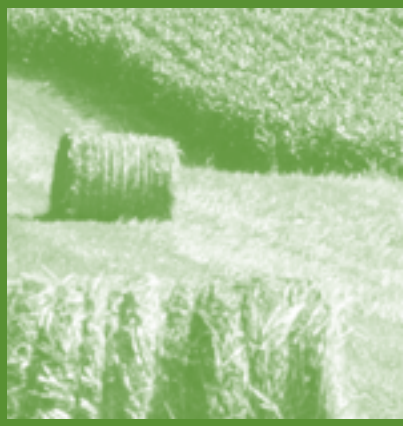
Next-Generation Biofuels

Taking the Policy Lead for the Nation



A REPORT OF THE CHESAPEAKE BAY COMMISSION AND THE COMMONWEALTH OF PENNSYLVANIA

SEPTEMBER 2008

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STATE OF INNOVATION

Commonwealth of Pennsylvania

Chesapeake Bay Commission
Policy for the Bay

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Chesapeake Cellulosic Biofuels Project

To Our Readers:

As America's dependence on foreign oil continues to grow, our nation is confronted with an energy crisis that jeopardizes our economy, our national security and our way of life, reasons that underscore the urgency of investing in and developing homegrown, alternative fuels.

The Chesapeake Bay region has the opportunity to emerge as the leader in this transformation, particularly in the development of next-generation biofuels. In order to do so, however, we must proceed in a manner that maximizes the economic opportunities of this emerging technology, while also protecting our natural resources.

This publication represents the culmination of a year-long effort on behalf of the Commonwealth of Pennsylvania and the Chesapeake Bay Commission to guide the region to a leadership role in the nation's evolution to cellulosic biofuels. In the course of this effort, the issues of energy independence and the economy assumed new importance as gasoline and grain prices reached record highs. Against the backdrop of these unprecedented challenges, our Biofuels Advisory Panel developed a roadmap to develop the next generation of biofuels using a new set of feedstocks independent of food crops that can be grown sustainably with greater environmental benefits for our lands and waters.

We present here the results of their work — 10 regional and 10 state-specific recommendations on how to enter the cellulosic era in a way that ensures both economic growth and environmental stewardship. These recommendations will be discussed thoroughly on September 4, 2008, at the Cellulosic Biofuels Summit in Harrisburg, Pennsylvania. This first-of-its-kind gathering will offer attendees valuable information on how the competitive advantages of our region — an extensive supply of forest and agricultural crop residues, favorable conditions for growing perennial grasses, and the existing volume of municipal solid wastes — can establish the region as a national leader in this endeavor; yield lasting benefits to our farm, forest and industrial economies; and advance our Chesapeake Bay restoration goals.

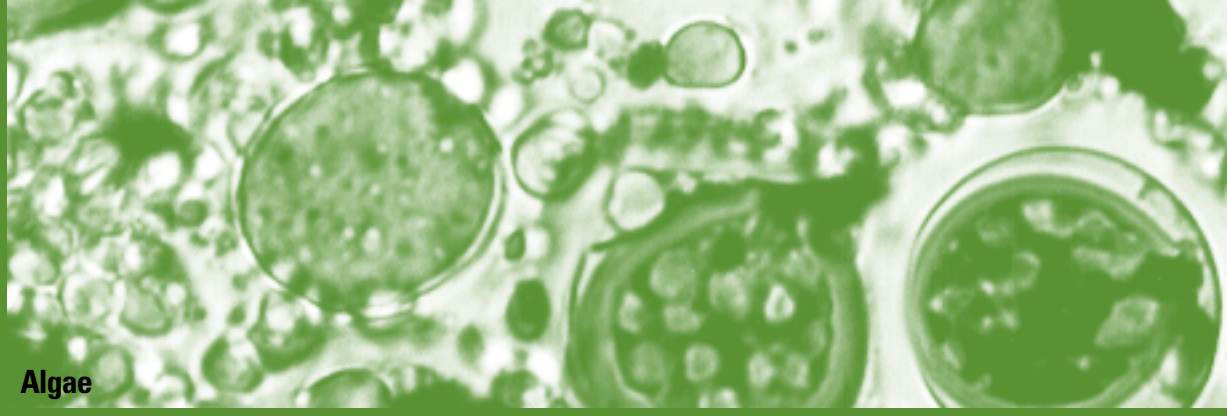
We look forward to working with you on this important matter.

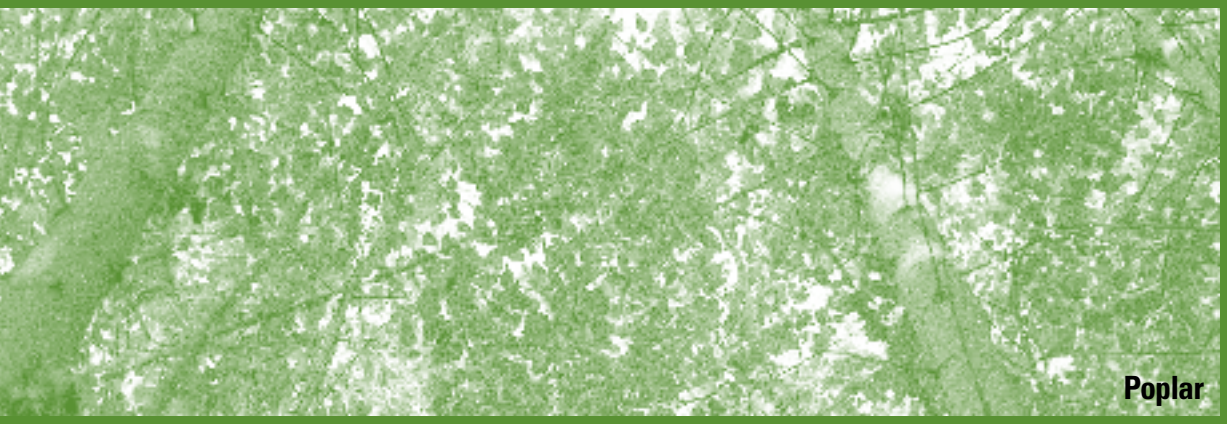
Sincerely,

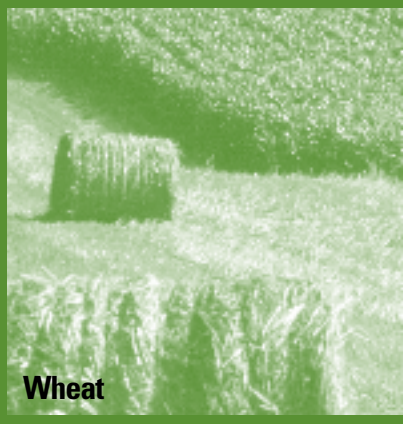
Edward G. Rendell, Governor
Commonwealth of Pennsylvania

Rep. Arthur D. Hershey, Chairman
Chesapeake Bay Commission

Manure


Algae

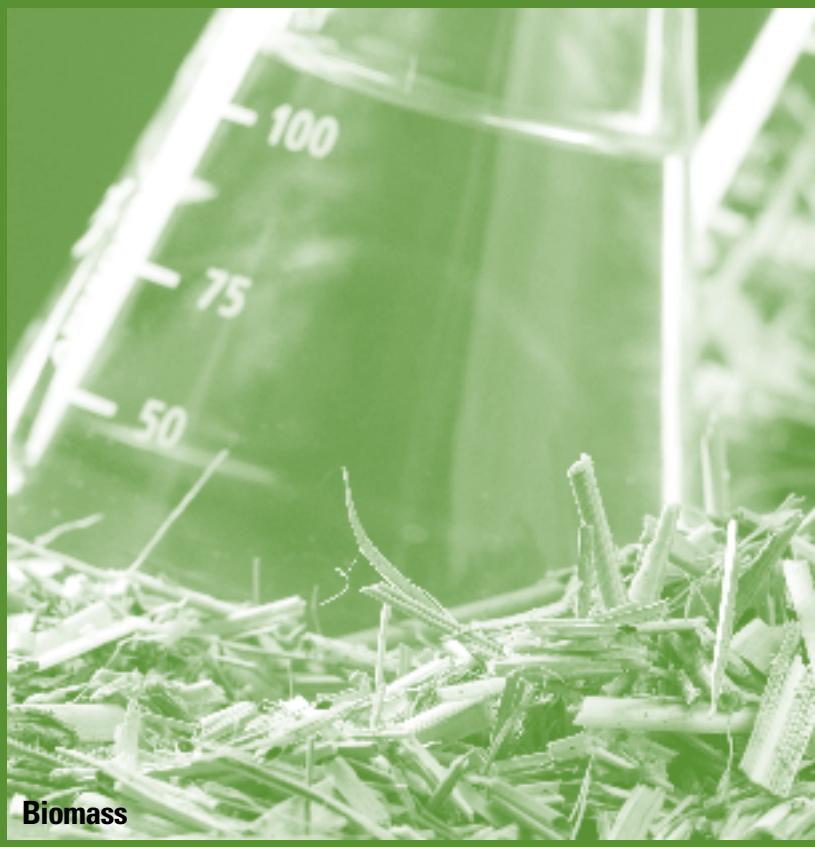

Poplar


Wheat

Willow

Switchgrass

Wood chips



Biomass

Barley

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BARLEY: LYNNE HOOT

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SEPTEMBER 2008

The Chesapeake Biofuels Project

Biofuels Advisory Panel

The Chesapeake Bay Commission and the Commonwealth of Pennsylvania wish to thank the following experts for generously sharing their time and knowledge in the preparation of this report. Without their tireless participation and expertise, this report would not have been possible. We also extend our appreciation to Delegate James Hubbard for his proficient leadership of our policy-making process.

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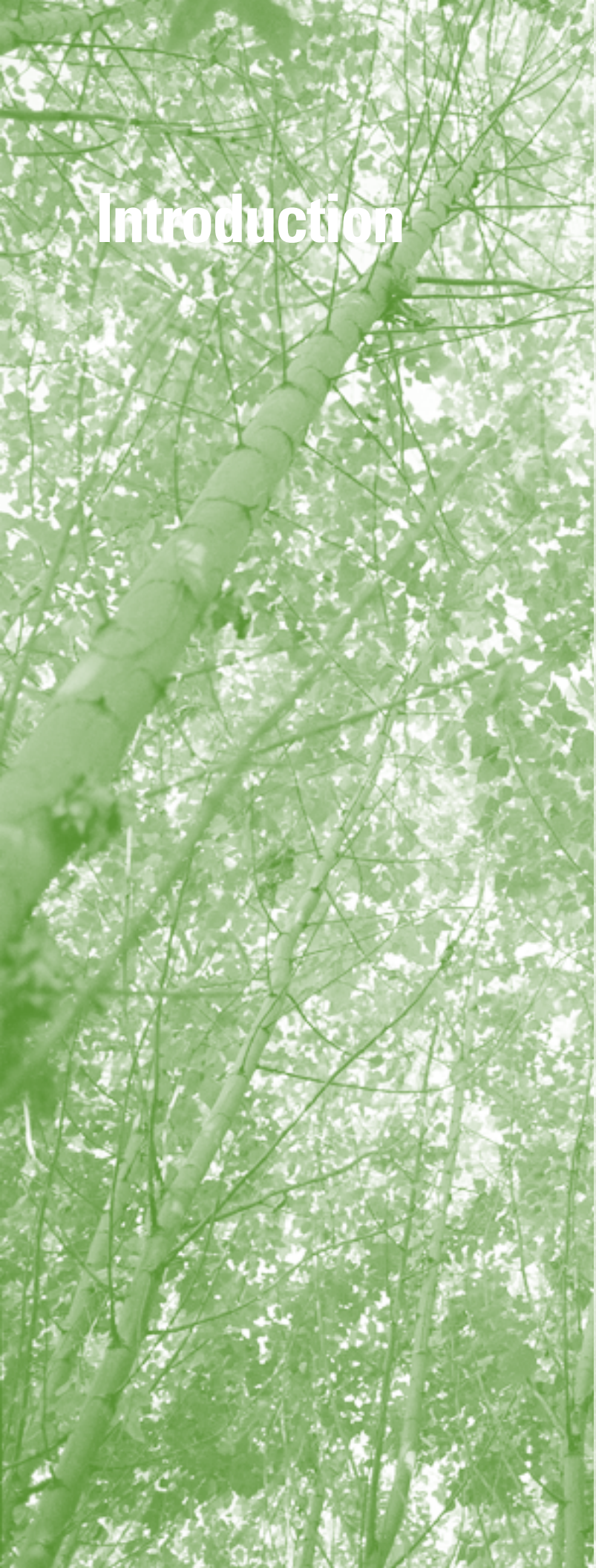


Introduction

Every major source of energy used by modern society has an environmental impact — and all too often these impacts are negative. Today, the Chesapeake Bay region has an unprecedented opportunity to take the lead in a new era of energy production that could produce a wealth of positive impacts for our economy, farms and families, as well as our forests, rivers, and the Chesapeake Bay.

