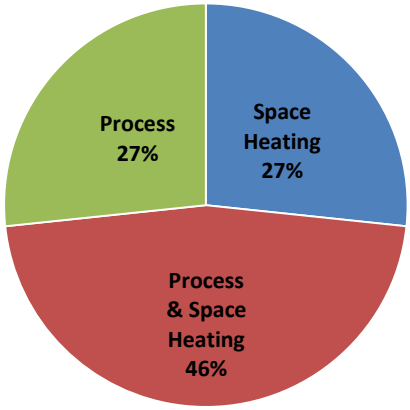
Benefits of Energy Assessments Conducted on Wood-Fired Boilers in North Carolina

Wood-fired boilers are common at furniture and lumber facilities in North Carolina. As shown in Figure 1, the steam generated by the boilers is used for process heat (such as drying kilns), space heating or both. Many of the boilers are older, with an average age being 46 years old. These boilers were originally designed to support the steam demands of a large manufacturing operation. Over time, the steam demand at many facilities has significantly decreased with the boilers operating at very low loads. In addition, many of the boilers do not have measurement or control systems to maintain efficient combustion. **An energy assessment conducted by an experienced professional on these older boiler systems can often provide cost-effective recommendations to improve their efficiency**.

Figure 1: Steam Use at Facilities



Typical fuels for the boiler are sawdust or woodchips that are waste materials generated from on-site processes such as milling. Additionally, a small amount of waste-wood may be obtained at low cost from nearby lumber or furniture facilities. In addition, some facilities burn other fuel types such as natural gas during the winter months when extra steam is needed. The moisture content of the wood-waste greatly impacts the heat content of the fuel.

The fuel in a wood-fired boiler is often burned in suspension using fans. This makes controlling combustion operationally more difficult than for oil or gas fired units.

Since controlling combustion is more complex and given that the fuel is generally free, there seems to be little incentive to operate wood-fired boilers more efficiently. However improving efficiency has several advantages which are listed below.

Benefits of Improving Boiler Efficiency

- Reduced fuel use
- Less maintenance
- Better control of the combustion
- Reduced use of water and water treatment chemicals
- Reduced air pollution emissions

Average Reduction in Fuel Use

23%

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Energy Savings

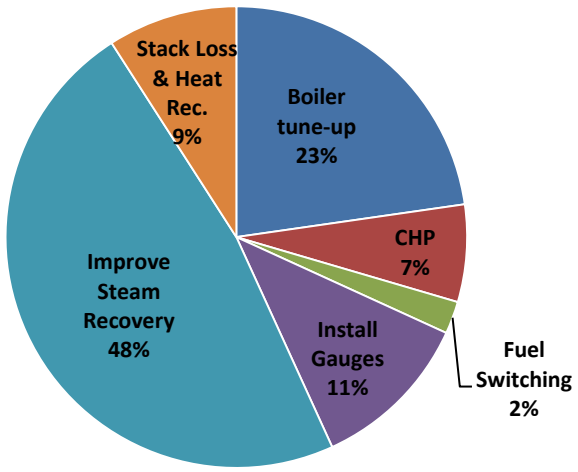
Since 2011, our partners at North Carolina State University (NCSU) and Waste Reduction Partners (WRP) have conducted over 20 energy assessments on wood fired boiler systems. These assessments identified specific recommendations where facilities can reduce fuel use and costs associated with the boilers and steam systems. Implementing the energy assessment recommendations would reduce fuel use by 23 percent at a typical facility. In addition to energy efficiency, the assessors identified operational repairs that needed to be conducted on several of the boilers. Any energy savings that may result from performing the repairs could not be quantified by the assessors.

The figures and table below discuss the energy saving opportunities identified during the assessments.

Common Problems with Boiler Systems

- High stack temperatures
- Non-operational fans
- Broken baffles inside the boiler
- Steam leaks and failed steam valves
- Operating boiler at low loads

Figure 2: Frequency of Recommendations



Typical Recommendations to Improve Efficiency

Boiler tune up	Improve combustion efficiency by adjusting fuel to air ratio
Reduce stack losses and improve heat recovery	Clean heat transfer surfaces, repair baffles in boiler, and insulate condensate tanks
Improve steam recovery	Increase condensate return and repair steam traps
Install gauges	Monitor temperature, pressure and make-up water flow
Fuel switching	Switch to natural gas for smaller process operations which enables wood boilers to be shut down in summer months
Install Combined Heat and Power (CHP) systems	Use excess steam to produce electricity (See information below)

Cost Savings

A significant portion of the facilities obtain fuel for free. However, the assessments did identify a number of costs saving measures associated with the boilers. The average cost savings for implementing the recommendations identified at a facility during an assessment is $10,000 per year. These savings include purchased fuel, maintenance, and water treatment costs.

