4.0 Vehicle Weight and Size Reduction

Vehicle weight, size, and fuel consumption are all intimately connected. Assessing the prospects for fuel consumption reductions requires an understanding of the ways in which vehicle sizes and weights may evolve in the future. All else equal, a vehicle with a significantly lower weight will consume significantly less energy per kilometer traveled. As discussed in more detail in Chapter 5, a 1% reduction in vehicle weight reduces per-kilometer fuel consumption by approximately 0.6%–0.7%, holding size and acceleration performance constant.

Changes in vehicle weight emerge from two fundamentally opposing forces; it is helpful to think about the weight effects from these two forces separately. On the one hand, improvements in vehicle capabilities, such as higher performance, larger size or carrying capacity, and greater levels of equipment, add weight to a vehicle. Features and functionality that add weight are most appropriately viewed as design attributes to be traded off against size, fuel consumption, and acceleration performance. On the other hand, advances in materials, design, and manufacturing technologies tend to reduce the weight of vehicles. These are more appropriately considered to be sources of technology improvement that expand the feasible set of vehicle designs. Manufacturers must carefully balance content added to vehicles against investments in weight-saving technology during the course of product development. Similarly, analysts attempting to understand future fuel consumption trends should separately consider trends in both weight-increasing capabilities and weight-decreasing technology improvements.

4.1 Vehicle Weight in an International Context

By international standards, vehicles in the United States are relatively heavy. In the United States, average passenger vehicle weight increased dramatically between 1987 and 2004, before leveling off in recent years. As shown in Figure 4.1, this trend has been driven both by the increasing average weights of cars and trucks and by a shift in sales volume from cars to trucks, and lately back to cars.

![Figure 4.1](image_url)  
**Figure 4.1** Average weight of new cars, new trucks, and cars and trucks combined in the United States from 1975–2010 [EPA, 2014]
In Europe between 2001 and 2008, passenger vehicles averaged 1,380 kg, and no time trend in weight was evident. However, in the United States, the average car weight increased from 1,400 kg (3,080 lbs) to 1,470 kg (3,240 lbs) over this same period, and the average new light-duty vehicle (LDV) (including light-duty trucks as well as cars) increased from 1,620 kg (3,570 lbs) to 1,720 kg (3,790 lbs). It is interesting to note that passenger cars in the United States are only slightly (~5%) heavier than European passenger vehicles. But when light trucks are included, the average U.S. LDV is about 20% heavier than the average LDV in Europe.

In Asia, the contrast with the United States is more pronounced. In China, various estimates have placed the average curb weight of new passenger cars to be between 1,200 kg (2,640 lbs) and 1,300 kg (2,860 lbs) in recent years, which is approximately 10%–20% less than the average new car in the United States (and 20%–30% less than the average new LDV in the United States). In Japan, the average weight of an LDV is approximately 1,200 kg, with cars and light trucks (compact trucks and very small “K-trucks”) weighing approximately the same.

4.2 Weights and Sales by Vehicle Class

Increases in average vehicle weight since the mid-1980s have been driven by both shifts from lighter to heavier classes of vehicles, and by weight increases within classes. In 1980, just 16% of the LDVs sold in the United States were trucks, and the overwhelming majority of these were pickup trucks (Figure 4.2). By 2004, trucks comprised over half of all LDVs sold in the United States, with virtually all of the growth coming from (mini-) vans and Sport Utility Vehicles (SUVs). At the same time, small cars represented an ever-shrinking share of the market, while the shares of midsize and large car shares were largely preserved. Coincident with fuel prices beginning to rise in 2004, these trends were reversed in subsequent years. Light trucks fell to below 40% of new LDVs in 2009, with small and midsize cars picking up the slack.

![Figure 4.2](image)

**Figure 4.2** Shifting market shares of vehicle types in the United States [EPA, 2014]
The weight differences between various vehicle classes (Figure 4.3) are important, but have changed significantly over time. Unsurprisingly, large cars weigh more than midsize cars, which weigh more than small cars. However, these differences have been declining over time. Whereas the average large car outweighed the average small car by more than 800 kg (1,760 lbs) in 1975, this gap had shrunk to a little over 300 kg (660 lbs) by 2010. The weights of vans and SUVs have tracked together since 1975, while the weight of pickup trucks has changed more dramatically. Between 1986 and 2010, the average new van gained 250 kg (550 lbs) and the average new SUV gained 270 kg (590 lbs). Over the same period, the average weight of new pickup trucks increased by 750 kg (1,650 lbs).

