

**Practices and Plans for Sustainability in Georgia's Pulp and Paper Sector:  
Results from the Georgia Manufacturing Survey 2008**

Jan Youtie<sup>1</sup>, Philip Shapira<sup>2</sup>, and Luciano Kay<sup>3</sup>

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<sup>1</sup> Enterprise Innovation Institute, Georgia Institute of Technology, Atlanta, GA 30332-0640, USA. Email:

[jan.youtie@innovate.gatech.edu](mailto:jan.youtie@innovate.gatech.edu)

<sup>2</sup> Manchester Institute of Innovation Research, Manchester Business School, University of Manchester, Manchester, M13 9PL, UK; School of Public Policy, Georgia Institute of Technology, Atlanta, GA 30332-

0345, USA. Email: [pshapira@mbs.ac.uk](mailto:pshapira@mbs.ac.uk)

<sup>3</sup> School of Public Policy, Georgia Institute of Technology, Atlanta, GA 30332-0345, USA. Email:

[scarley3@mail.gatech.edu](mailto:scarley3@mail.gatech.edu)

## **Abstract**

Sustainability is a subject that encompasses a range of technologies, techniques and outcomes. The pulp and paper industry provides a context for examining issues of sustainability practice and performance, in part because of its diversity of size and business focus (mills versus converters), but also because of the energy intensity of the industry. According to the Georgia Manufacturing Survey 2008, pulp and paper manufacturers have adopted sustainability practices into more of their manufacturing processes than other manufacturing subsectors. However, pulp and paper manufacturers are less likely to offer sustainability training to employees than manufacturers in other subsectors. We also show that reducing energy intensity, measured as energy expenditures per million dollars of sales, is associated with increased productivity in terms of value-added per employee. This presents an opportunity for pulp and paper manufacturers to maintain green practices.

## **Acknowledgements**

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## Introduction

U.S. manufacturing competitiveness is a concern of all industry sectors in general and of the pulp and paper industry in particular. In the past, competitiveness concerns were driven mainly by increasing imports competition, with exporters perceived as “better” manufacturers than non-exporters, partly due to the success of export-led economies that created such a competitive pressure. Indeed, some research has found that exporters perform better than non-exporters in some aspects, supporting the rationale of policies to promote exporting industries, yet the condition of exporter alone does not allow predicting the future performance of the firm (Bernard et al., 1995). Since more recently, new competitiveness factors related to energy security and sustainable manufacturing are of growing interest for policy-makers and companies’ managers. Certainly, an increasing number of firms have begun to view environmental performance as an area of potential competitive advantage (NAE & NRC, 1999). Furthermore, as in the case of exporters, there is an assumption that “green industries” have exports and job creation potential, which has led to increasing interest at the highest levels of the U.S. government and several concrete initiatives at the state level (Bezdek, 1993). Yet, in spite of this, the debate about whether environmental policies have positive effects continues.

The evidence behind that optimism in the virtuous relation between environment protection, sustainable manufacturing, and competitiveness is diverse and still allows distinct interpretation. For instance, while sometimes energy and climate policies are considered potentially positive for industry competitiveness (Bezdek, 1993; Bezdek et al., 2008; Brown & Atamturk, 2008), in other cases is less clear whether existing policy options can influence current trajectories of capital investments toward a more sustainable path in a meaningful way (Auffhammer & Carson, 2008; Bezdek, 1993). Indeed, traditionally the net impact of environmental protection has been considered negative for the economy and job markets (Bezdek, 1993), but more recent evidence at the U.S. state level has shown that environmental protection, economic growth, and jobs creation are complementary and compatible. In other words, states can have strong economies and simultaneously protect the environment (Bezdek et al., 2008). Furthermore, some evidence from research studying technological trajectories of different sectors indicates that firms can profit from “green technologies” and “green products” manufacturing (Becker & Shadbegian, 2008; Miozzo et al., 2005). In particular, some research has found that the “green industry,” grouping environmental products manufacturers, performs better than other manufacturers in terms of employment, employee compensation, exports, and productivity (Becker & Shadbegian, 2008). Also, according to other studies, sustainability practices like improved management of materials or materials substitution are likely to bring benefits to manufacturers while reducing substantially CO<sub>2</sub> emissions, usually associated to energy usage in manufacturing activities (Davis et al., 2008; Hekkert et al., 2000).

Also many energy and climate policies may have a significant positive impact upon the future of the pulp and paper industry, in particular those related to directing capital investments for the promotion of renewable energy and limitation of gas emissions. These policies may promote the diversification of the pulp and paper industry toward expanding biopower and biofuels markets, accelerating investments in new facilities and overcoming any projected decreasing final demand for domestically produced paper products (Brown & Atamturk, 2008). Furthermore, the pulp and paper industry is considered one of the potential contributors for reducing overall industry energy intensity (Silveria & Luken, 2008). The introduction of new business practices (Becker & Shadbegian, 2008; Hekkert et al., 2000) or the assimilation and effective use of pervasive technologies are likely to conduct the process of change in this industry (Dewick et al., 2004; Miozzo et al., 2005). In particular, the development and incorporation of technologies for the manipulation of organisms, information, and materials (i.e. IT, biotechnology, and nanotechnology) is considered to have a net positive effect in manufacturing, lowering the resource intensity of industries like pulp and paper (Dewick et al., 2004). New IT developments are also likely to

increase overall efficiency and save energy, while biotechnology would allow higher resource efficiency (Miozzo et al., 2005). However, the ability to measure and account for investments in sustainable manufacturing remains a challenge, since existing environmental metrics usually do not address current environmental challenges (de la Rue du Can & Price, 2008; NAE & NRC, 1999). Better environmental methodologies and indicators will be a valuable tool for influencing decision making and driving innovation in sustainability practices.

The link between these questions of sustainability and performance is especially prominent within the pulp and paper industry. In general, during the last three decades, the U.S. pulp and paper industry has increased its overall productivity and followed a process of concentration with consolidation of operations, vertical integration of paperboard and pulp mills, and elimination of small manufacturers (Urmanbetova, 2004). It is still both a capital- and energy-intensive industry, with paper and paperboard mills as the biggest consumers of energy (Brown & Atamturk, 2008). It is also usually considered a supplier-dominated industry in terms of the Pavitt's taxonomy of sectoral patterns of technical change (Pavitt, 1984). For this reason pulp and paper firms are considered to benefit, for example, from supplier innovations by purchasing major capital equipment from equipment providers (Youtie et al., 2006). Consequently, pulp and paper companies, relative to those in other industries, are more apt to use traditional business process approaches such as acquisition of capital equipment to engage in innovation and less apt to use knowledge-based approaches like the development of patents or other forms of intellectual property. Thus, more investment in skilled workers and R&D may be required to make use, for example, of pervasive technologies that lead to sustainable manufacturing. On the other hand, some pulp and paper companies focus innovation efforts on issues such as how to minimize waste and byproducts harmful to the environment or how to reduce capital and operational costs to promote efficiency (Youtie et al., 2006). These firms may be better prepared for introduce new sustainability practices in the short-run.

In summary, sustainability is a subject that encompasses a range of technologies, techniques and outcomes. Included here are those both specific to energy and environmental areas as well as general process practices. In addition, there is an open question about the link between sustainability practices and business outcomes. The pulp and paper industry provides a context for examining these issues of practice and performance, in part because of its diversity of size and business focus (mills versus converters), but also because of the energy intensity of the industry. These attributes suggest several research questions. To what extent do pulp and paper manufacturers adopt sustainability practices? How do these rates compare with those of other manufacturing industries? And is there a business performance impact associated with reducing non-sustainable features? These research questions are the probes for inquiry for this study.

## Data and Sector Definitions

The data analyzed in this report is drawn from the Georgia Manufacturing Survey 2008. This is the sixth in a series of statewide manufacturing surveys conducted since 1994. The survey benchmarks manufacturing performance in the state and identifies needs, issues, challenges, capabilities, and opportunities facing Georgia manufacturers so that strategies for enhancing their competitive advantages can be developed and improved. The 2008 survey focuses on, among other topics, current and planned use of sustainable manufacturing technologies and techniques.<sup>1</sup>

The 2008 survey went to all Georgia manufacturing establishments with 10 or more employees. Of the 830 responses received, 763 surveys met the criteria of manufacturers with 10 or more employees (Table 1). These 763 surveys were weighted to reflect the actual distribution of

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<sup>1</sup> For additional information about the Georgia Manufacturing Survey, including a copy of the survey questionnaire, see <http://www.cherry.gatech.edu/survey>.

manufacturers by sector and employment size in Georgia and form the basis for the results described in this report. Manufacturing facilities are classified according to sub-industry sectors: Pulp and Paper, Food and Textiles (abbreviated “Food-Text”), Materials, including among others Plastics and Rubber Products and Non-metallic Mineral Products manufacturing (“Materials”), Metals and Machinery (“Mach”), Electrical and Transportation industry (“Elec-Trans”), and Science-based high-technology industries (“Science”) including Petroleum & Coal Products and Chemical Products manufacturing, and Medical Equipment and Supplies.<sup>2</sup> We also categorize the sectors according to their employment size: facilities that have between 10 and 99 employees are labeled as “small” and facilities with 100 or more employees are considered “large.”

Manufacturing facilities within the Pulp and Paper sector are also classified into different groups for the analysis. “Mills” are facilities that produce either pulp or paper at their facility. “Non-mills” include paper converters, package manufacturers, and other establishments that do not actually produce paper products from raw or recycled materials. Facilities were designated as a mill if they have a 4-digit NAICS code 3221. Within this sector, there are a total of 45 respondents, of which 32 are classified as small and 13 classified as large (Table 2).

