*, Reuters (Jan. 2, 2013, 10:22 AM), http://www.reuters.com/article/2013/01/02/usa-fiscal-biofuels-idUSL1E9C228X20130102.
477. Luke Geiver, *Conrad, Grassley Introduce VEETC Extension*, Biomass Mag. (Apr. 21, 2010, 2:14 PM), http://biomassmagazine.com/articles/3668/conrad-grassley-introduce-veetc-extension/.
478. *See* Leonard, *supra* note 470.
479. *See id.*
480. *See* Fact Sheet: Biomass Crop Assistance Program, *supra* note 217.
481. *Farm Bill Appropriations: FY2012 Appropriations Status Complete*, FarmEnergy.Org, (Nov. 21, 2011), http://farmenergy.org/farm-bill-policy/farm-bill-clean-energy-appropriations.
482. Chris Clayton, *Biomass Program Faces Tight Cap*, RFDTV, (Nov. 22, 2011), http://www.rfdtv.com/news/agriculture/news_feed/biomass_program_faces_tight_cap_076/.
483. *Cf. id.*
484. *See* Fact Sheet: Biomass Crop Assistance Program, *supra* note 217, at 1.
485. *See* Elisabeth Rosenthal, *Rush to Use Crops as Fuel Raises Food Prices and Hunger Fears*, N.Y. Times, Apr. 7, 2011, at A1, *available at* http://www.nytimes.com/2011/04/07/science/earth/07cassava.html (indicating that "no one is suggesting that countries abandon biofuels").
486. *Id.*
487. *See* Jad Mouawad, *Exxon to Invest Millions to Make Fuel From Algae*, N. Y. Times, July 14, 2009, at B1, *available at* http://www.nytimes.com/2009/07/14/business/energy-environment/14fuel.html?pagewanted=all (Exxon made plans to announce an investment into biofuels).
488. *See* Press Release, Joule, *Joule Secures First of Multiple Sites to Host Solar Fuel Production* (May 5, 2011), *available at* http://www.jouleunlimited.com/news/2011/joule-secures-first-multiple-sites-host-solar-fuel-production (announcing an investment in production of renewable diesel and ethanol).
489. *See Sustainable Energy Through Synthetic Biology*, GenetiFuel, http://genetifuel.com/index.html (last visited Sept. 6, 2012) (indicating that algae as a renewable source of biofuels will significantly reduce processing costs).

III. Conclusion

When the Great White Fleet returned to the United States in 1909, President Roosevelt exclaimed to the officers and men, "[o]ther nations may do what you have done, but they'll have to follow you."[490] In that same vein, the U.S. Navy's decision to launch the Great Green Fleet represents a historic opportunity to lead the world in the development of drop-in renewable fuels and to redefine how all nations achieve greater energy security.[491] Hopefully, the entire nation will follow the Navy's lead. Before doing so, however, Congress must find the political courage to finally abandon ethanol in favor of drop-in renewable fuels.[492] The stakes are simply too great to continue with the status quo given the increasing competition and potential for conflict over finite petroleum resources.[493] By establishing a new drop-in renewable fuel standard and by resisting the urge to choose winners in the renewable fuel industry, Congress can set our nation towards a path for substantially improving our long-term energy security.[494]

490. *Theodore Roosevelt*, Solar Navigator, http://www.solarnavigator.net/history/theodore_roosevelt.htm (last visited Dec. 18, 2012).
491. *See* U.S. Navy, *Navy Sailing Toward Great Green Fleet*, (Oct. 22, 2010, 12:15 PM). http://www.navy.mil/search/display.asp?story_id=56757.
492. *See supra* pp. 103–04.
493. *See* Gail E. Tverberg, *Our World Is Finite: Is This a Problem?*, Energy Bulletin, (Aug. 22, 2007), http://www.energybulletin.net/node/29117.
494. A Navy Energy Vision, *supra* note 21.