U.S. DEPARTMENT OF
ENERGY

Office of
ENERGY EFFICIENCY &
RENEWABLE ENERGY

2023 Billion-Ton Report: An Assessment of U.S. Renewable Carbon Resources

Collecting corn stover. *Photo courtesy of the National Renewable Energy Laboratory.*

The U.S. Department of Energy (DOE) Bioenergy Technologies Office (BETO) 2023 Billion-Ton Report (BT23) is an assessment of renewable carbon resources potentially available in the United States. This report explores these resources in terms of quantity, price, geographical density and distribution, and market maturity. The BT23 also considers economic conditions, environmental constraints, market pull, and food supply and demand.

The BT23 Report finds that the nation can sustainably produce from 1.1 to 1.5 billion tons per year of biomass, tripling current U.S. bioenergy production while still meeting projected demand for food, feed, fiber, conventional forest products, and exports. The BT23 Report quantifies national biomass production capacity from 60 resources, including wastes, forestry, agriculture, and algae. Each resource has different attributes and opportunities and can play a unique role in a national decarbonization strategy.

Key Metrics

1.1-1.5 BILLION TONS of biomass production potential *Biomass includes food waste, municipal solid waste, agricultural and forest wastes, animal wastes, and energy crops.*	**15% of future U.S. energy needs** *If the findings of the BT23 were implemented at its full potential, tripling bioenergy production, it would cover 15% of U.S. energy demand.*	**~60 BILLION GALLONS of renewable carbon liquid fuels** *or biofuels made from renewable biomass resources.*[1]

Billion-Ton Studies Over Time

Beginning in 2005, BETO commissioned a series of Billion-Ton reports to inform national bioenergy policies, as well as research, development, and deployment strategies. Each report builds upon the last, adding additional feedstocks and better modeling and data, and taking into account additional factors and variables in each edition.

- **2005 Billion-Ton Report** – The first edition explores the biomass resource supply, from forestry to agriculture to waste.
- **2011 Billion-Ton Report** – This edition adds economic modeling—including cost analyses and spatial resolution—to find out the price of making biomass feedstocks available across the United States.
- **2016 Billion-Ton Report** – The third edition focuses on the importance of environmental sustainability and explores environmental and economic modeling of feedstocks in various scenarios.
- **2023 Billion-Ton Report** – The fourth and latest edition adds market scenarios, additional feedstock resources, an enhanced data portal[2], Renewable Fuel Standard[3] qualifications, and assesses the U.S. renewable carbon resources that exist today and could be available in a future mature market.

1. energy.gov/eere/bioenergy/sustainable-aviation-fuels
2. bioenergykdf.ornl.gov/bt23-data-portal
3. epa.gov/renewable-fuel-standard-program/final-renewable-fuels-standards-rule-2023-2024-and-2025

Additional Feedstocks Explored in BT23

The BT23 Report includes data and information from feedstocks incorporated into previous Billion-Ton reports, including agricultural residues such as corn stover and other unused crop wastes, logging residues, municipal solid waste, and algae.

Newly incorporated feedstock resources in the BT23 Report include winter oilseed crops; trees and brush harvested from forests to prevent wildfires; macroalgae such as farmed seaweed; city waste; renewable natural gas; and industrial carbon dioxide waste from powerplants, cement plants, and other industries. With these additional feedstocks, the U.S. could boost biomass by 100 million tons per year.

Exploring a variety of feedstocks for bioenergy use is critical as no one single feedstock can supply all the necessary biomass. Different regions across the United States specialize in different biomass opportunities depending on local conditions, end-use applications, and evolving conversion technologies.

Sustainable Aviation Fuel Grand Challenge

One billion tons of biomass can produce about 60 billion gallons of biofuel, or 1.7 times the amount of sustainable energy needed to achieve the Biden-Harris administration's Sustainable Aviation Fuel (SAF) Grand Challenge goal of supplying enough SAF to meet 100% of U.S. aviation fuel demand by 2050. *Photo from iStock 129413154*

Key Results

The BT23 Report provides estimates of biomass resource potential in response to market demand scenarios. Below are key results from this national assessment:

- BT23 identifies a potential 1.1 - 1.5 billion tons of biomass per year in the future, which could triple the current U.S. bioeconomy.
- Currently available but unused biomass resources can add around 350 million tons of additional biomass per year above current uses, and can double the U.S. bioeconomy.
- Under mature market conditions, the United States has the potential to add over 400 million tons of biomass resources, bringing the total to available biomass to more than 1 billion tons annually.
- Resource quantities vary by price, depending on market conditions, geographic location, and type of biomass resource.
- The resource amounts projected in the BT23 Report are not the total national supply available, but instead a fraction of total biomass that meet economic and environmental sustainability constraints (see Available Resources Reference Scenarios).
- Following sustainability constraints identified in this analysis is critical to avoid overharvesting or harmful environmental effects.
- Further technological innovations (explored in Chapter 7) could lead to evolving and emerging resources that represent additional biomass potential.

