

IEA INTERNATIONAL ENERGY AGENCY



*Annex VII: Hybrid Vehicles
Overview Report 2000*

Chapter 8: Cost aspects

*Worldwide developments and activities
in the field of hybrid
road-vehicle technology*

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This report

This Overview Report on the status of Hybrid Vehicle Technologies and Programmes is the result of collaborative work carried out in phase I of Annex VII between June 1998 and June 2000. It incorporates the results of both Subtask VII/1 and Subtask VII/2 over this period. The main text is based on the information collected by the participants on the status of hybrid vehicle technology and the R&D and implementation projects and programmes in various countries. As the Topics that have been studied in Subtask VII/2 closely relate to the aspects that are analyzed in the Overview Report resulting from Subtask VII/1, the Topic Reports have been integrated into this report at the appropriate places. Whenever this is the case, authors of the Topic Report are clearly mentioned.

At the end of phase II an updated version of this Overview Report will be published, incorporating the Topic Reports on subjects studied in phase II.

The structure of the report is as follows:

Chapter 2 introduces the various hybrid drivetrain configurations which are being developed and studied by the light duty and heavy duty vehicle manufacturers in the world. Roughly spoken, one can divide hybrid drivetrain configurations using electrical storage devices into series-, parallel and combined hybrids. Furthermore, hybrids making use of a mechanical energy storage device are briefly discussed.

Chapter 3 takes a closer look at some concrete examples of hybrid vehicles that have been developed for different applications (two-wheelers, passenger cars, vans, buses and trucks) and discusses some trends. Different vehicle applications demand different hybrid configurations. On the basis of existing examples the choices made by the R&D community and automotive industry are illustrated.

Subsequently, Chapter 4 deals with the two main components that are specifically developed for hybrid vehicle applications: thermal energy sources and energy storage devices (i.e. batteries, supercapacitors and flywheels). An overview and analysis of the state-of-the-art of these components is presented and some general reflections on the latest developments are given. In a future version of this report more components for hybrid powertrains will be discussed.

Chapter 5 describes large programmes and projects on hybrid vehicles that are being carried out worldwide. These are on the one hand divided into governmental and industrial programmes and on the other hand split up for the three regions Europe, USA and Asia.

Based on the vast amount of data collected in Annex VII Chapter 6 analyses worldwide trends within the field of hybrid vehicle technology in a more statistical manner. Trends in R&D (for instance status of hybrid vehicles, components used within several hybrid vehicle configurations), market introduction and mass production are visualized. Furthermore time paths for the development and introduction of hybrid electric vehicles and fuel cell vehicles are discussed.

Chapter 7 is focused on energy and emission aspects of hybrid vehicles. This chapter is composed of various Topic Reports written by the Annex VII participants. Attention is paid to test methods for HEVs, energy consumption and emissions of hybrids and the perspectives for using alternative motor fuels in hybrid vehicles. As part of the discussion on energy aspects a comparative assessment is presented of different HEV configurations using the simulation tool ADVISOR.

The next chapter (Chapter 8) presents a study of the cost aspects of hybrids, fully based on a Topic Report devoted to this subject.

Chapter 9 concludes the report with some final remarks. A summary of the conclusions from the various chapters of this report can be found in the executive summary.

Finally in Chapter 10 a general overview is given of the information collected on hybrid vehicles (from human powered hybrid two-wheelers up to heavy duty vehicles) which are currently in the R&D or early commercial stage (prototypes, testing vehicles, concept cars). The overview is of course not complete. A selection is made of those vehicles that are attractive or illustrative by virtue of their technical innovation, or that are already in the (pre-) commercial stage. Apart from general vehicle data, some technical information of the driveline configuration is given (whenever available).

Contents

8	Cost Aspects.....	5
8.1	Introduction	5
8.2	Cost aspects of hybrid vehicles	5
8.2.1	Introduction.....	5
8.2.2	Overview.....	5
8.2.3	Key findings and opportunities.....	6
8.2.4	Vehicle cost and price.....	6
8.2.5	Sales tax	7
8.2.6	Profitability	8
8.2.7	Pricing policy.....	9
8.2.8	Government policy.....	9
8.2.9	Ownership costs.....	11
8.2.10	Consumer characteristics	14
8.2.11	Summary.....	18

8 Cost Aspects

8.1 Introduction

When first introduced to the market new technologies are generally more expensive than conventional alternatives. With increasing production volumes economies of scale and learning effects will reduce production costs. For a new technology to be successful it must either be cheaper than its conventional alternatives or it must bring added value at an acceptable higher price. Unless stringent emission legislation or energy policy simply require the application of new technologies, car manufacturers are faced with a chicken-and-egg problem when introducing new clean and efficient vehicles. Without cost reduction no significant sales can be achieved, while cost reduction is only possible when production volumes increase. Government policy may help overcome this problem. To find out which policy instruments may be successful, a first analysis has been made of vehicle production costs and sales prices in different regions of the world. Section 8.2 presents the results of this study in the form of a Topic Report.

8.2 Cost aspects of hybrid vehicles

Topic Report

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8.2.1 Introduction

The objective of this study is to identify global factors affecting the success of hybrid vehicles and opportunities for supportive actions by IEA members in Asia, Europe and the US. Regional data were solicited from the Asian and European IEA members.

The study relied heavily on information and analyses supplied by IEA representatives from the Netherlands and the US, supplemented by selected data from Belgium, Finland, France, Japan and public sources. Specific comparisons between some European countries and the US were possible, but the data supported only general comparisons between all three regions. A word of caution – information from the largest Asian and European automobile-producing countries was not made available and generalizing the results across the regions without localized analyses is somewhat risky.

