

Gleaning Inspiration from Brazil’s Multi-Faceted Energy Policy: Towards a Second Generation of U.S. Biofuel Initiatives

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If we truly want an innovative and creative renewable fuel industry, then it needs to be challenged. And if we create a set of protections that allow it to not be as creative and innovative as possible, then we aren’t doing a service to the industry or to the people of this country.

– Tom Vilsack

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I. INTRODUCTION

By harnessing and promoting use of its natural resources, Brazil has developed some of the most progressive energy policies in the world. Due partially to its use of alternative energy sources, Brazil continues to experience rapid economic growth which substantially outpaces that of other nations. Brazil’s regulatory framework and mixed-use energy policies serve as a particularly appropriate model for the United States (“U.S.”), which is unlikely to reduce its reliance on fossil fuels in the near future without incentives encouraging the use of other

energy forms. Like Brazil, the U.S. should increasingly look to develop a mixed-used energy policy that encompasses use of both traditional and alternative fuel sources, and when developing these provisions should take on a multi-faceted approach that considers the environmental, economic, and public health implications, among others. As the U.S. grapples with issues surrounding possibly increasing domestic drilling of oil and natural gas, growing the nation's reliance on alternative fuels may serve as yet another mechanism to assist the U.S. in reducing its dependence on foreign oil. Moreover, spreading energy resources across several mediums may promote price stability and help the U.S. economy buffer shocks in oil prices.¹

Although the use of ethanol and other alternative energy sources is unlikely to completely halt the U.S.'s dependence on foreign oil, Brazil's energy policies provide an excellent model for the U.S. to glean inspiration. Though the U.S. already promotes domestic ethanol production, its current initiatives have been largely unsuccessful in generating demand for alternative fuels. Brazil's alternative energy initiatives have demonstrated that for a national energy policy to be effective, it must take into consideration demands from all facets. Therefore, U.S. policymakers should shift the emphasis of the U.S.'s alternative energy policy to promoting initiatives at the consumer level, and should encourage new producers to enter the industry. Like Brazil, the U.S. should increasingly focus on promoting the development of flex-fuel vehicles and must make substantial infrastructure changes in order to promote the viability and longevity of alternative fuel sources. Instead of focusing its initiatives on subsidizing domestic ethanol production, the U.S. should require the development of mixed-fuel or flex-fuel vehicles. The U.S. should also continue to increase the minimum percentage of biofuels required in each gasoline-powered car so that, over time, these vehicles come to resemble flex-fuel engines. Although requiring the use of biofuels in gasoline-powered cars may require re-tooling the design of new vehicles, continuing support for alternative sources of energy is a functional and pragmatic way for the U.S. to approach the dwindling supply of foreign oil reserves. Furthermore, the U.S. should actively look to promote domestic development of other biofuels and alternative energy sources; so doing may also help to promote job creation and to strengthen the economy. Finally, because Brazil can produce ethanol more cheaply than can the U.S., the U.S. and Brazil should increasingly work to foster relations and strengthen their trade relationship.

¹ This statement assumes that the consumer will be able to shift to an alternative fuel type with the assistance of appropriate regulatory and price supports.

II. BRAZIL'S ENERGY FRAMEWORK

Due to its novel approach to harnessing ethanol and other alternative energy sources, Brazil's energy framework has now become a model for other nations seeking to transition away from the use of foreign oil reserves.² Brazil's multi-pronged approach to alternative energy did not come into existence through market forces, but instead is the result of specific, targeted initiatives designed to reduce the country's dependence on foreign energy reserves and increase domestic energy production.³ As a result of its combined energy provisions, Brazil's transition towards energy independence has promoted a dramatic jump in national GDP, while its unemployment rate has dropped substantially.⁴ Estimates suggest Brazil's transition to domestic oil and sugarcane ethanol production has bolstered the nation's GDP by nearly thirty-five percent since 1980.⁵ Brazil's GDP now exceeds that of California—no small feat for a country that has experienced substantial economic difficulties in the past.⁶

The impetus for enacting target initiatives aimed at increasing the country's production and use of alternative energies came from global effects caused by an oil embargo by the Organization of Petroleum Exporting Countries ("OPEC") in the early 1970s. In response to the 1973 world oil crisis, which resulted in widespread stagflation (simultaneously rising inflation and unemployment rates), the Brazilian government endeavored to reduce the nation's reliance on foreign oil reserves.⁷ In 1975, Brazil developed its first biofuel policy with the birth of

² See Michael McDermott et al., *Brazil and Biofuels for Autos: A Model for Other Nations*, 2 GSTF J. BUS. REV. (GBR) 162, 162–64 (2013).

³ U.S. ENERGY INFO. ADMIN., BRAZIL: INTERNATIONAL ENERGY DATA AND ANALYSIS 3–5 (2015) [hereinafter BRAZIL]. Brazil is currently the second-largest ethanol producer in the world, following only the United States. *Id.* at 7.

⁴ Marc D. Weidenmier, Joseph H. Davis & Roger Aliaga-Diaz, *Is Sugar Sweeter at the Pump? The Macroeconomic Impact of Brazil's Alternative Energy Program* (Nat'l Bureau of Econ. Research, Working Paper No. 14362, 2008) ("The empirical analysis suggests that real GDP is approximately 35 percent higher in Brazil" due to energy independence efforts."); Edmar Fegundes de Almeida et al., *The Performance of Brazilian Biofuels: An Economic, Environmental and Social Analysis* 46 (Int. Transport Forum Discussion Paper No. 2007-5, Dec. 2007) ("The number of jobs created in the ethanol industry is estimated at 700 thousand of direct jobs and 200 thousand of indirect jobs The number of jobs per energy unit is estimated to be 100 times greater than in oil production"); CONSTANZA VALDEZ, USDA ECON. RES. SERV., SUGAR AND SWEETENERS OUTLOOK/SSS-249 31 (2007) ("Rising ethanol demand in global markets is driving the growth of Brazil's sugar/ethanol complex with new investments in infrastructure and technology.").

⁵ *Id.* at 2.

⁶ Grover G. Norquist & Patrick Gleason, *Brazil's Energy Policy Powers Economy*, POLITICO, <http://www.politico.com/news/stories/0412/74947.html> (last visited October 15, 2015).