The opportunity lies with the new biofuels industry, which is currently exploding on both the national and international levels. The assets of the Chesapeake region make it well-positioned to become a leading player in the production and use of biofuels. Our climate, soils, and landscape can produce a wide range of feedstocks. Refining facilities can be placed near the sources of feedstocks, with efficient access to petroleum blenders and the open market. And the region already hosts a thriving biotechnology industry and a multitude of excellent, university-based researchers.

Many decisions driving the growth of the biofuels industry are made in a global marketplace and are beyond our control. However, as a region not yet fully invested in the production of first-generation biofuels (e.g. ethanol derived from corn or other grains), we have a rare opportunity in which our region's business, political and scientific leaders can proactively assert leadership in producing the next generation of biofuels — and they can shape elements of this emerging industry to serve both economic and environmental goals. To do this, we must act now.

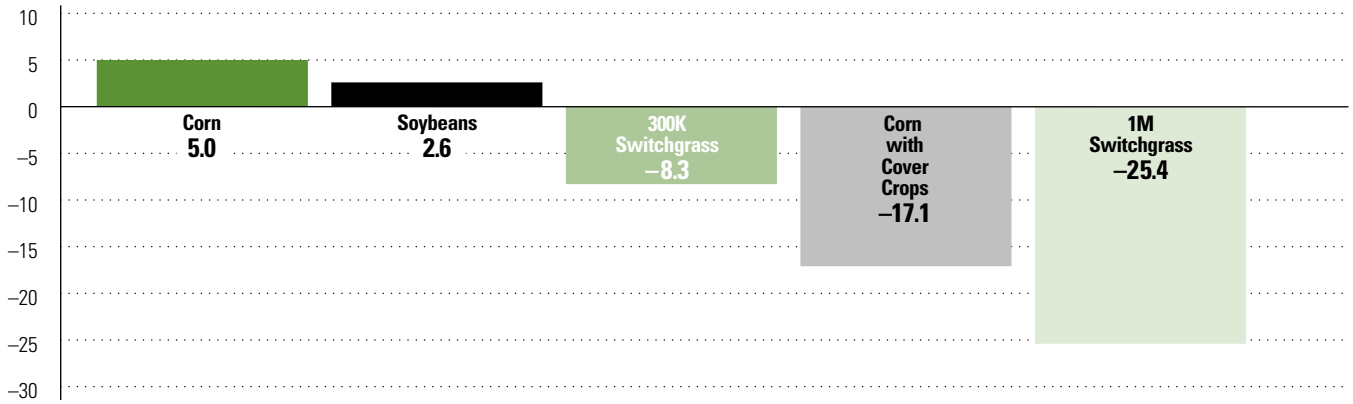
The Chesapeake Bay Commission's 2007 report, *Biofuels and the Bay: Getting it Right to Benefit Farms, Forests, and the Chesapeake,* outlined a number of ways in which the growth in biofuel production could harm our region's environment (see Figure 1). It also demonstrated a number of ways we could capitalize on biofuels for both economic and environmental benefits. One of the many recommendations in the report was to make the Chesapeake region a leader in the development of cellulosic ethanol.

Cellulosic ethanol is among the suite of next-generation biofuels that will soon emerge from research laboratories to the commercial market. Ethanol and other fuels derived from cellulose hold much promise for supporting the nation's energy needs while helping to advance environmental goals. First-generation ethanol — derived from corn, barley and other grains — can degrade water quality in rivers, streams and the Chesapeake Bay, unless aggressive best management practices are put into place. On the other hand, cellulosic ethanol and other advanced biofuels use plant material for feedstock, such as perennial grasses,

FIGURE 1

Comparing Nitrogen Loads from Various Biofuel Feedstocks

Millions of pounds per year of nitrogen delivered from the Chesapeake Bay watershed to the Bay under five modeling scenarios.



Assumptions for Alternative Scenarios (Next 3–5 Years):

- **Corn:** 300,000 additional acres of corn with typical levels of management practices
- **Soybeans:** 300,000 additional acres of soybeans with typical levels of management practices
- **300K Switchgrass:** 300,000 acres of switchgrass, converted primarily from hay and pastureland, with no fertilization
- **Corn with Cover Crops:** Cover crops on all existing and new (additional 300,000) corn acres and one quarter of all other row crops, watershed-wide.
- **1M Switchgrass:** 1 million acres of switchgrass, converted primarily from hay and pastureland, with no fertilization

SOURCE: U.S. EPA CHESAPEAKE BAY PROGRAM OFFICE, 2007

woody material, and corn stover. These feedstocks can help meet the nation's fuel needs while actually helping to protect water.

Although not yet commercially viable, most experts agree that a cellulosic biofuels industry is only a few years away. In response, Pennsylvania Governor Ed Rendell and the Chesapeake Bay Commission stepped forward at the 2007 meeting of the Chesapeake Executive Council to jointly champion the Chesapeake Cellulosic Biofuels Project.

The Commission and the Commonwealth appointed a 22-member Biofuels Advisory Panel, comprised of experts from the public, private, and academic sectors across the watershed, to provide substantive and political guidance throughout the process. Delegate James Hubbard, who first led the Commission to investigate biofuels as 2007 Chairman of the Chesapeake Bay Commission, was appointed chairman of the advisory panel.

The Chesapeake Cellulosic Biofuels Project was staffed by the Chesapeake Bay Commission, assisted by a talented team of consultants. A Coordinating Committee was named, consisting of agency representatives from each state in the watershed, to help ensure transparency and a constant flow of information. A large number of funders also helped to ensure our success. A complete listing is provided on page 36.

The Coordinating Committee also helped the Advisory Panel and staff team conduct stakeholder outreach sessions and state briefings to solicit a continuous stream of substantive input. Via face-to-face meetings and extensive e-mail exchanges, the Advisory Panel and staff team drew upon input from farmers, forest landowners, biofuel developers, environmental and conservation representatives, rural development advocates, agricultural and wood product and petroleum industry representatives, as well as academic and government partners, to develop the policy recommendations presented in this report.

As co-champions of this effort, the Commonwealth of Pennsylvania and the Chesapeake Bay Commission offer these recommendations to policy makers, opinion leaders, energy providers and consumers for consideration and adoption, so that the legacy of biofuels in our region will be one of economic prosperity, environmental sustainability and resource restoration.

Why the Chesapeake? Why Now? The Case for Cellulosic Biofuels

Biofuels and the Bay: Getting It Right to Benefit Farms, Forests and the Chesapeake, published by the Chesapeake Bay Commission in 2007, makes quite clear that biofuel development can produce significant benefits on multiple fronts — if managed correctly. The region's economy, environment, and farm and forestry communities each stand to gain from a smart, energetic entry into the biofuels market.

The nation may benefit, too. Biofuels can help displace a significant portion of the more than 180 billion gallons in petroleum-based gasoline, diesel and home heating oil consumed in America each year. As shown in Figure 2, the six states that comprise the Chesapeake region account for a substantial share of these fuels, including over 43 percent of home heating oil. While portions of some states are outside the watershed, they are likely also markets for biofuels produced within the watershed.

Water quality in the Chesapeake Bay and its rivers may also benefit from biofuels, once cellulosic and other advanced biofuels become commercially viable. The initial burst of ethanol production in the United States, which has focused on corn and other grains as a feedstock, is troubling for water quality. Corn tends to demand high levels of fertilizer and uses it relatively inefficiently. Without the aggressive use of best management practices, an increase in corn crops could also increase the amount of nitrogen runoff in the Bay and its rivers. In fact, the expanded planting in the Corn Belt is contributing to the record size of the oxygen-starved dead zone near the Mississippi Delta.

The feedstocks for cellulosic biofuels, on the other hand, create far less concern for water quality. The planting, management and use of cellulosic feedstocks such as perennial grasses and woody crops can in fact move us closer to Bay restoration goals by absorbing nitrogen and reducing the erosion of sediment into local waterways.

The Science & the Opportunity

To date, the production of ethanol and biodiesel in the Chesapeake watershed has not been significant (see map, page 8). There are several reasons for this. Ethanol is currently produced for market using corn or other grains as feedstock. Some farmers in the Bay region have tapped into this market, but the farms here are smaller than the U.S. average and produce more specialty crops. Farmers must also balance the new demand for ethanol feedstock with the long-standing local market for corn and soybeans as livestock and poultry feed. Another challenge is the comparatively high cost of prime farmland due to develop-

FIGURE 2

Sales of Traditional Fuels In the Chesapeake Bay Region

Millions of gallons sold

	Gasoline (2007)	On-Highway Diesel (2007)	Home Heating Distillate Fuel (Oil and Kerosene) (2006)
New York	5,683.1	1,097.0	1,092.7
Pennsylvania	5,020.4	1,515.0	689.2
Virginia	3,945.5	1,073.0	184.5
Maryland	2,464.0	558.7	138.0
West Virginia	731.5	294.5	15.5
Delaware	448.9	66.8	28.8
District of Columbia	89.2	8.3	7.5
Region Total	**18,382.6**	**4,613.2**	**2,156.2**
National Total	**137,765.6**	**39,118.3**	**4,984.8**
% of National Total	**13.3%**	**11.8%**	**43.3%**

SOURCE: John Urbanchuk analysis of EIA Preliminary Petroleum Marketing Annual 2007, Table 45, and Fuel Oil and Kerosene Sales 2006.