4.3 Technologies for Reducing Vehicle Weight

Weight-reducing technologies include a broad range of design and manufacturing techniques, as well as the replacement of traditional materials with lighter and stronger alternatives. Particularly important are major architectural choices in vehicle design including the selection of front-wheel drive versus real-wheel drive, as well as the selection of unitized body (unibody), space frame, or body-on-frame construction. These major architectural changes, and the replacement of conventional steel and iron with lighter materials, are examined here. A broader definition of weight-reducing technologies would also include myriad other advances in engineering, design, and manufacturing practices that permit materials to be used more effectively in building vehicles.

4.3.1 Major Architectural Changes

New cars in the United States underwent significant architectural shifts between 1975 and 1990 that contributed substantially to reductions in weight. In 1975, about half the cars on the market in the United States used unibody construction, and fewer than one in 10 were front-wheel drive. By 1990, 95% used unibody construction and 85% were front-wheel drive [Environmental Protection Agency (EPA), 2012].
4.3.2 Unibody Construction

Unibody construction reduces weight by eliminating the traditional frame and integrating its structural functions into the vehicle’s body shell. Data compiled by Audatex North America indicate that the overwhelming majority of cars offered in the United States since 1975 have used either unibody or body-on-frame construction. In addition, a small fraction of cars have used space frame construction, which employs a three-dimensional structure of welded tubes to which non-structural body panels are attached, primarily in low-production, high-performance cars. A few others have used unibody-on-frame construction, incorporating elements of both the unibody and body-on-frame architectures.

Estimates of the weight savings from unibody construction vary widely. Dupnick (1996) suggested a weight difference of more than 450 kg (1,000 lbs) between unibody and body-on-frame cars, whereas a 1970s case study from Ford attributed only 87 kg (192 lbs) of weight reduction to the switch from body-on-frame to unibody [Gutherie, 1978].

The weight savings from replacing body-on-frame with unibody construction can be estimated by creating matched sets of unibody cars and comparable body-on-frame cars, using a Mahalanobis matching algorithm. Size, transmission, drive, and model year data were obtained from a database maintained by the U.S. EPA. Data on construction type by model and year were provided by Audatex North America, and were merged with the EPA database. Matched sets of vehicles were created by matching unibody cars with body-on-frame cars that had the same transmission type and drive type, similar interior volume (within 5 cubic feet or 0.14m³), and were of similar vintage (within two model years). The difference between these groups indicated that, on average, a unibody car weighs 280 kg (616 lbs) less than a body-on-frame car with the same drive type, transmission type, and size (from the same model year). A similar analysis indicates that the average space frame car weighs 156 kg (344 lbs) less than a comparable unibody car, and that cars using unibody-on-frame construction do not differ significantly in weight from comparable unibody cars. These results are summarized in Table 4.1.
Table 4.1  Estimated weight changes from switching vehicle architectures in cars

<table>
<thead>
<tr>
<th>Comparison</th>
<th>Applies to</th>
<th>Estimated Difference (kg)</th>
<th>Standard Error (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Construction Type</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unibody vs. Body-on-Frame</td>
<td>Unibody Cars</td>
<td>-280</td>
<td>5</td>
</tr>
<tr>
<td>Space Frame vs. Unibody</td>
<td>Space Frame Cars</td>
<td>-156</td>
<td>19</td>
</tr>
<tr>
<td>Unibody-on-Frame vs. Unibody</td>
<td>Unibody-on-Frame Cars</td>
<td>-39</td>
<td>35</td>
</tr>
<tr>
<td><strong>Drive Type</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Front-wheel Drive vs. Rear-wheel</td>
<td>Front-wheel Drive Cars</td>
<td>-296</td>
<td>6</td>
</tr>
</tbody>
</table>

4.3.3 Front-wheel Drive

A second major architectural change in cars in the United States is the transition from rear-wheel drive to front-wheel drive. When compared with rear-wheel drive, front-wheel drive yields both a direct weight reduction in the drivetrain, and an indirect weight reduction due to improved packaging of the drivetrain. Eliminating the need for a tunnel running the length of the vehicle increases interior space and permits exterior dimensions and weight to be reduced while maintaining interior volume.

