BIOENERGY AND U.S. RENEWABLE FUELS STANDARDS: LAW, ECONOMIC, POLICY/CLIMATE CHANGE AND IMPLEMENTATION CONCERNS

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I. INTRODUCTION

The United States intensified efforts to address the energy problems facing the country with the passage of The Energy Independence and Security Act of 2007 (EISA).[1] An important component of EISA is the bioenergy-related provisions that increase the renewable fuel standards, turning an effort to reduce the dependence on

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1. Energy Independence and Security Act of 2007, Pub. L. No. 110-140 (codified at 42 U.S.C. § 17001 (2006 & Supp. 2008)).

fossil fuels.[2] Bioenergy interest has been greatly stimulated by the petroleum price increase between 2005 and mid-2008, as also happened during and after the late 1970s energy crisis. Drivers of this interest involve bioenergy as a way to: (a) protect against rising fossil fuel prices; (b) increase energy security by reducing reliance on imported petroleum; (c) provide, in the long run, reliable domestic supplies mitigating against lessened or higher cost supplies due to expanding international demand and a dwindling global supply of conventional petroleum with increased reliance on more expensive sources; (d) improve the balance of payments by reducing outflows of money to pay for imported oil; and (e) reduce combustion of fossil fuels, which are the majority of greenhouse gas emissions that in turn are argued to be precipitating climate change.[3] All these factors influence attitudes toward domestic production of liquid biofuels such as ethanol and biodiesel.

This paper discusses some implementation challenges associated with the expanded renewable fuels standard (RFS) mandated under EISA that could undermine its effectiveness. Part II discusses ways that bioenergy has been promoted by United States energy policy. Part III summarizes the historical evolution of energy legislation, ending with an analysis of EISA. This is followed in Part IV with a discussion of challenges that must be addressed to achieve the goals of EISA. The paper concludes in Part V with recommendations for implementing regulatory schemes that will reduce the difficulties in achieving the goals of the Act.

II. U.S. POLICY AND BIOENERGY

Bioenergy has been known to man and exploited for thousands of years.[4] But its use waned in the developed countries during the 20th century largely due to the availability of cheap fossil fuels. However, political and economic factors in the 1970s combined to reinvigorate interest. Principal among these were the "Energy Crisis" that arose when OPEC reduced world crude oil supply and fuel prices increased substantially, and the Iranian Revolution of 1978-79 that led to heightened

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2. Press Release, Office of the Press Secretary, U.S. Dept. of Energy, President Bush Signs H.R. 6, the Energy Independence and Security Act of 2007 (Dec. 19, 2007), *available at* http://www.ethanolmarket.com/PressReleaseWhiteHouse121807.

3. *See generally* Kenneth L. Denman et al., *Couplings Between Changes in the Climate System and Biogeochemistry*, *in* CLIMATE CHANGE 2007: THE PHYSICAL SCIENCE BASIS 499, 511-13 (Susan Solomon et al. eds., 2007) (discussing fossil fuel combustion).

4. Siwa Msangi & Mark Rosegrant, *Agriculture and the Environment: Linkages, Trade-Offs and Opportunities*, 19 GEO. INT'L ENVTL. L. REV. 699, 703 (2007) ("Biofuels already constitute the major source of energy for over half of [sic] world's population, making up more than ninety percent of the energy consumption of those living in the world's poorest countries. For these people, access to electricity or liquid fuel is limited compared to the availability of fuelwood").

concern about U.S. import dependence and national security.[5] Congress responded with a series of legislation during the latter 1970s. The Energy Tax Act of 1978 first defined 'gasohol' and provided what amounted to a 40 cents per gallon subsidy on ethanol use in gasoline.[6] The Energy Security Act of 1980 followed this up by instituting a federal ethanol tax incentive.[7] The ethanol incentive was increased to 50 cents per gallon under the The Surface Transportation Assistance Act of 1982[8] and 60 cents per gallon under the Tax Reform Act of 1984.[9] Subsequently, the bottom fell out of oil prices and a barrel of oil dropped from $30 to $10 in 1985,[10] making ethanol production noncompetitive against gasoline at lower oil prices.[11]

Ethanol production got some boost in 1988, when Colorado mandated the use of oxygenated fuels for winter use to control pollution.[12] The bigger boost came with the passage of the Clean Air Act of 1990, which required gasoline to have a

5. *See* SALVATORE LAZZARI, CONG. RESEARCH SERV., ENERGY TAX POLICY: HISTORY AND CURRENT ISSUES 3 (2006); Charli E. Coon & James Phillips, *Strengthening National Energy Security by Reducing Dependence on Imported Oil*, THE HERITAGE FOUND., Apr. 24, 2002, http://www.heritage.org/Research/EnergyandEnvironment/BG1540.cfm ("U.S. dependence on foreign oil has increased steadily since the 1973 Arab oil embargo. Projections show the nation's dependence increasing to over 60 percent by 2020 if Congress fails to take necessary actions to enhance energy security").

6. Energy Information Administration, Ethanol Timeline, http://www.eia.doe.gov/kids/history/timelines/ethanol.html (last visited Apr. 22, 2009) ("Gasohol was defined as a blend of gasoline with at least 10 percent alcohol by volume, excluding alcohol made from petroleum, natural gas or coal. For this reason, all ethanol to be blended into gasoline is produced from renewable biomass feedstocks.") [hereinafter Ethanol Timeline].

7. On June 30, 1980, President Carter signed the Energy Security Act of 1980, Pub. L. No. 96-294, 94 Stat. 611 (applicable sections codified as amended at 42 U.S.C.A. §§ 8802-03, 8813-16, 8820 (West 2009)). The Act offered insured loans for small ethanol producers (less than 1 million gallons per year), loan guarantees that covered up to ninety percent of construction costs on ethanol plants, price guarantees for biomass energy projects, and purchase agreements for biomass energy used by federal agencies. It also established the DOE Office of Alcohol Fuels and authorized $600 million to both USDA and DOE for biomass research.

8. Surface Transportation Assistance Act of 1982, Pub. L. No. 97-424, 96 Stat. 2097 (codified as amended at 26 U.S.C. § 40 (2006)).

9. Tax Reform Act of 1984, Pub. L. No. 98-369, 98 Stat. 494 (codified as amended at 26 U.S.C. § 40 (2006)).

10. Brendan I. Koerner, *The Trillion-Barrel Tar Pit*, WIRED (July 2004), *available at* http://www.wired.com/wired/archive/12.07/oil.html.

11. *See* Ethanol Timeline, *supra* note 6 ("Many ethanol producers went out of business, despite the subsidies. Only 74 of the 163 commercial ethanol plants (45%) remained operating by the end of 1985, producing 595 million gallons of ethanol for the year").

12. *See* Thomas J. Knudson, *Antipollution Plans Stirs Ire of Colorado Motorists*, N.Y. TIMES, July 27, 1987, at A8 ("Colorado's oxygenated fuels program is the first in the nation to mandate the sale of high-oxygen gasoline. It is also the most dramatic development so far in a growing national movement to encourage the use of cleaner and more abundant motor fuels. Adding oxygen makes gasoline burn more completely and thus emit fewer polluting byproducts").

minimum oxygen percentage.[13] The Act favored additives, including ethanol, that contain a high percentage of oxygen, but the role was filled throughout the 1990s by methyl tertiary butyl ether (MTBE), which was generally cheaper. However, MTBE use was banned in many U.S. states in the early 2000s, as it was found to leach into water supplies, be highly toxic, and be a carcinogen. Subsequently, ethanol was favored and production expanded rapidly, with ethanol selling at a significant premium relative to gasoline. This premium peaked in June 2006, shortly after MTBE was totally banned.[14]

The Clean Air Act boosted ethanol production, even though the 60 cents per gallon subsidy was reduced to 54 cents per gallon under the Omnibus Budget Reconciliation Act of 1990.[15] In 1992, the President signed The Energy Policy Act of 1992 (EPAct) that in Title IV, Section 403 contained alternative fuels provisions, and defined the term "alternative fuel" to include ethanol.[16] EPAct also defined other gasoline blends that required ethanol, and mandated the purchase of vehicle fleets that used alternative fuels.[17] In 1998, Congress passed The Transportation Equity Act for the Twenty-First Century that contained provisions extending the subsidy on ethanol,

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13. Clean Air Act, 42 U.S.C. § 7545(m) (2006).

14. Press Release, EPA, New Oxygenated Fuels Program. (Oct. 30, 1992), http://www.epa.gov/history/topics/caa90/09.htm ("This Sunday, November 1, marks the beginning of one of this country's most ambitious programs to combat urban air pollution, according to EPA Administrator William K. Reilly. Gas stations in 39 metropolitan areas are ready to begin dispensing a new, specially-blended fuel that will cut carbon monoxide (CO) emissions from cars and trucks by 15-20 percent. . . . The oxygenated fuels program is required by the 1990 Clean Air Act in all areas exceeding the federal carbon monoxide air quality standard. Increasing the oxygen content of gasoline reduces the CO emissions through better combustion of fuel, which is generally less efficient in cold temperatures. The oxygen boost also offsets the effects of fuel-rich operating conditions that occur during vehicle startup in cold weather").

15. Omnibus Budget Reconciliation Act of 1990, Pub. L. No. 101-508, § 11502, 104 Stat. 1388 (The act is also known as "OBRA-90," and was enacted November 5, 1990).

16. *See* Energy Policy Act of 1992, Pub. L. No. 102-486, §§ 301, 403, 106 Stat. 2776 (The term "alternative fuel" is defined as "methanol, denatured ethanol, and other alcohols; mixtures containing 85 percent or more (or such other percentage, but not less than 70 percent, as determined by the Secretary, by rule, to provide for requirements relating to cold start, safety, or vehicle functions) by volume of methanol, denatured ethanol, and other alcohols with gasoline or other fuels; natural gas; liquefied petroleum gas; hydrogen; . . . electricity . . .; and any other fuel the Secretary determines, by rule, is substantially not petroleum and would yield substantial energy security benefits and substantial environmental benefits").

17. *See* James A. Duffield and Keith Collins, *Evolution of Renewable Energy Policy*, CHOICES, 1st Quarter 2006, at 9-10, *available at* http://www.choicesmagazine.org/2006-1/2006-1.pdf ("[EPAct] extended the fuel tax exemption and the blender's income tax credit to two additional blend rates containing less than 10% ethanol. The two additional blend rates were for gasoline with at least 7.7% ethanol and for gasoline with 5.7% ethanol").

but reducing the blender's subsidy to 51 cents per gallon beginning in 2005.[18] This subsidy level still holds today. In 2005, these acts were followed up with renewable fuels standards that will be discussed in part III of this paper.

