Lessons learned from the Californian ZEV Mandate: From a “technology-forcing” to a “market-driven” regulation

Philippe LARRUE

IFReDE-E3i – GRES et INSEAD

Université Montesquieu Bordeaux IV
Avenue Léon Duguit
33608 PESSAC

E-mail: philippe.larrue@insead.edu

Cahier n° 2003 - 7

Juin 2003
Les enseignements du mandat californien sur les véhicules à émissions nulles : d’une réglementation « technology-forcing » à une réglementation « market-oriented »

Résumé

Afin d’analyser précisément les relations qu’entretiennent les processus d’innovation et réglementaires le cas de la réglementation californienne sur les véhicules à émission nulle est examiné en détail depuis la période de débat pré-réglementaire à la fin des années 1980 jusqu’aux dernières tentatives de révisions en 2003. L’approche privilégiée pour traiter ce cas consiste non pas à rechercher des effets mécaniques réciproques entre les aspects réglementaires et les développements technologiques, mais à tenter de replacer leurs influences réciproques selon les comportements stratégiques des divers acteurs qui interviennent dans ces processus. Les réglementations véhiculent des hypothèses quant aux comportements et réactions des utilisateurs, des producteurs et également quant aux performances potentielles des diverses technologies alternatives. Ces hypothèses sont étroitement dépendantes des stratégies propres aux détenteurs du pouvoir réglementaire et des informations qui leur sont accessibles, via les divers groupes d’utilisateurs potentiels, de citoyens concernés, d’industriels... C’est dans ce contexte de jeux stratégiques complexes que doivent être appréhendées les relations entre les processus d’innovation et réglementaires. Après avoir retrace ces jeux stratégiques selon les différentes phases qu’a traversé le ZEV Mandate et mis en évidence dans ce cadre les relations entre les processus d’innovation et réglementaires, nous concluons en nous intéressant aux grands dilemmes auxquels doit faire face les régulateurs dans un contexte d’incertitude technologique.

Mots-clé : Réglementation Environnement Innovation Jeux stratégiques Véhicule électrique

Lessons learned from the case of the Californian ZEV Mandate: From a “technology-forcing” to a “market-driven” regulation

Abstract

In this paper, we investigate how Californian regulatory authorities and the principal stakeholders that have contributed to the design of the ZEV Mandate have dealt with this complex task. In the first three sections we present, in three stages, the evolution of the ZEV Mandate from its inception to the most recent developments, trying to reconstruct the debate that surrounded this evolution. We present some conclusions in the final section. Given the constructivist approach we adopt in this paper, our contribution can only be modest. No definitive, consensual and ready-to-apply lessons can be drawn from such a controversial case. However, the Californian example, particularly because of its excesses in various regards, offers valuable inputs to draw a line around technology-forcing regulations, stressing the major pitfalls of the regulatory design process. Moreover, this case has proved especially powerful in raising lively debates among the various communities of stakeholders involved to a greater or lesser extent in alternative vehicles and more generally in environmental regulations. We claim that these types of debate are nothing less than the very first stage of the design and evaluation of an “effective” regulation.

Keywords: Regulation Environment Innovation Strategic behaviors Electric vehicle

JEL : L2, L51, L62, Q42
Introduction\(^1\)

Since the 1970s, Californian environmental regulations have been observed with scrutiny by all concerned policy makers and scholars in the rest of the US but also in Europe and Japan. Especially in the domain of vehicle pollution, their stringent regulations have acted as a "\textit{model of practise}" far beyond the frontiers of the state (Braun, Wield, 1994, p. 266).

A particular landmark in the history of Californian air pollution regulations was the vote of the Zero Emission Vehicle Mandate (hereafter "ZEV Mandate") in September 1990. This regulation was implemented by the Californian Air Resource Board (CARB), an institution with a long history of developing and implementing programs to improve air quality in California. The ZEV Mandate aimed at drastically reducing mobile source of pollution by forcing the seven largest carmakers to produce and commercialise an important and increasing number of vehicles with no onboard polluting emissions in 1998, 2001 and 2003. Because of the magnitude of the requirements that carmakers had to meet, in terms of both number and type of vehicles, the ZEV Mandate triggered extreme, positive and negative, reactions among various communities of stakeholders. As a result, it ambiguously affected the pace and direction of technical changes in the area of alternative vehicles. Therefore, more than a decade later, although the results on technical progress and air quality might not be as straightforward as was originally planned, the ZEV Mandate still acts as a "perfect laboratory" to investigate the interaction between environmental innovation and regulation. Given the doubts raised by the effectiveness of the consensus-based regulatory approach implemented by the European Commission, the case of the stringent "technology-forcing" Californian regulation might be especially useful to European policy makers.

The reference to an optimal regulation as a concept tool in order to drive and advise the regulatory process is now increasingly subject to criticism. Regulations are not optimal nor designed to be so; they are the result of a negotiation process, more or less open and equitable, involving public and private groups of stakeholders. They are a crucial component of the institutional infrastructure that -paraphrasing the famous definition of institutions provided by J.R Commons- not only collectively control, but also liberate and expand, individual action (Commons, 1931). According to that perspective, regulations are not “opposed to market mechanisms”, nor even merely supposed to correct their failures, they contribute to the social construction of technologies and markets (Brown, 2001; Braun, Wield, 1994). Particularly when environmental issues and/or long-term objectives are at stake, as is the case for alternative vehicles, regulations can provide an agenda and direction for related technological change and product attributes in socially desirable ways. Although regulations are only one component of technology policy and must be coordinated with technology promotion initiatives (research and demonstration programs for instance), the well-documented history of science and technology has proven that they are essential for the success of controversial technologies.

However, it is not our objective to replace pessimistic and individualistic neo-liberal theories with a naïve view of the regulatory process based on the “miracle” of multi-stakeholders negotiations. On the contrary, in the absence of any reference to an optimal

\(^1\) Ce working paper a été présenté à la Conférence \textit{Propulsioni alternative e settore auto: opzioni possibili, vincoli economici e potenzialità di sviluppo}, Turin, le 25 Octobre 2002. Nous tenons à remercier Giuseppe Calabrese (Ceris-CNR) et Andrea Bardi (Istituto Per il Lavoro) pour leurs commentaires.
regulation or self-regulatory approach, the question of the design of the regulation is an even greater task. The latter is all the more complex since there is no consensus on what technologies or prescriptions are “socially desirable”. There is no consensus either on what is “possible” given the great market and technology uncertainties. Finally, most categories of actors, including public authorities to some extent, carry particular interests and therefore try to influence the regulations towards specific directions, which may not be compatible with the collectively determined socially desirable ends.

In this paper, we investigate how Californian regulatory authorities and the principal stakeholders that have contributed to the design of the ZEV Mandate have dealt with this complex task. In the first three sections we present, in three stages, the evolution of the ZEV Mandate from its inception to the most recent developments, trying to reconstruct the debate that surrounded this evolution. We present some conclusions in the final section. Given the constructivist approach we adopt in this paper, our contribution can only be modest. No definitive, consensual and ready-to-apply lessons can be drawn from such a controversial case. However, the Californian example, particularly because of its excesses in various regards, offers valuable inputs to draw a line around technology-forcing regulations, stressing the major pitfalls of the regulatory design process. Moreover, this case has proved especially powerful in raising lively debates among the various communities of stakeholders involved to a greater or lesser extent in alternative vehicles and more generally in environmental regulations. We claim that these types of debate are nothing less than the very first stage of the design and evaluation of an “effective” regulation.

Once Upon A Time In The West: The First Phase Of The ZEV Mandate (1990-1995)

Although the ZEV Mandate surprisingly did not raise a considerable debate before it was voted, the magnitude of the requirements triggered major conflicts between the pro and the anti mandate when both camps realized what was at stake with this regulation.

The pre-mandate period

It is very hard to find information regarding what happened before the vote of the ZEV Mandate in California. This might be evidence, backed by conversations we have had with protagonists, that very little public and technical debate took place at that time, despite the high stakes associated with this stringent regulation.

