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Future EV Pricing

- *Auto Industry Pricing / Costing Issues*
- *Role of Pricing in Marketing Strategy*
- *Hypothetical EV Pricing Scenarios*

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Executive Summary

Costing and pricing practices in the automobile industry are not widely understood, in spite of a growing amount of information available in the public domain. Since different auto companies use different practices to account for costs and set prices—and often the same company will use different approaches for different models—this is to be expected. There is no universal system by which automakers determine a fixed cost/price relationship.

Within that context, the principal investigators of this study examine the costing and pricing practices related to electric vehicles (EVs). The goal is to explain the practices used in the auto industry, both those actually used with EVs and those employed in the industry that could be applied to EVs.

The following are the key findings of this study, which is based in part on the authors' previous similar study, "Pricing for Success: Using Auto Industry Models to Review Electric Vehicle Costing and Pricing," October 1996. The findings are fully documented, with footnotes, in the text of this report.

1. While standard practices of automobile costing and pricing exist, they are not uniformly applied to all models. In addition, variations among different manufacturers on seemingly similar models reflect different internal accounting practices, different vehicle development processes, different cost structures and different marketing goals. The auto industry is more a "world unto itself" than many other manufacturing industries, largely because of its enormous size, the substantial price of its primary product and the capital-intensive nature of the business.

2. EV costs presented and prices used to market EVs during the past few years by automakers appear to be high, perhaps saying more about auto companies' feelings about proposed government regulation than about electric vehicles themselves. For example, the high initial prices of EVs fail to take into account historic precedents of subsidizing the cost of specialty or low-volume vehicles deemed important to an automaker's overall marketing program or corporate positioning. Whether it was musclecars during the Sixties, sports cars in the Eighties, or now electric cars in the new century, a car that becomes a key part of the company's basic image receives corporate support with less expected in terms of program return-on-investment. High prices also belie a committed attempt to establish and build a market for EVs.

3. A manufacturer's suggested retail price (MSRP) represents a vehicle's cumulative presentation to the buying public. If it's successful, the price's primary purpose is to reflect the public perception of the vehicle's value, a complicated amalgam of the vehicle's size, components, technology, competition and positioning in the pantheon of the automotive world. That price is usually a carefully guarded corporate entity, revealed only as part of the vehicle's launch, since it is subject to competitive market pressures. Always quite fluid, prices are often changed by subsidies and promotional programs or sometimes raised to capitalize on a vehicle's popularity.

4. Manufacturing and materials costs bear little direct relationship to retail prices in today's globalized automotive world. Otherwise, General Motors would sell its Cadillac Sevilles for no more than twice what a Chevrolet Cavalier retails for, rather than the four times it sells for in the current market. If manufacturing and component costs were so critical to pricing, the Cavalier would cost more and the Seville would cost substantially less.

This study examines several conventional automobile development programs—GM's Saturn, Chrysler's Viper and PT Cruiser, Volkswagen's New Beetle and Honda's hybrid Insight—to develop case histories of costing and pricing issues as well as instruction on volume and price relationships in the new world paradigm.

The intention of this study is to provide an overall, balanced view of auto industry costing and pricing practices and how they relate to establishing real-world retail prices for the new genre of electric vehicles. It also provides a basis for the hypothetical EV pricing scenarios presented later in this study.

Other significant movements in the auto industry and industry at large are impacting EV development. Advances in manufacturing and development technology are already delivering on promises to cut time-to-market and increase the flexibility of production facilities while enhancing the variety of product ***and*** escalating profits. These advances benefit all vehicle programs, but EVs hold a special place as part of the instigation of some of the advances and the likely recipient of their progress. Both auto companies and suppliers are rethinking many of their traditional approaches in an attempt to find new efficiencies that will bring down costs, particularly at low production volumes such as those that EVs will have in their early years.

Trends toward supplier subassembly of vehicle components—and even entire vehicles—hold special promise for the EV industry. Use of suppliers in this manner drives down development and manufacturing costs, critical in the early stages of a complex project like an EV. It also opens the door to potential standardization of components that could lead to further cost reductions.

Another key factor enhancing development of the EV industry are the rapidly converging technology fields of computers, electronics and advanced technologies such as fuel cell research. Developments in each of these fields impact the others and have so far produced progress unlike that seen in the traditional automotive research and development (R&D) arena. Component costs are dropping in half during two-year development cycles while technology is still advancing. Because of these rapid changes, which are compounded because they are in fields that have no track record to use as a gauge, factoring future technology costs is not an easy matter. The key is that using current costs as a basis for linear cost projections will not produce realistic forecasts of what a future technology will cost nor allow for a scenario in which a lower cost and parallel technology developments will further impact future costs.

As it is, R&D costs such as those for electric vehicles are not typically charged to a specific vehicle program. Those tied to corporate image like Motorsports are usually charged off within the auto industry to corporate image, marketing, advertising or public relations. In order to meet expected market prices for EVs (substantially below those presented during California's Memoranda of Understanding period), automakers need to move more of these early EV costs to the corporate balance sheet in order to present a more consumer-friendly EV that has the potential of building a true market presence.

Another recent major change happening in the automotive marketplace is cultural. As was seen in the previous decade with safety issues, the environmental "scorecard" of a vehicle is becoming a part of the marketing process. Consumers are looking for environmental information about a vehicle and respond positively to marketing messages trumpeting environmental or technological advances.

Electric vehicle pricing is a key factor that will continue to influence all market projections since retail price alone has the capability of driving a significant part of volume. Other factors, which are discussed here, include marketing tools used daily by the auto industry to drive sales to a desired volume. The tools include subsidized leases, specialized incentives and targeted promotions, all aimed at getting a particular vehicle in front of its desired audience.

EV sales under the Memoranda of Understanding (MOA) period have not produced a true market. Automaker goals, where they are apparent from marketing programs, were focused on a relatively quick completion of MOA goals as opposed to building and sustaining a market for EVs. That is evident from the high prices, unusual acquisition barriers placed before potential EV buyers (filling out forms, waiting for approval, then waiting for the vehicle) and the limited nature of the vehicles offered to consumers. And, of the six manufacturers offering EVs under the MOA, only two actively marketed to consumers while all six focused heavily on the fleet market.

Passing through the MOA period, the electric vehicle industry has entered a new era. Factory built and serviced EVs are the norm. Performance is enhanced with advanced nickel-metal-hydride (NiMH), Lithium Ion (LiIon) or

advanced lead-acid batteries. A charging infrastructure, only a plan five years ago, is in place and still expanding. The public, in its response to market research polls, is ready to buy EVs.

Electric vehicles are not a short-term proposition, which can be a problem in the auto industry. Even with its relatively long product development period, the auto industry is under pressure from investors and others looking for immediate results. Monthly sales reports and quarterly earnings statements put a company's fiscal health on public display.

Investments like electric vehicles are unlikely to help greatly with either sales or income in the near-term, although they can be used to enhance corporate image and present a strategic vision. GM did this with the Impact and EV1, and Ford with its TH!NK Group, by prominently featuring them in corporate materials. That image is significant because it can directly impact both other (non-EV) vehicle sales and stimulate the investment community.

Historically, new technologies often enter the market at prices higher than where they eventually settle. The case might be made that, like those first generation $2,000 VCRs, the first-generation EVs should be priced high. The difference is that, in the VCR analogy, VCRs didn't have to compete with some steam-powered version of the technology. In the EV's case, the automobile market is mature and the EV, while new technology, has to compete against the established century-old, highly evolved internal combustion engine. As is seen later, the EV offers many positive characteristics, but in its first generation form does not have a performance or price advantage over this entrenched competition. Those two factors—performance and price—are the ones used most often in the auto industry as market differentiators for mass-market vehicles.

Automakers do appear to be warming to a long view of the electric vehicle and related technology as they prepare not just for an EV market, but one for hybrids, alternative fuel vehicles and variations of fuel cell-powered vehicles.

Auto marketers dating back to Henry Ford assert that if you charge a reasonable price for a product, you can actually create the market. This is certainly one logical way in which to view the advent of the electric vehicle. There is no shortage of studies indicating there is a consumer market for EVs even with today's limited performance and range capabilities, as long as the purchase price is reasonable. Certainly, retail price is expected to be a significant driver in initial electric vehicle sales. When examining existing studies that point to an extremely limited market for EVs, it is very possible that much of the projected market resistance is not the result of technology limitations, but rather the price point at which automakers say they are planning to sell this technology. As noted, another factor may be political motivation, since many of those studies were directed primarily at ending the California Zero Emission Vehicle (ZEV) production requirement.

In this study we present realistic, through hypothetical, marketing scenarios for electric vehicles based on reasonable cost estimates, market projections, vehicle prices and the potential market response. The methodology employed is similar to what automakers use to make go/no-go decisions on new model platforms and to establish retail prices.

As these examples show, EV marketing will not be an easy job, but no one would suggest that marketing gasoline-powered vehicles is that kind of job either. It also is clear that, while not instant moneymakers, EVs have the potential to be positive contributors to the corporate coffers, even in their early years. The different scenarios presented demonstrate logical market development and are further extended by scenarios offering a longer view of how the EV market may further mature during the rest of the decade.

The significance of this hypothetical EV scenario is that assumptions used as a normal part of an automotive company's program review process are applied to several potential EVs, and various market projections are made. Based on information drawn from GM's process when it was considering production of the EV1, the scenarios show a detailed plan of what a manufacturer could expect in manufacturing costs, market size and growth over a five-year period. They dramatically demonstrate that different marketing/pricing decisions can make the difference between a profitable and unprofitable vehicle program. In the hypothetical EV scenario, the most drastic pricing plan (customer-oriented pricing, which prices a product based on customer expectations and perceived value) is

the one that produces two key things for the automaker—a higher volume of sales that allow more cost-effective production and a higher rate of return for the program.

Further projections assume the continuing integration of EVs into the automotive industry worldwide. The conclusion that is clear from these scenarios is that there is no cost-prohibitive reason why EVs cannot be manufactured and marketed profitably, particularly as EV technology progresses and a worldwide market matures. Even in the near-term, EVs can be a positive contributor to an automaker's lineup.

When addressing the more immediate contention that electric vehicles can't be marketed competitively with internal combustion vehicles, one school of thought offered the view that they should not be. Since EVs are an entirely new automotive product with unique and positive attributes all their own, they should be marketed in this light and intentionally distinguished from internal combustion automobiles. GM is following a variation on this theme by marketing the EV1 at Saturn, clearly its division with the youngest customer base, the most customer-friendly operation and an unorthodox approach to the marketplace. Unfortunately, on the other side of the coin is Saturn's tenuous alignment with GM in the public's mind (and the EV1 is branded as a GM vehicle) and the generally low-end expectations of the Saturn buyer.

Another example is the very hip "Smart" microcar, which started as a joint venture of Mercedes-Benz and SMH, the manufacturer of Swatch watches. The car, available at non-traditional retail outlets, has been a hit in Europe. Plans are to offer it with four different economical powertrains, including an EV option.

Because of an EV's positive characteristics, our market research indicates consumers are willing to pay a premium for an EV. The most basic EV attributes give it definite market potential:

- Positive contribution to air quality and the environment (lessening greenhouse gas emissions, increasing national energy security);
- Cleanliness (no tailpipe emission, fumes or engine oil drips);
- No need for trips to the gasoline service station;
- Lower operating costs;
- Convenience of home recharging;
- Less maintenance (no oil changes, tune-ups or smog checks);
- Silence of operation.

Charging a fully amortized retail price for a new electric vehicle model in this time frame is likely unrealistic, just as it has been unrealistic for the new hybrid EV models that have debuted from Honda and Toyota. From the way in which these two automakers have priced their all-new hybrid models – and the way in which succeeding hybrids from all automakers must be priced in the short-term due to competitive pressures -- it is clear that automakers understand the strategy of pricing new vehicles appropriately to accomplish specific goals. They fully understand that short-term losses may well be a necessity on the road to long-term profits and the attainment of market share in a new and growing segment.

It's reasonable that electric vehicles can and should follow a path similar to that of hybrids in their drive to market. However, such a move will require a significant change in the way that automakers view the vehicle development process and how it applies to EVs.

The EV is not simply another new model, but an entirely new type of vehicle. The market for EVs is likely to grow not only in the U.S., but also throughout the world, which is fitting given the recent globalization of the auto marketplace. It is not beyond the stretch of the imagination to view the establishment of an electric vehicle market, alongside the hybrid and fuel cell vehicle markets, as an investment in the future of the automobile itself.

Introduction

Electric vehicles are accepted by a growing body of experts as key to meeting the clean air and energy diversity needs not only of the U.S., but many industrialized and developing nations throughout the world. They are not a "silver bullet" that solves all pollution problems, but they remain a critical part of a multifaceted strategy to mitigate the toll that the cruel combination of geography and dense population have taken on areas like greater Los Angeles, Mexico City, Athens, Rome and Shangahai.

EVs have the unique ability to emit zero localized (tailpipe) emissions in areas impacted by poor air quality, creating a substantial net decrease in global emissions even when factoring in recharging emissions at the powerplant.[1]

As opposed to some temporary emissions reduction measures or internal combustion engines (ICEs) whose emissions degrade over time, EVs continue to have zero emissions throughout their vehicle life, resulting in an even greater cumulative effect. When commercialized in significant numbers, EVs also promise to mitigate the U.S. transportation sector's growing dependence on imported oil.[2]

By design, they will appeal to consumers looking for environmentally conscious, functional, quiet, contemporary transportation.

Of all the impediments that electric vehicles face as they enter the mass market, perhaps none are so pervasive as the issues of cost and price. With several years of experience of EVs in the market during the MOA, pricing issues are at the forefront of the critical issue of whether there is a viable market for current EVs.

The relatively high price of the first fully-equipped electric vehicles on the market is not indicative of the eventual market price of EVs, nor a reflection of the ultimate cost of producing these vehicles. Rather, these high prices bear a direct relationship to today's extremely small market size.

Development/Component Costs High

Mixed—and errant—signals abound in the realm of EV costs. Evan as they claimed EV R&D and component costs precluded consumer-friendly market prices and therefore produced a still-born EV market, two major auto companies brought heavily subsidized hybrid vehicles into their showrooms and three other automakers pre-announced their own high-volume hybrids. Those first-generation hybrid vehicles came to market in small volumes (by auto mass production standards, but four to 10 times the best-selling EV to date) at consumer-friendly prices (around $20,000) and with full national marketing campaigns (costing $15 million in the Toyota Prius' case). The result has been similar to what has happened with EVs—consumers have over-subscribed the vehicles, driving up retail prices and/or creating a waiting list.

In spite of the reported losses estimated by industry analysts of $8,000 to $20,000 per vehicle, Toyota and Honda (with its hybrid, the Insight), have increased production to meet consumer demand for the cars. This stands in contrast to actions with EVs, where in Honda's instance production of the EV Plus was halted as soon as the MOA was accomplished.

What is happening very explicitly in Honda's case with the Insight is the company is willing to lose money on its way to building a leadership position in the developing hybrid. While it may lose money on the Insight, Honda recently announced plans to migrate the Insight's technology in its high-volume Civic compact, a quick transition from a costly hand-built exotic car to a mainstream model.

Logically, EV technology could follow a similar path, one already laid out by DaimlerChrysler in the Mercedes-Benz A-class and Smart cars as well as by General Motors in the Chevrolet Triax concept. All three feature

"propulsion-neutral" designs that can accommodate ICE, hybrid or electric powerplants and maintain the high-volume production critical to efficient and profitable auto manufacturing.

EV Price Estimates

Accurately estimating future vehicle prices, much less future prices of a rapidly evolving technology, is not an easy task. The ultimate price of a 2003 EV, for example, will be greatly influenced by its level of sophistication, standard features, drivetrain configuration, driving range, powertrain technology, battery technology and many other factors, including development costs. However, more significant with an EV (or any vehicle) will be the competition in the marketplace, their pricing and competitive features as well as the inherent perceived value of the brand presenting the EV.

What is clear is that the prices at which EVs have been generally leased during the past three years is not necessarily the price point at which modern EVs *must* be sold, particularly in the consumer market.

Volume Is Key

Volume of production exerts a substantial influence on the costs at this stage of the EV's drive to market. The extremely low volume of sales experienced by automakers has the effect of reinforcing high costs by keeping component prices fixed at low volumes. That in turn has led automakers to seek to recover a high portion of these costs by setting high retail pricing.

In spite of high prices, limited marketing and performance (compared to comparable ICE vehicles), demand for EVs has exceeded the supply. Waiting lines exist for both consumer and fleet EVs, waiting for manufacturers to produce them. Higher volume production will lead to lower costs and should lead to better pricing with better margins than the present low volume-high price situation.

As this study explores, marketing can play a significant role in helping to create that larger market by using moderate prices in the early years to drive broader acceptance of the EV. The result will be a growing volume that leads to profit in later years.

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1. "Quantifying the Air Quality Impact of EV Recharging," Green Car Journal, October 1993, p. 116

2. James M. Ohi, Senior Environmental Analyst, National Renewable Energy Laboratory, quoted in Green Car Journal, January 1995, p. 8

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General Pricing/Costing Issues

The goal of all commercial businesses—and the auto industry remains one of the largest commercial entities in the world—is to make a profit. Failure to do so leads to the kind of boardroom coup that changed management personnel--and style—at General Motors a decade ago and more recently has been a factor in the international consolidation of the industry. The core of an auto company's business remains selling high volumes of cars and trucks at a profitable rate. Which is not to say that the sole focus in the auto industry is moving retail merchandise. A great deal of attention is paid to overarching issues of corporate image and strategic direction.

But the bottom line in the car business is car sales and profits. A company's stock may fluctuate on day-to-day matters, but the basic questions remain:

- How many vehicles did you make?
- How many did you sell, creating how much revenue?
- What profit did you make on those you sold?
- What is your bottom line for this year—and how much of that will have to be spent on the new products for next year?

Wall Street and stockholders measure an auto company's performance in profit per vehicle sold and revenue per vehicle. In addition they will take key measures of profitability such as net margins—the annual net income divided by revenues over the past year—and figures like sales/earnings per employee. While corporate issues may enter into production decisions, such as running certain volumes from a manufacturing facility in order to amortize overhead costs, ultimately it is what is sold to consumers and the revenue generated that matters to a modern auto company. How a company gets to that is a path that includes many twists and turns, which is why the consideration of costs and the setting of prices is so important.

Business Cases

Each new product fits into this mix by having a business case that outlines its costs and revenue potential, a key component of which is the price of the vehicle. The price set for a given product line is no simple matter, but after more than 100 years of experience, the auto industry has matured to the point where it has fairly established formulas for this practice. Metrics are finely tuned to reflect the various aspects of costs that go into creating a vehicle, but many other factors also intrude.

In addition to producing profitable individual products, an auto company also has a variety of marketing and corporate goals to meet in the real world. It must maintain competitive pricing, set up a structure to attract new buyers as well as retain current ones and meet regulatory requirement like federal Corporate Average Fuel Economy (CAFE) standards. With all of these (sometimes conflicting) objectives, it is not surprising that the ideal goal of creating an entire lineup of profitable vehicles is elusive at many automakers. Part of what business is all

about is balancing the short-term and long-term goals of a company, sometimes taking risks that are not clearly contributing to the bottom line.

Price Control

Costs and prices are two marketing variables over which automakers have a significant amount of control. They are not, as has sometimes been portrayed, items beyond the manipulation of the manufacturer. Costs in particular are subject to constant manufacturer scrutiny and may be the foundation of radical changes in the industry, as appears to be the driving force in the recently created Internet-based parts procurement system, Covisint.[3]

Cost control also has been one of the big stories of the past decade at all car companies, driving record profits even when sales dropped or competition squeezed retail margins. The best example of this remains the former Chrysler Corporation, where the lean approach to manufacturing that emphasized supplier "partnering" and a speedy time-to-market for innovative products built a company fiscally attractive enough to be courted by German powerhouse Daimler-Benz.

As a starting point, let us settle on a definition for price. Functionally and historically, in the auto industry, a vehicle's price fits the textbook definition:

"Price is where the value of a product to the customer and the company's compensation for producing the product intersect."[4]

Such a definition means price is more than merely a sum of component, assembly and overhead costs plus arbitrary profit, as is examined below. That may mean an automaker will lose money on a specific product *or* may be able to take large profits. This is the short-term supply and demand intersection, but the auto company's goal is to move beyond this to achieve mid-and long-term profitability--or at a minimum add value to the company through a particular product line.

Price Objectives

Pricing serves a variety of objectives for an auto company, many of which may be addressed at one time. Not necessarily in order of priority, those objectives are:

- Profit – covering all production costs and yielding a profit margin
- Profit Maximization – making total revenue as large as possible in relation to costs
- Market Share – a low price attracts many customers and encourages them to develop brand loyalty
- Sales Growth – a low price that increases sales for the short term
- Return on Investment – a price that makes total revenues for the product larger than those for alternative investments
- Status Quo – a price that maintains the levels of production capacity, volume and profitability
- Product Quality – a price that reflects the quality and image of the product

Pricing is not static and the auto industry is full of examples of price changes as a product moves through its life cycle. In fact, in textbook pricing, the profit objective is often set in the mature stages of a product's life cycle,

when, having recovered development costs of the product, the company seeks to make money on it. In recent years, auto companies have become much more sophisticated in their pricing policies, moving to multiple price "steps" during a model year, sometimes to avoid a large increase at new model introduction time. The interim price increases, while always announced, rarely get the attention that those at new model introduction time get. Thus, subtle price manipulation, often combined with changes of product content, becomes part of an overall marketing strategy that builds additional revenue for the manufacturer. Other marketing mitigation techniques may then be brought into play if the market is unwilling to accept the price increases. Prices also can be reduced on an interim basis to reflect the above goals.