A. *Farm Bills*

Energy policy is also advanced by Farm Bills. In the 1996 Farm Bill, Congress emphasized the need for research and development programs directed toward production of agriculture-based bioenergy feedstocks. The Biomass Research and Development Act of 2000 directed the Secretaries of Agriculture and Energy to cooperate and to coordinate "policies and procedures that promote research and development leading to the production of biobased industrial products."[19] The 2002 Farm Bill established new programs and grants for the purchase of bio-based products to support development of biorefineries.[20] The 2002 bill also included provisions to educate the public about the benefits of biodiesel fuel use, and promote the purchase of renewable energy systems by farmers, ranchers, and rural small businesses,[21] while expanding and reauthorizing the 1996-2001 Farm Bill bioenergy program.[22]

The 2008 Farm Bill, the Food, Conservation, and Energy Act of 2008, introduced new authorizations and also expanded renewable energy programs.[23] Title VII

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18. *See* Transportation Equity Act for the 21st Century, 26 U.S.C. § 40(h)(2) (2006).

19. Biomass Research and Development Act of 2000, Pub. L. No. 106-224, § 304, 114 Stat. 358, 430, *amended by* Food, Conservation, and Energy Act of 2008, Pub. L. No. 110-246, § 9001(b), 122 Stat. 1651, 2065 (to be codified at 7 U.S.C. § 8101).

20. Econ. Research Serv., USDA, 2002 Farm Bill Title IX: Energy, http://www.ers.usda.gov /Publications/AP/AP022/AP022.pdf#Title9 (last visited Apr. 22, 2009). The procurement program is authorized under Title IX, Section 9002(g). Farm Security & Rural Investment Act of 2002, Pub. L. No. 107-171, § 9002(g), 116 Stat. 134, 477 (codified at 7 U.S.C. § 8102 (2006)).

21. The Farm Security and Rural Investment Act of 2002, Section 9004(d) authorized funding for biodiesel fuel education programs at $1 million annually through the Commodity Credit Corporation for FY 2003-07. The education provisions are included under Section 9005. Section 9006(f) established a loan program for farmers, ranches, and small rural businesses at a funding level of $23 million annually for FY 2003-07. Farm Security and Rural Investment Act of 2002, Pub. L. No. 107-171, §§ 9004-9006, 116 Stat. 134, 480-82, *amended by* Food, Conservation, and Energy Act of 2008, Pub. L. No. 110-246, §§ 9004-9006, 122 Stat. 1651, 2075-77 (to be codified at 7 U.S.C. §§ 8104-8106).

22. The biomass research and development activities authorized under the 1996-2001 farm legislation were extended under the 2002 legislation and funded with $5 million of Commodity Credit Corporation funds for FY 2002 and $14 million annually for FY 2003-07. Farm Security and Rural Investment Act of 2002, Pub. L. No. 107-171, § 9008, 116 Stat. 134, 483, *amended by* Food Conservation, and Energy Act of 2008, Pub. L. No. 110-246, § 7304, 122 Stat. 1651, 2003 (to be codified at 7 U.S.C. § 7304(e)).

23. The Food, Conservation, and Energy Act of 2008 was passed as Public Law 110-246, 122 Stat. 1651 and signed into law by President Bush on June 18, 2008. TOM CAPEHART, CONG.

addresses research funding for renewable energy and biofuels.[24] Title IX mandates the establishment of a National Testing Center Registry for testing "biobased products that will serve biobased product manufacturers,"[25] encourages biorefineries to switch to using biofuels to produce heat or power in their operations, and authorized mandatory funding of thirty-five million dollars for fiscal year 2009,[26] including assistance for small rural businesses through grants.[27] Title XV includes provisions for tax credits for cellulosic biofuel production and trade provisions to restrict imports of ethanol.[28]

III. THE EMERGENCE OF A RENEWABLE FUEL STANDARD

A. *The Energy Policy Act of 2005*[29]

The Energy Policy Act of 2005 (EPAct05) marked an important transition in U.S. energy policy,[30] because it contains extensive provisions promoting the production and use of biofuels.[31] EPAct05 uses a combination of subsidies, tax breaks, re-

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RESEARCH SERV., RENEWABLE ENERGY POLICY IN THE 2008 FARM BILL 1, 3 (2008) (for an excellent discussion of the provisions in the bill).

24. Food, Conservation, and Energy Act of 2008, Pub. L. No. 110-246 §§ 7101-7529, 122 Stat. 1651, 1973-2040 (to be codified in scattered sections of 7 U.S.C.). Section 7207 of Title VII establishes an agricultural bioenergy feedstock and energy efficiency research and extension initiative. *Id.* § 7207, at 2000 (to be codified at 7 U.S.C. § 5925(e)).

25. *Id*. § 9002(f), at 2071 (to be codified at 7 U.S.C. § 8102). "Of the funds of the Commodity Credit Corporation, the Secretary shall use to provide mandatory funding for biobased products testing and labeling as required to carry out this section – (A) $1,000,000 for fiscal year 2008; and (B) $2,000,000 for each fiscal years 2009 through 2012." *Id.* § 9002(h)(l), at 2071.

26. *Id*. § 9004, at 2075 ("The Secretary shall carry out a program to encourage biorefineries in existence on the date of enactment of the Food, Conservation, and Energy Act of 2008 to replace fossil fuels used to produce heat or power to operate biorefineries").

27. *Id*. § 9007(a), at 2077 (authorizing the Secretary of Agriculture, in consultation with the Secretary of Energy, to establish a "Rural Energy for America Program to promote energy efficiency and renewable energy development for agricultural producers and rural small businesses").

28. *Id*. § 15334, at 2279 (to be codified at 19 U.S.C. § 1313) (placing "limitations on duty drawback on certain imported ethanol").

29. Energy Policy Act of 2005, Pub. L. No. 109-58, 119 Stat. 594 (codified as amended at 42 U.S.C. § 15801 (2006)).

30. President George W. Bush, Remarks at Signing the Energy Policy Act of 2005 (Aug. 8, 2005), *available at* http://www.redorbit.com/modules/news/tools.php?tool=print&id=201110 ("This bill launches an energy strategy for the 21st century").

31. *Id*. ("I used to like to kid, but I really wasn't kidding when I said, some day a President is going to pick up the crop report -- (laughter) -- and they're going to say we're growing a lot of corn, and -- or soybeans -- and the first thing that's going to pop in the President's mind is, we're less dependent on foreign sources of energy. It makes sense to promote ethanol and biodiesel").

search and development support funding, and amendments to existing regulations to promote the expansion of biofuel production.

Probably the most significant biofuel-related provision under EPAct05 is the Renewable Fuels Standard (RFS) program that mandates a specific volume of biofuels be used in the nation's fuel supply. EPAct05 changed sections of the Clean Air Act[32] to require that "gasoline sold or introduced into commerce in the United States (except in noncontiguous States or territories), on an annual average basis, contains the applicable volume of renewable fuel."[33] The mandated schedule under EPAct05 began at 4.0 billion gallons of renewable fuel in 2006, and increased to 4.7 in 2007, 5.4 in 2008, 6.1 in 2009, 6.8 in 2010, 7.4 in 2011, and 7.5 billion gallons in 2012.[34] EPAct05 also extended biodiesel credit provisions that were due to expire in 2006.[35]

B. *The Energy Independence and Security Act of 2007*

The Energy Independence and Security Act of 2007 (EISA) sought *inter alia* "[t]o move the United States toward greater energy independence and security [and] to increase the production of clean renewable fuels . . . ."[36] EISA further amended the Clean Air Act to require that "transportation fuel sold or introduced into commerce in the United States (except in noncontiguous States or territories), on an annual average basis, contains at least the applicable volume of renewable fuel, advanced biofuel, cellulosic biofuel, and biomass-based diesel."[37] EISA extends the

32. Clean Air Act, 42 U.S.C. § 7401 (2006).

33. Energy Policy Act of 2005, § 1501.

34. *Id*. § 1501, 119 Stat. at 1067.

35. *Id*. § 1344, 119 Stat. at 1052 (amending 26 U.S.C. § 40A). Section 40A was added to the Internal Revenue Code of 1986 by the American Job Creation Act of 2004, Pub. L. No. 108-357, § 302, 118 Stat. 1463. This addition provided for a biodiesel mixture credit and a biodiesel credit valued at $180 million. This credit was to expire on December 31, 2006. Section 1345 of EPAct05 further amended Section 40A to extend the credit provisions. *See* ENERGY INFO. ADMIN., U.S. DEP'T OF ENERGY, FEDERAL FINANCIAL INTERVENTIONS AND SUBSIDIES IN ENERGY MARKETS 2007, at 120 (2008), http://www.eia.doe.gov/oiaf/servicerpt/subsidy2/pdf/subsidy08.pdf.

36. Energy Independence and Security Act of 2007, Pub. L. No. 110-140, 121 Stat. 1492.

37. Energy Independence and Security Act of 2007, § 202 (codified as amended at 42 U.S.C. § 7545 (2006 & Supp. 2008)). Renewable fuel means "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." *Id*. § 201(1)(J). Advanced biofuel means "renewable fuel, other than ethanol derived from corn starch, that has lifecycle greenhouse gas emissions . . . that are at least 50 percent less than baseline lifecycle greenhouse gas emissions." *Id*. § 201(1)(B), at 1519. Cellulosic biofuel was redefined to mean "renewable fuel derived from any cellulose, hemicellulose, or lignin that is derived from renewable biomass and that has lifecycle greenhouse gas emissions . . . that are at least 60 percent less than the baseline lifecycle greenhouse gas emissions." *Id*. § 201(1)(E), at 1520. Biomass-based diesel means "renewable fuel that is biodiesel . . . and that has lifecycle greenhouse gas emissions . . . that are at least 50 percent less than the baseline lifecycle greenhouse gas emissions." *Id.* § 201(1)(D).

