Automakers' Corporate Carbon Burdens

REFRAMING PUBLIC POLICY ON AUTOMOBILES, OIL AND CLIMATE

EXECUTIVE SUMMARY

ENVIRONMENTAL DEFENSE
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Cover photo: Copyright © 2001 Jim West. New Jeep Grand Cherokees outside DaimlerChrysler's Jefferson-North Assembly Plant in Detroit.

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AUTHORS
John DeCicco, Senior Fellow, Environmental Defense
Feng An, Consultant, Novi, Michigan

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Executive summary

On a spring day in 1992, the first Jeep Grand Cherokee rolled off the assembly line at Chrysler's recently completed Jefferson-North assembly plant in Detroit. A vehicle that helped set the SUV trend, the Grand Cherokee had undergone three years of design and development work since then-Chrysler head Bob Lutz first revealed the concept at the 1989 Detroit auto show. The new factory entailed a $1 billion capital outlay, all the more significant because it represented Chrysler's allegiance to investing in Michigan, rather than using the new product as a chance to shift production away from America's automotive heartland.

That first Grand Cherokee also represented a commitment to emit an average of 6.4 tons of the greenhouse gas carbon dioxide (CO_2) annually over its operating life. At 19 miles per gallon, it required 730 gallons of gasoline for a typical 12,000 miles of yearly driving, implying a demand for 17 barrels of oil. While a gallon of gasoline weighs six pounds, when burned and combined with oxygen from the air, the result is nearly 20 pounds of CO_2. For this reason the vehicle, which itself weighs just under two tons, emits over three times its body weight in CO_2 per year.

After a six-year initial run, the Grand Cherokee was redesigned for the 1999 model year with a fuel economy averaging 20 mpg, or about 5% higher, for CO_2 emissions of 6.2 tons per year. By then, annual sales had reached 300,000, and the Jeep Grand Cherokee fleet was consuming 5 million barrels of oil and emitting 1.9 million tons of CO_2 each year. These emissions correspond to 0.5 million metric tons of carbon (MMTc) in the common parlance of climate policy.

Emissions of carbon dioxide from U.S. cars and light trucks nearly match those of all sources in Japan, and exceed those of India and Germany, which rank fifth and sixth among the world's countries in terms of global warming emissions. Controlling CO_2 emissions from personal vehicles is key to addressing global warming, yet this stands as an utterly unmet challenge in the United States. In fact, new fleet average CO_2 emissions rates are rising. Controlling these emissions will also help reduce the global demand for oil. Not only is oil the dominant fossil fuel, it also is a geographically concentrated resource, the unchecked use of which has serious implications for security and the economy.

The decision to invest in a new vehicle model represents a substantial capital commitment for a design that will be marketed with little technical change over its multi-year production run. This decision also locks in a statistically predictable rate of oil demand and CO_2 emissions. The resulting annual emissions are what we call the *carbon burden* of a group of motor vehicles. Many factors ultimately determine the fuel use and CO_2 emissions associated with personal transportation. But the design of new cars, vans, pickups, and SUVs is fundamental. This report uses government data to assign each major automaker a carbon burden based on its new vehicle sales and examine how the firm's carbon burden evolved between 1990 and 2000.

The carbon burden concept presents a way to frame the policy discussion in order to better emphasize the "bottom line" for progress on both energy security and the environment. Effective management from either a corporate or public policy perspective must ultimately focus on outcomes measured in terms of tons of carbon, or barrels of oil, rather than numbers of alternative fuel vehicles,

hybrids, advanced technologies, or other means to the end, no matter how promising these appear to be.