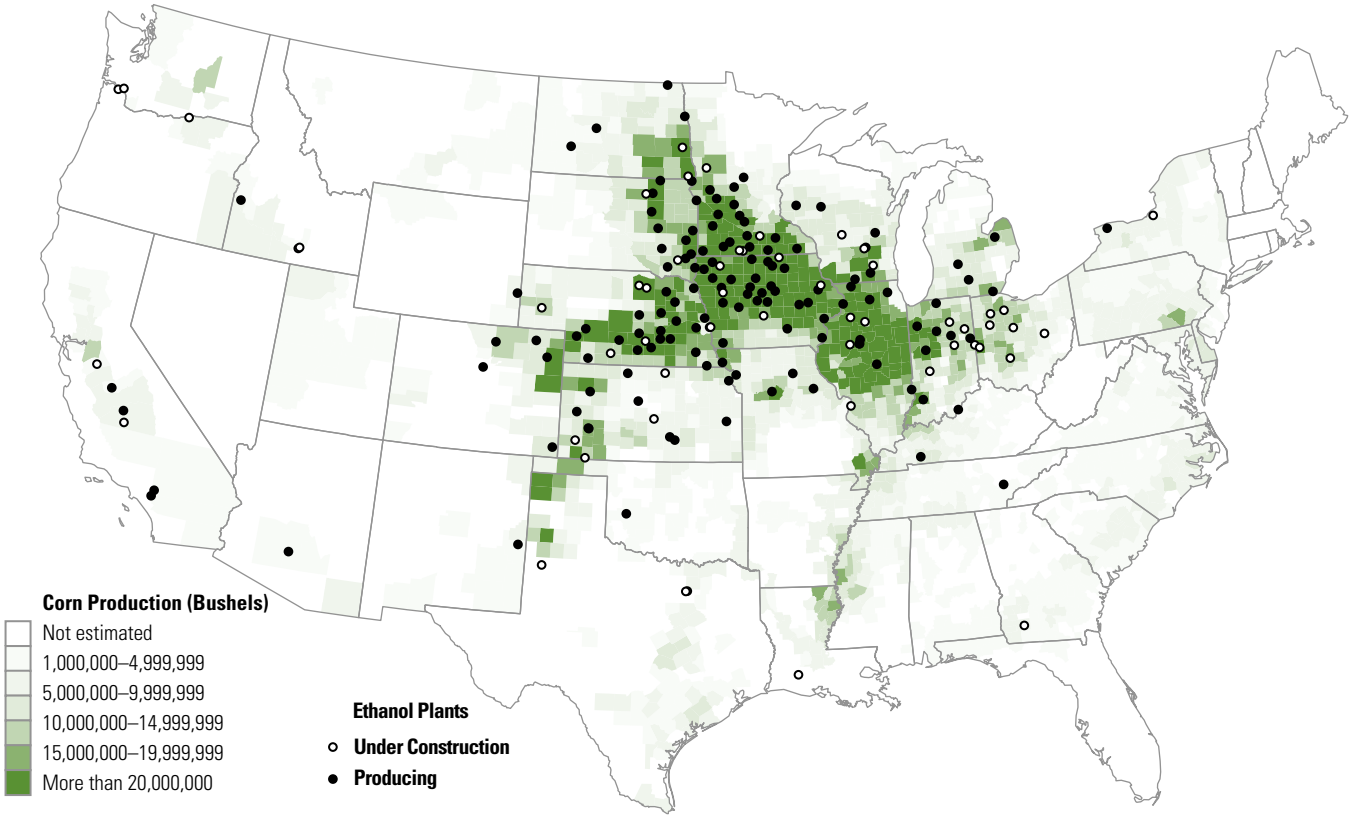
ment pressures throughout much of the region. Farmers find it economically difficult to expand production of traditional crops and thus difficult to support the current biofuels industry.

However, impending advances in technology will soon spawn the next generation of biofuels. Cellulosic ethanol and other fuels made from crop residues, perennial grasses, woody material, manure, algae and even municipal waste (see Figure 3) will help overcome the challenges associated with corn-based ethanol, such as nutrient leaching and degraded water quality. Biofuels also represent an opportunity to move farming in the region from a chronically low-margin sector of the local economy into an area of sustainable growth and value-added opportunities.

Extensive research is being conducted throughout the country to define the most efficient methodologies for producing cellulosic ethanol at a cost and volume that will meet market needs. As seen in Figure 4, there are currently 55 pilot plants and early commercial ventures under construction in the United States that will assist in

Choosing Our Future

The Chesapeake region is the least invested in ethanol of any corn-growing region in the nation.



SOURCE: U.S. Department of Agriculture, National Agricultural Statistics Service, 2007

FOCUS National Renewable Fuel Standard

The National Renewable Fuel Standard (RFS), established in the Energy Independence and Security Act of 2007, mandates annual increases to the U.S. production of biofuels. By 2022, biofuels will constitute 36 billion gallons, or about 20 percent of U.S. transportation fuels. These increasing annual goals are listed in the chart below. The Act also grants the Administrator of the U.S. Environmental Protection Agency the authority to temporarily waive part of the biofuels mandate if implementing the Act would severely harm the economy or the environment, or if there is an inadequate domestic supply to meet the requirement.

To date, ethanol derived from corn has been virtually the exclusive renewable fuel produced in the United States. The 2007 production level was approximately 8.5 billion gallons. The RFS calls for 15 billion gallons of this type of biofuel to be produced by 2015 and maintained at that level through 2022. After 2015, next-generation biofuels — which are slated to come on line in 2009 — will make up the remaining increase to total 36 billion gallons by 2022.

A variety of fuels are considered to be next-generation biofuels, including: ethanol made from cellulose, hemicellulose, lignin, sugar or starch (except for corn starch) or from waste material such as crop residue, animal waste, food waste, or yard waste; biomass- based diesel; biogas including landfill gas and sewage waste treatment gas; biobutanol; and other fuels derived from cellulosic biomass.

The RFS mandate, together with generous federal incentives and state participation, can help to position the Chesapeake region as a leader in cellulosic biofuels. With comparatively little investment in corn ethanol in the region, abundant stocks of cellulosic feedstocks, top university resources and other regional advantages, the Chesapeake region is poised for the front line of next-generation biofuel production.

Renewable Fuel Standard

Phased-in schedule in billions of gallons

Year	Renewable Biofuel	Advanced Biofuel	Total Renewable Fuel
2008	9.0		9.0
2009	10.5	0.6	11.1
2010	12.0	0.95	12.95
2011	12.6	1.35	13.95
2012	13.2	2.0	15.2
2013	13.8	2.75	16.55
2014	14.4	3.75	18.15
2015	15.0	5.5	20.5
2016	15.0	7.25	22.25
2017	15.0	9.0	24.0
2018	15.0	11.0	26.0
2019	15.0	13.0	28.0
2020	15.0	15.0	30.0
2011	15.0	18.0	33.0
2022	15.0	21.0	36.0

FIGURE 3
Potential Biofuel Crops for the Chesapeake Bay Region

Common Name	Latin Name	Biofuel Use	Comments
Alfalfa	*Medicago sativa*	cellulosic ethanol	
Algae	(Various species)	biodiesel, cellulosic ethanol	Grown in ponds or indoors
Barley	*Hordeum vulgare*	grain ethanol, cellulosic ethanol	Can be grown as winter crop
Camelina	*Camelina sativa*	biodiesel	Some areas of watershed
Canola	*Brassica juncea B.rapa, B.napus*	biodiesel	Can be grown as winter crop
Castor Bean	*Ricinis communis*	biodiesel	Some areas of watershed
Corn	*Zea mays*	grain ethanol	
Cuphea	*Cuphea* hybrid	biodiesel	Some areas of watershed
Miscanthus	*Miscanthus xgiganteus*	cellulosic ethanol	Double the biomass of switchgrass
Mustard	*Brassica nigra, B. juncea, Sinapis alba*	biodiesel	Double the oil of soybeans/acre
Peanut	*Arachis hypogaea*	biodiesel	Extreme southern watershed
Poplar	*Populus* hybrid	cellulosic ethanol	
Sorghum	*Sorghum bicolor*	grain ethanol, sugar ethanol	Some areas of watershed
Soybean	*Glycine max*	biodiesel	
Sugar beet	*Beta vulgaris*	sugar ethanol	
Sunflower	*Helianthus annuus*	biodiesel	
Switchgrass	*Panicum virgatum*	cellulosic ethanol	
Other biomass sources under consideration for advanced biofuels include wood chips, willow, forest slash, and mixed municipal waste.			

SOURCE: National Arboretum "Power Plants," Agricultural Research Service, USDA, 2008

defining the technologies of the future for this industry. Six are under construction or planned for in Bay states: three in New York, two in Pennsylvania, and one in Maryland. Not all are in the watershed.

A collaboration involving the U.S. Department of Energy, Conoco Phillips, and Iowa State University is also developing cellulosic technologies that will use gasification, pyrolysis, and fermentation to produce fuels from corn stalks, stems, leaves, other non-food agricultural residues, hardy grasses and fast-growing trees. In addition to the production of cellulosic ethanol, emerging technology will soon support a wide range of biofuels including biobutanol, renewable diesel, and biogasoline and jet fuel (see Figure 5).

Government grants, loans, loan guarantees and tax credits — coupled with Renewable Fuel Standards (see Sidebar, page 9) and cutting edge research at universities and government labs — are also boosting the development of cellulosic biofuels. The U.S. Department of Energy is investing up to $375 million in three new Bioenergy Research Centers that will accelerate the development of cellulosic ethanol and other biofuels, as part of the national "Twenty in Ten" initiative to reduce U.S. gasoline consumption by 20 percent within 10 years. The U.S. Department of Energy is also investing $385 million for six cellulosic bio-refinery projects over the next four years. When fully operational, the bio-refineries are expected to produce more than 130 million gallons of cellulosic ethanol per year.

The adoption of a low-carbon fuel standard in California to reduce the carbon intensity of the state's transportation fuel use 10 percent by 2020 will further advance the development of cellulosic biofuels. Other states may follow, only furthering the demand.

Positioned to Lead

The Chesapeake Bay region is well positioned to take leadership in this revolutionary shift to greener, renewable fuels, and to enjoy its economic and environmental benefits.

A number of diverse feedstocks can be grown in the Bay region as sustainable crops for cellulosic biofuels throughout the year and transported at low cost to major East Coast energy markets. A large number of universities and research institutes in the region are already working on cellulosic biofuels, and many private companies are willing to partner and develop competitive technologies. This research will not only produce a variety of biofuels such as ethanol, butanol, biodiesel and biohydrogen,

FIGURE 4

Cellulosic Refineries are Emerging in the U.S.

	Commercial Scale	Demonstration Scale	Pilot Scale
Completed	-	2	3
Under Construction	1	3	5
Planning Stage	21	14	6
Total	**22**	**19**	**14**

Commercial-scale biorefineries use at least 700 tons of feedstock per day to produce 10 to 20 million gallons per year of biofuel.

Demonstration facilities use approximately 70 tons of feedstock per day, yielding at least 1 million gallons per year.

Pilot-scale plants are generally smaller and are used to develop new methods and technologies.

Cellulosic Refineries in the Bay Watershed States

Facilities Under Construction			
Location	**Scale**	**Size**	**Feedstock**
Clearfield, PA	Pilot	5 tons/day of feedstock	Wood, agricultural residues
Madison, PA	Pilot	40,000 GY	Cellulosic waste, municipal solid waste
Rome, NY	Pilot	500,000 GY	Wood chips, paper waste
Planned Facilities			
Location	**Scale**	**Size**	**Feedstock**
Lyonsdale, NY	Pilot	183,000 GY ethanol & 5 MGY jet fuel	Wood Chips, willow, low-grade timber
Middletown, NY	Demo	8 MGY	Municipal solid waste
Curtis Bay, MD	Demo	3.5 MGY	Marsh grasses, waste material

GY = gallons/year MGY = million gallons/year

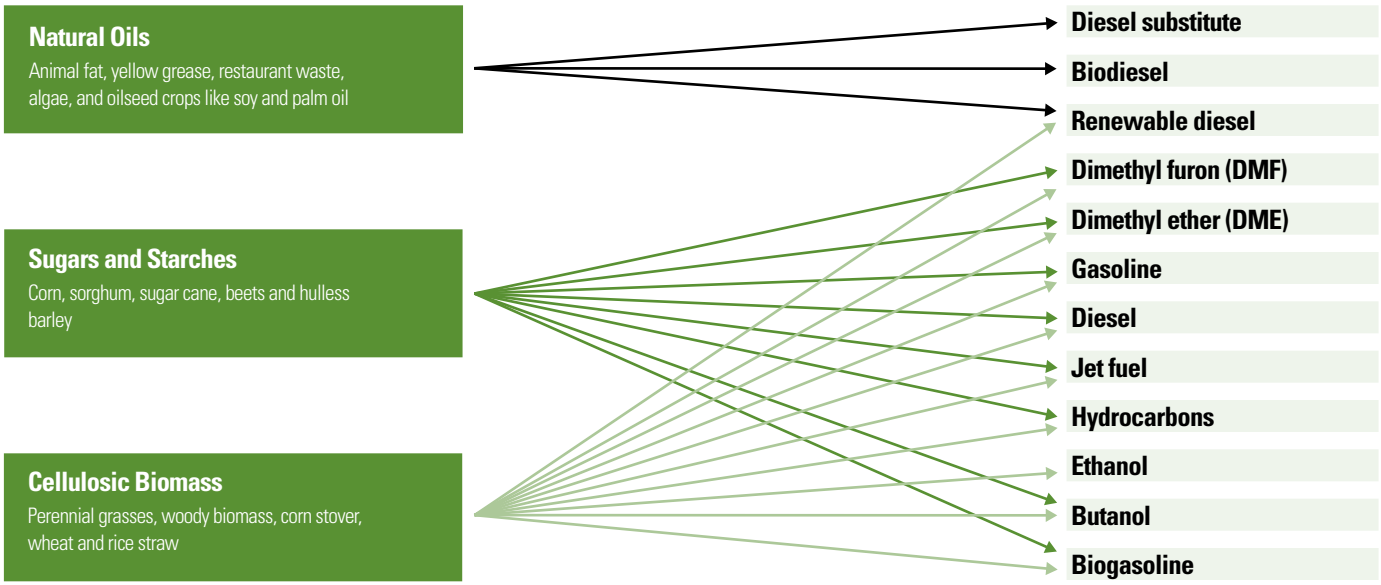
SOURCE: Environmental and Energy Study Institute, July 2008; EESI includes the use of municipal solid waste in their feedstocks for a cellulosic refinery.

but also by-products that will have extra value for use in polymers, animal feed supplements and as substrates in the cosmetic and supplemental nutrient business (see Sidebar, page 13).

