The Allure of Technology: How France and California Promoted Electric Vehicles to Reduce Urban Air Pollution

David Calef and Robert Goble

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David Calef, *Fondazione Eni Enrico Mattei*
Robert Goble, *George Perkins Marsh Institute, Clark University*

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Summary

All advanced industrialized societies face the problem of air pollution produced by motor vehicles. In spite of striking improvements in internal combustion engine technology, air pollution in most urban areas is still measured at levels determined to be harmful to human health. Throughout the 1990s and beyond, California and France both chose to improve air quality by means of technological innovation, adopting legislation that promoted clean vehicles, prominently among them, electric vehicles (EVs). In California, policymakers chose a technology-forcing approach, setting ambitious goals (e.g., zero emission vehicles), establishing strict deadlines and issuing penalties for non-compliance. The policy process in California called for substantial participation from the public, the media, the academic community and the interest groups affected by the regulation. The automobile and oil industries bitterly contested the regulation, in public and in the courts. In contrast, in France the policy process was non-adversarial, with minimal public participation and negligible debate in academic circles. We argue that California's stringent regulation spurred the development of innovative hybrid and fuel cell vehicles more effectively than the French approach. However, in spite of the differences, both California and France have been unable to put a substantial number of EVs on the road. Our comparison offers some broad lessons about how policy developments within a culture influence both the development of technology and the impact of humans on the environment.

Keywords: Environmental policy, Electric vehicles, Air pollution, Technology policy, Sustainable transport

JEL Classification: O33, O57, Q53, K32, L5

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Address for correspondence:

David Calef
Fondazione Eni Enrico Mattei
Corso Magenta 63
20123 Milano
Italy
Phone: +390252036934/+390644340196
Fax: +390252036946
E-mail: d.calef@tiscali.it

1. Introduction

In an effort to reduce air pollution in Los Angeles and other metropolitan areas in the state of California, the California Air Resources Board (CARB)[1] adopted in September 1990 a plan to encourage the development and use of zero emission vehicles (ZEV). At the time only battery-powered electric vehicles (EVs) qualified as ZEVs while other potential ZEV technologies, such as fuel cells and flywheels, were far from being commercially viable. The ZEV mandate was just one component of a multi-pronged attack on pollution, but it was the one that attracted the most attention throughout the following decade.

The regulation created in California is an example of *technology-forcing*; it required the regulated industry to produce and sell efficient electric vehicles, within a set period of time, even though the technology was not fully developed when the regulations were created. As in the case of the 1970 Clean Air Act Amendments (CAAA) that instigated the auto industry to introduce catalytic converters, the major automakers, the oil industry as well as several policy analysts bitterly contested the ZEV regulation. Indeed the mandated development of EVs triggered a controversy about the merits of the new technology that engaged substantial public participation in California and in the rest of the country. This is not surprising. To a far greater degree than people in other industrialized countries, Americans often fervidly debate technological issues, whether concerning electric cars, information technologies, antidepressant drugs (Prozac), public health measures (fluoridation) or national defense systems (Strategic Defense Initiative). And the controversies that typically accompany public discourse on any of these technologies have usually intensified each time the new technology was regulated by the federal government or, as in the case of the ZEV mandate, by a state agency[2].

Over the same time period, starting in 1992, and throughout the 1990s, the French government designed policies and passed legislation whose objective was to encourage the deployment of EVs as a means to improve air quality. But in France the process of creating regulations designed to promote EVs was remarkably bereft of conflict between government and industry and the role of interest groups was much more restrained than was the case in the United States. Indeed one would have been hard pressed to find any debate at all about EVs in France.

Our review contrasts the EV policies adopted in California and France, the relationships between industry and government, societal attitudes toward technology and the role of interest groups[3]. We explore the distinctive features of US regulation of air pollution in the transportation sector and describe how and why Americans have paid exceptional attention to electric cars, show how polarized the debate about EVs was in the United States, and contrast that debate with the collegial atmosphere that characterized the emergence of EVs in France. We compare what has happened to date in the two settings with respect to EV technology and the effects on urban air pollution. Our objective is to extract from the comparison some broad lessons about how policy developments within a culture influence technology development and influence human impacts on the environment.

2. Air pollution in California and in France

Once in a while a whole day would be clear, nobody quite knew why.
Raymond Chandler, *The Long Goodbye*

Over the past 33 years, California has distinguished itself for passing the most innovative and advanced legislation to control and reduce air pollution produced in the transportation sector, mainly because the Los Angeles basin and other metropolitan areas in the state have suffered the worst air quality in the country[4]. Nowadays, in most metropolitan areas, cars and trucks are the major source of air pollution. This holds true in California, where mobile sources are responsible for 33% of smog (EPA, 1998). Over the last five decades, automobile use has increased steadily in California as well as in the rest of the United States (TRB, 1997; AAMA, 1998) and in every other industrialized country (Schipper, 1995). Table 2 shows the progressive growth in population in California, paralleled by the rise in the number of registered vehicles and number of vehicle miles travelled (VMT).

Year	**Population** (Million)	**Registered Vehicles** (Million)	**Vehicle Miles Travelled** (Billion)
1960	16	8	71
1980	24	17	155
2000	33.4	23.9	306.3

Table 1. The rise in population, registered vehicles, and VMT in California: 1960-2000
Sources: U.S. Census Bureau, 2002, Ward's, 2002, CARB, 2000, Caltrans, 2001)

These trends show no sign of abating soon: as measured by VMT, automobile use is forecasted to increase in the foreseeable future (OTA, 1994). Despite the steady rise of population and VMT in the Los Angeles area, air quality has improved substantially, as shown by the trend represented in figure 1. (Ozone trends in the Basin Area and the Ile-de-France). Nonetheless, there are still numerous days when ozone levels remain higher than the standard judged safe by the state.

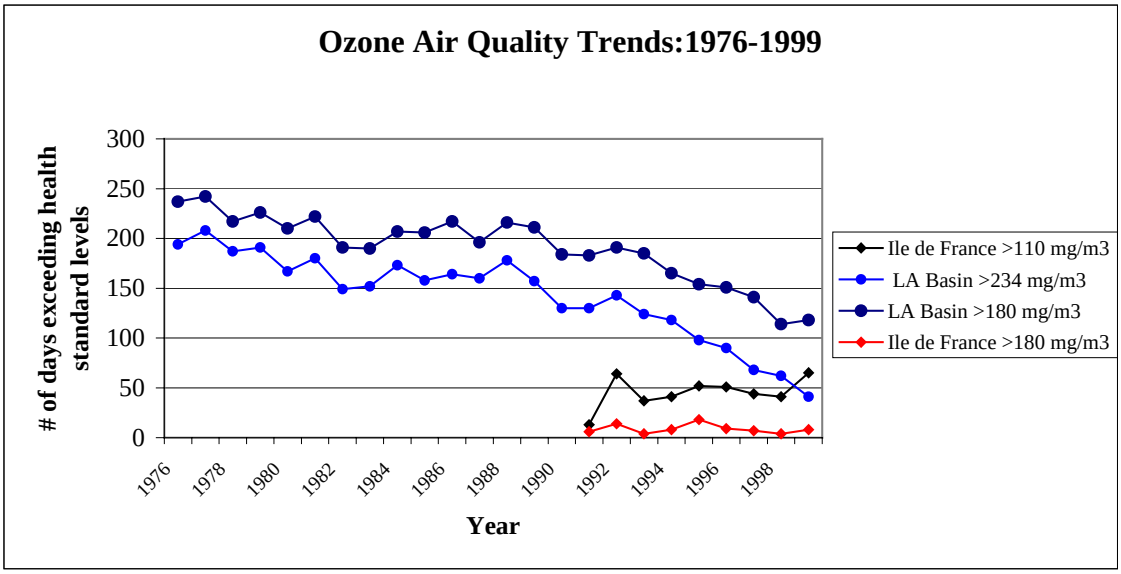

Figure 1: Ozone air quality violations in Los Angeles and Paris
Sources: SCAQMD, 2003 and Airparif, 2003.

Thus progress in air quality achieved by means of strict air pollution control regulation and ever-improving emission control technology has been insufficient[5]. The air of the Los Angeles Basin remains extremely unhealthy and the state of California dominates the U.S. smog "top ten," boasting five areas with the highest ozone levels and eight areas with the most frequent violations of the federal standard[6]. Moreover, the CARB maintained that projected increases in VMT (384 billion in 2010 and 475 billion in 2020) would slow and, possibly, reverse the decline in ozone levels (Caltrans, 2001). Along with the rise in miles driven, the major reason that explains the inadequacy of emission reduction improvements is the stagnation in automobile fuel economy over the last thirteen years. In 1988, the new car fleet fuel economy was 28.8 miles per gallon (mpg) and in 2000 it was 28.1 mpg (EPA, 2000). Furthermore, the market share of sport utility vehicles (SUV) and light trucks, which are about a third less fuel-efficient than passenger cars, has increased from 22% in 1983 to 46% in 2000 thus lowering the average fuel economy of light-duty vehicles to 24 mpg, the lowest since 1980 (EPA, 2000). The increasing popularity of SUVs and light trucks, subject to lax government fuel efficiency standards, as well as the rise in VMT has largely offset the air quality gains brought by pollution reduction technologies (catalytic converters, fuel injection, variable valve control). Furthermore, throughout the period under exam, the worsening urban traffic congestion effected by growth in car-based mobility in most urban areas, precipitated adverse social consequences (e.g. gridlock, rising volumes of polluting exhaust and monetary losses) (Shrank and Lomax, 2002)[7].