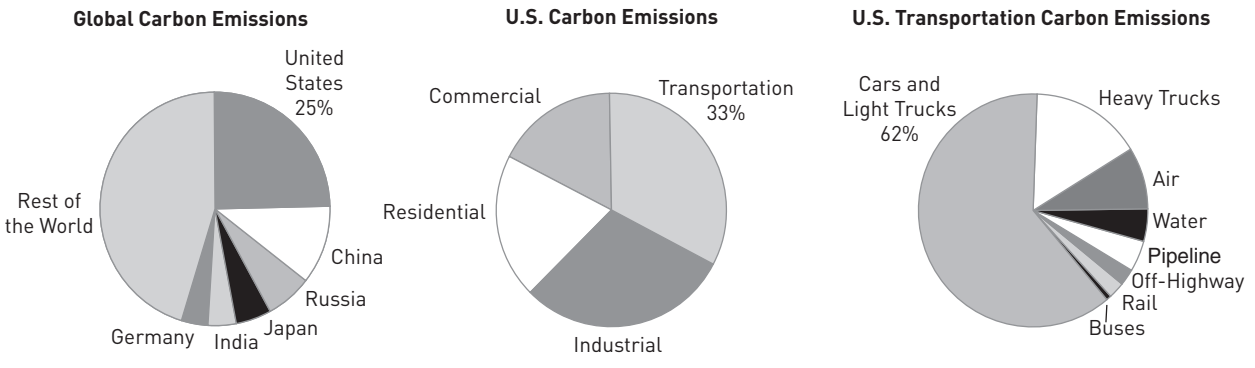
It is the very success of the automobile that makes its impacts so vast. Automakers rank among the world's largest firms. They command access to capital and skill as well as political leverage. Automakers continually invest to improve their products and get ahead in a competitive market. Proportionate to their success comes a responsibility to the broader society that sustains their market. As humanity moves to meet new challenges, a question for the auto industry is how well it will respect societal needs and cooperate in reducing the oil and carbon burdens imposed by its products.

Cars and trucks in context

The United States accounts for 25% of world CO_2 emissions, as shown in Figure 1, or 1,562 MMTc of the world's estimated total of over 6,100 MMTc in 2000. Transportation accounts for one-third of CO_2 emissions from U.S. energy consumption, and the 302 MMTc from cars and light trucks accounts for 62% of U.S. transportation emissions. Thus, U.S. car and light truck emissions represent about 20% of U.S. carbon emissions and about 5% of the world total. If the U.S. personal car and truck fleet were a country, it would rank fifth in terms of global warming emissions.

The carbon burden concept can be used to connect any individual vehicle or collection of vehicles to greenhouse gas emissions from automobiles at national and international levels. Benchmarking the CO_2 emissions associated with each automaker's sales is a first step in linking product planning and investment decisions to an environmental impact of paramount importance. Although the auto industry's responsibilities are the focus of this report, the carbon burden concept can be applied on the demand side of the market as well. Individuals, households, businesses, communities and public agencies all operate motor vehicles. All have opportunities to manage vehicle choice and use in ways that complement—and can help advance—the industry's task of supplying cars and trucks designed with high fuel economy and other attributes needed to cut CO_2 emissions.

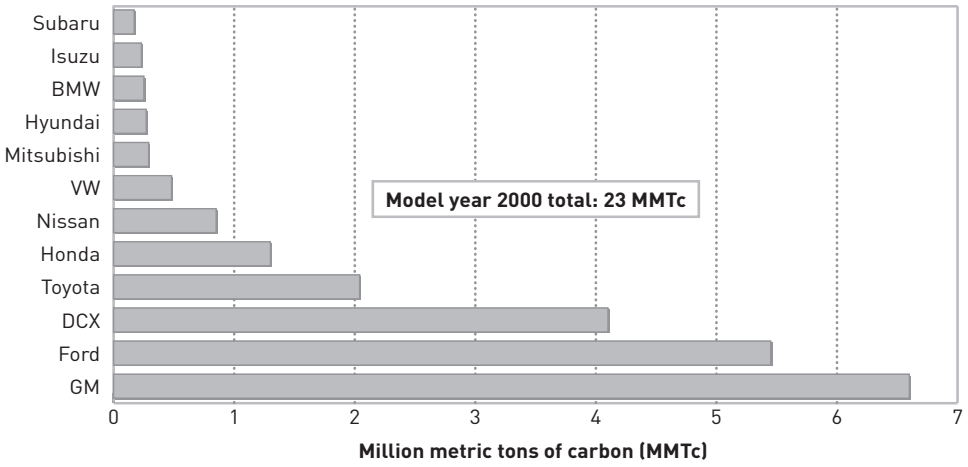
FIGURE 1
Global, U.S., and U.S. transportation sector carbon emissions



U.S. cars and light trucks account for 20% of the nation's CO_2 emissions and 5% of the world total. This level is more than all fossil fuel CO_2 emissions from India, which ranked 5th among countries.

