Industrial Sectors Market Characterization

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

Oakland, California, February 2012

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Acronyms and Abbreviations

AB 32	Assembly Bill 32 the Global Warming Solutions Act
ACEEE	American Council for an Energy Efficiency Economy
AMO	Advanced Manufacturing Office
ANSI	American National Standards Institute
ARB	California Air Resources Board
ARRA	American Recovery and Reinvestment Act of 2009
Btu	British thermal unit
CAA	Clean Air Act
CEI	continual energy improvement
CNC	computed numerically controlled
CO_2	carbon dioxide
CO_2e	carbon-dioxide equivalent
CWA	Clean Water Act
EEPS	Energy Efficiency Portfolio Standards
ESA	Endangered Species Act
GHG	greenhouse gas
GWh	gigawatt-hour(s)
IAC	Industrial Assessment Center
kWh	kilowatt-hour
LBNL	Lawrence Berkeley National Laboratory
MBtu	million British thermal unit
MW	megawatt
NAICS	North American Industry Classification System
O&M	operations and maintenance
PG&E	Pacific Gas and Electric Company
RCRA	Resource Conservation and Recovery Act

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RPS	renewable portfolio standard
S&P	Standard & Poor's
SCE	Southern California Edison Company
SEP	Superior Energy Performance
TBtu	trillion British thermal unit
tpy	tons per year
TXI	Texas Industries Inc.
U.S.	United States
U.S. DOE	U.S. Department of Energy
U.S. EPA	U.S. Environmental Protection Agency
VSD	variable speed drive

Summary of Key Research Findings

Industry Description

Metalworking is an expansive, diverse industry that produces a broad array of products, both commodity and specialty. With around $500 billion in annual sales, it encompasses a diverse set of manufacturers that develop products in iron, steel, aluminum, copper, and assorted other non-ferrous metals. While each of the 75 subsectors within metalworking is unique, businesses can be categorized broadly into one of two categories:

- Basic metal producers. These manufacturers take raw materials, either ore or scrap, and produce bulk-metal products (e.g., hot rolled steel) for further industrial use. This category includes manufacturers producing basic rolled, drawn, bar, plate, rod, sheet, strip, wire, or form pipe and tube shapes from iron and steel they have produced themselves. Aluminum smelters fall in this category as well.
- Applied metal producers .These manufacturers and service providers take basic metal products as inputs and manufacture metal products for specific industrial, commercial, or residential purposes. This category includes foundries, various non-ferrous primary metal producers, secondary metal manufacturers making structural and nonstructural metal products like metal cans, and companies machining or treating metal in different ways.

Business Models and Cost Structure

The metalworking industry is split into a consolidated commodity-producing, energy-intensive group with high volumes and low margins and a diffuse, diverse group of companies serving specialty niche markets with value-added products. Basic metal producers produce commodity products that compete on global markets. Production is capital-intensive and has a large manufacturing footprint that entails substantial energy and raw material costs, ultimately favoring the largest players. Major corporations have consolidated the market, and the United States (U.S.) is dominated by a handful of industry leaders like U.S. Steel, Nucor, and Alcoa. Because of stringent regulations and geographic distance from major automotive manufacturers, few basic metal producers manufacture in California. USS-Posco industries, a joint venture between U.S. Steel and a major Korean conglomerate, is an exception located in California.

For the large basic metal producers, margins are small, sunken capital considerable, competition from large foreign competition is growing, and demand is highly cyclical. Construction, automotive and transportation, containers, and downstream industrial metal producers make up 75–80 percent of demand for basic metal products. During the recent recession, the construction and automotive sectors were particularly hard hit, giving basic metal producers a substantial drop in revenue. Many issued stock, cut dividends, did major layoffs, or closed plants to stay afloat.

Applied metal production encompasses many companies which tend to be smaller and focused on narrow or specialized market segments. There is considerable diversity across businesses, many subsectors have low barriers to entry, and the competitive landscape is characterized by heavy fragmentation (i.e., little dominance when it comes to market share). Nearly all of these firms produce specialized products and many serve regional markets rather than national or global ones. Costs center on labor and raw materials, which are typically basic metal products. Success generally depends on knowing customers well and producing quality workmanship at faster rates and lower costs. One exception is metal container manufacturers like Ball Corporation and Silgan Containers, which can grow to be substantial in size. They compete fiercely with substitutes from the glass and plastic industries and must keep costs down. The economic downturn affected applied metal producers in varying ways. For instance, metal container manufacturers fared relatively well since food and beverage consumption is not highly cyclical, but specialty auto parts manufacturers suffered.

Technology and Energy Consumption

Technology can be a differentiator in the metalworking industry, allowing commodity metal manufacturers a cost advantage and specialty metal producers a precision and quality advantage. But the costs are high and some stay competitive without it. Energy efficiency itself is rarely the primary driver, even with the largest energy consumers. Basic metal producers and foundries use large amounts of energy (~1700 trillion British thermal units [Btu] annually) because the process often involves melting and casting. Depending on the metal and production process, energy may be in the form of electricity, coal, or natural gas. However, technological and process changes have transformed the industry, lowering costs and energy use. Electric arc furnace technology allows steel makers to build smaller, efficient, and flexible *mini-mills,* which rely on recycled scrap rather than raw ore for input. This has allowed Nucor in particular to excel because it uses mini-mills exclusively, with commensurate savings in energy, materials, and labor costs. Aluminum is not conducive to electric arc furnace melting, however nearly 60 percent of aluminum production now relies on recycled scrap, which uses 95 percent less energy overall than relying on virgin bauxite. Across all metals, continuous casting technology has lowered energy consumption considerably by reducing the number of steps in the casting process.

Fabricating cold metal inputs into applied metal products can be done with smaller operations and requires much less energy than basic metal production, almost always in the form of electricity. When these cold fabrication operations get to be large enough, like the metal can plants in the Bay Area and Central Valley, they can be significant energy consumers but still only consume a fraction of the energy of major foundry or basic metal plant. Nevertheless, applied metal production accounts for only about one-quarter (~550 trillion Btu annually) of metalworking energy consumption nationwide, despite accounting for over one-half of revenue.

Market Barriers and Opportunities for Energy Efficiency

Market barriers in the metalworking sector are typical for a fragmented industry serving a wide range of customers. While some producers are pursuing proprietary designs, most firms are risk averse when it comes to changing proven equipment or processes. Most respondents acknowledged that new, unproven technologies face a strong barrier to adoption in this industry. This attitude does create barriers but it also provides opportunities for utility programs.

There have been significant energy efficiency gains among the largest metal producers driven by the cost reduction pressures of commodity markets, making innovation valuable. However, there is a substantial but diffuse group of small metalworking firms with efficiency potential which may be an aggregated opportunity. Across the market, minimizing downtime is essential and access to capital difficult for many of the smaller firms. New climate regulatory obligations under California Assembly Bill 32 (AB 32) will impact only the largest manufacturers. Any added costs may make commodity products uncompetitive if the regulations are not uniform worldwide.

Moving forward, many individual basic metal producers are developing proprietary designs for their processes and technology that save energy, including infrared heating, microwave melting, solar furnaces, molten oxide electrolysis, new cathode technology. These efforts promise dramatic energy savings of 25–50 percent. More conventionally, there is still room for energy savings from increasing scrap usage; improving melting efficiency via preheating, stacking melters, optimizing scheduling and batch size; and cold casting. Substantial energy reduction for applied metal production requires programs targeting marginal energy efficiency gains at many places. Automation and control, information technology, and achieving best practices for manufacturing are likely to be the most effective ways to achieve energy reductions.

Conducting demonstration projects or using measurement techniques that can show where savings are possible have the best potential to encourage firms to replace existing equipment. This is also one way to introduce (or reintroduce) energy saving technologies to this sector.

Overall Findings

Although multiple potential strategies exist for energy efficiency programs in the metalworking sector, California has few basic metal producers, even though they are the largest individual targets. In general, cost pressures and technology have led the largest metal manufacturers to major efficiency gains over the last 20 years. In reducing energy use, major consumers must employ innovation or seek the modest gains associated with marginal efficiency improvements. Individually, there are ready opportunities with applied metal producers, but programs must be designed to address the entire operation of this diffuse market to capture quantitative gains.

The primary research found that the knowledge of utility programs was generally lacking. Enhancing communications with this sector is recommended, via trade associations, newsletters, and marketing. Partnerships with trade associations can assist with communications about industry specific programs, and provide a neutral forum for sharing energy efficiency successes. Respondents expressed the desire to stay informed on the latest practices and technologies but did not have the time or knowledge to devote to finding, interpreting and applying it.

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

- *Provide industry-specific audits and best practices*. Custom efficiency programs work well with metal working firms due to their varied production processes. 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.
- *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 for this largely fragmented industry.
- *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 and Summary

The industrial sector consumes over 30 percent of the nation's energy,[1] presenting enormous opportunities for energy efficiency.[2] 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 Company (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)
- Utility-specific appendices containing proprietary data and customer information (Appendices).

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

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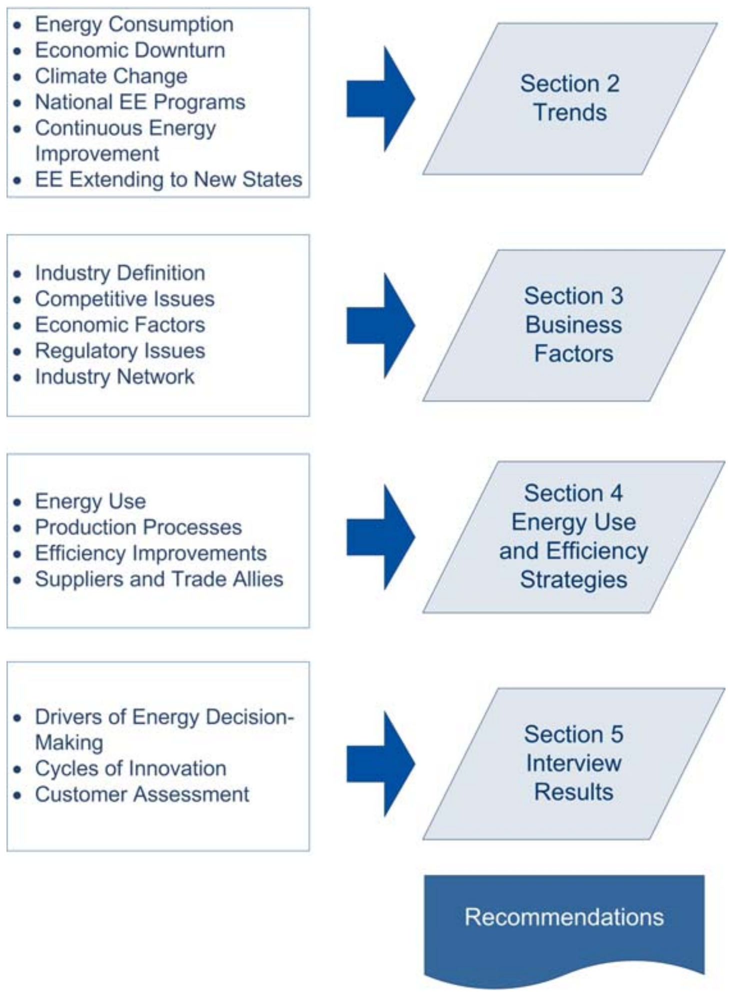
[1] Quinn, Jim. 2009. *Introduction to the Industrial Technologies Program*. Save Energy Now Series Webinar. January 15.
http://www1.eere.energy.gov/industry/pdfs/webcast_2009-0115_introtoitp.PDF

[2] 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 provides a graphic overview of the report.

Figure 1: Graphic Overview of the 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,[3] 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 United States has increased dramatically. Energy efficiency potential savings have been estimated at 20 percent or more by 2020, both nationally[4] and in California.[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 continual energy improvement; and energy efficiency adoption outside California and national energy efficiency programs. 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]

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

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

[5] KEMA. 2008. *Strategic Industrial Report for PG&E.*

[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

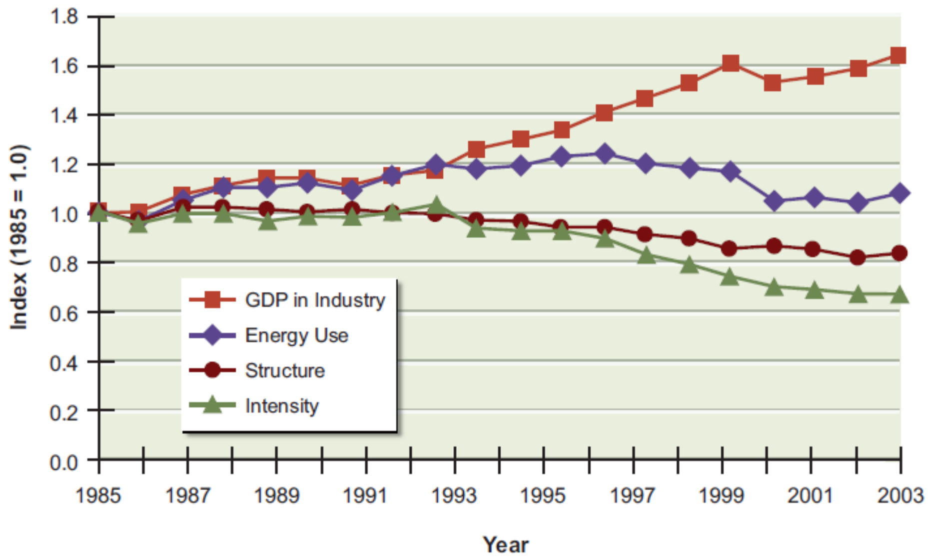
Source: Energy Information Administration[7]

Figure 2 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. California's total energy use has continued the trend of relatively flat to gradually reducing energy consumption, similar to the national trend.[8]

[7] U.S. Department of Energy. 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

[8] 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

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



Source: National Academy of Sciences[9]

2.2 Economic Downturn Effect on Industrial Production

Most U.S. industries experienced a sharp drop in production as demand for manufactured goods declined, starting in the last quarter of 2008.

A method of observing the economic downturn's effect in California is to consider trends in carbon emissions. Although multiple factors affect emissions, including energy efficiency and carbon reduction, dramatic short-term changes do indicate likely reductions in production. According to analysis by research firm Thomson Reuters Point Carbon, an overall reduction of carbon emissions of 11 percent from 2008 to 2010 was observed among the 343 California facilities that must comply with California's cap-and-trade program. Table 2 displays the carbon dioxide (CO_2) emission changes by industrial sector. Facility closures was the major driver for cement, glass, pulp and paper industries' decline while chemicals sector emissions increased largely from a new hydrogen plant in SCE's territory.

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

Table 2: Percent Change in CO_2 Emissions among Largest Calif. Industrial Sectors, 2008–2010

CO2 Emissions 2008 vs. 2010	California Industrial Sector	Notes
+21%	Chemicals	Driven by new $80MM hydrogen facility in SCE territory
+5%	Metals	Increase in production
-34%	Cement, lime and glass	Driven by facility closures
-35%	Pulp, paper and wood	Driven by facility closures

Source: Thomson Reuters Point Carbon[10]

The economic recession is forcing businesses and governments to take a close look at initiatives that save money and do not require capital investments, such as the best practices developed by the U.S. Department of Energy's (DOE) Advanced Manufacturing Office and through increased energy management systems, as discussed in the following sections.

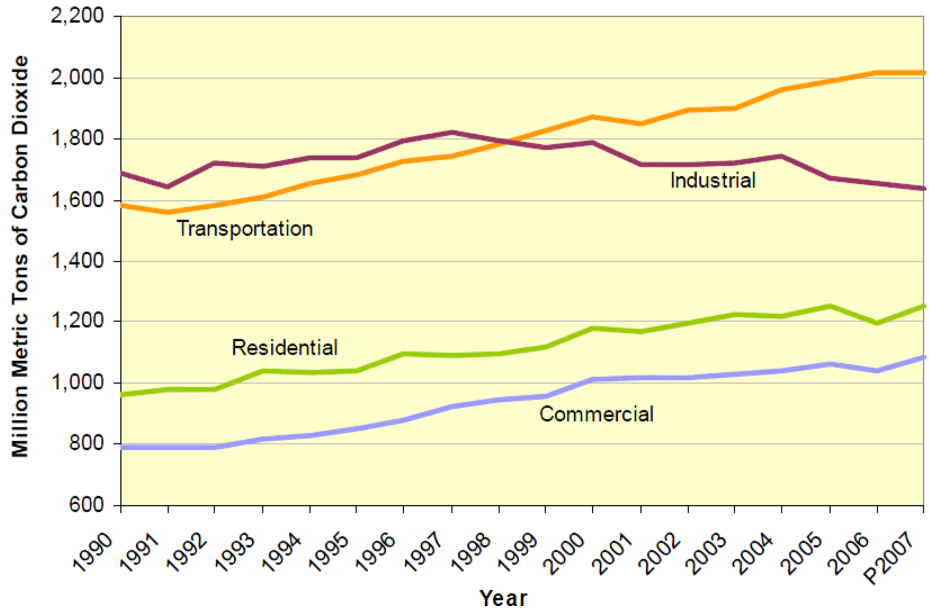
2.3 Climate Change and Energy Legislation

Industry's energy-related CO_2 emissions have decreased in the last decade, while rising more dramatically in other sectors, as shown in Figure 3. This reduction is largely attributable to U.S. industry's net decrease in energy consumption, according to the American Council for an Energy Efficient Economy[11](ACEEE) that resulted from a decrease in manufacturing activity as well as energy efficiency gains. Still, industry accounts for approximately 27.4 percent of total energy-related CO_2 emissions in the United States.

[10] Thomson Reuters Point Carbon. 2011. *California Emissions in 2010 Down by 11%.* August http://www.pointcarbon.com/aboutus/pressroom/1.1564622

[11] Chittum, A., R. Elliott, and N. Kaufman. 2009. *Trends in Industrial Energy Efficiency Programs: Today's Leaders and Directions for the Future*. American Council for an Energy Efficient Economy, Report IE091. September 2009.

Figure 3: U.S: Energy-Related CO_2 Emissions by End-Use Sector, 1990–2007



Source: ACEEE[12]

Greater energy efficiency will almost certainly be an important component in comprehensive national—and global—strategies for managing energy resources and climate change in the future. Energy efficiency is generally acknowledged to be the lowest cost and fastest-to-deploy resource to slow the growth of carbon dioxide emissions, and it also results in positive economic impacts. Congress is not expected to approve any policy mechanisms to reduce CO_2 emissions in the short-term although legislation encouraging greater energy efficiency in the U.S. manufacturing sector is possible.

2.4 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.

[12] Chittum, A., R. Elliott, and N. Kaufman. 2009. *Trends in Industrial Energy Efficiency Programs: Today's Leaders and Directions for the Future*. American Council for an Energy Efficient Economy, Report IE091. September 2009.

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.[13] Four metal industry facilities received energy assessments for large facilities:

- Carlton Forge Works, Paramount
- TAMCO Steel, Rancho Cucamonga
- Ball Corporation, Torrance
- Rexam Beverage Can, Chatsworth

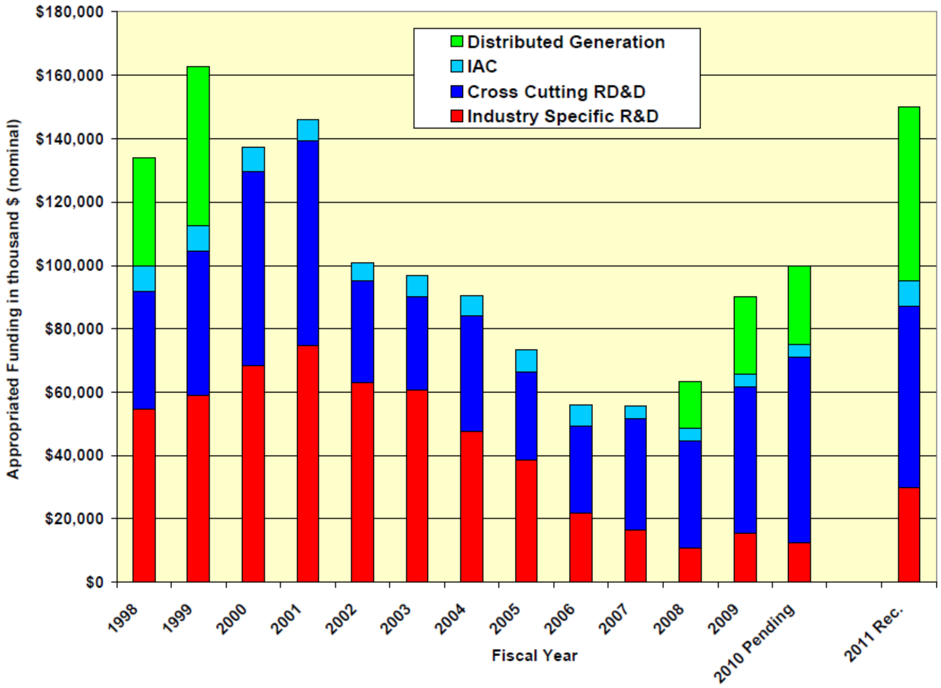
The U.S. DOE's AMO has been the primary federal entity supporting manufacturing research and development (R&D) in partnership with industrial stakeholders. The AMO R&D program has been recognized as one of the most successful federal R&D efforts operating today. However, in recent years support for the 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."[14] 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.

