Biomass Potential – The Billion-Ton Study Update

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Major Differences Between the 2005 BTS Study and the 2011 Billion-ton Update

- Purpose of the 2011 *Billion-Ton Update*
  - Evaluate biomass resource potential
  - Improve upon the 2005 *BTS*
    - Assess production and costs
    - Address sustainability
    - Model land-use change
- Significant findings of the 2011 study
  - Enough resource potential to meet the 2022 advanced biofuel goals
  - Potential resources are widely distributed
  - Energy crops are the single largest source of new feedstock

2005 BTS	2011 Update
National estimates – no spatial information	County-level with aggregation to state, regional and national levels
No cost analyses – just quantities	Supply curves by feedstock by county – farmgate/forest landing
No explicit land use change modeling	Land use change modeled for energy crops
Long-term, inexact time horizon (2005; ~2025 & 2040-50)	2012 – 2030 timeline (annual)
2005 USDA agricultural projections; 2000 forestry RPA/TPO	2010 USDA agricultural projections: 2010 FIA inventory and 2007 forestry RPA/TPO
Crop residue removal sustainability addressed from national perspective; erosion only	Crop residue removal sustainability modeled at soil level (wind & water erosion, soil C)
Erosion constraints to forest residue collection	Greater erosion plus wetness constraints to forest residue collection

Biomass Feedstock Resource Base

- About one-half of the land in the contiguous U.S.
  - Forestland resources: 504 million acres of timberland, 91 million acres of other forestland
  - Agricultural resources: 340 million acres cropland, 40 million acres idle cropland, 404 million acres pasture (cropland pasture & permanent pasture)

- Forest resources
  - **Logging residues**
  - **Forest thinnings (fuel treatments)**

  } **Combined into composite**

  - Other removals and other forestlands
  - **Conventional wood (new)**
  - Fuelwood
  - Mill residues
  - Pulping liquors
  - Urban wood residues

- Agricultural resources
  - **Crop residues**
  - Grains to biofuels
  - **Perennial grasses**
  - **Short-rotation woody crops**
  - Animal manures
  - **Annual energy crop (new)**
  - Food/feed processing residues
  - MSW and landfill gases

EXCLUDES ALGAL FEEDSTOCKS

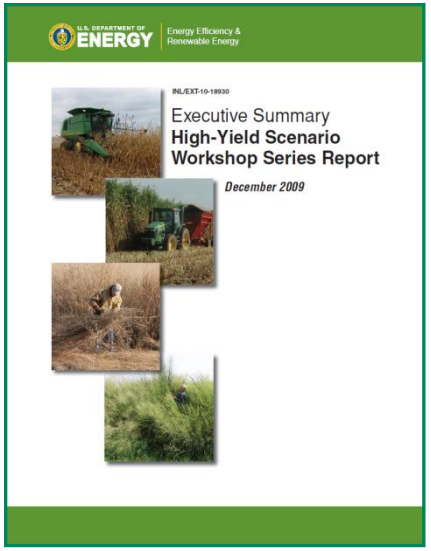
Billion-Ton Update Scenarios

Baseline

- USDA Projections extended to 2030
- National corn yield: 160 bu/ac (2010) increases to 201 bu/ac in 2030
- Stover to grain ratio of 1:1
- Small grain and sorghum residue
- Assumes a mix of conventional till, reduced till, and no-till
- No residue collected from conventionally tilled acres
- Energy crop yields increase at 1% annually attributable to experience in planting energy crops and limited R&D

High-yield

- Same as Baseline Scenario except for
  - Corn yields increase to a national average of 265 bu/acre in 2030
  - Higher amounts of cropland in reduced and no-till cultivation
  - Energy crop yields increase at 2%, 3%, and 4% annually (more R&D)



https://inlportal.inl.gov/portal/server.pt/community/bioenergy/421/high_yield_scenario/8985

