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The origin of California's zero emission vehicle mandate

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ABSTRACT

The California Zero Emission Vehicle (ZEV) rule, adopted in 1990, is arguably one of the most daring and controversial air quality policies ever adopted. Some consider it a policy failure, while others credit it with launching a revolution in clean automotive technology. This paper is the first systematic empirical study of the policy process that resulted in the adoption of the ZEV mandate. We draw upon theoretical frameworks of the policy process, empirical data from public documents, and personal interviews with key stakeholders, to explain how a confluence of technology, policy, and political circumstances created a window of opportunity that led to the adoption of this policy. We expect the conclusions of our analysis to be useful to other policy debates that involve technological innovation.

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1. Introduction

The California Zero Emission Vehicle (ZEV) rule is arguably one of the most daring and controversial air quality policies ever adopted. Adopted in 1990 as part of the Low Emission Vehicle (LEV) program, and subsequently known as the ZEV mandate, it required major auto companies to “make available for sale” vehicles with zero criteria-pollutant tailpipe emissions. Some consider the ZEV mandate a policy failure; others credit it with launching a revolution in clean automotive technology.

Various assessments of the ZEV program have been conducted (e.g. [Shnayerson, 1996](#), [Doyle, 2000](#), [Burke et al., 2000](#), [Dixon et al., 2002](#), [Shaheen et al., 2001](#)), but none are comprehensive scholarly reviews of its adoption. As noted in [Kemp \(2005\)](#), “[t]here does not exist a detailed analysis of the genesis of the LEV programme.”

The goal of this paper is to document and explain the origins and adoption of the ZEV mandate. We investigate how this milestone policy came into being, focusing on the role of particular stakeholder groups and the regulatory process itself. Our goal is not to judge the merits of the rule, but rather to describe and explain the interplay of interest groups and policymakers. We explain how and why the ZEV mandate unfolded as it did, and elicit lessons learned.

We organize this paper as follows. In Section 2 we describe methodological issues and the theoretical framework; in Sections 3–7 the policy setting, statutory process, and other aspects of the adoption process; and in Section 8 our overall findings.

2. Research approach and data

To guide the analysis, we use the Multiple Streams (MS) theoretical framework, first developed by [Kingdon \(1986\)](#), with the main elements borrowed from the “garbage can model” of organizational choice introduced by [Cohen et al. \(1972\)](#). The central tenet of the Multiple Streams (MS) framework is that policy agendas are set by the dynamics of three “streams” of

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processes that are essentially independent of each other: a stream of problems, a stream of policies, and a stream of politics (the 3P's). While we find that this assumption of independence between streams is oversimplified, MS provides a useful framing of the ZEV policy process.

The assumption of independence has one important qualification. When the streams do intersect they create “policy windows” – opportunities for policy actors to push for their views of policy problems and solution alternatives, and to elevate them to the policy agenda. Kingdon (1995) defines an agenda as “the list of subjects or problems to which government officials, and people outside of government closely associated with those officials, are paying some serious attention at any given time” (p. 3). The ZEV mandate happened during one of these policy windows.

We use the MS framework to address the following set of research questions:

- (1) What was the general socio-political context preceding and surrounding the development of the program?
- (2) What was the statutory context?
- (3) What was the role of technical information?
- (4) How did the ZEV mandate enter the regulatory process?
- (5) How did the mandate survive political conflict to finally be adopted?

Questions 1 and 2 are related to the streams of problems and politics; question 3 relates to the stream of policy; and question 4 to the crossing of the streams and the creation of a window of opportunity. Question 5 goes beyond the MS framework.

According to MS, the processes of agenda setting and alternative selection are “highly fluid” and thus behave to some degree as chaotic systems. An underlying structure coexists with some level of randomness. Structure is provided by the constraints acting upon the emerging streams of problems, policies, and politics, as well as by the factors affecting the dynamics within and between the streams.

The data used in this study came from two main sources (Collantes, 2006):

- (a) Public documents of the policy process. We studied official transcripts of the public hearing of September 27–28, 1990, when the program was adopted; written documents submitted by stakeholders to the regulatory agency, the California Air Resources Board (CARB); and other relevant documents published by CARB.
- (b) Interviews. The corresponding author conducted a set of about 50 interviews with key individuals involved in the policy process. His sampling scheme included individuals from every major stakeholder organization. Stakeholder organizations were grouped into five broad categories: government (primarily CARB), regulated industry (automakers), environmental non-profit organizations, electric utilities, and the scientific community. A central component of our research design was to ensure the confidentiality of interviewees, and therefore he cannot disclose their names and he is the only person with direct access to the interview materials. He was successful in obtaining interviews with most of the key policy actors in the ZEV debate.

To guide the interviews, we developed, with the participation of Prof. Paul Sabatier of the University of California, Davis, a comprehensive interview structure, shown in Appendix A. The interview structure guided the interviews, but the interviews were in practice free flowing to allow for capturing of relevant information that escaped the context of the questions.

3. The socio-political environment preceding the ZEV mandate

The ZEV mandate emerged out of the larger policy debate over air quality. It did not emerge from concerns over oil, global warming, or even industry competitiveness. It emerged from the air quality debate largely because the air quality regulatory process is a well established process with broad political support and strong enforcement provisions and, very importantly, because California has special authority to regulate vehicle emissions. California is not allowed to regulate vehicle energy use, and at that time global warming was a less salient concern.

Regulatory attitudes were shifting at the federal and state levels during the Administration of President George Herbert Walker Bush (1988–1992) (Collantes, 2006). The Carter Administration (1976–1980) had aggressively pursued regulatory reform, but these efforts subsided during the subsequent Reagan Administration (1980–1988), particularly in the areas of health, safety, and the environment. By the late 1980s, concern with environmental quality was on an upswing. Public opinion was now increasingly concerned with acid rain, air pollution, ozone layer depletion, and global warming. New scientific knowledge on these problems was partly responsible for this heightened concern, together with events such as the Exxon Valdez oil spill in Alaska in March 1989 and the hot dry summer of 1988 that attracted media attention to global warming. The World Bank called the environment its leading priority for the 1990s (Landsberg, 1989).

In his first State of the Union address on February 9, 1989, President Bush said he would promote a new, more effective Clean Air Act. On July 21, 1989, the White House unveiled a sweeping proposal to amend the Clean Air Act that included a requirement that one million alternative fuel vehicles be sold in the most polluted regions of the country by 1997.

At the same time, courts were refining the principles and practice of air quality regulation. In a case brought by the Natural Resources Defense Council, the US Court of Appeals on July 28, 1987 decided, in an 11-to-0 vote, that the US Environmental Protection Agency (EPA) should use health considerations, and not cost to industry, in setting safety levels of toxic

pollutants. Judge Robert H. Bork wrote “(toxic pollutant safety levels) must be based solely upon the risk to health. The [EPA] administrator cannot under any circumstances consider the cost and technological feasibility at this stage of the analysis.” The Court did not specify any particular method for determining safety levels, but said they should be based on expert judgment and may take into account scientific uncertainty (Lewis, 1987).