Significant additional investment will be needed to commercialize and expand these next-generation technologies, which are not without challenges. Unlike converting corn and other grains to ethanol, cellulosic materials require significant pretreatment or mechanical preparation before the conversion (see Figure 6). Therefore, the capital costs for launching cellulosic production facilities will be higher. Emerging opposition to first-generation biofuels by the petroleum, livestock, poultry and food manufacturing industries could challenge the resolve of the federal government to support the development of next-generation biofuels. This risk is exacerbated by the impact of the global credit crisis, which has caused limited access to capital.

FIGURE 5

Biofuels: Think Beyond Ethanol



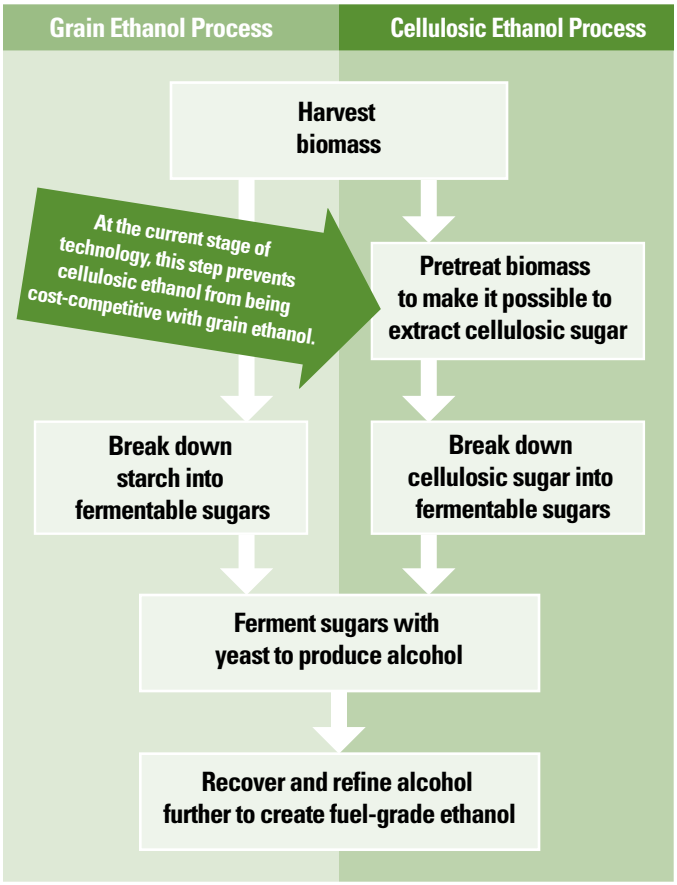
SOURCE: Chesapeake Bay Commission, 2008

Nevertheless, the biofuels sector has benefited from ready access to capital markets, thanks in part to supportive government energy policies. And the cost associated with next-generation start-up facilities has not deterred interest: the potential production volume and significant positive environmental results continue to attract skilled researchers and investors. Overall, the growth of venture capital investments in renewable energy technology has grown exponentially — jumping to $3.4 billion in the United States in 2007 and more than tripling the amount invested two years earlier. On a global scale, investments grew by 60 percent in 2007 and climbed to nearly $150 billion.

Assuming a level of continued investment in the region, the new conversion technologies will create opportunities for crops and woody biomass that can be specifically adapted for growth in the region as biofuel feedstocks, especially on marginal lands not suitable for producing more traditional crops. According to analysis by the Chesapeake Bay Program, at least one million acres of these lands are available in the watershed. Additionally, cellulosic feedstocks lend themselves to the types of best management practices that serve to lower carbon dioxide emissions and mitigate nitrogen, phosphorous and sediment impacts on water quality.

FIGURE 6

Grain-Based vs. Cellulosic Ethanol Production: Moving From Feedstock to Fuel



SOURCE: Chesapeake Bay Commission, 2008

FOCUS Co-Products, By-Products & Residues

Making the Most of an Integrated Bio-refinery

Dr. Tom Richard, Penn State University

A bio-refinery exists to produce fuel. But the decision to launch a bio-refinery — and the ability to make it profitable — may equally depend on the plant's co-products, by-products and residues.

Co-products are jointly and intentionally produced marketable products (for example, lumber and plywood from trees). By-products are ancillary and of considerably less value than the primary products (to continue the example, sawdust). Residues are recovered wastes whose markets are weak and sometimes negative (paper-mill sludge).

These distinctions begin to blur in well-integrated systems, often moving materials up the value chain from residue to by-product or even co-product. Sawdust, for example, was once a waste or residue, but is now a byproduct with increasing value, especially as it is converted to pellets to be burned as an energy source in pellet stoves.

A profitable bio-refinery will need markets for co-products, by-products and residues. When feedstock prices rise or fuel prices fall, income from these products often makes the difference between profit and loss. In fact, sales of some by-products are cited as one of the drivers for ethanol plants now being built in the Chesapeake region. These include dried grains and solubles, which are largely used as animal feed, and carbon dioxide, which supports the food industry by putting the "pop" in carbonated beverages.

Next-generation bio-refineries will generate their own suite of co-products, by-products and residues. Cellulosic fermentation, for example, will produce carbon dioxide and lignin as the primary co-products. That lignin might be burned or gasified to produce heat, power and possibly liquid fuels. Even the residual ash contains minerals such as calcium, phosphorous and potassium, and has value as a fertilizer or admixture for concrete. Microbial biomass, another residue, could be burned, marketed as livestock feed or perhaps used as a fertilizer.

One particularly interesting by-product, derived from a processing technique known as pyrolysis, is the residual char. This char significantly improves soil quality and can be used to recycle nitrogen and other nutrients back to agricultural crops. Recycling char may increase the potential for biomass harvests, while enhancing the long term sustainability of the entire system.

Supporting the research and developing the markets for these types of products not only makes for an efficient use of resources, but may provide investors with a more enticing and profitable entry into the biofuels industry.

The Chesapeake Cellulosic Biofuels Project: A Grand Vision

In accepting its charge from Governor Rendell and the Chesapeake Bay Commission to make the Chesapeake region a leader in sustainable next-generation energy, the Biofuels Advisory Panel developed the following vision statement:

The Chesapeake Bay region will lead the nation in the evolution of sustainable cellulosic and advanced biofuel production.

The words of this statement were chosen carefully. First, "evolution" recognizes that next-generation biofuels are not possible without the utilization of first-generation technologies. Specifically, the Advisory Panel recognized that corn ethanol is a necessary national foundation for the development of infrastructure and markets that will make next-generation technologies commercially viable (see Sidebar, page 15).

Second, "sustainable" refers to environmental, economic, and social factors and has been defined by the Advisory Panel to include practices that result in:

- The reduction in nutrient and sediment loadings to the Chesapeake Bay and its rivers;
- Net energy benefits;
- Net greenhouse gas reductions, both direct and indirect;
- Neutrality or benefits with respect to food security and cost;
- Net social and economic benefit to affected local communities; and
- No net loss of biodiversity and natural resources, including both water quality and quantity.

Third, the reference to "cellulosic and advanced biofuel" highlights the unique potential cellulosic biomass presents to the region, but encourages a flexible approach to policymaking that is favorable to the development of multiple next-generation biofuels.

To achieve its vision, the Advisory Panel adopted a guiding principle and set of objectives which was used to inform all subsequent panel decisions (Sidebar, page 17).

The Listening Sessions

During May 2008, the Advisory Panel of the Chesapeake Cellulosic Biofuels Project reached out to a diverse collection of stakeholders, conducting four listening sessions throughout the Bay watershed. The purpose of the listening sessions was to provide updates on goals, deliverables and timelines, and to obtain feedback on the assumptions,

FOCUS Corn Ethanol

The Foundation for Tomorrow's Biofuels

Nearly all biofuel plants operating in the United States today are producing ethanol by using corn as their primary feedstock. As of July 8, 2008, the Renewable Fuels Association reported that 161 ethanol plants are currently in operation and another 49 are either expanding or under construction. When fully operational, these 210 plants will have the capacity to produce 13.6 billion gallons of ethanol annually, which could displace nearly 10 percent of the nation's transportation fuel. Ethanol production in 2007 was approximately 8.5 billion gallons.

Corn ethanol, however, has faced political, environmental and economic challenges. It has been subject to much criticism for its water quality impacts, net energy benefits and competition with the food supply. The Chesapeake region imports more corn than it produces due to the extensive demand for livestock and poultry feed, so there has been a great deal of concern over the increased cost of corn and the extent to which this is due to ethanol competition. There is also interest is assuring that any augmentation of local corn production does not increase risk to water quality. Bay states must step up their dedication to the aggressive use of best management practices to mitigate the potential for additional nutrient runoff associated with increased corn acreage.

Nonetheless, corn ethanol production remains the foundation of the nation's expanding biofuels industry. While the federal government is investing millions of dollars to accelerate the commercial scale development of cellulosic ethanol and other alternative biofuels, the cumulative investments, research, skilled employees and infrastructure associated with corn ethanol production have created a solid platform for producing large quantities of home grown fuels that stimulate local economies and reduce our dependence on foreign oil.

Corn ethanol also provides a foundation for testing and evaluating new feedstocks, as well as biomass pretreatment and conversion technologies. These critical contributions will aid in the transition to a new generation of transportation and home heating fuels. In addition, many cellulosic ethanol and other next-generation biofuel plants will likely be co-located with existing corn ethanol plants. Much of the infrastructure for storing, processing and transporting feedstocks and fuels is already in place or under construction, thus reducing some of the technological and capital risks associated with cellulosic biofuels.

vision and principles that would serve as the building blocks for the Advisory Panel's recommendations. Collectively, the sessions also proved to be an important forum for establishing and strengthening relationships with stakeholders who will influence the evolution of biofuel development in the watershed.

