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Re: Comments of the Biotechnology Industry Organization in response to RFI-11-27-PKM, Defense Production Act Title III Advanced Drop-in Biofuels Production Market Research

The Biotechnology Industry Organization (BIO) on behalf of its member companies commends the U.S. Navy, Department of Energy (DOE) and Agriculture (USDA) on their Memorandum of Understanding (MOU) designed to help develop advanced drop-in and marine biofuels to power military and commercial transportation. We are pleased to provide this response to the joint request for information (RFI).

I. Introduction and Description of BIO, its Members and Their Work and Potential Related to this RFI

a. BIO and its Members: Overview

BIO is the world's largest biotechnology trade organization, representing more than 1,100 biotechnology companies, academic institutions, state biotechnology centers and related organizations across the United States and in more than 30 other nations. BIO members are involved in the research and development of innovative healthcare, agricultural, industrial and environmental biotechnology products.

BIO's Industrial and Environmental Section includes more than 85 member companies, from small start-ups to large commercial producers, representing the entire value chain of biofuels, biobased products, and renewable chemicals. Companies include dedicated energy crop and other feedstock producers, enzyme producers, commercial integrated biorefinery developers, and large chemical and energy companies.

b. Opportunities and Challenges for the Industry to Produce Commercial Volumes of Biofuels, Particularly Advanced Drop-in Biofuels

Individual advanced biofuel producers have achieved milestones toward commercial development of a diverse array of feedstock and technology combinations. Some advanced biofuel companies already have worked with the Department of Defense (DOD) or with commercial airlines to test and certify advanced biofuel/petroleum blends, and more are poised to do so. The challenges of creating entirely new upstream feedstock and downstream market value chains while simultaneously raising capital for construction of pioneer biorefineries are challenging and warrant public policy assistance. The full range of projects located in diverse areas of the country, combining local feedstocks with tailored technology and processes, represent a robust response to the challenges, particularly for military biofuel needs.

U.S. military forces require reliable fuel supplies and secure supply lines both at home and abroad, which add to the fully burdened costs of fuels. Access to adequate fuel supplies in strategic locations could be an important "force multiplier," by increasing the military's ability to operate where needed and reducing the necessity to protect long supply lines. Small-to-medium scale biorefineries producing advanced biofuels from local feedstocks represent perhaps the best option for meeting military needs. Conversely, though the U.S. military represents only two percent of the U.S. fuel market, it possesses sufficient purchasing power to drive development of new advanced biofuels in sufficient quantities at the right price. By playing the role of an early customer and partner, the DOD can speed commercialization of advanced biofuels that can grow to meet commercial consumer market needs.

On the date the Energy Independence and Security Act of 2007 (EISA) was signed into law, a few pilot-scale advanced biorefineries existed for proving the technology and working out economic and technical issues prior to scale-up. Today, four years later, more biorefineries – thermochemical, biochemical and hybrid, with variations on different process stages – have reached demonstration and pilot scales, and many developers are raising capital to build new commercial-scale facilities. Since 2007, BIO has tracked the development of more than 65 pilot, demonstration and commercial projects for advanced, cellulosic and algae biofuels across the United States and in Canada.

These 65 projects are pursuing a variety of feedstock and technology strategies that are specific to regional supplies. The growth of the industry is therefore not likely to follow the pattern of the conventional biofuel industry, which was based on a single feedstock (corn) and technology strategy (dry mill biorefining). Biotechnology companies have developed the technology to produce a range of chemical molecules – including butanol and other higher alcohols, ketones and aromatics, diesels and oils – that can be used as drop-in fuel, fuel additives, or upgraded to military specifications for fuel. The projects we've tracked are also pursuing a range of capital formation strategies, including licensing of technology, adding advanced biofuel capacity to existing conventional capacity, or converting conventional capacity to advanced production.

c. <u>Role of Federal Support to Help Bridge the "Valley of Death"</u>

Start-up companies raising capital and developing a market for a new technology face significant challenges. The process of taking any new technology from the laboratory and scaling it up in early commercialization is often described as "the valley of death."

Biofuel producers' ability to raise capital – in particular debt capital – has been hampered by the recent economic recession and banking crisis. A 2009 report from Bio Economic Research Associates, estimated the need to construct 389 new biorefineries, ranging from 20 million to

200 million gallons per year in nameplate capacity, by 2022 to meet the volume requirements under the federal Renewable Fuel Standard (RFS). The total capital cost was projected to be more than $95 billion.[1] A report from Sandia National Laboratories found no fundamental barriers to the construction of an even larger 60 billion gallon biofuel industry, though capital expenditures on the order of $250 billion were needed to construct a complete value chain from feedstocks to fuel delivery.[2]

The RFS—revised under EISA in 2007—and its consistent implementation is one of the fundamental policy drivers for continued development of the U.S. biofuels industry, especially for advanced and cellulosic biofuels. The RFS help provides industry and investors some long-term policy stability and market access necessary to foster capital formation and commercialization of these fuels. The large volume of the advanced biofuels mandate of the RFS (21 billion gallons by 2022) permit a number of technologies, feedstocks and strategies to compete for market space, depending on their ability to achieve cost competitiveness and regulatory approvals and meet end-user needs. The RFS also allows the mandate to be met by additional categories of jet fuel and home heating oil.

