ENERGY AND THE US HARDWOOD INDUSTRY – PART II: RESPONSES TO INCREASING PRICES

Omar Espinoza,* Urs Buehlmann, and Brian H. Bond

This second manuscript in the series about energy and the US hardwood industry reports results from research investigating the impact of energy prices on the US hardwood industry. The manuscript focuses on actions by the industry to improve energy performance. Most companies (63 percent) indicated that they are focusing on improving energy efficiency and/or improving productivity (41.3 and 41.9%, respectively) to cope with rising energy prices; however, only 8.6% of the survey respondents indicated that they have established energy usage baselines and energy performance indicators. Sixty-seven percent of companies indicated that they are training employees on energy saving issues. Other common initiatives for energy costs reductions were installing more efficient lighting, acquiring new high energy-efficient equipment, and measures to reduce the wastage of energy, like switching off high energy consuming equipment or close off or lit off sections with no traffic.

Keywords: Energy; Hardwood products; Energy efficiency; Energy consumption

*Contact information: Department of Wood Science and Forest Products, Virginia Tech, 1650 Ramble Road, Blacksburg, VA 24060; * Corresponding author: omar.espinoza@vt.edu*

INTRODUCTION

This second manuscript in this two-part series about energy and the US hardwood industry. The first part (Espinoza et al. 2011) reported results related to the use of energy and the impact of rising energy prices on the profitability of the US hardwood industry. The share of energy expenses on total production costs of wood products manufacturers has likely risen over the last decade (1998 to 2008) as electricity prices have risen at an average annual rate of 1.4%, diesel prices by 9.3%, and prices for natural gas for industrial use by more than 100% (adjusted for inflation using producer price index, data from Energy Information Administration, 2011a). Findings reported stem from a mail survey targeting 2,405 hardwood industry businesses in the Eastern US, which resulted in 188 usable responses (adjusted response rate 9.0%). Forty-one percent of respondents were primary hardwood lumber manufacturers (e.g., sawmills, NAICS 321113), which produced, on average, 6.4 million board feet (MMBF) of hardwood lumber per year. Responding secondary manufacturers, e.g., manufacturers of engineered wood products, millwork, pallets and containers, kitchen cabinets, and furniture (NAICS 3211131, 3211137, 321911, 321912, 321918, 337110, 337122, 337129, 337211, and 337212, [U.S. Census Bureau, 2011]) used, on average, 2.7 MMBF of hardwood lumber per year. A third (34.4%) of all respondents reported to be involved in lumber drying. The average kiln-drying capacity reported was 520.8 MBF. Overall, 33.9% of respondents reported

using wood biomass as a thermal energy source, but only four companies (2.2%) also generated electricity (cogeneration).

Overall, the share of energy expenses on total production costs of respondents was 7.9%. Average, estimated energy expenses were higher for primary manufacturers (9.7%) than for secondary manufacturers (7.1%). A majority of respondents (61.8%) agreed that energy expenses have increased during the last five years, and reported, on average, an increase of 18.7%. Half of all respondents (50.6%) reported that the negative impact of higher energy prices on their profits was 5% or larger, with 90% of those reporting a negative impact indicating a negative effect of 15% or larger. Thus, increasing energy costs put a measurable burden on the profitability of hardwood products manufacturers and, therefore, actions are needed to alleviate the negative consequences.

Having realized the negative implications of rising energy prices and the inefficient use of energy, the US government's energy policy strongly encourages making improvements in energy efficiency (Doris et al. 2009). Besides the relationship of energy costs and global business competitiveness, the US government is also concerned about energy independence, global warming, and environmental sustainability (The White House 2011). Energy efficiency is defined as the quantity of product that can be manufactured with a given amount of energy (Office of Energy Efficiency and Renewable Energy 2007). Outcomes of improving energy efficiency are, among other things, the conservation of energy and reduced negative impacts on the environment. Most importantly, from a manufacturer's point of view, increased energy efficiency translates into cost savings and increases in market competitiveness besides, possibly, improved compliance with energy and environmental regulations.

