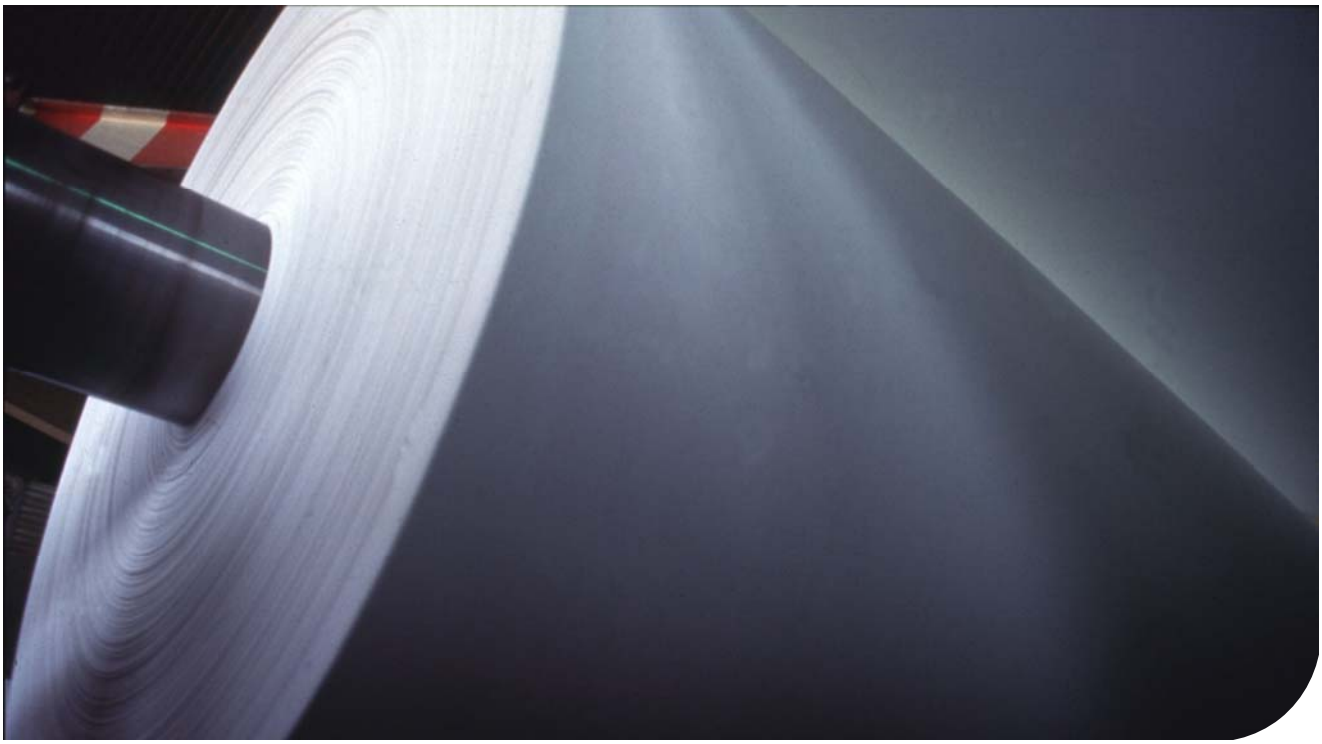
Industrial Sectors Market Characterization

Paper Industry

Developed for Pacific Gas & Electric Company and Southern California Edison Company



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Oakland, California, January 2012

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Acronyms and Abbreviations

AB32	Assembly Bill 32 the Global Warming Solutions Act
ACEEE	American Council for an Energy Efficient Economy
AMO	Advanced Manufacturing Office
ARB	California Air Resources Board
Btu	British thermal unit
CAA	Clean Air Act
CWA	Clean Water Act
CO_2	carbon dioxide
CO_2e	carbon-dioxide equivalent
GHG	greenhouse gas
GMP	good manufacturing practices
FDA	Food and Drug Administration
GWh	gigawatt-hour(s)
ESA	Endangered Species Act
kWh	kilowatt-hour
LBNL	Lawrence Berkeley National Laboratory
MBtu	million British thermal unit
NAICS	North American Industry Classification System
O&M	operations and maintenance
PG&E	Pacific Gas and Electric Company
R&D	research and development
RCRA	Resource Conservation and Recovery Act
SCE	Southern California Edison Company
TBtu	trillion British thermal unit
VSD	variable speed drive
U.S.	United States
USGS	U.S. Geological Survey
U.S. EPA	U.S. Environmental Protection Agency
U.S. DOE	U.S. Department of Energy

Summary of Findings

Industry Description

Industries categorized under the North American Industry Classification System (NAICS) three-digit prefix of 322: paper manufacturing make pulp, paper, and converted paper products. Paper Manufacturing is generally subdivided into two industry groups: the first for the manufacturing of pulp and paper and the second that uses paper inputs to manufacture converted paper products. Pulp mills, paper mills, and paperboard mills comprise the first industry group. Establishments that make products from purchased paper and other materials make up the second industry group. In California, there are no longer any facilities that create pulp from forest products,[1] which is a highly intensive energy process. California is home to over 500 facilities that make paper and wood products, primarily in northern California. These include paperboard container manufacturing, paper bags and treated paper, stationery products, and converted paper products such as tissue paper and disposable diapers

There are approximately 4,000 companies that manufacture paper products in the United States, although the market is dominated by International Paper Co., Kimberly Clark, Smurfit-Stone, MeadWestvaco, Domtar (which merged with Weyerhauser), Temple-Inland, AbitibiBowater, Greif Inc., and Packaging Corp of America. Acquisitions, divestitures, and restructurings have been common over the previous decade in the North American market. The market consolidation and specialization trend is influenced primarily by the need to stay profitable in a mature industry characterized by large capital requirements and high barriers to market entry.

Business Models and Cost Structure

The pulp and paper industry is characterized by large industry leaders and numerous smaller manufacturing firms. The large players tend to be highly vertically integrated. For example, a firm may own and manage forestry resources, manufacture pulp, mill paper and cardboard, manufacture converted paper products, and distribute goods to markets. These companies take advantage of economies of scale, control over the supply of inputs, and cash resources for technological research and development. Smaller companies generally do not manufacture their

[1] The Center for Paper Business and industry studies, Pulp Mills, Pulp & Paper Mills, Paper Mills in California, http://www.cpbis.gatech.edu/data/mills-online?state=California

own inputs and do not have economies of scale in production. These firms are especially vulnerable to input market volatility, causing many to enter into bankruptcy during periods of volatile input prices during the mid to late 2000s.

The primary costs for paper converting industries such as cardboard box and food packaging operations are purchases of input materials. About 60 percent of costs stem from purchasing market pulp, paperboard, paper, old corrugated containers, adhesives, resins, chemicals, and other inputs to the manufacturing process. Energy costs are less than 2 percent of revenue. Recycled fiber costs have also fallen in the recession. Containerboard manufacturers are major consumers of recycled fiber, with some producers relying on old corrugated containers for more than half of their fiber supply.

Paper manufacturers have also seen a decrease in capital costs in recent years. Investment in buildings, machinery and equipment has declined due to global economic slowdown symptoms such as downsizing of operations, lower returns on investments, and difficulty in securing financing.

Overall, demand for paper products has been consistently flat or negative based on fundamental changes in technology, consumer habits, and the anemic economy. The recession has exacerbated the financial situation of pulp and paper product manufacturers, further accelerating the trends of industry consolidation, downsizing of workforces, shuttering of manufacturing plants, and off shoring of production.

Technology and Energy Consumption

The pulp, paper, and converted paper products industries have undergone dramatic changes in the late 1990s and 2000s due to increased computerization and automation of manufacturing processes. Production processes for making cardboard have improved resulting in reduced energy consumption, reductions in chemical use, and increased volume of recycled material use.

A large amount of research over the past five years has been directed toward reducing energy consumption, improving environmental performance, and increasing the inclusion of recycled material in manufacturing. The American Forest and Paper Association initiated the Agenda 2020 Technology Alliance, an industry led partnership with government and academia, meant to re-invent the forest products industry through innovation in processes, materials, and markets.

The supply chain for the paper products industry relies on either internal sources of forest products (for a vertically integrated company) or market prices of pulp or paper. Hardwood forests in North America require a longer growth cycle and harvest rotation compared to fast growing eucalyptus trees in South America. In addition, eucalyptus pulp has lower production costs due to more favorable labor and energy costs where the trees are grown. These trends likely mean further shutdowns of North American hardwood pulp capacity.

Market Barriers and Opportunities for Energy Efficiency

The paper industry has been slowing down for the last several years. Due to the consolidations and facility shutdowns, no pulp mills remain in California, and the primary industry is converted paper manufacturing. This segment has much lower energy use than the pulp and paper subsector, is highly cost competitive, and likely less sophisticated regarding energy efficiency than other industrial subsectors.

Energy efficiency opportunities exist by optimizing existing systems for pumps, motors, air compressors, dryers and boilers. An applicable emerging technology is magnetically coupled adjustable speed drives.

Overall Findings

Although California has no pulp mills, multiple potential strategies exist for energy efficiency programs in the paper segment. Low-cost opportunities are most likely to be accepted.

Given the modest interest in energy efficiency, utilities can design programs to first inform, and then engage customers into tapping their in efficiency opportunities. The following findings regarding improving the adoption of energy efficiency measures in the water and wastewater industry are based on the research presented in this report.

- *Provide industry-specific audits and best practices*. Custom efficiency programs work well with basic manufacturing sectors like converted paper products. The primary research noted customers preferred utility-sponsored audits. Additionally, the utilities can work with this segment to understand their maintenance and upgrade needs over the next 10 years. These are the best times to upgrade to efficient equipment.

- *Engage the uninterested in measurement*. One of the biggest challenges in the industrial sector is getting participation. One opportunity for engaging the less interested customers is to focus on the measurement of their utility use, and assist them in

breaking down their bill to specific operations. This can then highlight energy efficiency opportunities.

- *Design innovative pilots to address a range of needs*. Programs that focus on short-term gains, low-cost or no-cost options such as predictive maintenance, and behavior are appropriate.

- *Identify Planned Upgrades and Document Associated Efficiency Opportunities*. Companies will continue to invest in plants where long-term markets are perceived. Major upgrades may be infrequent, possibly only every 10 years. As utilities are aware of the customers' long-term plans, they can encourage the addition of energy efficiency. Early and complete documentation of the utility's involvement will assist in appropriate net-to-gross evaluations for energy efficiency projects.

1. Introduction

The industrial sector consumes over 30 percent of the nation's energy,[2] presenting enormous opportunities for energy efficiency.[3] Many market forces beyond simple energy cost drive industrial customer decision making. Attaining a better understanding of the customer's world will assist Pacific Gas and Electric Company (PG&E) and Southern California Edison (SCE) in their design and implementation of industrial energy efficiency programs. Following upon a potential study developed in 2009 for PG&E, PG&E and SCE engaged energy-consulting firm KEMA, Inc. for the next phase to prepare market intelligence on seven key energy-intensive sub-segments.

The research objective is give PG&E and SCE staff study results to facilitate improved marketing of energy efficiency products and support face-to-face engagement of customers with those products. To address the objective of this study, the work was organized into key elements. These include:

- Perspectives about broad trends affecting California and the nation's industrial sectors (section 2)
- Detailed in-depth, industry-specific analysis of business and process drivers developed from secondary research (section 3)
- Energy usage, target technologies and process, and energy efficiency opportunities (section 4)
- Real-time perspectives and intelligence gained from key industry insiders through interviews and Webinar/Forum group discussions (section 5)
- Recommendations (section 6).

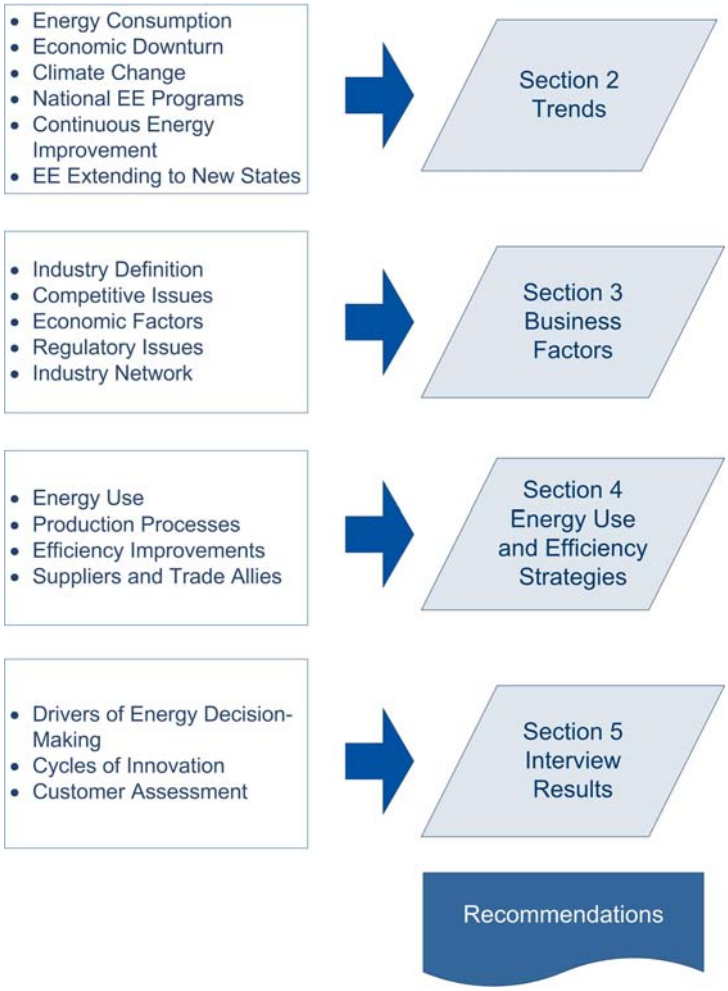
In practice, these report elements are built stepwise--broad national trends inform industry-specific secondary research and industry-specific analysis informs the primary interviews and roundtable discussions. The outcome is a thorough research report intended to provide PG&E

[2] Quinn, Jim. 2009. *Introduction to the Industrial Technologies Program*. Save Energy Now Series Webinar. January 15.
http://www1.eere.energy.gov/industry/pdfs/webcast_2009-0115_introtoitp.PDF

[3] U.S. Census Bureau, 2008.
http://www.census.gov/compendia/statab/2010/tables/10s0892.xls

and SCE staff members the breadth necessary to position their industrial energy efficiency products optimally and the depth necessary to knowledgeably engage their customers.

