Chapter 9

THE IMPACT OF CARBON CONSTRAINTS ON COMPETITIVENESS AND VALUE CREATION IN THE AUTOMOTIVE INDUSTRY

Niki Nikolaus Rosinski
Generation Investment Management LLP, London, United Kingdom,
niki.rosinski@generationim.com

Abstract: The purpose of this article is to quantify the financial risks and opportunities faced by the automotive industry from "carbon constraints"—policy measures designed to mitigate climate change by limiting emissions of carbon dioxide (CO_2) and other greenhouse gases. This article is derived from Austin D, Rosinski N, Sauer A and Le Duc C (2003) *Changing Drivers*, a report which explores how carbon constraints in global automotive markets may affect value creation in 10 leading automotive companies between now and 2015. The full report and other relevant materials can be downloaded free of charge from Internet URL <:http://www.sam-group.com/changingdrivers/> or <:http://capitalmarkets.wri.org.> The Original Equipment Manufacturers (OEMs) assessed are BMW, DaimlerChrysler (DC), Ford, GM, Honda, Nissan, PSA, Renault, Toyota and Volkswagen (VW)—the world's largest independent automotive companies. The geographical scope of the assessment is the United States, European Union and Japanese markets, which together account for nearly 70 percent of current global sales.

Changing Drivers is the result of collaboration between SAM Sustainable Asset Management (SAM)—a Zurich-based independent asset management company specialising in sustainability-driven investments—and the World Resources Institute (WRI)—an environmental research and policy organisation based in Washington D.C. Drawing on the respective strengths and expertise of the two organisations, the report analyses both the risks and opportunities of carbon constraints, and then estimates the combined implications for the OEMs' future earnings. The analysis is explicitly forward-looking, focusing on the main factors affecting the OEMs' exposure to carbon constraints, and drawing on the latest publicly available information about the 10 assessed OEMs.

S. Schaltegger, M. Bennett and R. Burritt (Eds.), Sustainability Accounting and Reporting, 207-229.

1. INTRODUCTION

Climate change is a relatively new issue for the automotive industry, and one that may have significant financial impacts for the sector. Climate change policies (or "carbon constraints") are already in place in several major automotive markets and appear likely to spread, forcing automotive Original Equipment Manufacturers (OEMs) to lower the carbon emissions profile of new vehicles. At the same time, new technology options in various states of development offer the potential to meet new carbon constraints while increasing profitability. Carbon constraints thus create a combination of risk and opportunity for OEMs.

In view of the growing carbon constraints on automotive markets, a key challenge for sector investors and OEM managers is to quantify the impact of carbon constraints on competitiveness. In this article we analyse how carbon constraints could affect the shareholder value creation of 10 leading OEMs: BMW, DC, Ford, GM, Honda, Nissan, PSA, Renault, Toyota and VW. The geographical focus is the US, EU and Japanese markets, which account for nearly 70 percent of current global sales. The time period analysed is from 2003 to 2015.

Carbon constraints create both risks and opportunities for OEMs. Risks principally take the form of possible increases in costs to meet new standards and/or loss of market share to more fuel-efficient producers. Opportunities lie in the potential to develop successful strategies to reduce carbon emissions that translate into technological leadership, enhanced market share and greater profits.

To assess risks and opportunities, we performed two complementary analyses:

- A *Value Exposure Assessment* identifies the risks of carbon constraints in terms of the estimated costs for each OEM to meet new CO_2 emissions standards by 2015.
- A *Management Quality Assessment* identifies the opportunities for OEMs to capitalise on carbon constraints and enhance their competitiveness, by virtue of their superior management quality and focus on lower-carbon technologies.

A key challenge for analysts is to determine the implications of these findings for shareholder value creation. Consequently, we translate the results of both the Value Exposure and Management Quality assessments into changes in forecasted EBIT (Earnings before Interest and Taxes) for the period 2003 through 2015. EBIT is a foundation for valuation estimates in this sector and so changes in an OEM's EBIT offer useful insight into possible changes for overall Return on Invested Capital (ROIC) and thus shareholder value.

2. VALUE EXPOSURE ASSESSMENT

In all three main automotive markets covered in this report—the United States, European Union and Japan—governments have committed to higher fuel economy or CO_2 emission standards in the coming years. These standards will require OEMs to make potentially costly changes to vehicle specifications and sales mix. The costs incurred by each OEM will vary depending on its product portfolio and the current sales-weighted average fuel economy of its fleet, and on the costs of achieving CO_2 reductions for different vehicle types. The Value Exposure Assessment aims to quantify the range of costs that carbon constraints may impose on OEMs over the next 12 years.

The Value Exposure Assessment seeks to answer the following question:

What costs do OEMs face in meeting higher fuel economy standards in 2015, given their initial sales levels and vehicle mix?

2.1 Methodology

We developed a methodology to estimate the cost that each OEM will incur to meet different possible carbon constraints between now and 2015. In our analytical model, each OEM is characterised by its 2002 sales and fuel economy levels and has access to three main categories of lower-carbon technologies—incremental technologies, diesel, and hybrid technology. While fuel cell technology forms part of the management quality assessment thanks to its potential impact on competitiveness, it is ignored for the cost calculation. This is mainly due to the expected low penetration rate through 2015 and hence minimal contribution to actual CO_2 reductions within this time frame.

The model calculates the lowest-cost combination of technologies that an OEM must add to its existing vehicle fleet to ensure that it meets the specified new standards. Separate analyses are completed for the US, EU and Japanese markets and then aggregated to produce an overall cost estimate for each OEM. For more details on the model, please refer to Internet URL <:http://pdf.wri.org/changing_drivers_appendix.pdf>.

Because of uncertainties about the future regulatory environment, we assess sensitivity to different levels of carbon constraint that may emerge by 2015. In addition, we explore different market penetration rates for diesel and hybrid technologies, because of uncertainties regarding their technological development and acceptance by regulators and consumers.

Though the main analysis does not take into account inevitable changes in sales and vehicle mix over the next decade, it provides some quantitative insight into the magnitude of costs that each OEM might face in order to improve the carbon intensity of its vehicles.

2.1.1 Scenarios

While significant carbon constraints are in place in Europe and Japan, the outlook for the United States is more uncertain. To reflect uncertainty about future carbon constraints, we analysed two different levels of emissions standards ("high" and "low") for each market for 2015 (see Figure 9-1a-c.).