In addition to creating a guaranteed market, EISA created other federal programs – such as grants to support continued research and development, loans or loan guarantees to match private capital investment– designed to hurry the market introduction of advanced biofuels. Implementation of the RFS, loan guarantees, reverse auction and other important federal programs has been slow, due to lengthy rulemaking procedures and inconsistent budgetary funding through Congressional appropriations. Additional programs that support the creation of feedstock supply chains – such as the Biomass Crop Assistance Program (BCAP) enacted under the Food, Conservation, and Energy Act of 2008 (Farm Bill) – also were subject to lengthy rulemakings and Congressional appropriations. Tax credits for cellulosic biofuel production are set to expire at the end of 2012, before most companies will be able to claim them.

Enduring federal commitment to the goals of EISA and the Farm Bill is vital to continued investment and commercialization progress. These goals include energy security through domestic production of transportation fuel and environmental improvement through the reduction of greenhouse gas and other particulate emissions associated with fuel combustion. Additional benefits include creating new markets for agricultural products, keeping productive or strategic farm land in use, and improving trade balances.

While also beneficial to military advanced biofuels development, these programs are targeted primarily at civilian surface transportation (car and truck) markets. It is important to note that no program currently exists to overcome the specific challenges of advanced drop-in biofuels for aviation and marine use. The MOU addressed by this RFI directly addresses these challenges, and is thus of vital importance to achieving the objectives of this collaboration.

[1] Bio Economic Research Associates (bio-era™), "U.S. Economic Impact of Advanced Biofuels Production: Perspectives to 2030." Biotechnology Industry Organization, February 2009.
[2] "90 Billion Gallon Biofuel Deployment Study." Sandia National Laboratories/GM. February 2009.

II. Industry is Poised to Produce Volumes of Cost-competitive Domestic Advanced Drop-in Biofuels to Meet Military and Commercial Demand

Branches of the military have worked with several biofuel suppliers to test and certify that biofuels meet exacting requirements for performance and cost.

a. Current and Future Production Capability of Advanced Drop-in Fuels

Ethanol from corn starch is produced commercially through proven technology and has comparatively well-established upstream and downstream value chains; production rapidly expanded to meet the production and use levels mandated in the RFS. The biofuel industry leveraged existing supply chains for corn, existing biorefineries that could be expanded, and newly constructed biorefineries based on replicable models and technology. Biodiesel from soy has also expanded to meet the RFS mandates, though it was hampered by expiration of tax incentives.

Some advanced drop-in biofuel producers are scaling up technology for new advanced biofuel molecules by leveraging these existing biorefineries. Some of the diesels and jet fuels tested by the military were refined in existing biodiesel biorefineries from camelina and algae oils. Other companies are seeking to convert corn biorefineries to new molecules, or add cellulosic capacity through collection of corn stover. Additional companies are leveraging well-established supply chains for sugarcane and building first-of-a-kind biorefineries in Brazil. These strategies can lower the costs for capital and permitting associated with new construction, allowing more rapid scale up.

Supply chains for cellulosic and many other advanced biofuel feedstocks must still be established at sufficient commercial scale. Crop residues such as corn stover or wheat straw are generally used as ground cover or soil amendment in the field but portions of this resource can also be sustainably collected as a feedstock source; some large-scale collection in field trials and demonstration-scale farms has been established to support individual biorefineries. Energy grasses have not been grown on commercial scale, though some large field trials and demonstration-scale farms have been established. Forest thinning and slash traditionally is not collected, although value chains for forestry products exist. Municipal solid waste, while collected, is not sorted for easy extraction of cellulosic content. Sorghum and other starches have established value chains but are not produced on the same scale as corn, sugarcane and soy. Other feedstocks – such as animal fats – are currently waste streams from established value chains. Algae biodiesel and biofuels have made strides toward commercial development since 2008 but were not fully incorporated into the RFS and associated EISA policies in 2007.

b. Maturity of Specific Technologies and Biorefinery Operations that Could be Deployed to Achieve Commercial Scale Production

BIO estimates there are nearly 20 pilot and demonstration biorefineries currently producing small volumes of advanced biofuels – primarily cellulosic ethanol, but also butanol, aromatics and diesel oils from renewable biomass and algae. There are a few additional pilot and demonstration projects scheduled to come online in 2011 and 2012, set to prove new technological and feedstock processes.

A handful of the existing demonstration facilities have proved the technological and economic requirements to scale-up for commercial projects, and at least two companies have broken ground on commercial-scale biorefineries. Please see Appendix A for a list of current and expected advanced biofuel biorefineries, including their projected fuel, location and capacity.

III. Industry is Poised to Produce Sufficient Domestic Feedstocks for the Commercial Production of Advanced Drop-in Biofuels

This section outlines several domestic feedstocks industry is poised to produce in adequate quantities to achieve commercial production of advanced drop-in biofuels. In addition, any RFP pursuant to the MOU should not unnecessarily constrain feedstocks or technologies. In particular, any RFP should be written so that eligibility requirements allow for innovative technologies that can directly synthesize and secrete fungible fuel molecules using CO2 as a feedstock. Sources of CO2 include emissions from industrial and energy generation projects. Ensuring this eligibility would not only help further the energy security goals of the MOU, but could also help reduce greenhouse gas emissions, especially if carbon dioxide may be used to directly create fungible fuel.

a. Woody Biomass

i. Description

Worldwide, wood is the largest source of biomass for energy and also has applications for the production of biofuel, including liquid transportation fuels. Wood can be converted into fuel in solid, liquid, and gaseous forms and can supplement or replace any other energy source. While some BIO members utilize woody biomass for heat production, more are working on advanced processes that can convert woody biomass into advanced biofuels.

