READY TO ROLL

An Assessment of New Jersey's Readiness for the
Zero-Emission Vehicle Program

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EXECUTIVE SUMMARY

Despite tighter emission standards on automobiles over the last three decades, New Jersey continues to face significant automobile-related air pollution problems. While new federal standards set to take effect in 2004 will further limit emissions from cars and light trucks, those standards will likely not provide sufficient protection against health dangers from smog, air toxics and other air pollutants.

To further reduce air pollution from motor vehicles, and foster the development of new, cleaner, high-technology vehicles, three northeastern states – New York, Massachusetts and Vermont – have adopted California's Low-Emission Vehicle II (LEV II) program, which includes the Zero-Emission Vehicle (ZEV) requirement. Under the ZEV requirement, automakers must sell specific percentages of zero-emission and near-zero-emission vehicles by the middle of this decade.

New Jersey will become eligible to adopt the LEV II program beginning in the 2006 model year. This report analyzes the potential benefits of the ZEV requirement and assesses whether the technology, consumer acceptance, and infrastructure are in place to make the program a feasible public policy option for the state.

We find that:

The ZEV program would bring environmental, energy and economic benefits to New Jersey.

- As part of the Low-Emission Vehicle II (LEV II) program, the ZEV program would play a major role in reducing emissions of smog-forming and toxic pollutants. A 2002 NJPIRG Law & Policy Center report estimated that LEV II would reduce air toxics emissions from light duty cars and trucks by 23% by 2020 and emissions of smog-forming volatile organic compounds by 19%.

- Technologies encouraged by the ZEV program – such as hybrid-electric and battery-electric vehicles – can also reduce New Jersey's emissions of global warming gases. Battery-electric vehicles produce less than half the carbon dioxide emissions per mile of conventional vehicles.

- The ZEV requirement can enhance New Jersey's economy by reducing its susceptibility to oil price shocks, encouraging the development of clean vehicle industries within the state, and helping to promote advanced technologies with applications in other sectors of the economy.

- The LEV II program and ZEV requirement can also help New Jersey meet its responsibility under the Clean Air Act to reduce levels of ozone smog, allowing federal transportation dollars to continue to flow to the state.

The technology exists for automakers to meet the ZEV requirement.

- Nearly a half-million vehicles that run on alternative fuels are currently on America's roads. Automakers have already manufactured thousands of electric vehicles that qualify for the ZEV program, and are beginning to make cars that qualify for partial ZEV credit.

- All six of the major automakers (General Motors, Ford, DaimlerChrysler, Honda, Toyota and Nissan) are projected to produce vehicles that satisfy aspects of the ZEV program by 2005.

- The annual anticipated cost of the ZEV program to automakers in its early years represents less than one percent of automakers' annual media spending and net profits. Offsetting economic benefits of the program and consumers' willingness to pay more for some ZEV-compliant vehicles will reduce those costs further.

Consumers are eager to buy cleaner cars and have embraced ZEVs wherever they have been introduced.

- Electric vehicle drivers in California and in public-sector fleets express strong satisfaction with their vehicles. Surveys indicate that the majority of EV drivers would recommend the vehicles to others and that EVs fit better within drivers' "real world" driving patterns than owners had anticipated.

- Vehicle fleets in New Jersey are likely to provide a substantial market for clean vehicles – particularly if the state reorients its alternative-fuel vehicle purchasing programs to focus on the procurement of cleaner cars.

- Demand for battery-electric and hybrid-electric vehicles has outstripped supply. Consumers have weathered long waiting lists to purchase the first generation of hybrid-electric vehicles and automakers are preparing to increase production to meet the demand.

- The ZEV program would be unlikely to have a substantial negative effect on overall new vehicle prices, while most vehicles covered by the requirement would likely remain within the price range of consumers. Automakers may even choose to assume the costs of more expensive "pure ZEVs" in the short run in order to maximize long-run profits and build market share.

New Jersey can have the infrastructure in place to support the ZEV program by 2006.

- The vast majority of vehicles covered by the ZEV program – such as clean conventional cars and hybrid-electric vehicles – run on gasoline and will require no special infrastructure.

- While New Jersey currently lacks extensive infrastructure for alternative fuel vehicles, fueling and recharging stations can be erected quickly and with limited cost. California and New York State provide workable models of how this can be done.

The goals of a ZEV requirement in New Jersey are attainable, and achieving them would be beneficial to the state. To ensure successful implementation of the program, the state should take a leadership role in coordinating the expansion of alternative-fuel infrastructure and educating the public about clean cars, and work to secure both public and private resources to support those efforts.

INTRODUCTION

In 1990, the state of California took a pioneering step toward reducing air emissions from motor vehicles when it adopted its Zero-Emission Vehicle (ZEV) requirement. The ZEV requirement was something entirely new in the long-running battle to reduce the environmental and health effects of automobile air pollution. Rather than focusing exclusively on limiting emissions from the tailpipe in the short run, the ZEV program sought to initiate a shift toward a new generation of inherently cleaner technologies by requiring automakers to sell specific percentages of zero- and near-zero emission vehicles.

The need for such a technological shift has grown more urgent over the past decade as dramatic increases in automobile travel have threatened the efficacy of tailpipe emission standards. In New Jersey, for example, the number of miles traveled on New Jersey's roads increased by about 12 percent between 1990 and 2000.[1] During the summer of 2001, New Jersey registered 35 days during which levels of ozone reached unhealthy levels.[2] And as of late August, about one out of every three days during the summer of 2002 had seen unhealthy levels of ozone in at least part of the state.

There are other motivations for shifting to cleaner automotive technologies. Volatility in gasoline markets has led to periodic price spikes that threaten our economy and underscore the need to diversify the nation's transportation fuel mix. Meanwhile, the nation continues to struggle to find ways to limit our emissions of greenhouse gases, much of which come from cars and trucks.

Seeing the value of the ZEV program's unique approach, three northeastern states – New York, Massachusetts and Vermont – have adopted the program for themselves. But the question that has dogged the ZEV program from its inception continues to be asked today: Are the program's goals attainable?

The answer is "yes."

Over the past decade, a revolution has begun to take shape in automotive technology. Electric vehicles – once futuristic car-show concepts – have become the day-to-day transportation choice of thousands of drivers. Other alternative-fuel vehicles – such as those that run on compressed natural gas – have continued to make their way into vehicle fleets in New Jersey and elsewhere. And great strides have been made in the development of fuel cells, which many believe are the clean automotive technology of the not-too-distant future.

Even cars that run on conventional gasoline have taken part in this revolution. Hybrid-electric vehicles – which fuse internal combustion and electric vehicle technologies and boast improved energy efficiency and reduced emissions – can be seen in steadily increasing numbers on New Jersey highways. And new emission-control technologies have allowed automakers to begin to produce traditional internal combustion cars that approach zero emissions.

The ZEV program is also more attainable than ever due to recent changes in the program's rules. Where the program once focused entirely on the development of electric vehicles, the ZEV program now enables automakers to gain credit through the use of a host of improved automotive technologies.

Recent experience with electric, hybrid and other cleaner cars demonstrates that consumers are not only willing but eager to drive low-polluting advanced technology cars. And while the ZEV program will require some adaptation by automakers and government, such adjustments are clearly feasible.

The Zero-Emission Vehicle Program

History

The ZEV program has its roots in a quirk in environmental regulation in the United States, one whose history goes back to the mid-1960s.

California has long experienced severe air pollution problems, owing partially to its automobile-centered culture and its smog-conducive climate. In the early 1960s, the state began taking action against pollution from automobiles, pioneering new strategies for reducing tailpipe emissions.

At the same time, the federal government was beginning to awaken to the dangers posed by automobile air pollution. In 1970, Congress made its first comprehensive attempt to deal with air pollution by passing the Clean Air Act. One provision of the law barred individual states from regulating automobile emissions – a move intended to protect automakers from having to manufacture 50 separate cars for 50 states. However, it preserved a special place for California, allowing the state to adopt tougher emission standards to address its unique air pollution problems.

By 1977, with more cities facing smog problems similar to those in California, Congress gave the states – through Section 177 of the Clean Air Act – the opportunity to adopt California's vehicle emission standards rather than sticking with the weaker national standards. Several states took advantage of that opportunity by adopting California auto emission standards – including the ZEV program – in the early 1990s.

New Jersey was not among them, although it did look for a time as though the state would be governed by California standards. In 1994, acting as the Ozone Transport Commission (OTC -- a body created by the Clean Air Act), the northeastern states petitioned the EPA to implement California's Low-Emission Vehicle (LEV) standards from Maine to Virginia. EPA agreed to implement California emissions standards in the region, but left states to decide whether to adopt a ZEV requirement.

However, the petition was later thrown out in court, leading to the negotiation of a voluntary emission standard called the National Low Emission Vehicle (NLEV) program, under which automakers would provide cars meeting California emission standards in the northeast beginning in 1999 and nationwide beginning in 2001. States participating in the NLEV program agreed not to adopt California standards (including the ZEV requirement) to take effect before the 2006 model year.

As the debate over the OTC's adoption of the California standards was taking place, the New Jersey Legislature was laying out its own rules for the state's participation in the program. In 1993, legislation was enacted that would prevent the Department of Environmental Protection (DEP) from adopting the California LEV program unless 40 percent of registered vehicles in the northeast were also covered by the program – a condition that has not yet existed.[3]

Meanwhile, as the initial 1998 compliance date for the original ZEV program crept nearer, California moved to add flexibility to the program. The original 1990 ZEV program required that two percent of automobiles sold beginning in 1998 be zero-emission vehicles, with the percentage increasing to five percent in 2001 and 10 percent in 2003. In 1996, however, the California Air Resources Board (CARB) – the body empowered to set auto emission standards in California – dropped all ZEV requirements from 1998 to 2003 in exchange for a commitment from major automakers to produce between 1,250 and 3,750 advanced battery-electric vehicles for sale in California between 1998 and 2000.[4]

In 1998, CARB amended the program again to allow manufacturers to receive partial ZEV (PZEV) credit for near-zero-emission vehicles. In 2001, CARB again revised the program to encourage the development of advanced technology vehicles and allow manufacturers to claim additional credits toward compliance with the program. Because other states adopting California's air pollution standards must give automakers two model years of lead time before implementation, this effectively pushed back the introduction of the ZEV requirement in Massachusetts, New York and Vermont to the 2005 model year.

New York and Massachusetts have adopted the latest changes to the ZEV program, but it remains to be seen whether they will be enforced. First, in adopting the new requirements, the two states also proposed an alternative compliance plan (ACP) that would give automakers another option for complying with the program. (Vermont, which took part in initial negotiations over the ACP, has not yet adopted the plan and appears to be staying with the California version of the program, which is incorporated in Vermont's regulations by reference.)

In essence, the ACP exchanges a commitment from automakers to put clean conventional vehicles on the road a year earlier than planned for the relaxation of early requirements for the introduction of "pure" zero-emission vehicles. The ACP also includes a number of additional credits automakers can use toward compliance with the program. The ACP ends in 2007, meaning that the participating states will revert to the ZEV standards in place in California.

However, the exact requirements of the ZEV program – in both California and the northeast – remain in doubt as this report goes to press.

In June, a federal district court judge in California issued a preliminary injunction preventing the implementation of the 2001 amendments to the ZEV program in that state for the 2003 and 2004 model years.[5] The injunction was based on a narrow legal argument made by automakers that one of the 2001 amendments represented a fuel economy standard, which states are not permitted to set under federal law. Automakers have also filed litigation against New York State for its adoption of the ACP.

Ironically, in attacking the 2001 CARB amendments and the ACP, automakers may end up removing much of the additional flexibility that has been built into the program. In the California case, CARB may choose to rewrite the rules again, appeal the decision, or allow more stringent ZEV standards – adopted in 1999 – to stand, a move that would likely trigger an additional legal challenge, but would essentially force automakers to produce more "pure" ZEVs in the near term.

The analysis in this report assumes that CARB's 2001 amendments to the ZEV program will eventually take effect with minor modifications to deal with the narrow legal arguments made by automakers. While the injunction may result in a delay in the implementation of the ZEV program in California and the northeastern states that have already enacted it, this analysis assumes that a program would be in place for New Jersey to adopt for the 2006 model year.

How It Works

The percentages of ZEV and near-ZEV vehicles called for under the ZEV program do not represent actual percentages of cars sold. Rather, automakers have many opportunities to earn credits toward the ZEV requirements that reduce the actual number of ZEV-compliant vehicles they must produce.