**Table 1. Number of Establishments Participating in the Georgia Manufacturing Survey by Sector and Size**

Number of employees	Sector						All manufacturers
	Pulp and paper	Food-text	Materials	Metal-mach	Elect-Transp	Science	
Small - less than 100	32	85	184	167	41	62	571
Large - 100 and more	13	55	46	43	22	13	192
All establishments	45	140	230	210	63	75	763

Source: Georgia Manufacturing Survey 2008. Note: only establishments with 10 or more employees are included.

**Table 2. Pulp and Paper Establishments Participating in the Georgia Manufacturing Survey by Type of Facility and Size**

Number of employees	Type of facility		All pulp and paper
	Non-mills	Mills	
Small - less than 100	27	5	32
Large - 100 and more	6	7	13
All pulp and paper	33	12	45

Source: Georgia Manufacturing Survey 2008. Note: only establishments with 10 or more employees are included.

In this study, we conceive of sustainability strategies in manufacturing as encompassing not only immediate reductions in the use of energy or materials but as involving the redesign of products, processes, training, logistics, organizational forms, and other practices to meet current manufacturing needs without compromising abilities and resources required to meet future needs. Sustainable manufacturing involves minimizing the use of energy and resource inputs, and reducing or eliminating toxic materials, waste emissions, and unnecessary resource and materials usages over the life cycle of the product to optimize social, environmental and economic benefits.

<sup>2</sup> Definition of sectors by NAICS codes: Pulp and Paper includes NAICS 322; Food-Text includes NAICS 311, 312, 313, 314, 315, 316; Materials includes NAICS 321, 323, 326, 327, 337, 339; Machinery includes NAICS 331, 332, 333; Electrical-Transportation includes NAICS 334, 335, 336; and, Science includes NAICS 324, 325, and 3391.

## Georgia's Pulp and Paper Sector: Sustainability and Existing Manufacturing Functions

The Georgia Manufacturing Survey asked respondents to indicate whether they currently use or plan to introduce sustainability practices into 12 existing manufacturing processes. The currently most used technique by pulp and paper establishments is the Design of Manufacturing Processes for Waste Reduction, as mentioned by 80 percent of the respondents (Table 3). The least used technology is in the area of Logistics, as indicated by 25 percent of the pulp and paper respondents. Comparing with establishments in other sectors, pulp and paper establishments are more likely to use the Extraction and Processing of Raw Materials and the Design of Manufacturing Processes. The only technique that the pulp and paper sector is significantly less likely to use when compared with other sectors is Supplier Selection. While 56 percent of establishments in all sectors use that technique, only 43 percent of pulp and paper establishments do that.

**Table 3. Current use of technologies and techniques to improve sustainability of the manufacturing processes, Pulp and Paper establishments vs. other sectors.**

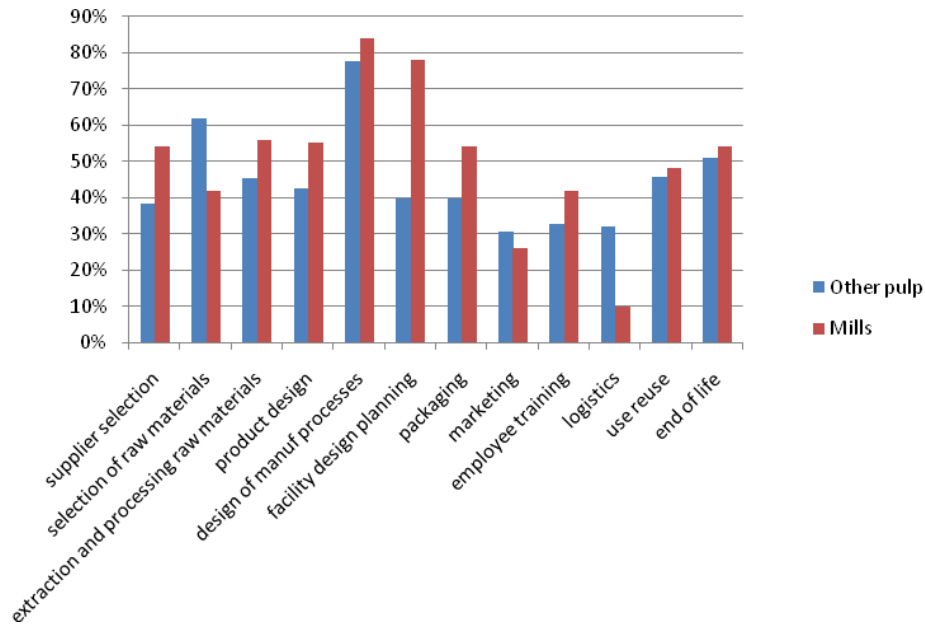
Technology / technique	Pulp and paper	Food-text	Materials	Mach	Elec-trans	Science	All manuf.
Supplier Selection	42.9%	55.3%	55.1%	49.8%	63.9%	77.8%	55.9%
Selection of Raw Materials	56.0%	50.3%	46.0%	42.0%	59.5%	70.5%	49.9%
Extract. and Process. of Raw Mat.	48.4%	33.6%	27.2%	12.9%	19.5%	33.5%	26.5%
Product Design	46.2%	47.7%	36.7%	33.0%	42.7%	44.7%	39.7%
Design of Manuf. Processes	79.6%	61.8%	57.8%	51.1%	54.9%	68.2%	59.1%
Facility Design Planning	51.0%	40.5%	35.6%	25.4%	48.5%	28.6%	36.0%
Packaging	44.1%	48.4%	34.2%	28.2%	45.1%	46.7%	38.1%
Marketing	29.2%	25.5%	19.4%	9.6%	26.5%	39.7%	21.4%
Employee Training	35.3%	44.0%	30.9%	32.0%	44.9%	53.1%	36.8%
Logistics	25.4%	29.8%	24.0%	21.2%	36.8%	22.9%	25.6%
Use Reuse	46.5%	44.1%	40.9%	35.2%	42.7%	51.7%	41.7%
End of Life	51.9%	41.0%	40.9%	36.0%	35.1%	45.0%	40.4%

Source: Georgia Manufacturing Survey 2008, weighted responses of 763 manufacturers.

The pulp and paper sector has the higher percentage of respondents that have introduced sustainability into more existing manufacturing processes compared to our other sectors. However, within these existing processes, pulp and paper is rather weak in terms of its use of sustainability practices in Supplier Selection, Employee Training, and Logistics compared to the other sectors; the weakness in Employment Training for sustainability is especially noteworthy in that the levels are much below that of food-textile, electrical-transportation, and science-based establishments.

A closer look at the pulp and paper sector reveals that mills are more likely to have introduced sustainability practices into more manufacturing processes than are non-mills. This highest level of activity by mills is in Design of Manufacturing Processes for Waste Reduction, as indicated by 84 percent of mill respondents (Figure 1). Also Facility Design and Planning was especially prevalent, with 79 percent of mills indicating that. In particular, Facility Design and Planning is twice more likely used by mills than other pulp and paper facilities. Also other pulp and paper establishments used Design of Manufacturing Processes the most, as mentioned by 78 percent of these respondents. On the other hand, the least used technologies by mills are Logistics and Transportation services—only 10 percent of the mills report using these technologies while more than 30 percent of other pulp and paper establishments does that.

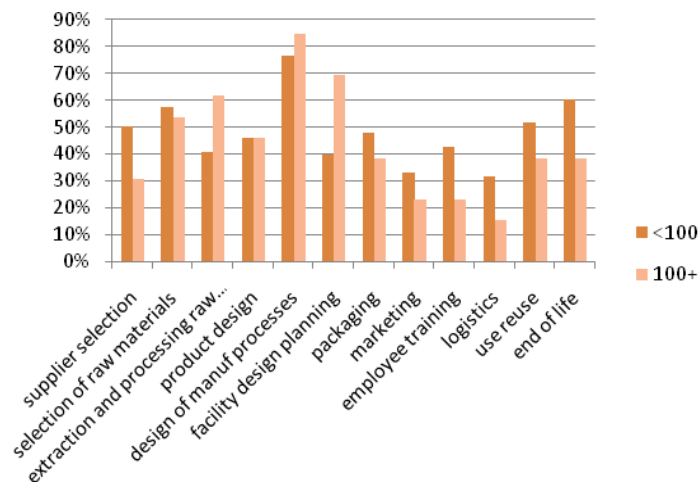
**Figure 1. Current use of technologies and techniques to improve sustainability of the manufacturing processes, Mills vs. other Pulp and Paper establishments.**



Source: Georgia Manufacturing Survey 2008, weighted responses of 45 pulp and paper manufacturers.

Within the pulp and paper sector, there are some differences between small and large establishments in terms of existing sustainability practices. While large establishments are more likely to use Design of Manufacturing Processes, Extraction and Processing of Raw Materials, and Facility Design and Planning, small establishments are more likely to use the rest of the practices in the survey (Figure 2). Interestingly, this is not the same pattern observed in all manufacturing sectors as a whole, where large establishments are more likely to use all the sustainability practices.