Figure 1: Graphic Overview of Report



2. Trends in Industrial Energy Efficiency

The industrial sector consumes an immense amount of energy, nearly 32 percent of total U.S. consumption in 2008,[4] to produce goods and materials for wholesale and retail sales. In the past three decades, the overall energy efficiency of the industrial sector in the U.S. has increased dramatically. Energy efficiency potential savings nationally have been estimated at 20 percent or more by 2020.[5] It has thus been an attractive target sector for utilities and government looking to reach new levels of energy savings through efficiency.

Changing energy markets and climate change policies are driving greater interest in energy efficiency technologies. Key trends discussed are energy consumption patterns; effect of the economic downturn on manufacturing; climate change and energy legislation; the rise of continuous energy improvement; energy efficiency adoption outside California and national energy efficiency programs; opportunities for combined heat and power. These trends are discussed in more detail below.

2.1 Energy Consumption Trends

California ranked first in the nation in gross domestic product, at $1891.4 billion in 2009. Table 1 shows the industrial energy consumption. California ranks only third in the nation for energy use, reflecting higher efficiency levels in the industrial sector.[6]

Figure 2 shows U.S trends in industrial energy intensity over time. This figure shows that there has been a general trend since 1993 toward stable or slightly decreasing energy use, even while the economy prospered. More significantly, the energy intensity, or energy per unit of production, has been steadily increasing. Thus, the industrial sector has shown consistent improvement in reducing the amount of energy required to produce manufactured goods.

[4] U.S. Census Bureau, 2008. *Energy Consumption, by End-Use Sector*. http://www.census.gov/compendia/statab/2010/tables/10s0892.xls

[5] McKinsey & Co. 2009. *Unlocking Energy Efficiency in the U.S. Economy.* July. http://www.mckinsey.com/clientservice/electricpowernaturalgas/downloads/_energy_efficiency_exc_summary.PDF

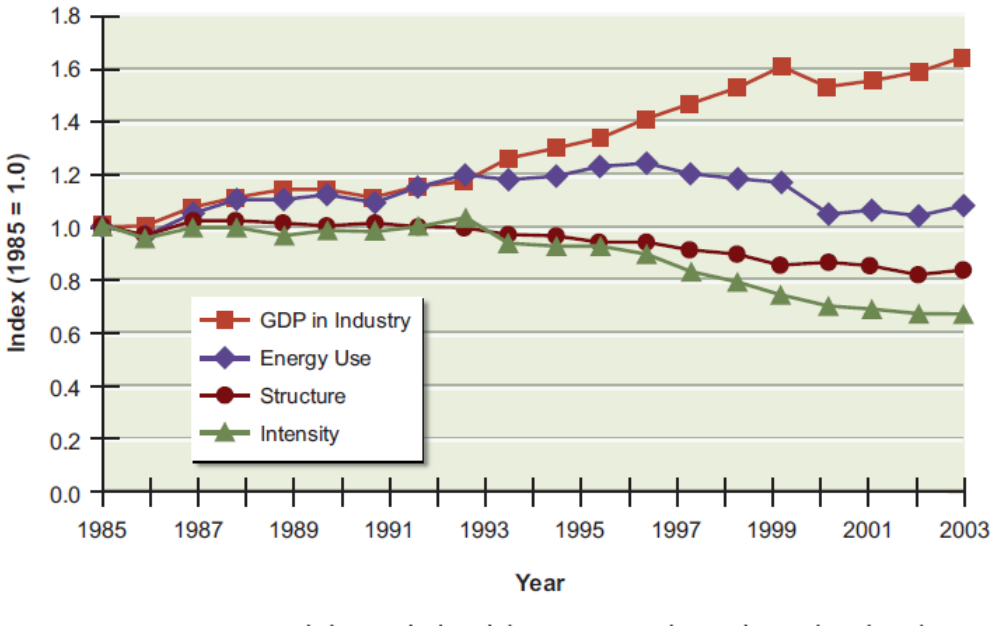
[6] U.S. Department of Energy, Energy Efficiency and Renewable Energy, State and Regional Partnerships. 2011. http://www1.eere.energy.gov/industry/states/state_activities/map_new.asp?stid=CA

Table 1: Industrial Energy Consumption, California

Year	California Industrial Energy Consumption (Trillion Btu)
2009	1,770
2008	1,955
2007	1,958
2006	1,979
2005	2,001
2004	2,053
2003	1,986
2002	1,999
2001	2,137
2000	2,132

Source: Energy Information Administration[7]

Figure 2: U.S. Trends in Industrial Energy Intensity Delivered Energy, 1985-2004



Source: National Academy of Sciences[8]

[7] U.S.DOE. 2011. *State Energy Consumption Estimates 1960 through 2009*. DOE/EIA-0214(2009). June 2011.
http://205.254.135.7/state/seds/sep_use/notes/use_print2009.PDF

2.2 National Programs

Typical utility programs address only a subset of the energy efficiency improvement opportunities, focusing primarily on retrofits and capital improvements. Less attention is given to behavior or maintenance. Federal, regional, and state government agencies, utilities, and others have developed a range of programs to improve industrial energy efficiency. These include providing incentives, audits and technical assistance, and continuous improvement programs.

Many of PG&E and SCE's customers participate in these programs, which can yield insights and best practices to inform utility programs, such as energy assessments offered by the U.S. DOE's Advanced Manufacturing Office (AMO), formerly the Industrial Technologies Program. In California, 49 assessments were completed for small and medium facilities in 2009 through 2011 and 38 assessments for large facilities between 2006 and 2011.[9]

The U.S. DOE's AMO has been the primary federal entity supporting manufacturing R&D in partnership with industrial stakeholders. The AMO R&D program has been recognized as one of the most successful federal R&D efforts operating today. However, in recent years support for the program's R&D funding has faltered, particularly for the industry-specific R&D funding. This has been the most effectual initiative, considering its track record of commercializing products useful to industry. A U.S. DOE peer review report called the manufacturing R&D pipeline "largely empty."[10] This is challenging for the transformation of manufacturing because even though AMO's industry-specific R&D reaches commercialization faster than most other federal R&D, it can still take seven to ten years for results from R&D to reach a plant floor.

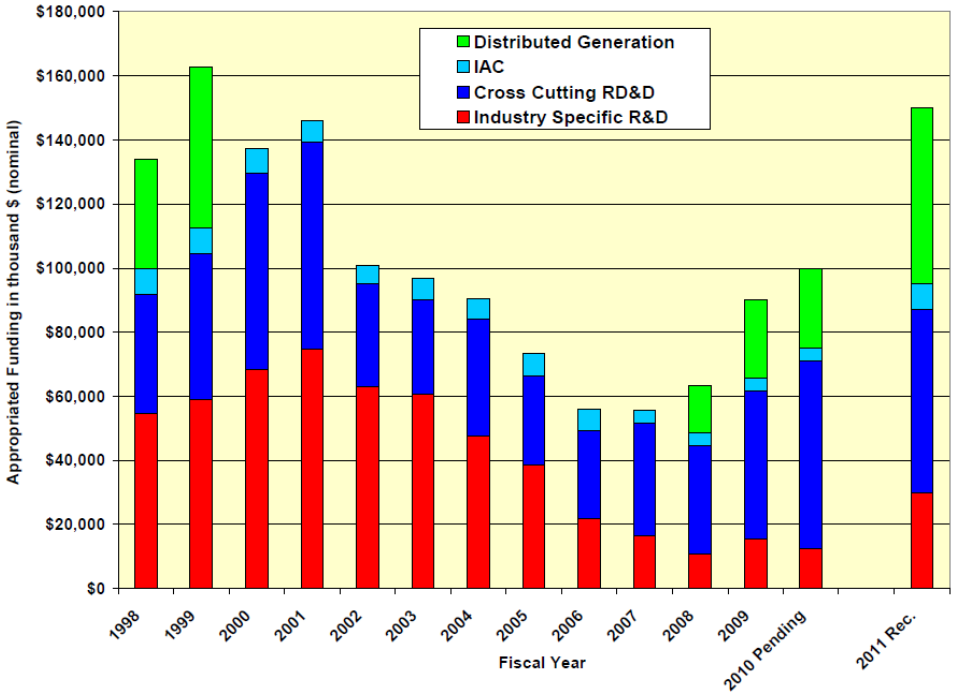
In addition to R&D activities (both the industry specific mentioned above and cross cutting), AMO has two technology and best practices programs: Better Plants (formerly Save Energy Now) and the Industrial Assessment Centers.

[8] National Academy of Sciences. 2010. *Real Prospects for Energy Efficiency in the United States*. National Academies Press.

[9] U.S. Department of Energy, Energy Efficiency and Renewable Energy, State and Regional Partnerships. 2011. http://www1.eere.energy.gov/industry/states/state_activities/map_new.asp?stid=CA

[10] ACEEE 2009. Barriers to energy efficiency investments and energy management in the U.S. industrial sector. http://www.aceee.org/files/pdf/fact-sheet/ACEEE-Barriers_to_industrial_EE_10-20-09.pdf

Figure 3: Industrial Technologies Program Funding, 1998-2010



Source: ACEEE[11]

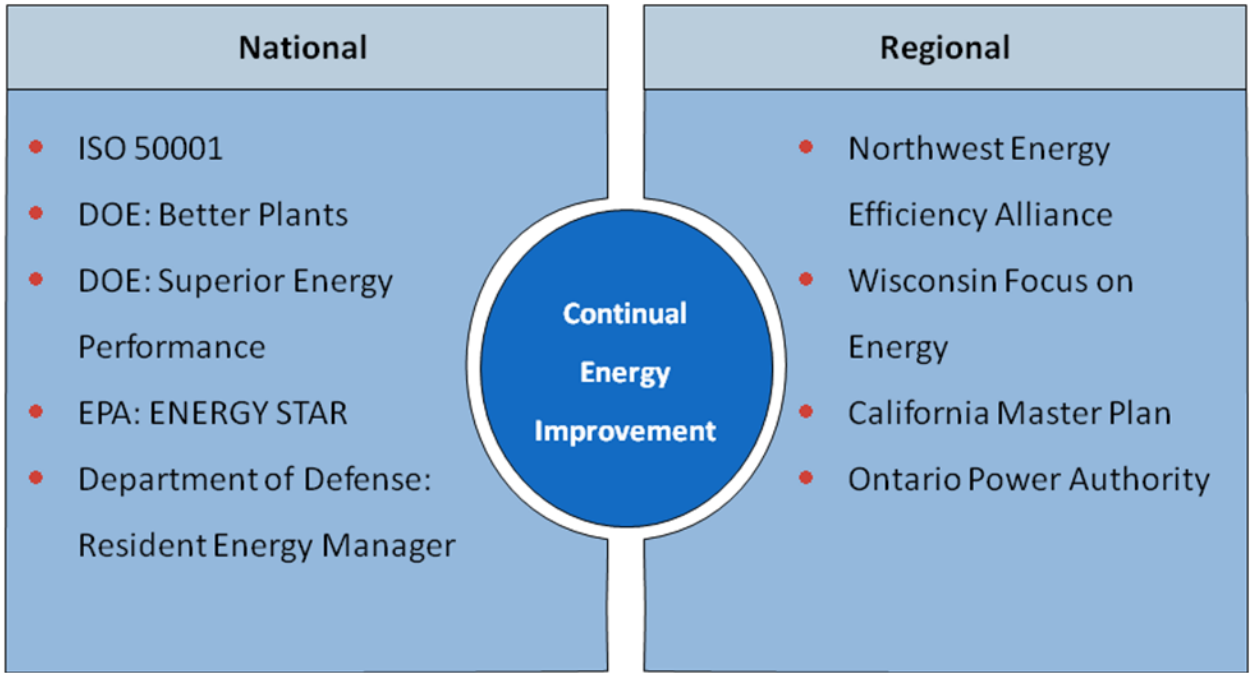
Better Plants works with large industrial energy consumers to help reduce their energy intensity using audits, software tools, and best practices. The other program, Industrial Assessment Center (IAC), serves a similar function for small- and mid-sized industrial facilities, and also trains the next generation of industrial energy engineers. Twenty-six centers at U.S. engineering universities train students to identify energy savings opportunities and perform no-cost assessments for small and medium industrial customers. In California, the San Francisco State University and San Diego State University run IAC programs. The IAC program has a public database of recommendations dating back to 1981, a resource for customers on industrial energy efficiency improvements.

[11] American Council for an Energy Efficient Economy. 2009. *Barriers to energy efficiency investments and energy management in the U.S. industrial sector*. October 20, 2009.