Approach to Supply Curve Estimation

- Focus on major primary feedstocks
- Currently used and potential feedstocks
- Farmgate or roadside analysis – no losses
- POLYSYS (Econ model) for ag residues and energy crops
  - USDA data – USDA projections, Census, NASS, extended to 2030
  - Sustainability – erosion, soil carbon, BMPs in costs
  - Costs – Grower payments, production costs for energy crops, collection /harvest based on INL and ORNL modeling
- Forestland resources separate
  - Cost-quantity analysis used to estimate supply curves
  - USDA/FS data – Forest Inventory Analysis, Timber Product Output, Resource Planning Act
  - Sustainability – roadless areas, steep and wet sites, road building, biomass retention, best management practices in costs
  - Costs – stumpage, FS FRCS model (Fuel Reduction Cost Simulator)
- Secondary processing residues and tertiary wastes estimated using technical coefficients

Sustainability Approach

- **Crop Residues**
  - **Residue removal tool used to estimate retention coefficients for wind and water erosion and soil C**
  - **No removals on tilled land**
  - **Nutrient replacement**

- **Forest Residues**
  - **Removed reserved and roadless designated areas**
  - **Removed steep and wet areas, and sites requiring cable systems**
  - **No road building**
  - **Biomass retention levels by slope class**
    - **Logging residues - 30% left on-site**
    - **Fuel treatment thinnings - Slope <40% = 30% of residue left on-site; Slope >40% to <80% = 40% of residue left on site; Slope >80% = no residue is removed (no limbs or tops yarded)**
  - **No harvest greater than growth by state**
  - **Merchantable mill capacity limits by state**
  - **Assumed BMP compliance in costs**

Sustainability Approach (Continued)

- **Energy Crops**
  - **Allowed on cropland, cropland pasture, permanent pasture (no forestlands)**
  - **Did not include CRP lands**
  - **Not allowed on irrigated cropland & pasture**
  - **No supplemental irrigation**
  - **Intensification of pasture land required to meet lost forage**
  - **Conversion of pasture constrained to counties east of the 100th meridian except for Northwest**
  - **Energy crops returns must be greater than pasture rent plus additional establishment and maintenance costs**
  - **BMPs for establishment, cultivation, maintenance, and harvesting of energy crops**
  - **No tillage for perennial grasses establishment**
  - **Used limits of land change to ensure landscape diversity**
    - **10% of cropland can convert annually up to 25% maximum**
    - **20% of cropland pasture annually up to a maximum of 50%**
    - **5% of permanent pasture annually up to a maximum 50%**
  - **Annual energy crops (i.e., energy sorghum) limited to non-erosive cropland and part of multi-crop rotation**
  - **Retained low-levels of biomass for long-term site productivity with nutrient replacement**

How Much Biomass is Available According to the New 2011 Update?

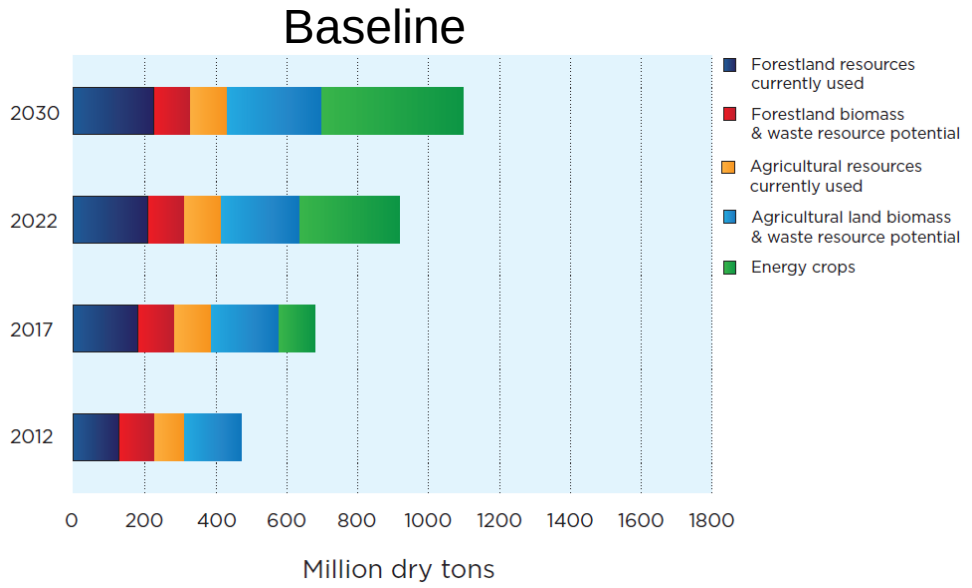
- **It all depends**
  - Specific feedstock or feedstock category
  - Sorts – currently used or potential
  - Spatial interest
  - Selected price
  - Specific year
  - Scenario

