Green Heating
The goal of green heating is to use the least amount of fuel to heat a conditioned space.

\[
\left( \frac{\text{Heatloss (BTU)}}{\text{(Indoor Temperature - Outdoor temperature)} \times 1HR} \right) \times \left( \frac{\text{Heating Degree Days} \times 24\text{hrs}}{\text{CCF's of Gas} \times 100\text{kBTU}} \right) = \% \text{ Efficiency}
\]
Heating System Efficiency can further be broken down into three parts.

- Fuel Efficiency
- Boiler Side Efficiency
- System Side Efficiency
Fuel Efficiency

kg CO2 per MMBtu

From John Sigenthaler P.E.
Comparison and Conversion of Different Fuel Costs in Connecticut

Electricity: 20.56 cents per kwh = $6.025 per therm
Natural Gas: $1.61 per ccf = $1.57 per therm
#2 Heating Oil: $2.48 per gallon = $1.79 per therm
Propane: $2.61 per gallon = $2.86 per therm

1 therm = 100,000 btu’s
Fine Particulate Emissions

From Brookhaven Labs
Relative Emissions of Fine Particulate Matter From Home Heating Devices

- Outdoor Wood Boiler: 72 g/hr
- Conventional Wood Stove: 18.5 g/hr
- EPA Certified Wood Stove: 6 g/hr
- Oil Furnace: 0.07 g/hr
- Gas Furnace: 0.04 g/hr

Ref. Smoke Gets in Your Lungs: Outdoor Wood Boilers in New York State October 2005
New York State Office of the Attorney General Environmental Protection Bureau

From BrookHaven Labs
Solar
Free Energy
Geothermal Energy from the Ground
Combined Heat & Power
Boiler Side Efficiency

“The Fuel Savings were Immense!”

Brook Jones, the homeowner
Boiler Replacement Study

<table>
<thead>
<tr>
<th>School</th>
<th>Before Therms Steam</th>
<th>After Therms LT/Cond Blr</th>
<th>Therms Saved</th>
<th>Percent Saved</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>69,327</td>
<td>25,171</td>
<td>44,156</td>
<td>64%</td>
</tr>
<tr>
<td>2</td>
<td>50,875</td>
<td>16,607</td>
<td>34,268</td>
<td>67%</td>
</tr>
<tr>
<td>3</td>
<td>64,513</td>
<td>24,008</td>
<td>40,505</td>
<td>63%</td>
</tr>
<tr>
<td>4</td>
<td>96,671</td>
<td>29,933</td>
<td>66,738</td>
<td>69%</td>
</tr>
<tr>
<td>5</td>
<td>42,078</td>
<td>12,034</td>
<td>30,044</td>
<td>71%</td>
</tr>
<tr>
<td>6</td>
<td>64,780</td>
<td>19,787</td>
<td>44,993</td>
<td>69%</td>
</tr>
<tr>
<td>7</td>
<td>61,499</td>
<td>23,496</td>
<td>38,003</td>
<td>62%</td>
</tr>
<tr>
<td>8</td>
<td>54,333</td>
<td>17,025</td>
<td>37,308</td>
<td>69%</td>
</tr>
<tr>
<td>9</td>
<td>97,257</td>
<td>23,210</td>
<td>74,047</td>
<td>76%</td>
</tr>
<tr>
<td>10</td>
<td>77,514</td>
<td>24,623</td>
<td>52,891</td>
<td>68%</td>
</tr>
<tr>
<td><strong>Average</strong></td>
<td></td>
<td></td>
<td><strong>68%</strong></td>
<td></td>
</tr>
</tbody>
</table>

Table 1: Steam to condensing boilers.