8.2.2 Overview

The economics of hybrid vehicles present challenges for both the manufacturers/sellers and potential customers. Consequently, factors affecting both sides of the sales transaction are assessed to identify opportunities for supportive actions. Government agencies can influence the price to the customer through regulation, taxes or incentives on either side of the sales transaction. This study seeks opportunities to influence a vehicle sale from the perspective of the seller (influencing vehicle cost and price) as well as the consumer (influencing the transaction price, ownership costs and buying habits). The paper addresses the following major topics:

- Vehicle cost and price (including taxes)
- Ownership cost
- Customer characteristics

8.2.3 Key findings and opportunities

1. Basic elements of vehicle production cost are similar in Europe and the US.
2. Conventional powertrains cost roughly 12.5% (or 2,600 EUR) of a vehicle priced at 20,800 EUR in both Europe and the US. [Note: \$US 1 = 1.04 EUR for purposes of this discussion – the exchange rate is not a critical factor in this study].
3. Sales taxes are a significant component of vehicle price in the European Union (EU) and range from 15% to over 200% of the pre-tax price (including VAT).
4. Government-sponsored purchase incentives for hybrid vehicles are widely available.
5. Fuel economy, fuel price and low emissions are not primary decision factors in a typical vehicle purchase.

The opportunities for potential government action are those that decrease the sales price or address the concerns of owning and operating a hybrid vehicle:

1. Subsidized sales prices or other investments in manufacturers (e.g., R&D) to insure that hybrid powertrains cost less than 2,600 EUR and/or hybrid vehicles cost less than 20,000 EUR.
2. Sales tax exemption or reduction in the EU.
3. Import duty exemption or reduction for hybrid trucks in the US.
4. Unilateral or joint programs with manufacturers to reduce the risk of higher ownership costs (e.g., subsidized hybrid vehicle repair and maintenance insurance).

8.2.4 Vehicle cost and price

Production cost

Hybrid vehicles cost more to manufacture than conventional vehicles due to higher cost propulsion systems (used synonymously with “powertrains”). Estimates of additional cost range from \$US 2,000 (~2,080 EUR) for a ‘mild’ parallel hybrid to \$US 10,000 (~10,400 EUR) for a full-performance series hybrid with substantial electric range. The powertrain in a typical \$20,000 car in the US costs about \$2,500, or 12.5% of the price. And as shown in the comparison of Figure 8.1, the powertrain costs are similar in the Netherlands. Materials other than powertrain and assembly labor are also similar. When added to powertrain costs, they equal roughly half the selling price. The similarity continues in the dealers’ and manufacturers’ shares of the price. The typical dealer’s share (roughly 18% in the US) accounts for their costs and profit. Though it is not evident in this breakdown, the smallest share of the price is the manufacturer’s profit – roughly 2.5% (\$500) for a \$20,000 car in the US.

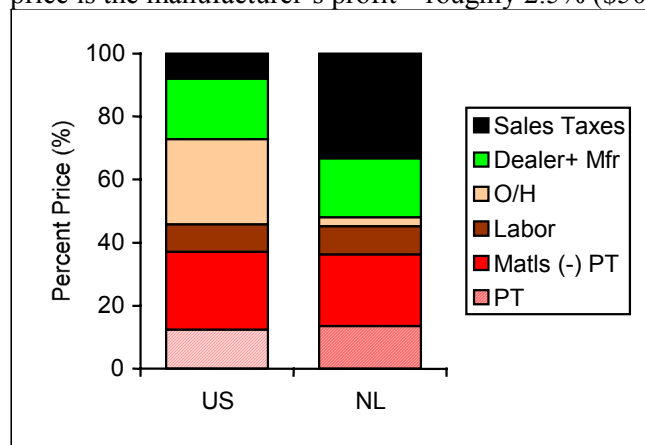


Figure 8.1 Vehicle cost/price structure

Sources:

US: CSMI Automotive
 Netherlands: TNO Automotive

The apparent differences in the comparison are overhead (O/H) and sales tax. The difference in overhead is at least partly due to different assumptions in the two data sets. The US estimate includes all corporate costs – engineering, development, investment and all other operating costs plus vehicle destination (shipping) charges, warranty funds and litigation expenses. The data from the Netherlands is based on plant costs – primarily machinery and buildings. The difference would not be so substantial if the additional corporate elements of overhead were included.

8.2.5 Sales tax

Continuing the discussion of Figure 8.1, sales tax in the Netherlands is comprised of the ‘BPM’ (tax on passenger and motor vehicles) plus the VAT (value added tax). The BPM is 45.2% of the pre-tax price – minus 1540 EUR for petrol-fuelled cars or plus 328 EUR for diesel fuelled cars. The VAT, ranging from 16-25% in the EU, is 17.5% in this case. Sales taxes vary widely in the EU (Figure 8.2), ranging from the lowest VAT of 16% to over 200% of the pre-tax price.