Post-harvest agricultural residue collected. *Photo courtesy of the National Renewable Energy Laboratory.*

Ethanol plant. *Source: Genera*

Contributors and Reviewers

The BT23 was directed and funded by the U.S. Department of Energy's Bioenergy Technologies Office (BETO), and the following agencies and organizations contributed research, analysis, and other expertise to the report. The report was also reviewed by participants from federal agencies, academic institutions, and private institution stakeholder groups (listed in report).

Contributors

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- U.S. Department of Energy
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Available Resources Given Sustainability Constraints

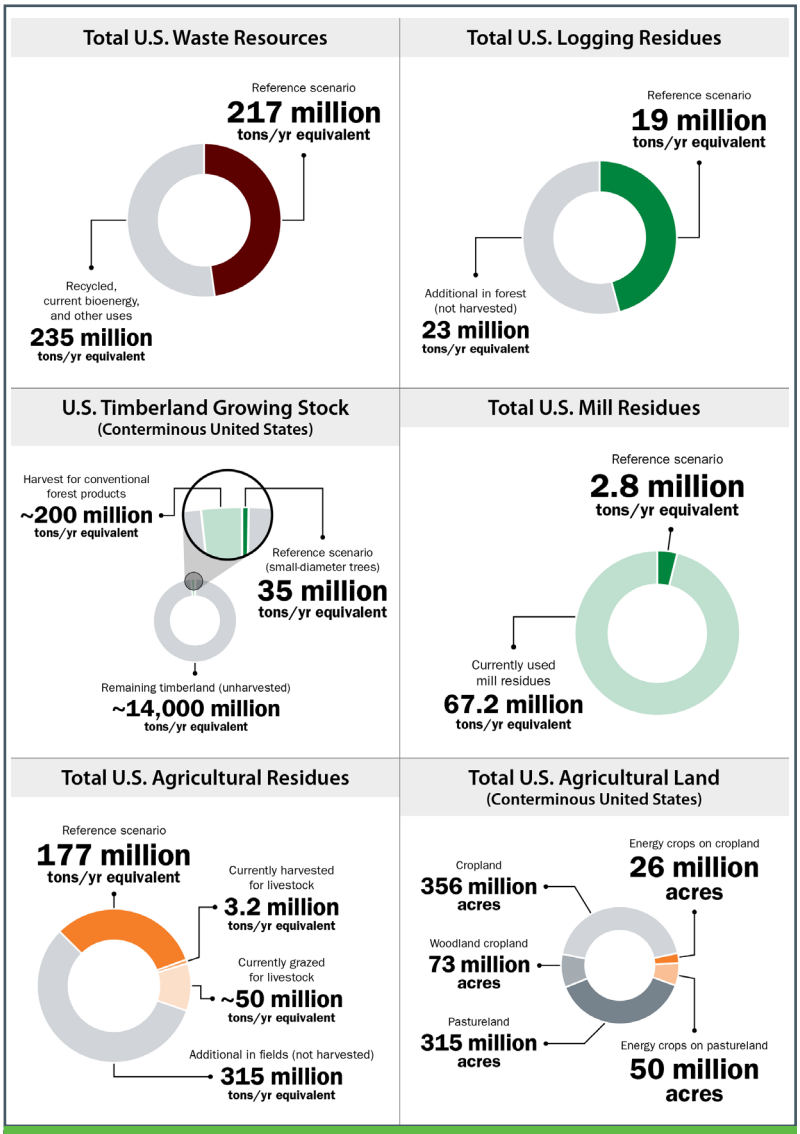

Figure note: BT23 Report estimates do not represent all available biomass in the United States. They represent a fraction that might be collected using sustainability constraints.

Reviewers

- Oak Ridge National Laboratory
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- U.S. Environmental Protection Agency
- World Resources Institute
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- U.S. Department of Agriculture
- Minnesota Department of Resource Forestry
- Beckman Coulter Life Science
- Carbon180
- U.S. Department of Energy
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- Grantham Foundation for the Protection of the
- Environment
- Carbon Direct
- POET

About the Bioenergy Technologies Office

BETO supports research, development, and demonstration to enable the sustainable use of domestic biomass and waste resources for the production of biofuels and bioproducts. BETO's overall goals are designed to:

- Lower costs and reduce technology risks for production of biofuels and bioproducts
- Improve environmental benefits of bioenergy production
- Reduce greenhouse gas emissions from the transportation, industrial, and agricultural sectors to address the climate crisis
- Support the scale-up of sustainable, low-carbon biofuel production technologies
- Create economic opportunities and good-paying jobs in agriculture and manufacturing sectors.

Meeting these goals requires significant and rapid advances in technology development and innovation across the entire biomass-to-bioenergy supply chain.

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BIOENERGY TECHNOLOGIES OFFICE

For more information, visit: energy.gov/eere/2023-billion-ton-report

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