Energy Trends in Selected Manufacturing Sectors:

Opportunities and Challenges for Environmentally Preferable Energy Outcomes








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3.8 Metal Finishing

3.8.1 Base Case Scenario

Situation Assessment

Recent Sector Trends Informing the Base Case

Number of facilities: ↓
Value of shipments: ↓
Electricity energy intensity: ↑

Major fuel sources: Electricity, natural gas, petroleum

Current economic and energy consumption data are summarized in Table 46 on page 3-72.

A subset of the fabricated metal products industry, metal finishing (NAICS 332813) encompasses a variety of surface finishing and electroplating operations that coat an object with one or more layers of metal to improve resistance to wear and corrosion, alter the appearance, control friction, or impart new physical properties or dimensions. This diverse sector is composed of approximately 2,900 facilities, most of which are small, independently owned facilities that employ 50 or fewer people.[235] The industry is geographically concentrated in highly industrialized areas of California, Texas, and the Great Lakes states.[236]

The metal finishing industry participates in EPA's Sector Strategies Program.

The sector faces economic pressures from foreign competition and declines in the U.S. automobile industry, experiencing an 11 percent decline in the number of facilities since 2000, and a 21 percent reduction in the number of employees.[237] Profit margins in the industry are generally small, which, combined with the small average business size, means that metal finishing companies have limited financial resources at their disposal. From 1997 to 2004 the sector experienced no growth in value added and a small annual decline in value of shipments (see Table 46).[ffff] [238] According to the organization Energy Industries of Ohio, electroplating operations have been particularly hard hit by rising production costs and the pressures of foreign competition that keep product prices down. In response, the electroplating industry shows a general trend of moving overseas.[239]

Between 2002 and 2004, electricity represented approximately half of the industry's energy costs, with purchased fuels (a large percentage of which was natural gas) comprising the remaining portion.[240] Different types of metal finishing operations have different energy requirements; though some operations use relatively more direct fossil fuel inputs, electroplating operations are electricity intensive. Since Census Bureau data from the *Annual Survey of Manufacturers* (ASM) do not provide the annual amount of energy produced from purchased fuels, it is not possible to calculate the total energy intensity of the metal finishing industry, though it is possible to calculate electric intensity (kWh/dollar value of shipments). Industry-wide electric intensity increased by approximately 3 percent from 1998 to 2004.[241]

The National Metal Finishing Strategic Goals Program (SGP), a voluntary environmental partnership between EPA and several metal finishing trade associations that focuses on electroplating operations, collected energy intensity data (thousand Btu/dollar of sales) from program participants. According to these data, energy intensity remained relatively steady from 1998 to 2003, increasing by just 0.07 percent over the period, with year-to-year fluctuations that may be attributable to economic production trends and variations in the number of companies reporting data. Additionally, an independent third-party, the National Center for Manufacturing Sciences, tracked the progress of 150 participating metal finishers that consistently reported

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ffff U.S. Census Bureau data on the industry's value added and value of shipments from the *Annual Survey of Manufacturers* covers a broader NAICS category (NAICS 3328: coating, engraving, heat treating, & allied activities) than the metal finishing industry.

their environmental progress. Through 2001, cumulative improvements for these facilities included a 7 percent reduction in energy use, normalized by dollar value of sales.[242] The differences in electricity intensity (ASM data) and energy intensity (SGP data) are in part attributable to the fact that the SGP energy intensity metric includes both electric and fuel energy inputs. Also, ASM data represent a larger cross-section of the metal finishing industry, as SGP data are primarily from electroplaters.[243]

In general, most current efforts at improved energy efficiency and technology adoption in the metal finishing sector are being driven by customer demand. These may take the form of improved environmental performance (such as ISO 14001 certification), which requires modification to existing processes, or lower-cost products, which requires efficiency of operations and inputs, including energy. Many of the emerging technologies that offer energy efficiency improvement opportunities for the metal finishing sector focus on waste reduction in existing processes and substitutes to current electrochemical processes. At the same time, metal finishing companies have little in-house technical expertise and tend to rely heavily on their equipment suppliers for information.[244] There are clear energy efficiency opportunities available to the metal finishing industry, but given the economic pressures on the industry, it seems most likely that improvement may come from retrofitting existing technologies with more efficient equipment, as opposed to wholesale process changes.[245]

Table 46 summarizes current economic trend and energy consumption data originally presented in Chapter 2.