⁷ See generally LINDA LEVINE, CONG. RES. SERV., ECONOMIC GROWTH AND THE UNEMPLOYMENT RATE 1 (2013); ROBERT SKIDELSKY, KEYNES: THE RETURN OF THE MASTER (PublicAffairs reprint ed. 2010). At that time, no economic theory could explain stagflation. Keynesian economic theory, which had been predominately relied upon at that point in time, proposes a trade-off between a nation's unemployment rate and inflation. *Id.* Due to the shortcomings of the prevailing economic theories, monetary policy was largely ineffective in buffering the economic impact of the

Pró-Álcool, Brazil's national alcohol program.⁸ *Pró-Álcool* promoted ethanol use and production through a multi-faceted approach that considered all aspects of the production process.⁹ The Brazilian government mandated ethanol use in fuel, increased access to ethanol-powered vehicles, improved infrastructure, and promoted the development of ethanol mills.¹⁰ Brazil has intermittently amended the precise mechanics of the original initiatives set forth under *Pró-Álcool* and introduced subsequent government initiatives upon replacing the program. Among other refinements, Brazil periodically alters the minimum percentages of ethanol for fuel in response to market factors and fluctuations in supply.¹¹ Today, Brazil's alternative energy and biofuel program has extensive reach and encompasses provisions for vehicles, producers, farmers, and businesses. As a result of these combined initiatives, the use of biofuels has become pervasive throughout the country. For instance, as of 2006, eighty-three percent of vehicles sold in Brazil have the capacity to run on either ethanol or gasoline.¹²

Expanding its aims beyond ethanol use, Brazil's energy policy now encompasses numerous initiatives that promote the use of ethanol and other renewable energy sources among smaller producers located in less-densely populated areas.¹³ Among other examples, in 2003, Brazil created the National

oil crisis, which in turn dramatically sparked an interest in transitioning to alternative fuel sources. *Id.* (stating that, under Okun's Law, "[o]ver an extended period of time, there is a negative relationship between changes in the rates of real GDP growth and unemployment").

⁸ CHRISTINE L. CRAGO, MADHU KHANNA, JASON BARTON, EDUARDO GIULIANI & WEBER AMARAL, ENERGY BIOSCIENCES INST., COMPETITIVENESS OF BRAZILIAN SUGARCANE ETHANOL COMPARED TO US CORN ETHANOL 2 (2010).

⁹ Maurício Antonio Lopes, *Agricultural Innovation and Challenges in Promotion of Knowledge and Information Flows in Agrifood Systems in Brazil*, OECD (2012). Consequently, there are several reasons why Brazil has developed a comparative advantage in sugarcane ethanol production. First, the Brazilian government is committed to furthering this interest, and public policies therein have been developed as a result. *Id.* Second, Brazil's infrastructure is stable and has allowed for the increasing development of technologies to further research into ethanol production. *Id.* Third, Brazil's landscape and climate uniquely suitable for sugar cane production, and the nation has both rich, tillable soils and other mineral resources. *Id.*

¹⁰ *Id.*

¹¹ SERGIO BARROS, U.S. DEP'T OF AGRIC. FOR. AGRIC. SERV., BRAZIL: BIOFUELS ANNUAL 2010 6–7 (2010) (outlining shifts in Brazil's ethanol blend mandate); *see also* Jim Lane, *Biofuel Mandates Around the World: 2015*, BIOFUEL DIGEST (Dec. 31, 2014) (providing that Brazil's minimum ethanol content is "currently 25 percent, although the government is looking at 27.5 percent and the percentage was as low as 20 percent earlier this year when ethanol supplies tightened n rising global prices for sugar").

¹² Juscelino F. Colares, *A Brief History of Brazilian Biofuels Legislation*, 35 SYR. J. INT'L L. & COM. 101, 103 (2008).

¹³ ENERGY, BIO FUELS AND DEVELOPMENT: COMPARING BRAZIL AND THE UNITED STATES 292 (EDMUND AMANN, WERNER BAER & DONALD COES EDS., ROUTLEDGE) (2011). Sugar cane presently comprises an important portion of the Brazilian economy, though the cultivation of other crops continues to comprise the majority of all crop production. *Id.* *See also* Porto Velho, *Scarcity in the Midst of Surplus*, THE ECONOMIST (Aug. 16, 2007), <http://www.economist.com/node/9660102>. Nonetheless, there is still concern that expanding sugar cane production for ethanol could harm the rainforest and restrict the production of other crops. *Id.* These concerns are perhaps warranted because

Programme of Biodiesel Production (“PNPB”) to encourage increased biodiesel production and foster regional development outside of urban centers.¹⁴ In order to preserve small farmers’ profitability, the Ministério de Desenvolvimento Agrário (“MDA”) similarly created the *Selo Combustível Social*, which promotes business relationships with small ethanol farms.¹⁵ Brazil also instigated an agroecological zoning plan to expand sugarcane production¹⁶ for use in ethanol across the nation.¹⁷ Finally, demonstrating the nation’s multifaceted approach, Brazil’s energy initiative extends to creative energy sources. For instance, Brazil has developed resources to promote electric power and thermal plants powered by the sun and steam.¹⁸

Brazil’s multifaceted energy policies are the result of targeted government initiatives that help to sustain the viability of ethanol and other alternative energy sources. Even more, these policies have indirectly fostered job creation and strengthened the nation’s infrastructure – improvements that the U.S. desperately needs.

III. UNITED STATES ETHANOL PRODUCTION

A. U.S. Regulatory Provisions

The U.S. has already developed several regulatory provisions to promote domestic ethanol production and has recently raised these standards, thereby signifying its strong commitment to cultivating alternative energy sources.¹⁹ For instance, the Energy Policy Act of 2005 mandates a minimum amount of ethanol and other alternative fuels that must be utilized under the Renewable Fuel Standard (“RFS”).²⁰ Similarly, the Energy Independence and Security Act of 2007 increased the RFS, thereby raising the minimum amount of alternative energy sources that must be used in gasoline.²¹ As a result of these provisions and others,

Brazil has the capacity to expand its production of sugarcane ethanol at least tenfold by 2020 *Id.*

¹⁴ *Id.* at 269.

