INTERNATIONAL BIOMASS CONFERENCE & EXPO
a BBI International event

April 20-22, 2015
Minneapolis Convention Center
Minneapolis, MN

CONNECTING INDUSTRY TO INNOVATION

Exploring the Viability of Dry Wood Chips vs. Wood Pellets in Wood Boilers

Analysis of In Field Drying of Woody Biomass

A Comparison to a Business as Usual Fuel Model

Project Funded by:

Fond du Lac Band of Lake Superior Chippewa

Office of Indian Energy and Economic Development

Division of Energy & Mineral Development

- Cooperators:
  - Fond du Lac Resource Management Division
  - Fond du Lac Logging and Timber Enterprise
  - Fond du Lac Construction
  - University of Minnesota – Forest Resources
  - Natural Resources Research Institute
  - Skogforsk - Swedish Forest Research Institute
  - Itasca Community College
  - Wood Master (Northwest Manufacturing, Inc., Eventemp Biomass,
  - Rotochopper Inc., and Portage & Main Outdoor Wood Boilers
- Additional data presented for fuel model supported by funding from the Legislative Citizens Commission on Minnesota Resources (LCCMR) and Minnesota State Bonding through Itasca Community College.

Background

The use of forest biomass for wood heating fuel has great potential to provide a renewable, clean source of energy while investing in rural economies. In the northern region of the U.S. 1/3 of the fossil fuel use is for thermal heating. Woody biomass could replace some of the fossil fuels used in thermal heating especially in the northern tier of forested states.

Treatments

Harvest residue, comprised of tops and limbs is retrieved after processing the round wood. The tops and limbs are collected and piled to be dried in the field to enrich the recoverable energy.

Treatments

Piles are selected at random to be covered with a bioblanket at time of construction.

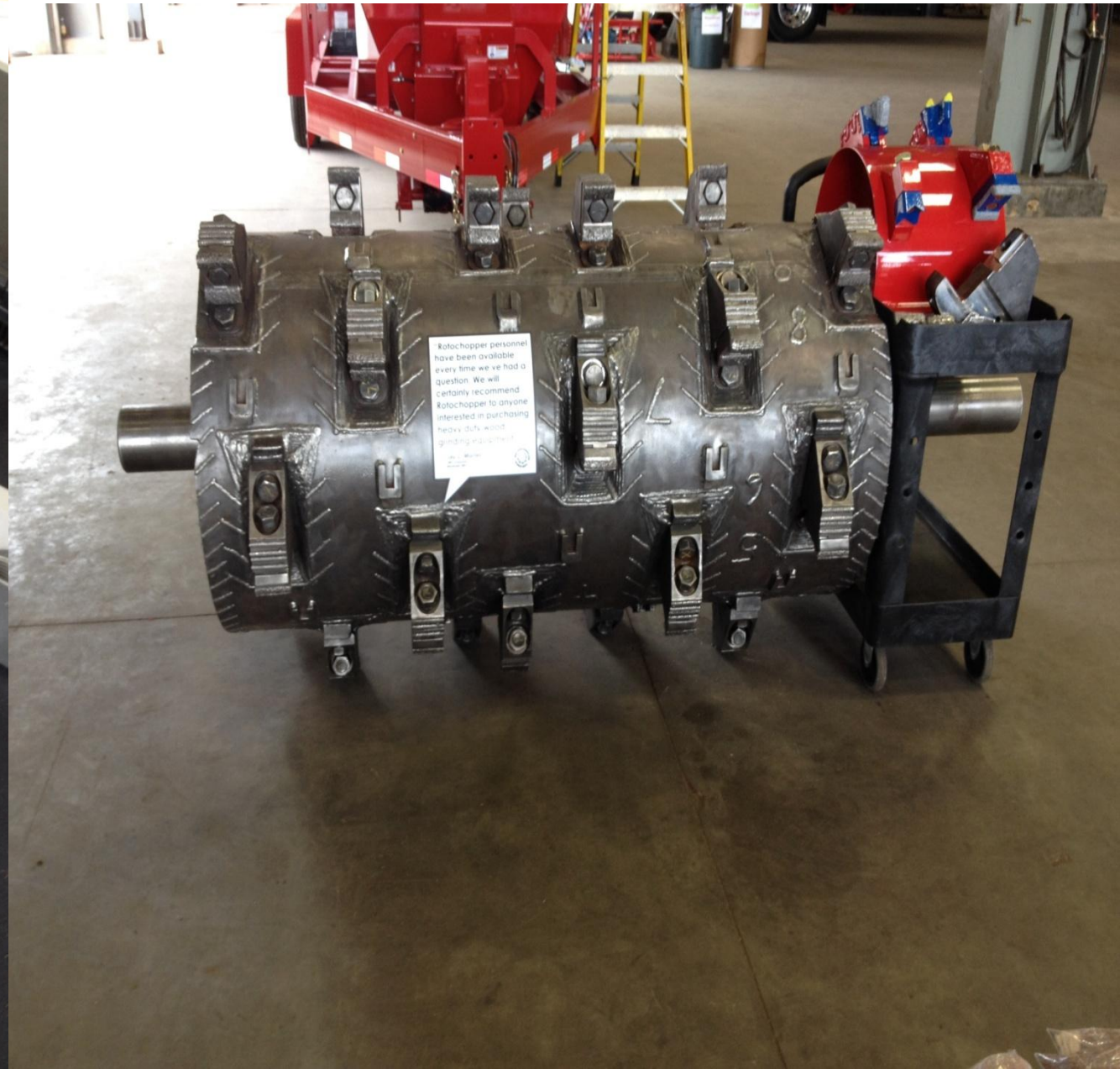
After a season of drying (1 year), piles are chipped for biomass fuel.

Sampling Biomass & Collection Bandit Industries

Initial and interim samples are extracted using a chainsaw and saw-dust collector. Each pile is sampled at butt, top and both sides. A total of 24 locations on each pile is extracted for assessment.

Final samples are collected from the operational chip stream to determine moisture, heat and ash content from the pile cross-section. Samples are collected during the chipping of the pile to compare drying effects within the residue piles.

