FOREST BIOFUEL
- Renewable Energy “Rebound” -

Adam Smith
Woody Biomass Project Coordinator
Nebraska Forest Service
FORESTS = “Carbon Neutral Energy”

1.1 Tons O₂

1 Ton Wood Growth

1.5 Tons CO₂
Location: Northwest Nebraska

Enrollment: 2,800 FTE

Geographic Feature: Pine Ridge Escarpment

Nearest Forest: Nebraska National Forest

- E. Hoffman, CSC, '03
Chadron State College

24 buildings
1.1 million sq. ft.
281 acre campus

- E. Hoffman, CSC, ‘03
Chadron State College

- Resident campus
- Approximately 1,000 students in residence
- 100 faculty members
- 300 total employees

- E. Hoffman, CSC, ‘03
Central Steam Plant

- Wood fired boiler (2) conversion - 1991
- Gas fired boilers (2) serve as backup
- Steam absorption chiller - 2004
- Cooling tower

- E. Hoffman, CSC, ’03
GROWTH, MORTALITY & HARVEST
- Arizona & New Mexico National Forests -
  (non-reserved timberland)

Cubic Feet (MMM/year)
- Net Growth
- Mortality
- Harvest

173.839
6.980
30.904

- USFS, '03
Burns ponderosa pine biomass:
- wood
- bark
- needles
- cones

In-woods chipping of slash piles resulting from commercial timber harvest operations

- E. Hoffman, CSC, ‘03
Total on-site reserve = 800 - 900 tons

All fuel reserves are used prior to mid-May

New fuel reserves are delivered each new fiscal year

- E. Hoffman, CSC, '03
Fuel Storage

- Storage capacity = 100 tons
- Maximum daily burn = 45 tons
- Annual consumption = 8,000 – 9,000 tons

- E. Hoffman, CSC, ’03
Fuel Migration

- Fuel moves from live bottom pit to in-floor auger
- Floor auger moves fuel to collection box

- E. Hoffman, CSC, '03
Fuel Migration

- Collection box delivers fuel to covered, incline conveyor
- Live bottom floor, floor auger & incline are demand regulated with time delay relay starts

- E. Hoffman, CSC, ‘03
Fuel Feed Control

- Conveyor delivers fuel to metering bin
- Metering bin regulates fuel delivery to each boiler
- Fuel delivery from this point controlled by VFD’s

- E. Hoffman, CSC, ‘03
Fuel Feed Control

- Fuel feed regulated by VFD’s to boiler stokers
- Stokers feed boilers through grate & retort system

- E. Hoffman, CSC, ‘03
- E. Hoffman, CSC, '03
System utilizes 2 under-fire, retort, fire tube boilers

Rated at 200 & 350 HP with combined capacity of 19,000 lbs./hour of saturated steam

- E. Hoffman, CSC, '03
Boiler Controls

- Computerized controls regulate/monitor:
  - fuel feed
  - combustion air
  - steam pressure
  - refractory temp.
  - stoker motor
  - induced draft

- E. Hoffman, CSC, ‘03
Combustion air forced into furnace burn box by 10 h.p. belt drive fan

Air quantity regulated by damper system

- E. Hoffman, CSC, ‘03
Bag house scrubbers located after each breach & ahead of each induced draft fan

- E. Hoffman, CSC, ‘03
- Ash & boiler waste collected in closed, roll-off container
- Ash generated = 3% of input (wood biomass)
- Classified as inert ash

- E. Hoffman, CSC, '03
Central Chiller

- Newest addition to steam plant

- E. Hoffman, CSC, ‘03
Absorption Chiller

- Rated at 700 tons of cooling capacity

- E. Hoffman, CSC, ‘03
Absorption chiller controller
Central Cooling

- 10” chilled water distribution lines
- Circulation pumps
- Currently serving 4 buildings

- E. Hoffman, CSC, ‘03
Thermo or ice storage created during off peak hours for use during peak times

Capacity of storage = 100 tons over 4 hour use

- E. Hoffman, CSC, ‘03
RENEWABLE ENERGY
- Reduces Harmful Air Emissions -

Year

Tons/Year

Heated Space (Mill. MWhr)

Dust Particle Reduction

SO₂ Reduction

Renewable Energy Increase

- Swedish District Heating Association
<table>
<thead>
<tr>
<th>Country</th>
<th>% Space Heating</th>
</tr>
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<tbody>
<tr>
<td>Finland</td>
<td>50%</td>
</tr>
<tr>
<td>Denmark</td>
<td>50%</td>
</tr>
<tr>
<td>Sweden</td>
<td>38%</td>
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<tr>
<td>Germany</td>
<td>12%</td>
</tr>
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<td>France</td>
<td>4%</td>
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<td>3%</td>
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<tr>
<td>Norway</td>
<td>3%</td>
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<tr>
<td>Netherlands</td>
<td>3%</td>
</tr>
<tr>
<td>Canada</td>
<td>1%</td>
</tr>
</tbody>
</table>

- EuroHeat & Power, "District Heat in Europe", '97
TARM
- How It Works -

- TARM USA, Inc., '06
Air injection ports (2) inside ceramic brick provide oxygen for complete combustion.