In France, the transportation system has provided French residents with a high level of personal mobility, although less than that enjoyed by Americans[8]. See Table 2 for a comparison of transportation data in France, the United States and California).

	Population (million)	# of vehicles (million)	Public Transport PS-km (billion)	Private Transport Ps-km (billion)	# of EVs	# of HEVs
France	58.5	32.1	41	699.6	7,744	164
U. S.	271	203.7	77.6 (2001)	7136 (2001)	5,000	31,132
California	33.4	23.9	N.A.	841.9	3,900[9]	16,000

Table 2. Data on Road Transportation for France, the USA and California in 2002*

*: except where noted

Passenger-km: One passenger traveling the distance of one km. Total passenger-km traveled gives the total distance traveled by all people

Sources: (1) Population: Bureau of Census, 2002 (US and CA); Insee (France); (2) Motor vehicle registrations: DoF, 2002 (US and CA); CCFA, 2002 (France); (3) Passenger Activities: FHWA, 2003 (US and CA); CCFA, 2000; (France); (4) Motor Vehicles: Ward, 2002 US; CARB, 2002 (CA); CCFA, 2002 (France); (5) EVs: Energy Information Administration, 2002, (US); Cackette, 2003 (CA); GIVE, 2003 (France); (6) HEVs: EVAAA, 2003 (US); Eley, 2003 (CA); Boyer, 2003 (France).

But, as in the United States, the growth in automobile mobility has worsened air quality. In 1993 cars, trucks and buses produced about half of the ozone-forming hydrocarbons, 60% of all the carbon monoxide pollution and 68% of the oxides of nitrogen, 90% of lead and 41 % of the particulates (Citepa, 1998). And if since 1980, as Table 3 shows, total (i.e. from industrial, service and transportation sectors) emissions of NO_x, have declined

considerably, the contribution of the transport sector to overall emissions output over the same period did not decline.

Pollutant	**1980**	**1990**	**2000**
France NO_x Total	1654	1585	1435
France NO_x Transport	860	1038	728
California NO_x Total	1843	1789	1286
California NO_x Transport	884	995	674

Table 3. NOx emissions (total and from the transportation sector) in France and California 1980-2000. All data are in kilotons. Sources: Citepa, 2002 for France and CARB, 2002 for California.

Although new cars met ever stricter standards, in several metropolitan areas, including those of Grenoble, Lyon, Marseilles, and Paris, air quality remained far from satisfactory throughout the 1990s owing to the increase in volume of road traffic (Patel, 1995). Ile-de-France, the region around Paris where 19% of the French population (11 million people) lives, has received the greatest attention because it is one of the most polluted and politically important areas of the country. In 1995 and 1997 there were four "level 2" ozone alerts, (concentrations exceeding 180 micrograms per cubic meter).[10]

3. The California ZEV mandate

In September 1990, convinced of the inadequacy of existing federal air quality standards, the CARB proposed new regulations based on new definitions of types of vehicle as a policy to reduce motor vehicle emissions in California. The proposal required the phased introduction of low-emission vehicles and the clean fuels needed by them. The low-emission vehicles were to meet one of four sets of exhaust emission standards. The emission standards (shown in Table 4) established by the Board were: Transitional Low-Emission Vehicles (TLEVs), Low Emission Vehicles (LEVs), Ultra-Low-Emission Vehicles (ULEVs) and Zero-Emission Vehicles (ZEVs) (CARB 1990).

Category	NMOG* (g/mile)	CO (g/mile)	NO_X (g/mile)
CV**	0.250	3.4	0.4
TLEV	0.125	3.4	0.4
LEV	0.075	3.4	0.2
ULEV	0.04	1.7	0.2
ZEV	0.000	0.0	0.0

Table 4. California Standards for Light Vehicles.

* Non-methane organic gases (i.e. hydrocarbons with the exclusion of methane).
** Conventional vehicles.
Source: (CARB, 1990)

Unlike the standards for TLEVs, LEVs and ULEVs, those for ZEVs could not be met by means of gasoline-powered cars, even those equipped with the most advanced emission-control technology available. The portion of the new regulations that dealt with ZEVs (hereafter the ZEV mandate) mandated that 2% of all passenger cars and light trucks (less

than 3750 lbs. loaded vehicle weight) sold in the state by every major car manufacturer must emit zero exhaust emissions, beginning with the 1998 models[11]. The percentage of zero emission vehicles was to increase to 5% in 2001 and to 10% in 2003. The CARB could fine an automaker failing to meet the ZEV requirement up to $5,000 for each violation.

Although strongly opposed to the mandate, Chrysler, Ford and General Motors (GM) responded to the challenge presented by the CARB by forming, together with the Department of Energy (DOE) and the Electric Power Resource Institute (EPRI) (representing the electric utilities), the U.S. Advanced Battery Consortium (USABC). The primary objective of the consortium was to improve existing battery technology, as it was generally assumed that, without major improvements in that sector, no electric vehicle meeting a satisfactory range (~ 100 miles with one charge) would have been ready by 1998.

In 1992 and 1994, the CARB reviewed the status of technological progress and upheld the mandate in its original form. Most of the attention of the CARB, as well as that of anybody interested in the potential of EVs, was focused on the state of the art of battery technology, unanimously recognized as the Achilles' heel of electric cars. In the early 1990s, the few types of batteries considered reliable (e.g., lead-acid, nickel-cadmium) were also the ones that provided the most disappointing performance. In 1995 in order to assess the current state and the future prospects of battery technology, the CARB commissioned a study to a team of four experts. The report that came out of the study (Kalhammer *et al*., 1995), concluded that: a) lead-acid (Pba) and nickel-cadmium battery technology had improved significantly during the early 1990s and would be available in 1998, although some of their characteristics would remain well below the midterm criteria set by the USABC; b) Several types of advanced batteries (nickel-metal hydride, lithium ion, sodium-nickel chloride) showed excellent promise to meet the USABC midterm goals and were good enough to allow the development of pilot-scale production; c) The plans to initiate commercial-scale battery production (10,000-40,000 battery packs per year) depended on commitments made by car manufacturers to buy batteries on that scale; d) The battery manufacturers and researchers interviewed by the panel were unanimously convinced that the ZEV mandate had accelerated investment and progress in developing advanced batteries for electric vehicles. Further progress hinged on a stable program aimed at developing EVs with advanced batteries; e) In a best-case scenario, with no technical or decision delays in any of the various development phases, electric vehicles powered by advanced batteries could become available in 2000 or 2001.

By the end of 1995, the CARB technical staff reached conclusions that reflected those contained in the technical assessment made by the panel about batteries (CARB, 1995):

- Lead-acid batteries remain the primary high-volume option for 1998 electric vehicles, but would not be able to satisfy long-term requirements such as reasonable long range.
- Although some advanced batteries (i.e., non-lead-acid) would be available by 1998, high production volumes of advanced batteries are not expected until 2001.
- The existing ZEV requirements should be altered to be more responsive to these issues.

In March 1996, the CARB suspended the ZEV requirements for the model years between 1998 through 2002, replacing them with an agreement under which the automakers committed to introduce on the market electric vehicles as early as 1996 and to supply as many as 3,750 EVs (~ 0.02 percent of all the cars sold in California in one year) between 1998 and 2000. The CARB also worked out separate Memoranda of Agreement (MOAs) with each of the seven automakers subject to the ZEV requirement. According to the MOAs, automakers would manufacture cleaner light-duty vehicles nationwide by 2001 and would continue the R&D efforts aimed at introducing large volumes of EVs by 2003[12]. For its part, the CARB was obligated to work with the state and local authorities to ensure the development of ZEV infrastructure, remove barriers to the introduction of ZEVs and contribute to the implementation of incentive programs for ZEVs (CARB, 1996a). If the automakers breached the MOA by failing to fulfill their obligations, the CARB had the authority to reinstate the provisions of the original ZEV mandate and to impose damage penalties of up to $100 million for breach of contract.

In order to encourage the development of advanced batteries, the MOA included provisions granting multiple ZEV credits to EVs powered by high (> 60 Wh/kg) specific-energy batteries. The credits scheme functioned as an incentive to use advanced batteries at the expense of lead-acid batteries; in other words, they favoured EVs capable of at least 100-mile range (CARB, 1996b).

In 1995, the CARB staff had discussed possible amendments to the LEV regulation in order to provide greater flexibility to the auto industry to meet California's emissions requirements. After having reviewed the existing information about the technology of hybrid electric vehicles (HEVs), CARB staff proposed that HEVs with an all-electric range of at least 30 miles could receive partial ZEV credits (CARB, 1995)[13] but in June 1996, CARB decided to drop the proposal of partial ZEV credits for HEVs (CARB, 1996c). Two years later, CARB changed its mind about hybrid technology: hybrid electric vehicles had become increasingly attractive to policymakers because they did not require esoteric technology and provided already substantial benefits towards the goals of automobile emission reduction and fuel-efficiency improvements[14]. The HEV models offered on the US market after 1999 provided the same range drivers expected from ICEVs, did not suffer from the recharging-time problems (whether perceived or real) of EVs and were significantly more fuel efficient than most conventional gasoline cars[15].

