Energy Conservation in the Wood-Furniture Industry

Mary C. Emplaincourt, Mississippi State University, Industrial Assessment Center
Kristoffer S. Findley, Mississippi State University, Industrial Assessment Center
B. K. Hodge, Mississippi State University, Industrial Assessment Center

ABSTRACT

The Industrial Assessment Center (IAC) at Mississippi State University (MSU) has conducted assessments in over thirty wood-furniture manufacturing facilities since 1994. As a result of these assessments, energy, waste, and productivity recommendations common to this industry have been identified. End-point energy usages for electricity and natural gas experienced by the facilities and a discussion, including expected savings and payback period, of energy and waste recommendations common to the wood-furniture industry are presented. Much of the information contained in this paper is also in a brochure mailed to plant managers in the wood-furniture industry to provide technical assistance on energy, waste, and productivity management practices.

Introduction

In the northern part of Mississippi, the wood-furniture industry is a dominant industry. The Industrial Assessment Center (IAC) at Mississippi State University (MSU) has conducted assessments in over thirty wood-furniture manufacturing facilities since 1994. This geographic region is served by the Tennessee Valley Authority (TVA), a quasi-public utility, and enjoys utility rate structures significantly lower than the national average. The paper begins by examining the end-point energy usages for thirty wood-furniture manufacturing facilities, a summary of data collected by the MSU IAC over an eight-year period. The rest of the paper is devoted to energy conservation measures and waste minimization recommendations developed over this time period that have the potential to positively impact profitability for this industry. The MSU IAC concentrates on developing recommendations based on a two-year payback period or less, as requested by the wood-furniture industry. A special project allowed the MSU IAC program to assemble and distribute to wood-furniture facilities a bi-fold brochure, "Energy Management Practices Guide for the Wood Furniture Industry" regarding the information and recommendations resulting from the assessments.

Electrical and Natural Gas End-Point Energy Usage

The pie charts in Figures 1 and 2 show average annual end-point energy usages for electricity and natural gas in thirty facilities. More dollars are spent annually for electricity than for natural gas in these facilities. Process energy at forty-three percent accounts for the largest portion of the annual electrical energy usage. Lights account for twenty-three percent of the annual electrical usage. Eighteen percent of electricity is used for space conditioning mainly the administrative offices. Typically, air conditioning production areas is cost prohibitive. These operations are housed in older buildings not economically conducive to retrofitting for efficient cooling.

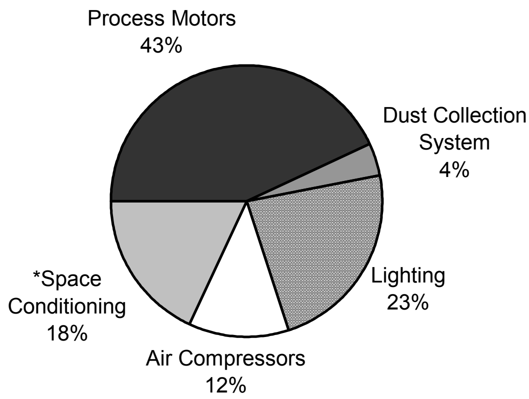
Dust collection systems use the least end-point energy usage percentage of electricity, and this percentage is expected to diminish since many of the facilities visited anticipate receiving wood subassemblies or wooden components ready to be assembled and finished. Additionally, kilns are being used less since facilities are buying lumber already dried. The annual electrical usage for air compressors is twelve percent. Potential savings associated with repairing air leaks is low because air leaks that are located in inaccessible places cannot be evaluated.

Heating the production areas of these facilities dominates the annual usage of natural gas. Mississippi winters average from 1200 to 3000 heating degree day (HDD-Fahrenheit); most of the wood furniture industry is located in 2500-3000 HDD (F) range. The process equipment used in the wood-furniture industry does not provide enough heat for space conditioning on the production floor. Gas used in processes, such as paint drying and packaging, makes up the rest of annual natural gas usage.