2.3 Rise of Continual Energy Improvement

Utilities, and private organizations, and governments around the world have developed programs in the last few years that focus on setting goals and targets to achieve continuous energy improvement (CEI) in industry. National programs in the U.S. have been developed by DOE (Save Energy Now and Superior Energy Performance) and EPA (ENERGY STAR). Figure 4 displays some examples of national and regional continual energy programs. From a business perspective, interest in energy management is increasing, as shown by the increasing number of participants in these programs.

Figure 4: Examples of National and Regional Continual Energy Improvement Programs



Two important developments in 2011 are expected to heighten interest and activity around energy management: the release of ISO 50001, a global energy management standard, and the launch of superior energy performance, a national program to support energy intensity reductions for industrial plants and commercial buildings.[12]

[12] McKane, Aimee, Lawrence Berkeley Laboratory, 2011. Presentation at the ACEEE Market Transformation Conference, Piloting Energy Management Standards for the U.S and the Globe. http://www.aceee.org/conferences/2011/mt/program

The recent work on U.S. and international energy management standards will have a significant impact on how energy is used in the industrial sector. The International Standards Organization (ISO released an international energy management standard, ISO-50001 in June 2011.

The U.S. Department of Energy is in the process of launching the Superior Energy Performance (SEP) program to promote industrial energy management and increased energy efficiency. This voluntary program will focus on fostering an organizational culture of energy efficiency improvement in U.S. manufacturing facilities, targeting mid- to large-sized plants.

Participants establish an energy management system that complies with ISO 50001 and meets other SEP program requirements, including robust measurement and verification of energy savings. Pilot programs have been launched in Texas and the Pacific Northwest, and the full SEP program is expected to begin in 2013. A California pilot is also planned within the next two years. The American National Standards Institute (ANSI) is developing companion standards to support SEP. ANSI MSE 50021 will provide the additional energy performance and management system requirements for SEP certification that goes beyond basic conformance with ISO 5000; and ANSI 50028 will provide the requirements for verification bodies for use in accreditation or other forms of recognition.[13]

Regional CEI programs have been developed under the Northwest Energy Efficiency Alliance,[14] working with the Bonneville Power Administration and the Energy Trust of Oregon. California has identified CEI as an important aspect of its strategic plan.[15] Similarly, Wisconsin's Focus on Energy employs an internally developed tool called Practical Energy Management©.[16] CEI is still in its infancy, with few CEI programs beyond the pilot stage.

[13] U. S. Council for Energy-Efficient Manufacturing 2010. Superior Energy Performance. http://www.superiorenergyperformance.net/pdfs/SEP_Cert_Framework.PDF

[14] Northwest Energy Efficiency Alliance. Continuous Improvement for Industry website. http://www.energyimprovement.org/index.html

[15] California Public Utilities Commission. 2011. *CA Energy Efficiency Strategic Plan, January 2011 Update*. http://www.cpuc.ca.gov/NR/rdonlyres/A54B59C2-D571-440D-9477-3363726F573A/0/CAEnergyEfficiencyStrategicPlan_Jan2011.PDF

[16] Wisconsin Focus on Energy, Industrial Program. Practical Energy Management tool. http://www.wifocusonenergy.com/page.jsp?pageId=368

2.4 Additional States Adopt Industrial Energy Efficiency

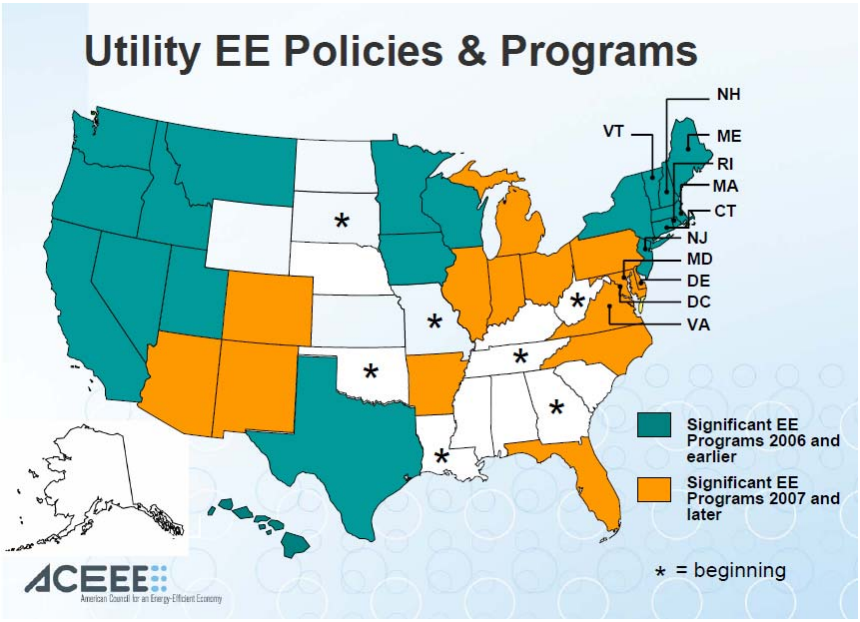
California has long been perceived as a leader in energy efficiency programs. Historically, energy efficiency trends and best practices tended to spread from California to other states involved in industrial energy efficiency. More recently, a sizable contingent of states have made significant commitments to energy efficiency programming as shown in Figure 5. The flow of information is changing as energy efficiency programs spread to locations in the Midwest and South that typically had provided modest or little ratepayer funding for energy efficiency. Program development efforts in many of the aforementioned states are in their early stages compared to California.

These states have signaled their commitment to energy efficiency by adopting aggressive Energy Efficiency Portfolio Standards[17] (EEPS) policies[18] that exceed those in California. As shown in Table 2, California ranks number 14 for cumulative electricity savings targets by 2020, below states primarily in the Northeast and Midwest.

[17] Covers all sectors including residential, commercial and industrial efficiency.

[18] These include: Illinois, Maryland, Michigan, New Mexico, Ohio, Pennsylvania, and Virginia (provisionally).

Figure 5: Utility Energy Efficiency Policies and Programs, 2006 vs. 2007+



Source: ACEEE[19]

The electric EEPS targets in most of these states rise from 1 to 2 percent of retail sales per year within the first 5–10 years of the standard, rivaling the annual savings levels currently being achieved in only a handful of leading states. For example, North Carolina has until recently been relatively inactive in energy efficiency, but has enacted a Renewable Portfolio Standard (RPS). Under this RPS, energy efficiency can meet up to 40 percent of the total requirements of the state's investor-owned utilities (IOUs) and an unlimited amount of the publicly owned utilities' requirements.

The rise of energy efficiency policies and programs indicates that California utilities can increasingly draw on program experience in other states to inform their own experiences.

[19], Nadel, Steven. 2011. *Program Introduction*. (Presentation, ACEEE 2011 National Symposium on Market Transformation, Washington DC, April 10–12, Conference 2011). http://www.aceee.org/files/pdf/conferences/mt/2011/Introduction%20-%20Steve%20Nadel.PDFpdf

Table 2: 2020 Cumulative Electricity Savings Targets, by State[20]

State	2020 EE Target	State	2020 EE Target
Vermont	30%	Indiana	14%
New York	26%	Rhode Island	14%
Massachusetts	26%	Hawaii	14%
Maryland	25%	**California**	**13%**
Delaware	25%	Ohio	12%
Illinois	18%	Colorado	12%
Connecticut	18%	Utah	11%
Minnesota	17%	Michigan	11%
Iowa	16%	Pennsylvania	10%
Arizona	15%	Washington	10%

Source: ACEEE[21]

[20] Includes extensions to 2020 at savings rates that have been established.

[21] Nadel, Steven. 2011. *Program Introduction*. (Presentation, ACEEE 2011 National Symposium on Market Transformation, Washington DC, April 10–12, 2011). http://www.aceee.org/files/pdf/conferences/mt/2011/Introduction%20-%20Steve%20Nadel.PDF

3. Industry Characterization

3.1 Industry Definition

Industries categorized under the NAICS three-digit prefix of 322: paper manufacturing make pulp, paper, and converted paper products. In 2006, the U.S. pulp and paper industry generated nearly $79 billion in product shipments or around 1.6 percent of the total value of the product shipments of the U.S. manufacturing sector.[22]

Paper manufacturing is generally subdivided into two industry groups, the first for the manufacturing of pulp and paper and the second that uses paper inputs to manufacture converted paper products. Pulp mills, paper mills, and paperboard mills comprise the first industry group. Establishments that make products from purchased paper and other materials make up the second industry group.

These include:

- **Paperboard container manufacturing** uses corrugating, cutting, and shaping machinery to form paperboard into containers.
- **Paper bag and coated and treated paper manufacturing** establishments cut and coat paper and foil.
- **Stationery product manufacturing** establishments make a variety of paper products used for writing, filing, and similar applications.
- **Other converted paper product manufacturing** includes, in particular, the conversion of sanitary paper stock into such things as tissue paper and disposable diapers.

Table 3 below provides the primary NAICS codes for the pulp and paper market segment.

[22] Lawrence Berkeley National Laboratory. 2009. *Energy Efficiency Improvement and Cost Saving Opportunities for the Pulp and Paper Industry: An ENERGY STAR® Guide for Energy and Plant Managers.* Prepared for the U.S. EPA. LBNL-2268E. October 2009.
http://www.energystar.gov/ia/business/industry/downloads/Pulp_and_Paper_Energy_Guide.PDF

Table 3: Summary of NAICS Code 322

322100	Industry Group: Pulp, Paper, and Paperboard Mills
322110	Pulp Mills
322120	Paper Mills
322130	Paperboard Mills
322200	Industry Group: Converted Paper Product Manufacturing
322210	Paperboard Container Manufacturing
322211	Corrugated and Solid Fiber Box Manufacturing
322212	Folding Paperboard Box Manufacturing
322213	Setup Paperboard Box Manufacturing
322214	Fiber Can, Tube, Drum, and Similar Products Manufacturing
322215	Non-folding Sanitary Food Container Manufacturing
322221	Coated and Laminated Packaging Paper and Plastics Film Manufacturing
322222	Coated and Laminated Paper Manufacturing
322224	Uncoated Paper and Multiwall Bag Manufacturing
322231	Die-cut Paper and Paperboard Office Supplies Manufacturing
322232	Envelope Manufacturing
322233	Stationery, Tablet, and Related Product Manufacturing
322299	All Other Converted Paper Product Manufacturing

In California, there are no longer any facilities that create pulp from forest products, which is a highly intensive energy process.[23] In California, there are over 450 paper manufacturing facilities, nearly all of which are converted paper products. A few paper and paperboard mills remain.[24] The majority of California mills are in northern California.[25]

[23] Georgia Technical University, Center for Paper Business and Industry Studies. 2011. *Pulp Mills, Pulp and Paper Mills, Paper Mills in California.*
http://www.cpbis.gatech.edu/data/mills-online?state=California

[24] American Forest & Paper Association. 2011. *Forest and Paper industry at a Glance, California*. June 2011.
http://www.foresthealth.org/pdf/California%20June%202011.PDF

[25] Georgia Technical University, Center for Paper Business and Industry Studies. 2011. *Pulp Mills, Pulp and Paper Mills, Paper Mills in California.*
http://www.cpbis.gatech.edu/data/mills-online?state=California

The primary products manufactured in this segment include the following:

- **Pulp** is the raw material used to make all paper products. Pulp is made by separating wood fibers from a substance called lignin, which acts as a glue holding the fibers together. Pulp is often bleached to prepare it for end use. In most cases, a mixture of different kinds of pulp is prepared to create the specific characteristics of the paper or paperboard into which it will be processed. This is a highly energy intensive process. Much less energy is needed to make pulp from recycled paper. California no longer has any pulp manufacturing.
- The **printing and writing paper** market consists of uncoated and coated paper. Uncoated paper is used for publishing, writing, and business applications such as photocopying, computer printing, and envelopes. Lower grade uncoated paper is used for products such as preprinted newspaper inserts, paperback books, and telephone directories. Coated paper is used principally for magazines, catalogs, and other publications that require colored inks.
- **Newsprint** is the thin paper used for daily newspapers. It is generally made with a majority of mechanical pulp and may include some chemical pulp. In 2007, newsprint represented 12 percent of total paper production. Its market share has been steadily declining, as newspapers are increasingly read online.
- Products in the **paperboard** area are divided between containerboard and boxboard. In recent years, these products have accounted for slightly more than half of the national industry's total paper and paperboard production.
  - **Containerboard** is the material used to make corrugated containers for packaging applications. Containerboard is made of two kinds of paperboard: linerboard and corrugating medium. Linerboard is the material used on the inside and outside of corrugated boxes. Corrugating medium is the fluting material comprising the middle portion of corrugated containerboard. Containerboard materials are made from both virgin and recycled fibers.
  - **Boxboard** is used to make folding packaging for food, toiletries, cosmetics, pharmaceuticals, milk, and other products. Boxboard includes solid bleached sulfate board (the premium grade used in folding cartons), unbleached Kraft boxboard, and recycled boxboard.
- **Tissue paper** is used in sanitary products such as bath tissue, paper towels, facial tissue, and napkins.

