Production of quality feedstock from forest residues

Han-Sup Han
Humboldt State University
Arcata, California, USA
Forest Residues

Logging Slash

Forest Thinnings
### Feedstock Quality – W2W biomass conversion techs

<table>
<thead>
<tr>
<th>Biomass Conversion Technology</th>
<th>Product</th>
<th>Particle size (inch)</th>
<th>Moisture Content (% wet basis)</th>
<th>Ash content (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gasification</td>
<td>Biochar</td>
<td>0.1 - 4</td>
<td>&lt; 25%</td>
<td>&lt; 15%</td>
</tr>
<tr>
<td>Torrefaction</td>
<td>Torrefied chips</td>
<td>0.1 – 1</td>
<td>&lt; 30%</td>
<td>no limit</td>
</tr>
<tr>
<td>Densification</td>
<td>Briquettes</td>
<td>&lt; 2</td>
<td>4% - 15%</td>
<td>no limit</td>
</tr>
<tr>
<td>Gasification</td>
<td>Electricity</td>
<td>0.5 - 2</td>
<td>10% - 30%</td>
<td>&lt; 15%</td>
</tr>
</tbody>
</table>

(Schatz Energy Research Center, 2017)
Current practice

Sorting tree tops

Sawlogs
Forest residues

Sawlogs
Processed tops
Slash piles
Sorting tree tops during timber harvesting

Processed Tops → Sawlogs

Slash Pile

Unprocessed Tops
Forest Residues Sorted and Processed

Processed conifer

Unprocessed conifer

Processed hardwood

Unprocessed hardwood
Production of quality feedstock from forest residues

- Size distribution:
  - Chipped materials: >95% chips less than 2 inches
  - Ground materials: >55% ground materials larger than 2 inches

<table>
<thead>
<tr>
<th>Material Type</th>
<th>Ave. particle size (inch)</th>
<th>Ash content (%)</th>
<th>Moisture content (%)</th>
<th>Bulk density (lb/ft³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Processed conifer</td>
<td>0.68</td>
<td>0.27</td>
<td>26</td>
<td>14.24</td>
</tr>
<tr>
<td>Unprocessed conifer</td>
<td>0.72</td>
<td>0.64</td>
<td>27</td>
<td>14.92</td>
</tr>
<tr>
<td>Processed hardwood</td>
<td>0.71</td>
<td>1.03</td>
<td>29</td>
<td>20.11</td>
</tr>
<tr>
<td>Unprocessed hardwood</td>
<td>0.81</td>
<td>1.07</td>
<td>27</td>
<td>19.34</td>
</tr>
<tr>
<td>Slash</td>
<td>1.87</td>
<td>1.50</td>
<td>19</td>
<td>8.57</td>
</tr>
</tbody>
</table>

Chipped Materials

Ground Materials
Various types of feedstock produced from forest residues

- Wood chips (<3/4 inch)
- Micro-chips (<1/4 inch)
- Sawdust (<5/32 inch)
Moisture content reduction study

Objective:
Develop on-site methods to lower moisture content

- Processor piled
- Teepee
- Criss-cross
- Scattered
- Covered vs. Uncovered
Key messages...

- Sorting stem wood and tree tops from other residues during a timber harvest operation facilitates the use of a chipper.

- Through sorting and chipping of forest residues, we were able to produce various types of quality feedstock.
  - Small, uniform in size
  - Low moisture content (<20%)
  - Low ash content (<1%)
  - High bulk density
Thank You!

http://wastetowisdom.com/