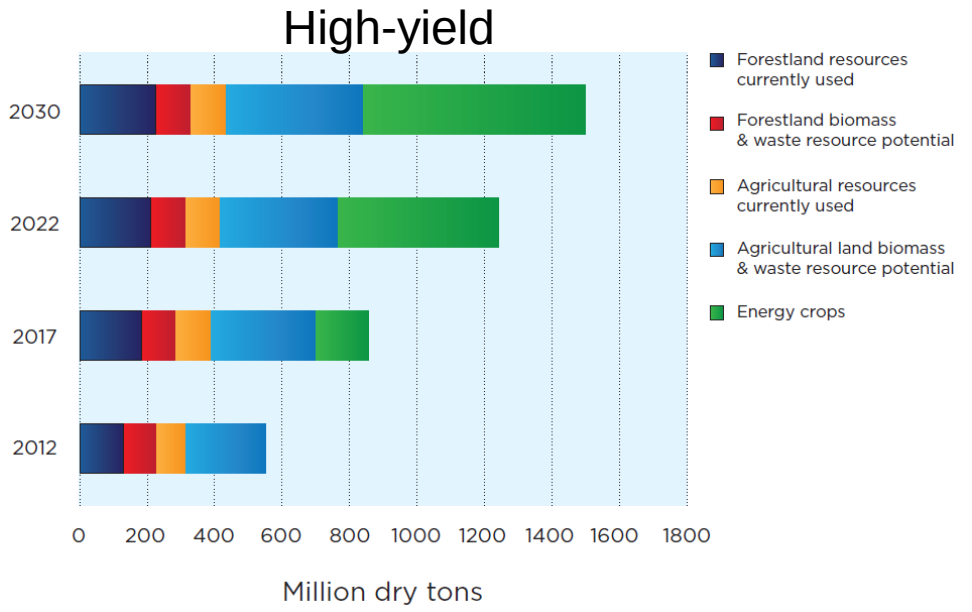
- **How to find**
  - Update report is national summaries at selected prices and years for all feedstocks, sorts, and scenarios
  - KDF for desired spatial analyses, prices, and years for all feedstock categories, sorts, and scenarios

