



# Zero Emission Vehicles: A Dirty Little Secret

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California's decision to mandate the sale of zero-emissions vehicles (ZEVs) as a means of improving air quality in the state looked like a clear victory for the environment. However, technology breakthroughs have proven elusive, resulting in ZEVs with high costs and poor performance. If the costs of producing ZEVs and subsidizing their purchase are spread across California's new car market, consumers are likely to respond to the price increases by holding onto their older vehicles, which have much higher emissions rates. Even a small increase in their use will generate extra emissions that will more than offset emissions reductions from ZEVs.

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Even though California no longer holds the undisputed title for the worst air pollution in the United States, many areas within the state still exceed federal and state air quality standards. As policymakers in California seek effective ways to improve air quality, good intentions have occasionally resulted in some deeply flawed programs. The state's mandate for the sale of zero-emissions vehicles (ZEVs), now scheduled to take effect in the 2003 model year, falls into this category. It represents a triumph of environmental symbolism over environmental substance that will increase rather than reduce emissions while imposing substantial costs on California consumers.

Noting that vehicles generated approximately half of all smog-forming pollutants in California, the California Air Resources Board (CARB) in 1990 adopted a requirement that car companies include ZEVs in their California sales mix beginning in 1998. The requirement mandated that ZEVs should comprise 2% of all vehicle sales start-

ing in 1998, rising to 10% of sales in 2003 and thereafter. At the time of CARB's decision, it was widely expected that ZEVs would run on battery power, although other possible zero-emissions systems were not explicitly ruled out.

Despite large-scale research and development (R&D) funded by government and private sources, the technological challenges to the deployment of batteries with sufficient performance to make electric vehicles reasonable substitutes for conventionally powered cars proved to be insurmountable. Recognizing that workable zero-emission propulsion systems would not be available in 1998, CARB in 1996 delayed implementation of its ZEV mandate until 2003. Major automakers agreed to continue R&D activities and to maintain limited distribution of prototype ZEV vehicles within California. In 1998, CARB reduced the mandate for "true" ZEVs to 4% by adopting provisions that allowed manufacturers to use extremely clean advanced-technology vehicles, referred

to as “partial ZEVs,” to meet up to 6% of the overall 10% requirement.

Over the last several years, R&D efforts have made significant progress in reducing emissions from conventional vehicles through the design and initial production of fuel-efficient hybrid vehicles and the development of fuel-cell technologies. (These technologies could eventually provide viable ZEVs after cost reductions and the development of a hydrogen-refueling infrastructure.) However, although the car companies have followed through on their commitments to CARB, battery technology breakthroughs remained elusive. For example, at a recent environmental technology seminar, Toyota Senior Vice President Jim Wilson said that, despite years of research, an electric vehicle would still cost \$20,000 more to build than a comparable gasoline-powered car. CARB staff estimates a cost premium of between \$8,000 and \$20,000 for production of an electric ZEV with performance characteristics inferior to those of a conventional vehicle.

Notwithstanding the continuing shortcomings of ZEV technology, CARB voted unanimously in September 2000 to reaffirm the ZEV mandate. Unless current rules are revised, between 4%–10% of all cars, minivans, pickups, and sport-utility vehicles sold by the major car companies in California starting in model year 2003 must run on battery power. At first glance, CARB’s decision would appear to represent a victory for the environment over the manufacturers and dealers of conventional cars and trucks. A closer look, however, reveals a dirty little secret—the mandate will make the air in California dirtier rather than cleaner for the foreseeable future.

### Why the ZEV Program Will Increase Emissions

The electric car requirement will slightly reduce emissions from the average *new* car sold in California. However, the program will also raise the prices of both electric and non-electric new cars sold in the state as companies seek to recover the costs of developing and producing electric vehicles and the subsidies needed to get consumers to buy them. It is the economic response of Californians to these higher prices that will turn CARB’s good intentions into extra tons of emissions. Californi-

ans are likely to purchase fewer new cars and to continue driving their old cars longer.