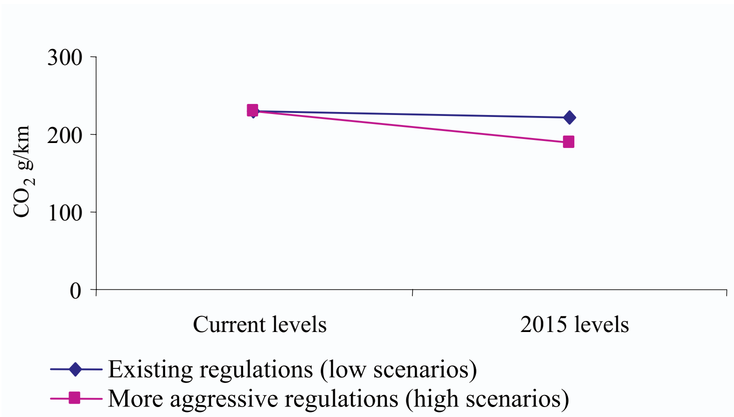


Figure 9-1a. Current and future carbon constraints in the United States.

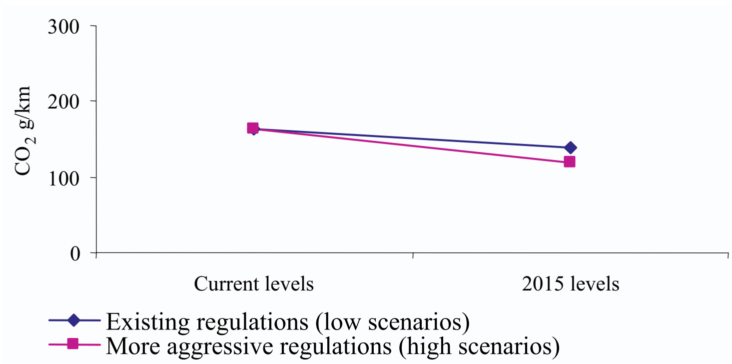


Figure 9-1b. Current and future carbon constraints in the European Union.

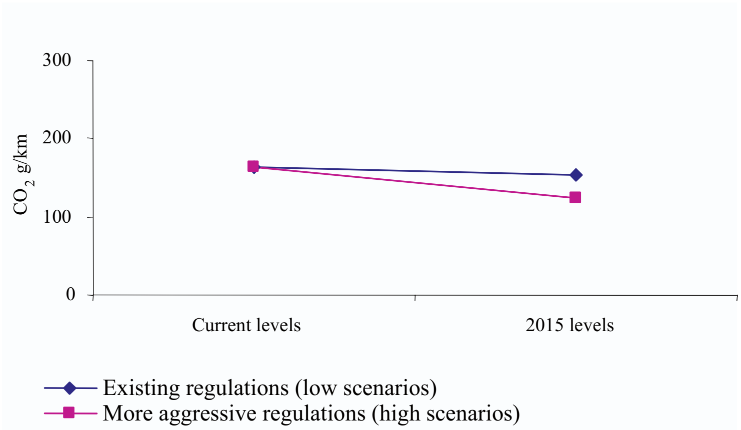


Figure 9-1c. Current and future carbon constraints in Japan.

For the European Union, future standards have already been signposted through voluntary agreements and regulations. Hence, high and low scenarios in this market are based on existing commitments. For the United States, scenarios reflect much greater uncertainty. The United States recently tightened its CAFE (Corporate Average Fuel Economy) standards for light trucks to 22.2 mpg (249 g CO_2/km) from 20.7 mpg (267g CO_2/km). However, fuel economy standards for passenger cars may not change before 2015. Bills proposing tighter standards for passenger cars have repeatedly been rejected by the US Congress, while both the Administration and Congress have shown little willingness to introduce policies to address climate change. On the other hand, some recent developments argue for the possibility of significantly tighter carbon constraints for passenger cars by 2015. California has passed a law that will regulate CO_2 emissions from vehicles by 2009, and other states have shown interest in emulating this approach. In addition, continued energy security concerns may advance CAFE standards by 2015.

The details of the scenarios used for each region are described under the "Market Specific Results" section. Predicting which of these, or other, scenarios is likely to occur is inherently difficult, given the many factors that may influence the setting of carbon constraints between now and 2015. Consequently, we weigh high and low scenarios equally, which effectively brackets the possibilities.

2.1.2 Characterisation of OEMs

OEMs may be limited in their capacity to adjust segment mixes in response to carbon constraints. Each OEM is characterised in terms of vehicle sales in seven separate segments for each of the three main markets. OEMs have different initial levels of carbon intensity for each segment in each market. One limitation of the analysis is that vehicle sales by company and by segment are kept constant at 2002 levels. This assumes that consumers will continue to buy the same types of vehicles from the same OEMs. In practice, of course, an obvious response to carbon constraints is for OEMs to adjust segment mix to produce relatively more low-emissions vehicles.

2.1.3 Technology Costs

Costs of lower-carbon technology will vary across segments and OEMs. Between now and 2015, OEMs will have access to three core types of CO_2-reducing technologies: incremental technologies (engine, transmission and vehicle technologies applied to a traditional internal combustion engine to improve fuel economy), diesel and hybrid technology. These technologies will have different costs in terms of dollars required to generate a given reduction in CO_2. In addition, the costs of a given technology will vary across different vehicle segments (e.g., hybridisation may be more expensive in pickups than smaller cars) and in some cases by OEM (e.g., Toyota and Honda should be able to add hybrid technology at lower cost than other OEMs).

Cost information on incremental technologies forms the basis of our estimates. We used cost data from a recent National Academy of Sciences (NAS) study addressing both *existing* and *emerging* technologies that should be readily available by 2015 (National Research Council 2002). The underlying cost data reflect both capital and operating costs required to improve fuel economy. For such technologies, capital expenditures are expected to account for approximately one third of total costs. For incremental technologies, costs are assumed to be equal across all OEMs, given the well-understood and relatively well-developed nature of those technologies. In practice, though, some OEMs may have small near-term advantages in this area because of existing expertise in conventional ICE technology (internal combustion engine).

These cost curves are modified in certain sub-scenarios by introducing diesel and hybrid powertrains as additional CO_2-reducing technologies. For most OEMs, costs are lower in scenarios where diesel and hybrid technology is available. Availability of diesel and hybrid technologies differs by market. For example, diesel, which is already established in Europe, appears in all sub-scenarios for the European Union but is ignored in Japan. Also, while it is assumed that incremental technologies can be applied to all vehicles, ceilings are placed on the adoption rate of diesel and hybrid technologies, reflecting likely production and market constraints on their penetration over a 12-year period (see Table 9-1).

Table 9-1. Maximum assumed Diesel and Hybrid penetration rates in 2015, by market.