[13] 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

[14] Savitz, et al.2009. *DOE Industrial Technologies Program 2008 Peer Review*. http://www1.eere.energy.gov/industry/about/pdfs/itp_peerreview_report2008.PDF

Figure 4: Industrial Technologies Program Funding, 1998–2010



Source: ACEEE[15]

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, 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.

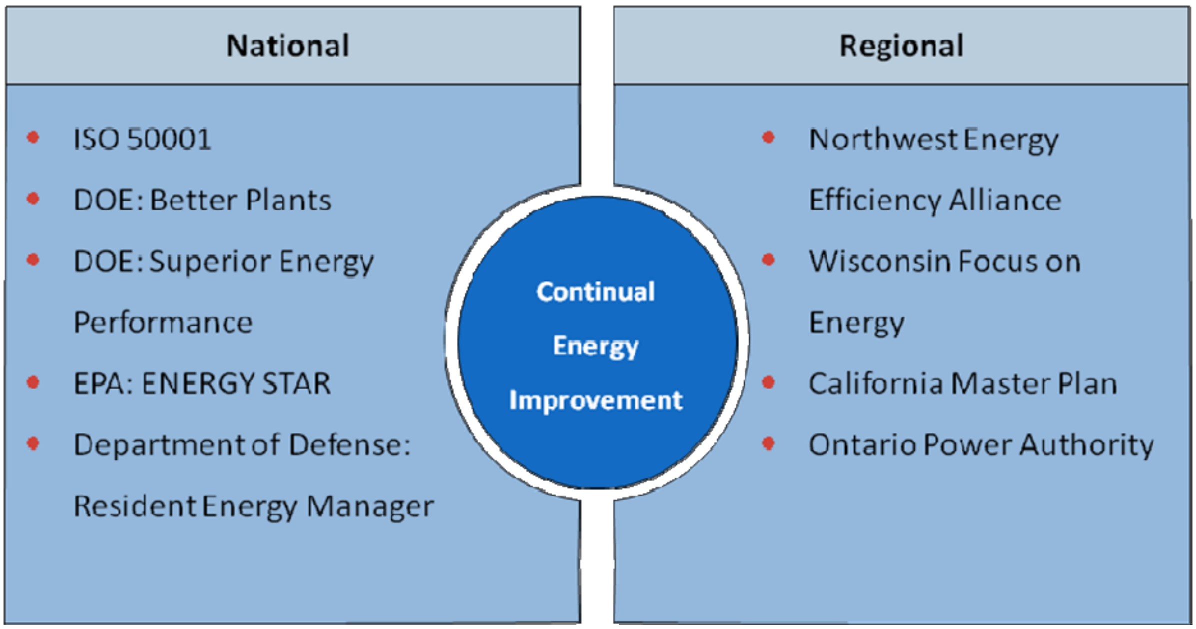
2.5 Rise of Continual Energy Improvement

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 continual

[15] 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.

energy improvement (CEI) in industry. National programs in the United States have been developed by the DOE (Save Energy Now and Superior Energy Performance) and EPA (ENERGY STAR). Figure 5 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 5: 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.[16]

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.

[16] 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 U.S. DOE 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. Several plants will participate in the California pilot scheduled to begin in 2012. 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.[17]

Regional CEI programs have been developed under the Northwest Energy Efficiency Alliance,[18] working with the Bonneville Power Administration and the Energy Trust of Oregon. Puget Sound Energy has a Resource Conservation Program that focuses on continual improvement, particularly behavioral changes.[19] California has identified CEI as an important aspect of its strategic plan[20]. PG&E is developing a pilot CEI program; upcoming evaluations will inform the future development of CEI in California. Similarly, Wisconsin's Focus on Energy employs an internally developed tool called Practical Energy Management©.[21] CEI is still in its infancy, with few CEI programs beyond the pilot stage.

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

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

[19] Puget Sound Energy, Business Energy Management, Resource Conservation Program. http://www.pse.com/savingsandenergycenter/ForBusinesses/Documents/3462_RCM.pdf

[20] California Energy Commission 2011. *Long Term Energy Efficiency Strategic Plan, Jan 2011 update*. http://www.cpuc.ca.gov/NR/rdonlyres/A54B59C2-D571-440D-9477-3363726F573A/0/CAEnergyEfficiencyStrategicPlan_Jan2011.pdf

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

2.6 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 6. 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.

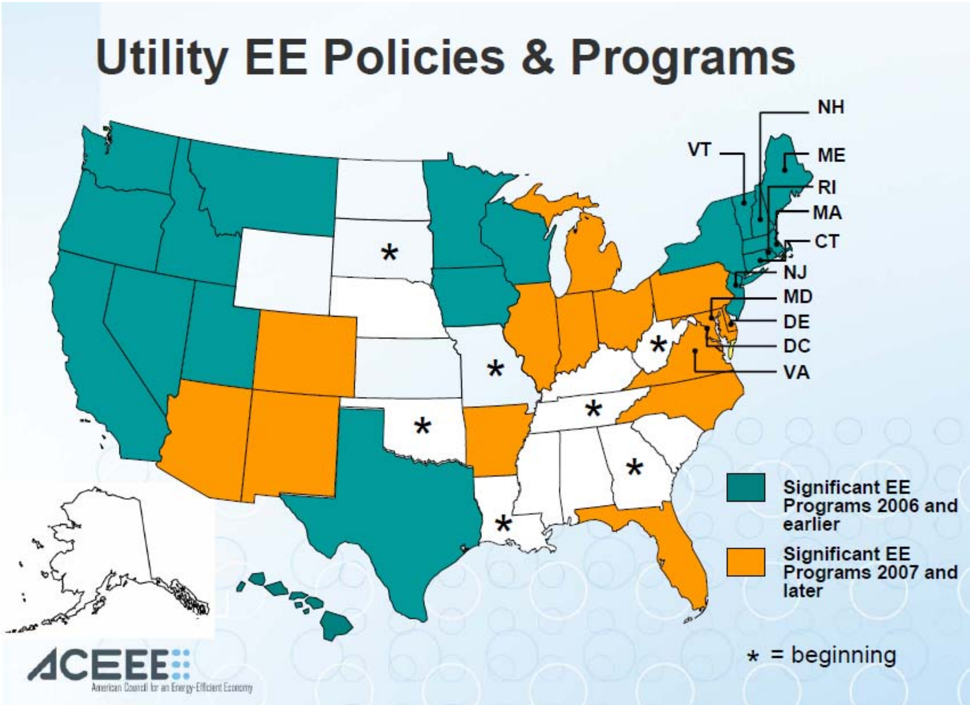
These states have signaled their commitment to energy efficiency by adopting aggressive Energy Efficiency Portfolio Standards[22] (EEPS) policies[23] that exceed those in California. As shown in Table 3, California ranks number 14 for cumulative electricity savings targets by 2020, below states primarily in the Northeast and Midwest.

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.

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

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

Figure 6: Utility Energy Efficiency Policies and Programs, 2006 vs. 2007+



Source: ACEEE[24]

[24] 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

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.

Table 3: 2020 Cumulative Electricity Savings Targets, by State[25]

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[26]

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

[26] 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

Metalworking is a broad term that is applied to a diverse set of industrial sectors which develop products in iron, steel, aluminum, copper, and assorted other non-ferrous metals. Due to the characteristic strength and longevity of metals, as well as the ability to mold metals into highly customized forms, metalworking industries generally produce durable goods. The North American Industry Classification System (NAICS) groups metalworking into primary metal manufacturing (NAICS three-digit code of 331) and fabricated metal product manufacturing (NAICS three-digit code of 332). Primary metal manufacturers smelt and/or refine scrap, ore, or pig (an intermediate metal product made from smelting ore with coke fuel). Fabricated metal product manufacturers transform metal into finished products, with the exception of machinery, furniture, and electronics, all of which are classified in other categories. Businesses which forge, stamp, cast, form, bend, machine, weld, or assemble metal into products are all classified as fabricated metal product manufacturers. The most recently published U.S. Census Bureau Annual Survey of Manufacturers, using 2006 data, shows that U.S. primary metal manufacturers had total sales of $234 billion, with a value add of $84 billion and that U.S. fabricated metal product manufacturers had total sales of $317 billion with a value add of $169 billion.[27]

Primary metal manufacturers and fabricated metal product manufacturers are inextricably linked and the NAICS does not necessarily capture business and operational distinctions that exist across the industry. To help distinguish important differences between manufacturers in the industry, this report does not categorize companies strictly based on their NAICS classification as either a primary metal manufacturer or a fabricated metal product manufacturer. Instead, this report breaks metalworking into two categories:

- Basic metal producers. These manufacturers take raw materials, either ore or scrap, and produce bulk metal products (e.g., hot-rolled steel) for further industrial use. This category includes manufacturers producing basic rolled, drawn, bar, plate, rod, sheet, strip, wire, or form pipe and tube shapes from iron and steel they have produced themselves. Aluminum smelters fall in this category as well.

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[27] U.S. Energy Information Administration. 2009. *2006 Energy Consumption by Manufacturers*. June 2009. http://www.eia.gov/emeu/mecs/mecs2006/2006tables.html

Occasionally, it is useful to further sub-divide this category into commodity basic metal producers, which manufacture products priced in global commodity markets, and value-added basic metal producers, which manufacture basic metal products with specialized properties not available in commodity products.

- Applied metal producers. These manufacturers and service providers take basic metal products as inputs and manufacture metal products for specific industrial, commercial, or residential purposes. This category includes foundries producing metal castings, various nonferrous primary metal producers, secondary metal manufacturers making structural and nonstructural metal products like metal cans, and companies machining or treating metal in different ways.

In general, basic metal producers fall under the NAICS category of primary metal manufacturing and applied metal producers fall under the NAICS category of fabricated metal product manufacturing, but not always. Foundries are a notable exception. A number of large manufacturers in California in particular are better described by the Basic/Applied categories than their NAICS descriptors.

Within the metalworking industry, there are over 70 subsectors encompassing both basic and applied metal producers. In California, there are at least a few businesses classified into every sub-sector, while the largest subsectors by number have thousands of businesses. This report will emphasize the top 20 subsectors based on energy consumption data from two of the three major investor-owned utilities in the state but will also illustrate trends universally affecting the entire range of metalworking business. The top 20 sectors themselves provide a cross section of the industry. Table 4 lists the top California subsectors by six-digit NAICS code.

Table 4: Top Metalworking Subsectors in California, Based on Energy consumption

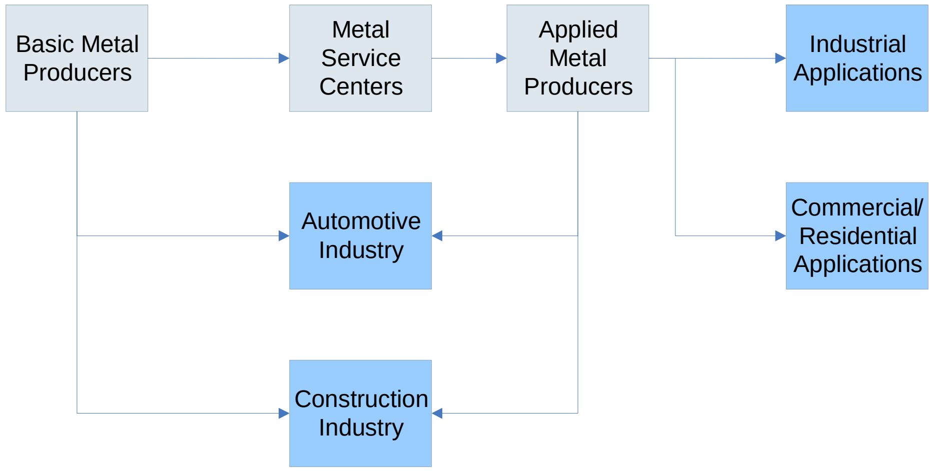
NAICS code	Metalworking Sub-sectors
331111	Iron and Steel Mills
331221	Rolled Steel Shape Manufacturing
331222	Steel Wire Drawing
331316	Aluminum Extruded Product Manufacturing
331492	Secondary Smelting, Refining, and Alloying of Nonferrous Metal (except Copper and Aluminum)
331511	Iron Foundries
331513	Steel Foundries (except Investment)
331524	Aluminum Foundries (except Die-Casting)

NAICS code	Metalworking Sub-sectors
332312	Fabricated Structural Metal Manufacturing
332322	Sheet Metal Work Manufacturing
332431	Metal Can Manufacturing
332510	Hardware Manufacturing
332618	Other Fabricated Wire Product Manufacturing
332710	Machine Shops
332722	Bolt, Nut, Screw, Rivet, and Washer Manufacturing
332811	Metal Heat Treating
332812	Metal Coating, Engraving (except Jewelry and Silverware), and Allied Services to Manufacturers
332813	Electroplating, Plating, Polishing, Anodizing, and Coloring
332912	Fluid Power Valve and Hose Fitting Manufacturing
332913	Plumbing Fixture Fitting and Trim Manufacturing

Source: PG&E and SCE data

Metalworking businesses typically supply other businesses and few entities classified in this industry supply goods or services to consumers. Basic metal producers sell rolled metals or metal pipes and tubes for supply to secondary metal manufacturers, usually via intermediate metals distribution centers, as well as directly to a few select industries including automotive and construction. Generally, basic metal producers are defined by their commodity, (in descending order): iron and steel, aluminum and copper, and non-ferrous except aluminum and copper. Rolled steel shapes and steel wire drawing are subsectors important in Northern California that are a part of basic iron and steel production. Applied metal producers take the output of primary metal manufacturers and create a diverse set of products ranging from steel construction plates to nuts and bolts to highly specialized machined parts, which they sell downstream. Hence, basic and applied metals manufacturers depend on each together, but basic metal manufacturers focus on large consolidated markets (i.e., auto manufacturing), while applied metals producers tend to create products to address specific markets and have various distribution channels. Applied metal producers can be major producers serving large markets like metal can manufacturers and structural construction plate makers, or serve niche markets as machine shops do. Thus, applied metal producers have a stronger customer focus and add more value while primary metal manufacturers nearly always have larger scale with smaller margins and often focus on commodities. The 2008 recession hit the automotive and construction industries hard, sharply reducing overall demand for metalworking products from all subsectors. The closure of the northern California New United Motor Manufacturing Inc automotive plant, for example, had a direct effect on job loss for suppliers. [28].

Figure 7: Basic Schematic of Input/Output Flow in the Metalworking Industry



Source: KEMA, Inc

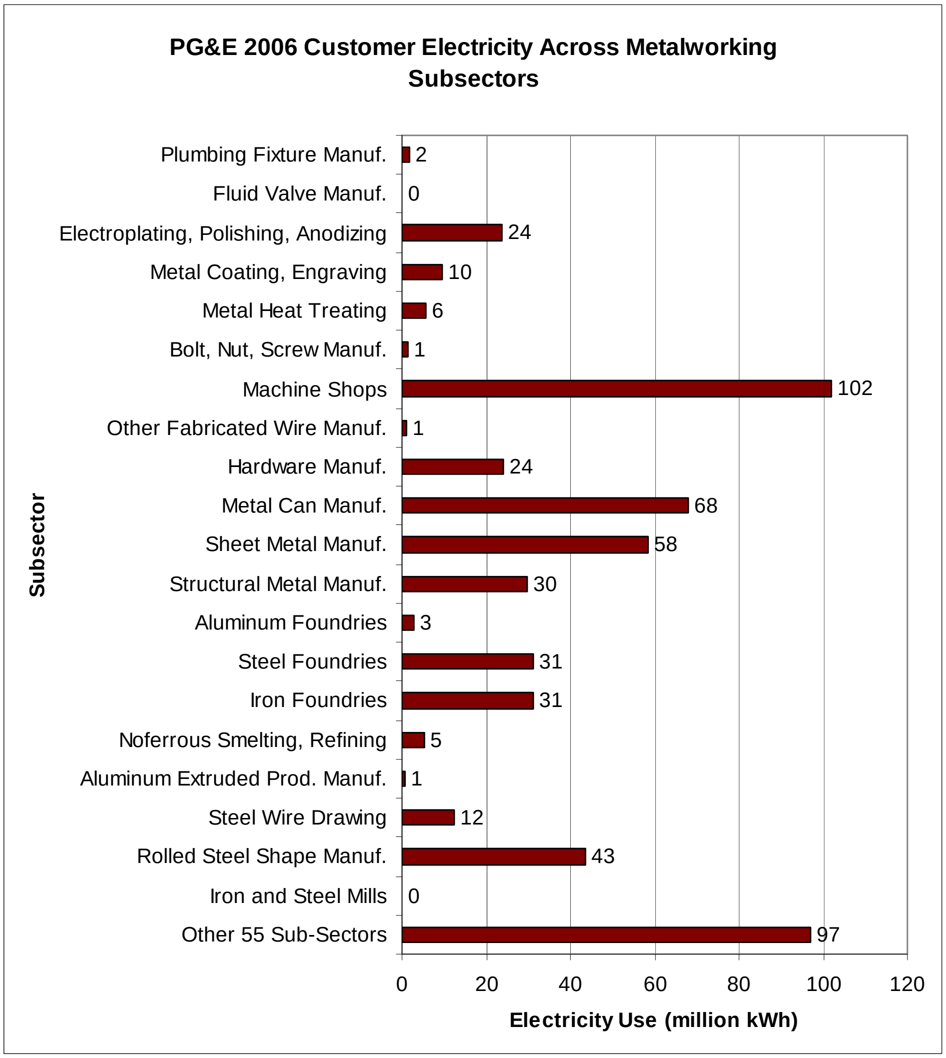
The metalworking subsector electricity use within California is variable across subsectors and per capita energy use per subsector tends to vary greatly. For example, machine shops (applied metal producers) are the leading electricity users, but this sector encompasses nearly 1,200 customers. Similarly the third largest subsector, sheet metal manufacturing (applied metal producers), consists of almost 200 customers. In contrast, the second- and fourth-largest subsectors, metal can manufacturing (applied metal producers) and rolled steel shape manufacturing (basic metal producers), consist of less than 20 customers.

Gas usage is split between sectors that use a relatively high amount of natural gas for metalworking production (rolled steel shape manufacturing, metal can manufacturing, foundries) and those that use little or no natural gas (e.g., fluid valve manufacturing). Unlike electricity use, gas use is concentrated among subsectors with only a few major manufacturers in them. Specifically, rolled steel shape manufacturing, metal-can manufacturing, and foundries combine for around 1 percent of the customers by number, but over two-thirds of the overall gas usage.

[28] Gonzales, Richard. 2010. NPR news. NUMMI Plant Closure Ends Toyota-GM Venture. April 1. http://www.npr.org/templates/story/story.php?storyId=125430405

Figure 8 shows the metalworking subsector electricity use within PG&E's territory. Overall, electricity use across subsectors is variable. However, per capita energy use per subsector tends to vary greatly. For example, machine shops (applied metal producers) are the leading electricity users, but this sector encompasses nearly 1,200 customers. Metal-can manufacturing and rolled steel shape manufacturing encompass less than 20 customers each.