**Figure 2. Current use of technologies and techniques to improve sustainability of the manufacturing processes, Pulp and Paper establishments, small vs. large establishments.**



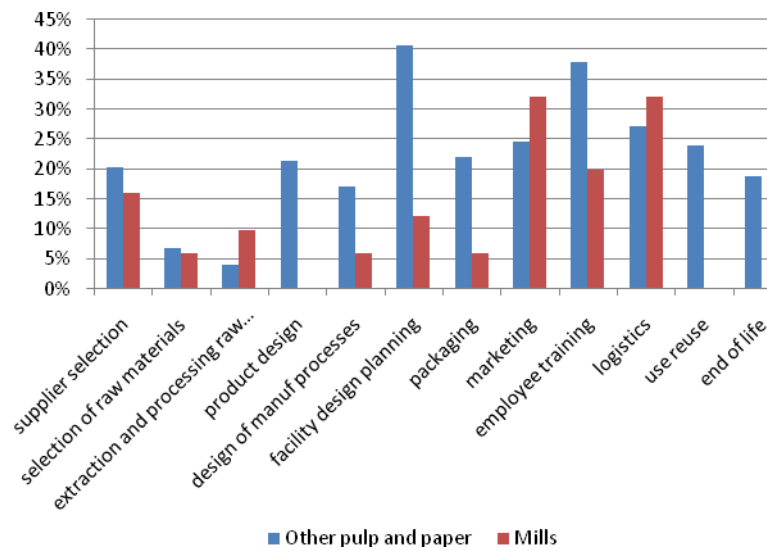
Source: Georgia Manufacturing Survey 2008, weighted responses of 45 pulp and paper manufacturers.

## Plans to Implement Sustainability Improvements

Pulp and paper establishments plan to use primarily Employee Training, Facility Design and Planning, Logistics, and Marketing in the next 2 years, as indicated by 33 percent, 32 percent, 29 percent, and 27 percent of the respondents, respectively.

While the data show that mills are more active in introducing sustainability practices into existing manufacturing processes, other pulp and paper establishments are more likely to say they are planning to implement sustainability improvements in more areas in the next 2 years. Non-mill pulp and paper facilities have a higher percentage of respondents (than mills) indicating plans to introduce sustainability practices into Product Design, Design of Manufacturing Processes, Facility Design Planning, Employee Training, Use/reuse/maintenance of Product, and End of Life functions (Figure 3). On the other hand, mills respondents more frequently indicated plans to introduce sustainability practices into Marketing and Logistics functions in the next 2 years. The least planned technologies and techniques for all pulp and paper establishments are Selection of Raw Materials and Extraction and Processing of Raw Materials.

**Figure 3. Planned use of technologies and techniques to improve sustainability of the manufacturing processes in the next 2 years, Mills vs. other Pulp and Paper establishments.**



Source: Georgia Manufacturing Survey 2008, weighted responses of 45 pulp and paper manufacturers.

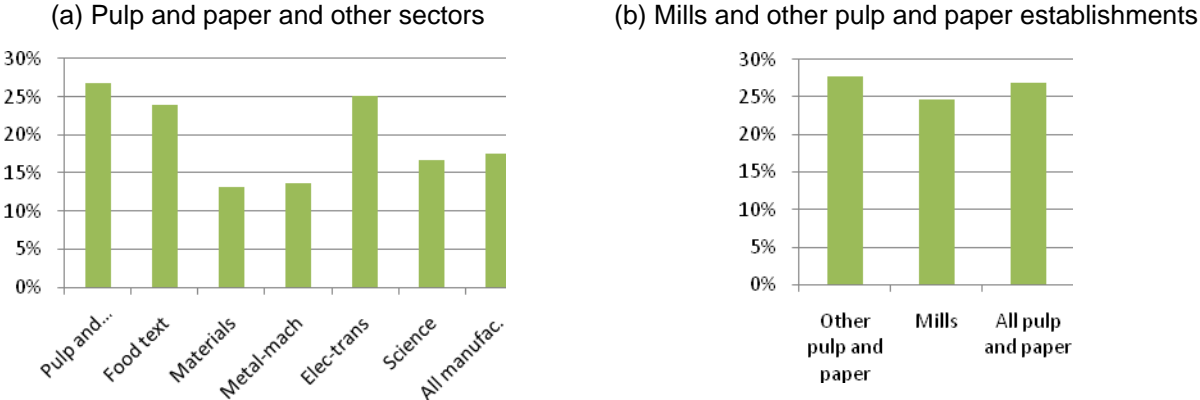


## Energy Reduction Targets

The Georgia Manufacturing Survey asked respondents whether their facility had set targets to reduce the amount of energy used. About 27 percent of pulp and paper establishments responded to have set targets for energy reduction for 2008 or future years (Figure 4.b). This level of target setting was much higher than in the manufacturing base as a whole, where only 17 percent of respondents had set energy targets (Figure 4.a). Since the pulp and paper sector (especially paper mills) are typically large users of energy in their processes, this is not an unexpected result. The proportion of pulp and paper establishments setting energy targets is similar to that of food-textile and electrical-transportation sectors but much higher than material, machinery, or science-based respondents. In terms of establishment size, there is no significant size gap in the percentage of pulp and paper manufacturers setting energy reduction targets while there is a sizeable gap for the manufacturing base as a whole.

Within the pulp and paper sector, mills are less likely to set energy reduction targets than other types of establishments, even though the difference is not significant (Figure 4.b). Almost 25 percent of mills set targets for energy reduction, three percentage points less than other pulp and paper establishments.

**Figure 4. Proportion of establishments setting energy reduction targets, Pulp and Paper establishments vs. other Sub-industries, Mills vs. other Pulp and Paper establishments.**

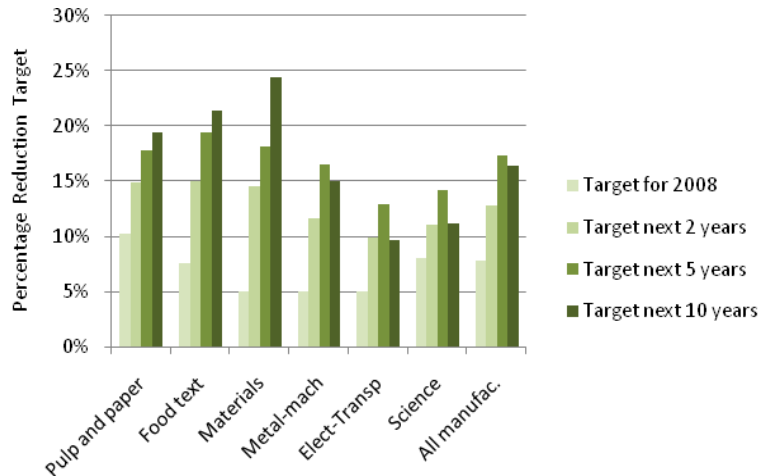


Source: Georgia Manufacturing Survey 2008, weighted responses of 729 manufacturers from all sectors and 9 pulp and paper manufacturers.

Among respondents that indicated they had set energy targets, the survey asked to indicate the percentage of current reduction (in 2008) and over the next 10 years. Eighteen percent of pulp and paper establishments reported a percentage reduction target for 2008, but this level of target setting dropped to almost 15 percent by 2018.

The energy reduction targets set for 2008 differ to some extent when comparing the pulp and paper sector with all the manufacturing industry (Figure 5). In 2008, pulp and paper establishments have set in average 10 percent reduction targets, higher than all other manufacturing sectors and the industry as a whole, which has an average reduction target of almost 8 percent. However, when considering targets set for 2018, food-textile and materials sectors have set higher average reduction targets, of 24 and 21 percent respectively. Meanwhile, the average target set by pulp and paper facilities for the next 10 years is about 19 percent. This percentage is still above the average for the manufacturing industry as a whole, which is around 16 percent for 2018.

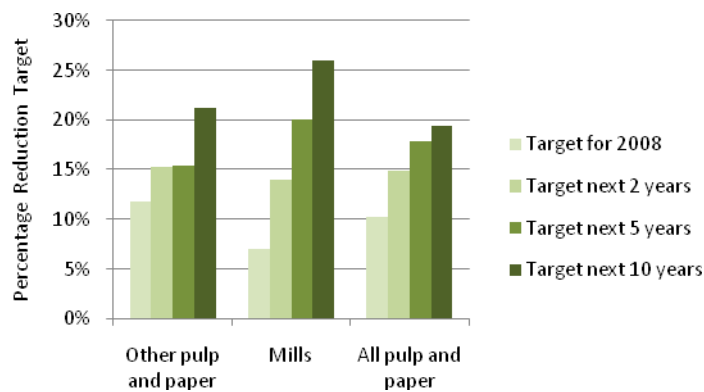
**Figure 5. Average Energy Targets for different time horizons, Pulp and paper vs. other manufacturing sectors.**



Source: Georgia Manufacturing Survey 2008, weighted responses of 729 manufacturers.

Within the pulp and paper sector, the data reveal that mills have set higher average targets for the next 5 and 10 years, of 20 and 26 percent, respectively (Figure 6). Meanwhile, other pulp and paper establishments have set higher average targets for 2008 and 2010. Their average reduction target for 2008 is 12 percent, 5 percentage points higher than the average mills' target.

**Figure 6. Average Energy Targets for different time horizons, Mills vs. other Pulp and paper establishments.**



Source: Georgia Manufacturing Survey 2008, weighted responses of 45 pulp and paper manufacturers.

## Adoption of New Sustainability Management Techniques

The survey asked respondents to indicate whether they currently use or plan to introduce any of eight different sustainability management activities. Pulp and paper manufacturers were mostly likely to pursue Recycling of Production Materials; three quarters of all pulp and paper manufacturers currently used recycling in their facilities (Table 4). Also common were High Efficiency Lighting (used by 50 percent of the establishments), Energy Audits (used by 48 percent), Water Recycling (used by 33 percent) and Environmental Stewardship (used by 29 percent). Compared with other sectors, pulp and paper manufacturers had a much higher rate of using Energy Audits, twice as high as that of the typical manufacturer. Pulp and paper manufacturers were also more likely to have adopted Recycling of Production Materials, Water Recycling, participated in Federal Energy Programs, and adopted Environmental Stewardship practices. On the other hand, pulp and paper establishments were less likely to adopt activities like ISO 14000 and Life Cycle Costing than the typical manufacturer.