Typical capital investments ranged from $0 to $15,000. Payback time for the capital investment varied significantly based on whether the facility obtained its fuel for free or purchased fuel. Inexpensive recommendations with immediate payback include regular steam trap maintenance, monitoring stack temperature, measuring feed water and changing bottom blowdown procedures.

The table below summarizes the average fuel savings, cost savings, and emissions reductions from the twenty assessments that were conducted by our partners.

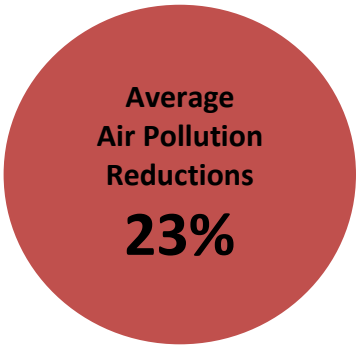
Projected Average Savings and Emission Reductions

	Energy Savings (MMBtu/yr)	Cost Savings ($/yr)	Initial Capital Cost ($)	GHG CO_2e (ton/yr)	SO_2 (lb/yr)	NO_X (lb/yr)	HAP (lb/yr)
Boiler tune-up	1,900	$6,800	$10,000	200	47	700	70
Fuel Switching	5,500	$0	$100,000*	250	136	2,300	200
Install Gauges	200	$320	$1,100	20	13	40	6
Improve Steam recovery	1,100	$4,400	$3,300	120	197	580	50
Reduce Stack Loss & Improve Heat Recovery	900	$210	$14,500	90	33	430	40

*The high value is due to new equipment costs from switching to natural gas. This is not included in the capital investment range.

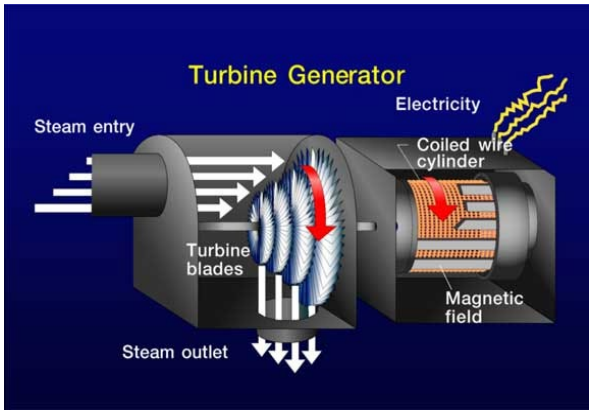
Air Pollution Reductions

Implementing cost-effective energy efficiency measures at furniture and lumber facilities decreases emissions of air pollutants from the boilers by approximately by 23 percent. This reduction in air pollution can be beneficial in two ways. First, it decreases the emissions that are reported for regulatory compliance on the air quality permit. This decrease may change the type of permit required by the facility. Second, the decrease in air pollution can be included in any sustainability reports developed by the company.



Combined Heat and Power (CHP)

It is common practice for facilities that generate wood-waste in excess of their steam use to periodically burn the wood-waste and vent the unwanted steam into the atmosphere. This is done to save money on transporting and disposing of the excess wood. Combusting excess wood-waste has two drawbacks. First, the facility incurs costs for operating the boiler. Second, it increases air pollution unnecessarily.



Advantages of CHP

- Reduces energy costs for the user
- Reduces risk of electric grid disruptions
- Provides stability in the face of uncertain electricity prices

In this case, the assessors recommended installing small a steam turbine to generate electricity from the excess steam. These small micro-turbines are becoming more economical due to the decrease in capital costs and state incentives promoting renewable energy programs in North Carolina. CHP projects are eligible for North Carolina's **35 Percent Renewable Energy Investment Tax Credit**[1]. Electric utilities can also purchase electricity generated from wood-waste to comply with the Renewable Energy and Energy Efficiency Portfolio Standard[2](REPs).

The U.S. Department of Energy (DOE) provides technical assistance for combined heat and power projects to facilities to help them through the project development process - from initial screening to installation. More information about the program can be found at the U.S. Department of Energy CHP Technical Assistance Partnerships (Southeast region) website (http://www.southeastchptap.org/).

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[1] http://www.ncleg.net/Sessions/2009/Bills/House/PDF/H512v5.pdf
[2] http://www.ncga.state.nc.us/Sessions/2007/Bills/Senate/PDF/S3v6.pdf