Printing and writing paper, wrapping and packaging paper, and paperboard accounted for 80 percent of total U.S. production by mass in 2006. The remaining production was newsprint, household and sanitary paper, and all other miscellaneous paper and paperboard.[26]

3.2 Industry Leaders

There are approximately 4,000 companies that manufacture paper products in the United States although the market is dominated by International Paper Co., Kimberly Clark, Weyerhaeuser, Smurfit-Stone, MeadWestvaco, Domtar, Temple-Inland, AbitibiBowater, Greif Inc., and Packaging Corp of America. Acquisitions, divestitures, and restructurings have been common over the previous decade in the North American market. Between 1997 and 2002, at least 12 important mergers occurred with a combined value of around $55 billion.[27] The market consolidation and specialization trend is influenced primarily by the need to stay profitable in a mature industry characterized by large capital requirements and high barriers to market entry.

International Paper is the largest pulp and paper company in the world with manufacturing operations in North America, Europe, Latin America, Russia, Asia and North Africa. Headquartered in Memphis, Tennessee, the company employs over 60,000 people in more than 20 countries.[28] Its businesses include uncoated papers and industrial and consumer packaging distributed by Xpedx, the company's North American distribution company. In 2005 and 2006, International Paper underwent significant restructuring, selling over 6,000,000 acres (24,000 km^2) of forestland in the United States, along with its coated paper, kraft paper, wood products, and beverage packaging businesses, as well as selling subsidiaries Arizona Chemical and New Zealand-based Carter Holt Harvey.[29] In 2008, International Paper bought Weyerhaeuser's containerboard, packaging, and recycling business. The deal more than doubled International Paper's North American containerboard capacity and made it the world's largest producer of containerboard and corrugating medium.

[26] Lawrence Berkeley National Laboratory. 2009. *Energy Efficiency Improvement and Cost Saving Opportunities for the Pulp and Paper Industry: An ENERGY STAR® Guide for Energy and Plant Managers.* Prepared for the U.S. EPA. LBNL-2268E. October 2009.

http://www.energystar.gov/ia/business/industry/downloads/Pulp_and_Paper_Energy_Guide.PDF

[27] Ibid.

[28] International Paper website. http://www.internationalpaper.com

[29] Data Monitor. 2009. *Global Paper Products: Industry Report.* Reference code: 0199-2123. March 2009. http://favormall.net/clientimages/38996/manufacturing-globalpaperproducts.PDF

In 2007, Weyerhaeuser merged with Domtar Corp. This merger combined the second- and third-largest North American producers of uncoated free-sheet paper, making Domtar the leading producer in North America, with a share of more than 30 percent.[30]

Also in 2007, Abitibi-Consolidated Inc. and Bowater Inc., merged to become the world's largest producer of newsprint. The new company, called AbitibiBowater Inc., has about a 47 percent share of the North American newsprint market and a 17 percent share of the global market. However, demand for newsprint has been in a steady decline, and both of these highly leveraged companies struggled to turn a profit over the past three years. In April 2009, AbitibiBowater filed for bankruptcy protection. AbitibiBowater is rebranding as Resolute Forest Products.[31]

3.3 Competitive Issues

The pulp and paper industry is characterized by high competition between the large industry leaders. The pulp and paper industry has a large number of buyers since paper products are used nearly universally, especially in the food processing, newspaper, and office supplies industries. Most pulp and paper products are commodities with only small differences between products from different companies. Therefore, price rather than brand is the primary consideration in buyers' decision making. Other product differentiators are quality, durability, and environmental considerations. The market does have space for smaller manufacturers to operate in niche markets in higher quality specialty products.

The cardboard box and food container manufacturing sub-segments of the industry are not highly concentrated as the four largest companies hold only one third of the total market share. International Paper is the largest player with 15 percent of industry revenue. These are the bulk of the California operations. The low level of concentration gives no particular firm significant market power, and creates a highly competitive environment in the industry. Also, approximately half of all the industry products sold are generic cardboard boxes that are difficult to differentiate between manufacturers.

[30] Ibid.

[31] Marotte, Bertand. 2011. "AbitibiBowater: From behemoth to lean and green." The Globe and Mail. Dec 26, 2011. http://www.theglobeandmail.com/report-on-business/industry-news/energy-and-resources/abitibibowater-from-behemoth-to-lean-and-green/article2283877/

Cardboard box and container manufacturers also compete with suppliers of substitute products, such as plastic bags, which are increasingly replacing solid fiberboard containers for the packaging of clothing and footwear products and some food products, such as snack foods. Other substitute products include shrink-wrap film, plastic beverage bottles, expanded foam polystyrene boxes, wooden pallets and boxes, and returnable plastic crates. Plastic packaging technologies have developed over the past decade, improving energy consumption and chemical use in production, making the product more durable, environment friendly, and increasing its application and diversification in packaging. This has resulted in intensified competition with cardboard packaging.

However, paperboard containers enjoy several competitive advantages over substitute packaging. Paper-based packaging is usually perceived as more environmentally friendly than plastic containers. Industry incumbents have long-term supply contracts with their clients. The industry has been developing various new products, often incorporating other materials such as plastics, polyurethane and aluminum, which entrench its hold on the market. Heavy-duty packaging has increased exposure to the previously unattainable market for packaging of heavy non-durables, taking market share away from wooden pallets.

Another source of competition is the growing penetration of imports. Rapid improvements in paper and packaging industries in developing countries such as China and Brazil have intensified the level of global competition, resulting in more purchases of cheaper products from those countries. Imports have also been on the rise due to off-shoring practices by U.S. companies.

The paper industry is also suffering from over capacity, particularly in North America and Europe. Globally, newsprint consumption is down. Growth is present in Latin America and Asian markets.[32]

3.3.1 Business Models

The pulp and paper industry is characterized by large industry leaders and numerous smaller manufacturing firms. The large players tend to be highly vertically integrated across the country, despite not operating all types of facilities in California. For example, a firm may own and manage forestry resources, manufacture pulp, mill paper and cardboard, manufacture converted paper products, and distribute goods to markets. These companies take advantage of

[32] Ibid.

economies of scale, control over the supply of inputs, and cash resources for technological research and development.

The one exception to vertical integration tendencies of large firms is the trend by paper companies to divest themselves from timberland ownership. Access to timber resources is no longer seen as critical to controlling costs. As such, these firms have sold millions of acres over the past decade and in the process have raised capital for strategic acquisitions and equipment modernization.

Smaller companies generally do not manufacture their own inputs and do not have economies of scale in production. They usually do not hold large contracts either, and may not be able to pass on a full increase in the cost of inputs onto output prices. These firms are especially vulnerable to input market volatility, causing many to enter into bankruptcy during periods of volatile input prices during the mid to late 2000s.

Many firms maintain dedicated sales forces to sell their products. The sales staff markets the products to distributors, industrial customers, and integrated and independent converters and manufacturers. They sell directly to paper-intensive industries, including printers, publishers, direct mail firms, retail and corporate copy centers, and office supply retailers. Paper companies typically have sales offices located throughout the United States and a few own large distribution businesses with customer service and retail store locations. Some paper companies also use paper merchants or brokers to sell their products.

3.3.2 Cost Structure

The primary costs for paper converting industries such as cardboard box and food packaging operations are purchases of input materials. About 60 percent of costs stem from purchasing market pulp, paperboard, paper, old corrugated containers, adhesives, resins, chemicals, and other inputs to the manufacturing process.[33] Increased use of recycled materials in production has increased average input prices.

In 2006, the industry spent roughly $7.5 billion on purchased fuels and electricity. Around $4.7 billion of this was for purchased fuels and around $2.8 billion of this was for purchased

[33] IbisWorld. 2009. *IBISWorld Industry Report, Paper Mills in the US: 32212*. April 27, 2009.

electricity. Energy costs are a sizeable fraction of operating costs, equal to roughly 20 percent of the industry's total cost of materials in 2006.[34]

Nearly 15 percent of total costs stem from labor.[35] These costs are expected to decline significantly over time. The total number of employees, and the value of employee wages, has been on a downward trend partially due to improved productivity in machinery and less reliance on human labor. In California, nearly 23,000 people are employed in the pulp and paper industry.[36]

Paper manufacturers have also seen a decrease in capital costs in recent years. Investment in buildings, machinery and equipment has declined due to global economic slowdown symptoms such as downsizing of operations, lower returns on investments, and difficulty in securing financing.

Utilities, rent, sales and administrative expenses, restructuring, advertising and other expenses all account for a small portion of industry expenditures. Utilities are expected to decrease from 1.6 percent of industry revenue in 2004, to 1.5 percent in 2009 due to few establishments and improvements in energy consumption in production. [37]

In 2008, prices for energy inputs were extremely high; prices for oil and natural gas especially put significant pressure on industry profitability.

Recycled fiber costs have fallen in the recession. Containerboard manufacturers are major consumers of recycled fiber, with some producers relying on old corrugated containers for more than half of their fiber supply. Old newspapers and mixed office papers are also major sources of recycled fiber.

[34] Lawrence Berkeley National Laboratory. 2009. *Energy Efficiency Improvement and Cost Saving Opportunities for the Pulp and Paper Industry: An ENERGY STAR® Guide for Energy and Plant Managers.* Prepared for the U.S. EPA. LBNL-2268E. October 2009.

[35] IbisWorld. 2009. *IBISWorld Industry Report, Paper Mills in the US: 32212*. April 27, 2009.

[36] American Forest & Paper Association. 2011. *Forest and Paper industry at a Glance, California*. June 2011.

[37] IbisWorld. 2009. *IBISWorld Industry Report, Paper Mills in the US: 32212*. April 27, 2009.

3.3.3 Technology Development

The pulp, paper, and converted paper products industries have undergone dramatic changes in the late 1990s and 2000s due to increased computerization and automation of manufacturing processes. Production processes for making cardboard have improved resulting in reduced energy consumption, reductions in chemical use, and increased volume of recycled material use.

A large amount of research over the past five years has been directed toward reducing energy consumption, improvements in environmental performance, and the inclusion of recycled material in manufacturing. The American Forest and Paper Association initiated the Agenda 2020 Technology Alliance, an industry led partnership with government and academia, meant to re-invent the forest products industry through innovation in processes, materials, and markets. [38] The Agenda was initiated in partnership with the U.S. Department of Energy with a focus on improved energy efficiency and to accelerate research, demonstration, and deployment of break-through technologies. The U.S. DOE also developed an energy bandwidth study to assess the best available technologies and potential savings.[39]

Environmental concern, manifested in changing market demands and more stringent environmental regulations, is among the most important drivers of technological change in the pulp and paper industry. Environmental concern has also led to increased paper recycling

3.3.4 Supply Chain Management

To manufacture paper and forest products, a company must first develop sources for its raw materials. For a pulp and paper mill operation, a firm's method of procurement depends on its degree of vertical integration and its operating strategy. The principal means of fulfilling timber needs include owning timberlands, signing cutting contracts to harvest timber (on land that is either government-owned or privately held), and purchasing already harvested logs from contractors or landowners.

[38] American Forest & Paper Association. 2011. *Increasing Paper Recovery for Recycling.* Fact sheet. http://www.afandpa.org/whatwebelieve.aspx?id=1897

[39] Jacobs and Institute of Paper Science and Technology at Georgia Institute of Technology. 2006. *Pulp and Paper Industry, Energy Bandwidth Study. August*. http://www1.eere.energy.gov/industry/forest/pdfs/doe_bandwidth.PDF

Paper makers who are not vertically integrated must rely solely on market prices of milled paper or market pulp.

Eucalyptus trees are increasingly becoming an important source of pulp for the paper industry. These trees, which thrive in hot climates such as South America, produce short-fibered hardwood that grows back from the stump after being cut. Unlike hardwoods in North America, eucalyptus trees grow year round. They are among the fastest growing trees in the world, growing more than 10 feet per year. Soil and climate conditions in Brazil allow for about a seven-year harvest rotation, compared with 25- to 70-year harvest rotation for hardwood trees in the United States, Canada, and Scandinavia. Eucalyptus fibers are the shortest among all hardwoods, giving them low coarseness, good liquid absorption, high opacity, and superior smoothness. In addition, eucalyptus pulp has lower production costs due to more favorable labor and energy costs where the trees are grown. These trends likely mean further shutdowns of North American hardwood pulp capacity.

The fulfillment of raw materials needs has taken on greater complexity in recent years as the timber supply from federal lands has been increasingly curtailed by environmental regulations. The alternative to virgin wood fiber is recycled fiber, which can come from a variety of sources, including used corrugated containers, old newspapers and other wastepaper. Prompted by growing public awareness, environmental protection laws and by the reduced availability of virgin wood fiber, the U.S. pulp and paper industry has dramatically increased its use of recycled fiber.

According to the American Forest & Paper Association, about 37 percent of the fiber used in the production of paper at U.S. mills came from recovered paper, up from 27 percent in 1990. [40] Recycling of newspaper and cardboard boxes has been common for some time while reuse of magazines and office paper has been increasing. Old corrugated containers had a recycling rate of 85 percent in 2010, the highest of all paper grades. Behind old corrugated containers is recycled old newspapers, which were recycled at a rate of 72 percent in 2010. Printing and

[40] American Forest & Paper Association. 2011. *Facts about Paper.* http://www.afandpa.org/FunFacts.aspx

writing papers were recovered at a rate of 55 percent in 2010.[41] The paper industry has set a target of 70 percent recovery by 2020.[42]

3.3.5 Value Chain

A value chain is a chain of activities where products pass through in order, and at each activity, the product gains some value. Examples of "primary activities" in the value chain include inbound logistics, operations, outbound logistics, marketing and sales, and customer service. "Support activities" include administrative infrastructure management, human resources, technology development, and procurement. The firm's margin or profit depends on the effectiveness in performing these activities efficiently, so that the amount that the customer is willing to pay for the products exceeds the cost of the activities in the value chain. Firms that achieve competitive advantage in one or more of these areas are more successful in the market place.