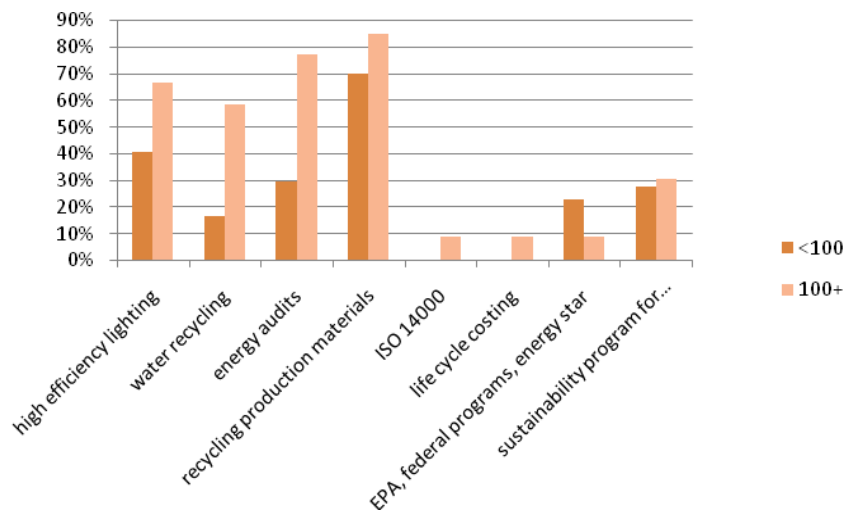
**Table 4. Sustainability management activities currently used at the facility, Pulp and Paper establishments vs. all manufacturing industry.**

Management activity	Pulp and paper	Food-text	Materials	Mach	Elec-trans	Science	All manuf.
High Efficiency Lighting	50.0%	54.8%	45.2%	48.6%	51.5%	44.4%	48.4%
Water Recycling	33.0%	29.1%	18.4%	13.5%	13.3%	47.5%	21.8%
Energy Audits	47.7%	30.5%	17.1%	15.2%	27.9%	32.1%	23.2%
Recycling Production Materials	75.6%	64.5%	57.2%	61.6%	60.1%	75.3%	62.2%
ISO 14000	3.3%	10.3%	6.1%	6.9%	11.1%	15.0%	8.0%
Life Cycle Costing	3.3%	10.3%	6.5%	4.7%	15.0%	12.9%	7.9%
EPA, Federal Programs, Energy Star	17.6%	8.5%	9.3%	7.4%	12.8%	15.4%	10.1%
Sustainability Program For Environmental Stewardship	29.1%	25.9%	17.0%	7.8%	27.5%	29.1%	19.3%

Source: Georgia Manufacturing Survey 2008, weighted responses of 763 manufacturers.

Within the pulp and paper sector, there is a substantial difference in adoption rates of new sustainability management activities between large and small pulp and paper manufacturers (similar to what we see in the industry as a whole.) In general, small pulp and paper manufacturers have lower adoption rates than their large manufacturing counterparts. In particular, larger establishments (those with 100 or more employees) are more likely to pursue all sustainability management practices with few exceptions (Figure 7). The most used activity is Recycling of Production Materials, as indicated by 85 percent of large establishments. Also Energy Audits, High Efficiency Lighting, and Water Recycling were prevalent, as mentioned by 77 percent, 67 percent, and 58 percent of these large respondents, respectively. US EPA or other Federal Programs was among the least used sustainability activities (as indicated by about 9 percent of the large respondents,) activity embraced by small establishments more than twice as often as their large counterparts. On the other hand, only large establishments use ISO 14000 and Life Cycle Costing, although adoption rates of these practices remain low.

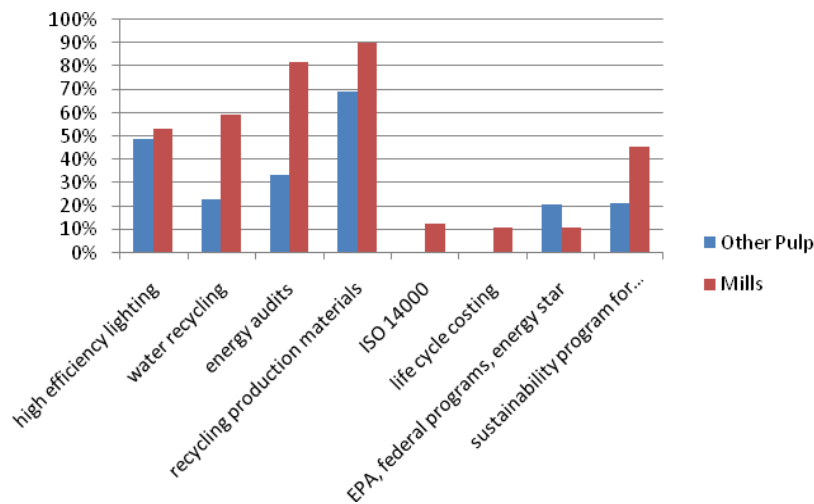
**Figure 7. Sustainability management activities currently used at the facility, Pulp and Paper establishments, small vs. large establishments.**



Source: Georgia Manufacturing Survey 2008, weighted responses of 45 pulp and paper manufacturers.

Almost without exception, mills are more likely than other pulp and paper establishments to adopt new sustainability management activities provided in the survey. In particular, mills are much more likely to adopt Water Recycling and Energy Audits activities, with about 60 percent and 80 percent of the establishments respectively reporting that they currently use these activities (Figure 8). Mills are also more likely to have adopted ISO 14000 Practices and Life Cycle Costing albeit at low levels. In contrast, other pulp and paper establishments have slightly higher rates than mills of usage of US EPA or other Federal Programs.

**Figure 8. Sustainability management activities currently used at the facility, Mills vs. other Pulp and Paper establishments.**

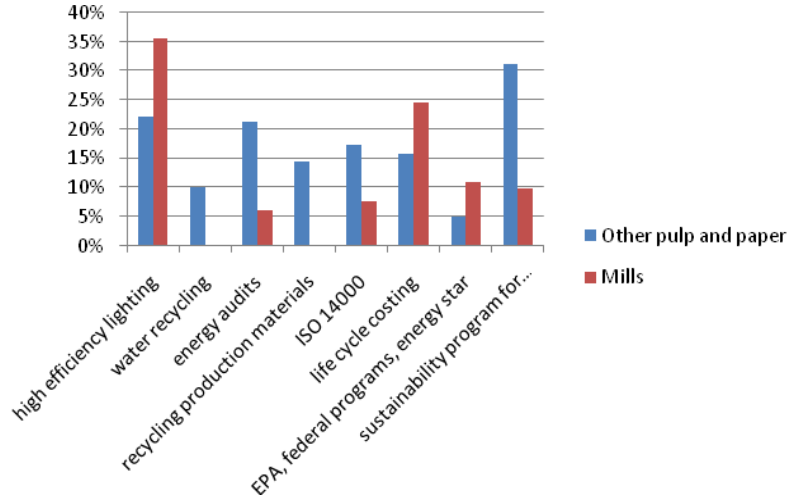


Source: Georgia Manufacturing Survey 2008, weighted responses of 45 pulp and paper manufacturers.

In terms of future plans for sustainability management activities, the pulp and paper sector does not differ significantly from other sectors. The most important difference is in Energy Audits, with about half of the pulp and paper establishments planning to implement these activities in the next two years, while less than 30 percent of establishments in other sectors plan to do that. Moreover, pulp and paper establishments are less likely to implement ISO 14000 and Life Cycle Costing activities compared to other sectors, according to their plans for the next 2 years. In particular, contrasting small establishments' plans, large pulp and paper establishments are primarily planning to use EPA or Other Federal Programs (e.g. Energy Star) and Sustainability Program for Environmental Stewardship in the next 2 years, as mentioned by 18 and 38 percent of the large respondents, respectively.

In general, a relatively minor proportion of pulp and paper establishments plan to use the sustainability activities suggested in the survey for the next 2 years. Moreover, some differences exist between mills and other types of establishments within this sector. Mills responded to have plans for using particularly High Efficiency Lighting and Life Cycle Costing, while other pulp and paper establishments mentioned more frequently plans for using Sustainability Programs for Environmental Stewardship among others (Figure 9). On the other hand, while mills do not plan to use Water Recycling and Recycling of Production Materials in the next 2 years, about 10 and 15 percent of other pulp and paper establishments responded to do so, respectively.

**Figure 9. Planned sustainability management activities for the next 2 years, Mills vs. other Pulp and Paper establishments.**



Source: Georgia Manufacturing Survey 2008, weighted responses of 45 pulp and paper manufacturers.