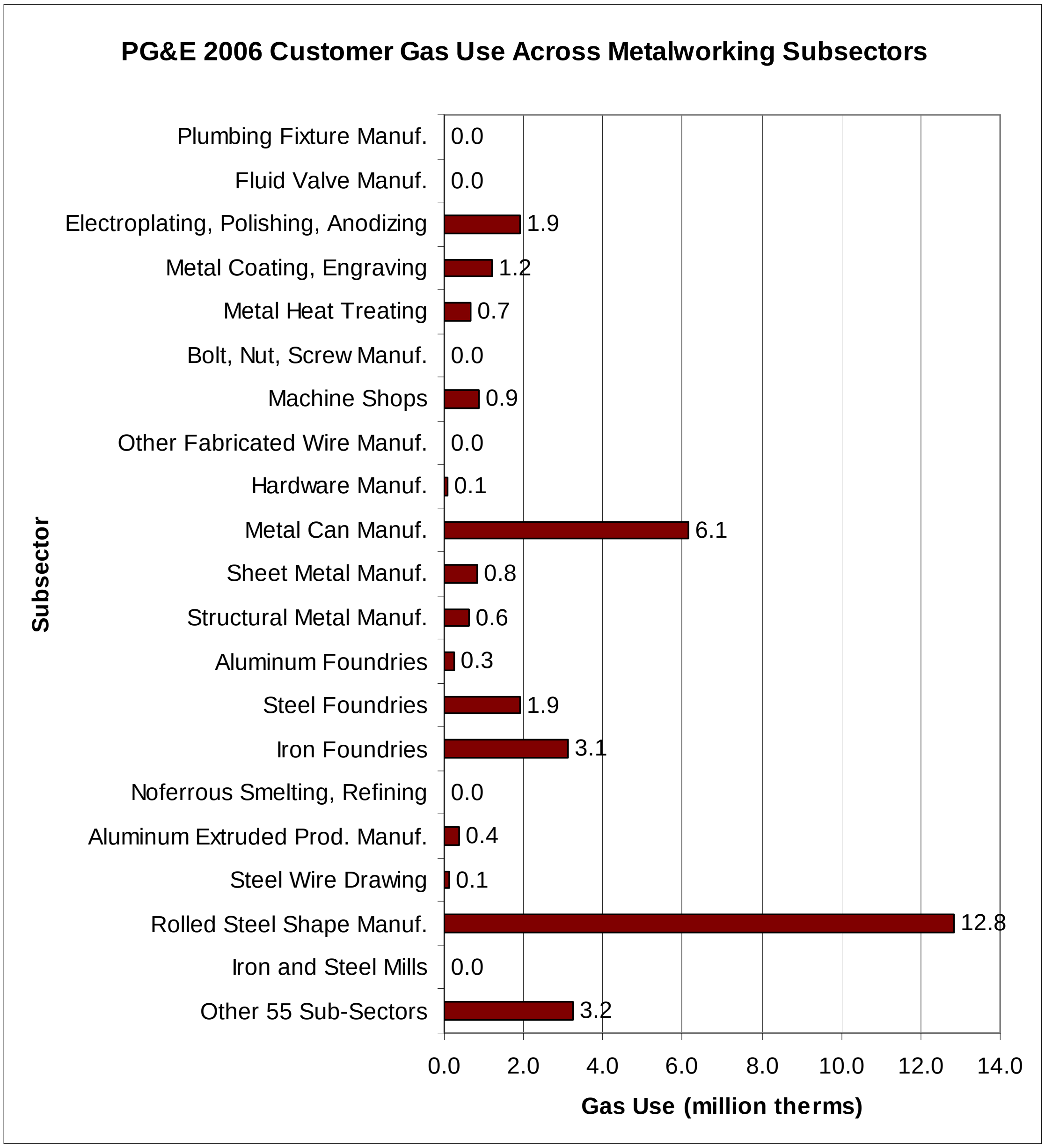
Figure 8: Metalworking Subsector Electricity Purchases from PG&E



Source: KEMA, Inc with PG&E Data

Figure 9 shows metalworking subsector gas use within PG&E's territory. Gas usage is split between sectors that use a relatively high amount of natural gas for metalworking production (rolled steel shape manufacturing, metal-can manufacturing, foundries) and those that use little or no natural gas (e.g., fluid valve manufacturing). Unlike electricity use, gas use is concentrated among subsectors with only a few major manufacturers in them.

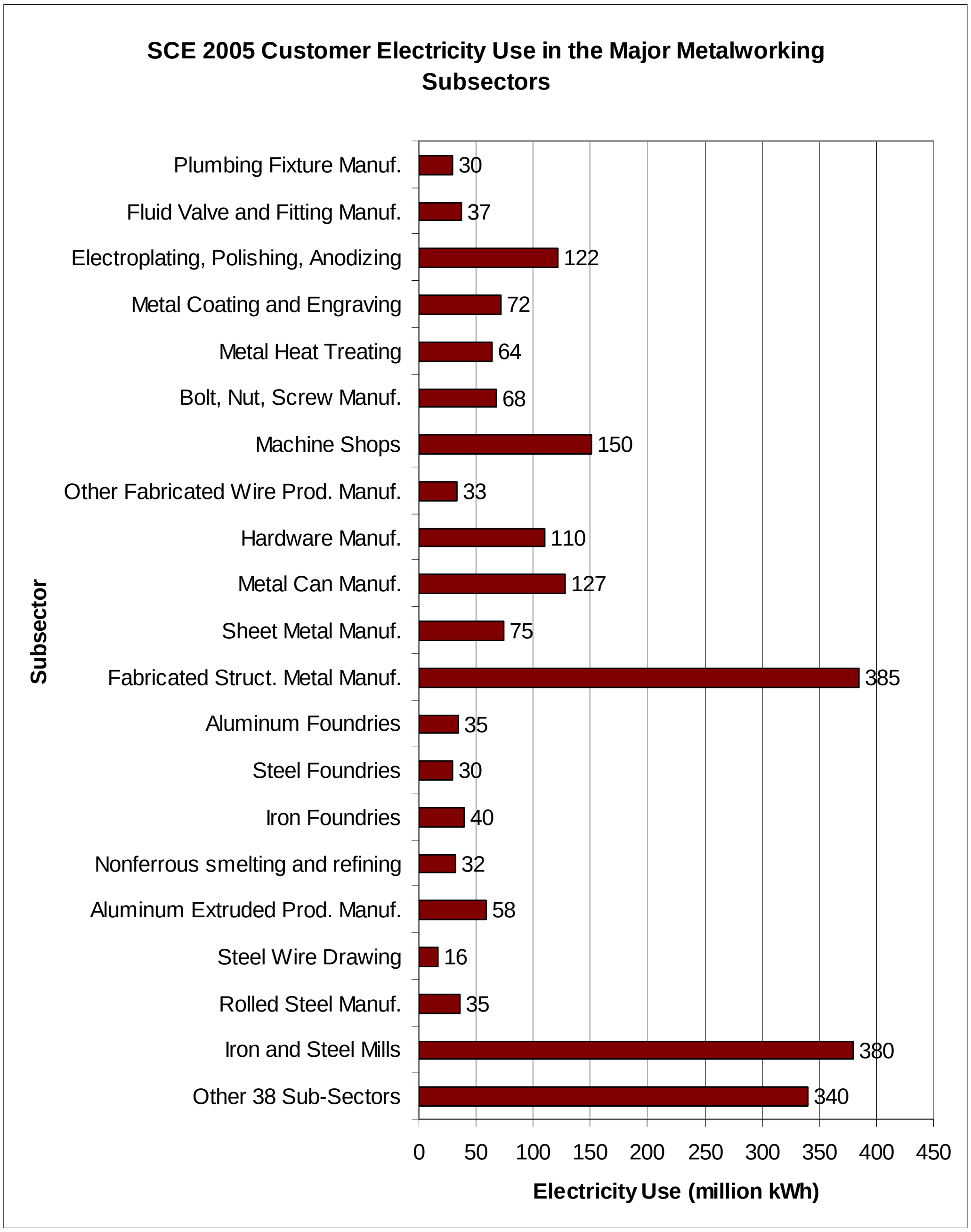
Figure 9: Metalworking Subsector Gas Purchases from PG&E



Source: KEMA, Inc with PG&E Data

Figure 10 shows the metalworking subsector electricity use within SCE's territory. Overall, electricity use across subsectors is comparable except for a few large consumers.

Figure 10: Metalworking Subsector Electricity Purchases from SCE



Source: KEMA, Inc with SCE Data

Per capita energy use per subsector tends to vary greatly. For example, fabricated structural metal manufacturers are the leading electricity users, but this sector encompasses over 100 customers. Iron and steel mills and metal-can manufacturers consist of far fewer customers. At a high level, basic metal producers are more concentrated among a few customers and a few facilities, while applied metal producers are fragmented into many customers and many facilities, with some exceptions. However, total electricity use in SCE's territory is spread between basic and applied metal producers.

At a high level, basic metal producers, with the exception of metal can manufacturers, are more concentrated among a few customers and a few facilities, while applied metal producers are fragmented into many customers and many facilities, with some exceptions. Applied metal producers have much higher total electricity and gas use in PGE's territory, even though there are a few large basic metal producers who individually use large amounts of energy.

Compared with the U.S. breakdown of the metalworking industry, PG&E's service territory is heavily weighted towards applied metal producers and has a specific emphasis on niche markets, high precision/high value machining and finishing, and the construction industry. SCE's territory is spread between basic and applied metal producers. Northern California has a particularly strong grouping of foundries not found in other parts of the state. Most basic metal production is located in the Midwest and Northeast by historical association with the auto industry and traditional U.S. ore mining. California's relatively stringent environmental regulatory heritage has also served as a deterrent to primary metal manufacturers. The basic metal producers in California tend to be smaller operations relative to their Midwestern brethren, and often take recycled scrap as input. Whereas Midwestern or southern California companies may focus on commodity steel, basic metal producers in northern California focus on steel shapes, wire, non-ferrous metals, and other varied basic metal products. Overall, there are very few major global companies, but California does have a small, but self-sustaining set of mid-tier suppliers and specialized players serving the California and West Coast regional markets.

3.2 Industry Leaders

Metalworking has been a major part of the U.S. and worldwide economy from the beginning of the industrial revolution. As such, the economic health of the primary steel manufacturing industry is extrinsically tied to the overall health of U.S. manufacturing. Basic metal producers gained dominance in the early years of the industrial revolution through sales and production growth and by meeting the demand generated by World Wars I and II and the expanding automotive industry. The advent of globalization saw the trend towards growth and consolidation continue beyond the U.S. borders.

In the past decades, the move toward electric arc furnace technology in the steel industry jump-started a second trend in response to globalization, the growth of so-called *mini-mills*. The mini-mills opened up opportunities to serve smaller and regional markets since they require a smaller manufacturing footprint and can rely on scrap metal instead of ore, as input to the steel manufacturing process. According to Standard and Poor's (S&P), at the end of 2008, mini-mills produced 57.4 percent of all raw steel in the United States, up from 8.4 percent in 1960, and integrated steel makers account for the balance. Further expansion of mini-mills has been limited due to higher scrap prices.

Applied metal producers tend to manufacture specialized products, operating at smaller scales than primary metal producers. The secondary metals industry is very diverse and fragmented. Leaders obtain and maintain market share by producing and delivering high-quality, in-demand metal products. Many subsectors among applied metal producers rely on the construction and automotive industries for demand. Sectors which sell primarily to the construction industry include fabricated structural metal manufacturing, sheet metal work manufacturing, hardware manufacturing, bolt, nut, screw, rivet, and washer manufacturing, fluid power valve and hose fitting manufacturing, and plumbing fixture fitting and trim manufacturing. Sectors with heavy reliance on the automotive industry include machine shops, metal heat treating, and metal coating and engraving.

The industry leaders can be considered in three categories: 1) Global Leaders, which have worldwide reach, billions in revenue, and tens of thousands of employees, but may not have a presence in California; 2) Domestic Leaders, which have over $1 billion in annual revenue and serve markets throughout the country and often have a California presences; and 3) Local Players, which have a very strong presence in each region, dominate regional markets, and may or may not have a wider geographic presence. The source of the following information is the company websites of these organizations.

3.2.1 Global Leaders

These firms all have operations in California, unless specifically noted.

- With 21,000 employees and $23 billion in annual revenue, Nucor is one of the largest primary steel producers in the U.S., operating primarily mini-mills, and one of the largest steel recyclers as well. Manufacturing basic steel in bar, sheet, and structural forms, steel joist and joist girders, steel deck, cold finished steel, steel fasteners, and metal building systems. Nucor produced 20.4 million tons of steel in 2008, down nearly 10 percent from a record year in 2006, and delivers its products to manufacturers and metals service centers. Although it operates 20 steel mills in the United States, none are located in California. Nucor has seen rapid revenue growth over the last five years, primarily as a result of a series of acquisitions in the U.S. and abroad. Nucor is horizontally integrated, producing a range of basic steel products, and has moved towards some vertical integration by taking some control of its supply chain in certain geographic areas. During the recession, Nucor saw sharply reduced shipments and lower revenue per ton, which caused it to curtail its ongoing expansion efforts.

- Pittsburgh-based United States Steel Corporation is one of the leading steel producers in the country. In 2008, U.S. Steel delivered over 20 million tons of raw steel, tubular steel, and other minor products mainly to steel service centers, the automotive and aerospace industries, container manufacturer and the oil, gas, and petrochemical industries. Revenue was $18 billion in 2008 and the company employs nearly 29,000 people. Despite its heritage in the Midwest, the company has made domestic and global acquisitions in the last few years, buying major production facilities in Texas, Canada, Slovenia, and Slovakia, although overall exports are only a small part of revenue. Over the previous decade, U.S. Steel has divested some ownership in ore operations, relying more than ever on outside suppliers for its primary inputs. During the recession, U.S. Steel issued common stock to pay down debts and sharply cut its dividend in an effort to improve its balance sheet and cash flow. U.S Steel's California facility is a joint venture.

  U.S. Steel has also entered into joint ventures. Partnering with POSCO, a South Korean integrated steel production company, the company created USS-POSCO Industries. USS-POSCO has a jointly owned rolled steel mill in northern California. Historically, USS POSCO has been a PG&E customer, but upon implementation of electricity deregulation in California, USS-POSCO entered into an agreement with Calpine for a combined heat and power facility located on USS POSCO land,[29] keeping connections to PG&E for

[29] Nailen, R. "Safety, reliability key concerns in a steel finishing plant: How USS-POSCO Industries' California plant achieves efficiency and self-sufficiency." *Electrical Apparatus*, February 2010. http://www.allbusiness.com/energy-utilities/utilities-industry-electric-power/15715355-1.html.

backup power. The 555 megawatt (MW) facility runs on natural gas and supplies 25 million kilowatt hours per month to USS Posco. [30].

- ArcelorMittal Steel USA is the U.S. subsidiary of the largest steel company in the world, Luxembourg-based ArcelorMittal. Formed by a chain of mergers which occurred from late 2004 to mid 2006, ArcelorMittal has over $27 billion in annual revenue and over 20,000 employees. In the United States, ArcelorMittal Steel USA operates over 20 major steel mills in the United States, mostly located in the Midwest and South. In addition to core products of various forms of rolled steel, the U.S. business also makes coke, wire-rod products, and wire rope among others. The company has some characteristics of vertical integration, with interests in joint ventures to support existing facilities and raw materials producers, as well as railroad assets.

- Alcoa is the world's largest producer of primary aluminum. Exhibiting characteristics of both horizontal and vertical integration the company operates in seemingly all segments of aluminum production. Making primary aluminum, fabricated aluminum and alumina, Alcoa mines, refines, smelts, fabricates and recycles aluminum. The company had revenues of $14.3 billion and employed 87,000 in 2008. Both are steep declines from peak production a few years earlier. In 2007, Alcoa had capacity to produce 4.5 million metric tons of aluminum, but the company has shut a number of plants down in the last few years. Alcoa has production facilities throughout the United States and the world, including a fastener plant in Fullerton, California. As aluminum prices declined with the recession, Alcoa responded by sharply cutting its dividend and issuing common stock in early 2009.

3.2.2 Domestic Leaders

- A major operator of iron foundries manufacturing metal components and products, Precision Castparts Corporation had revenues approaching $7 billion in 2008 and over 21,000 employees. Precision Castparts produces large, complex, structural, high quality investment castings in comparatively large quantities. Core production segments include aerospace and power generation, and products include structural and airfoil, specialty alloys, fasteners, structural forms, industrial gas-turbine forms, prosthetic device casts. Prior to the recent recession, growth was robust, driven through strategic acquisitions

[30] Nailen, Richard L. "Safety, reliability key concerns in a steel finishing plant," Electrical Apparatus, Feb, 2010. http://www.allbusiness.com/energy-utilities/utilities-industry-electric-power/15715355-1.html

and strong demand from the aerospace sector. California facilities are in San Leandro and Irvine.

- Ball Corporation is among the world leaders in metal and plastic packaging. Serving the beverages, food and household product industries with applied metal products, Ball had nearly $8 billion in 2008 revenue and over 14,000 employees. In addition to being a leading packaging manufacturer, Ball gets about 10 percent of its revenue from specialized aerospace products. Metal cans, mostly for beverages, accounted for 60 percent sales in 2008. Ball operates four major metal can facilities in the U.S., one in Puerto Rico, and one in Canada. There are two facilities in California, one in Oakdale and one in Fairfield. Although the company saw weakened revenue in early 2009 due to falling demand, quarterly revenue has since rebounded. Nevertheless, revenue is not yet back to pre-recession levels.

- Titanium Metals Corporation (Timet) is a leader in non-ferrous metals other than aluminum as oppose to the more dominate iron, steel and aluminum categories. The Denver-based company operates five U.S. plants, including one in California, and produces titanium sponge, slab, and ingot for aerospace and various other industries. The company had $1.1 billion in revenue in 2008 and employs 1,700 people. Over the last five years prior to 2009, Timet saw rapid growth in shipments, revenues, and profits as demand increased significantly. Demand leveled in 2009 due to the economic recession.

- Hardware is an important applied metal product and with nearly 10 percent of the hardware manufacturing market and a 166-year history, Stanley Works is the leading maker of tools, doors, storage equipment, and hardware. Selling under the Stanley, Bostitch, Husky, Monarch, and Mac Tools brands, Stanley Works had $4.5 billion of revenue in 2008, 60 percent of which came from the U.S. Stanley Works. The company is seeing growth primarily through recent acquisitions and through cost management combined with added marketing and branding for existing businesses. The company is horizontally integrated, producing a large array of hardware products, but it is not vertically integrated because it does not produce or control the inputs for its own production. Instead, it is typical of applied metal producers in that it sources inputs from metals service centers and other applied metal producers.

  In November 2009, Stanley Works announced a merger with Black and Decker Corporation. Black and Decker sells under the DeWalt, Baldwin, Delta, Price Pfister, Weiser Lock, and Kwikset brands. With 20,000 employees, Black and Decker enjoyed $6 billion in revenue in 2008.

3.2.3 Local Players

Local players are smaller firms than the national and domestic leaders, with facilities in California.

- With roughly 2 percent of the metal-can market and 2008 domestic revenues of $280 million, Rexam Beverage Company claims to produce over 40 billion cans per year. Rexam Beverage Company is the U.S. subsidiary of U.K.-based Rexam PLC and the third-largest producer of consumer beverage cans in the United States. With a geographically diverse set of manufacturing plants, the company sells to core group of soda and beer producers mostly in the United States, but also in Central and South America. In addition to basic soda cans, the company is able to produce cans printed with thermo, glow-in-the-dark, and wet-look inks, as well as tactile-print if desired. Over the last two years, Rexam closed metal-can plants in Georgia and Oklahoma, and reduced the scale of its operations in Texas. In the midst of the recession, Rexam's debt load increased to nearly $4 billion, and interest payments consumed a third of operating profits, leading S&P to lower Rexam's credit rating. Rexam has a metal-can plant in Fairfield. It closed a metal-can end plant in San Leandro, California in 2004.

- Pacific Steel Casting is a privately held steel foundry located in West Berkeley. Surviving industry consolidation and the overall decline of the domestic steel industry, the company now ranks as the fourth largest steel foundry in the in the country.[31] To counter high operating costs, the company has focused on customer service and delivering high-quality steel castings. The company serves a regional market with emphasis on construction and transportation. They practice lean manufacturing.