At the end of 1998, the CARB amended again the mandate introducing a new category of extremely clean cars: the super ultra low emission vehicle (SULEV) standard that stood to gain partial zero emission vehicle (PZEV) credit toward the 10 per cent requirement[16]. Under the 1998 amendments, 4 per cent of the cars offered for sale by the automakers had to be electric, while the remaining 6 per cent of the original 10% ZEV requirement set for 2003 could be met with PZEVs (CARB, 1999).

Ten years after the ZEV mandate was first proposed, the most crucial uncertainty about the feasibility of large volume sales of EVs regarded the cost and the performance of rechargeable batteries. In order to answer lingering questions about recent progress made by battery manufacturers, the CARB contracted a second battery-technology assessment to three experts who in June 2000, produced a second report about batteries. The panel concentrated its investigation on advanced batteries having estimated that lead-acid and nickel-cadmium batteries would not provide the performance expected by large

numbers of customers. According to the panel's findings the best candidate EV-battery was NiMH (Nickel-Metal Hydride)[17]. On the basis of the battery panel assessment, the CARB biennial review held in September 2000 confirmed the requirement for 4% pure ZEVs by 2003.

In January 2001, the CARB approved new amendments requiring that, by 2003, only 2% of the cars (roughly equivalent to 4,650 EVs) to be pure ZEVs, another 6% had to be PZEVs and the remaining 2% vehicles identified as advanced technology partial zero emission vehicles (ATPZEVs) (natural gas, hybrid electric, methanol fuel cell) and capable to satisfy the SULEV standards (CARB, 2001). Other key elements of the amendments called for a gradual increase of the overall ZEV requirement from 10 % in 2003-2008 to 16 percent in 2018, for the provision of additional credit multiplier based on the vehicle's energy efficiency and, starting in 2007, sport utility vehicles and light trucks would be included in the sales figures employed to calculate the ZEV quotas. Furthermore, having recognized that lower-range vehicles could satisfactorily fill a number of market applications, the CARB lowered the minimum range required for a ZEV to obtain multiple credit to 50 miles on a single charge thus providing a more gradual incentive for range rather than the "all-or-nothing step function at 100 miles" used in the previous version of the mandate (CARB, 2001). From the early 1990s until 2002, at any given time, there were never more than 3900 EVs in California, half of which were owned by government and utility fleets (Cackette, 2003)

3.1 Technology-Forcing and the Biennial Review Mechanism

The CARB staff was well aware that one of the most delicate issues of the LEV regulations was the technological feasibility of the proposed standards. Indeed the first CARB proposal for the LEV regulation admitted that

> "The requirement for ZEVs is based on the projected viability of electric vehicles after receiving input from vehicle manufacturers and electric vehicles design engineers. It is widely acknowledged that further research and development will be needed before vehicles capable of meeting the emission standards in use are ready for commercial production." (CARB, 1990)

In order to monitor the progress made by automobile manufacturers the technical team of CARB claimed that "it would continue to work closely with the vehicle and fuel industries in implementing the regulations and identifying any appropriate changes to the regulations that may be needed in the future". The staff recommended that it would report back to the Board every two years on the implementation of the ZEV program.

Although in 1990, battery technology was still costly and no breakthroughs had occurred for many years, the CARB's selection of electric vehicles as an appropriate technology to reduce the problem of urban air quality was not really haphazard. As in other past technology-forcing regulations, the ZEV mandate relied on the assumption that the industry was relatively close to developing a viable technology (La Pierre, 1977; Ashford et al., 1985). Indeed, the CARB staff had been encouraged to pursue the EV technology option by the EV prototype program launched by GM in the late 1980s[18].

The success of the ZEV program depended greatly on the CARB's ability to design an appropriate regulatory strategy to facilitate the emergence of a battery technology that could power EV in a cost-effective and reliable way. In this respect CARB took several decisions that illustrate the agency's effort to consider new technological developments and address industry's concerns without weakening the technological momentum created by the mandate. In a momentous move, CARB postponed the deadline for the first ZEV requirement from 1998 to 2003 and allowed automakers to gain ZEV credits by means of hybrid cars that had unexpectedly benefited from the advances in battery technology[19].

Although formally the CARB left the choice of the technology to meet the ZEV requirements to the discretion of the automakers, EVs were the only feasible option at the time the mandate was conceived. Indeed the ZEV mandate sparked an international revival of the EV technology that had been dormant for decades. American, French and Japanese automakers that had neglected research on EVs and advanced batteries throughout the 1970s and the 1980s resumed their interest in it mainly as a result of the ZEV mandate (Cornu, 1998; Sato, 2001).

Having favored electricity over other alternative fuels for automotive transportation, the CARB revealed again its predilection for technology-forcing as it attempted in the 1998 revisions to influence the technological trajectory development of batteries. Indeed, by granting ZEV credits to vehicles exceeding 100 mile range the CARB pushed the development of advanced batteries to the detriment of lead acid batteries. But with the changes that, in 2001, extended the ZEV credit scheme to low range EVs, leveling the playing field for lead acid batteries, the CARB showed that technology-forcing need not be rigid and unresponsive to market concerns as its critics suggest. In fact, although created in 1990 as a public policy clearly biased in favor of the development of battery-powered electric cars, the ZEV regulation ended up accelerating the development of other clean-vehicle technologies, such as fuel cells, which are widely considered the most promising long-term clean propulsion technology for automobiles (Williams, 1994; Ogden, 1999)[20].

Discussing the development of fuel cells, Firoz Rasul, CEO of Ballard Power Systems, one of the leading firms in fuel cells R&D, acknowledged that the mandate functioned as a catalyst for the development of the new technology. In 2001, Rasul said:

> "It's not just going to happen by market forces…I can certainly tell that Ballard would not be here today, if it was not for the zero emission vehicle regulation set in 1988. Without that requirement we could have not raised the money" (Rasul, 2001).

4. Reactions to the ZEV Mandate

Predictably, the strict standards imposed by the ZEV mandate caught the attention of many interest groups in California and in rest of the country eliciting a vast array of reactions. Perceiving the appearance of EVs as a direct threat to their monopoly on fuels for automobiles, the oil companies were bluntly hostile to the ZEV mandate while the major automakers were at best reluctant to reconfigure their industry around electric motors powered by rechargeable batteries.

On the other hand, electric utilities saw the CARB's regulations as an opportunity to expand their markets and optimize the existing electricity generating capacity. Indeed, a market for EVs would affect the utility rates (Ford, 1994) and would also create potential new customers. Environmental groups and public health organizations welcomed the ZEV mandate, but were not as vehement and resourceful in their support as the oil and the auto industries were in their opposition to it. Within a year of the mandate's approval, both the oil and the auto industry engaged in an intense campaign to oppose the CARB regulation. The degree of hostility towards the mandate was different for the two industries since the stakes were different. The automobile-makers were always going to manufacture automobiles, whereas, in the long run, oil companies risked the loss of significant fraction of the market and perceived the emergence of electric vehicles as a long-term threat to their business.

The major automobile manufacturers claimed that the electric vehicles available on the market had one crucial technical weakness (limited driving range) and were too costly to be marketable[21]. The anti-EV camp employed many strategies to influence the outcome of the policy decision-making process including:[22] political contributions, advocacy advertising, funding of studies, traditional lobbying and astroturf lobbying, and challenges in the courts.

4.1 Lobbying and Public Relations

With considerable financial resources and political clout at their disposal, the anti-EV camp was able to make extensive efforts to influence the public debate about the mandate. The oil companies employed a traditional method of influencing public policy formulation by contributing money to candidates for political office. Atlantic Richfield Co., BP America, Exxon, Mobil Oil Co., Phillips Petroleum, Shell Oil Co. and Texaco donated a total of $1.1 million to legislative candidates in 1994 and in the first six months of 1995. During the same period, the auto industry donated $276,000 (Kasnitz and Mashke, 1996). In particular, California's governor Pete Wilson received $325,000 and $76,000 from oil and auto industry groups, respectively.

Mobil Oil Corporation attempted to secure the approval of the general public using advocacy advertising strategies. The company regularly purchased advertising space in the *New York Times*, *USA Today*, the *Wall Street Journal*, the *Washington Post* and large-circulation news magazines such as *Newsweek* and *Time*, spending an estimated $3.5 million (Kasnitz and Mashke, 1996). Aimed at discrediting all potential alternative fuel vehicles, including electric cars, the Mobil campaign sought to do three things:

1. Reassure customers that the world was not running out of oil. As part of the *Clearing the Air* series, the *Running out of oil?* ad (Mobil #1, 1995) warned readers that a "sizeable number of regulators and politicians are pushing mandates and subsidies[23] to drive the public to buy alternative fuel vehicles"[24].

2. Illustrate the inadequacy of EV technology as a means of transportation for the average American and discredit their environmental benefits[25]. An ad titled *Who pays for plugging in?* reassured the general public that: "We have no problem with electric cars competing in the marketplace. We do have a problem, though, with

mandates, particularly mandates at this time that would lock in our current electric technology. That technology simply is not good enough."

3. Foster the values of the free-market system, which Mobil saw as threatened by ever-expanding government regulations and stir up economic apprehension by arguing that the mandate would cause tax increases.