RFS program to 2022, increases the required volumes, and adds new, separate mandates starting in 2009 for advanced biofuels, including cellulosic ethanol and biodiesel.[38] The provisions under EISA contain significant increases in the volumetric requirements for renewable fuels, increasing the volume from 9 billion gallons in 2008 to 36 billion gallons in 2022.[39] For advanced biofuels, the applicable volume begins at 0.6 billion gallons in 2009 and increases to 21 billion gallons in 2022.[40] Cellulosic biofuel volume is to increase from 0.1 billion gallons in 2010 to 16 billion gallons in 2022,[41] while biomass-based diesel volumes increase from 0.5 billion in 2009 to 1 billion in 2012.[42]

The RFS program has led to a significant increase in ethanol production and demand for corn. As a congressional report points out, "[i]n 2005, the United States produced 3.9 billion gallons of ethanol, requiring roughly 1.4 billion bushels of corn; in 2007, those numbers had increased to 6.5 billion gallons and 2.3 billion bushels. In 2007, roughly one-quarter of the U.S. corn crop was directed to ethanol production."[43] In addition to the RFS program, EISA also includes R&D provisions for infrastructure development, energy efficient equipment standards, and promotion of fuel efficient cars.[44]

C. *How the Renewable Fuels Standard (RFS) Program Works*

Under Section 211(o) of the Clean Air Act, the Administrator of the Environmental Protection Agency (EPA) must determine, on an annual basis, a renewable fuels standard (RFS) applicable to refiners, importers, and certain blenders of gasoline.[45] EPAct05 directs that the Administrator of the Energy Information Agency (EIA) provides to the Administrator of the EPA projections of gasoline to be sold in

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38. *Id*. § 202, at 1521-23.
39. *Id*. § 202(a)(2)(B)(i)(I), at 1522.
40. *Id*. § 202(a)(2)(B)(i)(II), at 1522.
41. *Id*. § 202(a)(2)(B)(i)(III), at 1523.
42. *Id*. § 202(a)(2)(B)(i)(IV), at 1523.
43. BRENT D. YACOBUCCI, CONG. RESEARCH SERV., WAIVER AUTHORITY UNDER THE RENEWABLE FUEL STANDARD (RFS) 1 (2008), http://www.nationalaglawcenter.org/assets/crs/RS22870.pdf.
44. *See* FRED SISSINE, CONG. RESEARCH SERV., ENERGY INDEPENDENCE AND SECURITY ACT OF 2007: A SUMMARY OF MAJOR PROVISIONS 4-7 (2007), http://www.nationalaglawcenter.org/assets/crs/RL34294.pdf.
45. Clean Air Act, 42 U.S.C. § 7545(o)(2)(A)(i) (2006) ("Not later than 1 year after August 8, 2005, the Administrator shall promulgate regulations to ensure that gasoline sold or introduced into commerce in the United States (except in noncontiguous States or territories), on an annual average basis, contains the applicable volume of renewable fuel determined in accordance with subparagraph (B)").

the following year.[46] The Administrator of the EPA calculates and publishes in the Federal Register a *percentage* figure representing the amount of gasoline that must be replaced by a biofuel.[47] This percentage figure is obtained using a mathematical formula that combines the volumetric figure mandated under EPAct05 and the projections of gasoline quantities obtained from the EIA.[48] The EPA considers the percentage figure to be an important element in accomplishing the goals of the energy legislation because it provides a clear guide to parties that must comply with the provisions under EISA.[49]

When EPAct05 became law on August 8, 2005, Congress directed the Administrator of the EPA to develop regulations within one year to implement the RFS program provisions. The EPA could not meet all of the regulatory process requirements and protocols (notices, hearings, drafts, etc.) within the time allotted for 2006, so the Agency used the default percentage (2.78%) provided under the legislation.[50] The 2.78% figure means that for the year 2006, gasoline supplied by all obligated parties—refineries, blenders, importers, and other suppliers—must contain at least

46. *Id*. § 7545(o)(3)(A).

47. *Id*. § 7545(o)(3)(B)(i) ("Not later than November 30 of each of calendar years 2005 through 2012, based on the estimate provided under subparagraph (A), the Administrator of the Environmental Protection Agency shall determine and publish in the Federal Register, with respect to the following calendar year, the renewable fuel obligation that ensures that the requirements of paragraph (2) are met. (ii) Required elements: The renewable fuel obligation determined for a calendar year under clause (i) shall – (I) be applicable to refineries, blenders, and importers, as appropriate; (II) be expressed in terms of a volume *percentage* of gasoline sold or introduced into commerce in the United States; and (III) subject to subparagraph (C)(i), consist of a *single applicable percentage* that applies to all categories of persons specified in subclause (I).") (emphasis added).

48. For an analysis, data requirements, and calculational procedures for the RFS percentage, see Revised Renewable Fuel Standard for 2008, Issued Pursuant to Section 211(o) of the Clean Air Act as Amended by the Energy Independence and Security Act of 2007, 73 Fed. Reg. 8665 (Feb. 14, 2008) (to be codified at 40 C.F.R. pt. 80.1105).

49. EPA, EPA Finalizes Regulations for a Renewable Fuel Standard (RFS) Program for 2007 and Beyond (Apr. 2007), http://www.epa.gov/otaq/renewablefuels/420f07019.htm ("Due to the certainty provided to investors by the RFS program, production capacity for ethanol and other renewable fuels has significantly increased since the Energy Policy Act was signed, and the construction of new and expanded facilities is projected to continue. As a result, nationwide volumes of renewable fuel already greatly exceed the RFS requirements. By 2012, nationwide volumes are projected to reach over 11 billion gallons, compared to the 7.5 billion gallons required").

50. EPA, EPA Completes Regulations Clarifying the Default Standard Under the Renewable Fuel Standard Program 2 (2005), http://www.epa.gov/oms/renewablefuels/420f05057.pdf ("EPA does not believe that it can meet the August 2006 statutory deadline. The issues that need to be resolved in adopting such comprehensive regulations are complex, making it important for EPA to receive input from the various stakeholders which will require significant amounts of time and effort, including analysis of important issues such as feasibility, costs, emissions inventory impacts, and benefits. This work cannot be completed in the context of a final rulemaking by August 2006 which must be preceded by a notice and comment period").

2.78% biofuel. The EPA does not enforce the percentage on an individual basis; instead the Agency looks at the total gasoline sold and the percentage of biofuel in total. If the percentage is less than the mandated quantity, the deficit is carried on to the following year and used to adjust the percentage for the new year.[51] For 2007, the EPA mandated an RFS of 4.02%,[52] and for 2008 7.76%.[53] On November 21, 2008, the EPA announced an RFS of 10.21% for 2009.[54] There are indications that the 2009 RFS may change in the near future as the EPA seeks to streamline the RFS program. The EPA is asking obligated parties to continue to apply the 2008 RFS standard.[55]

51. *Id*. ("Compliance with the default standard, however, will be determined on a collective, rather than an individual, basis for 2006. Under this approach, refineries, blenders, and importers together will be responsible for meeting the default 2.78 percent standard, and compliance with this standard will be calculated over the pool of gasoline sold to consumers. An individual refinery, blender, or importer will not be responsible for meeting the 2.78 percent standard for the specific gasoline it produces. EPA will determine compliance after 2006 using gasoline and renewable fuel consumption data available from the Energy Information Administration, supplemented by information readily available from other sources. If EPA determines that the default standard had not been met in 2006 on this collective basis, any deficit will be carried forward and applied as an adjustment to the standard for 2007").

52. 40 C.F.R. § 80.1105 (2007).

53. Revised Renewable Fuel Standard for 2008, Issued Pursuant to Section 211(o) of the Clean Air Act as Amended by the Energy Independence and Security Act of 2007, 73 Fed. Reg. 8665 (Feb. 14, 2008). The EPA initially projected an RFS of 4.63% for 2008. Regulation of Fuels and Fuel Additives: Renewable Fuel Standard Program, 72 Fed. Reg. 23,900, 23,912 (May 1, 2007). Later in 2007, the EPA reissued an RFS of 4.66% for 2008 given changes in market conditions. Renewable Fuel Standard Under Section 211(o) of the Clean Air Act as Amended by the Energy Policy Act of 2005, 72 Fed. Reg. 66,171 (Nov. 27, 2007). When the EISA became law on December 19, 2007, it raised the required volume of renewable fuels from the initial 5.4 billion gallons stated under the Clean Air Act to 9 billion gallons in 2008. EPA revised its RFS to 7.76% to accommodate the new volume requirement under the law.

54. Renewable Fuel Standard for 2009, Issued Pursuant to Section 211(o) of the Clean Air Act, 73 Fed. Reg. 70,643 (Feb. 21, 2008) (According to the EPA, the announced standard "is intended to lead to the use of 11.1 billion gallons of renewable fuel in 2009, as required by the Energy Independence and Security Act of 2007").

55. *Id*. ("EPA is developing a Notice of Proposed Rulemaking that will describe our proposed approach to all these changes to the RFS program (hereafter referred to as the 'RFS2' program). With very few exceptions, the new EISA requirements are not effective until such time as EPA issues final regulations to implement them. Therefore, until the RFS2 rulemaking is finalized and implemented, the changes required by EISA will generally not be applicable, and the current RFS regulations (hereafter referred to as 'RFS1' regulations) will continue to apply. Therefore, for the 2009 compliance period regulated parties will continue to be subject to the existing RFS1 regulations at 40 CFR part 80, Subpart K").

IV. CHALLENGES IN IMPLEMENTING EISA

The development and implementation of a credible energy policy depends on the resolution of complex technical, economic, and political challenges. EISA is designed to begin to break what George W. Bush has labeled "America's addiction to oil" by emphasizing the use of alternative fuels, but also has goals relative to greenhouse gas emissions.[56] This part of the paper examines some of these critical challenges that must be addressed to achieve the goals of EISA.

A. *Developing Life Cycle Analysis (LCA) Estimates*

Bioenergy production can provide an important GHG emission offset. Bioenergy forms reduce GHG emissions because their usage displaces fossil fuels like coal and petroleum, essentially entering into a carbon recycling operation. In particular, as plants grow they remove CO_2 from the atmosphere via photosynthesis. Then, when the biofeedstocks or their derivative fuels are combusted, the carbon is released into the atmosphere. Fossil fuel use, on the other hand, releases nearly 100% of the contained carbon. The net GHG emission consequences of a form of bioenergy then depend on the amount of fuels from fossil sources used in producing that item, in terms of the petroleum, natural gas, and coal-based electrical energy needed to raise, transport, and process the feedstock.[57] The common way of examining such issues involves life cycle analysis (LCA).[58]

EISA imposes LCA requirements on eligible fuel types. Specifically, emissions associated with renewable fuels must meet a minimum level of GHG reduction.[59] LCA has been described as a "cradle-to-grave" approach for assessing indus-

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56. *See* President George W. Bush, State of the Union Address (Jan. 31, 2006), *available at* http://stateoftheunionaddress.org/2006-george-w-bush.

57. BRUCE MCCARL, LIFECYCLE CARBON FOOTPRINT, BIOENERGY AND LEAKAGE: EMPIRICAL INVESTIGATIONS 1 (2008), http://www.farmfoundation.org/projects/documents/McCarltopost.pdf [hereinafter Lifecycle Carbon Footprint].

58. *See* M.Q. WANG, U.S. DEPT. OF ENERGY, ANL/ESD-39, GREET 1.5 – TRANSPORTATION FUEL-CYCLE MODEL (1999), http://www.transportation.anl.gov/modeling_simulation/GREET/pdfs/esd_39v1.pdf [hereinafter GREET 1.5]; Michael Wang et al., *Life-Cycle Energy and Greenhouse Gas Emission Impacts of Different Corn Ethanol Plant Types*, 2 ENV'T RES. LETTERS 024001, at 1, 7 (2007), http://iopscience.iop.org/1748-9326/2/2/024001/pdf/1748-9326_2_2_024001.pdf [hereinafter *Life-Cycle Energy*]. *See generally* M. WU ET AL., U.S. DEPT. OF ENERGY, ANL/ESD/06-7, FUEL-CYCLE ASSESSMENT OF SELECTED BIOETHANOL PRODUCTION PATHWAYS IN THE UNITED STATES (2006), http://www.transportation.anl.gov/pdfs/TA/377.pdf.