While each listening session was unique, they elicited five shared perspectives from the participants:

1. *Strong support exists for regional collaboration.* There was widespread agreement that next-generation biofuels will present an opportunity to improve the economic viability of agriculture and forestry in the region, while simultaneously improving water quality and benefiting living resources in the Chesapeake Bay.
2. *Cellulosic feedstocks will soon be in demand.* While market conditions will determine which feedstocks are grown in the region and where, participants in the listening sessions believe that the next generation of feedstocks will include cellulosic materials like corn stover, straw and other crop residues, winter annuals (especially barley and canola), perennial grasses, forest trimmings, wood residues, short-rotation woody biomass crops and municipal waste.
3. *The Biofuels Project should advance cellulosic biofuels as a whole, rather than focusing solely on cellulosic ethanol, and support next-generation conversion technologies that match the region's feedstocks.*
4. *The greatest asset for the development of a biofuels industry in the Chesapeake region is the extraordinary expertise among its many renewable energy advocates.* The intellectual capital demonstrated during the listening sessions shows that the region can create a model for the nation. Our farmers and other renewable energy leaders are committed to controlling nutrient runoff from their lands and understand the implications of crop decisions on the Bay and its rivers. This knowledge is being leveraged to create a regional, diversified portfolio of biofuels that capitalizes on the local potential while optimizing benefits for the environment.
5. *Whatever actions are taken with respect to next-generation biofuels, the results must be economically, socially and environmentally sustainable.* In part, this perspective was a reaction to the recent negative publicity surrounding grain-based ethanol. It was also a reflection of the Chesapeake Bay Commission's report, *Biofuels and the Bay,* which indicated how production of grain-based ethanol crops could use proven management practices to actually improve water quality and the Chesapeake.

Crafting a Regional Roadmap

Drawing on input from the listening sessions, as well as its own expertise, the Biofuels Advisory Panel identified three major areas in which action is required to make this region a national leader in the evolution of cellulosic and advanced biofuels:

Feedstocks: The Chesapeake region is blessed with the land and climate to produce a significant amount of cellulosic biomass. To establish this promising industry, we must assure the production of a large, reliable and accessible supply of biomass.

Natural Resource Protection: As shown in the *Biofuels and the Bay* report, the production of certain biomass crops has the potential to not only sustain water quality but improve it. However, that potential depends on the types of biomass used, where they are grown, and the best management practices that are put into place.

Marketing and Infrastructure: With no existing commercial biofuel plants in the Bay region, there are both opportunities and challenges for production capacity, distribution of feedstocks and biofuels, and marketing of biofuels and their co-products.

We recognize that many of the decisions related to the development of the cellulosic biofuels industry are in the hands of private investors and producers, but the public sector can also play a role in overcoming certain market weaknesses. In fact, our goal of economic, environmental, and social sustainability can best be achieved through the cooperative efforts of both the public and private sectors.

The recommendations below are suggestions for sustainable cellulosic biofuels policies that make sense for this region at this time. Some are best dealt with in the near term, while others set out long-term objectives for the region. Because individual recommendations may address more than one of the above subject areas, they are instead categorized by those actions that require regional cooperation or could be taken within individual states.

Opportunities for state-level policy or legislation appear under both regional recommendations and state recommendations. Specific actions that could occur at the state level and address these opportunities are identified and succinctly summarized in Appendix I.

The following recommendations will not apply equally to all six states, because some states have already taken actions on a few of these recommendations. To assist the states in their policy analyses, a comprehensive list of the current biofuels-related policies of the six Chesapeake watershed states is provided at www.chesbay.state.va.us.

The Panel's Guiding Principle and Objectives

Before launching their effort, the Biofuels Advisory Panel agreed to an overarching principle to guide their work, along with a set of objectives that would execute their vision.

Guiding Principle

It is necessary to support the successful attainment of the Chesapeake Bay region's biofuels goals while simultaneously reducing nutrient and sediment loadings and strengthening the economic viability of agriculture and forestry in the watershed.

Objectives

To accomplish these multiple objectives we will:

- Encourage regional collaboration among research institutions, stakeholders, government agencies and policy makers.
- Advance policies and programs that are economically viable, environmentally sound and socially acceptable.
- Support research to find new alternative biofuels that maximize energy output while minimizing environmental impact.
- Capitalize on the region's unique assets including diversity in technology, intellectual capital, ability to sustainably produce feedstocks and proximity to markets.
- Effectively engage land owners and managers, planners, community leaders and other stakeholders in the development of recommendations.
- Maintain the capacity to produce safe and abundant quantities of food, feed and fiber.
- Efficiently and effectively leverage government resources while encouraging private investment.

FOCUS Algae: Fuel of the Future?

Dr. Jennie Hunter-Cevera, University of Maryland Biotechnology Institute

The Mid-Atlantic region is rich in water, sunlight and carbon dioxide. Unfortunately for the Chesapeake Bay, we are also rich in the capacity to grow algae. However, what has long been the bane of the Bay may one day be an ally in its restoration. Scientists are investigating how algae-based biofuel conversion systems may provide a significant opportunity for future fuel production, much like cellulosic biofuel but with a greater yield.

Research has demonstrated that biofuels produced from algae could potentially supply enough fuel to meet all of America's transportation needs by using a scant 0.2 percent of the nation's land, an area equivalent to that of Maryland. Water, sunlight, nitrogen, phosphorus and carbon dioxide are the basic ingredients to grow algae. Demonstrations have shown that algae may double their volume overnight under optimal conditions and be harvested day after day. The oil produced by algae, up to 50 percent of their weight, can then be harvested and converted into biodiesel. The algae's carbohydrate content can be fermented into ethanol.

Algae crops and conversion techniques may result in a cleaner-burning fuel than petroleum-based diesel or gas. It is conservatively estimated that a properly managed algae growing system could produce from 2,000 to upwards of 5,000 gallons of liquid fuels per acre per year. Current annual crop-based biofuels production is approximately 420 gallons of ethanol per acre of corn; and biodiesel yields per acre of 30 gallons from corn, 60 gallons from soybeans, 150 gallons from canola, and 650 gallons from palm.

There are an estimated 65,000 to 100,000 known algae species. Hundreds of thousands more species may still be identified and cultured. Algae do not require soil and can grow well in brackish water. In the desert southwest, where much of the groundwater is saline and unsuitable for other forms of agriculture, algae can proliferate. Algae require 1/100th of the water per acre compared to other crops, and the carbohydrate and protein elements can be used for other purposes including feed and fertilizer. Algae are low maintenance and their ability to ingest carbon dioxide and excrete oxygen is attractive; it serves as an important means for mitigating the buildup of carbon dioxide in the atmosphere due mainly to fossil fuel emissions.

Using algae as an alternative fuel is not a new idea. Between 1978 and 1996, the U.S. Department of Energy performed algal biofuel research at their National Renewable Energy Laboratory in Golden, Colorado. Field trials with open ponds in California, New Mexico and even Hawaii were performed.

Difficulties encountered included land area requirements, evaporation of water and contamination by invasive plant species and other life forms in the ponds. Ultimately, the oil produced from algae was not economically competitive in 1996, when the price of a barrel of oil was $20.00.

In 2007, in response to the change in oil prices and the call for energy independence, the Energy Security and Independence Act included language promoting the use of algae for biofuels, and triggered a renewed interest in the technology. From Maine to Florida, Virginia to California, Canada to Mexico and overseas, there are government, academic and industry researches working toward a reliable and reproducible source of algae-based biodiesel fuel to meet air and land transportation needs. But there are obstacles to overcome, especially production costs. Algae biodiesel costs have to compete with both traditional petroleum-based diesel and other alternative biofuels. As of yet, no one has demonstrated the ability to achieve this at either a commercial or demonstration scale.

Issues with large-scale algae farms or facilities include "balance within the system." The water needs to be just the right temperature for algae to proliferate. Ponds can become overgrown with unwanted plant and animal species, and atmospheric levels of CO_2 are often not high enough to spur exponential growth. Although algae usually produce more oil when they are starved, they do not reproduce themselves at high rates under starvation conditions. Additionally, ponds have a limited amount of surface area for solar absorption.

Potential solutions include new and novel equipment and structures to begin the widespread mass production of algae; better monitoring tools for quality assurance; and improved harvesting and conversion techniques. Infrastructure costs with regard to equipment and controls are viewed as the biggest obstacle in making algal biofuels affordable and reliable. The bottom line rests on scale-up costs. Can a commercial-scale algae facility produce biodiesel at a cost competitive with petroleum or other biofuel sources?

Solutions are being explored by many different firms using vertical growing systems, bioreactors, solar tubes and flue gas-fed systems, as well as other growing media using effluent and run-of-river systems to reduce the volume or space needed to grow algae. Many more exciting and novel solutions are routinely being tested.

Scientists are even experimenting with growing algae at wastewater treatment plants, including in the Bay region. Turning sewage waste into biodiesel could be a promising means to making fuel while also eliminating a significant contributor to the Bay's water quality problems. The algae could assist in the sewage treatment process by taking up the nutrients in the wastewater so less nitrogen and phosphorus could be discharged to the Bay — and biodiesel could be produced from the algae.

With this significant amount of research activity, algae systems could soon be deployed in a widespread manner. The talent and other resources available in the Chesapeake region, including algae, provide a competitive advantage. Continued mindful investments in ongoing research, establishment of key partnerships, and proof-of-concept production trials on large scale projects are clearly the next steps in making algal biofuel a significant choice for our alternative fuel needs.

Recommendations for Regional Action

1 Coordinate regional action to secure federal funding. New opportunities have arisen in the federal Food, Conservation, and Energy Act of 2008 ("the Farm Bill") and the Energy Independence and Security Act of 2007 ("the 2007 Energy Act"). In addition, the Department of Energy (DOE), via the Energy Policy Act of 2005 and other DOE programs and the Department of Defense (DOD) present significant research and development funding opportunities.

Sections of the two Energy Acts and of the Energy and Conservation titles of the Farm Bill provide opportunities to facilitate the development of next-generation biofuels. But their complexity and funding status as authorizations, mandatory programs and programs needing appropriations all call for ongoing cooperation among the states of the Chesapeake region to assure maximum access and utility of the funds. Bay states should establish a cooperative group to sort through the various provisions and work together to secure funding for biofuels development.

Background: The 2008 Farm Bill provides a wide range of new programs related to biofuels (see Appendix II). Particular focus should be on:

1. The provisions of the Energy Title related to the Transition Assistance Program for farmers, as well as grants and loan guarantees for biomass energy systems that can help close the funding gap for small, first-stage facilities; and
2. The provisions of the Conservation Title related to the Bay watershed, as well as harvest guidelines for cropland enrolled in the Conservation Reserve and Conservation Reserve Enhancement Programs.

In addition to the Farm Bill, there are provisions to assist biofuels development in both the 2005 and the 2007 Energy Acts. The new biofuel-related provisions included in the 2007 Energy Act are summarized in Appendix III. The DOE is dedicated to finding a solution to transportation fuels through cellulosic feedstocks. In addition, the DOD is focused on converting battlefield trash of all types (e.g. shipping pallets, mess hall waste and other refuse) into energy.

The combination of all these provisions needs to be understood and mapped out for the region in a cooperative undertaking by Bay states to most effectively access and support these programs.

2 Coordinate regional input on U.S. Department of Agriculture (USDA) conservation programs to promote sustainable feedstock production and harvest.

States should ensure that areas under USDA Conservation Reserve and riparian buffer programs may be used for biofuel feedstock production where it is possible to guarantee that the conservation purposes of those programs remain in effect.

Background: The growing demand for biofuels and the move to cellulose-based biofuels could potentially result in the conversion of important resource lands to cropland for feedstocks. In particular, there is concern about the loss of lands enrolled in the Conservation Reserve Program and the Conservation Reserve Enhancement Program, as well as lands in use as forest and other riparian buffers under state programs. While it may be possible to combine the use of such lands for some biofuel crops and still meet the goals of conservation reserves and buffers, guidelines for planting and harvest should be clear and compliance assured.

In turn, appropriate use of biofuel crops may provide an added incentive for participation in these programs, thus expanding and enhancing them. States should collaborate with each other and with the USDA to establish guidelines for planting, fertilizing and harvesting feedstocks consistent with the conservation programs when such lands are being proposed for biofuel use.

3 Discourage use of invasive non-native feedstocks.

States in the Chesapeake region should agree to a long-term protocol that discourages the introduction and use of invasive non-native species as feedstocks for the next generation of biofuels.