Market	Diesel penetration rate (%)	Hybrid penetration rate (%)
US	20	15
EU	65	15
Japan	n.a.	30

Moreover, for hybrid and diesel technology, we assume that manufacturing costs vary among OEMs according to level of expertise with these technologies. Using results from the Management Quality Assessment, which evaluates the OEMs' relative quality regarding the management of a portfolio of lower carbon technologies, we ranked OEMs in terms of their expertise with diesel and hybrid technologies (excluding fuel cell technology due to its expected low penetration rate and hence minimal contribution to CO_2 reduction through 2015). Leaders in each group were assumed to be able to implement the new technology at a 5 percent cost reduction, while laggards were assumed to incur a 5 percent cost penalty (see Table 9-2).

Table 9-2. Ranking of OEMs by technological leadership (source: Management Quality Assessment).

Technology	Leader (5% cost reduction)	Neutral	Laggard (5% cost penalty)
Diesel	PSA, VW	BMW, DC, Renault (Nissan), Toyota	Ford, GM, Honda
Hybrid	Honda, Nissan (Renault), Toyota	DC, Ford, GM	BMW, PSA, VW

2.2 Market-Specific Results

Costs for each OEM were determined for the United States, European Union and Japan. Results from each market are described below.

2.2.1 United States

For the United States, we evaluated two scenarios of equal weight. The low scenario was based on the conservative assumption that no further changes are made to CAFE standards over the next 12 years beyond the recent tightening for light trucks. This raises standards by 1.5 mpg for light trucks by 2007 to 22.2 mpg (249 g CO_2/km).

In the high scenario, fuel economy standards rose to 33 mpg and 25 mpg (167 g CO_2/km and 221 g CO_2/km), respectively, for cars and light trucks. These represent standards that the NAS finds will maximise net economic and social benefits and can be achieved using available or nearly available technologies (National Research Council 2002). Though a significant increase over today's standards, they still fall well below *current* standards in the European Union and Japan. Furthermore, these standards are in line with the levels that would be achieved in 2015 if the current CAFE increase of 1.5 mpg over 3 years for light trucks were extended at the same rate for all vehicles over this time frame.

Though there has been debate about the future structure of the CAFE program, we assumed that the distinction between imported and domestic vehicles disappears by 2015 for both scenarios. In addition, we assumed that the distinction between cars and light trucks would persist, but that the light truck category would expand upwards to include several large models of SUVs and pickups that currently are exempt from CAFE standards.

The costs of meeting a stricter CAFE standard vary widely among companies, because of the different vehicle mix and initial levels of average fuel economy (see Figure 9-2). Costs also vary significantly between the high and low scenarios. Ford, GM, BMW and DC incur the greatest additional costs per vehicle. Honda is virtually unaffected in either scenario.

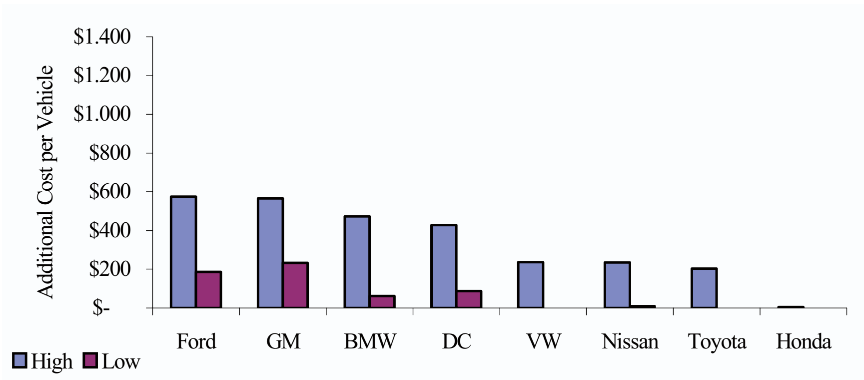


Figure 9-2. Cost *per* vehicle of meeting higher CAFE standards in the United States.

OEMs not shown do not have sales in the United States. Figures represent the costs of altering today's vehicles to meet the standards assumed for 2015.

2.2.2 European Union

For Europe, we evaluated a low scenario reflecting the first step of the ACEA (European Association of OEMs) agreement (140 g CO_2/km) and a high scenario in which CO_2 emissions standards are tightened to the 120 g CO_2/km rate that is the eventual goal of the agreement.

To date, the industry has not disclosed the working structure of its voluntary commitment, creating marked uncertainty for investors about its financial implications. For this analysis, we assumed in both scenarios that the target would eventually be binding on each OEM's fleet. A binding target reflects the strong interest of EU regulators in seeing the agreement succeed and their likely willingness to step in if it does not. If so, it is plausible to imagine a system that places equal responsibilities on individual OEMs, whether it requires each to meet the standard through emissions reductions in its own fleet or whether the standard can be met through some form of trading among OEMs of CO_2 reduction credits. However, until the structure of the agreement is fully disclosed, investors will remain uncertain about the financial consequences for OEMs: while a CAFE-like structure of a single target for each OEM would reward companies currently producing vehicles that are the least carbon-intensive, a structure based on proportionate reductions from current starting points would have the opposite effect.

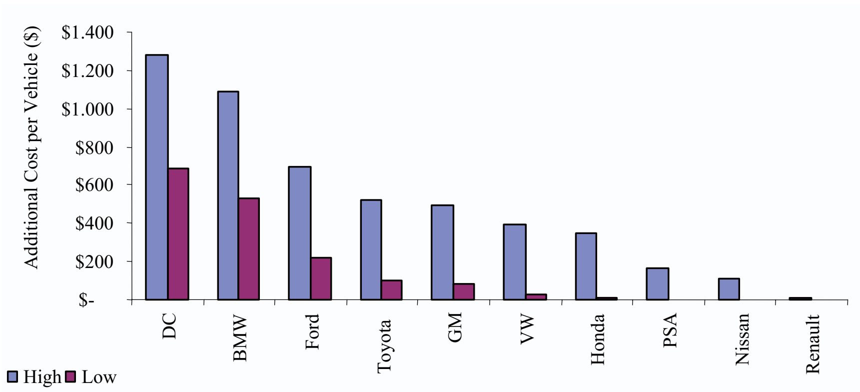


Figure 9-3. Cost per vehicle of meeting lower CO_2 emissions standards in the European Union.

Again, costs vary significantly by OEM (see Figure 9-3). DC and BMW have the highest additional costs per vehicle in both scenarios. Renault, Nissan and PSA stand out as having little or no new additional costs in either scenario. Note that the high figures represent manufacturing costs only. If OEMs rely on diesel technology to lower carbon intensity—as is expected—it is likely that they could recoup all or most of these costs given the price premium that currently exists for diesel technology.