59. Bioelectricity has largely been left out of the story, with some small research and development undertaken, but no large policy stimulus programs. This largely reflects the U.S. abundance of coal. However, today's rising coal prices and demands for GHG abatement, coupled with the possibili-

trial systems. In the context of this paper, LCA refers to accounting for total greenhouse gas emissions in the process, spanning from the manufacture of production inputs through to the ultimate consumption of a good.[60] In the bioenergy context, this means accounting for the GHGs emitted in (1) producing fertilizer, seed, pesticides and other inputs for crop production; (2) crop production, including tilling the land, irrigating, planting the crop, and harvesting the crop; (3) conveying the crop to the biorefinery or bioenergy production facility; (4) preprocessing and processing the crop at the processing facility, including drying, heat sources, etc; and (5) conveying the energy production to the point of consumption. LCA also offsets net emissions with credits for byproducts, where refinery byproducts are used for animal feeds or as sources of heat and power. "By including the impacts throughout the product life cycle, LCA provides a comprehensive view of the environmental aspects of the product or process and a more accurate picture of the true environmental trade-offs in product and process selection."[61]

The rationale for imposing the LCA on fuel types is simple. If the goal of society is to achieve GHG reductions and energy independence by using advanced biofuels to replace gasoline that is fossil fuel based, then we must judge the extent to which a fuel production system, used in substitution, in fact reduces the emission of greenhouse gases relative to the greenhouse gases emitted in using the replaced fuel. This is why the baseline lifecycle greenhouse gas emission is tied to gasoline and diesel, as "[t]he term 'baseline lifecycle greenhouse gas emissions' means the average lifecycle greenhouse gas emissions, as determined by the Administrator, after

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ties of substituting natural gas into the transportation portfolio, is stimulating expanded activity in renewable electricity including, but not limited to, biomass based sources.

60. SCIENTIFIC APPLICATIONS INT'L CORP., EPA, EPA/600/R-06/060, CONTRACT NO. 68-C02-067, LIFE CYCLE ASSESSMENT: PRINCIPLES AND PRACTICE (2006), http://www.epa.gov/nrmrl/lcaccess/pdfs/chapter1_frontmatter_lca101.pdf.

61. *Id.* at 1. For a discussion of other methods for quantifying greenhouse gas emissions, see RICHARD A. NEY & JERALD L. SCHNOOR, CTR. FOR GLOBAL & REG. ENVTL. RESEARCH, GREENHOUSE GAS EMISSION IMPACTS OF SUBSTITUTING SWITCHGRASS FOR COAL IN ELECTRIC GENERATION: THE CHARITON VALLEY BIOMASS PROJECT (2002) (The authors discuss three main approaches for quantification. The first approach, the "point-source approach," measures emissions from a single point on a continuous basis. This approach has been used to monitor sulfur dioxide emissions, where a direct physical measure of emissions is taken before and after a change to determine reductions. The method is, however, inadequate in accounting for the net balance of greenhouse gases from fossil fuels. The second approach, the "zero-net approach," is based on guidance by the Intergovernmental Panel on Climate Change (IPCC). The approach accounts for carbon uptake during the growing season. In effect, "this method offsets the carbon dioxide emissions from the bioenergy fuel by crediting the carbon cycle for plant material that is combusted, resulting in a net-zero emission of carbon." The problem is that the method does not account for other greenhouse gas emissions. The third approach, considered superior to the first two approaches, is the life cycle analysis, and is the subject of this section of the paper).

notice and opportunity for comment, for *gasoline* or *diesel* (whichever is being replaced by the renewable fuel) sold or distributed as transportation fuel in 2005."[62]

The GHG emissions associated with advanced fuels will be measured using the LCA approach and compared to the baseline greenhouse gas emissions as defined above. EISA defines the term "lifecycle greenhouse gas emissions" as

> the aggregate quantity of greenhouse gas emissions (including direct emissions and significant indirect emissions such as significant emissions from land use changes), as determined by the Administrator, related to the full fuel lifecycle, including 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, where the mass values for all greenhouse gases are adjusted to account for their relative global warming potential.[63]

To drive home the importance of the LCA requirement, we interpret some of the sections in the legislation. For example, the legislation defines "advanced biofuel" as "renewable fuel, other than ethanol derived from corn starch . . . that has a lifecycle greenhouse gas emission that are at least 50 percent less than baseline lifecycle greenhouse gas emissions."[64] This provision means that if a particular biofuel is to be classified as "advanced biofuel," and meets the EISA requirements for usage thereof, then the total greenhouse gas emission, counting from raw material acquisition, production, transportation to a conversion facility, conversion into renewable motor fuel, and transportation of the renewable fuel to the consumer (cradle-to-grave), must be less than 50% of the baseline greenhouse gas emission, that is, the emission associated with gasoline or diesel production.[65] In this case, society achieved a net reduction in GHG emissions by substituting the advanced biofuel for gasoline or diesel. Based on market conditions and available technology, the Administrator is authorized under the legislation to modify the greenhouse gas emission percentages.[66] The legislation prescribes the amount and levels of adjustment.[67] The LCA requirements on eligible fuels are summarized in Table 1.

Table 1. EISA LCA Requirements for Eligible Fuels

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62. Energy Independence and Security Act of 2007, Pub. L. No. 110-140, § 201, 121 Stat. 1492, 1520 (to be codified at 42 U.S.C. § 7545) (emphasis added).

63. *Id.*

64. *Id.* at 1519.

65. *See* Regulation of Fuels and Fuel Additives: Renewable Fuel Standard Program, 72 Fed. Reg. 23,899, 23,922 (May 1, 2007) (to be codified at 40 C.F.R. pt. 80).

66. Energy Independence and Security of 2007, § 202 ("The Administrator may, in the regulations under the last sentence of paragraph (2)(A)(i), adjust the 20 percent, 50 percent, and 60 percent reductions in lifecycle greenhouse gas emissions . . . .").

67. 42 U.S.C. § 7545(o)(4)(B) (2006).

Source: Energy Independence and Security Act of 2007.

Eligible Biofuel	Mandated percentage of LCA GHG (%)	Permissible modification %
Conventional biofuel	20	Not less than 10
Advanced biofuels	50	Not less than 40
Cellulosic biofuel	60	Not less than 50
Biomass-based Diesel	50	40
Undifferentiated Advanced biofuels	50	40

Table 2 shows the volumes of renewable fuels that will be needed to meet the RFS requirements under EISA. While conventional corn-based ethanol will continue to play a significant role in meeting the renewable fuels objectives of the United States, there is strong interest in promoting the use of alternative feedstocks, such as advanced biofuel and cellulosic biofuel. For example, based on Table 2, there is a 300% increase in traditional corn-based renewable fuel between the years 2008 and 2022, compared to percent increases that run into the thousands for advanced biofuel and cellulosic biofuel for the same period. Technological advances that improve the use of alternative feedstock would go a long way to reduce the concerns associated with using corn as feedstock in ethanol production.

Table 2. Applicable Volumes of Renewable Fuels under the Energy Independence and Security Act of 2007

Source: Energy Independence and Security Act of 2007.[68]

	Fuel Type in billions of gallons			
Year	*Renewable fuel*	*Advanced biofuel*	*Cellulosic biofuel*	*Biomass-based diesel*
2006	4.0	-	-	-
2007	4.7	-	-	-
2008	4.9	-	-	-
2009	11.1	0.6	-	0.5
2010	12.95	0.95	0.1	0.65
2011	13.95	1.35	0.25	0.80
2012	15.2	2.0	0.5	1.0
2013	16.55	2.75	1.0	-
2014	18.15	3.75	1.75	-

68. *Id.* at 1522-23.

2015	20.5	5.5	3.0	-
2016	22.25	7.25	4.25	-
2017	24.0	9.0	5.5	-
2018	26.0	11.0	7.0	-
2019	28.0	13.0	8.5	-
2020	30.0	15.0	10.5	-
2021	33.0	18.0	13.5	-
2022	36.0	21.0	16.0	-

B. *Indirect Land Use/Leakage*

The fuel substitution provisions under EISA may not fully achieve their intended goals, due to a long-standing agricultural economic finding that higher prices and/or land related policy like conservation programs cause countervailing reactions that offset environmental gains.[69] This phenomenon has been labeled as leakage in the global climate change context. Formally, the Intergovernmental Panel on Climate Change (IPCC) defines leakage as "the part of emissions reductions in Annex B countries that may be offset by an increase of the emissions in the non-constrained countries above their baseline levels."[70] Leakage can occur if, for example, market forces such as today's high commodity prices increase production and, in turn, increase GHG emissions in other areas of the world or portions of the economy.[71]

Since the biofuel substitution provisions under EISA will require expansion in biomass production, leakage can occur either through land use changes to expand biomass production, changes in the price of fuel, or changes in the price of feedstock.

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69. Leakage is also a concern in farm policy settings where it is called "slippage." *See, e.g.*, JunJie Wu, *Slippage Effects of the Conservation Reserve Program*, 82 AM. J. OF AGRIC. ECON. 929 (2000); JunJie Wu et al., *Environmental and Distributional Impacts of Conservation Targeting Strategies*, 41 J. ENVTL. ECON. & MGMT. 333 (2001).

70. CLIMATE CHANGE 2001: SYNTHESIS REPORT 377 (Robert T. Watson et al. eds., 2001) (emphasis in original omitted) (According to the IPCC, leakage can occur through "(i) relocation of energy-intensive production in non-constrained regions; (ii) increased consumption of *fossil fuels* in these regions through decline in the international price of oil and gas triggered by lower demand for these energies; and (iii) changes in incomes (thus in energy demand) because of better terms of trade").

71. *See* Brian C. Murray et al., *Estimating Leakage from Forest Carbon Sequestration Programs*, 80 LAND ECON. 109, 112 (2004); Heng-Chi Lee et al., *Leakage and Comparative Advantage Implications of Agricultural Participation in Greenhouse Gas Emission Mitigation*, 12 MITIGATION & ADAPTATION STRATEGIES FOR GLOBAL CHANGE 471 (2007). For the proposition that trade can lead to leakage, see Richard Black, *Trade Can 'Export' CO2 Emissions*, BBC NEWS, Dec. 19, 2005, http://news.bbc.co.uk/2/hi/science/nature/4542104.stm ("Researchers found that US imports of goods from China cause a greater production of carbon dioxide than if the goods were made in the US").