FIGURE 2

Carbon burdens of U.S. new light vehicle sales in 2000



The 23 MMTc carbon burden imposed by new sales represents 7.5% (about 1/13) of the 302 MMTc emitted by all U.S. cars and light trucks on the road in 2000.

Computing the carbon burden

After Daimler and Chrysler merged in 1998, the Jeep Grand Cherokee was part of a combined product line that achieved 2.7 million sales in 2000. This new fleet had an average fuel economy of 22.3 mpg, implying an average per-vehicle emissions rate of 5.6 tons of CO_2 per year (TCO_2/yr). Multiplying this average CO_2 emissions rate by the number of sales yields a company's new fleet carbon burden. That of DaimlerChrysler (DCX) was 4.1 MMTc, as shown in Figure 2 along with those of other major automakers in the U.S. market. The overall new car and light truck fleet total amounted to 23 MMTc.

Each firm's results depend on its market share and average fuel economy. General Motors, with its 28% market share in 2000, has the largest carbon burden, at 6.7 MMTc. Firms with better-than-average fuel economy have a carbon share lower than their market share. Such is the case for Honda, whose 1.1 million sales gave the company a 7% market share in 2000. Its carbon burden of 1.3 MMTc was 5.6% of the total, since Honda's new fleet fuel economy was 25% better than average. Conversely, DaimlerChrysler's fuel economy was 8% lower than average, so its carbon burden share of 18% was greater than its 16.6% market share. A company's relative fuel economy depends partly on the size mix of its fleet. Firms emphasizing light trucks, such as DaimlerChrysler, will have inherently higher carbon shares than firms such as Honda, whose concentration is on cars.

The 23 MMTc total shown in Figure 2 represents the carbon burden associated with the new vehicles sold in 2000. Total U.S. car and light truck emissions are the sum of emissions for the on-road stock of all vehicles, new and used. That total stood at 302 MMTc in 2000. The firm-level analysis given here examines only the evolution of each company's new fleet carbon burden. It is not directly comparable to the total corporate CO_2 emissions estimates that some companies have reported, which include all of a firm's vehicles in use and may also include emissions from manufacturing facilities.

The emissions analyzed here are those that occur when vehicles are driven. Greenhouse gases also are produced while making the steel and other materials that go into cars and during the auto manufacturing process. Counting the entire lifecycle of automobiles, about 11% of carbon emissions occur during production; these are tallied with industrial sector emissions, for example, in the middle pie chart of Figure 1. The remaining 89% of automotive lifecycle CO_2 emissions are directly related to fuel consumption, although some of these emissions occur at refineries and other locations associated with supplying motor fuel.

This analysis focuses on the portion of CO_2 emissions that occurs when vehicles are used because it is the largest portion and because it is seeing no progress toward reduction. In contrast, automakers, refiners and other businesses have slowly been improving energy efficiency in industrial operations. Although more progress needs to be made in all facets of the economy, the United States has not yet even begun the task of controlling the carbon burdens associated with personal vehicle use.

Trends in automotive carbon emissions

Total car and light truck CO_2 emissions have changed as a result of growth in the amount of driving and changes in fuel economy. The 302 MMTc emitted in 2000 is based on fuel consumption of 8.2 million barrels per day, or 126 billion gallons per year of gasoline. The level is 56% higher than it was in 1970, but this increase is much less than the 146% increase in driving (by a factor of nearly 2.5) that occurred since then.

The oil and carbon burden connection

Oil is the world's dominant fuel, accounting for 40% of global energy use. As such it also accounts for the largest portion of human-produced CO_2 emissions. But oil is unique among fossil fuels because of its geopolitical concentration.

Petroleum products are now seen as ideal transportation fuels, so oil use is especially concentrated in the sector. Transportation in the United States is 97% oil dependent and accounts for 67% of the nation's petroleum consumption.

The 19 million barrels per day (Mbd) of oil consumed by the United States is 26% of the 75 Mbd world total and far exceeds the country's 5.8 Mbd oil production. Cars and light trucks alone consumed 8.2 Mbd in 2000, 40% of U.S. oil consumption and 11% of the world total.