Figures represent the costs of altering today's vehicles to meet the standards assumed for 2015.

2.2.3 Japan

For Japan, we evaluated a low scenario based on the 2010 standards, which a majority of vehicles are already in compliance with. In the high scenario, the recent rate of mandated fuel economy improvements was extended to 2015. This implies a 46 percent increase in fuel economy by 2015 relative to 1995 levels. Although this standard seems quite stringent, the implied trajectory of improvement is consistent with that required to achieve the government's goal of reducing transport emissions from the baseline by 17 percent to meet Kyoto targets. Moreover, given the number of vehicles that exceed the 2010 standard already, such a target seems feasible.

The Japanese government has established a clear preference for hybrid over diesel technology. Thus, we assume that only incremental and hybrid technologies will be adopted by 2015. Again, costs fall on OEMs to different degrees (see Figure 9-4). Ford and Nissan would incur the greatest additional costs if more stringent CO_2 emissions standards were enacted in Japan. There are virtually no costs incurred in the low scenario.

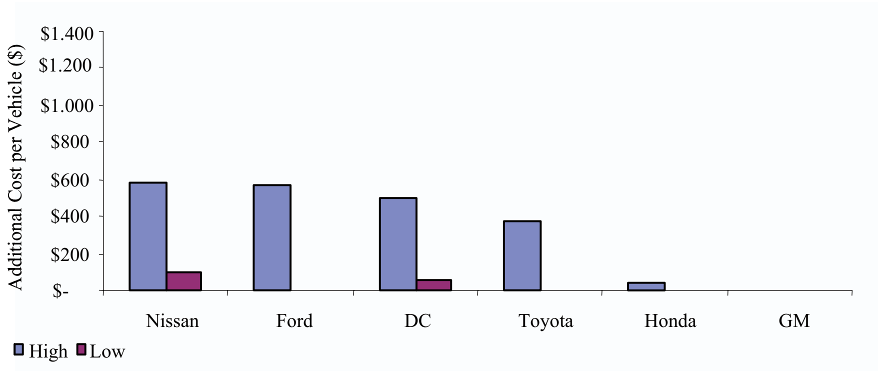


Figure 9-4. Cost per vehicle of meeting lower CO_2 emissions standards in Japan.

OEMs not shown do not have sales in Japan. Figures represent the costs of altering today's vehicles to meet the standards assumed for 2015.

2.3 Aggregate Results and Further Implications

Total costs to meet carbon standards in the major global automotive markets differ substantially among OEMs. The financial impacts for the separate markets were aggregated to identify the overall cost for each OEM to meet new standards in the markets in which it competes (see Figure 9-5 and Tables 9-3 and 9-4). Because OEMs have different product mixes with different carbon-intensity levels, the costs incurred in meeting new standards will vary across the industry. Our analysis shows that costs of compliance per vehicle will range from nearly $650 for BMW to less than $25 for Honda.

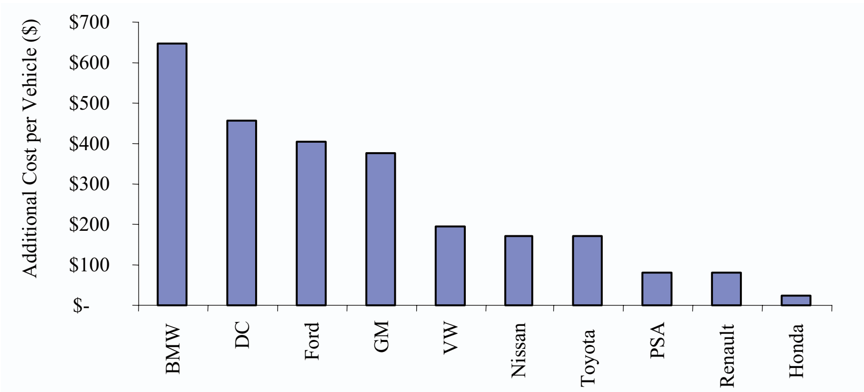


Figure 9-5. Estimated costs per vehicle to meet CO_2 emissions standards by 2015.

Table 9-3. Estimated costs per vehicle to meet CO_2 emissions standards by 2015, by market.

	BMW	DC	Ford	GM	Honda	Nissan	PSA	Renault	Toyota	VW
US	$267	$257	$380	$399	$2	$122	-	$122	$102	$119
EU	$807	$984	$455	$289	$175	$54	$82	$3	$314	$210
JP	-	$279	$287	-	$23	$340	-	$340	$190	-
Total	$649	$459	$403	$377	$24	$172	$82	$79	$170	$195

Average costs per vehicle reflect sales-weighted averages of costs in individual markets.

Table 9-4. Estimated total costs to meet CO_2 emissions standards by 2015, by market ($ millions).

	BMW	DC	Ford	GM	Honda	Nissan	PSA	Renault	Toyota	VW
US	$69	$642	$1,333	$1,869	$3	$50	-	$40	$177	$59
EU	$502	$957	$757	$336	$32	$19	$170	$3	$202	$554
JP	-	$10	$18	-	$18	$123	-	$98	$254	-
Total	$571	$1,609	$2,107	$2,205	$53	$192	$170	$141	$634	$613

Renault is attributed sales in US and Japan because of its 44 percent stake in Nissan.

Although mid- to long-term competitiveness in the industry will rest heavily on the successful development and commercialisation of diesel, hybrid and fuel cell technologies, our analysis indicates that the majority of the near-term carbon reductions are achieved by less-heralded incremental technologies that are already available.

3. MANAGEMENT QUALITY ASSESSMENT

Offsetting the risks, emerging carbon constraints create opportunities for OEMs to enhance their competitiveness by developing vehicles that produce fewer carbon emissions. The degree to which OEMs succeed in this depends on the quality of management decisions made with regard to lower-carbon technologies. One challenge for managers is to establish leadership in one or more lower-carbon technologies that may be vital for future profits. In addition, given that most OEMs compete in more than one of the three major automotive markets, each of which has its own technology preferences, another challenge is to ensure that the strategy for reducing carbon emissions is robust, or balanced, across the multiple technology pathways.

The Management Quality Assessment seeks to answer the following question:

Which OEMs have the strongest potential to capitalise on their investments in lower-carbon technologies and so benefit from carbon constraints?

We identified diesel, hybrid and fuel cell technology as key sources for future competitive advantage. The actual development of these technologies is only part of the challenge facing OEMs. OEMs also have to commercialise market and mass produce these technologies if they are to reap the full rewards. Consequently, an OEM's ability to capitalise on carbon constraints depends on a wide range of management attributes regarding lower-carbon technologies, beyond just technological development capabilities.