This is supported by several studies that have identified and discussed the key factors in the size of leakage to include: (a) the amount of marketed production that is offset (note that residues and waste product feedstocks tend to have lower market offsets while the use of conventional commodities are one to one substitutes); (b) the land use that replacement acres come from and the embodied emissions where large offsets may occur when rainforest, forest, or CRP land is involved; (c) the supply responsiveness of competitive areas; and (d) the market share of the country producing the bioenergy.[72]

The importance of accounting for leakage in the biofuel substitution initiative is underscored by findings from a study by Professor Bruce McCarl which show that "international leakage easily offsets nearly 50% of the domestic diverted production."[73] In turn, when GHG offsets per acre are equal this offsets 50% of the GHG gains.[74] McCarl's calculations show the offset occurs at an even higher rate if acres with higher emissions are involved, as in the rainforest or CRP.[75]

The potential that the leakage problem could frustrate policy efforts to address the problem of greenhouse gas emissions is recognized in policy circles in the United States and the rest of the world. The International Energy Agency, for example, has called on EU countries to "develop a comprehensive set of policies in readiness to tackle carbon leakage, the loss of business to companies in regions unconstrained by emissions trading schemes or carbon taxes."[76]

For the first time, a bill has been introduced in the U.S. House of Representatives to directly address the problem of carbon leakage.[77] According to the sponsors, the bill seeks to "distribute emission allowances under a domestic climate policy to facilities in certain domestic energy-intensive industrial sectors to prevent an increase

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72. *See generally* Joseph Fargione et al., *Land Clearing and the Biofuel Carbon Debt*, 319 SCI. 1235 (2008); Timothy Searchinger et al., *Use of U.S. Croplands for Biofuels Increases Greenhouse Gases Through Emissions from Land-Use Change*, 319 SCI. 1238 (2008); HARNESSING FARMS AND FORESTS IN THE LOW-CARBON ECONOMY: HOW TO CREATE, MEASURE, AND VERIFY GREENHOUSE GAS OFFSETS (Zach Willey & Bill Chameides eds., 2007); Murray et al., *supra* note 72, at 109.

73. *See generally* Bruce A. McCarl, *Bioenergy in a Greenhouse Mitigating World*, CHOICES, 1st Quarter 2008, at 31, 32 [hereinafter *Greenhouse Mitigating*]; Searchinger, et al., *supra* note 73 ("when acres are directly replaced by rainforest reductions, . . . net GHG emissions would increase"); Fargione et al, *supra* note 73 (the risks of emission increases vary with land use and feedstocks).

74. *Greenhouse Mitigating*, *supra* note 74.

75. For studies that contain detailed analyses of leakage offset issues, see Fargione et al., *supra* note 73; Searchinger, et al., *supra* note 73, at 1240.

76. Tom Young, *EU Urged to Prepare to Tackle "Carbon Leakage,"* BUSINESS GREEN, Oct. 28, 2008, http://www.businessgreen.com/business-green/news/2229268/eu-ready-stop-carbon-leakage.

77. Carbon Leakage Prevention Act, H.R. 7146, 110th Cong. (2008). Representative Jay Inslee, a Democrat from Washington, introduced the Carbon Leakage Prevention Act on September 26, 2008 during the 110th Congress, 2nd Session. The bill was co-sponsored by Representative Michael Doyle, a Democrat from Pennsylvania.

in greenhouse gas emissions by manufacturing facilities located in countries without commensurate greenhouse gas regulation, and for other purposes."[78] Congress found *inter alia* that "[c]arbon leakage can be mitigated substantially through the output-based distribution of emission allowances."[79] One of the purposes of H.R. 7146 is "[t]o prevent carbon leakage resulting from direct and indirect compliance costs incurred under a domestic cap-and-trade program."[80] This bill is currently in committee but its success could go a long way to minimize leakage problems that could arise in implementing the biofuel substitution provisions under EISA.

We note here that there could also be positive leakage due to the impact of increased corn prices on livestock feed demand. For example, if as a result of an increase in the price of corn, the quantity of livestock feed were to decline, the number of livestock on feed should decline. Since livestock accounts for nine percent of global carbon emissions, thirty-five to forty percent of global methane emissions and about sixty-five percent of global nitrous oxide emissions of the three major greenhouse gases, the decline in livestock numbers should have a positive effect in reducing global anthropogenic emissions.[81]

C. *Bioenergy and GHG Offsets*

The issues of LCA, leakage, and GHG offsets are interrelated. The GHG offset issue arises as follows. The RFA under EISA mandates that a certain percentage of gasoline be replaced by a renewable fuel such as ethanol.[82] The question is, will the GHG associated with producing the quantity of renewable fuel be lower than the GHG associated with the mandated percentage of gasoline to be replaced? In its rulemaking to implement the RFA mandate, the Environmental Protection Agency (EPA) used a model developed by the Department of Energy's (DOE) Argonne National Laboratory (ANL) called the Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation (GREET) model.[83] GREET was used to conduct what the EPA termed "well-to-wheel" analysis of the RFS program.[84]

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78. *Id*.

79. *Id*. § 2.

80. *Id*. § 3.

81. HENNING STEINFELD ET AL., FOOD & AGRIC. ORG. OF THE UNITED NATIONS, LIVESTOCK'S LONG SHADOW: ENVIRONMENTAL ISSUES AND OPTIONS, at xxi (2006), http://www.fao.org/docrep/010/a0701e/a0701e00.htm (The estimate for carbon is based on estimates for deforestation and pasture degradation, the estimate for methane is due primarily to enteric fermentation and manure, and the estimate for nitrous oxide is primarily from livestock activities).

82. Energy Independence and Security Act of 2007, Pub. L. No. 110-140, § 202(a)(l), 121 Stat. 1492, 1521-22 (2007) (codified as amended at 42 U.S.C. § 7545 (2006 & Supp. 2008)).

83. EPA, REGULATORY IMPACT ANALYSIS: RENEWABLE FUEL STANDARD PROGRAM 223 (2007), http://www.cpa.gov/oms/renewablefuels/420r07004-sections.htm [hereinafter REGULATORY

The accuracy of the GHG offsets measurement that goes into LCA, used in rulemaking to implement RFA standards, has received considerable attention in the literature. There has been controversy regarding whether a U.S.-based GREET derived LCA is in fact a good way to measure global GHG offsets.[85] This has arisen in part because LCA typically does not pay attention to international leakage.[86] These gaps in GHG accounting have led some researchers to argue that GHG offsets may be negative; that is, it takes more fossil energy to produce the renewable fuel than is contained in the renewable fuel itself.[87] Others have suggested that a more general equilibrium analysis applicable to LCA is needed that takes into account the effects on livestock herds of altered feed availability and the ripple effects on, for example, altered crop production.[88]

There is another issue that will undoubtedly raise its head if the United States gets to the point that the advanced bioenergy concept, envisioned in the 2007 Energy

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IMPACT ANALYSIS] ("GREET, a multi-dimensional spreadsheet model, is one of the most widely used model of this type for transportation fuels. . . . It is the most comprehensive and user-friendly model of its type. It has been under development for over 10 years, with input from EPA, USDA, DOE laboratories, and industry representatives. The model addresses the full lifecycle for an exhaustive number of alternative transportation fuels and automotive technologies. For these reasons, EPA felt it was the best tool for evaluating the energy and emission impacts of the RFS program." Other competing models are the ERG Biofuel Analysis Meta-Model (EBAMM) developed by the Energy and Resources Group (ERG) of the University of California-Berkeley, and the Lifecycle Emissions Model (LEM) by Mark Delucchi at the Institute of Transportation Studies of the University of California-Davis).

84. *See id*. at 217 (stating that "[f]or transportation fuels, lifecycle modeling considers all steps in the production of the fuel. This includes production of the fuel feedstock, transportation of the fuel feedstock to a processing facility, fuel processing, and distribution of the fuel to the retail outlet. If the analysis considers only the finished product, it is sometimes called a 'well-to-pump' analysis; if the fuel combustion emissions are included, it can be called a 'well-to-wheel' analysis. While both approaches have advantages, in this work we have considered 'well-to-wheel' impacts").

85. *See id*. at 225-27.

86. *See infra* Part IV.D (discussing leakage).

87. *See, e.g.*, Fargione et al., *supra* note 73, at 1236-37; Searchinger et al., *supra* note 73, at 1238. *See also* David Pimentel, *Ethanol Fuels: Energy Balance, Economics, and Environmental Impacts are Negative*, 12 NAT. RESOURCES RES. 127, 127 (2003); David Pimentel & Tad W. Patzek, *Ethanol Production Using Corn, Switchgrass, and Wood; Biodiesel Production Using Soybean and Sunflower*,14 NAT. RESOURCES RES. 65, 65 (2005). *But cf.* Roel Hammerschlag, *Ethanol's Energy Return on Investment*: *A Survey of the Literature 1990-Present*, 40 ENVTL SCI. & TECH. 1744, 1744 (2006); Alexander E. Farrell et. al., *Ethanol Can Contribute to Energy and Environmental Goals*, 311 SCI. 506, 506 (2006); Jason Hill et. al., *Environmental, Economic, and Energetic Costs and Benefits of Biodiesel and Ethanol Biofuels*, 103 PROC. NAT'L ACAD. SCI. U.S.A. 11206, 11206 (2006); REGULATORY IMPACT ANALYSIS, *supra* note 84, at 224 ("Authors of the GREET model have also concluded that the lifecycle amount of fossil energy used to produce ethanol is less than the amount of energy in the ethanol itself. Based on our review of all the available information, and the results of our own analysis, we also believe that the energy balance is positive").

88. Lifecycle Carbon Footprint, *supra* note 57, at 8-9.

Bill, is fully implemented or if the GHG offset price were to become significant.[89] Namely, strong economic incentives to reduce GHG emissions will stimulate innovation and factor substitution, reducing bioenergy process-associated GHG emissions.[90] This means the LCA assumption, that the GHG contribution of inputs used in production are constant, may be questionable. This is manifest in changes in the GREET model, where there has been a recent 34% reduction in GREET agricultural emissions assumptions.[91] Such an adjustment was undoubtedly stimulated by farmers' reactions to increased energy prices and/or the cost price squeeze. That adjustment would be equivalent in many ways to the adjustments that might be caused by a carbon price signal or an advanced bioenergy definition. This would be manifest in many ways; for example, bioenergy processing facilities could switch heat sources from fossil fuels to corn stover or other renewables. What emerges from the broad concerns with GHG offsets is that the performance of LCA and stability of measured GHGs will depend on the rate of technological change.

McCarl has conducted a fairly comprehensive, consistent LCA across the full spectrum of agricultural bioenergy possibilities, including possibilities for bioenergy to go into ethanol, biodiesel, and electricity.[92] The method for this is as follows:

Step a: A consistent regionalized set of crop budgets was adopted for the accounting, which was obtained from the Forest and Agricultural Sector Optimization Model (FASOMGHG).[93]

Step b: GHG emission estimates of the GHG CO_2, methane (CH_4), and nitrous oxide (N_20) emitted when making fertilizer, lime, and specific pesticides were adapted from U.S. Environmental Protection Agency (EPA) assumptions, and applied to estimate emissions based on levels of input use in the budgets.

89. Note that in 2008 the price of a ton of carbon on the Chicago Climate Exchange ranged from $1.90 in January to $7.40 in June, while a ton of carbon on the European Climate Exchange cost $34.28 on July 21, 2008. EcoLogistics, LLC, The Cost of Carbon, http://www.ecologisticsllc.com/cost.html (last visited Apr. 22, 2009).