If the cost of producing electric cars, as estimated by CARB, is spread across the entire new car sales base in California, previous experience with the consumer response to higher new car prices suggests that total new car purchases will fall by 2%–3%, with an offsetting increase in the retention of older cars in the fleet. While the consumer response is small in terms of numbers of vehicles, the emissions impacts will be substantial, because old cars have much higher emission rates than new ones. Yet a recent CARB staff analysis, which suggests that the ZEV program will very modestly reduce emissions from the vehicle fleet, simply ignores this consumer response and its emissions implications. Once this response is properly taken into account,

CARB’s own emissions models suggest that the emissions increase resulting from more intensive use of older cars will overwhelm the expected emissions reductions from new ZEVs.

Let’s look at the numbers. CARB’s own emissions model projects that in 2010, cars and light trucks manufactured *before* model year 2003 will emit about 20 times as much reactive organic gases (ROG) and 10 times as much nitrogen oxides (NO<sub>x</sub>) as the fleet of 2003 and newer vehicles. According to CARB’s most optimistic scenario, by 2010 the ZEV program could cut total emissions of ROG and NO<sub>x</sub> from cars manufactured after model year 2002 by roughly 10%. However, the new car fleet

is already very clean, so this is only a small reduction in tons of pollution. The emissions from older cars that would be driven more because of the program will swamp this environmental benefit. Indeed, I estimate that the extra emissions from older cars in 2010 will be 3 to 15 times CARB’s estimated emissions reduction from the new-car fleet. If the program proceeds on its present course, Californians can look forward to paying \$500 million more each year for their new cars and getting dirtier air in the bargain.

### Broader Lessons

The first lesson that could be gleaned from analyzing California’s counterproductive ZEV initiative is that new programs

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sometimes fall into old traps. Published results from my 20-year-old doctoral dissertation examined the possibility of perverse effects from tighter emissions standards for new cars in an environment abounding with grandfathered (older) cars. Indeed, a series of recent inquiries regarding my research from participants in discussions surrounding the environmental impacts of ZEVs had alerted me to the California program, which appears to be a far more glaring example of perverse effects than I ever thought possible in the early 1980s.

Second, regulatory advocates and designers appear to show selective recognition of the importance of market responses. Environmentalists have frequently called attention to the problems inherent in grandfathered emissions standards for electric power plants and criticized their contribution to the life extension of old units with high emissions rates. They have vigorously pursued remedies under existing law, such as the proposed application of new source review requirements to old plants that undertake major maintenance, as well as new legislation to force emissions reductions from older plants.

However, although the same market responses clearly affect the environmental impact of the ZEV program, actions to reduce grandfathering are probably not politically attractive because their direct impact would fall on drivers of older vehicles rather than on corporate polluters perceived to have deep pockets. Indeed, an effort by CARB's predecessor agency to require retrofits of rudimentary emissions controls on existing vehicles in California during the 1960s was quickly reversed by the state legislature in the face of consumer protests. Political pragmatism, however, should not preclude environmental advocates and planners from taking account of the economic and environmental reality of a market response to regulations in the marketplace. Their unwillingness to do so has resulted in an electric car program that is a lose-lose proposition—more emissions and higher costs.

The larger message—that the pursuit of environmentally “perfect” technology can be environmentally counterproductive once the consumer response is considered—should also be remembered as regulators consider future measures to clear the air. California consumers want a cleaner environment and are willing to pay for it. However, policymakers have the responsibility to weed out feel-good policies that squander consumers' money and fail to deliver environmental improvement.

A third lesson relates to the scope of environmental analysis. The CARB staff analysis presents a misleading perspective on implications for total tailpipe emissions by focusing exclu-

sively on emissions from new vehicles and ignoring emissions due to the market response. While analyses completed with finite time and finite resources must have some boundaries, there is no justification for choosing boundaries that deliberately crop the overall picture to avoid results that make a particular policy look less attractive.

In addition to excluding the emissions effects of consumer responses in the vehicle markets, the CARB staff analysis did not even address the potential for increased emissions of lead and other toxic metals associated with the use of battery-powered ZEVs, an issue that has received considerable attention. While the CARB staff has previously disputed estimates that each vehicle powered by lead-acid batteries requires the processing and recycling of 80 times more lead than a conventional vehicle, there is simply no basis for completely ignoring the environmental implications of sharply increased lead use contained in the CARB staff analysis itself. Government agencies have a particularly strong obligation to provide neutral predecisional analyses rather than advocacy-type analyses designed to support a particular policy choice.