Generally speaking, value chain improvements tend to focus on incremental improvements in production efficiency and capacity utilization through the production process. Large commodity paper manufacturers generally compete on price, therefore running efficient operations and minimizing raw material costs through superior inbound logistics are the primary value generating activities.

Vertical integration is an important variable in determining production costs. A firm may specialize in one or more value chain activities and outsource the rest. The extent in which a firm performs upstream and downstream activities is described by its degree of vertical integration. While a firm exhibiting a high degree of vertical integration is poised to better coordinate upstream and downstream activities, a firm having a lesser degree of vertical integration nonetheless can forge agreements with suppliers and channel partners to achieve better coordination. Large firms tend to be moderately vertically integrated, owning the means of production, sales and marketing staff. However the recent trend has been for these firms to outsource timberland ownership and logging operations. Some companies own their own

[41] American Forest & Paper Association, Paperrecycles.org. 2011. *2010 Recovered Paper Statistics*. http://paperrecycles.org/stat_pages/recovery_rate.html

[42] American Forest & Paper Association. 2011. *Increasing our Energy Efficiency*. Fact sheet. http://www.afandpa.org/whatwebelieve.aspx?id=1899.

distribution networks. One such company is International Paper, which owns and operates a paper product distribution company: Xpedx.[43]

For converted paper product manufacturers such as cardboard box manufacturers who do not also manufacture their own inputs (i.e., pulp and paper), efficient operations, output logistics, and customer service are important value add activities. Many firms have begun changing their business model to manufacture products only after they are ordered, thus reducing the need and cost of customers to warehouse packaging materials. Custom design for specialty applications and fast turnaround times also allow these firms to add value for their customers and distinguish themselves in the marketplace.

Considering that the industry products have a relatively low price tag, and differences in price may not be large, some larger clients may purchase the more expensive option in exchange for ease of ordering, superior after-sale service, and timely and efficient delivery. A similar principle applies for companies which can offer more environmentally friendly products, or support a local business, which gives them a competitive advantage among clients sensitive to such issues.

3.3.6 Pricing

Price differentiation is a major competitive advantage in pulp and paper manufacturing, so there is strong motivation to minimize costs. Because paper products have a wide range of applications, market players can sell to a large number of buyers, many of whom are relatively small, and, under these circumstances, buyer power is weakened. Extremely high barriers to entry mean paper buyers are unlikely to integrate backwards into paper production.

However, as with many mature product industries, similarity between paper products increases buyer power to keep prices low. It is possible to differentiate paper products to a relatively high degree as paper may be manufactured with a wide variety of properties, depending on its intended use. However, within individual market sectors, such as printing paper of a certain grade, buyers tend to view paper products as a commodity. Market players must therefore compete primarily on price.

Overall, demand for paper products has been consistently flat or negative based on fundamental changes in technology, consumer habits, and the anemic economy. Traditional newspaper circulation is sharply down as consumers increasingly get news from TV and online

[43] IbisWorld. 2009. *IBISWorld Industry Report, Paper Mills in the US: 32212*. April 27, 2009.

sources. To keep prices up, manufacturers have been disciplined in reducing capacity thereby keeping supply in line with demand.[44] However, prices have slackened significantly over the past year given the overall global reduction in demand across most sectors. Because there is very little sign demand will pick up in North America anytime soon, paper product prices should remain at historic lows unless domestic capacity is severely curtailed.

3.4 Economic Factors

3.4.1 Business Cycles

From 1970 to 1994, total U.S. pulp production increased from 40 million tons to 66 million tons. Since then, pulp production has declined 15 percent to 56 million tons. During the same period, U.S. paper production has increased from 46 million tons to 82 million tons, an average increase of 2.5 percent per year.[45] The reduction in U.S. production growth over the past decade has been linked to increased competition from foreign paper, increased use of electronic communication in lieu of paper, and the decline of demand for newspapers. Newsprint peaked at approximately 7 million tons in 2000, but has since decreased by 30 percent.[46]

The recession has further exacerbated the financial situation of pulp and paper product manufacturers, further accelerating the trends of industry consolidation, downsizing of workforces, shuttering of manufacturing plants, and off shoring of production. This trend has continued through 2011.[47] The depressed state of the paper industry has made energy efficiency a lower priority.[48]

As part of a competitive market environment, the performance of the paper and forest products industry is driven mainly by the interaction of supply and demand versus traditional cyclical

[44] Marotte, Bertand. 2011. “AbitibiBowater: From behemoth to lean and green.” The Globe and Mail. Dec 26, 2011.

[45] Lawrence Berkeley National Laboratory. 2009. *Energy Efficiency Improvement and Cost Saving Opportunities for the Pulp and Paper Industry: An ENERGY STAR® Guide for Energy and Plant Managers.* Prepared for the U.S. EPA. LBNL-2268E. October 2009.

[46] Ibid.

[47] FOEX Indexes, 2011. Accessed December 28. http://www.foex.fi/

[48] Northwest Energy Efficiency Alliance. 2008. *Evaluation of the Industrial Efficiency Alliance (IEA), Market Progress Evaluation Report #4*. Prepared by the Cadmus Group. Report #08-191. May 2008. http://neea.org/research/reports/E08-191.PDF

factors (i.e., seasonal trends, etc.). Because the sector is so dependent on factors such as global economic health and the capacity of the industry, supply and demand are frequently out of balance. Paper manufacturers try to keep supply from greatly exceeding demand by limiting capacity expansion. In addition, producers on occasion take downtime, halting production to allow supply and demand to balance out, or to conduct scheduled or unscheduled maintenance.

One sector that provides some hedging for the industry from economic swings is nondurable goods. Many of these non-durable goods are shipped in corrugated containers (i.e., cardboard boxes). Cardboard boxes are mainly used by the food, beverage, and agricultural industries, which together account for about half of sales. Other items shipped in boxes include products made of paper, petroleum, and plastic as well as appliances, electronics, and machinery. While food and beverage business is moderately stable, other categories of consumer products are highly dependent on the health of the economy.

3.4.2 Availability of Capital and Credit

The pulp and paper industry is the most capital-intensive manufacturing sector in the United States .[49] A large paper machine can cost between $300 million and $500 million to construct and building a large integrated pulp and paper facility can require more than $1 billion. The large fixed-cost base encourages producers to run their facilities at high operating rates to reduce their capital cost per ton and generate cash. This creates pricing and earning pressures for all industry players during periods of excess industry capacity. In general, paper manufacturers are highly leveraged and rely on extensive borrowing from capital markets to operate.

The California market consists largely of the converted paper industry, which does not require these capital-intensive facilities. However, California facilities operated by multi-national players will be subject to corporate funding constraints. Large multi-national corporate players can fund new projects, facility improvements, and even some new facilities from operating cash. They also have access to the corporate debt market and issue bonds most often to pay for acquisitions. The major players are highly leveraged and operate under a large amount of existing debt, meaning that their bond ratings are not always favorable enough to support issuing bonds and notes without penalty rates. Mergers and acquisitions, which had been the

[49] U.S DOE, Energy Efficiency and Renewable Energy, Industrial Technologies Program. 2005. *Energy and Environmental Profile of the U.S. Pulp and Paper Industry*. Prepared by Energetics Incorporated. http://www1.eere.energy.gov/industry/forest/pdfs/pulppaper_profile.PDF

norm since the mid 1990s, allow firms to raise cash to upgrade equipment and focus on narrower segments of the market.

Compared to large pulp and paper mill operations, the cardboard box and container board industry has relatively low barriers to entry, evident by the large number of firms in California. The main barrier is the cost of setting up a new business and securing financing. Costs vary based on the type of machinery required and the location of the plant. Nearly all new entrants will borrow money to open a manufacturing facility, and the availability of such funds can depend on many factors, including business prospects and regulation on lending and borrowing. During the recession, few new businesses began operations because little credit was available to pay for the sunk costs associated with startup. Venture capital is generally not available because the conceivable markets are so specialized that they will unlikely ever achieve the rapid growth sought by venture capitalists. Therefore, most small businesses take collateralized loans to begin operations. Costs for such credit have gone up considerably, representing a higher barrier to entry for new entrants into the field.

Once the new company is set up in the industry, several barriers exist to prevent new entrants from gaining significant share of the total U.S. paperboard market. Major companies operating within the market are generally vertically integrated and can benefit from the fact that they also manufacture the raw materials required for paperboard conversion (although not in California). The long lead times required in setting up a new manufacturing plant means that substantial losses would be made, even for a successful enterprise, for at least the first 3–5 years. It will also take at least this long to achieve economies of scale, and hence reduce marginal costs to a minimum point.

Established businesses have long-term contracts to supply paperboard containers to various downstream industries and this can represent a major barrier to entry, although when the contracts come up for renewal/tender, it is possible to obtain new customers.

Despite the fact that the substantial capital investment required to establish a competitive paperboard container manufacturing facility in the United States creates a high entry barrier, it is possible for companies with sufficient funds to enter this industry and compete with its major players. This is usually easier for already established companies in similar industries, such as pulp, paper or cardboard manufacturing, which can enter the industry by expanding its existing product mix.

3.5 Regulatory Issues

The pulp and paper industry is subject to a myriad of environmental regulations on federal, state, and local levels.

The pulp and paper industry must comply with the following environmental laws:

- The **Clean Air Act (CAA)** regulates air emissions from stationary and mobile sources. The pollutants defined include particle pollution (often referred to as particulate matter), ground-level ozone, carbon monoxide, sulfur oxides, nitrogen oxides, and lead, as well as 188 hazardous air pollutants such as mercury. Regulated sources are stationary sources or group of stationary sources that emit or have the potential to emit 10 tons per year or more of a hazardous air pollutant or 25 tons per year or more of a combination of hazardous air pollutants.
- The **Clean Water Act (CWA)** establishes the basic structure for regulating discharges of pollutants into the waters of the United States and regulating quality standards for surface waters. Under the CWA, EPA has implemented pollution control programs such as setting wastewater standards for industry. The CWA made it unlawful to discharge any pollutant from a point source into navigable waters, unless a permit was obtained.
- The **Resource Conservation and Recovery Act (RCRA)** gives EPA the authority to control hazardous waste from the "cradle-to-grave." This includes the generation, transportation, treatment, storage, and disposal of hazardous waste. RCRA also set forth a framework for the management of non-hazardous solid wastes. The 1986 amendments to RCRA enabled EPA to address environmental problems that could result from underground tanks storing petroleum and other hazardous substances. HSWA—the Federal Hazardous and Solid Waste Amendments— are the 1984 amendments to RCRA that focused on waste minimization and phasing out land disposal of hazardous waste as well as corrective action for releases.
- The **Endangered Species Act (ESA)** focuses on the conservation of threatened and endangered animals and plants, as well as their habitats. The ESA is enforced through the Fish and Wildlife Service. The ESA has implications for limiting the supply of forest products.

Responsibility for enforcing environmental laws is distributed between the federal government (usually the EPA), state agencies, counties and municipalities. In general, facilities in the pulp

and paper industry are long accustomed to complying with existing environmental regulations as part of their normal course of business.

The fulfillment of raw materials needs has taken on greater complexity in recent years, as the timber supply from federal lands has been increasingly curtailed by environmental regulations. The main federal regulatory action in this area was the June 1990 ruling by the U.S. Fish and Wildlife Service that listed the northern spotted owl as a threatened species. This decision prohibited timber harvesting from about nine million acres of land in the Pacific Northwest, where the owls reside. Since this ruling eliminated a substantial supply of logs, particularly from old-growth trees, the industry has had to develop alternative raw materials sources.

The Roadless Area Conservation Rule, enacted by the Clinton administration in January 2001 and upheld in court decisions in 2011, further attempted to restrict use of raw timber materials by prohibiting roads on 50 million acres of national forest.[50]

Climate Law and Regulations

In 2006, California's Global Warming Solutions Act (AB32) became the first legislation signed into law in the United States to establish mandatory limits on greenhouse gas emissions. Starting in 2009, California facilities that emit more than 25,000 metric tons of CO_2 equivalent were required to report their emissions to the Air Resources Board. Few if any California paper plants are likely to have sufficient emissions to be required to comply with AB32.

EPA Regulation under the Clean Air Act

The U.S. EPA is pursuing implementation of greenhouse gas regulation under the Clean Air Act. In 2009, the EPA determined that greenhouse gases from mobile sources threaten public health and welfare, effectively enabling it to create rules under the Clean Air Act. The details of the Clean Air Act automatically trigger regulation of stationary sources once mobile sources are regulated. The EPA then promulgated the "Tailoring Rule" which states that the Clean Air Act's regulation of greenhouse gasses only applies to large stationary emission sources (> 75,000 metric tons CO_2 per year for new facilities and >100,000 metric tons per year for existing facilities). For new facilities and major modifications of existing facilities, the State air regulator will make a determination what the best available control technology is for GHG emissions. In general, this will mean plant managers will be required to purchase energy efficient equipment.

[50],Paulson, Steven K. 2011. "Roadless Area Conservation Rule Upheld by US Appeals Court." The Huffington Post. October 21, 2011. http://www.huffingtonpost.com/2011/10/21/roadless-area-conservation-rule_n_1025801.html

Implementation of this rule will likely not affect existing paper manufacturers in California, but may include future large pulp and paper plants.

3.6 Industry Network

The major industry groups associated with the pulp and paper industry are identified in this section. The American Forest & Paper Association and the Institute of Paper Science and Technology are particularly active in the sustainability and energy efficiency areas. The source of the following information is the company websites of these organizations.