<table>
<thead>
<tr>
<th>School</th>
<th>Before Therms 180°F HW</th>
<th>After Therms LT/Cond Blr</th>
<th>Therms Saved</th>
<th>Percent Saved</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>59,246</td>
<td>28,207</td>
<td>31,039</td>
<td>52%</td>
</tr>
<tr>
<td>12</td>
<td>67,255</td>
<td>38,689</td>
<td>28,566</td>
<td>42%</td>
</tr>
<tr>
<td>13</td>
<td>54,812</td>
<td>24,051</td>
<td>30,761</td>
<td>56%</td>
</tr>
<tr>
<td>14</td>
<td>45,262</td>
<td>28,089</td>
<td>17,173</td>
<td>38%</td>
</tr>
<tr>
<td>15</td>
<td>49,553</td>
<td>24,636</td>
<td>24,917</td>
<td>50%</td>
</tr>
<tr>
<td>16</td>
<td>60,487</td>
<td>24,629</td>
<td>35,858</td>
<td>59%</td>
</tr>
<tr>
<td>17</td>
<td>55,109</td>
<td>31,099</td>
<td>24,010</td>
<td>44%</td>
</tr>
<tr>
<td>18</td>
<td>57,987</td>
<td>20,804</td>
<td>37,183</td>
<td>64%</td>
</tr>
<tr>
<td>19</td>
<td>39,150</td>
<td>26,040</td>
<td>13,110</td>
<td>33%</td>
</tr>
<tr>
<td>20</td>
<td>44,651</td>
<td>22,357</td>
<td>22,294</td>
<td>50%</td>
</tr>
<tr>
<td><strong>Average</strong></td>
<td></td>
<td></td>
<td><strong>49%</strong></td>
<td></td>
</tr>
</tbody>
</table>

Table 2: Conventional HW boilers to condensing boilers.

From the ASHRAE Journal by Tom Durkin P.E.
Five ways to save Energy on the Boiler Side

- Lower water Temperature
- Recover Heat from the Condensate
- Less Standby Losses
- Reduce Short Cycling
- Tune combustion for lower stack temperature and oxygen.
“After we installed radiant floor heating in several rooms, even on the coldest days, you can stand anywhere in the room and you’re warm and comfortable. And with our indirect water heater, we never run out of hot water. Just as important, our hydronic system has cut our heating bills by 30%.”

-- Albert James, owner of a 3,000 sq. ft. home in Stamford, CT
CAD Drawings
System Side Efficiency

From John Sigenthaler P.E.
• Santa waves bye bye to the energy as it escapes out of the vent.
Best Ways to save energy on the system side

- Lower the water temperature
- Run smaller distribution pipes
- Do not run pipes in unconditioned spaces
- Put your heat emitters on the inside walls
- Turn down the thermostat
- Balance the room temperatures
European Style Hydronics

• “In Europe, essentially 100% of home heating systems are hydronic. Advantages reported for hydronic systems include comfort, reduced electric power consumption, and near elimination of energy losses associated with distribution systems (duct losses can reach 30-40%)”.

• by Dr. Tom Butcher, Dept Head, Energy Efficiency Buildings Div, Brookhaven Laboratories (One of 10 U.S. Dept of Energy Laboratories)
Low Temperature Hydronics

• In Germany it is illegal to design for more than 138 degrees and an outdoor reset control is mandatory.

• The rule of thumb is for every 2 or 3 degrees you lower the water temperature you can save 1% in fuel.
Even Temperatures are delivered with warm comfortable radiant heating. Central Europe is 67% Radiant Heat.
Radiant Heating
Before and After
Underneath and Above
Jaga low temperature radiators and convectors
Jaga DBE

• Prepare yourself for the future: same size, 3 times the heating output

• Standard Low-H2O emitters are the most powerful on the market, thus the best choice for condensing boilers. But that’s not all! With optional DBE, these outputs can even be tripled! Combined with DBE the same fin tube element emits 2 to 3 times more heat, with no increase of size! This makes Low-H2O the best solution for heat pumps, solar energy and all systems running with extremely low water temperatures as low as 95°F. DBE technology gives you the opportunity to make the best use of the full range of new, environmentally friendly systems.
Artistic Statements
The European House

Sani Roeda

condensing boiler or heat pump

Strada

Comfort guaranteed with or without radiant heating system

Mini Canal
Thank you!

• John Ruhnke
• JR’s ComfortableHeat LLC
• JR@ComfortableHeat.com
• (203) 849-1479