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

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Abstract

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The United States Navy has embarked upon an ambitious endeavor to obtain half of its energy requirements from renewable sources by 2020. As part of this effort, the Navy aims to set sail the Great Green Fleet, a strike group composed of nuclear powered carriers and submarines, hybrid electric ships powered by a 50/50 blend of algae-based naval propulsion fuel, and aircraft flying on a 50/50 blend of camelina-based naval aviation fuel. For these renewable fuels, the Navy's central requirement is that they must be compatible with the existing petroleum-based infrastructure and fuel systems. In order to improve the long-term energy security of the United States, this Article argues that Congress should follow the 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. Section II 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. Section III 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.

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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."

- National Defense Strategy, Issued by Secretary Robert M. Gates, Department of Defense, June 2008

"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 Robert M. Gates, Department of Defense, February 25, 2011

* Secretary Robert M. Gates, Department of Defense, Address at the United States Military Academy (Feb. 25, 2011)(transcript *available at* http://www.defense.gov/speeches/speech.aspx?speechid=1539).

I. Introduction

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 by diversifying its energy portfolio and by alleviating the pressure to utilize military action to ensure the free flow of oil throughout the world market. To appreciate the magnitude of our nation's energy dilemma and how renewable fuels may serve as a potential solution, it is important to first recognize the underlying problem. In 2010, the United States consumed 19.2 million barrels per day of petroleum products with net imports accounting for approximately 49 percent of the total amount.[1] In comparison, the world economy consumed just over 97.4 million barrels per day of petroleum products meaning that the United States accounted for just over 21 percent of total global consumption.[2] Looking towards the future, by 2035, the U.S. Energy 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 percent of the increase emanating from developing countries in Asia and the Middle East.[3] Given that the Middle East holds almost 55 percent of the world's total proven oil reserves while the United States only holds 2.2 percent, the potential for further conflict over this finite energy resource is significant.[4]

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[1] U.S. ENERGY INFORMATION ADMINISTRATION, ANNUAL ENERGY REVIEW 2010 134 (Oct. 2011), *available at* http://www.eia.gov/totalenergy/data/annual/pdf/aer.pdf.

[2] BP STATISTICAL REVIEW OF WORLD ENERGY JUNE 2011 9 (2011), *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_2011.pdf.

[3] U.S. ENERGY INFORMATION ADMINISTRATION, INTERNATIONAL OUTLOOK 2011 25 (September 2011), *available at* http://www.eia.gov/forecasts/ieo/pdf/0484(2011).pdf.

[4] BP STATISTICAL REVIEW OF WORLD ENERGY JUNE 2011 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), *available at* http://www.gao.gov/new.items/d07283.pdf.

The future of renewable fuels, however, remains deeply debated within Congress and clouded by special interest groups that often lobby for their particular industry at the expense of others.[5] At the forefront of this debate is ethanol – a form of grain alcohol that only contains about two-thirds the energy density of gasoline.[6] Following decades of political support in the form of subsidies and tax breaks from the federal and state governments, ethanol derived from corn starch now accounts for over 90 percent of the biofuels production in the United States.[7] Much of the controversy over ethanol focuses on the extent that ethanol is compatible or incompatible with the existing fossil fuel infrastructure, the food versus fuel debate, and the environmental impacts of industrial agriculture. 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."[8] These potential problems are not just isolated to engine performance, but also carry over to gas pumps, storage tanks, and pipelines.[9] The food versus fuel debate addresses whether it is appropriate to divert agricultural resources from food production to energy production. Lastly, the environmental impacts of industrialized agriculture are widespread, but the most pertinent as it relates to energy security is the overuse and degradation of limited fresh-water supplies.

At the end of 2011, the ethanol tariff and subsidy, which has existed in one form or another for over three decades, finally expired through legislative inaction. Prior to expiring, the

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[5] Melissa Powers, *King Corn: Will the Renewable Fuel Standard Eventually End Corn Ethanol's Reign?*, 11 Vt. J. Envtl. L. 667 (2010).

[6] Hal Bernton, William Kovarik & Scott Sklar, THE FORBIDDEN FUEL, A HISTORY OF POWER ALCOHOL (2d ed. 2010); Arnold W. Reitz Jr., *Biofuels – Snake Oil for the 21st Century*, 87 Or. L. Rev. 1183, 1186 (2008).

[7] NATIONAL RESEARCH COUNCIL, EXPANDING BIOFUEL PRODUCTION: SUSTAINABILITY AND THE TRANSITION TO ADVANCED BIOFUELS 29 (2010), *available at* http://www.nap.edu/catalog/12806.html.

[8] 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.

[9] Shelia Karpf, Locking in Ethanol Locks Out Alternatives, Environmental Working Group (Apr. 7, 2011), http://www.ewg.org/agmag/wp-content/uploads/2011/04/Final-ethanol-infrastructure-report2.pdf.

ethanol tariff consisted of a $0.54 per gallon duty and a 2.5 percent tax while the ethanol subsidy amounted to a $0.45 per gallon tax credit for blending ethanol into gasoline.[10] Foreshadowing the demise of these protectionist measures, Congressional support for the domestic ethanol industry appeared to finally reach a zenith in 2010. Near the close of the 111th Congress, in dueling letters to the 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. [11] The first group of 17 Senators argued that the continuation of the ethanol subsidies and import tariffs were "fiscally irresponsible and environmentally unwise, and their extension would make our country more dependent on foreign oil."[12] In contrast, the second group of 15 Senators 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."[13] Shedding light on these two very different and, in part, mutually exclusive propositions, an analysis by the Center for Responsive Politics showed that the first group of Senators drew significant contributions from the oil and gas industry and lobbying groups for industries impacted by the rising price of corn, such as the Grocery Manufacturers Association, the American Meat Institute, and the National Chicken Council.[14] In contrast, the second group of Senators shared common geography in the Corn Belt and each had received a notable amount of

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[10] CONGRESSIONAL BUDGET OFFICE, USING BIOFUEL TAX CREDITS TO ACHIEVE ENERGY AND ENVIRONMENTAL POLICY GOALS 6-7 (July 2010), *available at* http://www.cbo.gov/ftpdocs/114xx/doc11477/07-14-Biofuels.pdf.

[11] Letter from Senator Dianne Feinstein (and 16 other Senators) to Senate Majority Leader Harry Reid (Senator Feinstein Letter)(Nov. 30, 2010)(*available at* http://voices.washingtonpost.com/plum-line/Letter%20to%20Reid%20%26%20McConnell%20re%20ethanol.pdf); Letter from Senator Kent Conrad (and 14 other Senators) to Senate Majority Leader Harry Reid (Senator Conrad Letter)(Nov. 30 201)(*available at* http://grassley.senate.gov/about/upload/Biofuels-Support-Letter-to-Leaders-Reid-and-McConnell-signed.pdf).

[12] Senator Feinstein Letter, *supra note* 10.

[13] Senator Conrad Letter, *supra note* 10.

[14] Michael Beckel, Senators Supporting Ethanol Subsidies Reap Riches From Corn Interests, Center for Responsive Politics (Jan. 3, 2011), http://www.opensecrets.org/news/2011/01/ethanol-lobby-finds-friends-foes.html.

campaign contributions from pro-ethanol interest groups and companies such as the National Corn Growers Association, Monsanto, Archer Midland Daniels, and POET.[15]

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.[16] Despite this compromise, the controversy over ethanol spilled into the 112th Congress. 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.[17] 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.[18] 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.[19] The bill would have reduced the blending credit to $0.20 in 2012 and to $0.15 in 2013.[20] For the remaining three years, the subsidy would convert to a variable tax incentive based on the average 3-month futures price for light sweet crude on the New York Mercantile Exchange.[21] The credit would range anywhere from $0.30 per gallon if the price of oil fell below $50 per barrel to no

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[15] *Id.*
[16] Tax Relief, Unemployment Insurance Reauthorization, and Job Creation Act of 2010, Pub. L. No. 111-312, § 708, *available at* http://www.gpo.gov/fdsys/pkg/BILLS-111hr4853enr/pdf/BILLS-111hr4853enr.pdf.
[17] 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.
[18] *Id.*
[19] 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
[20] http://www.opencongress.org/bill/112-s884/text
[21] S. 884,112th Cong. § 2 (2011), available at http://www.opencongress.org/bill/112-s884/text.

credit whatsoever if the price of oil remained above $90 per barrel.[22] In addition, DEPA would reduce the ethanol tariff, extend the cellulosic biofuel producer credit, extend and modify the alternative fuel vehicle refueling property credit, and extend the special depreciation allowance for cellulosic biofuel plant property.[23] Although ethanol proponents continued to push for phasing out the subsidy, on June 16, 2011, the Senate voted to end the subsidy at the midyear point by a vote of 73 to 27 mainly based on geographic rather than political affiliation.[24] With no corresponding action in the House of Representatives, the ethanol tariff and subsidy finally expired on schedule at the end of 2011. In spite of this significant development, Congress continues to support ethanol through a renewable fuel standard that effectively mandates blending specified amounts of ethanol into transportation fuels.

Largely free from the direct pressures of lobbying groups and campaign contributions, the United States Navy, as part of a broader effort by the Department of Defense, has pursued a strategy to develop renewable fuels that do not compete with food crops and that match "the characteristics and performance of conventional petroleum-based fuels."[25] The Navy expects these drop-in renewable fuels to require no modifications to existing platforms, and to appear indistinguishable to operators in terms of performance in comparison to petroleum-based fuels.[26] The Navy has already successfully tested a naval aviation fuel blend made from camelina, a rotation crop generally grown intermittently with wheat, for the F/A-18 in 2009 and the F/A-18

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[22] *Id*.
[23] S. 884,112th Cong. §§ 3 – 6.
[24] Steven Mufsonand & Lori Montgomery, *Senate approves cut in ethanol subsidies*, THE WASHINGTON POST (June 16, 2011), *available at* http://www.washingtonpost.com/business/economy/senate-approves-cut-in-ethanol-subsidies-votes-for-feinstein-amendment/2011/06/16/AGwrfhXH_story.html.
[25] UNITED STATES NAVY, A NAVY ENERGY VISION FOR THE 21ST CENTURY 5 (2010), *available at* http://greenfleet.dodlive.mil/files/2010/10/Navy-Energy-Vision-Oct-2010.pdf.
[26] *Alternative fuels for the military need to be "drop-in": Navy Sec'y*, Platts (3 Jul 2011), *available at* http://www.platts.com/RSSFeedDetailedNews/RSSFeed/Oil/6245497.

Super Hornet in 2010.[27] 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 while powered by about 20,000 gallons of algae-based fuel.[28] Following additional demonstrations in naval exercises around Hawaii, the Navy aims to operationally set sail in 2016 the Great Green Fleet, a strike group composed of nuclear-powered carriers and submarines, hybrid electric ships powered by a 50/50 blend of algae-based naval propulsion fuel, and aircraft flying on a 50/50 blend of camelina-based naval aviation fuel.[29] The namesake of this fleet pays homage to President Theodore Roosevelt's Great White Fleet, which "travelled around the world on steam generated by the combustion of coal" effectively releasing "the Navy from the vagaries of wind."[30] Following this naval tradition of energy innovation, the Great Green Fleet will "demonstrate the Navy's commitment to achieving energy security, enhancing combat capability, and reducing greenhouse gases."[31] The Navy's ultimate goal is to obtain half of its energy requirements for both the afloat fleet and ashore installations from renewable sources by 2020.[32]

Thomas L. Friedman, New York Times columnist and noted "green" author, praised the 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

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[27] A NAVY ENERGY VISION FOR THE 21ST CENTURY, *supra* 25, at 6.
[28] 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.
[29] *Id. at* 6; William Cole, *Going Green, The Navy puts biodiesel to the test as the alternative fuel will power a strike group during RIMPAC exercises in 2012*, HONOLULU STAR-ADVERTISER (Dec. 10, 2011), *available at* http://www.staradvertiser.com/s?action=login&f=y&id=135368283.
[30] A NAVY ENERGY VISION FOR THE 21ST CENTURY, *supra* 25, *at* 3.
[31] NAVY FUELS *GREAT GREEN FLEET* VISION, LATEST MILESTONE ON THE ROAD TO ENERGY SECURITY 18, CURRENTS (Winter 2011), *available at* http://greenfleet.dodlive.mil/files/2011/01/Win11_Great_Green_Fleet_Vision.pdf.
[32] A NAVY ENERGY VISION FOR THE 21ST CENTURY, *supra* 25, at 5 – 6.

corn ethanol or liquid coal — neither of which are clean or efficient, but are located in many Congressional districts" throughout the United States.[33] More than simply refraining from meddling with the military's energy strategy, this Article argues that Congress should follow the 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. Section II 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. Section III 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.