Table 46: Current economic and energy data for the metal finishing industry[gggg]

Economic Production Trends[hhhh]				
	Annual Change in Value Added 1997-2004	Annual Change in Value Added 2000-2004	Annual Change in Value of Shipments 1997-2004	Annual Change in Value of Shipments 2000-2004
	0.1%	-1.2%	-0.3%	-2.0%
Energy Intensity in 2002[iiii]				
	Energy Consumption per Dollar of Value Added (thousand Btu)	Energy Consumption per Dollar Value of Shipments (thousand Btu)	Energy Cost per Dollar of Value Added (share)	Energy Cost per Dollar Value of Shipments (share)
	NA	NA	6.7%	4.0%
Primary Fuel Inputs as Fraction of Total Energy Supply in 2002 (fuel use only)[jjjj]				
		Natural Gas	Net Electricity	Fuel Oil
		54%	42%	2%

gggg No fuel-switching data are available for this sector.

hhhh Economic data are for the larger NAICS category of coating, engraving, heat treating, & allied activities (NAICS 33281).

iiii Energy intensity data are for the larger NAICS category of coating, engraving, heat treating, & allied activities (NAICS 33281).

jjjj Fuel use data are for the larger NAICS category of fabricated metal products (NAICS 332).

Expected Future Trends

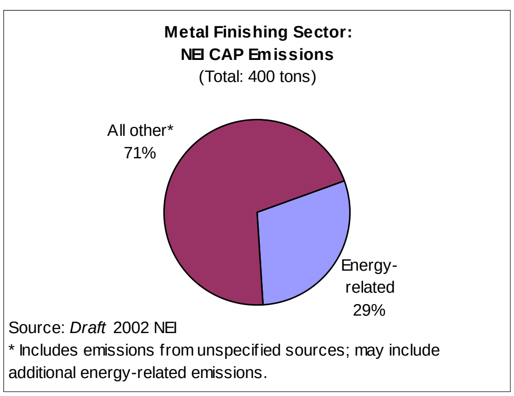
No energy projections are available for the metal finishing industry. The "metals-based durables" sector is one of the industrial sectors modeled in the CEF report and by AEO 2006, and includes the following industries: fabricated metal products, machinery, electric and electronic equipment, transportation equipment, and instruments and related products. Though we do not present a full analysis of CEF and AEO 2006 projections as we do for other sectors, it is helpful to consider the metals-based durables projections in terms of extrapolating what future energy trends are likely to be for the metal finishing industry. Further complicating efforts to predict future energy consumption trends for the metal finishing industry is the heterogeneous nature of the sector itself. For instance, trends for electricity-intensive segments of the industry (like electroplating) may differ from trends in segments that rely more heavily on natural gas.

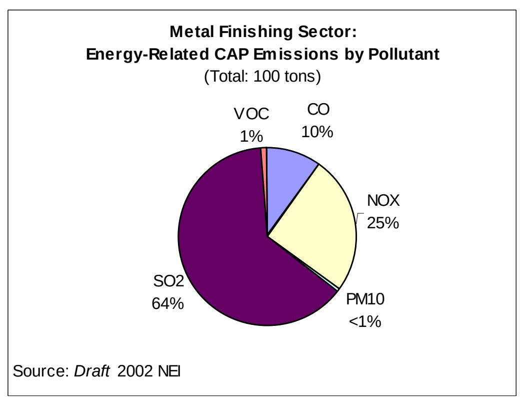
Under the reference scenario for the metals-based durables industry, CEF and AEO 2006 project no major fuel mix changes through 2020, as the industry remains dependent on natural gas and purchased electricity. In general, there is little opportunity for the metal finishing industry to replace electricity and natural gas inputs with less expensive fuels, and we do not anticipate any future fuel-switching trends for the metal finishing industry.

