Overview of the *2016 Billion-Ton Report: Volume 2*

The *2016 Billion-Ton Report (BT16) Volume 2: Environmental Sustainability Effects of Select Scenarios from Volume 1* is a pioneering effort to analyze a range of potential environmental effects associated with illustrative near-term and long-term biomass-production scenarios. *BT16* volume 2 seeks to accelerate progress toward a sustainable bioeconomy by identifying actions and research that could enhance the environmental benefits while minimizing negative impacts of biomass production.

Combined agricultural and forestry scenarios		Agricultural scenarios			Forestry scenarios			
Combined identifier	Year	Identifier	Energy crop annual yield increase[a]	Corn annual yield increase	Identifier	Description	Housing starts	Wood energy demand
Base-case yield (BC1) & baseline (ML) 2017	*2017*	BC1 (base-case yield)	1%	0.8%	ML (baseline)	Moderate housing–low wood energy	Returns to long-term average by 2025	Increases by 26% by 2040
Base-case yield (BC1) & baseline (ML) 2040	*2040*	BC1 (base-case yield)	1%	0.8%	ML (baseline)	Moderate housing–low wood energy	Returns to long-term average by 2025	Increases by 26% by 2040
High yield (HH3) & high demand (HH) 2040	*2040*	HH3 (high yield)	3%	1.9%	HH (high demand)	High housing–high wood energy	Adds 10% to baseline in 2025 and beyond	Increases by 150% by 2040

[a] Yield improvements are only applied at establishment and are not applied after year one for perennial crops until replanting

Scenarios considered in *BT16* volume 2 analyses.

Summary

BT16 volume 1, released in July 2016, concluded that the United States has the potential to produce at least 1 billion dry tons of nonfood biomass resources annually by 2040. These estimates are generated while considering projected needs for food, feed, forage, and fiber production. The biomass estimates are also limited by environmental considerations, such as exclusion of sensitive lands, limited agricultural residue removal to protect soils, and no conversion of forests. However, the environmental effects of the biomass production scenarios in volume 1 have not been previously quantified.

BT16 volume 2 is a first effort to address this critical knowledge gap. This study uses environmental models to investigate changes in greenhouse gas (GHG) emissions, soil organic carbon (SOC), water quality and quantity, air emissions, and biodiversity for particular 2017 and 2040 biomass-production scenarios. In addition, volume 2 discusses the land-use and land-management implications of the scenarios, climate sensitivity of feedstock productivity, potential environmental effects of algae production, and strategies to enhance environmental outcomes.

Most analyses in *BT16* volume 2 show potential for a substantial increase in biomass production to support a growing bioeconomy with minimal or negligible environmental effects under the biomass supply constraints assumed in *BT16*.[1]

Where corn ethanol has been shown to achieve GHG emissions improvements over fossil fuels, cellulosic biomass shows further improvements in certain environmental indicators covered in this report.

The harvest of agricultural and forestry residues generally shows the smallest contributions to changes in certain environmental indicators investigated. The scenarios show national-level net SOC gains. When expanding the system boundary in illustrative cases that consider biomass end use, reductions in GHG emissions are estimated for scenarios in which biomass—rather than oil, coal, and natural gas—is used to produce fuel, power, heat, and chemicals.

Analyses of water quality reveal that there could be tradeoffs between biomass productivity and some water quality indicators, but better outcomes for both biomass productivity and water quality can be achieved with selected conservation practices.

Biodiversity analyses show possible habitat benefits to some species, with other species showing potential adverse effects that may require additional safeguards.

Increasing productivity of algae can reduce GHG emissions and water consumption associated with producing algal biomass, though the effects of water consumption are likely of greater concern in some regions than in others. Moreover, the effects of climate change on potential biomass production show gains and losses in yield among feedstocks across the continental United States.

Insights and Implications

Research gaps and needs are identified in *BT16* volume 2, ranging from local monitoring of environmental indicators, to national modeling studies and global indirect land-use change. Volume 2 also describes many strategies to enhance en-

[1] Results are specific to *BT16* constraints and scenarios, which are described in chapter 2.

vironmental outcomes, such as applying best management practices and landscape design principles.[2]

Integrating resource analysis and sustainability concepts should continue to be a broad goal for future research on potential biomass supply in the United States. *BT16* volume 2 can assist stakeholders in identifying beneficial biomass production opportunities while considering their local conditions and specific environmental goals. For example, the Department of Energy (DOE) Bioenergy Knowledge Discovery Framework (www.bioenergykdf.net) provides data sets from both *BT16* volume 1 and volume 2, as well as interactive tools that can be used to investigate relationships between biomass production and environmental effects, as well as to explore how different assumptions can influence outcomes. Furthermore, *BT16* volume 2 provides an extensive resource for informing future research and development efforts to enhance environmental benefits and mitigate negative effects associated with a growing bioeconomy.

[2] See *BT16* volume 2 chapter 14.

Background

Researchers selected a small subset of the agricultural and forestry assessment scenarios and scenario years from *BT16* volume 1 for analysis in *BT16* volume 2. The scenarios in volume 2 include a low-yield and high-yield scenario, as well as near-term and long-term estimates from volume 1. "Yield" refers to annual improvements in crop yield for commodity crops and energy crops. The $60/dry ton price model runs off the base-case[3] and high-yield scenarios were chosen from the agricultural assessment in volume 1.[4] From the forestry assessment, the baseline and high housing-high wood energy scenarios were selected.[5]

[3] The terms "base case" and "baseline" have specific meanings in *BT16* that may differ from the use of these terms in other studies.

[4] Base case refers to a 1% annual yield increase. High yield refers to a 3% annual yield increase.

[5] The baseline scenario (ML) assumes moderate housing and low wood energy demand. The high housing–high wood energy scenario (HH) assumes a high demand for housing. In the forestry assessment, biomass availability decreases from 2017 to 2040. Furthermore, biomass is lower in the HH 2040 scenario than in the ML 2040 scenario because of the high demand assumed for housing.

BT16 volume 2 provides a spatially explicit illustration of potential biomass production opportunities and associated environmental implications, rather than a prediction of biomass production and environmental effects that will inevitably occur. It is important to note that the biomass supply estimates presented in *BT16* are policy independent and based on specified price and yield scenarios that assume a market demand.

This report differs from efforts that seek to depict potential biomass demand and related market, environmental, and land-use interactions under specifically defined business-as-usual or policy conditions. Modifying assumptions used in *BT16* regarding land transitions and supply constraints would likely result in different environmental effects.

This fact sheet refers to the following documents:

U.S. Department of Energy. 2017. *2016 Billion-Ton Report: Advancing Domestic Resources for a Thriving Bioeconomy, Volume 2: Environmental Sustainability Effects of Select Scenarios from Volume 1*. R. A. Efroymson, M. H. Langholtz, K.E. Johnson, and B. J. Stokes (Eds.), ORNL/TM-2016/727. Oak Ridge National Laboratory, Oak Ridge, TN. 640p.

Download and view the report, explore its data, and discover additional resources at www.bioenergykdf.net.

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