3.1 Methodology

The analytical framework we used to assess lower carbon management quality is based on a management competence model developed by SAM. For the purpose of this report, SAM Research's standard competence model was adapted to focus on OEMs' ability to derive competitiveness through strategies to achieve lower carbon intensities (or "lower-carbon strategies"). The quality of such strategies is driven by a core set of management competencies, including strategic, financial, governance, customer and product, human, and process (see Table 9-5).

The Management Quality Assessment focuses on the three technologies - diesel, hybrid and fuel cell technology - that are most likely to form the basis for long-term competitive advantage. We believe that there is less scope for an OEM to establish a competitive edge through lower-carbon technologies based on advanced gasoline engines and incremental technologies, given the mature stage of development of these technologies and widespread understanding of these technologies.

Table 9-5. Management competencies relevant for assessing lower carbon strategies.

Competence	Business Case	Core Indicators
Strategic	Alignment of lower carbon strategy to business strategy enhances strategic co-ordination and is essential to derive competitiveness from lower carbon technologies	Level of strategic commitment Level of strategic co-ordination Targets Milestones
Financial	Ability to fund development and commercialisation of lower carbon technologies is a key driver for turning lower carbon strategy into a competitive advantage	Cash position Level of R&D Expenditure Capital structure Access to capital Investor relations
Governance	Setting de facto standards in lower carbon technologies allow OEMs to capitalise on first mover advantages, such as enhanced pricing power	Ability to set de facto standards Market share License to operate
Customer & Product	Introducing a lower carbon technology ahead of competition holds strong potential for competitiveness, including brand equity.	Ability to derive brand equity Margins Market share Cross-selling Customer feedback
Human	Access to technology and ability to capitalise on intellectual capital through partnerships is essential for deriving competitiveness from lower carbon technologies	Number of patents R&D headcount Partnerships
Process	The ability to generate economies of scale allows to compensate development costs ahead of peers	Economies of scale Process efficiency Production flexibility Industrial ecology

The full set of competencies was assessed and evaluated for each of the three lower-carbon technologies. The six competencies were scored for each technology using a simple scoring system of 0 (Low), 1 (Medium), and 2 (High). The scores for the individual competencies were then aggregated (equally weighted) into a management quality score for each lower-carbon technology. In turn, the technology-specific scores for diesel, hybrid and fuel cell technology were aggregated (equally weighted) into an overall management score to provide an indication of overall management strength (see Figure 9-6).

Finally, though Nissan and Renault are treated as separate OEMs for the Value Exposure Assessment, they received the same management quality scores. This reflects their close alliance and the expected increasing level of integration and strategic coordination between the two OEMs over the next decade.

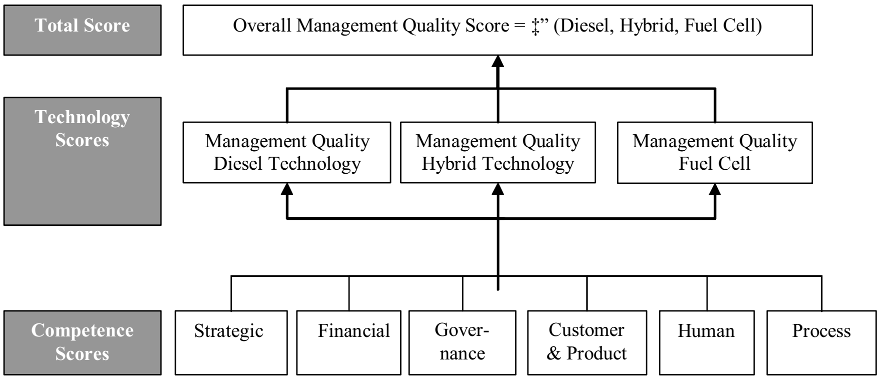


Figure 9-6. Structure of management quality assessment.

3.2 Technology-Specific Results

3.2.1 Diesel

Process competence and customer competence will be crucial for capitalising on diesel technology. Diesel is a relatively cheap and well-established lower-carbon technology. As a result, financial and technology development competencies are of increasingly less competitive relevance. Rather, the management challenge will be to maintain margins in the face of increasing competition through strong reputation, economies of scale, and flexibility of production. Consequently, management quality is reflected in a strong diesel sales base, high diesel margins, and cost leadership.

European OEMs are more competitive in diesel. VW’s and PSA’s market leadership in diesel is clearly reflected in their high management quality scores (see Figure 9-7). Among the non-European OEMs, Toyota and Ford appear to be the most interesting. Toyota has recently stepped up its efforts in diesel due to a more aggressive push into Europe, where diesel is key for growth, and in preparation for meeting new Tier 2 air quality standards in the United States from 2007 onwards. By cooperating with PSA, Ford may have an opportunity to improve its diesel capabilities quickly by leveraging economies of scale. As a result, Ford's process competence regarding economies of scale is a key driver for its management quality score.

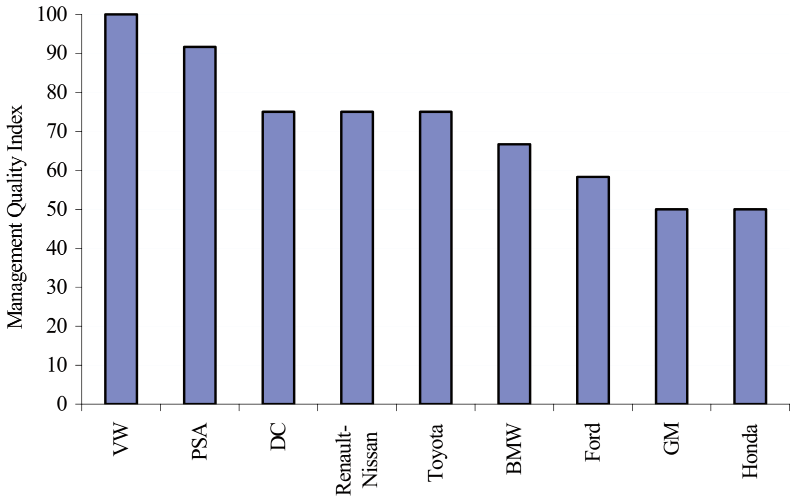


Figure 9-7. Management quality assessment: Diesel technology.

3.2.2 Hybrid

Financial, governance, and customer competencies will be important for capitalising on hybrid technology. Given the nature of HEVs as a relatively immature, emerging lower-carbon technology, the main challenges centre around high development costs and lack of customer acceptance. As a result, the strategic management challenge is quickly to recoup development costs and to grow a strong customer base. Accordingly, key characteristics of management quality are the ability to forge strategic partnerships as well as moving faster up the learning curve. These factors increase the potential to set de facto standards.