It is particularly striking that, during all the period that preceded the vote of the ZEV Mandate, the whole range of potential providers of ZEV technologies, particularly the carmakers, were not systematically consulted. Despite the fact that California has “an open political system with high levels of technical expertise in which there is a continuing and sophisticated debate about air quality management” (Grant, 1995, quoted by Kemp, 2003, p. 9), neither serious ZEV market studies nor ZEV technology reviews were implemented. According to Tom Cackette, the Chief Deputy Executive Officer of CARB at that time:

“The 2% and 5% numbers we came up with were tied to fleet sales and the ability of fleets to use a significant number of the vehicles. The study we did addressed where these vehicles might be sold in the early years when their limits
Lessons learned from the Californian ZEV Mandate

on range would be the greatest. It was not a marketing study. In fact, we predicted fleets constituted the greatest use and that’s how we sized the early mandate”².

In fact, most of the public hearings that preceded the adoption of the ZEV Mandate were focused on the other three emission classifications included in the Low Emission Vehicle Program³. Surprisingly, ZEVs, the fourth emission classification of the Program, raised little discussion. Both public debate and private efforts followed rather than preceded CARB’s announcement (Brown, 2001, p. 67). To understand this lack of consultation and investigation, it is important to recall the context in which the ZEV Mandate was proposed and passed:

i) Although it is difficult to precisely appreciate the weight of political pressures on the vote of the mandate, it is worthwhile stressing that the ZEV Mandate was discussed and voted in the midst of a political campaign for the succession of the Governor of California. Originally adopted by the Governor George Deukmejian Administration in September 1990, it was kept and reinforced by its successor, Pete Wilson, formerly a US Senator. Given the very poor environmental concerns and the “anti-government” attitude of the conservative Republican George Deukmejian during its mandate, it is reasonable to assume that the election of Pete Wilson, also Republican, was not unrelated to the vote of the ZEV Mandate the very same year. As opposed to George Deukmejian, Pete Wilson “was elected on a genuinely strong environmental protection record in the U.S. Senate as well as a strong program of environmental promises”⁴. ZEVs were associated with a positive “green” image, which was apparently highly valued by Californian middle-class electors.

ii) By 1990, California was experiencing a severe recession, partly because of important cuts in the military defence spending that until then greatly contributed to the powerful “Californian economic engine”. New high-tech sectors to invest in had to be found, and the prospective ZEV industry seemed to perfectly fit the requirements for defence conversion (Morales, Scott, 1991).

iii) The technological context seemed favourable. Recent progress in advanced battery technologies for consumer electronics raised high expectations about their potential scale-up and use in automotive applications. Also, GM had, since the end of the 1980s, a plan for commercialising a very innovative electric vehicle, namely the Impact. The presentation of the Impact at the LA Auto Show in January 1990 had a great influence not only on the public but also on Californian policy makers that took this event as evidence that “it was actually possible” (Kemp, 2003; Shnayerson, 1996). Moreover, the Impact had been designed by Hughes Aircraft, a subsidiary of GM located in California. It was therefore also a sign that high-tech Californian non-automotive companies could bypass Detroit giants. Therefore, ironically, it is perhaps one of the strongest opponents of the ZEV Mandate, GM, which might have contributed to its final approval by Californian politicians and regulatory authorities.

iv) Finally, in the context of a history of distrustful and adversarial relationships between the car industry and Californian regulators, CARB could hardly correctly appraise

---

² Automotive Industries, April 1993, “What if electric vehicles don’t sell”.
³ Transitional Low Emission Vehicle (TLEV), Low Emission Vehicle (LEV), Ultra Low Emission Vehicle (ULEV). These standards of alternative vehicles were defined according to their level of emission of non-methane organic gases, NOx and Carbone Oxide.
the technical and commercial prospects for ZEVs (Wallace, 1995). Most of their source of information on this emerging technology were ex-engineers, most of the time retired from the auto or space industry, or scientists who may be too “technology-focused”. This misinformation of politicians and CARB staff may have led them to over-react to the general context of optimism regarding the future of electric vehicle technologies.

**The basics of the ZEV Mandate**

CARB adopted the “ZEV Mandate” in September 1990, as part of the Low Emissions Vehicles and Clean Fuels (LEV) regulations. This regulation was based on the statement that the air quality in South California, especially the Los Angeles area, was the worst of all the United-States and had a considerable cost in terms of citizens’ health. This was of course not the first time Californian public authorities tried to tackle this issue. Since the 1950s, when Cal Tech researchers proved that the LA smog was a result of the joint role of hydrocarbons (HC) and nitrogen oxides (NOx), a number of air quality regulations were adopted. Although these Californian regulations were more stringent than federal standards, and allowed the slight reduction of pollution levels, the ZEV mandate represents a step forward relative to past regulations. Indeed, never before had Californian authorities passed such a “radical regulation”. On the technology side, fully battery-powered electric vehicles were seen as the only means of complying with the regulation. Therefore, in the absence of any major change in the typical US driving patterns, this regulation undoubtedly called for a technological breakthrough in order to compete with conventional vehicles. Battery technologies, the true bottleneck and common-link of all electric vehicles technologies, were particularly in demand. On the market side, the percentage of total sales of their passenger vehicles and light trucks that had to be ZEVs really challenged the carmakers: 2% in 1998, 5% in 2001, up to 10% in 2003. Carmakers that failed to meet the requirements would be exposed to a $5,000 fine per vehicle that falls short of the requirement.


<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>GM</td>
<td>330,000</td>
<td>6,600</td>
<td>16,500</td>
</tr>
<tr>
<td>Ford</td>
<td>320,000</td>
<td>6,400</td>
<td>16,000</td>
</tr>
<tr>
<td>Toyota</td>
<td>195,000</td>
<td>3,900</td>
<td>9,750</td>
</tr>
<tr>
<td>Chrysler</td>
<td>135,000</td>
<td>2,700</td>
<td>6,750</td>
</tr>
<tr>
<td>Honda</td>
<td>125,000</td>
<td>2,500</td>
<td>6,250</td>
</tr>
<tr>
<td>Nissan</td>
<td>90,000</td>
<td>1,800</td>
<td>4,500</td>
</tr>
<tr>
<td>Mazda</td>
<td>45,000</td>
<td>900</td>
<td>2,250</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1,240,000</strong></td>
<td><strong>24,800</strong></td>
<td><strong>62,000</strong></td>
</tr>
</tbody>
</table>

*Source: CARB*

The extent of the ZEV market to jumpstart was all the more impressive since twelve other states decided to adopt the stringent Californian regulation soon after it was passed. It is particularly the case of Massachusetts, New York and Vermont that automatically adopt California’s emission standards. With California, these four states represented 18% of the US auto market in 2000.

---

5 Average reductions of 80% for HC and carbon monoxides (CO); 50 to 70% for NOx compared to the levels measured in 1965. However, at the beginning of the 1990s, cars still accounted for over 60% of HC and NOx, and 90% of CO emissions (Hall, 1997). The resulting pollution is especially worrying in the Californian South Coast Air Basin: in the mid-1990s this region exceeded federal standards for ozone on more than 100 days out of every year (Ashuckian, 1997).
Lessons learned from the Californian ZEV Mandate

Crazy environmentalists against polluting industries

It is only after the regulation was passed that the true “debate” really started. Given the lack of consultation prior to the vote and the magnitude of the requirements that carmakers had to meet, in terms of both number and type of vehicles, it is not very surprising that the first phase of the regulation was characterized by very tough conflict. The debates opposed on one side carmakers and their allies, principally their traditional suppliers and oil companies, and on the other side CARB staff supported by diverse environmentally-concerned communities and organizations6.

The “cons”

The companies threatened by regulation opposed the Mandate before Californian courts, spending millions of dollars in these trials7. The numerous talented lawyers hired by the automobile industry tried to prove by any means that the ZEV Mandate was irrelevant, unfair and inefficient. Carmakers also provided public authorities and medias with their own state of the art of the technology.

Their statement was clear: because ZEVs technologies could not be ready by 1998, the regulation was unrealistic. It was an historical -say political- accident that had to be rapidly corrected, so the area of alternative vehicles could return to its traditional path driven by technologies and consumers, not by policy makers. Their arguments clearly favoured a self-regulation approach. Regulators should minimize as much as possible their intervention and “let the market do it”. As soon as companies had a better, less polluting, technology at an affordable price, competition would force them to commercialise it.