II. 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.[34] Like most commodities in the global market, oil is subject to the law of supply and demand. When supplies are plentiful and accessible, oil is inexpensive. When supplies are disrupted or outstripped by demand, the price of

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[33] Thomas Friedman, U.S.S. Prius, New York Times (Dec. 18, 2010), *available at* http://www.nytimes.com/2010/12/19/opinion/19friedman.html.

[34] KEITH CRANE, ANDREAS GOLDTHAU, MICHAEL TOMAN, THOMAS LIGHT, STUART E. JOHNSON, ALIREZA NADER, ANGEL RABASA, HARUN DOGO, IMPORTED OIL AND U.S. NATIONAL SECURITY 5 (2009)(RAND CORPORATION, INFRASTRUCTURE, SAFETY, AND ENVIRONMENT AND NATIONAL SECURITY RESEARCH DIVISION), *available at* http://www.rand.org/pubs/monographs/2009/RAND_MG838.pdf. Processing a 42 gallon barrel of oil will produce 44 gallons of petroleum products including 19 gallons of gasoline, 10 gallons of diesel, and almost 4 gallons of jet fuel. U.S. ENERGY INFORMATION ADMINISTRATION, WHAT FUELS ARE MADE FROM CRUDE OIL?, http://www.eia.doe.gov/kids/energy.cfm?page=oil_home-basics (last visited July 19, 2011).

oil rises. 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."[35] 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 percent increase in the price of gasoline would trigger a 1 percent decrease in consumption.[36] Faced with sustained higher oil prices though, consumers will eventually change their consumption patterns by purchasing more efficient vehicles, utilizing public transportation, and taking fewer trips.[37] On the supply side, elasticity estimates of oil production "range from 0.3 to 0.5" meaning that "a 10-percent increase in long-term prices should result in a 3 to 5 percent increase in global supply."[38]

This inelasticity in both supply and demand is a primary factor for the volatility of oil prices. For example, at the turn of this century, the price of oil rose from a low of $20 per barrel in 2001 to triple that amount by the middle of 2007.[39] 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 five months later as the global recession took hold and demand plummeted along with the slowing economy.[40] A report by the Brookings Institution ultimately concluded that the increase in oil prices "was caused by strong demand confronting stagnating world production."[41] Likewise, the precipitous drop in oil prices demonstrated that oil producers failed to accurately anticipate and

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[35] IMPORTED OIL AND U.S. NATIONAL SECURITY, *supra* note 34, 14.
[36] *Id*. at 15.
[37] *Id*.
[38] *Id*.
[39] JAMES HAMILTON, CAUSES AND CONSEQUENCES OF THE OIL SHOCK OF 2007 – 2008 1 (The Brookings Institute 2009), *available at* http://www.brookings.edu/~/media/Files/Programs/ES/BPEA/2009_spring_bpea_papers/2009_spring_bpea_hamilton.pdf.
[40] *Id.*
[41] *Id*. at 2.

respond in a timely manner to the significant decrease in the demand for oil. Another factor contributing to price volatility stems from the political instability found in oil producing nations in the Middle East and North Africa. With the uprisings across this region in 2011 and the military intervention in Libya, oil prices significantly increased in response to uncertainty over whether production would be disrupted in a region of the world that is responsible for over a quarter of the world's oil production.[42]

Unlike other commodities traded in the global market, oil is not completely driven by the free market due to the pervasive influence of state owned oil companies that are responsible for over half the world's oil production.[43] These National Oil Companies (NOCs), which include Saudi Aramaco (Saudi Arabia), Pemex (Mexico), and PDVSA (Venezuela), operate as an extension of their governments with "corporate goals driven by political rather than commercial" concerns."[44] This mode of operation often results in hiring more workers than needed for each unit of output, rapid depletion of existing reserves, and under investment in equipment, maintenance, research, and development.[45] As a consequence, NOCs "tend to be less efficient than privately owned oil companies" and less responsive to bourgeoning demand signals from the market.[46] In contrast, private companies or International Oil Companies (IOCs), which include Exxon, Chevron, and BP (formerly British Petroleum), are primarily concerned with

[42] Associated Press, Oil prices jump amid crisis in Libya, MSNBC (Mar. 21, 2011), *available at* http://www.msnbc.msn.com/id/42191519/ns/business-oil_and_energy/; Neela Banerjee and Ronald D. White, Turmoil in OPEC nation drives oil prices up sharply, Libya doesn't sell a lot to the U.S., but the effects could stunt American job growth, Los Angeles Times (Feb. 22, 2011), *available at* http://articles.latimes.com/2011/feb/22/business/la-fi-oil-20110222.
[43] U.S. ENERGY INFORMATION ADMINISTRATION, WHO ARE THE MAJOR PLAYERS SUPPLYING THE WORLD OIL MARKET?, http://www.eia.doe.gov/energy_in_brief/world_oil_market.cfm (last visited July 19, 2011).
[44] IMPORTED OIL AND U.S. NATIONAL SECURITY, *supra* note 34, 16.
[45] *Id*.
[46] *Id*.

maximizing profit for their shareholders.[47] As a consequence, IOCs tend to operate at peak efficiency, invest heavily in equipment, development, and exploration, and are generally more responsive to the demands of the market.[48] In 2009, IOCs only had full access to 8 percent of the world's proven oil reserves while NOCs, including Russian companies, controlled over 92 percent.[49] As a historical comparison, in 1970, IOCs had unrestricted access to over 85 percent of the world's oil reserves while NOCs and the Soviet Union only controlled 15 percent.[50]

The precipitous decline in access by IOCs to the world's oil reserves is directly attributable to the rise of the Organization of Petroleum Exporting Countries (OPEC). 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."[51] As of 2011, there were twelve member countries in OPEC: Algeria, Angola, Ecuador, Iran, Iraq, Kuwait, Libya, Nigeria, Qatar, Saudi Arabia, the United Arab Emirates, and Venezuela.[52] Altogether, in 2010, these twelve countries held 77.2 percent of the world's proven oil reserves and were responsible for 41.5 percent of world oil production.[53] OPEC ultimately aims to maintain an appropriately high price for oil "by determining how much of the gap between world

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[47] WHO ARE THE MAJOR PLAYERS SUPPLYING THE WORLD OIL MARKET?, *supra* note 43.
[48] NATIONAL INTELLIGENCE COUNCIL, GLOBAL TRENDS 2025: A TRANSFORMED WORLD 42 (2008), *available at* http://www.dni.gov/nic/PDF_2025/2025_Global_Trends_Final_Report.pdf/; ROBERT PIROG, CONG. RESEARCH SERV., RL34137, THE ROLE OF NATIONAL OIL COMPANIES IN THE INTERNATIONAL MARKET 5 (2008), *available at* http://www.fas.org/sgp/crs/misc/RL34137.pdf.
[49] U.S. Energy Information Administration 2009 Energy Conference, Meeting the World's Demand for Liquid Fuels, slide 6 (*presented* April 7, 2009, Washington, D.C.), *available at* http://www.eia.gov/conference/2009/session3/Sweetnam.pdf.
[50] *Id*.
[51] 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 (2009).
[52] Organization of Petroleum Exporting Countries, Member Countries, http://www.opec.org/opec_web/en/about_us/25.htm (last visited July 19, 2011).
[53] BP STATISTICAL REVIEW OF WORLD ENERGY JUNE 2011, *supra* note 2, at 6 – 8.

demand and non-OPEC supply is filled by their production."[54] 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."[55] 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.[56] Some of these countries are openly hostile towards the United States. 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 both Iraq and Afghanistan.[57]

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).[58] 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.[59] 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. Second, GATT Article XX(g) exempts measures from GATT obligations that are related "to the conservation of exhaustible natural

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[54] WHO ARE THE MAJOR PLAYERS SUPPLYING THE WORLD OIL MARKET?, *supra* note 43.
[55] 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, 789 (2009).
[56] CENTER FOR NAVAL ANALYSIS, POWERING AMERICA'S DEFENSE: ENERGY AND THE RISKS TO NATIONAL SECURITY 1 – 16 (2009), *available at* http://www.cna.org/sites/default/files/Powering%20Americas%20Defense.pdf.
[57] CLAY WILSON, CONG. RESEARCH SERVICE, RS 22330, IMPROVISED EXPLOSIVE DEVICES (IEDS) IN IRAQ AND AFGHANISTAN: EFFECTS AND COUNTERMEASURES (2007), *available at* http://www.fas.org/sgp/crs/weapons/RS22330.pdf.
[58] Office of Senator Frank R. Lautenberg, Busting Up the Cartel: The WTO Case Against OPEC (2004), *available at* http://lautenberg.senate.gov/documents/foreign/OPEC%20Memo.pdf.
[59] *Id.* at 2.

resources [so long as] such measures are made effective in conjunction with restrictions on domestic production or consumption."[60] 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. Thus, at least with respect to curtailing OPEC, the WTO provides limited mechanisms for improving greater energy security.

The finite nature of oil also raises the important question as to when the world will reach peak oil production. A 2007 report by the Government Accountability Office 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."[61] Peak oil 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.[62] Of these factors, the remaining amount of oil contains a significant amount of uncertainty because of three primary reasons. First, "many parts of the world have not been fully explored for oil."[63] For example, after the publication of the congressional report cited above, the U.S. Geologic Survey concluded in 2008 that the Arctic may hold up to 90 billion barrels of oil and 44 billion barrels of natural gas liquids.[64] Second, OPEC controls most of the world's oil, "but its estimates of reserves are not verified by independent auditors" and some have even expressed concern that some OPEC members have

[60] General Agreement on Tariffs and Trade art. XX(g) 1994, Apr. 15, 1994, Marrakesh Agreement Establishing the WTO, Annex 1A, 1867 U.N.T.S. 187, 33 I.L.M. 1153.
[61] CRUDE OIL, UNCERTAINTY ABOUT FUTURE OIL SUPPLY MAKES IT IMPORTANT TO DEVELOP A STRATEGY FOR ADDRESSING A PEAK AND DECLINE IN OIL PRODUCTION, *supra* note 4, at 4.
[62] *Id.*
[63] *Id.*
[64] U.S. Geological Service, Circum-Arctic Resource Appraisal: Estimates of Undiscovered Oil and Gas North of the Arctic Circle (2008), *available at* http://pubs.usgs.gov/fs/2008/3049/fs2008-3049.pdf.

greatly exaggerated their oil reserves.[65] Third, new technologies and drilling techniques allow companies to reach previously inaccessible sources of oil. For example, companies have started to use controversial fracking techniques on oil shale deposits, which some advocates argue will allow the United States to increase domestic oil production by 25 percent within the next decade.[66] For the foreseeable future, however, the world's production capacity will keep pace with demand. The U.S. Energy Information Administration predicts that 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, gas-to-liquids, and shale oil)"[67] Nonetheless, when peak oil production for the world eventually comes to pass, as it already did for the United States in 1970, 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

Energy security is an amorphous concept that varies based on the perspective of a nation or an organization.[68] For the United States, "energy security is assured when the nation can deliver energy economically, reliably, environmentally soundly and safely, and in quantities

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[65] CRUDE OIL, UNCERTAINTY ABOUT FUTURE OIL SUPPLY MAKES IT IMPORTANT TO DEVELOP A STRATEGY FOR ADDRESSING A PEAK AND DECLINE IN OIL PRODUCTION, *supra* note 4, at 4; Jeff Girth, Forecast of Rising Oil Demand Challenges Tired Saudi Oil Fields, New York Times (Feb. 24, 2004), *available at* http://www.nytimes.com/2004/02/24/business/forecast-of-rising-oil-demand-challenges-tired-saudi-fields.html.

[66] Clifford Krause, Shale Boom in Texas Could Increase U.S. Output, New York Times (May 27, 2011), *available at* http://www.nytimes.com/2011/05/28/business/energy-environment/28shale.html?_r=1.

[67] U.S. ENERGY INFORMATION ADMINISTRATION, INTERNATIONAL OUTLOOK 2011 25 (September 2011).

