2016 BILLION-TON REPORT

Advancing Domestic Resources for a Thriving Bioeconomy

Volume 2: Environmental Sustainability Effects of Select Scenarios from Volume 1

January 2017

U.S. DEPARTMENT OF ENERGY

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Advancing Domestic Resources for a Thriving Bioeconomy

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Bioenergy Technologies Office

Volume 2:
Environmental Sustainability Effects of Select Scenarios from Volume 1

January 2017

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Availability

This report, as well as supporting documentation, data, and analysis tools, can be found on the Bioenergy Knowledge Discovery Framework at bioenergykdf.net. Go to https://bioenergykdf.net/billionton2016/vol2reportinfo for the latest report information and metadata.

Additional Information

The U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy's Bioenergy Technologies Office and Oak Ridge National Laboratory provide access to information and publications on biomass availability and other topics. The following websites are available:

energy.gov
eere.energy.gov
bioenergy.energy.gov
web.ornl.gov/sci/transportation/research/bioenergy/

Front cover images courtesy of ATP[3], Oak Ridge National Laboratory, Abengoa, Solazyme, and BCS, Incorporated.

Preface

On behalf of all the authors and contributors, it is a great privilege to present the *2016 Billion-Ton Report* (*BT16*), *volume 2: Environmental Sustainability Effects of Select Scenarios from volume 1*. This report represents the culmination of several years of collaborative effort among national laboratories, government agencies, academic institutions, and industry. *BT16* was developed to support the U.S. Department of Energy's efforts towards national goals of energy security and associated quality of life.

As director of the U.S. Department of Energy's Bioenergy Technologies Office (BETO), I would like to thank Kristen Johnson, sustainability technology manager who served as one of the leads on this report, Alison Goss Eng, the program manager of Advanced Algal Systems and Feedstocks Supply and Logistics, and Mark Elless, technology manager in the Feedstock Supply and Logistics team for their leadership on crafting this document with the numerous contributors and reviewers. I would especially like to express gratitude to the additional report leads: Rebecca Efroymson, research scientist at Oak Ridge National Laboratory; Matthew Langholtz, research scientist at Oak Ridge National Laboratory; and Bryce Stokes, senior advisor of Allegheny Science and Technology.

This product builds on *BT16 volume 1*, which evaluated the most recent estimates of potential biomass resources that could be available for new industrial uses in the future (up to 2040). Consistent with prior versions of the *Billion-Ton Study, BT16 volume 1* identified potential biomass resources of one billion tons or more per year in the United States. While volume 1 focused on potential resource analysis, volume 2 is a pioneering effort at evaluating changes in land management and environmental indicators associated with select production scenarios derived in volume 1. Addressing a critical knowledge gap, this report uses environmental models to investigate how particular 2017 and 2040 scenarios from volume 1 affect greenhouse gas emissions, soil organic carbon, water quality and quantity, air emissions, and biodiversity. Volume 2 also discusses potential qualitative environmental effects of algae production, and strategies to enhance environmental outcomes.

The results from volume 2 are not meant to be predictions or final answers, but they provide rich quantitative and spatially explicit information revealing potential benefits and challenges that may need to be considered as biomass production increases in the U.S. *BT16 volume 2* will soon be incorporated into BETO's interactive Knowledge Discovery Framework (KDF) at bioenergykdf.net, providing an extensive online resource to inform future R&D as well as efforts to enhance positive effects and reduce potential challenges. Data from the report's rigorous studies will be available to the public, and users can leverage the platform to explore relationships between potential biomass production and potential environmental effects and visualize results to gain new insights. We invite the user community to take a step forward with us and use this report and associated data to perform further analyses, join the vibrant discussion of the latest understanding of environmental indicators and land management, ask more questions, and inform strategies to enhance environmental outcomes of a growing bioeconomy

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Contributors

Many people contributed to the analyses and reporting in the *2016 Billion-Ton Report (BT16)* volume 2. In addition to completing the analyses, researchers composed report chapters, while also contributing their expertise and rigorous efforts towards enhancing the overall quality and effectiveness of the report. Others contributed technical, managerial, and production skills and knowledge, both to the accuracy and comprehensiveness of the analyses and to the delivery of the information and data in text and electronic formats. The many contributors are listed below by their organizations.

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This report is the product of multidisciplinary collaboration among numerous institutions that contributed to the process—defining assumptions, providing data, conducting analysis, reviewing methods and results, and developing the report. This collaboration ranges from federal agency scientists and national laboratories to universities and contractors. A special thanks and recognition goes to the U.S. Forest Service in the U.S. Department of Agriculture (USDA) for their long-established support and contributions to the Billion-Ton studies and major contributions to this study in particular. USDA has always been a significant collaborator. We also acknowledge the use of USDA data for both agricultural and forestry analyses.

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The authors of chapter 4 on greenhouse gas emissions would like to give special thanks to the study leads, as well as Craig Brandt of ORNL, Jeongwoo Han of Argonne National Laboratory, Michelle Wander of the University of Illinois at Urbana-Champaign, and Ho-Young Kwon of the International Food Policy Research Institute, as well as participants of the peer review workshop who provided written and oral comments on the chapter.

The water footprint analysis (chapter 8) is built upon cumulative efforts developing the Water Analysis Tool for Energy Resources (WATER) model and its components and data inventory development, data dissemination and analysis, and scenario development. The authors of chapter 8 would like to recognize the substantial contributions of Sheshikanth Yalamanchili (Argonne National Laboratory [Argonne]) in the model and database development and in assisting scenario implementation. A special thanks goes to Craig Brandt (ORNL) for intensive data processing and management, Christina Canter (Argonne) for scenario data management, Laurence Eaton (ORNL) for detailing critical assumptions in agriculture scenarios, and Ge Sun (USDA Forest Service) for verifying technical approaches in forestry water analysis. The authors appreciate those who reviewed the chapter on the water consumption footprint. These include Alex Mayer (Michigan Technological University), Tom Richard (Penn State University), Allison Thomson (Field to Market), Marilyn Buford (USDA Forest Service), Steve Kaffka (University of California, Davis), Steve Evett (USDA Agricultural Research Service), and Bob Rose (U.S. Environmental Protection Agency [EPA]).

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Reviewers

The workshop titled "Presentation and Expert Review of the *2016 Billion-Ton Report Volume 2*" was held May 11, 2016, in Washington, D.C. Contributors presented an overview of their methods and assumptions, and reviewers provided verbal comments at the workshop and electronic written feedback after the workshop. Full draft chapters were then distributed to reviewers on July 21, 2016, and reviewers, including some who did not attend the workshop, responded with electronic comments. Reviewer comments were addressed during the subsequent revision of the report.

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