According to them, any technology-forcing regulations that distorted the free market could only worsen the situation. They claimed for instance that alternative vehicles that were forced into the market would have greater production costs. Therefore, consumers would not buy them, preferring to keep their older, more polluting, vehicles for longer, which would further increase air pollution. The only solution would be to subsidize the price of ZEVs until it came down at least to an acceptable price for upper-class potential drivers. This subsidy, if not integrally covered by the government, would be carried forward on the price of conventional vehicles, which would affect principally people who cannot afford to buy a ZEV. It is also likely that the additional costs the ZEV Mandate impose on corporate companies will reduce their profits and, in turn, their R&D expenses. Hence, this will negatively affect innovation and the environmental problems the ZEV Mandate intend to solve. Furthermore, if alternative vehicles are forced into the market before they are completely ready, the bad reputation of these “half-baked” vehicles will “poison the market”. This negative effect may last and affect even later more satisfying generations of alternative vehicles. The social legitimation of new technologies is crucial and often significantly affects their fate on the basis of perceptions.

6 The following sections list the principal arguments of the pro-Mandate and anti-Mandate mainly based on an extensive survey of newspapers articles and on the transcripts of the CARB hearings during which all stakeholders were invited to comment on the ZEV Mandate. These transcripts are available on-line on CARB’s website (http://www.arb.ca.go).

7 According to a report from the California Interest Public Research Group, oil companies and carmakers spent $24m to lobby California officials from 1990 to 1994 (San Francisco Chronicle, May 12, 1994, “Driving them crazy”).
The “pros”

On the “other side”, powerful environmental associations and lobbies such as the Sierra Club, the Calstart consortium and the Planning and Conservation League Foundation put a lot of pressure on Californian authorities in order to make sure that they would not step back. They often recalled the long history of carmakers’ resistance to socially desirable changes related to safety and environment, which indeed did not support the self-regulatory approach proposed by the automobile industry.

Opposing the “free-market argument”, they claimed that at that stage of development of alternative vehicles there is no market, no competition nor price that might drive the innovation process. Moreover, air being a public good, advocates of stringent regulation claimed that even if there was a market “somewhere” supporting firms’ strategies in the area of non polluting cars, it would not effectively work and provide incentives for companies to develop these vehicles. In the absence of market and prices to drive carmakers, the only way through which potential consumers could express their preferences are social and political pressures that drive regulations. In turn, regulations lead company behaviours. Therefore, during these early stages of an innovation process, regulation is the closest institution from the market… Put in a less provocative way, regulations create a “virtual market”, i.e. they substitute for market demands that cannot be expressed in other than political ways (Braun, Wield, 1994).

Moreover, regulations do not only compensate for the lack of a proper market, they assist the take-off of alternative vehicles markets. Within the mandated niches, ZEVs will benefit from both economies of scale and learning processes. In turn, the improved, less costly, technology will find broader public acceptance, allowing for the regulation requirements ramp-up. The ZEV Mandate can therefore trigger a virtuous circle between the market take-off and technology progress. Environmental benefits would in the end derive from this virtuous circle.

However, beyond environmental benefits, the ZEV Mandate was not only about the air that California breathed but also about the economic development of California and, at an even larger scale, the future of the American industry as a whole. According to some “pro-Mandates”, such as Calstart whose leitmotiv soon became “Why wait for Detroit?”, the only way to achieve the required technological breakthrough was to bypass the incumbents and bet on other less technologically conservative companies. Indeed, at first glance, the traditional industry seemed more inclined to spend money on justice courts than on research. This local development strategy could of course benefit the numerous Californian innovative companies that at that time suffered from the slump of military contracts due to the end of the cold war. Because ZEVs are a new paradigm, an IT company could more easily design the car of the future than the traditional carmakers. Clearly, “the time for incremental change was over” (Cronk, 1995, p. 34). Once the process got under way, some first movers would begin to cement their advantages and build these into durable market shares (Morales, Storper, 1991, p. 96) Pushing further the dream, what was soon known as the “Californian ZEV industry” could become a laboratory for a new type of industry that matched the leading industrial model of the beginning of the nineties, that of “lean production”: a considerable segment of the industry would consist of “small-scale niche market manufacturers linked into a dense
network of upstream input suppliers, subcontractors and service providers, thus forming a specialized industrial district in Southern California” (Morales, Storper, 1991, p. 2). As a result, the days of the old mass production model that dominated the automobile industry, characterized by industrial concentration -not to say collusion- and slow technological progress with little care for the consumers, were counted. Incubated within the “Californian ZEV industry”, this industrial model would expand to other industrial sectors and countries.

The ambiguous effects of the original ZEV Mandate

The actual effects of the ZEV Mandate were of course not as good or bad as both opposing camps claimed it. After five years, many contradictory effects, both positive and negative, could be disentangled.

Positive effects, the pro-mandates were right

First of all, there is no doubt that the ZEV Mandate triggered an unprecedented level of research and demonstration activities in the domain of electric vehicle technologies. Carmakers, because they could not take for granted that the CARB would eventually “come back to earth”, implemented large cooperative research programs on alternative vehicles. The very first one, created in 1992, was the United States Advanced battery Consortium (USABC). It gathered the Big Three, the electric power companies and the federal Department of Energy. It was aimed at investigating a wide range of battery technologies that could match the energy needs of future ZEVs. Two years later, the Big Three and their suppliers joined by the federal administration, represented by seven of their agencies, created the PNGV (Partnership for a New Generation of Vehicles) whose very ambitious goal was to produce the “Supercar”, this is to say a car three times as efficient (80 miles per gallon) as the typical 1990 sedan. Many official documents from USABC and PNGV referred directly to the potential ZEV markets enforced by CARB’s regulation. For instance, the two sets of criteria issued by the USABC, the mid-term and long-term battery goal performance, were respectively aimed at the 1998/2001 and 2003 deadlines of the ZEV Mandate (Larrue, 2003).

In California, new high tech firms aimed at ZEV markets emerged and rapidly grew. These companies developed a wide range of products from components to whole cars. Electrosource, for instance, developed advanced lead acid batteries for electric vehicles. US Electricar a company that produced electric vehicles grew to 300 employees in 1995. In the electronic and electrochemical area a certain number of these companies were spin-offs, such as Arias Research Associates, another advanced lead acid batteries supplier. It is worthwhile noticing that during this early period, before the first 1998 deadline actually initiated a ZEV market, these companies were also supported by public financing through various channels (demonstration programs of ZEV technologies, research grants etc.).

Finally, although it is very pervasive and therefore hard to accurately account for, the most important effect of the Californian regulation was to bring the issue of mobile sources of pollution and alternative vehicles to the forefront of worldwide public debates. As it is claimed by Shnayerson, the writer of the book on the history of the GM Impact project:

“It seems clear that the mandate, by forcing the world’s largest carmakers to start the hard R&D march to electric vehicles at a time when none but GM wished to do so, has been a triumph of social policy as important to the betterment of this country in its day as the Clean Air Act was a generation ago. Quite literally, it has jumpstarted the future of automotive transportation, and in
doing so shown, in an age of political selfishness and cynicism, that government can, on occasion, offer enlightened leadership” (Shnayerson, 1996).

As a symbolic event, it supported the legitimation of various projects in existing companies that were reluctant to invest heavily in alternative vehicle technologies. It is especially the case of advanced battery companies that were much more focused on the fast growing and lucrative consumer electronics markets. Therefore these companies had little incentives to invest in a market for which neither the market, nor the technology was ready, if ever. The ZEV mandate has greatly helped the supporters of the electric vehicle challenge inside these companies. It is almost impossible to find a publication about their activities regarding batteries for electric vehicles, either technical or commercial, from one of these companies that does not start by a reference to the ZEV Mandate. This was further confirmed during our interviews with managers of advanced battery R&D departments, who told us the importance of the ZEV Mandate to defend internally the projects they were working on. This legitimation effect was also of dramatic importance for public authorities in all industrialised countries. We already mentioned that in the US, a dozen states followed the Californian strategy by adopting the ZEV Mandate. But it also had a major influence in Europe and in Japan which always referred to the “Californian benchmark” to legitimate their intervention in the area of alternative vehicles.