The weight effect of front-wheel drive relative to rear-wheel drive was estimated by matching front-wheel drive vehicles with rear-wheel drive vehicles that had the same transmission type and construction type, similar interior volume (within 5 cubic feet or 0.14m³), and were of similar vintage (within two model years). Based on the difference between these groups, a front-wheel drive car weighs an estimated 296 kg (653 lbs) less than a rear-drive vehicle with the same transmission type, construction type, interior volume, and model year.

4.3.4 Engine Size

Engine technology has matured in numerous ways since the 1970s, allowing manufacturers to extract more performance from a given engine mass. Aluminum blocks and cylinder heads have gradually replaced cast iron, and ancillary equipment (such as intake manifolds and accessories) is increasingly made of composite materials. Apart from this shift to lighter materials, however, engines have also just become smaller over time, as significant improvements in power density have enabled the replacement of 6- and 8-cylinder engines with 4- and 6-cylinder engines.

To estimate the weight savings resulting from substituting a smaller engine, vehicle weights were compared between different engine sizes, holding vehicle model, model year, body style, and transmission type constant. There was an average decrease in weight of 64 kg (142 lbs) when decreasing from 8 to 6 cylinders, and an average decrease of 67 kg (147 lbs) when decreasing from 6 to 4 cylinders.
4.3.5 Alternative Materials

Traditional low-carbon steel and iron now make up less than half the weight of a new vehicle in the United States, as they are increasingly displaced by alternatives such as high-strength steel, aluminum, plastics, composites, and magnesium. Since the substitution of alternative materials into a vehicle’s design is strongly dependent on the demands of the specific application in question, estimating the amount of weight saved by these materials is difficult. Nevertheless, it is helpful to generate some rough approximations based on the properties of different materials and reports in the literature. Cheah (2010) and Wohlecker et al. (2006) provide relationships for estimating the weight ratios of parts made with alternative materials to those made with conventional materials, in a variety of generic load cases. These provide a useful starting point for estimating the weight-reduction potential of various alternative materials. In addition, a variety of authors have reported rules of thumb and case studies of vehicle designs using alternative materials. Midpoint estimates for the weight-saving potential of key materials are summarized in Table 4.2.

### Table 4.2 Approximate weight-saving potentials of key materials

<table>
<thead>
<tr>
<th>Material</th>
<th>Weight Savings</th>
<th>Weight Reduction Potential</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conventional steel &amp; iron</td>
<td>0%</td>
<td>1.0</td>
</tr>
<tr>
<td>High-strength steel</td>
<td>23%</td>
<td>1.3</td>
</tr>
<tr>
<td>Aluminum</td>
<td>45%</td>
<td>1.8</td>
</tr>
<tr>
<td>Magnesium</td>
<td>60%</td>
<td>2.5</td>
</tr>
<tr>
<td>Plastics &amp; composites</td>
<td>50%</td>
<td>2.0</td>
</tr>
</tbody>
</table>

**High-strength Steel**

Based on rule-of-thumb relationships like those mentioned above and typical values for materials properties, parts made from high-strength steel (HSS) are expected to weigh between 0% and 25% less than a conventional steel part, depending on the application. Salonitis et al. (2009) estimated a 10%–30% weight reduction from using advanced high-strength steels, and Roth et al. (1998) reported an advanced steel unibody weighing 25% less than conventional unibodies. Das, Curlee, and Schexnayder (1997) assumed that high-strength steels could reduce weight by 50% relative to conventional steels, but the rationale for this high value was unclear. A particular challenge in estimating the weight-reduction potential is that there is such a broad range of available grades of HSS, with widely varying properties. When focusing on materials substitutions to date, it can be assumed that each kg of HSS replaced 1.3 kg of conventional steel (a 23% weight reduction).

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12 Fraction of weight saved by replacing conventional steel or iron with alternative material.

