Energy Trends in Selected Manufacturing Sectors:

Opportunities and Challenges for Environmentally Preferable Energy Outcomes

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3.9 Motor Vehicle Manufacturing

> **Recent Sector Trends Informing the Base Case**
>
> Number of facilities: ↓
> Value of shipments: ↑
> Electricity intensity: ↓
>
> Major fuel sources: Electricity, natural gas
>
> Current economic and energy consumption data are summarized in Table 48 on page 3-78.

3.9.1 Base Case Scenario

Situation Assessment

This report looks at motor vehicle manufacturing operations—specifically facilities that assemble finished automobiles and light duty vehicles from premanufactured automotive parts including the engine, chassis components, and wheels and tires (NAICS 33611).[249] The assembly process generally includes stamping, body welding, general assembly, and painting.

According to data published by the Alliance of Automobile Manufacturers, in 2006 there were 61 assembly plants for automobiles and light duty trucks operating in 21 states, with Michigan, Ohio, Indiana, Illinois, and Missouri among the states with the most manufacturing facilities.[250] Over the last 20 years, production has gradually shifted south, with new plants opening in central Tennessee in the 1980s, and in Alabama, Mississippi, and South Carolina in the 1990s.[251]

In terms of the dollar value of production, the automobile industry is the largest industry in the United States.[252] The industry's value added declined slightly from 1997 to 2004, but value of shipments increased by a small annual amount (see Table 48). However, the economic data also show substantial interannual variation, and larger annual increases in value added from 2000 to 2004. [253] U.S. automakers face pressure from foreign competitors, which have an increasing manufacturing presence in this country. The Big Three North American Original Equipment Manufacturers (OEMs)—General Motors, Ford, and DaimlerChrysler—are reacting to declining sales figures and economic strain by closing certain plants and downsizing their companies. Ford announced in January 2006 that it would be closing 14 North American manufacturing plants and cutting 18 to 21 percent of employees. GM is following suit with 12 plant closings and a 30,000 job cut through 2008.

The majority of sector energy demand is met by electricity, with natural gas and other purchased fuels meeting the remainder. Energy expenditures comprise approximately 1 percent of total vehicle production costs.[254] Major end uses of electricity include painting systems (27-50 percent), facility lighting and HVAC (26-36 percent), compressed air (9-14 percent), and welding (9-11 percent). Fuels generate hot water and steam used in paint booths and heat in the curing ovens used to dry paint.[255] The amount of energy used in painting systems is affected by VOC control requirements. Low-VOC powder paints (including anti-chip primers, clear coats, and lacquers) have been developed that rely on the electrostatic attraction between the powder and the vehicle to deposit the coating onto the surface.[256] Though powder paints may require more heat in the curing process, by eliminating solvents, less energy is required for ventilation, pollution control, paint application, and paint gun cleaning. In addition, manufacturing powder paints is slightly less energy intensive than solvent paints, resulting in additional indirect energy savings.[257] At the same time, substituting powder-based coating for solvent-based coating cannot be accomplished without major capital-intensive process and equipment changes to the painting lines and operations.

From 1998 to 2004, electricity purchases have ranged between 50 to 60 percent of total energy costs for the industry.[258] Since Census Bureau data from the *Annual Survey of Manufacturers* do not provide the annual amount of energy produced from purchased fuels, it is not possible to calculate the total energy intensity of the motor vehicle manufacturing industry, though it is possible to calculate electric intensity (kWh/dollar value of shipments), which fell by almost 9 percent from 1998 to 2004.

Table 48 summarizes current economic trend and energy consumption data originally presented in Chapter 2.