Japanese OEMs have a strong strategic position in hybrid technology. In contrast to Europe, the Japanese government has long expressed a preference for hybrid technology over diesel. This has allowed Japanese OEMs to establish early-mover advantages that are reflected in their management quality scores (see Figure 9-8). In addition, because of uncertainty regarding future technology pathways in the United States, US-based OEMs have recently stepped up their hybrid development. This is reflected in the slightly above average level of management quality. However, their ability to derive competitiveness from hybrid technology is still limited compared to their Japanese counterparts, who are the dominant players in this technology.

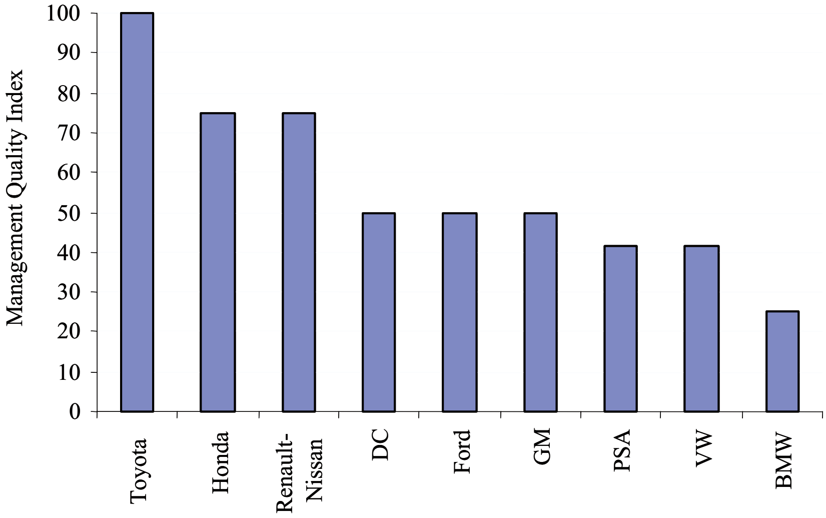


Figure 9-8. Management quality assessment: Hybrid technology.

3.2.3 Fuel Cells

Financial, governance and human competencies will be key for capitalising on fuel cell technology. Because it is still early days for fuel cells, a range of technology issues remain to be resolved. This will require continued financial and R&D commitment. Importantly, the challenge is to bring the technology to the market ahead of rivals in order to recoup development costs and benefit from first-mover advantages. The key aspects of management quality on fuel cells are strong institutional and human R&D capacity, resource allocation and the ability to work through strategic partnerships.

Two key partnerships are advancing fuel cell technology. As a result of these challenges, relative strategic positioning with respect to fuel cells is determined primarily by two main partnerships that have developed: DC-Ford and Toyota-GM. These tie-ups are designed to provide partners with a head start as the market for FCVs emerges (see Figure 9-9). Their strategies differ slightly. While DC and Ford are outsourcing development and future production of fuel cells to Ballard Power Systems, Toyota is working on a proprietary technology. If successful, this could be the source of valuable licensing revenue as other OEMs utilise the technology.

Based on the competence evaluation, the two dominant OEMs in this area are Toyota and DC. Given that BMW is not visibly pursuing fuel cell technology as a powertrain option, we have considered their efforts to commercialise a hydrogen-powered internal combustion engine. In an environment of uncertainty around the emergence of fuel/technology pathways, a hydrogen-powered ICE could prove a viable alternative to fuel cells. This explains the relatively high score of BMW in Figure 9-9.

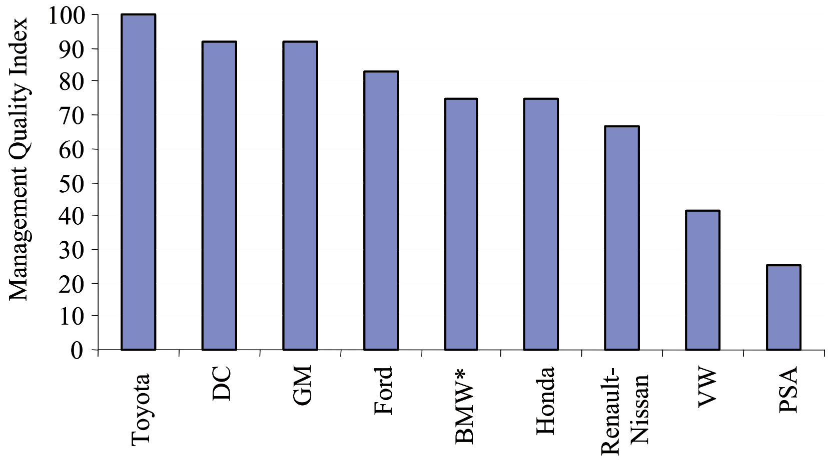


Figure 9-9. Management quality assessment: Fuel cell technology.

Management quality score for BMW reflects its development of a hydrogen-powered internal combustion engine.

3.3 Main Results

OEMs differ in the overall strength of their lower-carbon strategies. By combining scores across technologies, we derive an overall score for lower-carbon strategy for each OEM (see Figure 9-10). Toyota, DC and Renault-Nissan appear to have the strongest current management quality with regard to lower-carbon technologies. At the other end of the scale, PSA and BMW display the weakest management positioning regarding lower-carbon technologies.

Managementt quality score for BMW reflects its activities regarding the hydrogen-powered internal combustion engine.

Besides overall strength, an OEM's current strategy with regard to carbon constraints may be more or less robust (or balanced) across alternative technology pathways. Based partly on prevailing regulatory regimes in their most important markets, OEMs have developed different preferences for lower-carbon technologies. Figure 9-11 reflects the strategic choices made by OEMs. While most European OEMs display a strategic bias toward diesel, US-based OEMs focus on fuel cell technology. Toyota and Honda show most bias toward hybrid technology. Renault-Nissan stands out among

OEMs as having one of the more balanced lower-carbon strategies, reflecting the alliance's strategic fit and competitive potential.

Management quality score for BMW reflects its activities regarding the hydrogen-powered internal combustion engine.

