



**Department of  
Development**

**Policy Research and Strategic Planning Office**  
A State Affiliate of the U.S. Census Bureau

# **THE OHIO MOTOR VEHICLE INDUSTRY**

**February 2009**



**Ted Strickland**, Governor of Ohio  
**Lee Fisher**, Lt. Governor of Ohio  
Director, Ohio Department of Development



## Department of Development

Ted Strickland, Governor  
Lee Fisher, Lt. Governor

Mark Barbash, Interim Director

Dear Fellow Ohioan:

The Motor Vehicle Industry is facing an unprecedented global transition -- and Ohio, second in the nation for vehicle production, is directly impacted by these changes. From assembly plants to plastic fasteners, Ohio's manufacturers serve the motor vehicle industry, and a wide variety of business sectors depend upon the industry for their revenues.

This report outlines the size, location, and trends of the motor vehicle facilities located in our state. Three-year trends are provided whenever possible. There are detailed profiles on Honda, General Motors, Ford, and Chrysler, as well as an analysis of national trends that will be impacting the big assemblers and the hundreds of Ohio-based suppliers. An Input-Output model of Ohio's economy suggests that more than 370,000 people depend upon the motor vehicle cluster for their jobs and income.

Ohio's diverse industry base makes our state a global market leader. This diversity is complemented by a business environment that facilitates professional success and a high quality of life that allows for personal fulfillment. Ohio's unique combination of life and work amenities makes our state a place where you can achieve true professional and personal balance.

I invite you to review the attached report to further your understanding of Ohio's large and diverse economy. We welcome your input. If you have any questions or comments, please contact John Magill, our Department's Chief Strategic Officer at (614) 466-2116.

Sincerely,

Mark Barbash  
Interim Director  
Ohio Department of Development



Department of  
Development

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**FEBRUARY 2009**

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## NAICS CODES: INDUSTRY DEFINITION AND EXAMPLES

Beginning with the 1997 Economic Censuses, the nation's industry statistics have been collected under the North American Industry Classification System (NAICS) (Office of Management and Budget, 1998). Establishments producing goods or providing services sufficiently alike are classified in the same *industry*. A six-digit NAICS code is assigned to each industry. Closely related industries formed an *industry group*. The first four digits of the code indicate the group to which the industries belong. (A five-digit code defines a subgroup when it subsumes more than one six-digit code; otherwise, it serves as an industry code.) Industry groups with common elements and shared characteristics comprise a *major industry* or *sub-sector*, and are indicated by the first three digits of the code. Most of the data from government sources used in this report have been collected under that system.

Three groups from the *transportation equipment* sub-sector (NAICS 336) combine to form the core of the motor vehicle industry in this report. They are *motor vehicles* (3361, also referred to as assembly operations), *motor vehicle bodies and trailers* (3362), and *motor vehicle parts* (3363). The *tires* subgroup (32621) and *storage batteries* (335911) are included – when information is available – because most of the goods produced in those industries are original equipment or replacement parts for motor vehicles. Industries wherein most of the goods produced are not used in motor vehicles are excluded from this report, although some exceptions may be made for establishments at least mostly dedicated to motor vehicle parts. Diesel engine and automotive glass production (333618 and 327215, respectively) are examples of this.

The defining concept for the motor vehicle industry is manufacturing equipment for transporting people and goods over a network of roads. This definition excludes establishments producing ships, boats, railroad and aerospace vehicles and equipment. Also excluded for various reasons are establishments producing motorcycles, bicycles, military armored vehicles and tanks, all-terrain vehicles, go-carts, golf carts, racecars, snowmobiles, animal-drawn vehicles, children's vehicles, and their components. After the discussion of the industry's impact on Ohio's economy, industries dependent on motor vehicles – suppliers of materials to the industry, makers of equipment used to manufacture motor vehicles-bodies-trailers-and-parts, wholesalers, retailers, gas stations, and repair services – are not included.

Motor vehicle establishments use production processes similar to machinery manufacturers (333): bending, forming, welding, machining and assembling metal, glass, rubber and/or plastic parts into components and finished products. However, most machinery is used to produce other goods, and the goods-moving machinery – agricultural, construction, and material-handling equipment – is not intended for highway use. Other people-moving machinery such as elevators, escalators, or moving sidewalks is also classified in the machinery industry.

Examples of products made in various motor vehicle industries follow the NAICS codes and industry titles below.