Woody biomass is derived from timber, urban wood waste, trimmings, and construction debris etc. After tree harvesting, woody biomass is commonly chopped, chipped, or pelletized in a preprocessing step and transported to conversion and power generation facilities. It is then converted into fuel, heat, or energy via thermochemical or biochemical processes, such as gasification, biogasification, or pyrolysis.[1]

While the southern U.S. produces more wood products than any other region of the country due to its forestry, thinning, and harvesting activities, other parts of the country also have strong and vibrant forest industries. Wood is a feedstock for a broad array of applications and there are already established infrastructures surrounding its processing. Moreover, the transportation and processing infrastructure that has developed around woody biomass makes it a competitive and

[1] C. Staudhammer et al., *Wood to Energy: Using Southern Interface Fuels for Bioenergy*, The United States Forest Service, GTR-132, (2011). *available at* http://www.srs.fs.fed.us/pubs/gtr/gtr_srs132.pdf.

viable feedstock for biofuel production; making it an example of the type of feedstock requested under the RFI.

ii. Economic Feasibility

A major factor in the economic feasibility of woody biomass is the ease with which sugar can be released from the feedstock without excessive processing. To process woody biomass into fuel, it must be treated in order to release the sugars that are bound up in the plant's cell walls. Once the sugars are released, a variety of biofuels can be generated, including liquid fuels. Some BIO members have been developing tree varieties that can release more than two times the usual amount of sugar.

DOD should consider short rotation woody biomass as a feedstock. Some of today's short rotation species, including Eucalyptus and Poplus species, have produced exceptional yields that can easily release cellulose for bioprocessing to aviation turbine fuels or middle distillates.

Several studies have suggested that woody biomass is one of the lowest cost biomaterials available today on a Btu-to-pound ratio, compared to both fossil fuels and other materials.

The forestry industries are capable of producing sufficient woody biomass feedstocks, as noted in the most recent Billion Ton Update reviews by the American Forest & Paper Association, August 17, 2011. The baseline scenario in the 2011 report places the availability of currently unused woody residues from logging, precommercial thinnings, fuel treatments, and municipal solid waste at about 100 million dry tons a year. The previous study estimated the availability of unused woody biomass circa 2005 at about 137 million dry tons a year. The current study projects that more of the biomass likely to be available for energy uses – 37% of the total – will come from dedicated energy crops, including short rotation woody biomass and less from forests and crop residues. For long-term sustainability of feedstocks, DOD should consider new sources of short rotation woody biomass. Residues and waste supplies already have competitive uses in electrical and steam power generation and export markets for woody biomass pellets.

By planting purpose grown hardwoods as biomass crops, a sustainable supply of high quality wood for conversion to sugars can be assured, and the versatility of trees and variety of species make trees a crop that can easily be grown in much of the United States. The ability of the government to sign long term fuel contracts also represents the best chances we have today for landowners generally and timber (forestry) landowners, specifically to recognize the potential of purpose grown trees. Numerous DOE, USDA and state forestry reports point to the strong yield from sustainable forestry for biofuels.

b. <u>Sugar Platform</u>

Any RFP arising from this MOU should include a systematic, collaborative program to optimize all unit processes in the production of advanced drop-in biofuels. For the biochemical pathway, this would include an integrated optimization effort around biomass pretreatment, enzymatic hydrolysis and synthesis of fuels from biomass sugars. Biomass conversion technologies will have to be optimized with other downstream processes to make marine diesel and jet fuel molecules. Any RFP resulting from this RFI should allow a framework for biomass to sugar technology partners (such as pretreatment and enzyme technology leaders) to work with fuel producers (such as providers of synthetic organisms for fuel molecules or fuel precursors, or providers of technology for catalytic conversion of sugars to fuels).

The most successful route to minimize costs is for all technology experts in the process to work closely together in a unified team toward a common economic target. Recognizing that additional optimization will be required for establishing a complete value chain with costs competitive with petroleum is a key step in securing development of this emerging industry.

Therefore, for the near term, MOU partners should consider use of industrial sugars (starch or sugarcane) as a feedstock commodity, with a goal and commitment to transition to lignocellulose sugars as soon as possible.

c. Grasses as Dedicated Energy Crops

i. State of Commercialization and Deployment of Grasses

BIO's membership includes several leading biomass crop developers, who are well-positioned to provide large-acreage plantings of biomass crops for biofuel production. These developers have invested heavily in research and breeding over the last 5+ years to demonstrate the productivity of energy grasses – including miscanthus, switchgrass and sorghum –in trials and small commercial facilities throughout the United States. These grasses are highly productive, and several can yield 10+ dry tons per acre per year. Many are perennial grasses, and yield productive stands many years from a single planting. On the supply chain and logistics side, thousands of acres have been harvested under demonstration regimes using both conventional and newly developed harvesting equipment. These biomass crops are ready for deployment -- what the industry currently needs are firm offtake agreements to support commercial-scale seed production, grower adoption of these crops, and ramp up of the supply chain for large-scale delivery of biomass for conversion to biofuels.

ii. This Joint Initiative is Important

Key elements the federal government can provide are financing and firm offtake agreements to create an economic pull through the drop-in biofuels supply chain. While we anticipate that at scale energy grass-based fuels production systems will be competitive with fossil fuel alternatives, financing and offtake agreements are needed to support commercial scale up and private sector investment in large acreage plantings, as well as harvest and transport to biorefineries for production of biofuel. Private financing sources are currently unavailable, given economic conditions and uncertainties around long-term fossil fuel prices and how quickly the biofuels industry can drive down the cost curve at scale.