90. According to the theory of induced innovation, those technological innovations that reduce the relative cost of scarce inputs will be invented and adopted. *See* YUJIRO HAYAMI & VERNON W. RUTTAN, AGRICULTURAL DEVELOPMENT: AN INTERNATIONAL PERSPECTIVE 53-54 (1971).

91. *See* E-mail from Michael Quanlu Wang, Argonne National Laboratory, to Bruce McCarl, Professor of Agricultural Economics, Texas A&M University (Dec. 11, 2008, 21:05:11 CST) (on file with author).

92. Lifecycle Carbon Footprint, *supra* note 57.

93. For details of the accounting procedures, see Darius Adams et al., FASOMGHG Conceptual Structure, and Specification: Documentation 71 (Feb. 2005) (unpublished manuscript, *available at* http://agecon2.tamu.edu/people/faculty/mccarl-bruce/papers/1212FASOMGHG_doc.pdf) (The budgets were developed based on extension service budgets and USDA Agricultural Resource Management Survey (ARMS) data).

Step c: GHG emission estimates embodied in gasoline, diesel, natural gas, and electricity (regionalized) use were adopted from EPA and GREET model work, and applied to estimate emissions based on levels of input use in the budgets.[94]

Step d: Intergovernmental Panel on Climate Change (IPCC) default emission rates were applied to estimate fertilizer-related N_2O emissions.[95]

Step e: Crop soil sequestration rates were incorporated based on CENTURY model runs.[96]

Step f: The above data were unified on a regional basis, using eleven regions defined in the FASOMGHG, to get regional average GHG emissions per acre and per unit (e.g. bushel) of crop.[97]

Step g: Bioenergy processing budgets were drawn together, based on the literature for a wide variety of agricultural feedstocks for transformation into ethanol, cellulosic ethanol, biodiesel, and electricity, including alternative electricity co-firing rates. These budgets contained assumptions about the fuel being replaced (typically gasoline, diesel, and coal), the foregone fossil emissions, and emissions from transforming feedstocks into bioenergy.

Step h: Hauling cost was computed based on feedstock density in a region, crop yields, and processing plant feedstock needs, following the formula in Ben French's *Some Considerations in Estimating Assembly Cost Functions for Agricultural Processing Operations* as in McCarl's *Competitiveness of Biomass-Fueled Electrical Power Plants*.[98]

Step i: Total GHG emissions per unit of energy output were computed, unifying the emissions per unit of crop input, per unit hauled, and per unit transformed on a regional basis, and then were computed as the percent net savings in emissions per unit of fuel displaced.

Step j: A national set of results was generated using the regional results, favoring areas where the acreage of the biofeedstock was the largest or where the prospect is commonly referred to (e.g. Cornbelt and South for switchgrass).

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94. *See* GREET 1.5, *supra* note 58. *See also Life-Cycle Energy*, *supra* note 58.

95. *See* Cecile De Klein et al., *N_2O Emissions from Managed Soils, and CO_2 Emissions from Lime and Urea Application*, *in* 4 2006 IPCC GUIDELINES FOR NATIONAL GREENHOUSE GAS INVENTORIES: AGRICULTURE, FORESTRY AND OTHER LAND USE 11.1 (Simon Eggleston et al. eds., 2006), *available at* www.ipcc-nggip.iges.or.jp/public/2006gl/index.html.

96. *See* W.J. Parton, *The CENTURY Model*, *in* EVALUATION OF SOIL ORGANIC MATTER MODELS: USING EXISTING LONG-TERM DATASETS, 282, 282-91 (1996).

97. *See* Adams et al., *supra* note 94.

98. *See* Ben C. French, *Some Considerations in Estimating Assembly Cost Functions for Agricultural Processing Operations*, 42 J. FARM ECON. 767 (1960). *See also* Bruce A. McCarl et al., *Competitiveness of Biomass-Fueled Electrical Power Plants*, 94 ANNALS OPERATIONS RES. 37, 49 (2000).

Step k: Byproducts like lignin and distillers dry grain were credited at the GHG emissions of the items they replaced.[99]

The resultant data for a number of bioenergy feedstock and final energy possibilities appear in Table 3. In these data, the net GHG contributions of a bioenergy depend upon the amount of fossil fuel used in: (a) producing the feedstock; (b) making production inputs; (c) hauling; (d) processing transformation; and (e) byproduct credits.

Table 3.
GHG Offsets When Raw Products Replace Conventional Fossil Fuel-Based Energy

Commodity	Crop Ethanol	Cell Ethanol	Bio diesel	Electricity Co-fire 10%	Electricity Fire 100%
Corn	30.5				
Hard Red Winter Wheat	31.5				
Sorghum	38.4				
Log Residue		80.0		99.1	97.4
Corn Residue		74.0		93.4	87.3
Wheat Residue		72.9		95.5	91.1
Lumber Milling Residue		84.8			
Manure				99.4	96.5
Switch Grass		68.6		94.4	89.5
Hybrid Poplar		61.9		94.2	89.1
Willow		67.7		96.7	93.7
Soybean Oil			70.2		
Sugarcane	64.8				
Corn Oil			55.0		

99. The results differ from the procedure in Bruce A. McCarl et al., *Economics of Biochar Production, Utilization and Greenhouse Gas Offsets*, *in* BIOCHAR FOR ENVIRONMENTAL MANAGEMENT: SCIENCE AND TECHNOLOGY 341 (Johannes Lehmann & Stephen Joseph eds., 2009), in that byproduct credits were omitted from the earlier results.

Bagasse	90.1	100.0	100.0
Lignin		100.0	100.0

The data within Table 3 show the percentage of direct reduction in carbon dioxide equivalent emissions when gasoline, diesel, or coal fired electricity is replaced. For example, the percentage reduction in net GHG emissions when using corn-based ethanol is 30.5% relative to using gasoline. This means 69.5% of the potential emissions savings from replacing the gasoline are offset by the emissions from the use of fossil fuels or fossil fuel using inputs in producing the corn, transporting it to the plant and transforming it into ethanol. We also see higher emission offset rates for electricity, principally because the feedstock is burned with little transformative energy needed once it is at the processing site. Also, co-firing generally has a higher degree of offsets because hauling distances are shorter as lower feedstock volumes are required and because of the hotter burning caused by the presence of coal, which increases feedstock heat recovery. This is classical LCA without the indirect land use results, and shows if at least 50% of the production is replaced then corn falls below the 20% requirement.

Broadly looking across the table, the results illustrate and/or reflect a number of things. First, there are relatively lower offset rates involved with the production of liquid fuels as opposed to electricity. Second, the lowest liquid fuel offsets arise for grain-based ethanol, while relatively higher values generally arise from cellulosic ethanol and biodiesel from soybean oil. Third, the results show that differential offset rates arise across the different feedstocks and processes. The results reflect that, for example, production of some biofuels requires substantial use of GHG emission-intensive inputs (corn is a large fertilizer user). Fourth, more GHG emission-intensive transformation processes go into making ethanol, along with successively fewer processes to make cellulosic ethanol, biodiesel. and electricity. Finally, as a matter of economics, it is apparent that if higher GHG prices were to arise, there would be a shift in production away from grain-based ethanol toward cellulosic and a trend to move toward electricity. For a credible RFA program, there is a need to intensify research efforts that help to better account for the GHG emissions associated with various technologies. The success of our energy policies is critically dependent on the accuracy of our metrics.

D. *Land Use Change*

High agricultural prices stimulate increased production. Increased production is achieved through intensification or extensification.[100] "Under extensification the argument is that the high agricultural prices, income potential, and land values stimulate additional land being brought into production use either in the United States or internationally."[101] The argument in the United States is that the bioenergy contribution to higher prices, farm income, and farmland value will cause: pastureland to be converted to cropland; conservation reserve program (CRP) and other fragile retired lands to revert back into agricultural cropping; forested lands to be deforested and moved into agricultural production; and other forms of land development, like wetlands exploitation.[102]

The same argument has been presented at the international level, but in this case, the concern also includes potential conversion of rain forest lands into cropping uses or to augment grazing land.[103] Several studies have shown that "higher prices and/or land-related policy like conservation programs cause countervailing reactions that offset environmental gains."[104] This has been labeled leakage in the International GHG/Kyoto accord context, or slippage in farm policy settings.[105] In addition to the leakage issues, extensification has raised concerns about environmental quality including:

> (a) loss of habitat for endangered species and consequent loss of biodiversity; (b) loss of future opportunities for exploitation of species that are made extinct; (c) loss of carbon sequestered in rain forests; (d) loss of water purification and other ecological services from the lands transformed; (e) increases in runoff and other emissions from agricultural

100. *See* U.N. Econ. & Soc. Council [ECOSOC], Food and Agric. Org. of the U.N., *The State of Food and Agriculture 2008: Biofuels: Prospects, Risks and Opportunities*, at 60, U.N. Doc. AD/I/I02090E/1/9.08/3000 (May 26, 2008), (*prepared by* Ken Wiebe et al.), *available at* ftp://ftp.fao.org/docrep/fao/011/i0100e/i0100e.pdf ("Over the past five decades, most of the increase in global agricultural commodity production (around 80 percent) has resulted from yield increases, with the remainder accounted for by expansion of cropped area and increased frequency of cultivation . . . ." (citing Peter Hazell & Stanley Wood, *Drivers of Change in Global Agriculture*, 363 PHIL. TRANSACTIONS ROYAL SOC'Y B 495, 496 (2007)).

101. BRUCE A. MCCARL & TOBIAS PLIENINGER, AM. INST. FOR CONTEMPORARY GERMAN STUDIES, BIOENERGY IN THE UNITED STATES AND GERMANY 18 (2008), http://www.aicgs.org/documents/pubs/polrep36.pdf.

102. *See generally* DANIEL G. DE LA TORRE UGARTE ET AL., U.S. DEP'T OF AGRIC., THE ECONOMIC IMPACTS OF BIOENERGY CROP PRODUCTION ON U.S. AGRICULTURE (2003), http://www.usda.gov/oce/reports/energy/AER816B.pdf.

103. *See* Fargione et al., *supra* note 73, at 1235. *See also* Searchinger et al., *supra* note 73, at 1238.

104. MCCARL & PLIENINGER, *supra* note 102.

105. *See supra* Part IV.B (discussing leakage).

land due to increased chemical use relative to the prior land-use; and (f) increased use of water for irrigation.[106]

Increased production may also involve intensification.[107] Under intensification, "farmers will increase input usage on existing lands since the increased marginal returns can justify additional costs of production."[108] This would be manifest in higher usage of irrigation, fertilization, and pesticides, plus more intense cropping patterns and tillage, among other possibilities.[109]

Again "this is argued to be environmentally sensitive in terms of added usage of scarce resources like water, increased chemical usage, increased agricultural runoff, diminished water quality, and threats to biodiversity among other environmental concerns."[110] Such actions can occur either in the United States or internationally.[111] In the context of implementing the RFS program under EISA, land use changes will have two primary impacts. First, land use changes, through expansion or intensification of production to increase biofuel feedstock production, will reinforce the technical measurement problems associated with leakage. The second impact that could frustrate the implementation of the RFS program is the possibility that the size of the loss of environmental services could be such as to trigger widespread opposition by environmental groups and other stakeholders in the environmental services sector. These two impacts could significantly raise the transaction costs associated with implementing the RFS program under EISA.