The oil industry did not limit itself to advocacy advertising. Concerned that the general public would be skeptical of positions taken by “big business”, oil companies also resorted to *astroturf lobbying*[26].

Westerns State Petroleum Association (WSPA), a trade organization of the oil industry, mobilized two consumer groups that normally lobbied to keep utility bills low: Toward Utility Rate Normalization (TURN) and Utility Consumer's Action Network. Over the course of the anti-ZEV campaign, a group called Californians Against Utility Company Abuse (CAUCA) was set up by oil companies in order to promote senate bill SB 1819 and assembly bill AB 3239 which would have prevented the legislature from using utility revenues to develop an infrastructure for natural gas and electric vehicles. CAUCA, managed by the Burlingame-based public relations firm Woodward & McDowell, started its campaign by sending a letter to 200,000 ratepayers urging them to protest against the proposed $600 million utility investments in alternative support systems. The letter, signed by TURN executive director Audrie Krause and by Howard Owens, director of Congress of California Seniors, made no mention that it had been written by Woodward & McDowell or that the whole effort had been paid by the WSPA[27]. About 50,000 citizens returned postcards to Woodward & McDowell, which in turn forwarded the cards to legislators' offices. To further its astroturf strategies, WSPA created fake grassroots movements such as Californians Against Hidden Taxes (CAHT) and the National Institute for Emergency Vehicle Safety, a one-man group that claimed to speak for emergency response workers concerned about hazards related to EVs (such as battery shocks, battery leaks, etc.)[28].

Ultimately the essence of the lobbying efforts produced by automakers and oil companies could be found in a *Request for Proposal* issued in the spring of 1995 by the American Automobile Manufacturers Association (AAMA) an organization that includes Chrysler, Ford and General Motors. While it acknowledged that “Recent surveys indicate a majority of Californians believe zero emission vehicles (ZEVs) are a ‘workable and practical’ means of reducing air pollution”, the Proposal’s objective read as follows: “The AAMA is conducting a search for a qualified contractor to manage a statewide grassroots and educational campaign to create a climate in which the state’s mandate requiring automakers to produce a fixed percentage of electric vehicles beginning in 1998 can be repealed” (AAMA, 1995).

Industry groups that favoured the ZEV mandate did not refrain from using astroturf tactics either, although they did so primarily in response to the oil industry efforts. Electric utilities hired a PR firm, PS Enterprises, to organize the Santa Monica-based Californians for Jobs and Clean Air (CJCA). The main objective of CJCA was to create press releases aimed at counteracting the oil industry's bleak news about the effect of EVs on the California economy[29]. In typical astroturf style, the press releases did not

disclose the origin of the funding for CJCA which was a consortium of electric utilities (Parrish, 1994).

4.2 Studies about the ZEV mandate

"You think the stories are true?"
"No, "Eric said.
"Then why do you spread them?"
"For the tone of course."
"For the edge."
"For the edge. The bite. The existential burn."

Don DeLillo, *Underworld*

The campaign run by interest groups to discredit or to support EVs and the ZEV mandate borrowed technical arguments, from the supposedly scientific debate that took place among scientists, engineers and policy analysts who were called to provide impartial assessment of the new technology. Between 1993 and 1996, researchers around the country carried out analyses that assessed the technical and the policy issues involved in the ZEV mandate. In several cases, the technical expertise offered during the crucial years of the mandate turned out to be almost as tendentious as the rhetoric that fueled the slogans of lobbyists and PR officials. Indeed, quite a few studies produced to discredit EVs made assumptions that either conflicted with undisputed data or, more subtly, emphasized the weaknesses of EVs omitting their strengths. These studies happened to be the ones that attracted the most attention from the media.

The honor of opening the first round of salvos against the ZEV mandate went to Sierra Research (SR), a consulting firm based in Sacramento, California, which published five reports on the emission benefits and the cost-effectiveness of California's low-emission vehicle regulation. Funded by the AAMA, the report "The Cost-Effectiveness of Further Regulating Mobile Source Emissions" concluded that: “The ZEV mandate does not appear to be a cost-effective control strategy even assuming that new car sales volumes are unaffected and power-plant emissions are zero” (Sierra Research, 1994)[30]. To reach these conclusions SR had to discount emission reductions achieved by EVs in attainment areas or during seasons with no air quality standards violations, effectively treating those reductions as without value. Furthermore, in comparing EVs and Internal Combustion Engine Vehicles (ICEVs), SR analysis ignored the vehicles' operating costs and considered only initial vehicle costs, thus giving an unfair advantage to ICEVs, whose operating costs are higher than those of EVs.

Shortly after the Sierra Research reports were greeted by a warm response among groups hostile to the ZEV mandate, another study brought the controversy about the ZEV mandate to the national stage. In May 1995, *Science* published the results of the study "Environmental Implications of Electric Cars”,[31] conducted at Carnegie-Mellon University by L.B. Lave, C.T. Hendrikson and F.C. McMichael[32]. The thrust of the Carnegie-Mellon report was that, since the mandate would require the use of many electric vehicles powered by lead-acid batteries, lead emissions would increase and pose a threat to Americ`n chtizens. The authors concluded that "electric cars do not deliver the promised environmental benefits" and that "a 1998 model electric car is estimated to

release 60 times more lead per kilometre of use relative to a comparable car burning leaded gasoline" (Lave, Hendrikson and McMichael, 1995). Lamentably, the article contained several errors that undermined the dramatic conclusions reached by the authors. Lave and boauthors used obsolete data indicating, for instance, that the energy density of the lead-acid battery used in the General Motors Impact[33] was 18 Watthour per kilogram (Wh/kg) while the figure given by GM was 40 Wh/kg (GM, 1996). Although this error was corrected in the accompanying text, it appeared that all the calculations were based on the incorrect figure. The number given for the battery mass for the Impact was 1378 kg (but it was 522 kg according to GM) which was greater than the entire mass of the car which had a curb weight of 1350 kg. According to Lave et al., the Impact's range was 50 miles when in fact it was estimated to be at least 70 miles. Furthermore, the authors estimated an energy capacity of 25 KWh, a figure, apparently obtained by multiplying the wrong battery mass (1378 kg) by the incorrectly-stated energy density (18 Wh/kg).

In order to estimate the amount of lead emissions in the environment Lave and co-authors assumed that the lead used in the batteries was virgin-mined lead, when in fact about 97% of lead batteries is recycled and only a fraction is produced from virgin lead. Furthermore, the article did not differentiate between the air-borne emissions of lead and lead solid waste which is relatively easier to monitor[34].

In 1996 further skepticism about the environmental benefits of EVs emerged in a study carried out at the Massachusetts Institute of Technology (MIT) (de Neufville et al., 1996) in which evidence against ZEVs was obtained by means of a selective examination of facts: thus the setbacks encountered by sodium-sulphur batteries were duly mentioned but the achievements of NiMH were not; the average life span of several advanced batteries, according to the MIT researchers, did not reach the 1.5-2 years range when in fact it does (Karlhammer et al., 1995) and the assertion that supplying additional electric loads to power EVs would inevitably require using dirty and inefficient power plants was questionable since electric utilities' emissions vary greatly across geographical areas depending upon energy mix, in many actual cases, can provide net environmental benefits (U.S. GAO, 1994; MacKenzie, 1994).

Not all those who had a stake into the ZEV mandate or were called upon to assess its viability provided an assessment of it proved to be as partial as the researchers of MIT, Carnegie Mellon and SR[35]. And there was concern by proponents of EV technology over some aspects of the mandate. Alan Cocconi president of AC Propulsion Inc., a small manufacturer of EVs powered by lead-acid batteries based in Southern California challenged in several occasions the technology-forcing provisions related to battery development. In March 1994, responding to a *Los Angeles Times* editorial, Cocconi, suggested that rather than forcing the sale of 2% EVs in California in 1998, the CARB should have employed market instruments to create a robust demand for EVs by building recharge outlets in public places and lending special lane privileges to EV drivers (Cocconi, 1994). Between 1998 and 2000, AC Propulsion criticized the CARB ZEV credit scheme aimed at producing incentives for automakers to use advanced batteries. The ZEV mandate, in the version approved in 1996 and confirmed in 1998 and 2000, granted extra ZEV credits to automakers on the basis of the range of the EVs they produced. The arbitrary threshold of 100 miles range precluded any EV passenger car using lead-acid batteries (that do not have sufficient specific energy to go beyond 70-90

miles) from achieving any extra ZEV credit. According to Cocconi, relying on costly advanced battery technology at the expense of inexpensive lead-acid batteries, was bound to frustrate consumer demand and slow EV market development. In order to stimulate an affordable near-term market for EVs (i.e. based on EVs powered by relatively cheap PbA batteries) AC Propulsion proposed to extend the multiple ZEV mechanism below the 100 miles range (Gage, 2000). AC Propulsion's argument reflected a pessimistic view of the possibility of the battery industry to improve NiMH battery performance and lower costs by 2003 while it denied the notion that lead acid batteries were unsuitable for a "real world" EV. Although the AC Propulsion interest in the revision of the ZEV credit mechanism was obvious, it was not pushed forward by means of specious arguments, a circumstance singularly rare in the debate about the ZEV mandate.

4. 3 The ZEV mandate and the Courts

"Scarcely any question arises in the United States which does not become, sooner or later, a subject of judicial debate."

