Energy Trends in Selected Manufacturing Sectors:

Opportunities and Challenges for Environmentally Preferable Energy Outcomes








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3.5 Forest Products

3.5.1 Base Case Scenario

Situation Assessment

> Recent Sector Trends Informing the Base Case
>
> Number of facilities: ↓
> Pulp and paper value of shipments: ↓
> Wood products value of shipments: ↑
> Energy intensity: ↓
>
> Major fuel sources: Wood biomass, black liquor, natural gas, & electricity
>
> Current economic and energy consumption data are summarized in Table 34 (pulp & paper) and Table 35 (wood products) beginning on page 3-41.

Forest products manufacturing (NAICS 321 and 322) includes companies that grow, harvest, or process wood and wood fiber for use in products such as paper, lumber, board products, fuels, and many other specialty materials. The forest products sector can be divided into two major categories: (1) pulp, paper, and paperboard products; and (2) engineered and traditional wood products. As reported by DOE's Industrial Technologies Program (ITP), there are more than 4,600 pulp and paper facilities and 11,600 lumber and wood products facilities,[121] typically located near wood sources to minimize transportation costs. While the industry has operations in all 50 states, Wisconsin, California, and Georgia are the nation's top three producers of forest products.[122] The forest products industry participates in EPA's Sector Strategies Program.

From 1997 to 2004 the pulp and paper industry showed a decline in value added and value of shipments, and the wood products industry showed slow growth in both metrics (see Table 34 and Table 35). The primary economic pressure on the U.S. forest products industry is from foreign competition, both from its historical competitors such as Canada, Scandinavia, and Japan, and from countries with emerging industries such as Brazil, Chile, and Indonesia.[123] Over the past 10 years, DOE/ITP reports that many forest product companies have been forced to close or idle a large number of mills to reduce costs and remain competitive.

The forest products sector has several unique energy consumption attributes that distinguish it from other manufacturing sectors. More than half of the sector's energy needs are met with renewable biomass fuels that are byproducts of the manufacturing process, and which facilities burn in boilers to generate steam and electricity.[124] Renewable byproduct fuels are primarily spent pulping liquors (chemicals and other burnable substances dissolved from wood in the pulping process) and "hogged fuel" (logging and wood processing waste such as bark and other wood residuals).[125] The forest products industry is the largest user of wood byproduct fuels, representing 93 percent of total wood fuel usage by U.S. manufacturing industries.[126] According to energy data reported by AF&PA in 2002, spent pulping liquors met more than 40 percent of pulp and paper manufacturing energy requirements, and wood waste met around 15 percent. For wood products manufacturers, wood waste met more than 65 percent of total energy requirements.[127] (These fractions are slightly higher than MECS' estimates of "other" fuel use fractions for the sectors in 2002, which may in part be attributable to differences in the data collection methodologies employed by the two sources.) Trees remove carbon from the atmosphere as they grow, and thus from a lifecycle perspective, consumption of wood byproduct fuels represents an almost carbon neutral energy source. (There is some energy consumption associated with harvesting and transporting biomass, and accounting for such energy use means that it is not entirely carbon neutral). At the same time, the forest products industry has the third-highest fossil fuel consumption among manufacturing industries,[128] so further reducing fossil fuel inputs represents both a cost savings and an environmental improvement opportunity for the sector.

The other characteristic that distinguishes energy consumption by the forest products industry from that of other manufacturing industries is the extent to which combined heat and power

(CHP) applications are used to meet demand for electric and thermal energy. As discussed previously, CHP (also referred to as cogeneration) is considered an environmentally preferable generating technology because the simultaneous production of thermal and electric energy is more efficient than electric-only generating processes, and onsite electricity production eliminates the energy losses associated with long-distance transmission and distribution of electric power over the grid. The forest products sector is the largest cogenerator among U.S. manufacturing industries, with more than 65 of the industry's electricity needs are being met through cogeneration processes.[129] Thermal energy (primarily steam) is used for process heating, evaporation, and drying, as well as to power equipment such as saws and conveyors. Electricity is primarily used to power process equipment.[130]

Energy use by the industry is dispersed geographically but is highest in the East North Central, West North Central, and West South Central regions.[131] Pulp and paper manufacturing accounted for 86 percent of the energy used in 2002, while wood products manufacturing accounted for the remaining 14 percent.[132] The majority (81 percent) of the sector's energy requirements are for process heating and cooling systems, particularly those used for drying and evaporation.[133]