**Negative effects, the carmakers were right**

However the Californian regulation also had several negative effects on the pace of innovation in the area of electric vehicle technologies.

At the level of vehicles, the regulation put an end to the pre-existing electric vehicle project of GM. The “Impact” project was initiated before the vote of the ZEV Mandate and discontinued soon after, in 1992\(^9\). This event, which was in fact more related to a GM stringent cost-cutting plan, was of course used as an additional weapon in the Californian clean air battle: “what if public policy makers had mandated the PC in the 1970s?” innocently asked B. Purcell, Impact project manager at GM\(^10\). The official reason given was that the ZEV market was interesting for the company only if GM could act as a first mover and keep its monopoly position on that technology. Because the ZEV Mandate forced its six most serious competitors into the market, despite a certain leadership of GM due to its earlier investment in the area, it was not profitable anymore to commercialise an EV.

At the level of batteries, the three US carmakers announced one after the other in 1994 that their first generation of EV, aimed at the 1998 ZEV Mandate deadline, would have their energy stored and supplied by lead-acid batteries. It is all the more striking as, during the first years after the regulation was passed, the attention and all hopes were focused on new advanced batteries coming from the consumer electronic industries, especially nickel-metal hydride and lithium batteries. Unfortunately, at that time, these batteries had yet not been successfully scaled-up from small-size batteries for laptops to large capacity batteries for EVs. This conservative choice was seen by the supporters of the ZEV Mandate as the last strategy of carmakers in order to ruin the Californian regulation. On the opposite side, carmakers emphasized that they were obliged to choose the best available technology, *i.e.* the more than centenary lead-acid battery, because of the agenda of the regulation. They claimed during the

---

\(^9\) *Automotive News*, December 14, 1992, “GM backs off electric goal”.

\(^10\) *Automotive News*, September 18, 1995, “Purcell: mandate has slowed EV”.

1994 biennial review that the ZEV Mandate was compelling the industry to develop “sub-standards vehicles” that, in the end, nobody would buy because of their poor performance. According to them, the first deadline of the regulation was too close for them to be able to integrate new technologies into their EVs.

Especially in the case of purpose-built EVs, it is indeed impossible to simply integrate the best battery at the last moment into a vehicle with a drive train and a body that has been designed individually from the battery. Let us recall that, in ZEVs, the battery determine all the performances of the vehicle, from its cost to its speed, acceleration and, last but not least in vehicle design, its weight. A certain level of coordination is therefore needed in the co-development of the battery and the vehicle. Moreover, before a battery can be integrated in a commercial vehicle it has to be extensively tested in real conditions in order to verify the on-board durability of its performance. During our interviews, battery and ZEV experts often insisted upon the extent to which this electrochemical device was still some kind of “black box” whose performance could be measured but whose internal processes were hardly understood at a fundamental level. Despite recent progresses in simulation models, advances in battery R&D were therefore strongly based on trial and error processes, this is to say that any changes on battery active materials had to be followed by a long phase during which the new design had to be “cycled”, first in laboratories according to various standardized cycles representing different uses (urban, sub-urban etc.), then on-board, given that laboratory tests and on-road tests often provided different results.

Therefore, the choice of the battery for the ZEV generation 1998 had to be done as soon as 1994, four years before the first regulation deadline. As a consequence, the ZEV 1998 model-year was locked in the battery technology at 1994 levels.

Phase II: Ceasefire And Peace Treaty…

A compromise was eventually found and the situation unblocked in 1996. Contrary to the initial version that was intended to force its way to the commercialisation of ZEVs, the resulting amended mandate clearly favoured a more progressive and coordinated approach to the development of ZEV technologies and the market take-off. However, this was clearly seen by the regulation advocates as a step back from CARB. According J. Phillips, research Director at the Planning and Conservation League Foundation this plan proved “that the car company had managed to pull CARB into their campaign to suppress electric vehicle technology and cripple the small start-up companies”.

From a “technology-forcing” to a “market-driven” regulation

The first revision was preceded by a phase of evaluation of the progresses accomplished since the mandate was passed in 1990. On this basis, a “market-driven” approach, which took into account in a coordinated manner the market and the technology development, was implemented.

---

12 Calstart News Press Release, August 2, 1996, “CARB Staff proposal repeals ZEV Mandate capitulates to oil and auto industry”.
Evaluation of the state of art of battery technologies

One of the most important evaluations of the expected performance and availability of batteries for ZEVs was carried-out in 1995 by a group of experts -the Battery Technical Advisory Panel- commissioned by the CARB. F.R. Kalhammer, a former research program manager at EPRI, the common research body of US electricity utility companies, headed this panel. In order to evaluate the readiness of battery technology for the 1998 implementation of the ZEV program, these experts visited almost all (about 20) current leading advanced battery producers in Europe, Japan and the US, scanning ten different battery technologies. They also visited major automobile manufacturers engaged in electric-vehicle R&D.

The report supplied to the CARB concluded that only improved lead-acid and nickel-cadmium batteries would be available in 1998, which validated the choice of lead-acid batteries that carmakers made in 1994. Indeed, based on the very similar views provided by battery producers regarding the steps and schedules required for successful development and commercialisation of advanced batteries, they confirmed the time-scale problem of the initial regulation which had been raised by carmakers. Indeed, according to these concordant elements of information, it was concluded that, after completion of cell-level R&D, at least eight years were needed to reach commercial operation. The Panel also emphasized that throughout this period, close collaboration between battery developers and vehicle manufacturers was essential to the successful integration of batteries into vehicles and the development of the specific performance for a commercial ZEV (Kalhammer, 1995). Although the Panel did not investigate the marketability of ZEVs with lead-acid batteries, they confirmed that most experts, especially in the automobile industry, believed that their limited range would restrict these vehicles to a market share less than the requirements of the 1990 regulation.

The confirmation of this apparent unresolved gap between the mandate ZEV requirements and the state of the art of ZEV technologies had a tremendous impact on the debate. It was a critical element of information that confirmed that carmakers could hardly fulfil the 1998 deadline. Consequently, at its March 1996 hearing session, CARB announced that it had decided to modify the ZEV Mandate. As it was confirmed in a later report from the Californian institution, in making its decision CARB “relied significantly on the findings of the Battery Technical Advisory Panel report” (CARB, 1998, p.21), to the point that the report was said to be the “cornerstone for CARB’s decision to modify the original 1990 ZEV regulation” (p. 22).

However, the report was of course not the only element that triggered the CARB decision. During our interviews, a Ford battery program manager put the emphasis on the fact that a CARB representative was entitled to assist at technical meetings of the USABC, the formerly mentioned battery consortium. According to the manager, this direct channel of information to the “core” of US advanced battery R&D provided the CARB with up-to-date information that was different from those they used to collect through individual hearings of battery

---

13 Because of the toxicity of the materials, nickel-cadmium batteries were not seen as a desirable option in the US.
14 Since this first Battery Panel Report, two other reports investigating the progresses of battery technologies have been releases, respectively in 2000 and 2002. The last one focused on batteries for hybrid vehicles, while the two first ones were exclusively concerned with batteries for pure “ZEVs.”
makers. Rumours and information regarding possible changes in the Mandate were becoming more and more precise since early 1995, before the release of the Panel report.

**Coordinating ZEV’s market and technology**

Based on these various expertise, CARB came to the conclusion that, although battery technologies had experienced progresses, an early introduction of ZEVs that could not perform to consumer expectation would have harmed the ZEV program as a whole. Consequently, the 1998 and 2001 deadlines were suppressed and replaced by a voluntary agreement between carmakers and the CARB. Contrary to the initial regulation, the Memorandum Of Agreement (MOA), which was the pillar of what CARB claimed to be a “market-based approach”, was aimed at encouraging the early years of ZEV introduction. According to the MOA, while maintaining the requirement for ZEVs in 2001 and 2003 and beyond, carmakers had to offset emission benefits lost due to the elimination of the ZEVs requirements in 1998 through 2002 by continuing investment in ZEV and battery R&D and placing specified numbers of advanced battery-powered ZEVs in marketplace demonstration programs.