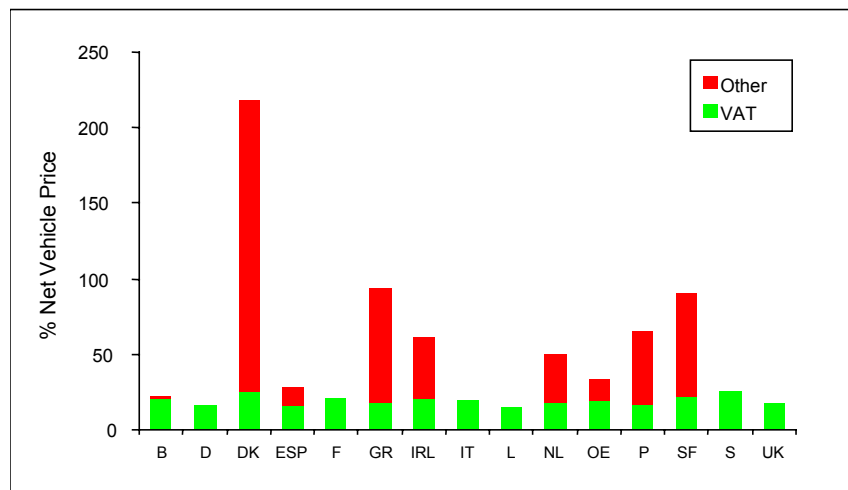


Figure 8.2 Taxes on passenger vehicles in Europe

Source:
ACEA (via TNO Automotive)

In the US, sales taxes vary by state and range from 0 to 8%. Considering a specific global vehicle, such as the Ford Focus, illustrates the relative importance of taxes. Figure 8.3 compares prices in Belgium, France, the Netherlands and the US. Apparently, the price can vary by several thousand EUR (>20%) between Belgium and the Netherlands (with shared borders). The price comparison between the European countries and the US is not quite as clear because engine options differ. 1.6-liter petrol and 1.8-liter turbodiesel engines are available in Europe (i.e., “1.6” and “1.8td”) while only 2.0-liter petrol engines are available in the US. However, the lower contribution of taxes in the US is apparent.

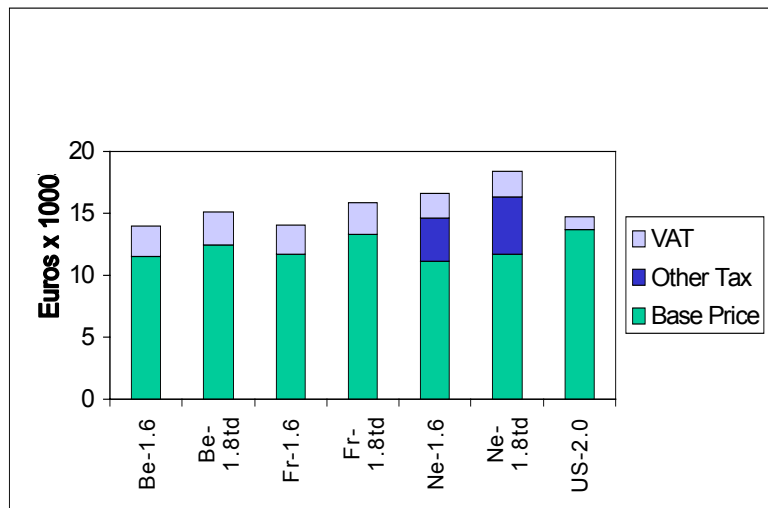


Figure 8.3 Ford Focus prices

Sources:

Europe: TNO Automotive

US: Yahoo New Car Guide

8.2.6 Profitability

Hybrid vehicles must be profitable to manufacturers. The previous discussion of a typical \$US 20,000 car included a manufacturer's profit of approximately \$US 500, leaving little flexibility to incorporate a more costly powertrain. However, vehicle profitability improves substantially as the price increases. As illustrated in Figure 8.4, material costs, labor and overhead do not increase proportionally with price. The dealer's share grows some, remaining substantial throughout the product line, but the manufacturer's profit grows to as much as 10,000 EUR for a 35,000 EUR Sport Utility Vehicle (SUV) or luxury car in the US. This profit difference across the vehicle portfolio fostered the marketing approach of introducing new features on premium vehicles, then rolling down the options to lower priced vehicles as investment is recovered and costs decrease. If hybrid vehicle marketing uses the same approach, the obvious opportunity for hybridization in the US is the SUV due to the high fuel consumption, high profit levels and substantial market share.

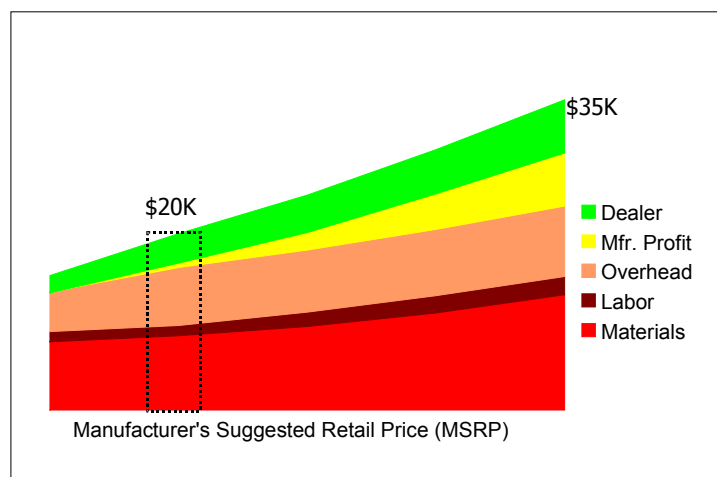


Figure 8.4 Cost elements versus price

Source:

CSMI Automotive

The large range of profitability shown in Figure 8.4 is not as pronounced in Asia or Europe since smaller vehicles are generally more profitable in those regions. The conclusion from this simple analysis is that there is a greater opportunity to insert hybrid propulsion components in higher priced vehicles because there is more room to absorb the costs – but the manufacturer has to give up profit. The corporate-level decision to “subsidize” hybrid vehicles in this manner is a matter of pricing policy. These companies believe that the corporate pride and marketing value of being perceived as “green companies” justifies the subsidy, at least in the short term.