Energy Management Recommendations

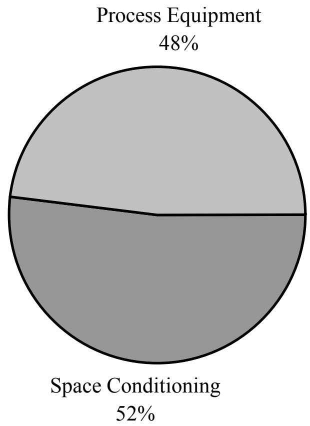
Common recommendations to conserve electricity were to improve/reduce/control lighting, to control HVAC systems, to improve dust collection systems efficiencies, to reduce the demand on air compressors, and to improve power factors. Suggestions to lower natural gas heating costs in the winter months were to utilize radiant gas heaters for spot heating employees and to recover waste heat from equipment (such as air compressors) to help space condition production areas. Other ideas encouraged by the IAC were to check natural gas equipment efficiencies annually and to consider preheating combustion air in natural gas equipment.

Figure 1. Average Electrical End-Point Energy Usage



*18% for space conditioning is an average.

Figure 2. Average Natural Gas End-Point Energy Usage



Improve Lighting Efficiency

Replacing standard T-12 fluorescent lamps using magnetic ballasts with T-8 fluorescent lamps using electronic ballasts saves energy and provides the same or better lighting intensity.

For wood-furniture facilities where metal halide high-intensity discharge lamps (MH) were used and where color rendering of the lighting was not an issue, the replacement of MH lamps with high-pressure sodium high-intensity discharge lamps (HPS) was recommended.

The annual operating hours (number of shifts per day) of a wood furniture facility is a critical factor in terms of an attractive payback period when recommending more energy efficient lamp/ballasts. In Table 1, the payback periods (calculated using TVA rate structures), based on type of lighting replacement and the number of shifts the facility is operating are shown. In the facilities that operate multiple shifts, replacing standard T-12 lamps/ballasts with T-8 lamps/ballasts or replacing MH lights with HPS lights is a viable economic alternative.

Table 1. Financial Payback Period for More Efficient Lighting

	Payback	
	Single Shift Operation	Multiple Shift Operations
Replace Incandescent Bulbs with T-8 Fluorescent Lamps and Electronic Ballasts	One Year or Less	
Replace T-12 Fluorescent Lamps and Magnetic Ballasts with T-8 Fluorescent Lamps and Electronic Ballasts		Two Years or Less
Replace Metal Halide Lights with High Pressure Sodium Lights		Two Years or Less

Reducing and controlling lighting will save energy. Ways to reduce lighting are to use task lighting, to decrease lighting in minimum traffic areas, to utilize skylights (particularly in warehouse areas), to paint walls and floors with light-reflective color, to utilize daylighting, to turn lights off during non-working hours and in non-utilized areas, and to disconnect ballasts from delamped fixtures. Installing photo-sensor controls to utilize daylighting and installing motion sensors in warehouse areas to control lighting are recommended. Lighting recommendations (two-year or less payback) have the potential to reduce lighting kWh usage by 25% in the wood-furniture facilities visited.

Improve Space Conditioning Efficiency

Recommendations to improve heating, ventilation, and air conditioning (HVAC) efficiency were made. An energy management system (EMS) was recommended if the facility had multiple thermostats that could be easily controlled from a centralized point. Other recommendations were to install programmable thermostats on smaller unitary systems, to adjust set-point temperatures appropriately, and to separate warehouse space conditioning from production area space conditioning. The payback period (based on TVA electric rates) for an EMS or programmable thermostats to cool or heat is one year or less. Space conditioning efficiency recommendations have the potential to reduce space conditioning kWh usage by 19% in the wood-furniture facilities visited.