Rotochopper, Inc. Carbide Cutter Teeth Wood Grinders



Rotochopper Heavy Duty Wood Grinding Equipment

Filling 850 to 950 Pound Totes for Biomass Furnace Trials

Jim Eiynck noticed how little ash there was and how clean it burned

Lower Emissions less particulate than Green Chips

Northwest Manufacturing has an alternative to wood pellets

High Efficient Clean Burn with Low Emissions

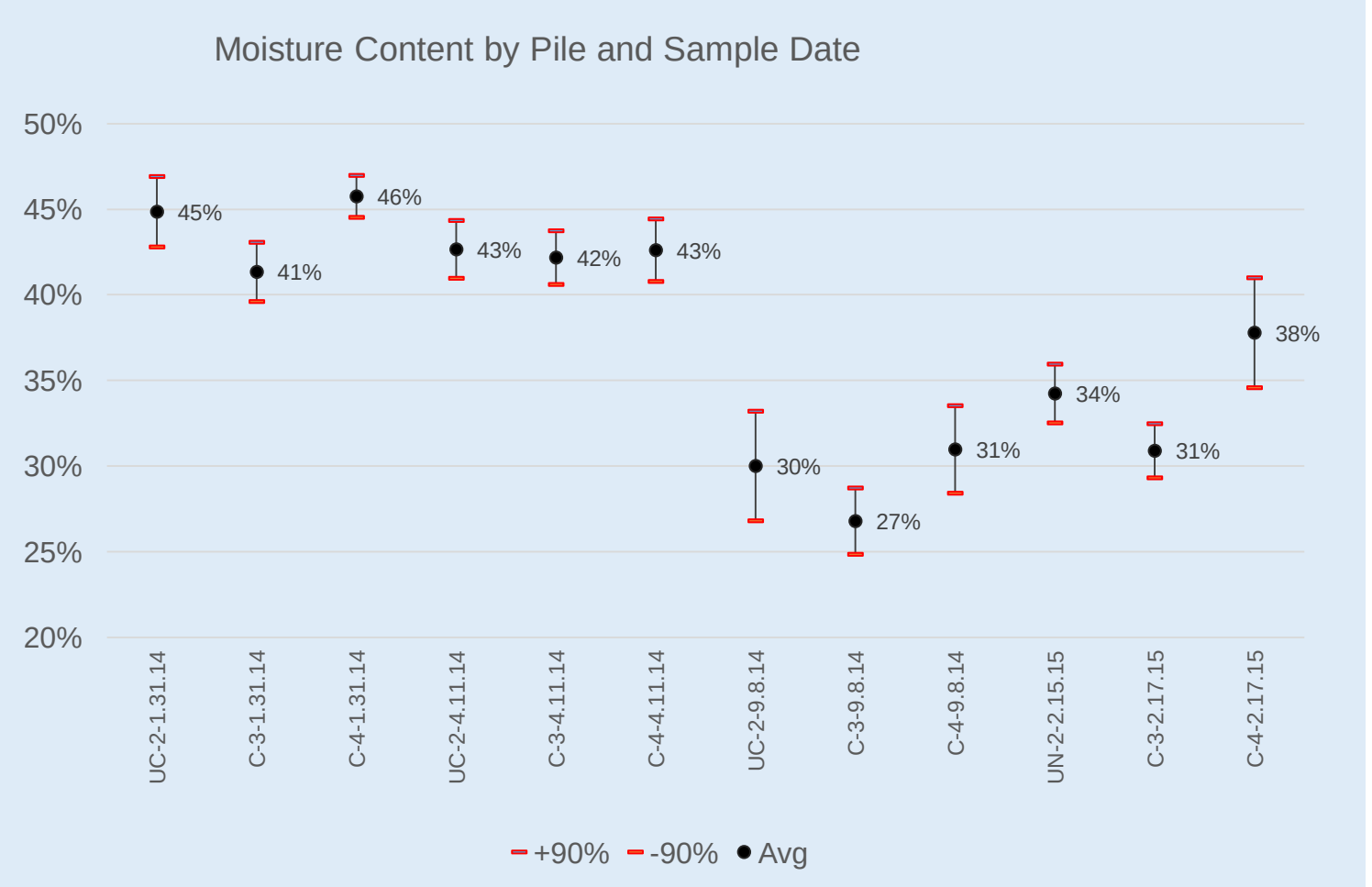
Sampling biomass - analysis

Each sample is oven dried using ASTM standards for woody biomass (ASTM D4442-07 & E871-82).

Once dried, samples are ground to powder and pelletized for analysis of fuel value according to ASTM standards (ASTM E711-87).