8.2.7 Pricing policy

Pricing policy is one of the better-kept secrets in the automotive industry. This paper discusses factors that influence the manufacturers/sellers with respect to environmental vehicles, including corporate objectives and government policy. Selling price depends on internal objectives, externally imposed costs or constraints and the customers’ willingness to pay. In the simplest scenario, corporate policy would set the Return on Investment (ROI) target, i.e., profitability, for a new product. However, pricing environmental vehicles – until they become profitable – requires a substantial commitment by the manufacturer (e.g., GM EV1 or Toyota Prius).

8.2.8 Government policy

Government agencies have numerous opportunities to influence manufacturers and consumers through regulations or mandates, taxes, incentives and import duties. The (supposed) intent of government mandates is to insure the achievement of objectives for the public good that might not occur without government intervention. The most obvious examples in the US are the Corporate Average Fuel Economy (CAFE) and the California Zero Emission Vehicle (ZEV) mandate, implemented at Federal and State levels, respectively. In addition to mandates, constraints such as emissions regulations affect pricing due to the need to recover additional development and production costs.

Manufacturers generally consider regulations/mandates as negative influences, but positive government initiatives, in the form of monetary or other incentives are available for the sale of some environmental vehicles. Taxes have been previously addressed; therefore the factors of government policy/constraints that merit further discussion in this section are regulations/mandates, purchase incentives and import duties.

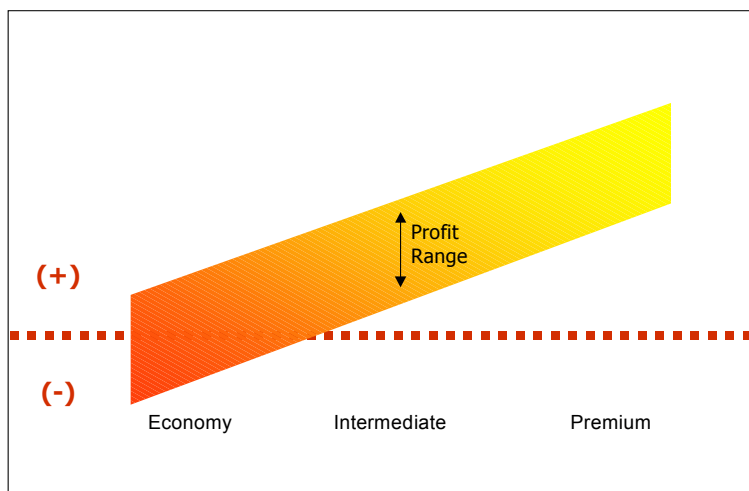


Figure 8.5 Range of profitability for US vehicle portfolio

Source:
CSMI Automotive

Regulations/mandates

CAFE requires all passenger cars sold by manufacturers to average at least 27.5 mpg (8.7 l/100 km) and light trucks to average 20.7 mpg (11.6 l/100km). The public's appetite for large vehicles has caused manufacturers to influence the US fleet mix by selling some economy cars at little or no profit.

Figure 8.5 illustrates the resulting profitability as a function of general vehicle class for several US car companies. Inherent differences between automobile manufacturers influence competitiveness and relative profitability as well, but CAFE regulations apparently influence the negative profitability at the economy end of the vehicle spectrum. The penalty for noncompliance is \$5.50 per car for each 0.1 mpg that a manufacturer violates the regulation. This seems inconsequential at face value, but failure to comply can be costly.

The latest CAFE figures, released June 13, report that the total fleet of light vehicles sold in the US had an average fuel economy of 24.7 mpg (9.7 l/100km). This composite figure is made up of the light truck category – pickup trucks, SUVs and minivans – which averaged 21.1 mpg (11.3 l/100km) and passenger car category which averaged 28.4 mpg (8.4 l/100km). DaimlerChrysler, Ford and General Motors all met the threshold for domestically produced cars, but missed the limit for foreign-produced vehicles. Japanese manufacturers, including Honda, Nissan and Toyota, met the requirement easily. European manufacturers had mixed results. BMW fell under the limit after paying \$US 13.9M in penalties last year, the highest of any manufacturer. Total penalties in 1999 were \$US 16.3M.

Manufacturers view the ZEV mandate in California as a hindrance, but the California Air Resources Board (CARB) decision to allow partial credits for clean internal combustion vehicles could boost the sale of hybrids. According to the exhaust emission standards adopted in August 1999 by the CARB, a baseline partial ZEV allowance of 0.2 (versus a full allowance of 1.0) is available for vehicles that demonstrate the following:

- Certify the vehicle to the 150,000-mile (240,000-km) SULEV exhaust emission standards for passenger cars (PCs) and light duty trucks (LDTs);
- Certify the vehicle to the zero evaporative emissions standards;
- Certify that the vehicle will meet the applicable on-board diagnostic requirements;
- Extend the performance and defects warranty period to 15 years or 150,000 miles (240,000 km), whichever occurs first.

Vehicles that meet these requirements and have zero-emission vehicle miles traveled (VMT) capability receive an additional ZEV allowance, not to exceed 0.6, according to the following equation:

$$\text{Zero-Emission VMT Partial ZEV Allowance} = 0.6 \times \text{Zero-Emission VMT Factor}$$

where Zero-Emission VMT factor is the ratio of the zero-emission miles the vehicle travels to the total miles traveled per trip. The VMT factor varies by electric range of the vehicle from 0.0 (range less than 20 mi or 32 km) to 1.0 (range greater than 100 mi or 160 km). The regulation is complicated, offering manufacturers the option to propose alternative procedures as well as providing some flexibility of CARB in granting allowances. The reader is encouraged to refer to the latest information at their web site, <http://ww.arb.ca.gov/>.