13 Mass of conventional material displaced per unit mass of alternative material used.
Aluminum

Rules of thumb based on generic load cases suggest that substituting aluminum for conventional steel can reduce weight by up to 70%, with a 50% reduction predicted in many applications. The trade press has noted that the greatest concentration of automotive aluminum use is in engines, and that aluminum engine blocks weigh half as much as iron blocks [Murphy, 2006]. Stodolsky et al. (1995) estimated that in engine applications, aluminum reduced cylinder head weight by 50% and block weight by 40%. They also reviewed a number of studies and concluded that substituting aluminum for steel in the body reduces weight by about 40%–47%, even when “the design of the vehicle is not completely optimized for aluminum manufacture.” Mayer and Seeds (1994) concluded that a 45% reduction in weight for the body-in-white was possible by substituting aluminum for steel in a BMW 3-series. Das, Curlee, and Schexnayder (1997) assumed that substituting aluminum for steel and cast iron delivers a 45% weight reduction, while Carle and Blount (1999) estimated a 40% reduction in weight relative to steel in automotive body applications. Although generic load cases suggest that replacing steel with aluminum can reduce weight by as much as 70%, most of the (considerable) literature on the topic suggests that a value of around 45% is more reasonable in practical applications.

Magnesium

Magnesium still represents a very small fraction (0.3% in 2009) of automotive materials usage, and fewer estimates of its weight reduction potential have been reported. Based on generic load cases, it is estimated that magnesium can reduce weight by up to 70% compared with conventional steel or iron. Luo (2002) calculated savings as high as 80% for some wrought magnesium alloys. Das, Curlee, and Schexnayder (1997) assumed that substituting magnesium for steel and cast iron would deliver a 67% weight reduction. As a general rule, it is reasonable to assume that each kilogram of magnesium replaced 2.5 kg of conventional steel or iron—which represents a 60% weight reduction.

Plastics and Composites

Estimating the weight-reduction potential of plastics and composites is particularly difficult because of the wide range of materials included in this category. However, some rough calculations with typical ranges of values for materials properties indicate that weight reductions in excess of 80% could be possible, relative to conventional steel or iron. For example, Luo (2002) estimated a weight-reduction potential of 35%–70% for polycarbonate/Acrylonitrile butadiene styrene (ABS) based on generic load cases. Das, Curlee, and Schexnayder (1997) assume a 30%–60% weight reduction from substituting composites for steel. The American Chemistry Council (ACC), 2011 has estimated that each kg of plastics and composites replaces 2–3 kg of other materials (a 50%–67% reduction). A report commissioned by Plastics Europe [Pilz, Schweighofer, and Kletzer, 2005] concluded that each kg of plastic replaces an average of 1.5 kg of heavier material (a 33% reduction in weight), but found reductions of up to 75% in some components. As a general rule of thumb, it is reasonable to assume that each kg of plastic or composite material has displaced 2 kg of traditional steel or iron (a 50% weight reduction).
Carbon fiber composites are a promising technology deserving particular attention. Among the many materials included under the “plastics and composites” umbrella, carbon fiber composites offer some of the greatest potential for weight reduction, and have seen significant progress in recent years. In generic load cases, carbon fiber composites offer weight reductions of up to 80% relative to conventional steel and iron. In practical applications, weight reductions of 60% have been reported by a number of investigators [Das, Curlee, and Schexnayder, 1997; Lovins and Cramer, 2004; Prado, 2007]. For many years, carbon fiber composites were found only in a handful of ultra-premium vehicles, most famously the McLaren F1. More recently, the Corvette Z06 employed carbon fiber components, and now BMW is taking carbon fiber mass-market in its i3 city car. Currently, the picture is changing quickly for carbon fiber but it remains to be seen whether longstanding challenges in manufacturing and cost have finally been overcome.

4.4 Weight Added by New Features

While the use of weight-saving technologies has steadily grown, it has been offset (and at times, more than offset) by increases in the deployment of weight-increasing features and a shift toward heavier (larger) car classes. The widespread addition of new features—including safety, emissions control, and comfort and convenience features—has been one of the most obvious changes to vehicles during the past four decades.

Zoepf (2011) multiplied the weights of various features with their take rates in order to estimate their contributions to the weight of the average new car in the United States. In total, he estimated 109 kg (240 lbs) of feature weight in the average 1975 passenger car. In 2010, this number had grown to 223 kg (62 kg safety, 25 kg emissions, 136 kg comfort/convenience—a total of 491 lbs). These estimates include only the weight of the relevant subsystems, and exclude the contributions of secondary weight, discussed in the following section.