In another case, brought by the Coalition for Clean Air and Sierra Club in 1988, a federal court ordered the federal government (EPA) to promulgate a plan to improve air quality in the South Coast Air Quality Management District (SCAQMD, which includes Los Angeles), if local officials failed to do so (Reinhold, 1989). The lawsuit was inspired by the fact that the SCAQMD had failed – by a long shot – to comply with the December 31, 1987 deadline to attain federal air quality standards. The region suffered 176 days with ozone levels above the standard in 1988 – far more than any other metropolitan area in the United States (Reinhold, 1989). California found itself at risk of losing federal funds for the construction of transportation infrastructure if it did not show progress toward air quality attainment. This risk tempered local political resistance to air quality regulation.

A variety of stakeholders pushed their preferred solutions, generating a stream of policy proposals. Some promoted alternative fuels. The oil industry promoted reformulated gasoline.

It was at this time that the notion of the battery electric vehicle (BEV) emerged as a prominent option. The Center for Politics and Policy of the Claremont Graduate School carried out a study partially funded by Southern California Edison on the potential of BEVs to reduce air pollution in the region (Hempel et al., 1989). The study caught the attention of the media. The study argued that BEVs were becoming attractive because new batteries were available on a demonstration basis that offered up to 122 miles on a single charge. It cautioned, though, that electric vehicles would not match conventional vehicles in terms of speed and power and that they were best suited for the second-vehicle market (Hempel et al., 1989; Koenn, 1988). In the same year, Los Angeles Council member Marvin Braude led the so-called L.A. Initiative – a solicitation for companies to manufacture and deploy 10,000 BEVs in the city of Los Angeles by 1995. The program was supported by the Los Angeles Department of Water and Power and Southern California Edison, but never fully funded. One large automaker, Peugeot, responded. Clean Transport, a small Swedish company, was awarded the contract, but eventually delivered only one prototype hybrid car.

Dr. James Lents, in early January 1988 in his second year as SCAQMD's Executive Officer, announced a campaign to recruit public support for its ambitious Air Quality Management Plan. Lents believed that the District had been excessively concerned with industry interests, to the detriment of air quality, saying, “It's my perception that on the whole our board in the last decade did not do the job they should have done” (Stammer, 1988). On March 17, 1989, the South Coast's board of governors voted 10–2 to adopt a daring three-tier plan to reduce air pollution in the region. Tier I would span the period of 1989–1998 and called for important lifestyle changes such as reducing the use of automobiles and increasing the use of public transportation. Tiers II and III envisioned automobiles progressively transitioning to cleaner fuels such as methanol, propane, and electricity, with all automobiles running on fuels other than gasoline by the year 2007. The SCAQMD Air Quality Management Plan became the first regulatory initiative to include requirements for electric vehicles.

In summary, the seriousness of the air pollution problem had risen to the agenda by the end of the 1980s, along with a belief (both in government and industry) that mainstream technologies could not by themselves solve the problem. There was a generalized sense of urgency to clean the air and a sense that drastic steps would be needed. It was in this context that the Zero Emission Vehicle mandate was adopted in California.

On September 28, 1990, at the end of a two-day public hearing, the California Air Resources Board adopted resolution 90–58 approving a Low Emission Vehicle and Clean Fuels program (later referred to as the LEV program). After due consideration of further comments, the Executive Officer issued Executive Order G-604, which amended several sections of Title 13, California Code of Regulations. In particular, Section 1960.1(g)(2) note (9) indicated that, starting in 1998, in addition to meeting the fleet average non-methane organic gases requirement, certain percentages of passenger cars and light-duty vehicles under 3750 pounds sold by any major auto manufacturers should be zero emission. The central language is as follows: “While meeting the fleet average requirement, each manufacturer's sales fleet of passenger cars and light-duty trucks from 0 to 3750 lbs LVW, shall be composed of at least 2% ZEVs each model year from 1998 through 2000, 5% ZEVs in 2001 and 2002, and 10% ZEVs in 2003 and subsequent model years” (CARB, 1990a, p. 22). This requirement for zero emission vehicles (ZEV) became known as the ZEV mandate. It was not viewed as a particularly dramatic event at the time, but rather as a small provision within the large and complex LEV program.

The rules allowed automakers to bank emission credits derived from ZEVs for use in later years (with a discount factor), and allowed manufacturers to trade excess credits to other automakers. They also had the option of paying a fine of \$5000 per vehicle in lieu of selling a ZEV. The rules fully applied to companies with sales of 35,000 vehicles or more per year, which included, at the time, Chrysler, Ford, General Motors, Honda, Mazda, Nissan, and Toyota. Intermediate volume manufacturers were required to meet the rules beginning in 2003. Small volume manufacturers were exempt, but were permitted to sell ZEV credits. The ZEV rules were to be reviewed by the Board every two years thereafter.

The California Air Resources Board is an agency of the California government. It is headed by a Board constituted of a full-time chair and 10 part-time members, each of whom represents a certain constituency. Five members are elected officials from air quality management districts (South Coast, San Diego, San Francisco Bay Area, San Joaquin Valley, and any other district). Three members have expertise in one of the following areas: public health; automotive engineering; and science, agriculture, or law. The two remaining members are unspecified citizens. (Dan Sperling was appointed to the automotive engineering seat on the Board in February 2007.) The Board oversees a staff of approximately 1000. As confirmed in our

interviews, CARB is widely viewed as having strong technical expertise, remaining somewhat independent of political influences, and being an international leader in air quality regulation.

Much of the power of CARB is due to its independence and political transparency. Unlike typical executive agencies of government, it does not formally report to the governor or the legislature for approval of its decisions. All decision making takes place in public at monthly Board meetings. And any contact by a stakeholder must be disclosed before each vote, meaning political influence is difficult to hide and stakeholders (including politicians) are deterred from trying to put pressure on the Board in ways that go against public opinion.

The agency is not, however, unresponsive to political influence. All Board appointments are made by the governor – who has the power to replace them at any time – and ratified by the Senate. Also, the legislature sets the agency's annual budget, authority that gives key legislature members some leverage to weigh in on the agency's policymaking process. We found, however, a culture of independence that is respected by all stakeholders.

As a regulatory agency, CARB activities follow statutory guidelines. In its broadest sense, the mission of CARB is to (1) attain and maintain healthy air quality, (2) conduct research into the causes of and solutions to air pollution, and (3) systematically attack the serious problem caused by motor vehicles, which are the major causes of air pollution in the State (CARB, 2006). In the particular case of the LEV program, the statutory authority came predominantly from the 1988 California Clean Air Act (CCAA), also known as the Sher Act, which enacted and amended a number of sections in the California Health and Safety Code relating to air pollution. The 1988 Sher Act required CARB to take whatever actions are necessary, cost-effective, and technologically feasible to reduce vehicular emissions of reactive organic gases by at least 35%, oxides of nitrogen by at least 15%, and other emissions to the extent feasible by 2000.