- U.S. Pipe and Foundry is based in Birmingham, Alabama and has a plant in Union City, California. The company has been serving the water and wastewater industry for over 100 years, producing ductile iron pipe, ductile iron fittings, and joint restraints. It is one of the four largest ductile iron pipe manufacturers in the country. In February 2010, U.S. Pipe announced it was closing its North Birmingham, Alabama facility because of decreased demand for its products.

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[31] Pacific Steel Casting, http://www.pacificsteel.com/get_started.html

- AB&I Foundry, located in San Leandro, California, uses recycled scrap and makes pipes and fittings and custom castings for domestic and international customers. It is the largest manufacturer of cast iron soil pipes and fittings in California, focusing on the automotive, valve, water and wastewater, construction, and agricultural industries. With 250 employees, the company has a total capacity of 60,000 net tons per year.

- Sumiden wire products is the wholly owned U.S. subsidiary of Japan-based Sumitomo Electric Industries, Ltd. The company has a 30-year old plant and head office in Stockton, California, where it focuses on making high-tensile steel cable for use in pre-stressed concrete structures for the construction industry. Sumiden has been actively seeking tariffs against and quality investigations of low-cost Chinese steel-wire imports.

- Applied Aerospace Structures, formerly known as Parsons of California, employs 250 people at its Stockton, California facility. The company specializes in design, fabrication, and testing of lightweight aerospace structural assemblies for use in space and aviation vehicles and counts a number of launch successes. It is privately held.

- With a facility in Fontana, California just outside Los Angeles, California Steel Industries (CSI) has one of the few steel mills in California. Owned in equal shares by Kawasaki Steel Holdings (USA), Inc, a subsidiary of Kawasaki Steel Corporation of Japan, and by Rio Doce Limited, a subsidiary of Companhia Vale do Rio Doce (CVRD), a Brazilian corporation, CSI is leading producer of rolled steel products in the western United States. With a regional focus west of the Rocky Mountains, the company had revenues of approximately $1.5 billion in 2008. About 900 employees work at the Fontana facility. In 2008, CSI had 2.2 million tons of capacity for hot-rolled steel, 1.1 million tons of cold-rolled steel and 750,000 tons of galvanized steel. CSI serves the construction and automotive industries. In 2008, the company saw declining deliveries, but increasing prices, which protected its profit margin through the initial part of the recession.

- Founded in 1956 and now owned by Tokyo Steel Manufacturing, Ameron International, and Mitsui & Co., TAMCO produces a half-million tons of concrete rebar from scrap metal every year. The privately held company operates the only electric-arc-furnace steel mini-mill in California and serves markets in California, Arizona, and Nevada. There are 350 employees based in the Rancho Cucamonga location. According to American Metal Market (amm.com), TAMCO reported a net loss $1.7 million in Q1 2010 and Ameron is under pressure to sell its stake in the company.

- Metal Container Corporation is a wholly owned subsidiary of Anheuser-Busch, supplying roughly two-thirds of Anheuser-Busch's containers and roughly three-quarters of its lids. With annual production of 25 billion cans and 27 billion lids from 11 factories, the company makes about one-quarter of the aluminum cans produced in the United States. The company operates a facility in Riverside, California. In addition to supplying Anheuser-Busch, Metal Container's customers include soft drink makers such as PepsiCo, Coca-Cola, and Hansen Natural.

- RSR Corporation is the subsidiary for U.S. operations of Quexco, a Dallas, Texas-based holding company which also owns Eco-bat, a U.K. company. Quexco is one of the largest lead smelters in the United States and is a leading secondary lead producer, recycling lead-acid batteries. RSR technologies was formerly the research and development unit of Quexco, but now provides technology and product development services to the metals industry in addition to lead production. Quexco operates four plants in the United States, including one in City of Industry, California.

- Steelscape Inc. produces metallic-coated and pre-painted steel coils for the construction markets in the United States and Canada. With factories in Rancho Cucamonga, California and two other U.S. locations, Steelscape employs about 450 people and produces over 400,000 tons of coated steel per year. The company was acquired by Ternium Mexico (formerly Grupo IMSA) in 1990. In 2008, Ternium Mexico sold Steelscape to BlueScope steel, an Australia-based company with global holdings in the steel industry as part of a $750 million, five-company deal.

3.3 Competitive Issues

For basic metal producers, the competitive landscape has changed significantly in the last two decades due to long-term trends of new manufacturing technology, consolidation, foreign competition and imports, and raw materials costs. Steel companies are at the forefront of the changes.

Until the 1980s the steel manufacturers were often cited as prototypical examples of vertically integrated companies. Steelmakers would make massive capital investments, investing in iron ore mines, coal mines, equipment, and processing plants in order to make finished steel products. Originally, steel mills would cool molten steel from blast furnaces into ingots, which were then transformed into semi-finished products. Huge operations with high fixed costs and large workforces relying on relatively expensive organized labor were normal.

The advent of continuous casting technology, in which molten steel is poured into a water-cooled mold and drawn through a series of rolls and water sprays directly into semi-finished products, made the process more efficient. The invention of electric arc furnaces presented an alternative to blast furnaces. Mini-mill steelmakers—often small regional companies making a limited number of commodity steel products requiring only one-quarter of the capital required of larger integrated steelmakers—arose as a new competitive business model to take advantage of the new technology and underutilized steel scrap. At the same time, they employed a non-union workforce with lower costs than the unionized workers at integrated steelmakers. Nucor Corporation embodies the rise of the steel mini-mill.

The rise of steel mini-mills, along with globalization ushered in a wave of consolidation that has crested in the last five years. Because foreign competition can employ much cheaper labor and mini-mills can enter the market with much less capital, traditional steel firms have had to drastically drive down costs by becoming more efficient with increased labor productivity, and dropping legacy costs wherever possible. Many have given up vertical integration, divesting raw materials operations. Some have merged to form some of the largest companies in the world.

Aluminum manufacturers, on the other hand, remain vertically integrated even though globalization is driving a trend toward consolidation. There is an oligopoly of major aluminum manufacturers, including Alcoa and a few others, which still enjoys major advantages over steel manufacturers in pricing power and supply line control. Because the energy savings of using scrap in aluminum production is greater than using scrap in steel productions, the aluminum oligopoly captured the cost advantages of using recycled scrap as input long ago. Because aluminum production is capital intensive and energy intensive, in a practical sense, only mini-mills using scrap as input can realistically enter the market, but they can only produce a limited product line. New entrants would need to take market share from the established oligopoly. On the other hand, large aluminum manufacturers have stable costs in their production inputs, but can be impacted severely by fluctuating energy prices because they have such an energy intensive manufacturing process.

For applied metal producers, the situation is vastly different. There is considerable diversity across businesses, many subsectors have low barriers to entry, and the competitive landscape is characterized by heavy fragmentation (i.e., little dominance when it comes to market share). Nearly all of these firms produce specialized products and many serve regional markets, rather than national or global ones. Success generally depends on knowing customers well and producing quality workmanship at faster rates and lower costs.

Applied metal producers directly or indirectly depend on the economic demand for capital goods. The construction industry drives demand for a large share of industrial metal product and service producers, so the recent precipitous decline of commercial and residential construction has rippled through many subsectors. Government stimulus spending on public infrastructure is saving some businesses, especially spending on *shovel-ready* projects that can immediately reduce metal product producers' inventories and provide new on-demand orders to metal service companies. In contrast, there are pockets of stability among industrial product and service producers. For instance, metal treating and plating businesses maintained relatively stable income and profit levels through the recession, in part because businesses tend to be small, perform specialized activities, and serve a diverse set of customers. Although the overall industry has seen a decline, the impact among various producers is sporadic.

While small niche companies do not face much competition among competitors providing the same product or service, substitution from other industries can be a considerable competitive pressure. For example, metal cans compete with glass and plastic packaging among food and beverage customers. Thus, competition from outside the industry can impact pricing within the industrial metal product service sector.

The largest customers in northern California are primarily applied metal producers, with strong emphasis on metal container manufacturers and foundries. Only a handful of the global leaders maintain operations in California, notably Ball Corporation and USS-POSCO Industries. Outside of the large foundries and metal can operations, the individual businesses are typically metalworking shops, metal finishers, structural and structural metal producers, the type of business that produce higher value products. These customers tend to operate in a much more fragmented and competitive landscape and are subject to pressures of increasing foreign competition and trends towards industry consolidation.

The largest customers in Southern California are split between basic metal producers and applied metal producers. The businesses are more typically metalworking shops and structural metal producers, the type of business that produce higher value products. These customers tend to operate in a much more fragmented and competitive landscape and are subject to pressures of increasing foreign competition and trends towards industry consolidation. Their proximity to the U.S./Mexican border makes its customers particularly susceptible to competition from Mexico in the era of the North American Free Trade Agreement.

Due to a heavy reliance on the construction, automotive, and high-technology industries, metalworking firms in northern California saw demand decline across the board for their products and services during the recession. Metal can manufacturers were hit somewhat less than other types of producers, but the pain was widespread.

Due to a heavy reliance on the construction and aerospace industries, metalworking firms in Southern California saw demand decline across the board for their products and services during the recession. Metal can manufacturers were hit somewhat less than other types of producers, but the pain was widespread.

Although foreign competition and consolidation are likely to continue moving forward, the competitive landscape for metalworking companies is so heavily fragmented that it will take time before changes are noticeable. Few firms bear the legacy costs prominent in other geographic areas. Many firms maintain a clear regional focus, know their local customers well, and serve narrow market segments, positioning them well for recovery.

3.3.1 Business Models

Basic metal production, including steel, aluminum, and other metals, is highly capital intensive. Although once dominated by large, vertically integrated firms, basic industrial metal manufacturers have been forced to change their business model in the past 20 years. Integrated companies have downsized considerably, and the large steel makers have divested raw materials holdings in coke, coal, and iron ore. Labor restructuring has been contentious, but necessitated by bankruptcies, mergers, and plant closings. In 1960, large integrated steel firms produced 92 percent of the steel in United States, by 2008, their market share has dropped by half, to 46 percent.[32] The market share lost by large integrated steelmakers have gone to the small operations, such as mini-mills where they are able to produce a relatively limited set of basic steel products with factory operations that require a much smaller footprint. Mini-mills often use recycled scrap as a raw input and serve diverse regional markets as opposed to relying on the automotive segment as many integrated steelmakers still do. The decline of U.S. Steel ($8 billion market cap, $12 billion annual revenue), symbolic of vertically integrated steelmakers, and the rise of Nucor, ($14 billion market cap, $12 billion annual revenue), which relies exclusively on mini-mills, epitomize the changing business model. Globalization has allowed USS-POSCO Industries to flourish in California, despite its distance from the traditional geography of vertically integrated steel manufacturing in proximity to the automakers in the Midwest and Northeast. However, USS-POSCO operates under a different model, *cold-rolling*, *hot-dipping* or applying other finishing to steel brought in from other plants in Korea, China, or

[32]. Standard & Poor's. 2009. *Industry Surveys, Metal: Industrial*. February 19, 2009.

the midwestern United States. For U.S. Steel, a joint partner in USS-POSCO, this type of distribution breaks the traditional integrated model.

Basic aluminum producers (also highly capital intensive) typically operate as vertically integrated entities, with operations to mine and produce the raw materials needed to produce finished products. The major aluminum manufacturers own large reserves of bauxite, the raw material for aluminum, and invest heavily in plants and equipment. At the same time, 35 percent of aluminum is produced from recycled scrap, which can save 95 percent of the energy costs of refining bauxite. Historically, aluminum plants have been located close to dams to take long-term power contracts for their energy needs. However, as this link between hydro-power and aluminum has become less prominent, the industry has increasingly seen results impacted positively or negatively from changes in overall wholesale electricity prices. The vertical integration of aluminum plants does not extend to electricity generation. The high capital needed for entry, market dominance of established players, and structural advantages have allowed the aluminum oligopoly that includes Alcoa and a few other companies to persist. No members of the oligopoly have major operations in California. Although mini-mill technology exists, there is as of yet no way to reliably make sheet aluminum, the most profitable primary product, from a mini-mill. Unlike steel manufacturing, vertical integration is the norm.

Other basic metal manufacturers that produce non-ferrous metals like titanium or magnesium are usually used in specialty applications where they are not easily substituted. These producers serve considerably smaller, niche markets and tend to have models similar to applied metal manufacturers, rather than basic metal manufacturing businesses.

Applied metal producers take the outputs of basic metal manufacturers as inputs for their own production. Most companies are small or medium sized and produce well-defined services or products. There are only modest capital requirements to enter many niche markets, but some companies establish an advantage by investing outsized amounts of capital in the latest technologies and hiring more skilled employees. The increased quality these producers can provide allows them to add more value and gives them access to markets (e.g., defense and medical) with more demanding standards and the ability to earn higher margins. Other companies dominate highly specialized niches, relying on superior expertise or providing a product or service which no one else offers. Niche companies serving only a few large customers are vulnerable to take over from the companies they serve. Another niche for companies is to provide products with reasonable quality in the shortest timeframe at the lowest cost possible. These companies can grow by increasing scale. Companies in this category tend to grow by increasing capacity through mergers and acquisitions.

The small scale of many industrial metal product and service providers as well as the overall diversity across the sector provides a degree of flexibility. Flexibility allows companies to shift the customers and industries they serve, buffering overall revenue for the industry through volatile economic periods. For instance, although the automotive industry is in decline, the market for military aircraft has remained robust. Firms delivering electroplating serve both. However, companies are susceptible to swings in the cost of materials because most rely on commodity steel and aluminum obtained through metal service centers. Many industrial metal product and service providers also lack the deep resources of larger firms, making them more vulnerable to widespread economic downturn. Layoffs and bankruptcies were common during the recent economic downturn.

3.3.2 Cost Structure

Basic metal producers, including steel, aluminum, and other metals, face the highest capital costs, but also have the largest existing asset base and the largest scale of operations. Despite significant contract restructuring, integrated basic metal producers like U.S. Steel and Alcoa retain legacy costs associated with the fixed benefit programs provided to retired employees. Much of the basic metal production industry has aging equipment which mean depreciation represents a cost that is declining in importance. Newer steelmakers like Nucor have a leaner cost model due to the smaller capital outlays for mini-mills and employing less expensive labor.

For basic metal producers, raw inputs are the costliest expense, consuming between one-half to two-thirds of revenue depending on the subsector. Mini-mill steelmakers, once buffered from raw ore costs due to their reliance on scrap metal are now facing increases in scrap prices that now follow ore prices due to competition for usable scrap. Furthermore, mini-mill steelmakers are very sensitive to electricity prices because their technology requires significant electricity input.

Vertically integrated aluminum firms have stable, but relatively high input costs, due to their ownership of the mining and scrap operations. Fuel and electricity costs can also be significant, depending on the production process involved, ranging from 5–10 percent of revenue. Vertically integrated aluminum makers spend around 6 percent of revenue on energy.

Basic metal products like rolled steel, aluminum, and copper are global commodities. While governments sometimes set protective tariffs, pricing is generally set on worldwide markets subject to the forces of supply and demand. Demand from infrastructure growth in China has strongly influenced the price of steel. Worldwide demand in the automotive and food and beverage sectors has been a price determinant for aluminum. At the same time, the aluminum market has been in surplus for nearly 20 years, a legacy of the collapse of the Soviet Union. Former Soviet companies flooded the world market with exports as domestic demand dried up, but China has become one of the biggest producers and consumers of aluminum. Analysts from S&P suggest China's aluminum industry will drive world supply and dynamics moving forward. Other basic metal prices are cyclical to the supply and demand from sectors which use the metal (e.g., magnesium for automotive die casters or copper for household plumbing).

Applied metal producers' costs are largely driven by labor. There are few major barriers to entry because capital costs are relatively low. Materials purchases represent the largest cost in most subsectors. For instance, hardware manufacturers and machine shops each spend 44 percent of revenue to purchase materials, according to IBISWorld analyst reports, despite operating in very different business segments. Paying wages consumes significantly more revenue for industrial metal product and service providers than it does for basic metal producers. Labor costs fall in the range of 15 to 25 percent of overall revenue in most segments. Energy costs are often well below 10 percent of revenue.

3.3.3 Technology Development

Electric arc furnace technology is a key component in modern steel mills and in many foundries. It is considered modern furnace technology and allowed the rise of steel mini-mills. Electric-arc technology also allowed the use of 100 percent scrap steel as an input for basic steelmaking, rather than iron ore, with a significant advantage in energy per unit weight required for processing. The ability to process scrap metal opened the possibility of major steel recycling and created an alternative resource for steel production. Unlike traditional blast furnaces, electric-arc furnaces can be turned on and off relatively rapidly,[33] allowing mini-mills to be far more responsive to real-time variations in demand than traditional steelmakers. Outside of primary steelmakers, many foundries working with ferrous or non-ferrous metals also rely on electric arc furnaces. Large integrated aluminum makers also enjoy energy savings up to 95 percent when they use scrap as an input, rather than raw bauxite.

Technology can be a differentiator among applied metal producers. The most sophisticated companies have highly automated production lines, using computer-aided design and computer-aided manufacturing equipment. Companies rely on some combination of presses, screw machines, rotary transfer machines, number controlled, and computer controlled single-

[33] More information on operation of electric arc furnaces can be found in tutorials from the World Steel Association, www.steeluniversity.org.

and multiple-spindle lathes, and turning and machining centers. The more sophisticated equipment users need more engineering and process design and better trained technicians to run the equipment. The advantage is the ability to maintain tighter specifications and produce output faster. In some subsectors, there is a price premium available to companies that can use technology to develop new products like specially curved metal containers. The disadvantage of new technology is the capital cost, so larger more established companies with more ready access to capital are more likely to invest in new technology. If they have a high level of skill and experience in a particular niche and longstanding customer relationships, companies relying on older, less sophisticated technology can coexist with companies using the latest technology. In such a fragmented industry, customer relationships endure and the craftsmanship of small experienced operators sometimes trumps the speed and efficiency of larger automated operations. Depreciation costs are declining in many applied metal production markets, indicating that companies are holding onto older technology and the less-automated business model is still viable.

3.3.4 Supply Chain Management

Leading basic metal producers tend to have some degree of horizontal and vertical integration. As a legacy from when they operated as vertically integrated entities, traditional large steel making plants are located near ports, for maximum efficiency in transporting iron ore to the plant and distributing outputs. Many of the largest steel mills are located near the Great Lakes or rivers in the northeast United States, easing transport to their traditional automotive customers. Steel mini-mills are smaller and can be located anywhere because they rely more on scrap than ore and do not require the land resources or major steelmaking operation. Among aluminum manufacturers, energy cost and availability is one driver of geography because the process is so energy intensive. When aluminum production expanded rapidly during World War II, many plants were built close to dams, which provided abundant low-cost (at the time) power for large-scale energy-intensive manufacturing processes. Many plants have not moved since. Among the largest players, energy costs can influence medium-term decisions about which facilities to ramp up or ramp down in response to economic cycles.

Basic aluminum producers (also highly capital intensive) typically operate as vertically integrated entities, with operations to mine and produce the raw materials needed to produce finished products. The major aluminum manufacturers own large reserves of bauxite, the raw material for aluminum, and invest heavily in plants and equipment. At the same time, 35 percent of aluminum is produced from recycled scrap, which can save 95 percent of the energy costs of refining bauxite. Historically, aluminum plants have been located close to dams to take long-term power contracts for their energy needs. However, as this link between hydro-power and aluminum has become less prominent, the industry has increasingly seen results impacted positively or negatively from changes in overall wholesale electricity prices. The vertical integration of aluminum plants does not extend to electricity generation. The high capital needed for entry, market dominance of established players, and structural advantages have allowed the aluminum oligopoly that includes Alcoa and a few other companies to persist. Only Alcoa has operations in Southern California. Although mini-mill technology exists, there is as of yet no way to reliably make sheet aluminum, the most profitable primary product, from a mini-mill. Unlike steel manufacturing, vertical integration is the norm.

Basic iron and steel producers supply metals distributions centers, which vary from small local operations to major corporations, and downstream steel processers (e.g., foundries) with over half their production, according to IBISWorld. Another one-third goes directly to the automotive and construction industries. The remainder is scattered among machinery, electrical, and container manufacturers. Table 5 gives the market segmentation of basic iron and steel producers, adapted from IBISWorld.