[68] Wen-Chen Shih, *Energy Security, GATT/WTO, and Regional Agreements*, 49 Nat. Resources J. 433, 435 (2009).

sufficient to support our growing economy and defense needs."[69] For the United States Navy, "energy security is having assured access to reliable supplies of energy and the ability to protect and deliver sufficient energy to meet operational needs afloat and ashore."[70] 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 countries via exports of crude oil, products, and capital for further investment in refining and product marketing."[71] 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."[72]

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."[73] 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.[74] At the same time, OPEC announced a twenty-five percent cut in overall production.[75] Oil prices skyrocketed from $3 per barrel in 1972 to $11.65 per barrel in early 1974.[76] The principle aims of the embargo

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[69] United States Energy Association, National Energy Security Post 9/11 7 (2002), *available at* http://www.usea.org/Publications/Documents/USEAReport.pdf.
[70] UNITED STATES NAVY, A NAVY ENERGY VISION FOR THE 21ST CENTURY 4 (2010).
[71] Energy Security, GATT/WTO, and Regional Agreements, 49 Nat. Resources J. 433, 435.
[72] UNITED NATIONS DEVELOPMENT PROGRAMME, WORLD ENERGY ASSESSMENT 42 (2004), *available at* http://www.undp.org/energy/docs/WEAOU_part_III.pdf.
[73] Daniel Yergin, *Ensuring Energy Security*, 85 Foreign Aff. 69, 78 (2006), *available at* http://www.un.org/ga/61/second/daniel_yergin_energysecurity.pdf.
[74] KEITH CRANE, ANDREAS GOLDTHAU, MICHAEL TOMAN, THOMAS LIGHT, STUART E. JOHNSON, ALIREZA NADER, ANGEL RABASA, HARUN DOGO, IMPORTED OIL AND U.S. NATIONAL SECURITY, *supra* note 34, at 27.
[75] *Id*.
[76] *Id*.

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."[77] In January 1974, following several rounds of shuttle diplomacy 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."[78] By March 1974, OAPEC lifted the oil embargo and OPEC resumed normal oil production. The damage, however, was already done. 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.

Congress immediately responded by enacting the Energy Policy and Conservation Act of 1975,[79] which, in part, required greater fuel efficiency for the automotive fleet in the United States through mandated increases in Corporate Average Fuel Economy (CAFE) standards. This signaled the start of a long history of intermittent legislative endeavors to promote greater efficiency and conservation based on the ebb and flow of energy prices and the political affiliation of the executive branch.[80] From the National Energy Conservation Policy Act of 1978[81] to the more recent Energy Independence and Security Act of 2007 (EISA 2007),[82] Congress promulgated legislation that shifted 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.[83] 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

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77 *Id*.
78 *Id*.
79 PUB. L. NO. 94-163 (1975).
80 See generally SALVATORE LAZZARI, CONG. RESEARCH SERVICE, RL 33578, ENERGY TAX POLICY: HISTORY AND CURRENT ISSUES (2008), *available at* http://www.fas.org/sgp/crs/misc/RL33578.pdf.
81 PUB. L. NO. 95-619 (1978).
82 PUB. L. NO. 110-140 (2007).
83 *Id*.

miles per gallon for all new passenger vehicles by 2020.[84] Touting the benefits of greater fuel efficiency, President Obama declared that his administration is "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."[85] The benefits of efficiency are clearly demonstrated through the ability of the United States to achieve greater economic output from fewer energy inputs.[86] However, a potential downside of these measures is the rebound effect, an economic theory that posits greater efficiency may actually lead to greater energy consumption over time.[87]

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.[88] IOCs began investing heavily in non-OPEC countries to develop and exploit new sources of oil.[89] In addition, the federal government helped by opening markets and ensuring access to energy through various free trade agreements. For example, in the North American Free Trade Agreement (NAFTA), the United States secured unfettered access to

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[84] Evan Turgeon, *Triple-Dividends: Toward Pigovian Gasoline Taxation*, 30 J. Land Resources & Envtl. L. 145, 151 (2010).

[85] President Barrack Obama, Address at Georgetown University (Mar. 30, 2011) (transcript available at http://www.whitehouse.gov/the-press-office/2011/03/30/remarks-president-americas-energy-security).

[86] U.S. DEPARTMENT OF ENERGY, *Energy Intensity Indicators in the U.S.*, http://www1.eere.energy.gov/ba/pba/intensityindicators/total_energy.html (last visited July 19, 2011).

[87] JESSE JENKINS, TED NORDHAUS & MICHAEL SHELLENBERGER, ENERGY EMERGENCE: REBOUND & BACKFIRE AS EMERGENT PHENOMENA 8 (BREAKTHROUGH INSTITUTE, 2011), *available at* http://thebreakthrough.org/blog/Energy_Emergence.pdf.

[88] U.S. ENERGY INFORMATION ADMINISTRATION, ANNUAL ENERGY REVIEW 2010 141 (2011).

[89] AMY MYERS JAFFE & RONALD SOLIGO, THE JAMES A. BAKER III INSTITUTE FOR PUBLIC POLICY, THE INTERNATIONAL OIL COMPANIES 13 (2007), available at http://bakerinstitute.netfu.rice.edu/publications/NOC_IOCs_Jaffe-Soligo.pdf; BASSAM FATTOUH & COBY VAN DER LINDE, INTERNATIONAL ENERGY FORUM, TWENTY YEARS OF PRODUCER-CONSUMER DIALOGUE IN A CHANGING WORLD 54 (2011), *available at* http://www.clingendael.nl/publications/2011/2011_IEF_History_of_IEF_Clinde_BFattouh.pdf.

Canada's oil production market.[90] 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 oil and gas resources in pre-salt prospects in Brazil's Outer Continental Shelf."[91] Through these continuing efforts, the United States reduced the respective market shares of imported oil for the Persian Gulf and OPEC from a peak of 27.8 percent and 70.3 percent in 1977 to 14.5 percent and 41.6 percent by 2010.[92] Just under half of oil imported into the United States now comes from sources in the Western hemisphere with Canada serving as our leading supplier with a 25 percent market share as of 2010.[93] 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"[94] resulting into relatively equal price increases for both domestic and foreign sources of oil.[95]

Partly due to the inherent 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. 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.[96] Much later, in response to the Soviet

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[90] North American Free Trade Agreement, ch. 6, Dec. 17, 1992, Can.-Mex.-U.S., 32 I.L.M. 296 (entered into force Jan. 1, 1994).
[91] 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.
[92] U.S. ENERGY INFORMATION ADMINISTRATION, ANNUAL ENERGY REVIEW 2010 141.
[93] *Id.*; U.S. ENERGY INFORMATION ADMINISTRATION, HOW DEPENDENT ARE WE ON FOREIGN OIL, *available at* http://www.eia.gov/cfapps/energy_in_brief/foreign_oil_dependence.cfm?featureclicked=3/ (last updated June 24, 2011).
[94] IMPORTED OIL AND U.S. NATIONAL SECURITY, *supra* note 34, at 14.
[95] National Energy Security Post 9/11, *supra* note 69, at 15.
[96] CHRISTOPHER BLANCHARD, CONG. RESEARCH SERV., RL 33533, SAUDI ARABIA: BACKGROUND AND U.S. RELATIONS 4 (2009), *available at* http://assets.opencrs.com/rpts/RL33533_20091116.pdf.

Union's invasion of Afghanistan in 1979, President Carter issued the following warning, which became to be known as the Carter Doctrine, in his 1980 State of the Union address:

> Let our position be absolutely clear: An 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, and such an assault will be repelled by any means necessary, including military force.[97]

Extending this 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."[98] Formalizing this stance during the first year of his presidency, President H.W. Bush issued National Security Directive 26, which began with a frank acknowledgement of the United States' interest in Middle East oil fields:

> Access to Persian Gulf oil and the security of key friendly states in the area are vital to U.S. national security. The United States remains committed to defend its vital interests in the region, if necessary and appropriate through the use of U.S. military force, against the Soviet Union or any other regional power with interests inimical to our own.[99]

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."[100] To this day, as highlighted in the National Defense Strategy, the United States continues to ensure energy security by maintaining "access to and flow of energy resources vital to the world economy."[101]

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, leading the charge to liberate Kuwait in Operation Desert Storm, and maintaining security in Operation Iraqi Freedom (OIF).

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[97] IMPORTED OIL AND U.S. NATIONAL SECURITY, *supra* note 34, at 60.
[98] *Id*. at 61.
[99] The White House, National Security Directive 26 1 (Oct. 2, 1989), *available at* http://bushlibrary.tamu.edu/research/pdfs/nsd/nsd26.pdf.
[100] DEPARTMENT OF DEFENSE, UNITED STATES SECURITY STRATEGY FOR THE MIDDLE EAST 6 (1995).
[101] DEPARTMENT OF DEFENSE, NATIONAL DEFENSE STRATEGY 16 (2008), *available at* http://www.defense.gov/news/2008%20national%20defense%20strategy.pdf.

During the Iran-Iraq War, in Operation Earnest Will, the U.S. Navy escorted Kuwaiti oil tankers carrying Iraqi oil and cleared Iranian mines from the Straits of Hormuz.[102] When Saddam Hussein invaded Kuwait, President George H.W. Bush issued National Security Directive 45 ordering the U.S. Military to defend the national integrity of Saudi Arabia, including its oil fields, from further Iraqi aggression.[103] 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. In 1995, the U.S. Navy reactivated the Fifth Fleet in Bahrain and began to take a more active role in securing the seas lanes for shipping oil in and out of the Persian Gulf.[104] 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 percent of Iraqi oil flowed through to awaiting tankers.[105] This increased security allowed Iraq, which has the third largest share of proven oil reserves at 8.3 percent, 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.[106]

Unfortunately, these oil security operations exact a heavy toll on the American taxpayer. A 2009 monograph by the RAND Corporation, which reviewed several different studies, estimated that that the Department of Defense spent up to $143 billion dollars per year for

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[102] IMPORTED OIL AND U.S. NATIONAL SECURITY, *supra* note 34, at 73.
[103] The White House, National Security Directive 45 (Aug. 20, 1990), *available at* http://bushlibrary.tamu.edu/research/pdfs/nsd/nsd45.pdf.
[104] IMPORTED OIL AND U.S. NATIONAL SECURITY, *supra* note 34, at 70.
[105] Douglas Jehl & Elizabeth Becker, A Nation at War: The Looting; Experts' Pleas to Pentagon Didn't Save Museum, New York Times (Apr. 16, 2003), *available at* http://www.nytimes.com/2003/04/16/world/a-nation-at-war-the-looting-experts-pleas-to-pentagon-didn-t-save-museum.html; *Clean Energy Policies that Reduce Our Dependence on Oil: Hearing Before the Subcomm. on Energy and Environment of the H. Comm. on Energy and Commerce*, 111th Cong. (2010)(statement of Robert Diamond, Lieutenant (RET), United States Navy, Security Fellow, Truman National Security Project).
[106] BP STATISTICAL REVIEW OF WORLD ENERGY JUNE 2011 6 (2011); U.S. ENERGY INFORMATION ADMINISTRATION, INTERNATIONAL OUTLOOK 2010 35 (July 2010).

maintaining oil security in the Middle East, of which $89 billion dollars were attributed to OIF operations related to oil security.[107] 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.[108] Far removed from Iraq and the sea lanes of the Persian Gulf, these casualties are the hidden cost of gasoline that many Americans don't realize or fully appreciate when they fill up their tank at the local gas station.