The transportation equipment industries:

- 3361 Motor Vehicles.
- 33611 Automobiles and Light Duty Motor Vehicles.
- 336111 Automobiles. Establishments assemble complete automobiles (uni-body or body and chassis) or produce chassis alone. The manufacture of car bodies or assembling vehicles on a purchased chassis is classified in 336211.
- 336112 Light Trucks and Utility Vehicles. Establishments assemble complete light trucks (body and chassis) or produce light truck chassis alone. Light duty trucks include minivans, pick-ups, and sport-utility vehicles. The manufacture of truck and bus bodies or assembling vehicles on a purchased chassis is classified in 336211.
- 33612 Heavy Duty Trucks. Heavy-duty trucks also include buses, heavy-duty motor homes, and other special purpose heavy-duty motor vehicles for highway use. Establishments assemble complete trucks (body and chassis) or chassis alone. Medium-duty trucks (as defined by Ward's) are also included in this industry.
  
- 3362 Motor Vehicle Bodies and Trailers.
- 336211 Motor Vehicle Bodies. Establishments produce truck cabs as well as car, truck and bus bodies. These may be sold separately or assembled on a purchased chassis and sold as complete vehicles. Dump truck lifting mechanisms and fifth wheels are included.
- 336212 Truck Trailers. Examples also include truck trailer chassis, cargo container chassis, detachable trailer bodies, and detachable trailer chassis sold separately.
- 336213 Motor Homes. The defining element is the integration of the motor and the living quarters in the same unit. Whether or not the chassis is purchased is irrelevant. Car and van conversion is included if the work is done on an assembly line. Mobile homes are classified in 321991, and customized cars and trailers are classified in 811121.
- 336214 Travel Trailers and Campers. Examples include transport trailers for cars, camping trailers, horse trailers, and utility trailers.
  
- 3363 Motor Vehicle Parts.
- 33631 Motor Vehicle Gasoline Engines and Engine Parts.
- 336311 Carburetors, Pistons, Rings, and Valves. Both original and rebuilt equipment is included.
- 336312 Gasoline Engines and Engine Parts. Examples include crankshafts, flywheels, ring gears, fuel injection systems and parts, manifolds, positive crankcase ventilation (PCV) valves, mechanical pumps, and timing gears and chains. Both original and rebuilt equipment is included. Other gasoline engine equipment – carburetors, pistons, piston rings,

valves, wiring harnesses, electrical and electronic equipment, transmissions, radiators, steering and suspension components, rubber and plastic belts and hoses without fittings – is classified elsewhere in 3363. Stationary gasoline engines and parts of the same nature but not for use in motor vehicles are classified outside of the motor vehicle industry. All diesel engines, including those used in motor vehicles, are classified in 333618.

- 33632 Motor Vehicle Electrical and Electronic Equipment.
- 336321 Vehicular Lighting Equipment. Vehicular lighting fixtures are included, but bulbs are classified elsewhere.
- 336322 Other Motor Vehicle Electrical and Electronic Equipment. Examples include alternators, generators, coils, distributors, ignition cable sets, wiring harnesses, instrument control panels, spark plugs, block and battery heaters, and windshield washer pumps. Equipment of the same nature but not for use with motor vehicles is classified elsewhere. Electric motors (even for electric vehicles), railway traffic control signals and passenger car alarms, and car stereos are classified elsewhere.
- 33633 Motor Vehicle Steering and Suspension Components. Examples include steering wheels and columns, rack and pinion steering assemblies, struts, and shock absorbers. Spring manufacturers are classified in fabricated metal products (332).
- 33634 Motor Vehicle Brake Systems. Examples include cylinders, drums, hose assemblies, calipers, pads, linings and shoes. Rubber and plastic hose and belting without fittings are classified in 326.
- 33635 Motor Vehicle Transmissions and Parts. Examples include automatic and manual transmissions, axle bearings, differentials and axle assemblies, torque converters, and universal joints. Both original and rebuilt equipment is included. Mechanical power transmission equipment not for use in motor vehicles is classified elsewhere.
- 33636 Motor Vehicle Seating and Interior Trim. Seat belts, and seat and tire covers are included.
- 33637 Motor Vehicle Metal Stampings. Examples include fenders, hard tops, body parts, moldings, and exterior trim. Tops for convertibles are classified in 336399.
- 33639 Other Motor Vehicle Parts.
- 336391 Motor Vehicle Air Conditioning. This industry produces air conditioning compressors and systems for cars, trucks and buses. It also produces them for vehicles that are not part of the motor vehicle industry: aircraft (NAICS 336411), farm machinery (NAICS 333111), construction machinery (NAICS 33312), and related vehicles. The reason equipment for such other vehicles is included is probably because it is highly similar to that used in motor vehicles and the greatest portion of it is used in motor vehicles. Establishments producing air-conditioning compressors and systems not used in vehicles are classified in NAICS 333415.
- 336399 All Other Motor Vehicle Parts. Examples include air bags, catalytic converters, intake filters, luggage and utility racks, mufflers, resonators, radiators (including those for stationary engines), trailer hitches, and wheel rims. Both original and rebuilt equipment is included.