Table 5: Market Segmentation of Basic Iron and Steel Production

Market Segment	Market Share
Metal service centers	23%
Downstream steel producers	23%
Automotive	15%
Construction	14%
Exports	13%
Machinery manufacturers	4%
All others	8%

Source: IBISWorld[34]

Basic aluminum producers split 80 percent of their production among packaging makers, construction manufacturers, exports, and transportation-related industries, as shown in Table 6. Other non-ferrous basic metal producers supply metals distribution centers and targeted market segments.

Table 6: Market Segmentation of Basic Aluminum Production

[34] IBISWorld. 2009. *IBISWorld Industry Report, Iron & Steel Manufacturing in the US: 33111*. August 18, 2009.

Market Segment	Market Share
Transportation	28%
Packaging	21%
Construction	15%
Exports	15%
Electrical	7%
Consumer durables	6%
Machinery	6%
Other	2%

Source: IBISWorld[35]

Most applied metal producers lack the clout of major automotive and construction firms, so they use metal service centers to obtain their basic products. A few firms, like Ball Corp, which makes metal cans, can obtain steel directly from producers. However, they are the exception rather than the norm in California. The level of globalization is relatively low among industrial metal product and service producers and many supply durable products to a local or regional customer base. Delivery logistics consist mostly of straightforward ground transport. A significant share of industrial metal product and service firms are themselves one part of a larger supply chain, e.g., aircraft manufacturers.

3.3.5 Product Development and Roll-out

Product development is not a major business factor for most metalworking firms. While the production processes may evolve to be more efficient, faster, or cost effective, the products themselves vary little. Customers generally know the products and the production processes well. However, pockets of innovation do exist in certain subsectors like defense, medical devices, and metal containers. Firms supplying the defense and medical industries may have their own research and development operations or join research consortiums developing new products targeted to very specific needs. Customers are most often fully aware of new product developments because metal firms are responding directly to their stated needs. Metal container manufacturers like Ball Corporation are competing with plastic and glass container manufacturers primarily for market share in the food and beverage industry, although some applications like oil drums provide additional revenue. New product innovation is often inspired by the relative strengths of plastic and glass. For instance, a major recent innovation is the ability to create complex custom shapes with metal containers. An aluminum soda can that is

[35] IBISWorld. 2009. *IBISWorld Industry Report, Aluminum Manufacturing in the US: 33131*. July 28, 2009.

especially easy for consumers to hold is a typical example. Metal container makers are marketing these innovations using well-established relationships with large food and beverage makers in an attempt to take market share from competing plastic and glass manufacturers.

3.3.6 Pricing

Because raw inputs are the largest costs nearly universally in the metalworking industry, prices of metal products respond to the global metal commodity trends, including demand from China, and recent volatility. Most basic metal producers provide commodity-grade metals, but a small percentage manufacture value-added products like coated and flat-rolled sheet. Commodity basic metal producers have low margins and compete solely on price. Controlling costs is crucial to maintaining low prices. In the steel industry, gaining or defending market share is critical because the market is growing slowly, becoming globalized, and mini-mill technology has lowered the barriers to entry. Value-added basic metal producers garner higher prices, but products cost more to make. Efficiently producing value-added basic metal products and slightly undercutting the competition has been an effective business strategy.

Applied metal producers, with the major exception of metal container producers, can price products at a premium if they can demonstrate higher quality and/or faster delivery. Because many companies operate in specialized niches, relationship management is a key value-added service which can differentiate companies from their competitors. Customers are often willing to pay more for products from companies they know and trust.

However some niche markets require producers to compete on price. In the fabricated metal product segment, some pricing is controlled by contracts with state and local governments as they build or repair infrastructure. Metal container manufacturers must consider glass and plastic substitutes as they price their products, leading companies to smaller margins than they might otherwise have. Metal container manufacturers sometimes enter into long-term contracts with their customers, insulating them somewhat from price volatility. Professional machine shops occasionally face competition from hobbyist operations, which vastly underprice them. Bolt, nut, and screw manufacturers serving the aerospace industry command higher prices than those serving the consumer household market because aircraft manufacturers demand higher performance from their hardware than homeowners. There is significant heterogeneity in the details, but the basic price drivers of raw material costs and level of value-added service are apparent throughout the industry.

3.3.7 Value Chain

A value chain shows how materials and processes turn out a final product that contains more value after undergoing these activities. The final product value is higher than the cost of what is sold. This idea was developed to explain how a company is more than a random compilation of machinery, equipment, people and money. Combined, these all work together to create higher value in the product. In this section, we evaluate the value that each activity adds to the company's products.

The business model and operations create the highest value. Basic metal producers add value by taking raw materials or scrap and processing them into commodity suitable for downstream industrial use. The value add between raw materials and sale of final metal products is concentrated in the manufacturing process itself. Improving the qualities of basic metal beyond commodity-grade rolled or drawn metal products can add-value, but the products must be tailored to specific customer requirements. For those customers, the enhanced properties are large value add, but most downstream users need only commodity metal.

Smaller applied metal producers create significant value by adding superior expertise, highly trained labor, and specialized equipment to create products and services for niche markets. Generally, these players like Applied Aerospace Structures convert the output from basic metal manufacturers or other metal product manufacturers to application-specific products and services. There is a much higher value add for metal product and service manufacturers than basic metal manufacturers, but much lower volumes.

3.4 Economic Factors

3.4.1 Business Cycles

Revenue and earnings for basic metals and industrial metal products and services depends on the demand for consumer products like automobiles, containers, and major appliances. Steel and fabricated steel products rely on the demand for capital goods, while aluminum and metal containers are rely on demand for consumer durable goods. Despite some variations, the industry is highly dependent upon economic cycles. Various business analyst estimates from S&P, IBISWorld, and Mergent place the drop in shipments and revenue at around 30–35 percent from 2008 through 2009. Profits were pressured not only from reduced sales, but also price drops. In 2008, the price of scrap metal fell from a high of $550/ton to $90/ton. Scrap metal prices gradually recovered to nearly $500/ton by the end of 2011.[36] The price of hot-rolled steel dropped from $1080/ton to $795/ton. Copper prices fell from $3.99/lb to $1.45/lb.[37] Copper recovered, to over $3.35 by the end of 2011.[38] In general, recovery has been slow because the metalworking industry is driven by purchases of capital goods, which have not rebounded. Capital good demand typically increases late in the recovery phase of the economic cycle, so metalworking companies often must wait to see profits rebound. This high volatility is expected to reduce interest in making investments.

3.4.2 Availability of Capital and Credit

The availability of capital and credit can affect the ability of organizations to invest in those energy efficiency projects which are also capital intensive. Large multi-national corporate players can fund new projects and facility improvements from operating cash. They also have access to the corporate debt market and issue bonds, but they sport a range of credit ratings. U.S. Steel was recently downgraded by Fitch to junk status and in January 2010, Alcoa was hovering at the lowest investment grade credit rating at all three major credit agencies. On the other hand, Nucor enjoys a moderately favorable credit rating. Players with low credit ratings are highly leveraged and carry higher levels of existing debt. A general trend towards mergers and acquisitions among basic metal manufacturers that began in 2000 ended in 2008 when credit markets froze. Acquisitions leveraging high levels of debt ceased and have not resumed. With the thaw of the credit markets, major players continue to refinance existing debt and mergers and acquisitions may restart. Companies with a leaner business model and no major legacy costs like Nucor are making profits again and better positioned to make acquisitions, but neither is known to be making large moves at the time of writing.

Smaller players typically need new capital up front to establish operations and therefore can be saddled with debt from launch. During the recession, few new businesses began operations because little credit was available to pay for the sunken 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. Many small businesses

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[36] World Steel Price Charts, Historic Price graphs. 2011. http://www.steelonthenet.com/pricing_history.php

[37] Mergent. 2009. *North America Metal Works Sectors.* Industry Report. March 2009.

[38] Kitco. 2011. Spot Copper Historical Charts and Graphs. http://www.kitcometals.com/charts/copper_historical_large.html

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. Another option for operations which require special machines or processes, like machine shops, is to obtain manufacturer-sponsored financing when they purchase equipment. For many segments of the metalworking industry, this can be an attractive financing option.

3.5 Regulatory Issues

The metalworking industry is subject to a long list of environmental regulations on federal, state, and local levels. Additionally, steelmakers face highly politicized trade tariffs. The following sections describe the regulatory issues facing the metalworking industry.

3.5.1 Environmental

The metalworking industry must comply with the following environmental laws:

- The Clean Air Act (CAA) regulates air emissions from stationary and mobile sources. Key pollutants are defined as particle pollution (often referred to as particulate matter), ground-level ozone, carbon monoxide, sulfur oxides, nitrogen oxides, and lead. 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. Steel plants in particular were mandated by the 1990 Amendments to the CAA to reduce emissions from coke ovens. As a result, coke operations became significantly more expensive and many integrated steel firms shut their coke ovens and turned to outside suppliers for their coke needs. The regulation also gave another competitive advantage to electric arc furnaces. Currently, the U.S. EPA is preparing to move forward with regulation of greenhouse gases under the Clean Air Act, as discussed in Section 3.5.2.

- 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, the 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 the EP 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 Comprehensive Environmental Response, Compensation, and Liability Act of 1980 is also known as the Superfund. Metal manufacturers incur the costs for rehabilitating plant sites contaminated by hazardous substances. Some steel and aluminum manufacturers are involved in legal proceedings and the final costs to comply with Superfund legislation are as yet to be determined.

- The California Beverage Container Recycling and Litter Reduction Act (CA Beverage Container Recycling Program) require beverage manufacturers and distributors in California to apply a minimum redemption value associated with aluminum cans. A vendor or manufacturer of aluminum cans subject to these deposit-refund system incurs a cost from handling these returned cans, as well as a potential benefit from interest earned on deposits, sales of these used products, and the value of unclaimed deposits. The California Department of Conservation is the agency that implements the Bottle and Can Recycling Law.

Responsibility for enforcing environmental laws is distributed between the federal government (usually the U.S. EPA), state agencies, counties and municipalities. In California, regional air districts are charged with developing and enforcing air quality regulations that are more stringent than federal standards. In general, facilities in the metalworking industry are long accustomed to complying with existing environmental regulations as part of their normal course of business.

3.5.2 Climate

California Global Warming Solutions Act

In 2006, California's Assembly Bill 32, the Global Warming Solutions Act (AB 32) became the first legislation signed into law in the United States to establish mandatory limits on greenhouse gas emissions. The California Air Resources Board (ARB) was designated as the lead agency tasked with developing the regulatory structure to achieve emissions reductions targets for CO_2 and other greenhouse gases (GHG).[39]

In January 2009, ARB adopted a Scoping Plan that provides the blueprint for achieving the reductions through a mix of incentives, direct regulatory measures, and market-based compliance mechanisms.

Key elements of the Scoping Plan include:

- Expanding and strengthening existing energy efficiency programs, as well as building and appliance standards
- Developing a California cap-and-trade program that links with other Western Climate Initiative partner programs to create a regional market system
- Establishing targets for transportation-related emissions for regions throughout California, and pursuing policies and incentives to achieve those targets.

Most primary metals manufacturers and some secondary metal manufacturers in California are likely to be affected by the cap-and-trade program, which was adopted by ARB in 2011.[40] After collecting three years of data from the largest emitting industries, the ARB will establish emissions caps. For each business sector, an emissions benchmark will be established, and business will be allowed emissions up to 90 percent of the benchmark (cap) in 2013. Cap and trade requires large emission sources to surrender emissions permits equal to their actual emissions in any given year. The amount of total available permits declines over time, thereby making it more and more expensive to emit greenhouse gas emissions. Emissions permits are tradable among market actors and emissions reductions from non-capped sectors, known as offsets, can also be used for low-cost compliance purposes As California implements AB 32, affected chemicals manufacturers can expect to be treated as capped sources. The implementation of the cap-and-trade under AB 32 has been delayed to 2013, although the state plans to develop the regulatory framework in 2012.

[39]These gasses include methane (CH4), nitrous oxide (N2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF6). Since each of these gases' unique physical properties causes them to have varying heat trapping effects, they are normalized into carbon dioxide equivalents. For example, one metric ton of methane is equivalent to 21 metric tons of CO_2 equivalents (CO_2e).

[40] Cart, Julie. 2011. "*California becomes first state to adopt cap-and-trade program*,". Los Angeles Times. October 21, 2011.
http://articles.latimes.com/2011/oct/21/local/la-me-cap-trade-20111021

Starting in the first compliance period of 2013, all large industrial facilities that emit over 25,000 metric tons CO_2e per year will be required to acquire and hold emissions permits. Starting in the second compliance period of 2015, industrial fuel combustion at facilities with emissions at or below 25,000 metric tons CO_2e per year will be included.

For some energy-intensive industrial sources, stringent requirements in California, either through inclusion in a cap-and-trade program or through source specific regulation, have the potential to create a disadvantage for California facilities relative to out-of-state competitors unless those locations have similar requirements. Recent analysis by the California Legislative Analyst suggests that this effect will not be significant for the overall economy. Sectors most affected are likely those with high-energy intensity and significant trade-related activities where increased costs may not be able to be reflected in higher prices.[41]

EPA Mandatory Reporting

The U.S. EPA issued a rule for mandatory GHG reporting from large emissions sources in the United States. The rule, which took effect on December 29, 2009, established EPA's program to collect accurate and comprehensive emissions data to inform future policy decisions. Facilities that emit 25,000 metric tons or more of GHG emissions per year to submit annual reports to the EPA. From 85–90 percent of total national U.S. GHG emissions, from approximately 13,000 facilities, are covered by the rule. EPA estimates the average cost of reporting under this proposed rule would be approximately $0.04 per metric ton.. Large metal manufacturing plants have sizable enough emissions, which they are required to monitor and report to the EPA.

EPA Regulation under the Clean Air Act

Greenhouse gas emissions are now regulated in the United States under the Clean Air Act. According to the Tailoring Rule,[42] GHG permitting requirements will cover for the first time new construction projects that emit GHG emissions of at least 100,000 tons per year (tpy). Modifications at existing facilities that increase GHG emissions by at least 75,000 tpy will be subject to permitting requirements, even if they do not significantly increase emissions of any other pollutant. By 2016, the EPA may lower the threshold to 50,000 tpy.

[41] Taylor, Mac. 2011. *Letter to Honorable Dan Hogue*., California Legislative Analyst's Office. May 13, 2011. http://www.lao.ca.gov/reports/2010/rsrc/ab32_logue/ab32_logue_051310.PDF

[42] Federal Register. 2010. *Environmental Protection Agency: Prevention of Significant Deterioration and Title V Greenhouse Gas Tailoring Rule*. Vol. 75, No. 106, June 3, 2010. http://www.gpo.gov/fdsys/pkg/FR-2010-06-03/pdf/2010-11974.pdf#page=1

Under the EPA rulemaking for New Source Review, proposed emissions sources will be required to install best-available control technology. Typically, this means installing energy efficiency equipment. Large sources permitted through the Title V program may have emissions limits on GHG emissions in the future.

3.5.3 Tariffs

Metals are sometimes the subject of highly visible, politically motivated tariffs. In 2002, the Bush Administration temporarily raised the tariff on U.S. steel imports from around 1 percent to between 8 and 30 percent. After a wave of bankruptcies, domestic steel makers had clamored for protection from international competitors. The Bush Administration obliged, following precedents set for steel tariffs during the George H.W. Bush and Ronald Reagan Administrations. In response, the European Union successfully argued to the World Trade Organization that the tariffs were unfair, and nearly brought retaliatory tariffs on U.S. produced orange juice and automobiles. The U.S. steel tariffs were removed in response to the threat.[43] As the tariff dispute unfolded, the United States' primary steel industry was already undergoing consolidation and labor restructuring which ultimately improved global competitiveness. Despite the high-profile political failure of the 2002 steel tariff, there are over 100 antidumping and countervailing duty measures restricting various steel products from 32 countries according to a list maintained by the U.S. International Trade Commission.

Steel is not the only metal product frequently subject to tariffs. The E.U. imposes tariffs on aluminum from the Persian Gulf countries, Brazil, China, and other places. Many countries impose tariffs on rare earth metals exported from China. Because most secondary metal products are capital goods, they can be subject to trade tariffs as well.

3.5.4 Metals Standards

Metals standards exist to provide uniformity of products and ensure safety. Most standards come from ASTM International and are designed to ensure adequate strength and longevity in structural applications or minimum performance in consumer and technological applications. Because metals are used so widely and in so many industrial products, there are thousands of individual standards covering both ferrous and nonferrous metals, including steel, copper, aluminum and many others. The major categories of metals standards are analytical chemistry standards, cast iron standards, copper standards, corrosion and wear standards, fastener

[43] IBISWorld. 2009. *IBISWorld Industry Report, Iron & Steel Manufacturing in the US: 33111.* August 18, 2009.

standards, fatigue and fracture standards, metallic coating standards, nonferrous metal and alloy standards, and steel standards. Details on all the standards can be found on the ASTM website (http://www.astm.org/Standards/metal-standards.html).

3.6 Industry Network

No single industry group could represent all the various interests across different segments of the metalworking manufacturing industry, so industry associations tend to align around individual segments. This extensive list of organizations is designed to provide a resource for utilities seeking energy efficiency partnering opportunities with trade associations and allies. Major industry associations lobby, market, promote standards, and provide education and networking for metals manufacturers. Companies associate primarily to promote common interests to the government and the community, as well as obtain industry-specific market conditions and emerging market trends, and general information and advice on legislation affecting firms in this industry.

- The American Iron and Steel Institute (AISI, www.steel.org) is a longstanding market and policy advocacy for the steel industry. AISI is comprised of 24 member companies, including integrated and electric furnace steelmakers, and 138 associate and affiliate members who are suppliers to or customers of the steel industry. According to its own calculations, AISI's member companies represent approximately 75 percent of both United States and North American steel capacity.

- The World Steel Association (www.worldsteel.org) was founded in 1967 as the International Iron and Steel Institute and changed its name in 2008. Headquartered in Brussels, Belgium and with a second office in Beijing, China, the organization represents approximately 180 steel producers (including 19 of the world's 20 largest steel companies), national and regional steel industry associations, and steel research institutes. Members produce around 85 percent of the world's steel. World Steel promotes steel and the steel industry to customers, the industry, media and the general public and seeks a zero-accident environment across its membership.

- Based in Arlington, Virginia, the Aluminum Association (www.aluminum.org) promotes aluminum, focusing on automotive, packaging and construction material uses. The Association represents around 100 U.S. and foreign-based primary producers of aluminum, aluminum recyclers and producers of fabricated products, as well as industry suppliers. Member companies operate more than 200 plants in the United States, with many conducting business worldwide. The Association engages in lobbying, marketing, research and education, and industry data collection on behalf of its members.

- The International Aluminum Institute (www.world-aluminum.org) has 27 member companies representing more than 80 percent of world primary aluminum production. Members are represented on the IAI Board of Directors by their CEOs. The IAI represents aluminum and alumina producers worldwide and its key objectives are marketing, providing a cooperative forum for regional and national associations, collecting industry data, promoting research, and providing a unified industry voice to international agencies. IAI is based in London.

- The Metals Service Center Institute (MSCI, www.ssci.org) is a trade association that supports and represents multiple elements of the metals value chain, from metals producers, distributors, to processors. Primary members consist of metals service centers, businesses that inventory and distribute metals for industrial customers and perform first-stage processing. Activities include networking, educational, lobbying, and research. Based in Rolling Meadows, Illinois, MSCI has more than 350 members in the United States, Canada, Mexico, and elsewhere around the world.

- Founded in 1938, the Can Manufacturers Institute (CMI, www.cancentral.com) is a trade association of the metal-can manufacturing industry and its suppliers in the United States. CMI members account for over 81 percent of annual domestic production of 133 billion cans. CMI is based in Washington, D.C. and focuses on lobbying, media communication, marketing, and research. It also is a primary technical and networking forum for the industry.

- The Copper Development Association (www.copper.org) was founded in 1962 and is headquartered in New York City. The organization focuses on industry market development, research, networking and technical service, including education. Copper producers and fabricators are eligible for full membership and others can join as associate members.