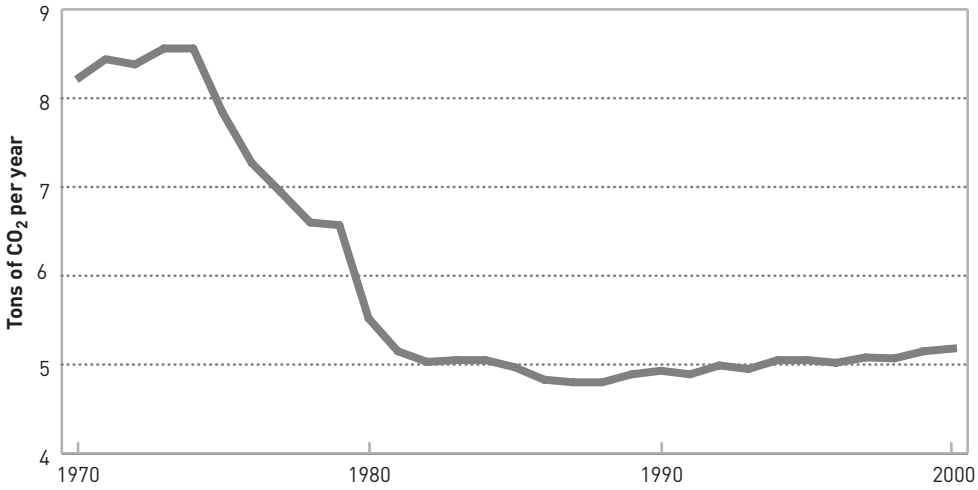
The carbon burden associated with motor vehicle fuel use corresponds to a locked-in quantity of petroleum demand. For example, the new cars and light trucks sold in model year 2000 essentially commit the country to needing 620,000 barrels per day of oil over the life of the vehicles. This fuel demand equals the output of eight typical petroleum refineries.

Unchecked, such demand contributes to tight domestic gasoline markets as well as pressure on the volatile world oil market. With 65% of global oil reserves located in the Persian Gulf, oil consumption presents an ongoing national security issue for the United States.

Given that car and light truck fuel use entails an oil demand "burden" that causes economic and security as well as environmental problems, concerted efforts to manage it would be sound first steps in addressing global warming.

FIGURE 3

Average new car and light truck CO_2 emissions rate



The oil shocks and CAFE standards trimmed the new fleet CO_2 emissions rate by 4.4% per year from 1973–1987, but since then it has been growing at 0.6% per year.

CO_2 emissions grew more slowly than travel because fuel economy improved, so per-vehicle CO_2 emissions rates fell substantially over the 30-year period. Figure 3 shows the 1970–2000 trend in average new vehicle CO_2 emissions rate, derived from the inverse of fuel economy. The oil crises and Corporate Average Fuel Economy (CAFE) standards pushed fuel economy rapidly upward in the years following 1973. As a result, new fleet average CO_2 emissions rates fell from a high of 8.6 TCO_2/yr in 1973 to a 30-year low of 4.8 TCO_2/yr by 1987. Since then, fuel economy has slowly declined due to the well-known shift to light trucks, which captured 46% of the light vehicle market by 2000. The new fleet average CO_2 emissions rate climbed 8% over 1988–2000, to 5.2 TCO_2/yr, but it was still 43% lower than in 1973. Total light vehicle CO_2 emissions are now rising in step with the amount of driving, no longer offset by increases in fuel efficiency.

The role of market shifts

The shift from sales of vehicles classified as passenger cars to those classified as light trucks has been underway since the mid-1970s. From 1975–2000, light trucks gained market share at an average rate of 1.1 points per year. The trend can be seen in three waves by body style. The minivan wave began in 1984. The second trend was that of the sport-utility vehicle (SUV), which took off around 1990. The third wave now underway is the crossover vehicle, with body styles such as car-based sport wagons and pickup-SUV blends.