http://bioenergykdf.net

U.S. Billion-Ton Update: Findings

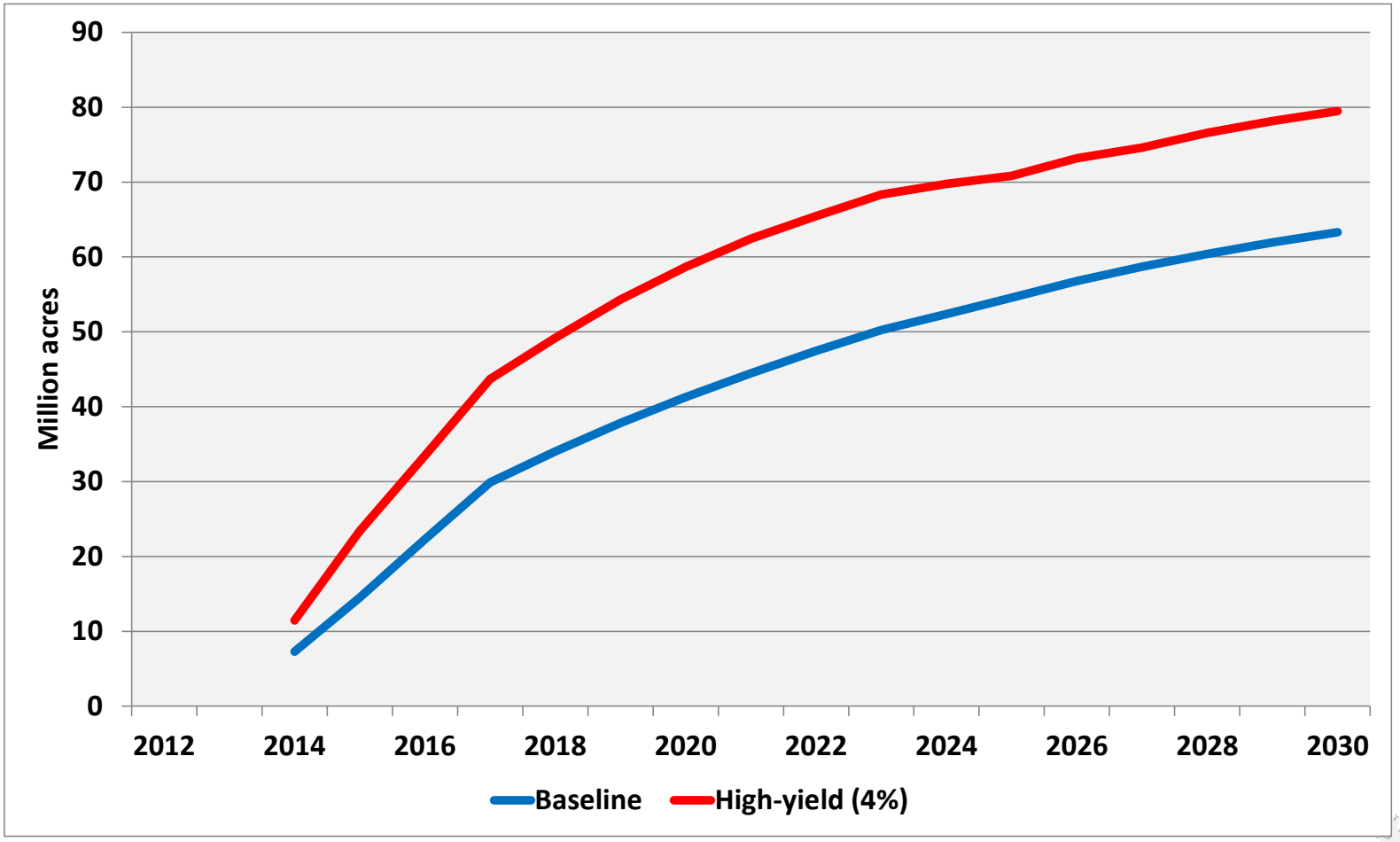
- Baseline scenario
  - Current combined resources from forests and agricultural lands total about 473 million dry tons at $60 per dry ton or less (about 45% is currently used and the remainder is potential additional biomass)
  - By 2030, estimated resources increase to nearly 1.1 billion dry tons (about 30% would be projected as already-used biomass and 70% as potentially additional)
- High-yield scenario
  - Total resource ranges from nearly 1.4 to over 1.6 billion dry tons annually of which 80% is potentially additional biomass
  - No high-yield scenario was evaluated for forest resources, except for the woody crops