Improvements in energy efficiency at the factory level can be undertaken in one or more of the following categories: (1) educational, where plant managers and operators are instructed on energy-saving techniques; (2) prescriptive programs, which include a financial incentive for the adoption of specific technologies or equipment that meets requirements for energy efficiency; or (3) company-wide energy management systems (Russell 2005; Hoffman 2008). Company-wide energy management systems are the most comprehensive approach and are designed for a specific facility, usually after a comprehensive assessment of overall energy consumption. Examples for such company-wide energy management systems encompass free energy assessments by nonprofit organizations such as, for example, the Land of Sky regional council free energy savings program (Land-of-Sky Regional Council 2005) or the Department of Energy's plant energy assessment program (U.S. Department of Energy 2010). Such programs typically offer free energy audits and advice on energy efficiency improvements.

Given the trajectory of energy prices and the energy intensity of the US hardwood industry (Bergman and Bowe 2008; Espinoza and Bond 2011; The Alliance to Save Energy, n.d.), the industry's energy consumption and the resulting costs are of high priority; however, limited data as to the impact of rising energy costs or as to the initiatives being undertaken to address energy consumption are available. The objective of this research was to investigate the impact of rising energy prices on the US hardwood products industry and learn about the actions the industry is taking to face this challenge. A first manuscript in this two-part series (Espinoza et al. 2011) presented an energy profile of the US hardwood industry and described the impact of rising energy prices on

the industry's profitability. In this manuscript, actions taken by the industry to improve energy efficiency are presented.

MATERIALS AND METHODS

In the Fall of 2010, a survey was conducted among US hardwood industries in the 35 Eastern states of the US. The questionnaire was intended for primary (NAICS 321) and secondary (NAICS 321 and 337) manufacturers of hardwood products. A mailing list of 2,405 companies was compiled from various sources, including industry association websites (AHMI 2009; AWI 2011; KCMA 2008; NHLA 2011; NWFA 2009; WCMA 2011; WPMA 2011), business directories (Hoover's 2011; Manta 2011), and state government agencies (ForestryUSA 2010). The survey was executed following Dillman's Total Design method (Dillman 2009), and mailings were made from August to October 2010. Two sets of questionnaires and postcards were mailed, with a two week-separation between each mailing. To estimate non-response bias, early and late respondents were compared. This approach assumes that there is a continuum in the likelihood of a company completing and returning questionnaires, and thus late respondents are used as a proxy for non-respondents (Dalecki et al. 1993; Etter and Perneger 1997; Lahaut et al. 2003). No differences were found between respondents and non-respondents for the five dimensions compared (geographical location, material input, number of employees, industry sector, and change in energy-related expenditures). A more detailed description of the survey methods used, non-response bias, and study limitations are presented in Espinoza et al. (2011).

RESULTS AND DISCUSSION

One hundred and eighty-eight usable questionnaires out of a total of 2,405 mailed were returned. Accounting for wrong addresses, companies out of business, and companies not part of the target population, the adjusted response rate was 9.0%.

Company Characteristics

The primary activity, at 41.1% of the respondents, was hardwood lumber manufacturing (e.g., sawmills), followed by millwork (13.5%), kitchen cabinets (11.9%), hardwood flooring (11.4%), components and dimension (8.1%), and household and institutional furniture (6.5%, (Espinoza et al. 2011). The "Other" category included companies involved in the production of picture frame mouldings, cutting boards, custom turnings, urns, drawers, toys, novelties, and boats. For the rest of this manuscript, respondents other than sawmills will be referred to as "secondary manufacturers," while the terms "sawmills" and "primary manufacturers" are used interchangeably. The species distribution of respondents (board foot basis) was red and white oak (36.2%), maple (18.4%), yellow-poplar (11.7%), cherry (6.6%), hickory (3.2%), ash (2.8%), walnut (3.3%), other hardwoods (11.8%), and other softwoods (4.9%, Espinoza et al. 2011). The percentages for walnut and cherry usage by respondents differed considerably from what

is reported by the Census Bureau in its Current Industrial Report for Lumber Production and Mill Stock for 2005-2009 (0.9 and 2.4%, respectively; U.S. Census Bureau 2010). Thus, survey respondents use about three times as much of these species as a percentage of their total inputs. The difference may be explained, in part, by the fact that this survey includes answers from both primary and secondary manufacturers while the Census numbers report output by sawmills only. Additionally, the potential presence of larger firms among respondents than found in the general population (larger firms can better afford cutting these relatively expensive species) may also contribute to the difference observed.