The related industries:

- 32621 Tires.
- 326211 Tire Manufacturing, except retreading. Includes pneumatic, semi-pneumatic and solid tires, inner tubes, and repair materials. Most new tires are produced for motor vehicles.
- 326212 Tire retreading. The feature distinguishing this industry from tire repair service is the reliance on assembly line operations. Retreads are used by school buses and commercial trucks (Rubber Manufacturers Association, 2006). These markets are much smaller than the markets for passenger cars and non-commercial light trucks.
- 335911 Storage Batteries. In particular, lead-acid batteries smaller than 1.5 cubic feet.

## GLOSSARY

A number of terms used in this report have more or less specific meanings. The term *motor vehicles* includes a variety of products: cars, vans, sport-utility vehicles (SUVs), crossover vehicles, buses and trucks. The basic industry divisions are between passenger cars, light trucks, and medium- and heavy-duty trucks. The most detailed industry reports divide trucks into eight classes based on gross vehicle weight (GVW - the combined weight of the vehicle and its maximum pay-load). These eight classes are regrouped into *light, medium, and heavy-duty* for general discussion. It must be noted that classes comprising the light, medium and heavy groups vary by author. Among three sources repeatedly cited in this re-port, class 1 and 2 trucks, with GVWs of 10,000 pounds or less, are always considered light-duty. Light trucks include small and family vans, sport-utility vehicles (SUVs), and pickups, and account for around 95 percent of all truck sales these days. Class 8 trucks, with GVWs over 33,000 pounds, are always considered heavy-duty. However, Standard and Poor's call class 3 trucks, with GVWs of 10,001-14,000 pounds, medium-duty, while Ward's classifies them as light-duty. Standard and Poor's and Ward's call class 7 trucks, with GVWs of 26,001-33,000 pounds, medium-duty. The Census Bureau considers any truck with a GVW over 14,000 pounds to be heavy duty (Levy, 2008: 5; U.S. Bureau of the Census, 2009; Ward's, 2005; Wang, 2008: 10).

*Assembler* distinguishes motor vehicle manufacturers such as Ford, GM, Honda, or Kenworth from other companies making only the parts and modules comprising a vehicle. The latter are *parts manufacturers* or *suppliers*. Suppliers produce goods and modules for use either as *original equipment (OE)* or to be sold as *replacement parts* in the *aftermarket (AM)*. Many do both to varying degrees. Parts makers also are grouped depending on their position in the supply chain. *Tier 1* refers to those selling parts and sub-assemblies directly to assemblers. *Tier 2* companies make parts for tier 1 companies, and *tier 3* companies supply the raw materials to tier 1 and 2 companies. *Powertrain* is a generic term refer-ing to engines and transmissions.