New Product Pricing

Particularly with a new product, a company attempts to attract customers for the product and keep them for the long term. Initial low prices may attract many customers, encouraging them to develop brand loyalty and bringing in additional customers through positive word–of-mouth. To the automaker, the customers who follow offer an advantage in that they may purchase the product at a higher price.

The key element here is that price is not the only attraction for the product. DaimlerChrysler's PT Cruiser fits this pattern. Even though the company had evidence of tremendous interest in the vehicle, it still priced it very competitively to build sales and brand loyalty, rather than maximizing profit-per-unit and risking both lower volume and alienating potential buyers.

With electric vehicles, the auto industry is not only introducing a new product (which it does on a tediously regular basis), but a new product category. While other factors may enter into the final equation, an initial low price is a classic strategy used to establish such a product. In fact, as we shall see later, Toyota and Honda used that strategy with their hybrid gas-electric vehicles. Why this was not used with electric vehicles may say more about the auto companies' feelings about the proposed government regulation than EVs themselves.

In attempting to gain market share, a company may even set initial prices so low that production costs are not even covered.[5] Although this is obviously not a long-term strategy, a company may take this action in the belief that costs will be recovered over the life cycle of the product or service.

In the case of recently introduced hybrid cars from Toyota and Honda, the belief appears to be that brand loyalty based on the respective company's environmental and technological leadership justifies the losses at retail sales.

Similarly, a market price can be adjusted to fit changing expectations and volume in the marketplace and actions taken by competitors. For example, in the highly competitive auto marketplace, the competitive pressure created by the affordably priced Insight and Prius hybrids will certainly cause all other automakers to price their new hybrid electric vehicles similarly in the next few years.

Four Methods of Price-Setting

With the above objectives in mind, prices are set through four basic methods or a combination of the four. Prices can be deemed to be:

- Cost-oriented
- Competition-oriented
- Customer-oriented
- Demand-oriented

Of the three, demand-oriented pricing is the most theoretical since it relies on a prediction of the market that is beyond most companies. Therefore, we will look at the remaining three as potential models for the auto industry.

As we shall see, the automakers' electric vehicle pricing primarily uses only the first method, compared with their traditional methodology, which uses a mixture of the three different models. That first method is "closely associated with the profit objective, as well as the product quality objective. Using this method, a company establishes a standard profit margin. After the company figures the cost of producing a given item, it determines the price to charge for that item by adding the standard profit margin to the costs of production."[6]

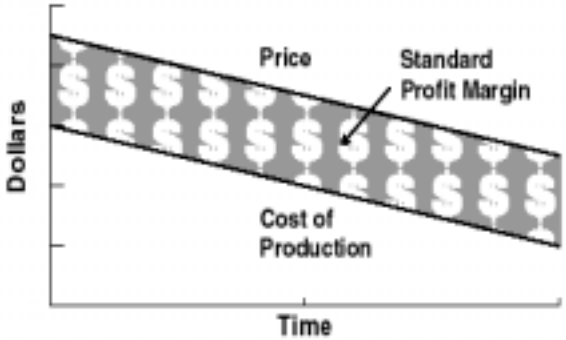
In the auto industry, manufacturers sell all cars at a wholesale price charged to the retail car dealer. Ideally, within that price is a percentage of profit as well as allowances for marketing costs born by the manufacturer, all of which vary from model to model and at different times of the model year and the product life cycle.

"One version of this (cost-oriented) pricing method was developed at General Motors during the 1920s. While the GM pricing policy considered volume fluctuation through the business cycle and the cost of capital involved in running the business, prices to meet profit targets were based completely on internal company costs, rather than on the market."[7]

Cost-Oriented Pricing

The question with the auto industry is not only the methodology of setting prices, but also the determination of costs to be applied to the cost-oriented pricing formula. Some marketers question whether the costs of advertising or research and development should be included in the formula for each product line at all. In this day and age of multi-level and cross-brand promotion, it is questionable whether the arbitrary assignment of corporate overhead to a product line serves any legitimate financial purpose.

Fig. 1: Cost Oriented Pricing



Source: Green Car Institute

While some may not question the formula, which is used widely in the auto industry to establish vehicle line pricing, they may question the numbers used by the industry. Both issues are subject to further scrutiny below.

"One of the major drawbacks to cost-oriented pricing in today's market is that it is completely inward-looking: It in no way reflects what customers in the marketplace are willing to pay for a particular item."[8]

That analysis, of course, leads to a discussion of the conflicting EV customer research being presented, which is reviewed later in this study.

Historically, some companies have encountered problems when they attempted to pass through to the customer their costs of production plus a markup regardless of the level of price sensitivity. U.S. Steel kept prices at a level high enough to allow several other companies to take a substantial marketshare in the late 1970s.[9] The auto industry has been accused of similar practices and results during the days of "voluntary import restraints" during the 1970s and 1980s, when domestic prices were kept at artificially high levels.

The rationale put forward by automakers regarding their EV prices is that they were attempting to recover as much of their costs as possible, a slightly modified version of cost-oriented pricing in which they claim to have abdicated any profit factor.

Competition-Oriented Pricing

If competition-oriented pricing is used, a company sets its prices relative to—above, below or equal—those of the competition in general or of the primary competition, based on its desired market position or relative perceived value. This method is typically used in the introduction of a new product into a highly competitive market segment, which defines the bulk of the auto industry. Historically, the auto industry has used this method of pricing, particularly in California. As a result of foreign competition in the small car segment, General Motors slashed the price of its subcompact Chevrolet Chevette in 1977. Moreover, both GM and Ford Motor Company priced their 1978 subcompacts less on the West Coast, where Japanese competition was stiffest, than elsewhere.

That move may have been the first in a long line of machinations that has saddled the two American companies with a segment of cars that are critical to the marketplace, yet produce no profit for their makers.

Regional pricing continues today, where pricing differences seem to have become a standard feature of modern marketing. Automakers respond to slow sales in a model or region with pre-packaged programs of subsidized leasing or financing rates, or cash rebates, in order to either sell additional product or adjust product inventories in response to competition.

In another example, to remain competitive in the brutal subcompact market, Honda has strived to keep prices on its Civic model down, manufacturing more of them in the U.S. with an increasing number of U.S. components. However, these models were saddled in the mid-1990s with a dollar-yen relationship that left them $2,000 more expensive than a comparable American subcompact, with Honda still losing money on every one sold. Still, the car's quality, premium image and strong Honda owners' loyalty kept the model on the best-seller list. The corporate approach to this dilemma of good sales and cash flow coupled with low or no profits was to engineer as much cost as possible out of the next generation Civic, which debuted in the 1996 model year, in order to return to profitability.[10] The model is critical to Honda's marketing strategy since it is the entry-level vehicle for the Honda-Acura stable, serving as a stepping stone to other Honda models. Thus the car delivers profits to the company not only through the initial purchase, but later in the customer's product purchase cycle.

Another dramatic recent example of competition-oriented pricing is Toyota's U.S. pricing of its Prius hybrid. While the Prius is larger and more feature-rich than its competition, the Honda Insight, Toyota set its retail price at less (though by only a few dollars) than its Honda competitor. The rationale for such a move is:

1) The competition between the two manufacturers for supremacy in the "green car" market.

2) A larger sales target for the Prius (two to three times more than the two-seat Insight).

3) Toyota's introduction of the Prius after the Insight, meaning it lost the first-mover advantage of being known as the company that introduced a new technology to the market.

Customer-Oriented Pricing

Customer-oriented pricing is probably one of the most relevant ways to think about pricing. Not surprisingly, it's one not advanced by the auto industry for EVs, even though it is routinely used for other vehicles. Its concept involves assessing the value of a product or service to the customer and using that value as a ceiling in determining price.

As one economist with experience in the auto industry commented:

"The customer does not care about manufacturing problems (or efficiencies) or lead-time problems. They simply want the component, feature or vehicle, and expect it to be priced competitively and at a proper level for the value received."[11]

This market attitude can be described as the "*Consumer Report* factor," in which consumers buy vehicles as functional appliances. Such attitudes have grown rapidly in recent years due to the influence of the Internet, which widely disseminates industry information such as invoice (wholesale) pricing previously known only to a few insiders.

This commonization of the automobile has led to the entrenchment of high-value, reliable, reasonably priced (though not price-leader) models like the Honda Accord and Toyota Camry as perennial best sellers in the U.S.

As the CEO of General Motors said in his earlier days, speaking before an audience of engineers (somewhat ironically in light of the company's EV1 pricing), "…getting to market first with the latest and greatest technology won't make one ounce of difference to our customers if almost nobody can afford to buy it."[12]

Value-Oriented Pricing

Value pricing is an alternative term describing customer-oriented pricing, in this case adjusting suggested retail prices and equipment levels to reflect regional or market segment customer preferences. Again, the Internet has become a driving force pushing the customer point of view in pricing. Combined with the medium's broad communications capabilities and the apparent willingness of many customers to travel extensively for a "value" that matches their own perception, it has led to phenomena like Dave Smith Motors in Idaho. That Dodge Truck dealer sells more vehicles annually than the total population of the rural town in which the dealership is located, which can only be attributed to his customer-oriented pricing and customer service attitudes.

Image and Strategic Goals Important

Customer-oriented pricing requires serious work on the part of the marketer. It also can take into consideration other significant factors, such as the image of the manufacturer and its strategic goals. Such an approach presents the auto industry with the broad opportunity to take what continues to be a negative image (the auto industry's fight against electric vehicles and consumer-oriented high technology) and turn it into a positive one. Although it faces ongoing challenges, the auto industry was able to turn around public opinion about its attitude on a safety/technology issue such as air bags.

The significance of the environmental image of a car company has already attracted high-level attention and public comment by auto leaders. While being pro-environment has become almost a "motherhood and apple pie" issue for the industry, recent statements raise the stakes in this arena.

Ford Motor Company's chairman, William C. Ford Jr., issued his company's first "corporate citizenship report," which cited the dilemma that its most profitable products are often the least socially responsible. He also said he wants Ford to be known as the most environmentally conscious automaker.[13]

Meanwhile, Toyota Motor Corp.'s president Fujio Cho said his company "wants to be No. 1 in the world as a company conscious of the environment" while committing to a full lineup of green vehicles in the near future.[14]

Not to be left out, Honda's manager of advanced environmental vehicle marketing, Robert Bienenfeld, was quoted as saying the recently introduced Insight (again the first of a flurry of similar vehicles) is "very important in our big picture as a leader of new technology."[15]

And other major manufacturers have expressed similar, though not as dramatic, corporate pronouncements on the environment.

With such high-level support, and the knowledge that pricing is a flexible component as demonstrated with Toyota's and Honda's hybrid strategy, it is logical that auto companies could use their fleet of zero or near-zero emission vehicles as image-leaders even if their initial pricing is not designed to fully recover the vehicles' wholesale costs.

Another argument is that high-technology vehicles like EVs and hybrids can command a premium price because of their positive environmental attributes, lower operating costs and low-volume "uniqueness." That has certainly been part of the strategy used thus far by auto companies. This theory has received mixed results in market research, though our recent market research shows Californians wanting to purchase an EV and willing to pay more than he/she would for a comparable gasoline vehicle.

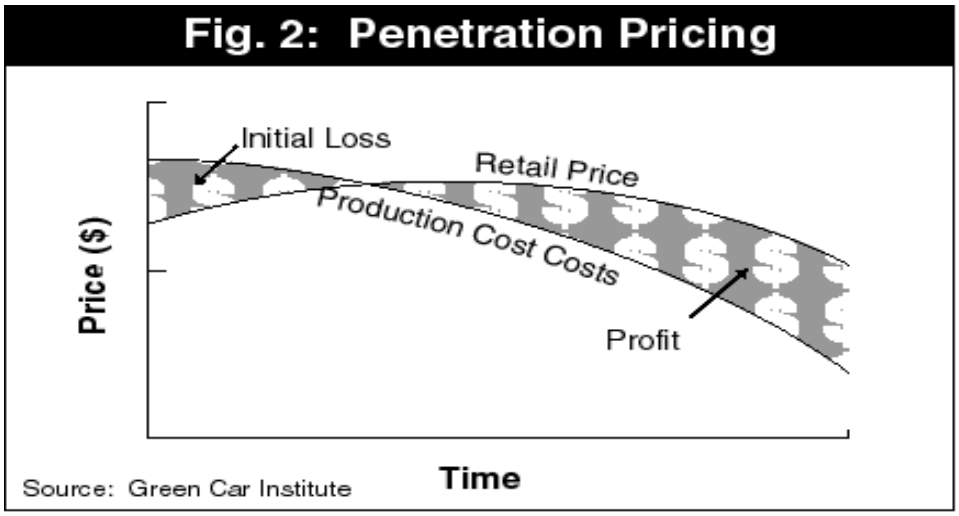
The current marketplace is harder to read. While demand may actually have exceeded EV supply during the past year (1999), that tends to lead to light price resistance. But marketing efforts were largely aimed at fleets, and the volume is so low as to not be a meaningful statistic.

EVs are only the latest vehicles that serve an additional corporate purpose that may be a factor in pricing. Chrysler Corporation (now DaimlerChrysler) used the Dodge Viper and Plymouth Prowler, Chevrolet the Corvette and Acura the NSX, as low-volume, high-image "halo" cars for their divisions. Those low-volume, marginally profitable (in some cases possibly not profitable) cars help create an image that is used to drive volume sales of the division's bread-and-butter cars by creating excitement about the brand and drawing people to the showroom. As automakers have stated, these vehicles are kept in the product line-up not because of their direct contribution to the bottom line, but because of the aura of performance, technological or styling leadership that they carry for the rest of the line.

As an example, General Motors put the EV1 on the cover of its annual report without expecting to boost sales of the model, but rather to emphasize the company's technological accomplishments to shareholders and potential investors.

Penetration Pricing

Since the EV represents not merely a new model, but a whole new category of vehicle, the automakers could approach it as a long-term investment with positive financial returns not expected until the category is well-established, something complicated since the initial market size will probably be driven by regulation rather than traditional market forces. Automakers have taken a "long-term investment" approach in recent times, for example, when GM set up its Saturn Corporation and when Honda, Toyota and Nissan established American luxury car divisions.



The stiff competition in both cases was initially assaulted by aggressive pricing. In spite of GM's massive $4.7 billion investment in Saturn, the compact cars were priced to generally undercut the primary competition from Japan. In the Japanese automakers' case, they were attempting to establish a new category of luxury vehicles in the U.S., and pricing needed to be balanced with a level of attainment of other features in the luxury category (quality, power, features). Still, their initial pricing was designed to strongly position their cars as a value choice in an attempt to lure potential buyers from the competition. At the time, engineers from their German competitors were unusually vocal about what they suspected was the "true" cost of producing cars like the Lexus LS400 compared with the prices at which they were being offered to the public. Not surprisingly, prices for those Japanese luxury cars have risen steadily over the intervening years after they established themselves in the market.

This is an example of a classical marketing approach, where a product that is functionally similar or identical to competing products -- since a car as a transportation mode is the same whether a subcompact, minivan or luxury sedan -- drives a company to adopt a penetration pricing strategy. This strategy involves setting a low initial price that does not cover the firm's costs, but enables the marketer to gain quick entry into the marketplace, gain as large a market share as possible, perhaps drive competition off, and ultimately reduce costs through a larger volume that would presumably result as the market grows.

The introduction of EVs presents a non-classical product introduction strategy. Usually, in its introductory stage, a new product generally enjoys protection from competition. Marketers are faced with the decision of whether to use penetration (market share maximization) or skimming (profit maximization) pricing.

Six manufacturers produced electric vehicles for sale in California while, in total, possibly as many as a dozen manufacturers around the world have production or near-production EVs. The EVs produced are functionally similar, although they span the gamut of vehicle types from two-seat sports cars (the GM EV1) to compact pickups (the Chevy S-10 and Ford Ranger) to small sport utility vehicles (the Toyota RAV4 EV) to minivans (the DaimlerChrysler EPIC). The key missing vehicle type is the most popular car sold in the U.S., the midsize five-passenger four-door sedan.

To further complicate matters, most car companies focused marketing efforts solely on fleet markets, while those who marketed to consumers found relatively low demand, which may be attributed to the limited vehicle types, high lease prices and other marketing restrictions (including requiring potential purchasers to fill out applications and wait for approval and vehicle availability, mileage limitations, garage requirement and limited consumer awareness, among other things). Other than a short promotion by Ford where its Ranger was offered at a very competitive lease rate, little price competition was seen in this new marketplace. The EVs were sold to relatively small, highly targeted markets in the very limited volumes necessary to comply with the Memoranda of

Agreement (MOA) signed with the state of California. Since no truly competitive marketing was practiced, manufacturers did not establish any "beachhead" from which to build an EV market. Essentially, the EV market has yet to begin even though electric vehicles from major manufacturers have been on sale for almost five years and approximately 2300 are presently being used in the state.

Separate Component Pricing

Another approach to pricing, when the market does not seem to support full cost-oriented pricing, is to price components or peripheral equipment separately. The auto industry does this routinely with its low-volume, "price-leader" models.

For example, when Chrysler's Neon subcompact was introduced in 1995, its "starting" price of $8,975 was heavily advertised as part of the vehicle's entry-level appeal. The model at that low price, which had little of the usual equipment found even in this basic segment, accounted for only about 10 percent of Neon sales. Some entry-level cars, like the Toyota Tercel, run only about five percent of the model mix. Car dealers use these models to bring customers into the showroom. As a matter of course, customers at the showroom often move up from these price leader models to more fully optioned, higher profit margin cars.

"Decontenting" has been used in the auto industry as a hedge against currency fluctuations. For instance, when the Nissan Maxima was redesigned in 1995 much of the standard equipment of the previous generation (such as a security system, alloy wheels and a $1,000 automatic transmission) was shifted to become options. The result was a $2,500 drop in price, which was augmented by cost-savings in components used in the new car.[16]

For EVs, separate component pricing could be used in two different ways. An entry-level EV incorporating lead-acid batteries and very basic equipment might be presented as the "loss-leader," a vehicle that demonstrates an EV's price equity with conventionally powered vehicles. Concurrently, most of those sold might actually use advanced batteries and have a higher level of standard equipment. However, the retail "magic" of this plan may hinge on the price of the "up-level" still being in the range of a comparable ICE vehicle, not at a $5,000 or $10,000 premium as has been suggested.

The analogy would be in the musclecar era vehicles that came from Detroit. Virtually every model had a base version that often had a smaller engine and fewer features than the top-of-the-line model. From a corporate perspective, profits on the car line will come disproportionately from those high-end models, with the entry-level models often generating no profit at all. They are used to keep a certain price-conscious customer within the brand with the hope that his/her next purchase will be a product that has a higher profit margin.

The problem with price premiums in the automotive marketplace is that they are not something strategized on paper. Vehicles commanding price premiums typically are those which have heritage, recognized product content and/or a consistent image built up over many years that rationalize the added price. That will present a hurdle to the EV.

A second approach to separate component pricing centers on the EV's batteries, acknowledged as the prime culprit in high EV cost. It has been suggested that batteries could be priced separately from the vehicle in order to create a more positive market price for the EV. Once separated, those costs could be dealt with via government incentives or special lease arrangements that take their cost out of the EV owners' financial equation. Since battery cost is a critical part of the creation of a practical EV, handling their costs becomes a key component of a successful market launch.

Price Does Not Stand Alone

Finally, price is only one element of the marketing mix, although often the dominant one.

Advertising is a traditional element of marketing, but not one included in product costs in all cases.

Some advertising may be part of a campaign branding or positioning a new product or creating a corporate or product image. Such campaigns can lead to sales, but their goals (and accounting) are not usually tied strictly to vehicle sales. Those sales would be driven by other campaign elements of either retail advertising or direct mail, for example, aimed at generating dealer visits or test drives. But in the auto industry, most advertising costs are related to a brand and are typically charged as part of that model's cost overhead.

Recently in the auto industry (calendar year 1999), those advertising numbers were tracked from a low at Ford Division of $170 per vehicle sold to a high at Oldsmobile of $943 per vehicle, where much of the advertising could be viewed as building up a new brand image as well as trying to generate specific vehicle sales.[17] And, as the numbers demonstrate, the advertising did not appear to generate sales anywhere near the industry average (Jeep and Nissan bracketed the $600 per vehicle average for the top 10 model advertisers). Of course, this does not factor in the profit per vehicle, which should be higher on a prestige line like Oldsmobile compared to a broader product line like Ford, Chevy or Dodge.

What is significant is that advertising costs per vehicle sale do not necessarily follow the retail price; that is, more expensive cars do not necessarily have more ad dollars spent on them per vehicle sale. As we shall see in later case studies, the relationship between sales volume, revenue generation and marketing dollars spent is not always in the same proportion.

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3. Covisint is an Internet-based marketplace set up by several automakers, along with key suppliers, to handle annual purchases by automakers and suppliers. Equity partners in the program are Ford Motor Co., General Motors, DaimlerChrysler, Renault SA and Nissan Motor Corp. The goal is to save money by reducing the cost of purchasing parts and supplies, facilitate quicker product development and create better communication between suppliers and automakers.
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Chapter
2

Auto Industry Pricing/Costing Issues

For much of its century of existence, the auto industry operated in relative obscurity in regards to its financial underpinnings. However, a variety of factors in the past two decades has changed that. Part of the new "openness" could be ascribed to the blossoming of the information age, part to the more aggressive nature of companies' public owners and part again to the consolidation of the industry, which has opened up more internal information to public scrutiny.

Even Japanese companies, which historically operated behind a veil of official and unofficial secrecy for most of their existence, have recently seen their practices and financial operations unveiled. Renault's takeover of Nissan exposed a wealth of information about practices there as has GM's investment in Isuzu, Suzuki and Fuji Heavy Industries (Subaru). The ongoing weakness of the Japanese economy and increasingly aggressive financial reporting in that country also has been a major factor in exposing business operations there. Likewise, the merger of industry giants Daimler-Benz and Chrysler Corp. opened the books on those two companies more than in the past.