- American Forest & Paper Association (AF&PA)–AF&PA is the national trade association of the forest, paper and wood products industry. The site offers statistical and educational information on paper and wood products, recycling, and forestry. It also carries news and government legislation affecting the forest products and paper industry.
- Technical Association of the Pulp & Paper Industry–TAPPI is an association for the worldwide pulp, paper, packaging, and converting industries and publisher of Paper360°. TAPPI serves four distinct segments of the global industry: pulp and paper technical, pulp and paper operations, converting and packaging, and suppliers and consultants. Technical information for energy efficiency is primarily housed here.
- Paperboard Packaging Council is the primary industry association representing the paperboard industry. Like their counterparts in the AICC, the PPC provides technical support focused on the paperboard segment of the industry.
- Association of Independent Corrugated Converters–AICC represents a majority of the independent corrugated packaging manufacturers and their suppliers.
- Center for Paper Business and Industry Studies–CPBIS is an academic research center providing business knowledge of relevance to the global forest products industry.
- Composite Tube & Can Institute–The CCTI is an international trade association representing the interests of manufacturers of composite paperboard cans, containers or canisters, tubes, cores, cones, fiber drums, spools, ribbon blocks, bobbins, and related or similar composite products; and suppliers to those manufacturers of such items as paper, machinery, adhesives, labels, and other materials and services.
- Corrugated Packaging Council–The Corrugated Packaging Council (CPC) develops programs to promote the performance and environmental benefits of corrugated packaging.
- Fibre Box Association–The FBA is a non-profit organization representing and serving the North American corrugated industry.

- Flexible Packaging Association–The Flexible Packaging Association is one of the leading trade associations for converters of flexible packaging and suppliers to the industry.
- Forest Products Society–An international not-for-profit technical association that provides an information network for all segments of the forest products industry.
- Institute of Paper Science and Technology–A consortium for industrial research and development for the paper and forest products industries. Located at Georgia Tech, the consortium addresses the technical, strategic and economic challenges faced by these industries.
- National Paperbox Association–Represents the concerns of boxmakers nationally and internationally, and at the local level through its Regional Divisions.
- Pulp and Paper Products Council–The Pulp and Paper Products Council is an alliance of product associations serving an international membership in the pulp and paper industry. PPPC provides up-to-date, comprehensive market data and market intelligence on global pulp and paper markets.
- Recycled Paperboard Technical Association–RPTA is a non-profit association that brings together the expertise of over 100 paper mills worldwide, which manufacture products from at least 90 percent recovered fiber.
- U. S. Department of Energy–Forest Products–The Advanced Manufacturing Office, formerly the Industrial Technologies Program, seeks to improve the overall energy efficiency of the U.S. forest products industry.

3.6.1 Supplier and Trade Allies

The supplier and trade allies for the pulp industry are primarily small niche process engineering firms and business consultants. A selection of industry suppliers potentially useful for partnering for energy efficiency is listed below.

- **MK Systems** develops and manufactures advanced laboratory test equipment and quality control instrumentation for the pulp and paper industry. The company concentrates on fundamental issues such as digesting, sheet-forming, formation, and absorbency.
- **Voith AG** is a German firm whose paper division makes machines used to produce graphic paper, packaging, and tissue. Voith AG claims that its machines supply one third of the world's paper production. The company employs 43,000 people and reports sales of over € 4.9 billion.

- **Kemira** is the world's largest provider of pulp and paper chemicals. Their business is divided into four customer segments: Pulp, Printing & Writing, Packaging & Board and Tissue & Specialties.
- **Metso** is a global supplier of pulp, paper, board and tissue manufacturing lines, covering the full range of paper products. Approximately one third of the global paper production is performed on production systems supplied by Metso Paper. The company's largest market areas are Europe, Asia and North America.

4. Target Technologies / Processes and Energy Efficiency

The pulp and paper industry is a highly energy intensive industry. The U.S. pulp and paper industry is among the largest energy consuming industries in the United States.[51] As of 2006, the industry accounted for over 8 percent of the purchased fuels and over 9 percent of the electricity consumption of the entire U.S. manufacturing sector.[52] The converted paper industry, such as is found in California, has much lower energy use. Significant opportunities remain for energy efficiency in the pulp, paper, and converted paper production process.

4.1 Energy Use

Energy is used in many aspects of the papermaking process, including grinding up or chemically separating wood fibers, heating water to generate steam, and drying massive rolls of paper.

Primary energy consumption in the U.S. pulp and paper industry grew at 1.5 percent per year between 1970 and 1994 and 1.3 percent per year between 1980 and 1994. The composition of the fuel mix has changed substantially over the period. Biomass and electricity grew more rapidly, increasing their shares from 35 percent and 5 percent in 1970 to 43 percent and 7.2 percent in 1994, respectively. According to the American Forest and Paper Association, today pulp, paper, and wood products mills generate on average 65 percent of their energy needs on-site from carbon-neutral biomass. Use of coal and coke, along with oil, decreased most rapidly in the paper sector, as coal and coke fell from 21 percent to 11 percent, and oil fell from 11.4 percent to 7 percent, between 1970 and 1994.[53]

[51] Brown, M. and Y. Baek 2009. "The Forest Products Industry at a Crossroads: Preliminary NEMS Analysis of Renewable Standards and Cap and Trade Policies." (Paper presented, TAPPI Engineering, Pulping & Environmental Conference, October 2009).

[52] Lawrence Berkeley National Laboratory. 2009. *Energy Efficiency Improvement and Cost Saving Opportunities for the Pulp and Paper Industry: An ENERGY STAR® Guide for Energy and Plant Managers.* Prepared for the U.S. EPA. LBNL-2268E. October 2009.

[53] American Forest & Paper Association, 2011. Wesbite. http://www.afandpa.org/default.aspx

For the converted paper industry, energy requirements are small, and the cost of utilities accounted for less than 2 percent of revenue in 2009.[54]

4.2 Production Processes

The upstream side of the pulp and paper industry converts fibrous raw materials into pulp, paper, and paperboard. Downstream, manufacturers convert raw paper into products such as cardboard boxes and food containers. The following describes the basic processes involved in pulp and paper manufacturing.

4.2.1.1 Paper Manufacturing

The processes involved in papermaking include raw materials preparation, pulping (chemical, semi-chemical, mechanical, or waste paper), bleaching, chemical recovery, pulp drying, and papermaking. The most significant energy-consuming processes are pulping and the drying section of papermaking. Because pulping no longer occurs in California at this time, this discussion presents only a brief overview of the whole process, and focuses on the papermaking aspects. Figure 6 provides an overview of the processes.[55]

Paper manufacturing involves the following steps: wood preparation, pulping and papermaking.

Wood Preparation. For paper made from virgin wood, the raw materials preparation operations typically include debarking, chipping, and conveying. Logs are transported to pulping mills where the bark is removed. After debarking the logs are chipped, most often in a radial chipper.

Pulping. The next stage in the papermaking process is pulping. The primary purpose of pulping is to free the fibers from the lignin that binds the fibers together in wood, and then to suspend the fibers in water. There are two main pulping processes: mechanical and chemical. In the chemical pulping process, the wood chips are combined with a highly alkaline solution, called white liquor. These ingredients are mixed together in a digester where they are pressurized and

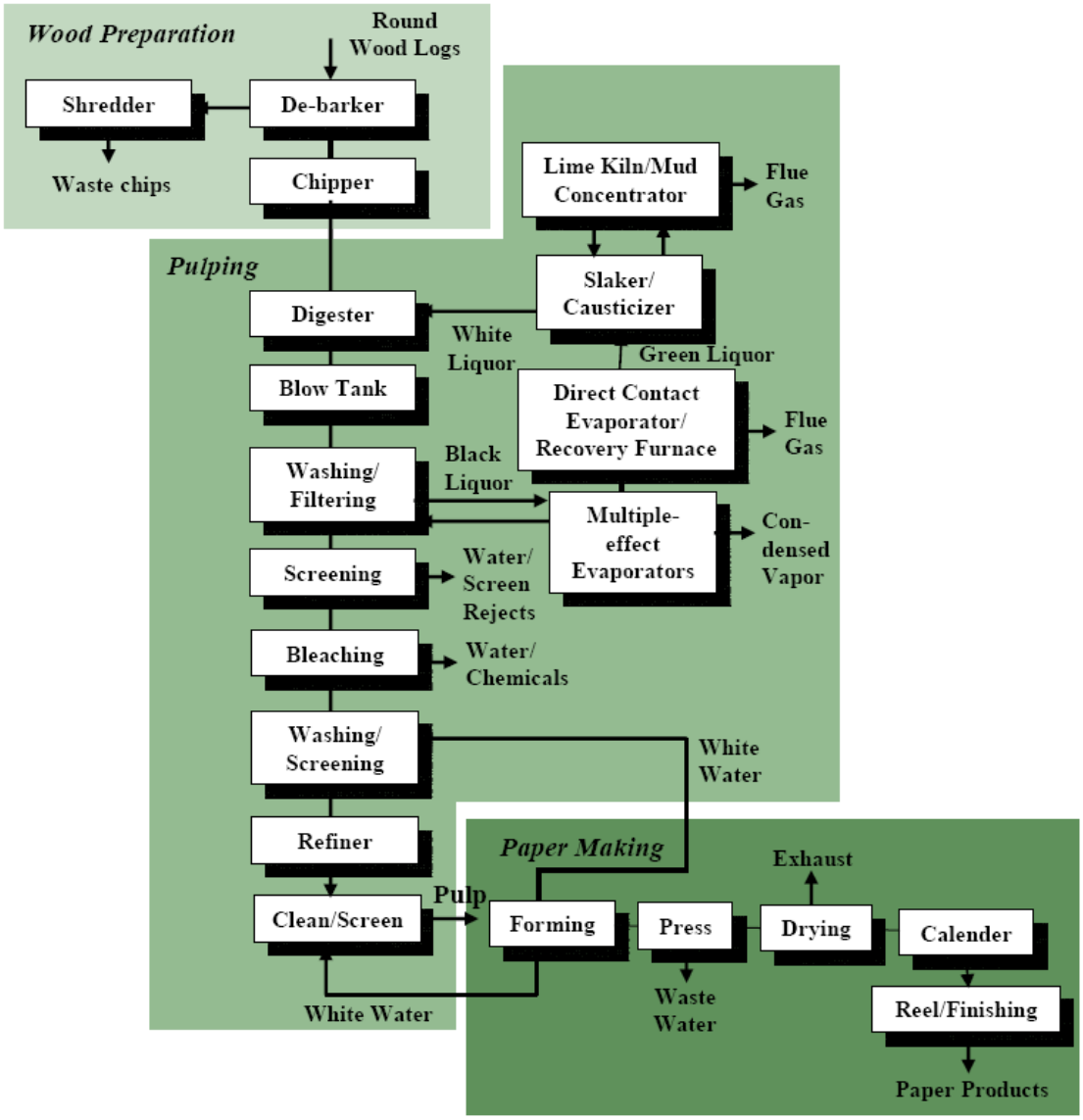
[54] IBISWorld. 2009. *IBISWorld Industry Report, Coated & Laminated Paper Manufacturing in the US: 32222*. May 4, 2009; IBISWorld. 2009. *IBISWorld Industry Report*, *Office Stationery Manufacturing in the US: 32223*. May 27, 2009; and IBISWorld. 2009. *IBISWorld Industry Report*, *Cardboard Box & Container Manufacturing in the US: 32221*. March 25, 2009.

[55] U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards. 2010. *Available and Emerging Technologies for Reducing Greenhouse Gas Emissions from the Pulp and Paper Manufacturing Industry.* October 2010.
http://www.epa.gov/nsr/ghgdocs/pulpandpaper.PDF

heated until most of non-fibrous materials in the wood are dissolved. The spent liquor and dissolved contaminants, now called black liquor, are washed away and the fibers move on to the bleaching phase. The removal of the remaining lignin that is still closely bonded to the pulp occurs through a series of bleaching stages.

Papermaking. After bleaching, the pulp is ready to be made into paper. Where the mill is not integrated with the pulp plant, the wet pulp is dried and shipped to paper mill sites. After screening, the pulp is screened. The stock is prepared by blending pulps and additives to form an uniform and continuous slurry. This slurry is put through a paper machine where paper is formed once the fibers have been sufficiently dewatered. Subsequently, they move on to the press section where the paper is pressed to remove water and promote further bonding between fibers. Lastly, the paper moves to the drying section, where steam filled rollers dry the paper through evaporation. This section consumes the bulk of energy in papermaking. The last stage in the papermaking process is the calendar stack, in which the paper is run through a series of carefully spaced rollers that control the thickness and smoothness of the final paper. The paper is then wound onto storage reels.

Figure 6: Stages of Papermaking



Source: U.S. Environmental Protection Agency 2010.[56]

[56] Ibid.

4.2.2 Cardboard Manufacturing

Cardboard is made in a machine that corrugates one roll of paper, which is then glued between two other layers called liners. The glue is cured by passing the cardboard over heated rolls. At the end of the corrugator, a slitter-scorer cuts the cardboard into large sheets called box blanks. The box blanks are then transported to machines that convert them into finished containers.

