Revising FRCS to Update the “Billion Tons of Biomass” Study

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1. What is the Billion-Ton Study?

2. What is BTS2?

3. What is FRCS?

4. Modifying FRCS for use in all regions of the USA

5. Using the FIA database with SAS and FRCS to develop biomass supply curves for BTS2
What is the Billion-Ton Study?

- Report published jointly by DOE & USDA in 2005
- Concluded that > 1 billion dry tons/year of biomass are “available” to support a bioenergy, biofuels, bioproducts industry
- Sources: farm products and residues, forests, mill residues, urban wood waste, clearing waste
- Emphasized “availability”, not economic supply
2005 Billion-Ton Study: Results

**US agriculture can produce 933 million dry tons of biomass annually while continuing to meet food, feed, and export demands.**
- 424 million ODT annual crop residues
- 377 million ODT perennial crops
- 56 million ODT grains for biofuels
- 75 million ODT excess animal manure

**US forestry can produce 368 million dry tons of biomass without affecting the supply of conventional forest products.**
- 52 million ODT of fuelwood for bioenergy
- 144 million ODT mill residues
- 47 million ODT urban wood waste
- 64 million ODT logging & clearing residues
- 60 million ODT fuel-reduction treatments
Criticism of BTS1

- Technical availability is not economic supply
- No comprehensive assessment of recovery cost for forest biomass
- Only national-level data were used; regional differences not apparent
- Issues related to biomass supply incident to sawlog/pulpwood harvest not dealt with
Thus, BTS2

- Economic supply of both agricultural and forest biomass for energy & fuel
- County-level supply curves for biomass for all states but AK & HI
- Biomass sources:
  - Agricultural residues
  - Annual energy crops
  - Perennial energy crops (including short-rotation woody crops)
  - Forests
### EISA Report

- **Energy Independence and Security Act of 2007**
  - (signed Dec 2007, takes effect Jan 2009)

- **Defines mandates for production of biofuels under Renewable Fuel Standard**

- **Report required by EISA**
  - (preliminary BTS2 results) will be provided to the EPA via the “Biomass Board” in June 2008

#### Billions of gallons to be produced annually under the 2007 Renewable Fuel Standard (increased from 2005 RFS)

<table>
<thead>
<tr>
<th>Year</th>
<th>Corn Ethanol</th>
<th>Cellulosic Biofuels</th>
<th>Total Biofuels</th>
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Cellulosic biofuels must achieve ≥ 60% reduction in lifecycle greenhouse gas emissions compared to fossil fuels.

Rules to implement RFS will be published by EPA.
BTS2 Design Parameters

- Forest biomass modeled explicitly:
  - Harvest small trees (1-5” dbh) from fuel-reduction thinnings
  - Utilize tops & limbs from larger trees

- Other sources are exogenous (mill residues, nongrowing-stock sources, urban wastes)

- Use FIA plot data to drive simulations; only plots with SDI > 30% of maximum for area and forest type are treated

- Treatments remove trees across all dbh classes when dbh ≥ 1”

- Treat only FRCC 2 & 3 on federal land
• Forest biomass recovery limited by sawlog and pulpwood harvest levels

• Supply curves to include costs of residues and biomass trees chipped and loaded at roadside (to compare with farmgate prices from agriculture analysis)

• Whole-tree harvesting (cable if ≥ 40% slope)

• Tops & limbs of non-biomass trees “free” at landing; only cost is for chipping/loading

• Non-federal biomass stumpage starts at $4/GT, increases to 90% of pulpwood stumpage when the current pulpwood harvest level is reached for a particular State
BTS2 Regions

- **West** (Rocky Mountains, PNW, and PSW but excluding AK & HI)
- **South**
- **North** (North Central and Northeast)
- Canada is not included in BTS2
What is FRCS?

- **Fuel-Reduction Cost Simulator** (Fight et al. 2006)
- Microsoft Excel model
- Simulates fuel-reduction thinnings, **Interior West**
- Adapted from ST-Harvest (Hartsough et al. 2001)
- Harvest-cost engine in My Fuel Treatment Planner
- Used for several similar West-wide studies
FRCS—Activities Simulated

- **Felling**
  - Mechanical Whole-Tree Felling and Bunching
  - Manual Whole-Tree Felling
  - Manual Felling and Bucking
  - Harvester Felling and Cut-to-Length Processing

- **Yarding**
  - Ground Skidding
  - Cable Yarding
  - Bundle and Forward Residues
  - Cut-to-Length Forwarding
  - Helicopter Yarding

- **Landing Operations**
  - Chipping of Residues and Small Trees
  - Processing of Whole Trees into Logs
  - Loading of Logs
Time-study equations for the original FRCS were extracted from 62 published reports.

Although intended for use in the Interior West, production-rate equations are from the West Coast, South, Northeast, Canada, and France.

To develop variants for the North (North Central and Northeast) and the South, equations were extracted from an additional 34 published reports.
FRCS Cost Updating

- Base dates for costs in original FRCS:
  - **Wages** – December 2000
  - **Equipment prices** – December 2002
  - **Fuel prices** – December 2004

- No provision for updating in original FRCS

- For BTS2, all costs updated to December 2007. Also disaggregated regionally:
  - **Wages** – state level, from BLS online series for NAICS 1133 (Logging)
  - **Fuel prices** – subregional, from Energy Info Administration’s online diesel price series
  - **Equipment prices** – national level, updated from 2002 with PPI for construction machinery manufacturing from BLS (2008)
## FRCS (Revised) Batch Data Page

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<th>Stand</th>
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<th>lb/ft3CT</th>
<th>CT Hdwd Frac</th>
<th>ST/ac</th>
<th>ST Res Frac</th>
<th>ft3/ST</th>
<th>lb/ft3ST</th>
<th>ST Hdwd Frac</th>
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### Small (Pulpwood) Trees

### Large (Sawlog) Trees

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### Costs

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<th>All Costs, $/ac</th>
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<th>Residue Chips, GT/ac</th>
<th>ST Logs, ft3/ac</th>
<th>LT Logs, ft3/ac</th>
<th>CT Chips, $/GT</th>
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Supply Curve Estimation

1. **SAS**
   - Read data from FIA individual state datafile
   - Make calculations for FRCS
   - Open FRCS programmatically, write data

2. **FRCS**
   - Run simulation using state data
   - Write results for each plot in output columns of batch data page

3. **SAS**
   - Read output data from FRCS
   - Prepare county-by-county and statewide supply curves for biomass; aggregate regionally and nationally; combine with other data for overall biomass supply curves
Example Supply Curves (West)

- Millions of dry tons of biomass per year
- $/Dry ton of biomass, including stumpage on non-Federal land

States represented: WY, WA, UT, SD, OR, NM, NV, MT, ID, CO, CA, AZ
Imperfections

- Assumes that biomass markets (will) exist everywhere
- FIA data are not fully compatible with FRCS (e.g., AYD issue)
- Incomplete modeling of competition with pulpwood and lumber (e.g., logs at left were converted into lumber)
- Thinnings-only strategy for recovering biomass may be overly restrictive