The 1990–2000 period was dominated by the SUV trend. Over the 1990s, the typical SUV had a fuel economy of 20 mpg. The corresponding CO_2 emissions rate is 6.2 TCO_2/yr, 40% higher than the 4.4 TCO_2/yr average for passenger cars, which SUVs typically replaced. The lower-than-average fuel economy and rising market share pushed the carbon burden share of SUVs from 7% in 1990 to 24% of the overall new light duty fleet carbon burden as of 2000.

Although average SUV fuel economy rose from 13 mpg in 1975 to 20 mpg by 1990, the fact that it has not changed since then means that *all* of the engineering, design and technology improvements to SUVs between 1990 and 2000 were applied for reasons other than higher fuel economy and lower CO_2 emissions rates. In this regard, SUVs are not unique, but rather serve as an icon for the trends of the 1990s, during which the auto industry's resources were allocated to provide greater performance and amenity throughout the market while fuel economy remained generally flat within segments.

In spite of the rising CO_2 emissions trends of the 1990s, it is important to note that most of the efficiency increases since the 1970s still remain in place. Moreover, the net efficiency gain now squarely reflects technology improvement. The oil shocks from 1973 through the early 1980s did result in downsized cars. But since then the vehicle mix has been getting heavier and more powerful as technological progress is plowed into amenities other than fuel economy. Although the average new vehicle CO_2 emissions rate has increased 8% since 1988 largely due to rising light truck share, it was still 43% lower in 2000 than in 1973. All in all, technology change has been five times more important than market shifts in affecting the overall fuel efficiency and CO_2 emissions characteristics of U.S. motor vehicles. Shifting away from SUVs would not yield large emissions reductions compared to those attainable by improving the technology in SUVs and other vehicle types.

Another environmentally adverse trend is associated with alternative fuels policy. Federal law provides credits toward CAFE standards for automakers who sell flexible-fuel vehicles (FFVs), regardless of how much alternative fuel is actually used. Each of the Big Three is applying the credits to make up for sales of less efficient vehicles, resulting in increased fleet average CO_2 emissions rates. The FFV credits resulted in combined light duty fleet CO_2 emissions rates that were 0.8% higher for GM and 3% higher for both Ford and DaimlerChrysler than they otherwise would have been in model year 2000. A recent Department of Transportation report estimated that the FFV credits caused excess carbon emissions of 1.5 MMTc in 2000; the impact is projected to reach 8.3 MMTc by 2008.

FIGURE 4

New fleet carbon burdens for Big Six in 1990 and 2000

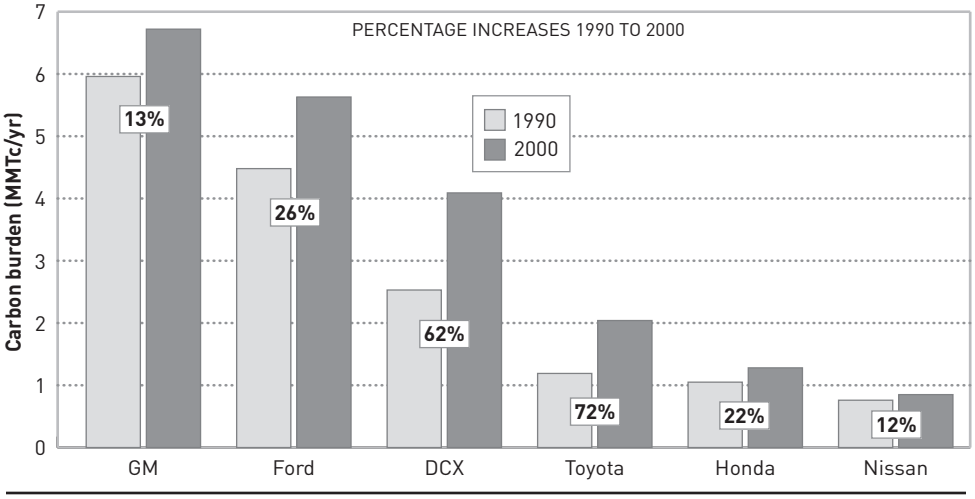
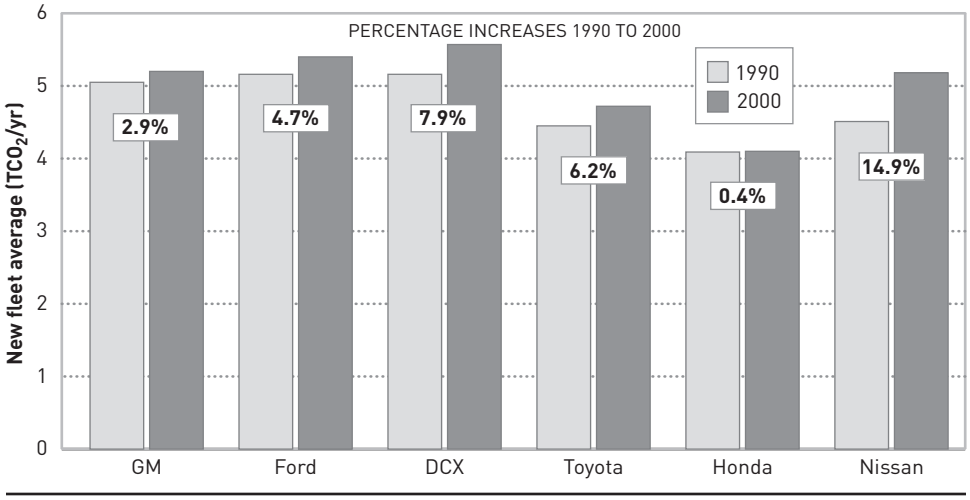