Another key factor in the increasing quantity and quality of information available is the Internet. In addition to simply making research and news information more broadly and quickly available, the Internet's investment community also delves deeply into the workings of publicly held companies like the major automakers.

Thus, we know the net profit margin at General Motors, the world's largest automaker, is only 3.2 percent (according to Morningstar's analysis, though GM President John Zarella recently said the company had hit the 4 percent mark). Both are actually above the industry average of 2.8 percent. In lay terms, this means that for every $1,000 in sales in the last 12 months, GM has netted $32 in profit after expenses and taxes. GM trails Ford, DaimlerChrysler and Honda in these numbers, but leads Toyota, Volkswagen and Nissan. But the auto industry remains the heavyweight of the corporate world when it comes to profits. In the first quarter of 2000, DaimlerChrysler, Ford and GM collectively announced almost $7 billion in profits. At the same Honda and Toyota reported their fiscal year end with close to $10 billion in profits between them in spite of a difficult home market and currency pressures abroad.

But the money auto companies are earning in this era could be called "smart" money as opposed to simply gross profits. While aggressive cost-cutting programs and new technologies are contributing to the bottom line, the really significant result is in new product.

As GM CEO Richard Wagoner told a group of journalists, "The engineering resources – money and people – freed up from the productivity gains are being reinvested in additional new, innovative vehicle programs."[19]

A "Typical" Car's Costs

Financial analysts, who can draw a picture of the various cost components in a "typical" car, have subjected the products of the auto industry to scrutiny. Cost components include product development (7 percent), purchased materials and manufacturing (62 percent), OEM overhead, which includes manufacturer profit, taxes and warranty costs (7 percent), and retail distribution and sales costs, much of which is born by the manufacturer (24

percent). . Since the purchased materials portion of a vehicle is such a high proportion of its ultimate cost (43 percent by the Goldman Sachs study, with approximately two-thirds of that being components that make up the car or truck), it obviously receives a great amount of attention from the automaker.[20]

This focus led to the creation of Covisint, which envisions the Internet as a means to save on purchased materials costs as well as improve their quality through better communication, and to reduce inventory, which is another key cost in the car-building process. Another route is the development of suppliers as sub-assemblers of automobiles, which is discussed later. These initiatives are broadly aimed at the whole product lines of automakers, but it is logical to see EVs as a test-bed to measure the effect of such processes, since their component costs are currently disproportionately high.

The Model T Learning Curve

The classic cost/pricing example in the auto industry is the Model T from Ford Motor Company. It demonstrates what the auto industry is best at—volume economics. As the market for the car expanded, the kind of manufacturing process changed and economies were derived both from the volume and rate of production.

While it is recognized that Ford's assembly line production method produced an economy of scale that allowed low initial cost of the vehicle, that cost actually dropped as production continued—not simply because of the volume of production, but because the learning curve of the manufacturing process allowed Ford to shave costs and increase the rate of production.

The same effect is still seen today in plant die-changeover times and efficiencies as measured by industry analysts like The Harbour Report. Production efficiencies are a key component to creating a profitable car. The most recent Harbour Report tallied not only manufacturing efficiencies, but labor costs, marketing and design costs to measure overall vehicle profit. For the 1999 calendar year, Harbour found DaimlerChrysler to be the best, earning $1,497 on each car it makes, a 2 percent gain from the previous year. Number two in profit per vehicle at $1,440, Honda increased its earnings per vehicle by 45 percent over the previous year.[21]

The report shows that earnings do not follow a strict pattern, varying from plant-to-plant and manufacturer-to-manufacturer, but the overall concept is well established. Unit costs drop not only when vehicles are put into mass production, but as that production continues and the process is refined. Put simply, the 100,000th unit of a vehicle is cheaper to produce than the 10,000th one was, because the production process becomes simpler and more cost effective.

Most estimates of costs for volume production of electric vehicles do not address this second cost effect gained during regular production. Even though EVs may be low production vehicles, because manufacturers are designing them to be integrated into "sister" vehicle production lines, they are beneficiaries of this cost effect along with their gasoline-powered brethren. This is the kind of savings that can amortize the added component costs of special EV equipment, batteries or potentially even fuel cells.

As GM's executive director of Advanced Technology Vehicles Bob Purcell said, "The Triax [GM's concept vehicle] is designed as a global vehicle with the ability to produce internal combustion, hybrid or electric vehicle models. It is what we call a multiple-propulsion platform. Building different propulsion technology models off a single platform will help with overall program costs, because you can package different propulsion systems without tearing up the whole car." It's a more viable business proposition because, "Many new-technology vehicle programs do not have sufficient sales volume to really make the business cases work. So if you design a vehicle for more than one propulsion technology, you have the chance to achieve higher sales volume on the combined requirements for all the different versions of the vehicle…This scenario addresses the fundamental business challenge of getting better leverage on our engineering and capital spending. While any one of the models may not

be sufficient to pay back our investment, the combined volume of any of the three yields an acceptable financial return."[22]

Integrating EVs and other high-tech advances into regular production appears to be the key to achieving the classic automotive manufacturing economies that help create the profits upon which the industry is built.

A Different Paradigm

Another key factor in EV production that actually gives it a cost advantage over traditional auto economics is its roots in the dynamics of other industries.

Purcell noted this factor in GM's different generations of electric vehicle powerplants. Generation II propulsion systems increased the performance of the EV1 at nearly one-half the cost of Generation I systems. Generation III systems, due to be launched soon, are targeted to be one-half the cost of Generation II with reduced numbers of parts and size of components.

"[This is] not the automotive industry norm," Purcell said. "That's the telecommunications and computer industry paradigm."[23]

Automotive economists seem to have difficulty predicting this effect on future EV costs because it is different from their typical assumptions.

Supplier Savings

Another area of potential savings that could drastically affect EV cost projections comes from the supplier arena. During this past decade automakers, led by the then cash-strapped Chrysler Corp., have revamped supplier relations to elicit cost reductions along with quality and efficiency gains. The win-win scenario continues unabated as design for manufacturing now includes supplier input.

"[C]armakers are…calling their suppliers to the front line in a war on sticker prices. And parts makers are responding by wringing costs out of their products. In some cases, suppliers are talking about slashing costs on parts 30 percent, 40 percent, 50 percent, by altering their designs, changing materials and adopting new factory methods."[24]

One recent trend reflects the Triax assembly process described by Bob Purcell of GM: modular assembly. It is being used for the 2001 Pontiac Aztek at its Ramos Arizpe, Mexico, plant. Journalists who toured the plant describe the vehicle assembly as like a "giant jigsaw puzzle":

> "Thirty-two major modules (about 30 percent of the total vehicle) and hundreds of parts and subassemblies arrive just in time through nearly 60 doors along a skinny, T-shaped building. Modules range from complete instrument panels to dressed engines to simpler stamped metal assemblies. They come from suppliers based on-site and at three nearby industrial parks.
>
> "Modular assembly at its most extreme means giving a supplier the responsibility to engineer, validate, build and warranty a large chunk of the vehicle. In some cases, supplier employees bolt the module to the vehicle.
>
> "The benefit is lower cost."

A University of Michigan study estimated that an automaker can cut its development and manufacturing costs by about 15 percent by outsourcing modules.[25]

For GM's $22-25,000 Aztek, this is an obvious advantage. Even though the vehicle was not initially designed as a modular showcase, it appears to be benefiting from this experiment. GM of course hopes to export the best aspects of the Aztek production to other plants.

EVs would seem to be a natural for such a process, outsourcing the non-standard subassemblies such as the powertrain and battery pack to suppliers (and saving money in that process). Or the entire assembly process could be done as a supplier project, as Ford initially planned to do with the Ranger EV.

Some industry analysts see the emergence of a new tier of suppliers—called Tier 0.5 Suppliers—who are coming from the consolidation that parallels what is happening on the manufacturer side. These Tier 0.5 suppliers, according to a recent Automotive World report, take over R&D from vehicle manufacturers as well as design, some assembly and even customer service.[26] One report even suggests that low volume (under 30,000 units a year) could be better, that is more profitably, done by a supplier than most manufacturers.[27]

Research and Development Costs

Production cost estimates are only part of the automotive costing equation. Another major factor in electric vehicle costs (as presented by automakers) has been the inclusion of research and development costs. As is seen in the case studies presented later, R&D amortization of those costs can, ultimately, be influential in whether the corporation views the project as a profitable or losing proposition. That number can vary as much as a factor of one-third in its public version, as seen in various journalists' reports written from interviews with different corporate spokespersons at different times.

The second factor is the determination of the time at which general R&D is deemed to end and specific work on a vehicle begins. A corporation has quite a bit of flexibility with allocation of R&D and other charges, and in deciding what will be absorbed as part of the general overhead. That decision affects the most important numbers of the corporation: its vehicle production break-even point and overall profitability. The key issue is determining the somewhat arbitrary point that one economist calls "when the meter starts running."

This issue is even more critical in the area of alternative fuel technology development. In a typical vehicle program the powertrain and fuel storage R&D is usually not a major component, although special programs such as Chevrolet's Corvette or DaimlerChrysler's Viper might have a concentration of effort and expense in this area. But with an EV, since it is still a developing technology, an extraordinary amount of development dollars could be allocated to the "propulsion" unit. The critical issue is how much technology development is accounted for as a corporate expense (and thus spread among all of the company's vehicles) and how much is charged specifically to an EV product program.

The most recent example of R&D costs being expended under the corporate banner is DaimlerChrysler's June 2000 announcement of a $1 billion fuel cell program designed to field a production vehicle in 2003.[28] While it is clearly a program designed to develop a vehicle for the market (as manufacturers did with electric vehicles in the 1990s), it is even clearer that there is no expectation that those initial low-volume fuel cell vehicles will be able to recoup the substantial investment the corporation has made in them.

"DaimlerChrysler has the lead in the technology and one day when it becomes a volume business, DaimlerChrysler may be able to maintain a higher share of the market," explained Hans Scholbach, an auto analyst with Oppenheim Finance in Frankfort.

Cost-Shifting

In addition to R&D charges, many other expenses in electric vehicle development could find their way to accounting ledgers as other than strictly EV product development. An example offered by one auto industry

insider, who asked not to be identified by name, is that of the charge for a paint shop for a new model. Instead of charging the paint shop, which is an integral part of the product manufacturing process, to vehicle development (as would be done with changes to the manufacturing facility to accommodate a new product), the business plan showed the paint shop presented as a corporate charge for environmental compliance. In that way, that product manager was able to shift some of his costs to the general corporate overhead, where it comes back to his costs as a much smaller expense. Such cost shifting allowed that product's business plan to show a profit with substantially fewer vehicles produced since a major cost has been taken off its books.

Other creative approaches could be used to view amortization of EV R&D costs. If seen as part of the corporate ledger, other programs' savings could offset them. For instance, GM recently announced that its use of advanced computer design tools has resulted in $1 billion in savings, at least partially because vehicle development time has been reduced from 42 to 24 months. At the corporate level, those savings might be allocated to pay for a special R&D effort like an EV program.

Once a vehicle is on the market, its cost basis changes and development costs are no longer chargeable to vehicle costing. As one experienced automotive economist said:

> "You obviously do not price each unit at total recovery cost. You try to work out the cost as a function of the cumulative volume."[29]

Those cumulative volumes, of course, are merely planned volumes until the vehicles are built and sold. So the estimation of the market becomes the key to the volume, which in turn allows the cost to be figured.

A less sophisticated approach is one with historical precedent at some auto companies: simply raise prices on high-margin vehicles to cover losses with others. That was exactly what happened in 1978. In order to gain a competitive advantage on Japanese small cars, General Motors and Ford drastically lowered the retail prices on their subcompacts in the West. At the same time GM raised prices on its luxury cars.[30]

Technology Benefits to the Corporation

The reverse situation is when an R&D development, such as the EV's drive to reduce weight, brings benefit to the whole product line. Such R&D could legitimately be charged to the corporate account rather than the individual product line.

Larry Howell, executive director of science in General Motors R&D and Planning, said recently, "More than 130 technological innovations are found on GM's PNGV demonstration vehicle, the Precept. Seventy-five percent of Precept's technologies have application to the mainstream product lineup."[31]

While the Precept is recognized as a development, not a production-intent, vehicle, and therefore has no projected revenue stream, the EV1 is a car in the GM stable. Answering the question of how advanced technology vehicles like the EV1 have made GM's other products better, executive director of GM Advanced Technology Vehicles Bob Purcell said:

> "Look at the advances that have come from the EV1: lightweight chassis components, lightweight interior, electric braking systems, some incremental technologies like tire pressure warning systems that use the ABS (antilock braking) system—that technology is now going into high-volume production and improving the fuel economy of our core products.
>
> "The EV1 is more than just a technology story—it's also about manufacturing and marketing advanced vehicles. We put together an entire vehicle assembly operation in the Lansing (Mich.) Craft Center in just eight months for $15 million. The learning of how to implement fast, low-cost production programs is now being applied to a number of other GM product programs."[32]

While there is a clear value to the corporation, one that could be charged against specific vehicles benefiting from the technology, it is unlikely that this would be put into practice. On the other hand, it is logical that the EV1 program in this instance should be credited with generating more value and revenue for GM that what might show up in its vehicle sales figures.

When such programs are clearly aimed at the corporate bottom line, they naturally find themselves on the corporate rather than the vehicle program balance sheet. When they come as a side-benefit to a vehicle program, as with the EV1 program, it can be less clear where on the balance sheet they should be placed. What is obvious, however, is that there are benefits from an advanced technology program like the EV1 that need to be factored when its costs are determined.

Charging of Costs

In charging development costs, the key is doing it honestly. That is not always the case, but usually a company's internal watchdogs make sure costs find their proper home. The process is to build an honest business case for a vehicle, and then have it blessed by management. That allows a company to analyze its R&D costs *and* benefits (as in the case with GM's EV1), both tangible and intangible, before making a decision on a vehicle project.

The other very significant factor in the general pricing of products at auto companies (one which may cause them to account for costs in different ways) is the "big picture." Product lines and product development do not exist in isolation. The competition must be considered. This may cause a company to price a vehicle below what the corporation might wish if it were only trying to maximize its return on investment.

Market position, whether this vehicle is the first one in a new segment or whether it is entered after several others in a crowded one, plays into accounting and pricing decisions. Early entrants tend to have the luxury of being able to command a premium price while those entering the fray later often have to use price and other enticements to carve out a market share.

Finally, government regulations can affect cost accounting. When government safety rules encouraged the use of air bags as supplemental restraint systems (but allowed a transition period for auto companies to phase them in as product interiors were redesigned), most companies responded with programs that minimized the incremental cost for each model as the interiors were upgraded. Chrysler Corporation, on the other hand, made a bold move by installing air bags across the board in all its domestic product lines. Such a move pulled product programs out of normal development cycles and added new costs, but it apparently was absorbed at the corporate level, since prices were not hiked to cover the new equipment. What Chrysler did was use the technology upgrade to its advantage in advertising in an attempt to boost sales and cover its expenses by selling additional units overall.

High Proportion of High-Profit Vehicles

Since auto companies can and do take a view that does not isolate product lines, a vehicle's development might benefit from other actions the company takes. A good example is the Chrysler Corporation of the mid-1990s.

As was predicted in news media reports (drawn from internal Chrysler documents), Chrysler consciously pushed its truck-car mix toward the former during the decade, ending up with approximately two-thirds of its total volume allocated to light trucks, which included its popular minivans, pickups and Jeep sport utility vehicles. That mix put it well above the industry average.

"This strategy has big implications for Chrysler's bottom line because minivans, sport-utility vehicles and pickup trucks are much more profitable than cars, according to the company's internal documents. Chrysler is projecting that its overall per vehicle profit will rise gradually to $2,182 in 1999 from a projected $1,765 in 1996."[33]

As with many financial projections, those numbers were difficult to hit as a target when, in spite of a booming market, Chrysler Division (now part of DaimlerChrysler after its 1998 merger) found increased competition in these lucrative market segments, which drove down its operating profit even as sales rose. As a result, its average per vehicle (manufacturer) profit dropped to around $1,400 per vehicle in the first quarter of 2000 because of increased marketing costs.

While the current market may give DaimlerChrysler some pause about new vehicle programs, the company's overall fiscal strength allowed it to announce a $1 billion investment to develop and market fuel cell cars over the next two years. The parallel actions from Chrysler in the early 1990s were the investment in the Viper and Prowler image cars—low-volume, high-image vehicles designed to carry forward corporate messages as much as generate additional sales and revenue. While an equal amount of money spent on a light truck program might have generated more income for the company, the money spent on Viper/Prowler programs added much to corporate image and prestige. It is not a stretch to say that the Viper and Prowler programs could have been financed by sales of minivans and Jeeps.

Separate California Market

If the California market is viewed as a separate market from the rest of the U.S., a view to which both automakers and California state officials seem to subscribe, it makes sense from an economic standpoint to view automakers' operations in the state in isolation as well. This takes into account the state's 10 percent ZEV requirement due to take effect in 2003 (recently modified to allow for 4 percent pure ZEVs and partial ZEV credits from a mixture of other vehicles to make up the 10 percent total).

Historically, automakers have made allowances for the California market's specific emissions demands by increasing their manufacturer's suggested retail price by an additional $100 (approximate, since the actual charge varied from manufacturer to manufacturer). Recently, that charge was dropped as manufacturers rolled emissions program costs into all vehicles produced nationally. From a marketing standpoint the automakers viewed the separate charge for California emissions programs as negative to their other marketing efforts.

Auto companies routinely make regional variations in their vehicle prices, usually through consumer or dealer incentives. So the possibility of pricing vehicles separately for California to recover program costs for EVs or near-EVs, or other emissions requirements, has historical precedent, as does the pattern of absorbing those costs either statewide in all vehicles sold, or even nationally.

Vehicle profit margins may also allow manufacturers some flexibility in pricing. Not surprisingly, GM, Ford and DaimlerChrysler chose as base vehicles for EVs ones that were top sellers that also brought significant revenue to the corporation. The high-volume Chevy S-10 pickup, Ford Ranger pickup and DaimlerChrysler minivan allowed the parent company significant advantages over programs utilizing a unique product design or smaller volume base (such as the GM EV1, Toyota RAV4, Honda EV Plus and Nissan Altra), though they may not make for the most elegant execution of an electric vehicle.

By basing EVs on popular models that bring substantial profits to the corporation (ranging as high as $10,000+ on some minivan models in DaimlerChrysler's case, according to analyst estimates), the companies could afford to view EVs as an offset to its other programs in the state.

To illustrate this, let us review some approximate numbers. For example, DaimlerChrysler sells a slightly lower proportion of its minivans in California than its does nationally. But Dodge-, Chrysler- and Plymouth-badged minivans sold an estimated 52,000 vehicles in the state in the most recent calendar year (10 percent of the 1999 national total). Industry analysts estimate DaimlerChrysler averages more than $5,000 profit on each of these vehicles, well above its per-vehicle average, which is why they are one of the "crown jewels" of the company's operations (as with all automotive market numbers, these are currently being affected—negatively—by heavy incentives to move the last of the old model minivans in preparation for an all-new model's launch).

This quarter-million dollar profit in the state could be viewed as an offset to the cost of the EV program. Of course, shifting costs in this manner puts more pressure on other vehicle programs to generate profits, but as noted earlier, the EV program has the potential of producing other positive revenue for the company by promoting a positive environmental image among consumers.As one automotive economist commented: "To the extent to which you are doing a program driven by penalties—for instance, if selling one EV allows you to sell another high-profit vehicle—this is a valid way to look at pricing."[34]

As has been seen with Corporate Average Fuel Economy (CAFÉ) constraints nationally, if a company can sell more high-profit vehicles, it may be advantageous to continue sales of some models even at a loss.

Offering thousands of EVs for sale (still a relatively small number of vehicles compared to total vehicle sales statewide and nationally) becomes the ticket of entry to the lucrative automobile market in California (and possibly other states in the Northeast). The variety of exceptions, offsets and the flexible time frame (starting with the 1999 model year) for a variety of low emissions and ZEV vehicles allows manufacturers the ability to adjust product mix to meet the regulations with a relatively low cost to the company's bottom line in 2003. Because all of the major automakers are under the same regulatory constraints, the competitive advantage for any one company is developing the best business case or vehicle mix that will meet the regulations and also deliver a positive impact to the company's overall image, possibly enhancing other vehicle sales.

Much as California's separate, more stringent emissions standards have added headaches to the vehicle development process for decades, this new challenge is worth meeting because the massive market makes the extra expense worthwhile. This state's market has always been a strong one for high-margin, high-end companies such as BMW and Mercedes-Benz and served the same function with automakers with broad product lines. The tradeoff of being able to sell nine Lincoln LS sedans by putting one Ranger EV in the market, for example, would seem to be a good one for Ford. In a similar situation on the CAFÉ front, Ford historically was selling one of its entry-level Escorts at a loss in order to continue marketing each high-margin Crown Victoria or Lincoln at a profit.

Given the structure set up in the state to allow credits for vehicles sold now, auto companies potentially can launch sustained marketing programs promoting their EVs (or all low-emission vehicles), reaping corporate image benefits while meeting future regulatory standards.

Strategy

The flexible structure of the ZEV emissions regulations proposed for 2003 in California gives auto companies a strategic challenge. The regulations have been on the books long enough that each company has to have developed a plan of attack and allocated the financial resources to develop vehicles to meet the regulations.