## NOTES

- 1 Honda's plant in E. Liberty makes both cars and light trucks; GM's Moraine plant closed in December, 2008.
- 2 Daimler AG sold 80.1 percent of Chrysler to Cerberus Capital Management in 2007, retaining a 19.9 percent interest in Chrysler. Cerberus very recently gave a 35 percent share to Fiat as part of an exchange agreement. Cerberus also owns Tower Automotive, which employs about 380 people in Ohio. Therefore, it may be argued that Cerberus is the lead employer of well over 3,700 industry workers in Ohio.
- 3 Total company employment figures for the motor vehicle industry include the sites employing less than 50 people. Also, Rockwell Automation, Saint-Gobain, Sumitomo Electric Industries, and U.R.S. Corp. are included in the 47 Fortune companies, but listed only in table A1 because their lone establishments employ less than 50 people in Ohio in the industry.
- 4 This includes \$130.5M for the DMAX diesel engine plant, a joint venture with Isuzu Motors, Ltd.; most assembler figures in this section include investments in parts operations.
- 5 The concentration would be even higher if diesel engine production for motor vehicles was included.
- 6 Unfortunately, the value of the latter cannot be disaggregated because the Census Bureau must maintain the confidentiality of respondents. Given that cars were produced in slightly larger numbers than light trucks in 2002 (Ward's, 2003), and assuming that light trucks average a little higher value, one might guess that the value-added for cars (NAICS 336111) is approximately the same as for light trucks – about 20 percent of the industry value-added in Ohio. That implies that the value-added attributable to heavy-duty trucks may be 10 percent the industry total for the state. However, this is just speculation.
- 7 There have been, and are, exceptions; recent examples follow. Honda makes some engines for GM's Saturn models, helping the latter meet California's low-emissions requirements for vehicles sold there. In turn, GM supplies some diesel engines for vehicles Honda sells in Europe (Harbour Consulting, 2004). DaimlerChrysler, Mitsubishi, and Hyundai formed their Global Engine Manufacturing Alliance (GEMA) to produce engines for some of their vehicles. Ford and GM cooperated on designing, engineering, and testing front wheel drive six-speed transmissions. Some assemblers bought six-speed transmissions made by specialists such as Aisin Seiki (in which Toyota has a minority stake) and Borg Warner (Harbour Consulting, 2006: 170-172).

- 8 It should be noted that GM's stamping plant in Lordstown is adjacent to its assembly plant.
- 9 The fact that 53.4 percent of all of Honda's tier-1 suppliers are located in N. America indicates just how much of an American company Honda has become.
- 10 Two foundries (NAICS code 3315) dedicated to the motor vehicle industry were excluded in the previous section so that consistent comparisons could be made with the national industry. They are included in this section, and their employment is included in the next section.
- 11 As with BLS data – and for the same reasons – ODJFS/LMI and Census Bureau data are not strictly comparable.
- 12 Value-added and GDP figures are closely related. The computation of GDP begins with value-added (largely the difference between the value of shipments and the costs of labor and materials), and proceeds by subtracting additional costs such as services purchased by the manufacturing establishment. This explains why GDP figures are less than value-added figures.
- 13 The percentage of value-added for bodies and trailers in Ohio during 2004-2006 are greater than the percent of U.S. GDP originating in Ohio, leading one to believe that the former is concentrated here. However, these percent-ages – and the totals on which they are based – are not reliable because the relative standard errors of the bodies and trailers estimates are way too high (see U.S. Census Bureau, 2008).
- 14 Using value-added in Ohio as a percentage of the nation removes the effects of inflation, making comparisons of one year with any other more meaningful. It should also be noted that the decline in value added from 2002 to 2003 is inconsistent with the increases of GDP and light vehicle production for the same period (U.S. Bureau of the Census, 2005a; U.S. Bureau of Economic Analysis, 2008a; Ward's, 2005).
- 15 Capital expenditures also vary with the size and degree of vertical integration of the company. GM and Ford generally spend more than the smaller and less vertically integrated Chrysler (Levy, 2008: 13).
- 16 In this section, vehicles, parts, and accessories from Canada and Mexico are imports. In the Market Share Trends section that follows, they are considered domestic production.
- 17 One possible explanation for the mismatches is that U.S. trade is asymmetric. Overall, about one-half of industry exports go to Canada, while imports from Canada are a minor part of all imports. Furthermore, change in the index value of the dollar –

based on a number of currencies – is a crude measure, poorly capturing the effects of specific currency change on trade in specific items from specific countries. It works better with the overall balance of trade.