C. Energy Security through Renewable Fuels

While the efforts discussed above focused on reducing demand through efficiency and increasing or maintaining an adequate supply through diversification and military action, the United States has also attempted to supplant the use of petroleum with renewable fuels. The history of renewable fuels in the United States, much like the contemporary renewable fuels marketplace, revolves around ethanol.[109] Although touted as a fuel of the future, ethanol is really a fuel from the past. 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,[110] ethanol promised to serve as a homegrown solution for reinvigorating America's struggling agriculture sector in the early part of the twentieth century.[111] However, the Prohibition era and the subsequent campaign by the petroleum industry against alcohol blended gasoline in the 1930s

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[107] IMPORTED OIL AND U.S. NATIONAL SECURITY, *supra* note 34, at 63-65.
[108] *Clean Energy Policies that Reduce Our Dependence on Oil: Hearing Before the Subcomm. on Energy and Environment of the H. Comm. on Energy and Commerce*, 111th Cong. (2010)(statement of Robert Diamond, Lieutenant (RET), United States Navy, Security Fellow, Truman National Security Project)(detailing the death of 2 U.S. Navy Sailors and 1U.S. Coast Guardsman in defending an oil terminal during an insurgent attack).
[109] See generally Hal Bernton, William Kovarik & Scott Sklar, THE FORBIDDEN FUEL, A HISTORY OF POWER ALCOHOL (2nd ed., 2010).
[110] *Id.*
[111] U.S. Energy Information Administration, Energy Timelines, Ethanol; http://www.eia.doe.gov/kids/energy.cfm?page=tl_ethanol (last visited July 19, 2011)

effectively stymied the ethanol fuel industry for the next several decades.[112] With the onset of the Arab Oil Embargo, the ethanol industry found new life. Addressing the nation during the immediate aftermath of the energy crisis, President Nixon bound together renewable fuels and the vaunted notion of energy independence:

> Let 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.[113]

Shortly thereafter, Congress passed the Solar Energy Research, Development, and Demonstration Act of 1974,[114] the first of many legislative proposals to promote ethanol through the "research and development of the conversion of cellulose and other organic materials (including wastes) into useful energy or fuels."[115]

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."[116] With the National Energy Conservation Policy Act of 1978,[117] Congress responded to this figurative call to war by providing a $.40 per gallon tax exemption for every gallon of ethanol blended with gasoline.[118] In 1980, Congress implemented "the twin policy of ethanol tax [exemptions] and offsetting import tariffs designed to deny importers the benefit of those

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[112] THE FORBIDDEN FUEL, A HISTORY OF POWER ALCOHOL, *supra* note 109, 12 – 27. The Ethanol industry enjoyed a short lived resurgence during World War II. *Id.*
[113] Antoine Halff, *Creating a Legal Framework for Sustainable Energy: 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.
[114] PUB. L. NO. 93-473 (1974).
[115] Energy Timelines, Ethanol, *supra* note 111.
[116] Antoine Halff, *Creating a Legal Framework for Sustainable Energy: 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).
[117] Pub. L. No. 95-619 (1978).
[118] Melissa Powers, *King Corn: Will the Renewable Fuel Standard Eventually End Corn Ethanol's Regin?*, 11 Vt. J. Envtl. L. 667, 680 (2010).

subsidies and protect home producers from lower-cost foreign competitors."[119] Brazil, the second largest producer of ethanol, enjoys a significant comparative cost advantage over the United States in producing ethanol from sugar cane.[120] The impact of the tariff, however, was significantly reduced 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 is comprised of at least 50 percent locally grown feedstock.[121] Although the exception was limited to 7 percent of total U.S. ethanol consumption, non-CBI countries, namely Brazil, avoided the tariff by routing exported ethanol through CBI countries where it was blended and subsequently shipped duty free to the United States.[122] In addition to foreign competitors, crashing oil prices in the mid 1980s also threatened the economic viability of the domestic ethanol industry.[123] Congress responded by mandating the addition of oxygenates, such as ethanol and MTBE, to gasoline to allow the fuel "to burn more completely and thus reduce pollutants."[124] Ethanol eventually dominated the oxygenate market because "MTBE turned out to be a toxic, carcinogenic chemical that readily leached into and contaminated groundwater supplies" near storage tanks.[125] Furthermore, under the American Jobs Creation Act of 2004,[126] Congress changed the ethanol tax exemption to a blending tax credit, which was referred to as the

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[119] 19 Antoine Halff, *Creating a Legal Framework for Sustainable Energy: 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).
[120] 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, 283 (2010).
[121] Madhu Khanna, Xiaoguang Chen, Haixiao Huang and Hayri Onal, *The Renewable Energy Legislation Puzzle: Putting the Pieces Together: Land Use and Greenhouse Gas Mitigation Effects of Biofuel Policies*, 2011 U. Ill. L. Rev. 549, 558 (2011).
[122] *Id.* In 2007, total imports accounted for 6 percent of U.S. consumption with about 40 percent imported directly from Brazil and 60 percent routed through CBI countries. *Id.*
[123] Melissa Powers, *King Corn: Will the Renewable Fuel Standard Eventually End Corn Ethanol's Reign?*, 11 Vt. J. Envtl. L. 667, 678.
[124] *Id*.
[125] *Id*.
[126] PUB. L. NO. 108-357 (2004)

Volumetric Ethanol Excise Tax Credit (VEETC).[127] These measures proved successful in raising domestic corn-based ethanol production from 175 million gallons in 1980 to 3.9 billion gallons in 2005.[128]

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).[129] The RFS required producers, refiners, and importers to blend a minimum amount of biofuels into gasoline for automotive vehicles starting with 4 billion gallons in 2006 and rising to 7.5 billion gallons by 2012.[130] The passage of the first RFS also signaled Congress's intent to promote the development of advanced biofuels including cellulosic biofuels and other non-food crop biofuels.[131] 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 (i.e. – cellulosic biofuels were worth 2.5 times more than corn ethanol).[132] In practice, "an oil producer, importer, or refiner would need to purchase only 1 gallon of waste-derived fuel for every 2.5 gallons of corn ethanol to meet its RFS."[133] In spite of these measures, corn ethanol continued to dominate the market because targeted subsidies made it significantly cheaper than other biofuels.[134]

Two years later, with the Energy Independence and Security Act of 2007 (EISA 2007),[135]

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[127] *Id*.
[128] Melissa Powers, *King Corn: Will the Renewable Fuel Standard Eventually End Corn Ethanol's Reign?*, 11 Vt. J. Envtl. L. 667, 668.
[129] PUB. L. NO. 109-58 (2005).
[130] Melissa Powers, *King Corn: Will the Renewable Fuel Standard Eventually End Corn Ethanol's Reign?*, 11 Vt. J. Envtl. L. 667, 681.
[131] *Id.* at 707.
[132] *Id*. at 671
[133] *Id.*
[134] *Id.*
[135] PUB. L. NO. 110-140, § 202, 121 Stat. 1492 (2007) (amending Clean Air Act § 211, 42 U.S.C. § 7545 (1990)).

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,[136] by increasing the amount of biofuel required for blending, and by establishing limits for the lifecycle greenhouse gas emissions for renewable fuels.[137] With EISA 2007, Congress repealed certain equivalency values mandated by EPACT 2005 and established new volumetric standards for renewable fuel, advanced biofuel, cellulosic biofuel, and biomass-based diesel.[138] The new standard required increasing the amount of blended renewable fuel from 9 billion gallons in 2008 to 36 billion gallons by 2022.[139] 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."[140] Renewable biomass, however, encompasses a relatively smaller universe of materials including algae, various kinds of animal, yard, and food waste, and specified crops, trees, and their respective residues.[141] 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."[142]

Of the total amount required for RFS2, the portion constituting advanced biofuel

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[136] 42 U.S.C. 7545(o)(1)(L); U.S. Environmental Protection Agency, Questions and Answers on Changes to the Renewable Fuel Standard Program (RFS2), http://www.epa.gov/oms/fuels/renewablefuels/compliancehelp/rfs2-aq.htm.

[137] 42 U.S.C. 7545(o)(1)(H).

[138] Regulation of Fuels and Fuel Additives: Changes to Renewable Fuel Standard Program, 75 Fed. Reg. 14670, 14709 (Mar. 26, 2010).

[139] FRED SISSINE, CONG. RESEARCH SERV., RL 34294, ENERGY INDEPENDENCE AND SECURITY ACT OF 2007: A SUMMARY OF MAJOR PROVISIONS 5 (2007), *available at* http://energy.senate.gov/public/_files/RL342941.pdf.

[140] 42 U.S.C. 7545(o)(1)(J).

[141] 42 U.S.C. 7545(o)(1)(I).

[142] Jody M. Endres, *Symposium: The Renewable Energy Legislation Puzzle: Putting The Pieces Together: Agriculture at a Crossroads: Energy Biomass Standards and a New Sustainability?*, 2011 U. Ill. L Rev. 503, 511 (2011).

increases from 0.6 billion gallons in 2009 to 21 billion gallons in 2022.[143] Although advanced biofuel specifically excludes ethanol derived from corn starch, it may include other types of ethanol derived from vegetative waste material, animal waste, cellulose, hemicellulose, lignin, sugar, or any other starch.[144] 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.[145] The standard for advanced biofuel subsumes the volumetric standards for cellulosic biofuel, which peaks at 16 billion gallon in 2022, and biomass-based diesel, which peaks at 1 billion gallons in 2022.[146] Although there is no volumetric standard for corn ethanol, the "remaining portion of total renewable fuel not met with advanced biofuel is allowed to be corn-based ethanol."[147] This was not an unanticipated result. 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."[148] Incidentally, EPA projects that the remaining 15 billion gallons by 2022 will be satisfied entirely with corn-based ethanol.[149] To limit any unintended economic impacts, Congress empowered EPA to make adjustments to the various renewable fuel production quotas in the event that the market is incapable of producing the statutorily mandated quantities.[150] In other words, if industry is not forecasted to produce

[143] 42 U.S.C. 7545(o)(2)(B)(i)(II).
[144] 42 U.S.C. 7545(o)(1)(B).
[145] 42 U.S.C. 7545(o)(1)(B).
[146] 42 U.S.C. 7545(o)(2)(B)(i)(III)&(IV).
[147] Madhu Khanna, Xiaoguang Chen, Haixiao Huang and Hayri Onal, *Symposium: The Renewable Energy Legislation Puzzle: Putting The Pieces Together: Land Use and Greenhouse Gas Mitigation Effects of Biofuel Policies*, 20ll U. Ill. L. Rev. 549, 556 (2011).
[148] Antoine Halff, *Creating a Legal Framework for Sustainable Energy: 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, 410 (2008).
[149] Regulation of Fuels and Fuel Additives: Changes to Renewable Fuel Standard Program, 75 Fed. Reg. 14670, 14746 (Mar. 26, 2010).
[150] 42 U.S.C. 7545(o)(2)(B)(ii)-(v).

sufficient quantities of cellulosic biofuel, then EPA may reduce the amount required for blending below the statutorily prescribed standard. This effectively prevents a situation where a limited supply of cellulosic biofuel causes a spike in fuel prices at the pump. For 2011, EPA reduced the statutorily required mandated amount by 97 percent from 250 million gallons to 6.6 million gallons because the cellulosic biofuel industry is still in the early phases of development.[151]

EISA 2007 also makes a noteworthy attempt to address climate change. In quantifying the lifecycle greenhouse gas emissions for each type of renewable fuel, Congress directed EPA to consider both "direct and significant indirect emissions" including 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[.]"[152] 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."[153] All renewable fuels from facilities that commence construction after December 19, 2007 must achieve at least a 20 percent reduction below the baseline lifecycle greenhouse gas emissions for the applicable petroleum product.[154] To clarify, renewable fuels that are produced from existing capacity of 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.[155] This exemption primarily benefits corn ethanol production facilities because they

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[151] Regulation of Fuels and Fuel Additives: 2011 Renewable Fuel Standards, 75 Fed. Reg. 76790, 76792 (Dec. 9, 2010).
[152] 42 U.S.C. 7535(o)(1)(H).
[153] 42 U.S.C. 7535(o)(1)(C).
[154] Regulation of Fuels and Fuel Additives: Changes to Renewable Fuel Standard Program, 75 Fed. Reg. 14670, 14677 (Mar. 26, 2010).
[155] *Id*.

dominated the biofuels market when President Bush signed EISA 2007 into law.[156] In comparison, regardless of the construction date of the facility, advanced biofuels and bio-based diesel must obtain at least a 50 percent reduction below the applicable baseline for petroleum fuels while cellulosic fuels must achieve at least a 60 percent reduction.[157]

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).[158] First, Congress created a credit, which expires on December 31, 2012, for the production of cellulosic biofuel amounting to $1.01 per gallon.[159] Second, Congress created the Biomass Crop Assistance Program (BCAP) in an effort to address the "classic chicken-or-egg challenge around the start up of commercial scale bioenergy activities."[160] In a fact sheet providing an overview of BCAP, the U.S. Department of Agriculture 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 Renewable Fuels Standard (RFS) requires 21 billion gallons of non-corn-starch 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.[161]

For crop producers, the actual subsidy for eligible crops amounts to a reimbursement of up to 75 percent of the cost of establishing a bioenergy perennial crop with a limit of five years of annual

[156] Melissa Powers, *King Corn: Will the Renewable Fuel Standard Eventually End Corn Ethanol's Reign?*, 11 Vt. J. Envtl. L. 667, 672.
[157] 42 U.S.C. 7545(o)(1)(D).
[158] PUB L. NO. 110-234 (2008).
[159] *Id.*, § 15321.
[160] U.S. Department of Agriculture, Fact Sheet: Biomass Crop Assistance Program (May 3, 2011), *available at* http://www.fsa.usda.gov/Internet/FSA_File/bcap_update_may2011.pdf.
[161] *Id.*

payments for herbaceous crops and 15 years of annual payments for woody crops.[162] In addition, for a two year period, producers are eligible for a matching payment of up to $45 per ton for the delivery of crops, including corn stover, to cellulosic biorefinieries.[163] 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.[164] 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.[165]

Altogether, government support through mandates and subsidies helped the industry produce over 13 billion gallons of ethanol in 2010.[166] But in reaching this milestone and continuing to press forward with increasing mandates, the American taxpayer has paid and will continue to pay an exorbitant price. From 2005 through 2011, the VEETC has cost approximately $30 billion in foregone tax revenue.[167] Focusing on how much ethanol production is solely attributable to subsidies, the Congressional Budget Office (CBO) estimates taxpayers pay $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."[168] Likewise, the "CBO estimates that the costs to

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[162] *Id.*
[163] *Id.*
[164] 2008 Farm Bill, *supra* note 158.
[165] Environmental Working Group, Farm Subsidy Database: Corn, http://farm.ewg.org/progdetail.php?fips=00000&progcode=corn.
[166] U.S. Energy Information Administration, Fuel Ethanol Overview (December 2011), *available at* http://www.eia.gov/totalenergy/data/monthly/pdf/sec10_7.pdf.
[167] Office of Senator Tom Coburn, Amendment 309 – Repeal the Voumetric Ethanol Excise Tax Credit (VEETC) and Save Over $3 Billion**,** http://coburn.senate.gov/public//index.cfm?a=Files.Serve&File_id=ff76d919-1234-4e07-add8-d14925cd5524.
[168] CONGRESSIONAL BUDGET OFFICE, USING BIOFUEL TAX CREDITS TO ACHIEVE ENERGY AND ENVIRONMENTAL POLICY GOALS 10 (2010).

