Biofuels Action Plan

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EXECUTIVE SUMMARY

Biofuels in the Market Today

Since the publication of the 2008 National Biofuels Action Plan (NBAP), the growth of biofuels in the market has been considerable. The Energy Independence and Security Act (EISA) of 2007, the Food, Conservation, and Energy Act of 2008, and the American Recovery and Reinvestment Act of 2009, which authorized many bioenergy research, development, demonstration, and deployment efforts, have been driving forces in accelerating feedstock production, logistics, and conversion technology. As a result of these policies, research, pilot, and demonstration projects on biomass feedstock production, logistics, and conversion technology are in progress across the country. An effective public-private partnership has fueled tremendous technology advancements, and biofuels are expected to account for the most growth in domestic liquid fuels over the coming decades.[4]

The Renewable Fuel Standard (RFS2), implemented under EISA, mandates 36 billion gallons per year (BGY) of renewable fuels by 2022—a marked increase from the volumes required under the previous Energy Policy Act (EPAct) in 2005. With the RFS2 volume requirements in place, ethanol production capacity nearly doubled since 2007, leading to a near-saturation of the E10 market. In April 2012, EPA approved the first applications for registration of ethanol for use in gasoline blends that contain up to 15% ethanol (E15), enabling further expansion of the ethanol market.

While the United States is on schedule to meet RFS2 targets for conventional biofuels, meeting the cellulosic biofuel volume requirements has been challenging. Acknowledging the lack of U.S. capacity, EPA reduced the required annual volumes of cellulosic biofuels from the original statutory goals for 2010, 2011, and 2012. Major challenges stem from insufficient capital investment to establish new, commercial-scale feedstock production, logistics, and conversion technology systems.

Despite these challenges, there have been important advances in cellulosic biofuel production. The first commercial-scale cellulosic ethanol plants broke ground in 2011, and cellulosic ethanol is on the verge of cost-competitive commercialization. Additionally, drop-in fuel technologies from cellulosic feedstocks show promise in the mid- to long-term, and it is likely that other advanced biofuels will help make up shortfalls in reaching cellulosic ethanol targets.

Biomass Feedstocks

The United States has abundant agricultural and forestry resources that could be a significant resource for bioenergy. With research, land resources could be effectively used for feedstock production and still meet demand for production of other goods and services. By 2030, about 1 to 1.6 billion dry tons of sustainably available biomass could be produced annually from forestry, agricultural, and waste resources. Each feedstock can be converted into a range of fuels through various pathways. Feedstock availability will be regionally determined depending on local land, water, and growing conditions. In addition to terrestrial resources, preliminary analyses indicate that sufficient domestic land and water resources exist to potentially support production of advanced biofuels from algae.

[4] Energy Information Administration (2012). Annual Energy Outlook 2012. http://www.eia.gov/forecasts/aeo/pdf/0383(2012).pdf.

Major Accomplishments

Since the publication of the first NBAP, federal agencies have made substantial investments in basic and applied research and development (R&D) for feedstocks development and in the deployment of feedstock production systems, including new programs for algal systems. Financial assistance to owners and operators of agricultural and non-industrial private forestland has supported biomass feedstock production.

In 2011, a comprehensive biomass resource assessment was completed. Partnerships with industry and universities are addressing barriers to sustainable feedstock supply. In addition, several efforts are underway to facilitate the development of advanced feedstock supply systems.

Remaining Needs

There have been significant advances in feedstock supply and logistics technologies, but more advances are needed to achieve the potential one billion tons annually. Improvements in production, harvest, and transport systems for bioenergy feedstocks are needed and will likely require significant efforts from industry, academia, and government.

Conversion Technologies

Conversion R&D is focused on advancing the state of biofuels conversion technology so that non-food biomass sources can be used in addition to conventional starch feedstocks. Multiple conversion technologies are required to accommodate the diverse characteristics of the broad range of feedstock materials and final products. Process intensification strategies are essential to this development. To date, significant R&D funding has been committed to developing technologies for cost-competitive production of cellulosic ethanol. Ongoing efforts to develop multiple conversion routes to produce a suite of hydrocarbon products and fuels will leverage previous work on ethanol production. However, new organisms, catalysts, and processing strategies are required to produce a new array of products, including transportation hydrocarbon fuels and chemicals from bio-oil.