As is the case with CEF projections, AEO 2006 projects substantial growth in economic production for the metals-based durables industry through 2020, with the value of shipments increasing 60 percent from 2004 levels. Energy consumption grows by 30 percent over the same period, and energy intensity (energy consumption per dollar value of shipments) declines by 1.2 percent per year. Though subsets of the industry like metal finishing may be unlikely to experience the same degree of growth (particularly given recent shifts towards overseas production), some increase in energy consumption may result from increasing production.

Environmental Implications

Figure 20: Metal finishing sector: energy-related CAP emissions





> **Effects of Energy-Related CAP Emissions**
>
> SO_2 and NO_x emissions contribute to respiratory illness and may cause lung damage. Emissions also contribute to acid rain, ground-level ozone, and reduced visibility.

Figure 20 compares NEI data on energy-related CAP emissions with non-energy-related CAP emissions for the metal finishing sector. According to the figure, energy-related CAP emissions are a relatively moderate fraction of all CAP emissions; however, NEI data attribute emissions from electric power generation to the generating source rather than the purchasing entity. Given that purchased electricity supplies approximately half of the sector's energy needs, NEI data underestimate energy-related CAP emissions for this sector. At the facility level, almost 90 percent of energy-related emissions are sulfur dioxide and nitrogen oxides. On a ton basis, the metal finishing sector's energy-related CAP emissions at the facility level are relatively small compared with energy-related CAP emissions by other sectors (see Table 13).

Figure 21: Metal finishing sector: CAP emissions by source category and fuel usage

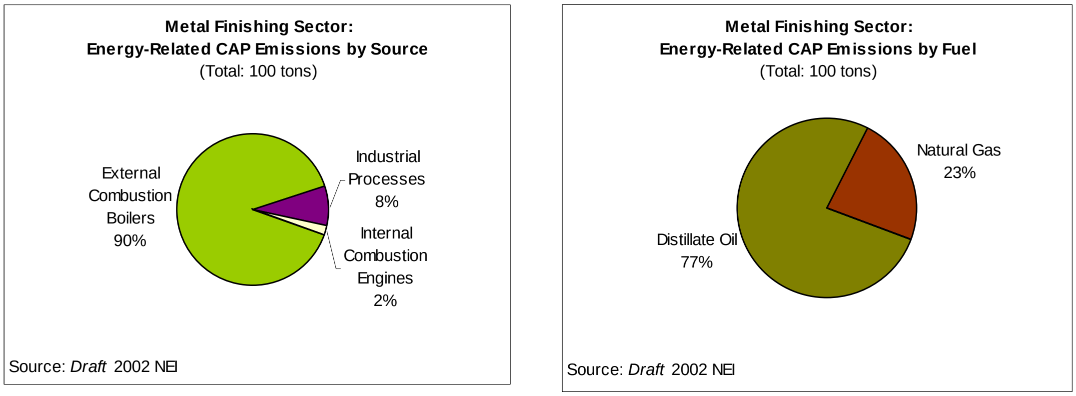


Figure 21 presents NEI data on the sources of energy-related CAP emissions shown in Figure 20. The metal finishing industry is a relatively minor source of onsite energy-related CAP emissions compared with other sectors considered in this analysis—only 100 tons per year compared with more than 700,000 tons per year for the chemical manufacturing industry.

Ninety percent of energy-related emissions are associated with external combustion boilers, with distillate oil contributing to roughly two-thirds of energy-related emissions, and natural gas contributing the remaining third. Given that fuel oil supplies around 2 percent of the sector's energy requirements, the large fraction of energy-related emissions arising from fuel oil use is most likely attributable to NEI data reporting errors.

Increases in sector energy consumption would affect energy-related CAP emissions at the electric power generation level, as well as at the facility level through increased consumption of natural gas and petroleum-based fuels. The geographic dispersion of the metal finishing industry and the relatively small volume of energy-related CAP emissions compared with other sectors included in this analysis indicate that energy trends are unlikely to have a substantial impact on regional air quality.