- The London Metal Exchange (www.lme.co.uk) is the primary world non-ferrous metals commodity market. It offers futures and options contracts for aluminum, copper, nickel, tin, zinc, lead, aluminum alloy. Membership is required to trade because the market uses as a principal-to-principal exchange model without central clearing. In 2008, volume was over $10 trillion for the year and averaged between $40–45 billion per day.

- The Precision Metals Association (PMA, www.pma.org) is a Cleveland, Ohio-based trade association representing industrial members who create precision metal products using stamping, fabricating, spinning, slide forming and roll forming technologies, and other value-added processes. Nearly 1,100 member companies include suppliers of equipment, materials and services to the industry. PMA provides advocacy, networking, and statistics. Additionally, PMA publishes a magazine, sponsors conferences and supports an educational foundation.

- The Fabricators & Manufacturers Association, International (FMA, www.fmanet.org) is a professional association with more than 2,000 individual and company members. Members are involved in various metal fabrication processes including cutting, drawing, extruding, fastening, stamping, and welding, among others. Activities include technology councils, educational programs, networking events, trade shows, and publications. FMA is based in Rockford, Illinois.

- The Cleveland, Ohio-based Forging Industry Association (FIA, www.forging.org) has over 100 members from the metal forging industry. The group has programs in statistics and benchmarking, marketing and outreach, training, networking, and technology transfer.

- American Metal Market (AMM) is a leading metals industry information publication for producers, intermediaries, recyclers and industrial users of metals. AMM provides news and pricing information for the ferrous and nonferrous metals markets with a focus on North America and world markets where applicable. AMM is a member of the Metal Bulletin family of publications, which offers other periodical publications, research newsletters, information directories and worldwide conference support. AMM is based in New York City.

Smaller industry associations serving an ecosystem of specialty producers also exist, but without the clout of those mentioned above.

3.6.1 Supplier and Trade Allies

Many existing suppliers and trade allies position themselves as providing products, services or information that support energy efficiency. The following list provides a cross-section of examples across the entire metalworking industry to highlight some of the niches these suppliers and trade allies occupy. Few suppliers and trade allies focus solely on energy efficiency for the metalworking industry and as a $300 billion industry overall, there are thousands of companies serving the metalworking industry. However, many existing suppliers and upstarts position themselves as providing products and services with high-energy efficiency. The following list provides a cross section of examples across the entire metalworking industry to highlight some of the niches these suppliers and trade allies occupy. It is meant to be illustrative, not exhaustive.

Scrap Processing Equipment

- Started in 1919, GENSCO (www.genscoequip.com) produces equipment for scrap processors, steel mills, rebar fabricators, building supply houses, electrical switchgear manufacturers or electrical contractors. Products include grapples, scrap magnets, cable processing, balers, shears, crushers, cutting tool, hand tools for rebar, electrical equipment, welders, and generators. In addition to manufacturing partnerships with various other companies, GENSCO maintains a distribution and dealer network.

- Harris Equipment (www.harrisequip.com) manufactures ferrous processing equipment, including shears, balers and shredders. It is itself a fabricated metal product manufacturing firm serving other fabricated metal processing firms. Harris products are designed to process recovered papers, paperboard, plastics, solid waste and light ferrous and non-ferrous metals.

Melting Equipment

- Nabertherm (www.nabertherm.com) builds foundry furnaces designed for energy efficiency and integration with automation systems. They make melting and holding furnaces, dewaxing furnaces, furnaces for core drying, thermal decoring, and preheating, heat-treatment furnaces, and tempering systems for steel and aluminum

- Established in 1901, Johnson Gas Appliance Company (www.johnsongas.com) operates an industrial furnace division which produces high-speed heat treating furnaces, pot furnaces, soft metal melting furnaces, advanced melting furnaces, forge furnaces, crucible furnaces, and others. The company also makes burners, industrial blowers, and temperature control equipment.

Foundry Equipment

- General Kinematics (www.generalkinematics.com) engineers and designs vibrating equipment supplies with one division focused on foundry products. The key functions of vibrating equipment include cooling, heating, coating, drying, separating, grinding, and conveying and feeding.

- Clansman Dynamics (www.clansmandynamics.com) builds forge and foundry products. The company is committed to providing robust high-technology solutions for material handling in forges, foundries, steelworks and garbage handling for energy conversion. When building its manipulators, power-breakers, wedges, and robots, it seeks superior reliability and maximum simplicity, marketing lower maintenance costs and smoother production.

Machining Equipment

- Mazak Corporation is the U.S. subsidiary of major international machine tool builder, Yamazaki Mazak Corporation, which is based in Oguchi, Japan. The company produces machine tools and systems for the precision machining of metal parts, including CNC turning centers, horizontal and vertical machining centers, multitasking machining centers, turnkey cells, and software solutions to help customers achieve lean, efficient manufacturing operations.

- Kitamura corporation creates gear driven spindles for machining which are more energy efficient than direct drive or integral spindles. These machines use smaller motors resulting in a two-thirds saving in energy while maintaining the same cutting capacity.

Automation and Process Optimization

- Siemens is a major global industrial conglomerate. Within its automation technology division (www.automation.siemens.com) Siemens builds computer hardware and software products to monitor the entire manufacturing chain of primary metals producers. Process analyzers and analyzer systems from Siemens have main applications in raw material analysis, production optimization, plant safety, quality control and emission monitoring. Steelmaking is a primary target, but analyzers can be applied to many metal production processes.

- Summit Automation Inc. provides of energy efficient turnkey solutions for the most difficult applications in automotive parts and other manufacturing industries. They maintain applications in assembly, welding, material handling, and stamping.

Consultants

- Integer Research (www.integer-research.com) a specialist provider of research, data, analysis and consultancy services across a growing range of global commodities markets. Steel and ferroalloys are a core competency of the firm. The company provides a financial bulletin service, as well as annual and semi-annual reports covering the steel and ferroalloy industry.

- Accenture (www.accenture.com) is a global management consulting firm with a metals practice. Accenture develops strategies, business processes, and implements information technologies for metalworking clients through consulting and research. With a list of major clients ranging from Dongkuk Steel to Aluminio Brasilia SA to Gerdau, the company is global in scope and focuses on the largest companies in the world. Competitors such as McKinsey, Deloitte, and BCG provide similar management consulting services.

- California Manufacturing Technology Consulting (www.cmtc.com) is a non-profit consulting practice which provides third-party verified, industry-specific services to California businesses. The Energy Management Services practice performs energy assessments, process and equipment improvement analysis, process mapping, and energy-savings verification.

4. Target Technologies / Processes and Energy Efficiency

Metalworking is a large industry encompassing a myriad of different production processes, each with its own end-use profile. Broadly speaking from an energy perspective, the industry can be broken into processes that require smelting, melting, casting, and forging, and those that manipulate cold metal, through stamping, cutting, and so forth. Melters and smelters tend to be basic metal producers manufacturing hot-rolled steel, drawn wire, or other products from raw or scrap inputs, although foundries also fit the category. Cold-metal companies, which do not melt, tend to be applied metal producers, although there are some exceptions. Melters require much more energy and typically have larger operations often with natural gas as an important fuel. In California, there are few, if any, major companies relying on blast furnaces for melting; nearly every major melter uses an electric arc furnace. Smaller companies may vary, but blast furnaces often need to be large with high throughput to be profitable. Fabricating cold metal inputs into applied metal products can be done with much smaller operations and requires much less energy almost always in the form of electricity. When these cold fabrication operations get to be large enough, like the metal can plants in the Bay Area and Central Valley, they can be significant energy consumers but still only consume a fraction of the energy of major foundry or basic metal production facility.

Energy efficiency targets and technologies for the metalworking industry are then split between those which improve hot metal operations, including the rolling, casting, and forming processes, and those which improve cold metal operations used for fabricating many applied metal products.

Fundamentally, the smelting, melting, and processing at basic metal production plants represent the major processes requiring energy in the metalworking sector. Because the basic metal production sector is concentrated—the top five firms nationally in the steel subsector combine for 64 percent market share and the top five firms in the aluminum subsector combine for 54 percent market share[44]—these provide the largest targets for energy reduction. However, most large basic metal producers themselves have recognized the potential cost savings associated with energy efficiency and invested money and effort into achieving efficiency gains already. Some metals manufacturers are actually at the forefront of plant automation, R&D, and new

[44] IBISWorld. 2009. *IBISWorld Industry Report, Iron & Steel Manufacturing in the US: 33111*. August 18, 2009. IBISWorld. 2009. *IBISWorld Industry Report, Aluminum Manufacturing in the US: 33131*. July 28, 2009.

process implementation. Aside from metal cans, applied metal production is far less concentrated—for instance, the top three foundries control only 14 percent of the market[45] and no machine shop controls more than 1 percent of the market[46]—but many of the smaller operations are likely to have made little or no investment in energy efficiency. When aggregated, the opportunities to implement straightforward, less complicated efficiency measures with fabricated metal manufacturers may allow the realization of significant energy savings. For instance, bringing efficient automation and control programs to a major share of the nearly 3,000 machine shops in California could yield worthwhile energy reduction in aggregate, even though energy reduction at any single machine shop may be relatively small.

4.1 Energy Use

According to the Manufacturing Energy Consumption Survey (MECS), the metalworking industry in total used 2,132 trillion Btu, or 10 percent of the U.S. total, in 2006, the most recent survey year. Table 7 gives a breakdown of total energy consumption for metalworking by category. Within metalworking, basic metal producers use around three-quarters of the energy, with iron and steelmakers alone accounting for just under half of the overall metalworking energy use, and applied metal producers, including foundries**,** use around one-quarter of the energy.

Table 7: Metalworking Total Energy Consumption by Category.

Category	Energy Use (Trillion Btu)	Energy Use (% of total metalworking)
Basic iron and steel production	1,118	52%
Basic aluminum production	307	14%
Other basic metal production	147	7%
Foundries	164	8%
Applied metal production (except foundries)	396	19%
Total	2,132	100%

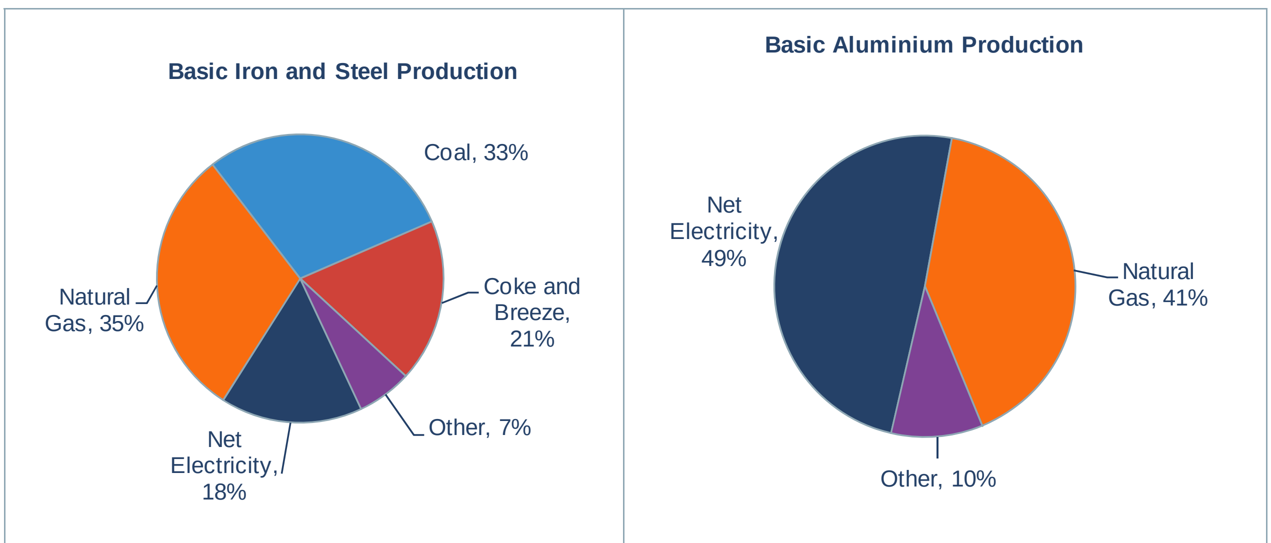
Source: U.S. Energy Information Administration[47]

[45] IBISWorld. *IBISWorld Industry Report, Ferrous Metal Foundry Products in the US: 33151*. November 2, 2009.
[46] IBISWorld. *IBISWorld Industry Report, Machine Shop Services in the US: 33271*. August 24, 2009
[47] U.S. Energy Information Administration. 2009. *2006 Energy Consumption by Manufacturers*. June 2009. http://www.eia.gov/emeu/mecs/mecs2006/2006tables.html

Given the diversity of technologies and shift from blast furnaces to electric arc furnaces among iron and steel mills, the aggregate nationwide fuel breakdown for the subsector is also a mix—roughly one-sixth of the energy use is electricity, one-third natural gas and the remaining is coal, which is mostly used in coke ovens. Any given individual steel mill has an energy-use profile that depends on the technology in use: a mini-mill with an electric arc furnace will be relying heavily on electricity, while a traditional mill with a blast furnace and coking operations would have heavy coal and coke use. Basic aluminum manufacturers as a group use about half of their energy as electricity, usually hydropowered, about 40 percent from natural gas, and the remaining one-tenth comes mostly from internally generated steam. Metal foundry operations are primarily natural gas users, with a secondary reliance on electricity for about one-third of their energy consumption.

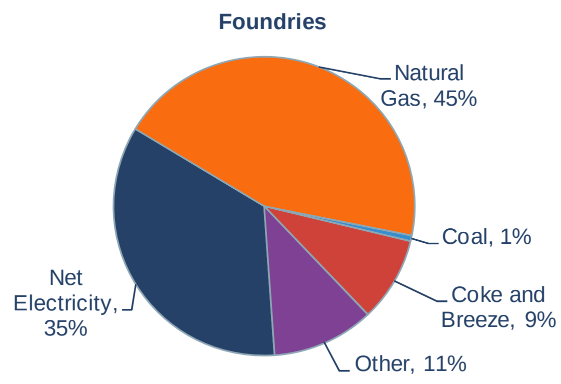
The breakdown of energy use by type, based on MECS data for the entire United States, is shown in Figure 11.

Figure 11: Metalworking Energy Use by Type

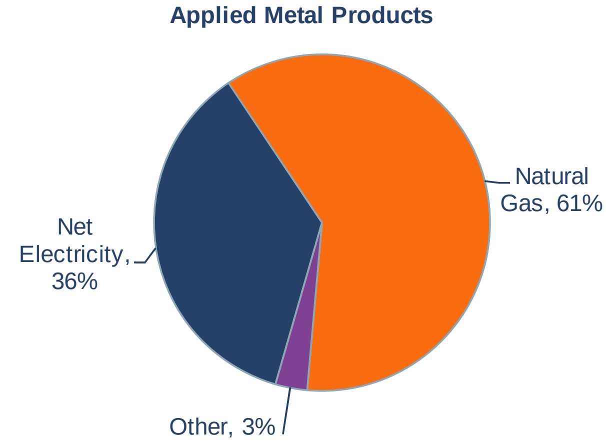


Source: U.S. Energy Information Administration[48] *Source: U.S. Energy Information Administration*

[48] U.S. Energy Information Administration. 2009. *2006 Energy Consumption by Manufacturers*. June 2009. http://www.eia.gov/emeu/mecs/mecs2006/2006tables.html



Source: U.S. Energy Information Administration



Source: U.S. Energy Information Administration

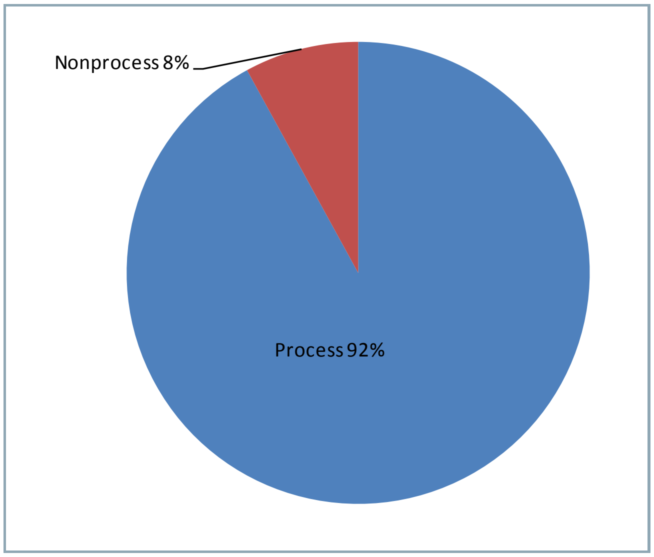
Process energy among basic metal producers and foundries (which are applied metal producers) is primarily for melting, smelting, and processing via rolling, drawing, and so on. Inputs come from the mining sector as metal ores or scrap producers as recycled metals. Ores do not contain metals in the form needed to make primary metal products, so primary metalworkers transform the ores, often adding other inputs to create alloys. Iron and steelmakers first smelt ore with coke (from coal) into pig iron in blast furnaces (or take scrap directly) then melt and reprocess it into iron and steel alloys. Aluminum ore (bauxite) requires high temperature electrolysis and copper requires flash smelting or electrolysis, although recycled scrap provides critical inputs to maintain current production of both these metals. Downstream, the metals are rolled, formed or drawn into finished products. Foundries take primary or scrap input, melt it, and produce metal castings.

4.2 Energy Consumption by End Use and Energy Efficiency Potential

Figure 12 and Figure 13 display electricity consumption in the basic metals producers (NAICS 331, also called the primary metals industry) and are based on U.S. industry data from the 2006 Manufacturing Energy Consumption Survey (MECS).

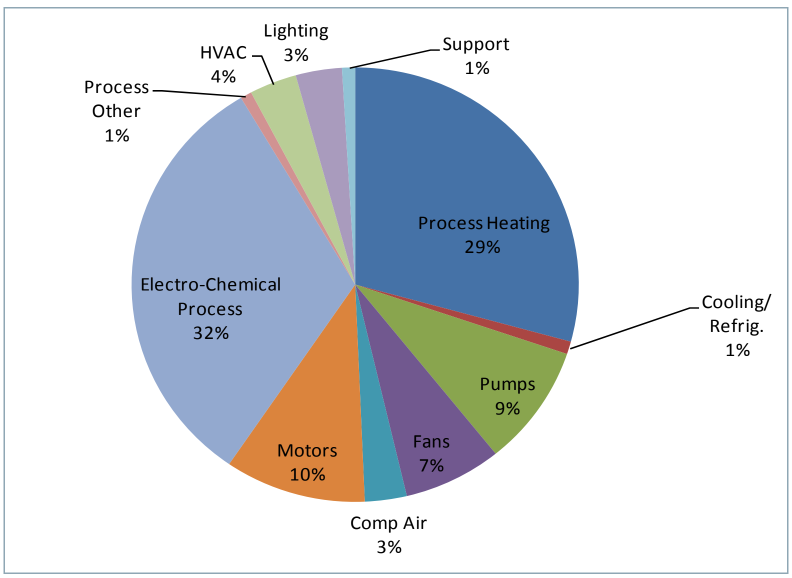
Figure 12 reinforces our findings that the majority of energy consumption (92 percent) by the primary metals industry is directly related to the manufacturing process. Non-process energy use, like facility lighting and HVAC, accounts for a small fraction (8 percent) of the industry's electric consumption.