With respect to materials used and sold, the average annual lumber input per company for the entire sample (e.g., primary and secondary manufacturers) was 4.5 million board feet (MMBF), with an average of 6.4 MMBF for sawmills and an average of 2.7 MMBF for secondary manufacturers (Table 1). Lumber output was only reported for sawmills, and was 6.7 MMBF, on average (Espinoza et al. 2011).

Table 1. Company Characteristics of Respondents

Sector	Average	Median	N
	--------- Material input* (MMBF) ---------		
Overall	4.5	2.0	129
Primary manufacturers	6.4	4.0	54
Secondary manufacturers	2.7	0.3	75
	--------- Lumber output** (MMBF) ---------		
Primary manufacturers	6.7***	5.2	50
	--------- Number of employees ---------		
Overall	45.2	20.0	175
Primary manufacturers	33.1	21.0	73
Secondary manufacturers	51.1	19.0	102

* Log input in Doyle scale for primary manufacturers.
** Only primary manufacturers reported.
*** The percentage difference between output and input for sawmills is commonly referred as overrun, or the difference between estimated (log scale) and actual lumber yield (lumber tally) in lumber manufacturing. Overrun can be positive or negative (Ray, Wadhwa, and Michael, 2007)

Impact of Energy Prices on the Industry

A detailed description of the impact of rising energy prices on the hardwood industry is presented in the first manuscript of this series (Espinoza et al. 2011). Table 4 shows a summary of the results. A majority of respondents (61.8%) agreed that energy expenses have increased during the last five years. The magnitude of the energy price increase was reported to be higher for primary manufacturers than for secondary manufacturers (26.2 and 14.5%, respectively).

Table 2. Impact of Rising Energy Prices on U.S Hardwood Products Manufacturers

Impact of increasing energy prices	Overall	Primary manufacturers	Secondary manufacturers
Share of energy expenses on total costs (%)	7.9%	9.7%	7.1%
Energy expenses increased over last five years (% of respondents stating "YES")	61.8%	57.8%	64.6%
Increase in energy costs (% increase)	18.7%	26.2%	14.5%
Impact of increasing energy expenses on profits (% of respondents with 5% or higher negative impact on profits)	50.6%	65.3%	39.8%

Energy Management

Energy management, in the context of this study, is understood as any systematic effort by organizations to improve energy efficiency (Energy Information Administration 2011b). Ideally, energy management should be approached as a systematic, sustained, and company-wide effort. Efforts in energy management not only reduce energy consumption, but they also contribute to improved processes (Morvay and Gvozdenac 2008). This study was, among other issues, interested in learning if companies have adopted and employed energy management practices during the last five years.

Energy audits

Energy audits are a critical component of energy management and consist of a comprehensive assessment of a facility's energy usage to establish a current energy performance base-line (Dutrow 2005). An energy audit can go from a simple walkthrough to visually-inspect the facilities and find the most obvious opportunities for improvements, to an in-depth study of energy balances for all processes and activities. The in-depth study of energy balances for all processes and activities requires establishing an accounting system for energy savings and a financial analysis of improvements, and, hopefully, achieves the highest return on investment. An energy audit typically consists of the following sequential stages: (1) gathering historical usage data and facility walk-through, (2) establishment of actual demand through an energy balance at each process or activity, (3) comparison of findings with performance specifications and identification of improvements, and (4) recommendations based on technical feasibility and economic impact (Espinoza and Bond 2010).

Responses from the target audience of this survey as to whether they have conducted such energy audits during the last two years are summarized in Fig. 1. Only 22.5% of respondents indicated that their company has performed at least one energy audit over the past two years. A significantly larger number of secondary manufacturers conducted audits (29.2%, compared to 12.5% of primary manufacturers, Chi-Square test p=0.009). When asked about the source of financial support for energy audits, a majority answered that resources came from their energy supplier or that the audits were self-financed (55.6% and 48.4%, respectively). Local or state governments financed audits at 12.5% of respondents' companies involved in this practice.