FIGURE 5

Average CO_2 emissions for Big Six in 1990 and 2000



Results for the Big Six automakers

The six largest selling automakers in the U.S. accounted for 91% of the new fleet carbon burden in 2000. These firms, GM, Ford, DCX, Toyota, Honda and Nissan, also accounted for 90% of new vehicle sales. In analyzing the 1990-2000 period, we tally a major firm's mergers, acquisitions, and controlling interests under the corporation as it was constituted in 2000. Thus, our DaimlerChrysler analysis includes the Mercedes-Benz and Chrysler lines; our Ford analysis includes Mazda, Volvo and Jaguar. By this reckoning, the Big Three (GM, Ford, DCX) combined market share fell from 73% in 1990 to 69% in 2000.

Figure 4 shows the total carbon burdens for the Big Six in 1990 and 2000. It grew for all firms, reflecting the 28% overall expansion of the market and a 4% decline in average fuel economy over the decade. Absolute growth was greatest for DaimlerChrysler, at 1.6 MMTc. Toyota's increase was the greatest in percentage terms, with its new fleet carbon burden growing 72% from 1990 to 2000, due largely to expansion of market share but also to the company's shift toward light trucks.

Changes in carbon burdens are a result of the combined changes in overall market size, market share and fuel economy. The last factor, which depends on vehicle design and technology, determines a firm's fleet average CO_2 emissions rate. Figure 5 shows these emissions rates as they changed between 1990 and 2000 for the Big Six. All firms increased the average CO_2 emissions rates of their product lines, with the overall market average emissions rate rising 4% over the decade, from 4.9 TCO_2/yr to 5.1 TCO_2/yr. Highlighted below are the notable findings for each of the Big Six automakers.

GENERAL MOTORS

Largest overall carbon burden, linked to leading market share

- The 6.7 MMTc imposed by GM's model year 2000 sales accounted for the largest portion, at 30%, of the total new light duty fleet carbon burden that year.

- GM's light vehicle market share declined from 35% to 29% over 1990-2000, while the light truck portion of its sales rose to 46% and its SUV sales increased fourfold.
- GM's overall new fleet average CO_2 emissions rate increased 2.9% (counting the effect of FFV credits and only vehicles covered by CAFE standards).
- Counting the firm's largest SUVs, such as the four-wheel drive Suburbans exempt from CAFE standards, would push GM's average CO_2 emissions rate upward by 1.3%.

General Motors did not increase its light truck sales as fast as some other companies during the 1990s. It increased the average fuel economy of its separate car and light truck fleets. GM used FFV credits, but not as extensively as Ford and Chrysler. GM answered Ford's SUV efficiency pledge with a commitment to maintain leadership in light truck fuel economy. While less specific than the Ford pledge, one interpretation of GM's pledge would imply a 4% reduction in fleet average CO_2 emissions rate, which would more than make up for the 2.9% increase in the company's emissions rate between 1990 and 2000.

