Making the Most of Wood Heat in Greenhouses

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Consider
Energy Conservation First!!
50% – 80% of land area in New England is forested
How Much Wood/acre?

- Average volume in Connecticut
  - 2000 cubic feet/acre
  - 15.6 cords/acre
  - 39 tons green chips/acre
  - 2730 gallons fuel oil equivalent
  - Will heat 30’ x 96’ greenhouse all winter
What type of Fuel?

- Cordwood
- Log length
- Wood chips
- Pellets
- Bioblocks
- Sawdust
- Hogged fuel
Storage
Comparison to fuel oil

- 1 cord hardwood = 175 gal
- 1 ton pellets = 130 gal
- 1 ton chips/sawdust/hogged
  - 15% = 120 gal
  - 30% = 90
  - 50% = 60
First Stage (<500 deg)  
Moisture removal 

- Heat wood  
- Drive off moisture
Second Stage (500 – 1100 deg)
Volatile distillation

- Wood breaks down
- Volatiles driven off
- Vapors burn
Third Stage (>1100 deg)
Burning of Carbon

- Charcoal burns
- Ashes formed
Small Wood Stoves for Greenhouse Heat

- Limited output
- Frequent filling
- Non-uniform heat distribution
Pellet stoves

- Low moisture fuel
- Fuel easy to handle
- Automatic feed
- Thermostat control
- May not need a chimney
- Need power
Pellets delivered in Bulk
Outdoor Wood Furnaces

- Many manufacturers
- 150,000 – 1 M Btu/hr
- Natural or forced draft
- Regular or stainless steel
- Water jacket capacity
- Chimney height
- Smoke problems
- Backup burner
- Safety controls
High Efficiency OWF
Wood Gasification

- Volatiles are driven off
- Burned in separate chamber
- Maintains high heat (2000+ degrees)
- Heat transferred to water or air in heat exchanger
Pallet burner
Heat Storage Tanks
Outdoor Wood Furnace - Example

- Five – 30’ x 100’ hoophouses
- Current fuel usage – 15,000 gal/yr
- Cost at $2/gal = $30,000
- 1 million Btu OWF – provides 75%
- Wood needed – 100 cords
- Cost @ $100/cord = $10,000
- Total cost to heat greenhouse –
  - $7,500 oil + $10,000 wood = $17,500
- Savings = $12,500/yr
- Payback = < 6.4 years
Wood chip boiler

- Limited manufacturers
- Large size units
- Burn any biomass
- Automatic feed
- Automatic ash removal
- Meets environmental requirements
- Can get cogeneration
Wood Chip Boilers
## Estimated cost of wood chip boiler

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost</th>
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<tbody>
<tr>
<td>900,000 Btu/hr boiler</td>
<td>$65,000</td>
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<tr>
<td>Hoophouse w/concrete floor</td>
<td>20,000</td>
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<tr>
<td>Metering bin</td>
<td>8,000</td>
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<tr>
<td>Double wall chimney</td>
<td>1,000</td>
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<tr>
<td>Hot water supply piping</td>
<td>4,000</td>
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<tr>
<td>Electrical supply &amp; controls</td>
<td>5,000</td>
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<tr>
<td>Site prep, driveway, permits</td>
<td>5,000</td>
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<tr>
<td><strong>Total cost</strong></td>
<td><strong>$108,000</strong></td>
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</table>
Large Wood Boilers
## Fuel Selection – example

**30’ x 100’ double poly greenhouse**

<table>
<thead>
<tr>
<th>Quantity</th>
<th>Type</th>
<th>Price</th>
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<tbody>
<tr>
<td>4350 gallons</td>
<td>propane @ $2.00</td>
<td>$8700</td>
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<tr>
<td>3000 gallons</td>
<td>#2 fuel oil @ $2.00</td>
<td>$6000</td>
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<tr>
<td>23 tons</td>
<td>wood pellets @ $250</td>
<td>$5750</td>
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<tr>
<td>3570 gallons</td>
<td>cooking oil @ $1.50</td>
<td>$5350</td>
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<tr>
<td>4140 therms</td>
<td>natural gas @ $1.00</td>
<td>$4140</td>
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<tr>
<td>1000 bushels</td>
<td>corn @ $4.00</td>
<td>$4000</td>
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<tr>
<td>70 tons</td>
<td>graded wood chips $50</td>
<td>$3500</td>
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<tr>
<td>16.6 tons</td>
<td>hard coal @ $180</td>
<td>$2988</td>
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<tr>
<td>17 cords</td>
<td>seasoned hardwood @ $100</td>
<td>$1700</td>
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</table>
Advantages to burning wood

- Renewable fuel source
- Readily available in New England
- Reduced fuel cost
- Can get winter’s fuel supply during the summer
- Equipment is getting more efficient
Concerns with burning wood

- Equipment usually more expensive
- Good wood supply needed
- Wood storage
- Air pollution
- Ash disposal
For more information

Heating with Wood and Coal