Democracy in America, Alexis de Toqueville

It is not surprising that, in a country where the law has traditionally played a central role in the solution of public policy issues, the controversy about the ZEV mandate became the subject of judicial review[36]. Indeed, as various versions of the ZEV mandate were adopted, practically all the parties affected, engaged in recurring actions to challenge it in courts around the country. In May 1992, Massachusetts and New York adopted the California LEV plan, including the ZEV mandate. Less than two months later, the Motor Vehicle Manufacturers Association of the United States (MVMA) and the Association of International Automobile Manufacturers (AIAM) filed a suit against the New York Department of Environmental Conservation (*Motor Vehicle Manufacturers Association of the U.S., Inc. v. New York StateDepartment of Environmental Conservation,* 810 F. Suppl. 1331, 1993, hereafter MVMA, 1993). The automobile manufacturers complained that the LEV rules adopted by the state of New York violated the "third vehicle" provision of Clean Air Act Section 177 since New York had not adopted the clean fuels portion of the California's LEV program.

The American Auto Manufacturers Association also sought to enjoin implementation of tailpipe emissions regulations adopted by the Massachusetts Department of Environmental Protection (D.E.P.) (American Auto Manufacturers Association v. Massachusetts D.E.P., 31 F.3d, 18 First Circuit, 1994, hereinafter AAMA, 1994). The action suits filed against the two Northeast states were similar: the automobile manufacturers claimed that the rules adopted by Massachusetts and New York were pre-empted by the CAA. In 1994, the court of appeals upheld the adoption of LEV regulation, but in 1997 the court ruled that Massachusetts DEP ZEV regulations were not identical to California standards as required by Clean Air Act (CAA) §177 and thus, were pre-empted by CAA §209(a) (American Automobile Manufacturers Ass'n v. Commissioner, 97). In the following years, automakers and car dealers, in Massachusetts and in New York, have repeatedly taken action against the two states' environmental departments, usually following the ZEV mandate revision cycles (AIA, 2000; Daimler Chrysler et al., 2002).

In 2001, General Motors filed a suit in California to overturn the mandate, alleging, among other things, that the CARB ignored the financial impact of the mandate

on the automakers (O'Dell, 2002). The next year, General Motors, DaimlerChrysler and several car dealers filed a second suit in California challenging the ZEV regulations on the grounds that the provisions pertaining to gasoline-electric hybrid vehicles were related to fuel economy standards and, as such, were preempted by the Energy Policy and Conservation Act, the federal law that established the CAFE standards in 1975 (US Court of Appeals, 2002. Subsequently, several environmental and public interest groups filed a *amicus* briefs on behalf of the state of California (Hwang, 2002), whereas private individuals, car dealers and the federal government filed such briefs on behalf of the plaintiffs (Central Valley Chrysler-Plymouth, INC. et al. v. Michael Kenny, 2002; Central Valley Chrysler-Plymouth, INC. ET AL. v. Michael P. Kenny, 2002).

Environmental groups, outside California, also seized the opportunities provided by the American legal system to pursue policy goals in the courts. In January 1996, shortly before the MOA were signed by the automakers and the CARB, the Sierra Club Legal Defense Fund (now the Earth Justice Legal Defense Club) filed an antitrust complaint against the automakers and the oil industry. According to the Fund's allegations, federal and state anti-trust laws had been violated by the industry in an effort to derail California's LEV program. The Department of Justice investigated the charges but eventually rejected the case (EUW, 1996; Becker, 1998).

5. The French Model of EV Development

> Méchanicien: Jeune Homme, vous avez bien raison de vous interesser à cela car. Cela c'est l'avenir. Je vois dans l'avenir des bornes électriques le long des routes ou l'on rechargera les accumulateurs, car je suis pour l'électricité et le progres. Ne me parlez pas du petrole. (Raymond Queneau, *Le Vol d'Icare*, 1968)

There are two good reasons to contrast the EV policies pursued by the CARB with France's. First, roughly at the same time, the ZEV mandate was developed, French regulators also developed a strategy that aimed at promoting EVs. Secondly, France is home to two prominent car companies, Peugeot and Renault, two major battery manufacturers, Saft and CEAC and Electricité de France (EDF), a large, resourceful national electric utility. In the early 1990s, the worsening of air quality in French urban centers led to substantial activity in the policy and legislative arena. In 1994 the results of the project ERPURS (Evaluation des Risques de la Pollution Urbaine pour la Santé) *Impact de la Pollution Atmospherique sur la Sante en Ile-de France: 1987-1990*, an epidemiological study on the effects of atmospheric pollution on human health in the Ile-de-France were published. The study established a quantitative linkage between the levels of NO_x, SO_2, O_3 and the number of deaths and hospitalizations in the region around Paris (Medina, 1994). The results of the study were reported several times in the daily press and left little doubt about the seriousness of the air pollution problem in the Ile-de-France (Kremer, 1995; Normand, 1995). Providentially for the politicians who were under pressure to find solutions to the problem of air pollution, France found itself in a favorable situation for the development of electric vehicles for the following reasons:

1. The dense layout of French urban centers makes the use of EVs less problematic than it is in the US. Recent surveys indicate that local (within 80 km) travel by car accounts for 95% of total car travel. It was estimated that the average distance covered in each car trip in 1994 was 10 km (URF, 1998) and that 52% of all trips cover less than 3km (Coroller, 1997).

2. EDF, which is administered under state supervision,[37] relies on the world's most advanced use of nuclear power. Nuclear power plants supplying roughly 75 percent of the country's electricity emit the least amount of pollutants compared with other energy resources. This means that France stands to benefit the most from replacing ICEVs with EVs in terms of air quality[38] (GAO, 1994).

3. In absence of government regulations, EDF in the 1970s and PSA Peugeot Citroen in the early 1980s had declared an interest in EV technology (Callon, 1980; Helmer, 1991).

4. The French government, like most governments in Europe, imposes heavy taxes on gasoline, making alternative fuels such as electricity more attractive to car buyers.

Of these favorable factors, France's utilization of nuclear energy played the most pivotal role in the development of EVs. Although the production of nuclear energy attracts opposition or at least skepticism in most industrialized nations, it still enjoys strong support in France on account of the independence from foreign energy resources it affords. The French anti-nuclear movement has been vehement in its opposition to the government nuclear program, but its impact has been marginal.[39] Thus, even though the potential environmental benefits of a French EV program are truly remarkable[40], the nuclear origin of the electricity that would fuel EVs has weakened the case of the latter in the eyes of the majority of environmental groups. These would support them only if electricity was produced by non-nuclear power plants (Parvilliers, 1998; Stephane, 2000; Godinot, 2001)[41].

5.1 Why France may not be so serious about EVs

Along with the positive factors encouraging the development of EVs in France, a few factors have hampered it:

1. Car ownership is less diffuse in France than it is in United States and in California. Whereas there are 1.3 people for every car in the United States, there are 1.8 people for every car in France (CCFA, 2000). Given the current shortcomings of EVs (limited driving range, long refueling time and high price tag), it is unlikely that a household with only one car would prefer an EV to a more reliable ICEV.

2. The French environmental movement is relatively weak compared to most Northern European countries and to the United States. This means that there is

less than meets the eye in the widespread consensus on the need to develop clean technologies to curb air pollution.

3. The majority of environmental groups have given at best a half-hearted support to EVs since they could not summon any enthusiasm for a technology that would reinforce the use of nuclear energy[42].

4. A successful effort to electrify the fleet of passenger cars, would entail for substantial tax revenues losses for the French Government, as gasoline is heavily taxed (at about 80%) whereas electricity is taxed only at about 20% (IEA, 2001b).

5.2 EVs Policies in France: *Colbertisme* lite

> Thus the State, which is answerable for France, is in charge, at one and the same of yesterday's heritage, today's interests, and tomorrow's hopes. (Charles de Gaulle, *Memoirs of Hope: Renewal and Endeavour*, 1971)

The French government has been a key player in the development of EVs so far. The state-owned electric utility EDF, the auto industry (the three automakers Peugeot, Citroen and Renault) as well as local administrative institutions have come together to contribute financially to the development of the electric vehicle industry. An initial protocol, the Accord-Cadre sur le Developpement du Véhicule Electrique, coordinated by the Ministry of Industry, the Ministry of the Environment, EDF, PSA (a consortium formed by Peugeot and Citroën), Renault and the government agency Groupe Interministériel Véhicules Electriques (GIVE[43]) on July 28, 1992 considered EVs as a timely instrument to reduce pollution and noise in French cities as well as a CO_2 emissions. The signatories pledged that within three years the automobile companies would manufacture thousands of EV and EDF would build the appropriate charging infrastructure. Several government research agencies including ADEME, CNRS, and INRETS were called to participate into the EV program to bring about the protocol's objectives. A more ambitious and formal agreement signed on April 1995 by the minister of Industry, Renault, PSA, EDF and GIVE defined the modes of engagement of the various partners in the EV program. The 1995 Accord-cadre aimed for the following by 1999:

- 100,000 EVs should be on France's roads
- Electric vehicles should constitute 5% of the newly registered vehicles
- 10% of public sector vehicle fleets would be electric (GIVE, 1995).

All the goals were voluntary and no penalties were established in the event the goals were not achieved.