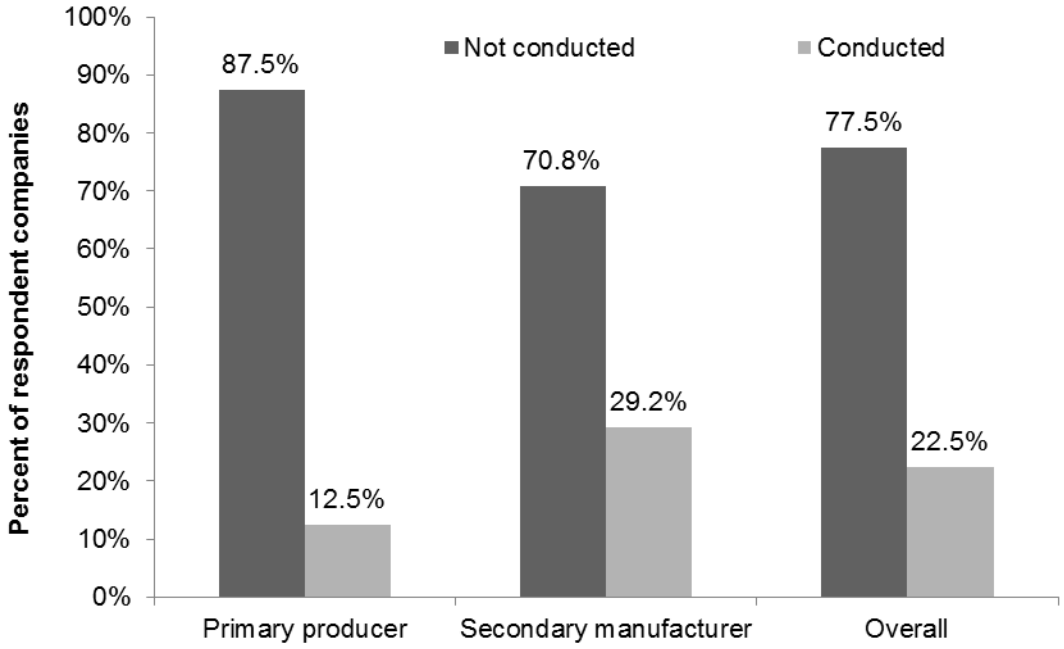

Fig. 1. Percent of companies practicing energy audits. Significant differences exist between primary and secondary manufacturers (Pearson Chi-Square test, p=0.009)

Electric energy management programs

Questions regarding specific practices aimed at reducing electric energy consumption and costs were included in the questionnaire. Questions in particular included whether respondents practiced electricity load control, applied power factor correction, participated in special rate schedules, and/or conducted interval metering.

Interval metering consists of recording energy usage at regular and frequent intervals and involves the installation of specialized devices with software to track and display energy usage (SCE 2011). Interval metering facilitates the identification of sources of waste of electric power, indicating potential opportunities for energy savings. Few companies were involved in this activity at the time of the survey (11.1 and 4.7% of primary and secondary manufacturers, respectively, 7.0% on average of all respondents). Twenty one percent and 16.0% of primary and secondary manufacturers, respectively, and 17.3% of all respondents, were participating in special rate schedules commonly offered by utilities to promote energy savings, an example is the "time-of-the-day" schedule, where different rates are charged during peak and off-peak hours (Wengert and Meyer 1992). A larger percentage of respondents' companies (30.6 and 21.7% of primary and secondary manufacturers, respectively, 24.3% on average of all respondents) reported the usage of power factor correction systems, where banks of inductors or capacitors are installed to reduce the reactive energy load (Emplaincourt et al. n.d.). Since most utilities have a reactive demand charge, companies have an economic incentive for this practice. Another electric power consumption reduction system is

electricity load control (Leonardo Energy 2009). Electric load control is any action by utilities to reduce total peak demand in their network. This is often achieved by offering incentives to customers, through a price difference (peak and off-peak rates) or by agreements committing the facility to reduce load at short notice from the electricity supplier in exchange for financial incentives. A higher proportion of secondary manufacturers (17.9%) reported to be involved in this management practice than were primary manufacturers (12.5%). The overall industry (e.g., primary and secondary manufacturers combined) involvement rate was 15.1% for all respondents. Detailed results are listed in Table 3.