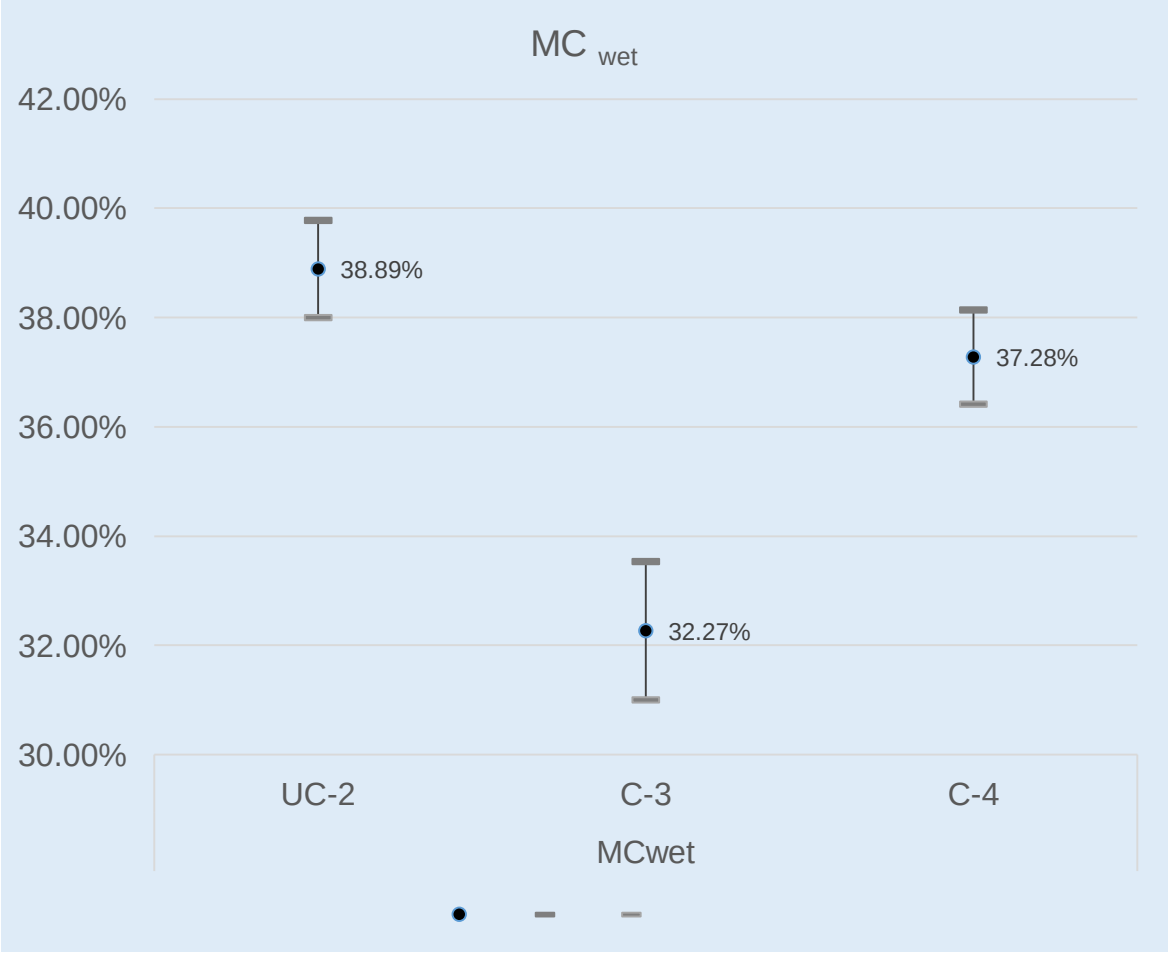
Dry-down results

- Effect of cover on moisture content over one season of drying
  - Sample dates:
    - Initial – 1/31/2014
    - Interval 1 – 4/11/2015
    - Interval 2 – 9/8/2015
    - Final – 2/17/2015
  - UC = Uncovered piles
  - C = Covered piles
- Band indicates a 90% confidence interval around the sample mean



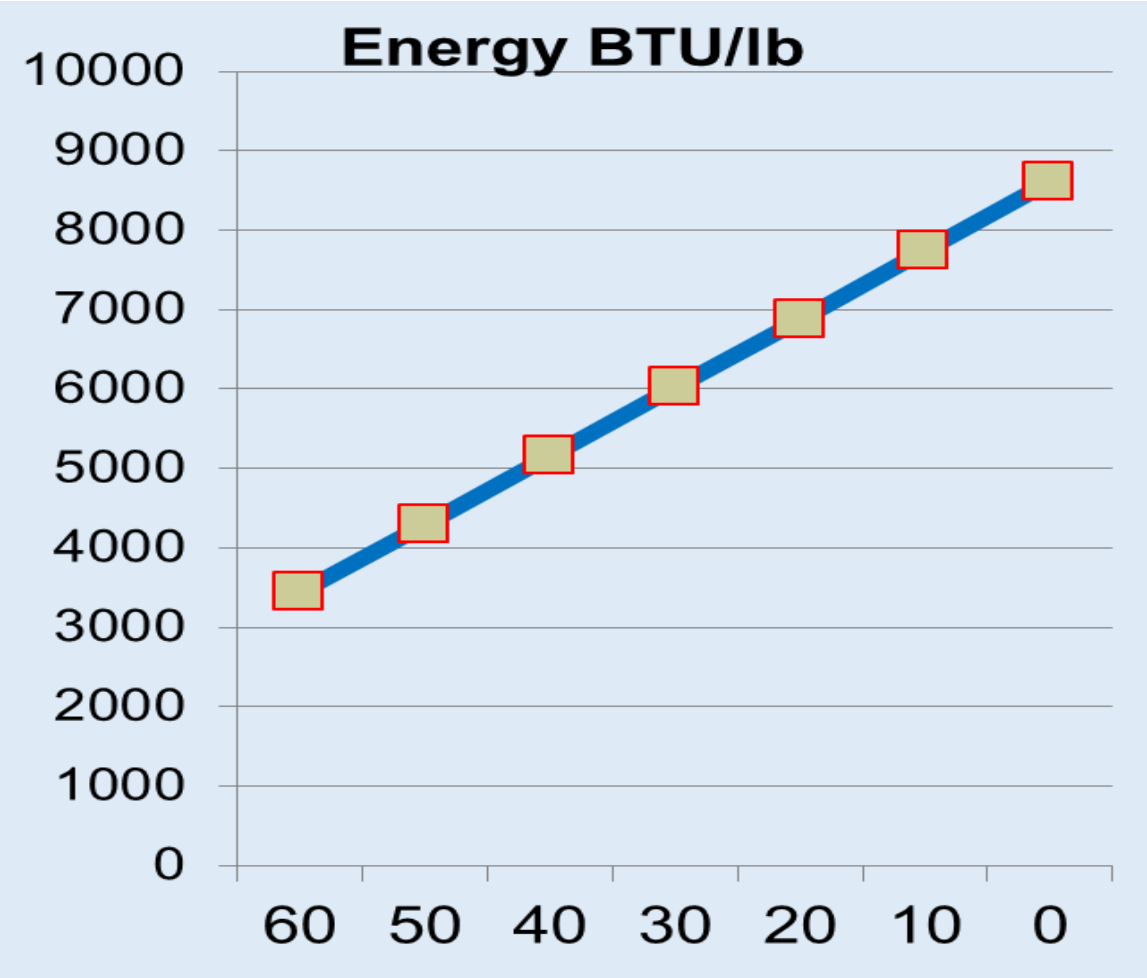
Moisture Content results – operational chips

- Moisture content of the operational chips (OC) was obtained through sampling during the chipping process
- This is compared with the extracted samples (ES)
  - Date of chipping (2/27/2015)
  - UC-2 = uncovered pile (38.9% OC, 34.2% ES)
  - C-3 = covered pile (32.3% OC, 30.9% ES)
  - C-4 = covered pile (37.3%OC, 37.8 ES)