To formalize cooperation between the government and the private sector and to provide tangible support for the development of a market for electric vehicles, a decree was signed in May 1995 allocating financial aid (5000 FF ~$1,050) for private citizens

who buy electric vehicles. The decree was followed by another protocol in March 1996 that provided more subsidies from EDF (10,000 FF ~ $2,100).

At the end of 1996, given the persistence of poor air quality throughout France, the French government passed the *Loi sur l'Air et l'Utilisation Rationelle de l'Energie* (Law on the Air and the Rational Use of Energy) with the express intent of curbing air pollution and fostering the rational use of energy. The Loi sur l'Air contained one provision aimed at promoting the development of alternative fuels vehicles. Under title VII, article L. 8-B read:

> Within two years from the publication of Law 96-1236 of December 30 1996, the State, the public, national corporations...when they manage a fleet of at least 20 vehicles must acquire or use, at least, 20 % vehicles powered by electricity, liquid petroleum gas and natural gas. This measure applies to all the automobiles ...with the exception of those which weigh more than 3.5 tons" (*Journal Officiel de la Republique Francaise*, 1997).

Although the Loi sur l'Air called for the acquisition of alternative fuels vehicles by government agencies, no penalties were imposed on the administrative bodies that failed to equip their fleets with clean vehicles.

In order to make the French public aware of the benefits of electric cars, French authorities set up EV several rental programs that had the ambitious objective of altering the way people use vehicles in urban areas and fostering a system of car-sharing where a fleet of vehicles is used by multiple customers[44]. Praxitèle, the most ambitious of these programs, was started in 1997 in the town of Saint-Quentin en Yvelines on the periphery of Paris. Launched by a consortium of industrial groups (including Renault, EDF, and Dassault) and two research institutes (INRIA and INRETS), Praxitèle aimed at providing French citizens with the mobility, comfort and independence of private car ownership as well as with the benefits of public transit. At Saint-Quentin en Yvelines fifty electric Renault *Clios* were available in strategic places (parking areas near train and bus stations) to multiple users on a "use it and leave it" principle. Customers had access to the *Clios* by means of a special magnetic card and paid for the vehicle only when they were using it and not when it was parked (Parent, 1997). Praxitèle closed its operations in June 1999 as it was not considered profitable by the automakers (Parent, 2000)[45].

By the end of 2002, more than 7,500 EVs were circulating in France, far less than 100,000 set as a goal in the 1995 Accord-cadre, but still more than any other industrialized country[46]. Contrary to what happened in California, more than 90% of all the EVs were used in fleets of municipalities and utilities, bearing out the intention of the government to strengthen EV policies by means of public procurement programs (Ademe, 2001).

Although by 1995, Renault had already presented the *Next*, a hybrid vehicle prototype[47], and several French policy analysts have since suggested that HEVs could be a viable technological option to reduce air pollution (Larbaoui, 1998, Badin *et al*, 2000), the French legislation and the buying public have barely acknowledged the existence of the new technology. In fact, to date, the only legislative act that has reflected the progress of HEV technology came at the end of 2000: a new provision in the tax code offering a

tax rebate of 1525 euro (~$1600) to customers of HEVs (Law n.2000-1353, JO, 31 Décembre 2000). But despite this financial incentive very few HEVs have been sold[48].

Although, they do not deal with alternative fuel vehicles, two other titles of the Loi sur l'Air are germane to our cross-national comparison: title IV, Article 12 stated: "when the alert threshold is trespassed the prefecture takes measures aimed at limiting the intensity and the effects of the pollution on the population. The measures...entail a mechanism of restriction or suspension of the activities concurring to the pollution, including the circulation of vehicles....".

And title V, Article 28-1, by imposing the adoption of *plans de deplacements urban* (PDU) (to urban centers with more than 100,000 inhabitants), encouraged to shift travel demand to more efficient modes: from single occupant vehicle to higher occupancy modes (carpooling and public transit) or to non-motorized modes (pedestrian and bicycle). A revealing expression of the intent to achieve the desired air quality goals by reducing the circulation of private vehicles was exhibited every time the government decreed a special arrêté (ordinance) of *circulation alternée* (alternate circulation) in Ile-de-France in days when air pollution reached health threatening levels[49]. Under the *circulation alternée* policy, cars with odd-numbered license plates were banned from driving on odd days and cars with even-numbered license plates were banned on even days. Following European Union guidelines, all cars were banned during the no-car day in many French cities or in sections of them, in 1998 and subsequent years (Airparif, 2000).

A view shared by many in the policy community is illustrated by a case presented at the workshop "Pollutions Atmosphériques: Transports and Santé", organized by the Institut pour un Nouvel Environnement in 2002. Philippe Lameloise, head of Airparif, the agency charged with monitoring air quality in the Paris area, spoke of the recent evolution of CO pollution in two locations in Paris. Over a period of ten years, the levels of CO in Place Victor-Basch have declined dramatically, while on the Champs-Elysées, only a few hundred meters away from Place Victor-Basch, the decline has been notably modest. The explanation given for this apparent discrepancy was the following. Place Victor-Basch has always been in a state of permanent congestion, so that traffic volume cannot increase any further and the emission reductions reflect the technological improvements in automobiles. However, on the Champs Elysées, traffic growth continues offsetting the improvements of the new vehicles. Lameloise concluded that technological advancements alone would not attain satisfactory reductions of air pollution (Hopquin, 2002)[50]. Unfortunately, the actual effectiveness of the PDUs to date, has been disappointing. For instance, the regional plan approved in 2000 for the Ile-de-France called for a 6% reduction of automobile traffic by 2006, but by the end of 2001, traffic had increased by 2% (Hopquin, 2002).

6. Liberalism and Dirigisme

> In every case, at the head of any undertaking, where in France you find the government…in the United States you are sure to find an association
>
> *Democracy in America*, Alexis de Toqueville

There are two elements of the American cultural landscape that are relevant to this discussion of EV policies and that set the United States apart from France. To a large extent the industry reaction against the ZEV mandate can be explained in terms of the anti-government sentiment that is prevalent among large segments of American society. Between 1994 and 1996, while the oil and auto industries led their strongest efforts to derail the mandate, the Republican members of the newly-elected 104th Congress launched an unprecedented campaign against environmental regulation that was part of a broader crusade against the powers of central government. In those years the belief that the ZEV mandate was a typical example of suspect government interference in the workings of the market was rarely expressed more clearly than at a CARB workshop in December 1995. Sacramento assemblyman Bernie Richter, said: "…and the other decision that is similar to this (mandate) was made in 1917, at the culmination of the Russian revolution creating the Soviet State, and communizing, and socializing the Russian economy" (Richter, 1995). What Richter's remarkably over-the-top historical parallel reveals is that opposition to the ZEV mandate did not necessarily arise from well-founded skepticism about the viability that electric vehicles could provide a viable alternative to gasoline-powered cars, but rather originated from traditional mistrust of governmental action.

For most of the 1990s, there was intensive national media coverage of the ZEV mandate. Frequently, dailies would run front-page columns and large circulation weeklies would publish cover stories about electric cars or about the ZEV mandate itself. Mainstream publications covered the subject of EVs in neutral or even sympathetic terms; conservative publications, couched their hostility to the California legislation in explicit anti-government rhetoric. (Taylor III, 1993; McKenna, 1995)

Several environmental groups challenged the CARB's policies whenever they believed that the state agency was caving in to the pressures of the automakers and oil industry (Kasnitz and Maschke, 1996; Heavner, 2000). Throughout the 1990s, many of these groups suspected that the state agency had been "captured" by the oil and automobile interests while the latter claimed that, on the contrary, the CARB had been unduly influenced by the environmental lobby. Thus, the CARB, the industry and environmental groups remained locked in a confrontational relationship fueled by mutual mistrust.

The substantial public participation in the workshops organized by the CARB attests to the pluralistic nature of the American decision-making process. Under the pluralist model, the policy agenda was accessible to all organized interests. Ideally, a just public interest equilibrium should have emerged out of the competition of various policy claims. However, the process was characterized by untrammeled competition between interest groups deeply suspicious of each other**,** by recourse to the courts and ruthless use of lobbying strategies, and by mistrust and open conflict. If the continued revisions of the mandate reflected the difficulty of designing an appropriate policy for the development of a new pollution-control technology, they also suggest the perils encountered in a policy arena where the CARB was forced into endless brokering among various interest groups**.**

6.1 Dirigisme and Cooperation

What characterized the French EV industry in the 1990s was the heavy involvement of the central government, confirming France's penchant for *dirigisme*, the

tradition of strong state intervention actively engaged in subsidizing and protecting certain industrial enterprises[51]. In fact, the development of EV technology in France can be seen as an example of French industrial policy in action based on the cordial relationship policymakers maintain with the business sector. The French government designed and carried out EV policies in close consultation with automakers without provoking any outcry from them or from any other interest group. The traditional familiarity between businessmen and government officials fostered the development of a shared ethos concerning the main tenets of the EV policy thereby reducing the risk of confrontations. The government upheld its central role long after it had passed the law. Indeed, the Ministry of the Environment set up the Conseil National de L'Air, a study group, whose goal was to assess the effectiveness of the Loi sur L'air. The Conseil National de L'Air produced a report where the Minister Corinne Lepage admitted that the Loi sur l'Air could have been much more stringent had it not been for the pressures of oil and automobile companies (CNA, 2001)[52].