Zoepf’s analysis is unable to capture all improvements in vehicle quality. Noise, vibration, and harshness (NVH), for example, have dramatically improved in new vehicles as a result of balance shafts, sound-insulating materials, and active noise cancellation. Other metrics, such as reliability and body rigidity, have also improved. Zoepf only reported on the weight effects of discrete features associated with specific identifiable components.

4.4.1 Secondary Weight Effects

For every unit of weight added to (or removed from) a vehicle, the supporting systems and structures must also grow (or shrink) so that structural integrity, braking, acceleration, and handling performance can be maintained. These indirect weight effects are referred to as secondary weight. The addition or removal of secondary weight may be discontinuous, as in the case of a discrete number of existing engines or transmissions being available for inclusion in a particular vehicle model. Moreover, secondary weight effects may vary depending on the subsystem in which the primary weight reduction occurs. Nevertheless, it is common to estimate secondary weight effects by multiplying a single secondary weight factor by a primary weight change occurring at the component level.
Cheah (2010) reviewed more than 20 published studies of secondary weight and identified estimates ranging from 23%–129%, with a mean value of 79.6%. In this report, secondary weight is assumed to be 80% of the primary weight added or removed. This secondary weight coefficient was applied only to the bottom-up analyses of features and materials, in which the initial estimates of weight change were generated from component-level data. However, the secondary weight multiplier was not applied for mix shifting or architectural changes, since the weight effects of these changes had already been assessed at the whole-vehicle level.

### 4.4.2 Aggregate Effects

The aggregate weight-reduction effects of more weight-efficient architectures and materials can be estimated from growth in the adoption of those technologies, and the weight-savings effects reported above. Figure 4.4 summarizes the estimated contributions of front-wheel drive, unibody construction, alternative materials, and small engines to weight reductions in the average new car in the United States since 1975. Details of this analysis, including the analytical methodology and data on the growth in various technologies, have been reported elsewhere [MacKenzie, Zoepf, and Heywood, 2014].

![Cumulative contributions of major weight-savings technologies since 1975](image)

**Figure 4.4** Cumulative contributions of major weight-savings technologies since 1975 [MacKenzie, Zoepf, and Heywood, 2014]
Collectively, the growth in the use of unibody construction, front-wheel drive, alternative materials (primarily aluminum and high-strength steel), and smaller engines, has eliminated approximately 750 kg from the average new car since 1975. The overall rate of change has varied over time. Between 1975 and 1982, a sufficient number of new technologies were added to reduce weight by approximately 52 kg per year (115 lbs/year), or about 3% of the average car weight in 1975. Between 1982 and 1990, this figure was about 26 kg per year (57 lbs/year), or about 2% of the average car weight in 1990. From 1990 to 2009, new weight-saving technologies only eliminated about 11 kg per year (24 lbs/year) from the average new car, or roughly 1% of the average car weight in 1990.

Over the same period, sales have shifted from smaller car classes to larger car classes, and more features have been added. Figure 4.5 summarizes the estimated weight increases due to these changes since 1975. The weight increase due to mix shifting was estimated by calculating the average of the 1975 weight in each class, weighted by each year’s sales mix. The weight increase due to new features was calculated as in Zoepf (2011), and includes secondary weight effects. Since 1980, new features have added steadily to the weight of the new cars, at an average rate of about 7 kg per year (15 lbs/year).

![Figure 4.5](https://example.com/figure4.5.png)

**Figure 4.5** Estimated cumulative change in weight of average new LDVs due to the addition of new features and shifts in market shares of size classes. Featured weight estimates include secondary weight effects.
4.5 Prospects for Future Vehicle Weight

Automakers in the United States and globally have recently announced plans to reduce vehicle weight by roughly 30–40 kg per year (6–88 lbs/year), or 2%–3% of initial vehicle weight annually in the coming years. For example, Ford has a goal to cut 340 kg (750 lbs) from its vehicles by 2020, and reduced the weight of the F-150 pickup by 320 kg (700 lbs) in its 2014 redesign. Renault and PSA Peugeot Citroen established a goal of cutting 200 kg (440 lbs) by 2018, while Hyundai planned in 2010 to cut its average vehicle weight by 10% [150 kg (330 lbs)] over five years. A recurring source of ambiguity is that it is seldom clear whether numbers like these refer to gross weight reduction (i.e., the weight removed through more advanced technologies) or net weight reduction (i.e., the actual change in the weight of a vehicle, after accounting for the addition of new features and capabilities).