While the Sher Act became the legal foundation for the LEV program, it was soon realized that the emissions reductions required by the Sher Act would not be sufficient to meet air quality standards in the Los Angeles and the Central Valley. Moreover, the Sher Act reductions would be achieved via the normal process of vehicle turnover and enforcement of existing regulations.

AB 234, introduced by Assembly Member Bill Leonard on January 12, 1987, had a more direct influence on the development of the LEV regulation. It was aimed at accelerating the adoption of alternative fuels (particularly methanol) as a way of achieving large reductions in emissions. It was premised on a widely held belief, in both industry and government, that large reductions were possible only with a shift to new fuels.

The bill faced strong opposition from the oil companies. It was eventually passed as a watered-down study bill, creating an Advisory Board on Air Quality and Fuels to study the feasibility of the adoption of alternative fuels. A key recommendation in the report issued by the AB 234 Advisory Board was to supply alternative fuels using a complex “fuel-pool,” whereby fuel requirements were to be adopted for fuel suppliers based on the emission levels of vehicles using these fuels. The idea of the fuel-pool, however, was not perceived as an effective one in CARB, where it became known as the “fool-pool” concept.

The AB 234 report played a crucial role in two ways: (1) it planted the seed of alternative fuels in regulators' minds, setting the stage for ZEVs and (2) it introduced the revolutionary concept of averaging. Averaging provisions provided the regulatory context for establishing a ZEV standard. Until that time, all regulators in the US had applied a single uniform emission standard to all cars. As part of the LEV program, CARB created three certification categories with increasingly stringent emissions standards – Transition Low Emission Vehicle (TLEV), Low Emission Vehicle (LEV), and Ultra Low Emission Vehicle (ULEV) – plus the ZEV category.

The LEV program included mandates not only for ZEVs, but also the distribution of so-called clean fuels, a designation that included methanol (neat or blended with gasoline), ethanol, liquefied petroleum gas, compressed natural gas, and electricity. Gasoline suppliers would have to distribute specified volumes of these fuels based on the number of alternative fuel vehicles sold. CARB believed that such mandates would enable more fair competition for vehicle fuels: “[b]ecause the gasoline suppliers are required to distribute certain volumes of [alternative] fuel into the marketplace, this will ensure fuels are competitively marketed and made attractive to the consumer. . . . Market forces may not be sufficient by themselves for the transition years when these fuels are new (CARB, 1990b, p. 50). No such requirement was imposed on the dispensing of electricity fuel, however, because CARB believed that “it is better for people to use home recharging systems than to have centralized refueling facilities.”

Of the two main mandates originally proposed by CARB's staff – one on the distribution of clean alternative fuels and one on zero emission vehicles sales – only the latter survived intact. The Board, after receiving public comment, decided to drop the requirement on oil companies to distribute specified minimum volumes of alternative fuels (excluding electricity). It did, however, retain a requirement that a certain proportion of retail gasoline outlets supply a particular alternative fuel if 20,000 vehicles using that fuel were sold in a given year.

4. How the ZEV mandate was inserted into the LEV regulatory program

The inclusion of the ZEV requirements in the language of the LEV proposal was a clear manifestation of electric vehicles rising to the policy agenda, the ultimate event that MS purports to explain. According to MS, this event should be the result of policy entrepreneurs taking advantage of a window of opportunity created by the intersection of the three streams defined in previous sections. The analyses in Sections 2 and 3 have shown that the conditions in all three areas – problems, politics, and policy – were indeed present for policy entrepreneurs to push for their preferences. The situation in early 1990 can thus be characterized as a crossroad of the three streams, or a window of opportunity.

At about the same time of the AB 234 report, the staff wrote an internal report on battery ZEVs in response to an inquiry from outside the agency (and possibly also from one of the Board members, although this was not confirmed) about battery electric vehicles (BEVs). The staff's conclusion was that BEVs did not offer much promise at the time – they were limited by the cost and performance of lead-acid batteries and thus could not achieve a reasonable driving range per charge. This explains why there were no provisions requiring ZEVs in initial pre-1990 drafts of the LEV regulations.

On January 3, 1990, at the Los Angeles Auto Show, General Motors unveiled the Impact – a prototype two-seater that was designed from the bottom up as an electric vehicle. The Impact showed important progress in performance relative to previous electric cars. Speaking at this event, Roger Smith, then General Motor's Chairman and CEO, said that the Impact could go from 0 to 60 miles per hour in 8 seconds and that it could go 124 miles before recharging. "There are no yet-to-be-solved secrets," he asserted, adding that "[t]he thing is its marketability. . . We want an electric car that's producible, that can handle itself on the highway and that can meet the federal standards out there and that is a marketable product. We believe we've accomplished two-thirds of that" (Lee, 1990).

Smith was explicit about the limitations of the Impact vis-à-vis comparable standard gasoline vehicles. He indicated that, assuming 10,000 annual vehicle miles of use, the Impact would cost about \$30 per month more than a comparable gasoline auto, mostly because of the need to replace the battery pack approximately every 20,000 miles, at an estimated cost of \$1500. He apparently did not consider the cost of the vehicle nor depreciation in these cost calculations. He indicated that improvements in battery technology were expected that could extend battery life to 50,000 miles, thus making operating costs competitive with those of standard gasoline vehicles (Lee, 1990; Stevenson, 1990). Smith said that if consumer surveys showed that a demand existed such that "GM could one day profitably churn out 100,000 or so impacts annually, the company would be prepared to put much more funding into it" (Wartzman, 1990). These media reports show that Smith offered an optimistic though cautious portrayal of the Impact. This version of the events is slightly different from that given in other published accounts, which tend to focus on Smith's optimism more than his caution (see, for example, Doyle, 2000).

Not only is Roger Smith's speech one of the most famous in the history of air pollution policy, but it is also an interesting case study on the role of information on environmental regulatory activity. Many of our interviewees, primarily from government and non-profit organizations, remember that speech as a General Motors' promise to market electric vehicles by 1996. This simplified reading of General Motors' statements may be explained in part by the history of limited communication, asymmetry of information, and distrust between regulators and auto manufacturers. This context may have induced environmental groups to interpret the information as a strong indication of the company's capabilities. At the same time, as some interviewees pointed out, General Motors has a particular public relations style. In an effort to portray itself favorably in the eyes of government and the public, the company often crafts public statements in ways that may lead to misinterpretations. Some audiences may (intentionally or not) be led to believe that the company is farther along a particular technological learning curve than it really is.

It is generally believed that Roger Smith's public introduction of the GM's Impact prototype directly seeded the idea of the mandate in CARB's mind. This notion needs some clarification, however. Well before Smith's speech (possibly as early as 1988, according to our interviews), Don Drachand, then CARB's Chief of the Motor Vehicle Emissions Control Division, was convinced that eventually zero emission vehicles had to be required. In view of the expected improvements in tailpipe emissions of standard internal combustion vehicles and the growth projections of population and amount of travel, widespread adoption of ZEVs seemed the only means to achieve clean-air goals. At the time of developing the LEV emission standard, Drachand and his staff realized that emissions from vehicles seemed to deteriorate considerably as they aged. To solve the problem of emissions deterioration, Drachand proposed going all the way down to zero emissions, and adding a new regulatory category of ZEVs. These vehicles not only had no emissions, but because they lacked a combustion engine, the emissions would never deteriorate. Thus, in the earliest working drafts of the LEV regulatory program, electric vehicles were not mandated but rather treated as a means to comply with the ULEV standard. The media reported: "[t]he California Air Resources Board is considering a proposal to require that 15% of new vehicles sold by the year 2003 be so-called ultra-low emission vehicles, which would include electrics" (Lee, 1990).