¹⁵ *Id.*

¹⁶ *Id.* In Brazil, two types of ethanol used to power vehicles include anhydrous ethanol and hydrous ethanol. *Id.* Hydrous ethanol is most commonly used in Brazilian flex-fuel vehicles. *Id.* Anhydrous ethanol is usually blended with gasoline, with up to twenty-five percent of the final product comprised of ethanol. *Id.* Moreover, ethanol production in Brazil is not spread throughout the nation, but is instead concentrated in a few areas, including the area surrounding Sao Paulo, which present comprises sixty percent of the nation’s ethanol development. *Id.*

¹⁷ Lopes, *supra* note 9, at 1.

¹⁸ Luiz P. Rosa, *Energy Policy in Brazil in the Context of Global Energy Security and Environmental Constraints: The Case of Electric Power* (Briefing Paper No. 12-2007, 2007).

¹⁹ Kaylan Lytle, Comment, *Driving the Market: The Effects on the United States Ethanol Industry if the Foreign Ethanol Tariff is Lifted*, 28 ENERGY L.J. 693, 694–95 (2007).

²⁰ Energy Policy Act of 2005, Pub. L. No. 109-58, 119 Stat. 595, Tit. XV (outlining U.S. ethanol program for motor fuels) [hereinafter 2005 Act].

²¹ Joshua A. Blonz, Shalini P. Vajjhala & Elena Safirova, *Growing Complexities: A Cross-Sector*

the use of ethanol and other alternative fuels has been steadily increasing in the U.S. For instance, in 2007, alternative fuels constituted 3.78% of all fuel use, and this figure jumped to 5.46% in 2008.²² Under current trends, the U.S. is expected to annually produce thirty-six billion gallons of ethanol and other alternative fuels by 2022.²³

While current U.S. policy initiatives have already begun to promote the use of ethanol and other biofuels, the pace has been slow, and alternative energy sources continue to constitute only a small proportion of the total makeup of the U.S. energy portfolio.²⁴ Even more, most of the changes proposed by current U.S. policy focus narrowly on promoting incentives at the producer level.²⁵ As demonstrated through Brazil's success, a true transition cannot be achieved until these initiatives are accompanied by infrastructure improvements and consideration of consumer interest.²⁶

B. Differences between U.S. and Brazil Ethanol Production

In both the U.S. and Brazil, alternative fuels are typically more expensive to produce than oil and natural gas. As a result, government-backed mandates and other subsidies play a large role in promoting investment in production of ethanol and other alternative energy forms. In the U.S., due to rising oil costs and the national security issues related to foreign oil, policymakers continue to emphasize the development of alternative energy and have actively worked to lower the costs of producing ethanol.²⁷ The U.S. government's recent push to promote ethanol production has become apparent.²⁸ Among other examples, most of the nearly two

Review of U.S. Biofuels Policies and their Interactions (Dec. 2008), <http://ssrn.com/abstract=1368419>.

²² See generally Robert Z. Lawrence, *How Good Politics Results in Bad Policy: The Case of Biofuel Mandates* (Harv. Kennedy Sch. Working Paper No. 10-044, 2010) (mentioning that ethanol use is also correlated to oil prices; if oil prices drop substantially, this could impair efforts to convert to ethanol in the absence of stringent federal requirements).

²³ Mark Gehlar, Ashley R. Winston & Agapi Somwaru, *Effects of Increased Biofuels on the U.S. Economy in 2022*, 1 (U.S. Dep't of Agric., Econ. Report No. 102, 2010).

²⁴ U.S. ENERGY INFO. ADMIN., TOTAL ENERGY: MONTHLY ENERGY REVIEW OCT. 2015 (2015); see also *Frequently Asked Questions*, U.S. ENERGY INFO. ADMIN., <http://www.eia.gov/tools/faqs/faq.cfm?id=92&t=4> (last visited Nov. 22, 2015) ("In 2014, renewable sources of energy accounted for about 10 [percent] of total U.S. energy consumption and 13 [percent] of electricity generation.").

²⁵ See 2005 Act, *supra* note 20, at Tit. XV. Subtit. A (outlining tax credits available to producers for renewable energy production).

²⁶ Dustin Meyer et al., *Brazilian Ethanol: Unpacking a Success Story of Energy Technology Innovation*, in THE GLOBAL ENERGY ASSESSMENT ch. 24 (Thomas B. Johansson et al. eds., 2012); see generally ALBERT SALVO & CRISTIAN HUSE, NORTHWESTERN KELLOGG SCH. MGMT., CONSUMER CHOICE BETWEEN GASOLINE AND SUGARCANE ETHANOL (2011) (outlining role of consumer demand and ethanol use).

²⁷ See, e.g., FED. TRADE COMM'N, 2014 REPORT ON ETHANOL MARKET CONCENTRATION 2–3 (2014) (discussing recent changes in U.S. renewable fuel standard mandates).

²⁸ *President Obama Announces Major Initiative to Spur Biofuels Industry and Enhance*

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hundred ethanol plants currently in operation have been created within the past fifteen years.²⁹

Due to its size and demographic makeup, the U.S. is currently the world's largest ethanol producer, ranking just ahead of Brazil.³⁰ Though the U.S. and Brazil both produce substantial quantities of ethanol fuel, their products differ substantially. While Brazilian ethanol is derived from sugarcane, U.S. ethanol is corn-based. The differences between U.S. and Brazilian production are relevant because these disparities affect the competitiveness of U.S. domestic ethanol production, which may become especially important as the nations produce rivaling ethanol fuels.³¹

Brazil maintains a comparative advantage in ethanol production because it is more suited to sugarcane ethanol, which is cheaper to produce than corn ethanol.³² Sugarcane ethanol production also places less of a strain on the nation's total cropland than corn-based ethanol.³³ For instance, acreage for ethanol production comprises only five percent of Brazil's total cropland, yet it strains U.S. farmland to a much greater extent.³⁴ Sugarcane ethanol is also typically much more efficient to cultivate and creates over forty-five percent more ethanol per land unit than does corn ethanol, regardless of the location where it is produced.³⁵ Finally, in Brazil, where both large and small-scale producers sell ethanol and are dispersed geographically throughout the nation,³⁶ U.S. ethanol production is instead concentrated in the Midwest and is undertaken by a small number of producers.³⁷ As a result, high transportation and distribution costs may limit the distances that

America's Energy Security, THE WHITE HOUSE (Aug. 16, 2011).