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."[169] 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.[170] Based on current standards mandated by EISA 2007, the U.S. Energy Information Administration (EIA) predicts that biofuels will only increase from 4 percent in 2009 to 11 percent in 2035 of the total amount of liquid fuels consumed in the United States.[171] From a trading perspective, this growth in the biofuels market will shelp the United States significantly reduce its net imports in petroleum products from 52 percent in 2009 to approximately 42 percent in 2035.[172] However, because the United States will still heavily rely on foreign sources of petroleum in 2035, the goal of energy independence through renewable fuels appears increasingly unrealistic and outdated in an interconnected world where energy commodities are traded in a global marketplace.

III. 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."[173] Rather, Secretary Chu emphasized that the DOE is much more focused on using biomass to create synthetic versions of gasoline, diesel, and jet fuel because such fuels don't require the special infrastructure that is necessary to increase the utilization of ethanol.[174] As discussed in the introduction, the U.S

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[169] *Id.*
[170] U.S. ENERGY INFORMATION ADMINISTRATION, ANNUAL ENERGY OUTLOOK 2011 81 (2011).
[171] *Id.*, Table A11.
[172] *Id.* at 83. Increasing fuel efficiency standards also help to reduce net imports of petroleum products.
[173] Phillip Brasher, Chu: Ethanol not the best biofuel, Des Moines Register (Nov. 29, 2010), *available at* http://blogs.desmoinesregister.com/dmr/index.php/2010/11/29/chu-ethanol-not-the-best-biofuel/.
[174] Robin Bravender & Darren Samuelsohn, EPA: More renewable fuels required, Politico (Nov. 30, 2010), *available at* http://www.politico.com/news/stories/1110/45691.html#ixzz1M9m3n9Bw.

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. The drive behind these efforts stems from some very basic problems involving the production and use of ethanol as a transportation fuel. These problems cast significant doubt as to whether ethanol – particularly the corn-based variety – actually improves or enhances America's energy security. As discussed above, 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."[175] 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.

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. As mentioned previously, 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. Up until 2010, EPA had authorized ten percent ethanol to gasoline blends (E10) for all vehicles and 85 percent ethanol to gasoline blends (E85) for all flex fuel vehicles (FFVs), which currently constitute just over three percent of the U.S. automotive market.[176] In November 2010 and January 2011, EPA partially granted a petition by Growth Energy that ultimately authorized an increase in the blended amount of ethanol in gasoline to 15 percent (E15) for certain classes of

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[175] National Energy Security Post 9/11, *supra* note 69, at 7.
[176] U.S. DEPARTMENT OF AGRICULTURE, A USDA REGIONAL ROADMAP TO MEETING THE BIOFUELS GOALS OF THE RENEWABLE FUELS STANDARD BY 2022 13 (2010), *available at* http://www.usda.gov/documents/USDA_Biofuels_Report_6232010.pdf.

vehicles.[177] EPA approved the use of E15 for model year 2001 and newer cars, light duty trucks, and SUVs.[178] However, EPA 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 any model year 2000 or older vehicles.[179] Several industry groups including the American Petroleum Institute and the Alliance of Automobile Manufacturers condemned the EPA's decision citing incomplete testing and concerns that the higher concentrations of ethanol would impair engine performance and cause safety problems.[180] Ultimately, according to the U.S. Department of Agriculture, 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."[181]

Even with the potential to use higher ethanol blends for some model year 2001 and newer vehicles, 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.[182] 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

[177] U.S. Environmental Protection Agency, E15 (a blend of gasoline and ethanol), http://www.epa.gov/otaq/regs/fuels/additive/e15/ (last visited July 19, 2011).
[178] U.S. Environmental Protection Agency, EPA Announces E15 Partial Waiver Decision (2011), *available at* http://www.epa.gov/otaq/regs/fuels/additive/e15/420f11003.pdf.
[179] U.S. Environmental Protection Agency, E15 (a blend of gasoline and ethanol).
[180] Carlton Carol, American Petroleum Institute, EPA is premature in E15 decision, puts more consumers at risk: API (Jan. 21, 2011), *available at* http://www.api.org/Newsroom/e15-decision.cfm; 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.
[181] U.S. DEPARTMENT OF AGRICULTURE, A USDA REGIONAL ROADMAP TO MEETING THE BIOFUELS GOALS OF THE RENEWABLE FUELS STANDARD BY 2022 13 (2010).
[182] JAMES A. BAKER III INSTITUTE FOR PUBLIC POLICY, FUNDAMENTALS OF A SUSTAINABLE U.S. BIOFUELS POLICY, REPORT NO. 43, 4 (2010), *available at* http://bakerinstitute.org/publications/EF-pub-PolicyReport43-121809.pdf.

local distribution centers) or directly to major industry consumers."[183] The United States contains "an estimated 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."[184] In contrast, ethanol is distributed from distilleries in the Midwest via rail, truck, or barge with costs ranging from $.05 to $.30 per gallon depending on the mode of transportation.[185] The limited options for 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."[186] Consequently, petroleum pipeline owners are generally reluctant "to share their facilities with a product that could possibly damage them."[187] As an exception, Kinder Morgan operates an ethanol pipeline from Tampa to Orlando, which it batches with petroleum shipments to prevent corrosion.[188] Even if pipeline owners were willing to utilize these methods for reducing corrosion, "the geography of pipelines in the United States works against batching ethanol into existing pipeline infrastructure."[189] Most petroleum product pipelines flow from "southern U.S. coastal states northward to the Midwest instead of in the opposite direction."[190] 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,

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[183] *Id*.
[184] *Id*.
[185] JAMES A. BAKER III INSTITUTE FOR PUBLIC POLICY, FUNDAMENTALS OF A SUSTAINABLE U.S. BIOFUELS POLICY, RESEARCH PAPER, 32 (2010), *available at* http://bakerinstitute.org/publications/EF-pub-BioFuelsWhitePaper-010510.pdf.
[186] *Id*. at 28.
[187] *Id*.
[188] *Id*. at 129. Ethanol is currently transported by rail (66%), truck (29%), and barge (5%) with less than 1% now moving via the Florida pipeline. DEPARTMENT OF ENERGY, REPORT TO CONGRESS: DEDICATED ETHANOL PIPELINE FEASIBILITY STUDY 4 (2010), *available at* http://www1.eere.energy.gov/biomass/pdfs/report_to_congress_ethanol_pipeline.pdf.
[189] FUNDAMENTALS OF A SUSTAINABLE U.S. BIOFUELS POLICY, *supra* note 182, at 4.
[190] *Id*.

especially in the main gasoline consumption regions along the U.S. coasts."[191]

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.[192] In a 2010 report mandated by Congress under EISA 2007, DOE found that "[f]or the pipeline to be economically viable without major financial incentives, 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]."[193] DOE did find, however, that "[t]his level could be achieved in this region with a significant increase in demand for E85 and/or the widespread use of ethanol blends greater than 10 percent if an increase in the percent ethanol allowed for blending in motor gasoline is approved" by EPA, which it did as mentioned above.[194] Even with the higher authorized blends, however, E15 must still attain sufficient market penetration. 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."[195] 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

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[191] *Id*. at 5.
[192] Locking in Ethanol Locks Out Alternatives, *supra* note 9.
[193] REPORT TO CONGRESS: DEDICATED ETHANOL PIPELINE FEASIBILITY STUDY, *supra* note 188, at iv.
[194] *Id*.
[195] Locking in Ethanol Locks Out Alternatives, *supra* note 9.

station.[196] Perhaps most importantly, DOE concluded that the removal of the subsidies and tariff protections for domestic ethanol "would pose serious consequences for the feasibility of a dedicated ethanol pipeline."[197] With the tariff now removed, depending on respective feedstock surpluses, it potentially allows blenders to use more ethanol made from Brazilian sugar cane instead of Midwest corn. Because Brazil is an ally with a democratically elected government, such an outcome would likely enhance rather than diminish our nation's energy security.

2. Limits 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."[198] It would take an immense amount of corn production to supplant domestic oil consumption. 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 13 percent of the total domestic gasoline consumption.[199] Put another way, 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."[200] Similar constraints are found in the production of biodiesel from soybeans. If the entire domestic soybean crop were converted to biofuel, it would only replace approximately 6 percent of total diesel consumption

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[196] *The American Energy Initiative: Hearing Before the Subcomm. on Energy and Power of the H.Comm. on Energy and Commerce*, 112th Cong. (2011)(statement of Jeffrey Miller, National Association of Convenience Stores), *available at* http://republicans.energycommerce.house.gov/Media/file/Hearings/Energy/050511/Miller.pdf.
[197] REPORT TO CONGRESS: DEDICATED ETHANOL PIPELINE FEASIBILITY STUDY, *supra* note 188, at 13.
[198] VACLAV SMIL, ENERGY MYTHS AND REALITIES, BRING SCIENCE TO THE ENERGY POLICY DEBATE 101 (2010).
[199] *Id.*
[200] *Id*.

in the United States.[201] Despite increasing yields of crop per acre over the past several decades, an acre of corn yields just over 456 gallons of ethanol while an acre of soybeans only produces 56 gallons of diesel.[202] These limitations, in part, spurred Congress to encourage the development of advanced biofuels including cellulosic biofuels that would be able to take advantage of different feedstock options such as corn stover and other agricultural wastes. Cellulosic biofuels, however, are still in the early phase of development with a focus on producing ethanol, which does little to address the infrastructure constraints discussed above.[203] Because of the slower than expected development of the cellulosic biofuel industry, EIA projects that the United States won't even meet the 36 billion gallon renewable fuel standard until 2030 – a full eight years behind the target date established by Congress.[204] And even when the final RFS is actually achieved, as discussed above, renewable fuels will only account for just 11 percent of the total domestic liquid fuel supply by 2035.