Heat value

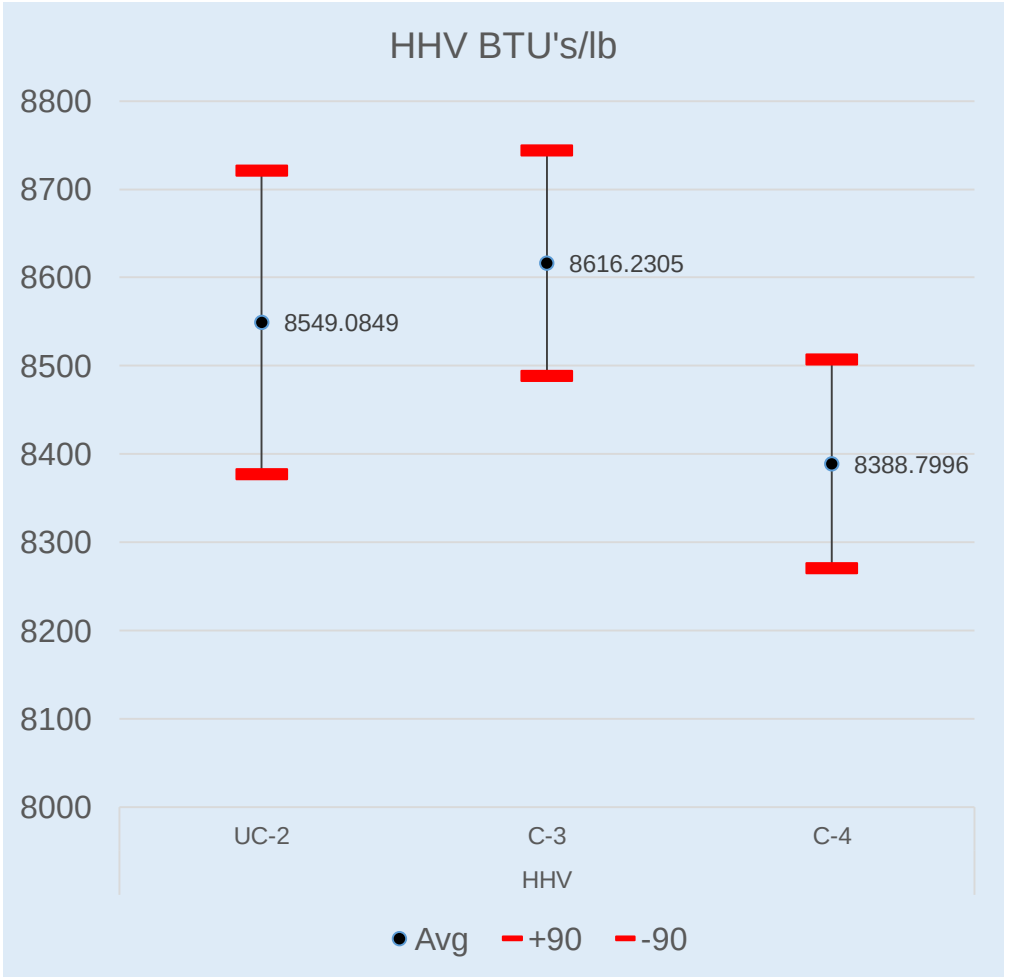
- Potential or higher heat value (HHV) is evaluated at each sample date to determine energy content of materials
  - Assessment of possible loss due to decay
- Recoverable energy (LHV) is calculated based on potential energy and moisture content
  - Assessment of potential energy available due to drying affect.



Forest Products and Wood Science, Schmulsky & Jones, 2011

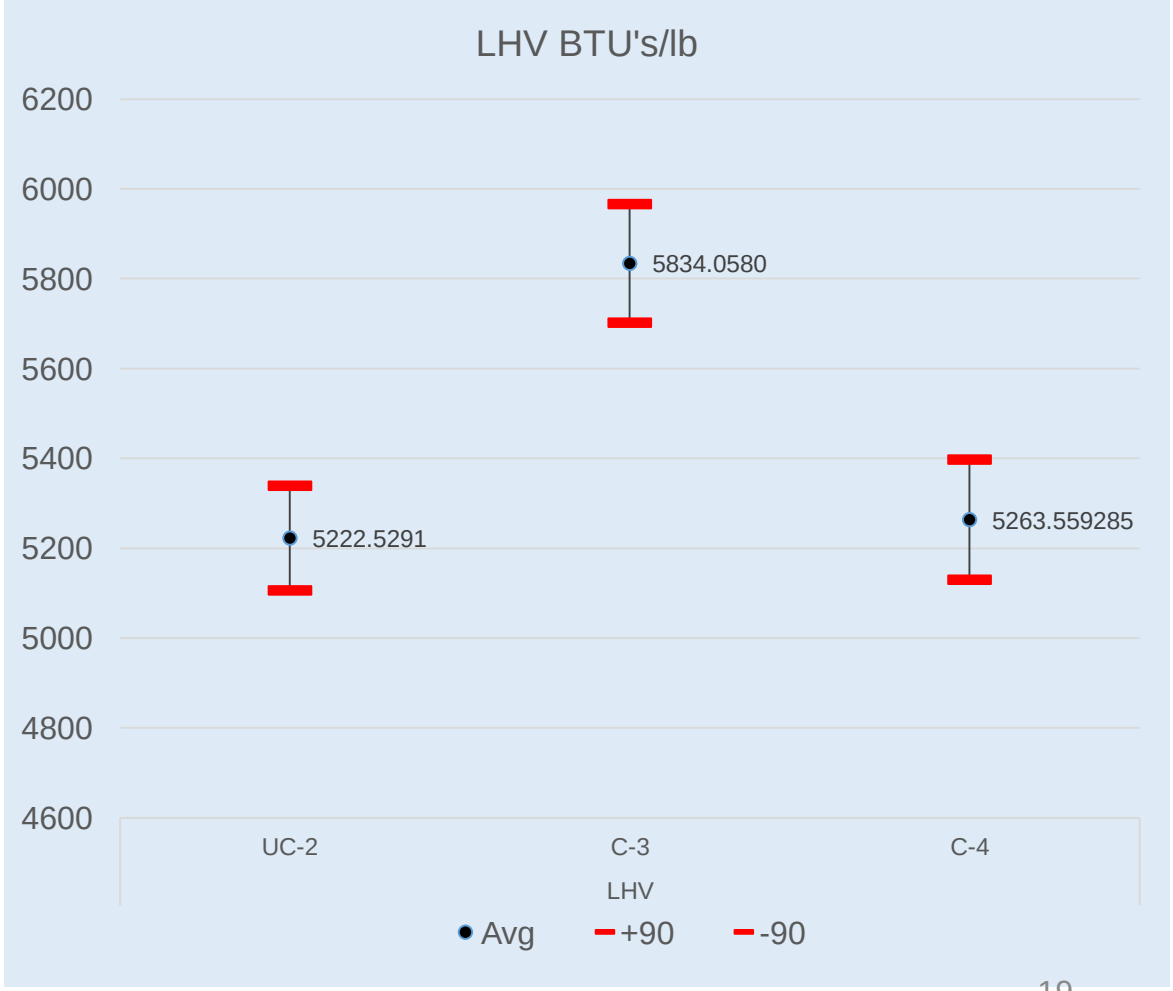
Heat Value results – operational chips

- Higher heat value of the operational chips was obtained using the samples collected from the chip stream
- Date of chipping (2/27/2015)
  - UC-2 = uncovered pile (8549 BTU/lb)
  - C-3 =covered pile (8616 BTU/lb)
  - C-4 = covered pile (8389 BTU/lb)