²⁹ KAREN E. THOME & C.-Y. CYNTHIA LIN LAWELL, U.C. DAVIS DEP'T OF ECON., INVESTMENT IN CORN-ETHANOL PLANTS IN THE MIDWESTERN UNITED STATES (Oct. 9, 2015) (finding that the renewable fuel standard dramatically increased U.S. ethanol production, and that during this time, "the number of operational ethanol plants rose from 35 plants in 1991, to 50 plants in 1999, and to 192 plants in September of 2010, for a total capacity of 13 billion gallons per year").

³⁰ AMANN, *supra* note 13, at 269.

³¹ CHRISTINE L. CRAGO, MADHU KHANNA, JASON BARTON, EDUARDO GIULIANI & WEBER AMARAL, ENERGY BIOSCIENCES INST., COMPETITIVENESS OF BRAZILIAN SUGARCANE ETHANOL COMPARED TO US CORN ETHANOL 2 (2010) ("[W]e find that while the cost of sugarcane ethanol production in Brazil is lower than that of corn ethanol in the U.S., the inclusion of transportation costs for the former and co-product credits for the latter changes their relative competitiveness.").

³² *Id.* at 1 ("[T]he cost of sugar cane ethanol production in Brazil is lower than that of corn ethanol in the U.S. . . .").

³³ *Id.* at 2–3.

³⁴ *Id.* at 2.

³⁵ *Id.*

³⁶ See CONSTANZA VALDEZ, USDA ECON. RES. SERV., BRAZIL'S ETHANOL INDUSTRY: LOOKING FORWARD 9 (2011) (outlining regional dispersion and producer size variation in Brazil).

³⁷ ANNETTE HESTER, CTR. FOR INT'L GOVERNANCE INNOVATION, A STRATEGY BRIEF ON U.S. ETHANOL MARKETS AND POLICIES 2 (2007) ("[D]ata from the Renewable Fuels Association shows that the top ten producers account for almost 50% of total production. Archer Daniels Midland (ADM) alone accounts for 20% of this capacity.").

Midwestern producers can sell their product while retaining a profit.³⁸ Due to its natural production limitations, the U.S. will likely not be able to reach energy independence without substantial infrastructure development.

Given these differences, the viability and further development of alternative energy sources in the U.S. largely hinges upon the country's ability to develop policies that will render alternative fuel sources cost-effective and will facilitate ease of access to consumers.³⁹

IV. CONSIDERATIONS FOR THE UNITED STATES

The U.S. has already installed several ethanol and biofuel policies in the country. However, in order to bolster the efficacy and longevity of these initiatives, the U.S. will need to incorporate consumer-side factors, such as pricing, convenience, and other individual needs. Future biofuels policies are also likely to be more effective if policymakers employ a multifaceted approach that incorporates local industry needs, limitations of existing national infrastructure, environmental considerations, and domestic and international trade opportunities.

A. Pricing Initiatives

Unsurprisingly, pricing remains a key factor in determining ethanol's viability on the U.S. market. Even if ethanol and other biofuels are readily available as fuel sources in vehicles and other machinery, consumers are unlikely to convert to alternative energy forms unless they are comparably priced to gasoline.⁴⁰ Because current ethanol prices typically carry a price premium over gasoline, the U.S. will likely need to carefully regulate policy provisions that simultaneously will lower prices and increase access to the ethanol fuel supply. Though many of these provisions have already been developed, the U.S. should also look to further develop and retail low-cost biofuels that can help to reduce price premiums.⁴¹ Policymakers should continue to promote biofuel use and production by creating

³⁸ See Blonz, *supra* note 21, at 31 (“Biomass (corn or switchgrass) must first be transported from the farms where it is grown to a biorefinery where it will be processed; due to the high costs of transporting raw biomass, most refineries limit the range from which they import biomass to within a 50-mile radius, based on truck transport and biomass resource costs.”).

³⁹ See generally Nancy I. Potter, *How Brazil Achieved Energy Independence and the Lessons the United States Should Learn from Brazil's Experience*, 7 WASH. U. GLOB. STUD. L. REV. 331, 350–51 (2008).

⁴⁰ See HESTER, *supra* note 37, at 6 (“An analysis presented by Brent Yacobucci of the Congressional Research Service, comparing the price of ethanol (pure) with gasoline and using prices from October to December 2006, found that ethanol is only competitive with gasoline if the US\$ 0.51/g tax incentive is included, and even then, only at the lower price range.”).

⁴¹ Such initiatives include, among others, the Bioenergy Program for Advanced Biofuels, Biorefinery Assistance Program, Repowering Assistance Program, and the Rural Energy for America Program (RFAP). See generally BRENT D. YACOBUCCI, CONG. RES. SERV. BIOFUELS INCENTIVES: A SUMMARY OF FEDERAL PROGRAMS (2012) (describing ethanol price subsidies).

tax exemptions and credits, government mandates, subsidies, and other initiatives.⁴² For instance, tax credits have been proposed as a way to protect smaller ethanol producers.⁴³ Coupled with these initiatives, the U.S. should also look to accommodate consumers looking to switch to flex-fuel cars, which are capable of running on varied mixes of ethanol and gasoline, by subsidizing the price of these vehicles.⁴⁴

So-called “price shocks,” caused by the volatility of corn prices, are particularly problematic for price-sensitive producers, who are often ambivalent about converting to flex-fuel due to its price. Because there are numerous factors that may cause price volatility, including supply shortages and unfavorable weather, the U.S. should actively work to reduce the price premium between alternative and conventional fuels, while also attempting to prevent dramatic price fluctuations. Moreover, in order to buffer price shocks, Brazil and the U.S. should attempt to foster a stronger relationship. The U.S. would receive the benefits of lower ethanol prices, while Brazil can increase its exports during times of low supply.⁴⁵ Demonstrating the viability of U.S. ethanol products, trade data indicates that the U.S. has now surpassed Brazil as the largest exporter of ethanol in the world.⁴⁶ The U.S. has also increased both ethanol imports from and exports to Brazil over the past two decades, thereby demonstrating that this relationship need not be one-sided.⁴⁷

B. *Mandating Use of Flex-Fuel Vehicles*

Although the U.S. has already developed numerous initiatives to encourage creation of alternative fuel products, it should follow Brazil's lead and require flex-fuel engines for all newly-manufactured vehicles.⁴⁸ Flex-fuel vehicles are

⁴² Miroslava Rajcanivova, Dusan Drabik & Pavel Ciaian, *How Policies Affect International Biofuel Price Linkages* (2011), <http://ssrn.com/abstract=1945022>.