The production capacity of renewable fuels, especially those from traditional food crops, also raises the specter of the food versus fuel debate. Renewable fuel 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"[205] The reality, however, is much more complex given that "crops tend to compete for the same inputs, land, fertilizers and

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[201] Joshua Fershee, Transportation Energy Policy in National and Global Perspective: A New Beginning?: Struggling Past Oil: The Infrastructure Impediments to Adopting Next Generation Transportation Fuel Sources, 40 Cumb. L. Rev. 87, 94, n.50 (2009).
[202] LESTER R. BROWN, PLAN B 2.0 34 (2006), *available at* http://www.earth-policy.org/books/pb2.
[203] U.S. ENERGY INFORMATION ADMINISTRATION, ANNUAL ENERGY OUTLOOK 2011 83.
[204] *Id*.
[205] *The American Energy Initiative: Hearing Before the Subcomm. on Energy and Power of the H.Comm. on Energy and Commerce*, 112th Cong. (2011)(statement of Bob Dinneen, President & CEO, Renewable Fuels Association), *available at* http://republicans.energycommerce.house.gov/Media/file/Hearings/Energy/050511/Dinneen.pdf. Corn is technically a grain, although it popularly known as a vegetable.

water (where irrigation is necessary), to find the best return on investment."[206] Plus, 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. Simply put though, 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. An increase in demand for a particular crop will result in a corresponding price increase, which also has a ripple effect on "the price of meat and dairy products because grain is used as feed."[207] Corn, which is a type of grain, happens to provide the largest source of livestock feed for cattle, hogs, and poultry in the United States.[208] The extent of the price increase that is attributable to biofuels, however, is subject to debate. A report by the World Bank, which attempted to explain a 130 percent increase in the international food commodity price index from January 2002 to June 2008, attributed up to 75 percent of the increase "to biofuels and the related consequences of low grain stocks, large land use shifts, speculative activity and export bans."[209] Although examining a shorter time period, the Federal Reserve Bank provided a more conservative estimate indicating that global biofuel production accounted for just over 12 percent of the rise for the two year period ending June 2008.[210] Domestically, the CBO estimated that the diversion of corn to ethanol production accounted for 10 to 15 percent of

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[206] Richard Doornbosch and Ronald Steenblik, *Organisation for Economic Co-operation and 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.

[207] Scott Baier, Mark Clements, Charles Griffiths, and Jane Ihrig, Board of Governors of the Federal Reserve System, Biofuels Impact on Crop and Food Prices: Using an Interactive Spreadsheet, Report No. 967, 6 (2009), *available at* http://www.federalreserve.gov/pubs/ifdp/2009/967/ifdp967.pdf.

[208] *Id.*

[209] DONALD MITCHELL, THE WORLD BANK, A NOTE ON RISING FOOD PRICES, POLICY RESEARCH WORKING PAPER 4682, 17 (2008), *available at* http://www-wds.worldbank.org/external/default/WDSContentServer/IW3P/IB/2008/07/28/000020439_20080728103002/Rendered/PDF/WP4682.pdf.

[210] Scott Baier, Mark Clements, Charles Griffiths, and Jane Ihrig, Board of Governors of the Federal Reserve System, *Biofuels Impact on Crop and Food Prices: Using an Interactive Spreadsheet*, Report No. 967, 2.

the rise in food prices from April 2007 to April 2008.[211]

Regardless of the actual contribution from the demand for biofuels, the price increases for food have real world impacts that reverberate through society, particularly on the more impoverished and vulnerable segments. Domestically, as of 2009, the USDA classified 14.7 percent of U.S. households (17.4 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."[212] Approximately one third of these "households (6.8 million households, or 5.7 percent 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."[213] The government often assists these households with the Supplemental Nutrition Assistance Program (SNAP) and the Women, Infants, and Children (WIC) program. The increasing demand for biofuels, however, ultimately makes these programs more expensive. 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."[214] With constrained budgets and immense budget deficits, these food assistance programs are often the first to be targeted for cuts in funding. Turning to the international arena, it is much harder to absorb food price increases in developing nations where a greater share of

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[211] CONGRESSIONAL BUDGET OFFICE, THE IMPACT OF ETHANOL USE ON FOOD PRICES AND GREENHOUSE-GAS EMISSIONS 6 (2009), *available at* http://www.cbo.gov/ftpdocs/100xx/doc10057/04-08-Ethanol.pdf.

[212] U.S. DEPARTMENT OF AGRICULTURE, HOUSEHOLD FOOD SECURITY IN THE UNITED STATES, 2009 4 (2010), *available at* http://www.ers.usda.gov/Publications/ERR108/ERR108.pdfhttp://www.ers.usda.gov/Publications/ERR108/ERR108.pdf

[213] *Id.*

[214] CONGRESSIONAL BUDGET OFFICE, THE IMPACT OF ETHANOL USE ON FOOD PRICES AND GREENHOUSE-GAS EMISSIONS 11-12.

family income goes towards purchasing food.[215] As a consequence, soaring food prices in these countries often lead to riots and political instability.[216] Although the underlying causes of the Arab Spring are varied and complex, the lack of food security and the 32 percent spike in international food prices during the second half of 2010 served as prime catalysts for triggering the revolts in Tunisia and Egypt.[217] 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."[218] Moreover, the tension between biofuels 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."[219] 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 tank – once –

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[215] Food and Agriculture Organization of the United Nations, Price Volatility in Agricultural Markets: Evidence, impact on food security and policy responses (2010), *available at* http://www.fao.org/docrep/013/am053e/am053e00.pdf.

[216] Rabah Arezki & Markus Brückner, The University of Adelaide School of Economics, *Food Prices, Conflict, and Democratic Change*, Research Paper No. 2011-04 (2011), *available at* http://www.economics.adelaide.edu.au/research/papers/doc/wp2011-04.pdf/.

[217] Ariana Eunjung Cha, S*pike in global food prices contributes to Tunisian violence*, THE WASHINGTON POST (Jan. 14, 2011) available at http://voices.washingtonpost.com/political-economy/2011/01/spike_in_global_food_prices_tr.html; Debora Mackenzie, *Egypt and Tunisia: rocked by the global food crisis*, NEW SCIENTIST (Feb. 8, 2011), available at 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*, THE TELEGRAPH (Jan. 30, 2011), available at http://www.telegraph.co.uk/finance/comment/ambroseevans_pritchard/8291470/Egypt-and-Tunisia-usher-in-the-new-era-of-global-food-revolutions.html.

[218] President Barrack Obama, Remarks by the President on the Middle East and North Africa (May 19, 2011), *available at* http://www.whitehouse.gov/the-press-office/2011/05/19/remarks-president-middle-east-and-north-africa.

[219] NATIONAL INTELLIGENCE COUNCIL, GLOBAL TRENDS 2025: A TRANSFORMED WORLD 14 (2008); *see also* THE WORLD BANK, REENGAGING IN AGRICULTURAL WATER MANAGEMENT, CHALLENGES AND OPTIONS (2006), *available at* http://siteresources.worldbank.org/INTARD/Resources/DID_AWM.pdf

contains enough calories to feed a person for an entire year."[220] The United States may eventually need to follow the lead of China, which "banned the use of grain-based feed stocks for biofuel production and reoriented the country's bioenergy plans toward perennial crops grown on marginal land."[221]

3. Adverse Environmental Impacts

A key measure of energy security is the ability to obtain energy supplies in an environmentally sound manner. On this count, growing corn to produce ethanol fails given the adverse environmental impacts of industrialized agriculture on water quality, air quality, public health, and wildlife habitat, all of which have been extensively documented.[222] 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.

Politicians have historically and unrealistically touted homegrown biofuels as the key to achieving energy independence and greater energy security.[223] 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 any nation in the world. Growing biofuels using industrialized agriculture may currently be feasible for Brazil and the United

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[220] Roberta F. Mann, *Like Water for Energy: The Water-Energy Nexus Through the Lens of Tax Policy*, U. Colo. L. Rev. 505, 521 (2011).
[221] Horst Weyerhaeuser, Timm Tennigkeit, Su Yufang, and Fredrich Kahrl, *Biofuels in China: An Analysis of the Opportunities and Challenges of Jatropha Curcas in Southwest China*, ICRAF Working Paper Number 53, 1 (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.
[222] 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, 257 (2009); Mary Jane Angelo, *Corn, Carbon and Conservation: Rethinking U.S. Agricultural Policy in a Changing Global Environment*, 17 Geo. Mason L. Rev. 593, 602 (2010).
[223] Antoine Halff, *Creating a Legal Framework for Sustainable Energy: 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, 408-409 (2008).

States, but it will not work for the 36 countries, home to about 1.4 billion people, that the National Intelligence Council (NIC) projects to be either cropland or freshwater scarce by 2025.[224] The NIC reports that lack of "access to stable supplies of water is reaching critical proportions, particularly for agricultural purposes," and that "the problem will worsen because of rapid urbanization worldwide and the roughly 1.2 billion persons to be added over the next 20 years."[225] Countries facing water shortages are more likely to continue to rely on petroleum-based fuels instead of agriculturally grown biofuels for meeting their emerging energy needs, thereby placing greater strain on the limited production capacity from global oil reserves. But even for the United States, using industrialized agriculture to produce corn ethanol simply uses too much water and degrades the quality of the water that it does utilize.

In comparison to petroleum-based fuels, growing corn to produce ethanol consumes a substantial amount of water. 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.[226] In comparison, producing a single gallon of ethanol from corn consumes 10 to 324 gallons of water.[227] Because the actual distillation process only consumes 3 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.[228] On the low end of the range, USDA Region 5, which encompasses Iowa, Indiana, Illinois, Ohio, and Missouri, consumes 7 gallons of irrigation

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224 NATIONAL INTELLIGENCE COUNCIL, GLOBAL TRENDS 2025: A TRANSFORMED WORLD 51 (2008).
225 *Id*. at viii.
226 Argonne National Laboratory, Consumptive Water Use in the Production of Ethanol and Petroleum Gasoline, ANL/ESD/09-1, 6 (2009), available at http://www.transportation.anl.gov/pdfs/AF/557.pdf.
227 *Id*.
228 *Id*.

water for every gallon of ethanol produced.[229] For the upper range, USDA Region 7, which encompasses North Dakota, South Dakota, Nebraska, and Kansas, consumes 320.6 gallons of irrigation water for every gallon of ethanol produced.[230] 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. For a typical light duty vehicle, driving a mile on petroleum-based gasoline will consume between 0.07 to 0.14 gallons of water.[231] Depending on the amount of irrigation, driving a mile on ethanol consumes between 1.3 to 62 gallons of water with an average of 28 gallons of water per mile – "almost 200 times as much as petroleum gasoline."[232] 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."[233] In addition to reducing crop yield, these water constraints will also negatively impact the public water supply, which is already facing growing demand signals across the United States.

Directly impacting water quality, 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" in ways that leads to greater erosion.[234] Whether from rain or irrigation, agricultural runoff carries fertilizers, which contain nutrients such as phosphorous and ammonium nitrate, and pesticides, which encompasses both herbicides and insecticides, into the ground water and local streams and rivers

[229] *Id*. at 3. Region 5 accounted for 51 percent of ethanol production in 2006. *Id*.
[230] *Id.*
[231] Roberta F. Mann, *Like Water for Energy: The Water-Energy Nexus Through the Lens of Tax Policy*, U. Colo. L. Rev. 505, 521 (2011).
[232] *Id*. at 520.
[233] Regulation of Fuels and Fuel Additives: Changes to Renewable Fuel Standard Program, 75 Fed. Reg. 14670, 14769 (Mar. 26, 2010).
[234] Mary Jane Angelo, *Corn, Carbon and Conservation: Rethinking U.S. Agricultural Policy in a Changing Global Environment*, 17 Geo. Mason L. Rev. 593, 602 (2010).

to varying effect. Fertilizers 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.[235] At the mouth of the Mississippi lies the Gulf of Mexico Dead Zone, an area that "is now longer than the distance between Washington, D.C. and Hartford, Connecticut."[236] 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."[237]

Pesticides also present a significant danger to both public health and aquatic life.[238] A 10-year study by the U.S. Geological Service found that the level where pesticides pose a threat to human health was exceeded for 1.2 percent of shallow ground water wells and 9.6 percent of streams in agricultural areas.[239] This same study found that the aquatic life benchmarks were exceeded in 57 percent of streams and 31 percent of sediment beds in agricultural areas.[240] 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."[241] 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

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[235] 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, 256 (2009).
[236] *Id*.
[237] *Id*.
[238] FUNDAMENTALS OF A SUSTAINABLE U.S. BIOFUELS POLICY, *supra* note 185, at 64.
[239] U.S. GEOLOGICAL SURVEY, THE QUALITY OF OUR NATION'S WATERS, PESTICIDES IN THE NATION'S STREAMS AND GROUND WATER, 1992–2001, 6 (2006).
[240] *Id.* at 8.
[241] *Id.* at 12.

submersed plants."[242] Meeting the mandates established by EISA 2007 with corn ethanol will only encourage greater corn production exacerbating these adverse environmental impacts.