Purchase incentives

Incentives are available for hybrid vehicles in most of the world and examples for each region follow.

Europe – A hybrid vehicle in the Netherlands with an electric motor rated higher than 10 kW is considered an electric and exempted from the sales tax (BPM) of about 45% of the pre-tax price. Hybrids with a lower power motor are treated as conventional vehicles. However, TNO Automotive notes that the number of electric and hybrid vehicles is so small that tax relief is an inexpensive gesture at this time and suggests that the incentive might be reduced or removed if sales volumes become substantial.

Japan – Direct incentives of up to 250,000 yen (~2,440 EUR) are available in Japan for hybrid passenger vehicles such as the Toyota Prius or Honda Insight. Substantially higher incentives (up to 4 million yen ~ 39,170 EUR) are available for large vehicles, such as buses and trucks. [Note: 1 EUR = 102.3 Yen].

US – Federal and many State governments in the US provide incentives for environmental vehicles in the form of tax deductions or credits.

Present Federal law includes tax deductions and tax credits for clean fuel vehicles (CFV). A tax deduction for purchasing or converting CFVs is available for business or personal vehicles and can be substantial:

- Truck or van, GVW of 10,000-26,000 pounds - \$5,000 (5,200 EUR)
- Truck or van, GVW more than 26,000 pounds - \$50,000 (52,000 EUR)
- Buses, with seating capacity of 20+ adults - \$50,000 (52,000 EUR)
- All other vehicles, off-road vehicles excluded - \$2,000 (2,080 EUR)

EVs are not eligible for the CFV deduction, but purchasers can receive up to \$4,000 (4,160 EUR) for 10% of the price. Funding for the program continues through 2004.

California and New York are representative of many States that offer incentives in addition to the Federal incentives:

- California
 - \$5,000 (5,200 EUR) for purchase/lease of ZEV plus electricity discount
 - \$1,000 (1,040 EUR) for natural gas vehicle
- New York
 - 50% of incremental cost (\leq \$5,000) for EVs/series HVs < 14,000 pounds
 - Up to \$10,000 (10,400 EUR) for vehicles over 14,000 pounds

Details for each can be found at the US DOE web site, <http://ww.fleets.doe.gov>.

Import duties

Tariffs effectively control or constrain the flow of goods across borders. Duties can be substantial in some cases, effectively limiting the competitiveness of a product. An example of this in the US is the import duty for trucks versus passenger cars. Passenger cars from countries not included in the North American Free Trade Agreement (NAFTA) are assessed 2.5% while importing trucks is discouraged with a 25% duty. This suggests the opportunity to encourage importing hybrid trucks to the US by reducing or eliminating the excessive import duty.

The duty is more straightforward in the EU countries – 10% for non-EU countries.

8.2.9 Ownership costs

An often-used selling point of high-fuel economy vehicles, including hybrids, is that ownership costs could be lower due to substantially lower fuel costs. This is more apparent in Asia and Europe than the US. The higher fuel costs in Europe are evident in Figure 8.6, which compares the US and Finland. If the Netherlands and Finland are representative, 18-30% of total operating cost is fuel.

In the US, 15-20% of the operating costs of an intermediate size vehicle is fuel, based on Federal Highway Administration and Intellichoice data. The US data in Figure 8.6 are based on a total

operating cost of \$US 0.395/mi (0.257 EUR/km).

The comparison also surfaces notable differences in lower insurance cost in Finland as well. For reference, the Finland vehicle is priced at FIM 140,000 (23,500 EUR).

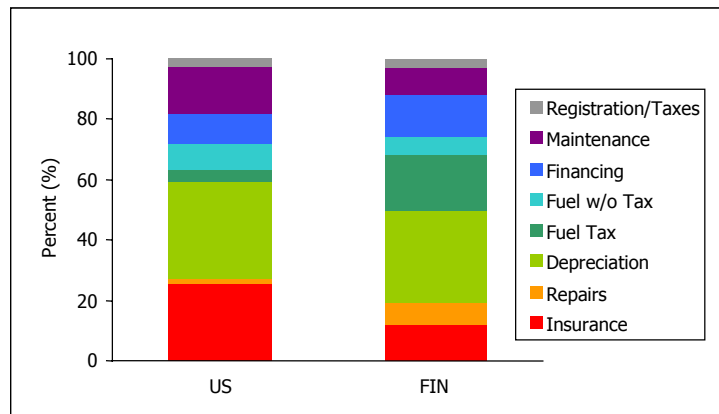


Figure 8.6 Comparison of operating costs

Sources:

US: FHWA web site (mid-size vehicle)

Finland: VTT

While the average annual driving distance in the Netherlands is 16,110 km, the vehicle tax structure in the Netherlands has produced noticeable differences in annual distance depending on fuel type (TNO Automotive). Gasoline cars average 13,110 km while diesels average 31,430 km and LPG cars travel 28,220 km in the Netherlands (Statistics Netherlands). The average annual distance in Finland is 20,000 km/year (VTT).

Elements of operating cost that are influenced by government actions include ownership tax, fuel tax and incentives.

Ownership tax

Ownership of automobiles is taxed on an annual basis worldwide. Consider first the situation in Europe using the data provided for Finland and the Netherlands.

In Finland, registration and licensing fees are around FIM 270 (45 EUR) when the vehicle is new, followed by an annual licensing fee of FIM 700 for passenger cars and vans newer than 1993. There is a yearly road tax for vehicles using fuels other than gasoline, depending on the gross weight of the vehicle. A diesel passenger car with a gross weight of 1,810 kg pays about 550 EUR per year while a 28,000 kg truck pays around 2,300 EUR per year.