The unknown factor is how the marketing of these vehicles will be implemented and how the market will react. Marketing during the MOA was rather haphazard, which is not to say that a substantial effort and expense did not go into it (particularly GM's EV1 effort). But the cumulative results were that very few vehicles were sold to consumers and those that did had mixed results in the marketplace (Honda withdrew from the market as soon as its MOA requirements were met; GM had to cope with a recall of a large number of its early EVs).

Ford now appears to be engaging in a strategy of laying the groundwork for its umbrella TH!NK operations with television commercials highlighting the consumer benefits of the vehicle in a lighthearted manner. Its Ranger EV marketing efforts also have resulted in that vehicle being the best-selling EV in the country with more than 1,000 on the road. Combined with statements by Ford Chairman William Ford, this gives the impression that the company is very serious about staking out a position as an environmental leader with a variety of vehicles being sold to back it up. Whether this symbiotic relationship results in an eventually profitable program will not be known for some time, but it has the potential for raising environmental considerations to a more prominent part of the vehicle choice decision and thus increasing the market potential of all EVs.

With a public battle on SUV fuel efficiency now engaged between Ford and GM, the general consciousness about automotive environmental impact has been raised to a new level. Other factors, such as Toyota's hybrid Prius launch and Honda's strategy of moving from the low-volume Insight hybrid to its Civic, promise to further heighten the dialogue.

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Chapter
3

Development Cost Case Studies

In this section we review several automobile development programs to provide pointed case histories of costing and pricing issues as well as instruction on volume and price relations that can be drawn upon when discussing costing for electric vehicles. It explores the volume and price relations viewed as viable business practices in the auto industry as a backdrop for considering how the industry looks at its electric vehicle program investments.

Saturn—Phase 2 (More $ for Corporate Image)

"Saturn was a grand experiment, a major innovation in auto making."[35]

As it comes close to the start of its third decade of existence, the roots of the Saturn project at General Motors may need to be reviewed. In some ways the genesis of the project and its execution are from another era of auto making, but even as it has evolved it is illustrative of various accounting practices in the auto industry.

Conceived on June 15, 1982, as America's answer to the Japanese small-car invasion, Saturn was capitalized with $4.7 billion in 1985 as a wholly owned GM corporation. In 1988, $1.9 billion in industrial revenue bonds were issued and purchased entirely by GM. Some major Saturn costs have been 'absorbed' by its parent company rather than charged against its own revenues, leading one writer to congratulate Saturn owners for driving a car "subsidized" by other GM vehicle sales.[36]

When the project was declared profitable in 1994, many felt this was a case of GM legerdemain. Yet it has been a solid performer in sales, quality and the establishment of a well-recognized brand with a loyal owner body.

Looking at the future of the brand from a 1994 perspective, some business journalists came to similar conclusions:

> "Based on the car's relatively small market share of less than 3 percent, Saturn is not exactly clobbering the competition. Three percent of the market does bolster GM's total share, but what good is market share without profit unless the low-profit activity absorbs overhead burden or acts as a springboard to later sales of more profitable products? In Saturn's case, the argument can be made that neither of these objectives is achieved. Saturn has a dedicated, limited-volume manufacturing facility and dedicated overhead. And Saturn does little or nothing to leverage the GM franchise as a whole."[37]
>
> "Saturn announced a profit in 1994, a $100 million beginning in paying back GM's huge investment. But additional spending on Saturn is a tough sell...At this rate, it'll take several decades for Saturn to earn its keep—far too long for earthbound investors."[38]

A Corporation Defines Profit

One sidelight of the process of "opening the books" on the Saturn operation was GM's opportunity to define its investment.

> "The numbers on Saturn don't look good. Luckily, the 'different kind of company, making a different kind of car,' evidently used a different kind of accounting. Saturn officials recently declared themselves to be at 'operational break-even.' Operational break-even was defined in this paper (*Wall Street Journal*)

> on Jan. 6 (1994) by Thomas Manoff, Saturn's vice president of finance, as not including taxes, interest and health care costs. However, about two months later, Saturn's public relations department in Spring Hill, Tenn., answered my question regarding a break-even point for Saturn as follows: 'The target date for break-even to include interest, taxes and health care costs was the end of calendar year 1993. Saturn achieved that goal and made a profit.' If Saturn itself can't decide what the break-even point is, it definitely has an accounting problem."[39]

The investment dollars for Saturn are illustrative of GM's strong commitment to the project—$5 billion (in 1985 dollars) for a single car line (albeit with three models and unique engines and transmissions). They dwarf any investments made by the big three individually or collectively on EV projects in the 1990-2000 time frame. And as is evident, the wisdom and return of that investment is suspect even though sales of Saturns are now substantial, hitting 232,000 units during the 1999 model year after peaking substantially higher earlier in the decade. Yet even with that robust volume, some analysts feel the potential for public failure, not its market success, is what is driving ongoing GM investment in Saturn.

Vehicle For The Future

> "Skip LeFauve, the chairman of Saturn Corp. in 1995, believed strongly that Saturn had a bright future not only in the U.S., but also internationally. His forecast of 500,000 cars a year, a volume increase requiring a 70 percent increase in plant capacity, includes selling 100,000 overseas...Maryann Keller of Furman Selz Inc. disagreed with his projections. 'A Saturn failure would be catastrophic for GM. There is simply too much at stake, including the $5 billion investment' (which may be much higher depending on how one views the internal accounting)."[40]

Big initial investment and start-up costs for its new plant and dealer network delayed freshening of the car until the 1996 model, which allowed competitors to bring totally new cars to market and negatively impact Saturn sales in the spring of 1994. In this case, GM had to spread out its investment in Saturn since part of the car's market appeal was as a relatively low-priced vehicle (so prices couldn't be raised).

GM renewed its investment in Saturn in the late 1990s, adding a second (midsize) model to its lineup in 1999 at a cost of $1.2 billion, but the parent corporation also changed the ground rules for its subsidiary. Saturn was required to draw from the GM worldwide parts bin for some of its components and lost a dedicated engineering operation. GM announced an additional $1.5 billion investment in expanded vehicle and engine facilities for Saturn in April of 2000 (which included the addition of a sport utility vehicle, a new sedan and coupe as well as a fourth new product that will be powered by a Honda V-6 engine). The investment amounts to what analysts called a “vote of confidence” in the ongoing Saturn project, rationalized because the division continues to bring in buyers who otherwise would not buy GM vehicles. But the new products come at a cost for what was a “different kind of car company.” Henceforth Saturn’s sales, service and marketing organization would function as part of the GM North American operation to “explore synergies to reduce structural cost and enable Saturn’s new product investment.”

“Saturn is still a learning laboratory, but for GM’s new approach: developing global technology along with a host of overseas partners,” said one industry reporter.[41]

That investment comes while Saturn struggles along with sales at half the level LeFauve had predicted five years earlier. While Saturns are marketed overseas, exports represent a small portion of the overall sales.

Success Beyond Selling

The corporate bottom line since GM Chairman Roger Smith announced the Saturn project in the mid-1980s has been that its success goes beyond merely selling cars and making a profit, although that has always been a part of the stated goals. The export of Saturns to Japan in 1996 puts one of those goals to a difficult test—it becomes the personification of the American challenge to the Japanese small car, going head-to-head on their home turf with the cars it was designed to beat in the U.S. marketplace.

At home, Saturn has sold well and developed a consistent, positive image, although this has been accomplished somewhat by distancing itself from the parent company. Saturn remains a solid example of how development costs can be absorbed by the corporation in order to promote its further corporate aims of demonstrating success in creating a "different kind of car company."

Even though it has a distinct identity apart from GM, GM chose Saturn dealerships as the site where its EV1 (the first General Motors-badged vehicle) would be retailed because of the division's customer-relations skills. So it might be said that GM's lauded investment in the Saturn program dovetailed into its EV program. The Saturn experience is also probably indicative of the type of ongoing investment in new product and exploitation of corporate synergy that will be necessary to launch a successful EV franchise.

Viper—Little $, Big Image

A good measure of the fast pace and forgiving nature of the auto industry is found in the Viper story. While the company's investment in the vehicle was small by Saturn standards, it was done at a time (1990) when Chrysler seemed on the edge of its automotive existence. Saddled with moribund product and increasingly strong competition, Chrysler was thought by many to be beyond help, an example of a company that had outlived it usefulness. In the face of that scenario, spending money on a low-volume sports car seemed to border on the absurd.

> "So why is cash-strapped Chrysler producing the Viper? Because Chrysler, like so many other automotive manufacturers, believes an image car like the Viper can become a cornerstone for a brand, giving it an instant identity that normally would take years to develop through its conventional models."[42]

Vehicle development costs can be viewed as an investment in something more than merely four-wheeled hardware. While Saturn certainly has an element of that kind of investment, its large dollar amount demands that some return be demonstrated. With Viper, Chrysler Corporation has shown another rationale for amortization of an investment—and also demonstrated a further method for spreading costs beyond the simple balance sheet of a single vehicle's development.

Strict Cost Goals

> "[Chrysler President Robert A. Lutz] set strict guidelines. Get the Viper ready in three years, he ordered—two years faster than usual for Chrysler. And he set the development budget at just $70 million, 45% less than Mazda Motor Corp. spent on its Miata roadster."[43]

> "Lutz has told financial analysts Viper will be among Chrysler's most profitable models despite tiny production runs of no more than 5,000 per year eventually. Chrysler says it will have spent some $75 million on Viper by the time the first cars are sold—pocket change in the car business and just 10% of what Chevrolet spent to restyle the Caprice. Chrysler says it will break even on 3,000 Vipers per year."[44]

> "The Viper has been brought to market for only $70 million. Ford, by comparison, expects to spend $1 billion on building its new Mustang for 1994."[45]

Two cost elements are illustrated here. One is the 10 percent variance in development prices as quoted in the media. The second is that even that small number was under scrutiny, so it was compared by Chrysler to the much more substantial budgets of other corporations. A third element is unseen. As discussed earlier, the open question is what is and what is not included in a budget number.

In this specific case, clearly the Viper concept car (the original Viper shown to the public in January 1989) was not included in the development number. Although usually unverified, industry estimates put major concept car development in the neighborhood of $1 million. Another related effort was the Viper's public outing as Pace Car at

the 1991 Indianapolis 500, which was a key part of the vehicle's marketing development, but probably not charged to the program since it was a larger corporate effort. Similar examples include GM's EV1 debut as the lead vehicle at both the men and women's marathons at the 1996 Summer Olympics in Atlanta, part of a large corporate marketing effort by GM, and that company's similar program showcasing the fuel-cell version of the Opel Zafira van at the 2000 Olympics in Sydney.

An Overwhelming Image Vehicle

That is only a part of Chrysler's rationale as laid out for the Viper.

> "The volumes (200 in 1992 model year) belie the importance of the car," said [then general manager of the Dodge Division Marty] Levine, who put eventual production and sales goals at about 3,000 cars a year. "The Viper is tangible evidence that we have the performance, that we have the flexibility to design and market niche cars that are consumer driven."[46]

> "However the Viper sells, Chrysler used the car as a laboratory for learning efficient new development techniques. ...Chrysler already is adapting some of the lessons it learned on the Viper to its new LH line of mid-size cars, due out next year [ed note: 1993 models]. But Lutz admits that 'by Japanese standards, there's still a lot of waste' in the LH program. On later models, he says, using Viper-style development will cut costs dramatically. Viper also is helping cut costs on the new JA compact line that was debuted in 1995, he said at the time."[47]

A Learning Test Bed

> "The Viper also uses innovative materials and production tricks. For instance, supplier Guardian Industries Corp. helped perfect a 'press bent' windshield that avoids the optical distortion common in the corners of dramatically curved glass. Chrysler plans to use the new glass in its LH sedans. And the Viper is the first Chrysler with an all-plastic body. The innovative resin-transfer molding process being pioneered in the U.S. by Chrysler and its suppliers saves bundles: Epoxy molds used for most body panels cost 90% less than steel ones used with sheet metal."[48]

The investment in new technologies and development processes was used by Chrysler as an up-front justification for a project that might or might not have survived financial scrutiny in a company that at the time was losing money. But it also demonstrated another technique for cost-shifting, which is particularly important in a low and tight-budgeted project such as the Viper.

Suppliers Absorb Costs

> "Chrysler also cut costs by having Viper suppliers engineer key components such as the transmission. More than 90% of the Viper's parts will come from suppliers, vs. 70% for a typical Chrysler."[49]

> "With this transmission we gained a substantial savings in development time without any performance sacrifice," said Peter Gladysz, Viper chassis development manager. "In accordance with our new platform team philosophy, Borg-Warner [the transmission supplier] completed the structural and durability testing [normally done by the manufacturer]...we were able to accomplish in 18 months what ordinarily would take five or six years (of development).

> "Once a supplier was awarded a contract, the supplier was expected to contact the appropriate Viper team member directly as needed," Bill Smith, the Viper plant manufacturing manager said. "Tooling and equipment suppliers met weekly with manufacturing. This type of relationship helped to eliminate redundancies and speeded up the development process.

> "...Chrysler's Team Viper was able to convince many companies (suppliers) to join a venture designed as the precursor to the new development methods and limited production volumes under which more vehicles will be created in the 1990's and beyond. 'We definitely expect the 1990's to be more of a niche market...where cars with volumes of 20,000 a year and less are in demand,' ventured David W. Swietlik, procurement and supply manager for the platform group handling the task of bringing the Viper to market in just 36 months."[50]

Spread Development Costs

This demonstrates a conscious effort on Chrysler's part to spread development cost among the Viper suppliers. As has been mentioned, the Viper is figuratively and literally the prototype for current vehicle development at Chrysler, so the cost shifting accomplished by having suppliers develop components and systems for new vehicles is tremendous. While much of this cost may come back in component cost during production, it reduces development costs directly and also—because it shortens development time—saves on project and corporate overhead. It also shifts costs so they are paid at a later time, in theory with less expensive dollars.

Several suppliers so badly wanted to be a part of Viper that they changed their way of doing business, which in some cases meant forgoing the expected profit on development costs. According to Borg-Warner's Vern Jones, engineering representative on Viper project: "We saw the Viper as an ideal way to 'grow the business' for this transmission." Facundo Bravo (owner of Uniboring, which machined major components of the V-10 engine) concedes the Viper assignment represented a "considerable investment of time and capital resources for a company its size (115 employees)," but felt the potential rewards were well worth it. Uniboring worked on some design work for certain components, located casting sources and, in some instances, assembled complete systems.[51]

Chrysler has blessed the success of the Viper program with ongoing activity in the program. The Viper roadster received a major redesign for the 1996 model year, and a distinct Viper GTS Coupe was added. The low-volume, high-cost coupe (1,500 units per year with a $66,700 price tag) was developed using many of the innovative program techniques of the original roadster. And then new features from the coupe were grandfathered back to the roadster, including a revised suspension with aluminum alloy wishbones, a lower rear roll center, increased caster, stiffer springs, relocated mounts for the shock absorbers, which have been revalved, and new Michelin MXX3 tires. Like the roadster before it, marketing efforts for the coupe were kicked off with a concept car revealed several years before and in 1996 involved a pace car program at the Indianapolis 500.

Finally, Chrysler announced that the total program cost for the coupe was $6 million, less than one-twelfth of what was spent on the roadster.[52] This is an incredible example of a corporate learning curve dealing with new materials and a completely new product that is obviously translating into profitable products.

Mitsubishi Concurs on Image

So, in the Viper's case, even those modest development dollars did not truly represent the scope of the vehicle's development cost. Lest the Viper be seen as an isolated example of how specialty car development is viewed by carmakers, note this comment on a mid-1990's Mitsubishi product:

> "Mitsubishi's Richard Recchia is often asked why the company gave the green light to a $57,000 retractable convertible hardtop, especially since the bottom has fallen out of the sports car market. Recchia, executive vice president of Mitsubishi Motor Sales of America Inc., answers that he believes the technology derived from the limited production 3000GT Spyder eventually could be applied to other Mitsubishi convertibles, such as the Eclipse."[53]

Mitsubishi went on to produce the convertible, and similar models have become the cornerstone of a second generation of Mitsubishi products as well. Chrysler Corporation, of course, launched a limited production (but more reasonably priced) Plymouth Prowler in the late 1990s.

While the high retail price and low production volume take the Viper program out of direct comparison with electric vehicle development, many elements seen in the program are similar. High-level supplier involvement to speed development and save costs was a critical part of the Viper program. The use of the Viper by the Dodge Division as a symbol for the brand and its use as a prototype for positive trends at the company are both themes that EVs could echo. The other element that rings true from a corporate perspective is that both the Viper and electric vehicles are "must build" vehicles, ones that promise to bring to the company positive image benefits well beyond their cost of production.

New Beetle—Leveraging the Past and Present

Volkswagen's New Beetle's development story represents a company's response to market demand and the rewards it can reap, though it also provides a cautionary tale about "world" cars.

The auto show car—a one-of-a-kind show car—that started the New Beetle on its path to production was dramatic. Designed by Americans, it updated the classic VW Beetle while retaining its unique style. Included in its concept was the option of three distinct powerplants: a turbocharged direct injection engine, a diesel hybrid, and a battery electric powertrain that would meet California's ZEV mandate. It fired up intense interest wherever it appeared on the show circuit. The problem at VW was that the home office did not want to build the vehicle, though it finally assigned the project to an outside German development house. At a critical juncture, the project was brought in-house and received some high-level attention, but its mission had changed dramatically.[54]

The New Beetle, as it was finally introduced in the U.S. in 1998, differed in almost all respects (except style) from the concept car. It was larger, being based on the existing Golf/Jetta platform, contained off-the-shelf internal combustion engines and would be built in Mexico (close to the key American market) alongside its sister cars. That allowed VW to bring the dramatic car to market at a low-enough cost that it undercut the early estimates of its retail price by several thousand dollars, helping to fuel interest among consumers.

The result was that the car was an instant success here, boosting VW sales overall more than 50 percent above the previous year—and it has sustained that role. Further, the car has led VW's resurgence in the American market during the past two years, even though it is not the best-selling model. VW's strong worldwide focus on entry-level cars like the New Beetle keeps its per-vehicle profits relatively low (under $1,000 U.S. per car) compared to some of its competitors with high-margin trucks and SUVs, but the company remains one of the major players in the global automotive marketplace.

Use of a high-volume platform becomes critical for the company under those circumstances. The platform-sharing philosophy has allowed VW to drop the break-even production point of key plants by as much as 30 percent, increasing corporate profits in a booming market and keeping it profitable when an inevitable downturn comes.[55]

What the New Beetle demonstrates is the strength of strong design and a company's ability to utilize a flexible platform to produce distinctive vehicles at a very competitive price. VW now builds more than a dozen models off of the Golf/Jetta platform used for the New Beetle, focusing on design differences that produce distinctive cars like the New Beetle, Audi TT and the Jetta. Because the New Beetle shares all of its key dimensional measurements with the Golf, manufacturing the vehicle was greatly simplified. In fact, under its dramatically different skin, the Beetle shares 80 percent of the Golf's mechanical components.

The only glitch in this story has been in VW's attempts to market the car worldwide. While it was a blazing success in the U.S. and has received positive attention in Japan, the home market of Germany and Europe has been a tougher sell. VW created some of the market difficulties by pricing the car substantially above its U.S. price point, making it more of a niche vehicle. To overcome this, the German company instituted aggressive marketing programs to boost the car's sales.

It is fascinating to speculate what potential might exist for the Beetle or other variations of this global platform, which VW is using for low and high-volume derivations around the world. Considering the tremendous interest shown in the New Beetle by a youthful audience in the U.S., and this same demographic's penchant for environmental issues, might it be possible to leverage a popular design like this with its original zero-emission intent?

In fact, recent reports indicate that VW is looking seriously at an EV variant of the New Beetle, with the project under the wings of Los Angeles-based AC Propulsion, whose founder Alan Cocconi helped design the prototype that led to GM's EV1.[56] Such a project is the logical extension of work already done with this utilitarian platform.

PT Cruiser—Creating a New Niche

The story of DaimlerChrysler's PT Cruiser is similar to VW's New Beetle, with a little twist. From a design and marketing standpoint, it has its origins in the Plymouth Prowler, a hit show car like the Viper that became a successful "halo" car. The PT Cruiser too began life as an auto show concept car and was brought to production quickly because of consumer reaction to the concept. It entered the market at a price substantially below what was expected because of the use of an existing platform, advanced Mexican production facilities, and under-the-skin commonality with many of the company's other higher volume vehicles.

While the PT Cruiser also has hints of the past in its design (picking up the factory "hot rod" style of the Prowler; retro a la the New Beetle), it also attempts to do something even more dramatic—break new ground for DaimlerChrysler (DCX) by creating a new product category, something the company has done in the past with its minivans.

> "We kept the overall exterior length of a small car to address global market needs, yet provided the inside space and functionality of a much larger vehicle by paying close attention to vehicle packaging and providing command of the road seating," said Tom Sidlik, then executive vice president and general manager, Small Car Operations, at DaimlerChrysler.[57]

DaimlerChrysler referenced the Viper project, as it often does when citing a dramatic vehicle development story. But in this case the company's expanded European contacts were brought into the process so the vehicle could be simultaneously brought to market there as well as the U.S. In addition, it was brought to the Japanese market quicker than any previous DCX product.

Underneath its eye-catching exterior, which remains the vehicle's primary appeal, the PT Cruiser uses a variety of elements from the company parts bin. Core to the company's ability to bring the Cruiser to market at a very attractive price (starting at about $16,000) was the plan to use an off-the-shelf powertrain, many common parts and site production at a plant that had been producing a related vehicle, the Neon, with whom the Cruiser shared a front suspension package and other components. More importantly, according to DCX executives, was that knowledge gained from the 2000 Neon program was applied to the PT Cruiser program and resulted in solving development issues easier and earlier.