B. The Promise of Drop-In Renewable Fuels

Drop-in renewable fuels promise to provide greater energy security by overcoming many of the drawbacks of ethanol. In general, drop-in renewable fuels match the performance characteristics of petroleum-based fuels and are capable of using existing distribution networks for transporting petroleum-based fuels. Moreover, the platforms for producing these drop-in renewable fuels have the potential to produce thousands of gallons per acre as opposed to hundreds of gallons per acre in comparison to conventional renewable fuels such as corn ethanol and soy-based biodiesel. They generally do not directly compete with agricultural food products, or at least have the potential to not do so, and they do not necessarily require the conversion of forest, prairie, and other arable land to grow feedstock materials. Lastly, some of these fuels do not require any freshwater for production; brackish, saline, and waste water will suffice. Not all drop-in renewable fuels, however, are created equal. Each type must overcome distinct limitations and challenges to successfully attain a significant market share in the transportation fuels market. But once industry achieves full scale commercialization, these drop-in renewable fuels offer an important glide path for transitioning away from petroleum as the demand for liquid fuel outstrips the production capacity of oil producing nations. Although certainly not an exhaustive list, the most promising drop-in renewable fuels include isobutanol, algae-based fuel, and diesel produced from microorganisms.

1. Isobutanol

Categorically classified as an advanced biofuel by EISA 2007, isobutanol is a four carbon

[242] Mary Jane Angelo, *Corn, Carbon and Conservation: Rethinking U.S. Agricultural Policy in a Changing Global Environment*, 17 Geo. Mason L. Rev. 593, 605 (2010).

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."[243] Possessing two more carbon atoms than ethanol, isobutanol contains 30 percent more energy and has a lower water solubility meaning that it lacks the corrosive properties associated with ethanol.[244] As such, it is more "compatible with the current gasoline distribution infrastructure and would not require new or modified pipelines, blending facilities, storage tanks, or retail station pumps."[245] Although current EPA regulations permit blending isobutanol with gasoline in concentrations up to 11.5 percent by volume, limited testing has shown that gasoline-powered vehicles can be fueled with isobutonol blends of 85 percent or greater with little to no modification.[246] Given these advantages, industry asserts that isobutanol could easily overcome ethanol's 15 percent blend wall.[247] More importantly, industry has developed the technology to modify existing ethanol production facilities to produce isobutanol. This means that the market could produce significant quantities of isobutanol without the need to start a completely new industrial base from the ground up. Despite these benefits, transitioning facilities from ethanol to isobutanol production is somewhat stymied by legislative preferences for ethanol. Isobutanol was not eligible for the ethanol blending credit, and ethanol, which costs less to produce, still currently enjoys a de facto carve out under RFS2.

Two companies are at the forefront of developing the technology to drive down the costs for producing isobutanol from biomass. Gevo, a publicly traded company, has developed a

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[243] Michael Kannelos, *Can Isobutanol replace Ethanol?*, GREENTECHMEDIA (June 1, 2011), http://www.greentechmedia.com/articles/read/can-isobutanol-replace-ethanol/.
[244] GEVO, ISOBUTANOL KEY MARKETS, http://www.gevo.com/our-business/our-markets/ (last visited July 19, 2011).
[245] U.S. DEPARTMENT OF ENERGY, BIOBUTANOL BENEFITS, http://www.afdc.energy.gov/afdc/fuels/emerging_biobutanol_benefits.html (last visited July 19, 2011).
[246] GEVO, ISOBUTANOL KEY MARKETS, *supra* note 244.
[247] U.S. DEPARTMENT OF ENERGY, BIOBUTANOL BENEFITS, *supra* note 245.

patented fermentation technology using genetically modified yeast that "was designed to enable the low cost retrofit of existing ethanol capacity for isobutanol production."[248] The company recently purchased an ethanol plant in Minnesota and expects to produce 18 million gallons of isobutanol per year by 2012, which can eventually be increased to 40 million gallons with additional investment.[249] Converting isobutanol into isobutylene and paraffinic kerosene, "Gevo has already produced renewable gasoline and jet fuel that meet or exceed all ASTM (American Society for Testing and Materials) specifications."[250] Butamax, a joint venture by DuPont and BP, utilizes a similar technology that uses sugarcane and corn to produce isobutanol.[251] 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)."[252] 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.[253] However, until the production of isobutanol shifts away from corn as feedstock material, 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.

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[248] GEVO, COMPANY OVERVIEW, http://www.gevo.com/about/company-overview/ (last visited July 19, 2011).
[249] David Shaffer, *In Luverne, corn based fuel takes a new turn*, STAR TRIBUNE (June 1, 2011), available at http://www.startribune.com/business/122743589.html.
[250] *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.
[251] BUTAMAX ADVANCED BIOFUELS, LLC, *Global Agricultural Fact Sheet*, available at http://www.butamax.com/_assets/pdf/global_agriculture_fact_sheet.pdf.
[252] *Id*.
[253] *Id*.

2. Algae-Based Fuel

Listed as a potential source of advanced biofuel under EISA 2007, algae are photosynthetic organisms that convert solar energy, carbon dioxide, and water into oxygen and macromolecules such as carbohydrates and lipids.[254] Many of these macromolecules are potential biofuels or biofuel precursors for producing diesel, gasoline, and alcohol fuels.[255] Overcoming the drawbacks of ethanol discussed above, algae-based fuels possess several distinct advantages. First, algal productivity offers "high biomass yields per acre of cultivation" with the Department of Energy projecting annual yields of anywhere from 1,000 to 6,500 gallons of oil per acre.[256] Some "algae strains are projected to be at least 60 times higher than from soybeans, approximately 15 times more productive than jatropha, and approximately 5 times that of oil palm per acre of land on an annual basis."[257] Second, algae can be cultivated in photobioreactors and open ponds thereby avoiding the need to use arable land best saved for food production, grazing, or conservation.[258] Third, algae can be cultivated using "waste water, produced water, and saline water, thereby reducing competition for limited freshwater supplies."[259] Fourth, fuels produced from algae "have the potential to be more compatible than other biomass-based fuels with the existing fuel-distribution infrastructure."[260] For these reasons, the private sector and the government have taken a keen interest in the development of algae-based fuels. Exxon, in collaboration with Synthetic Genomics, has already committed to investing over $600 million in

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[254] U.S. DEPARTMENT OF ENERGY, BIOMASS PROGRAM, NATIONAL ALGAL BIOFUELS TECHNOLOGY ROADMAP 11 (2010), *available at* http://www1.eere.energy.gov/biomass/pdfs/algal_biofuels_roadmap.pdf.
[255] *Id.*
[256] *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.
[257] *Id*. at 2.
[258] *Id*. at 29.
[259] *Id*. at 2
[260] *Id*. at 48.

research and development to eventually incorporate algae-based fuels into the petroleum production pipeline.[261] 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."[262]

Algae-based fuel, however, faces a myriad of challenges in reaching full-scale commercialization. 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 multiple interdependent steps."[263] 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."[264] 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,

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[261] EXXON MOBIL, Algal Biofuels, http://www.exxonmobil.com/Corporate/energy_vehicle_algae.aspx (last visited July 19, 2011); Katie Howell, *Exxon Sinks $600M Into Algae-Based Biofuels in Major Strategy Shift*, N. Y. TIMES (July 14, 2009), *available at* http://www.nytimes.com/gwire/2009/07/14/14greenwire-exxon-sinks-600m-into-algae-based-biofuels-in-33562.html.

[262] SOLAZYME, Technology, Biotechnology that Creates Renewable Oils from Microalgae http://www.solazyme.com/technology (last visited July 19, 2011), Press Release, *Solazyme Completes World's Largest Microbial Advanced Biofuel Delivery to U.S. Military, Inks New Contract for 150,000 gallons of 100% algal derived Soladiesel*HRF-76® *Renewable Naval Distillate fuel, more than 7 times the size of its initial Navy contract* (Sept. 15, 2010), http://www.solazyme.com/media/2010-09-15.

[263] 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.

[264] NATIONAL ALGAL BIOFUELS TECHNOLOGY ROADMAP, *supra* note 254, at 5.

not an emerging option that the military can use to supply its operations."[265] 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."[266] 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.[267] Providing a rationale for this effort, Navy Secretary Ray Mabus articulated 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."[268] 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 won't be cost competitive with petroleum until at least 2017 or 2018.[269]

3. Diesel Produced from Microorganisms

Bioengineering microorganisms that can secrete hydrocarbons presents a very promising path to drop-in renewable fuels. Although several companies are pursuing this strategy, two companies are leading the way with very different approaches for producing drop-in renewable

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[265] JAMES T. BARTIS, LAWRENCE VAN BIBBER, ALTERNATIVE FUELS FOR MILITARY APPLICATIONS xvi (2011)(RAND CORPORATION, NATIONAL DEFENSE RESEARCH INSTITUTE) *available at* http://www.rand.org/content/dam/rand/pubs/monographs/2011/RAND_MG969.pdf.
[266] Tom Zeller, Jr., *The Future of Algae is … When?*, N.Y. TIMES (Jan. 25, 2011), available at http://green.blogs.nytimes.com/2011/01/25/the-future-of-algae-fuels-is-when/.
[267] John Tomasic, *Navy Secretary Mabus unabashed about 'choosing winners' in fuel market*, THE COLORADO INDEPENDENT (July 13, 2011), *available at* http://coloradoindependent.com/93805/navy-secretary-mabus-unabashed-about-%E2%80%98choosing-winners%E2%80%99-in-fuel-market.
[268] *Id*.
[269] Stacey Feldman, *Algae Fuel Inches Toward Price Parity with Oil*, SOLVE CLIMATE NEWS (Nov. 22, 2010), *available at* http://solveclimatenews.com/news/20101122/algae-fuel-inches-toward-price-parity-oil.

diesel. Amyris, a publicly traded company, that counts the French oil company Total as its largest investor,[270] has developed a process that uses genetically modified yeast to convert sugar into isoprenoids, a class of organic compounds composed of two or more units of hydrocarbons.[271] In particular, Amyris has focused on producing a 15 carbon hydrocarbon known as biofene that may be used in wide variety of products, including renewable diesel, cosmetics, and lubricants.[272] 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."[273] Moreover, in comparison to petroleum-based diesel, Amyris renewable diesel offers several environmental benefits including a 90 percent reduction of greenhouse gas emissions, zero sulfur emissions, lower nitrogen oxide emissions, lower particulate matter emissions, and lower carbon monoxide emissions.[274] Based on these factors and additional road testing, EPA increased the authorized blend level of Amyris renewable diesel from 20 percent to 35 percent, the highest blend level authorized by the EPA for the commercial sale of renewable fuel as of November 2010.[275] 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."[276] Now operational, the company anticipates producing over 13

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[270] 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/.

[271] AMYRIS, *Production Process*, http://www.amyrisbiotech.com/en/science/production-process (last visited July 19, 2011).

[272] *Id.*

[273] AMYRIS, *Renewable Diesel*, http://www.amyrisbiotech.com/en/markets/fuels/renewable-diesel-fuel (last visited July 19, 2011).

[274] *Id*.

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

[276] *The future of biofuels, The post-alcohol world, Biofuels are back. This time they might even work,* THE ECONOMIST (Oct. 28, 2010), *http://www.economist.com/node/17358802.*

million gallons of biofene from its San Paolo production facility in 2012.[277]

Taking a radically different but simplistic approach, Joule, a privately held company headquartered in Cambridge, Massachusetts, has developed a patented system that converts sunlight and waste carbon dioxide directly into liquid fuels without the use of biomass feedstock, freshwater supply, and arable land. 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.[278] The process begins by pumping waste 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 the proprietary microorganisms.[279] Charged by sunlight, the cyanobacteria consume the carbon dioxide and continuously secrete through carbon fixation the desired end product into the medium.[280] A separator then extracts the product leaving the microorganisms to continue production for about eight weeks before the panels must be cleaned and inoculated with new cyanobacteria.[281] Having already demonstrated the technology at a pilot plant in Texas, Joule has taken the first steps to build a commercial production facility by entering into "a lease agreement providing access to 1,200 acres in Lea County, New Mexico,

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[277] Todd Woody, *Amyris Opens Biochemical Factory in Brazil*, FORBES (Apr. 29, 2011), http://blogs.forbes.com/toddwoody/2011/04/29/amyris-opens-biochemical-factory-in-brazil/.

[278] Paul Voosen, *As Algae Bloom Fades, Photosynthesis Hopes Still Shine*, N.Y. TIMES (Mar. 29, 2011), *available at* http://www.nytimes.com/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. "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." JOULE, *Frequently Asked Questions*, http://www.jouleunlimited.com/faq (last visited July 19, 2011).

[279] JOULE, *How It Works*, http://www.jouleunlimited.com/why-solar-fuel/how-it-works (last visited Jul 19, 2011).