Table 8.1 Ownership tax in the Netherlands

Vehicle Curb Weight (kg)	Fuel Type		
	Petrol (Euros)	Diesel (Euros)	LPG (Euros)
851 – 950	229	541	478
951 – 1050	298	643	585
1051 – 1150	367	745	692
1151 – 1250	436	844	801
1251 – 1350	505	946	908
1351 – 1450	576	1048	1015

Annual ownership tax in the Netherlands is dependent on the weight and fuel type (data in Table 8.1 as of April 1, 1999) and varies by province. Since the typical car weighs about 1,050 kg, the average ownership tax ranges from 298-643 EUR.

Ownership taxes in the US, such as annual license tag fees and property taxes, depend on the price or vehicle weight and vary by state. Taxes range from 1-5% of the price and can be as high as \$US 1,000 (1,040 EUR). Comprehensive details for each state can be found at several web sites, including <http://www.caltax.org/> and <http://www.ncsl.org/>.

Fuel taxes

The IEA compiles fuel price and tax data on a monthly basis. Figure 8.7 shows the latest fuel price and tax information for April 2000 from the statistics section of the IEA web site. It shows that gasoline prices excluding tax do not vary substantially (with the exception of Japan) and taxes are the largest part of fuel prices outside North America.

Similarly, diesel prices (Figure 8.8) without taxes vary noticeably only in Japan and taxes have a major effect on the end user prices.

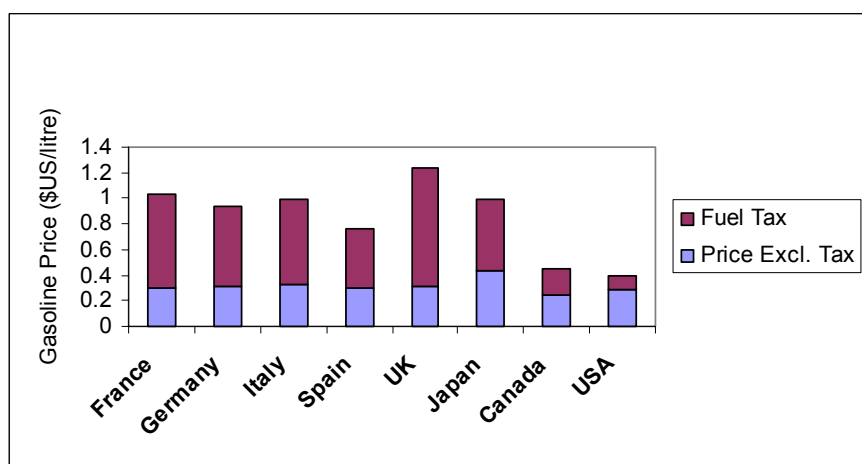


Figure 8.7 Gasoline prices – April 2000

Source:
IEA web site

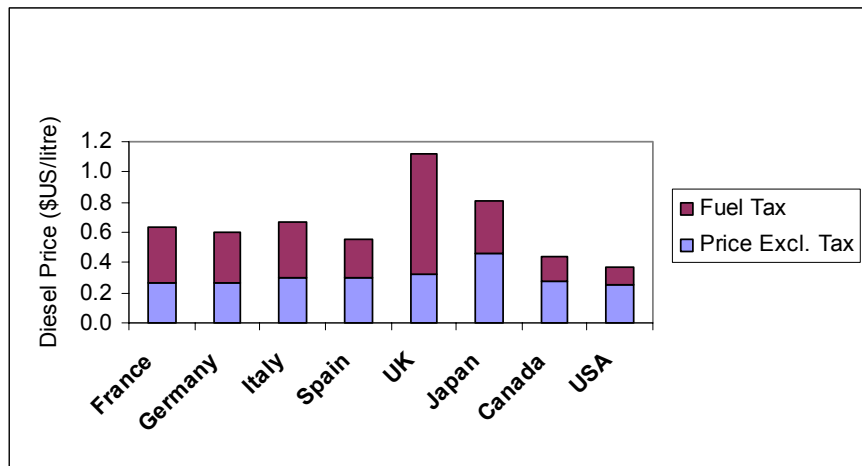


Figure 8.8 Diesel prices – April 2000

Source:
IEA web site

Ownership incentives

In addition to monetary purchase incentives described previously, drivers of environmental vehicles currently enjoy special privileges offered by States or municipalities worldwide. Representative examples for electric vehicles include:

- The Los Angeles Airport (LAX) and the City of Sacramento offer free parking and charging to EVs.
- The State of California allows single occupant EVs to use the high occupancy vehicle or carpool lanes beginning July 1, 2000.

Similar privileges could be extended to hybrid vehicles if visible support is desired.

8.2.10 Consumer characteristics

Consumers must purchase environmental vehicles in large numbers to noticeably reduce the global fleet's fuel consumption or improve air quality. This section summarizes and contrasts current vehicle ownership, modes of transportation to work and types of vehicles purchased. Consumer preference for fuel-efficient vehicles is also briefly addressed.

Vehicle ownership and mode of transportation

Multiple-car households are more likely to take the risk associated with purchasing a vehicle with new technology since the chance of being without a vehicle in case of a failure is less than for single-car households. Though this reasoning is more critical for the sale of an electric vehicle than a hybrid vehicle, it may still affect the potential buyer's decision. There are more multi-car households and more people drive alone in the US, as shown in Figure 8.9 and Figure 8.10, which compare Finland and the Netherlands with the US. The transportation mode data supplied for the Netherlands (Figure 8.10) appears to be typical of Europe.