This MOU and firm DOD offtake agreements would provide the incentives for land owners to invest in dedicated biomass crop production, offer growers a future income stream against which to purchase seed, and encourage various supply chain participants to invest further capital and research to reduce costs of delivered biomass. These commercial scale projects would encourage scale up of the biomass production system in the field, as well as seed production and distribution capabilities of energy grass producers. A success of a commercial-scale project would provide the final proof of concept and at-scale economic data necessary for private investors and commercial banks to support bioenergy crop production going forward.

iii. Industry is Poised to Produce Sufficient Domestic Feedstocks for the Commercial Production of Advanced Drop-in Biofuels

1. Grasses as Feedstocks

Among the leading energy crops being tested at pilot and demonstration scale in the U.S. are switchgrass, miscanthus, sugar cane, energy cane, and arundo donax. All of these feedstocks have different agronomy profiles (soil and water requirements, productivity, fertility regimes, etc.) and they show promise in certain environments. In the southernmost regions of the U.S., typically around the Gulf Coast and in Florida, sugar cane and energy canes have been tested. Switchgrass and miscanthus have been tested extensively from the Gulf Cost to the Great Lakes regions and both show great promise in the temperate climates.

2. Feasibility and Economic Viability of Grasses that Could be Employed to Meet Commercial Scale Production Volumes

The feasibility of commercial scale-up and economics of commercial production currently varies by crop. Switchgrass and now miscanthus can be propagated via seed, which greatly simplifies and reduces the time and cost to establish large, commercial-scale acres. Miscanthus and other perennial grasses require low inputs and little or no nitrogen, providing attractive economics and further reducing fossil fuel consumption in the biofuel production cycle."

Between the two crops, miscanthus currently is demonstrating higher yields than switchgrass in most production environments, which translates into better production economics. Other crops, such as Arundo and energy cane (and some miscanthus varieties) have to be propagated vegetatively either as stem cuttings, tissue culture multiplication, or rhizomes. While these methods have been tested extensively in the United States and abroad, they limit the speed of commercial ramp-up and the total number of biomass acres that can be established, and increase its cost.

In sum, many of the seeded perennial grasses currently being developed by BIO members will be ready for planting at the scale of thousands of acres over the next several years. All that is needed is financing and offtake agreements to provide the necessary signal for such production. And the economics of the winning energy grass systems are expected to be competitive with other biomass feedstock sources—namely agricultural residues and wood—and can be a source of economic development and stimulus in rural agricultural regions throughout many parts of the U.S.

d. Algae-based Biofuels

i. Description

Algae and some cyanobacteria (also known as blue green algae) function both as a feedstock and a production organism. Algal biomass has great potential as a plentiful and economic advanced drop-in feedstock, with many significant benefits. For instance, algae has a short growing cycle and can be grown quickly and in large quantities using land and water unsuitable for plant or food production; it may even be grown quickly in salt water in the desert.

Algae-derived biofuels can be made from autotrophic or heterotrophic algae. Autotrophic algae rely directly on photosynthesis to grow. They convert sunlight and carbon dioxide into organic carbon that can be converted into high quality oil. Heterotrophic algae can grow in the dark by ingesting organic molecules (molecules that contain carbon) present in their aquatic environment. They can convert carbohydrate feedstock derived from domestic, renewable, sustainable, next generation feedstocks into high quality oil. Both types of algae can result in oils that can be refined into gasoline, diesel and jet fuel with molecular structures similar to traditional petroleum. In fact, they can yield renewable equivalents to JP-5, JP-8, and F-76 fuels that fully comply with DOD's emerging specifications for these fuels (HRJ-5, HRJ-8 and HRD-76).

ii. Feasibility

Thanks in large part to significantly accelerated public and private investment in recent years, many BIO members are on the cusp of economically producing commercial volumes of drop-in algae-based advanced biofuels. For example, one company has produced over 150,000 gallons of oil for fuel utilizing tank operating volumes that are now within one order of magnitude of a commercial scale facility.

Since 2000, the private sector has invested more than $2 billion in the research and development of algae-based biofuels. And, there has been a significant increase in federal government support as well. For instance, in 2009, the DOE invested $180 million in the algae industry and also awarded "nearly $125 million in stimulus through its Integrated Biorefinery Program for two cost-shared pilot scale and one cost-shared commercial scale biorefineries that will produce algae-based fuels. In total, the federal government has invested more than $800 million in algal biomass research and algae-based biofuels."[3]

This significant recent investment has enabled many companies to develop their research and development and pilot and demonstration facilities to produce volumes of drop-in algae-based jet fuel that could be used for military use. In fact, branches of the military have worked with biofuel suppliers to test and certify that biofuels meet exacting requirements for performance and cost. For instance, one renewable fuel producer has supplied camelina-based renewable jet fuel for tests of numerous air craft, including the Navy's Blue Angels and the Air Force's

[3] *2010 Finance Summit Conference Report*, Algal Biomass Organization, available at http://www.algalbiomass.org/wp-content/uploads/2010/07/2010-Finance-Summit-conference-report.pdf

Thunderbirds flight squadrons. And another, has delivered to the Navy 20,000 gallons of jet and diesel from algae, the largest amount of advanced biofuel ever produced.

e. Municipal Solid Waste

i. Description

Urban waste is a source of feedstock for biofuel production. Components of urban waste include municipal solid waste (MSW) and construction and demolition debris (C&D). However, only a portion of this urban waste contains cellulosic materials that can be used for the production of biofuels. Thus, within the MSW stream, only paper/paperboard, wood, yard trimmings and food scraps can be used for biofuels production, and within the C&D stream, only woody materials can be used in biofuels production.