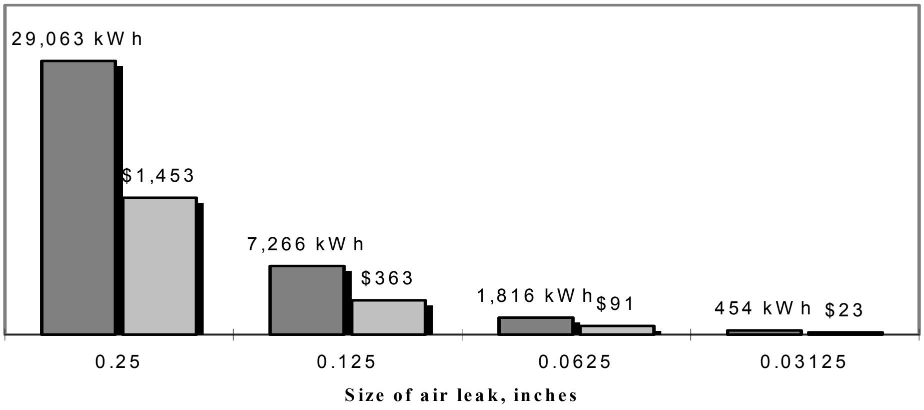
Improve Process Motor Efficiency

A recommendation to improve process motor efficiency is to replace standard V-belt drives with synchronous belt drives for more efficient power transfer. Synchronous belts do not slip yielding a better transfer of power, where as V-belts, due to friction slip, requiring additional electricity. Installing synchronous belts on large motors, typically starting at twenty horsepower, will yield a two-year or less payback for multiple shift operations. An appropriate energy conservation recommendation is to install energy efficient motors. However, in the southeastern region of the United States, this recommendation is not typically made because of the costs of electricity.

Reduce Energy Needed to Operate Air Compressors

For all assessments conducted, the most frequently made recommendation was to regularly check airlines to detect and repair leaks. As demonstrated in Figure 3, compressed air is an expensive commodity. In this bar graph, the annual cost of air leaks and the annual kilowatt hours lost are presented as a function of the diameter of the leak. The cost calculations are based on 100 psi operating pressure, a single shift operation, and $0.05/kWh cost of air. The payback period for repairing air leaks is immediate. Air leak recommendations with the potential to save 23% of the air compressor energy consumption were made to facilities visited.

Figure 3. Annual Energy Costs Associated with Compressed Air Leaks



Other recommendations that help reduce the energy required to operate air compressors include using outside air for cooling and for compressor intake and using synthetic lubricants.

Improve Dust Collection System Efficiency

To improve dust collection system efficiency and to reduce energy costs, a recommendation is not to exceed the required entrainment velocity in the dust collection ducts. If facilities are operating dust collection systems at velocities greater than the recommended velocity for the material being handled, then unnecessary electrical energy is being consumed. Facilities should have the dust collection systems checked for flow rates because according to the fan laws a ten-percent decrease in flow rate in a dust collection system equals a near thirty-percent decrease in power consumption. Figure 4 is a picture of a dust collection system taken at a wooden furniture manufacturer.

Figure 4. Photograph of a Typical Dust Collection System

Improve Power Factor

Capacitors banks can be installed to correct power factor problems. The payback period for a power factor correction is one-year or less for TVA electric rates. Power factor recommendations have the potential to save 4% on the annual electrical costs for the facilities visited.

Replace Personal Floor Heaters with Personal Warming Devices

Office personnel often use 1500-W (portable) heaters for personal comfort. On the average, a floor heater costs $5-$10 per kW per month and $0.03-$0.05 per kWh. The portable heaters are energy intensive, are fire and safety hazards, and cause a loss in productivity when overloaded circuit breakers trip. Replace the floor heaters with 60-W personal warming devices. A personal warming throw is pictured in Figure 5. Heating pads and/or seats can also be used.

Figure 5. Personal Warming Throw

Recommendations to Reduce Natural Gas Usage

In the facilities visited, 52 percent of the natural gas was used annually for space conditioning. Two recommendations to reduce natural gas used for heating are to recover compressor waste heat and to install radiant gas heaters. The recovered air compressor waste heat is used to heat areas of the buildings. Recovering air compressor waste heat has the potential to reduce natural gas usage used for heating by 12% in the facilities visited. Using radiant gas heaters to spot-heat personnel instead of forced-convection heaters for space conditioning, is recommended for receiving and loading docks, warehouses, and workstations. Shut off space heater pilot lights during the non-heating months

Forty-eight percent of the natural gas is used to operate process equipment in the wood-furniture facilities visited. Suggestions to reduce natural gas usage in processes are to preheat combustion air and to check natural gas equipment efficiencies regularly. If flue gases from natural gas equipment are used to preheat entering combustion air, the combustion process will require less natural gas.