Drachand and others in CARB had drive-tested the Impact at an exhibition organized by General Motors in Century City, and had been extremely impressed by it (our interviewees said this event was contemporary with the L.A. Auto Show, but they could not remember which event was first). Drachand and his staff knew it would not replace the internal combustion vehicle completely, but it struck them as a great commuting car with good performance. It was this event, more than Smith's announcement, that directly influenced the idea of a mandate. Thus, while Roger Smith's statements had no direct influence on CARB's ZEV proposal, the Impact, as a technological achievement, along with General Motors' overt optimism about it, did provide Drachand and his staff with the courage to push the ZEV requirements. California law required CARB regulations to be technology-neutral. Thus, the mandate was explicitly and consciously written for zero emission vehicles, not electric vehicles. Thus, the strategy was first to establish requirements for zero emission vehicles and then show that at least one technology could meet such standard. The impact provided Drachand with the best example of a feasible ZEV technology – the battery electric vehicle.

Drachand and his staff then briefed CARB's management on their idea, presenting preliminary estimates of emissions reductions and cost effectiveness. The Executive Officer in turn briefed the Board's Chairwoman, Jan Sharpless, who was also supportive. The decision was made internally to incorporate the ZEV mandate in the language of the LEV regulation

in 1990. In view of this description of events, Drachand can clearly be recognized as the policy entrepreneur referred to by MS.

In workshops organized by CARB, most automakers strongly opposed the ZEV proposal. To pursue adoption of a regulation, CARB's staff usually prefers to have support from at least one major auto manufacturer. If all the affected companies say a required standard is infeasible, it would be difficult for the staff to bring the proposal to the Board. CARB found such an "ally" in Ford Motor who, while not strictly supportive of the ZEV notion, did not present open opposition on the condition that sufficient lead time was allowed for and that the requirements were gradually phased in. Requiring 2% in 1998 seemed feasible to CARB at the time. To show the agency's commitment to the mandate, it was decided to increase requirements in later years, so they picked 5% in 2001 and 10% in 2003. By ramping up requirements to 10% they believed they would create the conditions for the market to take off, with no need for subsequent regulatory assistance.

LEV was technology-forcing. Such regulations are controversial and inevitably adversarial. Automakers tend to be conservative in stating what is possible, aiming to dampen regulatory zeal. In doing so, they place regulators in the difficult position of having incomplete information. Chrysler, for example, argued during the public hearing of September 1990, that the ZEV program would fail because the technology forcing standards could not bring forth the innovations needed in the required timeframe. CARB, on the other hand, believed, based on past experience with emission control technology, that such advances were possible. "The ARB has historically set the pace for manufacturers to meet progressively more stringent vehicle emission standards," maintained the agency (CARB, 1990c).

A number of stakeholders, including Ford, Mercedes, Chrysler, and Volvo, believed that zero emission vehicles should not be mandated, but rather be considered a goal. CARB was confident, however, that a mandate, and only a mandate, would ensure that developments in battery technology would be pursued.

5. The role of scientific and technical information

MS's stream of policies is directly determined by the set of alternative solutions available to address the policy problem. The vehicle emissions debate was dominated by technological solutions such as lower-emission vehicles and cleaner fuels. Electric vehicles emerged as a plausible solution in spite of, or because, information and experience were limited.

The single most important factor determining the commercial viability of BEVs has always been battery technology and costs. In 1990, when the LEV program was adopted, lead-acid batteries were the most commercially viable option. Conventional lead-acid batteries had an energy density of only about 35 Wh/kg, compared to 2000 Wh/kg for gasoline. At the time preceding the LEV program, advanced electric vehicle prototypes using lead-acid batteries typically had driving ranges of 90 miles and top speeds of 60 miles per hour (Hempel et al., 1989). CARB's staff knew that the lead-acid battery would not be sufficient. Drachand and his staff were, however, confident that there would be massive improvements in battery technologies other than lead-acid, driven by the electronics industry and the ZEV requirements themselves.

CARB's staff did not present a detailed analysis of the costs involved in the adoption of the ZEV mandate. Their best estimate of the additional cost of a battery electric vehicle, relative to a comparable gasoline internal combustion vehicle, was \$1350, with a possible ceiling of \$3500. CARB also assumed that the cost of replacing the battery would be roughly offset by the reduced maintenance cost associated with electric vehicles (CARB, 1990c). Apparently, these estimates did not include the cost of the home recharging equipment. Our interviews with staff suggest that, in hindsight, many at CARB felt that the initial feasibility analysis could have been more comprehensive. This limited analytical effort is not typical for CARB, and is explained by the fact that the ZEV mandate was introduced late in the development of the LEV program and that CARB had little previous expertise with electric vehicles.

CARB relied heavily on what they knew of the General Motors Impact. Supporting documentation stated: "General Motors has indicated it plans to introduce its Impact electric vehicle by 1996, and this vehicle is competitive in performance to gasoline-powered vehicles, although battery life is less than desired" (CARB, 1990c, p. 46). The same document also read: "[CARB's] cost estimates for electric vehicles are based on consultation with experts from Aerovironment, an engineering firm involved in the development of the GM Impact electric vehicle" (p. 47).

Apparently, most of CARB's economic analysis of electric vehicles focused on quantifiable techno-economic and social costs and benefits. This was appropriate. But for a full feasibility assessment, one must also analyze private non-monetary costs, such as the disutility of longer recharging times and shorter range. As explained by one interviewee, the actual demand for electric vehicles is something that the agency and the automakers learned "only by doing." The understanding of consumer markets was sketchy at best. Uncertainty is however an inherent characteristic of technology-forcing approaches, as regulators do not know how much innovation industry is capable of achieving, and industry is reluctant to provide such information (even if they knew). As one interviewee put it: "that has been the key balancing act of CARB – push hard enough to [accelerate] investments, but not so hard that they lose their credibility or the rule disintegrates."

Life-cycle cost analyses reported in different sources (e.g. Delucchi et al., 1989; Hempel et al., 1989) looked at a variety of scenarios to arrive at estimates of per-mile costs of electric vehicles. These studies concluded that, under some scenarios, battery electric vehicles had lower life-cycle costs than gasoline vehicles. For example, estimating the cost of lead-acid batteries at around \$95/kWh and assuming \$0.95 per gallon for gasoline and 5 cents per kWh for electricity, Delucchi et al. (1989) estimated the life-cycle cost of a compact gasoline internal combustion engine vehicle at 28.42 cents/mile, compared to 24.77–35.73 cents/mile for an electric vehicle of comparable size but much shorter driving range.