Table 48: Current economic and energy data for the motor vehicle manufacturing industry

Economic Production Trends				
	Annual Change in Value Added 1997-2004	Annual Change in Value Added 2000-2004	Annual Change in Value of Shipments 1997-2004	Annual Change in Value of Shipments 2000-2004
	-2.2%	1.9%	0.3%	0.1%
Energy Intensity in 2002				
	Energy Consumption per Dollar of Value Added (thousand Btu)	Energy Consumption per Dollar Value of Shipments (thousand Btu)	Energy Cost per Dollar of Value Added (share)	Energy Cost per Dollar Value of Shipments (share)
	NA	NA	1.1%	0.3%
Primary Fuel Inputs as Fraction of Total Energy Supply in 2002 (fuel use only)[kkkk]				
		Natural Gas	Net Electricity	Other
		48%	41%	7%
Fuel-Switching Potential in 2002: Natural Gas to Alternate Fuels				
			Switchable fraction of natural gas inputs	18%
		Fuel Oil	LPG	Coal
Fraction of natural gas inputs that could be met by alternate fuels		50%	42%	11%
Fuel-Switching Potential in 2002: Coal to Alternate Fuels				
			Switchable fraction of coal inputs	Withheld
		Natural Gas	Fuel Oil	Electricity
Fraction of coal inputs that could be met by alternate fuels		94%	14%	4%

[kkkk] Fuel input and fuel-switching data are for the larger NAICS category, transportation equipment (NAICS 336).

Expected Future Trends

Economic pressures on the motor vehicle manufacturing industry are expected to be the primary motivation for efficiency improvement, as the U.S. auto industry seeks to increase its competitive edge on the global market. A recent study predicts that the publicly traded companies that comprise the automotive industry may also be motivated to reduce the impacts of energy cost volatility by investing in efficiency.[259] According to research conducted by the Lawrence Berkeley National Laboratory (LBNL), due to the complexity, process, and technological variation in the automotive assembly industry a wide array of opportunities exist for energy efficiency and pollution prevention for paint, welding, and cross-sector practices (e.g., utilities, lighting, stamping, etc.). However, given the relatively small fraction of total production costs that energy entails, efficiency improvement is likely to be incremental. No major shifts in fuel mix are anticipated.

> **Voluntary Commitments**
>
> Through Climate VISION, member companies of the Alliance of Automobile Manufacturers have committed to achieve at least a 10% reduction in GHG emissions from their U.S. automotive manufacturing facilities, based on U.S. vehicle production, by 2012 from a base year of 2002.[a]

Environmental Implications

Figure 22: Motor vehicle manufacturing sector: energy-related CAP emissions

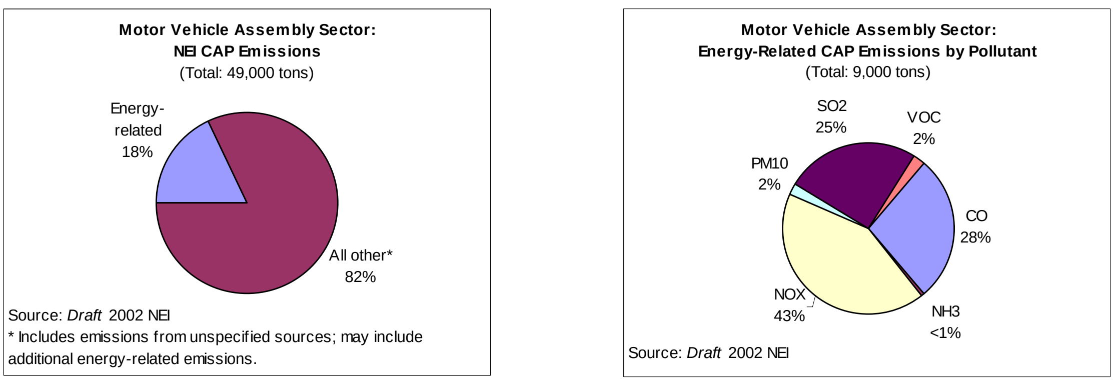
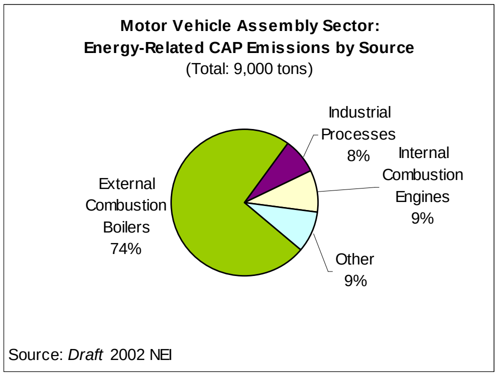