⁴³ Gehlar, *supra* note 23, at 1.

⁴⁴ *Flex-fuel Vehicles*, U.S. DEP'T OF ENERGY, <https://www.fueleconomy.gov/feg/flextech.shtml> (last visited Nov. 22, 2015) (providing that flex-fuel vehicles “are designed to run on gasoline or gasoline-ethanol blends of up to 85% ethanol (E85)”).

⁴⁵ Susanne Retka Schill, *EIA Report Summarizes Brazil's Rise as Energy Producer*, ETHANOL PROD. MAG., Oct. 3, 2013 (“[I]n the medium term, Brazil aspires to export ethanol to the United States, which recently removed tariffs on Brazilian sugar cane ethanol.”).

⁴⁶ U.S. DEP'T OF AGRIC. FOR. AGRIC. SERV., U.S. ETHANOL EXPORTS REBOUND IN 2014 (2015), <http://www.fas.usda.gov/data/us-ethanol-exports-rebound-2014> (finding that “the United States overtook Brazil as the world's largest exporter,” and that “U.S. ethanol exports are also being shipped to a more diverse range of markets”).

⁴⁷ U.S. DEP'T OF COM. INT'L TRADE ADMIN., 2015 ITA RENEWABLE FUELS TOP MARKETS REPORT 13 (2015) (“In recent years, the symbiotic relationship between the [U.S. and Brazil] has grown stronger, as evidenced by the steady trade in both directions . . . [and] Brazilian consumer demand for U.S. ethanol has been increasing”); *see also*, U.S. ENERGY INFO. ADMIN. U.S. ETHANOL IMPORTS FROM BRAZIL DOWN IN 2013 (2014), <http://www.eia.gov/todayinenergy/detail.cfm?id=16131> (describing ethanol trade between U.S. and Brazil).

⁴⁸ *See* U.S. DEP'T OF ENERGY, ALTERNATIVE FUELS DATA CENTER: FEDERAL LAWS AND

already available for sale in the U.S., though accessibility, price, and access to fueling stations remain impediments to their widespread use.⁴⁹ By requiring flex-fuel engines in a substantial percentage of new cars produced, market forces would work to increase the number of fuel stations retailing alternative fuel blends, and mass-production and geographic dispersion will increase the affordability and accessibility of flex-fuel vehicles.⁵⁰ Along these lines, the commercial development of “gasohol” provides some evidence that a commercial market for mixed-fuels can be developed if sufficient initiatives are instilled.⁵¹ Gasohol is comprised of a mixture of ten percent ethanol and ninety percent unleaded gasoline.⁵²

In order to foster this transition, the U.S. should consider gradually raising the RFS until vehicles come to mimic flex-fuel engines. Nonetheless, because researchers have estimated that ethanol alone will never be able to exceed sixteen percent of the energy for fuel needed in the U.S., the government should continue to promote research into developing and producing other low-cost biofuels that can be used in vehicles alongside ethanol.⁵³ For example, biobutanol, a corn-based isobutanol, appears to be promising for use in cars in the U.S. and is cheaper to produce than ethanol.⁵⁴

C. Environmental Considerations and Crop Yields

Most of the current focus on U.S. energy pertains to the opening of domestic oil and natural gas reserves, including drilling in the Marcellus Shale and in the Arctic National Wildlife Refuge.⁵⁵ However, many researchers believe that it is

INCENTIVES, http://www.afdc.energy.gov/laws/fed_summary (last visited Nov. 22, 2015) (listing federal alternative fuel initiatives); *see also* U.S. DEP’T OF ENERGY, ALTERNATIVE FUELS DATA CENTER: KEY FEDERAL LEGISLATION, http://www.afdc.energy.gov/laws/key_legislation (last visited Nov. 22, 2015) (summarizing federal energy legislation).

⁴⁹ *See* U.S. ENERGY INFO. ADMIN., ACCESS TO ALTERNATIVE TRANSPORTATION FUEL STATIONS VARIES ACROSS THE LOWER 48 STATES (2012) (“[T]here are currently about 10,000 alternative fuel stations in the [U.S.], compared to approximately 160,000 gasoline stations.”). *See also Ethanol (E85) Fuel Alternative*, CONSUMER REPORTS (Jan. 2011) (“Currently, there’s no financial advantage to consumers in buying [a flex-fuel vehicle].”).

⁵⁰ ASS’N FOR CONVENIENCE & FUEL RETAILING, E85 SALES HAVE ROOM FOR GROWTH . . . IF CERTAIN CONDITIONS EXIST (2014) (“There are opportunities to grow the E85 market – but only if E85 prices remain significantly below those of regulation grade gasoline and the automobile industry continues to produce flex-fuel vehicles at historical rates.”).

⁵¹ *See* Blonz, *supra* note 21, at 13–18, 34.

⁵² RONALD MEEKHOF, MOHINDER GILL & WALLACE TYNER, USDA ECON., STATS, AND COOP. SERV., GASOHOL: PROSPECTS AND IMPLICATIONS ii (Agric. Econ. Rep. No. 458, 1980).

⁵³ Potter, *supra* note 39, at 347. This estimate includes the “entire U.S. grain harvest” being used to convert into ethanol. *Id.*

⁵⁴ Timothy A. Slating & Jay P. Kesan, *A Legal Analysis of the Effects of the Renewable Fuel Standard (RFS2) and Clean Air Act on the Commercialization of Biobutanol as a Transportation Fuel in the United States*, 4 GCB BIOENERGY 107, 107 (2012).