In summary, CARB made some effort at presenting estimates of the monetary costs of purchasing and operating electric vehicles, but gave little attention to the non-monetary private costs that a potential consumer of this technology would face. The original ZEV mandate was not informed by studies of the market possibilities of electric vehicles.

As the Board is ultimately responsible for acting on the staff's proposal, it is important to understand how the technical information was perceived by its members. Jananne Sharpless, Chairwoman at the time of the passage of the LEV regulations, supported the ZEV elements, but her position was based only in part on an assessment of technical information. She understood that there were no guarantees of the technical and economic feasibility of the mandate. But she believed that battery electric vehicles had sufficient potential for CARB to push for them. Staff estimates of battery costs were questioned, however, by Board Member Dr. Wortman during the 1990 hearing: "...while we're all in favor of electricity, one thing that I think should be brought up: We did a study for the Department of Energy with lead-acid batteries, which at present are the most practical probably. Every 15 months, the lucky owner of that car is going to replace his battery set for a cost of between three and four thousand dollars. We're all dedicated to clean air. How many people are going to spend three or four thousand dollars every 15 months for a new set of batteries?"

6. The ZEV mandate adoption process: stakeholders' activity

The adoption of the ZEV mandate is a rare example of non-incremental policy innovation. The mandate proposed a disruption of the status quo, presenting the auto industry with a tremendous challenge and implying a new energy paradigm for transportation. How did a proposal that would potentially impact two such powerful industries survive the adoption process? In the words of an interviewee with CARB: "For any one of the standards that we enacted... getting the standard on the books is 40% of the fight. Sixty percent is to keep it there, because people come back, send lawyers, they call politicians, they call governors, and say 'no, we can't meet it, this is dumb.' And we have to answer to that." In other words, once a regulation is proposed, it has to survive a policy/political debate before it is formally adopted – what we call the adoption process. MS focuses on understanding how policy issues rise to the agenda but does not address the adoption process. In this section, we extend the analysis beyond the MS framework.

The adoption of the mandate benefited from it being a small part of the larger LEV program. An interviewee with CARB explained: "The fact that [the ZEV mandate] was part of a larger [policy] package was certainly key to it happening." Overall, there was more debate over the clean fuels part than over the low emission vehicle part of the regulation. On the vehicle side of the debate, most of the automakers attention was directed at the more immediate LEV and ULEV requirements.

6.1. Automaker position

The ZEV requirements were such a minor part of the LEV program that CARB interviewees often referred to the mandate as "an afterthought," while interviewees from the automakers often called it "a footnote." The auto industry focused its attention on the more immediate and broader elements of the regulations, not the ZEV requirements that would not become binding for another eight years.

Upper management in General Motors felt that there would be opportunities in the future to negotiate with CARB and try to get the required percentages down. Also, they believed that battery technology breakthroughs were possible, in which case they would be able to produce electric vehicles profitably. One interviewee explained: "As part of the compromises made on how the emission standards were put together – the sales-weighted averaging, the lead time, the biennial reviews, all of those things that were included in the regulation – GM's opposition was reduced." While General Motors tolerated the mandate at the beginning, it was not happy with it. The company's expectation, independent of the mandate, was that the Impact (later renamed the EV-1) might account for about 0.5% of its vehicle sales. CARB instead was requiring them to produce it at a 2% level, which was more than the share of its best-selling comparable car in California at the time – the Camaro sports car. General Motors also was dismayed that the mandate was requiring the other major car companies to compete with them for what already was a very small market niche.

While virtually no automotive executive thought that the mandate was good policy, the internal – not necessarily public – reaction to it varied across and within companies. Roger Smith's statements about the Impact on Earth Day 1990 were not necessarily endorsed throughout General Motors. Some knew that the statements could be used by regulators against the company. But the publicity of the Impact was part of a larger corporate strategy. As one interviewee described, "This was back in the time when General Motors was trying to reinvent itself, and wanted to show technology leadership. Building the Impact was a demonstration of technology leadership." The company was trying to "reinvent itself" by changing its image and rethinking the way engineering was done. Through this program, the company hoped to, and did, learn much about managing new technology, creative thinking, and integration of other divisions such as Hughes. At the same time, supporters of the Impact program in the company welcomed the mandate as a means to justify further investment in developing the vehicle.

The internal reaction to the ZEV mandate in other car companies, particularly Ford and Chrysler, differed from GM's. Given increasing public concern for the environment and the General Motors assertion that production of electric vehicles was possible, they felt that strong opposition to the mandate was not wise. Even though they were privately convinced that General Motors was overselling the Impact, they saw that CARB was taking it very seriously.

The automakers (mild) opposition to the mandate may be summarized as follows, as described by our interviewees from industry:

- (a) The ZEV mandate was perceived as a unilateral decision that moved away from CARB's more collaborative approaches of the past. The automakers view was that CARB historically had pursued a technology-forcing approach, first proposing a strong standard-setting regulation, then working collaboratively with the auto companies to learn about the evolution of technology and, if necessary, modifying the regulation accordingly.
- (b) While industry was used to facing technology-forcing regulations, the ZEV mandate was perceived, in the words of one interviewee, as "a little bit more extreme," because this time CARB was "mandating a new technology, and volume, and a schedule. You couldn't mandate all three – that's for sure."
- (c) Industry felt that CARB had not seriously addressed the question of the commercial viability of electric vehicles. Questions about cost, and consumer willingness to pay high costs and accept performance limitations were not carefully analyzed. As one interviewee from industry put it, "[CARB was] mandating the way the customers would have to behave."
- (d) The mandate was not perceived as a cohesive part of a regulation with clear policy goals. The car companies did not believe that requiring ZEVs was necessary to attain the desired air quality. They believed the mandate was not cost-effective. Car companies were about to spend billions of dollars that they felt could have been spent more productively on other clean technologies.
- (e) CARB did not look at the big picture. It concentrated on tailpipe emissions, but did not do a lifecycle analysis to rigorously consider power-plant emissions, electricity transmission economics, battery disposal environmental impacts, etc.

6.2. CARB's response to automaker concerns

While some interviewees from industry described California's air quality regulatory processes preceding LEV as collaborative, interviewees from CARB viewed them differently. To regulators, the auto companies had always displayed a propensity to oppose new emission standards on the argument that they were technologically infeasible or too costly. CARB believed that industry needed to be challenged. CARB interviewees would often refer to instances during the two decades preceding LEV when car companies managed to meet emission standards that they earlier had claimed were infeasible. CARB had learned to distrust the car companies – a byproduct of an adversarial technology-forcing policy approach.

At the same time, during early discussions on the LEV program, there was skepticism both in industry and within CARB about the difficulty of meeting the very stringent ULEV standard. This shared skepticism infused regulators with the belief that moving beyond the conventional gasoline vehicle was imperative. These factors, along with the promise shown by General Motors' Impact, diminished the force of opposing arguments, in CARB's eyes.