Background: Some of the species that may come under consideration for use as biofuel feedstocks may not be native to the Chesapeake region and may not have been grown here before to any extent. Given the experience with previously introduced non-native species that escaped cultivation to become invasive, care should be taken to evaluate the potential of a species introduced as a biofuel feedstock to become invasive. Where uncertainty exists, states within the region should collectively agree to withhold public funding for the planting or conversion of these species for biofuels, and to evaluate current regulations for their adequacy to protect against unintended consequences from establishment of these species.

4 Encourage local or on-farm use of biomass.

The use of biomass for combustion and gasification at the local or farm level should be encouraged. This sustainable practice, valuable in its own right for meeting energy goals, also helps build the market and infrastructure for next-generation biofuels from the same types of feedstock.

Background: Considerable progress has been made in the Chesapeake region using wood, switchgrass, straw and other feedstocks for local heating and energy generation through combustion and gasification. Pennsylvania has a program known as Fuels for Schools and Beyond, which works with schools, hospitals and businesses to convert heating systems to such fuels. These are proven technologies with long-term viability. They happen to use feedstocks that hold potential for next-generation biofuels and as such are helping to build the market and infrastructure for expanded production. But they are viable in their own right and should be encouraged so that biofuel applications of the feedstocks are in addition to and not in place of their development.

5 Develop a regional carbon trading strategy that addresses the role of biofuels.

A regional strategy should be developed to maximize opportunities from a federal carbon trading protocol and provide guidance for the role of biofuels in the carbon trading market. The strategy should be advocated to the region's Congressional leaders.

Background: The production of feedstocks for cellulosic biofuels can also help to sequester significant amounts of carbon and reduce greenhouse gas emissions. In a carbon trading market, this ecosystem service could generate carbon credits that would add another significant economic benefit to the region and further the growth of

forestry, agriculture, and advanced biofuels industries. The ability of best management practices to generate marketable credits will also provide incentives for their implementation.

However, these benefits will only be realized if the federal protocol acknowledges the types of carbon and other greenhouse gas reductions likely to be provided by sustainable farming and forestry practices in our region, including the full comparative life cycle effects of biofuel production. The benefits of biomass production and conversion in the watershed must be quantified and clearly communicated to the region's Congressional delegation in order for them to become advocates for the region's capacity to reduce greenhouse gas emissions and to assure inclusion in any federal legislation.

A starting point for Bay states is to develop state-level greenhouse gas registries that quantify all carbon sequestration and emission offset opportunities in the agricultural and forestry sectors, including offsets for the carbon dioxide (CO_2) generated during the production of ethanol. Other potential offsets include the use of CO_2 as a substrate by algae to produce biodiesel, the pumping of CO_2 into greenhouses to promote growth of specialty crops or greenhouse plants, or the sequestration of carbon in large amounts by certain microbes which are then utilized as an additional feedstock source.

6 Coordinate as a region to affect national energy policy.

National policy must establish an even playing field for advanced cellulosic biofuels, and regional leaders should work with their Congressional delegation to ensure this is a priority. Similar work should occur with state legislatures to achieve such fairness in state laws. Particular attention should be paid to even-handed treatment for all fuels.

Background: Much of the debate over biofuels relates to their associated subsidies and tariffs enacted by Congress, most recently in the 2008 Farm Bill and in debates over the future of the Renewable Fuel Standard (see Sidebar, page 9). At the same time, counter-arguments have been made that petroleum, coal and other traditional energy sources benefit from their own set of subsidies, tax breaks and other advantageous laws that must be considered before removing biofuel subsidies.

While the arguments on both sides have merit, this issue needs to be resolved by Congress and state legislatures. This recommendation, recognizing that there are important traditional fuel interests in Bay states, calls for maintaining biofuel subsidies until such time that these fuels become cost effective and can compete in the market place with petroleum-derived fuels.

7 Establish a regional analytical framework for biofuels development.

A regional biofuels analytical framework is needed to estimate how the industry will evolve, with regular updates that address regional feedstock capacities, competing uses, potential limitations such as water supply, economic diversity, infrastructure needs, and the potential benefits to the economy and state revenues. An advisory group of outside experts should be established to support this effort.

Background: Most land use decisions in the region are made by county or municipal governments, whose regulations often do not address biorefineries. Instead, local governments will most likely apply existing chemical manufacturing subdivision regulations, thus effectively preventing biorefinery construction.

Furthermore, nationwide, there is a high level of confusion, disagreement and controversy related to the development of biofuels. This has been illustrated in recent proposals to suspend or roll back the national Renewable Fuel Standard due to the alleged impacts of corn ethanol on food prices. There is no reason to believe that the level of conflict will be any less or the battles any fewer as next-generation biofuels enter the picture, although the primary adversaries may shift from food and feed producers to legacy energy and transportation fuel providers.

This makes it extremely important for decision-makers to be buffered from misinformation and inaccurate claims and to have access to current, accurate information on the actual and anticipated industry conditions. A regional analytical framework should be developed under the guidance of a panel of advisors to provide this level of security, possibly through engagement of a Chesapeake Bay Program Action Team. Because the industry and the global factors that impact it are dynamic, the analysis should be updated as needed to reflect changing conditions. This will provide state executives, lawmakers, investors, farmers and foresters with a common and up-to-date understanding of likely pathways and timeframes, and prevent over-reactions to short-term controversies that affect the biofuels industry.

8 Establish a regional strategy to encourage greater use of higher blends of biofuels.

As higher blends of biofuels become available, states in the Chesapeake region should work with the private sector to maximize their availability and use. The strategy could include incentives and warranties to encourage sales of vehicles that use higher blends, the installation of blender pumps and the guarantee of access to higher blend biofuels along major interstate highways or within heavily-populated areas.

Background: More and more vehicles are being manufactured to use higher concentrations of ethanol and biodiesel, while those fuels are currently widely available at ten and five percent mixes only. In order to help make 85 percent ethanol blends and up to 100 percent biodiesel mixes more reliably and readily available to drivers who can use them, there are a number of steps that could be taken regionally; other state-specific actions are outlined below. A regional strategy would be most useful in encouraging the manufacture and sale of vehicles that can use higher blends, developing blender pump technologies, and establishing biofuels corridors or pump concentration areas. The first such corridor will open this year along I-65 from Indianapolis, Indiana to Mobile, Alabama.

9 Establish regional research priorities for next-generation biofuels.

A regional agenda of research priorities should be developed with the participation of private sector biofuel interests, the regional biotechnology industry, government and the university-based biofuel research community.

Background: There is an ever-broadening research agenda for biomass production and advanced biofuel formulation and processing. While much of this is proprietary work done by investors, there are important issues that can be addressed by a more open collaboration of biotech industries and publicly-funded research institutions. The Chesapeake region has an enviable concentration of biotech companies and university and government research and extension capabilities that should be brought to bear, especially on issues of regional benefit. Key priorities for the Bay watershed consist of Research, Development and Demonstration projects to conserve and enhance natural resources, including:

- Nutrient reduction and carbon sequestration capabilities throughout the biofuels production system;
- Improved varieties of next-generation biomass feedstocks, tested through small-scale trials;
- The potential of algae, manure and urban wastes as feedstocks;
- Effective and environmentally acceptable harvesting and collection systems;
- Integration of best management "systems" for biofuel production from farms and forests;
- Soil carbon models to allow producers to compute how much crop residue can be collected without degrading soil quality;
- Systems and practices for harvesting, collecting, transporting and storing biomass energy feedstocks;
- Estimates of water needs and availability for feedstock production and refining;
- Ability to use acid mine discharge in biofuel manufacture;
- Impacts of climate change on biofuel feedstock production capabilities in the region;
- Increased utilization of distillers grains (assuming local grain-based ethanol production) and other biorefinery co-products;
- Life-cycle analysis of complete biofuel systems;
- Planting of underutilized farmland and reclaimed mine lands; and
- Technology capable of processing multiple and mixed feedstocks into biofuels and by-products.

10 Implement a regional outreach effort to promote next-generation biofuels.

A coordinated regional outreach effort should be established to ensure that the national and worldwide biofuels markets are fully informed about the natural assets and advantages of the Chesapeake region for the next generation of biofuels, namely:

- *The climate and soils to grow a wide diversity of feedstocks;*

- *Great variety in landscapes and land types for growing feedstocks;*
- *An underutilized forest products capacity;*
- *A reliable supply of municipal solid waste;*
- *The potential for refining facilities of all scales located near feedstocks;*
- *Ready integration of biofuel production with animal agriculture;*
- *Close proximity to petroleum blenders and markets;*
- *A thriving biotechnology industry; and*
- *An excellent university-based biomass research infrastructure.*

Background: It was surprising to discover how little investment in advanced biofuels has been made within the Chesapeake watershed, considering that federally supported biofuel crop and refining projects are operating in many other regions. In the future, when advanced biofuels become more clearly profitable for private investment, the region will be in the position to provide a great number of advantages, as set out above. Much of the documentation of these advantages already exists, such as that produced by the Northeast Sun Grant Initiative. A concerted effort is needed to notify potential investors that the region offers excellent conditions for a number of crops and facilities for these new biofuels, including algae, wood-based feedstocks, and municipal waste.

Recommendations for State Action

1 Proactively communicate consistent messages about the benefits of next-generation biofuels, including cellulosic biofuels, and the importance of their sustainable production.

Convey an awareness that biofuels are happening now, and that their development can happen in a way that maximizes the benefits to farmers, foresters, the general public, the state and the environment.

Background: At present, there is a high level of confusion among the general public over the costs and benefits of biofuels and their development. As state policies and programs regarding biofuels are developed and implemented, each citizen deserves a clear statement from state leadership that outlines likely developments, their implications, and strategies that can maximize the benefits and reduce the costs to states and communities.

Because decisions regarding land use, industry investment, and feedstock production are made at the local level, the need for consistent messaging is more critical at the state level than it is regionally. There should be an estimate of the likely scale of development, the impacts on land from next-generation feedstocks, and the effects on communities from investments in refining and transportation.

In preparing these messages, states should draw on the resources of national organizations such as the Ethanol Promotion and Information Council, the National Biodiesel Board, the Renewable Fuels Association, and the U.S. Department of Energy's Clean Cities Program.

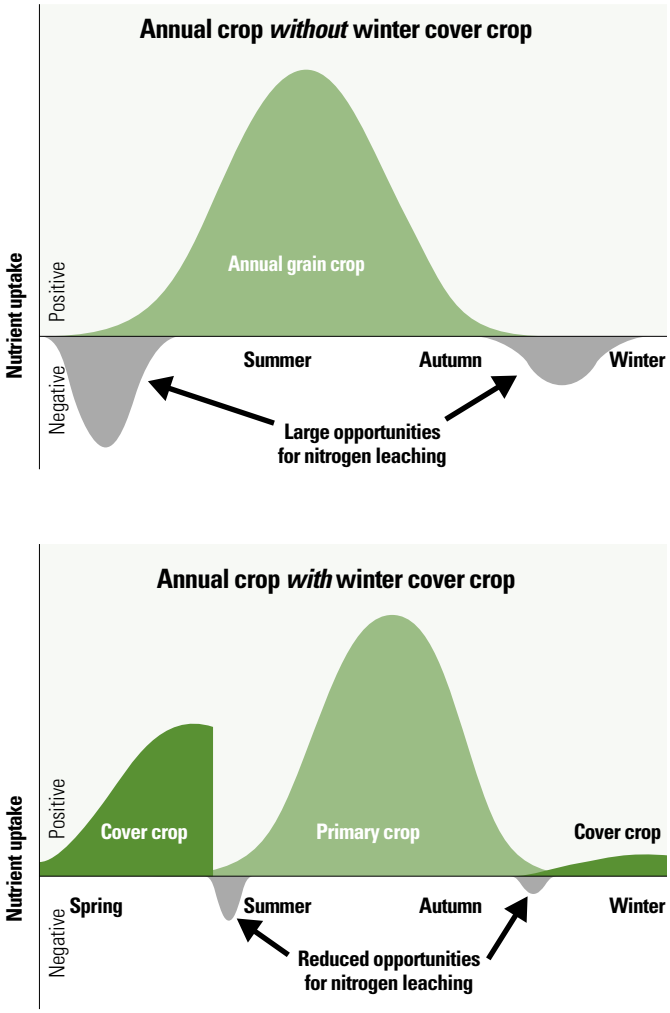
2 Encourage winter biofuel crops as first-generation feedstocks during the transition to advanced biofuels.