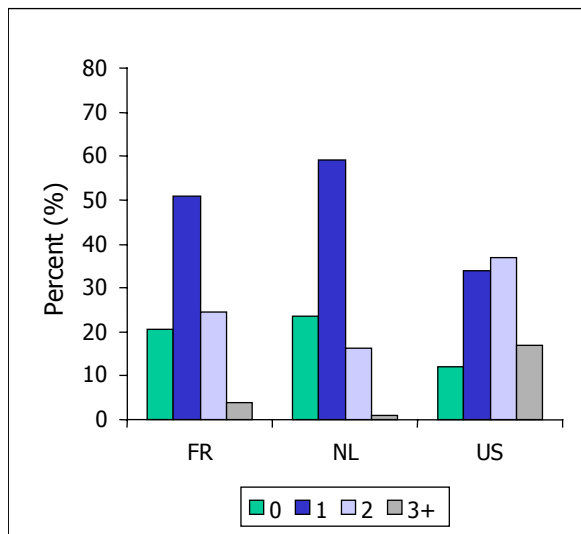


Figure 8.9 Household vehicle ownership

Sources:

France: L'industrie automobile francaise, Analyses et statistiques 1998

Netherlands: Statistics Netherlands (1998 data)

US: US Bureau of the Census (1990), Journey-to-Work and Migration Statistics Branch, Population Division

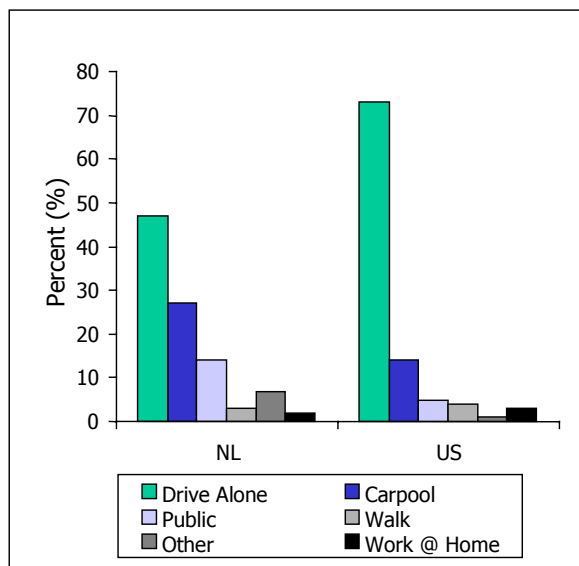


Figure 8.10 Mode of transportation to work

Sources:

Netherlands: Statistics Netherlands (1998 data)

US: US DOT (1990), Volpe Transportation Systems Center, Journey-to-Work Trends in the United States and its Major Metropolitan Areas, 1960-1990, Cambridge, MA 1994

Types of vehicles purchased

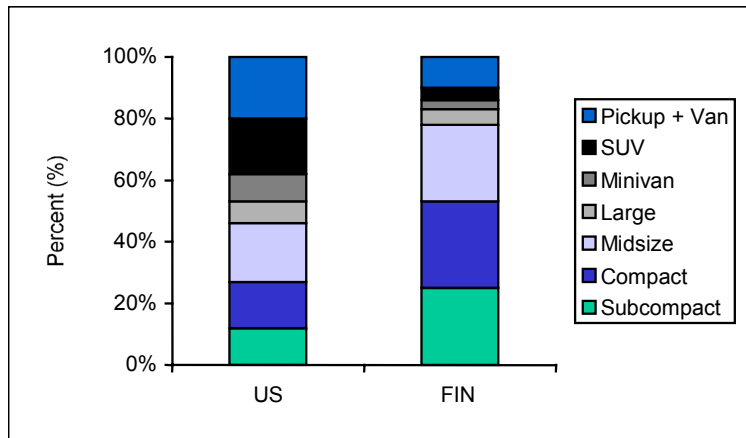


Figure 8.11 Comparison of vehicle types

Data sources:

US: Excerpted from “US Light Vehicle Sales Shares, 1976-1999” S. Davis, Oak Ridge National Laboratory, September 1999

Finland: VTT, 1999 data

Asia and Europe have more small cars in use than the US. An example is shown in the comparison of the US and Finland in Figure 8.11, which shows less than half the percentage of subcompact and compact vehicles in the US. The American fascination with SUVs, pickups and minivans is evident in the comparison as well.

The truck share of the US light vehicle market has been growing since the early 1980’s, with most of the growth attributable to SUVs and minivans. Collectively, light trucks accounted for 48% of light vehicle sales in model year 1999, with pickup trucks and vans at 22%, SUVs at 19% and minivans at 8%.

Reinforcing the differences, Table 8.2 compares the top selling vehicles in Europe and Japan with the highest production vehicles in North America. Mid-size and larger vehicles are highlighted – all 10 vehicles in North America fit in these categories, compared to only 2 of the top 10 Japanese and 1 of the top 8 European vehicles.