⁵⁵ *See, e.g.,* Kyla Asbury, *Bill Proposed to Ban Marcellus Shale Export to Other Countries*,

imperative that the world reduce its fossil fuel use to limit the amount of carbon dioxide emitted into the atmosphere, which, without intervention, is predicted to double over the next forty years.⁵⁶ Fortunately, estimates suggest that worldwide ethanol usage has reduced annual carbon dioxide emissions by around 33.2 million tons annually. Therefore, the U.S. will be able to more effectively develop ethanol and biofuels policies by interlinking economic, energy, and public health initiatives through these efforts.⁵⁷ When the U.S. devises alternative energy policies, it should also review its standards' effects on air quality, while acknowledging that any reduction in carbon dioxide will be beneficial. If ethanol is used in its purer states, such as E85, the benefits to air quality can be substantial.⁵⁸ While transferring to ethanol production in its lower forms such as E10 may also help the environment, the U.S. should promote "purer" forms of alternative energy for best results.

Though there are many benefits associated with ethanol production, the increased demand for ethanol for fuel may reduce the supply of other commodities. For instance, up to forty percent of the total corn crop currently produced in the U.S. in a given year is used as ethanol, which may limit corn's use as a food staple, and may restrict production of other commodities.⁵⁹ Similarly, U.S. Department of Agriculture ("USDA") researchers have noted that, over time, ethanol has increasingly taken on a larger percentage of the total crop production, thereby limiting the amount of corn that is available for other uses.⁶⁰

W.VA. REC. (Nov. 18, 2015); *Pennsylvania & Congressional Legislation*, <http://www.marcellus-shale.us/contact-Congress.htm> (last visited Nov. 22, 2015) (outlining legislative efforts regulating Marcellus Shale activity); U.S. GOV'T ACCOUNTABILITY OFFICE, GAO-12-7322, INFORMATION ON SHALE RESOURCES, DEVELOPMENT, AND ENVIRONMENTAL AND PUBLIC HEALTH RISKS (2012); Matthews J. Kotchen & Nicholas E. Burger, *Should We Drill in the Arctic National Wildlife Refuge? An Economic Perspective*, 35 ENERGY POL'Y 4720, 4720–21 (2007); ANWR: *Producing American Energy and Creating American Jobs*, HOUSE COMM. NAT. RES., <http://naturalresources.house.gov/anwr/> (last visited Nov. 22, 2015).

⁵⁶ *Green Growth and Energy*, OECD, <http://www.oecd.org/greengrowth/greening-energy/greengrowthandenergy.htm> (last visited October 15, 2015).

⁵⁷ Jane Bradley, Faryar Shirzad, Carlos Henrique Moojen de Abreu e Silva, James Feinerman & Whitney Debevoise, *The Changing International Economic Balance of Power*, 102 AM. SOC'Y OF INT'L LAW 293, 297 (2008).

⁵⁸ BRENT D. YACOBUCCI, CONG. RES. SERV., FUEL ETHANOL: BACKGROUND AND PUBLIC POLICY ISSUES 12 (2007) ("Compared to gasoline, use of E85 can result in a significant reduction in ozone-forming vehicle emissions in urban areas."). As a result, the U.S. should look to increasingly promote the use of higher quality ethanol production over time.

⁵⁹ Zachary R.F. Schreiner, Comment, *Frankenfuel: Genetically Modified Corn, Ethanol, and Crop Diversity*, 30 ENERGY L.J. 169, 175 (2009); U.S. ENERGY INFO. ADMIN., BIOFUELS ISSUES AND TRENDS 7 (Oct. 2012) (finding that "40 percent of the 2010 corn crop was consumed in order to produce ethanol and distiller grains in marketing year 2010/2011").

⁶⁰ STEVEN WALLANDER, ROGER CLAASSEN & CYNTHIA NICKERSON, U.S. DEP'T OF AGRIC. ERS, EIB-79, THE ETHANOL DECADE: AN EXPANSION OF U.S. CORN PRODUCTION, 2000-09 3 (2011) ("Non-ethanol uses of corn have not increased over the past decade, as greater ethanol production has captured a larger share of corn production."); see also COLIN CARTER, GORDON RAUSSER & AARON SMITH, U.C. DAVIS, DEP'T OF AGRIC. & RES. ECON., THE EFFECT OF THE U.S. ETHANOL MANDATE

According to one USDA study, forty percent of the total U.S. corn supply was used to make ethanol in 2011; in 2005, this figure was only fourteen percent.⁶¹

With large amounts of domestic corn diverted to supply ethanol, food prices may rise with the diminishing food supply.⁶² This may have a harsh impact on low-income individuals, who often struggle to afford food even at lower costs. This trend is largely the result of the fact that detracting corn production from the food supply for use in ethanol will often mean that food prices will rise.⁶³ Thus, policymakers should be mindful of any potential impact that increased biofuels production may have on the food supply and should work to stabilize the price of key agricultural commodities during times of supply shortage.

Moreover, the U.S. should create initiatives so that poorer nations that import food from the U.S. will not be hard-hit by the rising demand for ethanol.⁶⁴ A 2011 study by the National Research Council found that the expansion of biofuels was responsible for an up to forty percent increase in the price of international commodities.⁶⁵ Therefore, as much of the U.S. corn crop is diverted to ethanol production, the U.S. must take care to prevent unintended harms.⁶⁶

Despite these concerns, renewable fuels can also be used to aid in the economic development of low-income regions. For instance, biofuel production facilities can be placed in low-income, rural communities, thereby raising wages throughout the area. Therefore, fostering the construction of biofuel facilities in impoverished communities may help to spur economic development in these

ON CORN OIL PRICES 1 (2011).

⁶¹ See Carter, *supra* note 60, at 1 (“Under the expanded RFS, corn ethanol now comprises 10 percent of finished motor gasoline in the U.S., up from 3 percent in 2005.”). However, these policies have also had the effect of raising the price of corn; see also C. MATTHEW RENDLEMAN & HOSEIN SHAPOURI, U.S. DEP’T OF AGRIC., *NEW TECHNOLOGIES IN ETHANOL PRODUCTION* i (2007) (“[T]he fraction of annual U.S. corn production used to make ethanol rose from around 1 percent in 1980 to around 20 percent in 2006, and ethanol output rose from 175 million gallons to about 5.0 billion over the same period.”).