Table 3. Electric Energy Management Practices

Electric energy management*	Overall	Primary manufacturers	Secondary manufacturers
	% of respondents		
Power factor correction	24.3	30.6	21.7
Participate in special rate schedules	17.3	20.8	16.0
Electricity load control	15.1	12.5	17.9
Participate in interval metering	7.0	11.1	4.7

* For clarity, examples for each practice listed were included in the questionnaire.
No difference found between primary and secondary manufacturers, for all practices (Z-test of proportions, 95% confidence level)

In addition to the questions regarding electric energy management, companies were also asked about their participation in special programs for energy management. Results are listed in Table 4.

Table 4. Participation in Special Programs

Electric energy management*	Overall	Primary manufacturers	Secondary manufacturers
	% of respondents		
Equipment rebates	16.8	13.9	19.8
Other federal or state-sponsored program	4.3	2.8	5.7
Standby generation program	3.2	5.6	1.9

* For clarity, explanations for each practice listed were included in the questionnaire.
No difference found between primary and secondary manufacturers, for all programs (Z-test of proportions, 95% confidence level)

Equipment rebates are offered by utilities and/or governments (federal and/or state) to motivate companies to install high energy-efficient equipment, such as NEMA Premium® motors, or adjustable speed drives. Fourteen percent of the responding primary manufacturers took advantage of equipment rebates, as did 19.8% of the responding secondary manufacturers (16.8% of all respondents). Electric utilities occasionally offer credits on energy bills for facilities that agree to transfer loads from their facility standby generators to the network, at the request of the supplier. Only 5.6% of primary manufacturers and 1.9% of secondary manufacturers were participating in

such programs, 3.2% of all respondents. Lastly, 2.8% of all sawmills responding reported participating in "other federal or state-sponsored programs"; that percentage was 5.7% for secondary manufacturers, and 4.3% for all respondents. While most respondents did not specify the particular programs the company was participating in, two mentioned EnerNOC, a private company that develops energy management software (EnerNOC 2011). Lastly, only one respondent reported having an energy manager in the facility (e.g., less than one percent of the sample). This particular respondent reported annual lumber input almost three times the average of the entire sample. An energy manager, for the sake of this survey, was defined as a company having a designated person spending at least 50% of her/his time in activities aimed at improving energy efficiency.

Responses to High Energy Prices

For a company planning to reduce energy costs, numerous options exist (Russell 2005; Hoffman 2008; The Alliance to Save Energy, n.d.; Espinoza and Bond 2010). Examples include shopping for lower prices, implementing energy projects occasionally, investing in capital projects to install energy-saving equipment, or implementing a sustained effort to manage energy consumption and efficiency (Espinoza and Bond 2010). The purpose of the section "*Responses to high energy prices*," in the questionnaire was to learn which strategies respondents' companies are adapting to cope with increasing energy prices. Responses obtained to the question about higher energy prices and actions to reduce energy usage and improve energy efficiency are summarized in Table 5.

Table 5. Response to Higher Energy Prices

Response to higher energy prices	Overall	Primary manufacturers	Secondary manufacturers
	---------- % of respondents ----------		
Focused on increasing manufacturing productivity	41.9%	37.0%	45.5%
Reduced energy consumption by improving efficiency of our processes	41.3%	35.6%	45.5%
Reduced energy consumption by adopting energy-saving technologies	26.7%	20.5%	31.3%
Increased prices to our customers to compensate for higher energy process	25.6%	19.2%	30.3%
Absorbed costs and accepted lower profitability/made no changes	22.1%	28.8%	17.2%
Reviewed suppliers' contract arrangements	16.3%	16.4%	16.2%

About a fifth of respondents (22.1%) reported that they were not taking any action to alleviate the effect of energy prices, thereby accepting lower profit margins. More primary manufacturers (28.8%) than secondary manufactures (17.2%) decided to go this route. A small percentage of companies (16.3%) negotiated better rates or terms with

their energy suppliers, or switched suppliers altogether, and there was little difference between primary and secondary manufacturers (16.4 and 16.2%, respectively). About the same number of companies were focused on reducing energy consumption by improving energy efficiency or improving productivity (41.3% and 41.9%, respectively). A higher number of companies in the secondary manufacturing sector were focused on these strategies (45.5% focusing in productivity and the same percentage on improving energy efficiency) than primary manufacturers (37.0% for productivity and 35.6% for energy efficiency). Improving productivity (doing more with the same resources) reduces energy consumption by lowering the energy usage per unit produced. Investments in energy-saving technologies (e.g., variable speed drives or heat recovery) were reported by 26.7% of all respondents. Similar to previous initiatives, more secondary manufacturers reported focusing on energy-saving technologies than did primary manufacturers (31.3 and 20.5%, respectively). Also, a quarter of all respondents (25.6%) reported that their company had increased prices to customers to offset the effect of higher energy costs. Actions to reduce energy usage or improve energy efficiency are summarized in Table 6.

