A Vision for an Integrated Biomass Energy Program for Rural Alaska

DOE NREL Tribal Energy Program

7 November 2007
Yukon Flats Region
Council of Athabascan Tribal Governments
Subsistence Lifestyle -- Salmon Fish Wheel
Mature Housing
New Housing – Fort Yukon
Downtown Fort Yukon – Spring Festival -20F
Rural AK Powered by Diesel Fuel Oil

- Highest energy costs in nation $0.46/ KW Ave.
- $4.50 per gallon of heating fuel
- 800 gal. of fuel oil to heat one house 4K
- Heat School & Gym 30,000gals $125K
- Run Generators = 197,000gals $837K
Goal: Village Survival
Why Biomass as an Energy Source
Alaska has 1/7 of US Forest Lands

Source: AK Energy Authority
Fire Driven Ecosystem
12MM acres statewide in 2003-2004

Fires 1950-2004
Community Based Sustainability

- Program will be economically, socially, and ecologically sustainable.
Integrated Biomass Program

- Rural Economic Development
- Energy Cost Reduction
- Environmental Improvement
- Habitat Enhancement
- Wildfire Mitigation
Community Involvement

- Community must understand program and embrace it fully.
- Local communication is critical.
Phase 1
Pre-feasibility Approach

1. Analysis of energy needs and opportunities for communities and regions
2. Analyze Forest Resource
3. Analyze Cost Benefits
4. Create an integrated systems approach
For-Profit Wood Energy
Business Model Fort Yukon

- Forest Management Program – CATG
- Three For-Profit Companies –
  Gwitchyaa Zhee Native Corporation
    - Regional Wood Harvest Company
    - Village Wood Yard/Distribution Company
    - Wood Energy Utility – Diesel Biomass
      Hybrid Power Plant
Regional Supply Plan

- Harvest from private native lands
- Both summer and winter harvest is possible
- Silvicultural practices are known for interior AK
Wood Harvest Company

- Harvests wood from GZ lands summer and winter – start with recent fires
- Delivers to Village Wood Yard
- Paid upon delivery of wood by weight and dryness formula
- Requires harvest equipment with capacity for 10,000 tons production per year
Village Wood Yard/Distribution Company

- 2-3 acre wood yard - capacity to deliver split fire wood, boiler round wood, wood chips for electrical power boilers;
- Small sawmill for production of dimension lumber for village use;
-Develops supply contracts with end users;
-Or owns heat boilers and sells BTUs of heat and is responsible for feeding boiler
Forest land management plan

Contractual agreements with timber owners

Harvest Company contractual agreement with distribution companies

Village Wood Distribution Company

Contractual agreements with wood consumers

Wood consumed for energy for heat and power generation
Heat Production
Household to Large Buildings
200 KWH ORC Unit
Combined Heat and Power
Summer River Travel

- The most efficient and reliable river transportation system will be a critical component to the overall success of the harvest operations.
First estimate that the Fort Yukon will require more than 10,000 tons of wood annually to fuel their heat and electrical power consumption.
Acreage Harvested

- 10,000 tons / year
- 18 tons/acre
- 60 year biomass rotation
- 555 acres / year
- 33,300 acres / rotation
- GZ 214,000 acres
Wildlife and Land Management

- Integration of wildlife population and habitat management to improve subsistence resources.
- Increase from 1-7 moose/sq mi
A complete harvest system capable of producing 10,000 or more tons of woody biomass annually will cost approximately $800,000.
Ground Harvest Systems

- Small scale harvest systems with proven reliability will be employed
Harvest Production Model

### Biomass Acreage Requirements

<table>
<thead>
<tr>
<th>Tons/Acre</th>
<th>Tons Required Annually</th>
<th>Acres Required Annually</th>
<th>Rotation Age Assumption</th>
<th>Total Sustained Acres Required</th>
</tr>
</thead>
<tbody>
<tr>
<td>18</td>
<td>3700</td>
<td>206</td>
<td>50</td>
<td>1,300</td>
</tr>
</tbody>
</table>

### Biomass Harvest Assumptions

<table>
<thead>
<tr>
<th>Annual Harvest-Acres</th>
<th>Pieces Per Acre</th>
<th>Acres/Day Harvested</th>
<th>Pieces/Day Harvested</th>
<th>Tons/Day Harvested</th>
<th>Total Harvesting Days/Year</th>
<th>Cords/Day Harvested</th>
</tr>
</thead>
<tbody>
<tr>
<td>200</td>
<td>500</td>
<td>2.1</td>
<td>1,050</td>
<td>35</td>
<td>99</td>
<td>31</td>
</tr>
</tbody>
</table>