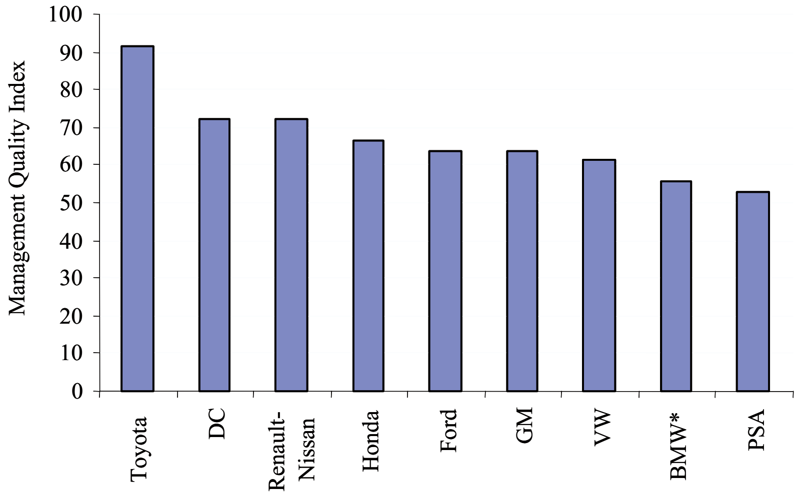


Figure 9-10. Management quality assessment: All lower-carbon technologies.

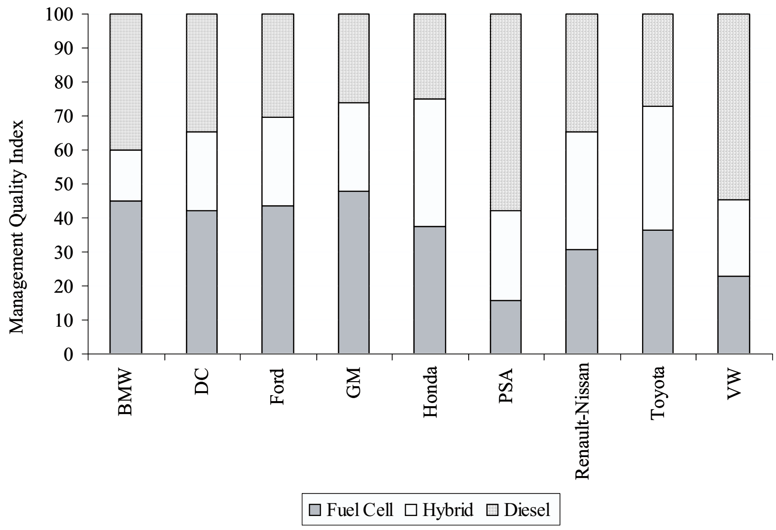
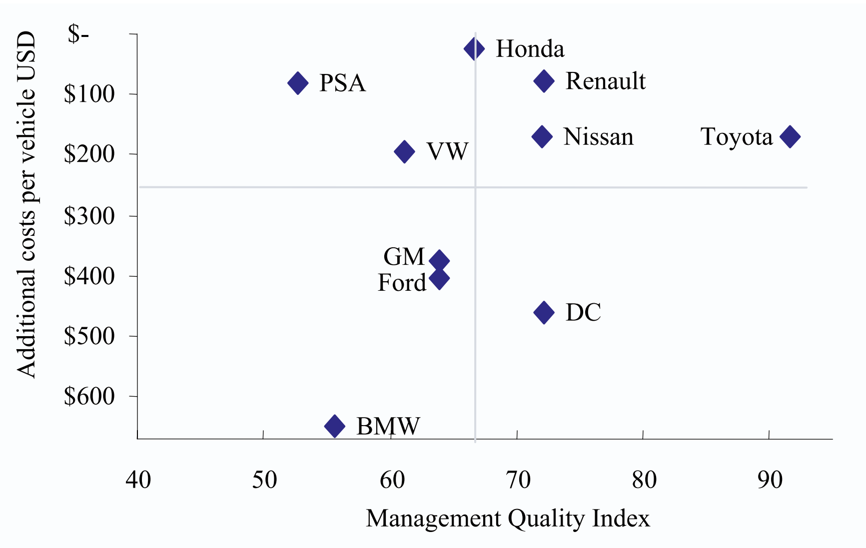


Figure 9-11. Relative robustness of management quality across lower-carbon technologies.

4. AGGREGATE RESULTS

The Value Exposure Assessment estimates the costs in dollars that carbon constraints could impose on OEMs. The Management Quality Assessment ranks OEMs on their potential to capitalise on carbon constraints. Combining the two results provides a two-dimensional matrix upon which OEMs can be mapped (see Figure 9-12). Risk reflected by the Value Exposure Assessment is measured on the vertical axis, while opportunity captured by the Management Quality Assessment is measured on the horizontal axis. The top right quadrant (low value exposure – high management quality) represents above average performance on both criteria.



The lines indicate industry averages in each category.

Figure 9-12. Quantification of the risks (value exposure) and opportunities (management quality) of carbon constraints.

OEMs vary considerably with respect to both value exposure and management quality around carbon constraints. This indicates that carbon constraints have the ability to influence competitive balance within the industry.

Honda, Nissan, Renault and Toyota appear to be the OEMs most strongly placed to meet the challenge of carbon constraints, with above average management quality scores and lower than average expected costs. In particular, Honda faces least immediate risk from carbon constraints as the current high fuel efficiency of its vehicles implies only minimal costs to meet anticipated carbon constraints. In addition, Toyota emerges as the clear leader on carbon-related management quality with a strong position in all three technologies that will be key for long-term competitiveness.

BMW stands out as having the greatest value exposure, though this may be somewhat misleading. BMW is the smallest of the 10 OEMs reviewed and produces exclusively premium (and high cost) vehicles. Consequently, BMW has a greater ability to pass on those costs to consumers than do other OEMs. PSA has the weakest management strategy regarding carbon constraints, which may limit its ability to exploit opportunities even though it faces low expected costs.

Ford and GM both have above average value exposure and below average management quality regarding climate risks. Their value exposure is driven principally by the relatively low fuel efficiency of their current vehicle mix. While much of this is due to their leadership in the carbon-intensive segments of the US market, which may not face immediate constraints, their current bias towards heavy vehicles coupled with below average positioning on hybrid and diesel technology may limit their near-term competitiveness in non-US markets.

5. IMPLICATIONS FOR VALUE CREATION

A key challenge for analysts is to determine the implications of these findings for earnings, return on invested capital (ROIC) and thus shareholder value creation. In this section, we tentatively translate the results of the Value Exposure and Management Quality assessments into changes in forecasted EBIT (earnings before interest and taxes) for the period 2003 to 2015. EBIT is a foundation for valuation estimates in this sector and so changes in an OEM's EBIT offer useful insights into possible changes for overall shareholder value.

Converting our cost estimates and management quality scores into EBIT figures sets our results in the context of existing and projected business performance. Though this adds confounding factors to our initial results, it nonetheless represents the basic challenge facing investors: to understand the additive effect that carbon constraints may have on each OEM's financial position.