In CARB, the mandate enjoyed broad support. Some in the technical staff were lukewarm about it, but none openly opposed it. Only Dr. Andrew Wortman – the Board member with industry background – expressed opposition. But Wortman was alone – his motion during the 1990 public hearing to eliminate the mandate was not seconded by any Board member.

The argument used publicly by CARB to defend the need for zero emission vehicles centered on projections of significant growth in population, vehicle ownership, and vehicle use in the state, and particularly in the Los Angeles area. CARB argued that, given these increases, air quality standards could be met only by shifting a part of the vehicle fleet to zero emissions.

To CARB, the mandate was a necessary element of the broader LEV policy package aimed at meeting the agency's statutory duties. According to Jim Boyd, then CARB's Executive Officer, LEV was "consistent with the requirements of the California Clean Air Act, Assembly Bills 1807 and 4392, which are the laws designed to identify and control toxic air contaminants." It also met "the goals set forth. . . in the CARB's long-range motor vehicle plan, meets the recommendations of the AB 234 Advisory Board on Air Quality Fuels, and meets the requirements of the CARB's State implementation plan for the South Coast Air Basin, which incorporates both the South Coast Air Quality Management plan and the Air Resources Board's motor vehicle and clean fuels programs" (CARB, 1990b, p. 7).

Once the case for zero emission vehicles was established, the question remained whether to set a sales requirement on ZEVs, or allow it to be just another category in which automakers could certify their vehicle (to meet a sales-weighted performance standard). Ms. Liwen Kao, CARB staff person, presented the agency's argument during the 1990 hearing: "ZEVs are different from other types of vehicles because they have the lowest emissions at certification time and in use. Emissions increase with age for combustion engine vehicles, but ZEVs, by definition, maintain zero exhaust and evaporative emissions throughout their entire lifetimes. Wide scale penetration of ZEVs could ultimately be needed to achieve and maintain healthful air quality in non-attainment areas of the state. The 1989 air quality management plan of the South Coast Air Quality Management District calls for complete penetration of extremely low-emitting vehicles in order to meet ambient ozone standards. Without a mandate, it is uncertain whether manufacturers would be willing to commit the resources needed to accelerate the commercialization of ZEVs" (CARB, 1990b, p. 32).

To undermine a possible legal challenge, CARB needed to demonstrate that the mandate was not technology-specific and that the technology was feasible. Kao addressed the technology-specific issue by acknowledging that only BEVs were expected to meet ZEV requirements initially, but that fuel cell vehicles and solar-powered vehicles were expected to "become

available in the more distant future.” To defend the technological feasibility of the ZEV elements in the regulation, CARB made reference to General Motors’s statements about the Impact. In Kao’s words: “commercially viable electric vehicles with good performance, like that demonstrated by General Motors’s prototype, the Impact, should be available by the 1998 year. General Motors has announced its intention to proceed as rapidly as possible with developing an electric vehicle for commercial production” (CARB, 1990b, p. 26).

As described in Section 5, CARB did not address rigorously the cost effectiveness of the ZEV elements, falling back on broader statements about the overall cost-effectiveness of the LEV program as a policy package. CARB’s Final Statement of Reasons stated that “The Board has further determined that no alternative considered by the agency would be more effective in carrying out the purpose for which the regulatory action was proposed or would be as effective and less burdensome to affected private persons than the action taken by the Board” (CARB, 1990c, p. 3).

6.3. The role of the oil industry

The oil industry opposed the ZEV mandate – a position as unsurprising as the electric utilities’ supporting it. But this opposition was quite mild until well after the mandate had been adopted by CARB.

The oil companies were closely monitoring the growing interest in electric vehicles and alternative fuels in the late 1980s. Automakers were not opposed to methanol because manufacturing flex-fuel vehicles did not pose significant risks or costs to them (Sperling, 1995). The implications for the oil industry were much greater: they would bear a much higher cost and be subjected to much greater disruption – as well as have their principal product, gasoline, lose market sales.

The ZEV mandate was not the immediate threat, though. It was methanol. Public documents and interviews with CARB, South Coast AQMD, and environmental groups confirm that, during the initial stages of the LEV program, the oil industry focused its efforts on opposing the Clean Fuels elements of the program, which featured methanol, and paid no attention to the ZEV mandate. The oil industry did not perceive the mandate as a serious threat to their interests. Their major concern and the main target of their opposition was language that mandated oil companies to sell – as opposed to just make available – certain amounts of clean fuels (electricity was not included in the definition of clean fuel, and there was no requirement on electricity availability in the regulation). The oil industry convinced members of the State legislature to send letters to Chairwoman Sharpless, and Chevron sent a letter to Governor Deukmejian expressing concerns about the fuel sales mandate.

The Western States Petroleum Association (WSPA) presented four witnesses at the September 1990 hearing in El Monte, while one witness – George Babikian – represented ARCO (later part of BP). None of these five witnesses directly addressed the ZEV mandate. The only document submitted by the oil industry that relates in some way to the ZEV mandate is a paper submitted by ARCO arguing “that the fuel/vehicle system life cycle costs, at the SAME AIR QUALITY EFFECT, are lower for reformulated gasoline than for any of the other commonly discussed clean fuels: CNG, Methanol (as M85), or electricity” (ARCO, 1990, p. 1).

The documented evidence shows that the oil industry’s investment in the policy process ramped up later during the 1996 biennial review of the ZEV program. At that time, WSPA presented a common front with the American Petroleum Institute, the industry’s national trade group, in opposing the Mandate (API, 1996; WSPA, 1996).

6.4. The environmental community

Environmental non-profit organizations supported the requirement on zero emission vehicles in the initial stages, and maintained this position throughout the adoption process. The environmental community did not present a coordinated front initially and was not significantly involved at any time through the 1990 adoption process.

The only environmental NGOs giving testimony at the Board meeting of September 1990 were Sierra Club and the Coalition for Clean Air, and only the latter directly addressed the ZEV mandate. The Environmental Defense Fund and the Natural Resources Defense Council submitted written comments supporting the ZEV requirements, but argued that the classification of vehicles as zero emission was fictitious because it ignored upstream emissions from electricity generation. Only much later, leading up to the 1996 biennial review did the environmental groups become actively involved.

We surmise that the environmental groups were of a mixed mind about the ZEV mandate in 1990. The prevailing philosophy in most of these groups was one of skepticism about technology and a desire to reduce vehicle use. For the more extreme members, the ZEV mandate was a way of perpetuating and entrenching cars. And thus, the environmental community sat on the sideline of this debate. Only later did the more mainstream members of the community assert themselves and launch a fight on behalf of electric vehicles and the ZEV mandate.

7. Discussion

Our analysis of the process that resulted in the adoption of the California Zero Emission Vehicle mandate, using the Multiple Streams framework, is summarized as follows:

The problem stream: California, and particularly the South Coast basin, had severe air quality problems. The Environmental Protection Agency was exerting strong pressure for the state to demonstrate reasonable progress toward attainment of air

quality standards. Simultaneously, there was a generalized perception that a solution to the problem would take a long time and require extreme measures. It was widely believed, within government as well as within industry, that gasoline and the gasoline-burning internal combustion engine could not be made dramatically cleaner, and that alternative fuels and/or new drivetrain technologies would be needed to achieve California's air-quality goals.