Heat Value results – operational chips

- Lower heat value (function of HHV and MC) of the operational chips was obtained using the same extracted sample
  - Date of chipping (2/27/2015)
  - UC-2 = uncovered pile (5223 BTU/lb)
  - C-3 = covered pile (5834 BTU/lb)
  - C-4 = covered pile (5263 BTU/lb)



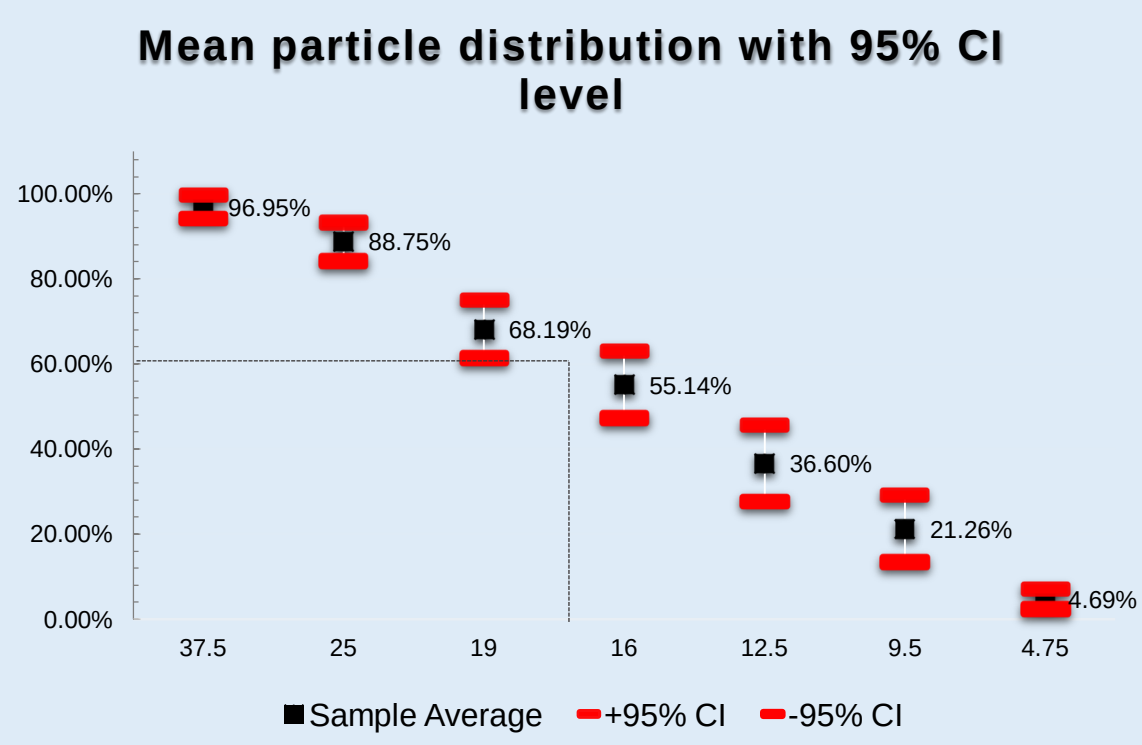
Business As Usual Fuel Model

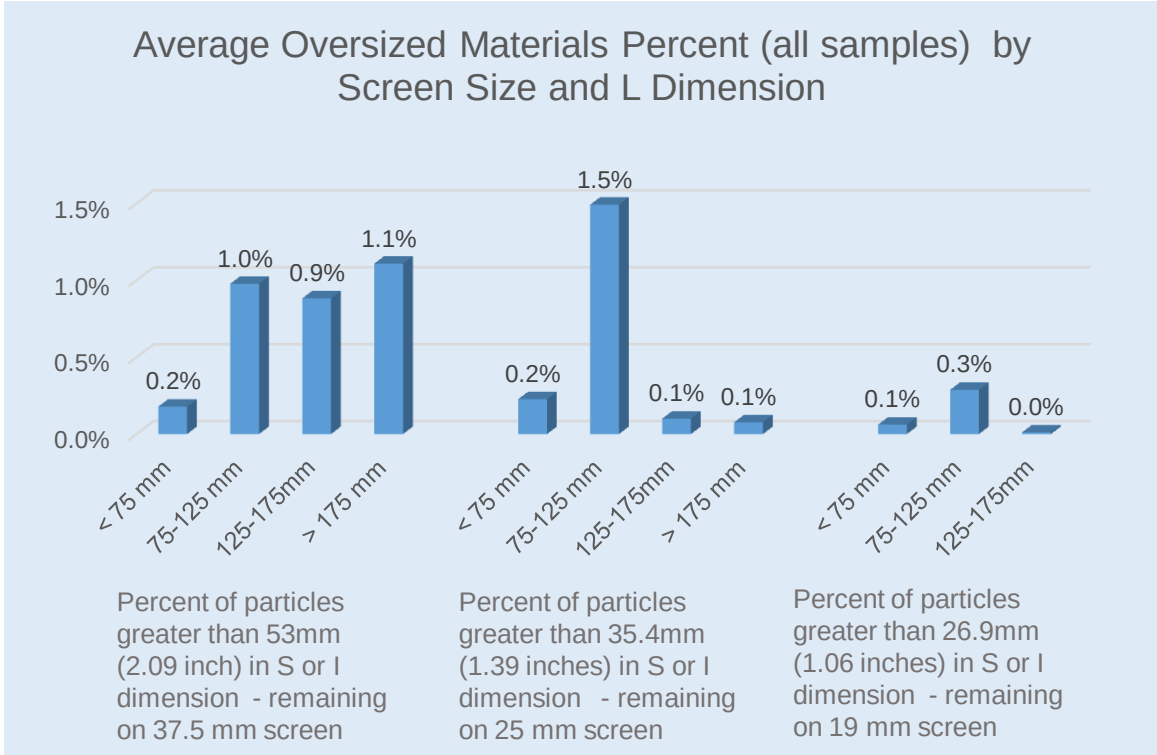
- As part of a innovative district type biomass heating plant being installed at Itasca Community College, a fuel model was built based on standard operational chippers in Northeast Minnesota
  - Four chipping configurations on 12 sites. Chippers with $^{5}/_{8}$ to $^{7}/_{8}$ chip slots and 300 to 600hp power plants
- Materials were analyzed for moisture, heat value and particle size distribution.
  - Green chips – MC_{wet} from 39.9% to 52.7% (Average = 44.6%).
  - HHV average = 8735 BTUs/LB
  - LHV average = 4847 BTUs/LB