According to the EPA in its RFS analysis and discussion, cellulosic feedstocks available at the lowest cost to biofuels producers will likely be chosen first. This suggests that urban waste, which is already being gathered today and incurs a fee for its disposal may be among the first to be used. The EPA has estimated that a total of 44.5 million dry tons of MSW (wood, yard trimmings, paper, and food waste) and C&D wood waste could be available for producing biofuels after factoring in several assumptions (e.g., moisture content, percent contamination, percent recovered or combusted for other uses). However, given the competition for some of this material for other uses, such as recycling and composting, the EPA has assumed that approximately 26 million dry tons could be used to produce biofuels in 2022 to meet EPA's 16 billion gallons of cellulosic biofuels mandate; which translates to the production of approximately 2.3 ethanol-equivalent billion gallons of fuel (assuming 90 gal/dry ton ethanol conversion yield for urban waste) from urban waste.

The EPA has acknowledged that this material offers a potentially reliable, abundant and inexpensive source of feedstock for renewable fuel production which, if used, could reduce the volume of discarded materials sent to landfills and could help achieve both the GHG emissions reductions and energy independence goals of the Energy Independence and Security Act of 2007. Urban waste that is diverted from landfills for biofuels production will save valuable landfill space for other materials and reduce the production of methane gas associated with the biogenic decomposition of these materials.

Certain existing biofuels technologies are able to recover and use the moisture in MSW with high moisture content, such as food waste, thereby resulting in a water neutral state or water positive state. Additionally, residue resulting from conversion of the MSW feedstock can have valuable uses, such as daily cover or compost materials.

ii. Feasibility and Economic Viability of Major Biomass Feedstocks that Could be Employed to Meet Commercial Scale Production Volumes

MSW comprises a great portion of the 26 million dry tons of urban waste that could be available for biofuels production in 2022. MSW is already being generated in large supply (approximately 243 million tons of MSW in 2009; approx. 62% of which consist of wood, yard trimmings, food scraps and paper that could be used for biofuels production) and is expected to grow in volume as the population grows (by 2022, EPA projects 415 million tons of MSW will be generated). Millions of tons of MSW continue to be disposed of in landfills across the country (approx. 132 million tons of MSW in 2009), despite recent large gains in waste reduction and diversion. The cellulosic fraction of this total stream represents a potentially significant resource for renewable energy (including electricity and biofuels). Because this waste material is already being generated, collected and transported (it would solely need to be transported to a different location), its use is likely to be less expensive than other cellulosic feedstocks. Additionally, MSW is very low cost for biofuel producers. Usually the MSW generator will have to pay a landfill a tipping fee to take the MSW. Instead of paying the landfill, the MSW generator will pay the biofuel producer the tipping fee to take the MSW.

When considering the cost savings for not having to pay the tipping fees at municipal dumping grounds, MSW feedstocks may avoid almost all the purchase costs for the raw material which would significantly help offset the high capital costs.

1. Sorting of MSW

One of the biggest costs associated with using MSW as a biofuel feedstock is the cost to sort the waste material. Some materials, such as metals and contaminated materials, must be removed so that they do not interfere with the biofuel production process. Other materials, such as paper or plastics, may also be separated due to their value as recovered materials or in order to increase the renewability content of the resulting fuel. Efforts to develop effective and efficient sorting technologies and processes are underway by industry and municipalities.

The EPA's Office of Solid Waste has estimated that sorting costs will likely be $20 - $30 per ton. However, in its projection for 2022 under RFS2, EPA projects that total sorting costs might be in the $30 to $40 per ton range, assuming that curbside sorting is involved, at least in a minor way. These sorting costs would be offset by the cost savings for not disposing of the waste material as well as the value of the recovered materials.

In addition to sorting costs, the biofuel producer would also have to pay for the transportation and disposal of unusable material. These costs may be relatively high due to the nature of this contaminated material. Offsetting these costs would be tipping fees received by the biofuel producer, which EPA estimates would be in the $30 per ton range. Industry participants have indicated that MSW would be available, at least initially, at close to zero net cost, after accounting for the receipt of tipping fees and the sale of recoverable materials. Whether the MSW was sorted or unsorted was not expected to make much of a difference from a cost perspective, as it is expected that the higher tipping fees received for unsorted MSW and the money received from the sale of the recovered materials would pay for the cost of sorting.

EPA believes that it is likely that as more biofuel producers seek to use MSW as a feedstock, the cost of this feedstock source will increase. Competition from waste to energy companies may be another driver for the cost increase of MSW. Taking all this into account, EPA has conservatively estimated that the average cost of MSW will be $15 per dry ton in 2022. While this is an admittedly conservative estimate, EPA believes that MSW remains the cheapest source of feedstock for the production of biofuels.

