Prioritizing Biochemical R&D To Achieve Biofuel Market Parity

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Keywords: biochemical, biofuel, technology.

Executive Summary: Renewable energy is crucial to the American economy and bio-based fuels bear strong potential for growth. A critical impediment to biofuels is the underdevelopment of bio-based chemical production that can add substantial value and create market parity with petroleum products. Under the Trump Administration, there is a political window for targeted investment in biofuels. There should be strategic prioritization of action and investment by the federal government to promote biofuel expansion in a way that is politically and economically advantageous. The Department of Energy should focus their efforts on: bioproducts that can create biofuel profitability, investments that will be mutually beneficial to a variety of technologies, and refinery partnerships.

I. Introduction

Addressing climate change requires viable sources of energy and materials other than petroleum that can be sourced economically. Alternatives to petroleum products and fossil fuels have existed for over a century, but they have always lacked economic—and thereby political—sustainability. As of 2014, the usage of alternative energy has reached historic heights with energy from biomass (comprised of biofuels, wood, and waste) serving as the most prolific source of renewable energy.[1] There is much to be said for the power of biology and its ability to serve as a source of power and source of products that will decrease dependence on foreign oil, aid in the fight against climate change, and grow the economy.

Biofuels (fuels or fuel additives, such as ethanol, derived from plant material) have experienced encouraging growth that is expected to continue. Global biofuel production has grown 625% from 2000 to 2010.2 Currently, biofuels account for 3% of total world road transport fuel, but that is expected to grow to 27% by 2050.2 This projected increase would cut 2.1 gigatonnes of CO2 per year,[2] which represents 4.3% of global emissions in 2010.[3] Biomass, both food-based and non-food based, is expected to be the predominant feedstock for future chemical and transportation fuel production.[4] The successes so far are contributing to the potential to further grow the economy by an additional $100 billion by 2030, with the creation of an additional one million jobs, particularly in rural areas where biomass is grown.[5]

II. Interdependence of bio-based fuels and chemicals—a missed opportunity

Biochemicals (chemicals that are derived from plant material) and biofuels share many of the same challenges and opportunities in production capacity such as sources of plant material, infrastructure, and land and water use.[6] They also share many benefits such as carbon sequestration and use, reduced dependence on foreign oil, and growth in local manufacturing.

Drawing a parallel to the petroleum industry, almost half of the profit from a barrel of oil comes from the roughly 15% of its volume that is dedicated to the refinement of chemicals.[7] In a similar way the production of chemical byproducts from biofuel production can create economic viability of the biofuel industry, thereby establishing market parity for biofuels. Currently, however, waste products from biofuel production are not being utilized.

Furthermore, there are great business opportunities for bio-based petroleum alternatives. The industrial biotechnology market (comprised of fuels, enzymes, and materials) in the United States was approximately $125 billion in 20125 and by 2030, it could grow to $225 billion, utilizing a potential of one billion tons of biomass in the United States.[1]

Additionally, trends indicate that the fuel market is shrinking, while the global chemical market is growing at 1% to 1.5%, which is greater than the world GDP's annual growth.[6]

III. Historical and Current Relevance

The Renewable Fuel Standard (RFS) was originally established in 2005 under the Energy Policy Act,[8] and was later expanded in 2007 under the Energy Independence and Security Act.[9] Under this policy, renewable fuels are defined as "cellulosic biofuels," "advanced biofuels," "biomass-based diesel," and "total renewable fuel."[9] Fuels are judged based on their respective ability to reduce carbon emissions. "Total renewable fuel" is a catch-all category that is essentially comprised of corn-based ethanol and has the lowest standard of carbon emissions reduction. "Advanced biofuel" is essentially comprised of cellulosic ethanol production. The RFS set a goal to produce 36 billion gallons of renewable fuel by 2022, of which 21 billion gallons would be advanced biofuel,[10] although there is massive shortfall in advanced biofuel production due to technological and economic disparity between biofuels and fossil fuels.[11] However, "total renewable fuels" have typically met their targets because of corn ethanol's ability to act as an affordable substitute to petroleum products. RFS has become a polarizing issue for many lawmakers, but opposition does not fall into neat partisan categories nor political ideologies. Most notably the concerns with RFS are: debatable decrease in carbon emissions by current renewable fuels, untimely regulatory action by the Environmental Protection Agency (EPA) along with its poor estimation of technological progress, competition of food-based fuels with the food market (which raises food prices), and unintended adverse environmental consequences.