4.3 Current Practices

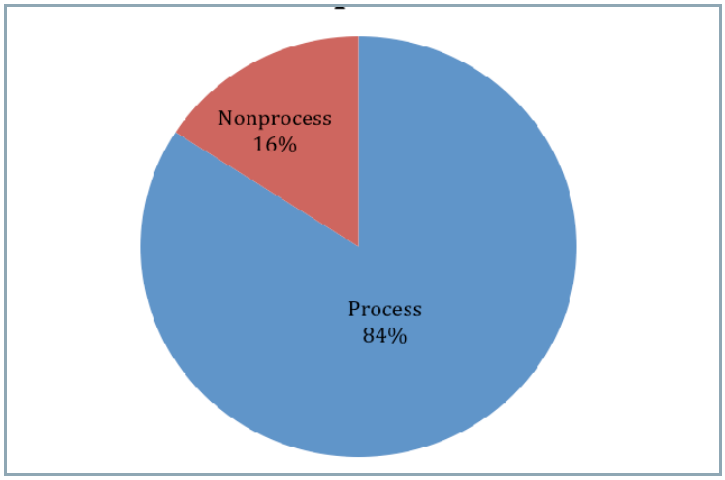
The following charts and graphs present KEMA's analysis of the energy use characteristics of the pulp and paper industry. Figure 7 and Figure 8 display electricity consumption for the paper industry (NAIC 322) and are based on national industry data from the 2006 Manufacturing Energy Consumption Survey (MECS). Figure 7 highlights the fact that the overwhelming majority of electric consumption (84 percent) by the paper industry is directly related to the paper product making process. Non-process energy use, like facility lighting and HVAC, accounts for a small fraction (16 percent) of the industry's electric consumption. These figures address the entire paper industry, as MECS does not provide data for the converted paper products industry.

Figure 8 expands on the high-level consumption information presented in Figure 7 and shows electric consumption by end use for the paper industry. Over 80 percent of total electric consumption in the paper industry can be attributed to machine drives as defined by MECS. Using information from prior research,[57,58] the machine drive consumption can be broken down roughly into motors (35 percent), pumps (26 percent), fans (16 percent), and compressed air (4 percent). Facility lighting (5 percent) and HVAC (5 percent) constitute the majority of non-process electric consumption in the paper industry.

[57] KEMA and Lawrence Berkeley National Laboratory, 2005. *California Statewide Industrial Sector Energy Efficiency Potential Study.* Prepared for Pacific Gas and Electric Company.

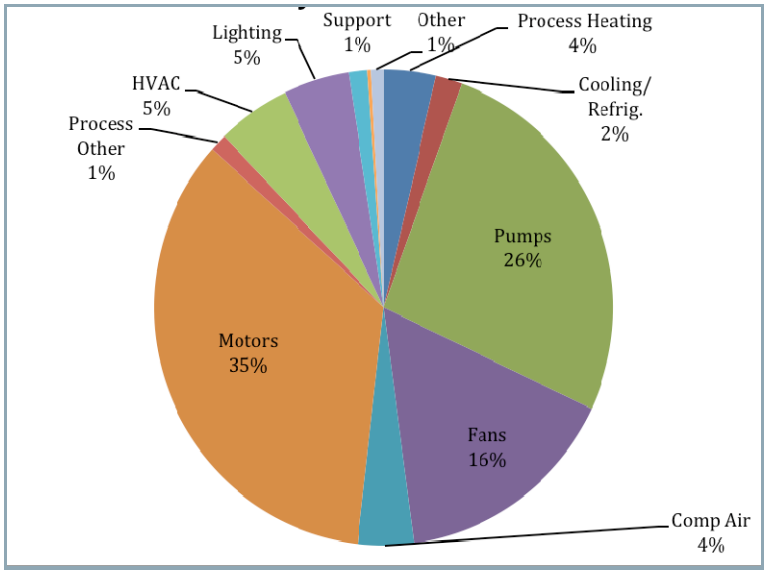
[58] XENERGY. 1998. *United States Industrial Electric Motor Systems Market Opportunities Assessment*. Prepared for Oak Ridge National Laboratory and DOE's Office of Industrial Technologies. December 1998.

Figure 7: Electric Consumption, Paper Industry



Source: 2006 Manufacturing Energy Consumption Survey[59]

Figure 8: Electric Consumption by End Use, Paper Industry



Source: 2006 Manufacturing Energy Consumption Survey[60]

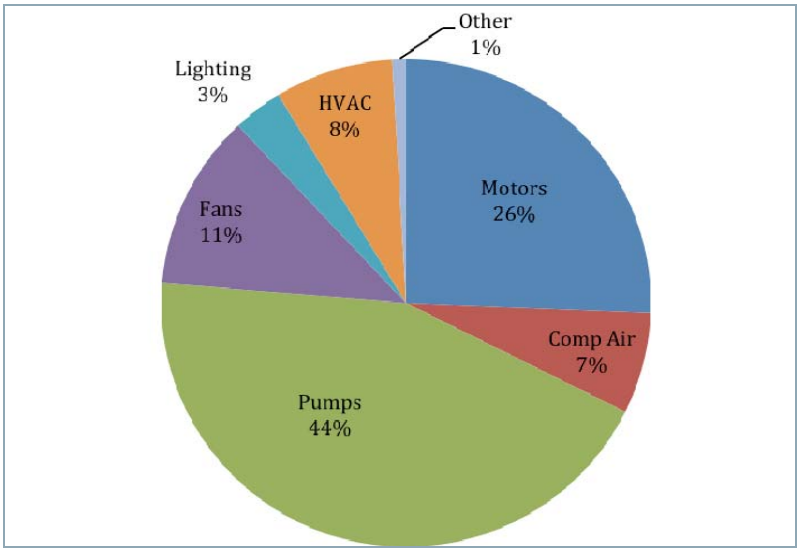
[59] U.S. Energy Information Administration. 2009. *2006 Energy Consumption by Manufacturers*. June 2009.

http://www.eia.gov/emeu/mecs/mecs2006/2006tables.html

[60] Ibid.

Figure 9 presents the electric energy efficiency potential by end-use for the paper industry (NAICS 322).[61] The largest potential for electric energy savings lies in pumps and motors, accounting for 44 percent and 26 percent respectively of the total energy savings potential in the paper industry. Given that pumps and motors are also the two largest electric end uses within the paper industry, exploring related efficiency measures presents the greatest opportunity for large-scale energy and utility bill savings.

Figure 9: Electric Energy Efficiency Potential, Paper Industry

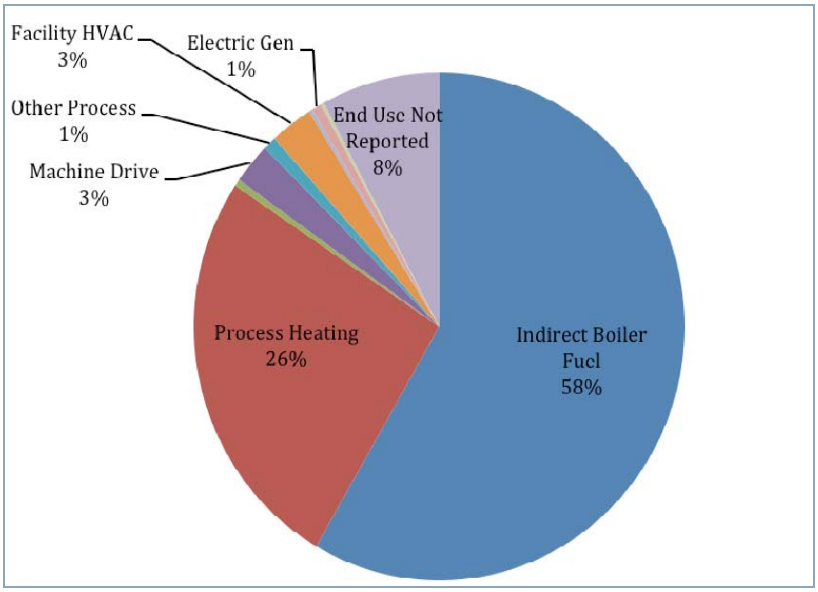


Source: 2006 Manufacturing Energy Consumption Survey[62]

[61] Ibid.

[62] Ibid.

Figure 10: Gas Consumption by End Use

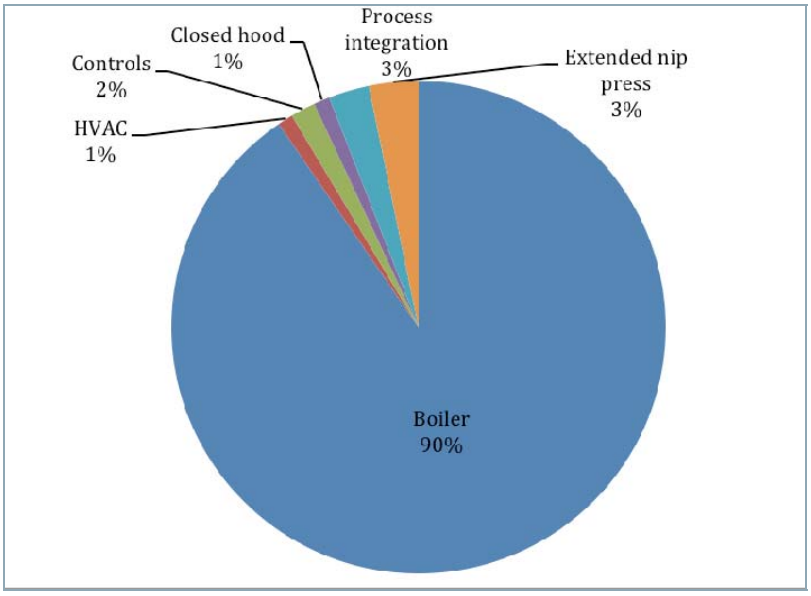


Source: 2006 Manufacturing Energy Consumption Survey[63]

Figure 10 breaks down the end use consumption of natural gas for the paper industry. The majority of natural gas usage within the paper industry is dedicated to indirect boiler fuel (58 percent) and process heating (26 percent).

[63] Ibid.

Figure 11: Gas Energy Efficiency Potential, Paper Industry



Source: 2006 Manufacturing Energy Consumption Survey[64]

Figure 11 displays the energy efficiency potential related to natural gas use within the paper industry (NAICS 322). Energy efficiency measures associated with improving the boiler and associated steam systems make up the overwhelming majority (90 percent) of the potential to save natural gas in the paper industry. Drying is the major process using steam in the papermaking process.[65]

4.3.1 Efficiency Improvements

A large number of technologies and measures exist that can reduce energy intensity of the various process stages of pulp and paper production. According to a Georgia Institute of Technology (Georgia Tech) survey of pulp and paper manufacturers, about 27 percent of pulp and paper establishments responded that they had set targets for energy reduction for 2008 or

[64] Ibid.

[65] Lawrence Berkeley National Laboratory. 2009. *Energy Efficiency Improvement and Cost Saving Opportunities for the Pulp and Paper Industry: An ENERGY STAR® Guide for Energy and Plant Managers.* Prepared for the U.S. EPA. LBNL-2268E. October 2009.

future years.[66] No data was available for manufacturers of downstream paper products such as cardboard boxes or food containers. The following measures have been shown to reduce the energy requirements for papermaking. Efficiency measures for pulping have been omitted due to the fact that there are currently no integrated pulp and paper mills in California.

- **Behavioral change–** Changing the way employees operate manufacturing facilities holds significant potential for energy savings. According to the GIT survey, 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.[67] An increased focus on energy management practices is a good place to start for energy savings.
- **Advanced dryers–**Most of the energy consumed in the paper manufacturing process is related to paper drying. Advanced drying technologies such as gas fired paper dryers, multiport dryers, and impulse dryers can significantly reduce energy consumption.[68]
- **Advanced dryer controls–**Providing control systems that the dryer operation can save energy. Commercially available products exist to offer better control of steam use by managing system set points and process parameters for drying.[69]
- **Optimizing water removal in forming and pressing–**Water removed from stages preceding drying greatly reducing the energy required for drying. Maintaining proper control of the vacuum dewatering and optimizing the press operation to remove water reduce the load on the dryer.[70]
- **Magnetically coupled adjustable-speed drives**–These are a new type of adjustable speed drive, in which the physical connection between the motor and the driven load is replaces with a gap of air. Torque is generated by the interaction of rare earth magnets on one side of the drive with induced magnetic fields on the other side. One

[66] Youtie, J., P. Shapira, and L. Kay. 2009. *Practices and Plans for Sustainability in Georgia's Pulp and Paper Sector: Results from the Georgia Manufacturing Survey 2008*. Georgia Tech Program in Science, Technology, and Innovation Policy. January 2009.

[67] Ibid.

[68] Lawrence Berkeley National Laboratory. 2009. *Energy Efficiency Improvement and Cost Saving Opportunities for the Pulp and Paper Industry: An ENERGY STAR® Guide for Energy and Plant Managers.* Prepared for the U.S. EPA. LBNL-2268E. October 2009.

[69] Ibid.