Table 6. Actions to Reduce Energy Usage or Improve Energy Efficiency

Actions to reduce energy consumption or improve energy efficiency*	Overall	Primary manufacturers	Secondary manufacturers
	---------- % of respondents ----------		
Training employees on energy management and saving issues	30.9%	33.3%	29.2%
Started documenting energy consumption and savings	20.2%	15.3%	23.6%
Establishing energy use baseline	9.0%	9.7%	8.5%
Establishing performance indicators	5.1%	4.2%	5.7%
Using externally validated standards	2.8%	5.6%	0.9%
Establishing cross-divisional plan	2.2%	4.2%	0.9%

* For clarity, examples for some of these practices were included in the questionnaire.

As for actions to reduce energy usage and improve energy efficiency, about a third of all respondents (30.9%) reported efforts to train employees in energy saving practices, and no big difference existed between primary and secondary manufacturers (33.3 and 29.2%, respectively). A fifth (20.2%) of respondents reported that their company had started documenting energy consumption and energy savings, with a smaller number of primary manufacturers reporting this practice (15.3% compared to 23.6% of secondary manufacturers); however, few companies reported establishing a usage baseline (9.0% overall) or developing performance indicators (5.1%). Finally, only 2.8% of respondents said they were using externally validated standards, and even fewer indicated that their companies (2.2%) were establishing a cross-divisional plan. Primary manufacturers were more active in using externally validated standards and establishing cross-divisional plans than were secondary manufacturers, with 5.6% of primary manufacturers

using externally validated standards and 4.2% establishing a cross-divisional plan, whereas only 0.9% of secondary manufacturers were involved in both categories. These results can serve as an indication as to how large is the US hardwood industry's potential for improvements in respect to energy efficiency.

The questionnaire also included an open-ended question about specific initiatives undertaken by respondents' companies to save energy costs. A total of 116 answers received to this question were grouped into 11 categories. Response frequencies are summarized in Fig. 2. More energy-efficient lighting was the most frequent response, since more energy-efficient lighting is relatively easy to implement and payback periods are normally short (Emplaincourt, Findley, and Hodge, n.d.). Typical lighting projects consist of replacing metal halide fixtures (MH) with high-pressure sodium lamps (HPS), or replacing T-12 fluorescent lamps using magnetic ballasts with T-8s (Emplaincourt, Findley, and Hodge, n.d.). Installing new equipment was practiced by 22 respondents. Typical initiatives in this group also included replacing electrical motors with more energy-efficient ones and investing in new compressors.

Waste reduction and energy conservation practices were mentioned by 21 of the respondents. Such practices included turning off lights in areas with no traffic, running heating units on an as-needed basis, closing down sections that do not need heating, and thermostat adjustment in office buildings. One in ten respondents (11) also reported equipment or facility upgrades, with typical responses being installing digital thermostats, boiler maintenance, or roof upgrades. A smaller number of respondents reported insulation upgrades (7), installation of biomass-fueled boilers (7), power factor correction (4), special rate schedules (3), or energy audits (3). Some initiatives included in the "Others" category were, for example, soft starts on large equipment, electric meter grouping, reducing working days, localizing heating areas, and buying kiln-dried lumber.