# Knowledge and Information Sources for Sustainability

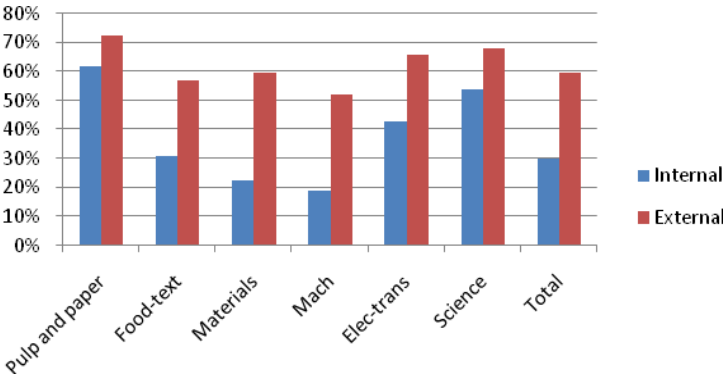
The survey asked respondents to indicate their knowledge and information sources for sustainability and management practices. For the purpose of this analysis, we classified the sources into internal and external (Table 4). Although this classification has some limitations, it allows comparing how establishments draw upon very different types of information or knowledge sources. A more detailed inter-sectoral comparison based on individual sources is available in the Appendix.

**Table 4. Internal and external sources of information and knowledge for sustainability management practices.**

Internal	External
Internal Energy or Environmental Manager at This Facility	Suppliers
Other Existing Staff at This Facility	Customers, Clients or Users
Other Units in the Enterprise Group - Subsidiaries, Branches, Affiliates	Competitors
	External Consultants
	R&D Labs, Universities, Public Assistance
	Trade Associations, Other Business Organizations
	Conferences, Seminars or Technical Meetings
	Printed Journals, Technical Papers
	Online Information Sources

Comparing with all Georgian manufacturers, pulp and paper establishments were more likely to use both internal and external sources of information in the last two years (Figure 10). Only the science sector used internal sources in a relatively similar manner. All the internal sources of information (Environmental Managers or Other Staff at the Facility or Within the Enterprise Group) were used by an average of 38 percent of pulp and paper respondents, while Suppliers (of materials, components, equipment) were the most important external source of information and knowledge as indicated by 52 percent of the pulp and paper respondents. On the other hand, pulp and paper establishments were less likely to use some external sources like Trade Associations and Other Business Organizations when compared with all manufacturing industry.

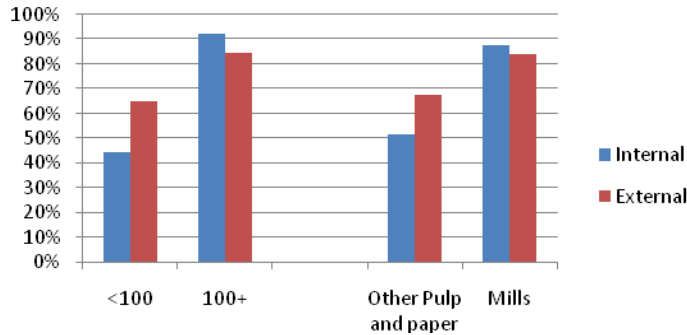
**Figure 10. Use of internal and external sources of information and knowledge for sustainability management practices, Pulp and Paper establishments vs. other sectors.**



Source: Georgia Manufacturing Survey 2008, weighted responses of 716 manufacturers.

When looking at the pulp and paper sector, the data reveal that that pattern of information and knowledge sources is different between small and large establishments and between mills and other establishments. Interestingly, mills were more likely to use both internal and external sources of information compared to other pulp and paper establishments (Figure 11). Large establishment were also more likely to use both types of sources of information. More than 90 percent of large establishments used internal sources and more than 80 percent used external sources. Only 44 percent of small establishments used internal sources, while 65 percent of them used external sources.

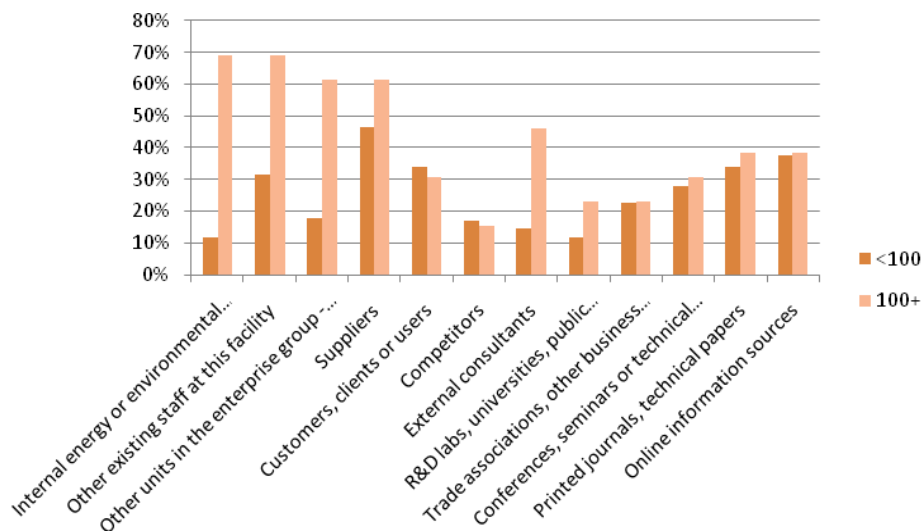
**Figure 11. Sources of information and knowledge for sustainability management practices, small vs. large, and mills vs. other pulp and paper establishments.**



Source: Georgia Manufacturing Survey 2008, weighted responses of 44 pulp and paper manufacturers.

Large pulp and paper establishments were more likely to use Internal Managers, Other Staff or Units Within the Same Enterprise Group, Suppliers, or External Consultants as sources of information and knowledge during the last two years, presenting significant differences with small establishments in that regard (Figure 12). The rest of the sources of information and knowledge do not present significant size gaps.

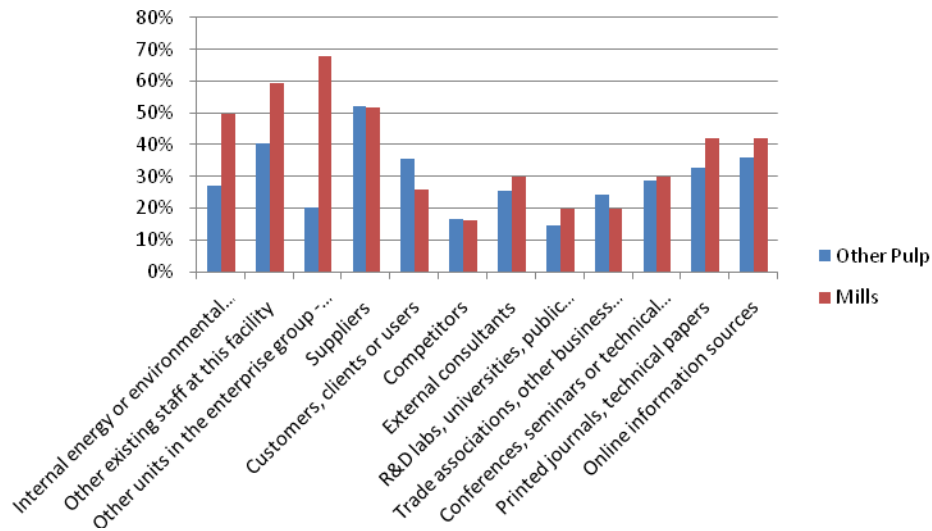
**Figure 12. Sources of information and knowledge for sustainability management practices, Pulp and Paper establishments, small vs. large establishments.**



Source: Georgia Manufacturing Survey 2008, weighted responses of 44 pulp and paper manufacturers.

When comparing mills and other pulp and paper establishments, we find differences similar to the large vs. small comparison. Mills used more internal sources of information in the last two years: 68 percent of them indicated the use of Other Staff Within the Enterprise Group, 60 percent indicated the use of Other Staff Within the Facility, and 50 percent indicated the use of Internal Energy or Environmental Managers (Figure 13). Other pulp and paper establishments were more likely to use Customers, Clients or Users as sources of knowledge, with about 35 percent of those establishments reporting that. Only 26 percent of mills indicated the same.

**Figure 13. Sources of information and knowledge for sustainability management practices, Mills vs. other Pulp and Paper establishments.**



Source: Georgia Manufacturing Survey 2008, weighted responses of 44 pulp and paper manufacturers.

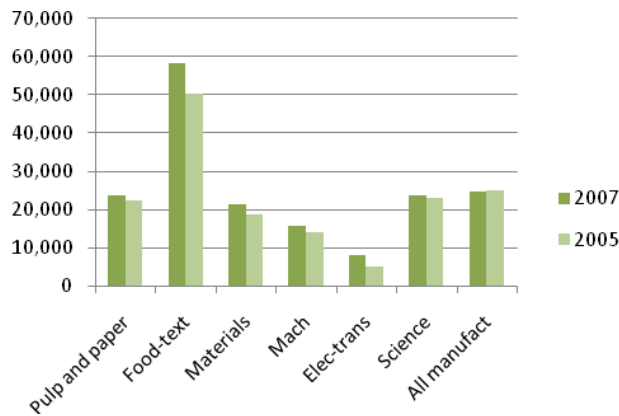
## Energy Intensity

One measure that is used to assess efficiency from an energy and sustainability perspective is the energy intensity ratio. In this analysis we use a definition of energy intensity that is energy expenditures (e.g., heat, electricity) per million dollars of total annual sales or gross value of shipments. Pulp and paper establishments are below the all industry average, with an average energy intensity of \$23,750 per \$ million of sales in 2007 (Figure 14). Food-textile is the only sector above that level, with an energy intensity of \$58,300 in 2007, the highest level for any sector.

In general, each manufacturing sector has increased their energy intensity between 2005 and 2007. Pulp and paper establishments were among those that increased their energy intensity the least, only about 6 percent between 2005 and 2007. That slight increase in energy intensity from 2005 to 2007 in all sectors likely reflects an overall increase in energy costs that has affected all sectors and particularly exceptional increases for sectors like science. Electrical-transportation is the sector that increased its energy intensity the most, by about 65 percent between 2005 and 2007.