Due to competitive pressures and the energy-intensive nature of its manufacturing processes, the forest products industry is highly motivated to control the costs of purchased energy. According to DOE, long-term reductions in energy intensity have been achieved primarily through process efficiency improvements and addition of CHP capacity.[134] To address the impact of rising energy costs in the 1990s, the sector made comprehensive energy efficiency investments, increased burning of wood waste to produce energy, and reduced petroleum inputs in favor of natural gas. From 1998 to 2002, the energy intensity of the wood products sector declined by 29 percent, and the energy intensity of the pulp and paper sector declined by 19 percent.[135] Available energy consumption data precede energy price increases that have occurred since 2002. AF&PA indicates that further energy intensity reductions have resulted from recent energy price increases, primarily through the closure of inefficient mills. Since 2002, the industry has sought to control energy costs through increased utilization of waste streams for energy content (spent pulping liquors and wood residuals),[136] and achieved energy consumption reductions through installation of variable speed motors and more energy-efficient lighting.[137]

Environmental compliance also represents a substantial cost for the industry. DOE reports that from 1997 to 2002, 14 percent of annual capital equipment expenditures were dedicated to environmental protection measures, at an industry-wide cost of $800 million per year.[138] The intersection between environmental compliance and energy consumption may involve trade-offs. For instance, according to AF&PA, natural gas consumption by the wood products industry has increased due to environmental regulations that require the installation of regenerative thermal oxidizers (RTOs), and the new Plywood MACT is expected to require additional RTO installations by 2008.[139]

Table 34 and Table 35 summarize current economic trend and energy consumption data originally presented in Chapter 2.

Table 34: Current economic and energy data for the pulp and paper industry

Economic Production Trends				
	Annual Change in Value Added 1997-2004	Annual Change in Value Added 2000-2004	Annual Change in Value of Shipments 1997-2004	Annual Change in Value of Shipments 2000-2004
	-1.2%	-3.6%	-1.6%	-4.0%
Energy Intensity in 2002				
	Energy Consumption per Dollar of Value Added (thousand Btu)	Energy Consumption per Dollar Value of Shipments (thousand Btu)	Energy Cost per Dollar of Value Added (share)	Energy Cost per Dollar Value of Shipments (share)
	31.1	15.2	8.8%	4.3%
Primary Fuel Inputs as Fraction of Total Energy Supply in 2002 (fuel use only)				
Other (Primarily Biomass)[sss]	Natural Gas	Coal	Net Electricity	Fuel Oil
54%	21%	10%	9%	5%
Fuel-Switching Potential in 2002: Natural Gas to Alternate Fuels				
			Switchable fraction of natural gas inputs	32%
		Fuel Oil	Electricity	LPG
Fraction of natural gas inputs that could be met by alternate fuels		80%	16%	9%
Fuel-Switching Potential in 2002: Coal to Alternate Fuels				
			Switchable fraction of coal inputs	23%
		Fuel Oil	Natural Gas	Electricity
Fraction of coal inputs that could be met by alternate fuels		66%	57%	10%

[sss] For pulp and paper manufacturing, biomass fuels categorized as "other" fuels in MECS include spent pulping liquor (approximately 70% of the "other" category) and wood residues and byproducts (approximately 27% of the "other" category).

Table 35: Current economic and energy data for the wood products industry

Economic Production Trends				
	Annual Change in Value Added 1997-2004	Annual Change in Value Added 2000-2004	Annual Change in Value of Shipments 1997-2004	Annual Change in Value of Shipments 2000-2004
	1.8%	2.5%	0.3%	0.2%
Energy Intensity in 2002				
	Energy Consumption per Dollar of Value Added (thousand Btu)	Energy Consumption per Dollar Value of Shipments (thousand Btu)	Energy Cost per Dollar of Value Added (share)	Energy Cost per Dollar Value of Shipments (share)
	10.6	4.2	4.7%	1.9%
Primary Fuel Inputs as Fraction of Total Energy Supply in 2002 (fuel use only)				
Other (Primarily Biomass)[ttt]	Net Electricity	Natural Gas	Fuel Oil	LPG&NGL
61%	19%	15%	3%	1%
Fuel-Switching Potential in 2002: Natural Gas to Alternate Fuels				
		Switchable fraction of natural gas inputs		20%
		Fuel Oil	LPG	Other
Fraction of natural gas inputs that could be met by alternate fuels		36%	36%	27%

Expected Future Trends

The forest products industry will continue to seek to control energy costs in an effort to maintain its competitive position in the global market, and the industry views increased biomass utilization as a key tool for achieving that objective. At the same time, several factors have the potential to increase energy demand:

- Increased facility energy use resulting from stricter pollution control requirements and increased facility automation.
- Reductions in timber acreage lead to increased harvesting of sub-optimal timber that requires more energy-intensive processing.