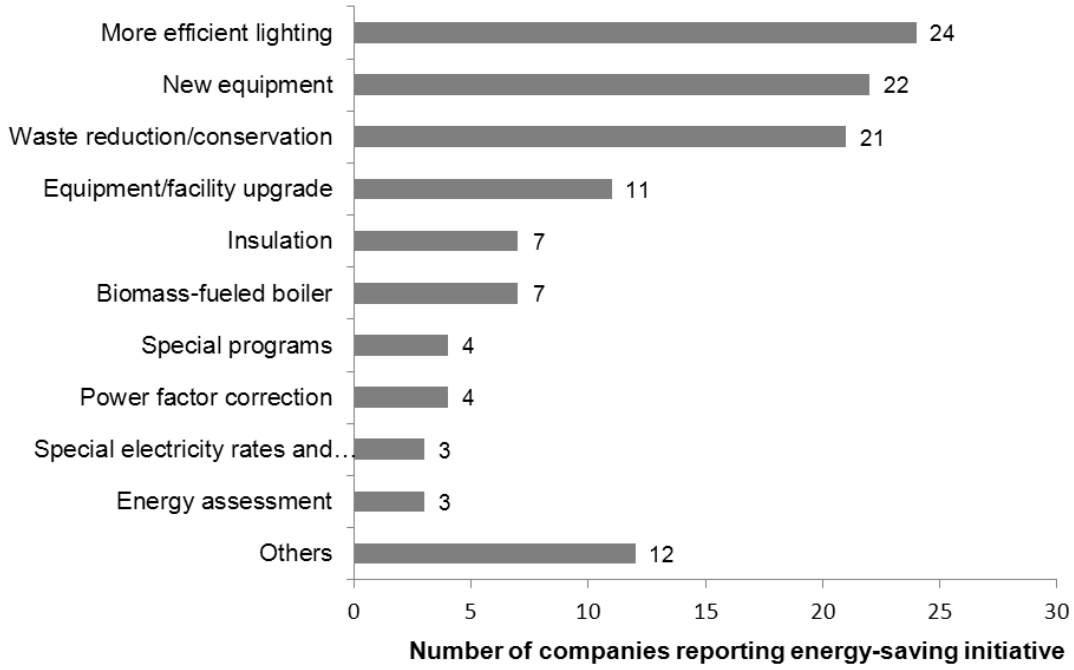

Fig. 2. Categorized initiatives to save energy costs

DISCUSSION

The US wood products industry is a leader in renewable energy utilization. For example, in the wood products subsector (NACIS code 321), close to half (48.8%) of the industry's total energy demand was generated from biomass in 2006 (mostly from wood residues, a byproduct of the manufacturing process), whereas the percentage of renewable energy usage for the entire US manufacturing sector (NAICS 31-33) was 12.3% (calculated with figures from U.S. Department of Energy, 2008). By 2013, the US Federal Government's mandatory target for energy supplies from renewable sources is 7.5% (only for the federal government's operations), while the European Union's target is 20% for 2020 (European Comission 2011; U.S. Department of Energy 2011). Thus, the US wood products industry is well ahead of these targets and will, hopefully, make good use of the industry's high level of energy independence. This study focused on hardwood products manufacturers, and found that over a third of respondents use wood biomass as a major energy source.

According to respondents to this survey, the share of energy expenses on total production costs for the US hardwood industry has increased 18.7% over the last five years (Espinoza et al. 2011). Given the low profit margins in the industry (American Hardwood Export Council 2006), these changes had a detrimental effect on the well-being of the industry. Results from this research demonstrate the negative impact of energy prices on hardwood products manufacturers' profitability, with half of all respondents reporting a negative impact of rising energy prices on profitability of 5% or higher (Espinoza et al. 2011). In response to these challenges, numerous survey respondents reported carrying out specific initiatives to alleviate the impact of higher energy prices; however, a sizeable number of companies (22.1% of all respondents, 28.8% primary, and 17.2% secondary) indicated that their company is not taking any action and is not increasing prices to compensate for higher energy costs. Such an approach further weakens the US hardwood industry, especially since the industry is already known to operate at low profitability levels (American Hardwood Export Council 2006). Low or no profitability decreases an industry's ability to invest for future success and does, therefore, not bode well for the industry. Also, despite the negative impact of rising energy prices on industry profitability, a majority of survey respondents (77.5%, Fig. 1) indicated that their company is not conducting any energy assessments in their operations. Energy assessments are a critical part of any energy management initiative, as they allow the identification of improvement opportunities and help in prioritizing projects based on potential impact. Energy assessments also allow tracking progress in becoming more energy efficient and providing a baseline on which to make informed investment decisions.