Particle Size Analysis

- Operational chips are sorted on a 7 stage vibratory screen using standard screens (ASTM E 11-09).
- Oversized materials are retrieved from the largest screens, longest axis dimension is measured and percent of sample by weight recorded.
- This materials was compared with the 12 BAU chipping operations generating green (or unseasoned) biomass materials collected the 2014-2015 logging season

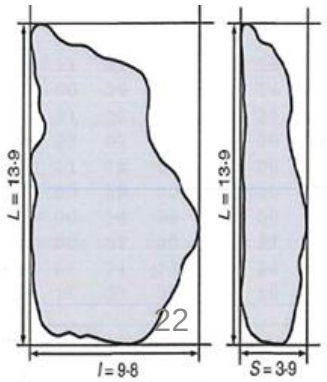
Particle Size Analysis – BAU chips





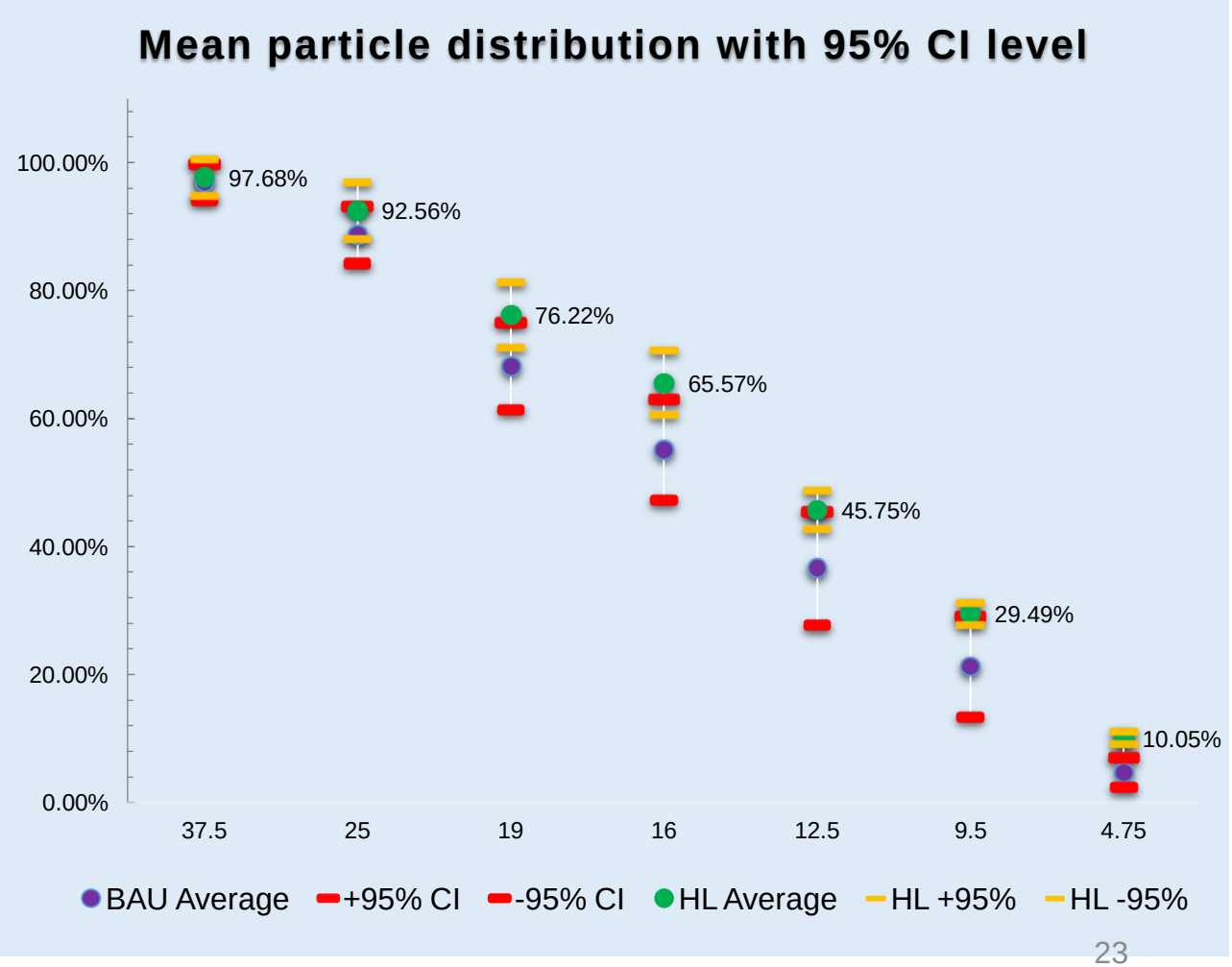
Particle size is displayed as the cumulative percentage that is passed through each successive screen size. Intersection shown above is the point where 60% percent of the material is passed by screens (P_{60}).