E. *Food Price Impacts*

1. *Effects on Commodity Prices*

Biofuel developments have coincided with large rises in some food and commodity prices. These increases in prices pose challenges to the implementation

106. *Id. See also* ECOSOC, *supra* note 101 ("Of the world's 13.5 billion hectares of total land surface area, about 8.3 billion hectares are currently in grassland or forest and 1.6 billion hectares in cropland. . . . Much of the land in forest, wetland or other uses provides valuable environmental services, including carbon sequestration, water filtration and biodiversity preservation; thus, expansion of crop production in these areas could be detrimental to the environment").

107. *See* Energy Independence and Security Act of 2007, 42 U.S.C. § 17021 (2006 & Supp. 2008).

108. MCCARL & PLIENINGER, *supra* note 102.

109. ECOSOC, *supra* note 101, at 62 ("While area expansion for biofuel feedstock production is likely to play a significant role in satisfying increased demand for biofuels over the next few years, the intensification of land use through improved technologies and management practices will have to complement this option, especially if production is to be sustained in the long term").

110. MCCARL & PLIENINGER, *supra* note 102.

111. ECOSOC, *supra* note 101, at 60, 63, 96.

of EISA because they could provide ammunition for stakeholders who may be opposed to the renewable fuels policies. For analytical purposes, it is best to examine this issue from two perspectives. One perspective is the general implication of a rise in commodity prices; for example, a rise in the prices of corn and soybeans. The second perspective is the implication of the rise in food prices and poverty alleviation in developing countries.

A request by the state of Texas for a waiver of the application of the renewable fuels standards is a good example of how rising commodity prices, as a result of bioenergy development, could lead to resistance from strategic stakeholders. On April 25, 2008, Governor Rick Perry of Texas sent a petition to the Administrator of the EPA requesting a 50% waiver from the renewable fuels requirements for the period of September 1, 2008 through August 31, 2009.[112] The request was predicated on the impact of implementing the RFS on the agriculture industry in Texas and higher food prices.[113] The Governor was especially concerned about the projected prices of corn that had increased from $2.06/bushel in 2004 to an average of $4.00/bushel in 2007, and was projected to increase to $8.00/bushel in 2008, and the devastating impacts these price increases could have on the livestock sector.[114]

EPA rejected Texas's request, "[a]fter considering all the public comments, and consulting with the Secretaries of Agriculture and Energy, EPA has determined that the waiver request should be denied."[115] The failure of the petition was due to the inability of Texas to show that harm resulted from the *implementation of the RFS program itself*, and also meet the high threshold of demonstrating *severe harm*.[116] The EPA's analysis of the Texas petition provides some insights on the burden of

112. Letter from Governor Rick Perry to Stephen L. Johnson, Adm'r, EPA (Apr. 25, 2008), *available at* http://www.epa.gov/oms/renewablefuels/rfs-texas-letter.pdf.

113. *Id*. ("In 2007, Texas farmers produced 296 million bushels of corn. Through our many animal feeding operations, 900 million bushels of corn are fed in Texas each year. Applying a simple calculation, it is easy to see that a one-cent change in the per-bushel price of corn will negatively affect Texas livestock industry by $6.04 million.") (emphasis omitted).

114. *Id*. ("In 2004, before the RFS was implemented, the price of corn was $2.06/bushel. In a conservative estimate, the U.S. Department of Agriculture (USDA) projects the price for the 2007 crop (post-RFS) will have averaged $4.00/bushel. The difference of $1.94/bushel equates to a negative impact on the Texas economy of $1.17 billion since the RFS has come out. And now, with the implementation of the new RFS, some estimates peg corn prices at $8.00/bushel for the 2008 crop, which would result in a negative impact to Texas of $3.59 billion.") (emphasis omitted).

115. Notice of Decision Regarding the State of Texas Request for a Waiver of a Portion of the Renewable Fuel Standard, 73 Fed. Reg. 47,168, 47,169 (Aug. 13, 2008).

116. *Id.* at 47,169 (The EPA has interpreted the statutory provisions to require "a determination based on the expected impact of the RFS program itself, a generally high degree of confidence that implementation of the RFS program would severely harm the economy of a State, region, or the United States, and a high threshold for the nature and degree of harm by requiring a determination of severe harm").

parties seeking waiver under the EISA. "As recognized by Texas, the straightforward meaning of this provision is that implementation of the RFS program itself must be the cause of the severe harm."[117] Texas would have preferred an interpretation of the statute that only required that "implementation of the RFS program would 'significantly contribute' to severely harming the economy" because "it would otherwise be impossible to ever demonstrate that the criteria of a waiver have been met and Congress could not have intended this result."[118] As explained by the EPA, it is possible that corn prices could be affected by several other market and non-market forces.[119]

According to the EPA ruling, Texas also failed to demonstrate the severe harm requirement for approving a waiver under the RFS program. Texas requested a waiver for the one-year period of September 1, 2008 through August 31, 2009.[120] Using an economic model developed by researchers at Iowa State University, the EPA determined that the economic impact could not rise to the level of severe harm within this period.[121] The EPA pointed out that even if the waiver were granted, thereby leading to a decline in ethanol production, the resulting decline in corn prices would be around $0.30 per bushel, and fuel prices may increase by about $0.01 per gallon. EPA did not consider these outcomes severe enough to support a waiver of the RFS program.[122]

This is the only request for a waiver that has so far been submitted to the EPA. Circumstances could lead to similar petitions being filed, as the Texas Governor seems to be raising alarms in strategic policy forums.[123] Whatever groundswell of petitions in the future, the EPA has left no doubt about its intentions not to drill into any deeper meanings than what the regulation currently says:

> While the EPA realizes that the criteria provided by the statute are quite general, the rationales of severe environmental or economic harm or inadequate domestic supply are sufficient for a basic framework upon which a petition can be built and evaluated. Each

117. *Id.* at 47170 ("Texas recognizes that the waiver provision 'speaks in terms of a singular causal link between the mandate and the harm (i.e. 'implementation of the requirement would severely harm') . . . .'").

118. *Id.*

119. *Id.* at n. 10 ("Even if the statute was less clear on its face, EPA would still reject the approach suggested by Texas. Many circumstances other than RFS could lead to impacts on an economic factor such as increased corn prices").

120. *Id.* at 47,168.

121. *Id.* at 47,173.

122. *Id.* at 47,169.

123. *See* Perry, *supra* note 113, at 2 (At a meeting of fellow Governors at a Republican Governors Association meeting, the Texas Governor warned, "[I]f you think it's bad for foreign countries to control our fuel, imagine what it would be like if they control our food supplies.").

> situation in which a waiver may be requested will be unique, and promulgating a list of more specific criteria in the abstract may be counter-productive.[124]

What the EPA position does is create uncertainties regarding the success of petitions for waiver. The uncertainty costs could serve as a deterrent to waiver requests, or it could provide a basis for aggressive political pressure for changes in the RFS program. If the latter holds, the well-intentioned goal of the RFS program would be frustrated.

2. *Food Prices and Poverty*

Expansion in bioenergy production has raised concerns about the implications for the world's poor, given the change in food prices.[125] In particular, the rise in commodity prices has led to increased prices for food commodities.[126] Given that the price increase has been simultaneous with the boom in bioenergy, this has been blamed on bioenergy.[127] One has to be cautious and distinguish between correlation and causality. Biofuel is only one of several factors responsible for the increase in agricultural commodity prices, so there may not be adequate support for establishing causality between biofuels production and agriculture commodity prices.[128] As some researchers have pointed out, a number of the critical food commodities for which

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124. Regulation of Fuels and Fuel Additives: Renewable Fuel Standard Program, 72 Fed. Reg. 23,899, 23,928 (May 1, 2007) (to be codified at 40 C.F.R. pt. 80).

125. WorldBank, Agriculture and Development, http://web.worldbank.org/WBSITE/EXTERNAL/TOPICS/EXTARD/0,,menuPK:33668~pagePK:149018~piPK:149093~theSitePK:336682,00.html (last visited Apr. 22, 2009) ("The World Bank Group's New Deal on Global Food Policy has been endorsed by 150 countries. The Bank's main contribution to emergency response under the New Deal is the $1.2 billion Global Food Crisis Response Program (GFRP), which embraces both short and medium-term responses, including safety nets; increased agricultural production; a better understanding of the impact of biofuels; and action on the trade front to reduce distorting subsidies and trade barriers").

126. Perry, *supra* note 113, at 1 ("While the RFS was a well intentioned policy, it has had the unintentional consequence of harming segments of our agriculture industry and contributing to higher food prices. For example, corn prices are up 138 percent globally over the past three years and global food prices have increased 83 percent over the same time period, in part because of the artificial economic forces created by the RFS").

127. ECOSOC, *supra* note 101, at 41 ("Agricultural commodity prices have risen sharply over the past three years, driven by a combination of mutually reinforcing factors, including, among others, the demand for biofuels. The FAO index of nominal food prices has doubled since 2002, and the index of real prices has also risen rapidly. By early 2008, real food prices were 64% above levels of 2002 after four decades of predominantly declining flat trends").

128. *Id*. at 85 ("Many factors are responsible for the recent sharp increases in agricultural commodity prices, including the growth in demand for liquid biofuels. Biofuels will continue to exert upward pressure on commodity prices, which will have implications for food security and poverty levels in developing countries").

prices have increased are well outside the domain of items used for widespread bioenergy production. Explaining the recent rise in food prices, the FAO states, "[t]he surge was led by vegetable oil prices, which on average increased by more than 97 percent [since 2002], followed by cereals (87 percent), dairy products (58 percent) and rice (46 percent)."[129] In the case of rice, researchers have attributed the increase in prices to demand expansion, exchange rate changes, and production conditions, with bioenergy policies only a contributing factor.[130]

For useful policy discussion, the relationship between bioenergy production, food prices, and poverty ought to be looked at from both long- and short-term perspectives. In the short-term, higher food prices will adversely affect poor urban and rural dwellers in net food importing countries. In the long-term, expansion in biofuel production and any associated increases in food prices could benefit rural dwellers, especially if governments in poor countries are willing to provide an enabling environment (infrastructure, appropriate laws, governance, extension services, etc.),[131] and let the market price provide signals to farmers. It has certainly been a classic argument of development economists that one strategy for alleviating poverty in the long-run has been to increase agricultural commodity prices through market and infrastructure development, plus removing trade barriers.[132] In the context of implementing the RFS under EISA, the poverty concerns become an issue only if they rise to the level where there has been some empirical support for causality between the RFS implementation, rising food prices, and poverty in developing countries. Even here, there will have to be enough concern before an international forum forces possible changes in the RFS program's implementation.[133] Historically, efforts by developing

129. *Id.* at 41.