CEF does not address the wood products sector, but since the pulp and paper industry has substantially greater

Voluntary Commitments

Through Climate VISION, the American Forest & Paper Association has committed to reducing the industry's GHG intensity by 12 percent between 2000 and 2012. Specific initiatives include improving carbon emissions inventories and reporting, enhancing carbon sequestration in managed forests and products, and increasing energy efficiency, cogeneration, use of renewable energy, and recycling. See http://www.climatevision.gov/sectors/forest/index.html.

The forest products sector also participates in DOE's Industries of the Future (IOF)/Industrial Technologies Program (ITP) as an "Energy Intensive Industry." ITP's goals for all energy intensive sectors include the following:

- Between 2002 and 2020, contribute to a 30 percent decrease in energy intensity.
- Between 2002 and 2010, commercialize more than 10 industrial energy efficiency technologies through research, development & demonstration (RD&D) partnerships.

See http://www.eere.energy.gov/industry/forest/.

[ttt] For wood products manufacturing, biomass fuels categorized as "other" fuels in MECS are primarily wood waste.

energy requirements, it is appropriate to focus our future scenario assessments on this subset of the forest products industry. The pulp and paper industry is also one of the three sectors (along with cement and steel) for which CEF made detailed parameter modifications to the NEMS model used to produce AEO 1999. Modifications included adjustments to baseline energy intensities and rates for annual improvements in energy intensity, which were adjusted to reflect best-available sector-specific research. It is important to note that the CEF analysis predates the energy price increases of 2004 and 2005 that have shifted the industry towards even greater use of biomass as an energy source (spent pulping liquor and wood waste), and toward lower energy intensity through the closure of older, less efficient manufacturing facilities.

Under the reference case scenario, CEF projects that the pulp and paper industry's energy consumption will continue to be dominated by renewable fuels (primarily biomass) and natural gas, though renewable energy sources will grow at the expense of natural gas, coal, and petroleum as the industry continues to reduce its demand for purchased fuels. Economic energy intensity (energy consumption per dollar value of output) is expected to decrease at the rate of 0.9 percent per year, and physical energy intensity (energy consumption per ton of production) is projected to decrease at the annual rate of 0.5 percent per year. Economic production is projected to grow at the rate of 1.2 percent per year.

CEF's assumptions about production growth in the pulp and paper sector drive the expected increase in energy consumption despite the trend of decreasing energy intensity. CEF projections are also based on the assumption that Kraft/sulfite pulping will increase from an 83.7 percent market share in 1994 to an 88.7 percent market share by 2020, with mechanical pulping dropping from 9.6 percent to 5.7 percent, and semi-chemical pulping dropping from 6.7 percent to 5.6 percent. Energy efficiency improvements embedded in CEF's reference case projections include an anticipated decline in energy consumption for raw materials preparation, an increase in heat recovery from mechanical pulping processes, slow penetration of energy-efficient grinding technologies, and reduced heat requirements for the papermaking process due to full commercialization of the CondeBelt process by 2020. (Appendix A-2 of the CEF report contains detailed descriptions of CEF's adjustment to the NEMS model in terms of expected rates of efficiency improvement for existing equipment and implementation of new energy-efficient technologies under the business-as-usual scenario.)

CEF reference case projections are summarized in Table 36.

Table 36: CEF reference case projections for the pulp and paper industry

	1997 Reference Case		2020 Reference Case	
	Consumption (quadrillion Btu)	Percentage	Consumption (quadrillion Btu)	Percentage
Petroleum	0.122	4%	0.096	3%
Natural gas	0.672	23%	0.427	14%
Coal	0.394	13%	0.269	9%
Renewables	1.483	51%	1.997	65%
Delivered electricity	0.258	9%	0.274	9%
Total	2.929	100%	3.063	100%
Annual % change in economic energy intensity (energy consumption per dollar value of output)				-0.9%
Overall % change in energy consumption (1997-2020)				5%