Traditional and newly developed winter crops, such as hulless barley, should be encouraged as biofuel crops that support existing combustion, grain-based ethanol and biodiesel technologies. They can also be managed to provide many of the benefits of cover crops, including erosion control and absorption of excess nutrients from previous row crops.

Background: Transition to next-generation biofuels from grain-based ethanol will not be instantaneous, and anything that can be done to augment farm income and reduce environmental impacts in the interim should be encouraged. Two biofuel crops that achieve this dual

FIGURE 8

Maximizing the Potential for Biomass Production and Uptake of Nutrients



SOURCE: Andrew H. Heggenstaller, Iowa State University

goal are barley and canola. Both can be grown as winter crops. If managed to optimize fertilizer efficiency, they can also act as cover crops that reduce erosion and nitrogen leaching from the field (see Figure 8). Barley can be used for grain ethanol or combustion and (eventually) its straw can be processed into cellulosic ethanol. Canola is the most popular crop for biodiesel in Europe. States should work with their Cooperative Extension offices, Conservation Districts and other technical assistance providers to modify programs or develop new programs to help this happen.

3 Assure broad and effective use of best management practices for growing and harvesting feedstocks.

Geographically-relevant conservation best management practices (BMPs) should be established for the planting and harvesting of biofuel crops, including crop residues and forest crops.

Background: Given the possible environmental effects and opportunities presented by converting substantial land areas to cropland for feedstocks, states in the region need to establish systems to maximize nutrient reduction, preserve wildlife habitat and achieve other goals for Bay restoration. Some of these actions will address how land is chosen and crops are grown. Others will focus on the use of fertilizer and other nutrients, while still others will deal with the management and protection of highly erodible land and other sensitive areas.

Each state will need to determine the mix of requirements and incentives to achieve the benefits of these BMPs, recognizing that farmer and forester interest in biofuels production may be an important catalyst for conservation. At a minimum, adequate funds need to be appropriated at the state level and provided by the federal government to establish or expand BMP cost-share programs as well as conservation education and technical assistance support. States should also consider establishing residue management assistance programs designed to help farm and forest land managers and owners properly harvest, store and transport cellulosic feedstocks for biofuel production.

4 Establish or update state removal guidelines for crop residues and forest slash and provide incentives for their adoption.

Crop residues such as corn stover and forest slash hold great promise as feedstocks for cellulosic and other next-generation biofuels, but there are concerns about the effects of their removal on long-term soil quality, erosion control, wildlife habitat and nutrient loadings to streams and the Bay. Consequently, removal guidelines should be established to reflect soil type, climatic conditions and land configuration, among other factors. In cases where existing guidelines were established before the demand for biomass feedstocks was a factor, such guidelines should be updated.

Background: There is a high level of interest over the potential of corn stover and forest slash as feedstocks in this region for cellulosic and other next-generation biofuels. Some corn stover is used for animal bedding and some for feed, but much is left on the field for soil conditioning and erosion control. While stover would make an excellent cellulosic feedstock, these other uses — especially the conservation portion — have caused concern about how much can be safely removed for biofuel production. Studies at Penn State and elsewhere in the watershed have laid the groundwork for these necessary guidelines and would allow significant portions to be removed under most land and soil conditions.

Forest slash (the leaves and branches left behind from logging) is another feedstock with enormous regional potential and presents a more mixed picture. In some areas, such as the pines of the lower watershed, slash is simply burned and adds to greenhouse gases. In the more northerly hardwood areas, slash has erosion and soil conservation values similar to corn stover and also provides good wildlife habitat.

Complementary management practices such as cover crops, rotations and forest thinning may permit higher removal rates, but long-term sustainability of these practices must be assured. Consequently, states should consult with the U.S. Department of Agriculture to set standards for removal that are consistent with local conditions. However, guidelines are not enough. States should also provide incentives for farm and forest landowners to implement the recommended practices.

5 Provide incentives for creating and implementing forest management plans.

The owner of any forest that provides biomass or fast-growing trees for biofuels feedstock should develop and implement a forest management plan. Special and unique forests with important conservation, historic and social value should be preserved from replacement with biofuel feedstocks, including fast-growing trees.

Background: Forests — which currently cover 60 percent of the Bay watershed — are a potential source of biofuel feedstocks from slash, thinnings and timber. Forests also serve important ecological functions, such as filtering nutrients, reducing sediment runoff and providing wildlife habitat. Working forests with sustainable management plans are the best kind of forest for nutrient retention because the trees are healthy and growing.

While proper thinning can enhance forest capabilities for timber, habitat and recreation, the potential increase in demand for timber and forest slash for biofuels may result in unsustainable harvests that could result in ecological harm. In order to allay these concerns, incentives should be in place to encourage implementation of forest management plans in forests used for feedstocks. There is a wide variety of available voluntary management plan opportunities for owners, from formal certification programs managed by forestry associations to state guidance and the web-based Forestry for the Bay program. Overall efforts should be made to preserve existing forests from clearing for biofuel crops.

One key incentive for implementing forest management plans is the ability of forest management practices to generate carbon credits that have market value. This subject is the focus of the Bay Bank initiative, spearheaded by the Pinchot Institute for Conservation.

6 Encourage the sustainable production of next-generation feedstocks on abandoned or underutilized land.

States should encourage the establishment of sustainable, next-generation feedstocks on abandoned lands (such as previously mined or farmed areas) as well as on reclaimed mined areas and other underutilized or lower value lands.

Background: Next-generation biofuels provide many opportunities to make use of abandoned or underutilized land that would otherwise be unproductive. This includes abandoned mine lands, reclaimed mine lands, abandoned farmland, dredge spoil sites and highly erodible lands.

Due to their extensive perennial root structure and ability to grow with limited fertilizer and other inputs, some biocrops can grow well where row crops or even grass pastures are difficult to produce or maintain. Cellulosic feedstock such as warm-season grasses or hybrid trees may be particularly suitable for these lands.

States could further this goal by including biofuel crops as an approved reclamation activity; the use of reclaimed mined land is already allowed under most mining regulatory programs. As lands are reclaimed, however, the programs should encourage the use of best management practices as part of their reclamation oversight. These activities could also be part of a larger effort within states to incorporate low-energy, sustainable development techniques in the mining and reclamation processes.

7 Ensure the nursery and seed industry has adequate supplies of seed and plant stocks.

States should share information about the development of biofuels policy with the nursery and seed industry to ensure that there is an adequate supply of seed and plant stocks to address the anticipated growth of biofuel crops.

Background: The nursery and seed industry is usually responsive to demand for species that need to be grown. However, the pace of development and the wide variety of potential new feedstocks could create unexpected demand and an underserved market. This is especially true of switchgrass and fast-growing trees like poplar and willow. States should work with nursery and seed associations to assure that the latest information from prospective investors is available.

8 Facilitate the production and purchase of biofuels through consumer incentives and infrastructure development.

In order to create a viable biofuels industry, sufficient infrastructure must be in place to deliver feedstocks to refineries and biofuel products to blenders and on to the ultimate consumer. Additionally, states should assist in the development of consumer demand for next-generation biofuels by establishing purchase requirements and incentives that range from internal state policy to public tax incentives.

Background: In order for a biofuel feedstock to have value, it must be able to be delivered to a refinery and ultimately to the consumer as a biofuel product. For cellulosic feedstocks, this will most likely require significant transportation over rural roads and rail lines. Unfortunately for our region, a lack of continued investment in these transportation systems has left them with a limited capacity to serve this emerging industry. Furthering the challenges, transportation of cellulosic feedstock is limited to roughly a radius of 50 miles due to the cost of diesel fuel. This requires consideration of locating a refinery in the center of a mostly rural or forested area uninterrupted by urban settings. Strategic planning and funding for this infrastructure is therefore needed to develop refining potential.

Likewise, in order to purchase biofuels, consumers must have both a reason to choose the biofuel and access to the biofuel itself. There are a number of ways that states are helping to build demand for biofuels. Some require state agencies to purchase flexible fuel vehicles and make use of biofuels in those state vehicles. Others encourage the public to purchase flexible fuel vehicles through vouchers or tax incentives. There are also efforts to increase the presence of biofuels at service stations through blending pumps and corridor programs, as noted earlier.

Some states have also adopted goals for the biofuel content of gasoline and diesel. The simplest of these in Eastern states is to extend statewide the 10-percent ethanol content used in some urban areas to meet air quality goals. Pennsylvania has recently adopted a series of biofuel content goals based on in-state production levels over time.

State incentives should target cellulosic and other advanced biofuels to maximize environmental and social benefits. Legislation establishing state tax credits for installing E85 (an alternative fuel that contains 85% ethanol and 15% gasoline) or blending pumps together with grants to assist in funding pump conversions should be considered. Also, state legislation may be required to overcome exclusivity contracts with petroleum suppliers. Finally, Underwriters Laboratories, as the entity responsible for certifying all fuel pumps in the nation, should be encouraged to prioritize the certification of E85 and blending pumps to accelerate their availability in the market.

9 Utilize state economic development programs.

States should make creative use of their economic development programs to support the development of feedstocks and refining facilities for next-generation biofuels.

Background: Some states outside of the Bay region, have established economic development programs that encourage new business investments in next-generation biofuels, with specific provisions related to agriculture.

The integration of these initiatives with the new programs and funds available under the federal Farm Bill and Energy Acts is especially important. In particular, the coordinated development of feedstock and refining capacities can help overcome the "chicken or the egg" problem of a start-up industry, which requires both reliable source materials and available processing capability.

Although we recommend earlier that states work together on effective ways to use the Farm Bill and Energy Act programs, overall assistance to the biofuels industry

must reflect the full range of programs available in each state. Therefore, each state should develop a strategy for providing a mix of state programs and federal assistance to potential investors. It is especially important to modify these tools to address likely gaps in the life cycle of biofuels from feedstock to conversion to delivery.

10 Focus facility support on small, first-stage operations.

States should give priority support to small, first-stage pilot plants for advanced biofuels.

Background: Both public and private funds for next-generation biofuels tend to focus on research and full-scale operational biofuel facilities. This leaves the start-up stage for new biofuels technologies relatively uncovered. While universities are bench-testing these technologies, states should provide assistance for small start-up plants while urging the federal government to help close this funding gap.

Examples of new state or federal biofuel development tools include loans, loan guarantees and tax credits coupled with standards that establish requirements for biofuel use. States can also reach out to investors and the federal government to match them with universities that have developed promising new technologies. A range of such incentives may encourage investors to sponsor a public/private partnership that can help move biofuels technology from the lab to the market. This critical transition phase, often called "the Black Hole of Commercialization," relies on small, first-stage plants that are firmly in need of funding.

Appendix I

Suggested State Legislative Actions

Appendix I provides suggestions for specific legislation to implement the state recommendations made in this report. Here, the actions are arrayed in five categories that each require a unique set of policy actions to facilitate the transition to next-generation biofuels.

1. Production Incentives

- Establish or increase existing production credits for cellulosic feedstocks so as to offer a larger incentive than grain-based feedstocks.
- Restrict existing biofuel production credits that use small grain winter cover crops to those grown within the Bay region.
- Set incremental state-wide biofuel production goal, either by aggregate mass/volume or percentage of fuel mixture.
- Pay producers a per acre fee (rental fee) to transition field production to cellulosic feedstocks.
- Establish a renewable or alternative biofuel energy grant program for conversion technology, facility construction, or retrofitting of farm equipment.
- Offer effective tax credits to feedstock producers, refiners, and other major stakeholders in the production supply chain.
- Remove any prohibitions on incentives, credits, or subsidies for production of cellulosic ethanol or biodiesel.