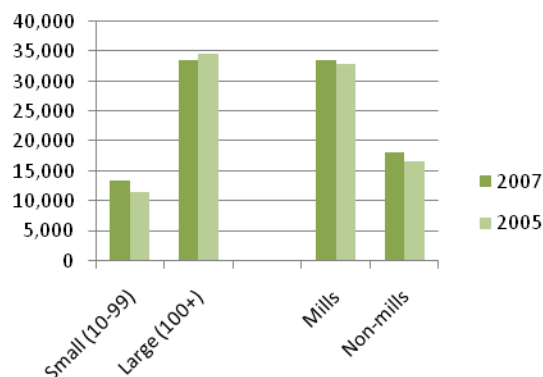
**Figure 14. Energy intensity (\$ per million in sales), Pulp and Paper vs. other manufacturing sectors.**



Source: Georgia Manufacturing Survey 2008, weighted responses of 470 manufacturers from all sectors and 32 pulp and paper manufacturers.

Within the pulp and paper sector, small establishments are much more efficient than their large counterparts. In 2007, large establishments had an average energy intensity of \$33,600 per \$ million of sales, while small establishments had an average of \$13,500. However, in terms of changes in energy intensity over time, only large establishments have become more energy efficient, decreasing their energy intensity ratio slightly by about 3 percent from 2005 to 2007 (Figure 15). This declining energy intensity in large establishments is only observed within the pulp and paper sector and not in the industry as a whole. The data also reveal that mills have much higher energy intensity than non-mills. In 2007, mills reported an energy intensity of \$33,600 per \$ million of sales, while other pulp and paper facilities reported an average of only \$18,200. While both mills and other pulp and paper establishments were subject to higher energy costs, energy intensity rose at a slower rate for mills (3 percent) compared to non-mills (which rose by 9 percent.)

**Figure 15. Energy intensity (\$ per million in sales), Pulp and Paper establishments, small vs. large and mills vs. other pulp and paper establishments.**



Source: Georgia Manufacturing Survey 2008, weighted responses of 32 pulp and paper manufacturers.

How does energy use relate to manufacturing performance?

We use an OLS regression based on a Cobb-Douglas model to assess how changes in energy intensity and other variables between 2005 and 2007 impacted on the added-value per employee of the establishments. There are certainly weaknesses in this approach such as the inability to contemplate time lags in the effects resulting from the adoption of sustainability practices or improvements in the use of energy. On the other hand, some data limitations reduce the potential of our model. For instance, since there are not data related to capital stock resulting from the survey, capital expenditure is used as a proxy of capital for this analysis. However, this analysis does allow us to explore the association between energy use and productivity as measured by value-added, even though we do not and indeed cannot, posit causal connections. The model used here is specified as:

$$\text{Invaddegr} = \beta_0 + \beta_1 \text{Inempgr} + \beta_2 \text{Incaperg} + \beta_3 \text{Ineintensegr} + \beta_4 \text{pulpandpaper} + \beta_5 \text{mill} + \beta_6 \text{less100} + \varepsilon$$

where variables are defined as follows:

<b>Invaddegr</b>	the natural logarithm of the change in added-value per employee between 2005 and 2007;
<b>Inempgr</b>	the natural logarithm of the change in employment between 2005 and 2007;
<b>Incaperg</b>	the natural logarithm of the change in capital investment per employee between 2005 and 2007;
<b>Ineintensegr</b>	the natural logarithm of the change in energy intensity between 2005 and 2007, with energy intensity defined as energy expenditure / sales;
<b>pulpandpaper</b>	a dummy indicating whether the establishment is in the pulp and paper sector (pulpandpaper=1);
<b>mill</b>	a dummy indicating whether the establishment is a mill (mill=1);
<b>less100</b>	dummy indicating whether the establishment has less than 100 employees (less100=1).

Estimates of this model with our current data yielded an R-squared statistic of .60, which suggests that the model is appropriate to describe the relationships between these variables (Table 5). An F-test allows discarding the null hypothesis that establishes that there is no relation between the dependent variable (change in added-value per employee) and all the independent variables included in the model (primarily, change in employment, change in capital, and change in energy intensity.) Therefore, overall, the model is likely to reflect the relations between variables in the population too.

The increase in capital has been the most important factor related to added-value growth for manufacturing establishments between 2005 and 2007. In general, a one percent increase in capital expenditure is related with a 1.15 percent increase in added-value per employee when holding constant other variables. Energy intensity (defined as energy expenditure over sales for each year) is also a statistically significant factor, although it has a negative impact on added-value per employee. In other words, establishments that are more efficient in the use of energy (i.e. have less energy intensity) have shown higher increases in added-value per employee. Employment growth has a positive effect on added-value per employee, yet it is not statistically significant.

Although pulp and paper establishments seem to have greater increases in added-value per employee compared with other manufacturing establishments, the relationship between this factor and the dependent variable is not statistically significant. Therefore, is not possible to conclude that this positive relation between pulp and paper establishments and added-value growth is also present in the population. Finally, those relationships between capital and energy intensity and added-value per employee hold regardless of establishment size or, within the pulp and paper sector, regardless the type of establishment (mills versus non-mills.)

**Table 5. OLS regression**

Variables	OLS
lnempgr	0.059
	(0.421)
lncapegr	1.149
	(0.000)***
lnintensegr	-0.114
	(0.030)**
pulpandpaper	0.183
	(0.107)
mill	-0.169
	(0.209)
less100	-0.016
	(0.684)
Constant	-0.017
	(0.649)
Observations	428
R-squared	0.6014

Source: Georgia Manufacturing Survey 2008

Dependent variable is the log of the change in value-added per employee between 2005 and 2007.  
Standard errors in parentheses.  
\* Significant at 10%; \*\* Significant at 5%; \*\*\* Significant at 1%

## Conclusions

This report has examined the energy usage and sustainability management and improvement attributes of pulp and paper manufacturers relative to other types of industries. We showed that reducing energy intensity, measured as energy expenditures per million dollars of sales, is associated with increased productivity in terms of value-added per employee. This presents an opportunity for pulp and paper manufacturers because, as is widely understood and referenced in other studies, energy intensity in this industry is higher than other manufacturing industries by in large. Indeed, large pulp and paper establishments have gotten more efficient than other manufacturing sectors, even though energy prices increased from 2005 to 2007.

Pulp and paper manufacturers were also shown to be “greener” than other industries in that they have adopted sustainability practices into more of their manufacturing processes than other manufacturing sectors. Pulp and paper manufacturers are also more likely to have formally set targets for energy reduction than other sectors. However, pulp and paper manufacturers are less likely to offer sustainability training to employees than manufacturers in other sectors. Even though employee training is a relatively less prominent area of sustainability practice, nearly one-third of pulp and paper establishments plan to introduce sustainability training in the next two years. Facility design, logistics, and marketing/eco-branding are also common areas for planned activity in the next two years. These training and design issues have been shown to be a challenge to implementing innovations outside of current practices in other studies (Youtie et al, 2006).

We also observed that while many manufacturers have a gap in adoption of sustainability practices between large and small establishments, such is not the case for pulp and paper manufacturers. Pulp and paper manufacturers with 100 or more employees have nearly the same percentage of respondents that introduced sustainability practices into their existing process as did their smaller counterparts. There are differences between mills and other pulp and paper facilities with mills have higher percentages of respondents introducing sustainability into supplier selection, product design, facility design planning, and packaging, while other pulp and paper facilities have higher percentages introducing sustainability practices in selection of raw materials and logistics.

In the case of adoption of new sustainability technologies and techniques, pulp and paper manufacturers are in less of a leading position. Their most common areas of adoption—recycling of production materials and high efficiency lighting—are also the top practices for all manufacturers. Pulp and paper manufacturers place a greater emphasis on energy technologies and techniques such as energy audits but have less activity across the broader range of sustainability practices such as ISO 14000 and life cycle costing. Information about sustainability practices comes from suppliers for more than half of the pulp and paper manufacturers surveyed. More than 60 percent of pulp and paper manufacturers use internal knowledge sources such as energy or environmental managers, other existing staff, or other units in the enterprise group as knowledge sources. Online sources and printed journals are also used by more than 35 percent of pulp and paper respondents. Use of external sources such as customers, competitors, external consultants, or R&D and public organizations are less common. Reliance on suppliers, internal knowledge sources, and online information can provide good information although it may not necessarily lead to innovation in sustainability because these resources are available to all rather than offering distinctive advantage.

In summary, pulp and paper manufacturers have notable strength in energy usage and sustainability practices. To attain a broad-based sustainability position, pulp and paper manufacturers will need to engage in a balanced range of technologies and techniques in addition to their leading position in energy reduction practices. Investments in employee training in sustainability practices and a diverse array of knowledge sources will be important in this regard.

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## Appendix

This appendix presents tabulated results from the Georgia Manufacturing Survey 2008. For a copy of the questionnaire and additional information, see <http://www.cherry.gatech.edu/survey>.