Given the economic realities which participants of the US hardwood industry face (e.g., the lingering effects of the recession that started in December of 2007, increasing competition from global competitors, changes in societal preferences), energy usage reduction represents an opportunity for costs reduction. Luckily, as this study has shown, the US hardwood industry has considerable opportunities for achieving more effective and efficient use of energy in its operations. An important first step to that end would be to incorporate energy management policies and actions into companies' continuous

improvement efforts as the most effective option towards sustained higher energy efficiency and lower energy costs (Russell 2005; Espinoza and Bond 2010; Peterson and Belt 2009). Moreover, reducing energy consumption per unit produced makes sense not only from a cost-reduction point of view. Improvements in energy savings are closely associated with improvements in operational efficiencies; for example, improvements in lumber stacking practices for kiln-drying can reduce drying times, thus reducing energy needed to run the fans for a longer period (Denig et al. 2000) while also reducing lead times. Also, a well-implemented energy management system can be a driver for organizational improvement, as it requires cross-divisional efforts and a sound performance measurement system (Morvay and Gvozdenac 2008).

Also, improving energy efficiency improves an industry's environmental performance. A considerable part of an industry's environmental impact is associated with energy consumption, such as, for example, air pollution or carbon emissions contributing to global warming (Bowyer et al. 2005). As society becomes more aware of and reacts more intensely to the detrimental effects of the use of fossil or nuclear fuels to our environment, US companies will face increased pressure to reduce energy consumption and improve energy efficiency. The US hardwood industry, with its carbon neutral, renewable raw material that also is a source of energy, is in an enviable position to become the leading industry in responding to society's concerns and evolve into a role-model for other parts of the economy in respect to energy efficiency, environmental friendliness, and sustainability.

SUMMARY

The US hardwood products industry was surveyed in 2010 to learn about the impact of rising energy prices on the industry's business and to learn about actions taken to reduce energy consumption and improve energy efficiency. A total of 188 usable responses were obtained, yielding an adjusted response rate of 9%. This second manuscript about energy and the US hardwood industry (first part: "*Profile and impact of prices*") reported actions of the industry to lower the negative impact of rising energy costs on the industry's profitability. The first manuscript reported results about the industry's use of energy and the impact of rising energy prices on the profitability of the US hardwood industry.

1. As a response to higher energy costs, most companies were found to be focused on improving energy efficiency (41.3% of respondents) and productivity (41.9%). However, a relatively low number of companies have established energy usage baselines and performance indicators (8.6 and 4.9%, respectively). Two thirds of companies indicated they were training employees on energy saving issues. The most common specific initiatives for energy costs reductions were installing more efficient lighting, investing in new high energy-efficient equipment, and implementing measures to reduce energy waste.
2. Only 22.5% of respondents reported that they participate in energy audits. The most common practice for electric energy management was power factor correction

(24.3%), followed by participation in special rate schedules (17.3%). Participation in equipment rebates, i.e. financial incentives for installing high energy-efficient equipment, was practiced by 16.8% of all respondents companies.

3. As energy prices continue their upward trend, pressure will grow on US hardwood products manufacturers to reduce energy consumption through energy efficiency improvements. Given the industry's inexistent pricing power, due to weak demand and increasing market pressures from imported products, manufacturers must make every effort to reduce manufacturing costs. Reducing energy costs per unit produced is one way to do so. Implementing an energy management system (EMS) as part of a company's continuous improvement process is an effective and efficient way to ensure sustained improvements in energy performance over time. However, results from this survey indicate that, at the time of the study, companies are most often implementing energy-related projects (such as installing more efficient lighting in selected areas) as one-dimensional efforts and not as a company-wide, long-term, continuous improvement initiative.
4. The US hardwood industry, thanks to its leadership role in the use of renewable energy, is in an enviable position to become the role-model for being an industry that covers its energy needs in an environmentally friendly, sustainable, and carbon neutral way. Additionally, by using the industry's process by-products for energy production, the industry also is in a formidable position to create a zero-waste business model.

IMPLICATIONS

Increasing energy prices decrease the profitability of US hardwood products manufacturers. However, improving companies' energy efficiency does reduce manufacturers energy costs and, at the same time, improves environmental performance, reduces exposure to further energy price hikes, and allows companies to appeal to customers who consider the environment in their buying decisions. The US hardwood products industry, therefore, has a profound self-interest in reducing its energy consumption, thereby becoming more internationally competitive while complying with environmental regulations. Also, given the leadership position that the industry has with respect to the use of renewable energy in the US, an opportunity exists to take advantage of the rising sensibility of consumers on issues related to the environment and the sustainability of human activities.

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