In recent years, California has moved toward policies that reduce the number of pure ZEVs required of automakers, while increasing the number of extremely clean vehicles eligible for partial ZEV (or PZEV) credits.

The key elements of the program are as follows:

PURE ZEVS

The latest version of the California ZEV program requires that two percent of the cars sold by large volume manufacturers by 2003 be "pure ZEVs"; those with no tailpipe or fuel-related evaporative emissions. Currently, that means battery-electric vehicles (EVs), but it is expected that this standard will soon lead to commercial introduction of hydrogen fuel cells. In early years of the program, manufacturers can meet the requirement either with full function ZEVs, or with "city" or "neighborhood" electric vehicles that have a smaller range and travel at lower speeds. Credits for neighborhood electric vehicles are scheduled to decrease over time, so that by 2006 they will count for only 0.15 of a full-function ZEV.[6]

Pure ZEVs are also eligible for additional credits and multipliers under the program that would reduce the number of vehicles automakers must sell to comply:

- **Extended range** – Vehicles with a zero-emission range of less than 50 miles are counted as one ZEV. Those with extended ranges receive additional credits, such that a ZEV with a range of 275 miles or more receives 10 times the credits of a low-range ZEV. These multipliers are gradually reduced as the years go on.

- **Increased efficiency** – Beginning in the 2005 model year, the extended range multiplier is gradually replaced by an efficiency multiplier in which vehicles that get over 50 percent more miles per gasoline equivalent gallon than an established baseline receive additional credit. The rules for this multiplier are tightened beginning in the 2008 model year.

- **Fast refueling** – ZEVs that are capable of being fully recharged or refueled in less than 10 minutes are eligible for the maximum extended range multiplier available under the program. Other vehicles with more limited fast refueling capabilities may be eligible for lesser credits. This multiplier expires with the 2008 model year.

PARTIAL ZEV (PZEV) CREDITS

The law also allows manufacturers to meet up to 6 percent of the 10 percent ZEV requirement by marketing ultra-clean conventional, gasoline-powered cars. To receive partial ZEV, or PZEV, credit, vehicles must meet LEV II's strict super-low-emission vehicle (SULEV) emission standards (the lowest vehicle emission standards short of zero emissions), have "zero" evaporative emissions, and have their emissions control systems certified and under warranty for 150,000 miles.[7] Under the 2001 rules, their introduction will be phased in between 2003 and 2006. Intermediate volume manufacturers – those that sell fewer than 60,000 light- and medium-duty vehicles in California annually – may meet the entire ZEV percentage requirement with PZEV credits. Each PZEV receives a credit equivalent to 0.2 of a pure ZEV.

ADVANCED TECHNOLOGY PZEVS (AT-PZEVS)

Manufacturers will be allowed to satisfy up to two percent of the 10 percent ZEV requirement by marketing vehicles that meet basic PZEV criteria, but also include advanced features or can run on compressed natural gas, hybrid-electric motors, methanol fuel cells, or other very clean means.

The value of an AT-PZEV under the program is determined by adding credits earned through a variety of advanced technologies to the baseline PZEV credit of 0.2.

- **All-electric range** – Vehicles that can travel at least 10 miles in electric mode are eligible for credits ranging from approximately 0.4 to 2.0 for a vehicle with 120-mile all-electric range.

- **Alternative fuel** – Vehicles that run on hydrogen or pressurized gaseous fuel (such as compressed natural gas) are eligible for a credit of 0.1.

- **Hybrids** – Vehicles that include an advanced battery integral to the operation of the vehicle are eligible for additional credit. The credits are determined based on the amount by which the hybrid system increases energy efficiency or reduces carbon dioxide emissions.

- **Clean fuels** – Vehicles that operate on fuels with very low emissions over their entire fuel cycles are eligible for a credit of up to 0.2.

- **Other multipliers** – AT-PZEVs are also eligible for the high-efficiency multiplier available for pure ZEVs.

Current hybrid-electric vehicles such as the Toyota Prius do not yet meet AT-PZEV standards, but there is no technological reason they cannot. Honda's natural-gas powered Civic GX does meet AT-PZEV standards. If manufacturers fail to fulfill the two percent allocated to AT-PZEVs, they must sell pure ZEVs instead.

OTHER FEATURES

Under the 2001 California rules, automakers can also receive credits for placing vehicles in demonstration programs, and can earn additional credit for placing vehicles in programs that allow for shared use of vehicles, use "intelligent" transportation technologies, or are linked to transit use.

In the initial years of the program, the ZEV requirement applies only to passenger cars and light trucks. Beginning in 2007, heavier sport utility vehicles, pickup trucks and vans sold in California will be phased into the sales figures used to calculate the ZEV requirement.

TABLE 1: CALIFORNIA ZEV PERCENTAGE REQUIREMENT[8]

Model Years	Minimum ZEV Requirement
2003-2008	10 percent
2009-2011	11 percent
2012-2014	12 percent
2015-2017	14 percent
2018-	16 percent

Another important change adopted by CARB in 2001 is a gradual ratcheting up of the ZEV requirement from 10 percent to 16 percent over the next two decades, as shown in Table 1. However, the ample opportunities for additional credits and multipliers available to manufacturers will significantly reduce the amount of vehicles that must be sold – particularly in the early years of the program. The complexity of the ZEV program credit scheme makes it impossible to predict how many of each type of ZEV or PZEV vehicle will be on the road, but the state of California has estimated the percentage of vehicles sold that would be ZEVs, AT-PZEVs and PZEVs. Adapting these percentages for New Jersey, and assuming that the state would adopt identical requirements to those in place in California for the 2006 and subsequent model years, the following reflects the approximate number of vehicles in each category that would be required in New Jersey under the program. (See Table 2)

TABLE 2: ESTIMATED SALES IN NEW JERSEY UNDER CALIFORNIA ZEV PROGRAM[9]

Model Year	ZEV	AT-PZEV	PZEV
2006	1,509	8,745	94,879
2007	1,649	9,554	103,935
2008	1,763	10,310	112,401
2009	2,369	14,201	124,074
2010	2,653	15,527	135,861
2011	2,896	16,866	147,763
2012	4,039	21,683	158,454
Total Sales	**16,877**	**96,844**	**877,367**

These figures likely overestimate the number of ZEV-compliant vehicles that would be required in New Jersey, particularly in the early years of the program. They assume that New Jersey would implement the ZEV program beginning in 2006 with the same requirements in place in California in that year. The current injunction against enforcement of the California ZEV program could result in lower numbers of ZEV-compliant vehicles being required there, which would also lower the number required in New Jersey. Adoption of an alternative compliance plan – as has been proposed in other northeastern states – or a delayed phase-in schedule for ZEV-compliant vehicles could further reduce these requirements. Because the purpose of this report is to evaluate the attainability of the ZEV program in New Jersey, these estimates sets a higher threshold for automakers, consumers and the state's infrastructure to meet, and are therefore conservative.

Why ZEVs?

The ZEV program holds several potential benefits for New Jersey. It provides environmental benefits by helping the state reach its air pollution reduction goals and reduce emissions of greenhouse gases. It provides energy conservation benefits by promoting the use of more energy-efficient vehicles. And it could provide economic benefits by enhancing the state's energy security and encouraging the development of high-tech alternative vehicle industries within the state.

AIR QUALITY BENEFITS

The ZEV program will have both short- and long-term air quality benefits for New Jersey.

In the short term, the ZEV program is an integral part of the Low-Emission Vehicle II (LEV II) standards currently being debated in New Jersey. The LEV II standards, like the ZEV program, are based on California regulations and are significantly tougher than the comparable federal standards, known as Tier 2.

A 2002 NJPIRG Law & Policy Center report analyzed the potential emissions reductions that could result from adoption of LEV II. That analysis, which was based on earlier modeling done by the Massachusetts Department of Environmental Protection, found that LEV II would lead to the following emissions reductions by 2020.

- An approximate 23 percent reduction in emissions of air toxics by light-duty cars and trucks versus federal Tier 2 standards.
- An approximate 19 percent reduction in light-duty emissions of smog-forming volatile organic compounds versus Tier 2.

Other analyses have found that the program could also lead to significant reductions in light-duty emissions of smog-forming nitrogen oxides.[10]

Under the LEV II program, manufacturers may certify their light-duty vehicles to one of a series of emissions "bins." Each bin includes limits on the emissions of a set of pollutants, with some bins allowing more pollution and others less. Manufacturers may certify vehicles to whichever bin they choose, so long as the average non-methane organic gas (NMOG) emissions of their entire fleet fall below a particular level. The fleet average NMOG requirement declines over time, forcing manufacturers to certify increasing numbers of vehicles to cleaner bins.

In addition, LEV II requires automakers to meet more stringent standards for evaporative emissions of hydrocarbons – those emissions that emanate from parts of the vehicle other than the tailpipe. LEV II standards represent a nearly 80 percent reduction in evaporative emissions from previous standards, while federal Tier 2 standards represent only a 50 percent reduction.[11]

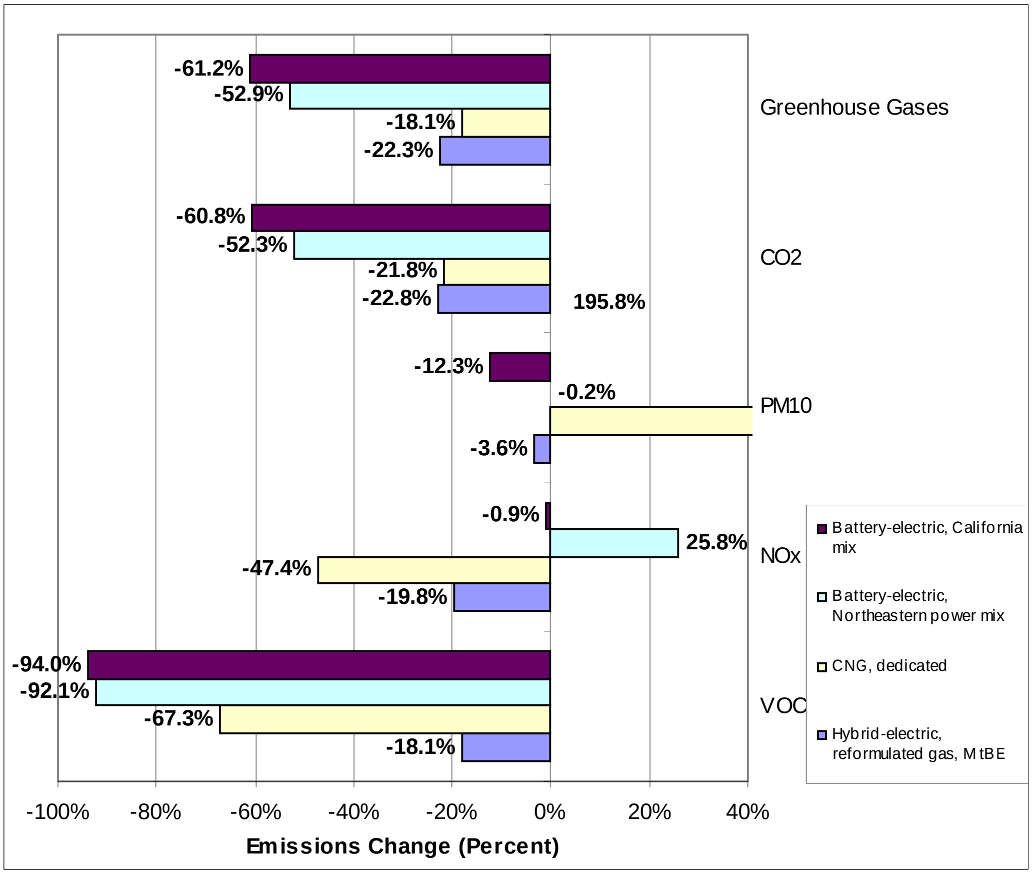
The ZEV requirement plays an integral role in helping automakers meet the LEV II standards, and yields emission reductions above and beyond the limits on fleet average emissions.

- By requiring automakers to certify specific numbers of vehicles to the two cleanest bins – ZEV and SULEV – the ZEV program frees up automakers to make and sell more vehicles in the "dirtier" bins of the program.
- Requirements that PZEVs have their emissions systems certified for a useful life of 150,000 miles (as opposed to the 120,000-mile useful life of LEV II) and that manufacturers place those systems under warranty for their full useful lives should reduce the degradation of emissions systems, ensuring that vehicles comply with emission standards for longer periods of time.
- The zero evaporative emission requirement for PZEVs will lead to further reductions in evaporative hydrocarbon emissions beyond the levels established by LEV II.