Oversize material is defined as the percentage of material, on a weight basis, that exceeds the cross sectional size of the screen in any axis (the particles L axis). Displayed by particles "L" length



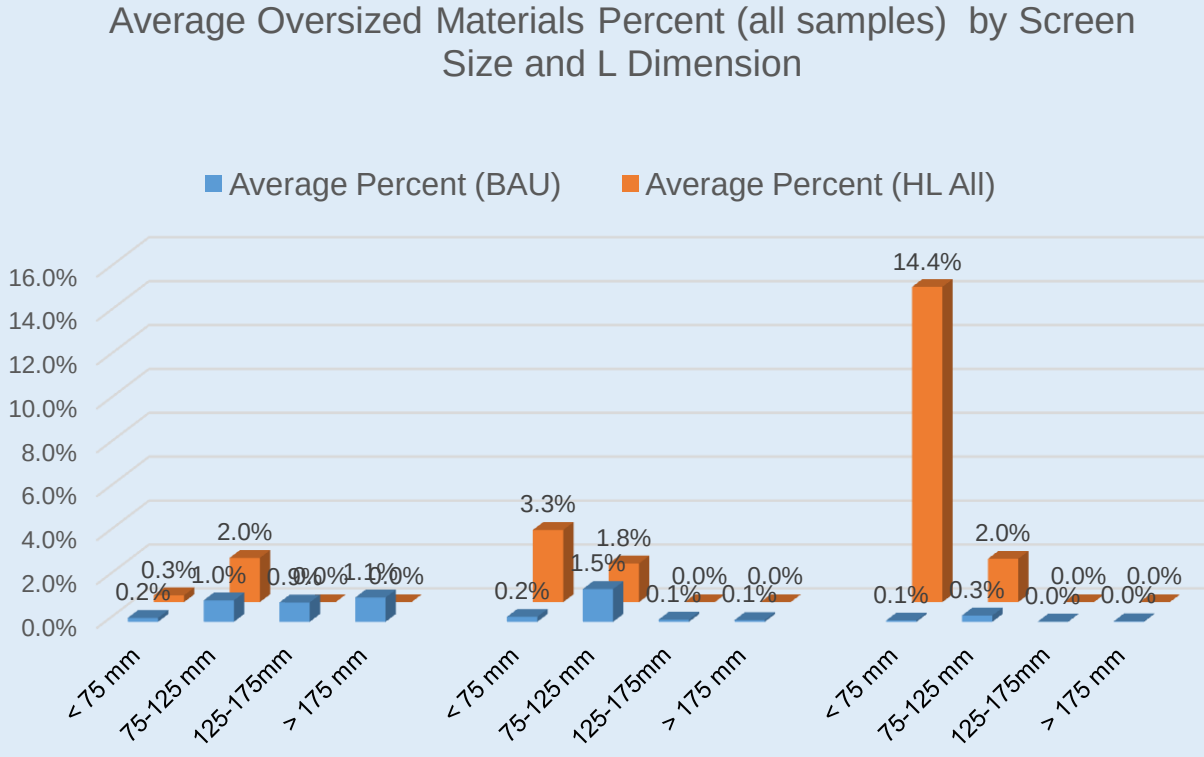
Particle Size Analysis – operational chips

- A slight particle size shift to smaller material, however, none of the changes were statistically significant, with the exception of the increase in percentage of fines (< 4.75 mm, or 0.2 inches)
  - 4.7% in BAU chips
  - 10.0% in dry-down material



Particle Size Analysis – operational chips

- Comparing the dry-down fuel with the BAU chips produced from green wood
  - Largest change increase in the material which measures between ~2 and 3 inches in the long axis
  - Slight increases in the percentages of material ~3 to 5 inches.



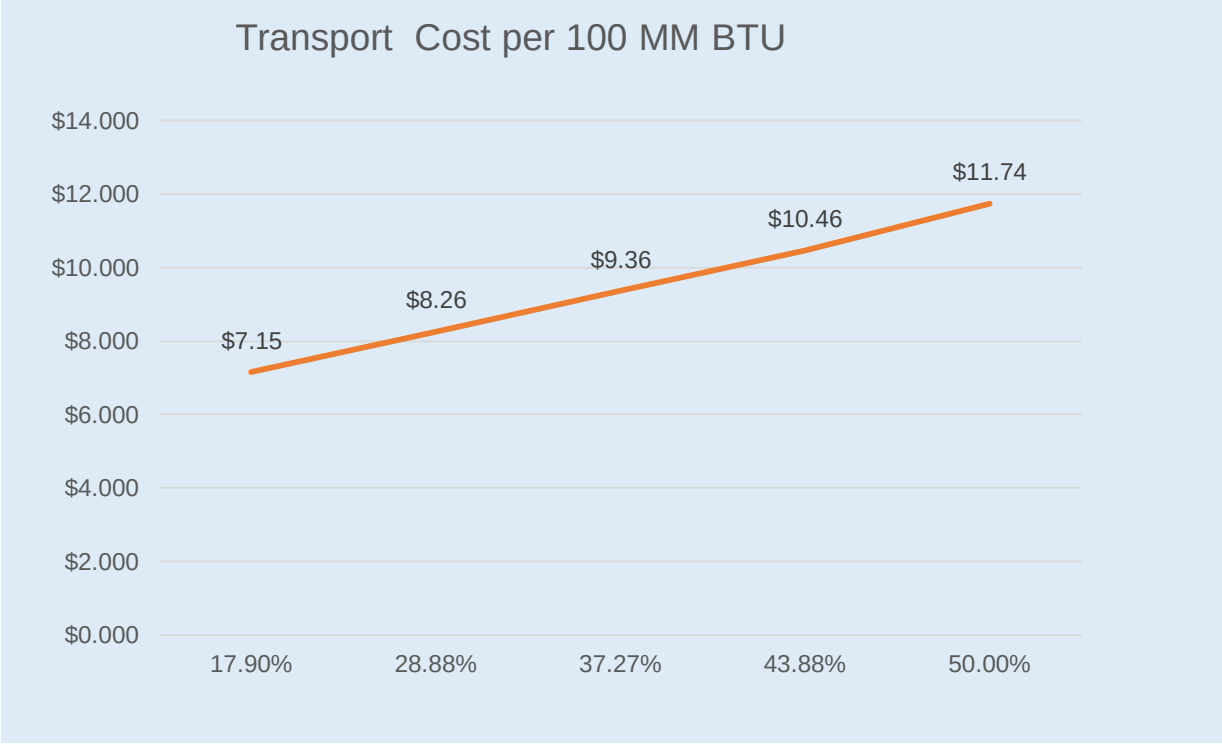
Percent of particles greater than 53mm (2.09 inch) in S or I dimension - remaining on 37.5 mm screen

Percent of particles greater than 35.4mm (1.39 inches) in S or I dimension - remaining on 25 mm screen

Percent of particles greater than 26.9mm (1.06 inches) in S or I dimension - remaining on 19 mm screen