A final lesson is that it is increasingly important to accurately characterize market responses in evaluating policies that seek small emissions reductions at high cost. The analysis of ZEV impacts summarized here reflects the extensive literature on price responsiveness in vehicle markets, but additional refinements could be made. ZEV opponents would probably claim that my calculations understate the resulting rise in emissions as ZEVs come into use by failing to account for the poor performance of ZEV vehicles. They note that the driving range between charges is too short, the time required to change batteries is too long, and there is a shortage of recharging stations. Because of these shortcomings, subsidies will have to exceed the extra cost of production to make enough consumers choose these vehicles to meet the mandate, resulting in a larger increase in the use of old high-emitting vehicles as the market response.

On the other side of the coin, ZEV advocates would point to some extra benefits available to ZEV owners. Some consumers will place a high value on being first to adopt new technology, while others will relish cutting their direct dependence on petroleum-based fuels. A state law passed in July 2000 provides the additional perk of access to freeway carpool lanes, even when driving alone. ZEV drivers can also park for free at the Los Angeles International Airport, park in more convenient locations at some shopping malls, drive through public toll roads without

paying, and receive free electricity at the Los Angeles Department of Water and Power headquarters, Costco stores, and other businesses in southern California. Some ZEV advocates even suggest that California should get a free ride, recommending that the car companies' stockholders or new car buyers outside the state cover ZEV costs. Whether ZEV opponents or ZEV advocates are correct, consumer response would appear to be a fruitful area for additional research.

### The Good News

Although I expect that the ZEV program as presently constituted will hurt rather than help air quality, the big picture is that the air is getting cleaner in California. In the 1970s, Los Angeles residents experienced over 100 Stage 1 smog alerts each year, indicating that ozone concentration had reached a very unhealthy level—an average of 0.20 parts per million for one hour. Policymakers took immediate action to curb emissions from vehicles, factories, and power plants. During the 1990s, air pollution was significantly reduced—Stage 1 smog alerts were announced no more than 14 times per year—and this year, the South Coast Air Quality Management Board boasts that the greater Los Angeles metropolitan area has not had any Stage 1 episodes for the second year in a row.

Despite improvements to date, more than 95% of Californians reside in areas that still do not comply with current federal or state air quality standards. However, further improvements in emissions performance—as more cars emitting fewer pollutants are driven on California freeways—would significantly reduce vehicle emissions despite continued increases in vehicle use. For example, total ROG and NO<sub>x</sub> emissions from cars and light-duty trucks in California are projected to fall by roughly 75% between 2000 and 2020, despite a projected 35% increase in vehicle miles traveled. These estimates reflect programs that

are already on the books—further improvements that might be implemented before 2020 could further reduce emissions.

It is also not too late for California to limit the damage from CARB's decision to affirm the ZEV mandate. In December 2000, just as this article was being finalized, CARB staff issued a new proposal to revise the ZEV program that CARB will consider in January. On the positive side, the new proposal would reduce the number of "true" battery-powered ZEVs required, reducing the level of costs and emissions increases resulting from the program. However, the CARB staff again missed an opportunity to provide credible estimates of environmental impacts by failing to incorporate likely consumer responses in their analysis. Additional elements of the new staff proposal—such as the introduction of factors unrelated to emissions performance into the ZEV credit system, and a "ramp up" of the overall ZEV target to 16% over the 2009 to 2018 period—appear likely to weaken the program's focus and performance compared to the current ZEV rules.

Other, better options are available. If politics preclude a complete retreat from the electric car mandate, for example, the state could provide increased tax subsidies to the purchasers of electric cars, an action that could reduce emissions increases by moderating price impacts in new car markets and the resulting shift away from new cars. The state could also improve air quality and save consumers money by expanding options for manufacturers to earn credits toward their ZEV obligation by identifying and implementing emissions reductions from any in-state sources that would not otherwise be obligated to make those reductions.

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