2. Transportation of MSW

Transportation is different for MSW biomass compared to forest and crop residues. Forest and crop residues are collected from forests and farms, which are both rural sites, and transported to the biofuel plant which likely is located at a rural site. The trucks which transport the forest and crop residues are large over-the-road trucks which can average moderate speeds because of the lower amount of traffic that they experience. Conversely, MSW is collected from throughout urban areas and would have to be transported through those urban areas to the plant site. If the cellulosic biomass is being collected at curbside, it would likely be collected in more conventional refuse trucks. As more landfills are being located farther and farther from urban areas, refuse trucks may then take the cellulosic biomass to transfer stations, and the biomass is then loaded onto long-haul trucks or rail cars to be taken to the landfill. If the biofuel plant is near the urban area, then the refuse trucks could transport the cellulosic biomass directly to the plant. In this case, the refuse trucks would simply be delivering the MSW to the biofuel producer instead of a landfill or waste sorting facility, and therefore would not result in any additional cost to the biofuel producer.

If, however, the biofuel plant is located far away from where the waste is collected and where the landfill is located, then the refuse trucks would probably need to be offloaded to more conventional over-the-road trucks with sizable trailers or rail cars to make transport more cost-effective. This would likely be an additional cost charged to the biofuel producer, as the MSW is now being transported farther to be used as a biofuel feedstock instead of disposed of at a local landfill. Because the roadside cost of MSW is significantly lower than the other feedstock sources it may still be cheaper to import MSW from some distance away rather than use an alternative, locally available feedstock.

3. Secondary Storage of MSW

Cellulosic biomass sourced from MSW is generated year-round. Thus, it will only be necessary for the biofuel production facility to store a small amount of feedstock on site, approximately 3-4 days' worth, and additional MSW can be received regularly from the producers.

f. <u>First Generation Feedstocks</u>

The biofuel feedstocks that are most widely utilized in the United States at this time are corn grain and soybeans. As summarized below, these feedstocks have made significant contributions toward lowering cumulative GHG emissions and helping to displace major quantities of imported petroleum in a sustainable and economic manner. As such, it is clear that such feedstocks should continue to be utilized as the nation strives to meet its energy needs in a more sustainable manner.

i. Corn

In the U.S., the primary feedstock for bioethanol has been corn grain, a renewable resource with a demonstrated record of meeting transportation needs, while reducing GHG emissions. The cumulative GHG reductions for U.S. corn grain ethanol through 2010 have been 0.13 Gt CO2e (GREET,2010). In addition to this GHG benefit, domestic corn ethanol significantly improves the local economies in which it is produced. This is especially critical in rural America, which would otherwise be even more adversely impacted by the global economic slowdown. By contrast, imported fuels (like sugarcane-based ethanol from Brazil) contribute to the U.S. trade deficit and produce no domestic jobs.

During 2010, U.S. corn ethanol displaced (on a total energy basis) approximately 174 million barrels of imported oil (corresponding to half the current U.S. imports from Venezuela). The total cost of oil imports to the U.S. economy is $873 million per day or $318 billion dollars annually. In addition, the U.S. exported 397 million gallons of ethanol in 2010. U.S. corn ethanol thus has a major positive impact on the U.S. balance of trade.

Unlike many other biofuels, corn grain ethanol results in the production of a valuable feed co-product: distillers dried grains (DDGs). The amount of DDGs produced is significant, about 17.4 lb/bushel, or 37 million metric tons (MMT) during 2010. While most of this material was used domestically as feed, 9 MMT were exported, directly contributing to the overall balance of trade story.

The U.S. supply of corn grain has grown exponentially since the early 1930's, with annual production remaining above 12 billion bushels for the past 5 years. This represents a more than 500% increase from the 2.3 billion bushels produced on about the same land area in 1939. The compound annual growth rate in U.S. average corn yields is now 1.63%, which exceeds the current rate of world population growth (1.13%). This excess supply has made it possible for the U.S. to utilize corn grain as a means to launch a sustainable biofuel business. Continued gains in corn grain are expected, based on better seed germplasm, continued biotech-based innovations, and more widespread adoption of advanced agronomic practices, such as precision agriculture. Another major new opportunity is to increase utilization of corn stover (see below), either as a feedstock for cellulosic ethanol, renewable energy generation, or as a feed supplement.

ii. Soybeans

Soybeans are by far the main source of vegetable oil production in the U.S. and likewise, biodiesel production. They represent almost 90% of U.S. biodiesel – with total U.S. production remaining less than 1 billion gallons. Canola is another potential biodiesel feedstock in the northern U.S. Although corn grain is relatively low in oil content (less than 5%), the volume of corn processed for ethanol makes corn a significant potential future source of biodiesel.

Soybean yields continue to increase in the U.S. Just as in corn, these advances are coming through advanced breeding, biotechnology, and improved agronomic practices. The compound annual growth rate in U.S. average soybean yields is now 1.29%, somewhat less than in corn, but still outpacing the rate of global population growth. This means that soybeans should continue to represent a sustainable biodiesel feedstock in the future.

iii. No Impact on U.S. Food Prices

The profound technical advances in agricultural production have contributed to lower costs for corn and soybeans, and therefore food. By 2009, U.S. per capita food expenditures had dropped to 9.5% of income (see Figure 1). In the 40 years from 1970 to 2010, America's farmers fed 100,000,000 more people, and increased their U.S. per capita food energy intake by about 500 calories. As shown in Figure 1, there is no evidence that the increasing use of corn and soybeans for biofuel during the latter stages of this period had any negative impact upon U.S. food prices. This is likely a combination of the dramatic increases in crop yields during this same time period, and the large amounts of quality feed (DDGs) that result from corn ethanol production.