Summary of Annual Energy Saving Recommendations

Table 2 list the annual potential energy savings identified by the MSU IAC for the thirty furniture facilities visited. The payback periods for these savings are two years or less.

Table 2. Annual Potential Energy Savings

Recommendation	Potential Annual Energy Savings
Improve Lighting Efficiency	Reduce kWh Usage by 25%
Improve Space Conditioning Efficiency	Reduce kWh Usage by 19%
Detect and Repair Air Leaks	Reduce Air Compressor Energy Consumption by 23%
Improve Power Factor	Reduce Annual Electrical Bills by 4%
Recover Air Compressor Waste Heat	Reduce Heating Natural Gas Usage by 12%

Waste Reduction/Recycling Recommendations

The three major waste streams encountered in wood-furniture facilities are cardboard, wood, and fabric. In Figure 6, the bar graph illustrates the number of facilities visited that were generating and recycling these three waste streams. Cardboard is the most recycled waste. Cardboard is lightweight, takes up excessive space, and does not pack well, driving up landfill costs for the facilities. Depending on the market, baled paper sells from $15 to $100 per ton. In contrast, fabric is the least recycled waste and, therefore, is mostly disposed of as landfill. The ability to recycle fabric is an area that needs improvement. A major problem preventing the recycling of most fabric is a polymer-based material that is applied to the back of fabric. Recycling machines processing fabric scrap with this backing material clog when the heat generated in the process melts the polymer material.

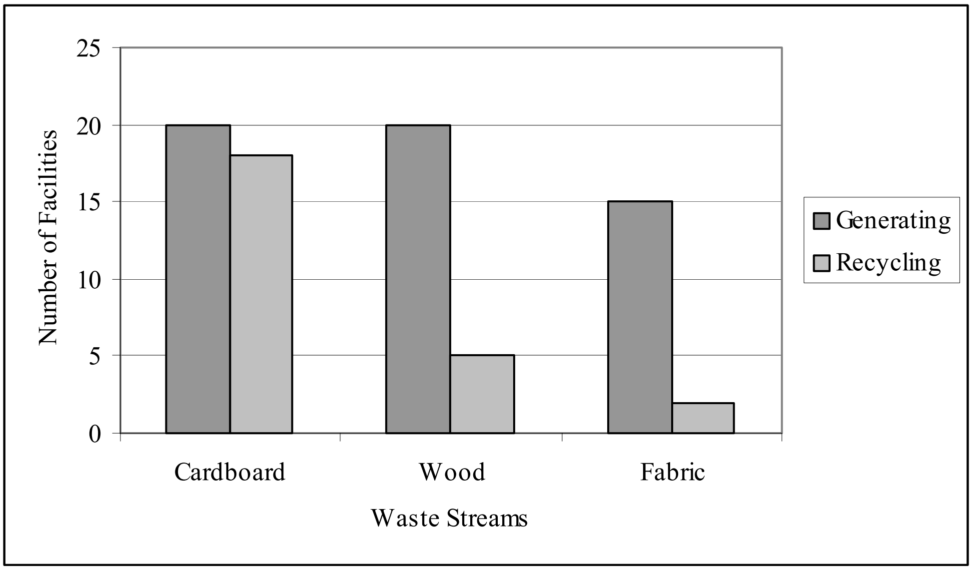
Recycling Cardboard

If a facility generates ten to twelve tons of cardboard/paper per month (20 to 24 bales of paper), then cardboard recycling facilities often will install a baler at no cost if the recycling facility picks up the baled cardboard. If a company generates at least five to six tons of cardboard/paper per month (10 to 12 bales of paper), then a baler may be economical. If a facility is located near a recycling center, then the recycler may be willing to pick up loose cardboard.