The policy stream: The policy debate over air quality in California began to include electric vehicles in the late 1980s. The City of Los Angeles issued a request for proposals in 1988 for the production and deployment of 10,000 battery electric vehicles (BEVs) and the South Coast Air Quality Management District approved in 1989 a plan that identified BEVs as a possible solution to the region's air quality problems. But BEVs were largely peripheral to the thinking and policy initiatives of virtually all leaders through 1989. This perception was transformed when the largest car company in the world, General Motors, introduced a state-of-the-art prototype electric sports car in January 1990, and announced that it intended to commercialize it within a few years. We found no evidence that General Motors advocated for policies to promote this commercialization, so the company cannot be thought of as an advocate of BEVs in a policy sense – this role was played by the regulatory agency instead. The electric vehicle policy arose from a very small group of people within CARB who were seeking solutions to the problem of air quality.

The politics stream: At the time, public opinion in California was becoming increasingly concerned with the environment in general and air quality in particular. Several air quality districts in the State were being sued to comply with federal standards, with the risk that EPA would block federal funds for transportation infrastructure projects. These factors put pressure on the Governor and State Legislature to support – or at least not strongly oppose – regulatory activity on air quality. Travel demand management attempts had yielded very limited results, and policymakers were in any case traditionally averse to policies that involved new taxes and commanded changes in individual behavior, especially those related to driving. Technology fixes were and still are more palatable. Moreover, the political clout of the car companies in the State was low relative to that of other stakeholders for several reasons, including their minimal investments in manufacturing in the state (and thus few manufacturing jobs), a perception that regulation of vehicle emissions would have a small impact on the State's economy, the their large role of cars in urban air pollution, and the perception that the car companies had consistently resisted rules and policies to reduce emissions.

Contrary to one of the fundamental tenets of MS, our analysis shows that the problem, policy, and politics streams were not independent. The politics stream described above was shaped to a large degree by the problem stream, namely the severe air quality problems and the threat of blocked federal transportation funds. Likewise, General Motors's use of the electric vehicle program to change the company's image became part of the policy stream – an instrument to address the problem of air quality. The apparent success of the electric vehicle program in turn interacted with the stream of politics: the higher political acceptance of command-and-control policies at the time, the centrality of the air-quality problem in the political agenda, and the relatively low political clout of the auto industry in California, combined to make the idea of mandating (electric) zero emission vehicles more palatable to policymakers. Also, the magnitude of the challenge facing CARB in 1990, defined by the problem stream, influenced the stream of policy proposals, which prodded the agency to turn to extremely innovative technologies. If the pollution problem had been less pressing, ZEV proposals would have received much less political support – another interaction between the streams of problems and politics.

The three streams intersected in early 1990. No significant constraints were present and the window of opportunity opened. The conditions were ripe for a policy entrepreneur to push for electric vehicles as a policy solution. That policy entrepreneur was Don Drachand. He was a credible, senior CARB staff person who strongly believed in BEVs as an important part of California's long-term air-quality strategy. MS does not elaborate on the necessary conditions for a policy entrepreneur to be successful in her/his quest to raise an item to the agenda. In this case, it certainly helped that the policy idea originated within the regulatory agency. Because of this, its credibility was not questioned, and the idea had to survive only a few formal check points – senior management and the Board's chair person – on its way to final adoption.

8. Further policy adoption issues

Multiple Streams is a limited framework. It is concerned with the factors that help an issue rise to the policy agenda. It is silent, however, on the policy process beyond that point. MS says nothing about the format in which an issue enters regulatory language (e.g. policy mechanisms, related timelines, etc.) or about the likelihood of a given regulatory proposal to survive the adoption process. A more sophisticated and extended framework is needed to study adoption and implementation of the ZEV mandate and policies like it. The MS framework inhibits the study of the following two central questions.

(1) *Why did the regulatory agency choose a mandate as the policy instrument?* Our analysis shows that the central factor was distrust. CARB felt that no other policy mechanism could extract the best effort out of car companies to develop and commercialize BEVs. As one interviewee described, mandates were a more common and accepted part of the policy/political language before Newton Gingrich and the 1994 "Republican Revolution." Under current circumstances, a policy like the ZEV mandate would have little chance to enter the language of any regulatory proposal, let alone be adopted. To understand the mandate, it is thus important to first understand the policy attitudes at that time.

Another factor explaining the choice of a rule based approach was CARB's simplified characterization of previous regulatory experiences. Technology-forcing, command-and-control regulations had been effective in bringing catalytic converters

to market. Their thinking was: Why not for ZEVs also? CARB did not fully appreciate the differences in cost, market acceptance, and technological challenge.

(2) *How did such a radically innovative policy idea survive the adoption process?* The answer resides in the complex convergence of a set of factors and events. Our analysis shows that the mandate survived because it was a very small fragment of the much larger and very important Low Emission Vehicles and Clean Fuels program. The LEV proposal included challenging emission requirements for automakers with earlier compliance deadlines, and pressing alternative fuel requirements for oil companies. The program also allowed for biennial reviews, meaning the car and oil companies could fight the ZEV battle later. They could focus on more pressing issues such as the ULEV emission standards and methanol fuel requirements, which affected many more vehicles and much more fuel sooner in time.

Another very important factor that eased opposition to the ZEV mandate was General Motors's alleged intention to produce a zero emission vehicle. It encouraged CARB staff to proceed with the rule, and defused claims by GM and other automakers that the technology was not feasible.

The convergence of the three streams, the creation of a window of opportunity, and the lead of a policy entrepreneur were, according to our analysis, necessary, though not sufficient conditions for the ZEV mandate to happen. A number of factors not contemplated by Multiple Streams, including embedding a requirement on radical innovation in a broader regulation, were essential for the mandate to reach implementation. The implications of such additional factors for policy adoption may have been unplanned but, because they are replicable, provide useful lessons for future policy processes.

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Appendix A. Interview schedule

- (1) Personal background
 - (a) Could you please describe your involvement in the policy process related to the zero emission vehicle program?
- (2) Institutional structure and behavior
 - (a) How would you characterize the goals of the organizations you were a member of during the ZEV policy process?
 - (b) How has your organization arrived at decisions related to the ZEV program? Have there been internal disagreements? If so, how has your organization resolved them?
 - (c) Who in your organization have had the most expertise and knowledge (political, economic/financial, or technical) and what role have those persons had?
 - (d) In your opinion, how have the California Air Resources Board (CARB) Chair and Board arrived at decisions related to the ZEV mandate over time?
- (3) Policy dynamics and strategy
 - (a) Why did the ZEV regulation happen, and why did it happen in California? Please consider discussing the importance of the following factors:
 - (i) Low industry initial opposition:
 - (1) Industry thought it would be just an experiment.
 - (2) Industry more concerned with main sections of LEV I.
 - (3) Industry distracted with the Clean Air Act Amendments.
 - (4) Biennial reviews allowed industry to postpone opposition.
 - (ii) Adopted ideas from other pieces of regulation (e.g. the South Coast Air Quality Management Plan).
 - (iii) External factors (Gulf War, Roger Smith's declarations about the Impact, etc.).
 - (iv) Statutory requirement.
 - (v) State Agency really believed it was essential to meet air-quality goals.
 - (b) What have your/your organization position, goals and general strategy been in the initial (1990) ZEV policy debate? How have these shifted over time?
 - (c) Have you and your organization coordinated activities with other organizations or individuals to pursue your goals during the ZEV policy process?
 - (d) Have this coordination been stable over long periods of time or was it rather a short-term tactical coordination? What motivated and sustained this coordination?
 - (e) How have you and your allies decided on the policy strategy to pursue? How has this strategy changed over time?
 - (f) How successful have you/your organization been in achieving your policy goals? Why?
 - (g) How have strategies related to the ZEV mandate differed across automakers?