⁶² Bruce A. McCarl & Fred O. Boadu, *Bioenergy and U.S. Renewable Fuels Standards: Law, Economic, Policy/Climate Change and Implementation Concerns*, 14 *DRAKE J. AGRIC. L.* 43, 68 (2009) (“[B]iofuel is only one of several factors responsible for the increase in agricultural commodity price, so there may not be adequate support for establishing causality between biofuels production and agricultural commodity prices.”).

⁶³ See ALYSSA CARDUCCI, HEARTLAND INST., *STUDY: ETHANOL MANDATES CAUSING SPIRALING U.S. FOOD PRICES* (2013) (“Rapidly rising corn prices, caused primarily by ethanol subsidies and mandates, are the most important factor in rising food prices.”).

⁶⁴ See Timothy A. Wise, *The Cost to Developing Countries of U.S. Corn Ethanol Expansion 5* (Global Dev. & Env’tl. Inst., Working Paper No. 1202, 2012) (noting that the poor are strained by increasing agricultural commodity prices).

⁶⁵ *Id.* at 1 (“[T]he National Academy of Sciences estimated that globally biofuels expansion accounted for twenty to forty percent of the price increases seen in 2007-8, when prices of many food crops doubled. Net-food importing countries were particularly hard hit.”). See also Wallander, *supra* note 60, at 2 (stating that the Congressional Budget Office report cites “research by the International Food Policy Research Institute (IFPRI) that 40 percent of the rise in corn prices between 2000 and 2007 was due to global ethanol demand”).

⁶⁶ Wise, *supra* note 64, at 13–15.

regions.⁶⁷

In sum, due to many of the environmental benefits associated with use of ethanol, the U.S. should encourage use of E85 and “pure” forms of biofuels. Moreover, in order to prevent shortages in the corn food supply, the U.S. should be increasingly willing to import lower-cost ethanol products from Brazil during times of insufficient U.S. supply. Policymakers should be judicious in monitoring the price volatility of these commodities in order to prevent harm caused to lower-income consumers.

D. Infrastructure and Compatibility with Older Vehicles

Though the development of ethanol and other similar alternatives confers many advantages, many older vehicles and machines cannot utilize this fuel efficiently. Among other incompatibilities, ethanol contains twenty-seven percent less energy than gasoline, and so may not adequately power some vehicles.⁶⁸ While the EPA has set forth an amendment to the RFS to increase mandated ethanol blends to fifteen percent of total fuel content, this standard is above what most car producers recommend and could even damage older vehicles.⁶⁹ Even more, because conventional and alternative fuels must be shipped through different methods, the U.S. must first promote substantial infrastructure development to transport alternative fuels. Finally, prior to developing new ethanol mandates, policymakers should ensure that producers are able to afford and obtain enough ethanol to meet the increased demands set forth by USDA policies.⁷⁰

Therefore, despite the advantages of alternative energy discussed above, mandating ethanol use is not in the nation's best interest unless the U.S. infrastructure is prepared and alternative means of power have been created.⁷¹ For instance, many cars would lose substantial efficiency and power if fueled solely by alternative energy.⁷² Due to the U.S.'s weak infrastructure, policymakers should continue to incentivize even lower-quality ethanol products, such as E10, which will help to ease the transition from gasoline to ethanol.⁷³ Though this

⁶⁷ *Analysis of the Scope of Energy Subsidies and Suggestions for the G-20 Initiative*, OECD (2010), <http://www.oecd.org/env/45575666.pdf>.

⁶⁸ *Alternative Fuels Data Center*, U.S. DEP'T OF ENERGY, http://www.afdc.energy.gov/fuels/ethanol_benefits.html (last visited October 16, 2015).

⁶⁹ *Id.*

⁷⁰ Ryan Tracy, *U.S. Ethanol Mandate Puts Squeeze on Oil Refiners*, WALL ST. J. (Mar. 10, 2013), <http://online.wsj.com/article/SB10001424127887324096404578352223846017206.html>.

⁷¹ *Id.* Right now, it is likely that the price of ethanol may fluctuate wildly because there are no anticompetitive conduct initiatives in place. *Id.*

⁷² *Id.* (stating that E85 “can be used in flexible fuel vehicles – a vehicle type that has an internal combustion engine and runs on either E85 or gasoline.”).

⁷³ See *id.*; see generally Frank Rusco, *Biofuels Infrastructure in the United States: Current Status and Future Challenges 2* (OECD Background Paper, Nov. 30, 2012); U.S. DEP'T OF ENERGY, ALTERNATIVE FUELS DATA CENTER: ETHANOL BLENDS, (last visited Nov. 22, 2015) (describing E10

process may occur less quickly, doing so will likely have the unintended impact of fostering public opinion toward the use of alternative fuels.

Similarly, the U.S. needs to better prepare the substantial infrastructure changes that will be needed to transport and produce ethanol.⁷⁴ Unlike gasoline, ethanol is often transported by truck, train, or barge, which the U.S.'s infrastructure is currently poorly prepared to accommodate, and these changes could cost several billion dollars over the next ten years.⁷⁵ Though developing such infrastructure could take decades, as evidenced by Brazil's thirty-year initiative, creating this infrastructure will be necessary to promote the widespread use of ethanol and other biofuels. Such infrastructure supports may include the development of ethanol or mixed-used pipelines, railways, and additional transportation methods, particularly from the Midwestern U.S. to the Eastern and Western coasts, to carry fuels from producers to consumers. Accordingly, as the U.S. seeks to promote alternative energy, policymakers should consider the changes needed to the infrastructure and should develop initiatives to build this framework more effectively.⁷⁶

In sum, U.S. policymakers should follow Brazil's lead and take a multifaceted approach toward alternative energy forms, which includes considerations for ethanol consumers, producers, and distributors. Because the impact of this transition affects both producers and consumers, changes to the U.S. infrastructure should consider all facets of ethanol production.

E. Enticing New Production and Trade Initiatives

Increased use of ethanol and alternative fuels has become a world phenomenon, and therefore U.S. policymakers must consider ethanol policy in a global context. When developing regulations, policymakers should and review the overall energy market and the current prices of oil and natural resources.⁷⁷ Despite the U.S.'s

and other ethanol blends).