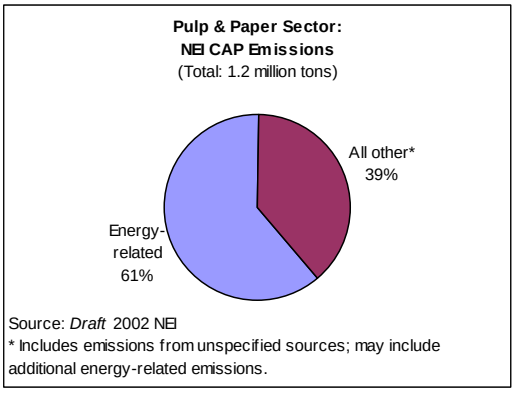
CEF's assumption of increasing economic production may be inconsistent with current industry realities given that key economic indicators for the industry—value added and value of shipments—have declined since 1997 (-1.2 percent per year and -1.6 percent per year, respectively). If economic production remains flat or declines further, sector energy consumption would be expected to decrease given expected energy efficiency improvements.

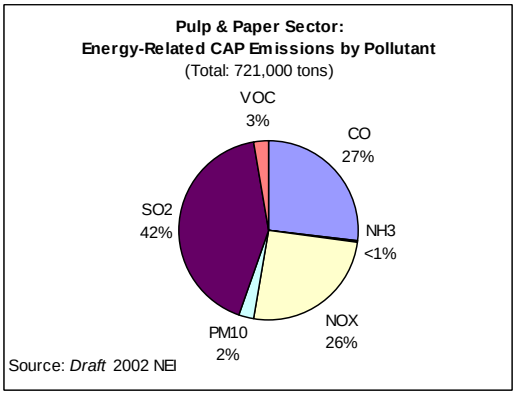
In an effort to assess the impact of recent trends that may have affected industry energy consumption since the CEF report was produced, we also examined reference case energy consumption projections for the pulp and paper industry produced in connection with EIA's *Annual Energy Outlook 2006* (AEO 2006), which also uses the NEMS model but incorporates more recent energy and economic data. However, AEO 2006 also projects production to grow (increasing at 1.1 percent per year), albeit at a slightly slower rate than projected by CEF, which drives an expected increase in energy consumption of 12 percent over the period. AEO 2006 projects a decrease in energy intensity of 0.5 percent per year. Consumption of renewable fuels is expected to grow by 20 percent over the period, meeting the majority of the sector's energy consumption increase. Petroleum consumption is projected to decline, and coal consumption is projected to remain static. CEF and AEO projections of increased reliance on renewable biomass fuels are in line with AF&PA expectations, though according to AF&PA data, the pulp and paper industry already meets 60 percent of its energy needs with biomass.[140]

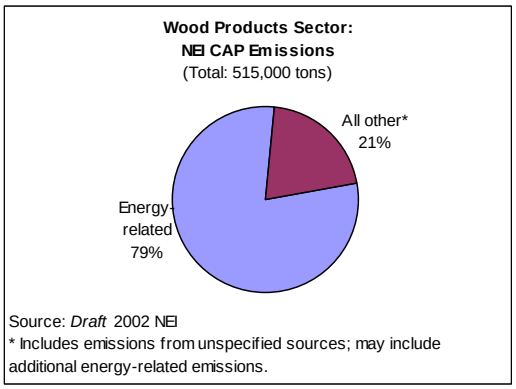
Continued energy pricing pressures are expected to drive increased utilization of biomass resources as an energy source. At the same time, increased yield and process efficiency reduces the availability of biomass byproducts for energy consumption purposes.[141] The industry is also concerned about increasing demand for biomass that would drive up the cost of the industry's raw material, in part due to government policies that broadly encourage the use of biomass as fuel—for instance, by renewable power generators.[142]

Environmental Implications

Figure 14: Forest products sector: energy-related CAP emissions







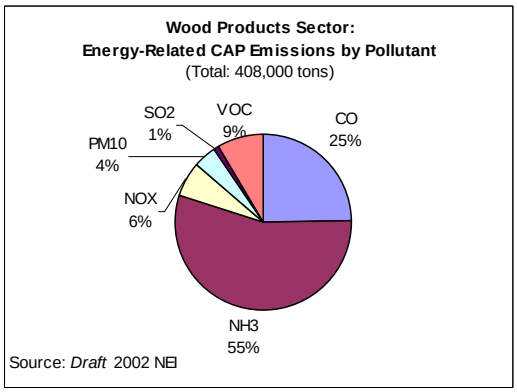


Figure 14 compares NEI data on energy-related CAP emissions with non-energy-related CAP emissions for the two subsectors of the forest products industry: pulp and paper, and wood products. The forest products sector's fraction of energy-related CAP emissions (as a percentage of total CAP emissions) is higher than that of many other sectors included in this analysis. This is in large part due to the extent to which the sector meets its own electric and thermal energy requirements through onsite power generation, with extensive use of relatively more energy-efficient CHP applications. (As discussed previously, onsite power generation also reduces the magnitude of energy losses that occur in power transmission and distribution.) Substantial process heating requirements in both sectors also contribute to the magnitude of the energy-related CAP fraction.