To facilitate the vehicle's intended international audience, its interior was designed to accommodate easy adaptation to right-hand drive for the English, Australian and Japanese markets. Adapting the PT Cruiser to the Toluca, Mexico, plant chosen as its primary source cost DaimlerChrysler $250 million, a relatively low investment for a plant that will now be producing 180,000 units, primarily for the North American market. That plant now has a sizable percentage of its parts coming from Mexican suppliers, helping to reduce costs further.[58]

The early success of the vehicle has allowed DCX to expand production, adding the PT Cruiser to the line at its Graz, Austria, plant to supply the European market. It also gave the company the ability to announce an almost

immediate price increase (up to 6 percent) in Fall 2000. That increase should accrue directly to DaimlerChrysler's bottom line, which was battered in the most recent quarter by high incentives on many vehicles in the U.S. market and the cost of the Cruiser launch, which was high because it was launched in three markets almost simultaneously (within four months in 40 markets). The commitment to a strong launch of the PT Cruiser was solid because the vehicle "will give the Chrysler brand a signature concept-to-reality production vehicle like no other in the world," said Martin R. Levine, then vice president, Chrysler/Plymouth/Jeep Division of DaimlerChrysler. The company believes the Cruiser will have a similar affect on brand identity as the Prowler did for Plymouth (they also are migrating the Prowler to the Chrysler brand with the demise of Plymouth) and as the Viper did for Dodge.

As with the New Beetle, the PT Cruiser demonstrates the strength of strong design and clever packaging, built on smart R&D and product planning. Leveraging existing product and manufacturing strengths and integrating EV development into other product plans can minimize the product cost differential. But where auto companies need to focus is the design and packaging, where each electric vehicle needs to compete in the marketplace by establishing its own identity.

"The $7,000 Car"—An Update

One of the automotive industry's most respected trade publications, *Automotive Industries*, presented its readers with a story that challenged some traditional costing and pricing assumptions. That story, "The $7,000 Car," appeared in its November 1995 issue.[59] The story starts with a premise that is the genesis of many car programs—a perception of a market need, in this case an entry-level vehicle at a price point significantly below any cars currently available.

Furthermore, this author presumed to present a business case that rationalized the $7,000 vehicle's manufacture and sale in the U.S. in spite of protests about the project's unfeasibility from industry innovators like Francois Castaing, Chrysler's former vice president of engineering (and one of the "fathers'" of the Viper). Castaing's opinion was that Chrysler had "used all the tricks of the trade" to produce the Neon profitably at a retail price point of just under $10,000. His "profitability" jibe was directed at cross-town competitors General Motors and Ford, who industry analysts said lost money on each of their entry Cavaliers and Escorts (respectively) that they sold.

Castaing said that the industry estimate of meeting mandates and regulations (safety, emissions, etc.) add $3,000 to the cost of a car as it is, and prospects held out even more stringent rules (like California's 2003 ZEV production requirement) in the future. But the trick, according to "The $7,000 Car" author Gerry Kobe in a recent interview, is not to count the additional expense but to "take the cost out" (as automakers are doing in many other product development programs) and drive to high-volume production because that's when manufacturers will learn the true costs of an EV. The current almost hand-built EVs, he feels, are not representative of what an EV will be like when it is mass produced because of the learning process that has been a part of high-volume manufacturing since the days of Henry Ford.[60]

In the article's counterpoint to industry naysaying, consultant Jim Harbour, president of Harbour and Associates, a highly respected company analyzing automotive operations, was approached. Harbour built a business case for a $7,000 vehicle that would meet entry-level market expectations. He posited a vehicle with few frills (no power accessories or air conditioning and in a sub-Neon class, powered by a 1.5-liter basic overhead valve gasoline engine). But at a volume of 300,000 units per year and a three-year amortization of tooling, he showed it could be done—at least on paper with a slim $600 (8.5 percent) dealer profit and $600 factory profit. And that is for a vehicle with a definite, but limited, market appeal.

Harbour uses conventional industry thinking (his background is working in manufacturing) to come up with his estimates, which include a $100 million tooling, dies and stamping investment and another $140 million for the body shop. The article then proposes that looking to innovations in design-for-manufacturing could seriously reduce even these costs, thereby increasing the factory/dealer profit margins and/or allow for more features to be added to the car at the same price/profit point.

The article suggested industry studies (by Ford's Manufacturing Development Center) showing that moving to an extruded aluminum spaceframe and a framing area instead of a body shop would halve the investment needed. Further, molded-in color could be used to reduce the need for a very expensive (and environmentally sensitive) paint shop. Companies around the globe are putting these ideas into practice, so this kind of cost-reduction has moved beyond the theoretical realm.

As the article points out, many of the cost-saving ideas, such as the use of spaceframes instead of conventional vehicle construction, are as feasible at the low volume levels at which EVs will start as the high-volume scenario painted here. One quote from Chuck Haddad, the late manager of advanced engineering at Ford's Design Staff, stands out in the article and has great relevance to EV design and manufacture:

> "We as a corporation keep protecting the past by stopping most ideas for the scantiest of reasons. The often-used excuse for shooting down an idea is that it has open issues. An idea is not new if it has no open issues."[61]

The article then goes on to use the under-$10,000 Citi car EV as an example of tradition-breaking thinking. The car, a plastic-bodied example on an extruded-aluminum spaceframe, embodies a very non-traditional approach to design and manufacture. It takes concepts of supplier involvement like those seen in the Viper and Prowler and applies them to a new type of vehicle starting at its conception.

Instead of starting with a current vehicle and trying to de-content it to a lower price point (or build essentially an electric-powered version of a gasoline-powered car or—worse yet—convert a current model to an EV, as much of the industry has done during the MOA period), *Automotive Industries* suggests literally going back to the drawing board with those capable of the most innovation—suppliers focused on creating new and more cost-effective components.

This approach bears much consideration when an EV is part of the equation. Many of these innovative cost-cutting programs are happening already; some are being institutionalized at corporations. The key is to make sure that the EV is a prime beneficiary of such programs, the best of the new thought. That will help this new vehicle to have the best chance in a market that might be reluctant to give it another chance if the first one is less than successful.

It is worth sharing here that the Ford TH!NK – the soon-to-be-introduced electric city car initially designed by PIVCO as a follow-on model to its Citi car – also incorporates much of the Citi's innovative features like spaceframe construction and a composite bodyshell with molded-in color. That Ford bought a majority interest in PIVCO with the intent to commercialize this electric car in Europe and North America is much more than interesting food for thought.

Ford Company Chairman Bill Ford has stated that its TH!NK program – which has now spun off into a completely separate business unit –that will focus on electric and advanced transportation—will support the development of new concepts in the use of plastic body components, as well as low-volume and flexible manufacturing. Thus, these technologies will ultimately apply as much to conventional vehicles as they do to EVs, and ultimately result in lower manufacturing and design costs for both.

That specific example seems to show the potential for EVs that are created from "out of the box" thinking. Kobe also feels that advancing of technology (from hybrid, fuel cell, computer and electronic work) will also positively and deeply impact EV development and lower costs in the near future.[62]

Cost-Cutting Programs—A Way of Business

The automotive world of today is quite different from the one of five years ago, much less the more traditional one of the era when the Saturn was first planned. When a groundbreaking study of the auto industry came out of MIT's International Motor Vehicle Program in the late 1980s,[63] it was clear that in general the Japanese

manufacturers had a distinct advantage in productivity, leading to better quality cars at lower prices. That in turn was translating into increased market share in the markets of North America and Europe.

The Japanese "secret weapon" in the auto wars was summarized in *The Machine That Changed the World* as "lean production," a process that focuses on "continually declining costs, zero defects, zero inventories, and endless product variety."[64] Even by the time of the study, that process under several different guises was working its way through the auto industry in varying degrees. Chrysler's acceptance of lean production was seen clearly in the Viper program and the standard it set for all product development that followed.

Of course, the litany of cost-cutting measures has even picked up in recent years as manufacturers have turned from boasting of extraordinary development cost figures (as GM did with the $5 billion Saturn project and Ford did with its $6 billion Mondeo/Contour/Mystique world car) to bragging of the breadth and depth of product that they have achieved for modest (by automotive standards) investments.

The watchword of the past decade has been reduction of development time and production costs, the keys to a more robust bottom line that in turn can be reinvested in more diverse future product reflecting ever-changing market demands. Typically, these cost-savings accrue to the corporate bottom line, not specific vehicle programs.

Further, the cost difficulties that the EV presents because it is a radically different type of automobile challenge this fundamental direction of the auto industry. Traditional approaches to automotive development applied to EVs have yielded exorbitantly high-cost, low-volume vehicles. EVs already have and will continue to benefit from the cost-sensitive environment in which the world auto industry currently works. Whether they will benefit more, or simply equally, is open to speculation. Clearly, since EVs represent some of the most recently developed automotive technology, they have the opportunity to most fully benefit from the latest advances in manufacturing processes. In that light, the example of the "$7,000 car" in the previous section bears close examination.

GM certainly bears out this thought in its reflection on the EV1 after three years of production.

> "We put together an entire vehicle assembly operation in the Lansing (Michigan) Craft Center in just eight months for $15 million. The learning of how to implement fast, low-cost production programs is now being applied to a number of other GM product programs," said Bob Purcell, executive director of GM's Advanced Technology Vehicles.[65]

The entire arsenal of cost-cutting weapons needs to be brought to EV projects, and new ones invented, to ensure that appropriate versions of these unique vehicles will be brought to market at consumer-friendly prices.

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Chapter
4

EV Development Cost Case Studies

Given the general development cost/price scenarios presented in Chapter 3, it is instructive to investigate cost and price estimates and market prices the Big Three and other sources used for ZEVs. These need to be analyzed as the industry does other cost/price proposals to see if they make sense from a profit (both for product line and corporation), competition and customer perspective.

General Motors

GM charged out of the EV gate at the Los Angeles Auto Show in January 1990 with the aptly named Impact, the hit of the show. With its purpose-built design, high-tech innards and sporty looks and performance, it appeared to be (and was) a literal glimpse into the future. Five years and many hundreds of millions of development and public relations dollars later, GM was the first major automaker to introduce a production EV on the market when the EV1 rolled into Saturn dealers in late 1996.

"GM says it has spent $350 million to develop the car (Impact), and has devised innovative methods to manufacture it."[66] So said Bob Purcell, then executive director of GM's electric vehicle operations. His direct charge from top GM executives was "to make a business" of the EV program.

The Impact has wowed the public and even skeptical journalists and politicians. But the car's success has become somewhat of an embarrassment to GM and other auto manufacturers who had claimed that EVs must be utilitarian, heavy and slow because of the battery technology involved.

In conventional R&D accounting terms, the $350 million referred to as development would normally be charged to corporate overhead until a vehicle program is authorized for production, much as the Viper's early work was done prior to program approval, but GM has used that number (and larger ones at times) when talking about its EV program investment.

The EV1 was joined in GM's EV market by an electric-powered version of its compact Chevy S-10 pickup. Much as the Viper was for Chrysler Corp., The EV1 was presented as a "halo" car for General Motors. The vehicle's extensive technological advances (dozens of patents and a breakthrough 0.19 coefficient of drag - Cd - making it one of the most aerodynamic vehicles ever to grace the road) coupled with zippy performance, garnered widespread praise in press previews.

Pricing on the EV1, like most EVs, was problematical. It did not carry a true window sticker listing a retail price because it was only available for lease. Initial lease prices were $477 a month for a 36-month closed-end lease plus another $55 for a leased charger plus $1000 to install the unit (in the Los Angeles basin where a variety of government incentives were available). Elsewhere (Arizona and San Diego), the monthly lease ran up to $640. After an initial flurry of interest, it was clear that a two-seat fixed roof car with a real-world driving range of about 60 miles and about 50 public recharging stations in the region did not have a wide appeal at those prices, even if it did represent the latest in transportation technology.

The lease option allowed GM (and other EV manufacturers) more latitude in adjusting the vehicle's marketing, which several took advantage of. In GM's case, the EV1 was assigned a residual value of $14,700 or 43.2 percent

of its MSRP, a number that might be typical of that company's vehicle values after three years, but certainly not reflective of aggressive lease values in the market. GM's EV1 lease rates fluctuated from that high of $640 down to a promotional $249 a month lease that included a free charger and installation.

During its first three years on the market, the EV1 also experienced what could only mildly be called "growing pains." Three different battery types were available—regular Delco lead-acid initially, then Panasonic advanced lead-acid or GM Ovonic nickel-metal-hydride (NiMH). GM widely advertised the vehicle and expanded its market availability (adding the Bay Area and Sacramento), but also had a complete and embarrassing recall of all of its first generation vehicles. Those EV1s are slated to have a wiring problem fixed and will probably be re-leased with upgraded batteries. While GM claims to have had a substantial surplus of vehicles available during its first three years on the market, consumers have reported difficulty in finding ones for lease. All told, GM leased more than 750 EV1s in California and added more than 225 S-10 EVs (with a mix of lead-acid and NiMH batteries) to the market. Based on an average monthly lease price of about $425, GM's EV program has generated more than $5,000,000 in revenue for the corporation, supplemented by incentive money provided by various government entities that goes directly to the corporation.

As has been mentioned, GM is preparing a Generation III powerplant for the EV1 and S-10, one that further brings down the cost of battery and EV motor components.

GM has publicly taken a long view on its EV program. Its chairman, Jack Smith, said it would take "less than 10 years for GM to see profits from EVs."[67] Those profits may be brought about from overseas markets, Smith noted, since European EV demand appears to be greater than in the U.S. The remarks also foreshadowed the kind of program illustrated by the Triax concept car shown last year (1999) at the Tokyo Auto Show. It was presented as a world car capable of production anywhere in the world featuring a variety of interchangeable drivetrains, including electric, hybrid and conventional gas/diesel engines.

As that vehicle was explained by Bob Purcell, executive director, GM Advanced Technology Vehicles:

> "The Triax is designed as a global vehicle with the ability to produce internal combustion, hybrid or electric vehicle models. It is what we call a multiple-propulsion platform. Building different propulsion technology models off a single platform will help with overall program costs, because you can package different propulsion systems without tearing up the whole car."
>
> So that makes it a more viable business proposition?
>
> "Yes. Many new-technology vehicle programs do not have sufficient sales volume to really make the business cases work. So if you design a vehicle for more than one propulsion technology, you have the chance to achieve higher sales volume on the combined requirements for all the different versions of the vehicle…This scenario addresses the fundamental business challenge of getting better leverage on our engineering and capital spending. While any one of the models may not be sufficient to pay back our investment, the combined volume of any of the three yields an acceptable financial return."[68]

Finally, in addition to direct revenue from vehicle leases, GM stands to profit from its supplier investments. As part owner of GM Ovonics, the lead developer of the NiMH battery, GM could do well should the next move in the industry be toward standardization of the battery pack with a single supplier (like Ovonics) as the source. Beyond that, the company also has a variety of patents ensuring additional revenue streams, including the inductive charging system used by the EV1, Chevy S-10 EV, Toyota's RAV4 EV and electric e-com, and Nissan's Altra EV and electric Hypermini.

Likewise, its affiliated (though now a separate entity) parts supplier, Delphi, is positioning itself as one of the primary sources for many EV components with manufacturers other than GM. Components like its electric power steering system are finding applications in current internal combustion engines, but also promise to be part of a new wave of components that will find further value in EVs, hybrids and fuel cell vehicles.[69]

Ford

Like GM, Ford promoted EVs prior to their market introduction with its Ecostar demonstration project and other showcase vehicles, many of which drew a very positive reaction from the press and public. But when the time to commit to ZEV production came, a different vehicle was proposed.

> "...Ford told fleet buyers from electric utilities it will put batteries in a Ford Ranger compact pickup in 1998.
>
> Price: about $30,000.[70]
>
> Range: about 50 miles."[71]

In 1996 and 1997, longtime Ford partner TDM Worldwide Conversions planned to sell an electric version of the Ranger, but those plans never materialized. TDM had hoped to have something special going for its version: a price 10 to 20 percent below the manufacturer-built version, which is consistent with general estimates of low-volume supplier assembly savings.[72] Ford's plans didn't go as originally envisioned and Ranger EV production has remained in-house at Ford. The small trucks have been marketed with lead-acid and NiMH batteries, providing better range than anticipated (50-72 mile and 70-93 mile ranges respectively).

Prices also proved flexible, ranging from a special promotion that lowered monthly payments to about $200 a month (and helped move enough pickups to meet Ford's MOA commitment) to higher ones of more than $1,200 per month (for an unsubsidized NiMH-battery version). As an aside, it is interesting to note that on the heels of its 1999 $7,000 educational incentive program for the Ranger EV in California and once it moved all the NiMH Ranger EVs it needed into the hands of lessees, Ford increased NiMH Ranger EV monthly lease terms to the higher rate. The lead-acid battery Ranger EV was then positioned at a monthly lease rate close to that of the previous NiMH variant.

Similar to the experience of the EV1, the Ranger's configuration limited its market appeal (a trait it shared with the S-10). Due to the heavy battery pack, the pickup's normal utility was compromised and its payload diminished substantially. Also due to weight limitations, the EV version was only offered in the regular cab version, far from the vehicle's most popular form. Some fleet customers found the configuration functional, but didn't agree with Ford's tradeoff of range for some of its added carrying capacity.

In spite of this, as of mid-2000, Ford claimed the Ranger is the best-selling EV in the U.S. with more than 1,000 sales nationwide (though specialty EV maker Global Electric Motorcars challenges the claim). This also was in spite of a parts shortage that caused production to be limited for some time. The parts shortage was indicative of what was admittedly a Tier 2 program, where a single supplier with no backup was unable to deliver as promised. Undoubtedly, the company would not tolerate such a problem in the normal Ranger program, which is a high-volume operation stocked by the company's top tier suppliers. Problems would be addressed swiftly and completely because of the potential revenue loss from a single part of a million-vehicle platform.

This seems to show that the EV program is not a project benefiting from the same type of cost-constraints and supplier input as the high-volume, narrow margin projects. Ford said additionally that it was experiencing a high component failure rate at final assembly, which of course increases costs at a critical juncture for a product already deemed too high cost by the manufacturer.

Ford is using the Ranger EV program as a jumping off point for a much broader EV initiative built on its TH!NK global EV brand. Already the company is running innovative TV commercials highlighting the TH!NK EV and trying to build up recognition for the brand. Additionally, Ford sited TH!NK's headquarters in California in recognition of this being ground zero of the EV market.

Ford has originally expected to sell 1,700 electric Rangers in the first two years and hoped to extend the program beyond that. Actual sales, complicated by production problems, were quite a bit less although still substantial.

With its high cost and price estimates, Ford does not project a profit for its version of the electric Ranger. Like other manufacturers, Ford blames the battery. "It is too expensive, has too short a life and must be recharged too often," said John R. Wallace, then electric vehicle planning and program office director and now director of the TH!NK Group at Ford. He estimated the battery cost alone in 1995 to be about $5,000 for the first generation lead-acid version.[73] But Ford officials also said the battery represented the only cost differential from their regular Rangers.

The real answer could lie in Ford's new environmental commitment, coming from chairman Bill Ford Jr. Back in 1990 when California's 1998 ZEV requirement was first passed, Ford was reported to have spent only $20 million on its EV development program since 1982. It now appears to be in full swing pursuing EVs as well as hybrids and fuel cell vehicles and aggressively developing an EV group encompassing cars, trucks, CEVs (community or city electric vehicles), NEVs (neighborhood electric vehicles) and bikes.

DaimlerChrysler

On one hand Chrysler (now DaimlerChrysler since its 1998 merger with Daimler-Benz) has been in the forefront of EV publicity, ranging from being the first major U.S. automaker to produce and sell a factory EV (the TEVan in the early 1990s) to promoting EV activities and the vehicles themselves. On the other hand, the company has been vocal in its discussion of the limitations of the current and near-future generation EVs. Chrysler also has been one company discussing the financial ramifications of California's ZEV program. At one point the company's then-CEO Bob Eaton said that his company was thinking of spreading the added cost of ZEVs to all cars sold in the state, possibly raising the cost of all California Chryslers by $2,000.

> "The next generation (electric-powered) minivans, slated to debut next year [1996], have been specifically designed with an electric powertrain option in mind. Why an EV variant instead of a ground-up effort? Chrysler sources say it would be inefficient to build a ground-up electric vehicle around battery technology it sees as inferior, and current consumer demands are considered too uncertain to warrant such a risk. According to the company, electric vans without batteries can be mass-produced for the same cost as gasoline ones. However, they point out that batteries are expected to add about $20,000 to the cost."[74]

Or so they said in 1994. That estimate was later revised downward to $4,500-$6,000 for the EPIC electric minivan's initial lead-acid batteries.[75] As with other manufacturers, Chrysler experienced a performance increase when it moved to advanced NiMH batteries. In total it has marketed about 110 minivans, mostly to the fleet market, incorporating innovations like fast-charging technology.

Chrysler weighed the two paths to bringing an EV to market —developing a ground-up vehicle (their "Destiny" project) or re-engineering an existing or future platform for electric propulsion —and then settled on the latter.[76] They chose the minivan platform since it represented the company's highest-volume model line and its strongest product in California. The platform also offers maximum versatility for accommodating future battery technology.

With an EV platform, Chrysler speculated a retail price tag in the $40,000 range, which is right about where the EPIC hit the market. Leases (available to fleet buyers only) of the NiMH model were approximately $450 a month. That approximates the lease price for a fully equipped top-of-the-line Chrysler Town & Country minivan, whereas a gasoline-powered Dodge Caravan configured like the EPIC would lease for slightly more than half that.

As it faced a mandate, a Chrysler spokesperson said, "you're probably going to have to price the vehicle substantially below its cost to get them to move."[77] That comment illustrates the market-driven direction that most automakers bring when trying to create a new market like EVs, which has not been fully realized with the EPIC.