Figure 22 compares NEI data on energy-related CAP emissions by pollutant type with total CAP emissions for the motor vehicle manufacturing industry. The industry is a relatively minor source of onsite energy-related CAP emissions compared with other sectors considered in this analysis—approximately 9,000 tons per year compared with more than 700,000 tons per year for the chemical manufacturing industry.

> **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.

As purchased electricity meets a substantial fraction of this sector's energy needs, it is important to note that NEI data attribute emissions to the generating source rather than the purchasing entity, and thus underestimate energy-related CAP emissions for this sector. In terms of onsite energy generation, the largest emissions fractions are nitrogen oxides and sulfur dioxide. (As noted in Section 2.3.3, NEI data on carbon monoxide emissions appear higher than would be expected for stationary sources, so we do not address carbon monoxide data in our assessment of CAP emissions for each sector.)

Figure 23: Motor vehicle manufacturing sector: CAP emissions by source category and fuel usage



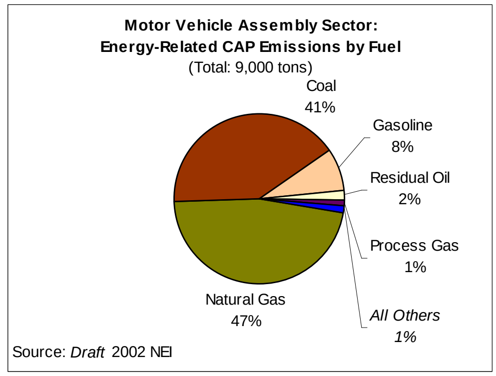


Figure 23 presents NEI data on the sources of energy-related CAP emissions shown in Figure 22, by source category and fuel usage. External combustion boilers contribute to almost two thirds of energy-related emissions for this sector. According to NEI data, 47 percent of energy-related CAP emissions are due to onsite natural gas consumption and 41 percent of energy-related emissions are due to onsite coal consumption. The sector does not use large amounts of coal, but coal's emissions intensity contributes to the relatively high fraction of coal-related CAP emissions (sulfur dioxide and nitrogen oxides are both linked to coal combustion).

NEI data from 2002 show that key opportunities for reducing the environmental impacts of sector energy use lie with reducing coal consumption and increased energy efficiency of external combustion boilers. According to the Alliance of Automobile Manufacturers, the industry has made substantial progress since 2002 in replacing coal-fired equipment with natural gas-fired equipment, including the elimination of coal use at five DaimlerChrysler assembly plants, and similar fuel conversions at other facilities.[260]

Given the motor vehicle manufacturing sector's dependence on purchased electricity, the sector's energy-related environmental footprint in part depends on energy inputs for local electric power generation. Energy efficiency improvements will primarily affect purchased electricity requirements, with associated reductions in energy-related emissions occurring at the utility level.

As there are no energy consumption projections for the motor vehicle manufacturing industry contained in AEO 2006, we do not report carbon dioxide emissions projections for this sector.