Effects of Energy-Related CAP Emissions

SO_2 and NO_x emissions contribute to respiratory illness and may cause lung damage. Emissions also contribute to acid rain, ground-level ozone, and reduced visibility.

The substantial fraction of ammonia (NH_3) emissions shown for the wood products industry is the result of an NEI data reporting error: 225,000 TPY of ammonia emissions reported in NEI are from a single facility and are believed to be incorrectly reported or misclassified as energy related. After correcting for this error by eliminating that data point, total energy-related CAP emissions for the wood products industry are approximately 180,000 TPY (as reported in Table 13, Section 2.3.3), and the largest fractions of energy-related CAP emissions are carbon monoxide (55 percent), VOCs (19 percent), and nitrogen oxides (14 percent). (As noted in Section 2.3.3, NEI data on carbon monoxide emissions appear higher than would be expected for stationary sources.)

Though the fraction of energy-related CAP emissions for the wood products sector is larger than the energy-related fraction for pulp and paper, due to the greater energy requirements of the pulp and paper industry, on a ton-basis energy-related CAP emissions are much larger for the pulp and paper sector than they are for wood products sector. According to MECS data (see Table 35), in 2002 purchased electricity met nearly 20 percent of the wood products sector's energy requirements, indicating that a substantial fraction of the sector's energy-related emissions are not captured by NEI data for the sector (as such emissions are attributed to the generating source rather than the purchasing entity). For pulp and paper, net electricity met approximately 9 percent of the sector's energy demand in 2002.

Figure 15: Forest products sector: CAP emissions by source category and fuel usage