Table 8.2 Top selling/produced vehicles by region

	EUROPE¹	JAPAN²	NORTH AMERICA³
1	Opel Astra (C)⁴	Toyota Corolla (C)	GM Silverado, etc. (SUV, P)
2	VW Golf (C)	Nissan Cube (SC)	Ford F-Series (SUV, P)
3	Renault Megane (C)	Mazda Demio (SW)	Ford Explorer, etc. (SUV, P)
4	Ford Focus (C)	Nissan March (SC)	GM Lumina, etc. (M)
5	Opel Corsa (C)	Toyota Starlet (SC)	GM S-10, etc. (SUV, P)
6	Peugeot 206 (C)	Honda Stepwagon (LM)	GM Alero, etc. (M)
7	VW Passat (M)	Toyota Mark II (LM)	DCX Minivans (V)
8	VW Polo (C)	Toyota Crown (M)	Toyota Camry, etc. (M)
9	Not available	Mitsubishi Chariot (V)	Ford Taurus, Sable (L)
10	Not available	Nissan Sunny (LM)	Dodge Ram (P)

¹ Source: Statistics Netherlands

² Source: Japan Automobile Manufacturers' Association (1999 data)

³ Source: Automotive News Market Data Book, May 2000, Platform production in US, Canada, Mexico

⁴ (SC) = Subcompact; (C) = Compact; (LM) = Low Mid-size; (M) = Mid-size; (SW) = Small Wagon; (MW) = Mid-size Wagon; (L) = Large; (SUV) = Sport Utility Vehicle; (P) = Pickup; (V) = Minivan

Purchase prices

Figure 8.12 summarizes the base prices for the top selling/produced vehicles by region, with prices from the Netherlands used as representative of Europe. The actual purchase prices are usually higher because of customer-added options. According to TNO Automotive, the average price in France in 1999 was 15,900 EUR for over 2 millions cars sold while the average in the Netherlands was 18,500 EUR for about 600,000 sales. Despite the differences across regions, it is clear that the majority of vehicles sell for less than 20,000 EUR, an obvious consideration for hybrid vehicles if they are to compete for large volume sales.

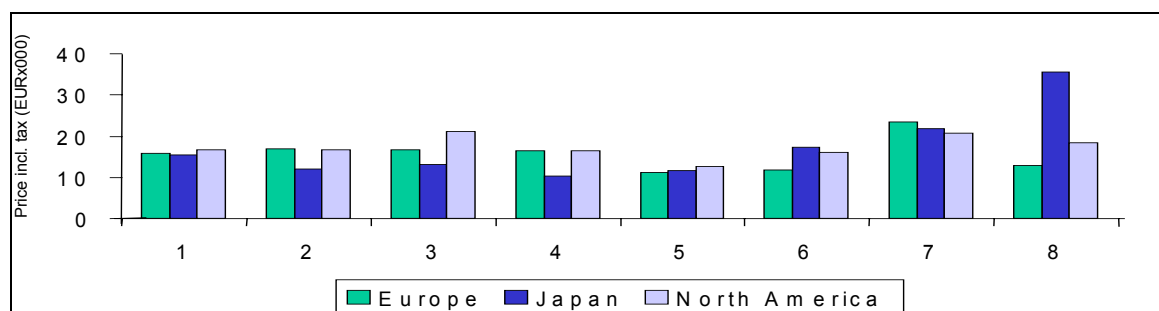


Figure 8.12 Base prices of top selling/produced vehicles by region¹

Sources:

Europe: TNO Automotive

Japan: Japan Automobile Dealers Association

US: Automotive News Market Data - May 2000

¹: see Table 8.2 for vehicles referenced on X-axis

Consumer preferences for fuel-efficient vehicles

It is obvious that European and most Asian countries are more aware and sensitive to global warming issues than US car buyers are. The unprecedented economic growth in the US in the last decade has caused many Americans to forget the oil shortages of the past – resulting in increased market share of large, inefficient vehicles (as shown in the previous section). Recent gas price increases (though prices are still well below the rest of the world) have increased awareness, but it is too early to determine if this will affect buying habits.

One recent study of US consumer preference was presented at the May 31, 2000 CARB workshop on California's ZEV mandate. A professor at the University of California at Berkeley found that average consumers would demand that a battery-powered EV be approximately \$US 28,000 less expensive than a comparable internal combustion vehicle before they would agree to own and drive it. Since the average price of the comparable conventional vehicle is only \$US 21,000, the study concluded that manufacturers would have to pay California consumers in addition to providing an EV to meet the requirements of the mandate.

However, the reception of hybrid vehicles in the Japanese and American markets has more enthusiastic – more hybrids sold in the first year in Japan than all the EVs in existence in the world. Though they are still produced in limited volumes, both Honda and Toyota have indicated that production will increase and Honda announced that they plan to incorporate their hybrid powertrain technology in the Civic product line.

8.2.11 Summary

The apparent similarities and differences between Asia, Europe and the US relative to the production and sale of hybrid vehicles include:

- Similar vehicle production costs in Europe and the US.
- Hybrid powertrain cost requirement of less than 2,600 EUR to compete on cost with conventional powertrains in Europe and the US.
- Hybrid vehicles must be priced less than 20,000 EUR to compete with the top selling conventional vehicles.
- Higher sales and fuel taxes in Europe than in the US.
- Similar reasoning in buying vehicles – fuel economy, fuel price and low emissions are not primary decision factors in a vehicle purchase – however efficiency is a more inherent characteristic in Asian and European lifestyles (and might not be seen as a key differentiator).

Global opportunities to influence manufacturers to build hybrid vehicles include:

- Direct subsidies of the sales price.
- Indirect subsidies to support hybrid powertrain cost reduction.

Global opportunities to influence consumers to buy hybrid vehicles include:

- Direct subsidies of the purchase price.
- Tax credits/exemptions for purchasing a hybrid vehicle. Sales tax exemption in some EU countries could reduce the purchase price substantially (66% in Denmark).
- Guaranteed lower ownership cost to ease the anxiety associated with adopting new technology (e.g., subsidized repair and maintenance insurance).

A specific opportunity in the US is import duty exemption for an imported hybrid truck.