Chrysler holds that EV cost-based pricing would make their vehicles price-competitive with internal combustion ones, except for battery costs.

But Chrysler's choice of the minivan, while it may have made sense from a product development and packaging standpoint, was flawed in ways similar to the Ford Ranger and Chevy S-10. While it appears to be one of the company's most endearing and popular vehicles, in reality the EV version is available only with a five-passenger seating capacity, by far the least popular of the minivan models. That detail alone could have been what directed DaimlerChrysler to target primarily fleet customers. Payload constraints also limited its use as a cargo carrier.

The merger of the German and American companies created another wild card in the DaimlerChrysler/ZEV equation. Daimler-Benz had an active EV planning program with its two smallest cars, the A-Class and Smart. Both cars, part of the fast-growing minicar segment in Europe, were designed to accommodate electric and fuel cell propulsion systems, though Mercedes-Benz has yet to offer such versions. Similar in concept to the GM Triax, different propulsion systems could be used and volume production maintained to amortize the additional cost of advanced technology powertrains. The company has used the car as the testbed for its fuel cell car, which features on-board hydrogen generation.

DaimlerChrysler recently (June-July 2000) reiterated its support for the A-Class by declaring it would launch a replacement version in 2004. Suppliers reported the company also was targeting 30 percent cost reductions for components for the next generation of vehicles.[78]

DaimlerChrysler's chairman, Juergen Schrempp, meanwhile committed his company to being the first automaker to launch fuel cell vehicles on the market. He said new city buses equipped with fuel cell drives would be delivered in 2002 and passenger cars would follow two years after that. During the next four years he said the company would invest around one billion dollars to develop this technology.

The positioning will allow DCX to take "the lead in the technology and one day when it becomes a volume business, DaimlerChrysler may be able to maintain a higher share in the market," according to one automotive analyst.[79]

Its growth into a large global company allows DCX (as is the case with the other major players, GM, Ford and Toyota) a variety of options to attack the ZEV mandate, from continuing refinement and production of its EPIC minivan to importation of A-Class EVs or fuel cell cars. Another available option is the development of new vehicles such as the ESX3 hybrid electric concept car that was the DaimlerChrysler show car for the joint Partnership for a New Generation Vehicle (PNGV) project. DCX's American spokespersons indicated that vehicle was part of a $7 billion worldwide R&D effort in 2000 to "address the challenges of being a global leader in the automobile industry (in environmental stewardship)."[80]

The series of ESX concept cars also represents a key element in the development and commercialization of new technology. While DaimlerChrysler has pointed through the years to its application of some of the technology developed during this series of "future" cars, the company also has been very vocal about the cost of producing the vehicles in volume. The first generation 1996 ESX was said to carry a $60,000 cost differential compared to an equivalent conventional vehicle; the 1998 ESX2 had a $15,000 cost differential and the 2000 ESX3 was down to $7,500.[81] What is clear from those examples is that the affordability of such advanced technology is coming in the near future, so long as incentives exist to prompt the company's continued investment in such efforts.

Honda

Honda entered the EV market with what it termed an "all-out effort and achievement by Honda's best talent." Its EV Plus car was built technologically on the company's EV experience going back to 1988; it featured a two-door, four-passenger compact (a unique design) that shared a family resemblance with Honda's Civic compact. Honda used advanced NiMH batteries to attain 100+ mile real world ranges.

Honda, along with GM and Ford, marketed its EVs in limited but high-profile ways to consumers, following what it described as a "typical" broad, general public launch with vehicles eventually available at eight dealerships in the state. Lease price for the vehicle was "comparable to a $25,000 Accord V6"[82] Honda said. But the actual monthly payment was $455 since it included insurance coverage, roadside assistance and all maintenance. This was not a typical lease arrangement, but one Honda preferred in order to provide "comprehensive support" for the vehicle.

Honda used extensive PR efforts, cooperative promotions, advertising, and direct mail to promote the vehicle, but was disappointed at the public response. It also put up a few unexpected roadblocks for potential EV Plus purchasers, such as requiring applications that were sent to corporate headquarters for "screening" and then required a six-week wait for a response. Only eight Honda retailers carried the EV Plus, which also limited the vehicle's reach. Only 122 consumer leases were completed in the first two years of the program. In total (including fleet leases), Honda put less than 300 EV Plus models in the market to fulfill its MOA obligation. At that point it announced it would build no more vehicles, even though it acknowledged there was ongoing consumer and fleet interest. In fact, it fulfilled its MOA agreement in only about two years, well before the time required by the state.

From market research with the general public, its dealers and EV Plus owners, Honda concluded that for an EV to successfully break through to a larger market it would need to have approximately twice the range of the EV Plus, half the cost, and faster recharging, as well as a larger public recharging infrastructure.

The Insight Experience

Almost simultaneous with the end of its EV Plus marketing, Honda launched it gas-electric hybrid, the Insight, in the U.S. The sales target for the two-seat, manual-transmission-only Insight (an EV1-like configuration) is low, only 4,000 units (since raised to 6,500).

The most significant aspect of the car is its market price. Honda put the Insight on the market at about $20,000 (for sale as well as lease), a price it admitted was below the vehicle's cost. Published reports estimate Honda is losing $8,000 on each Insight it sells, though dealers are doing well since they have been able to mark up the vehicles above the sticker price because of strong demand.[83] That's for a vehicle whose price is about $3,000 more than the slightly larger Civic model. They're able to accomplish that by positioning the Insight within Honda's established image of fuel-efficient, reliable cars while emphasizing this model's high tech features.

The company's willingness to meet the higher demand, even though that obviously meant further losses, indicates the commitment to the project (in contrast to its actions with the EV Plus). The Insight is being marketed nationwide as a low-emissions, high-technology, high fuel economy (70 mpg) vehicle. It also is an important marketing tool for Honda because it paves the way for a Civic hybrid that Honda has just put on sale in Japan. It is assumed that vehicle, which used the Insight hybrid powertrain but not its aluminum exterior or some other expensive features, will end up in the U.S. soon. When it does, Honda will have transposed this expensive and complex technology to a high-volume platform and probably erased all profit concern.

The move also demonstrates a corporate strategy of building an image with a low-volume, purpose-built vehicle and then expanding it to a mass audience by integrating its technology into a major platform. The electric component in the Insight is a small NiMH battery, so this hybrid model, along with others that will follow from Honda and its competitors, also may have a role in commercializing that battery technology by driving a higher production than might be achieved solely with EVs.

On interesting sidelight of Honda's environmental positioning of the Insight is that, even excluding the discontinued EV Plus, the car is not the company's lowest emissions vehicle. In California the Insight will be a ULEV (ultra low emission vehicle) though in much of the country it will only be an LEV (low emission vehicle), while Honda has an gasoline-only Accord that qualifies as a California SULEV (super ultra low emission vehicle).

Toyota

Toyota followed Honda's pattern in its EV marketing, bringing to market a single model (in this case an EV version of Toyota's popular small sport utility, the RAV4) with an advanced NiMH battery. But instead of targeting both consumers and fleets, as was the case with Honda, GM and Ford (to a limited extent), Toyota chose to limit its sales to fleets. This strategy allowed the company to limit expenditures on marketing and focus on EV-oriented higher volume locations.

Toyota leased 486 RAV4-EVs in California (1997-2000) and almost 200 additionally nationwide, primarily in electric utility and government fleets. The four-door, five-passenger vehicle (along with the Nissan Altra, the only EV of that configuration on the market) has a 125-mile range, $42,000 MSRP and $457 per month lease rate. Toyota was able to fulfill its MOA requirement rather quickly by targeting fleets, but continued to assert that the consumer market for an EV like the RAV4-EV did not exist at this price point and vehicle performance level. Toyota continues to lease about 125 to 150 RAVs per year to utility and other fleets, but there is a long waiting list and demand is much greater than supply.

While downplaying the RAV4-EV potential, Toyota is actively pursuing other automotive environmental initiatives, including a demonstration project with its e-com city EV in Southern California. These moves are consistent with Toyota president Fujio Cho's stated goal to make Toyota "Number 1 in the world as a company conscious of the environment."[84]

Prius—the First Hybrid on the Market

Toyota was the first company to introduce a mass-produced gas-electric hybrid, the Prius, in Japan. That vehicle, a four-door, five-passenger compact, has sold well, accumulating 37,000 in sales since its December 1997 introduction. The U.S. version, which Toyota is positioning as a second generation vehicle because of NiMH battery and engine advances, goes on the market this summer (2000) priced slightly less than competition, the two-seat Honda Insight. Like Honda, Toyota sold the Prius at a loss (estimated by Japanese media at up to $20,000 per vehicle, though Toyota officially would only say it was "not that high"[85]), yet increased production to meet market demand. It hopes to sell 12,000 Prius units in the U.S. during the first year and expects the vehicle to qualify as a super ultra low-emission vehicle (SULEV) under California's regulations, the closest category to zero emissions vehicles.

Prius' U.S. marketing seems to be specifically aimed at promoting the vehicle as the antithesis of an EV, prominently citing attributes like "powered by a battery that never needs to be recharged" and "an advanced electric motor that never needs to be plugged in." Unfortunately, the company also has been presenting the Prius as "Toyota's breakthrough alternative fuel vehicle," which of course it is not. In contrast to meager amounts spent on its EV advertising, Toyota committed to a $15 million multimedia advertising launch for the Prius, meaning at its stated goal of 12,000 vehicles, the company will be spending $1,250 per vehicle just for its advertising component.[86]

On another front, Toyota has signed an agreement with General Motors to cooperatively develop future technologies like fuel cells, a key industry move toward reducing R&D costs while speeding commercialization of new technology.

Since Toyota focused its RAV4-EV marketing on key fleets, where well-understood incentive programs that lowered the vehicles' cost could mitigate price sensitivity, it did not truly test the market potential for the vehicle. The Prius is a better example of consumer-oriented vehicle packaging and pricing backed by a full marketing campaign designed to generate market interest in a technologically advanced and environmentally friendly vehicle.

Nissan

Nissan fulfilled its MOA commitment with a Japanese-market vehicle, the Altra, a four-passenger, four-door high-cube wagon styled in the vein of a minivan. The Altra was offered via a $599 direct lease, by-passing the dealer body to allow the company to more closely monitor the vehicles in operation. It was also available in only a very limited way to select fleets and Nissan's own U.S. employee/internal fleet.

One key differentiator between the Altra and other EVs was its battery—an advanced Lithium Ion (LiIon) type that delivered a 100-plus mile range. Nissan was slowly expanding its California fleet when it decided to change battery suppliers, reducing the number of vehicles deployed by the start of 2000 to just over 80. It planned to continue marketing Altras with the new LiIon batteries through the end of 2001 to meet its MOA commitment. In addition, it has started to bring in its Hypermini small EV for test marketing.

Nissan is struggling with the Altra for several reasons. The vehicle is a body type (small minivan or high-cube wagon) not imported to the U.S. because the company's market research has consistently shown a lack of interest here. Thus, it starts with a vehicle that has no identifiable market here. On top of that it has one of the highest cost, most advanced batteries available, which was introduced with many unknowns about its performance. In operation, it has proved to be quite reliable, but its production potential remains a question.

Developments at Nissan during the past year have overshadowed EV, alternative fuel and even normal marketing efforts. The French carmaker Renault took a controlling interest in the company and has instituted dramatic reforms aimed at restoring the company to profitability. While Renault has some experience with EVs and advanced technology vehicles in France, Nissan COO Carlos Ghosn has indicated his company would seek an additional partner to develop fuel cell vehicles. But all advanced technology work seems to be taking a back seat to traditional product development and cost-cutting measures aimed at setting the company on a solid financial footing, though they have a continuing commitment to advancing environmental technology.

> "As for hybrid vehicles, the market is asking for more. We have already sold Tino hybrids. The problem is that we lose money (on them). But we need to continue to get feedback from the customers" by introducing hybrids, said Ghosn recently.[87]

One of the "traditional" products could have some impact in California. For 2000, Nissan introduced a model of its Sentra compact, the CA, that goes beyond the strict SULEV standards, even though running on gasoline. It is classified as a PZEV (partial zero emissions vehicle) since it has no evaporative emissions and its system is guaranteed for 150,000 miles. The Sentra CA will qualify for partial credit against the ZEV production requirements.

Other Automakers

Other manufacturers—including Mazda, Peugeot, Daewoo and Hyundai—all have EVs in either prototype, near-production or in production. The most significant is PSA Peugeot Citroen, which has produced 5,000 EVs in one plant since 1995.[88] It also produces them in a second plant in Spain on the same assembly line as its regular models. PSA Peugeot Citroen makes electric variants of the Citroen AX and Saxo models and the Peugeot 106 in three- and five-door passenger car and commercial models. The Spanish plant produces the Peugeot Partner and Citroen Berlingo commercial vehicles.

Most of these vehicles are sold to business and government fleets in France, where the government has set a goal of having 5 percent of all cars on the road electric, and 10 percent of government fleets. Government support to that end includes subsidies for vehicle purchase that brings EV prices to parity with petroleum-powered counterparts.

Those French EVs were at one point in the mid-1990s considered for potential importation to the U.S. either by an American company or directly –(with a target price of $11,000), but the discussions did not develop into a viable plan.[89]

Hyundai, now allied with DaimlerChrysler internationally, has a compact-based EV with a top speed of 87 mph, a range of 242 miles to full discharge and 0-60 mph acceleration of less than 15 seconds. The NiMH-battery powered vehicle features similar performance characteristics to Hyundai's gas-powered vehicles. The Korean company has said the vehicle was "manufacturable" with lower overall weight and more efficiencies in its drivetrain.[90]

India's REVA EV is about to be introduced on the market with a price of $4,120 U.S. With technology developed at Monrovia, Calif.-based Amerigon in the early- to mid-1990s, the car is notable in that it weighs 1,600 pounds, is only 6½ feet long and uses lead-acid batteries to produce a 50-mile range. The body features color-impregnated ABS plastic body panels that bolt to the chassis. Target production is 1,500 units the first year with that total doubling during the second year.[91] The car puts into practice many of the ideas promoted in the "$7,000 Car" story in *Automotive Industries* magazine and demonstrates how an EV can benefit from them.

Smaller manufacturers like Solectria, based in Massachusetts, and Unique Mobility of Colorado appear to be evolving from their prior vision as small-scale manufacturers to become component and technology suppliers. Solectria is one of Ford's TH!NK subcontractors and Unique Mobility has many supplier relationships around the world for its various technologies. As major manufacturers take a more active role and the EV market expands in volume it is likely that these smaller companies may either find a permanent supplier role or even be absorbed as that part of the automotive world consolidates. As was mentioned earlier, another supplier, TDM, is actively involved in TH!NK vehicle assembly for Ford. Other manufacturers, like Global Electric Motorcars, build specialized vehicles like neighborhood electric vehicles (Global claims a total production of more than 5,000 units). Many others have very successful businesses in the subsectors of the electric vehicle business producing components and or providing services.

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Chapter 5

Hypothetical EV Pricing Scenarios

Summary of Section

This section is intended to present another form of "case history" like those in Chapter 3 ("Development Cost Case Studies"), in this case looking at realistic, but hypothetical electric vehicles being brought to market by a major auto manufacturer. It presents basic assumptions on the potential marketplace, its size and growth, EV costs, vehicle lifecycles and manufacturing variables.

Three basic textbook marketing pricing plans are presented (taken from the discussion in Chapter 1, "General Pricing/Costing Issues"), one following cost-oriented pricing, one competition-oriented pricing and the final using customer-oriented pricing. The methodology used here follows that used by many auto companies as they attempt to price vehicles into a market. In addition, three models are presented to demonstrate different market scenarios.

The primary focus here is on the first five years of the California section of the EV market under the production requirements (2003-2008). The rationale for that narrow focus is to keep the modeling as realistic as possible. Because of the new infrastructure being built, both from a charging and manufacturer service standpoint, the most likely scenario for the introduction of EVs is that they will be rolled out regionally, in much the same way many import vehicles have been brought into the country. This scenario could be altered by regulations in other states and will be influenced by sales patterns during the past four years. The California market is large enough (more than 10 percent of the total U.S. market) and is considered a bellwether market for automobiles, so it is not a minimization of the EV launch.

The final subsection takes a longer view, looking at the next generation of electric vehicles (2008-2013) and providing a glimpse at how the market may progress as it matures beyond the initial stages.

Basic Assumptions

Some basic assumptions need to be made in drawing up this hypothetical EV scenario. The first, a major one that is central to this whole study, is that a market exists. This is not a simple assumption, since it is contrary to the arguments of some automakers who allege that the "market" is essentially an invention of the government of California and a few environmental advocates. On the other side of this argument is the consistently positive reaction of the public to EVs such as the EV1.

In addition, our recent market research, reported in our study, "The Current and Future Market for Electric Vehicles," demonstrates a strong EV market even given the limitations of current EV technology.[92] That study found that 12 to 18 percent of current new car buyers would like to buy an EV. That translates, in a California market of 1.5 million light-duty vehicles, into approximately 151,000 to 226,000 annual sales. In addition to the consumer market, that study found a fleet market that could absorb 12,000 to 24,000 vehicles annually.

California Is a Start

California is chosen as the target market for a number of reasons. While looking at a national or international market would obviously help build a case for a larger market with higher production numbers, it is not a realistic view of the early EV market.

Unlike their gasoline-powered counterparts, which have the benefit of an infrastructure finely tuned through almost a century of development and billions of dollar s of investment, EVs will need to have a system of recharging stations (and possibly the development of standardized recharging) in order for them to offer the convenience and security consumers have come to expect as part of the automotive experience.

This infrastructure system will need automaker investment and support. One starting place would be a standardized charging system for all EVs rather than the current VHS-Beta system that divides EV users into two separate camps. All this will take time.

California is the logical starting point for the EV market for obvious reasons. The state declared itself the beachhead for electric vehicles when it set up the ZEV requirement for 1998 back in 1990. Even with the pushback of the initiation of the ZEV requirement, California remains the home to the EV. Government, both state and local, support for EVs is very high in the state. California is also a large market, one able to incorporate an EV segment both because of its overall size and the inclination of its car buyers. Infrastructure development is also further along in California than elsewhere in the country, primarily because of the ZEV requirement.

Fleet and Consumer Markets

The market research referenced above also surveyed the fleet market and found it had the potential to absorb 12,000 to 24,000 new EVs annually by 2003. The fleet market is driven by the combined forces of government regulation mandating conversion of government fleets to alternative fuel vehicles and economic and environmental forces that find EVs a better fleet vehicle solution.

The fleet market is more price-sensitive than the larger consumer market. Fleet managers surveyed indicated a lower purchase/lease price for EVs was the most significant change they would seek in electric vehicles.

In the consumer market, the research showed a strong willingness among EV intenders to pay a premium for the vehicle. Almost 70 percent said they would pay a premium, while the remainder indicated they expected to pay the same or less than for a comparable gasoline vehicle.[93]

Variety of Vehicles Key

A second key assumption is that there will be a variety of vehicles available. It is critical that a variety of competing vehicles be on the market in order to stimulate interest and discussion of EVs. That variety also should make the pricing scenarios more likely. The removal of the CARB mandate, even with the memoranda of understanding with automakers, appears to have undermined this somewhat. While the six automakers presented a variety of vehicles—from two-seat sports cars to compact pickup trucks to minivans—those vehicles did not reach the public. And, except for the Honda EV Plus, they did not appear to be the most consumer-oriented configuration.

Again, the Green Car Institute/Dohring research showed clearly that the EV buyer, like his/her counterpart searching for a new gasoline vehicle, overwhelmingly favors four- and five-passenger sedans. In the marketplace, these are represented by the four-door Honda Accord, Toyota Camry and Ford Taurus models that perennially top the best-selling car list. The GCI/Dohring research found that 51.9 percent of the EV buyers and 43.9 percent overall (those choosing gas and electric vehicles for their next purchase) opted for that configuration of vehicle.[94]

Typical Production Costs

A third key assumption is that EV production costs will follow typical auto industry trends. Based on information presented in other portions of this study, we feel it is reasonable to assume that volume production of EVs will allow projections that follow typical industry patterns. These assumptions are critical to the amortization figures that make the critical business case for EVs.

Overall Cost Projections

Given these assumptions, we can now project an overall pricing model for a hypothetical EV to be introduced in the 2003 model year. That EV will be built in a dedicated plant with a capacity of 10,000 vehicles per year (as GM is doing with the EV1), on a production line alongside ICE vehicles (as the GM Triax and DaimlerChrysler A-class/Smart cars are designed to do) or at a supplier/upfitter facility (as Ford is doing with its TH!NK EVs). Our assumption is that the EV plant is either a greenfield (brand-new) plant or a plant covered by an agreement that allows flexibility in handling the often high costs of employee entitlements like pensions for retired workers and such. Both scenarios could result in incremental corporate profit through better capacity utilization of existing facilities, offsetting some of the program's capital tooling costs.

Development costs for this vehicle, with plant and tooling, are projected to be in the $75 to $100 million range, comparable to Chrysler's Prowler program. This cost estimate is substantially below GM's publicly reported investment in the EV1 and S-10 EV program and some other early OEM reports. But it reflects some of the more recent thinking that doesn't isolate an EV program from other vehicle and facility development programs, but integrates them and thus spreads some of what would be incremental costs throughout.

The model is expected to run for five years with a sales goal of being 4 percent of the company's California sales in 2003, followed by increases in the following years, but with the goal of being 10 percent of the company's California sales by the end of the product cycle. Additional product could be sold in other states to increase overall production volume.