130. PHILIP C. ABBOTT ET AL., FARM FOUND, WHAT'S DRIVING FOOD PRICES? 5, 5 (2008), http://www.farmfoundation.org/news/articlefiles/404-FINAL%20WDFP%20REPORT%207-28-08.pdf.

131. *See, e.g.*, Maros Ivanic & Martin Will, Implications of Higher Global Food Prices for Poverty in Low-Income Countries 18 (World Bank, Working Paper No. 4594, 2008), *available at* http://wwwwds.worldbank.org/external/default/WDSContentServer/IW3P/IB/2008/04/16/000158349_20080416103709/Rendered/PDF/wps4594.pdf.

132. ECOSOC, *supra* note 101, at 85 ("In the long run, growing demand for biofuels and the resulting rise in agricultural commodity prices can present an opportunity for promoting agricultural growth and rural development in developing countries. They strengthen the case for focusing on agriculture as an engine of growth for poverty alleviation").

133. This is not to deny that there are some individuals and organizations who are vehemently opposed to the general biofuels program altogether. For example, "[t]he current massive wave of investment in energy production based on the cultivation and industrial processing of crops like maize, soy, palm oil, sugar cane, canola, etc., will not solve the climate crisis nor the energy crisis. It will bring disastrous social and environmental consequences. It is already one of the causes behind the current food crisis. It creates a new and very serious threat to food production by small farmers and to the attainment of food sovereignty for the world population." *Id.* at 96.

countries to force Western countries to change their domestic economic policies to benefit developing countries have not been too successful.[134]

F. *Subsidy Policy*

Both federal and state governments influence prices and production in the biofuels market to a remarkable degree. The influence is felt through a complex of production and marketing tax incentives, subsidies, trade restrictions, and support for research and development.[135] Beginning with the Energy Tax Act of 1978, the federal and state governments have supported ethanol, and later biodiesel, production that explains the large increase in output. Table 4 shows the evolution of motor fuels excise tax exemptions since the 1978 Act.

Table 4.
Exemption from Motor Fuels Excise Tax for Alcohol Blends[136]

Value on pure ethanol basis	**Period**	**Authority**
$0.40/gallon	1978	Energy Tax Act of 1978
$0.40/gallon; $0.40/gallon blenders credit	1980	Crude Oil Windfall Profits Tax of 1980
$0.50/gallon; $0.90/gallon for ≥ E85[137]	1983	Surface Transportation Assistance Act of 1982
$0.60/gallon; $0.40/gallon blenders credit	1984	Tax Reform Act of 1984

134. *See* Ravi Kanth Devarakoda, *Cotton Subsidies Remain Big Hurdle in WTO Doha Round*, INTER PRESS SERV. (Nov. 20, 2003), *available at* http://globalgeopolitics.net/wordpress/2008/10/20/trade-cotton-subsidies-remain-big-hurdle-in-wto-doha-round/ (illustrating the refusal of the United States to reduce subsidies on cotton despite massive pressure from developing countries in addition to an adverse World Trade Organization ruling against the U.S. on cotton subsidies).

135. DOUG KAPLOW, INT'L INST. FOR SUSTAINABLE DEVELOPMENT, BIOFUELS – AT WHAT COST? GOVERNMENT SUPPORT FOR ETHANOL AND BIODIESEL IN THE UNITED STATES 20 (2006), http://www.globalsubsidies.org/files/assets/pdf/Brochure_-_US_Report.pdf ("Regulating a certain market share for any good normally drives up the price of that good. The size of the impact will depend on a variety of factors, including how large the mandated purchases are relative to what consumption would have been otherwise; the degree to which output of the good increases as prices rise; and whether competition from imports is allowed").

136. *See* Ethanol Timeline, *supra* note 6. Source summarized by authors based on Energy Info. Admin., Ethanol Timeline, http://www.eia.doe.gov/kids/history/timlines/ethanol.html (last visited Apr. 16, 2009).

137. SALVATORE LAZZARI, CONG. RESEARCH SERV., TAX TREATMENT OF ALTERNATIVE TRANSPORTATION FUELS 7 (1997).

\$0.06/gallon for ≥ E85[138]	1986	Tax Reform Act of 1986
\$0.54/gallon; \$0.54/gallon blenders credit	1990	Omnibus Budget Reconciliation Act of 1990
\$0.54/gallon net (4.16¢/gallon of 7.7% blend; 3.08¢/gallon of 5.7% blend	1992	The Energy Policy Act of 1992 extended pro-rated exemptions to lower blends of ethanol E5.7 and E7.7. Ethanol blends with diesel and ethanol produced from natural gas are also eligible.
\$0.53/gallon \$0.52/gallon \$0.51/gallon	2001-02 2003-04 2005-07	The Transportation Equity Act for the 21st Century initiated pre-scheduled reductions in the exemptions. Reductions set in 1997 by the Intermodal Surface Transportation Efficiency Act of 1997. The \$0.51/gallon subsidy is still in force today.
\$0.51/gallon	2005	The American Jobs Creation Act of 2004 replaces the excise tax exemption with a Volumetric Ethanol Excise Tax Exemption
\$0.51/gallon	2007	The Energy Independence and Security Act extends the ethanol blenders credit to 2022. The Bailout Bill included a \$1 per gallon biodiesel tax credit through 2009.

The usual justification for biofuels subsidization is to nurture an infant industry, although energy security, farm income support, and environmental GHG gains are also involved.[139] The U.S. corn ethanol industry is no longer in an infant stage, and is currently experiencing an expansion in capacity, with more plants coming online.[140] The expansion is due largely to huge profits made possible by a combination of subsidies, export restrictions, and mandates. Some have pointed to the high profits and massive expansion in ethanol plant capacity as justification for eliminating or redefining the subsidy programs based on petroleum and commodity prices.[141] The United States may also consider continuation of the biodiesel subsidy, since that industry is shrinking, and establishment of a subsidy for cellulosic ethanol and biopower if justified by the infant industry and GHG arguments. These suggestions are valid if the current biofuel market conditions and political climate hold true. However, conditions may change in dramatic ways due to both economic and political pressures. The rising demand for corn and the resulting price increases have already ea-

138. *Id.* at 8.

139. *See* KAPLOW, *supra* note 136, at 2 ("Liquid biofuels have been subsidized largely on the premise that they are domestic substitutes for imported oil; they reduce greenhouse gas (GHG) emissions; and they encourage rural development").

140. The number of ethanol producing plants under construction increased by 94%, from sixteen plants to thirty-one plants between January 2005 and January 2006, representing a capacity expansion of 136%, from 754 mgy in 2005 to 1778 mgy in 2006. The number of plants further increased by 145%, from thirty-one in 2006 to seventy-six in 2007, representing a capacity expansion of 217%, from 1778 mgy in 2006 to 5635.5 mgy in 2007. Renewable Fuels Ass'n, Statistics: Ethanol Industry Overview, http://www.ethanolrfa.org/industry/statistics/ (last visited Apr. 28, 2009).

141. *See, e.g.*, Wallace E. Tyner & Farzad Taheripour, Future Biofuels Policy Alternatives (Apr. 12, 2007) (unpublished manuscript, *available at* http://www.agecon.purdue.edu/papers/biofuels/St_Louis_conf_Apr07_Tyner_Taheripour.pdf).

ten into ethanol plants' profits. From a political economy perspective, there are both domestic and international pressures against the continued operation of subsidies in the ethanol market.[142] These pressures directly threaten the sustainability of the RFS program under EISA.

V. CONCLUSIONS

U.S. energy policy is promoting bioenergy, particularly liquid forms as part of the portfolio of solutions addressing high oil prices, energy security concerns, and greenhouse gas emission reduction desires. The attainment of the objectives, however, is subject to the successful resolution of technical, economic, and political challenges posed by both domestic and international stakeholders in the energy market.

Several technical challenges must be addressed. First, a comprehensive set of life cycle analyses (LCA) must be done and must take into account direct and indirect effects. While the science of the LCA has improved, there are still concerns about the accuracy of the LCA measures and the acceptance of these measures in a global context. Second, in the LCA, leakages likely to arise (emissions increases elsewhere stimulated by U.S. actions) are of the genre as those posed by the LCA, that is, the lack of a comprehensive and universally-acceptable approach to measurement. The leakage concerns today are manifest in concerns about the potential impact of bioenergy production on agricultural land use and the environment, both domestically and internationally. These concerns are gaining momentum in political circles and could raise the contract transaction costs facing participants in the biofuels industry. It may be important to implement complementary programs to reduce

142. In the domestic arena, the Cattlemen's Association has not changed its opposition to the continued granting of subsidies to the ethanol industry, stating "NCBA members think it's time to move toward a market-based approach for the production and usage of ethanol produced from livestock feedstuffs. NCBA supports sunsetting the existing blending tax credit (VEETC) and the ethanol import tariffs as scheduled and not allowing for renewal in their current form: [1] Blender Credit (VEETC, or Volumetric Ethanol Excise Tax Credit) 51 cents per gallon, Expires December 31, 2010; [2] Import Tariff 54 cents per gallon, Expires January 1, 2009. These subsidies were primarily designed to boost the initial development in renewable fuels production and technology. However, with feed grains-based ethanol production now growing at an astounding pace, cattlemen do not consider it appropriate for Congress to renew these mechanisms in their present form when they expire near the end of the decade." Nat'l Cattlemen's Beef Ass'n (NCBA), Renewable Fuels and Ethanol Production, http://www.beefusa.org/goveRenewableFuelsandEthanolProduction.aspx (last visited Apr. 28, 2009). In the international arena, the EU has threatened to bring an unfair trade action against the U.S. over its biodiesel subsidy policy. *See* Sarah Smith, *EU Pursues Legal Action Against U.S. –Subsidized Biodiesel*, BIODIESEL MAG. (Feb. 2008), *available at* http://www.biodieselmagazine.com/article.jsp?article_id=2030 ("The European Union recently announced that it will sue the United States for unfair trade practices to prevent U.S.-subsidized biodiesel from flooding its markets, fueling its cars and undercutting its status as world leader in biodiesel production").

problems like CRP reversion, rates of deforestation, soil loss, and to increase policies to better the urban poor. It is a truism that the success of any complex governmental policy, such as our national energy policy and promotion of biofuels, is based on the acceptance of such policy in national life. It is in this context that such issues as equity and politics become especially critical to success.

Successful implementation of laws and policies to promote bioenergy must also address several economic challenges. Rapid expansion of bioenergy production can have unintended and undesirable consequences for agricultural commodity costs and the continued availability of cheap food. For bioenergy to really become a major player it must use feedstocks that are less competitive with food, and it must additionally be supported by increases in rates of technological progress.

In addition, the future of bioenergy depends on the profitability of biofuel firms and is tied to oil prices, rapid technical change in both agricultural production and energy recovery, and government subsidy policies. All of these factors raise uncertainty in the biofuels market and ultimately on investment decisions by firms.