As NEI data do not include carbon dioxide emissions, we use carbon dioxide emissions estimates from AEO 2006, which totaled 157 million metric tons for the metals-based durables industry in 2004. (Carbon dioxide emissions from the metal finishing sector represent a fraction of these emissions.) AEO 2006 projects that by 2020 the metals-based durables industry's carbon dioxide emissions will increase by 25 percent. As discussed previously, a smaller rate of increase in carbon dioxide emissions would be expected for the metal finishing industry, given that energy consumption will likely increase at a slower rate than in the larger metals-based durables sector.

3.8.2 Best Case Scenario

Opportunities

Table 47 ranks the viability of five primary opportunities for improving environmental performance with respect to energy use (Low, Medium, or High). A brief assessment of the ranking is also provided, including potential barriers.

Table 47: Opportunity assessment for the metal finishing industry

Opportunity	Ranking	Assessment (including potential barriers)
Cleaner fuels	Low	The sector remains heavily dependent on electricity and natural gas and shows little fuel-switching trend.
Increased CHP	Medium	Given that many metal finishers use electric energy in the electroplating stage and thermal energy in heating the plating solution baths, small onsite generators that run on natural gas and have CHP capabilities may be cost effective for some businesses. Low NOx, high-efficiency generators are offered by a number of manufacturers. Local and state permitting requirements to install these devices may pose a potential barrier to implementation.[246] New CHP installations also face barriers in terms of utility rates and interconnection requirements if electricity production is expected to exceed onsite demand, and also from NSR/PSD permitting.[247]
Equipment retrofit/ replacement	Medium	The financial barriers in this industry indicate that retrofitting (versus replacing) existing technology with state-of-the-art equipment is likely to provide ongoing efficiency improvement. Facilities may also improve their efficiency by upgrading existing lighting and improving their HVAC systems.
Process improvement	High	Multiple process improvement opportunities exist in metal finishing, including using more efficient rinsing techniques and optimizing plating bath temperatures through adding insulation and using timers. Process optimization may have greater potential for adoption due to relatively low associated costs.
R&D	Medium	Several technologies in development could improve the energy efficiency of metal finishing processes, including metal powder coating, thermal spray, and sputtering technologies. Advanced wastewater treatment processes involving ion exchange and permeable membrane technologies may also produce future opportunities for energy savings. The industry is also looking at the substitution of non-cyanide-based plating solutions in place of cyanide solutions, which create costly and energy-intensive waste treatment issues.[248]

Optimal Future Trends

An optimal energy scenario for the metal finishing industry would involve increased energy efficiency through increased penetration of CHP applications, energy-efficient equipment, and process improvements, as well as increased investment in the development of new energy-efficient technologies and processes.

Given that CEF's projections for the metal-based durables industry are not particularly applicable to the metal finishing sector, we have not included a full summary of CEF's advanced case projections in this analysis, but the projections show relatively little change in the sector's fuel mix, a decrease in energy intensity of 2 percent per year (compared with the reference case projection of an annual decline of 0.7 percent), and an increase in energy consumption of 20 percent (compared with the reference case projection of a 60 percent increase).

Environmental Implications

Energy efficiency increases in the metal finishing sector would affect energy-related CAP and carbon emissions at both the electric power generation level and the facility level. Increased CHP would shift energy-related emissions from the electric power generation level to the facility level to some degree. In cases where electric power supply is produced by fossil fuel-fired power plants (which have the highest power generation losses), such a shift would produce the greatest decrease in total energy-related emissions, recognizing that emissions may actually increase at the facility level as power is produced onsite. However, such effects would vary according to local energy inputs for electric power generation. Energy efficiency improvements could also reduce natural gas and petroleum consumption, affecting energy-related CAP and carbon emissions at the facility level. NEI data indicate that sulfur dioxide and nitrogen oxide emissions would be most impacted by such efficiency gains.

Achieving an optimal energy scenario may be relatively more difficult for the metal finishing sector given current financial pressures and the number of small, geographically dispersed firms that comprise the industry.

3.8.3 Other Reference Materials Consulted

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