*Carmakers MOA advanced battery demonstration requirements*

<table>
<thead>
<tr>
<th>Year</th>
<th>Chrysler</th>
<th>Ford</th>
<th>GM</th>
<th>Honda</th>
<th>Mazda*</th>
<th>Nissan</th>
<th>Toyota</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1998</td>
<td>51</td>
<td>181</td>
<td>182</td>
<td>101</td>
<td>28</td>
<td>70</td>
<td>135</td>
<td>748</td>
</tr>
<tr>
<td>1999</td>
<td>103</td>
<td>363</td>
<td>365</td>
<td>202</td>
<td>55</td>
<td>141</td>
<td>271</td>
<td>1500</td>
</tr>
<tr>
<td>2000</td>
<td>103</td>
<td>363</td>
<td>366</td>
<td>203</td>
<td>55</td>
<td>141</td>
<td>271</td>
<td>1502</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3750</td>
</tr>
</tbody>
</table>

* Mazda, partly owned by Ford, decided not to develop its own ZEV model and buy ZEV credits from Ford to fulfill its requirements.

As the comparison of tables 1 and 2 shows, the amount of vehicles that carmakers had to put on the road for experimentation before 2002 (3750) was far below the initial 1998 requirements (which totalled 24800 ZEVs). However, the main important change had not so much to be found in the numbers but in the methodology of evaluation of ZEV credits. The agreement with carmakers now integrated a “technology development partnership” to further accelerate the commercialisation of advanced batteries. In order to provide incentives for R&D on new battery technologies, as opposed to the introduction of available lead-acid batteries, CARB differentiated batteries according to their respective performance. In the initial version of the Mandate, all ZEVs that had to be commercialised by carmakers had the same weight in the requirements set by the CARB, whatever technology they used. According to the revised mandate, a ZEV with superior performance could count three times more than other “traditional” ZEVs. Therefore, carmakers had the choice between either putting many

---

15 The importance of the CARB representative in USABC technical meetings is confirmed in CARB’s 1998 biennial report (CARB, 1998).
17 *Calstart News Press Release*, August 2, 1996, CARB announces proposed agreement with automakers for ZEVs".
“traditional” ZEVs on the road or introducing a smaller number of “advanced-technology” ZEVs. The performance of each type of vehicle was evaluated either according to the specific energy of the battery it integrated or according to its autonomy (see tables 3 and 4). Adding to this progressive approach, the requirements for each number of ZEV credits increased with time, making it more and more profitable for carmakers to choose ambitious ZEV technology strategies. Multiple credits for advanced batteries reduced the total ZEV requirements to just over 1,800 electric vehicles.

**Number of ZEV credits awarded according to the battery specific energy**

<table>
<thead>
<tr>
<th>Specific energy in Wh/kg</th>
<th>Number of ZEV credits by ZEV</th>
</tr>
</thead>
<tbody>
<tr>
<td>40 (as of 1998)</td>
<td>1</td>
</tr>
<tr>
<td>50 (from 1999)</td>
<td>2</td>
</tr>
<tr>
<td>60</td>
<td>2</td>
</tr>
<tr>
<td>90</td>
<td>3</td>
</tr>
</tbody>
</table>

*Source: CARB, ZEV Mandate, Final Regulation Order, Section 1960.1, Title 13*

**Number of ZEV credits awarded according to the vehicle autonomy**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>No minimum</td>
<td>&gt;100</td>
<td>&gt;140</td>
<td>2</td>
</tr>
<tr>
<td>&gt;70</td>
<td>&gt;130</td>
<td>&gt;175</td>
<td>3</td>
</tr>
</tbody>
</table>

*Source: CARB, ZEV Mandate, Final Regulation Order, Section 1960.1, Title 13*

The most important innovation of the 1996 revised version of the ZEV Mandate was the link it created between the ZEV market take-off and the progress of ZEV technologies. The idea underlying the initial 1990 regulation was that if some courageous public authorities challenged carmakers by mandating a large market for ZEVs, the needed technologies to meet this market would automatically follow because of the R&D incentives it provided. Several years later, confronted by the slow pace of progress and the opposition of carmakers they had to admit that it was not possible to mandate a breakthrough. On the “other side”, carmakers understood that a strategy of pure opposition, trying to remove by any legal means the regulation as a whole, was costly financially as well as in term of public image. They decided to cooperate with the Californian authorities in order to influence the regulatory process.

**Phase III: The Trojan Horse strategy…**

This cooperative phase, based on a pragmatic “market based approach”, went throughout following years. While “in the game” the carmakers requested public authorities to add more flexibility to the Mandate, so they could choose the most suitable and effective way to reduce polluting emissions. Backed by the technology of batteries, which was still slowly progressing, and by potential buyers of electric vehicles, who were still claiming in stated preferences surveys that they would accept to pay a premium for ZEVs but who were in fact
buying more and more SUVs, carmakers did obtain considerable amendments to the regulation. Soon after that, they began using this additional flexibility to unfold their real-and unchanged since 1990- strategy: the complete removal of the ZEV Mandate. As of now, although the story is not over, it seems that the ZEV Mandate-or what is left from it- may not survive this new phase of opposition.

**More flexibility to the ZEV Mandate**

Most of these changes were integrated during the 1998 and 2001 revisions. The remaining “2003 and beyond” deadline was considerably modified, both quantitatively and qualitatively. Quantitatively, a new decrease in the number of ZEVs to be put on the road was again implemented, down to only 8,137 vehicles according to the “2001 ZEV Amendments”. The requirements for 2008 and 2012 were doubled but, given the previous reductions, the ZEV requirements for carmakers did not pass the requirements of the initial Mandate until 2015. Qualitatively, the two main areas of change in the regulation negotiated by carmakers and their allies (the oil industry in the first place) for the year 2003 and beyond involved the definition of cars that could qualify for ZEV credits and the awarding of multiple credits for the early introduction of ZEVs. We discuss these two major changes in the following sections.

**More flexibility in the definition of cars qualified for ZEV credits**

Arguing that the introduction of ZEVs could only be a progressive process, carmakers made the case that the introduction of Hybrid Electric Vehicles (HEVs) and Neighbourhood Electric Vehicles (NEVs) could be an effective way to support the ZEV market take off. According to the “market-driven regulatory approach” started in 1996, which among other things stated that the regulation must provide carmakers the option to pursue their preferred path towards ZEV commercialization, CARB agreed to add these types of alternative vehicles to the regulation. As for the 1996 revision of the Mandate, CARB officials made clear that it was not a step back and that they remained “committed to achieving zero emissions performance wherever feasible in the vehicle fleet”, but that the challenge was still to “determine how to achieve sustainable success in the field” (CARB, 2000, p.i).

**Hybrid vehicles**

In 1998, “Partial ZEV credits” (accounting for less than one credit) were allocated to hybrid vehicles, which combine an electric engine with an internal combustion engine. It was claimed that these “non-pure ZEVs”, although they do emit pollutants, could be a step on the road towards pure-ZEVs. The technologies related to the electric part of the HEVs, especially the battery, could improve gradually and its cost could diminish while being used in these vehicles. Therefore, the hybridisation rate, that is to say the balance of the electric part and the internal combustion engine part, would increase and the polluting emissions of the vehicle would decrease. According to this scenario, hybrid vehicles would progressively get closer

---

19 We do not enter here into the details of the regulation, which became very complicated as it was modified. For instance, it differentiated between the seven initial large manufacturers (six since the merger of Daimler and Chrysler) and intermediate manufacturers (BMW, Hyundai, Isuzu, Jaguar, Kia, Mazda, Mitsubishi, Rover, Subaru, Volkswagen and Volvo), those that had to comply with the regulation only from the 2003 requirements. We focus here on the regulation affecting the seven initial large manufacturers.
and closer to ZEVs, without having to rely on the advent of a breakthrough in battery technology or a complete change in potential driver preference.

