WOOD FEEDSTOCK SUPPLY ASSESSMENT FOR YAVAPAI COUNTY

Upper Verde River Watershed Task Force

October 26, 2016

Tad Mason, CEO
TSS Consultants
PRESENTATION OVERVIEW

- Overview of Assessment
- Target Study Area
- Vegetation Cover
- Landownership

Findings
- Feedstock Supply
- Feedstock Competition
- Delivered Costs

- Observations
- Questions
FEEDSTOCK SUPPLY ASSESSMENT

Tasks completed:

- Biomass feedstock supply analysis
- Feedstock competition analysis
- Feedstock Delivered cost analysis
- Draft and Final Report
TYPES OF WOOD WASTE CONSIDERED

- Forest residuals from management operations (limbs, tops, small diameter stems)
- Wood waste from hazardous fuels reduction activities (limbs, small stems)
- Woodland restoration residuals (pinyon-juniper removals)
- Urban wood waste (pallets, clean construction wood)
- Residential tree trimmings
- Target Study Area (TSA) is Yavapai County
- 5,201,920 acres
- Includes portions of the Prescott, Coconino and Tonto National Forests
Vegetation cover types include:
tree-covered - conifer forest, 
pinyon-juniper woodland, 
juniper woodland, oak woodland; shrub-covered - 
shrubland, chaparral, mesquite, desert scrub; and grass-covered - 
native grasslands and grassland-steppe

Pinyon-Juniper woodlands lie mostly in the northern and eastern portions of the county.
VEGETATION COVER FINDINGS

- Chaparral, 30%
- Desert Scrub, 22%
- Grassland, 10%
- Conifer Forest, 2%
- Pinyon-Juniper, 18%
- Oak, 1%
- Shrubland, 8%
- Mesquite, 3%
- Sparse Veg, 3%
- Riparian/Water, 1%
- Developed, 2%
Major Landowners are the USFS, BLM, Arizona State Trust Lands and Private.

In the TSA landownership is dominated by federal and state managed public lands.
LANDOWNERSHIP FINDINGS

- USFS, 38.2%
- Private, 25.4%
- BLM, 11.6%
- AZ Trust, 24.3%
- Other Fed, 0.2%
- State&Local, 0.2%
- Native American, 0.1%
Land ownership of vegetation types with biomass potential - pinyon-juniper woodlands and conifer forest

<table>
<thead>
<tr>
<th>Ownership</th>
<th>Pinyon-Juniper Woodlands</th>
<th>Conifer Forest</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ACRES</td>
<td>%</td>
</tr>
<tr>
<td>BLM</td>
<td>14,984</td>
<td>1.6%</td>
</tr>
<tr>
<td>USFS</td>
<td>546,247</td>
<td>56.8%</td>
</tr>
<tr>
<td>Private</td>
<td>247,848</td>
<td>25.8%</td>
</tr>
<tr>
<td>State Trust</td>
<td>148,299</td>
<td>15.4%</td>
</tr>
<tr>
<td>TOTAL</td>
<td>957,377</td>
<td>99.5%</td>
</tr>
</tbody>
</table>