2. Infrastructure Incentives

- Establish cellulosic biofuels grant programs for installation of blender pumps at commercial and retail refueling stations — reimburse a certain percentage of installation costs (dispensing equipment, storage tanks, associated piping, etc.), or cost-share up to a certain percentage.
- Establish a competitive biofuels/alternative fuel funding program for municipalities for installation and infrastructure costs.
- Allow for an alternative fuel job creation tax credit or equivalent incentive that provides tax credits for businesses involved in the manufacture of components for Alternative Fuel Vehicles (AFVs), AFV conversions, or the production, storage, or dispensing of cellulosic ethanol as a vehicle fuel.

3. Tax Incentives

- Exempt alternative fuel from state sales tax; authorize municipalities to do the same. Consider limiting exemptions to higher biofuel blends (B20 or above, E85 or above).
- Exempt or reduce personal property taxes paid on AFVs or Flex Fuel Vehicles (FFV).
- Exempt or reduce vehicle excise tax paid on AFV/FFVs.
- Exempt or reduce vehicle registration fees by a certain percentage for all AFV/FFVs.

4. State Fleet Mandates

- Require a certain percentage of state vehicles, or require a certain percentage of fuel used by state vehicles, to use cellulosic ethanol or biodiesel, ensuring that the blend requirement is sufficient (E85, B20).
- Require all new state vehicles purchased be AFV/FFVs, or require state agencies to include a goal to purchase a significant number of AFV/FFVs in their vehicle procurement plans.
- Integrate into agency plans strategies on reducing petroleum consumption and emissions.
- Provide grant funding or cost-share opportunities to municipalities and school systems for purchasing new alternative fuel buses.

5. Natural Resource Protection

- Establish a regional protocol or interstate agreement that bans the introduction or use of invasive non-native species as feedstocks for advanced biofuels.
- Discourage or prohibit public funding or incentives for the establishment or use of invasive non-native species.
- Set regional research priorities to ensure improved varieties of feedstocks and natural resource benefits.
- Establish best management practices that lessen detrimental land-use changes and favor feedstocks that reduce nutrient and sediment runoff and fertilizer use.
- Appropriate adequate funds to establish or expand best management practice cost-share programs, conservation education, and technical assistance support.
- Establish residue management assistance programs to help farm and forestland owners and managers properly manage biofuel production.
- Develop or update removal standards for crop residue and forest slash that reflect soil types, climactic conditions, land configuration, and enhance local ecological function.
- Establish competitive incentives to ensure crop residue and forest slash removal standards are met.
- Require forestland owners to develop, possess, and implement a forest management plan for forests used as advanced biofuel feedstocks.
- Include biofuel crops as an approved reclamation activity on abandoned or underutilized land while encouraging use of best management practices as part of the reclamation process.

Appendix II

The 2008 Farm Bill

Federal programs benefiting biofuels production and the Chesapeake Bay:

Title XV — Trade and Tax Provisions

Tax Credit for Cellulosic Biofuels Production

Establishes a new tax credit for domestic producers of cellulosic biofuels of up to $1.01 per gallon for fuels produced from agricultural waste, wood chips, perennial energy crops and other non-food feedstocks. This tax credit is expected to be worth about $400 million over 10 years.

Title IX — Energy

Biomass Crop Assistance Program (BCAP)

Encourages production of next-generation biofuels by establishing project areas for biomass production and conversion. Pays producers up to 75 percent of costs for crops, plus annual payments to compensate for lost opportunity costs until crops are established and provides cost-share payments for collection, harvest, storage and transportation. All projects must follow conservation or forest stewardship plans. Preference is given for perennial crops and highly energy efficient annual crops, and to preserving natural resources. Uncapped funding, estimated at $70 million.

Rural Energy for America Program (REAP)

Assists farmers and rural businesses with grants for the development of renewable energy technologies, such as biofuels, and to increase energy efficiency. Also, provides loan guarantees for up to $25 million per project. Total funding is $225 million.

Bio-Refinery Assistance

Assists in the development of new and emerging technologies for next-generation biofuels by providing demonstration-scale plants with grants up to 30 percent of costs and commercial-scale plants with up to $250 million in loan guarantees. Total funding is $320 million.

Bioenergy Program for Next-Generation Biofuels

Encourages production of next-generation biofuels by providing incentive payments to producers. Up to 5 percent of total payments can be paid to large facilities with a refining capacity of more than 150 million gallons per year. Funded at $300 million.

Rural Energy Self-Sufficiency Initiative

Encourages rural communities to develop and implement energy self-sufficiency by authorizing grants to develop and install integrated renewable energy systems. Authorized at $20 million.

Repowering Assistance

Increases the market for energy crops by providing grants to existing bio-refineries to produce energy from biomass for plant operations and to replace fossil fuel boilers with new systems that run on renewable biomass. Funded at $35 million.

Biobased Markets Program

Expands the procurement requirements for federal agencies to purchase bio-based products and establishes a voluntary labeling program for producers of bio-based products. Funded at $9 million.

Biofuels Infrastructure Study

Directs the U.S. Department of Agriculture, Department of Energy, and Environmental Protection Agency to jointly study the infrastructure requirements of biofuels production, transport, and distribution. The study will include market trends, availability of feedstocks, water requirements, alternative transportation options, impacts on safety of transportation systems and resource conservation.

Biomass Research and Development

Creates a joint program for the U.S. Departments of Agriculture and Energy to coordinate policies and procedures to promote biofuels and conduct research and development for the production of biofuels and biobased products. Funded at $118 million.

Forest Biomass for Energy

Establishes a competitive research and development program to encourage use of forest biomass for energy. Project priorities include developing processes to use low-value forest biomass for energy production, integrating forest biomass into bio-refineries, new transportation fuels, and improving growth yield. Authorized at $60 million.

Renewable Fertilizer Study

Directs the U.S. Department of Agriculture to study the production of nitrogen and phosphorus-based fertilizer from renewable resources in rural areas. The study will address processes, technologies, cost-competitiveness, and environmental impacts. Authorized at $1 million.

Biodiesel Fuel Education Program

Provides grants to educate the public about the benefits of biodiesel fuel use. Funded at $5 million.

Title II — Conservation

Chesapeake Bay Watershed Program

Addresses resource concerns related to the Bay including improving water quality and restoring, enhancing and preserving soil, air and related resources. Authorized to be funded at $438 million.

Environmental Quality Incentives Program

Provides payments to producers to adopt and maintain agricultural conservation practices and now includes forestry practices such as forest management and fuels management. The program allows for innovative approaches that generate public benefits such as water and soil quality improvements, renewable energy production, and wildlife and open space protection. Authorized to be funded at $7.325 billion.

Conservation Stewardship Program

Creates a nationwide stewardship system of incentives for adopting, improving and maintaining practices to achieve environmental benefits. Authorized to be funded at $1.1 billion in additional funds.

Wildlife Habitat Incentives Program

Provides cost-share assistance to improve and protect wildlife habitat on agricultural, forest and tribal land. Authorized to be funded at $445 million.

Cooperative Conservation Partnership Initiative

Sets aside 6 percent of all conservation program funds for carrying out cooperative projects. Allows states, local governments, conservation districts, producer groups and nongovernmental organizations to develop conservation initiatives that address common natural resource concerns.

Farmland Protection Program

Helps keep land in farming activities by providing funds to purchase development rights. The program has been streamlined to allow for greater flexibility at the local level. Authorized to be funded at $743 million.

Wetlands Reserve Program

A revised procedure for valuing property and a streamlined review process will facilitate enrollment of wetlands acres. Authorized to be funded at $1.3 billion.

Appendix III

The 2007 Energy Bill

Federal programs benefiting biofuels production and the Chesapeake Bay:

Title II — Energy Security through Increased Production of Biofuels

Renewable Fuel Standard (RFS)

Increases the renewable fuel standard to 9 billion gallons in 2008, and expands it to 36 billion gallons by 2022. (See Sidebar, page 9).

Study of Impact of RFS

The National Academy of Sciences will study the impacts of the RFS on other competing feedstock related industries and consider policy options.

Environmental and Resource Conservation Impacts

Directs the U.S. Environmental Protection Agency to study the effects on of the RFS on air quality and other environmental concerns such as water quality, resource conservation issues and the growth and use of cultivated invasive or noxious plants.

Production of Next-Generation Biofuel

Supports next-generation biofuel production through a grant program that gives preference to proposals with the greatest reduction in lifecycle greenhouse gas emissions compared to the comparable motor vehicle fuel lifecycle emissions during calendar year 2005; proposals that do not achieve at least an 80 percent reduction in such lifecycle greenhouse gas emission will not be approved. Authorized at $500 million.

Renewable Fuel Infrastructure Grants

Provides grants for infrastructure development for renewable fuel blends of 10 percent to 85 percent ethanol. Includes technical and marketing assistance and a pilot program to establish refueling infrastructure corridors. Authorized at $1.4 billion.

Biofuel Production Research and Development

Provides grants to universities for research, development, demonstration and commercial application of biofuel production technologies in states with low rates of ethanol production, including low rates of production of cellulosic biomass ethanol. Authorized at $75 million.

Bio-Refinery Energy Efficiency

Provides grants for research and development and commercial applications of cellulosic biofuel technologies and for the conversion of existing corn-based ethanol plants to produce cellulosic biofuels.

University Based R&D Program

Creates a competitive, geographically diverse grant program to support universities in the research and development of renewable energy technologies. No grant will exceed $2 million. Authorized at $25 million.

Biofuels and Bio-Refinery Information Center

Develops a biofuels information repository housing data related to all facets of renewable fuels.

Prohibition on Franchise Agreement Restrictions Related to Renewable Fuel Infrastructure

Prohibits franchise agreements from restricting the ability of stations to sell E85, B20 or renewable diesel, including installation of related infrastructure.

Federal Fleet Refueling Centers

Requires each federal agency to install at least one renewable fuel pump at each federal fleet fueling center by January 1, 2010. Uncapped authorization.

Acknowledgements

Researchers, Writers and Facilitators

The Chesapeake Cellulosic Biofuels Project was managed by the Chesapeake Bay Commission. The report and its companion recommendations were crafted with the expertise of Bill Matuszeski, Ernie Shea and the Chesapeake Bay Commission staff members. Lara Lutz shared her editing skill for the report's final production.

The Coordinating Committee

Our special thanks go to the government liaisons who provided communication back to their agency leadership. The Committee, chaired by Ann Swanson, included Bill Brannon (W.Va.), Robins Buck (Va.), Patricia Buckley (Pa.), Corey Buffo (D.C.), Cathy Bunting-Howarth (Del.), Mark Dubin (CBPO), Peter Freehafer (N.Y.), Patrick McMillan (Md.), Russ Perkinson (Va.), and Chris Rice (Md.). Julie Winters served as our liaison to the EPA Chesapeake Bay Program Office.

Cellulosic Biofuels Project Sponsors

Chesapeake Bay Commission

Commonwealth of Pennsylvania
- Department of Agriculture, Hardwoods Development Council
- Department of Conservation and Natural Resources
- Department of Environmental Protection via Pennsylvania Association of Conservation Districts, Inc.

Financial Partners

We offer our gratitude to the partner organizations and agencies that provided financial support. Their vote of confidence made this policy analysis and report possible.

U.S. EPA Chesapeake Bay Program Office

Keith Campbell Foundation for the Environment

National Fish & Wildlife Foundation

Chesapeake Bay Trust

State of Maryland, Department of Natural Resources

Commonwealth of Virginia, Department of Mines, Minerals and Energy

Design

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Printed on Recycled Paper

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