Although this change in the Mandate had been discussed between the carmakers and CARB for several years, the final ruling was only published in 1998 because of the complexity of the issue. In particular, carmakers fought hard during the negotiations in order to gain more flexibility in the methods of determination of the number of ZEV credits that should be awarded to these vehicles. Eventually, a compromise was found and two methods were accepted to qualify hybrid vehicles for Partial ZEV credits: the so-called “efficiency method” and the “carbon dioxide method”. The efficiency method allows carmakers to qualify for Partial ZEV credits by commercialising hybrid vehicles with a federal fuel economy rating at least 30% better than a standard level set by the Californian regulation. The carbon dioxide method allows carmakers to earn partial ZEV credits with hybrid vehicles according to the difference of the vehicle’s CO2 emission and that of comparable gasoline-powered vehicles.

**Neighbourhood Electric Vehicles**

In 2001, Partial ZEV credits were awarded to small electric vehicles with limited speed and range. CARB had to acknowledge that these vehicles, named Neighbourhood Electric Vehicles (NEVs) not to say golf-carts, had clear advantages: while having zero emission, their technology is ready and their cost not prohibitive, contrary to full-size ZEVs which are still lacking the perfect low-cost high performance batteries. According to carmakers, neighbourhood vehicles could provide them with insights and research on the technology and the real condition use patterns of all types of electric vehicles.

Moreover, they had supporters among several environmentalists and alternative vehicles experts who claimed that the battery technology was a problem only if one considers that an electric vehicle had to replace, and therefore compete with, current internal combustion engines. According to them, NEVs could find a niche for short-range urban mobility, which accounts for a substantial part of air pollution. For instance Daniel Sperling, the very influential Director of the Institute of Transportation Studies at the University of California, Davis, who has testified many times as an independent experts before the CARB and the House of Representatives regarding alternative vehicles issues, has been a long-term supporter of NEVs (Daniel Sperling, 1995).

In 2001, CARB agreed to qualify these vehicles for ZEV credits. Neighbourhood vehicles were now part of the category of vehicles that, although they did not comply with the definition of ZEVs as it was set in the initial regulation, were awarded credits or partial credits. However, on the 10% of vehicles each carmaker had put on the road in 2003 throughout 2008 this category of vehicles (hybrid-vehicles, ultra low emission internal combustion engine vehicles, neighbourhood vehicles) that is left to the initiative of each carmaker could not account for more than 8%. Therefore, under the new rule, the remaining commitment of the six largest carmakers to “real” ZEVs was only 2%, instead of 10% as it was initially planned in 1990.

---

20 It is worthwhile noticing that CARB proposed to allow carmakers to partly meet their requirements with HEVs as soon as 1994. However at that time, carmakers seemed still more inclined to try to suppress completely the ZEV Mandate, starting from the 1998 deadline, not to modify it. See: *Automotive News*, May 9, 1994, “CARB appears ready to allow some hybrids”; *Automotive News*, June 12, 1995, “CARB leans toward new hybrids”; *Automotive News*, August 14, 1995, “Carmakers rip CARB hybrid straw man”. 

- 16 -
Lessons learned from the Californian ZEV Mandate

More flexibility in the schedule of introduction of ZEVs

Although the 1998 and the 2001 deadlines, had been removed from the Mandate schedule, several carmakers claimed that they were ready and willing to introduce ZEVs in California before the remaining 2003 deadline. They argued that these vehicles should be accounted for within ZEV requirements. Moreover, since these vehicles could significantly contribute to a successful ZEV market launch, carmakers argued that these early vehicles should be awarded more than only one ZEV credit. Indeed, both technically and symbolically, these early ZEVs were believed to be of great importance for a successful ZEV market launch: technically, they could be used as real conditions laboratories, delivering valuable information to all stakeholders; symbolically, they testified to Californian people the carmakers’ true commitment to electric vehicles. CARB officials, incline to favour any voluntary initiative from carmakers that could ease the fatidic passage of the 2003 deadline, accepted that the vehicles commercialised before the deadline would qualify for “Multiple” ZEV credits.

The final conflict?

Soon after the 2001 Amendments were passed, carmakers started the implementation of a new phase in their strategy, which might greatly endanger the very existence of the regulation. This strategy is based on exploiting the pitfalls of the last Mandate Amendments they negotiated with CARB in 1998 and 2001.

Free electric golf carts for California

Following several worrying articles in newspapers, GM officials confirmed in 2002 that they had a plan to deliver a great number of NEVs in California. Given the advantages discussed above regarding an early introduction of these vehicles on Californian roads, this plan was a priori compatible with the regulation. But it became a problem when the details of the plan were considered: the NEVs would not be sold, but given away to non-profit organizations such as non-profits businesses, hospitals, schools 21. Therefore private consumers, which were the target market of the ZEV Mandate, would not have access to these vehicles. Moreover, these vehicles would not operate outside of closed-campus environments. The argument claimed by carmakers when they were trying to convince CARB officials to award ZEV credits to these small electric vehicles, especially that they would allow them to “softly” test the market and the technology, was not valid anymore under these conditions. Although Daimler-Chrysler did not disclose a similar plan, the fact that it acquired in 2000 a golf-cart maker, Global Electric Motorcar, also raised some serious doubts about its strategy. As it was claimed by David Modisette, executive director of the California Electric Transportation Coalition, the concern, not just with GM but with all the automakers, is that “when you start giving [NEVs] away, then you are not trying to make a real business out of it but are using it purely as a way to satisfy regulatory issues. That's not really a good-faith effort to create a real market” 22.

The only interest of this plan of massive early introduction is of course for carmakers: by giving away or renting NEVs before the 2003 deadline, they are able to benefit at a reduced cost, compared to the price of real full-size electric vehicles, from four ZEV credits per

21 Carmakers were able to give away their NEVs instead of selling them since the term used in the regulation is “placement of ZEVs”.

vehicles. As a total, this “short-term dumping” of NEVs almost offset their entire ZEV requirements for the coming years\(^{23}\). Combining the credits allocated to NEVs and multiple credits for early introduction of electric vehicles, GM was supposed to benefit from 20,000 credits for the fleet of 5,000 NEVs given away. This opportunistic use of NEVs during the pre-2003 period was all the more worrying that these vehicles would be, after a year of operation by non-profits organizations, either bought by them or returned to GM. Not surprisingly, in addition to maintaining that these vehicles could still provide valuable insights regarding the use of electric vehicles, GM’s defence was also based on the “free market argument” and the advantages for consumers. Don Walker, a GM spokesman, declared “it’s a free market, and if we believe it is in the best interest of GM, then we will go ahead and do that (…). Our competitors are free to lower their prices. It's no different than big incentives on sedans. Maybe this will help bring the cost to consumers down.”\(^{24}\).

**The White House enters the arena**

Subsequent to their contribution to the modifications regarding the methods of determination of ZEV credits for hybrid vehicles and fuel cell vehicles, GM and Daimler-Chrysler decided to sue CARB, arguing that the new rule violates federal laws that prevent states from setting fuel-mileage standards. Only federal institutions are entrusted to do so. According to carmakers, because the “fuel efficiency method” allows carmakers to earn ZEV credits by improving the fuel efficiency of the hybrid vehicles they place on the market, the ZEV Mandate goes against federal laws and should be cancelled.

This lawsuit could be just one more in a long list of court actions against CARB filed by carmakers and their allies since the beginning of the nineties if the White House had not decided to join them in their lawsuit. In October 2002, the Department of Justice advocates declared that the ZEV Mandate was pre-empted by federal laws\(^ {25}\). This action must of course be replaced in its strategic and political context: on the political side, Georges Bush, who lost the important state of Michigan to Al Gore during the presidential election in 2000, has since then tried to get closer to the state’s important decision makers, such as the union autoworkers and other institutions related to a greater or lesser extent to the powerful Michigan automobile industry. In addition to the well-known close links between the Bush administration and the oil industry, it also must be noticed that Andrew Card, prior to his current position of White House Chief of Staff, was the chief lobbyist for General Motors and also headed an important auto industry trade association that was suing CARB’s ZEV rule in the nineties\(^ {26}\). On the strategic side, it may not be unrelated that carmakers attacked the mode of determination of credits for hybrid vehicles: the Japanese carmakers are way ahead of US carmakers regarding the commercialisation of hybrid vehicles. The Toyota and Honda hybrid vehicles (respectively the Prius and the Insight), although they are not as successful in the US as they are on their domestic market, have already entered the CARB review process to be awarded Partial ZEV credits\(^ {27}\). Despite several hybrid vehicle commercialisation plans disclosed by US

\(^{23}\) *Los Angeles Times*, December 5, 2001, “Amendment would tighten ZEV Mandate”.