* PERCENT calculation:
Using the total vegetation type acres in the TSA, what percent is found in specified ownership class.
<table>
<thead>
<tr>
<th>FEEDSTOCK SOURCE</th>
<th>POTENTIALLY AVAILABLE (BDT/YEAR)</th>
<th>TECHNICALLY AVAILABLE (BDT/YEAR)</th>
<th>ECONOMICALLY AVAILABLE (BDT/YEAR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Timber Harvest Residuals</td>
<td>3,421</td>
<td>2,053</td>
<td>1,553</td>
</tr>
<tr>
<td>Forest Management and Restoration</td>
<td>1,500</td>
<td>975</td>
<td>800</td>
</tr>
<tr>
<td>Juniper and Pinyon-Juniper Woodlands Treatment</td>
<td>23,365</td>
<td>15,187</td>
<td>15,187</td>
</tr>
<tr>
<td>Urban C&amp;D Wood Waste</td>
<td>11,081</td>
<td>1,662</td>
<td>1,662</td>
</tr>
<tr>
<td>Residential TreeTrimming</td>
<td>30,159</td>
<td>6,032</td>
<td>6,032</td>
</tr>
<tr>
<td><strong>TOTALS</strong></td>
<td><strong>69,526</strong></td>
<td><strong>25,909</strong></td>
<td><strong>25,234</strong></td>
</tr>
<tr>
<td>COMPETITION</td>
<td>SIGNIFICANCE</td>
<td>COMMENT</td>
<td></td>
</tr>
<tr>
<td>-------------------------------------------</td>
<td>--------------</td>
<td>------------------------------------------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>Firewood - personal Use and commercial</td>
<td>Very</td>
<td>Nat’l forests issue thousands of permits/year</td>
<td></td>
</tr>
<tr>
<td>Landscape cover and soil amendment</td>
<td>Minor</td>
<td>Occasional processed green waste delivered to Phoenix are landscape and soil amend enterprises</td>
<td></td>
</tr>
<tr>
<td>Biomass power generation</td>
<td>Minor</td>
<td>Novo BioPower at Snowflake occasionally procures fuel from Yavapai County area</td>
<td></td>
</tr>
<tr>
<td>Biomass power generation</td>
<td>Potential</td>
<td>Drake Cement may consider co-firing on biomass</td>
<td></td>
</tr>
<tr>
<td>Densified fuels</td>
<td>Potential</td>
<td>Densified fuel bricks, pellets or torrefied fuels show promise</td>
<td></td>
</tr>
<tr>
<td>Essential oils</td>
<td>Potential</td>
<td>Niche use for juniper as an aromatic extract</td>
<td></td>
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</tbody>
</table>
# Key Findings – Biomass Feedstock Delivered Cost Forecast

<table>
<thead>
<tr>
<th>Feedstock Type</th>
<th>Delivered Costs Base Case (Mid to High Density Stands)</th>
<th>Delivered Costs Worst Case (Low Density Stands)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low Range ($/BDT)</td>
<td>High Range ($/BDT)</td>
</tr>
<tr>
<td>Timber Harvest Residuals</td>
<td>$45</td>
<td>$50</td>
</tr>
<tr>
<td>Forest Management and Restoration</td>
<td>$45</td>
<td>$50</td>
</tr>
<tr>
<td>Juniper and Pinyon-Juniper Treatment</td>
<td>$55</td>
<td>$75</td>
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Juniper and PJ veg cover represents 960,000 acres in Yavapai County. This amounts to just over 18% of the County.

Conifer forest type is just over 111,000 acres, amounting to about 2% of the County.

**Planned Projects:**
- Prescott NF – Chino Restoration Project covers about 430,000 acres and will likely treat 90,000 acres (much of this is PJ veg cover).
- Kaibab NF – South Zone Restoration Project covers about 270,000 acres with small portion in Yavapai County.

As noted above, USFS is trending towards larger scale project areas. NEPA analysis can require up to 36 months, so lead time planning is critical.

Drake Cement alternative fuels testing project results will be important.

4FRI Project wood fiber output may jump start commercial-scale landscape cover and soil amendment markets in Phoenix.
RECOMMENDATIONS

- Monitor 4FRI Project progress and market development.
- Consider Forest residuals from management operations (limbs, tops, small diameter stems)
- Wood waste from hazardous fuels reduction activities (limbs, small stems)
- Woodland restoration residuals (pinyon-juniper removals)
- Urban wood waste (pallets, clean construction wood)
- Residential tree trimmings
EXAMPLES OF VALUE-ADDED OPTIONS

- Power and thermal energy
- Soil amendments (e.g., compost and biochar) and landscape cover
- Biochar as filtering media
- Animal bedding
- Post/pole products for agricultural use
- Post/pole products for architectural use (such as vigas)
- Fencing products
EXAMPLES OF VALUE-ADDED OPTIONS (cont’d)

- Firewood and densified fuel logs
- Wood pellets for heating and/or power
- Community-scale combined power and heat production
- Greenhouse and native plants nursery
- Rustic furniture/outdoor recreation sets
- Small log sawmill
- Advanced biofuels for transportation
- Bioproducts (biochemicals, nanocellulose)