Figure 12: Electric Consumption in the NAICS 311, Basic Metal Producers



Source: U.S. Energy Information Administration [49]

Figure 13: Electric Consumption by End Use for Basic Metal Producers

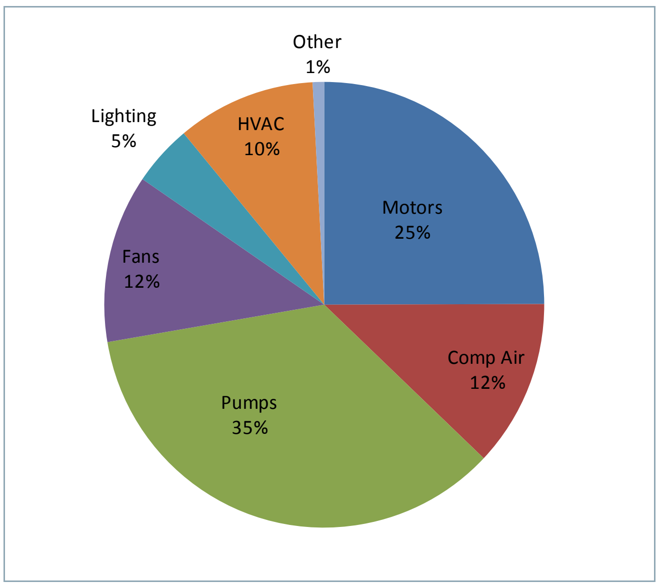


Source: U.S. Energy Information Administration

[49] U.S. Energy Information Administration. 2009. *2006 Energy Consumption by Manufacturers*. June 2009. http://www.eia.gov/emeu/mecs/mecs2006/2006tables.html

Figure 13 expands on the high-level consumption information presented in Figure 12 and shows electric consumption by end use for the primary metals industry. Energy use related to the electro-chemical process (32 percent) and process heating (29 percent) are the two largest end uses in the primary metals industry. Almost 30 percent of total electric consumption in the primary metals industry can be attributed to machine drives as defined by the MECS. Using information from prior research,[50,51] machine drive consumption can be divided into end-use categories for motors (10 percent), pumps (9 percent), fans (7 percent), and compressed air (3 percent). Facility lighting (3 percent) and HVAC (4 percent) dominate non-process electric consumption for the primary metals industry.

Figure 14: Electric Energy Efficiency Potential for Basic Metal Producers



Source: U.S. Energy Information Administration

Figure 14 presents the electric energy efficiency potential by end use for the primary metals industrial sectors (NAICS 331). The largest potential for electric energy savings lies in pumps and motors, accounting for about 35 percent and 25 percent respectively of the total energy savings potential in the primary metals industry.

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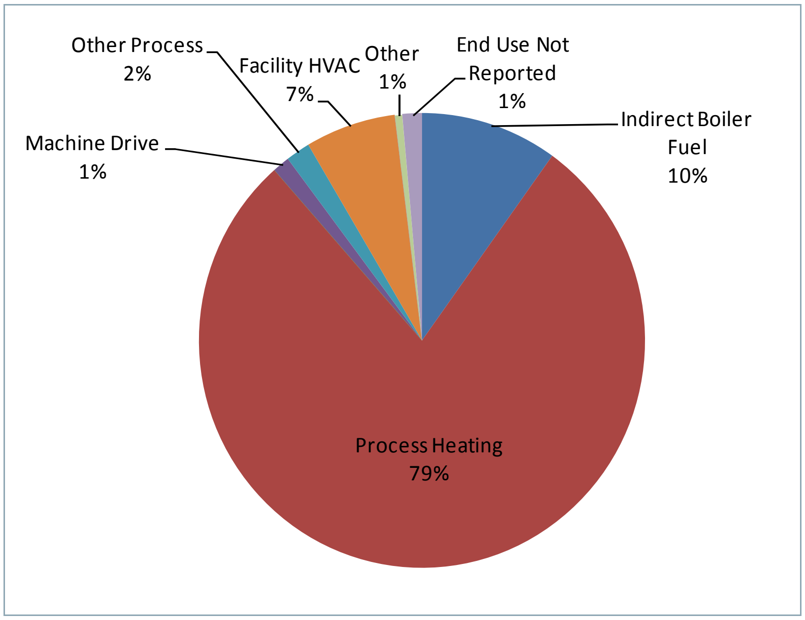
[50]KEMA and Lawrence Berkeley National Laboratory, 2005. *California Statewide Industrial Sector Energy Efficiency Potential Study.* Prepared for Pacific Gas and Electric Company.

[51] 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.

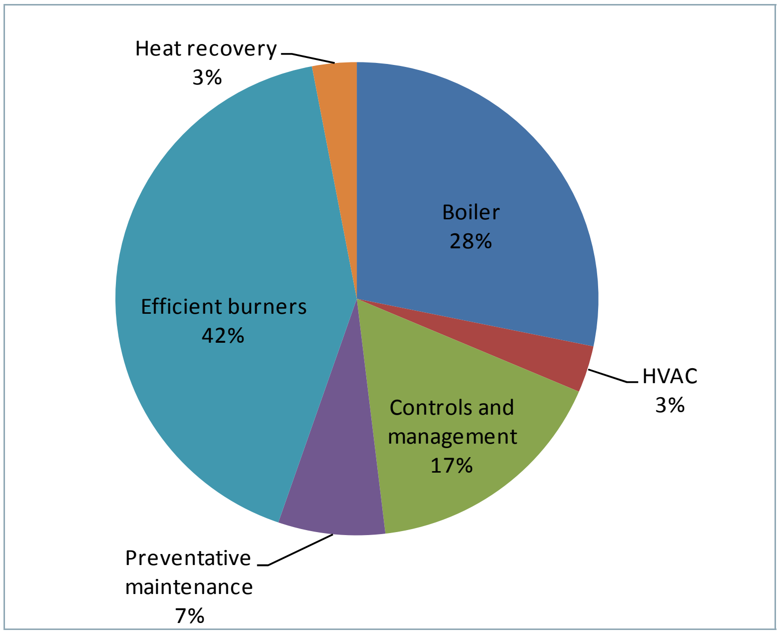
Figure 15: Gas Consumption in the NAICS 311, Basic Metal Producers



Source: U.S. Energy Information Administration

Figure 15 breaks down the end-use consumption of natural gas for the primary metals industry. The overwhelming majority of natural gas is used for process heating (79 percent).

Figure 16: Gas Energy Efficiency Potential for Basic Metal Producers



Source: U.S. Energy Information Administration

Figure 16 displays the energy efficiency potential related to natural gas use within the primary metals industrial sectors (NAICS 331). Efficient burners (42 percent of total potential) and boiler improvements (22 percent) represent the largest opportunity to save natural gas. Given that process heating is the largest gas end use within the primary metals industry, exploring related efficiency measures presents the greatest opportunity for large-scale energy and utility bill savings.

According to the U.S. DOE's energy and carbon footprint for the steel fabricated metals industry[52] (Figure 17), over 55 percent of energy use goes to production processes and approximately one third of input energy is lost in conversion of coal, natural gas, and electricity into useful energy. The DOE energy footprint Figure 17 attributes the energy loss to equipment inefficiency in motors, mechanical drives, and waste heat. Aluminum producers are similar, and foundries have a slightly smaller ratio of process energy use to total energy use.

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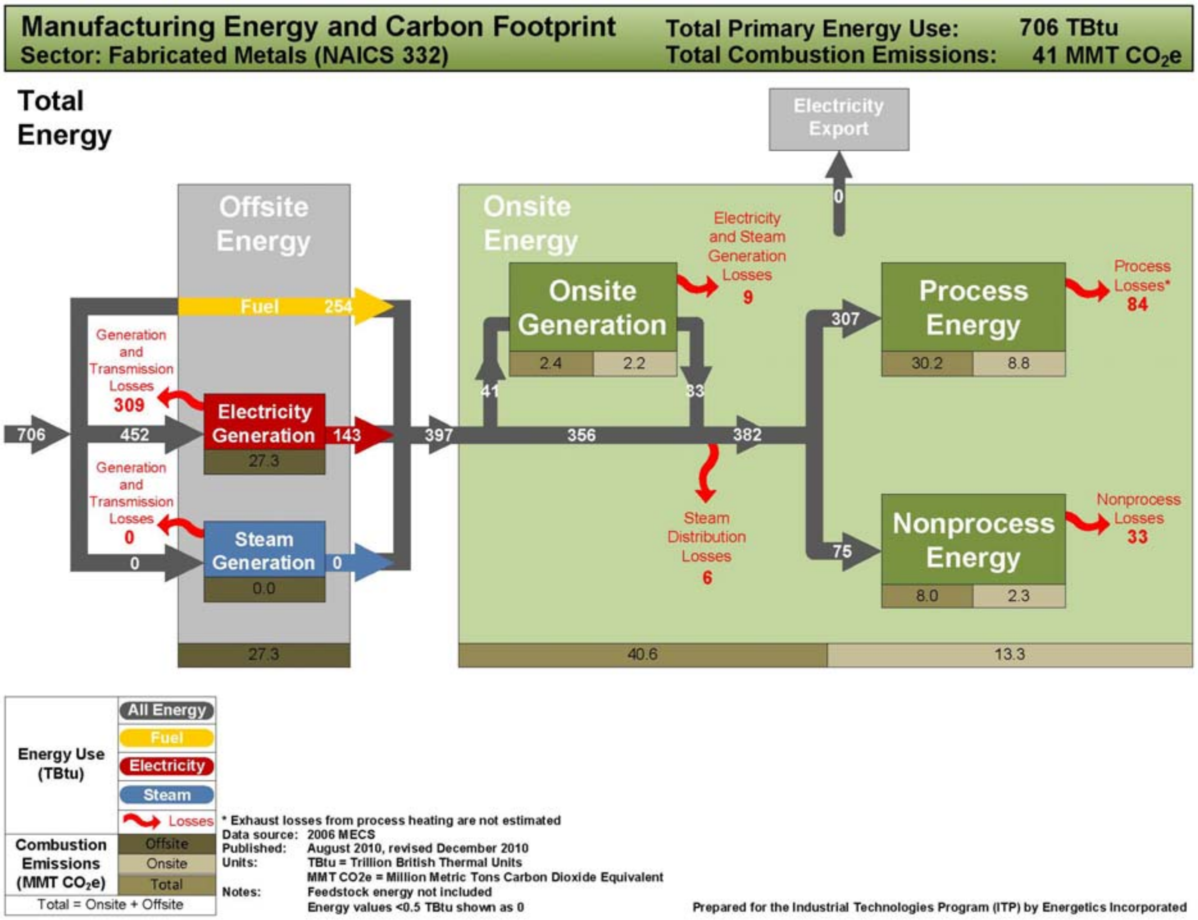
[52] U.S. Department of Energy, Advanced Manufacturing Office. 2010. *Manufacturing Energy and Carbon Footprint, Sector: Fabricated Metals*. http://www1.eere.energy.gov/industry/pdfs/metals_footprint.PDF

Figure 17: Energy Use and Loss Footprint for the Fabricated Metals Industry.



Source: U.S. DOE[53]

Although there are a wide range of business types for applied metal producers, these businesses are using natural gas and electricity almost exclusively to meet their energy needs. Energy end use is machining, treating, and forming. Metals service centers, which distribute basic metal products to applied metal producers, use comparatively little energy themselves.

[53] U.S. Department of Energy, Industrial Technologies Program. 2010. *Manufacturing Energy and Carbon Footprint, Sector: Iron and Steel*. http://www1.eere.energy.gov/industry/pdfs/steel_footprint.PDF

4.3 Production Processes

The process for basic metal production is highly dependent on the properties of the metal itself. For instance, aluminum, steel, and titanium (a typical non-ferrous metal other than aluminum) all have different processes. In general, elemental metal must be separated from within the ore. For steel, carbon in the form of coke from coal, is used as a cheap chemical reducing agent. It is not possible to use carbon as a reducing agent for aluminum, so an entirely different production process is required.[54] Further, different types of alloys involving a given metal demand different recipes of inputs. However, the production processes for different metals converge near the end of primary metal production. To be ready for delivery, molten metal must be cast, forged, rolled, drawn and/or finished, no matter what type of metal it is. Applied metal producers, like metal can manufacturers, then use the primary metal products for their needs—stamping, plating, machining, heat treating, re-melting, or otherwise modifying it.

For northern California, USS-POSCO and California Steel Industries are basic metal producers that do not operate as a traditional integrated steel mill or mini-mill. USS-POSCO processes hot-rolled steel purchased from other suppliers and California Steel processes smelted steel slab purchased from other suppliers. Thus these plants separate the steel finishing process from the smelting and initial production process.

TAMCO, another basic metal producer, operates the only steel mini-mill in California in order to produce rebar for construction. Schultz Steel is an applied metal producer which uses an electric arc furnace to perform vacuum arc remelting, which it relies upon to increase the strength of the primary steel it uses as inputs to forge aerospace grade products.

Metal can production is prominent in California and is illustrative of a typical applied metal production process. The bulk of manufacturing in the metal cans segment goes to aluminum cans, metal cans, and steel drums for shipping and storage. About 90 percent of metal can production is sold to the food and beverage industry.

Raw materials account for nearly two-thirds of industry costs, according to IBISWorld, and utilities as whole account for only 3 percent of costs, mostly for electricity. Because the utility costs are relatively minor and metal cans are not a global commodity the way steel is, metal can manufacturers may have given little attention to cutting costs through energy efficiency.

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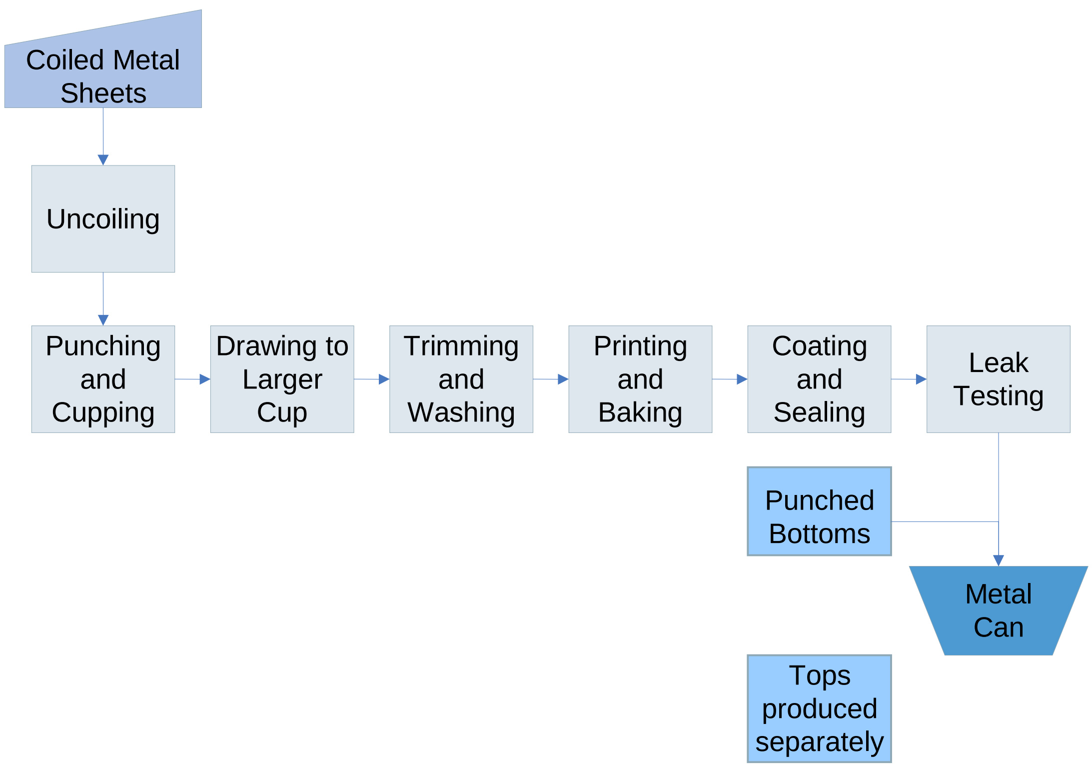
[54] Illinois Sustainable Technology Center, University of Illinois.. No date. Primary Metals, Aluminum Smelting and Refining, http://www.istc.illinois.edu/info/library_docs/manuals/primmetals/chapter1.htm

Electricity primarily goes to machine use, as metal cans are produced on an automated assembly line using the steps shown in Figure 18. Fundamentally, unlike primary steel production that the steelmakers and foundries do, metal can manufacturing does not entail any melting or re-melting of metal. Instead, they use a number of cold metal operations such as forming, drawing, cutting, punching, machining, molding, pressing, bending, shearing, stamping, coining, drilling, buffing, welding, joining, heat treating, anodizing, and others. Hence, because the metal remains cold, energy use per pound of product is much lower. Sizable metal can manufacturing operations can be significant energy users.

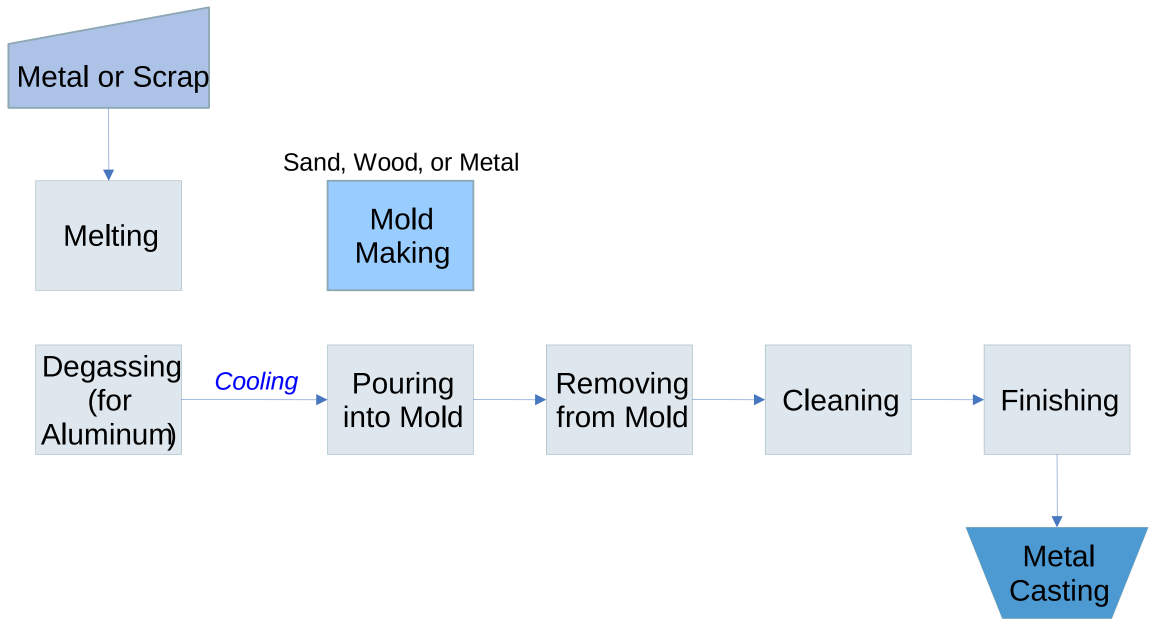
Figure 18: Metal Can Manufacturing Process



Source: KEMA, Inc

California has few iron and steel mills, typically the largest targets for energy efficiency improvements. On the other hand, California has a number of foundries. According to IBISWorld, fuel purchases make up 6 percent of costs for the foundry industry, well behind raw materials and labor as a proportion of spending. Foundries are one target of the U.S. EPA's ENERGY STAR program, particularly the melting process.

Figure 19: Foundry Production Process



Source: KEMA, Inc based on EPA[55]

4.4 Current Practices

Basic metal production has seen dramatic energy efficiency gains over the years , but manufacturing basic metals remains one of the most energy intensive industries in the United States. The energy needed to make steel has dropped around 30 percent over the last 20 years.[56] Over the last 45 years, the energy needed to make aluminum has dropped 64 percent.[57]

In general, applied metal producers have not made energy efficiency a priority because energy costs make up only a small portion of their budgets. Ball Corp is one exception, having joined the EPA's Climate Leaders and established goals for energy efficiency. Any gains among applied metal producers have been far less dramatic and have not been widely touted.

[55] U.S. Environmental Protection Agency. 2002. Economic Impact Analysis of Proposed Iron and Steel Foundries NESHAP. November. http://www.epa.gov/ttnecas1/regdata/IPs/Iron%20Foundries_IP.pdf

[56] AISI Press Release, December 11, 2009.

[57] Das, Subodh and John A.S. Green. "Aluminum Industry and Climate Change – Assessment and Response" *Journal of Metals*, 62 (2), 27-31, February 2010.

For both basic metals producers and applied metal producers, gains moving forward will depend on the types of process improvements and adoption of newer technology discussed below. For basic metal production, incremental improvements in rolling, casting, and forming seem promising going forward. More widespread adoption of automation and computer control among smaller operations is a real opportunity to see efficiency gains in applied metal production. Significant investment or innovation may be required to see efficiency gains similar to what the steel and aluminum industries achieved in previous decades.