\(^{25}\) More precisely it is pre-empted by the Energy Policy and Conservation Act of 1975.


\(^{27}\) This configuration, according to which Japanese carmakers do better than US ones at responding to US regulatory challenges, already happened in the 1970s with the Muskie Bill. This leads a Japanese scholar to provocatively stress an “interesting international distribution of labour between US policy making and Japanese technical solutions”: US policy makers define the problem and Japanese carmakers solve it (Maruo, 1997).
carmakers, it seems clear that they bet on fuel cell vehicles, which are still far from ready for commercial use. Once again, carmakers and their allies emphasized the ZEV Mandate impact on the “natural” timing of technical progress. They argue that the need to devote engineering staff and resources to mid-term batteries for electric or hybrid vehicles actually detract them from the pace of fuel cell commercialisation (CARB, 2003).

The “Strawman Proposal”

The result of the latest strategic assaults from carmakers against the ZEV Mandate have been so far very effective: since they were very cunning at exploiting early introduction multipliers for a wide range of ZEV technologies, they have today enough banked credits to basically meet their ZEV credit requirements without commercializing anymore ZEVs for the next 5 to 7 years. Moreover, major regulatory changes are expected again during the next 2003 biennial review. This new phase of changes, the third in 7 years, are not independent from the recent pressure of the automobile industry and Bush Administration. Indeed, their recent lawsuit, which resulted in a court injunction in June 2002, has blocked the implementation of the 2003 deadline, pending on the final resolution of the case.

The new changes proposed by CARB staff, which will be discussed later in 2003 are integrated in a package known as the “Strawman proposal”. According to this proposal (CARB, 2002):

− The start of the ZEV requirements is delayed until 2005. All carmakers banked credits are fully retained;

− The “pure-ZEV” requirements are reduced to 1% from 2005 to 2008, 1.25% from 2009 to 2011, 3% from 2012 to 2014 and 4% for 2015 and beyond. As a total, this represents an 85% cut in the number of pure-ZEVs requirements from 2003 to 2011 (Modisette, 2002);

− In order to cope with the federal preemption, the “fuel efficiency method” used for the calculation of Partial ZEV credits for hybrid vehicles is removed;

− In order to tackle the issue raised by carmakers that hybrid vehicles research and commercialization benefits from the timing of the Mandate to the detriment of fuel-cell vehicles, greater amounts of credits are awarded for the demonstration of fuel-cell vehicles from 2003 to 2011;

− Also, efforts by carmakers to install hydrogen infrastructure for fuel-cell vehicles will be rewarded by ZEV credits.

If these changes are voted in a likely “2003 ZEV amendments”, the ZEV Mandate will further lose its consistency and credibility to the point that its existence is greatly endangered.

28 This is true when total amounts of ZEV requirements and ZEV banked credits are considered for all automakers taken together. This may not be valid on an individual basis as some carmakers exceed the requirements and other fall short of it. However, total amounts calculations make sense since carmakers are allowed to trade their ZEV credits.
30 They were supposed to be discussed on the 27th of February 2003, but the revision was delayed because no agreement could be found. The various expectations about fuel cells have led the situation to a deadlock.
However, once again, the adversarial behavior from carmakers and, more recently, from the federal administration, is not the only factor in CARB’s step back: the technology still seems to be on the side of the regulation opponents: not only the “perfect battery” that could store great amount of energy at a competing cost is still lacking but also “projections regarding the pace of commercialization of fuel cells, which were projected to provide a second ZEV technology late in the current decade, have become less optimistic” (CARB, 2002). More precisely, CARB staff believes that a true commercial introduction will not occur before 2011 (CARB, 2003).

Conclusion

We have argued in this article that the case of the ZEV Mandate can provide valuable insight to policy makers, especially in Europe. Because this regulation oscillated from one extreme to the other, evolving from a very stringent “technology-forcing” regulation to its current progressive “dilution”, it can help policy makers to map effective responses to the various trade-offs which have to be solved while designing an ambitious regulation that aim at supporting the emergence of a radical technology.

i) Short-term versus long-term objectives. If the deadline of the regulation is too close relative to the state of the art of the technology at the moment the regulation is voted, it can “freeze” the technology by focusing research on short-term technological options. It was the case for the 1998 deadline of the ZEV Mandate which obliged industry to focus on the integration of lead-acid batteries to the detriment of research on advanced batteries. The problem, especially in the case of electric vehicles, is that as time goes by new marvelous technologies keep on emerging and raise high expectations. For instance, automakers have recently claimed that the next deadline deter research on the current long-term option, fuel cells, to the benefit of hybrid-vehicles. However, if the deadline is too far away, the regulation loses its strength and “dilutes” the technology.

ii) Means versus objectives. Although US regulations are usually mostly definitive on targets and flexible on means (Ashford, 2003), it was often argued in the case of the ZEV Mandate that CARB had become more interested in electric vehicles than in the air quality. The question was very complex at the beginning since ZEVs were at the same time a technology (fully battery-powered vehicles) and an environmental norm (no emission). To counter this argument and show it did not lose sight of the final objective, CARB staff has qualified more and more categories of vehicles, given the idea that the same level of environmental benefits can be achieved with various means. However, carmakers have so well exploited their newly acquired flexibility in the means with NEVs or low pollution gasoline vehicles than the final environmental objective of the regulation is today unlikely to be met.

iii) Rigidity versus flexibility. If the regulation does not leave a door open for negotiation and evolution, it cannot adapt to the new information supplied by the research and demonstration activities it triggers. Ambitious regulations with far reaching goals such as the ZEV Mandate rely on technology progresses that are uncertain by nature. However, if the regulation is too flexible, it loses its credibility and stimulates more lobbying efforts than innovative efforts, to the point that the content and agenda of the regulation is “captured” by powerful incumbents, as it seems to be now the case of the ZEV Mandate after the 1996 Amendments. One lesson of the ZEV Mandate is that a serious consultation and negotiation.
process with all concerned stakeholders must be carried-out before the creation of the regulation in order to limit strong oppositions from the start. Although regulations always operate in a certain level of uncertainty that raises controversy, it is important to at least obtain a certain degree of consensus regarding the technological and market assumption, or “scenario”, that underlies the regulation. This was far from being the case in the original version of the ZEV Mandate. When no consensus can be achieved there is a need for further research and experimentation until the uncertainty regarding technological possibilities, economic costs and environmental gains decreases to a “bearable” level (Kemp, 2000).

iv) Incremental versus breakthrough. If the ZEV Mandate may support the basic claim of carmakers, according to whom “it is impossible to mandate a technological breakthrough”, it has not invalidated ambitious regulatory approaches. However, these regulations that integrate in their assumption significant technological progress must set a path to their far-reaching goals, for instance by implementing progressive “technological steps” into their agenda. The all-or-nothing attitude initially adopted by CARB, relying on a very unlikely advent of a new paradigm shift that would permit to bypass the automobile industry, did not integrate such a progressive approach and was therefore doomed to fail. On the other hand, the current approach that allows more and more polluting and conventional vehicle to qualify for ZEV credits to the detriment of innovative solutions does not provide powerful incentives to innovate.

The ZEV Mandate does not only provide insights about the extreme solutions that circumscribe the principal regulation trade-offs, it also offers with its 1996 and 1998 amendments an example of a relatively well-balanced regulation. The very first positive aspect was that it had been preceded by an almost exhaustive technology survey and numerous negotiations with industry representatives. Thanks to the relationship with USABC prior to the amendment and a disclosure agreement with carmakers in order to track their efforts, they were able to closely follow the progress they have accomplished. Through the system of increasing credits according to the performance of the ZEV and its battery, it allowed for flexibility of choice while setting clear directions and incentives for technical progress and market take-off. In a way, the regulation provided an incremental approach towards a disruptive innovation. The system of partial credits for hybrid vehicle also followed the same vein, although it should have integrated a clearer reference to the hybridization rate of these vehicles.