State of the Market

The California Air Resources Board (CARB) changed its plan that would have required the seven largest automakers to produce 2 percent of their California vehicles as zero emission vehicles (ZEVs) in the 1998 model year; it entered into a Memoranda of Agreement (MOA) with the auto companies to promote advanced battery technology. The result of the MOA during 1996-2000 is that more than 2,300 EVs have been put on the roads in California (and more than 1,000 elsewhere in the U.S.), most with nickel-metal-hydride (NiMH) or advanced lead-acid batteries. This has not been a true market test since most of the vehicles have been targeted to the fleet market.

Pricing of EVs during the MOA on the whole was not competitive as the automakers simply tried to place the minimum vehicles required to fulfill their commitment. In fact, in spite of the different configurations of the vehicles, most of the EV lease prices during the MOA were virtually identical, hovering around the $450 per month figure.

Therefore, it is logical to look at various pricing strategies and their likely effect on the potential market for EVs. In this study we will project three different pricing scenarios based on different marketing strategies, following patterns laid out in Chapter 1.

Costs and Volume

A peek behind the curtain of both the automotive development process and specifically GM's electric car program was published in September 1996. That book, *The Car That Could* by Michael Shnayerson, forms the basis for many of the assumptions of this section. His detailed look at GM shows that the company prepared for EV1 production based on a variety of business plans during the early Nineties, including several that showed the vehicle not making a profit during its four-year life cycle.

As one GM top executive is quoted as saying to the EV1 program manager:

> "From day one we haven't expected Impact (GM's internal name for the EV1 project) to be profitable. What we wanted was to establish a preemptive place in the market."[95]

In *The Car That Could*, the piece (parts) cost of the EV1 was estimated to about $16,000,[96] not bad for a purpose-built design incorporating a high degree of specialized material. Tooling and investment costs added significantly to the program costs, even though it was one of GM's most efficient vehicle development programs.

"The Real Cost of Electric Vehicles"

Independent studies of EV costs have come up with other likely cost and pricing scenarios. One study, "The Real Cost of Electric Vehicles" by Shawn Boike and Bruce Severance,[97] researched EV costs in great detail and projected prices at various production volumes with variables for different EV powertrains/batteries and different production materials. In that study the authors, who have extensive automotive engineering backgrounds, researched detailed costs for EV components compared to internal combustion engine (ICE) components.

The Boike-Severance study viewed EV production at four volume levels—5,000, 10,000, 20,000 and 100,000 units per year—and using three different basic vehicle platform materials—stamped steel, formed aluminum and RTM (resin transfer molded) composite. All three have been used by the auto industry, although the latter two have had limited high-volume applications. The study's point is a key one for the emerging EV industry. Since it is using groundbreaking technology in its powertrain (and throughout the vehicle), it presents a great opportunity to also reach for new technologies in manufacturing process and content. Therein lies the potential for even greater cost savings than can be estimated using traditional analyses.

Here are some of the conclusions of the Boike-Severance study, whose cost projections do not include entitlements or profit, since they vary from manufacturer to manufacturer. As part of this study, we will factor in profit using several different marketing scenarios.

At 5,000 units per year, the Boike-Severance study found EV costs (exclusive of profit and entitlements) range from $25,000 to $30,000 per vehicle. As the volume rises to 10,000, the costs drop to a range of $17,500 to $22,000. At 20,000 units per year, those costs drop further to a range of $13,000 to $16,000. At mass production volumes of 100,000 units, costs come down further to a range of $11,000 to $12,500. These costs include amortization of tooling and component costs over a three-year period, which is very conservative given the anticipated low volume in the early years of production. That low volume will likely encourage manufacturers to extend the lifetime of EV tooling to lifecycles similar to current sport utilities or minivans (six to eight years) compared to current car lifecycles of four or five years. It also anticipates something the Boike-Severance report assumes, that the EV-specific component design, particularly the battery area, will be designed in a modular fashion to accommodate changes and advances that will occur in batteries during the coming years.

Cost Estimates (Air Resources Board)

The staff of the California Air Resources Board has done extensive research and analysis of the costs of various EV components, including batteries, and came to the following conclusions on the likely incremental cost of EVs in 2003.

Staff estimated that the incremental costs range from $7,500 for CEVs (city or community EVs with relatively short range but capable of all but freeway driving) to more than $20,000 for a freeway-capable EV with advanced NiMH batteries. Most of the cost differential is in the battery pack. These estimates are the cost to produce the vehicles, based on manufacturer input and independent studies. In volumes of more than 100,000 vehicles (a typical volume for a mass-market platform at a major automaker), CARB staff felt battery EVs could become cost-competitive with conventional vehicles on a lifecycle cost basis.[98]

The EVs fielded by automakers during the MOA period generally reflected 150 to 250 percent price differentials compared to similar gasoline vehicles. Those price differentials heavily reflect the low volume and resulting high component cost inherent with this stage of EV development. While automakers probably didn't set pricing at a profit-making level, they do appear to be attempting full recovery of costs in their EVs. They also are consistent with studies by the federal government (which had heavy automaker input) and a California university analysis of expected cost differentials.[99]

Lifecycle Planning

Anticipating the lifecycle of an EV is perilous because it is clear from the MOA period that it is a volatile thing—witness GM's complete recall of its first generation EVs. As we move beyond the MOA period where sales volumes are carefully prescribed and markets are carefully targeted, automakers can be expected to become more competitive, especially in pricing.

Another factor that may affect pricing is the likelihood that manufacturers other than the so-called Big Six (DaimlerChrysler, Ford, General Motors, Honda, Nissan and Toyota) will be bringing ZEVs or other low-emission vehicles to the market. In addition, various automakers have already announced they will be introducing new technology vehicles, hybrids and fuel cell-powered vehicles, within the next few model years. On one hand, this should raise the consumer level of awareness of emissions technology (much as the 'airbag race' of the early Nineties raised awareness about safety issues), but it also will force manufacturers to highlight the advantages of the technology they have chosen to present.

Beyond California and other markets in the U.S., automakers also need to view the potential overseas markets as another outlet for their EVs. That may rationalize higher production volumes or may lead to locating production at an overseas plant in order to take advantage of lower production costs and a secondary market (and possibly incentives from the local government).

Automakers have chosen a combination of purpose-built EVs (GM with the EV1 and Honda with the EV Plus) and current production vehicles adapted for EV use (everyone else). For those adapted vehicles, that makes the EV part of the product cycle of that vehicle, in many ways dependent on the vehicle's plan for changes.

For example, GM and Ford's small pickups were redesigned several years ago, but the pickups tend to be on the longest of automotive cycles—going 8 to 10 years before a major revision. The Ranger and S-10 pickups will probably not see substantial changes until well into this decade. That gives the manufacturer a stable platform on which to do EV development work, but could hamper marketing efforts if the same-styled vehicle is left on the market for that length of time. Also, if the vehicle's exterior appearance does not change while internal components (such as batteries and EV controllers) are updated, it makes marketing a more difficult task.

Chrysler chose its versatile minivan as its EV platform of choice. That vehicle, too, was redesigned in 1996 with an EV version in mind for 1998. The platform has been redone for the 2001 model year, which should mean a chance for further EV integration.

Discussion of the model lifecycle is important in a discussion of EV pricing and marketing because it can have such a major impact on pricing. As seen in the Boike-Severance study, a three-year amortization of EV manufacturing components yields prices significantly higher (by a factor of about one-third) than comparable, though higher-volume ICE cars. It is likely that EVs will need to have a long model cycle, with modular construction allowing them to adapt to changes in battery technology, in order to bring those costs down to ICE levels, even at lower volumes. The emphasis and R&D dollars in EVs is likely to be spent on internal developments in the early years, which is why most manufacturers are looking to mitigate their costs by using existing vehicle platforms. Even GM is taking that into consideration, since the EV S-10 pickup uses virtually the same drivetrain and many components from the EV1.

What the GM exercise with the EV1 has shown is that a purpose-built vehicle attracts more attention than a converted one. They even noted that in their press conference announcing the EV1, saying the S-10 EV was kind of lost with all of the attention going to the EV1, an admittedly showy and stylish car. Sales of the consumer-oriented EV1 were more than triple that of the fleet-only S-10 during the MOA.

That points out one of the truths of marketing, which needs to be factored into the following numbers. People buy vehicles for a variety of reasons, not the least of which is how they look. The packaging is going to be as important in an EV as it is in an ICE. Functionality will sell vehicles. Environmental concerns will sell vehicles. But a functional, environmentally sound vehicle in a stylish, unique package will always sell the most—if, and it is a big if, it is properly marketed. Which brings us to the pricing models.

Honda has previewed another marketing approach with its hybrid gas-electric technology (one, incidentally, they have not followed with EV technology since they dropped production of the EV Plus in 1999). That approach is one of aggressive market penetration with new technology and then migration to a high-volume platform. The Honda Insight was introduced in the U.S. market ahead of its rival, the Toyota Prius, with similar pricing (well below manufacturer cost). Although initial marketing volume targets were low for the high-tech, purpose-built vehicle, it exceeded Honda's expectations and the company has increased production. The vehicle remains popular at the retail level, commanding prices beyond the manufacturer suggested retail price.

Honda's next move was to announce that the hybrid technology, which they label IMA (integrated motor assist) would appear in the 2001 Civic, one of the company's two high-volume core product lines. Although only announced for the Japanese market, the 2001 Civic is a car that will be marketed throughout the world and it is assumed the hybrid Civic would appear in the U.S. market soon. The volume increase will make the Civic hybrid a profitable vehicle, according to Honda officials,

Market Size/Sales Cycles

At the crux of much of the debate over EV costs and prices is the issue of the market. Both sides agree that a mass-produced vehicle would be cheaper at the retail level than current limited production models. Both sides do not agree on what price points might be achieved through early volume production. Further, the impacts of market developments such as Honda's quick move to high volumes with its hybrid models have not been fully assessed. The growth of the hybrid market (and the fuel cell market, which appears to be only a few years further out) will drive volume of EV components and batteries quicker than had been anticipated in a pure EV market. Other developments, such as the imminent move to a 42-volt electrical system and a resulting increase in electric component volumes, also have yet to be measured.

Further, the automotive market is not always amenable to easy prediction. The growth of the minivan market in the Eighties and the growth of the sport utility vehicle market in the Nineties were neither anticipated nor fully accepted by all automotive experts or even some automakers until they were established facts.

Early projections (1990) saw a sizable commercial fleet market for EVs, in the neighborhood of 100,000 vehicles a year nationwide, based largely on use and refueling patterns found in the marketplace. More recent surveys indicate that the fleet market may be a little more difficult to boost to that level, but that consumers are ready and willing to buy EVs in those numbers.

The GCI/Dohring study showed a consumer market that understood the limitations of current EV technology and was willing in large part to pay a premium for it. That market, in California alone, was estimated to be between 150,000 and 225,000 annually.[100] The fleet market currently is smaller, approximately 12,000 to 24,000 EVs a year, but could increase as the vehicles' capabilities increase and prices drop.[101]

Niche Markets

Other experts agree with Alan Cocconi, designer of the GM Impact prototype's powertrain, that electric vehicles may only fill niche markets in the early years.

"They aren't all of a sudden going to supplant decades of fantastic gasoline technology," said Roland Risser, then director of new energy markets at Pacific Gas & Electric Company.[102]

But the niches EVs can fill are diverse and, collectively, potentially quite large. They include: fleets meeting mandated low- or zero-emission regulations; commuters; early adopters; techies; environmentalists; retirements communities such as Palm Springs, Phoenix and Southern Florida; limited use vehicles for urban areas; and others that may not even be perceived at present.

As DaimlerChrysler with its PT Cruiser and other companies have shown, niche vehicles can be a very positive part of a company's overall market plan. One of Ford's top product development executives, Richard Parry-Jones, said his company is working on a strategy that will allow it to produce more niche vehicles, a volume level he defined as 50,000 units a year worldwide. "We see the market continuing to fragment," he said.[103]

Another variation on this is the Volkswagen platform approach where very distinct vehicles are created off of essentially the same basic chassis. This approach obviously amortizes R&D costs and also simplifies and reduces manufacturing costs because plant configurations are more interchangeable.

Older auto industry studies predict a very low level of EV adoption (around 3,500 per year for both retail and fleet use).[104] But further analysis usually finds those studies predicated on EVs proposed at high prices and with other negatives emphasized. It is instructive to note that according to Shnayerson's book, GM did not have a firm estimate of the potential market for its EV.[105] Similarly, Honda has publicly said it relied on dealer estimates of "hundreds" of sales per retail outlet when doing its initial market planning.

Our GCI/Dohring study tested the consumer market potential and found, by conservative estimate, 12 to 18 percent of buyers desiring to purchase an EV.[106]

Wild Cards

Another wild car factor for the market size is the effect of external market incentives such as federal, state and local utility initiatives, such as current ones jointly funded by the California Energy Commission and regional air quality management districts.[107]

It is fair to assume that EVs will be subject to some government support programs, which at a minimum will raise awareness of the capabilities and functionality of the vehicles. Such programs would mesh well with expected automaker marketing and help capitalize on the market demand that research shows exists.

Competitive pressures may shorten cycles and skew many of these numbers. That is the nature of the free marketplace.

Different Growth Patterns

To try to predict the growth pattern of the EV market, the price point becomes critical. With a relatively high-price vehicle, the pattern will likely follow that of the introduction of Toyota's Lexus luxury division or Nissan's Infiniti division in the U.S. These brand new vehicles and divisions needed to establish new retail outlets and position themselves within the marketplace both corporately and by product.

Both divisions followed similar patterns, beginning with a two-vehicle portfolio and adding models during the five-year period reviewed. They also both built up sales volume during the first four years, fairly steadily as the product's reputation spread.

This could be contrasted with volume growth for a mass-market model such as Saturn, which during the same period grew year after year from a very small start to almost 300,000 units per year. Some envision the EV attaining this kind of market status. While it is possible, it is not the most plausible given the state of the technology, projected volumes and prices.

Using the Lexus/Infiniti scenario puts the EV in a slow-growth mode during its first five years, which is a reasonable assumption as new technologies are introduced and the market grapples with such infrastructure issues as whether conductive or inductive charging will be used. In one of our examples, however, we will use a growth pattern somewhat like that of Saturn, fueled by a pricing strategy designed to drive maximum sales.

The Lexus/Infiniti sales model is a reasonable market scenario for our hypothetical EV. First year sales will represent about 15 percent of total, second year about 17.5 percent, third 22 percent, fourth 24 percent and fifth, finally, 21.5 percent as the model ages. This allows for the usual market "fixes," styling freshening at some point during this cycle, and product content upgrades as they become available. Those were the case with Lexus and Infiniti, which is why, even with the differences, we feel they provide some good numbers from which to work.

It is reasonable to assume that a single EV product strategy will not hold up when automakers are required to market 4 percent of their California product as ZEV. But, as the CARB staff report points out in detail, automakers have many avenues to attack this challenge. Note that GM started with a two-vehicle strategy (the EV1 and S-10 EV pickup), Ford's TH!NK Group embraces a broad EV product line, and Toyota and Nissan are introducing additional models.[108]

Price/Demand Curve

We have used the accepted marketing principle of a demand curve that is reflective of pricing. For comparison, we can look at several examples of California vehicle markets that reflect the price/demand curve—and a couple that defy the normal pattern and may bode well for EV marketing in the state.

Compare, for example, Nissan's three sedans—Sentra, Altima and Maxima. Their sales pattern follows their pricing in inverse, as one would expect, with the low-priced Sentra outselling the mid-priced Altima, which in turn outsells the higher-priced Maxima. Nissan sells almost 8 percent more Altimas than Maximas and in turn sells almost 6 percent more Sentras than Altimas. On the other hand, in a higher priced segment, Mercedes-Benz sells less of its entry-level ($413,000 and up) C-Class cars than it does of the mid-level ($47,000 and up) E-Class cars.

In some more popular models, the price/volume relationship does not hold up. In California, the sporty Ford Mustang coupe outsells the lower-priced Contour sedan. In sheer volume, the $25,000 and up BMW 3-series outsells the entry-level $12,000 and up Dodge Neon as well as less expensive sporty rivals like the Chevrolet Camaro.[109]

This leads to the conclusion that Californians generally follow market trends of buying more of lower-priced vehicles, but are willing to pay a premium for a recognized brand that conveys the desired image.

Three Pricing Models

We present three classic marketing pricing scenarios, including corporate rationales, for our hypothetical EV. While every company's stated goal is that each product needs to be a profit center, automakers may need to make an exception for this early stage of EVs. Certainly that strategy is reflected in the marketing of Toyota and Honda hybrids, which is not to say that EVs should be a drain on corporate resources, particularly over the five-year period viewed.

The price is based on projected sales. Those numbers probably lie somewhere between the 7,500 that CARB projects Ford will need to market in 2003, to the less than 1,300 expected from Nissan. It is possible to speculate that sales would be higher if the market for EVs "caught fire" in the manner of other segments in recent years. For the purposes of this study, we want to maintain a conservative approach and will assume the pattern of vehicle sales will follow those of other auto introductions like the Lexus and Infiniti. For these purposes, then, let us assume that the first year vehicle sales will be in the range of 1,500 to 7,500 units depending on the car's retail price.

A side note about volume and profit

Most modern automakers are big and oriented toward big things—large numbers of vehicles producing massive profits. Low volume runs of vehicles do not generally fit into the business plan of most of the major auto companies. Only Chrysler among the Big Three seems to have developed the ability to produce low volume vehicles at a profit, with the Viper, Viper GTS Coupe and Prowler. But those are relatively high price vehicles, not designed to compete in the mass market like the EV.

Also, it is important to note that mass-market vehicles can present similar balance sheet problems. For example, the mid-90s Honda Civic and Ford Escort—even with volumes in the 100,000s (and in Honda's case, relatively high prices)—were not thought by automotive analysts to be bringing any profit to their parent companies. However, they did provide other important benefits: representing these major automakers in critical entry-level markets, bringing substantial cash flow from a high volume of sales, and keeping the company competitive in the marketplace.

Competition/Differentiation

The EV's essential problem is that, at least initially, it will be a low-volume vehicle competing in price class and size with high-volume, bread-and-butter ICE cars, the backbone of the auto industry. The EV's primary differentiator is its powertrain, although the model we use as our hypothetical one also proposes using RTM composite as its body material, which would further differentiate it from gasoline-powered cars. To compete, the EV must be priced within range of its ICE competition, with some allowance for a premium because of its unique powertrain. Early adopters will be the most likely to pay the premium for an EV, but that market is small and fickle, even in California.

Three Textbook Models

Here are the three different pricing scenarios based on different market strategies. The first is a classic straightforward cost+profit=price; it results in the lowest projected sales numbers. The second scenario is a modification of the first with the pricing set lower than a full profit initially, but not at a loss and above competitive ICE vehicles. The third is an aggressive low-price at introduction designed to stimulate a new market and defer profits. That price is increased as the market grows and volume increases.

Profit margins in these scenarios may actually be conservative estimates, since the Boike-Severance cost numbers were built on a three-year amortization program and we are using a more likely five-year plan. The OTA pricing estimates bear out directionally the costs presented here, but again are the results of very conservative modeling. Seen in comparison with GM's EV1 cost figures and EV costs from other manufacturers referenced in the Shnayerson book, the pricing scenarios presented here are quite plausible.[110]

California-only sales numbers are also used for this study although it is clear that EVs will be sold elsewhere in this country (and the world, as is discussed later in this report). On the other hand, because of the large size of the California market and its positive attitude towards EVs, this is likely to be one of the largest single markets for these vehicles. We feel that makes these projected volume numbers even more feasible.

Competition-based pricing is the most aggressive model because it is most focused on driving sales and less attentive to maintaining specific profit margins. General Motors has pursued this pricing approach in, of all places, Japan as part of its right-hand-drive Saturn launch.

"General Motors has chosen not to suggest a retail price for its Saturn line of cars when they go on sale in Japan next spring, instead opting to let dealers set their own prices," according to the company sources quoted in *Nikkei Weekly*.[111]

GM is using this technique since it is behind its American rivals in launching right-hand-drive cars in Japan. "GM maintains that its open-pricing system will allow it to widen its brand recognition without getting into a price war with other imports," according to the *Nikkei Weekly*.

Three Near-Term EV Sales Models

Here is how the numbers work in our scenario. They must be viewed in the context of each other; for example, price influences volume, and conversely, volume influences price.

The EV we use in this model is a basic commuter car seating four, built on an extruded aluminum spaceframe with composite body panels. As previously mentioned, it could be assembled in a new plant or an underutilized existing plant. The vehicle would serve as a laboratory for new assembly processes and materials for the manufacturer. Suppliers would be active partners, doing R&D on subassemblies and even the entire vehicle. As GM has acknowledged with the EV1, the primary goal of this vehicle is not to generate a high rate of return, but set the stage for the company to be a viable EV producer. Feedback from owners also would be used for the development and refinement of the next generation of EVs.

If this car carried a conventional gasoline engine, its volume would be targeted much higher and its retail price would be $15,000. Adding the CARB cost differential for a four-passenger EV of $21,817, this would create a full-retail price of $36,817 (with all manufacturer and dealer profit and marketing expenses factored in). The manufacturer's cost basis for the car (less profit but with battery) is $33,872, a little less than would be expected for a car of this retail price.

Price is the manufacturer's suggested retail price, which in this case is a "value price," following the model of Saturn and other GM models in California and elsewhere. Of course, actual retail price will be modified by announced and likely future incentives from government agencies and utilities. Those incentives currently

available could lower prices in some regional areas by several thousand dollars. In addition, if the manufacturer decides to use subsidized leasing as a marketing tool, the retail sales prices may be less meaningful in relation to profit.

By profit we mean the manufacturer's excess of income over expense based on retail prices.