- 18 U.S.-brand assemblers have made substantial progress in matching the initial-quality and frequency-of-repair records of Japanese-brand assemblers. At the same time, though, assemblers' recalls have risen. This is probably due to the increased use of electronics, tougher standards, and better reporting (Harbour Consulting, 2004).
- 19 The Federal Reserve Board used different indices to measure the value of the dollar. One, the G10, covered the period from 1967 through 1998, when it was discontinued. The second, G5a, dates to 1995. While the numbers differed during the overlapping periods, the trends are the same. A small number of imports are included in U.S. brands, and "Others" includes a couple of European brands made in the U.S. However, these percentages are tiny, roughly counter balancing one another, and do not alter the conclusion.
- 20 Loss of market share probably is not the only reason for Ford's and GM's current financial difficulties. Growing health care costs of retired and current employees amounting to hundreds of dollars *per vehicle* also eroded the companies' bottom lines; promises made years ago had become untenable. Both companies announced agreements with employees reducing benefits that are expected, in turn, to reduce losses, and both agreed to contribute varying amounts of money to a benefit association to soften the blow. By contrast, foreign-based manufacturers – notably Honda, Nissan and Toyota – do not have this competitive burden because they offer only limited health care coverage and have few retirees in America (Harbour Consulting, 2006: 6, 186).
- 21 Renault has an indirect interest in the American market due to its large minority interest in Nissan.
- 22 The actions of light vehicle assemblers contrast with those of medium- and heavy-duty truck makers, who have used discounts and rebates to stimulate sales only when necessary (Fiore, 2006: 14).
- 23 The four are: Daimler AG, with its Mercedes Benz, Freightliner, Sterling, and Western Star brands; Navistar International and its International Truck and Engine subsidiary; PACCAR, formed by merging Kenworth and Peterbilt; and Volvo, which bought Mack Trucks from Renault. Consolidation in the medium- and heavy-duty truck industry slowed after major mergers and acquisitions were accomplished in the wake of the downturn in the first years of this decade (Wang: 2008: 8-9).
- 24 Assemblers also establish and support a network of independent dealers with wholesale financing, marketing strategies and materials, etc. The dealerships, in turn, sell to independent truck operators – persons who typically buy just one vehicle from inventory (Wang, 2008: 11).

- 25 Conversely, companies based in Russia, China, and India making acquisitions in the West. Given the current difficulties, at least some companies are willing to sell assets, technology or skills. The most noted example is Ford's sale of Jaguar and Land Rover to India's Tata Motors. Mostly, though, it involves parts suppliers such as Russia-based Basic Element's purchase of a stake in Magna International. The non-monetary exchange is Basic Element gaining access to technical expertise, and Magna gaining access to the rapidly growing Russian market. Chinese companies also are looking to acquire U.S. parts suppliers (Levy, 2008: 8).
- 26 Both assemblers and suppliers face challenges in dealing with higher costs of raw material (steel, copper, rubber and plastics) due to increased demand for commodities. Rapid growth in developing countries – particularly China – is a significant factor in such demand.
- 27 On the other hand, the reliance on one source for a component risks slow-downs or even stoppages at assembly plants when production slows down or stops at the plant where the component is made. For example, operations at seven Chrysler and three GM assembly plants slowed for lack of a single part because of hurricane-induced floods at the supplier in North Carolina (Associated Press, 1999).
- 28 In the U.S., new safety features usually are incorporated by regulation; in Europe, they typically originate with customer demand. Consequently, European parts makers are leaders in this field (Levy, 2008: 10-11).
- 29 Electronics are an integral part of vehicles today. They are control many of the safety features mentioned as well as being the basis of entertainment and communications. The leading electronics suppliers are Delphi, Visteon, Robert Bosch, Siemens, and Denso. Electronic features are so popular that Delphi wants to focus on electronics, safety, and entertainment, and jettison its non-core operations (Levy, 2008).
- 30 Assemblers are making engineering changes to vehicles currently in production to increase gas mileage. These efforts include models that already get relatively high gas mileage; two examples are the Lordstown-made Cobalt and G5. Honda's V-6 engine, made in Anna, can operate on three or four cylinders as well. Other possibilities for simultaneously improving vehicle gasoline mileage and engine performance include:
- automatically turning off the engine at stop lights (some hybrids already use this),
  - using booster batteries during acceleration to supplement engines design for maintaining speed,
  - turbocharging,
  - getting gasoline engines to diesel, and
  - improving aerodynamics, including the underbody of the vehicle (Phelan, 2008).