Unfortunately, because the ZEV Mandate was amended in 1996 after six years of inflexible resistance, it seemed that CARB was giving in to regulation opponents. More than a change in the method, CARB’s new cooperative regulatory approach was therefore interpreted by the latter as a possible sign of weakness of Californian authorities. Subsequently, exercising constant pressures while “in the game”, carmakers managed to capture the regulation and begun clearing it out “from the inside”. This might be another lesson learned from this case: it is very hard to modify a regulation that experienced a “wrong start”. We hope the future of the regulation will prove the contrary and that it will provide more than a negative heuristic for other policy makers.
Bibliographie


Brown M.B., The civic shaping of technology : California’s electric vehicle program, Science, Technology and Human Values, Vol. 26, 1, pp. 56-81.

California Air Resources Board, 1995, Performance and availability of batteries for EV’s : a report of the battery technical advisory panel, Rapport du CARB.


California Air Resources Board, 2002, Draft Agenda – Workshop to discuss possible amendments to the ZEV Program, Presentation au workshop du 5-6 Décembre, Sacramento.

California Air Resources Board, 2003, Staff Report: Initial statement of reasons - Proposed amendments to the California ZEV program regulations, Rapport du CARB, 10 Janvier.


Kalhammer, 1995 Performance and availability of batteries for EVs : a report of the battery technical advisory panel, Rapport préparé pour le California Air Resources Board, Sacramento.


### Chronology of events related to the ZEV Mandate (1990-2003)

<table>
<thead>
<tr>
<th>YEAR</th>
<th>EVENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1990</td>
<td><strong>September:</strong> the Low Emission Vehicle Program, including the ZEV Mandate, is voted. The 7 largest carmakers in California must “place” 2% of ZEVs in 1998, 5% in 2001 and 10% in 2003. At that time, only fully battery-powered electric vehicles are considered as ZEVs.  &lt;br&gt;  <strong>Carmakers sue CARB for having implemented an irrelevant, unfair and inefficient “technology-forcing regulation”. They basically claim that it is impossible to mandate a technology breakthrough and that ZEVs without drivers will not improve the air quality.</strong></td>
</tr>
<tr>
<td>1992</td>
<td><strong>First biennial review of the ZEV Mandate:</strong> CARB makes no changes. The multiple lawsuits are maintained.  &lt;br&gt;  <strong>The Department of Energy and the Big Three create the United States Advanced battery Consortium. The common research efforts, undertaken on a wide set of different advanced battery technologies, aim at pure electric vehicles.</strong></td>
</tr>
<tr>
<td>1994</td>
<td><strong>Second biennial review of the ZEV Mandate:</strong> CARB makes no changes. The multiple lawsuits are maintained.  &lt;br&gt;  <strong>One after the other the US carmakers announce that their 1998 model year ZEVs will be powered by lead-acid batteries, not by advanced batteries (nickel-based, sodium-based or lithium-based batteries), which are still not ready.</strong>  &lt;br&gt;  <strong>The Big Three and the federal administration create the Partnership for a New Generation of Vehicles (PNGV). This research consortium mainly focuses on hybrid and fuel-cell vehicles able to reach the ambitious 80-mpg objective.</strong></td>
</tr>
<tr>
<td>1995</td>
<td><strong>CARB orders an independent electric vehicle battery technology survey.</strong> The result of the survey is that only lead-acid batteries will be ready for commercialization at a reasonable cost for the 1998 model year ZEVs.  &lt;br&gt;  <strong>CARB publicly asks carmakers to propose amendments to the ZEV Mandate.</strong></td>
</tr>
<tr>
<td>1996</td>
<td><strong>Third biennial review of the ZEV Mandate:</strong> CARB withdraws the 1998 and 2001 deadlines. The ZEV requirements until 2003 are replaced by a Memorandum of Agreement with the carmakers. Based on a “market-driven regulatory” approach, this collaboration aims at supporting both a progressive ZEV market launch and incremental progresses in ZEV technologies, especially batteries.</td>
</tr>
<tr>
<td>1998</td>
<td><strong>Fourth biennial review of the ZEV Mandate:</strong> The mandate is further amended to allow major manufacturers to satisfy up to six percent of their ZEV requirements with partial credits from extremely low-emission ZEV including compressed natural gas cars and Hybrid Vehicles (HEVs)</td>
</tr>
<tr>
<td>2001</td>
<td><strong>Fifth biennial review of the ZEV Mandate:</strong> Partial ZEV credits are provided to Neighborhood Electric Vehicles (NEVs). Moreover, multiple credits are awarded to the carmakers that will voluntarily place pure-ZEVs or HEVs or NEVs, before 2003.</td>
</tr>
<tr>
<td>2002</td>
<td>**Taking the most from the “2001 ZEV amendments”, carmakers “bank” multiple credits by putting on the road limited number of NEVs and ZEVs before 2003.  &lt;br&gt;  **GM, Daimler-Chrysler and the Bush Administration jointly sue CARB for having used fuel-economy standards, preempted by federal laws, in their methods of calculations of the number of ZEV credits awarded to HEVs. The implementation of the 2003 deadline is blocked.  &lt;br&gt;  <strong>The USABC, created in 1992 for 10 years, is terminated. Despite progresses, no battery technology match the initial performance-goals of the consortium.  &lt;br&gt;  <strong>The PNGV is replaced before its end by the Freedom Car Initiative that focus on fuel cell vehicles only.</strong></strong></td>
</tr>
</tbody>
</table>
| 2003 | **Sixth biennial review of the ZEV Mandate:** The “Strawman Proposal” is discussed. According to this proposal all ZEV requirements are delayed until 2005, “pure-ZEV” requirements are significantly reduced, greater amounts of credits are awarded to fuel-cell vehicles and efforts by carmakers to install hydrogen infrastructure for fuel-cell vehicles are rewarded by ZEV credits.  <br>  **CARB delayed rewriting the ZEV mandate. Deadlock over how to switch focus to fuel-cell vehicles. Carmakers propose to give up battery-powered ZEVs and dedicate more attention to long-term technologies such as fuel cells.**
Cahiers du GRES

Le Groupement de Recherche Economique et Sociales (GRES) réunit deux centres de recherche :
- **IFReDE** (Institut Fédératif de Recherches sur les Dynamiques Economiques), Université Montesquieu-Bordeaux IV
- **LEREPS** (Laboratoire d’Etudes et de Recherche sur l’Economie, les Politiques et les Systèmes Sociaux), Université des Sciences Sociales Toulouse 1

www.gres-so.org

Université Toulouse 1  
LEREPS – GRES  
Manufacture des Tabacs  
21, Allée de Brienne  
F - 31 000 Toulouse  
France  
Tel. : +33-5-61-12-87-07  
Fax. : +33-5-61-12-87-08

Université Montesquieu-Bordeaux IV  
IFReDE – GRES  
Avenue Léon Duguit  
F - 33 608 Pessac Cedex  
France  
Tel. : +33-5-56-84-25-75  
Fax. : +33-5-56-84-86-47

Cahiers du GRES :

2003-1 : DARAUT Sandrine, *Le système d’information organisationnel, objet et support d’apprentissage. Essai d’une analyse théorique*

2003-2 : VICENTE Jérôme, *De l’économie des interactions à l’économie géographique : théories et évidences*

2003-3 : OLTRA Vanessa, SAINT JEAN Maïder, *The dynamics of environmental innovations: three stylised trajectories of clean technology*

2003-4 : FRIGANT Vincent, *Défection et prise de parole dans les relations verticales interfirmeres : propositions pour une transposition du modèle d’Hirschman*


2003-6 : DUPOUET Olivier, YILDIZOGLU Murat, *Organizational performance in hierarchies and communities of practice*

2003-7 : LARRUE Philippe, *Lessons learned from the Californian ZEV Mandate: From a “technology-forcing” to a “market-driven” regulation*

La coordination scientifique des Cahiers du GRES est assurée par Alexandre MINDA (LEREPS) et Vincent FRIGANT (IFReDE). La mise en page est assurée par Dominique REBOLLO.