The contributions to the debate on EV technology in the media as well as in academic and research circles lacked the ideological virulence that characterized the American scene. This is understandable given that the French EV regulations were not nearly as stringent and binding as those adopted in California. What is still remarkable is that even mildly critical technology assessments were practically absent. The vast majority of technical reports produced (by and large in government research institutes) throughout the 1990s accepted the premise that EVs constituted a viable and cost-effective technology capable to achieve the goals indicated in the government documents (Clip 1994; Lamure, 1996; CIVP, 2000; Clip, 2001)[53].

The American pluralist model has always been aesthetically as well as politically distasteful to the French as it suggests a permanent state of conflict, compromise and expediency. In contrast to American faith in the virtues of pluralism and open access to the policymaking process, French technocrats display a Cartesian belief in reason and planning and believe that market forces do not necessarily produce a socially optimal outcome without the close supervision of the state. Several scholars have concluded, approvingly, that France is moving away from its *dirigiste* model (Schmidt, 1996; Levy, 1996; Mustar and Laredo, 2002). However, although France is indisputably shedding aspects of its heritage, the country has not, as far as the EV industry is concerned, abandoned its *dirigiste* model just yet[54]. Much of the interaction between government and business, the discussions, the meetings and the consultations took place without any need to resort to legislative action. Therefore the process was characterized by a tendency to conduct policymaking activity behind closed doors, free of public scrutiny (Lepage, 2003). Given the cooperative atmosphere between government and business, it is hardly surprising that the latter did not take a public stance against the former. Indeed, no interest group claimed that EV technology was ineffective to curb air pollution, let alone challenged the legislation in public or in the courts. In this respect, France provided a clear alternative model to the law-saturated one existing in the United States[55].

If the ZEV mandate was predicated on pervasive American technological optimism, the effort demonstrated by the French in the development of a national EV industry suggests that the United States does not have a monopoly on technological enthusiasm and know-how. France has a remarkable record of technological achievements such as high-speed trains (train à grande vitesse: TGV), civilian aircraft

(Caravelle), telecommunications (the Minitel system) and nuclear industry[56]. However, French technological prowess is driven by a rationale that does not coincide with the utilitarian enthusiasm at work in the US. Above all, technological programs in France even when they are consumer-oriented, tend to push forward a national agenda. In this respect, nuclear reactors, the *TGVs* and the *Concordes* have continued the tradition of Colbert's *grands projets*, where technological achievements blended with political purposes[57]. Developed and operated by state companies, these programs aimed to address a particular problem (boost an ailing electronics industry, reduce dependence on foreign oil, develop fast transportation to and from Paris) but were also designed to enhance France's international prestige. At stake in every *grand projet* was *la grandeur* of France. They served to build up French national pride and bring the nation together[58]. Ultimately, the EV technology program, although, pursued without the conviction of other *grand projets*, can be seen as a national strategy designed to affirm French supremacy in advanced automotive technology.

Another important element that distinguished the development of the French EV policies from its Californian counterpart was the weak role played by environmental groups. There are two major reasons for this. Although French culture can claim in J.J. Rousseau the first modern thinker who planted the seeds of modern *green* philosophy, the level of environmental awareness in the France is lower than that in the United States. In the institutional arena, the Ministry of the Environment created in 1971 had to struggle to maintain an independent identity from other more powerful ministries (in particular the Ministry of Transport, the Ministry of the Industry and the Ministry of Energy) and has often succumbed to them when confronted with policies that opposed their interests[59]. And, even if in 1995, a new law empowered environmental groups by giving them a formal venue in which to influence the decision-making process, the level of mobilization remains far weaker than it is in most northern European countries and in the United States (Hayes, 2002, Szarka, 2002).

Therefore, although in the mid 1990s the exacerbation of air pollution and congestion in most metropolitan areas increased the level of environmental activism, environmental organizations, by their own admission, have played only a marginal role in the decision-making process, especially that which led to the Loi sur l'Air (Godinot, 2001; Lefetey, 2001; Rebelle, 2001). Even though there is a multitude of associations that advance environmental issues, few have a national scope and all suffer from an endemic lack of financial resources (Szarka, 2002). Additionally, France's fragmented environmental movement has played only a small role in forming the policies intended to control urban air pollution, in part because few if any of the major environmental groups can afford paid staff to follow a thorny issue such as transportation (Lefetey, 2001). Ultimately, the evolution of EV policies has reflected the traditional view that the state is the principal and often the sole guarantor of the public good and that interest groups are almost superfluous and certainly less legitimate than the government[60].

6.2 The ZEV mandate and the allure of technology

Faced with the difficult problem of cleaning up the foul air of the cities of California, the CARB proposed an ambitious program that relied exclusively on technological improvements. Indeed, the LEV program did not contemplate any action to induce Californians to drive less. The policy choices made by the CARB have been in tune with the past regulatory tradition in which policymakers have not favored the application of land-use planning, demand travel management and fuel tax policies as means to reduce automobile emissions. In the transportation sector there has been a clear preference for technology standards within the framework of command and control regulations while at the same time big investments in highway infrastructure combined with zoning rules effectively enabled and accelerated the phenomenon of suburbanization and urban sprawl.

This does not mean that the CARB has not recognized the link between land-use planning and the benefits of alternative strategies to curb automobile emissions. In the 1990s, the Transportation Strategies Group at CARB sponsored several studies that highlighted the linkages between air quality benefits, land use and demand travel management strategies acknowledging that increasing public transit ridership and higher residential densities would assist in the long-term improvement and maintenance of California's air quality. However, as the former chief manager of the group acknowledged, when it comes to design programs to clean the air in California's cities, the CARB's priorities lie elsewhere (Geraghty, 1998). A speech made in 1998 by J.D. Dunlap, then CARB chairman, provides some insight into those priorities:

> Since the early 1950s, when the connection between motor vehicles and smog was established, we've had a clear choice: We can either tell the automakers to make cleaner cars, or we tell Californians not to drive - and we're not going to tell Californians not to drive (Dunlap, 1997).

In the vision for a clean-air future articulated by Dunlap there appears to be scant place for land-use planning or public transit policies[61]. This view of the options available to improve air quality is endorsed by many transportation experts and policy analysts. At the 1995 Asilomar Conference on Sustainable Transportation Energy Strategies, a group of well-known experts, reached this conclusion:

> The issues raised in the wrap-up session lead some of us to conclude that real progress in achieving sustainable transportation will have to be based on very good and nearly transparent technologies. (*Transparent*, in this case, refers to technologies that would involve *no change in consumer perceptions and behavior.*) (McNutt, Fulton and Greene, 1997) (emphasis added).

In the same year, Daniel Sperling, an academic who has written often in support of EVs, stated: "it is almost impossible to imagine a scenario in which a public transit as we know it in the US would expand its role in passenger travel, all trends suggest that suburbanization is unlikely to be reversed…" (Sperling, 1995)

Dunlap reflects the expectations of many other policy analysts when he expressed a strong reluctance to employ measures that would constrain the mobility of the American driver. Fiscal instruments (gasoline taxes), travel demand management policies (carpooling, high occupancy lanes), shift to public transit, which can be perceived as unbearable restrictions on individual freedom of choice, have met strong resistance even when they have enjoyed some measure of success. Certainly, any policymaker attempting to curb private passenger car demand would face a daunting task. Decades of sprawl have effectively marginalized public transport systems - inefficient in areas of low population densities - so that the commitment to private passenger cars and low fuel prices has become so strong that it would be extremely difficult for policymakers to reverse the course of an entrenched way of life.

The United States is a society that prizes individualism and distrusts government interference in public affairs. Since *laissez-faire* ideology exerts great influence on the public discourse and on the political agenda, environmental regulations which stimulate technological solutions and do not threaten citizens' lifestyles or core American values look very appealing to many policymakers[62]. As the ultimate technological fix, ZEVs do not call for efforts to change consumer behavior as would be necessary if demand travel management or public transit policies were implemented[63]. And policymakers in California know full well that it would be very difficult to pull the citizens of the state out of their cars.

The CARB's penchant for technological solutions to clean the air also reflects Americans' strong faith in the ability of technology to solve society's problems. To be sure, the attitude of Americans toward technology is complex and has changed over the years. As early as the period of the first successes of the industrialized society more ambivalent views began to set in. More recently and more dramatically, after the advent of nuclear weapons it became increasingly difficult to view technology solely as a benign agent of change. But overall, Americans remain in awe of technological progress[64]. This special relationship with technology is revealed by the remarkable degree of attention that the ZEV regulation has received in the press and among policymakers and industrial entrepreneurs. It would be difficult to dispute the positive impacts of technological advancement for private passenger cars. Yet, the effects of an excessive faith in the promise of automobile technology are evident in Southern California and throughout the United States. Although over the past 25 years California has been the recognized as the world-leader in pioneering policies to curb automobile emissions, many areas of the state are still affected by the foulest air in the nation[65]. Sophisticated technological advancements have so far proved woefully insufficient to offset the huge growth of the private car fleet and its stagnant fuel economy.[66]

7. Conclusions

Throughout the 1990s California and France each responded to concerns about urban air quality by making substantial efforts to promote the use of EVs. It is clear that these efforts had an effect; most of the worlds current stock of EVs can be found in these two areas. To date, however, this direct effect has been small; only a few thousand vehicles are driven in each place. Indirect effects, however, may prove to be much larger. The pathways taken by California and France were very different. California, acting through the CARB, took an active regulatory role that was explicitly and very publicly technology forcing. The response was also very public; there were lawsuits and

advertising campaigns both for and against the mandates; but along with complaints, industry put forth a very extensive research and development effort on batteries, fuel cells, and electric drive trains. While the CARB maintained an aggressive posture, it continued to monitor the suitability of available EV technology and modified its mandate accordingly. The emphasis was on development of vehicles which consumers would accept. Revisions to the mandate, reflected the CARB's recognition that EVs were not yet viable and allowed the agency to steer a technological trajectory which also served to catalyze alternative developments, notably hybrid vehicles which are already more popular than Evs and new progress toward vehicles powered by fuel cells.