In its 2000 review of the California ZEV program, CARB estimated that vehicles manufactured between 2003 and 2010 would release approximately 7 percent less combined reactive organic gases and nitrogen oxides in the South Coast region of California under a 4% ZEV/6% PZEV configuration of the ZEV program than if there were no ZEV requirement in place.[12]

In the longer term, the ZEV requirement will encourage the development of technologies that can yield significant reductions in emissions of air pollutants – including emissions of greenhouse gases responsible for global warming.

FIG. 1: DIFFERENCE IN PER-MILE FUEL-CYCLE EMISSIONS OF CLEANER PASSENGER CARS VERSUS CONVENTIONAL GASOLINE INTERNAL COMBUSTION CARS.[13]



CO_2: Carbon dioxide
PM_{10}: Particulate matter less than 10 microns in diameter
NOx: Nitrogen oxides
VOC: Volatile organic compounds

NOTE: Data based on total emissions of various pollutants. Urban emissions of PM10 for CNG vehicles and NOx for electric vehicles are projected to be lower than urban emissions of conventional gasoline internal-combustion vehicles.

Zero-emission vehicles will obviously release fewer pollutants from their tailpipes than conventional vehicles. (EVs, for example, have no tailpipes.) To fully understand the impact of the ZEV requirement, one must look at emissions from the entire fuel cycle, from fuel extraction and refining through emissions from vehicles and power plants that generate electricity to power vehicles.

Such a fuel-cycle analysis shows that near-term alternative technologies such as hybrid-electric vehicles, compressed natural gas (CNG) vehicles, and electric vehicles release significantly less carbon dioxide and greenhouse gases than internal-combustion vehicles burning conventional gasoline. (See Figure 1) Hybrid-electrics hold clear advantages in all pollutant categories, while CNG vehicles are generally cleaner, but may release more particulates.[14]

With regard to electric vehicles, much depends on what sources are used to generate the electricity. In the northeast, where a significant amount of power comes from older coal- and oil-fired power plants, EVs may lead to increased releases of nitrogen oxides.

This is not true in California, which uses cleaner sources for its electricity. Eventual shifts in power production in the northeast to renewable energy sources such as solar and wind, or to cleaner natural gas, would give EVs a distinct pollution advantage over conventional vehicles.

Shifting to alternative vehicles such as hybrids and EVs will lead to significant reductions in per-mile emissions of many pollutants and will reduce the contribution of New Jersey cars and light trucks to global warming. To the extent that the ZEV requirement hastens widespread adoption of these technologies, development of improved technologies, and displacement of travel in conventional gasoline vehicles, it will have a profound and lasting effect on air quality in the state.

ENERGY BENEFITS

Another benefit of the ZEV program is that it would reduce New Jersey's dependence on oil as a transportation fuel, enhancing the state's long-term energy security and reducing the need to import foreign oil or drill in ecologically sensitive areas.

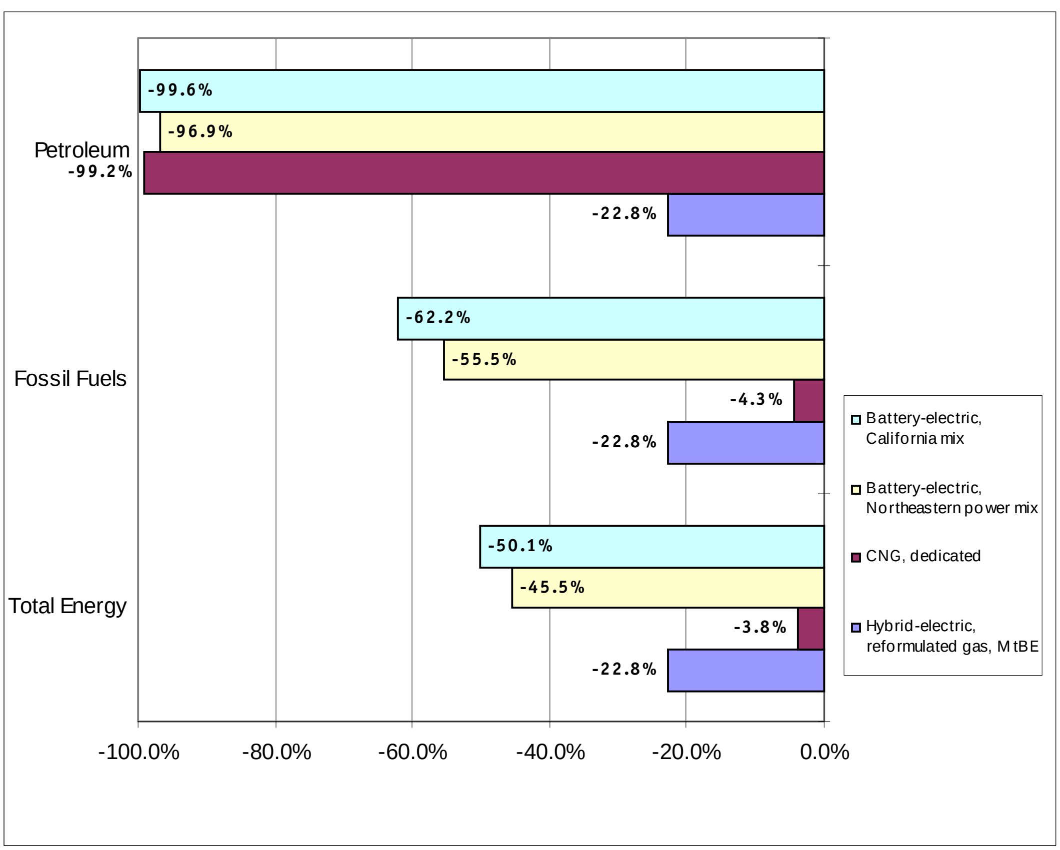
Many near-term alternative vehicle technologies have the benefit, along with lower emissions, of being more energy efficient than conventional vehicles. As Figure 2 demonstrates, battery-electric and electric vehicles are significantly more energy-efficient on a fuel-cycle basis than today's conventional vehicles.[16] On a per-mile basis, electric vehicles consume about half as much energy as conventional vehicles, while hybrid-electric vehicles use about 23 percent less energy. Again, as is the case with emissions, more energy-efficient methods of electric generation will lead to even greater gains in efficiency for electric vehicles.

ECONOMIC BENEFITS

As will be discussed in more detail below, the ZEV requirement will impose some additional new costs on automakers. However, the ZEV program also holds the promise of economic benefits for the state.

First, numerous New Jersey businesses are already engaged in clean vehicle development.

FIG. 2: DIFFERENCE IN PER-MILE FUEL-CYCLE ENERGY USE FOR CLEANER PASSENGER CARS VERSUS GASOLINE INTERNAL COMBUSTION CARS[15]



Eatontown-based Millennium Cell, for example, recently demonstrated its unique fuel-cell system – which generates hydrogen from a chemical derived from borax – in a DaimlerChrysler minivan at an electric vehicle show in California.[17] Other local businesses are involved in the development of fuel cell technologies. Establishment of a steady market for ZEVs in New Jersey could attract other such businesses to the state, creating high-tech jobs.

Second, the technological improvements brought about by the ZEV requirement will have applications well beyond vehicles. Fuel cells could have an application in distributed generation of electricity, providing individuals and businesses with a cushion against a California-style failure of centralized power generation and transmission markets without the pollution and public health risks posed by diesel generators. Advances in battery technology and electric drive systems sparked by the ZEV requirement have already found other applications both within and outside of the automotive industry.[18] Development of these technologies will benefit the economy both inside New Jersey and across the country.

In addition, as noted above, the energy efficiency benefits of the ZEV program hold the potential to safeguard the state's economy from future oil price shocks and to save individual consumers and fleets money on motor fuel.

Finally, to the extent that a shift to less-polluting or alternative fuel vehicles reduces emission of smog-forming chemicals into the state's air, the ZEV program can help New Jersey attain the ozone health standards in the Clean Air Act. Should New Jersey continue to fail to meet those standards, the federal government could eventually opt to withhold transportation funding from the state – a situation that would create severe economic consequences.

Summary

Adopting the ZEV program would have multiple benefits for New Jersey. It would lead to reduced air emissions from the vehicles covered by the program and – in conjunction with the tougher emission standards of LEV II – help New Jersey attain significant reductions in automobile emissions. It would also likely lead to improved energy efficiency for the vehicles manufactured to comply with the program. But the ZEV program potentially has even more profound benefits – hastening the development and implementation of a host of new energy technologies that have the power to transform society for the better.

New Jersey is well-suited to meet the goals of ZEV program. With reasonable effort by all concerned – automakers, state officials and the public – those goals can be readily achieved.

To evaluate New Jersey' readiness to implement the ZEV requirement, it is necessary to answer three questions:

- Do auto manufacturers have access to the technology needed to meet the requirement?
- Would consumers purchase ZEVs or near-ZEVs if they are made available?
- Can sufficient infrastructure be put in place to support vehicles produced to satisfy the ZEV requirement?

TABLE 3: LIGHT-DUTY DEDICATED ALTERNATIVE FUEL VEHICLES AVAILABLE IN MODEL YEAR 2002[19]

Manufacturer	Model	Fuel	Body
Dodge	Ram van/wagon	CNG	Van
Ford	Crown Victoria	CNG	Sedan
Ford	F-series	CNG	Truck
Ford	Econoline	CNG	Van/wagon
Ford	Ranger	EV	Truck
Ford	E-series cutaway	CNG	Van
Ford/Th!nk	Th!nk City	EV	2-seater
GM/Chevrolet	Sierra/Silverado	CNG	Truck
GM/Chevrolet	Medium-duty truck	LPG	Truck
Honda	Civic GX	CNG	Sedan
Nissan	Altra	EV	Sedan
Solectria	Citivan	EV	Van
Toyota	Camry	CNG	Sedan
Toyota	Rav4	EV	SUV

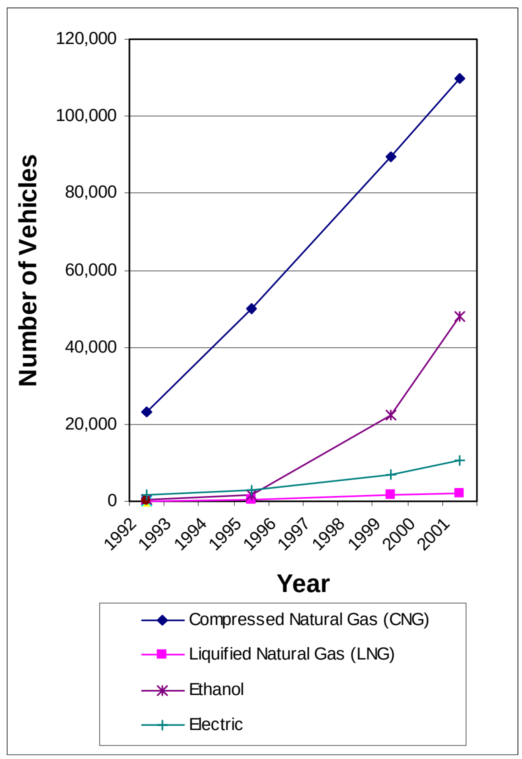
MANUFACTURER READINESS

The technology to make zero-emission and near-zero-emission vehicles is clearly available. Several technologies – including battery-electric, hybrid-electric, natural gas, and clean conventional vehicles – have the potential to fulfill portions of the ZEV requirement in the near term. And the development of new technologies such as fuel-cell vehicles promises to make the increasing ZEV sales percentages in future years of the program attainable for automakers.

Alternative Fuel Cars on the Road

Automakers are already making significant numbers of vehicles that run on fuels other than gasoline. The number of alternative-fuel vehicles on the road has nearly doubled over the last decade – from just over 250,000 in 1992 to more than 450,000 in 2001. Vehicles fueled by liquid (LNG) and compressed (CNG) natural gas, ethanol (E85), and electricity have seen the most dramatic increases. (See Figure 3)[20] Propane (LPG) remains the most common alternative fuel for vehicles, but its use has not increased significantly since the mid-1990s.