Transporting Dry-down Fuel

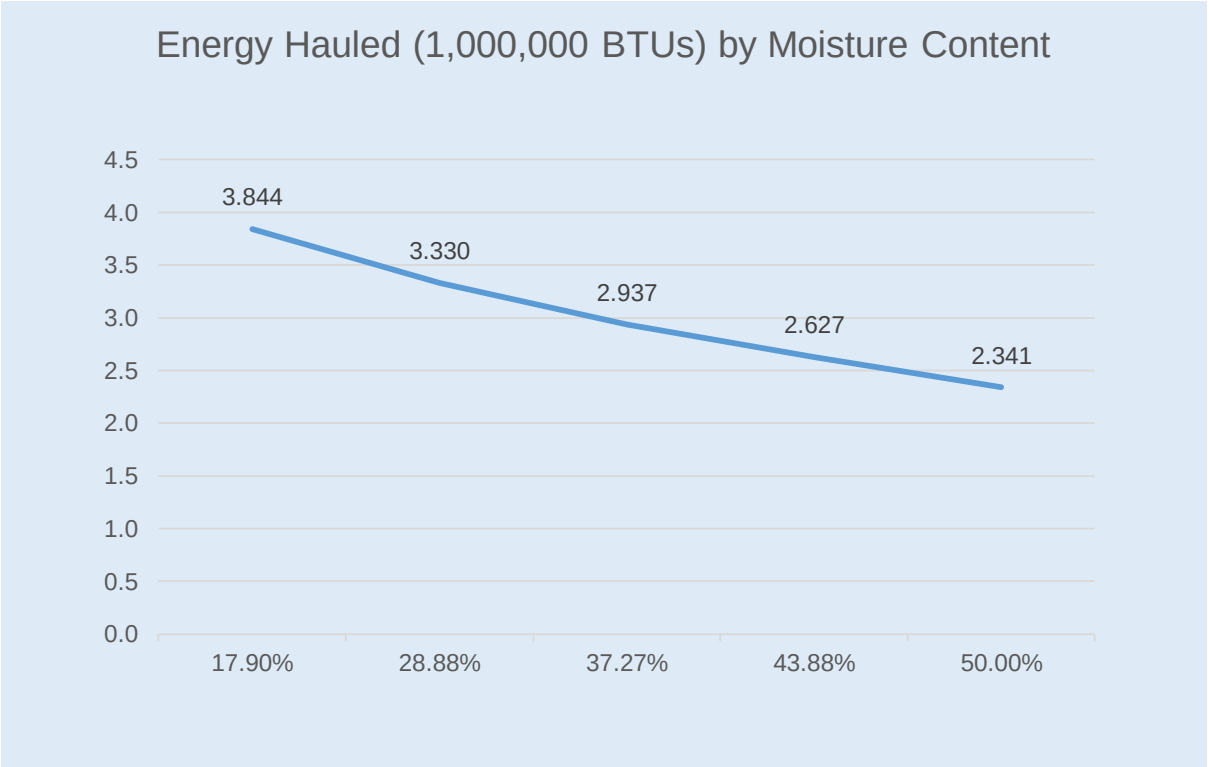
- Based on a 30 mile haul, the cost of hauling additional water has been evaluated.
  - By decreasing the moisture content of the wood from 50% to 29% (MC_{wet}), the payload weight decreases by 15,800 lbs (holding load volume constant).



Operation costs for tractor and van based on *Truck Costing Model for Transportation Managers*, Berwick & Farooq, 2003, NDSU Great Plains Transportation Institute.

Transporting Dry-down Fuel

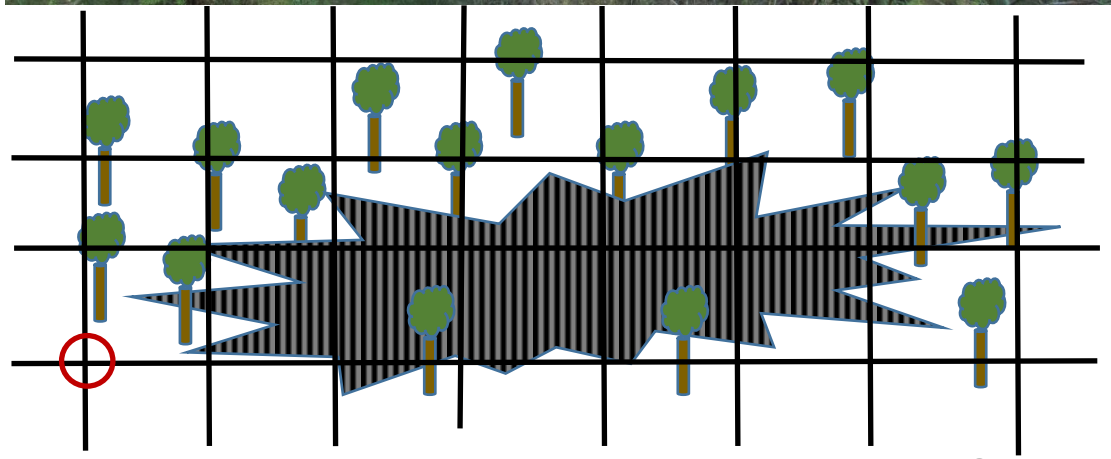
- Based on a 30 mile haul, the cost of hauling additional water has been evaluated.
  - Over the same range, a van containing the drier moisture content wood will contain over 1,000,000 additional BTU's of energy - nearly 30% more energy (holding load weight constant).



Operation costs for tractor and van based on *Truck Costing Model for Transportation Managers*, Berwick & Farooq, 2003, NDSU Great Plains Transportation Institute.

Site Level Evaluation

- Regeneration impact
  - Regeneration will be assessed establishing a grid to quantify the initial regeneration response at the end of the first growing season.
  - Using the permanently established grid, sampling will determine the area of impact and stem reduction caused by the pile removal.
  - Additionally, the regrowth in the following season will be assessed to determine long term impact.



Bradley Jones
Natural Resources Faculty
Itasca Community College
Room 115J, Dailey Hall
1851 East Highway 169
Grand Rapids, MN 55744
Phone: 218-322-2354
Brad.jones@itascacc.edu

Bruno Zagar
Energy Projects Manager
Fond du Lac Band of Lake Superior
Chippewa, Resource Management
Division , Environmental Program
1720 Big Lake Road
Cloquet, MN 55720
Phone: 218-878-7165
brunozagar@fdlrez.com