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# The updated billion-ton resource assessment

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ABSTRACT

This paper summarizes the results of an update to a resource assessment, published in 2005, commonly referred to as the Billion-Ton Study (BTS). The updated results are consistent with the 2005 BTS in terms of overall magnitude. The 2005 BTS projected between 860 and 1240 Tg of biomass available in the 2050 timeframe, while the Billion-Ton Update (BT2), for a price of 66 $ Mg$^{-1}$, projected between 994 and 1483 Tg in 2030. For the BT2, forest residue biomass potential was determined to be less owing to tighter restrictions on forest residue supply including restrictions due to limited projected increase in traditional harvest for pulpwood and sawlogs. Crop residue potential was also determined to be less because of the consideration of soil carbon and not allowing residue removal from conventionally tilled corn acres. Energy crop potential was estimated to be much greater largely because of land availability and modeling of competition among various competing uses of the land. Generally, the scenario assumptions in the updated assessment are much more plausible to show a "billion-ton" resource, which would be sufficient to displace 30% or more of the country's present petroleum consumption and provide more than enough biomass to meet the 2022 requirements of the Renewable Fuel Standard.



## 1. Introduction

The 2005 Billion-Ton Study (2005 BTS), was an estimate of "potential" biomass within the contiguous United States based on numerous assumptions about current and future inventory, production capacity, and technology [1]. The main conclusion of the study was that U.S. agriculture and forest resources have the capability to sustainably produce one billion dry tons of biomass annually (910 Tg) – enough to

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displace approximately 30% of the country's 2003 petroleum consumption of 1.2 $km^3$ $y^{-1}$. In this paper, the results of an update to the 2005 BTS in 2011, referred to hereafter as the Billion-Ton Update (BT2), are discussed [2]. The BT2 asked the question: Given better modeling of environmental constraints (e.g., soil erosion, soil carbon) can a billion dry tons (910 Tg) of biomass be produced in the United States and how much at varying prices? The BT2 improved upon the BTS by providing:

- Estimates of prices and available quantities (i.e., supply curves) for primary feedstocks;
- A more rigorous treatment and modeling of resource sustainability; and
- A county-by-county inventory of primary feedstocks.

Further, the update emphasizes the 2012 through 2030 time period coincident with implementation of Energy Independence and Security Act of 2007 (EISA) [3] and U.S. Department of Energy (DOE) initiatives rather than on updating the mid-century projection results in the original study. The BTS included biomass that was currently being used for energy production because it counted toward the billion-ton goal. In the update, currently consumed biomass resources, such as wood residues and pulping liquors used in the production of forest products, are treated separately to avoid confusion with the unused potential. These and other major differences between the 2005 BTS and the BT2 are summarized in Table 1. The update focuses on the larger primary biomass resources available for additional energy production at different prices and locations across the continental United States. Many of the more significant unused secondary residues and tertiary wastes as well as the currently used resources are evaluated and included in the study. However, in this paper these feedstocks are only discussed briefly. Further, this paper presents only the national results. County-level supply assessment results, visualization tools, model to optimize biomass supply chains, as well as other related information and data, are available on the Bioenergy Knowledge Discovery Framework web site [4]. Note that while the paper title "The Updated Billion-Ton Resource Assessment," the title refers to a billion short tons or 910 Tg of biomass.

## 2. Estimating the forest and agriculture resource potential

The BT2 focuses on estimating county-level feedstock supply curves for all major primary cropland and forest resources. These supply curves include costs to acquire or produce the resource and costs for collecting or harvesting the resource and moving it to the field edge or forest roadside ready for transport. The estimates in the BT2 are minimum farmgate or forest roadside prices and do not represent the total cost or the actual available tonnage to a biorefinery or conversion facility. There will be additional costs to preprocess, handle, store, and transport the biomass to a facility for conversion into fuel or power. The estimates include losses to the farmgate or roadside (assumed to be 10%), but do not include losses due to continued handling, additional processing, storage, and material degradation. More than one Mg from the estimates will be required to have one Mg ready to process at a biorefinery, with the amount depending on many variables in the supply chain and final conversion technology. In addition, the biomass will be in varied forms and may not be directly comparable at a biorefinery in either cost or conversion efficiency.

The primary forest resources include logging residues and fuel treatment thinnings, which are assumed collected as part of an integrated harvest operation and are summarized in the assessment as composite operations; other removal residues from land clearing and cultural operations (e.g., precommercial thinnings); thinnings from other forestland

**Table 1 – Major differences between the 2005 BTS and the 2011 BT2.**

- Separation of "used" and "potential" feedstocks. In the 2005 BTS, feedstocks currently used for energy production or could be shifted from another market to energy production were counted in the biomass potential. In the update, the currently used biomass is clearly delineated from the potential.
- The BT2 covers the 2012 through 2030 period instead of the 2025 to 2050 focus of the 2005 BTS.
- County-level agricultural environmental sustainability requirements include:
  - Cost assumptions include compliance with statutes, regulations, and BMPs.
  - Assumed the use of acceptable management practices.
  - Explicitly modeled crop residue retention, tillage, and crop rotation to provide erosion protection and maintenance of soil organic carbon.
  - Modeled nutrient replacement, crop rotation, and reduced tillage practices to ensure long-term site productivity.
- FIA plot-level forestry environmental sustainability requirements include:
  - Cost assumptions include compliance with statutes, regulations, and BMPs.
  - Assumed the use of acceptable management practices.
  - Little to no road building.
  - Operations are restricted if the slope is above 80%.
  - Used gradient retention of biomass based on ground slope.
- Energy crop sustainability requirements include:
  - Cost assumptions include compliance with statutes, regulations, and BMPs.
  - Assumed the use of acceptable management practices.
  - No conversion of forest lands.
- Energy crop potential is modeled at a county-level using an agricultural policy simulation model (POLYSYS).
- High-yield scenario for agricultural resources assumes changes in corn yield, changes in tillage, and several scenario growth rates for energy crop yields.
- Estimates of energy crop potential in the 2005 BTS and 2011 BT2 assume that demands for food, feed, and exports continue to be met.