FORD

SUV fuel economy pledge may not make up for 1990s increase in CO_2 emissions rate.

- Ford's new fleet carbon burden in 2000 was 5.6 MMTc, 25% of the total.
- Ford closed the decade with a light vehicle market share just under 24%, down 1.6 points from 1990.
- Ford's use of FFV credits has pushed its new fleet average CO_2 emissions rate 3% higher than it otherwise would have been in 2000.
- The truck share of Ford's light vehicle sales rose 15 points, reaching 50%, and the company's new fleet average CO_2 emissions rate increased 4.7% between 1990 and 2000.

Ford was a leader in the SUV trend, and the company added the CAFE-exempt Excursion to its lineup in 1999. Without this vehicle, Ford's SUV fuel economy would have been essentially the same in 2000 as in 1990. In July 2000, Ford pledged to improve the fuel economy of its entire SUV fleet 25% by 2005. The benefit of this commitment depends on the extent to which Ford continues shifting from cars to light trucks. If the company held its light truck share fixed and other things remain equal, the SUV pledge would yield a 4.6% reduction in Ford's fleet average CO_2 emissions rate.

If Ford continues shifting to light trucks at the rate it did during the 1990s, the net benefit of the SUV fuel economy pledge would drop to 4.2%, insufficient to make up for the 4.7% increase in its new fleet average CO_2 emissions rate from 1990 to 2000.

DAIMLERCHRYSLER

Merged firms post largest absolute increase in carbon burden over decade.

- DaimlerChrysler's carbon burden was 4.1 MMTc in 2000, 18% of the market total that year and up 1.6 MMTc from the sum of the separate Mercedes and Chrysler levels in 1990; this increase partly reflects the combined brands' three-point gain in market share.
- DaimlerChrysler's average CO_2 emissions rate also grew faster than the market trend, with a 7.9% increase between 1990 and 2000.

- The company has become heavily dependent on light trucks, which accounted for 64% of DCX light vehicle sales as of 2000.

Since Mercedes is a luxury brand, its sales are relatively low, so DaimlerChrysler's CO_2 emissions trends reflect mainly the company's Chrysler brands. DaimlerChrysler's SUV sales reached 800,000 by 2000, over four times higher than Chrysler's SUV sales in 1990. Although Chrysler offered no CAFE-exempt heavy SUVs, a notable high-volume addition was the Dodge Durango. Its CO_2 emissions rate is nearly 20% higher than Grand Cherokee's and over 45% higher than the overall light vehicle average in 2000.

DaimlerChrysler also relies significantly on FFV credits, which served to push its new fleet average CO_2 emissions rate 3% higher than it otherwise would have been in 2000.

TOYOTA

Carbon burden grows 72% over 1990–2000, faster than that of any other firm.

- Toyota's market share increased from 7.7% in 1990 to 9.8% in 2000, a gain that was compounded by overall growth in the light vehicle market.
- Light trucks rose from 24% to 37% of Toyota's sales, with the company's SUV sales tripling over the decade, and Toyota also had a 2% drop in its passenger car CAFE.
- Toyota increased its overall fleet average CO_2 emissions rate 6.2% over 1990–2000.

Toyota introduced the Prius, the world's first hybrid-electric car, to the Japanese market in 1997. The Prius offers a 40% efficiency boost. But the car did not reach the U.S. market until July 2000 as an early model year 2001 car, so it is not covered in our 1990-2000 analysis. In its first year on the U.S. market, Prius sold 15,600.

To make up for the 1990-2000 increase of 6.2% in its average CO_2 emissions rate, Toyota would have to sell over 315,000 hybrids with the Prius' level of efficiency improvement.

HONDA

Fuel economy leader shows the smallest increase in CO_2 emissions rate.

- Honda's new fleet carbon burden increased roughly 20% between 1990 and 2000, versus 30% for the market as a whole, closing the decade at 1.3 MMTc.
- Honda's average passenger car fuel economy increased 3% over the 1990s.
- By 2000, light trucks accounted for 16% of Honda sales, pulling the company's overall average fuel economy down by 0.1 mpg.
- Honda's new fleet average CO_2 emissions rate increased 0.4% over 1990–2000.