Previous assessments from this group have suggested that plausible targets for weight reduction through materials substitution are on the order of 20% over 25 years, or 30% after accounting for secondary weight savings [Bandivadekar et al., 2008; Cheah, 2010]. This amounts to about 1.2% of base vehicle weight reduced each year, or about 15–25 kg per year (33–55 lbs/year) (depending on the initial weight of the vehicle). Thus, the targets announced by automobile manufacturers appear to be more aggressive than our previous analyses had anticipated. However, the announced goals are within the range of historic rates of weight reduction observed in the 1970s and 1980s.

While historical performance suggests that weight can be reduced quite rapidly through the introduction of new technologies, it is less clear what the ultimate potential is for weight reduction. Some of the technologies available in the 1970s and 1980s—most notably unibody construction and front-wheel drive—are now found on almost all new cars, limiting their potential to deliver further weight reductions. About one-third of new light truck models in the United States still use body-on-frame construction and one-quarter employ rear-wheel drive, so the potential for weight reduction among light trucks may be somewhat greater than among cars (though front-wheel drive and unibody may never be appropriate for heavy-duty towing applications). Additional weight reductions might still be found through greater use of alternative materials and space frame construction, though this is not without challenges. As of 2006, more than half of new engines in North America used aluminum blocks, including 85% of those in cars [Murphy, 2006]. Only 25% of trucks had aluminum blocks, but this share has been growing rapidly. As the market for aluminum engine blocks becomes saturated (as has already happened with aluminum cylinder heads), further materials substitution will shift toward body structures. Conventional steel and iron still comprise about 40% of the weight of new vehicles. If all of this material could be replaced with alternatives that cut component weight by an average of 40%, then weight reductions on the order of 30% might be possible through materials substitutions (accounting for secondary weight effects). If processes can be developed that make space frame construction practical for high-volume models, its universal adoption might reduce average car weight by a further 11%.
Greater replacement of conventional steel and iron with well-developed alternatives, along with a switch to space frame construction, could cut vehicle weight by a maximum of about 35%–40% from current levels. Absent a switch to more radical alternative materials such as carbon fiber composites, or downsizing or de-featuring the vehicle mix, this seems like a plausible upper bound for weight reductions in the United States. If new technologies were added to reduce vehicle weight by 2% annually, this potential would be fully realized in 23 years. Though it is hard to foresee such a path right now, if new technologies could continue to cut weight by 2% annually through 2050, vehicle weight would be reduced by a little more than half relative to today.

In the United States, new features have added about 7 kg per year to new cars since 1980 (including secondary weight effects). To accommodate continued improvements in emissions, safety, and comfort and convenience of vehicles, it is reasonable to assume continued weight increases of up to 7 kg per year. However, it is also possible that the auto industry may shift to a greater emphasis on “virtual performance,” a term that refers to a philosophy of shifting design efforts to characteristics that do not add weight or otherwise increase fuel consumption [DeCicco, 2010]. This includes, for example, richer connectivity and media capabilities. If such features—which rely heavily on software—become the main profit center for new automobiles, then the functionality of vehicles could continue to be improved without necessarily increasing weight.

Downsizing the vehicle mix is another way to cut weight. Starting with the mix of new vehicles in 2010 in the United States, consider what would happen if every vehicle could be replaced with one from the next class size down. Suppose that large cars were replaced with midsize cars, midsize cars with small cars, and existing small cars remained the same. Suppose also that this scenario were repeated for SUVs, vans, pickups, and wagons. Based on the average weights of these segments, such a shift in volume would reduce average vehicle weight by approximately 9%. On the contrary, if the opposite shift occurred (small cars were replaced with midsize cars, midsize cars with large cars, etc.), the average weight would increase by about 9%.

Synthesizing the results noted here, it appears to be likely that by 2050, enough new technology will have been adopted to cut vehicle weight by 30%–50% (an average of 1%–2% per year). Assuming that the shares of various car and truck classes remain constant and new features add 4–7 kg per year (9–15 lbs/year) to new vehicles, the average new vehicle in the United States would weigh between 1,000 kg (2,200 lbs) and 1,460 kg (3,220 lbs) in 2050. This would represent a net reduction of somewhere between 13% and 40% from the 2010 average of 1,680 kg (3,700 lbs).
References