⁷⁴ U.S. GOV'T ACCOUNTABILITY OFFICE, GAO-11-513, BIOFUELS: CHALLENGES TO THE TRANSPORTATION, SALE, AND USE OF INTERMEDIATE ETHANOL BLENDS 2-4 (2007).

⁷⁵ *Id.*

⁷⁶ U.S. DEP'T OF ENERGY, BIOENERGY TECHNOLOGIES OFFICE, <http://energy.gov/eere/bioenergy/bioenergy-technologies-office> (last visited Nov. 22, 2015); U.S. GOV'T ACCOUNTABILITY OFFICE, GAO-07-713, DOE LACKS A STRATEGIC APPROACH TO COORDINATE INCREASING PRODUCTION WITH INFRASTRUCTURE DEVELOPMENT AND VEHICLE NEEDS 2-6 (2007).

⁷⁷ Michelle Rattton Sanchez Badin & Daniela Helena Godoy, *International Trade Regulatory Challenges for Brazil and Some Lessons from the Promotion of Ethanol* 34 (2011), <http://ssrn.com/abstract=2207894>. Sustainable energy could also be tied into existing frameworks, such as the United Nations Framework Convention on Climate Change (UNFCCC). *Id.* Presently, subsidies granted to those developing fossil fuels is around \$100 billion per year (GS1, 2009), with other estimates increasing this figure to \$557 billion (IEA, 2010). *Id.* Nonetheless, energy subsidies, if shifted to biofuel production, will increase economic development in certain regions that previously lacked capacities for such increased growth. *Id.* Moreover, some type of international energy reporting standard should be developed in order to monitor how nations choose to subsidize renewable fuels. *Id.*

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relative disadvantage in ethanol production as compared to Brazil, the U.S. should continue to promote domestic ethanol production in order to prevent reliance on one nation's energy source merely shifting to another, and to buffer international supply shortages.

In addition, because the ethanol industry young and developing, new ethanol companies face low barriers to entry. The U.S. should consider developing incentives to encourage interested fuel producers of all sizes to enter the market. In fact, under the Energy Policy Act of 2005 the Federal Trade Commission stated that "the level of concentration in ethanol production would not justify a presumption that a single firm, or a small group of firms, could wield sufficient market power to set prices or coordinate on prices or output."⁷⁸

Despite low market barriers, new players will not be motivated to enter the industry unless it is profitable. In order to entice new ethanol producers, the U.S. should develop tax credits and other mandates that provide benefits to new or converted producers. Although the role of tax incentives on the ethanol market has not been heavily studied, a USDA study found that ethanol production would decline substantially if it were not regulated.⁷⁹ As a result, tax incentives should be specifically aimed at incentivizing the entrance of new alternative fuel producers, especially those seeking to promote flex-fuel and other renewable energy forms.

V. CONCLUSION

In conclusion, the U.S. should look to model its energy policy after many of the initiatives developed in Brazil. Though the U.S. and Brazil substantially differ in geography and ethanol production capabilities, the U.S. can take inspiration from many of the innovative, multifaceted provisions that Brazil developed in its quest to attain energy independence. These include promoting the production and sale of flex-fuel vehicles, expanding access to and reducing prices for alternative energy, and developing infrastructure to sustain these changes. In sum, the key to emulating Brazil's success in promoting alternative energy lies in improving infrastructure to meet the needs of alternative energy production.

Still, perhaps Brazil's strongest contribution to renewable energy has been to provide greater awareness of the various considerations that must be implemented when developing an alternative energy policy, and to demonstrate to other countries that increased reliance on alternative energy is both feasible and

Other resources that Brazil has used include hydropower in the form of hydroelectric dams. *Id.*

⁷⁸ FED. TRADE COMM'N., 2006 REPORT ON ETHANOL MARKET CONCENTRATION 1-2 (2006), http://www.ftc.gov/sites/default/files/documents/reports/federal-trade-commission-report-ethanol-market-concentration/ethanol_report_2006.pdf.

⁷⁹ YACOBUCCI, *supra* note 58, at 11 ("An economic analysis conducted in 1998 by the Food and Agriculture Policy Research Institute . . . concluded that elimination of the exemption would cause annual ethanol production from corn to decline roughly 80% from 1998 levels.").

sustainable.⁸⁰ Following Brazil's multifaceted approach, U.S. policymakers should look creatively to alternative forms of renewable fuels, such as ethanol, to meet increased energy demands and promote energy independence.

⁸⁰ See Gabriella P.A.G. Pousa, André L.F. Santos & Paulo A.Z. Suarez, *History and Policy of Biodiesel in Brazil*, 35 ENERGY POL'Y 5393, 5393 (2007) (discussing the current biodiesel fuels used in Brazil).

APPENDIX

Summary of Recommendations

- Foster increased trade between the United States and Brazil in order to lower trade barrier and ethanol prices between the nations.
- Promote infrastructure development for biofuels, including development of ethanol or mixed-use pipelines, railways, and additional transportation methods, especially from the Midwest to the coasts; increasingly develop aims to reduce transportation costs.
- Look to convert ethanol transfer from vehicles and trains to pipelines and other similar endeavors.
- Encourage expansion of expand their biofuel and alternative energy program through tax subsidies and other initiatives.
- Increase federal support for alternative forms of energy, including wind, solar, and electric power.
- Continue to foster research for biobutanol, as well other biofuel methods in an attempt to lower input prices.
- Expand research initiatives on emissions and changes in air quality brought about by ethanol production.
- Continue to raise the Renewable Fuel Standard through a steady progression over the next decade; provide subsidies for those individuals who trade older vehicles and machinery that cannot use ethanol for newer ethanol-compatible models.
- Mandate or subsidize the purchase and sale of flex-fuel vehicles.
- Promote the use of E85 ethanol.
- Develop incentives to reduce likelihood of supply shortage of domestic ethanol; look for ways to promote expansion of ethanol production to the East and West Coasts.
- Develop initiatives increasing the number of ethanol fuel stations.
- Subsidize the cost of flex-fuel vehicles.
- Actively work to reduce hurdles for conversion to ethanol for older machinery.