FIG. 3: ALTERNATIVE FUEL VEHICLES IN USE IN U.S. (EXCLUDING PROPANE)[21]



Excluding flexible fuel and bi-fuel vehicles (which can either run on gasoline or an alternative fuel), auto manufacturers produced 14 models of light-duty alternative-fuel vehicles in the 2002 model year, as well as a number of alternative-fuel heavy-duty trucks and buses. As can be noted from Table 3, automakers have focused their development of dedicated alternative-fuel vehicles on two technologies: CNG and electric vehicles. While it is possible that ethanol, propane and other vehicles could be manufactured to meet ZEV program standards, it is more likely that they will be met by battery-electric vehicles (currently the only pure ZEVs on the market), CNG vehicles, hybrid-electric vehicles (many of which could qualify for AT-PZEV credit), clean conventional vehicles, and a technology that some believe will be the pure ZEV of the near future: hydrogen fuel cells. This analysis will therefore focus on those vehicles.

Pure ZEVs: Battery Electric Vehicles

Major automakers (a category that includes General Motors, Ford, DaimlerChrysler, Nissan, Honda and Toyota) have already demonstrated the ability to produce battery-electric vehicles. In addition, several major automakers either are currently producing or have plans to produce electric vehicles that will be eligible for credit as pure ZEVs.[22]

From 1998 to 2000, automakers sold more than 2,300 electric vehicles in California to fulfill the terms of CARB's memorandum of agreement with the automakers.[23] In its 2000 biennial review of the ZEV program, CARB's staff was clear: "There is no technological barrier to building battery powered ZEVs; the issue is cost and consumer acceptance."[24] These issues will be addressed later in this report, but comparison of the California production figures to those anticipated for New Jersey underscores the attainability of the ZEV requirement. Should automakers produce for New Jersey as many vehicles as they did under the California MOA, they would comply with most of the pure ZEV requirement through the 2007 model year.

Toyota's RAV4-EV (shown above) is the first battery-electric vehicle by a major manufacturer available for retail sale in the United States. The vehicle went on sale in February 2002 in California.
Photo: Electric Vehicle Association of Canada

With the 2000 expiration of the memorandum of agreement, automakers took several different strategies toward future production of battery-electric vehicles. Some, such as General Motors and Honda, discontinued their EV programs. Others, such as Toyota, Nissan and Ford, continued to manufacture EVs for fleet sales. Toyota, in fact, has moved to expand the availability of its existing EV model, making the RAV4-EV – previously available only to fleets – available for individual lease.[25]

One significant recent change is the emphasis of several automakers on the marketing of "city" and "neighborhood" electric vehicles. City and neighborhood EVs are low-speed, low-range vehicles designed to serve specific travel niche markets. City EVs are appropriate for use as a second car and as "station cars" – vehicles used for transportation to and from a central point, such as a commuter rail station.

Neighborhood electric vehicles travel at slower speeds and have more limited range than City EVs. They may or may not be approved for street travel, although they have applications in settings such as college campuses, housing developments, and other locations where full-function cars might not be appropriate. DaimlerChrysler's GEM neighborhood electric vehicle, for example, has a range of 30 to 35 miles and travels at a top speed of 25 miles per hour. It also has the advantages of low price (about $7,000) and the ability to be recharged through an ordinary household outlet.[26]

City and neighborhood vehicles may not provide a long-term solution to dependence on gasoline for automotive travel, but they may displace some travel in conventional automobiles, spur further development of battery-electric vehicle technology, and provide another option for automakers to meet the pure ZEV portion of the ZEV requirement – particularly in the early years of the program. Under California ZEV rules, neighborhood EVs are eligible for ZEV compliance credits of 1.25 in 2003, 0.625 in 2004-2005 and 0.15 thereafter. City EVs are eligible for somewhat more credit, depending on their range.[27]

The number of neighborhood and city EVs that have been, or soon will be, manufactured and sold is not insignificant. As of July 2000, Global Electric MotorCars (which was purchased by DaimlerChrysler in 2001) had produced more than 5,000 neighborhood electric vehicles.[28]

It is unclear how well city and neighborhood EVs can or will be integrated into New Jersey's transportation system. The New York Power Authority is currently involved in a station-car trial project in which city EVs are leased to commuters for $199 per month. The cars can be recharged at commuter rail stations.[29] Similar programs are underway in other cities as well. Should this concept prove successful, New Jersey, with its extensive network of commuter rail lines, would be fertile territory for expansion of the program.

The future of city and neighborhood EVs is in some doubt, however, as this report goes to press. This summer, GM announced plans to "give away" thousands of neighborhood EVs manufactured by a third party for a one-year lease in an effort to bank credits under the California ZEV requirement – a move that could undercut efforts by other manufacturers to sell neighborhood EVs. Then, in late August, Ford apparently terminated its Th!nk city and neighborhood EV program, which was to begin selling vehicles to the general public in California in late 2002.

Yet, whether through the renewed production of highway-capable battery electric vehicles, the placement of larger numbers of low-speed city or neighborhood electric vehicles, or a combination of the two strategies, most major automakers would be poised to meet the pure ZEV requirement in New Jersey. Experience during the 1998-2000 memorandum of agreement period in California demonstrates that such levels of production are feasible.

Fuel-cell vehicles – like the Chrysler concept car shown above – may be years away from broad commercial viability, but the sale of small numbers of fuel-cell vehicles could go a long way toward complying with the ZEV program.
Photo: Electric Vehicle Association of Canada

Pure ZEVs: Fuel Cell Vehicles

Rapid advances in technology over the last decade have led automakers, government officials and many analysts to conclude that fuel-cell vehicles are the ZEVs of the future. While fuel cells are not expected to become commercially viable for the next decade or so, they can play an important role for automakers in meeting the pure ZEV requirement in the near term.

Fuel cells use hydrogen to create a chemical reaction that generates electricity to power a vehicle. Fuels such as gasoline and methanol can be used to generate the hydrogen needed, or hydrogen itself can be used as a fuel. When hydrogen is used, the only "emissions" from the fuel cell are water and heat. Other base fuels generate small amounts of hydrocarbon emissions (thus disqualifying them as pure ZEVs) but produce far less pollution than conventional vehicles because of their superior efficiency, and could receive AT-PZEV credit.

TABLE 4: LIGHT-DUTY FUEL CELL VEHICLES[30]

Manufacturer	Model	Body Style	Fuel Type	Development Stage	Projected Production Date
DaimlerChrysler	NECAR 4	Sedan	Hydrogen	Prototype	2004
DaimlerChrysler	NECAR 5	Sedan	Methanol	Concept	2004
Ford	FC5	Sedan	Methanol	Concept	2004
Ford/Th!nk	Focus	Sedan	Methanol	Demonstration	2004
GM/Opel	Zafira	Minivan	Methanol	Concept	2004
Honda	FCX-V3	Sedan	Hydrogen	Prototype	2003
Mitsubishi	FCV	Sedan	Methanol	Prototype	2003-2005
Toyota	FCHV V4	SUV	Hydrogen	Demonstration	2003
Toyota	FCHV V5	SUV	Methanol	Demonstration	2003

Until recent years, fuel cells have been mainly used in specialized applications such as space travel. But over the last several years, public-private partnerships at the federal level and in California have worked to bring fuel-cell vehicles to the demonstration stage. The California program, the California Fuel Cell Partnership, aims to demonstrate more than 70 fuel cell-powered cars and buses in the state by 2003.[31] In addition, fuel cell buses are being tested in several cities.

Automakers are already working toward the introduction of fuel-cell vehicles into their fleets. Table 4 lists light-duty fuel-cell vehicle projects currently being undertaken by auto manufacturers.

In fact, it appears that several automakers are in a race to be the first to introduce fuel-cell cars to the market. In July, both Honda and Toyota announced that they would begin marketing limited numbers of fuel cell vehicles by the end of 2002, earlier than the automakers' previous 2003 target date.[32]

Another important milestone for fuel cells was reached in July when Honda announced that its fuel-cell FCX vehicle had become the first to receive CARB certification as a zero-emission vehicle. Honda plans to lease approximately 30 FCX vehicles in California and Japan during the next two to three years.[33]

While hydrogen fuel cells could become the first pure ZEV to compete with battery electric vehicles, they suffer from the opposite problem as battery EVs. Battery EVs have the advantage of access to a broad power grid, but the disadvantage of lower range than conventional vehicles. Hydrogen fuel-cell vehicles, on the other hand, show promise of performing on a par with conventional vehicles, but suffer from lack of access to hydrogen as a base fuel. There are also many engineering issues that must be ironed out for fuel cells to become a practical mode of powering vehicles.

However, given the structure of the California ZEV program's credit scheme, fuel-cell vehicles do not need to be commercially viable in order to help automakers meet the requirement.

First, the ZEV program gives additional credits to vehicles based on their range. Pure ZEVs receive multipliers ranging from 1 for urban all-electric range of 50 miles or less to 10 for vehicles that get an all-electric range of 275 miles or more.[34] Ford's first-generation fuel cell vehicle, the Ford Focus FCV, is anticipated to have a range of 100 miles when introduced in 2004, but fuel-cell vehicles have already attained ranges of greater than 275 miles in testing.[35] Honda's FCX has already demonstrated a driving range of 220 miles.[36]

Second, the California ZEV rules allow manufacturers to take credit for vehicles placed in advanced technology demonstration programs, such as the California Fuel Cell Partnership, in addition to those vehicles placed in service.

Should automakers produce fuel-cell vehicles that attain a range of 275 miles, they would need to produce only one-tenth of the number of low-range battery-electric vehicles required under the program. Moreover, these vehicles could be placed in demonstration projects or with fleets, where infrastructure issues related to refueling would pose less of a problem. With every major automaker planning to have a fuel-cell vehicle ready by 2005, fuel cells could play a significant role in helping automakers meet the ZEV requirement.

AT-PZEVs: Hybrid-Electric and Natural Gas

Automakers have ample opportunities to fulfill the two percent AT-PZEV option through two already-viable technologies: hybrid-electric and natural gas vehicles.

- Hybrid-electrics are the only advanced technology vehicles being sold through the mass market nationwide. While existing hybrid-electrics such as the Toyota Prius do not yet qualify for AT-PZEV or PZEV credit, there is no technological reason why they cannot.[38] Production levels of hybrids indicate that those automakers with hybrid vehicles on the market in 2006 should be able to take full advantage of the AT-PZEV option.
- Compressed natural gas (CNG) vehicles have become increasingly popular in fleet applications. The number of CNG vehicles on the road nearly quintupled between 1992 and 2001 and now stands at more than 100,000. Four of the six major automakers sold CNG vehicles during model year 2001. Some CNG vehicles will be eligible for AT-PZEV credit.

HYBRID ELECTRICS

Hybrid-electric vehicles made their debut in the United States with the introduction of the two-seat Honda Insight in late 1999. Soon after, Toyota introduced the five-seat Prius. In calendar year 2000, the Prius and Insight sold a combined 9,300 units in the United States.[39] Worldwide, Toyota has sold more than 100,000 hybrid vehicles since 1997, and anticipates manufacturing 300,000 hybrids per year by 2005.[40]

Several other manufacturers are preparing to introduce hybrids to the American market. Honda estimates that it will sell an average of 2,000 of its new hybrid-electric Civics per month.[41] In fact, Japanese automakers are expected to introduce between 10 and 15 new hybrid models by the end of the 2003 model year.[42] As can be seen in Table 5, at least six automakers have projected the availability of hybrid-electric cars by model year 2004. Should

TABLE 5: LIGHT-DUTY HYBRID-ELECTRIC VEHICLES[37]

Manufacturer	Model	Body	Fuel	Development Stage	Date Introduced/ Announced	Projected Production Date
DaimlerChrysler	Durango	SUV	Gasoline	Prototype	Oct. 2000	2003
Dodge	Ram Pickup Contractor Special	Truck	Gasoline or Diesel	Prototype	Nov. 2000	2004
Ford	Escape	SUV	Gasoline	Demonstration	Jan. 2001	2003
GM	Silverado/ Sierra	Truck	Gasoline		Jan. 2001	2004
Honda	Civic	Sedan	Gasoline	Production	Jan. 2000	2002
Honda	Insight	Coupe	Gasoline	Production	Dec. 1999	2000
Hyundai	Santa Fe	SUV	Gasoline	Prototype	Oct. 2000	2003
Toyota	Prius	Sedan	Gasoline	Production	June 2000	2000

each of those automakers sell approximately 2,000 hybrids annually in New Jersey, they would satisfy the AT-PZEV requirement through model year 2008. Additional credits could reduce those numbers further.

Months-long waiting lists for the Toyota Prius hybrid-electric vehicle (above) have led Toyota to increase distribution of hybrids to the United States. By 2005, the company expects to sell approximately 300,000 hybrids per year worldwide.
Photo: Electric Vehicle Association of Canada

Hybrid-electric vehicles have many advantages. Their performance and range is similar to that of conventional vehicles, with better fuel efficiency and lower emissions.