[280] *Id.*

[281] *As Algae Bloom Fades, Photosynthesis Hopes Still Shine*, *supra* note 278.

with the potential to scale the project up to 5,000 acres" for renewable fuel production.[282] Dwarfing the production capacity of other renewable fuels that must rely on costly biomass as feedstock, Joule anticipates that it will be able 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."[283] 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.[284]

C. Fulfilling the Promise of Drop-In Renewable Fuels

Before delving into the recommendations for improving energy security, it is important to first address why Congress should even encourage the development of drop-in renewable fuels. This is an especially important question given that some in Congress are already calling for the 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.[285] There is merit to this argument, but the premise is faulty for at least two 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.[286] Even if the renewable fuel standard were completely repealed, Congress would still be effectively picking

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[282] Press Release, *Joule Secures First of Multiple Sites to Host Solar Fuel Production* (May 5, 2011), http://www.jouleunlimited.com/news/2011/joule-secures-first-multiple-sites-host-solar-fuel-production.
[283]JOULE, *Why Joule?*, http://www.jouleunlimited.com/why-solar-fuel/overview (last visited July 19, 2011).
[284] 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.
[285] Press Release, *DeMint Supports Coburn Ethanol Amendment; Will Offer Separate Amendment to End Ethanol Mandates & Lower Taxes for Family Farms* (June 10, 2011), http://demint.senate.gov/public/index.cfm?p=PressReleases&ContentRecord_id=d9db6fc4-ff8a-4cea-88e7-5ed98bf66d26.
[286] MOLLY F. SHERLOCK, CONG. RESEARCH SERV., R41227. ENERGY TAX POLICY: HISTORICAL PERSPECTIVES ON AND CURRENT STATUS OF ENERGY TAX EXPENDITURES 2 (2010), *available at* http://www.cnie.org/NLE/CRSreports/10Jun/R41227.pdf.

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.[287] Given the entrenched legislative preferences for the petroleum industry, promoting the development of drop-in renewable fuels provides a semblance of balance under the law. Second, the transportation fuels market is not entirely free given the coordinated effort of OPEC to manipulate prices in the global oil market. This point sheds light on the primary justification for why Congress should encourage the development of renewable fuels. When OPEC sets production quotas to raise the price of oil, the IOCs such as Exxon and BP indirectly benefit through increased profit margins from their producing oil wells. Although these increased profit margins benefit the shareholders of these private companies, the same cannot be said for the American people. As such, our federal government has an independent interest in limiting the ability of OPEC, which must be recalled is really a small collective of sovereign nations, to impact our nation's energy security, economic productivity, and foreign policy.[288] In shaping a renewable fuels policy, however, Congress has a responsibility to do so in a way that is economically sound and, at the very least, environmentally neutral. 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.

1. 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. Private industry is moving in the right direction

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[287] Robert Barkman James, *Oil and the Environment: Reducing Oil Dependency in the Automotive Sectors*, 15 U. BALT. J. ENVTL. L. 1, 15 – 17 (2007).

[288] Ronald E. Minsk, Sam P. Ori, and Sabrina Howell, Plugging Cars into the Grid: Why the Government Should Make a Choice, 30 ENERGY L.J. 317 (2009).

as evidenced by the investments of leading energy companies mentioned above. And the U.S. Navy is certainly on the right path by 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. 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. 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 20 percent reduction in greenhouse gases. 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.[289] 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.[290] These measures ultimately hurt the development of drop-in renewable fuels because they artificially preserve ethanol's share of the renewable fuels market. In a properly functioning market, a superior and competitively priced renewable fuel should eventually displace an inferior one through competition. If a company developed a competitively priced drop-in renewable fuel, it would struggle to gain market share in this overly regimented system.

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 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

[289] 42 U.S.C. § 7545(o)(1)(B)(ii)(I – III).
[290] U.S Environmental Protection Agency, Regulation of Fuels and Fuel Additives: 2012 Renewable Fuel Standards, 76 FED. REG. 38844, 38847 (July 1, 2011).

using a 50/50 blend of drop-in renewable fuels and petroleum fuels, 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. But over time, the standard should increase to at least a 50/50 blend and perhaps even more as drop-in renewable fuel technology advances. As for limiting greenhouse gas emissions, setting different reduction targets for different types of renewable fuels unfairly segments the market given the comparative costs for achieving different emission standards. 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. In contrast, the new drop-in renewable standard would establish the same reduction target for all fuels, including those from existing plans. At first, a 20 percent reduction may suffice given that it is the minimum reduction required under the current renewable fuel standard. Over time, with the appropriate rulemaking authority, EPA should increase the reduction target while taking into consideration industry's ability to cost-effectively modify existing production plants. As industry gains more experience, it will most likely become more efficient, which should mean less greenhouse gas emissions overtime.[291]

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

[291] 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. 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.

systematically favors ethanol. In contrast to ethanol, drop-in renewable fuels 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. 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. Plus, Congress would no longer have to spur demand for an artificially inflated ethanol market by spending even more taxpayer money on special blender pumps at gas stations, ethanol only distribution pipelines, and flex-fuel engines. 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 into the future from the date of enactment to provide industry sufficient lead time to prepare and adjust. 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. 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.

From a global perspective, establishing a drop-in renewable fuel standard may lead to a pathway for other countries, not just the United States, to improve their energy security. Once companies develop the technology and production methods for large-scale commercialization, they can be licensed to other companies across the globe so that other countries can develop the capacity to produce drop-in renewable fuels. In Southeast Asia, which expects to see significantly increasing demand for transportation fuels through 2035, drop-in renewable fuels provide a mechanism for reducing tensions over competing territorial claims in the South China

Sea.[292] 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.[293] 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 that over half the world's sea borne commerce transits through every year. 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."[294]

Moreover, drop-in renewable fuels also promise to diminish the ability of OPEC to manipulate world oil prices. 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. 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. Lastly, as another strategic benefit, 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. 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.

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[292] Daniel Ten Kate, *South China Sea Oil Rush Risks Clashes as U.S. Emboldens Vietnam on Claims*, BLOOMBERG NEWS (May 27, 2011), *available at* http://www.bloomberg.com/news/2011-05-26/s-china-sea-oil-rush-risks-clashes-as-u-s-emboldens-vietnam.html.
[293] U.S. GEOLOGICAL SERVICE, World Petroleum Resources Assessment Project, Assessment of Undiscovered Oil and Gas Resources of Southeast Asia (2010), *available at* http://pubs.usgs.gov/fs/2010/3015/pdf/FS10-3015.pdf
[294] U.S. DEPARTMENT OF DEFENSE, Sustaining U.S. Global Leadership, Priorities for 21st Century Defense, Introductory Letter from President Barrack Obama (2012).

2. 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. For some, this entails an endless cycle of lobbying efforts to ensure that their particular renewable fuel industry receives the same blending credit as others.[295] However, the most cost effective and simplest way to achieve parity requires Congress to do nothing at all. The $1.01 credit for cellulosic fuels will expire at the end of 2012, and the $1.00 credit for biodiesel expired at the end of 2011 along with the VEETC. Once all of these subsidies expire, they should remain expired. 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. The lesson drawn from that failed endeavor is that Congress should not pick winners and losers among the various industries that produce renewable fuels.[296] 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. Besides the obvious reason that our nation can no longer afford subsidies in this period of austerity, the most important one is that they are no longer needed given the mechanism enacted to enforce the renewable fuel standard. When a facility produces renewable fuel, it generates a renewable identification number (RIN) that is transferred along with the fuel to the obligated party for the purpose of tracking compliance.[297] Obligated parties satisfy their assigned renewable volume obligations (RVOs), which are based on the annual volume of gasoline or diesel fuel they produce or import,

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[295] ALGAL BIOMASS ORGANIZATION, *How can Congress Support the U.S. Algae Industry*, http://www.algalbiomass.org/how-can-congress-support-algae/ (last visited July 19, 2011).
[296] Ideally, Congress should establish parity for all transportation fuels by eliminating all subsidies except for those related to research and development.
[297] U.S Environmental Protection Agency, Regulation of Fuels and Fuel Additives: Renewable Fuel Standard Program 72 FED. REG. 23900, 23908 - 23913 (May 1, 2007).

by turning in the necessary amount of RINs two months after the calendar year.[298] 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.[299] 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.[300] To avoid these penalties, obligated parties will direct investment and purchasing power towards the most efficient drop-in renewable fuel technologies. The market participants, not Congress, would choose the winners among the competing drop-in renewable fuel sources.

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."[301] 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. Moreover, despite the promise of algae-based fuels, they are not eligible for many of the credits afforded to other advanced biofuels.[302] Continuing existing 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. Second, subsidies create a culture of dependency making it difficult to end them once established. 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. This phenomenon is true even

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[298] *Id.*
[299] *Id.*
[300] *Id.* at 23950.
[301] Marilyn A. Brown & Sharon Chandler, *Governing Confusion: How Statutes, Fiscal Policy, and Regulations Impede Clean Energy Technologies*, 19 STAN. L. & POL'Y REV 472, 473 (2008).
[302] *How can Congress Support the U.S. Algae Industry, supra* note 303.

for legitimately mature energy technologies as evidenced 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.[303] Third, "[f]luctuating and sporadic fiscal incentives lead to uncertainty as well as abandonment of initiatives before their potential can be realized."[304] In other words, investors require certainty over a long time horizon. In contrast, Congress currently enacts targeted subsidies over relatively short time periods only to renew them at the last minute as shown by the recent one year extensions of the VEETC and cellulosic fuel credit at the end of 2010. In some cases, Congress extends subsidies even after they have expired as was the case with the biodiesel credit, which was retroactively extended through 2011 after expiring at the end of 2009.[305] It would not be unfathomable for Congress to revive the VEETC if oil prices were to suddenly plummet as Senators Grassley and Conrad sought to do with their proposed legislation. This is not the ideal scenario for creating certainty. 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.

Lastly, achieving parity means ending subsidies under the Biomass Crop Assistance Program (BCAP) while refraining from placing an arbitrary ban on any renewable fuel feedstock that competes with food crops. Consistent with the trend towards promoting uncertainty,

[303] Jeffrey Leonard, *Get the Energy Sector off the Dole***,** *Why ending all government subsidies for fuel production will lead to a cleaner energy future—and why Obama has a rare chance to make it happen.*, WASHINGTON MONTHLY (Jan./Feb. 2011), *available at* http://www.washingtonmonthly.com/features/2011/1101.leonard-2.html.

[304] Marilyn A. Brown & Sharon Chandler, *Governing Confusion: How Statues, Fiscal Policy, and Regulations Impede Clean Energy Technologies*, 19 STAN. L. & POL'Y REV 472, 486 (2008).

[305] Press Release, Biodiesel.org, *President Obama Signs Bill Extending Biodiesel Tax Incentive Into Law***,** http://www.biodiesel.org/news/taxcredit/default.shtm (last visited July 19, 2011).

Congress slashed funding for BCAP from $552 million in fiscal year 2010 to $17 million in fiscal year 2012.[306] The significant decrease in funding came about from a bicameral compromise that followed a House vote to terminate all funding.[307] This reduced funding level will also undoubtedly spawn more winners and losers as the U.S. Department of Agriculture struggles to divvy up a smaller pot of money among competing applicants.[308] 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. By choosing winners, Congress invariably chooses losers. To avoid this practice in enacting the new standard, Congress should also not ban duel use crops (i.e., crops used for both food and fuel) for energy production. From a fundamental standpoint, farmers should have the freedom to choose how they market their crops in order to maximize their return on investment. From a practical perspective, banning duel use crops for energy production would likely create unnecessary administrative burdens and enforcement costs, and would very likely lead to unforeseen consequences. Besides, 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 duel use crops as evidenced by investments from Exxon and Joule. The technologies and production processes that avoid duel 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.

IV. Conclusion

When the Great White Fleet returned to the United States in 1909, President Roosevelt

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[306] Farm Bill Appropriations, FY2012 Appropriations Status Complete, FarmEnergy.Org, (Nov. 21, 2011), http://farmenergy.org/farm-bill-policy/farm-bill-clean-energy-appropriations.
[307] *Id.*
[308] 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/.

exclaimed to the officers and men, "Other nations may do what you have done, but they'll have to follow you."[309] In that same vein, the 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. Hopefully, the first nation to follow the Navy will be our very own. But before doing so, Congress must find the political courage to finally abandon ethanol in favor of drop-in renewable fuels. The stakes are simply too great to continue with the status quo given the increasing competition and potential for conflict over finite petroleum resources. 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.

[309] William Stewart, The Great White Fleet, A collection of postcards, medals, photographs, and memorabilia, http://www.greatwhitefleet.info/ (last visited July 19, 2011).