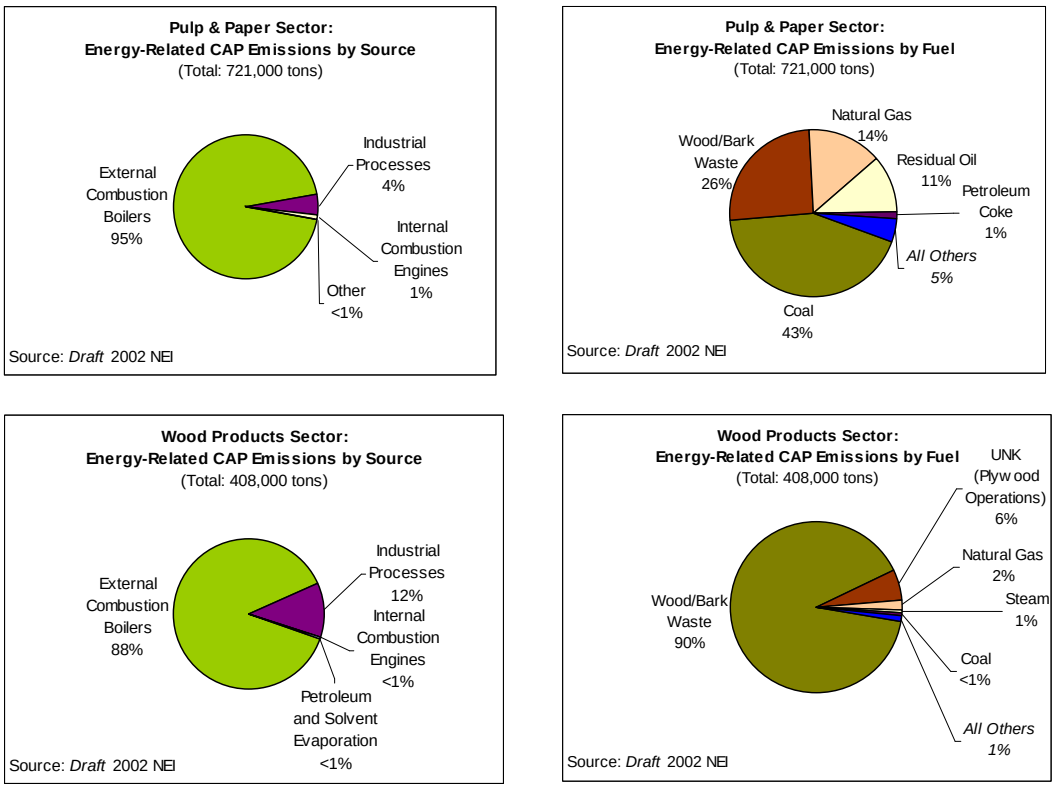


Figure 15 presents NEI data on the sources of energy-related CAP emissions shown in Figure 14. For both sectors, most energy-related emissions are classified as stemming from external combustion boilers. NEI data classifications are problematic due to reporting inconsistencies, as discussed previously. According to DOE data for the pulp and paper industry, process heating and cooling systems represent 81 percent of the sector's energy use, with drying and evaporation processes requiring substantial energy inputs. "External combustion boilers" includes steam systems reboilers. Direct-fired systems such as furnaces are likely included under "industrial processes." Motor-driven systems comprise 13 percent of the sector's end use of energy, which includes pumps, conveyors, compressors, fans, mixers, grinders, and other process equipment,[143] but are primarily electric powered so would not be represented in NEI data.

Although MECS data report that coal supplied only 10 percent of the pulp and paper industry's energy requirements in 2002, NEI data show coal as contributing to 43 percent of the sector's energy-related CAP emissions. As MECS reports more than 50 percent of the sector's energy coming from "other" fuels (which includes biomass), NEI data show that biomass (wood waste) is a less emissions-intensive energy source than coal. For wood products, combustion of wood/bark waste is the dominant energy-related source of CAP emissions.

The trend of increased renewable energy (biomass) consumption and decreased coal consumption projected by CEF and AEO 2006 under a business-as-usual scenario is likely to improve the CAP emissions profile for the pulp and paper industry. The effect of increased fuel usage of biomass on CAP emissions would also be likely to vary from site to site, depending on

factors such as boiler characteristics and pollution controls, as well as the type of biomass that is used for fuel (black liquor, waste paper products, wood chips, etc.)

As NEI data do not include carbon dioxide emissions, we use carbon dioxide emissions estimates from AEO 2006, which totaled 113 million metric tons for the pulp and paper industry in 2004. AEO 2006 projects that the industry's carbon dioxide emissions will remain relatively static from 2004 to 2020, despite the expected increase in energy consumption. This projection reflects the industry's utilization of less carbon-intensive biomass energy resources to meet increasing energy demand.

As noted previously, if CEF and AEO 2006 projections overstate future production growth for the industry, energy-related CAP and carbon dioxide emissions could remain static or decrease from current levels.

3.5.2 Best Case Scenario

Opportunities

Table 37 ranks the viability of five primary opportunities for improving environmental performance with respect to energy use (Low, Medium, or High). A brief assessment of the ranking is also provided, including potential barriers.

This opportunity assessment relies in large part upon a recent pulp and paper industry energy bandwidth study conducted on behalf of DOE that was published in August 2006.[144] From the energy consumption baseline established by 2002 MECS data, the DOE energy bandwidth study estimates potential reductions in energy consumption that would be possible through industry-wide implementation of best available technologies (technologies and processes in place at the most modern mills) as well as energy-savings potential from industry-wide implementation of advanced technologies (practical minimums). DOE estimates that best available technologies have the potential to reduce the pulp and paper sector's energy consumption by 26 percent and could reduce purchased energy requirements by 46 percent, with a 38 percent reduction in purchased electricity, and a 48 percent reduction in purchased fossil fuels. The largest areas of potential energy savings are in paper manufacturing (32 percent reduction in energy consumption), pulping (28 percent reduction), and onsite energy generating applications (22 percent reduction in energy losses from cogenerating equipment used to produce electricity and steam, referred to as "powerhouse losses.") Implementation of practical minimum technologies would further reduce sector energy consumption 17 below levels achieved by best available technologies.

Though the energy bandwidth study does not address the wood products sector, given the larger energy requirements of the pulp and paper sector it provides an appropriate indication of the largest opportunities for reductions in sector energy consumption.