Model EV-A

Applying the cost-oriented pricing model to an EV creates a retail price of $36,917 for EV-A, our first example. The high retail price of this basic car will make it a hard-sell in the competitive California market, where it would be up against near-luxury cars like the Volvo S80, Mercedes-Benz C-class and other luxury cars. Its main selling point is its propulsion system, although with this kind of pricing structure the manufacturer would be advised to load it with luxury items. Given this price, volume will start low and be difficult to increase, but if it follows the Lexus/Infiniti patterns this is what will occur:

EV-A	Sales Volume
2003	2,000 units
2004	2,275
2005	2,850
2006	3,100
2007	2,775

Retail prices are not a static phenomenon, so in this example, the company raises prices $3,000 for the second year to take advantage of the new, receptive market. In the following year, the price is raised by $2,000 to maximize profits, and then drops $1,000 respectively as the market cools. In the final year, the retail transaction price drops by $4,000 as the market demand droops on the aging model and marketing measures such as rebates or subsidized leases are instituted to keep sales volume up. To recap:

EV-A	Retail Price
2003	$36,917
2004	$39,917
2005	$41,917
2006	$40,917
2007	$36,917

Enough profits flow from the EV-A model back to the manufacturer to fund the five-year program, although it is a modest break-even situation. Manufacturer profits are as follows, on a per vehicle, annual and cumulative basis.

EV-A	Mfg. Profits: Per Vehicle/Annual/Cumulative		
2003	$2,945	$5.89 million	$5.89 million
2004	$5,945	$13.5	$19.4
2005	$7,945	$22.6	$42.0
2006	$6,945	$21.5	$63.5
2007	$2,945	$8.17	$71.7

This model probably does not allow enough reinvestment back in the product to maintain even the modest level of sales projected, so as is usual with cost-oriented pricing, it rests on the shaky ground of an assumption that the market will buy into its pricing scheme.

Model EV-B

With our second model, EV-B, the same vehicle is priced on a competitive basis at $25,000, the average price of a new car sold in the U.S. While that may be slightly high for the size/type of vehicle presented, it plays to a premium value buyers place on an EV. Profit margins are shaved in order to stimulate volume, but gradually increase through the life of the model, although they are not sufficient to overcome the deficit of the early years. This scenario assumes that other manufacturers will be offering similarly priced vehicles, which will keep margins down and make manufacturer profits very difficult to realize.

Dealer margins need to be kept high to retain dealer interest in this low-volume model (we would keep them at 10 percent of the total retail transaction). Though this model does not offer a great return on the manufacturer's program investment, positive cash flow from the project should lay the foundation for more reasonable returns in the next generation EVs. Also, this plan establishes a larger owner base than EV-A, again setting the stage for further market growth.

In the end, the increased volume, driven by modestly lower prices, will help bring some return, though not enough to rationalize this program from a traditional automotive standpoint. Vehicle prices are more volatile in this model because they are designed to be more sensitive to competitive pressures, which will be great in the early years of EVs because of the performance limitations of the vehicles. The sales curve follows the same Lexus/Infiniti trend. The projected sales volumes, prices and profits are as follows:

EV-B	Sales Volume
2003	4,000 units
2004	4,700
2005	5,900
2006	6,400
2007	5,720

EV-B	Vehicle Price
2003	$25,000
2004	$23,000
2005	$26,000
2006	$28,000
2007	$27,000

EV-B	Mfg Profits: Per Vehicle/Annual/Cumulative		
2003	$(8,872)	$(35.5 million)	$(35.5 million)
2004	$(10,872)	$(51.1)	$(86.6)
2005	$(7,872)	$(46.4)	$(133.0)
2006	$(5,872)	$(37.6)	$(170.6)
2007	$(6,872)	$(39.3)	$(209.9)

While this program obviously loses more than $200 million for the auto company, it does have a positive side for the corporate balance sheet. A total of 26,720 vehicles were sold and corporate revenue totaling $630 million was brought into the corporate coffers.

Model EV-C

Model EV-C presents the same vehicle on the market using a customer-oriented pricing system that emphasizes building volume at the expense of profits in the early years. Of particular interest is that this approach allows volume to build and prices to rise over the five-year period so that the result is a profit in the fifth year. It is similar to the lower-volume, higher-price approach of cost-oriented pricing (EV-A). For a growth pattern with this model, we have chosen to apply the growth curve of the Saturn since this type of pricing model is similar to the one used with Saturn, i.e., competitive pricing in order to establish a new vehicle in the market.

One difference is that with this scenario, dealers would be asked to forgo some of their per-vehicle profit since the factory is absorbing losses in order to build the EV market. There is some precedent for this as dealers have seen margins reduced on lower-profit vehicles. The dealers could possibly get some incentive in the final year of the program as volume increases and true profits are realized. Alternately, the factory could choose to incentivize them through its ICE models. In the latter plan, manufacturers could offer dealers an extra allotment of "hot" models as a reward for selling EVs or increase dealer margins on ICE vehicles to compensate for the dealer's reduced profits on EVs. The ultimate profit projected for this vehicle would allow the factory the option of allowing dealers their standard margin, but that would increase the factory investment and potentially jeopardize the return-on-investment for the whole program.

In addition, this scenario assumes a reduced component and battery cost in the third and fifth year of the program, a cost-reduction pattern established during the past decade. This will lower the manufacturer's cost basis for the car by $2,000 in the third year and $5,000 more in the fifth year.

This approach is less risky than the other two from a marketing standpoint since it removes price as a market impediment, although counting on a program payback from one "good" year is obviously risky as well. Based on our research, the pricing approach suggested here should open up the market to volumes at least as high as those projected here. It also parallels the initial market approach of hybrid cars, which came in at a slight premium to their gasoline-only counterparts, but found a solid market based on their technological and environmental appeal.

EV-C	Sales Volumes
2003	5,000 units
2004	7,000
2005	9,500
2006	12,500
2007	15,000

EV-C	Retail Price
2003	$20,000
2004	$24,000
2005	$25,000
2006	$26,000
2007	$27,000

EV-C	Mfg. Profits Per Vehicle/Annual/Cumulative		
2003	$(12,031)	$(60.2 million)	$(60.2 million)
2004	$(8,031)	$(56.2)	$(116.4)
2005	$(5.031)	$(47.8)	$(164.2)
2006	$(4,031)	$(50.4)	$(214.6)
2007	$1,969	$29.5	$(185.1)

Another likely scenario could turn any of these programs into a more profitable venture, which is using a Triax-style program that would cut the manufacturer margin significantly, offsetting the cost differential from the battery and component costs.

45. Coates, Michael, Green Car Institute, "The Current and Future Market for Electric Vehicles," September 2000. Market research included a 934-person survey of California new car buyers executed by The Dohring Company in July 2000. It has a margin of error of +/- 3 percent.

46. Ibid.

47. Ibid.

48. Shnayerson, Michael, "The Car That Could: The Inside Story of GM's Revolutionary Electric Vehicle," Random House, New York, September 1996. The executive quoted is Lloyd Ruess, at the time president of General Motors. p. 117

49. Ibid., p. 105 and 259

50. Boike, Shawn, and Severence, Bruce, "The Real Cost of Electric Vehicles," unpublished, 1996

51. Staff Report, California Environmental Protection Agency, Air Resources Board, "2000 Zero Emission Vehicle Program Biennial Review," August 7, 2000

52. Office of Technology Assessment, U.S. Congress (1995), "Advanced Automotive Technology: Visions of a Super-Efficient Family Car," OTA-ETI-638, Washington CE, U.S. Government Printing Office; and Lipman, Timothy, "Electric Vehicle Cost Study Review for CALSTART," Institute of Transportation Studies, University of California, Davis, May 1996

53. Coates, op. cit.

54. Ibid.

55. Marshall, Jonathan, "Charging Up Electric Cars," San Francisco Chronicle, August 28, 1995, p. B1

56. Kurylko, Diana T., "Ford: Next world car on schedule for 1999," Automotive News, April 1, 1996

57. Mullen, op. cit.

58. Shnayerson, op. cit.

59. Coates, op. cit. Estimates were based on response to market research but factored with other study findings which assume that an EV will not be the household's only vehicle and that households will only own one EV at a time.

60. CARB in its staff report also reiterated the critical nature of such programs, while indicating that some of the current ones may not be in force much longer.

61. Shnayerson, op. cit. This also can allow for a Triax-type vehicle with different propulsion units, for instance, an EV as well as a hybrid meeting PZEV requirements.

62. "The California Report," J.D. Power & Associates, March 1996

63. Shnayerson, op. cit.

64. "GM Adopts Open Pricing For Saturn," Nikkei Weekly, May 6, 1996

Chapter 6

Marketing Mitigation Techniques

Many means are available for an auto manufacturer to deal with an uncooperative market, almost all centering on price. Automakers are constantly juggling many of the elements under their control—production volume, market position, image and features—but price is critical. The goal: trying to find that balance of supply and demand that keeps production levels high enough to maximize return on facility and labor investment, and vehicle price high enough to return a profit to the corporation and its retailers. Because of the traditionally long pipeline, which even recently has still been measured in months from vehicle production to its arrival in the retail market, auto companies have trouble responding quickly to market changes. Automakers are constantly focused on bringing to a lower level the "breakeven" number of vehicles that need to be produced to return a profit, either by improving efficiencies in the plant, lowering component costs or cutting corporate overhead.

Corporate advertising and public relations help shape demand, which manufacturers try to match with vehicles already planned or produced. The focus is on the content of the vehicle or its features that appeal to a potential market segment. In the EV's case, the last few years demonstrated that these vehicles appealed to EV enthusiasts and early adapters of new technology. This is the "pull" that creates sales in the marketplace. Another less discussed part of marketing is the "push" that manufacturers create through dealer incentives, sales training, and promotion of models or option packages to dealers through special pricing, merchandising, promotional incentives or discounting.

Incentives

Incentives are a way of life in the auto business, something the auto companies and their investors want to keep in check and at a minimum level (since incentive dollars, other than those that may be part of a contingency marketing budget, come at the direct expense of profit). Nonetheless, they are a normal part of doing business, often routinely reported by companies to the investment community as part of a company's quarterly earnings reports.

> "Chairman Juergen Schrempp said DaimlerChrysler was feeling the squeeze of competitors slashing prices in the United States to snag customers for high-profit minivans and sport utility vehicles. The problem – rolling out rebates, discounts and other incentives in order to compete – has cut into DaimlerChrysler's bottom line, triggering a seven percent drop in the operating profit at Chrysler division."[112]
>
> "Ford's marketing costs – including incentives and rebates – rose to 11 percent of revenue, up one-tenth of a percentage point. That's in contrast to General Motors Corp., which said last week that higher rebates and incentives hurt earnings slightly."[113]
>
> "GM said earnings were eroded by continuing pressure on new-vehicle prices."
>
> "Burnham Securities analyst David Healy estimated that GM's incentives averaged $1,950 per vehicle – a $500 increase over the same quarter a year ago. He said the main reason was the stale line of passenger cars."[114]

Given those numbers (billions of dollars per company), it would not necessarily appear that EVs would cause those three automakers to strain their incentive budgets. This is especially true when taking into account a 1995 Department of Transportation study that projected no more than $50 to $131 would be required in cross-subsidy costs – the amount that prices of conventional gasoline vehicles would need to be raised to account for the higher cost of producing EVs after available incentives are factored in.[115]

AFV Incentives/Price Adjustments

Automakers have used incentives extensively as part of their alternative fuel vehicle marketing.

> "Our regional fleet marketing efforts have delivered more than 3,500 compressed natural gas (CNG) vehicles around the country since 1993, Chrysler's Manager - Fleet Client Relations Howard Bruno said in 1995. The premise is simple, we make a sound business case for our established fleet customers to give alternative fuel vehicles a look, especially considering fleet mandates for alternative fuel vehicle purchases coming in the late 90s. Sales have been accomplished by leveraging 'very generous incentives' that have made the purchase a zero-cost option..."[116]

On top of that, Chrysler also reduced retail prices of CNG Ram Van/Wagons 16 percent in an effort to boost sales, a technique that moves beyond the complexity of incentives or rebates.[117]

Ford's 3.0-liter V-6 equipped Taurus sedans and Ranger pickups are all designed as flexible fuel vehicles (FFVs), able to run on alternative fuels such as E85 (a fuel blend of 15 percent gasoline and 85 percent ethanol) as well as regular gasoline. Even though "the cost of making the cars or trucks FFV is estimated to be as much as $300 per vehicle, [this is a cost] which Ford does not pass on to the consumers. Upgraded components in FFVs include the fuel pump, fuel rails, fuel injectors, fuel lines and filler pipe. In addition, the package includes a unique engine control module to calibrate engine response to different fuel mixtures of gasoline and ethanol."[118]

Ford chose to absorb those extra costs in order to seamlessly market the FFVs, which have a positive impact on the corporation's federal CAFE (Corporate Average Fuel Economy) ratings, since they are allowed to count as higher than their actual fuel economy.

EV incentives/Tax Credits

Market incentives are on board for EVs as well, including:

- A 10 percent federal tax credit up to $4,000;
- A business tax deduction of $100,000 for electric recharging sites;
- Elimination of the luxury tax for alternative-fueled vehicles;
- A $5,000 incentive for ZEV fleets from California Energy Commission (CEC) and the U.S. Department of Energy;
- Funds for local governments to support leasing alternative fuel vehicles;
- Bay Area Air Quality Management District (BAAQMD) grants for the installation of public EV charging stations;
- BAAQMD purchase incentives ($5,000) to individuals and fleets;
- South Coast Air Quality Management District purchase incentives ($5,000) to public and private customers

- Other Air Pollution Control Districts in conjunction with the CEC purchase or lease incentives ($5,000) for public or private customers;

- Discount rates from various utilities for off-peak recharging of EVs (50 percent reduction on normal rates);

- CEC incentives to automakers for infrastructure development;

- Proposed legislation to establish a $3,000 per year tax credit, over three years, toward the purchase or lease of a ZEV.

These measures have the potential for mitigating much of the added cost of an EV even at the rates presented during the MOA, which generally were not competitive with gasoline-powered equivalent vehicles in the same way that automakers use rebates and discounted financing to draw buyers to their vehicles.

It is not unexpected that EV's will have these pricing struggles in their early years. John Wallace, executive director of Ford's TH!NK Group, said: "We've got to compete against that vehicle [the internal combustion automobile] in cost, and we're not going to be able to do it coming right out of the chute. All technologies, when they go through their life cycles, enter the mass market at a cost disadvantage."[119]

Non-Financial Incentives

As is the case with the marketing of many vehicles, non-financial incentives are often added to the mix to stimulate market demand for a vehicle. Among the many past iterations of this theme are:

- Free season ski passes with the purchase or lease of a new Jeep;

- Free roadside assistance as part of a new vehicle warranty;

- Themed apparel and goods offered by Volkswagen when it launched the New Beetle in Germany.

With all automakers' EVs, most of the incentives are similar across the board. Indeed, there may be reluctance on the part of manufacturers to try to capitalize on what is truly not a competitive advantage over other EVs. Nonetheless, there are arrays of incentives for choosing an EV over an internal combustion engine (ICE) vehicle, so they are worth discussing. This also is an area where automakers and co-marketers like electric utilities could do much more, although some programs have been put into place.

EVs have non-financial incentives of:

- Access to HOV (high occupancy vehicle) or "diamond" lanes even with one person is in a vehicle;

- Free parking in various locations;

- Free charging at various facilities;

- No need for oil changes or smog checks;

- No need to go to a gas station

CAFE Credits

Other positive effects of EV production for the manufacturers include credits toward CAFE (Corporate Average Fuel Economy). According to a very complicated formula, EVs will count disproportionately high toward automakers' CAFE numbers. In fact, EVs may add even more to increasing CAFE as advances in EV weight reduction are spun off into regular car production.

But the major benefit for corporations is that an EV's positive CAFE contributions will provide an offset so that the automakers will be able to sell more higher profit margin vehicles like full-size sport utilities that have lower fuel economy numbers. The same rationale that prompts them to build flexible fuel vehicles like the Ford Taurus, DaimlerChrysler minivans and upcoming GM sport utilities—and offer them to consumers at no premium—should impact EV pricing.

Subsidized Leasing

Another way of separating out costs to make EVs more marketable has been the use of leases, particularly subsidized leases. As is obvious from the variety of prices charged for leasing EVs during the MOA period, automakers are aware of the volatility possible with leases. Since the residual value of the EV was part guess and part guarantee at the beginning of this time, it made lease charges all the more problematical.

As an example of the types of leases possible with an EV, the French government has proposed a lease arrangement in which the batteries (the highest cost component for an EV) would be leased at a subsidized rate from a government-run utility. With the batteries out of the cost equation, the EVs were projected to sell for prices comparable to internal combustion vehicles and offer significant operating efficiencies because of the European gasoline/electricity pricing mix.[120]

California's Public Utilities Commission has prohibited California's investor-owned utilities from participating in battery-leasing pilot projects or ongoing programs, where a portion of the costs might be recovered from ratepayers. Non-utility companies in the U.S. have not created battery leasing companies for several reasons, the most important of which is that there have been no volume orders for EVs or components.

In addition, treating EV batteries as a separate entity allows the automaker and battery manufacturer to update the battery pack with new technology as it becomes available, following the example of programs in the computer industry. Such an arrangement would also allow automakers to monitor and mitigate negative attitudes about EVs at their source through a program that combined service and customer relations, not unlike those currently in practice for owners of luxury autos. GM had an opportunity, unfortunately, to put this theory into practice when they had to recall all of their first generation battery vehicles (EV1 and S-10) because of a faulty electrical component that created a potential fire hazard. It was unfortunate because, instead of being able to offer enthusiastic and loyal EV1 owners an upgrade to the new NiMH-battery EV1s, because of a lack of supply GM simply had to recall the older vehicles and buy the owners out of their remaining leases.

In one industry researcher's view, a subsidized whole vehicle makes the most sense for early EVs, since they seem destined to be obsolete and archaic by the end of a traditional lease or purchase.[121] This has not proven to be the case at Honda and GM, though, as both are preparing to re-lease EVs that are coming to the end of their first 36-month lease, which will increase total income from the vehicles, unlike what happens with other vehicles.

California is Lease Center

Like incentives, subsidized leases have recently become a key marketing tool in the automotive marketplace. Their impact is quite significant in some market segments. For instance, Infiniti and other luxury divisions' sales often depend on subsidizing leases, particularly if the division's product is not as fresh as that of the competition.

This is particularly pertinent since California leads other regions in leasing, with penetrations of 38 percent for some cars and 37 percent for some trucks (which includes minivans and sport utility vehicles). Customers seem to like the short-term leases factories are using to shorten the trading cycle. The average term for these factory-sponsored leases is 34 months..."[122] Leasing also makes sense for the early consumer of an EV, which will feature a technology almost guaranteed to change in the near-term.

What leasing accomplishes for the automakers is to keep their name and product in the public eye so they are prime candidates for purchase as the EV market matures. In much the same way, Ford has used short-term subsidized leases as part of a plan of "perpetual leasing" that ensures a customer for a new Ford vehicle every two years. Such a plan would keep customers captive while the technology improves. Lease subsidies vary based on market conditions and the type of vehicle involved, but they can even appear on popular vehicles. For instance, Edmunds.com, one of the most popular automotive websites for consumers, discovered a subsidized lease on the Honda Accord coupe on Honda's website, which featured a $900 capital cost reduction.[123] That made a $35 a month difference in a 36-month lease. Other subsidies include lease rates below the going market rate. As an example, recent ads (July 2000) for Saab and Saturn showed net lease rates of as low as 2.24 percent for some Saab models and 3.87 percent for some Saturns, less than a third and half respectively of the current market rate of 9 percent.[124]

Under a lease system customers could receive upgraded batteries and controller technology on a routine basis comparable to regular maintenance in an internal combustion car. In the interim, feedback from those early consumers should be fed back into the system to speed improvements in both EV technology and the overall vehicle package.

Export Markets

The Market Beyond California

Other than California, New York and Massachusetts have added ZEV requirements. Vermont and Maine are considering such requirements.

Additionally, other countries with severe pollution problems—Mexico, Japan, Korea, Taiwan and Europe (particularly France and Germany)—also represent potential markets. The ZEV market overseas is driven not only by severe pollution concerns but also by fuel costs that make EVs more palatable. As was mentioned earlier, the French EV market in particular has grown to a total of about 9,000 vehicles. In Japan, although growth has been slower than expected, through 1998 there were more than 2,000 EVs on the road, mostly small and mini-sized vehicles most adaptable to the country's narrow roads.

Developing countries, too, are intrigued by the potential of EVs because of the high cost of petroleum that strains most expanding economies. For example, gasoline costs are often higher by a factor of three or four compared to the U.S., making the expected battery costs roughly comparable to conventional fuel costs. Additionally, the environmental benefits are critical to areas where pollution is already a serious problem. On some small scales, EVs are making inroads. In Nepal, for instance, high in the Himalayas, the country's traditional three-wheeled, diesel-powered vehicles are being supplanted by EVs with government support. The environmental benefits are already being seen and local enthusiasm for the program is strong.[125]

For example, gasoline in France, which is heavily taxed, is about $4 a gallon, while electricity cost is relatively low. The energy cost for a 60-mile drive in an EV is about $1.60, compared to about $6 in a fuel-efficient car. Because EV development is being encouraged by the state, insurance and taxes on EVs also are cheaper than on gas-powered cars.[126]

Since many of these countries also have well-developed auto industries, EV advances are likely to come from a variety of sources, much as the original internal combustion engine was developed and has since been refined all around the world, adapting to local markets.

If the worldwide market turns out to be of the magnitude suggested by EV advocates and independent researchers, many of the current cost arguments put forward by the automakers lose validity. Even the introduction of hybrids using advanced batteries and fuel cell vehicles promises to spur further EV development and lower costs.

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