However, hybrids also come with two downsides. First, while they generally achieve lower emissions and higher fuel efficiency than conventional vehicles, they are not the "transformative" technology envisioned by the original ZEV requirement. Second, none has yet been certified to receive AT-PZEV credit. Both the Honda Insight and the Toyota Prius meet the tough tailpipe emissions standards (super-low-emission vehicle, or SULEV, standards), but they do not yet meet the other requirements for PZEV credit, including zero fuel-related evaporative emissions and a 150,000-mile warranty for their emissions systems. Should automakers resolve these issues with hybrid-electric vehicles – which Nissan has already proven possible with its Sentra CA (see below) – hybrids could play a major role in fulfilling the AT-PZEV portion of the ZEV requirement.

Honda's natural-gas powered Civic GX is the first car to be certified to AT-PZEV standards.
Photo: NREL/DOE

CNG VEHICLES

Vehicles that operate on compressed natural gas also have the potential to receive credit toward compliance with the ZEV requirement. While largely limited to fleet applications, CNG vehicles have increased dramatically in popularity over the last decade, with the number of vehicles on the road increasing from 23,000 in 1992 to nearly 110,000 in 2001.[43]

To date, one CNG vehicle – the Honda Civic GX – has qualified for AT-PZEV credit. Several models of DaimlerChrysler Ram vans and wagons and Ford E- and F-Series pickup trucks meet SULEV emission standards, a major prerequisite for AT-PZEV credit.[44]

While the lack of public CNG refueling infrastructure has meant that only fleet operators could buy CNG vehicles, one should not underestimate the role fleet sales could play in helping manufacturers fulfill the ZEV requirement. In 2000, there were about 6.6 million automobiles and 6.1 million trucks in fleets nationwide. Government fleets accounted for approximately 13 percent of the cars and 39 percent of the trucks.[45]

Incentives or requirements for the purchase of alternative-fuel vehicles at the state and federal level have helped expand the use of those vehicles in government fleets over the last decade, and may be responsible for the rise in the overall number of CNG vehicles on the road.

In 1999, there were about 2,000 CNG vehicles in use in New Jersey.[46] Should CNG vehicle use continue to increase in New Jersey at the 19 percent annual rate it did nationally between 1992 and 2001, manufacturers would sell at least 1,000 CNG vehicles in the state annually by 2006, or about 11 percent of that year's AT-PZEV requirement. (See Table 6) These projections are likely conservative. Even greater sales would be expected were there to be expanded refueling infrastructure for CNG vehicles, an issue to which we will return later in this report.

TABLE 6: CURRENT AND PROJECTED CNG VEHICLES IN NEW JERSEY AT 19 PERCENT ANNUAL GROWTH RATE[47]

Year	Vehicles in use	Minimum sales
1999	1,996	
2000	2,375	379
2001	2,827	451
2002	3,364	537
2003	4,003	639
2004	4,763	761
2005	5,668	905
2006	6,745	1,077

PZEVs: Clean Conventional Vehicles

Both large and intermediate auto manufacturers would be called upon to make and sell significant numbers of vehicles that qualify for partial ZEV credit beginning in 2006 under the California ZEV rules. While the California MOA required automakers to produce significant numbers of battery-electric vehicles, no such requirement was in place for PZEVs. In addition, the number of PZEVs that would be required in New Jersey in the near term would be far larger than the number of pure ZEVs. As a result, the implementation of the PZEV standard puts automakers and the state in uncharted waters, relative to the pure ZEV requirement.

Nissan has demonstrated the ability of automakers to manufacture conventional cars that meet PZEV criteria with its Sentra CA. Nissan has combined several technologies to achieve the emission reductions and durability requirements of the PZEV standards, including: double-wall exhaust manifolds; a quicker warm-up catalyst; a new combustion control sensor; an electronically controlled swirl control valve that reduces cold- and warm-start hydrocarbon releases; and a specially coated radiator that converts ozone passing through the radiator into oxygen.[48] Nissan was expected to sell approximately 500 of the cars in 2000, though their distribution is limited to California.[49]

In its 2000 review of the ZEV program, CARB projected that automakers would have to take several steps to convert their cleanest gasoline-powered vehicles into PZEVs, including the installation of additional emission control hardware, sealed fuel systems or other systems to prevent evaporative emissions, and a commitment to repair emissions systems under warranty for 150,000 miles.[50] However, by October 2001, CARB had revised its assessment, claiming that attainment of PZEV standards would be less involved than previously thought. The cost of additional hardware, for example, is now estimated to be $60 to $85 per vehicle.[51]

TABLE 7: AUTOMAKERS' DEVELOPMENT OF ZEV-COMPLIANT VEHICLES[52]

	ZEV		AT-PZEV, PZEV, SULEV		
	Electric	**Fuel Cell**	**Hybrid**	**CNG**	**Conventional**
Honda	No vehicle	Vehicle in prototype or concept phase	Vehicle in production	Vehicle in limited production, sale to fleets OR vehicle with limited capability	Vehicle in limited production, sale to general public
Nissan	Vehicle in limited production, sale to fleets OR vehicle with limited capability	Vehicle in prototype or concept phase	No vehicle	No vehicle	Vehicle in limited production, sale to general public
Toyota	Vehicle in limited production, sale to general public	Vehicle in demonstration phase	Vehicle in production	No vehicle	No vehicle
DaimlerChrysler	Vehicle in limited production, sale to fleets OR vehicle with limited capability	Vehicle in prototype or concept phase	Vehicle in prototype or concept phase	Vehicle in limited production, sale to fleets OR vehicle with limited capability	No vehicle
GM	No vehicle	Vehicle in prototype or concept phase	Vehicle in prototype or concept phase	No vehicle	No vehicle
Ford	Vehicle in limited production, sale to fleets OR vehicle with limited capability	Vehicle in demonstration phase	Vehicle in demonstration phase	Vehicle in limited production, sale to fleets OR vehicle with limited capability	No vehicle

Key:

- Vehicle in production
- Vehicle in limited production, sale to general public
- Vehicle in limited production, sale to fleets OR vehicle with limited capability
- Vehicle in demonstration phase
- Vehicle in prototype or concept phase
- No vehicle

In short, the production of large numbers of PZEVs may present logistical hurdles for automakers. The technology to achieve that goal, however, is clearly available.

Strategies for Compliance

The above analysis demonstrates that the aggregate sales requirements within the early years of the ZEV program are eminently attainable using existing or soon-to-be available technology. But not every major auto manufacturer is equally prepared to meet the ZEV requirements.

Manufacturers such as Ford, Toyota and Honda – which have invested in technologies such as hybrids and CNG vehicles and have made progress in the development of electric or fuel cell vehicles – would be in relatively good position to meet the program's requirements. Others – such as General Motors, which is not scheduled to market a hybrid until at least 2004, and has no vehicles currently certified to SULEV emission standards – will meet the requirement only with difficulty. It is unclear how easy or difficult it will be for intermediate volume manufacturers, which have not yet been subject to any ZEV requirement, to make enough PZEVs to comply.

Table 7 illustrates the various strategies the major automakers have taken toward the development of zero- and near-zero-emission vehicles. It should be noted that the information in this chart is based on data from federal and California government sources. Automakers may have other plans for development of vehicles that have not been disclosed to these sources, or may have been updated since their publication. Firms' PZEV and AT-PZEV readiness were based on compliance with SULEV emission standards – the main, though not only, technological hurdle for eligibility for PZEV credit.

Cost

One of the most frequently heard arguments against the ZEV requirement is that it is too expensive. The ZEV requirement in New Jersey would undeniably impose new costs on automakers. However, those costs are reasonable within the context of the automotive industry and come after decades of strong profits by automakers – profits fueled in part by taxpayer subsidies of highways and oil and gas development and the assumption by the public of health costs stemming from automobile-related environmental pollution.

In its 2000 biennial review of the California ZEV program, CARB estimated the costs of technologies most likely to be used to comply with the pure ZEV, AT-PZEV and PZEV portions of the ZEV program – both in the short term, and in the long term once volume production has been achieved. In the short-term, CARB found that the cost to manufacture ZEV-compliant vehicles will range from $500 (since reduced to $200) for gasoline-powered PZEVs to $24,000 for freeway-capable electric vehicles with advanced nickel metal hydride (NiMH) batteries.[53]

However, the cost picture changes significantly when volume production (defined by CARB as 100,000 units or more) is achieved. With volume production, CARB estimates that the incremental cost of a four-passenger battery-electric car with an advanced NiMH battery will drop from $21,817 to $9,980. A similar car with a lead-acid battery would come at a cost premium of $2,848 – similar to today's hybrid-electric vehicles.

Applying CARB assumptions of the near-term incremental cost of complying with the ZEV requirement to estimates of the number of ZEV, PZEV and AT-PZEV vehicles required for New Jersey under the program leads to the conclusion that construction of those vehicles would cost automakers $72.6 million in 2006 under a New Jersey ZEV program.

The costs could be much lower. By the time a ZEV program would take effect in New Jersey, California will (barring further legal issues over the future of the 2001 ZEV amendments) have had one to three years of ZEV sales. New York, Massachusetts and Vermont will likely have had two years of PZEV sales and one year of ZEV/AT-PZEV sales. As a result, automakers will not be starting at square one when they move to supply cleaner cars for the New Jersey market.

Even under the worst case scenario, however, the costs of the program are small when considered within the broader context of automakers' business operations. For example, the $72.6 million projected incremental cost of the current ZEV program in 2006 represents:

- 0.6 percent of automakers' spending on advertising alone in the U.S. during 2000.[54]

- 0.3 percent of the $23 billion in sales by New Jersey new-car dealers in 2000.[55]

- 0.2 percent of the net profits of the six major automakers during the last fiscal year for which complete data are available.

- 0.01 percent of the gross revenue of the six major automakers during the last fiscal year.[56]

Automakers do have several opportunities to recoup some of their investment in the ZEV program.

First, the ZEV program creates some tangible financial benefits for automakers. Work on alternative fuel vehicles can qualify automakers for government research and development assistance. Federal agencies involved in alternative-vehicle research, development and promotion requested budgets totaling $615 million in fiscal year 2001.[57] Just one initiative – the Bush administration's FreedomCAR program to promote the development of fuel cell vehicles – includes a proposed budget of $150 million for fiscal year 2003.[58]

Financial benefits will also accrue to automakers through the "spinoff" of EV technologies to other vehicle lines. Technologies developed for the Toyota RAV4-EV, for example, have been used in the popular Toyota Prius, while information gleaned from EV and hybrid development programs is likely to play an important role in the development of fuel-cell vehicles.[59] The manufacture of clean vehicles could also improve automakers' corporate image. Toyota, for instance, has heavily marketed its Prius hybrid in an effort to bolster the firm's overall environmental image.

Finally, consumers could help defray the costs – or provide profit to automakers – depending on their willingness to pay more for ZEV-compliant vehicles. Many ZEV technologies provide additional value to consumers, particularly over the lifetime of a vehicle. Battery-electric vehicles, for example, generally cost less to operate than conventional vehicles, need less routine maintenance, have a quieter ride and can be conveniently recharged at home. One survey of California consumers found that about one-third of new car buyers would be "likely" or "very likely" to purchase an electric vehicle if the cost were similar to that of a conventional vehicle. Of those who expressed interest in purchasing an EV, more than two-thirds expressed willingness to pay a premium for an EV.[60]

In the case of AT-PZEVs, consumers have already demonstrated their willingness to pay a premium for hybrid-electric vehicles. The perception of lower lifecycle costs may play a role in this. CARB has estimated that fuel cost savings for hybrids would amount to $1,600 over the lifetime of the vehicle, assuming an after-tax gasoline cost of $1.75 per gallon – compared to an incremental cost for hybrids of $3,200.[61]

Consumers' willingness to pay is affected by much more than just utilitarian concerns. As the automakers' recent success in marketing sport utility vehicles indicates, a vehicle's image – and how it plays into a consumer's self-image – is critically important. Automakers' eagerness to create an image for clean cars that sells in the marketplace will thus play a significant role in customers' willingness to pay for the vehicles.

Summary

The ZEV requirement is clearly attainable to automakers with existing technology and will be even more attainable by the time a New Jersey program would go into effect in 2006. New technology, such as hydrogen fuel cells, could begin to play a role in the automakers' compliance strategy within the next three years. Attaining the goals of the ZEV requirement will not be easy for all automakers, but for most, the requirement can be met with a reasonable amount of effort. In addition, the ZEV requirement is unlikely to impose a significant financial burden on automakers.