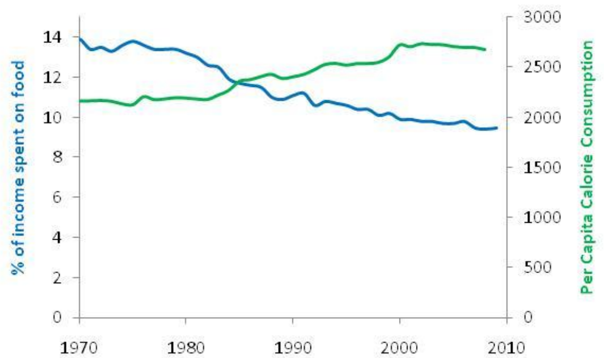

Figure 1: U.S. Food Expenses and Per Capita Consumption. Source: USDA

IV. Path to Economic Viability of Advanced Drop-in Biofuels

Technology that allows the production of drop in biofuels to be widely distributed could significantly improve the economic viability of the whole process. In reviewing economic viability of biofuels, there is a variance in net production cost by location and that is a result of the cost of feedstock transportation. Therefore, if the harvesting, processing, and conversion of cellulosic feedstocks can be accomplished within a few miles of each other the economics will be dramatically improved.

Several companies today have the technology and efforts underway that will enable them to economically produce commercial volumes of advanced drop-in fuels within the next five years. These efforts are greatly accelerated with appropriate and strong federal programs, including the joint MOU, BCAP, and recently announced USDA NIFA grants. These five research and development grants totaling $136 million are designed to lead to the commercialization of advanced drop in biofuels in the next five years. They were given to public-private partners in 22 states throughout the country.

Several technologies moving to commercialization are producing breakthroughs in biotechnology of production organisms to utilize well-established feedstock sources and processing equipment for production of advanced drop-in biofuels offering a rapid path to economic viability. Industrial biotechnology is also rapidly advancing production of advanced drop in biofuels from next generation feedstocks, such as cellulosic biomass, MSW and algae. These next generation feedstocks have the potential to provide greatly enhanced supply of economically sustainable advanced drop-in biofuels.

V. Potential Sustainable Biofuel Supply Chain (Feedstocks to Biofuels) in Hawaii, a Critical Command Location for all U.S. Military Services

There is great potential in Hawaii for the development of a sustainable biofuel supply chain – from feedstocks to biofuels. Several companies are operating in the State to develop feedstocks and make biofuels and renewable chemicals for use in co-products. Please see Appendix B for notes from a workshop BIO conducted in Hawaii last year.

VI. Industry is Poised to Produce a Broad Range of Value-added Co-products

a. Range of Co-products

Choice of biomass and distillation technologies and processed can yield a variety of by-products including attractive commodities – such as waste heat, spent biomass and quality proteins such as DDGs, with a value that can significantly and positively change the economics of the entire biofuel operation. In addition, by embracing a "biorefinery" approach where more than one product can be produced the economic viability of any given project can be improved.

Military biofuels are based on mixtures of hydrocarbons, or the "drop-in" family of kerosene, that have low to moderate flash point, and have different physical chemical properties compared to bioethanol, biobutanol, bioisobutanol, biodiesel, biobutadiene, bioisoprene and other renewable chemicals from renewable biomass for the advanced biofuels industry. These same renewable chemicals can be converted, either in the same process or further downstream process, using traditional catalytic conversion technologies and/or enzymatic processes, to drop-in biofuels for military applications. The high value-added renewable chemicals co-produced in these processes can range from biobased co-products such as benzene, toluene, all of the isomers of xylenes, rubber, ethylene, butylene, propylene, solvents, lubricants, polymers (polyesters, polycarbonates, polyurethanes, phenolics, unsaturated polyesters and vinylesters, and polystyrene). These biobased co-products find use in industrial applications for the construction, transportation, packaging, personal care, water and paper treatment, and health care markets.

b. Risks Associated with Producing, Marketing and Delivering Value-added Co-products and Methods for Mitigation

Value-added biobased co-products entering new markets will be faced with challenges of cost and market penetration, which is the case for any new product introduction, but an initial approach for these value-added biobased co-products is to enter existing, well-developed markets and provide opportunities that target petrochemical alternatives which will reduce the cost of entry. Consumers are increasingly seeking products with natural renewable ingredients, enhanced performance, industrial energy efficiency, and environmental benefits. These biobased co-products would represent an opportunity to commercialize innovative biotechnology applications because they are competitive on cost and performance in low-volume, high value specialty markets. Industrial biotechnology can realize substantial gains by reducing pollution and waste, decreasing the use of raw materials and water, reducing the number of process steps, generating new biobased materials from these value-added biobased co-products, and providing an alternative to petrochemical processes.

VII. Federal Support Necessary to Speed Commercial Production of Advanced Drop-in Biofuels

a. Any RFP Should Avoid Restricting Feedstock Eligibility Beyond the Constraints in Section 526 and Allow First Generation Feedstocks as Transitional Feedstocks for a Pathway to Sustainability

Section 526 of EISA (Section 526) prohibits federal agencies from purchasing unconventional fuels with higher greenhouse gas emissions than conventional fuels.

Section 526 has become an important policy driver for biofuels production in the U.S. It is most relevant to the DOD because it is the nation's largest single fuel purchaser and is leading federal efforts to support, develop and commercialize domestic alternative sources of fuel for military use. The MOU is just one example of these efforts.