### Biomass Harvest Costs Work-up

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>$ 97,000</td>
<td>$ 6,500</td>
<td>$ 500</td>
<td>$ 5.50</td>
<td>$ 5,125</td>
<td>$ 95,500.00</td>
<td>$ 153,033.50</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Man-hrs Per Day (All Inclusive)</th>
<th>$/Man-hr</th>
<th>Labor Cost Per Day</th>
<th>Labor Cost Per Acre</th>
<th>Labor Cost Per Ton</th>
<th>Machine Cost Per Ton</th>
<th>Logging Cost Per Ton</th>
</tr>
</thead>
<tbody>
<tr>
<td>40</td>
<td>25</td>
<td>1000</td>
<td>$ 6</td>
<td>$ 476.19</td>
<td>$ 55.96</td>
<td>$ 92.42</td>
</tr>
</tbody>
</table>
Economies of Scale
Annual Production Influence on Cost

Cordwood Production Costs Economies of Scale

Cost Per Cord

Tons Produced Annually @ 23 Tons Daily Production
**Fort Yukon Heat Analysis**

100 gals fuel oil = 1 ton of wood in BTUs

**Fort Yukon Village Heating Analysis**

<table>
<thead>
<tr>
<th>Village Wood Heating based on Houses, District Heat, Major Buildings</th>
<th>Equipment and Installation Costs</th>
<th>Annual Fuel Oil Consumption/gal</th>
<th>Fuel Cost $/Gallon</th>
<th>Annual Fuel Cost</th>
<th>Annual Cord Wood Use Equivalent @70% Displacement</th>
<th>Cord Wood Cost Delivered and Boiler Fed</th>
<th>Total Annual Wood Costs</th>
<th>Total Annual Savings</th>
<th>Annual Savings as % Capital Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>School &amp; Gym</td>
<td>$60,000</td>
<td>30000</td>
<td>$4.10</td>
<td>$123,000</td>
<td>$14.29</td>
<td>$250</td>
<td>$53,571</td>
<td>$32,629</td>
<td>+1%</td>
</tr>
<tr>
<td>Vocational School</td>
<td>$60,000</td>
<td>16000</td>
<td>$4.10</td>
<td>$65,600</td>
<td>11.429</td>
<td>$250</td>
<td>$28,571</td>
<td>$17,649</td>
<td>22%</td>
</tr>
<tr>
<td>4 District Systeme</td>
<td>$320,000.00</td>
<td>38400</td>
<td>$4.10</td>
<td>$157,440</td>
<td>27.429</td>
<td>$250</td>
<td>$58,371</td>
<td>$41,629</td>
<td>15%</td>
</tr>
<tr>
<td>100 Houses</td>
<td>$120,000.00</td>
<td>80000</td>
<td>$4.10</td>
<td>$328,000</td>
<td>57.143</td>
<td>$250</td>
<td>$142,857</td>
<td>$86,743</td>
<td>72%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$600,000</strong></td>
<td><strong>184400</strong></td>
<td><strong>$4.10</strong></td>
<td><strong>$674,040</strong></td>
<td><strong>1174.29</strong></td>
<td><strong>$293,571</strong></td>
<td><strong>$170,257</strong></td>
<td><strong>30%</strong></td>
<td></td>
</tr>
</tbody>
</table>

At $4.10/gal & $250/ton of delivered wood and 70% displacement of diesel an $80K boiler will pay back in 3 years via fuel oil cost savings.
Wood Energy = Greatest Opportunity for Local Economic Develop and Energy Self-Sufficiency

Summer 2005 Porcupine Burn 79,762-acre
Woody Biomass Advantages

- Stabilizes village energy costs and may reduce
- Energy import substitution
- Local employment
- Self-sufficiency = culturally sound
- Village sustainability
Funding Partners to Date

- USDA NRCS
- USDA Rural Development
- Alaska Division of Forestry – DNR
- CATG
- State and Private Forestry – USFS
- DOE Tribal Energy Program
  Nat’l Renewable Energy Lab
Key Components of Biomass Energy Program

- Forest Management Program
- Regional Harvest Company
- Village Wood Distribution Company
- Village Wood Heat Installations
- CHP Diesel Wood Hybrid Power Plant