Consumer Readiness

Provided that automakers can manufacture enough vehicles to satisfy a ZEV requirement, will anyone be interested in buying them?

While ultra-clean vehicles of the type required under the ZEV program have not yet been broadly marketed to the public, significant numbers of consumers appear ready to embrace cleaner cars. A 1997 national survey conducted by the Dohring Company found that more than 70 percent of consumers were interested or highly interested in reducing the amount of air pollution caused by their motor vehicles.[62] The enthusiastic response given to hybrid-electric vehicles since their introduction to the U.S. is yet more confirmation of consumers' willingness to purchase cleaner vehicles. Even battery-electric vehicles – long dogged by concerns about range and price – have shown strong appeal to the thousands who have had the opportunity to drive them in California and elsewhere, leading to continuing demand for electric vehicles that outstrips supply.

Combined with government policies that encourage the purchase of alternative-fuel vehicles by fleets, this consumer interest in cleaner cars should lead to healthy demand for ZEV-compliant vehicles in New Jersey.

The California Electric Vehicle Experience

As noted earlier, automakers pledged to produce limited numbers of battery-electric vehicles for sale in California from 1998 to 2000 as part of an agreement with CARB to eliminate the ZEV percentage requirement until the 2003 model year. The memorandum of agreement (MOA) period is thus one of the few opportunities to gauge real-world consumer interest in battery-electric vehicles.

Unfortunately, it is also an imperfect gauge. Only two automakers, GM and Honda, offered battery-electric vehicles to the general population, with the rest of the manufacturers focusing on fleet sales. No manufacturer produced vehicles of the most popular type on the road: four-door five-passenger sedans. And those consumers who did attempt to lease battery-electric vehicles often faced an onerous task.

A Failure of Product or of Marketing?

Both GM and Honda assert that during the early portion of the MOA period their inventories of electric vehicles far outstripped consumer demand, and that the lack of demand demonstrates that EVs are niche-market vehicles at best. While there is little reason to doubt the automakers' claims of an initially tepid consumer response, there is ample reason to doubt their conclusion. Most EV purchasers during the MOA period were forced to surmount unusual obstacles to obtain their vehicles. Those who did succeed in obtaining them were generally pleased. And the demand for electric vehicles appears to have grown, both during the course of the MOA and afterward – despite a severe lack of vehicle availability.

Individuals were not generally permitted to purchase EVs during the MOA period, even from GM and Honda. EVs were provided by those manufacturers through a three-year lease. Some leases came with restrictive 10,000-mile annual limits. Consumers testifying before CARB's 2000 biennial review of the California ZEV program cited sales staff who were unfamiliar with the vehicles, long delays in getting information, lack of clarity about their status on "waiting lists," and long delays in obtaining vehicles once orders were placed.[63]

One owner of a General Motors EV1 described the process this way:

> In order to drive an electric vehicle from a major automaker, you first have to get over the fact that you have to lease it. Then you have to figure out where you can get one. Then you have to wade through a raft of salespeople who would much rather have you purchase a gas car. . . . Once you do manage to get a hold of the right person, you have to prove to them that you can live with the "limitations" of an EV. After you have done this, you're allowed to be put on the waiting list for a car.[64]

A 2000 survey of California consumers conducted for the nonprofit Green Car Institute demonstrates that the initial lack of consumer demand for EVs during the MOA period could have as much to do with poor choices by automakers as with concerns about EVs themselves.

The survey found that about one-third of California new car buyers would be "likely" or "very likely" to purchase an electric vehicle if the cost were similar to that of a conventional vehicle. Yet the survey also showed that those consumers would be turned off by policies similar to those used by automakers during the MOA period. For example, less than 27 percent of these "EV intenders" expressed interest in purchasing the types of vehicles offered by manufacturers during the MOA period – compact pickups, sub-compact sedans or coupes, sports cars, minivans and compact SUVs. [65] Another 40 percent said they would opt to purchase a gasoline vehicle if leasing was the only option for obtaining an EV, as was the case during the MOA period.[66]

These results – along with anecdotal reports of consumer difficulty in obtaining EVs – indicate that automakers' manufacturing and marketing decisions were not properly designed to capture the maximum market share in California during the MOA period. Automakers cannot reasonably claim that the MOA period was a fair test of the marketability of EVs to the general public.

Consumer Response

Several surveys of electric vehicle owners in California show that EV drivers were generally satisfied with their experience – once they succeeded in obtaining vehicles.

One such study was conducted by the California Mobile Source Air Pollution Reduction Committee (MSRC) of 294 electric vehicle owners in March 2000. The survey found that:

- 80 percent of those surveyed were more satisfied with their EV than with their current gasoline car.
- 70 percent said they use their EV as their primary vehicle (93 percent of those had access to another vehicle).
- 74 percent said they use their EV more than three-quarters of the time. Only 46 percent said they expected to use their EV that much before taking ownership.
- 77 percent would lease another EV.[67]

Other studies cited by CARB in its 2000 biennial review found similar results.

- Almost 70 percent of California state employees who rented EVs through a state rental program said they would consider buying or leasing an EV, with many noting that EVs were easy to drive and performed well.
- Southern California Edison, which has put more than 4.5 million miles on more than 420 EVs, found that operating EVs is less costly than operating gasoline vehicles due to lower fuel and maintenance costs.
- 84 percent of public-sector fleet EV operators surveyed by Southern California Edison said they were satisfied with the performance of their EVs, and 96 percent of the agencies expressed interest in expanding their EV fleets.[68]

The results of these surveys indicate that the vast majority of those who have driven EVs in California have been satisfied with the experience. While some of those surveyed cited the vehicles' limited range as a concern, the results of the MSRC survey indicate that EVs served individuals' real-life driving needs better than most drivers had anticipated when they obtained the vehicles.

Demand But No Supply

The satisfaction of early EV owners in California and growing public awareness of EVs has led to continued interest in EVs in California, even after many automakers involved in the MOA curtailed production of electric vehicles.

During CARB's 2000 biennial review of the ZEV program, numerous individuals and fleet operators testified that they wished to purchase additional EVs, but had been unable to do so. Among those wishing to purchase or lease EVs were:

- Lessees of GM's EV1, which was the subject of a safety recall by the automaker. Lessees reported that they had been unable to lease another EV, either from GM or other automakers.

- Representatives of 14 corporate and governmental fleets.

- Southern California Edison, which had planned to put an additional 200 EVs per year into its fleet.

- CARB itself, which has been unable to obtain enough electric vehicles for its programs to place EVs with government agencies.[69]

In written testimony submitted to CARB for its 2000 review, Lisa Rawlins, an executive with Warner Brothers studios, detailed the company's frustrations with attempting to obtain EVs.

> DaimlerChrysler informed us that they were "sold out" of the EPIC electric minivan and would not be producing more until 2002. . . . Toyota informed us that their RAV-4s are all committed. . . . Nissan told us that their Altra EV is sold out for this year and that they have a long waiting list should any become available. . . . Ford told us that they may have a couple of Ranger EVs with nickel-metal hydride batteries left in the state, but they were only available at one dealer in Ventura. . . . We contacted Honda . . . (a)gain, we were told that we could be added to an already long waiting list . . .

Rawlins said that at least 50 employees of Warner Brothers identified themselves as seriously interested in buying or leasing electric or other clean vehicles. "To say that we were frustrated by the lack of product and unresponsiveness of the automakers is an understatement," she said.[70]

Another informal survey identified California fleet buyers interested in purchasing up to 9,000 additional EVs over the next several years.[71]

While there can be no guarantee that the New Jersey market would directly mirror that of California, a similar public response can be expected. It is also important to recall that the number of EVs to be sold in New Jersey in the short-term – fewer than 3,200 by 2007 under the current ZEV rules – can be satisfied through the development of niche markets, such as local government and corporate fleets and "early adopters," rather than a general market.

The California MOA experience suggests that automakers did not allocate sufficient time and resources to nurture the development of a market for a relatively new technology, but instead opted to cut their losses after a period of only a few years when the specific requirements of the MOA had been met. If this was indeed the case – and the above predictions of consumer interest in EVs hold true – it would make a strong argument for the necessity of steadily increasing EV sales requirements to create a stable market in New Jersey.

Clean Vehicles in Fleets

Evidence from state and local fleets across the country indicates that alternative-fuel vehicles can be a particularly good fit with fleet operations.

The U.S. Department of Energy's National Renewable Energy Laboratory conducted two 1999 surveys – one of city and state fleet drivers and one of fleet managers – in an effort to gauge reaction to a host of alternative fuel vehicles.

Fleet managers reported the following:

- Fleets with electric and E85 (ethanol) vehicles as their primary alternative fuel vehicle types reported the highest percentages of satisfaction of any alternative fuels. More than 60 percent of state fleet managers and 40 percent of city fleet managers reported being "very satisfied" with their electric vehicles.

- Most fleet managers indicated that drivers wanted to drive electric vehicles.

- More than 80 percent of state fleet managers reported receiving an equal number of complaints about EVs as about gasoline-powered vehicles. Equal numbers of managers reported receiving more complaints or fewer complaints about EVs than conventional vehicles.

- Fleet managers were less satisfied with the CNG vehicles in their fleets, although satisfaction levels were higher for vehicles made by original equipment manufacturers than for vehicles subjected to after-market conversion to CNG power.[72]

Fleet drivers reported the following:

- Among city drivers, 96.2 percent of dedicated CNG vehicle drivers rated overall performance as excellent or very good, as did 66.7 percent of EV drivers. Among state fleet drivers, 85 percent rated performance of their dedicated CNG vehicles as excellent or very good and 58 percent reported overall performance of their electric vehicles as excellent or very good.

- Among city fleet drivers, 66.7 percent said they were "very satisfied" with their EVs and 38 percent were very satisfied with their dedicated CNG vehicles. Among state fleet drivers, 41.9 percent said they were "very satisfied" with their electric vehicles and 38.5 percent were very satisfied with their dedicated CNG vehicles.

- Nearly all state and city fleet EV drivers, and more than half of dedicated CNG vehicle drivers, would recommend an alternative-fuel vehicle to others.[73]

NEW JERSEY

New Jersey has had limited experience with alternative vehicles in state fleets. In 1999, Gov. Christine Todd Whitman issued an executive order that committed the state to going above and beyond the requirements of the 1992 federal Energy Policy Act (EPAct) in its purchase of alternative-fuel vehicles.

A 2000 report by the Office of the State Auditor found that the state had indeed achieved its purchasing targets – placing more than 1,000 alternative-fuel vehicles in its fleet. However, it questioned the state's strategy of purchasing mostly bi-fuel vehicles, which can run on either an alternative fuel or conventional fuel. The report noted that, as of July 2000, 73 percent of the dual-fuel cars purchased by the state had never been operated on the alternative fuel, CNG.[74] The report suggested that this was the result of New Jersey's limited fueling infrastructure for CNG vehicles, a topic to which we will return later in this report.

New Jersey has also purchased limited numbers of hybrid-electric vehicles for state use and operated a station car program using electric vehicles at the Morristown train station in the late 1990s.

State officials have also worked to increase the use of alternative-fuel vehicles by municipal and county governments. With $500,000 in funding from the federal Congestion Mitigation and Air Quality (CMAQ) program, the state has established a rebate program for local governments and other public entities interested in purchasing clean vehicles. To date, the program has supported the purchase of approximately 34 vehicles, most of them powered by CNG.[75]

Should modest improvements be made in CNG fueling infrastructure – and should the state reorient its alternative-fuel vehicle purchasing strategy to focus on the purchase of dedicated, rather than bi-fuel vehicles – the state could be a significant customer for automakers seeking to comply with the ZEV requirement. If the state continues to purchase nearly 900 alternative-fuel vehicles per year for its fleets, as it did in 2000, and if all of those vehicles were AT-PZEVs, state purchases alone would fulfill about one-tenth of the AT-PZEV requirement through the 2007 model year. That number could be expanded should municipal, institutional and business fleets follow the state's lead and incorporate significant numbers of clean vehicles.

The Rush for Hybrids

No development in recent years demonstrates more clearly the demand for cleaner cars than the rush by consumers to snap up the first generation of hybrid-electric cars sold by Honda and Toyota beginning in late 1999.

Consumer demand for hybrid vehicles has been strong from the very start. Toyota, which has been marketing its hybrid Prius in Japan since 1997, received nearly 1,800 orders for the vehicles from its Web site before a single Prius had arrived in a dealer showroom.[76] Demand was also strong for the Honda Insight, a two-seater with less broad market appeal than the five-seat Prius. Demand for both vehicles spawned months-long waiting lists in parts of the country.