**Table A1. Current use of technologies and techniques to improve sustainability of the manufacturing processes, Pulp and Paper vs. other sectors.**

Technology / technique	Pulp and paper	Food-text	Materials	Mach	Elec-trans	Science	All manuf.
Supplier Selection	42.9%	55.3%	55.1%	49.8%	63.9%	77.8%	55.9%
Selection of Raw Materials	56.0%	50.3%	46.0%	42.0%	59.5%	70.5%	49.9%
Extraction and Proces. Raw Materials	48.4%	33.6%	27.2%	12.9%	19.5%	33.5%	26.5%
Product Design	46.2%	47.7%	36.7%	33.0%	42.7%	44.7%	39.7%
Design of Manuf. Processes	79.6%	61.8%	57.8%	51.1%	54.9%	68.2%	59.1%
Facility Design Planning	51.0%	40.5%	35.6%	25.4%	48.5%	28.6%	36.0%
Packaging	44.1%	48.4%	34.2%	28.2%	45.1%	46.7%	38.1%
Marketing	29.2%	25.5%	19.4%	9.6%	26.5%	39.7%	21.4%
Employee Training	35.3%	44.0%	30.9%	32.0%	44.9%	53.1%	36.8%
Logistics	25.4%	29.8%	24.0%	21.2%	36.8%	22.9%	25.6%
Use Reuse	46.5%	44.1%	40.9%	35.2%	42.7%	51.7%	41.7%
End of Life	51.9%	41.0%	40.9%	36.0%	35.1%	45.0%	40.4%

Source: Georgia Manufacturing Survey 2008, weighted responses of 763 manufacturers.

**Table A2. Current use of technologies and techniques to improve sustainability of the manufacturing processes, Mills vs. other Pulp and Paper establishments.**

Technology / technique	Other pulp	Mills	Total
Supplier Selection	38.3%	54.2%	42.9%
Selection Of Raw Materials	62.0%	42.0%	56.0%
Extraction And Processing Raw Materials	45.4%	55.8%	48.4%
Product Design	42.5%	55.3%	46.2%
Design Of Manuf Processes	77.7%	84.0%	79.6%
Facility Design Planning	39.7%	77.9%	51.0%
Packaging	39.8%	54.2%	44.1%
Marketing	30.6%	26.0%	29.2%
Employee Training	32.6%	42.0%	35.3%
Logistics	31.9%	9.9%	25.4%
Use Reuse	45.8%	48.1%	46.5%
End Of Life	51.0%	54.2%	51.9%

Source: Georgia Manufacturing Survey 2008, weighted responses of 45 pulp and paper manufacturers.

**Table A3. Current use of technologies and techniques to improve sustainability of the manufacturing processes, Pulp and Paper, small vs. large establishments.**

<b>Technology / technique</b>	<b>&lt;100</b>	<b>100+</b>	<b>Total</b>
Supplier Selection	50.4%	30.8%	42.9%
Selection Of Raw Materials	57.4%	53.8%	56.0%
Extraction And Processing Raw Materials	40.6%	61.5%	48.4%
Product Design	46.2%	46.2%	46.2%
Design Of Manuf Processes	76.4%	84.6%	79.6%
Facility Design Planning	39.7%	69.2%	51.0%
Packaging	47.8%	38.5%	44.1%
Marketing	32.9%	23.1%	29.2%
Employee Training	42.6%	23.1%	35.3%
Logistics	31.6%	15.4%	25.4%
Use Reuse	51.5%	38.5%	46.5%

Source: Georgia Manufacturing Survey 2008, weighted responses of 45 pulp and paper manufacturers.

**Table A4. Planned use of technologies and techniques to improve sustainability of the manufacturing processes in the next 2 years, Mills vs. other Pulp and Paper establishments.**

<b>Technology / technique</b>	<b>Other pulp and paper</b>	<b>Mills</b>	<b>Total</b>
Supplier Selection	20.3%	16.0%	19.0%
Selection Of Raw Materials	6.8%	6.1%	6.6%
Extraction And Processing Raw Materials	4.0%	9.9%	5.7%
Product Design	21.3%	0.0%	15.3%
Design Of Manuf Processes	17.1%	6.1%	13.8%
Facility Design Planning	40.6%	12.2%	32.2%
Packaging	22.2%	6.1%	17.3%
Marketing	24.7%	32.1%	26.8%
Employee Training	38.0%	19.9%	32.7%
Logistics	27.2%	32.1%	28.6%
Use Reuse	23.9%	0.0%	16.8%
End Of Life	18.8%	0.0%	13.2%

Source: Georgia Manufacturing Survey 2008, weighted responses of 45 pulp and paper manufacturers.

**Table A5. Planned use of technologies and techniques to improve sustainability of the manufacturing processes, Pulp and Paper vs. other sectors.**

Technology / technique	Pulp and paper	Food-text	Materials	Mach	Elec-trans	Science	Total
Supplier Selection	19.0%	12.6%	7.6%	6.9%	11.6%	6.1%	9.4%
Selection Of Raw Materials	6.6%	6.9%	8.1%	3.6%	5.6%	7.3%	6.5%
Extraction And Processing Raw Materials	5.7%	6.0%	6.9%	3.9%	4.2%	7.7%	5.8%
Product Design	15.3%	19.7%	14.2%	12.7%	22.4%	20.1%	16.2%
Design Of Manuf Processes	13.8%	15.2%	18.5%	12.4%	18.5%	19.3%	16.4%
Facility Design Planning	32.2%	24.4%	27.4%	28.0%	16.1%	28.3%	26.3%
Packaging	17.3%	23.9%	15.1%	13.6%	9.3%	16.3%	16.0%
Marketing	26.8%	29.4%	25.1%	13.3%	12.3%	11.9%	21.1%
Employee Training	32.7%	19.8%	25.6%	20.4%	17.5%	19.2%	22.8%
Logistics	28.6%	14.2%	16.9%	10.7%	13.7%	17.2%	15.7%
Use Reuse	16.8%	16.6%	10.9%	5.8%	9.8%	7.3%	10.8%
End Of Life	13.2%	10.3%	6.5%	3.2%	4.1%	4.5%	6.5%

Source: Georgia Manufacturing Survey 2008, weighted responses of 763 manufacturers.

**Table A6. Sources of information and knowledge for sustainability management practices, Pulp and Paper vs. other sectors.**

Sources of information and knowledge	Pulp and paper	Food-text	Materials	Mach	Elec-trans	Science	All manuf.
Internal Energy or Environmental Manager at This Facility	33.9%	22.4%	9.5%	8.6%	22.6%	31.5%	16.1%
Other Existing Staff at This Facility	46.1%	24.4%	15.6%	14.4%	31.3%	39.1%	22.2%
Other Units in the Enterprise Group - Subsidiaries, Branches, Affiliates	34.5%	14.0%	7.1%	6.9%	20.4%	29.9%	13.1%
Suppliers	52.2%	39.5%	35.3%	33.0%	45.2%	35.3%	37.6%
Customers, Clients or Users	32.6%	18.0%	25.9%	22.4%	29.7%	31.2%	25.0%
Competitors	16.3%	7.6%	10.1%	9.6%	18.5%	6.7%	10.5%
External Consultants	26.8%	20.8%	10.7%	14.5%	27.5%	29.5%	17.4%
R&D Labs, Universities, Public Assistance	16.1%	18.8%	8.0%	6.1%	14.0%	27.8%	12.1%
Trade Associations, Other Business Organizations	22.9%	27.1%	28.0%	26.1%	39.8%	36.1%	28.9%
Conferences, Seminars or Technical Meetings	29.0%	23.6%	24.5%	22.7%	23.5%	35.5%	25.0%
Printed Journals, Technical Papers	35.6%	26.3%	22.9%	20.2%	35.1%	31.4%	25.6%
Online Information Sources	37.9%	30.5%	32.9%	27.7%	42.4%	31.4%	32.5%

Source: Georgia Manufacturing Survey 2008, weighted responses of 716 manufacturers.



**Table A7. Proportion of establishments setting energy reduction targets, Pulp and Paper vs. other sectors.**

Sector	Proportion setting targets
Pulp and paper	26.8%
Food text	23.9%
Materials	13.2%
Metal-mach	13.7%
Elec-trans	25.2%
Science	16.8%
All manufac.	17.5%

Source: Georgia Manufacturing Survey 2008, weighted responses of 729 manufacturers.

**Table A8. Average Energy Targets for different time horizons, Pulp and paper vs. other manufacturing sectors.**

	Pulp and paper	Food text	Materials	Mach	Elec-trans	Science	All manufac.
Target for 2008	10.2%	7.5%	5.0%	5.0%	5.0%	8.0%	7.8%
Target next 2 years	14.8%	15.0%	14.5%	11.7%	9.9%	11.0%	12.8%
Target next 5 years	17.8%	19.4%	18.1%	16.5%	12.9%	14.2%	17.4%
Target next 10 years	19.4%	21.4%	24.4%	15.0%	9.6%	11.2%	16.4%

Source: Georgia Manufacturing Survey 2008, weighted responses of 729 manufacturers.

**Table A9. Average Energy Targets for different time horizons, Mills vs. other Pulp and paper establishments.**

	Other pulp and paper	Mills	All pulp and paper
Target for 2008	11.8%	7.0%	10.2%
Target next 2 years	15.3%	14.0%	14.8%
Target next 5 years	15.4%	20.0%	17.8%
Target next 10 years	21.3%	26.0%	19.4%

Source: Georgia Manufacturing Survey 2008, weighted responses of 45 pulp and paper manufacturers.