4.4.1 Efficiency Improvements

For basic metal producers have a strong driver to increase efficiency, as they rely more on processing scrap, which today is driven mostly by global commodity price trends. The efficiency of smelting, secondary melting, and rolling/finishing portions of production will likely improve through incremental technological gains. Applied metal producers who melt metal (e.g., foundries) can find significant energy efficiency gains with improved melting processes. Other producers who deal only with cold metal must rely on process improvement, automation, and control technologies to improve the efficiency of the production process.

Opportunities for energy efficiency improvements exist in moving to innovative technologies as follows:

- **Increase scrap usage coupled with electric-arc furnaces**. Using scrap eliminates the need to separate the desired metal from ore and thus requires less energy to produce per ton. Technologically, it depends on the metal, but most production processes can use efficient electric arc furnaces to achieve efficiency gains. Current energy efficiency technology practices among basic metal producers vary, but increased recycling of scrap is a universal efficiency benefit. Among steelmakers, the movement towards mini-mills, flexible production, and electric arc furnaces, with concomitant use of scrap, has driven much of the energy efficiency gains. Nucor embodies the trend. It began with a single electric-arc furnace in 1968 and used the efficiency advantages of the technology to grow into a global leader. Electric arc furnaces have themselves doubled in efficiency since they were originally introduced in middle of the twentieth century. The use of scrap to bypass the smelting process entirely also allowed sharp gains in efficiency. New furnaces are likely to be electric arc furnaces moving forward. Aluminum, copper, and other non-ferrous basic metal production have not seen as large technological changes, but the efficiency gains from utilizing scrap are tangible. Creating aluminum from scrap uses 95 percent less energy than producing virgin aluminum from bauxite ore,[58] which has resulted in around 60 percent of aluminum production coming from recycled scrap.[59]

Although not appropriate to any major California producers, U.S. and global companies may modify or update smelting technologies for virgin iron and steel production. This may include optimizing the timing and depth of oxygen lance placement in basic oxygen blast furnaces.

- **Improve secondary melting efficiency**. By preheating, oxygen co-firing, and operational process modifications, there are opportunities to use less energy for secondary melting for downstream processing, casting, and foundry products. A 2005 report[60] prepared under a U.S. DOE Office of Renewable Energy and Energy Efficiency program lists several possible ways to increase melting efficiency, along with an estimate of energy savings as a percentage:
  - Charge preheating (5–10 percent energy savings): Sorting and charging scrap prior to putting it in an electric arc furnace increases coil efficiency and shortens melting time. Overall melting time is reduced by preheating the charge to remove moisture and residual surfactants before melting.
  - Air preheating (5–10 percent energy savings): Using the high-temperature off-gas (or flue gas) from the melting chamber to preheat scrap can reduce the amount of energy needed for melting.
  - Molten metal stirring (5–30 percent energy savings): Eliminating temperature gradients within the molten metal creates more even heating and reduces the overall energy needed to melt the entire batch of metal. Electromagnetic pumps are often used for stirring.
  - Oxygen co-firing (0–40 percent energy savings): Using oxygen rather than air as a combustion fuel results in improved energy efficiency in remelt furnaces. Increased oxygen in the furnace environment, however, can lead to greater oxidation of the metal surface and increased formation of unwanted by-products and increased wear on the melting equipment.

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[58] Ibid.

[59] IBISWorld. 2009. *IBISWorld Industry Report, Aluminum Manufacturing in the US: 33131*. July 28, 2009.

[60] BCS Incorporated. 2005 *Advanced Melting Technologies: Energy Saving Concepts and Opportunities for the Metal Casting Industry*. Prepared for the U.S. DOE, Energy Efficiency and Renewable Energy, Industrial Technologies Program. November 2005.
http://www1.eere.energy.gov/industry/metalcasting/pdfs/advancedmeltingtechnologies.PDF

- Scheduling and batch-size modifications (0–30 percent energy savings): It takes energy to heat a cold furnace up, so when schedules require heating from a cold furnace or varying batch size significantly, more energy is required than a furnace that consistently heats the same size batch. Maximizing the number of batches per day through creative scheduling (e.g., fewer furnaces or fewer melting days per week), reduces radiant heat and energy losses associated letting furnaces cool, then heating them from cold.

- **Replace oven reverberatory melters with stack melters at metal casting plants**. Reverberatory furnaces heat the melting apparatus with burners on the roof or sidewall; that heat re-radiates from the melting apparatus and melts the metals below. Gas reverberatory furnaces are commonly used in foundries large and small because they ensure a steady and reliable supply of molten metal to the multiple operations in shop from the large central reservoir. The advantages of reverberatory furnaces reside in high-volume processing rates and low maintenance costs. Stack melters are essentially modern, more energy efficient reverberatory furnaces where flue gases preheat the metal and it slides through a tightly sealed stack into the main melting chamber. If there is enough vertical space for a stack furnace, the inherent preheating increases the efficiency of the furnace.

- **Avoid reheating as part of the casting and rolling process**. Nucor has invested significantly in plant-scale implementation of new rolling and casting processes. Castrip is a new casting technique to produce lighter gauge steel by feeding molten metal through twin counter-rotating rollers to avoid reheating. Traditional slab casters require multiple reheatings and additional energy to roll them into end product.

- **Automate and integrate information technology investments**. Modern machine shops and metal manufacturing often rely on computed numerically controlled (CNC) machine tools that allow end-to-end computer design (via CAD/CAM) and production. Computer operations produce precise output in a short amount of time and allow automation of complex metal fabrication tasks. When energy use is considered, automation processes can be modified to be optimally efficient. Many smaller operations do not employ any computer technology and could improve efficiency greatly. Operational adjustments may include anything from using a computer to track orders and shipments at a metals service center to a highly automated machine shop process. The Metals Service Center Institute reports that metalworking spent less on information technology than 20 other U.S. industrial categories.[61] Although many distributors and end users have invested in sophisticated inventory and operational control programs, there is still a notable portion of the market operating the "old fashioned way."

- The advent of computer-control systems improved efficiency at many applied metal production plants. Existing machine systems generally do not warrant costly retrofit with tighter control systems, which can be difficult to implement on older equipment. However, during rebuild the tighter control systems can pay for themselves through increased efficiency, so upgrades most often occur during major maintenance cycles. The largest manufacturers typically employ computer control systems already, but small- and medium-size enterprises may or may not use them. EE programs that promote computer control systems can improve efficiency most with smaller businesses.

- For manufacturers who are unable to justify major energy improvements, best practices around energy efficiency center on modifying batch preparation, making changes to existing furnaces, optimizing energy use during forming and annealing, optimizing heat and steam distribution, optimizing compressed air systems, and using lighting more efficiently. Table 8 is adapted from the Lawrence Berkeley National Lab reports on industrial energy efficiency. The recommendations around motors are especially important at the largest metalworking companies, which may run thousands of motors as part of their operations.

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[61] Murphy, H. L. "Believe it–The Computer Age has Arrived." *Forward Online: Global Perspective from MSCI.* May/June 2006.
http://forward.msci.org/articles/0606research.cfm#

Table 8: Additional Energy Efficiency Opportunities

Metals Specific	General Manufacturing Recommendations
Primary Metal Batch Preparation Optimize conveyor belts Use smaller or higher efficiency motors Use motors with variable speed drives Use high efficiency conveyer belts	**Heat and Steam** Improve insulation Perform regular maintenance Reduce excess air Repair leads Recover heat (steam or boiler heat)
Existing Furnaces Minimize excess air and air leakage Add Premix burners Use adjustable speed drives on fans Properly position burners Use sealed burners Use high luminosity burners (oxy-fuel only) Use a tall crown furnace (oxy-fuel only) Top heat (electric only) Optimize electrode placement (electric only)	**Compressed Air** Reduce leaks Turn off unnecessary compressed air Minimize pressure drops Reduce inlet air temperature Use air at lowest possible pressure Properly size regulators Properly size pipes Maximize dew point at air intake
	Lighting Install lighting controls Replace incandescent bulbs with LEDs, CFLs, fluorescent, or high pressure sodium lights Use daylight wherever feasible Install reflectors

Source: Lawrence Berkeley National Laboratory[62]

Metal engineers and research chemists have numerous other ideas about ways to improve efficiency and save money in the metalworking manufacturing process. The utility of advanced approaches to refining varies because the process differs greatly between segments and individual manufacturers. Infrared heating, microwave melting, solar furnaces, molten oxide electrolysis, new cathode technology, and other ideas are under investigation or at pilot scale. Individual companies also develop proprietary designs for their processes that save energy.

[62] Lawrence Berkeley National Laboratory. 2010. *Energy Efficiency Improvement and Cost Saving Opportunities for the U.S. Iron and Steel Industry, An ENERGY STAR® Guide for Energy and Plant Managers*. Report LBNL-4779E. October 2010.

4.4.2 Capital Expenditures for Energy Efficiency

Across the industry, global commodity metal prices impact the decision to implement energy efficiency measures. Metalworking companies individually have little control over the prices. For instance, global demand in the construction industry, driven by growth in China and emerging markets, strongly influences the price of new steel, which in turns influences the price of scrap, and also influences the price of ore. Basic metal producers are more likely to invest in energy efficiency when prices and profits are higher, while applied metal producers, which consume primary metal, are more likely to invest when input metal prices are lower.

On the basic metal production side, there are very few, if any, large integrated steel or aluminum plants under construction in the United States and the globalization of the metal markets over the last two decades has forced plants to implement efficiency measures for the production cost benefits, rather than any environmental or reputational reasons. The decision to employ efficiency measures typically hinges on the capital cost of implementing the new technologies at existing plants. Underlying all analysis is the projected cost of ore and metals and sometimes enacted or potential environmental regulations. Higher metal prices naturally make upgrades and retrofits around energy efficiency far more appealing. It is expected that a price on carbon emissions would have a similar effect. However, coal prices do not fluctuate the way metal prices do and electricity costs are regulated, so it is simply the size of the energy cost, rather than any uncertainty in energy prices, that creates the possibility of investment. Basic metal producers typically have access to the international debt markets, if not directly then via a parent company (e.g., USS-POSCO via U.S. Steel or POSCO). Because the largest California operations are either private or subsidiaries of global firms, it is difficult to assess the balance sheet of individual firms in the state to determine how well positioned they are to finance efficiency measures.

Applied metal producers are often small businesses and averse to investing research and development or unproven technologies because many of them operate with small profit margins. As noted in a U.S. DOE funded report by BCS Incorporated for the metal casting industry, a primary criteria for investing in energy efficiency in small businesses is avoiding capital outlay, primarily through relying on low-cost projects, but occasionally through government grants. Further, because the largest cost driver is raw metal purchases, fabricated metal products manufacturers are far more sensitive to commodity metal prices than energy prices. Thus, they are more likely to invest in capital projects like plant automation, when metals prices are consistently low. Their readiness is in contrast to primary metal manufacturers. The largest applied metal producers like Ball Corporation have access to the corporate debt markets, but most applied metal producers are smaller, private companies that must rely on bank loans or cash from operations for capital. In many cases the capital costs are too high or productivity losses during implementation drive the decision away from implementing something new for relatively small bottom-line cost savings. Efficiency measures which can be implemented online while production maintains at normal levels and incentives may be most appropriate for these companies.

The American Recovery and Reinvestment Act of 2009 (ARRA) provided federal funding for states to implement energy efficiency programs nationwide. Different states have targeted different areas for investment, with some giving energy efficiency grants to metalworking companies. American Metal Market reported in February 2010 that Ohio gave $11.8 million in grants to 18 metals firms for energy efficiency under ARRA. The funding may be indicative of political support of metalworking within the state, as state officials have some discretion in what programs to fund. California has not funded metalworking firms as much as Ohio.

5. Market Intervention

KEMA conducted in-depth interviews to elicit insights from metal working customers on energy efficiency decision making, drivers, barriers, innovation, technologies, and utility programs. The project approach recommended a webinar or forum for metalworking customers and experts. However, the response to the forum invitations was entirely lacking. The poor response is consistent with highly fragmented subsectors. Customers were more willing to participate in interviews, and eight interviews were completed. Key findings mentioned by these interviewees are described further below.

The following sections describe the insights and conclusions from our primary research.

5.1 Drivers of Energy Decision-Making

Many of the questions we asked (see Appendix A) focused on the decision-making process around investment in energy efficiency. We sought to understand the importance of energy in the operations of metal-working customers, what are the drivers are for investment, what role innovation plays in energy and process decisions and what barriers inhibit wider adoption of energy efficient technologies and practices. The following section summarizes the results of this investigation.

5.1.1 Energy Efficiency Planning

For this industry group energy efficiency means lowering the cost of fuel. They think in terms of kWh or MBtu/ton of raw materials processed. Energy efficiency is important but not the main priority. As a result, energy efficiency planning happens after other considerations are taken into account. Safety, reliability, and quality are examples of higher priorities.

5.1.2 Investment Priorities

Investment in this industry is driven by a host of competing issues. Maintaining or improving product quality, ensuring processes are reliable, employee safety and environmental concerns top the list. In addition, competitive pressures from low-cost providers are always a concern and, as a result, any way to reduce costs is considered.

It should be noted that reliability of energy service is also considered important by this sector. Because they are an energy intensive industry they are sensitive to energy costs whether from electricity and natural gas consumption or from electric demand charges. As a result, any tariff or process adjustment that helps manage their overall energy bill holds great potential for customer participation.

5.1.3 Project Financing

Most companies did not report any concerns about access to capital. Upgrades were treated as expense items and larger projects were included in capital budgets. None of the managers KEMA interviewed indicated difficulty accessing capital for energy efficiency projects as long as the projects met internal simple payback criteria.

Simple payback varied by firm but project hurdle rates of one to two years were most common. Some firms would allow energy efficiency or renewable energy projects with longer paybacks if that project satisfied other strategic or operational goals.

5.1.4 Barriers to Energy Efficiency Investment

The primary barriers we heard from our respondents are listed here in no particular order:

- **Risk aversion and unwillingness to experiment with working processes.** Respondents were reluctant to try technologies or processes that were not fully proven in an industrial setting. In several cases however, respondents indicated they would participate in small-scale demonstration projects where proper measurement could demonstrate savings and operations were protected. For example, they preferred to focus on compressors or smaller horsepower motors rather than large motors or equipment that played a key role in production. In addition, maintaining production, quality and safety goals with reliability are a high priority. Metalworking companies across the spectrum are very concerned about the reliability of all new equipment to meet their standards, including high efficiency equipment.

- **Lack of strong incentives for reducing energy consumption**. Based on the interviews, one major goal for firms is to reduce cost per unit. This may be measured in tons of steel processed or volume of product shipped. All inputs (materials, labor and capital) contribute to the cost side of this equation. Energy consumption and energy prices represent only two of several components of this decision process. Furthermore, firms are reminded of prices for energy along with raw materials and labor on a monthly (and sometimes daily) basis. To further reduce the emphasis on energy consumption, firms must address and meet the environmental constraints (as discussed in section 3.5

of this report) just to continue operations. As a result, energy consumption typically is often not considered within the context of ongoing operations.

- **Poor understanding of energy efficiency opportunities and best practices**. In addition to not knowing about utility rebate programs, respondents of smaller firms had no idea what they should be looking for in terms of future energy efficiency projects. Most often they had a small staff and did not have the time to do the research. Larger firms often had an energy engineer on staff (usually located in the corporate administrative center).

- **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. This is especially true among specialty applied metal producers because they compete on quality and specialization, so any loss of operational capacity, even for a short time, can be crippling.

- **Limited staff time and hassle factor.** Staffing limitations are another key barrier to increased energy efficiency. While most facility managers want to stay as efficient as possible, the number one priority of the staff is to keep the facility operational. Smaller energy efficiency projects are not pursued because they are not worth the trouble.

- **Cost effectiveness.** Most industrial customers have severe cost-effectiveness criteria. The recent economic recession has had a significant impact on acceptable payback period for projects that are designed to save costs. Industrial customers generally have payback cutoffs of less than five years, with some as low as one to two years. Commodity basic metal producers are especially sensitive to cost effectiveness, because they are competing almost exclusively on price.

- **Environmental costs and concerns.** Many industrial facilities must comply with stringent environmental regulations, especially in the steel, aluminum, and other primary metal segments; energy efficiency projects must conform with these system requirements. Requirements to minimize air and waste emissions can require additional process energy use. This is especially true in the southern part of the state where the South Coast Air Quality Management District imposes strict air quality criteria.

5.2 Cycles of Innovation

Beyond competitive pressures, none of the respondents in this industry reported any internal or external factors driving innovation. Some firms were looking at solar generation for their office buildings but not for their industrial facilities.

5.3 Customer Assessment

5.3.1 Utility Program Awareness

Most respondents reported little to no awareness of the full range of utility rebate programs. This was true regardless of the company's geographic location. The reasons for this varied. Some firms investigated equipment only when it was ready to be replaced and limited their research to that equipment. Others had corporate engineers that did most of the research and advised the plants on what type of projects to pursue.

Most respondents heard about a utility program only after being approached by a vendor that included a rebate value in a project description or bid.

Interestingly, one respondent with plants outside IOU service territories reported much higher awareness of utility programs. They were not assigned an account executive, but did receive a monthly newsletter from the Modesto Irrigation District with information on rebates and other utility offerings (i.e., audits, rates).

5.3.2 Customers' Experience

Although participants claimed little knowledge of current programs, most respondents viewed the programs they had participated in favorably. Since most reported little contact with the utility however, their satisfaction was based on the fact that the rebate helped the project meet their internal hurdle rates. In fact most respondents did not think in terms of utility programs. They learned rebates (or credits) were available for certain equipment (primarily through contractors) and evaluated their projects based on the reduced cost. The concept of *programs* is more of a utility internal designation rather than a term used by this customer group.

Many expressed an interest in audits beyond the basics. Respondents felt more improvement was possible for motors, compressors, furnaces and processes but they did not know how to go about identifying these options. They were interested in new ideas that were applicable to their operations, particularly improving motors and motor-driven equipment. One participant noted that their corporate parent group had goals on sustainability, and they expected plant goals to follow in the near future.

6. Next Steps and Recommendations

This investigation has revealed that metalworking customers are willing to consider new approaches, 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 encourage the adoption of energy savings technologies and practices. Respondents expressed the desire to stay informed on the latest practices and technologies, but did not have the time or knowledge to devote to finding, interpreting and then applying it in the plant.

- **Target trade associations** such as the ones listed in section 3.6 of this report. 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. Custom efficiency programs work well with metal working firms due to their varied production processes. 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. Changing linings on furnaces or replacing/reconfiguring large horsepower motors are some examples.

- **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 service territory. This could be done cost effectively through electronic delivery of information.

6.2 Evaluation

- **Develop innovative pilots to suit differing customer needs.** The metal worker sector is not known for leadership in energy efficiency. Thus highly sophisticated offerings such as Superior Energy Performance will have few takers. However, this industry may be receptive to shorter term programs like the Energy Trust of Oregon's *Kaizen Blitz* pilot program[63], and Puget Sound Energy's *Resource Conservation Manager* Program.[64] This Energy Trust's program offers an initial audit and one year of technical assistance, but requires the participants to set goals and implement fast payback options. Puget Sound Energy's program offers grants for a resource conservation manager and incentives for energy efficiency improvements. This program focuses on and rewards improvements in behavior and utility cost accounting.
- **Demonstration.** Risk aversion to new technologies is a strong barrier to new equipment adoption in this industry. Conducting demonstration projects or using measurement techniques that can show where savings are possible (compressor leaks), and how energy efficiency can support reliability, quality and environmental concerns have the best potential to encourage adoption.

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[63] Navigant. 2010. *Kaizen Blitz Pilot, Report One*. Prepared for Energy Trust of Oregon. October 2010 http://www.affiliatedrecon.com/studies/OR/Energy_Trust/General/ETO-Kaizen-Blitz-Pilot.PDF

[64] Puget Sound Energy. *2010 Business Energy Management, Resource Conservation Manager Program*. February 2010.
http://www.pse.com/savingsandenergycenter/ForBusinesses/Documents/3462_RCM.PDF

- **Engage the uninterested in measurement.** One of the biggest challenges in the industrial sector is getting participation. The metalworking sector was generally not interested or engaged in energy efficiency, as evidence by the complete lack of interest in attending a utility forum on the subject. 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. Customer 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 metalworking 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.