Within 18 months of their introduction to American consumers, both Honda and Toyota had taken steps to increase the availability of hybrid vehicles, with Honda increasing Insight availability by more than 50 percent for the 2001 model year and Toyota increasing the U.S. allotment of Prius cars by more than 40 percent.[77]

The demand for the Prius and Insight could be just the tip of the iceberg. A recent J.D. Power and Associates report found that 60 percent of new vehicle buyers would consider buying a hybrid-electric vehicle. Nearly one-third of those said they would still buy a hybrid even if the added cost of the vehicle was not fully offset by fuel savings.[78]

Automakers are clearly confident that sustainable demand exists for hybrid-electrics. Honda is launching a hybrid version of its popular Civic small car and plans to sell as many as 2,000 of the vehicles per month nationwide, Toyota is planning to ramp up production of its hybrid models, and several American auto manufacturers are nearing introduction of their own hybrids.

If they are correct, hybrid-electric technology could give automakers a clear way to satisfy the AT-PZEV or PZEV portions of the ZEV requirement, provided that they invest in the additional evaporative emission controls and enhanced warranties needed to meet PZEV criteria. The initial enthusiasm consumers have shown toward the Insight and the Prius – even at a time of low gasoline prices – augurs well for the sales of hybrid-electrics in the future.

Pricing

One factor that will inevitably affect consumer demand for ZEVs is price. For the majority of vehicles covered by the ZEV program, price is unlikely to be a major deterrent to consumer purchases. Even for more-expensive electric vehicles, automakers will have strong incentives to keep prices within reach of consumers. New Jersey consumers are also unlikely to see broad increases in new car prices as a result of the program.

The issue of pricing is very different from the issue of automaker cost. While the cost of new technologies to automakers is fixed (at least in the short term), pricing is a result of strategic decisions by automakers designed to achieve specific goals within a given marketplace. Automakers may set pricing to move product, to maximize short- or long-term profits, to improve reputations, or to gain competitive advantage.

With regard to PZEVs, whose incremental cost of manufacture is small, consumers are unlikely to see a significant difference in price versus conventional cars. Nissan, for instance, has decided not to recoup the incremental costs of its Sentra CA PZEV from California consumers.[79] As noted above, consumers have already demonstrated a willingness to pay more for hybrid-electric vehicles due to their lower lifecycle costs.

For electric vehicles, automakers' pricing decisions will depend on their time horizon for earning profits from the vehicles. The Green Car Institute, in a study of future EV pricing, posed three scenarios based on automakers' previous marketing efforts with new vehicle lines. To break even on their investment within five years, manufacturers would need to charge approximately $37,000 to $42,000 for their electric vehicles.[80] Two other scenarios, in which the price of EVs eventually reaches $27,000, would bring significant short-term losses, but would build volume. The study's authors concluded that pricing a vehicle initially at $20,000, with the price gradually rising to $27,000, would bring about sufficient volume that manufacturers could begin to make money on each vehicle sold by year five.[81]

An automaker seeking to maximize long-term profits and gain position in the EV market, then, would choose not to pass on the full costs of EVs to consumers in the short run, choosing instead to build volume. Once volume production is reached, the incremental cost of each vehicle falls, and profitability becomes possible at a lower price than would otherwise be the case. Because the ZEV program will require higher numbers of pure ZEVs in future years, such a strategy appears to be a more rational course than producing limited numbers of EVs at break-even prices in the short term.

In its initial marketing of the RAV4-EV to the public, Toyota appears to be steering a middle course. The list price of the small SUV, which is to be distributed in California, is $42,000, but a $9,000 credit from CARB and the $3,000 federal tax break reduces the cost to consumers to $30,000, which includes an in-home charging device.[82] Toyota, it should be noted, faces no competitive pressures in the EV market at present, since it is the only major automaker selling full-function EVs directly to consumers.[83]

General Motors has apparently decided to take a different pricing approach to comply with the pure ZEV requirement, opting to dump thousands of low-speed neighborhood electric vehicles on the market for free in order to bank ZEV early introduction credits that could enable the company to avoid the manufacture of full-function ZEVs for years to come. While billed as a "giveaway" of EVs, the businesses and charitable organizations receiving the vehicles will only be able to use them for one year, and then be given the option to buy. While the plan would clearly be a benefit for those who receive the vehicles, it has the potential to torpedo the commercial viability of neighborhood EVs sold by Ford, DaimlerChrysler and other manufacturers.

Of course, there is another option for automakers to recover the cost of ZEV production through pricing: increase the prices of all their products. In response to CARB's January 2001 proposed changes to the ZEV requirement, General Motors submitted a report by National Economic Research Associates and Sierra Research, Inc. that claimed automakers would spread the costs of the ZEV requirement across all their California vehicles, resulting in significantly higher prices for consumers. Using different figures but the same basic assumptions, CARB estimated the increase at only $36 per vehicle.[84] However, CARB also questioned why automakers would only choose to spread the costs to California vehicles, and, more fundamentally, whether automakers would have the freedom to raise prices *at all* in a competitive marketplace. An automaker that chose not to pass on the increased costs of ZEV production would presumably gain a competitive advantage in the automotive marketplace over one that did.

The competitiveness of the automotive market, therefore, limits the degree to which consumers will face increased overall vehicle prices as a result of the ZEV requirement. The prices of vehicles covered by the requirement will depend on strategic decisions by automakers and the complex workings of the market, but automakers would have substantial incentives to keep prices of ZEV-compliant vehicles low in the short term.

Incentives

To the extent that ZEV purchasers are asked to pay more for their vehicles, federal and state incentives can also help consumers defray those costs.

Federal incentives include tax deductions of $2,000 to $50,000 for purchase of clean fuel and hybrid cars, trucks, vans and buses. Deductions for clean fuel passenger vehicles are $2,000. In addition, a tax deduction of up to $100,000 per location is available for installation of refueling or recharging stations by businesses. However, this incentive is scheduled to be phased out beginning in 2004 and will end entirely in 2007.[85] The federal government has also offered a tax credit of up to 10 percent of purchase price or $4,000 toward the purchase of electric vehicles. This tax credit, however, is in the process of being phased out, and will end entirely in 2005.[86]

Both the U.S. House and Senate have included subsidies for hybrid and alternative-fuel vehicles in their versions of comprehensive energy legislation. The fate of that legislation remains uncertain as this report goes to press.

At the state level, New Jersey has offered rebates of $2,000 to $12,000 for local governments, universities and other public entities to purchase alternative fuel vehicles.[87] New Jersey does not currently offer tax incentives for the purchase of alternative-fuel vehicles.

Many states, however, provide either monetary or non-monetary incentives to encourage the use of ZEVs and alternative fuel vehicles. For example:

- At least five states allow certain types of alternative-fuel or clean vehicles to use the states' high-occupancy vehicle (HOV) lanes, regardless of the number of people in the car.

- At least 12 states provide tax credits or rebates toward the purchase of clean or alternative-fuel vehicles. California provides grants of up to $9,000 toward the purchase of an electric vehicle through the end of 2002, and grants of up to $5,000 for purchases made through the end of 2004.

- Several states provide partial or total exemptions from sales tax for the purchase of clean or alternative-fuel vehicles.

- Washington state exempts hybrid-electric vehicles that get at least 50 miles per gallon from the state's emission control inspection program.[88] In addition to providing a convenience benefit to consumers, such an exemption could potentially provide a budgetary benefit to the state.

Local governments and utilities have also instituted incentives of their own. Electric vehicles with an HOV lane sticker receive free parking in metered spaces in Los Angeles and several other California cities. Electric utilities and natural gas companies in California and elsewhere provide discounted rates or other forms of assistance to clean vehicle drivers.

While budget limitations will make it difficult for New Jersey to provide large monetary incentives to large numbers of ZEV drivers, a thoughtful mix of tax and non-financial incentives could make clean vehicles even more attractive to consumers in the state.

Summary

Consumers appear ready for the ZEV program and, together with fleet purchasers, should provide a substantial market for the vehicles once introduced.

- The California experience with electric vehicles has shown that EVs are highly attractive to specific segments of the motor vehicle consumer base – particularly those with strong concern for the environment or a propensity to be "early adopters" of technology. These users have demonstrated their willingness to make significant sacrifices in order to obtain EVs, and their numbers are significant.

- The experience of electric vehicle drivers has been generally positive, and most would lease or buy another EV or recommend it to others. Fleet experience with EVs and CNG vehicles has also been generally positive, although some concerns remain. Overall, in the places where clean vehicles have been introduced, they have fared well.

- The initial surge in demand for hybrid-electric vehicles – and the continuing demand for battery-electric vehicles – is an indication of the strong consumer preference for clean, efficient cars, and suggests that consumers will purchase ZEVs in the numbers required by the program.

- Lack of availability has been the primary drag on the development of an electric vehicle market, while infrastructure concerns have reduced the attractiveness of CNG vehicles. The California MOA experience proves that manufacturers will only supply EVs in the short run with a government requirement.

- Price is unlikely to be a substantial obstacle to consumers wishing to purchase ZEV-compliant vehicles or other new automobiles in New Jersey.

In addition, as noted in the previous section, experiments with city and neighborhood EVs could create new markets for the vehicles in years to come.

INFRASTRUCTURE READINESS

The development of appropriate alternative-fuel infrastructure is clearly the area in which New Jersey would have the most work to do to prepare for a ZEV program. Fortunately, however, the state has ample time to bring such infrastructure into place before large numbers of alternative-fuel vehicles would hit the road in New Jersey.

First, it is important to keep the need for infrastructure in perspective. The vast majority of vehicles needed to comply with the ZEV program – more than 98 percent over the 2006 to 2012 period – could be manufactured to run on conventional fuels. These vehicles will require no special infrastructure.

Second, for those vehicles that are powered by alternative fuels, California and New York have established themselves as models for the quick development of refueling infrastructure. With state leadership and the use of public money to leverage private investment, New Jersey could follow their lead.

Finally, the establishment of alternative-fuel infrastructure need not be prohibitively expensive or time-consuming. The establishment of electric vehicle charging stations is relatively inexpensive, and standardization of charging mechanisms will likely lead to further reductions in price. CNG fueling infrastructure is more costly, but strategic decisions on the location of CNG fueling stations – combined, perhaps, with financial help from the natural gas industry – could lead to New Jersey having sufficient CNG fueling infrastructure in place within the next several years.

Electric Vehicle Infrastructure

One of the most significant benefits of electric vehicles is their ability to be recharged overnight at home – in effect, giving drivers a "full tank" each morning without ever having to visit a filling station. However, many electric vehicle owners also want the convenience and added range provided by public charging stations. Unlike gasoline filling stations, public EV charging stations tend to be placed in locations where cars sit idle for long periods of time: shopping centers, places of employment, and commuter parking lots.

RESIDENTIAL RECHARGING

The cost to install home charging stations for electric vehicles is generally not great. According to CARB, conductive charging systems are likely to cost between $700 and $1,400, now that they have been chosen by CARB as the standard charging system for EVs. Installation costs typically run less than $1,500. Auto manufacturers in California have often included chargers with the EVs they lease or provided grants to help defray the cost, and Toyota is currently including home charging devices in the sticker price of its RAV4-EV.[89]

The essential components of an EV charging system include electrical service to the site, on-site wiring, and the EV charging equipment itself. There are several types of EV charging equipment, each with different requirements. Some deliver AC current directly to the vehicle, while others rely on equipment to convert household electricity to DC current. Some include conductive chargers that convey electricity through metal-to-metal contact, while others charge through magnetic induction of electricity. All must include features to ensure safety during operation. The type of charging system used dictates any changes in wiring and electrical service that must be made.

In the past, automakers were evenly split in their support for inductive and conductive charging systems, leading to consumer confusion, added investment in multiple public recharging platforms, and limited prospects for volume production. CARB's 2001 choice of on-board conductive charging as the standard charging system for EVs (effective in 2006) will resolve many of these problems and should ease the installation of both public and private charging infrastructure.

Residential recharging stations can also be installed quickly, generally with seven to 10 days lead time.[90] Complications can arise when residential sites do not have the minimum electrical capacity needed to support EV charging, but most single-family homes have sufficient capacity for overnight EV charging.[91]

Residential charging of EVs also requires the development of a regulatory framework to ensure public health and safety. Installation of EV charging equipment requires the involvement of local wiring inspectors and utilities. Electrical codes may also dictate siting and other conditions for the installation of chargers – conditions that might necessitate additional costs for homeowners such as improved lighting or running electrical conduits to outside garages not currently connected to electrical lines.