3.9.2 Best Case Scenario

Opportunities

Table 49 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 49: Opportunity assessment for the motor vehicle manufacturing industry

Opportunity	Ranking	Assessment (including potential barriers)
Cleaner fuels	Low	For plants located near landfills, landfill gas may provide an alternative boiler fuel to coal or other fossil fuels. Plants owned by Ford, GM, BMW, and DaimlerChrysler are currently using landfill gas,[261] but the location-specific requirements of this opportunity limit its potential for offering widespread energy savings.
Increased CHP	Low	CHP has limited application in assembly plants because many do not have a large thermal process load that is met by steam or hot water, but CHP may be cost effective for those plants with electricity, process heat, and steam requirements. To increase cost effectiveness, CHP may also be combined with absorption chillers for plants with cooling requirements. Though the LBNL study provided no examples of plants in the United States that implemented CHP, plants in Europe and Germany have successfully implemented CHP projects.[262] New CHP installations also face barriers in terms of utility interconnection requirements if electricity production is expected to exceed onsite demand, and also from NSR/PSD permitting.[263]
Equipment retrofit/ replacement	Medium	Replacing aging equipment with state-of-the-art equipment offers potential for efficiency improvement, within limitations imposed by capital constraints. Due to the high energy requirements of the painting process, painting equipment replacement has substantial energy-savings potential. Specific opportunities include ventilation system, oven, and control system replacement, as well as installation of high-efficiency motors.[264] There are also opportunities for energy efficiency improvements for body welding technologies and process changes.
Process improvement	High	Some process improvements may offer less capital-intensive opportunities for energy efficiency improvement, and also may improve product quality and reduce operating costs. The LBNL study provides many examples of process improvement, including reductions in ventilation energy use through reduced ventilation speed, and turning down air flow during breaks in the production process.[265] A motor vehicle manufacturing company seeking to reduce energy consumption through eliminating a shift was deterred by a potential triggering of NSR permitting requirements. NSR could have been triggered due to the need for additional process equipment during the remaining shift.[266]
R&D	Medium	The LBNL study references multiple ongoing technological developments in the industry that will improve sector energy efficiency. Examples include the development of microwave heating for paint curing, and VOC removal systems that will cost-effectively treat smaller amounts of pollutant than current scrubber systems. Additional R&D is also needed to facilitate further development of low-VOC paints or wet-on-wet painting as viable and cost-effective energy-savings opportunities.[267]

Optimal Future Trends

As no energy use projections are available for the motor vehicle manufacturing industry, it is not possible to compare a business-as-usual energy scenario with an optimal energy scenario. However, a preferred energy management strategy for the industry would primarily involve faster replacement rates of existing equipment with energy-efficient equipment, increased adoption of process improvements, and increased investment in R&D. Pilot applications of CHP in the U.S. automotive industry offer additional opportunities for energy efficiency improvement.

Environmental Implications

Given the automotive industry's dependence on purchased power, and due to the magnitude of energy losses during electric generation and transmission, efficiency gains at the facility level have a magnified impact on energy-related emissions at the utility level. With the automotive industry geographically concentrated in the Midwest, emissions reductions would also be fairly concentrated geographically, with potentially greater effects on regional air quality. Reducing fossil fuel inputs for boiler fuel through increased landfill gas applications offer opportunities for improving the sector's emissions profile at the facility level, particularly for nitrogen oxides, carbon monoxide, and sulfur dioxide.

3.9.3 Other Reference Materials Consulted

Ford Motor Company. *Ford Motor Company Pollution Prevention Case Study: Conversion of Regenerative Thermal Oxidizers to Regenerative Catalytic Oxidizers at the Ford Wixom Assembly Plant*. Internet source. Accessed February 7, 2006. Available at http://www.p2pays.org/ref/13/12248.pdf.

Isidore, C. "Ford to cut up to 30,000 jobs: No. 2 automaker to close 14 North American manufacturing plants in effort to stem losses," *CNNMoney.com*. January 23, 2006. Internet source. Available at http://money.cnn.com/2006/01/23/news/companies/ford_closings/index.htm.

"Toyota: We don't want to be No. 1," *CNNMoney.com*. Internet source. Accessed January 25, 2006.

U.S. Environmental Protection Agency. *National Emissions Inventory*. 2002.