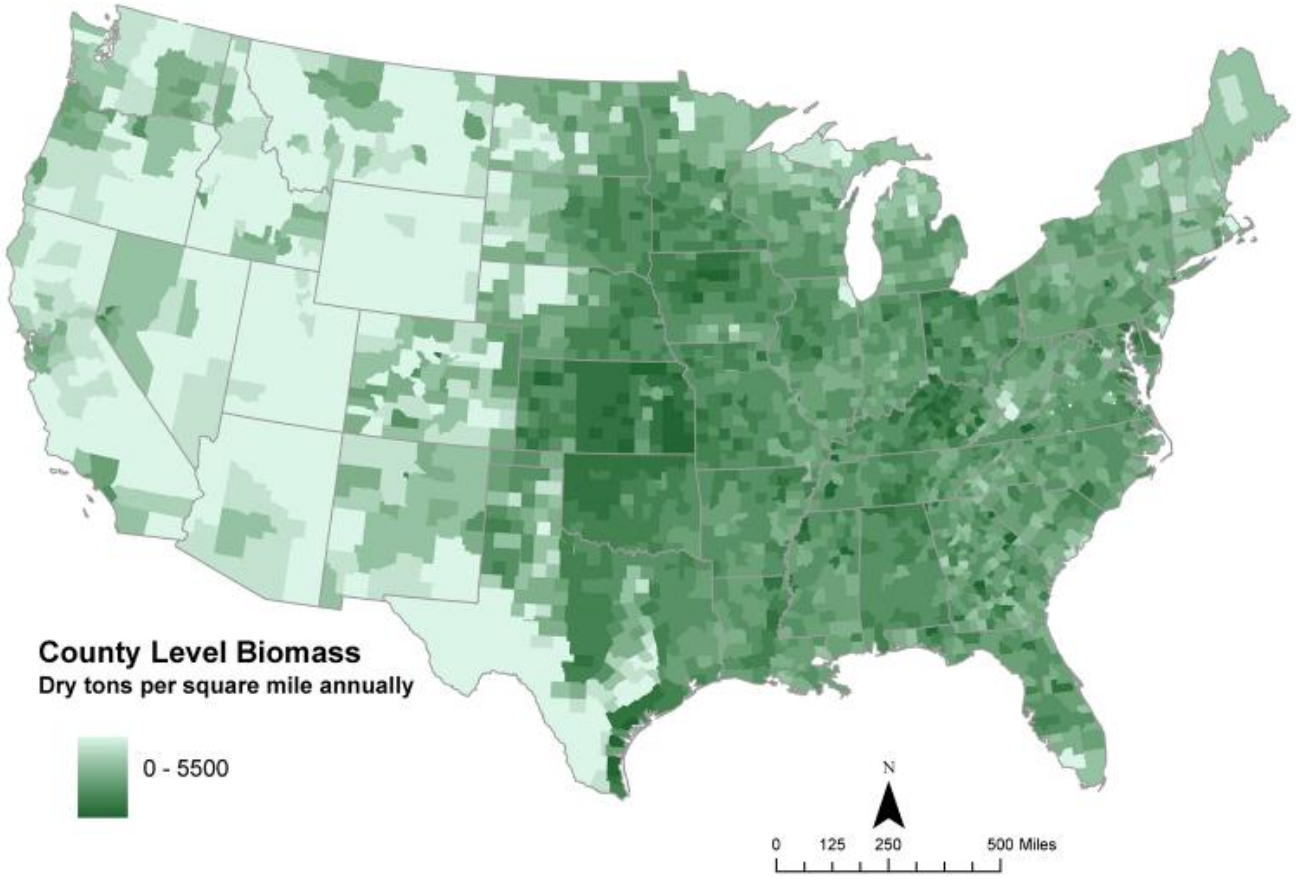


Land-use Change

- **Total land use change ($60/dry ton) is 63 million acres under the baseline scenario and 79 million acres under the high-yield scenario (4% annual growth in energy crop yield) by 2030**



Potential County-level Resources at $60 Per Dry Ton or Less in 2030 (Baseline Scenario)



Bioenergy KDF provides specific results of the update (http://bioenergykdf.net)