In short, the installation of EV recharging is possible for most owners of single-family homes in New Jersey at a reasonable cost, relative to the cost of the vehicle. Those costs should continue to decline over time and can be offset by manufacturer rebates and, perhaps in the future, incentives or off-peak electric pricing from electric utilities.

PUBLIC RECHARGING

Many, though by no means all, electric vehicle users turn to public recharging stations to extend the range of their vehicles. A 1998 survey of California electric vehicle users found that 46 percent use public charging at least once a week while 37 percent rarely or never use public charging stations.[92]

New Jersey currently has no public EV charging stations. However, the installation of public charging capacity can be done quickly and at reasonable cost. Public EV charging stations can be installed for approximately $5,000 to $7,000 at new construction sites or $10,000 at existing sites. The cost for installing additional chargers at a single site is significantly lower.[93] As is the case with residential installations, sufficient electrical capacity must exist to support the chargers.

California has shown that it is possible to create public charging infrastructure in a relatively short time-frame. From 1997 to 2000, the number of EV charging stations in the state jumped from 197 to 335, a 70 percent increase.[94] Because EV recharging practices are so different from gasoline refueling, it is difficult to place a number on how many public charging stations would be needed in New Jersey.

In California, the cost of electric charging stations has generally been covered by a combination of station owners, automakers, local governments and state government funds through the Petroleum Violation Escrow Account and the U.S. Department of Energy Clean Cities grant program.[95] Additional potential for funding exists through the federal Congestion Mitigation and Air Quality (CMAQ) program, which provides funding for projects that reduce vehicular air pollution. In addition, businesses that install electric vehicle charging stations can be eligible for federal tax deductions of up to $100,000.

Private businesses may also have incentives to create public charging opportunities. Costco wholesale stores, for instance, have installed EV charging stations at more than 50 stores in California, Florida, Arizona and Hawaii.[96] Provision of EV charging opportunities by retailers is an additional perk to customers, particularly those who drive long distances to reach a store. Employers could also provide EV charging – however, this would be effective only for employers that have significant numbers of EV-driving employees, or for those that use EVs in their fleets. Electric utilities could also play a role in helping to expand EV infrastructure.

Clearly, there is no technological barrier to the erection of a sufficient public EV charging infrastructure in New Jersey within the next several years, and there are many potential sources of funding – both public and private – for the construction of EV charging facilities. State funding for alternative-fuel infrastructure development (beyond the infrastructure needed for state fleets) would be beneficial, but is unlikely to be substantial at a time of budgetary shortfalls.

The state can, however, play a critical role by demonstrating leadership in the development of EV infrastructure. The development of a comprehensive plan is necessary to ensure that public and private money spent on EV charging infrastructure is invested wisely. The state can also play an important role by using federal funds to leverage additional private investment in charging infrastructure.

Efforts such as the U.S. Department of Energy's Clean Cities program provide a good model for how the public and private sectors can work together to promote alternative fuel vehicles and the development of refueling infrastructure. However, the ultimate responsibility for leadership rests with the state.

Natural gas fueling stations like the one above can be expensive to install, but strategic location of fueling stations could expand the market for CNG-fueled vehicles.
Photo: DOE/NREL

CNG Vehicles

The construction of CNG refueling infrastructure poses different problems than EV recharging. Because CNG vehicles are refueled in a similar fashion as conventional vehicles, the need exists for centralized refueling facilities – either private ones for fleets or "natural gas stations" for the public.

Currently, New Jersey has about 30 CNG fueling sites, none of which are open to the public.[97] New Jersey currently has only one CNG fueling station for state vehicles, limiting the ability of the state's 1,000-plus bi-fuel CNG vehicles to run on the alternative fuel. However, two more CNG stations for state vehicles are planned for installation within the next year.[98]

Surveys of city and state fleet alternative-fuel vehicle drivers indicate that fueling stations must be within five miles to be considered convenient.[99] The California Energy Commission projects the need for 2,500 CNG fueling stations in that state.[100] Applying these two figures to a state the size of New Jersey, the state would ultimately need somewhat more than 100 CNG fueling stations statewide to attain full coverage.

The cost of building a CNG fueling station can be high. Fast-fill stations of mainstream size cost approximately $500,000 to construct, with public access stations significantly more expensive than private-access ones.[101] The high costs of CNG refueling stations have generally limited construction to firms with CNG fleets that can refuel centrally and natural gas suppliers.

However, there is significant potential for the expansion of public and fleet CNG infrastructure. In New York State, state officials have used money from an environmental bond act to support the construction of alternative fuel infrastructure for state fleets. The plan includes a network of large fueling stations surrounded by 30 smaller stations for mid-day fill ups.[102] Through March 2000, the state had committed approximately $2.5 million for the installation of CNG infrastructure for state fleets, including the 30 fueling stations.[103]

The availability of fueling infrastructure has helped further the successful expansion of alternative-fuel vehicle use by creating "clean corridors" through which CNG vehicles can travel statewide. Since 1997, New York State has purchased more than 1,300 CNG vehicles for state fleets, along with more than 150 electric vehicles. At present, more than 2,000 of the approximately 13,000 vehicles in the New York State fleet are alternative-fueled vehicles; the majority of them powered by CNG.[104]

New Jersey can and should play an important role in the development of CNG refueling infrastructure. Highways such as the New Jersey Turnpike and Garden State Parkway serve as important interstate transportation corridors for millions of drivers. Making CNG and other alternative fuels available along these highways would not only make alternative-fuel vehicles a more attractive option for New Jersey drivers, but would also expand the attractiveness of such vehicles over the entire region.

Yet centralized refueling facilities may soon not be the only way for owners of CNG-fueled vehicles to power up their cars. Home-fueling systems could potentially enable homeowners to fuel their CNG vehicles directly from their home gas lines. Last year, Honda – manufacturer of the Honda Civic GX natural gas vehicle – purchased a 20 percent interest in FuelMaker, a manufacturer of natural gas vehicle fueling appliances. The company hopes to market a home refueling appliance within the next two years at a price of about $1,000.[105]

As with electric vehicle recharging, sources of public and private funding exist for the construction of CNG fueling stations. In particular, the natural gas industry could be called upon to provide support for efforts to expand CNG fueling capability. While the cost of CNG fueling facilities may be high, wise decisions on the location of those stations will be a key to their success. Again, the success or failure of infrastructure development depends on leadership. New Jersey should look to New York State for an example of how to bring leadership to bear to solve the CNG infrastructure problem.

Summary

Refueling infrastructure – especially for alternative fuel vehicles such as electric and CNG vehicles – represents one of the most significant obstacles New Jersey must overcome in a successful rollout of the ZEV program. It is important, however, to put that obstacle in perspective: more than one-third of the EV drivers in the California survey claim to rarely or never use public charging, while hundreds of CNG vehicles currently operate in New Jersey with only limited refueling opportunities. The addition of more fueling infrastructure, however, will dramatically expand the number of individuals, private fleets and government agencies that can fit alternative-fuel vehicles into their transportation plans. A relatively small number of facilities can go a long way to facilitating development of the market.

The good news is that New Jersey can create the necessary public infrastructure for electric and CNG vehicles by the year 2006. Neither the costs nor the lead time need be prohibitive. Government, businesses and vehicle owners all have roles to play in promoting infrastructure development. But the state must have a plan for the creation of alternative fuel infrastructure and support it with judicious application of funding from federal and state sources. Local public-private partnerships can help, but ultimately, the responsibility for leadership rests with the state.

CONCLUSION AND RECOMMENDATIONS

ADOPT THE ZEV REQUIREMENT

The adoption of the Low-Emission Vehicle II program and the zero-emission vehicle requirement would be beneficial public policy for New Jersey – reducing pollution caused by automobiles, enhancing the state's energy security, and encouraging the development of even cleaner vehicles in the future. It is also a viable public policy, given the technological advances in clean car technology over the past decade, consumer demand for clean vehicles, and the potential to create the necessary infrastructure to support the program in the near term.

OTHER MEASURES

The state of New Jersey has the power and the time to maximize the positive impact of a ZEV program in the years before it would go into effect. To achieve this goal, the state should take the following actions.

New Jersey should commit to the introduction of significant numbers of ZEV and near-ZEV vehicles.

The current ZEV program, as amended by California in 2001, is a realistic public policy option for New Jersey. The ZEV program assures that significant numbers of pure ZEVs and advanced technology vehicles would be placed on the state's roads by the middle of this decade.

New Jersey should take leadership in the development of infrastructure for alternative vehicles.

The state can play an important role in the development of alternative fuel infrastructure. State officials should provide leadership by working with multiple stakeholders to devise an alternative fuel infrastructure plan for the state. Commitments of public resources should be directed to areas of strategic importance – such as the state's interstate highway corridors – and should be used to leverage private investment in alternative fuel infrastructure. California and New York have demonstrated that state leadership in infrastructure development can pay dividends; New Jersey should follow their lead.

New Jersey should encourage and assist in efforts to educate the public about the benefits of cleaner vehicles.

Public awareness of zero- and near-zero-emission vehicles in New Jersey is low, but a public education plan leading up to the launch of the ZEV program could play a key role in the program's success. Such a program should not only clearly extol the environmental benefits of ZEVs, but should also promote the benefits to consumers and dispel the common mispersepctions about alternatve fuel or electric cars, such as worries about vehicle range and safety. The allocation of state resources to this effort would be beneficial, but there are also other public and private resources that can be also leveraged for this effort.

New Jersey should retain its goals for state purchases of alternative fuel vehicles, but refocus its efforts on the procurement of electric, hybrid, fuel cell, and dedicated natural gas vehicles.

New Jersey's alternative fuel vehicle purchasing program has been hindered by an over-reliance on bi-fuel vehicles that are rarely run on cleaner fuels. By refocusing its program on the purchase of dedicated alternative-fuel vehicles, the state can provide a steady market for alternative fuel providers as well as help the state meet any goals for the sale of ultra-clean cars under the ZEV program. Such purchases of dedicated alternative-fuel vehicles should also be matched by corresponding improvements in the fueling infrastructure for state vehicles.

New Jersey should offer tax and other incentives for the purchase of zero-emission and near-zero-emission vehicles.

While federal tax incentives to encourage the purchase of hybrid and other clean vehicles would help spur consumer demand, New Jersey should also act – as several other states have – to implement incentives for the purchase of ZEVs and near ZEVs.

We acknowledge that finding funds for such an effort at a time of budget shortfalls will be difficult, but this should not preclude creative efforts to provide incentives. For example, incentives could be financed by increasing taxes or fees on higher-polluting vehicles. Other creative programs, such as free or reduced cost parking or reduced highway tolls for clean vehicles, could also be implemented with limited cost.

APPENDIX: GLOSSARY OF ABBREVIATIONS

ACP – Alternative compliance plan for the ZEV program negotiated by northeastern states.
AT-PZEV – Advanced technology partial zero-emission vehicle credits.
CAFE – Federal Corporate Average Fuel Economy standards.
CARB – California Air Resources Board. Body charged with setting vehicle emissions standards in California.
CMAQ – Federal Congestion Mitigation and Air Quality grant program.
CNG – Compressed natural gas.
CO_2 – Carbon dioxide.
E85 – Fuel with 85% ethanol.
EPAct – Energy Policy Act of 1992, requires some fleet purchases of alternative-fuel vehicles.
EV – Battery-electric vehicle.
LEV II – Low-Emission Vehicle II program. Includes stringent limits on emissions from light- and medium-duty vehicles and the ZEV requirement.
LNG – Liquid natural gas.
LPG – Liquid petroleum gases, also known as propane.
MOA – Memorandum of Agreement negotiated between CARB and six major automakers in 1996 that eliminated interim ZEV requirements for 1998-2003 model years.
MTBE – Methyl tertiary butyl ether, a gasoline additive.
MSRC – California Mobile Source Air Pollution Reduction Committee.
NiMH – Nickel metal hydride batteries.
NO_x – Nitrogen oxides.
PbA – Lead-acid batteries.
PM_{10} – Particulate matter under 10 microns in diameter.
PZEV – Partial zero-emission vehicle credits.
SULEV – Super-low-emission vehicle; the second-cleanest emission bin under the LEV II program and a prerequisite for qualification for PZEV credit.
SUV – Sport utility vehicle.
VOC – Volatile organic compounds.
ZEV – Zero-emission vehicle.

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