Reduce Fabric/Foam Scrap

Using nesting software even without the programmable cutting machines will improve pattern layout, that in turn reduces fabric scrap and improves productivity. Facilities with the annual volume of production needed to justify the installation of automated cutting machines are using nesting software that cut multiple layers and/or a single layer of fabric/leather. One way not to landfill unneeded fabric is to sell rolls of leftover or obsolete fabric at discounted prices to the public. One wooden upholstery facility visited sells yards of leftover fabric ($30,000 annually) to the public for $4 per yard. Facilities visited using foam in the upholstery process are disposing of the scrap foam to companies that recycle the scrap into "shoddy pads" that are used to pad wall-to-wall carpet.

Figure 6. Generation and Recycling Breakdown by Waste Stream



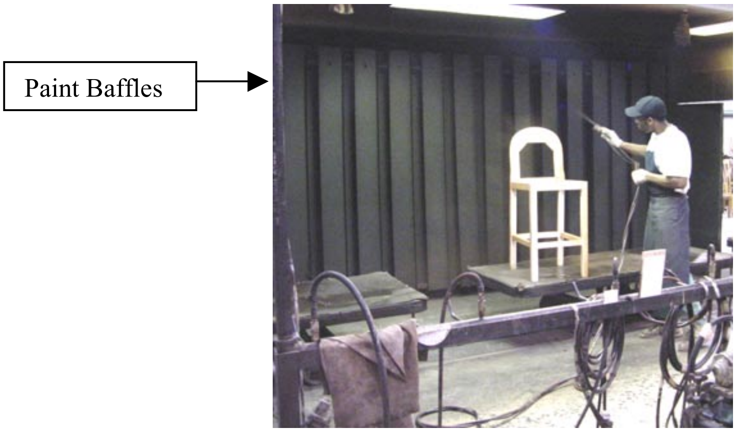
Recycle Wood

If at least 6 million pounds of wood scrap is annually land filled, then invest in a rotary grinder and sell the wood waste. A facility with a cogeneration system often is interested in buying wood waste. Ideally, the grinding of wood waste should occur during the second- and third-shift operations to reduce the peak electrical demand that would occur during the first shift.

Increase Life of Paint Filters

Install paint baffles to catch paint overspray and to increase the life of paint filters. The increased life of paint filters directly reduces the amount of solid waste being landfilled. In Figure 7, a worker is spray-painting furniture in a booth with baffles.

Figure 7. Baffles Catching Overspray from Paint Guns



Recycle Waste Oil

In Mississippi, facilities are allowed to burn waste oil to provide supplemental space heating. If waste oil disposal costs exceed $1,000 per year then the facility should invest in a waste-oil heater. This is an attractive recommendation because it eliminates any responsibilities associated with disposal.

Implementation Issues

One reason for failure to implement an energy conservation/waste recommendation is lack of time. Management's primary responsibility is with the day-to-day operations/problems in the facility. Managing manufacturing is an energy and time consuming effort and often leaves no time to plan and implement recommendations. Another reason for not implementing a recommendation is budget constraints—no money to spend regardless of the payback period. Mississippi State University's position is to have outreach programs, such as the IAC, continually helping industries in the state to find ways to enhance profitability. The MSU IAC will continue to assess, recommend, and encourage energy efficient measures in the wood-furniture industry. The MSU IAC was funded by the IAC program to summarize its work in these thirty facilities in the bi-fold brochure, "Energy Management Practices Guide for the Wood Furniture Industry." Much of the information contained in this paper is also in the brochure mailed to plant managers in the wood-furniture industry to provide technical assistance on energy, waste, and productivity management practices.

Conclusion

The thirty wood-furniture facilities visited by the MSU IAC shared several common traits including similar utility rate structures, waste issues, and implementation issues. As a result of these assessments, energy, waste, and productivity recommendations common to this industry have been identified. End-point energy usages for electricity and natural gas experienced by the facilities and a discussion, including expected savings and payback period, of energy and waste recommendations common to the wood-furniture industry were presented. MSU IAC recommendations would save 16% of the total electricity used in the facilities visited.