Honda built no light trucks for the U.S. market prior to the CR-V introduced in 1997; its Odyssey minivan was classified as a wagon until a larger version was introduced in 1999. Honda's new vehicle sales reached 1.1 million in 2000, for a 7% market share. The company has long marketed at least one high-technology, high-efficiency vehicle, and in 2000 it introduced the 70 mpg Insight hybrid-electric car. Although sales of such fuel economy leaders have been very low, Honda has applied efficient technology throughout its lineup.

NISSAN

Rising truck dependence pushed carbon burden up in spite of sagging market share.

- Nissan's carbon burden rose from 0.8 MMTc in 1990 to 0.9 MMTc in 2000.
- Nissan's market share closed the decade at 3.7% of light vehicle sales, down 2.2 points from its share in 1990, and the light truck portion of its sales rose from 23% to 52%.
- SUVs were the one segment where Nissan increased sales, but not enough to offset losses in other segments, and they pulled Nissan's light truck CAFE down by 4 mpg from 1990-2000.
- Nissan's new fleet average CO_2 emissions rate increased the most among the Big Six, with the 2000 level being 14.9% higher than the 1990 level.

The road ahead

The trends of increasing oil demand and carbon burdens appear poised to continue indefinitely. The market seems to have a limitless capacity to absorb technological progress in amenities other than higher fuel efficiency and lower CO_2 emissions. Business-as-usual projections have U.S. car and light truck CO_2 emissions growing from the 2000 level of 302 MMTc to 487 MMTc/yr by 2020, a 61% increase. If the fuel economy and shares of other segments and makes are unchanged, the Ford, GM and DCX light truck fuel economy pledges might trim CO_2 emissions by 17 MMTc in 2020, representing only a 3% reduction from the expected growth.

In terms of the auto industry's interests, reducing the emissions rates of their products is clearly preferable to reducing sales or market shares. That means making design changes that, practically speaking, will need to emphasize fuel economy improvement for at least the next decade. Just how much efficiency improvement is feasible over a given time frame is a subject of discussion. However, the fact that significant potential exists is not in serious dispute. The challenge is finding ways to channel technological capabilities to reduce fleet average fuel use and CO_2 emissions rates. Policies ranging from regulations to incentives and public education can push automotive design toward vehicles that emit less CO_2. These options are being explored, although historically effective measures such as CAFE standards have faced high political hurdles.

The automobile, in tandem with its great success, imposes a number of burdens on society. One of these burdens, which the United States has not addressed, is its carbon burden, or contribution to global warming. Reducing the carbon burden will also reduce demand for oil, helping protect the nation's economic and security interests. Over the past decade, the automotive carbon burden has been worsening, partly because of a shift toward SUVs. However, history shows that the shift to trucks is not the main issue. Carbon emissions from automobiles are increasing because of the failure to improve the fuel economy of all vehicles, cars and trucks alike.

Automakers have used recent design improvements for everything but higher fuel economy. To reduce the carbon burden imposed by automobiles, car companies need to increase fuel efficiency throughout their product lineup. Their success as the world's largest firms gives automakers a responsibility to lead in this arena. The carbon burden concept provides a way for policymakers and business leaders to measure progress in protecting the nation from the dual threats of global warming and unchecked oil demand.

ENVIRONMENTAL DEFENSE

finding the ways that work

National Headquarters
257 Park Avenue South
New York, NY 10010
212-505-2100

Capital Office
1875 Connecticut Avenue, NW
Washington, DC 20009
202-387-3500

California Office
5655 College Avenue
Oakland, CA 94618
510-658-8008

Rocky Mountain Office
2334 North Broadway
Boulder, CO 80304
303-440-4901

North Carolina Office
2500 Blue Ridge Road
Raleigh, NC 27607
919-881-2601

Texas Office
44 East Avenue
Austin, TX 78701
512-478-5161

PROJECT OFFICES

18 Tremont Street
Boston, MA 02108
617-723-2996

3250 Wilshire Boulevard
Suite 1400
Los Angeles, CA 90010
213-386-5501