Forest Resources

Forest biomass is an abundant biomass feedstock that complements the conventional forest use of wood for paper and wood materials. It may be utilized for bioenergy production, such as heat and electricity, as well as for biofuels and a variety of bioproducts, such as industrial chemicals, textiles, and other renewable materials. The resources within the *2016 Billion-Ton Report* include primary forest resources, which are taken directly from timberland-only forests, removed from the land, and taken to the roadside.

Summary

The *2016 Billion-Ton Report: Advancing Domestic Resources for a Thriving Bioeconomy* summarizes the most recent estimates of the availability of forest resources (within the 48 conterminous United States) available for biorefining in the future.

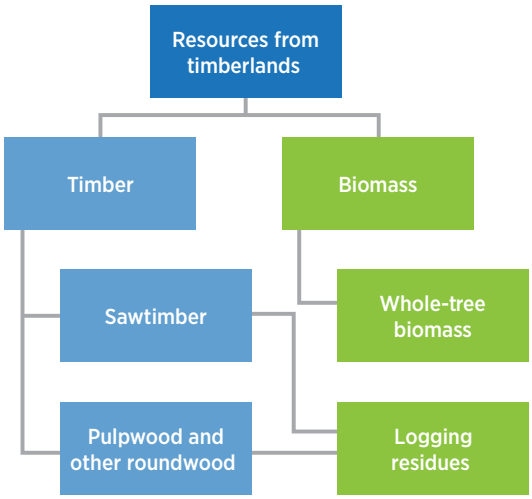
Forest biomass feedstocks can be one of two types: forest residues left after logging timber (including limbs, tops, and culled trees and tree components that would be otherwise unmerchantable), or whole-tree biomass harvested explicitly for biomass. Removal of residues improves regeneration and reduces fire risks. Harvesting excessive woody biomass can reduce the risk of fire and pests, as well as aid in forest restoration, productivity, vitality, and resilience.

The biomass estimates are at costs to roadside by type of feedstock, year, and scenario. Estimates are at the county level as shown in the Bioenergy Knowledge Discovery Framework.[1] These biomass estimates are developed for private (industrial, non-industrial, and tribal) timberland and federal timberland, and they are based on a series of underlying assumptions regarding ratios of harvest types, available land base, residue retention rates, growth rates, land cover and use management, growth limits, and harvest limits, among others.

At prices between $40 and $80 per dry ton, the *2016 Billion-Ton Report* estimates that annual gross potential of all forest biomass supply (including residues) is about 21 million to 116 million dry tons from 2017 to 2040 for both private and federal lands for the baseline scenario. This scenario is modeled on a moderate growth in housing starts, plantation intensity, paper, and foreign demand, with low growth in biomass for energy. Potential supply is variable upon several factors. Current and near-term supply factors of timber include what is already on the ground, what is harvested in the near term (10–15 years), and the existing timberland growth rates. Long-term (beyond 15 years) supply factors include timberland loss to other land uses, as well as landowner forest investment decisions (including but not limited to) planting of improved seedlings, intensive silviculture, conversion of non-forest to natural stands, and planting/replanting pine plantations.

In some cases, the logging residues are sufficient to meet the demand, and have no near-term or long-term supply factors.

The available woody biomass ranges from 88 million to 82 million dry tons annually under the lowest biomass demand (base case) at a price of $60 per dry ton to roadside. For the highest demand scenario, the estimated potential biomass is 79 million to 60 million dry tons per year at the $60 per dry ton price. Under the high-demand scenarios, less biomass is available in the future, as an underlying assumption that natural stands would not be converted to energy plantations was enforced.



Approach

The *2016 Billion-Ton Report* relies on the linear programming model ForSEAM (Forest Sustainable and Economic Analysis) to estimate the timberland production for traditional forest products to meet projected demands. Scenarios were developed for low to high biomass demands using the U.S. Forest Products Module Global Forest Products Model (USFPM/GFPM).[2] To calculate supply curves, the authors used Forest Inventory Assessment data to solve for the lowest-cost timber and biomass for the 305 production regions or agricultural statistical districts in the conterminous United States.[3] Estimates of economic value are used in place of actual prices to ensure uniformity.