- 31 Natural gas is a generic term referring to methane and ethane – the two most common types – but also including propane, butane, and other paraffin hydrocarbons. These are subject to processing before use. Gasoline consists of liquid hydrocarbons derived from crude petroleum by a variety of processes (Parker, 1984).
- 32 Honda’s Anna plant makes engines that use natural gas (Harbour Consulting, 2004), but the company limits sales of vehicles with such engines to fleet operations. Engines using natural gas also emit fewer pollutants than gasoline, but such vehicles have limited ranges, and there is no distribution network comparable to that for gasoline and diesel fuel.
- 33 Decades ago, farmers produced ethanol for use in their own engines (Wikipedia, 2008); cost-cutting and technical improvements in the production process may further reduce the break-even price of ethanol (Rohter, 2006).
- 34 Octane ratings of gasoline are based on the ratio of 2,2,4-trimethylpentane, which has eight carbon atoms chained together, to heptane (seven carbon atoms). Gasoline rated at 87 octane has a ratio of the former to the latter of 87 to 13. The more complex the chain, the more the molecule can be compressed before spontaneously igniting, allowing the engine to operate at a higher compression ratio and producing greater power. The octane rating of ethanol is typically 108-110 (Fischetti, 2006).
- 35 Ethanol can be fermented from a variety of plants; sugarcane is a better source than corn. Brazilian officials claim that U.S. import duties of \$.54 per gallon prevent the industry from developing even faster (Rohter, 2006; Wikipedia, 2008).
- 36 The reason cold engines are harder to start with ethanol is that it is less volatile than gasoline.
- 37 It is important to note that the Alias and other such vehicles are classified as motor cycles because they have three wheels. This designation exempts them from a number of safety features required for four wheel vehicles, thereby reducing costs. Furthermore, they were illegal on Ohio roads until the legislature changed the word from “saddle” to seat in the Ohio Revised Code when defining a motor cycle (Vellequette, 2008e).
- 38 Grant, *et.al.*, (2006) suggested hydrogen can be extracted from the next generation of nuclear reactors, liquefied and used as a coolant for super-conducting wires transmitting power while it is pumped to distribution centers.
- 39 Honda’s head of research and development is skeptical of plug-in hybrids because he says the battery technology is not ready; other companies disagree (Rowley, 2008).

- 40 See Wikipedia (2008) for illustrations of the differences between the two internal combustion engine types.
- 41 It is more efficient to run electrical devices from a steady power source such as a battery than to adapt them to work with a highly varying power source such as an internal combustion engine (Romm and Frank, 2006).
- 42 “Just as a motor can transform electrical energy stored in a battery into torque (the force that produces wheel rotation and hauling power), the process can run in reverse so that the torque created by slowing a moving car generates electricity that can be accumulated in the battery” (Romm and Frank, 2006: 74-76).
- 43 As this report was written, tax credits for purchasing hybrid vehicles were diminishing and set to expire by the end of 2008. This increases the payback time for recouping the greater cost of hybrids by gasoline savings alone (Zimmerman, 2008).
- 44 An upside-down loan is one where the balance due on the loan is more than the trade-in value of the vehicle.
- 45 Experts debate just exactly when world oil production will plateau or peak, followed by an inevitable decline. Some have concluded that it could occur in the next decade, while others think it is decades away. “Many industry experts... argue that today’s high prices are temporary, the result of technical bottleneck, sharply rising demand from Asia, and a plummeting dollar” (Roberts, 2008: 88). Others argue that speculation by large investors is the primary reason (Herbert, 2008b). Whatever the reason, though, high prices have not generated the output that prior price jumps have. Some industry experts counter this last point by noting that political and economic impediments above ground have prevented extracting more of what is below ground. Even if these problems are resolved and output increased, worldwide demand is expected to grow due to continued population growth as well as economic development, eventually outstripping supply. Extracting what remains will be much more difficult and costly. Furthermore, the amount of oil discovered each year since the early 1960s has trended downward. World oil production from existing fields has been falling by as much as eight percent per year, meaning that the oil companies must develop an average of up to seven million barrels *a day* in additional capacity to maintain current total output levels – let alone additional output to meet growing demand. Biofuels and more efficient motor vehicles may compensate to a degree – for a while, but sooner or later more fundamental and extensive changes to our currently energy-hungry lifestyle and economy must be made (Roberts, 2008).
- 46 The Renewable Fuel Program of the Energy Policy Act of 2005 “mandates a rise in renewable fuel use in gasoline to 7.5 billion gallons by 2012, nearly double the estimated four billion gallons of fuel ethanol consumed in the” U.S. in 2005 (Wang, 2008: 4). By comparison, U.S. production of gasoline in 2005 was nearly 126.6 billion gallons (U.S. Bureau of the Census, 2007c: table 874).

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