**Table A10. Sustainability management activities currently used at the facility, Pulp and Paper vs. other sectors.**

Management activity	Pulp and paper	Food-text	Materials	Mach	Elec-trans	Science	All manuf.
High Efficiency Lighting	50.0%	54.8%	45.2%	48.6%	51.5%	44.4%	48.4%
Water Recycling	33.0%	29.1%	18.4%	13.5%	13.3%	47.5%	21.8%
Energy Audits	47.7%	30.5%	17.1%	15.2%	27.9%	32.1%	23.2%
Recycling Production Materials	75.6%	64.5%	57.2%	61.6%	60.1%	75.3%	62.2%
ISO 14000	3.3%	10.3%	6.1%	6.9%	11.1%	15.0%	8.0%
Life Cycle Costing	3.3%	10.3%	6.5%	4.7%	15.0%	12.9%	7.9%
EPA, Federal Programs, Energy Star	17.6%	8.5%	9.3%	7.4%	12.8%	15.4%	10.1%
Sustainability Program For Environmental Stewardship	29.1%	25.9%	17.0%	7.8%	27.5%	29.1%	19.3%

Source: Georgia Manufacturing Survey 2008, weighted responses of 763 manufacturers.

**Table A11. Sustainability management activities currently used at the facility, Pulp and Paper, small vs. large establishments.**

Management activity	<100	100+	All pulp and paper
High Efficiency Lighting	40.5%	66.7%	50.0%
Water Recycling	16.6%	58.3%	33.0%
Energy Audits	29.5%	76.9%	47.7%
Recycling Production Materials	69.9%	84.6%	75.6%
Iso 14000	0.0%	9.1%	3.3%
Life Cycle Costing	0.0%	9.1%	3.3%
Epa, Federal Programs, Energy Star	22.8%	9.1%	17.6%
Sustainability Program For Environmental Stewardship	28.0%	30.8%	29.1%

Source: Georgia Manufacturing Survey 2008, weighted responses of 45 pulp and paper manufacturers.

**Table A12. Sustainability management activities currently used at the facility, Mills vs. other Pulp and Paper establishments.**

Management activity	Other Pulp	Mills	All pulp and paper
High Efficiency Lighting	48.8%	53.4%	50.0%
Water Recycling	23.0%	59.1%	33.0%
Energy Audits	33.3%	81.7%	47.7%
Recycling Production Materials	69.4%	90.1%	75.6%
Iso 14000	0.0%	12.4%	3.3%
Life Cycle Costing	0.0%	11.0%	3.3%
Epa, Federal Programs, Energy Star	20.6%	11.0%	17.6%
Sustainability Program For Environmental Stewardship	21.5%	45.8%	29.1%

Source: Georgia Manufacturing Survey 2008, weighted responses of 45 pulp and paper manufacturers.

**Table A13. Planned sustainability management activities for the next 2 years, Pulp and Paper vs. other sectors.**

Management activity	Pulp and paper	Food text	Materials	Mach	Elec-trans	Science	All manufac.
High Efficiency Lighting	50.0%	54.8%	45.2%	48.6%	51.5%	44.4%	48.4%
Water Recycling	33.0%	29.1%	18.4%	13.5%	13.3%	47.5%	21.8%
Energy Audits	47.7%	30.5%	17.1%	15.2%	27.9%	32.1%	23.2%
Recycling Production Materials	75.6%	64.5%	57.2%	61.6%	60.1%	75.3%	62.2%
Iso 14000	3.3%	10.3%	6.1%	6.9%	11.1%	15.0%	8.0%
Life Cycle Costing	3.3%	10.3%	6.5%	4.7%	15.0%	12.9%	7.9%
Epa, Federal Programs, Energy Star	17.6%	8.5%	9.3%	7.4%	12.8%	15.4%	10.1%
Sustainability Program For Environmental Stewardship	29.1%	25.9%	17.0%	7.8%	27.5%	29.1%	19.3%

Source: Georgia Manufacturing Survey 2008, weighted responses of 763 manufacturers.

**Table A14. Planned sustainability management activities for the next 2 years, Mills vs. other Pulp and Paper establishments.**

Management activity	Other pulp and paper	Mills	All pulp and paper
High Efficiency Lighting	22.3%	35.6%	26.0%
Water Recycling	10.1%	0.0%	7.3%
Energy Audits	21.3%	6.1%	16.8%
Recycling Production Materials	14.5%	0.0%	10.2%
Iso 14000	17.4%	7.6%	14.8%
Life Cycle Costing	15.9%	24.6%	18.5%
Epa, Federal Programs, Energy Star	5.0%	11.0%	6.9%
Sustainability Program For Environmental Stewardship	31.3%	9.9%	24.6%

Source: Georgia Manufacturing Survey 2008, weighted responses of 45 pulp and paper manufacturers.

**Table A15. Use of internal and external sources of information and knowledge for sustainability management practices, Pulp and Paper vs. other sectors.**

Source	Pulp and paper	Food-text	Materials	Mach	Elec-trans	Science	Total
Internal Energy Or Environmental Manager At This Facility	33.9%	22.4%	9.5%	8.6%	22.6%	31.5%	16.1%
Other Existing Staff At This Facility	46.1%	24.4%	15.6%	14.4%	31.3%	39.1%	22.2%
Other Units In The Enterprise Group - Subsidiaries, Branches, Affiliates	34.5%	14.0%	7.1%	6.9%	20.4%	29.9%	13.1%
Suppliers	52.2%	39.5%	35.3%	33.0%	45.2%	35.3%	37.6%
Customers, Clients Or Users	32.6%	18.0%	25.9%	22.4%	29.7%	31.2%	25.0%
Competitors	16.3%	7.6%	10.1%	9.6%	18.5%	6.7%	10.5%
External Consultants	26.8%	20.8%	10.7%	14.5%	27.5%	29.5%	17.4%
R&D Labs, Universities, Public Assistance	16.1%	18.8%	8.0%	6.1%	14.0%	27.8%	12.1%
Trade Associations, Other Business Organizations	22.9%	27.1%	28.0%	26.1%	39.8%	36.1%	28.9%
Conferences, Seminars Or Technical Meetings	29.0%	23.6%	24.5%	22.7%	23.5%	35.5%	25.0%
Printed Journals, Technical Papers	35.6%	26.3%	22.9%	20.2%	35.1%	31.4%	25.6%
Online Information Sources	37.9%	30.5%	32.9%	27.7%	42.4%	31.4%	32.5%

Source: Georgia Manufacturing Survey 2008, weighted responses of 716 manufacturers.

**Table A16. Sources of information and knowledge for sustainability management practices, mills vs. other pulp and paper establishments.**

Source	Other Pulp	Mills	All pulp and paper
Internal Energy Or Environmental Manager At This Facility	27.2%	49.7%	33.9%
Other Existing Staff At This Facility	40.4%	59.6%	46.1%
Other Units In The Enterprise Group - Subsidiaries, Branches, Affiliates	20.4%	67.9%	34.5%
Suppliers	52.3%	51.9%	52.2%
Customers, Clients Or Users	35.5%	26.0%	32.6%
Competitors	16.4%	16.0%	16.3%
External Consultants	25.5%	29.8%	26.8%
R&D Labs, Universities, Public Assistance	14.5%	19.9%	16.1%
Trade Associations, Other Business Organizations	24.2%	19.9%	22.9%
Conferences, Seminars Or Technical Meetings	28.7%	29.8%	29.0%
Printed Journals, Technical Papers	32.9%	42.0%	35.6%
Online Information Sources	36.1%	42.0%	37.9%

Source: Georgia Manufacturing Survey 2008, weighted responses of 44 pulp and paper manufacturers.

**Table A17. Sources of information and knowledge for sustainability management practices, Pulp and Paper, small vs. large establishments.**

Source	<100	100+	All pulp and paper
Internal Energy Or Environmental Manager At This Facility	11.8%	69.2%	33.9%
Other Existing Staff At This Facility	31.6%	69.2%	46.1%
Other Units In The Enterprise Group - Subsidiaries, Branches, Affiliates	17.7%	61.5%	34.5%
Suppliers	46.4%	61.5%	52.2%
Customers, Clients Or Users	33.8%	30.8%	32.6%
Competitors	16.9%	15.4%	16.3%
External Consultants	14.7%	46.2%	26.8%
R&D Labs, Universities, Public Assistance	11.8%	23.1%	16.1%
Trade Associations, Other Business Organizations	22.8%	23.1%	22.9%
Conferences, Seminars Or Technical Meetings	27.9%	30.8%	29.0%
Printed Journals, Technical Papers	33.8%	38.5%	35.6%
Online Information Sources	37.5%	38.5%	37.9%

Source: Georgia Manufacturing Survey 2008, weighted responses of 44 pulp and paper manufacturers.

**Table A18. Energy intensity (\$ per million in sales), Pulp and Paper vs. other manufacturing sectors.**

	Energy Intensity 2007		Change in Energy Intensity 2005-2007	
	mean	std.dev.	mean	std.dev.
Pulp and paper	23,750	23,920	6.5%	35.3%
Food-text	58,316	286,973	15.9%	99.7%
Materials	21,312	38,803	14.6%	64.0%
Machinery	15,798	22,621	13.0%	108.6%
Elec-trans	8,116	6,450	64.7%	290.1%
Science	23,599	25,140	3.0%	30.1%
All manufact	24,630	114,750	-1.2%	10.4%

Source: Georgia Manufacturing Survey 2008, weighted responses of 470 manufacturers from all sectors and 32 pulp and paper manufacturers.

**Table A19. Energy intensity (\$ per million in sales), Pulp and Paper, small vs. large establishments, and mills vs. other pulp and paper establishments.**

	Energy Intensity 2007		Change in Energy Intensity 2005-2007	
	mean	std.dev.	mean	std.dev.
Small (10-99)	13,475	8,021	16.4%	35.7%
Large (100+)	33,598	29,401	-2.9%	32.3%

Mills	33,594	34,080	2.3%	37.6%
Non-mills	18,218	12,731	8.9%	33.9%

Source: Georgia Manufacturing Survey 2008, weighted responses of 32 pulp and paper manufacturers.