[70] Ibid.

commercially available model is the MagnaDrive. A number of case studies have shown 60 percent energy savings versus the former constant speed system.[71]

- **Electro-hydraulic contaminant removal–**Adhesive materials on secondary fiber feedstock can significantly degrade the quality of recycled paper products. A new technology demonstration project that uses the principle of electro-hydraulic discharge can remove these contaminants using less energy than conventional means.[72]
- **Lateral Corrugator–**A corrugation machine turns paper into cardboard boxes. The lateral corrugator is a technology being developed by the Institute of Paper Science and Technology at Georgia Tech University. It is designed to increase the compression strength of corrugated containers by up to 30 percent, which may allow manufactures to use 15 percent less fiber to produce boxes of the same strength.[73] This reduction in raw materials would represent a signficant energy savings through the paper manufacturing process.
- **Optimization of existing equipment–**Opportunities often exist to improve operations equipment, such as boilers and paper machines. IT-driven "smart" systems increasingly incorporate real-time diagnostics to improve performance. Although most paper machines are already equipped with a process computer, an additional 2 percent reduction on energy demand can be achieved by the optimization of the control equipment.[74]
- **Energy-efficient lighting–**Factory buildings often use high-pressure mercury lamps for lighting. The use of light-emitting diodes, electronic ballasts and fluorescent tubes in depots and offices can result in electricity savings.
- **Efficient motor systems**–Motors are used throughout the pulp and paper industry to operate equipment such as fans and pump systems. Motor system improvements include motor management, selection and maintenance; properly sizing motors, fans and pumps; upgrading to efficient variable speed drive motors and efficient fan systems, air compressors, and other motor end uses and adjustable-speed drives.
- **Boiler improvements–**Typical boiler energy efficiency measures, including process controls, reduction of flue gas quantities, minimizing blow down, flue gas heat recovery, burner replacement, improved boiler insulation, and condensate return, are applicable to facilities with boilers.

[71] Ibid.

[72] Ibid.

[73] Ibid.

[74] Ibid.

4.3.2 Barriers to Industrial Energy Efficiency Adoption

Industrial facilities face a number of barriers to increased energy efficiency. The following are some key barriers for paper customers.

- **Limited capital–**Some of the energy efficiency equipment improvements in the paper subsector involve large capital investments, and limited capital availability is a key factor limiting increases in energy efficiency. Many targeted projects cost many millions of dollars, so even facilities with assigned capital budgets are severely constrained.
- **Production concerns–**For most facility and plant managers, keeping equipment and systems operational while meeting quality requirements and avoiding production disruptions is the highest priority. Since energy costs can be a small portion of total production cost, other cost considerations related to production take precedent.
- **Limited staff time and hassle factor**–Staffing limitations were another key barrier to increased energy efficiency. While most facility managers want to stay as efficient as possible, staff's number one priority is to keep the facility operational. Smaller energy efficiency projects are not pursued because they "are not worth the trouble."
- **Information–**While industrial customers typically have access to the information they need to make energy efficiency improvements, customer knowledge is mostly directed toward the "big ticket" equipment that are the primary energy users. Understanding of the energy-saving aspects of smaller items, such as preventative O&M may be lower.
- **Reliability concerns–**Maintaining production, quality and safety goals with reliability are a high priority. Industrial customers are very concerned about the reliability of all new equipment to meet their standards, including high efficiency equipment. While there are typically no difference in reliability between energy efficient and standard equipment, any installations of new equipment at the plant will generate some reliability concerns.
- **Environmental costs and concerns–**Many industrial facilities must comply with stringent environmental regulations; energy efficiency projects must conform with these system requirements. Requirements to minimize air and waste emissions can require additional process energy use.

5. Market Intervention

This section presents the results from primary research conducted via one-on-one interviews conducted with industry stakeholders. KEMA attempted to organize an industry roundtable meeting but could not garner enough interest. KEMA did however conduct six one-on-one interviews with major energy users in the PG&E and SCE service territory. Interviewees included plant engineers, general managers, and quality assurance leads. Although the interview sample size is small and there is a potential for bias from self-selection, KEMA found enough consistency in the responses to allow for general conclusions about the industry.

KEMA asked questions on relative importance of energy, key drivers and barriers for energy efficiency investment, and energy investment decision-making process. A summary of their responses is included in this section. The interview guide is provided as an attachment to this report.

5.1 Needs Assessment

Our survey was divided into two: one on drivers and barriers and one on the decision-making process and experience with utility programs.

5.2 Key Drivers and Barriers

The customers we spoke with all agreed that saving money was the most important driver for energy efficient practices and retrofits. Because paper manufacturers are under intense competitive pressures, they view saving energy as part of staying competitive. One respondent told us that his corporate office has directed them to reduce energy use to manage their carbon footprint. No other respondents identified carbon footprint as a driver.

We heard that energy efficiency is a medium to high priority. Energy is a high percentage of manufacturing costs, thus efficiency and conservation is an important hedge against rising operating costs. However, despite the importance of energy, efficiency projects often take a long time to be completed or never make it out of the initial investigation stage.

When asked, “How would you rank your company’s ability to undertake energy efficiency practices or investments, from 1 to 5 (where 1 = your company has taken all or nearly all cost-effective actions to reduce energy costs, or invests heavily in energy efficiency)” all responded with either a “2” or a “3.” One respondent said energy consumption was important but not over

equipment functionality. Another said that they had undertaken a number of efficiency projects, mostly lighting and variable speed drives for compressors. Another said that they had completed all the major projects for electricity but they could do more to save natural gas. He went on to say that they would not be able to make changes to specifications to reduce gas usage until the project line changed, thereby allowing for a fresh redesign. Our respondents reported that lighting and compressor upgrades were the primary efficiency improvements to be undertaken in the next five to ten years. All said that they were looking at solar energy systems to generate power for their operations.

The tolerable payback periods for efficiency investments ranged from 2 years (two respondents) to 3–4 years (1 respondent) and one unsure. All respondents stated that efficiency projects are financed out of capital budgets. A number stated that it was a significant challenge to get approval from corporate headquarters. The length of payback period was the only major barrier to efficiency projects identified by our respondents.

5.3 Decision-making Process

Our respondents had both bottom-up and top-down processes for energy efficiency research and project implementation. Some researched utility incentives from the plant level and made proposals to upper management for efficiency projects. One respondent stated that they let their contractors bring rebate opportunities to their attention. Another respondent took action only after receiving mandates from the corporate office. All respondents stated that rebates were the key component for getting approval for efficiency projects. The rebates can reduce the payback period enough to make the sales pitch to upper management successful.

Our respondents learned about incentives through their account representatives, contractors, and internet research. Most said that they primarily get their information from the contractors. One respondent complained that PG&E's website was not easy to navigate and thus made it hard for him to understand what rebates he would be eligible for. Another respondent complained that PG&E did not do a good job of keeping them informed about rebate opportunities. One respondent said that a regular newsletter with technical and rebate information would be helpful to keep them informed and sell projects to management.

Responses to a question asking how often the customer spoke with a utility representative ranged from often, once a month or more, to rarely, only a few times a year. One respondent said that their PG&E representative recently came to his plant with a representative from an energy efficiency firm to survey for energy efficiency projects.

The major factors for deciding whether to participate in a utility-sponsored program included technology maturity, payback period, and rebate availability. Customers need to be sure that a technology will save the energy as advertised. One respondent said that they are less interested in demand response programs due to difficulties in plant shut down.

All of our respondents stated that they believed their utility program did a good job addressing their energy concerns and all had participated in rebate programs in the past. The primary projects they took advantage of were for upgrades to compressors, dryers, lighting, demand response, and peak pricing.

We were told that the rebate and audit programs were the most valuable programs offered by the utility. One respondent was positive about a utility lead audit that analyzed air compressor leaks, motor efficiencies, production run, and manufacturing processes. He also identified lighting rebate programs as being valuable.

One respondent said they would definitely participate in future efficiency programs. He said that his company would have eventually done their lighting project, however the incentive helped them get it done sooner. He identified carbon footprint as an important driver for efficiency from the corporate level.

6. Next Steps and Recommendations

This investigation has revealed that paper industry customers are willing to consider new approaches, including a comprehensive approach to addressing their energy needs, beyond simply retrofitting equipment. Some suggested elements of that approach are presented below, and additional research focused on the feasibility of each of these recommendations would be prudent. Two key components of a successful effort are the participation of regulatory staff in the development of the options and CPUC recognition of the utilities' role in changes to a customer's policies and procedures regarding energy.

Our research suggests a number of opportunities for both program implementation and program evaluation.

6.1 Implementation

- **Develop an industry specific contact channel**. This could be a monthly electronic newsletter or email. Use these low-cost channels to promote utility programs and make energy efficiency “top-of-mind.” Continuous, relevant information that can illustrate the possibilities for energy efficiency is another way to remind customers of energy and money savings that accrue through the adoption of energy savings technologies and practices.
- **Target trade associations,** such as the ones listed in section 3.6 of this report, including the Institute of Paper Science and Technology at Georgia Tech University. Partnerships with trade associations can assist with communications about industry specific programs, and provide a neutral forum for sharing energy efficiency successes.
- **Identify planned upgrades and document associated efficiency opportunities.** Companies will continue to invest in plants where long-term markets are perceived. Major upgrades may be infrequent, possibly only every 10 years. As utilities are aware of the customers long term plans, they can encourage the addition of energy efficiency. Early and complete documentation of the utility’s involvement will assist in appropriate net to gross evaluations for energy efficiency projects.
- **Provide industry specific audits and recommendations.** This would include “best practices” and equipment that is not only energy efficient, but also conforms to the specific need of its industrial use. A focus on optimizing the papermaking machines, corrugated cardboard, boilers and drying operations is appropriate for this segment. The utilities have to assertively work with this segment to understand their maintenance and

upgrade needs over the next 10 years. These are the best times to upgrade to efficient equipment.

- **Encourage low-cost improvements.** Consider expanding custom rebates to include process changes as well as non-prescriptive equipment. Programs that focus on low- and no-cost items, such as improving reliability through a predictive maintenance program, also can engage customers with limited financial options.
- **Target corporate engineers and sustainability managers** even if they are outside the state. This could be done cost-effectively through electronic delivery of information.

6.2 Evaluation

- **Design innovative pilots to address a range of needs.** The paper segment as it exists in California primarily involves converted paper manufacturing. Given the current economic situation, highly sophisticated offerings such as Superior Energy Performance, will have few takers. However, this industry may be receptive to shorter term programs such as audits and resident energy managers. Some of the vertically integrated companies may have sustainability or energy efficiency goals that would drive participation in utility programs.
- **Engage the Uninterested in Measurement.** One of the biggest challenges in the industrial sector is getting participation. One opportunity for engaging the less interested customers is to focus on the measurement of their utility use, and assist them in breaking down their bill to specific operations. This can then highlight energy efficiency opportunities.

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A. Interview Guide

Section 1: Introduction

Hello. My name is [Interviewer Name] calling from KEMA Inc., an energy consulting firm. Your utility [Pacific Gas & Electric or Southern California Edison] has hired KEMA to conduct research to improve their industrial energy efficiency programs in the cement sector. You have been identified as someone knowledgeable at your company about energy efficiency decisions and participation in utility energy efficiency programs. Is this correct? [If no, ask for a colleague referral. If yes, start the interview questions below.]

First, I'd like to ask you about what drives decision-making in energy efficiency first, then ask about your thoughts on your utility's energy efficiency programs. Your responses are confidential. This interview will take approximately 30 minutes.

Section 2: What Drives Energy Efficiency Decision-Making?

1. What does energy efficiency mean at your company?
2. On a scale of one to ten, with 1 being the highest and 5 being the lowest, How would you describe your company's commitment to implementing energy efficiency practices or investments? (where 1 = invests heavily in energy efficiency or your company has taken all or nearly all cost-effective actions to reduce energy costs, 5 = only replace equipment on burnout)
3. Where does energy rank in terms of your business operation decisions?
   (Not a priority * low priority * medium priority * high priority * very high priority)
   a. What factors drive that ranking? i.e., need energy reliability for production/will pay any costs; energy costs in top 10 operating costs/huge impact on variable costs; or both?
4. What are the primary energy efficiency improvements that your company plans to make over the next…
   a. 2-5 years?
   b. 5-10 years?
5. How short of a payback does your company require to invest in energy efficiency measures?
6. How does your company typically pay for energy efficiency investments?
   a. What are the challenges involved with access to capital?
   b. How can the utility help with those barriers?

7. What other barriers are there to investment in energy efficiency in this industry?

Section 3: Utility Programs Communications

1. Please describe the typical process at your organization, from how you hear about energy efficiency programs offered by your utility to the final decision to participate or not.
    a. Who is involved?
    b. Who needs to participate in the decision-making process?
2. Are you familiar with the energy efficiency programs offered by your utility?
    a. How do you hear about utility sponsored programs? e.g. vendors, utility rep, colleagues, other?
3. Do you feel you have enough knowledge about the energy efficiency programs your utility offers? If no,
    a. Why not?
    b. How do you gather information to make an informed decision?
4. How often do you speak or meet with your utility representative?
    a. Would you prefer to meet: *more/less or the same?*
    b. How would you prefer to meet? *1-on-1, group, seminar?*

Section 4: Utility Programs Experience

1. What are the major factors your company considers when deciding whether to participate in a utility-sponsored program?
2. 2. What type of utility sponsored program(s) are you most likely to participate? Least likely? Has this shifted over time? If so, why?
3. Does your utility offer energy efficiency and/or energy management programs that address your important energy concerns?
    a. If not, what is missing?
4. Has your company participated in any utility sponsored energy efficiency program recently (e.g. past 2-3 years)?

If NO,

a. What factors have contributed the most to your decision not to participate in an energy efficiency program?
b. What would encourage you to participate? i.e. different type of program offerings; better/more communication about program opportunities; business need; other?

If YES,

a. What is the most effective and beneficial energy efficiency program you have participated in? Please explain what you found beneficial.
b. What led to your company's decision to participate i.e., how did you learn about the program, who at your company spearheaded the decision to participate?
c. Did participating meet your expectations?
    i. If yes, how?
    ii. If not, why not?
d. Would you participate in this program again? Why or why not?

Would you mind if I contacted you again as needed?

Thank you for your participation.