Federal research and development (R&D) dollars have made a profound impact on the maturity of the biofuel and biochemical industry. As of 2016, the U.S. Department of Energy (DOE) has invested an aggregate of $3 billion in programs that advance biofuels, develop feedstocks, convert municipal wastes into resources, produce biopower, and generate a variety of biochemicals.[12] Some of the most notable investments were in the 2008 Farm Bill, the 2009 Stimulus Bill, and the 2014 Farm Bill. The 2014 Farm Bill provides much of the authorization for bioenergy research and development programs that are operational today. The Food, Conservation, and Energy Act of 2008 (also known as the 2008 Farm Bill) included key investments in biofuels with a strong emphasis on cellulosic fuel technologies.[12] Importantly, the 2008 Farm Bill strengthened the USDA's BioPreferred Program, established in the 2002 Farm Bill, that is a consumer awareness program that supports bio-based products in the marketplace.[13] The Agricultural Act of 2014, known as the 2014 Farm Bill, supported a variety of investments in the bioeconomy. "Title IX: Energy" of the 2014 Farm Bill sought to encourage renewable energy, opportunities in bio-based manufacturing, and to grow the biofuel industry.

Other key investments in biochemicals and biofuels were made in the landmark stimulus package that sought to curb the recession: The American Recovery and Reinvestment Act of 2009 (ARRA). ARRA provided funding for biorefineries and other clean energy programs.[14] Specifically it gave $564 million for integrated biorefineries to demonstrate and deploy new technologies and more than $70 million for research and development in advanced biofuels, including fuels made from algae.[14] ARRA reflects an effective investment in biochemical production that is needed to establish parity for biofuels.

Most recently, President Trump signed the Executive Order on Promoting Agriculture and Rural Prosperity in America which establishes an interagency task force on Agriculture and Rural Prosperity—a replacement of the White House Rural Council.[15] Under section four, which enumerates the task force's goals, the order's twelfth goal is to "further the Nation's energy security by advancing traditional and renewable energy production in the rural landscape."[15] Under the Trump Administration, there is cognizance for the argument that biofuels benefit rural economies, however, it is not yet clear to what extent their focus will be on "traditional" rather than "renewable" energy. Furthermore, this executive order makes it possible to promote clean

and renewable fuels without expanding regulations, which President Trump has pledged to reduce, making renewable energy development possible while avoiding the political obstacle of expanding the government's involvement in the market.

Combined, the RFS and DOE investments have created a strong future for corn-based ethanol production in the United States. But despite past investments, the advanced biofuel market is struggling to compete with petroleum, and its future is very uncertain if RFS is ended by Congress. However, biochemical production could ameliorate this problem. For example, if waste lignin were used in cellulosic ethanol production, the price of production would significantly decrease.[6]

IV. Proposed Solution

The Bioenergy Technology Office (BETO) of the Office of Energy Efficiency and Renewable Energy (EERE) in the U.S. DOE should prioritize funding for research, development, and demonstration to produce high-value biochemicals that will support the advanced biofuel industry. This could result in a strong growth of the biofuel market, without increasing overall appropriation—a very doubtful prospect in this fiscally conservative Congress. In general, BETO should target investment in fields where biochemicals have the highest economic potential, focus on areas of investment with precipitous benefits, and increase collaboration with biorefineries.

Research and development investments need to be targeted to biochemicals with the highest economic potential. Taking this into account the BETO should:

- Prioritize investment in biochemical production that will offset costs for advanced biofuels
- Identify and promote technologies that can compete with petroleum alternatives based on performance merits
- Give priority to development investment with markets that will be especially receptive to green technologies when making R&D investments in biochemical production

To collaborate with biorefineries to support biochemical production the BETO should:

- Prioritize biorefinery grant and loan programs that support biochemical production
- Partner with the petroleum industry to support conversion of refinery capabilities to co-process biomass to produce biochemicals

V. Major Implementation Challenges

The EERE has come under scrutiny in the new presidential administration. Petroleum-based chemicals are cheaper than their bio-based alternatives and therefore, investments by the EERE are likely to be portrayed as corporate welfare to certain "green" companies. On the other side of the political spectrum, this prioritization may be seen as pandering to oil and gas producers, especially in co-processing projects. Taking a capitalistic approach such as this will lead some environmental advocates to claim that the EERE is not making investments where politically advantageous and not where important.

Additionally, grant money is limited and funding prioritization will decrease for other, worthy investments in the very likely scenario that overall appropriation will not increase for the DOE. With a vast field of emerging research in biotechnology, making a shift in funding policy that prioritizes a specific sector will receive backlash by parts of the technical and scientific community.

VI. Conclusion

Despite the RFS and other legislative efforts, biofuels have not been able to adequately compete with petroleum due to a disparity in the ability to produce high-value chemicals from waste streams. To support the biofuel industry, R&D investments should give priority to biochemical production to allow for biofuels to achieve parity in the marketplace. In the Trump Administration, there is a stated desire to support the biofuel industry—the type of support that has not been shared by other renewable energy sources. This presents an opportunity to invest R&D in a way that will have maximum effect on renewable energy production and decarbonization.

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