The Subregional Timber Supply was used to test the ForSEAM model and to analyze future market competition and supply in the South.

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[1] The Bioenergy Knowledge Discovery Framework may be accessed via www.bioenergy.kdf.net.

[2] USDA Forest Service. 2012. Future of America's Forest and Rangelands: Forest Service 2010 Resources Planning Act Assessment. Washington, D.C.

[3] USDA Forest Service. 2015. Forest inventory and analysis, FIA data and tools. [Online database]. U.S.Department of Agriculture. http://fia.fs.fed.us/tools-data/default.as

The *2016 Billion-Ton Report* defines specific assumptions, criteria, and constraints to align the various models and data sources described above. Only timberland (not all forestland) is included in the analysis, and all protected, reserved, and non-roaded forestland is excluded. High-value sawtimber is never harvested for biomass, as it is economically inaccessible. It is also assumed that no forestland losses occurred during the modeling time period, and there are no land cover changes (e.g., stands are regrown to their original stand type and species). As trees grow and mature, their value increases; therefore, only younger stands and smaller-diameter stands would be harvested as whole-tree biomass. The report only focused on the conterminous United States.

Chapter 3 of the *2016 Billion-Ton Report* focuses on the roadside costs, although these are not the total cost of a feedstock at a conversion facility. Also, feedstocks may incur losses in preprocessing, transportation, and estimated costs to the facility (shown in chapter 6).

Additionally, the amount of wood available for harvest to meet traditional and biomass demands is limited by three factors: (1) the growth constraint at the state level, which limits harvest to the estimated annual growth; (2) the harvesting constraint at the state level, which limits harvest region to 5% of the available volume; and (3) the constraint of re-harvest of "land-once-harvested," which limits harvesting to land that has reestablished a class 2 diameter-sized stand.

The Path Forward

Overall, more than 1 billion tons of biomass is available and accessible under the certain circumstances and limitations in the report, which is consistent with both the original *2005 Billion-Ton Study* and the 2011 *U.S. Billion-Ton Update*.

There are substantial changes between the 2011 *Billion-Ton Update* and the *2016 Billion-Ton Report*. The 2016 report has a more robust wood waste resource analysis and economic model, refined feedstock types, and updated assumptions and coefficients. It also includes new data aligning with updated analytical methodologies.

The addition of the ForSEAM model increases the insight into various costs, including the harvest costs, chipping costs, individual machine costs, labor costs, and fuel costs. The 2011 *U.S. Billion-Ton Update* calculated the harvest costs by the Fuel Reduction Cost Simulator, which measured the cost from forest to roadside. The *2016 Billion-Ton Report* updates and itemizes more of these costs by U.S. region, stand type, stand diameter class, cut (either clear or partial), products, harvest method, and ground slope condition, and it includes the transportation cost to the biorefinery.

Additionally, the original *Billion-Ton Study* and 2011 *U.S. Billion-Ton Update* did not consider competition for wood with conventional products such as lumber, paper, and panels.

The Bioenergy Technologies Office's Feedstock Supply and Logistics program is using this information to implement a focused strategy to achieve the vision of a thriving and sustainable bioeconomy. Investing in scientific technologies and workforce development ensures current feedstock and conversion technologies are moved from bench to pilot scale. The Bioenergy Technologies Office strives to collaborate with original equipment manufacturers and biorefinery partners to develop and implement strategies that mitigate losses in feedstock supply chains. By taking the knowledge and research done at bench and pilot scale, new or improved methodologies and technologies can be developed—increasing available low-cost biomass supplies, improving conversion efficiency, and reducing conversion cost.

This fact sheet refers to the following documents

U.S. Department of Energy. 2016. *2016 Billion-Ton Report: Advancing Domestic Resources for a Thriving Bioeconomy*. M. H. Langholtz, B. J. Stokes, and L. M. Eaton (Leads), ORNL/TM-2016/160. Oak Ridge National Laboratory, Oak Ridge, TN. 448p.

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

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