- (h) Have the existence of biennial reviews influenced your overall strategy?
- (i) In your opinion, what have been the reasons for the revisions to the program? (e.g. inclusion of hybrid electric vehicles, neighborhood electric vehicles, fuel-cell vehicles, transportation systems.)
- (j) Who have you perceived as the most influential players in the policy debate? Why were they so influential?
- (k) How did the program diffuse to other states? How did this diffusion affect the dynamics of the policy process?
- (4) Science and technology
 - (a) What role have your organization and CARB's Board assigned to scientific information in taking positions regarding the ZEV mandate?
 - (b) What have been the main sources of the information you and your organization used during the policy debate?
 - (c) In your opinion, has scientific information been misused during the policy debate? If so, how, and by whom?
 - (d) How would you characterize the effects of the ZEV program on technology development and innovation?
 - (e) How would you characterize your organization's efforts to promote the development of technologies related to zero emission vehicles?
- (5) Economic factors
 - (a) What has your position regarding the costs and benefits of the program been over time?
 - (b) What have been and will be the economic impacts of the ZEV mandate on your organization?
 - (c) What do you think was, is, and will be the demand for BEVs and FCVs?
- (6) Information flows and perceptions
 - (a) How would you characterize the role of the media during the policy process? Was the media manipulated?
 - (b) Are there any documents relevant to the ZEV policy process that you could share with us, or that you think we should search for?
- (7) Wrap-up questions
 - (a) What important policy lessons have the ZEV debate taught us?
 - (b) Have we missed anything important about the history of the ZEV program? What do you think are the major lessons from the experience so far? Where do you think the ZEV program is going in the future?

References

- American Petroleum Institute, 1996. Letter to the California Air Resources Board, March 20. Signed by William F. O'Keefe.
- ARCO, 1990. Fuel Sales Mandate Violates Statutory Requirement of 'Most Cost Effective' Regulation. Document Submitted the California Air Resources Board, September 28. Signed by D.J. Townsend, Manager, Clean Fuels Task Force.
- Burke, A., Kurani, K., Kenney, E.J., 2000. Study of the Secondary Benefits of the ZEV Mandate. Institute of Transportation Studies, University of California at Davis. Report UCD-ITS-RR-00-07.
- California Air Resources Board, 1990a. Final Regulation Order. Low-Emission Vehicles and Clean Fuels. California Exhaust Emission Standards and Test Procedures for 1988 and Subsequent Model Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles.
- California Air Resources Board, 1990b. Transcripts of Public Hearing, September 27 and 28.
- California Air Resources Board, 1990c. Proposed Regulations for Low-Emission Vehicles and Clean Fuels: Final Statement of Reasons.
- California Air Resources Board, 2006. About ARB <www.arb.ca.gov/html/brochure/arb.htm> (accessed 03.03.06).
- Cohen, M., March, J., Olsen, J., 1972. A garbage can model of organizational choice. *Administrative Science Quarterly* 17, 1–25.
- Collantes, G., 2006. The California Zero-Emission Vehicle Mandate: A Study of the Policy Process, 1990–2004. Ph.D. Dissertation. University of California, Davis.
- Delucchi, M., Wang, Q., Sperling, D., 1989. Electric vehicles: performance, life-cycle costs, emissions, and recharging requirements. *Transportation Research Part A* 23 (3), 255–278.
- Dixon, L., Porche, I., Kulick, J., 2002. Driving Emissions to Zero: Are the Benefits of California's Zero Emission Vehicle Program Worth the Costs? Rand, Santa Monica, CA.
- Doyle, J., 2000. Taken for a Ride: Detroit's Big Three and the Politics of Pollution. Four Walls Eight Windows, New York.
- Hempel, L.C., Press, D., Gregory, D., Hough, J.M., Moore, M.E., 1989. Curbing Air Pollution in California: The Role of Electric Vehicles. The Claremont Graduate School, Center for Politics and Policy, Claremont, CA.
- Kemp, R., 2005. Zero emission vehicle mandate in California: misguided policy or example of enlightened leadership? In: Sartorius, C., Zundel, S. (Eds.), *Time Strategies, Innovation and Environmental Policy*. Edward Elgar, Cheltenham, pp. 169–191.
- Kingdon, John, 1986. *Agendas, Alternatives, and Public Policies*. Longman, New York.
- Kingdon, John., 1995. *Agendas, Alternatives, and Public Policies*, second ed. Longman, New York.
- Koenenn, C., 1988. Plugging into Old Concept for the Electric Automobile Series: Reshaping the Future, *Los Angeles Times*, July 21.
- Landsberg, M., 1989. Global Warming is Expected to be the Hot Issue of 1990s Environment, *Los Angeles Times*, October 29.
- Lee, P., 1990. GM Unveils an Advanced Electric Passenger Car, *Los Angeles Times*, January 4.
- Lewis, N., 1987. Emission Rules Must Be Health-Based, *The Washington Post*, July 29.
- Reinhold, R., 1989. Drastic Steps are Voted to Reduce Southern California Air Pollution, *The New York Times*, March 18.
- Shaheen, S., Wright, J., Sperling, D., 2001. California's Zero Emission Vehicle Mandate – Linking Clean Fuel Cars, Carsharing, and Station Car Strategies. Institute of Transportation Studies, University of California at Davis. Report UCD-ITS-RR-01-26.
- Shnayerson, M., 1996. *The Car That Could: The Inside Story of GM's Revolutionary Electric Vehicle*. Random House, New York.
- Sperling, D., 1995. *Future Drive: Electric Vehicles and Sustainable Transportation*. Island Press, Washington, DC.
- Stammer, L., 1988. Sacrifice and Technology: Essential Keys to War on Smog, *Los Angeles Times*, January 4.
- Stevenson, R., 1990. GM Displays the Impact, An Advanced Electric Car, *The New York Times*, January 4.
- Wartzman, R., 1990. GM Unveils Electric Car with Lots of Zip but Also a Battery of Unsolved Problems, *The Wall Street Journal*, January 4.
- Western States Petroleum Association, 1996. Western States Petroleum Association Comments Regarding the Air Resources Board's Proposed Amendments to the Zero-Emissions Vehicle Requirements, March 26.