- TARM USA, Inc., '06
Combustion tunnel temperatures = 1,800 - 2,000 degrees

102,000 BTUs/hr
COMPARISON

- Evolution of Wood Stove Efficiency -
GARN
- How It Works -

- 2 stage combustion, induced draft & 5 pass heat exchanger

- Massive water storage for farm, community & industry use

- Ceramic combustion chamber burns wood gases at 2,000 degrees

- GARN, '05
BioMax 5 to BioMax 100 (kWe)

Modular Biopower Systems for Farms, Enterprises, Schools & Rural Communities

- Converts on-site biomass residues to power, heat & cooling
- Proven, in-field performance at multiple sites in USA and Asia since 2000
- Clean, green power and heat
- No smoke, smell, water or toxic wastes
- Responds directly to US energy crisis
- Cost: $2,000 to $4,000 / kWe
### Fuels for BioMax
- Forest, farm, and community -

<table>
<thead>
<tr>
<th>PROVEN</th>
<th>POTENTIAL</th>
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<tbody>
<tr>
<td>Wood chips</td>
<td>Cubed grasses</td>
</tr>
<tr>
<td>Construction wood waste</td>
<td>Cubed agriculture residues</td>
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<tr>
<td>Biomass pellets</td>
<td>Dried cakes</td>
</tr>
<tr>
<td>Plastic utensils, bags, etc.</td>
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<tr>
<td>Orchard pruning</td>
<td></td>
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<tr>
<td>Fruit pits</td>
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<tr>
<td>Most shells and hulls</td>
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</tr>
<tr>
<td>• Coconut</td>
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<tr>
<td>• Pecan</td>
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<tr>
<td>• Walnut</td>
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<td>• Nutmeg</td>
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<tr>
<td>• Pistachio</td>
<td></td>
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<tr>
<td>• Palm oil</td>
<td></td>
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<tr>
<td>• Apricot</td>
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Target Facility Types

- Residences
- Workshops
- Schools
- Hospitals
- Small businesses
- Warehouses
- Prisons
- Small scale power
Current Biomass Utilization in Nebraska

- Chadron State College (8,000 – 9,000 tons/yr)
- Arbor Day Lied Lodge – Nebraska City (3,500 tons/yr)
- Several alfalfa dehydrators – Statewide (total 12,500 tons/yr)
Chadron Community Hospital (400 tons/yr – 8 year payback)
Crow Butte Resources – Crawford (350 tons/yr – 13.9 year payback)
Nebraska College of Technical Ag – Curtis (1,040 tons/yr – 13.5 year payback)
Peru State College (3,200 tons/yr – 11 year payback)
UNL – East Campus (26,400 tons/yr – 3.5 year payback)
Interested Facilities

- Bluebird Nursery – Clarkson
- Gering Public Schools
- South Sioux City Parks and Rec
- Cargill Soybean Facility – South Sioux City
- IAMS Pet Food – Aurora
Biomass Source Options

- Forest management/thinning operations
  - Pine Ridge
  - Platte River Corridor
  - Republic River Valley
  - Niobrara River Valley
  - Missouri River Corridor

- Land management firms
  - Eastern red cedar removal

- Municipal wood waste
  - Tree care professionals

- Primary Wood Processors
  - Sawmills

- Secondary Wood Processors
  - Furniture makers, cabinet makers, pallet processors

- Biomass pellet distributors
Due to oncoming insect and disease threats, supply will increase:

- 44 million ash trees statewide
  - 1 million in communities
- 1.5 million black walnut tree statewide
- ~1 million Scotch pine on non-forested lands alone
- ~200,000 ponderosa pine trees on non-forested land (plus 250,000 acres of ponderosa pine forest)
Considerations for Conversion

- Complete feasibility study
  - Know your payback period
    - Typical boiler life is 30 years
  - Keep in mind, payback shortens as fossil fuel prices rise

- Available wood source
  - Established, reliable wood resource
  - Understand the potential price increases of your wood source
  - Remember storage and handling considerations
Barriers to Conversion

- Cost – facilities fail to raise enough capital for conversion
- Inadequate number of harvesters/processors – low market demand has led to low need to create supply
  - Entrepreneurs are needed to work with interested facilities to create supply while they work to conversion
- Public policy – currently, there is little public support for facility conversion
  - Plenty of money for studies and design but none for conversion funding
Federal Tax Incentives

- Wood heating system, biomass stove incentive
  - Capped at $300
- Existing home and principal residence
  - New construction and rentals do not qualify
- Used to heat home or heat water
- Require thermal efficiency of at least 75%
Hired Ralph Johnson as Marketing and Utilization Program Leader
  • Starts mid-May
Currently have a granting opportunity for initial feasibility studies
  • For public or private small to medium facilities interested in woody biomass conversion
  • Up to 50% cost-share, capped at $5,000
  • Contact Adam Smith, Nebraska Forest Service
    • (402) 472 – 1276 or amsith11@unl.edu
Information Resources

- NFS Wood Waste Supply Assessment
- Nebraska Statewide Resource Assessment
- www.woodboilers.com
- www.biomasscenter.org