Value Exposure translates into reductions in EBIT. As the results of our Value Exposure Assessment are denominated in dollars, it is relatively easy to integrate these into existing financial valuation models. Carbon-related costs will increase the costs of goods sold (CoGS) and so reduce EBIT.

Management Quality could affect multiple financial metrics. As an indication of how analysts might use these results, we translate scores from the Management Quality assessment into changes in EBIT margins in order to integrate them with the results of the Value Exposure assessment. We assumed, for simulation purposes only, that the OEM with the strongest management quality (i.e., Toyota) would see its projected EBIT margin increase by 20 percent, while the OEM with the weakest management quality (i.e., PSA) would see no change in its projected EBIT margin. For the remaining OEMs, changes in EBIT margin lay in between these two extremes based on their relative management quality scores. Integrating this strategy premium into the EBIT forecast reveals a significant upside effect, reflecting the potential to establish a competitive advantage through lower-carbon strategies.

We developed a simple model based on the SAM Sustainability DCF (Discounted Cash Flow) model to forecast the impacts of value exposure and management quality for each company's discounted EBIT from the period 2003 to 2015 (see Table 9-6). Information on recent years' cost and EBIT margins was combined with SAM and Deutsche Bank forecasts for sales growth and changes in EBIT margins to derive a baseline EBIT forecast. This baseline reflects important differences in OEMs' fundamental business performance. For example, some OEMs, like GM and Ford, are expected to see slower than average sales growth in the coming years as others compete for their profitable SUV segment. Additionally, some OEMs, such as BMW and Toyota, are expected to retain higher EBIT premiums because of such factors as quality and reliability.

Table 9-6. Influence of carbon constraints on discounted EBIT, 2003-2015 (percentage change).

	Impact of Value Exposure Assessment (risk)	Impact of Management Quality Assessment (opportunity)	Combined Impact
BMW	–4	1	–3
DC	–6	7	1
Ford	–14	4	–10
GM	–11	3	–7
Honda	0	3	3
Nissan	–1	4	3
PSA	–2	0	–2
Renault	–2	6	4
Toyota	–1	10	9
VW	–3	2	–1

These combined results are presented in Figure 9-13 to show the range of possible effects on EBIT, in terms of percentage changes from business-as-usual EBIT projections. The upper limits reflect the results from the

Management Quality Assessment alone, while the lower limits are results from the Value Exposure Assessment alone. The points indicate our estimate of the combined impact of both assessments on EBIT.

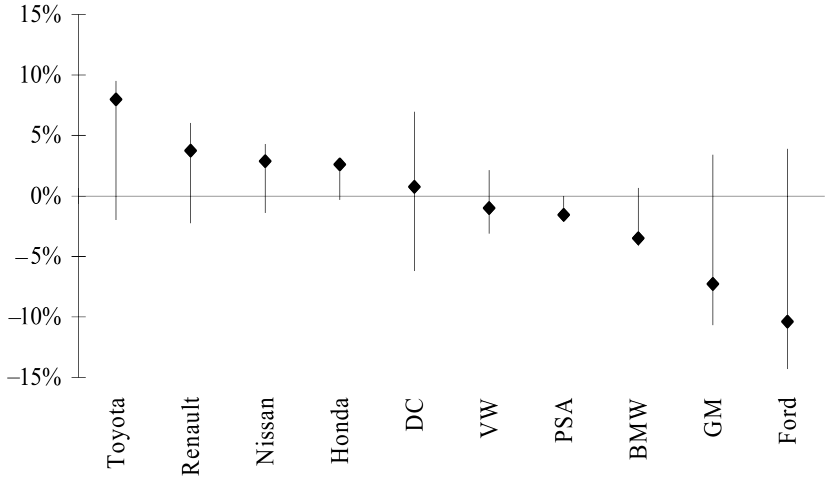


Figure 9-13. Potential impact of carbon constraints for EBIT (2003–2015) based on value exposure and management quality assessments.

Combining value exposure and carbon strategy scores into a single EBIT measure demonstrates once again that carbon constraints could significantly affect the competitive balance within the industry. Changes in EBIT forecasts range from a 9 percent increase to a 12 percent decrease. Toyota's position as leader is reaffirmed, while Ford has the weakest result.

6. MAIN CONCLUSIONS

Though the shape of future carbon constraints and the stringency with which they will be enforced are uncertain, there is every indication that they could have a profound effect on the competitive balance in the industry.

In the short term, carbon constraints could present the industry with new cost burdens that vary among OEMs. In particular, we find that BMW (with estimated costs of $649 per vehicle) may have to spend twenty-five times more per vehicle to meet carbon constraints than Honda ($24 per vehicle). Some of these costs could be recouped by price premiums for diesels and hybrids, both of which offer additional attributes that drivers may value. Even more of these costs could be recouped if more consumers were to account properly for fuel cost savings, though this varies from market to market.

In the mid- to long-term, carbon constraints will also raise the competitive significance of vehicle and engine technologies that offer improved fuel efficiency. This is an area in which OEMs are very differently positioned. Toyota stands out as best-positioned on these issues overall. In contrast, BMW and PSA are in the weakest positions. Certain OEMs show additional strengths and weaknesses with respect to particular lower-carbon technologies.

While the findings refer primarily to carbon constraints, they also shed light on how OEMs may perform in response to other pressures that would lead consumers or regulators to value fuel economy more highly (e.g., energy price rises or renewed energy security concerns). Indeed, consumer and policy responses to energy market shocks may play out considerably more rapidly than the steady progress in carbon regulations envisaged in this report, potentially making manufacturing adjustments more awkward. If so, the impacts on OEMs—whether positive or negative—may be more extreme than reported here.

REFERENCES

National Research Council (2002) *Effectiveness and Impact on Corporate Average Fuel Economy (CAFE) Standards* Washington DC, National Academy Press

Porter ME (1980) *Competitive Strategy: Techniques for Analyzing Industries and Competitors* New York, Free Press

Rappaport A (1998) *Creating Shareholder Value: A Guide for Managers and Investors* New York, Free Press

Schaltegger S and Burritt R (2000) *Contemporary Environmental Accounting: Issues, Concept and Practice* Sheffield, Greenleaf Publishing

Schaltegger S and Figge F (1999) *Environmental Shareholder Value* (WWZ/Sarasin & Cie-Study No. 54) (8th edition) Basel, WWZ/Sarasin & Cie.

Union of Concerned Scientists (2002) *Automaker Rankings: The Environmental Performance of Car Companies* Cambridge, UCS Publications

WBCSD (World Business Council of Sustainable Development) (2001) *Mobility 2001* Geneva, WBCSD