Table 37: Opportunity assessment for the forest products industry

Opportunity	Ranking	Assessment (including potential barriers)
Cleaner fuels	Medium	As the industry meets a substantial fraction of its requirements for thermal energy and electricity with biomass fuels, it uses emissions-intensive energy sources such as coal and petroleum primarily as marginal fuels, except for the direct fossil fuel inputs required by lime kilns in kraft mills.[145] Thus, transitioning to cleaner fuels is not considered to represent a substantial opportunity for environmental improvement. Increased biomass utilization is considered a key opportunity for the industry, but this opportunity is discussed in connection with the Process Improvement and R&D categories below.

Opportunity	Ranking	Assessment (including potential barriers)
Increased CHP	Low	Though approximately 65 percent of the sector's electricity demand is met by CHP, the majority of the sector's demand for steam is met by CHP, limiting the opportunity for additional CHP capacity. There is opportunity to increase the electricity-to-steam ratio of CHP applications through gasification technologies,[146] and such opportunities are discussed in connection with R&D efforts below. Though the forest products sector is currently a net importer of electricity, industry representatives are concerned that recent changes in policy under the Public Utility Regulatory Policies Act (PURPA), Section 210(m), have created less favorable market conditions for onsite power generation. These changes eliminated requirements that electrical utilities purchase power from qualifying facilities in certain markets.[147] The forest products industry believes the new policy presents a barrier to increasing the use of CHP and other technologies that have the potential to increase onsite power generation.[148] New CHP installations may also face barriers in terms of utility rates and interconnection requirements if electricity production is expected to exceed onsite demand, and also from NSR/PSD permitting.[149]
Equipment retrofit/ replacement	Medium	Energy efficiency gains are achievable through retrofits and through replacement of old equipment with more energy-efficient models. According to DOE, there are substantial energy-savings opportunities associated with implementation of equipment-related best practices, as well as with retrofit and replacement of process equipment—for example, installation of shoe presses to reduce drying energy requirements.[150] There are also energy-savings opportunities associated with power generating equipment, as a majority of recovery furnaces and conventional power boilers in existing pulp and paper plants are 20 to 30 years old; more than half of them will need to be replaced or upgraded in the near future.[151] Limiting the magnitude of equipment-related opportunities, capital turnover in the sector is slow—equipment is capital intensive and has a long service life, and as industry is currently stagnant, there is little need for expanded production capacity that would drive new equipment purchases. Making a business case for equipment modifications can be difficult unless the change is urgently needed to maintain production or environmental compliance. Anecdotal evidence suggests that this climate of scarce capital has discouraged operations managers from advocating even low-risk, cost-effective improvements in energy efficiency.[152] Additionally, mills that want to expand or modify their operations may be subject to PSD or NSR programs.
Process improvement	High	Process optimization is expected to continue to be an important mechanism for achieving energy efficiency gains for the forest products industry. AF&PA prioritizes further efforts to increase energy recovery from biomass waste, both through implementation of existing best practices and from new technology development.[153] Due to the substantial energy requirements of the drying stage of the papermaking process, DOE estimates that the largest potential energy savings are from implementation of best-available technologies in the paper drying process, and substantial additional potential in connection with liquor evaporation, and pulp digesting processes.[154] (In the DOE bandwidth study, potential energy savings from best-available technology implementation include equipment retrofits and replacement as well as process improvement, and it is not possible to disaggregate the relative potential savings from these opportunities.) DOE notes that as much of the sector's boiler fuel comes from renewable biomass fuels that are manufacturing process byproducts, there is a tradeoff between increased process efficiency (which reduces byproducts) and biomass fuel availability.[155]
R&D	High	As the forest products industry has limited resources to devote to R&D efforts, the support of programs like DOE's Industrial Technologies Program is essential to achieving new technology development objectives. In partnership with DOE, the *Forest Products Industry's Agenda 2020* has established a roadmap of R&D priorities, and there is a strong R&D pipeline for the industry (see http://www.eere.energy.gov/industry/forest/). DOE prioritizes three areas as having the greatest opportunity for energy savings: (1) In paper drying, increasing the solids content of material exiting the press sections to reduce drying energy requirements; (2) reducing energy requirements for black liquor evaporation through nonevaporative concentration of weak black liquor, which can be accomplished through processes like ultrafiltration or multiple effect evaporation; and (3) increasing the energy efficiency of the lime kiln.[156] AF&PA has a strong interest in the development of technologies to more fully exploit the industry's biomass resources for energy recovery.[157]