The prospect of a stable and long-term customer in the DOD is a major driver of early investment in advanced biofuels for aviation and marine applications. Since its enactment, Section 526 has provided a clear signal that energy security and climate security will be advanced in parallel to federal alternative fuel procurement. This stable policy signal has helped focus private investment and early DOD testing on advanced biofuels, which offer substantial greenhouse gas reductions in addition to their energy security benefits.

To maintain consistency and a stable policy signal that drives private investment in biofuels, any RFP resulting from this RFI should avoid restricting feedstock eligibility beyond constraints in Section 526 and allow first generation feedstocks as transitional feedstocks for a pathway to sustainability. The importance of this last point is described in detail in Section III(f) of these comments above.

b. Any RFP Should Strongly Consider Integrated Biorefineries

The U.S. has the potential to become the world leader in renewable chemicals and biobased products, as we are currently home of the most advanced renewable chemicals technology and intellectual property, and have access to a wide range of renewable feedstocks that can be sustainably produced. Renewable chemicals already represent about four percent of the worldwide chemical market and can be produced cost-competitively with their petroleum counterparts. Biorefineries can be designed to manufacture biofuels and high-value renewable chemicals as co-products. However, these high-value renewable chemical co-products are not receiving the same incentives as the biofuels. Policy needs to be developed that supports all technologies.

A robust and healthy business model for producing advanced biofuels should include integrated biorefinery production facilities that are not restricted in what they can produce so they can make a variety of renewable chemicals according to consumer demand. USDA's Biorefinery Assistance Program requires biorefineries to garner 70% of their revenues from biofuels and restricts the opportunities for the renewable chemicals and biobased products. Any RFP pursuant to the MOU should provide full opportunities to commercial scale integrated biorefineries that produce both biofuels for military applications and high-value renewable chemical co-products.

c. Importance of Long-term Government Off-take Agreements

Currently, the DOD and other U.S. civilian and military agencies are limited to five year contracts for the purchase of biofuels.

As mentioned above, the DOD is the largest single consumer of energy in the country, as it makes up approximately two percent of U.S. energy consumption. Accordingly, the DOD has the ability to drive investment and innovation through its energy purchases. For instance, the U.S. Navy plans to deploy a "Great Green Fleet" by 2016, which will be entirely operated on alternative fuels.

To realize these goals, the U.S. biofuel industry must substantially scale-up production of biofuels, especially advanced and cellulosic biofuels. At the same time, private sources of capital such as banks are reluctant to fund biorefineries because the investments needed are large, risky and generally have pay-back periods of 10-15 years. The DOD should make every effort to identify and utilize its authority to enter into longer term purchase agreements for biofuels. The ideal period would be 10-15 years, as it would significantly help industry secure the much needed capital to meet U.S. biofuels scale-up demands. It would provide investors with confidence that the fuel produced by their biofuels investments would have a market for the entire pay-back period. Should DOD conclude that it lacks adequate authority, Congress should authorize such authority without delay.

d. DOD Land-use Authority and Purpose Grown Energy Crops

Adoption and establishment of purpose grown energy crops (PGECs), such as perennial grasses, short-rotation woody crops, and algae, is one of the most important and challenging obstacles to achieving an adequate and sustainable supply of biomass for production of advanced biofuels, biobased products and renewable chemicals. BIO encourages DOD to utilize its full authority to facilitate establishment of PGECs. In addition to supplying feedstocks for military biofuel production, PGECs provide an outstanding compatible use for lands on or around military installations, training routes, or other strategic geographies.

The DOD currently manages 30 million acres of rural land that could be used for PGECs. In fact, various statutory authorities and existing DOD programs indicate that using lands on or around military installations for PGEC production is possible and productive for the military and its energy security needs, as well as for the affected communities. Additional benefits of using these lands for growing PGECs for biofuels for military use include limiting encroachment from growing populations, and providing the military with the open space it needs to conduct testing and training, while simultaneously facilitating the economic development of rural economies through agriculture.

The 2003 National Defense Authorization Act created the Sustainable Ranges Program granting the Secretary of Defense or the Secretary of a military department the authority to enter into agreements with state governments and private entities whose principal purpose is the conservation, restoration, or preservation of land and natural resources, or similar purpose or goal. Within the Sustainable Ranges Program is the Readiness and Environmental Protection Initiative (REPI). REPI funds are used to support a variety of DOD partnerships that promote compatible land use, including agriculture.

Farming, ranching, and forestry can be compatible with military use. Presently, the DOD is working with key stakeholders to encourage more compatible land use around military installations and ranges. These partnerships have resulted in the creation of land acquisitions, growth management laws, the creation of agricultural districts, improved planning and zoning, and the development of agricultural conservation easements. These measures enable landowners to dedicate their lands towards a particular purpose in exchange for compensation without having to sell their property. Additional benefits include job creation, natural resource protection, and land restoration and reclamation.

BIO encourages the Navy, USDA and DOE to examine fully all opportunities to facilitate adoption and establishment of PGECs. BIO and its members believe that dedicating specific lands on and adjacent to military installations can be compatible with the interests of various stakeholders while also helping the military transition its fleet from petroleum fuels to biofuels. Therefore, BIO supports continuing to develop partnerships on PGECs between the military, state and local governments, and private entities that will result in more biofuel feedstocks and help the military transition its fleet away from petroleum-based fuels.

VIII. Conclusion

The MOU is an important signal of federal support that will help U.S. advanced drop-in biofuel producers bridge the valley of death and produce sufficient volumes of those fuels for near-term military and ongoing commercial use. Thank you for considering these comments.

Respectfully,

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Biotechnology Industry Organization (BIO)