Major Accomplishments

The 2008 NBAP identified research areas needed to advance biomass conversion science and technology to develop the next-generation biofuels. Federal agency research investments and partnerships with private firms have focused on engineering novel enzymes or microorganisms with enhanced metabolic capabilities and improved catalysts to economically convert lignocellulosic feedstocks to biofuels. Multiple consortia research centers for basic and applied sciences have been established to coordinate efforts in conversion technology. The results of this research are beginning to impact biofuel production practices in the commercial sector.

Since 2008, technology improvements have led to improvements in pretreatment processes, the commercialization of two enzyme packages, and catalyst and process improvements to biomass-to-syngas conversion. Recently, the first commercial-scale lignocellulosic ethanol biorefinery broke ground. Several other conversion processes are meeting their targets at pilot scale and will be ready for commercial scale soon.

Remaining Needs

In order to fully address remaining technology challenges, research is needed to gain a deeper understanding of the fundamental science, processes, and materials involved in conversion processes. The development of efficient and robust enzymes and catalysts is required for further progress. Additionally, validation of pre-commercial technology and processes will be essential to gauge progress in conversion R&D.

Transport & Distribution Infrastructure and End Use

To date, there have been few major transport and distribution bottlenecks that have impacted the transportation of increasing volumes of biofuels into the market. Policies driving biofuels deployment have helped industry meet the rapid growth in demand for biofuel infrastructure over the past decade. However, further growth of the biofuels market will likely require rapid changes to existing transport and distribution infrastructure systems.

Ethanol and biodiesel are not fully compatible with conventional petroleum infrastructure; therefore, the transportation of these biofuels requires a separate infrastructure. Long-distance transport of current biofuel products at scale requires infrastructure that is either limited in capacity (e.g., rail) or unavailable at sufficient scale (e.g., dedicated pipelines). For ethanol, the development of the necessary transportation infrastructure has been shaped by ethanol production's unique footprint. Approximately 98% of current ethanol production capacity is located in the Midwest, close to agricultural-based feedstock production (typically 35–50 miles from corn-producing farms).

New, drop-in biofuels will also encounter distribution challenges, as the nation's existing petroleum-based transportation infrastructure is geographically misaligned with the biofuel supply chain. These geographic constraints could be eased by building future biorefineries closer to population centers and by fueling them with locally cultivated feedstocks. However, a significant share of biofuel production would still be expected to remain in the Midwest.

Major Accomplishments

Since the 2008 National Biofuels Action Plan, several federal research studies, projects, and tools have been developed that are aimed at better understanding the biofuel supply chain and transportation barriers. Meanwhile, private industry has made notable efforts to advance biofuel distribution research, development, and deployment (RD&D). National pipeline operators have conducted materials compatibility and fuel quality testing and have deployed short-distance ethanol pipelines. The Intermediate Blends Test program, completed in 2011, led to the EPA approval of a partial waiver for the use of E15 in light-duty vehicles from 2001 and newer. Further, the sector has seen successful commercial and military trials of biomass-based jet fuel.

Remaining Needs

For the nation to meet RFS2, the U.S. biofuels industry will require a responsive, reliable, and efficient transport and distribution infrastructure that can safely deliver biofuel products to their end-use locations. Understanding current and future biofuel supply chain logistics, capacity constraints, and safety issues, and ensuring material compatibility with existing and new fuels remain important areas for continued interagency focus.

The deployment of multimodal transport infrastructure is essential, including rail, highway, waterway, and pipeline assets to move biofuel feedstock and product. The development of this infrastructure can be constrained by geography, transportation systems, finance, policy, and market volatility. If not addressed, these issues could impede the existing transportation enterprise's ability to accommodate future biofuels production and distribution requirements. Economics, policy, and market uncertainty also significantly affect infrastructure development.

Summary

Biofuels are a home-grown source of economic value, energy production, and environmental improvement. To fully realize their potential impact, it is essential to continue to advance innovative technologies that will enhance their commercial development and deployment. For these efforts to be successful, there is a need for continued coordination and collaboration of research efforts across federal agencies and with industry stakeholders, academia, and state and local governments. This report puts forth recommendations from the Biomass Research and Development Board to further the progress of research and development in the biomass sector. Key agency accomplishments, activities, and major publications are detailed in the Appendix.

Purchase this course to see the remainder of the technical materials.