Opportunity	Ranking	Assessment (including potential barriers)
		Other developing technologies that DOE describes as having the potential to enable the industry to achieve practical minimum energy consumption include: (1) CondeBelt drying systems, which have higher drying rates by utilizing the temperature differential between heated and cooled drying belts; (2) black liquor and biomass gasification, involving the production of gas fuel from biomass process waste which, in combination with combined cycle cogeneration turbines, would greatly increase the efficiency of onsite power generation; and (3) forest biorefineries, which extract hydrogen and other chemical feedstocks from wood chips prior to pulping, creating another value stream for the industry. According to DOE, the net energy efficiency of the biorefinery model is still being investigated,[158] but biorefineries are closer to commercialization than gasification technologies.[159] General R&D barriers include the costs and risks associated with developing and commercializing new technologies. As the industry develops improved technologies and processes for utilizing biomass energy resources, one concern noted previously how policies that promote biomass energy might increase demand and bid up the cost of the industry's raw material.

Optimal Future Trends

CEF's advanced energy scenario for the pulp and paper industry is similar to the base case projection, with an even greater share of the sector's energy needs met by biomass fuels, and a slight decrease in coal use as the industry makes even greater reductions in carbon-intensive fuels. AF&PA notes that the industry's objective is to meet an even greater fraction of its energy needs with renewable biomass fuels than the 73 percent share noted in CEF's advanced energy scenario.[160] The annual decrease in economic energy intensity (energy consumption per dollar value of output) is slightly larger than under the reference case scenario, and the projected increase in overall energy use is smaller than under the reference case projection. Compared with the reference scenario, under the advanced scenario, the industry uses even more biomass and relatively less purchased electricity, with electricity inputs falling 22 percent from 1997 levels by 2020.

CEF's advanced case projections are summarized in Table 38.

Table 38: CEF advanced case projections for the pulp and paper industry

	1997 Advanced Case		2020 Advanced Case	
	Consumption (quadrillion Btu) [uuu]	Percentage[vvv]	Consumption (quadrillion Btu)	Percentage
Petroleum	0.123	4%	0.068	2%
Natural gas	0.677	23%	0.429	14%
Coal	0.395	13%	0.107	4%
Renewables	1.483	50%	2.186	73%
Delivered electricity	0.259	9%	0.201	7%
Total	2.937	100%	2.991	100%
Annual % change in economic energy intensity (energy consumption per dollar value of output)				-1.0%
Overall % change in energy consumption (1997-2020)				2%

CEF's advanced case projections are based on the same economic growth assumption as the reference case (1.2 percent per year). As previously noted, CEF's economic assumptions are probably overly optimistic given recent industry trends, and if the trend of decreasing production continues, sector energy consumption would be expected to continue to decline as well. In comparison with the reference case, the faster decline in economic energy intensity is produced by CEF's more aggressive assumptions about energy efficiency increases in new and existing equipment including increased energy efficiency of boilers, steam systems, and motors, falling film black liquor evaporation, increased lime kiln efficiency, and black liquor gasification.[www]

Environmental Implications

Under the CEF advanced case, the decrease in purchased electricity means that energy-related emissions will be concentrated somewhat more at the facility level, as opposed to the utility level. However, due to the energy losses associated with electric generation (particularly from fossil fuel-fired power plants), transmission, and distribution, energy production at the facility level is generally more energy efficient, and thus represents an environmentally preferable energy scenario. Reductions in coal consumption under the advanced energy scenario are expected to decrease CAP emissions, particularly sulfur dioxide and nitrogen oxides.

Under the advanced energy scenario CEF projects the pulp and paper industry to achieve a 52 percent reduction in 1997 carbon emissions levels by 2020, despite the projected increase in overall energy consumption. This difference is attributable to increased energy efficiency and reductions in carbon-intensive energy inputs such as coal. Increased use of carbon-neutral biomass fuels will be a key component of achieving reductions in net carbon emissions.

[uuu] As is the case with several sectors addressed in the CEF analysis, there are slight differences between 1997 fuel consumption data in the reference and advanced cases. We could find no explanation for such differences in the CEF analysis, but it could be that CEF made modifications to the base year (1997) parameters under the advanced case as compared with the reference case.

[vvv] Percentages do not add to 100% due to independent rounding.

[www] We have noted just a few of the parameter modifications made by CEF under the advanced case NEMS modeling effort. Appendix A-2 of the CEF report contains more detailed descriptions of CEF's advanced case scenario parameters.

3.5.3 Other Reference Materials Consulted

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