The establishment of strict standards and flexible implementation timetables coupled with the imposition of penalties and the commitment by a few major automakers to substantial R&D and commercial programs to reduce emissions, triggered a critical new phase of technological progress. In this respect, the CARB's mandate represents a watershed in the shift in road transportation from petroleum to electricity, yielding the accompanying benefits of reductions in air pollutants (including green house gases) and fuel-economy improvements.

In contrast with the American process, the French path to an EV industry was utterly guided from above with negligible public dialogue and controversy. While significant portions of American society engaged in a discussion of the new technology, fiercely assessing its merits and its drawbacks, the French public, the media and analysts remained quite aloof showing only a quiet interest in EVs. Rather than indicating an authentic national consensus about the effectiveness of EVs to reduce car emissions, the absence of controversies about EVs in France signaled a deficit of public participation and accountability. The programs and the legislation developed in France to electrify a fraction of the national car fleet were anything but a grand project and did not amount to industrial policy, although for several years they had the pretense of being one. Ambivalence about the program is now emerging both in government and in industry, where the apparent issue is not so much what electric vehicles can contribute but rather how much of a commitment government, industry and other institutions are willing to make to them. And France has so far shown very little interest in the hybrid technology that has emerged from electric vehicle research and development. Such differences in approach confirm what a number of observers of the international environmental health and safety arena noted earlier. Despite growing market integration and enmeshment of economic policy, industrialised nations retain distinctly different policy styles (Lundqvist, 1980; Badaracco, 1985; Vogel, 1986; Brickman et al., 1985; Weber and Hoogma, 1998). Indeed, the policy landscapes in which regulators, interest groups, the public at large interacted and pursued their goals in France and in California could scarcely differ more.

The differences in policy approach are only part of the story. France and California evince deep differences in attitude toward technology. In California (and the U.S. generally) technology provides solutions to problems, and technological solutions are generally preferred to solutions which require behavioral change or cultural adaptation. In France technology reflects a compromise between government and industry; it is a form of cultural elitism.

Whatever the outcome of the EV story, the road ahead in California looks different from that in France. From a California perspective, EVs still do not yet appear

commercially viable whereas hybrid vehicles, which have emerged during the CARB mandates do; suitably developed and put into general use they could lead to very substantial reductions in emissions. On the horizon fuel cell technology beckons, and one more breakthrough in battery technology could bring EVs back into play. There is still no interest in non-technological demand-side approaches to reducing emissions.

From a French perspective the vision of a society transformed by EV use coupled with other adaptations in public and private transport seems to be waning but still exists. The question is whether this vision will find a real commitment in French institutions. If it does not, France may simply come to use the prevailing technologies (such as hybrids) on the international market with a yet to be determined commitment to reduced emissions.

What are the lessons from this review? Technology forcing can work and can lead to substantial and important new capabilities. But the changes and the consequent technological evolution may follow an unpredictable path, yielding unexpected results. And the development of new capabilities does not necessarily translate into their widespread adoption and use. Industrial policy also can work and has worked in other settings in France (and elsewhere), but the very limited implementation of EV technology demonstrates that industrial policy requires a firm institutional commitment.

In democratic countries policies reflect, however imperfectly, the demands and the aspirations of public opinion. The difficulties encountered in both California and France to implement EV policies suggest that public support for sustainable transportation is not as strong as is often assumed. In other words, even though the citizens of California and – to a less degree of France – may express positive attitudes towards ambitious environmental goals, they are not yet prepared to change their lifestyles to achieve these goals. For either approach, success will ultimately require a cultural adaptation.

Notes

[1] Established in 1967 to promote and protect the public health, the CARB has focused on three main objectives: 1) attain and maintain air quality throughout the state; 2) conduct research into the causes of and solutions to air pollution; and 3) attack the serious environmental problem caused by motor vehicles.

[2] For an analysis of the conflicts surrounding new technologies in the US see Mazur, 1982 and Nelkin, 1984.

[3] Recently, Vogel argued that, since the late 1980s, the US and Europe have "traded places". In other words, whereas in the 1970s and in the 1980s, by adopting stringent and innovative legislation, the US provided a strong leadership in environmental policy, over the last 15 years, European countries have taken the lead (Vogel, 2003). Our study demonstrates that the French and American experience with EV policies forms an exception to this trend reversal.

[4]Los Angeles and its suburbs lie in a basin surrounded by a ring of mountains to the east and onshore winds from the west, which both serve to trap the pollution. Strong sunlight activity produces the photochemical reactions that lead to smog formation, and the topography of the area is such that air movement and pollutant dispersion are severely restricted.

[5] Recent medical literature indicates that even the current level of air pollution is harmful to human health (Bascom et al., 1996).

[6] In 1987, California set a state standard for ozone equal to 0.09 ppm (180 $\mu g/m^3$) for a 1-hour averaging time. There are many areas in the state where the state standard for ozone is exceeded more than a hundreds times per year (SCAQMD, 2002).

[7] According to the Texas Transportation Institute, in 2001, three California cities (Los Angeles, San Francisco-Oakland and San Jose) ranked in the Institute's top ten list of the most congested cities in the US (Shrank and Lomax, 2002).

[8] With over 540 cars per 1,000 inhabitants, France reached in 1999 the level of motorization (762 cars per 1,000 inhabitants) attained in the early 1970s in the United States (CFFA, 2000).

[9]The highest number of EVs in California was recorded in 2000. Since then, the number has been declining due to the recall by Ford, Honda and GM of their EV models (Fagan, 1999; Maynard, 2002; GM, 2002).

[10] The thresholds for the three ozone levels 1, 2 and 3 are 110, 180 and 360 $\mu g/m^3$ respectively.

[11] The category of "major manufacturers" denoted all those whose sales equaled at least 35,000 units in the state and included Chrysler, Ford, GM, Honda, Mazda, Nissan and Toyota. According to the proposed CARB mandate, small volume manufacturers (i.e., producing less than 3,000 vehicles for sale in California) manufacturers were not ever required to produce ZEVs and intermediate volume (selling between 3,000 and 35,000 units per year) would be required to produce ZEVs only in 2003.

[12] Furthermore, the seven manufacturers were required to file a report providing information regarding the number and type of ZEV placed in California and in the United States and data about the purchase of advanced battery technology within ninety days following the close of each year.

[13] Hybrid electric vehicles are equipped with two power sources: an internal combustion engine coupled to an electric motor. For a review of HEV technology see Wouk, 1995 and Westbrook, 2001.

[14]Models currently available on the markets are not designed to operate *only* with the electric motor. Such capability, however, could produce further benefits by controlling when and where emissions occur. With appropriate batteries (NIMH for example) that allow for a significant all-electric range, HEVs can be driven as ZEVs and can thus further contribute to CARB emission-reduction original goal. The idea that HEVs could significantly reduce exhaust pollution and fuel consumption in targeted areas at particular times was advanced already in the 1960s (Hoffman, 1967; Wouk, 1976).

[15] In 2003, the EPA rated the fuel economy of a Honda Civic hybrid to be 48 mpg (combined city/highway cycle) whereas a conventional Honda Civic was estimated to achieve only 37 mpg (EPA, 2003)

[16] The creation of the new SULEV standard reflected the advancements of technology for gasoline, hybrid and alternative fuel vehicles. In the spring of 1998, Honda had already offered for sale in California a compressed natural gas vehicle with emission levels at one tenth of ULEV and Toyota had begun selling the Prius, its first hybrid electric vehicle (CARB, 1998a). SULEVs would emit 0.010 (g/mi) of NMOG, 1.0 (g/mi) of CO and 0.02 (g/mi) of NO_X. (CARB, 1998b). Cfr with Table 4.

[17] Already available in low-volume production lines and employed in over 1000 vehicles in California, NiMH batteries could power a 4/5 passenger EV for 75-100 miles on a single charge and had the potential to last the life of the car, or at least 100,000 miles.

[18] In the late 1980s, GM had started to invest considerable financial and human resources on a program to manufacture an electric car, the Impact, a prototype that became in 1996, under the name EV1, the first EV offered for sale by a major American automaker. GM had been able to take advantage of the massive conversion programs that at the end of the Cold War were redirecting the resources of large military industrial companies (such as Hughes and Rockwell, both GM subsidiaries whose know-how had clear overlaps with EV technology) toward civil and commercial production (Shnayerson, 1996; Scott, 1995)

[19] HEV technology received some impetus from the Partnership for a New Generation of Vehicles (PNGV), an R&D program developed jointly by several US government agencies with the three main American automobile companies in 1993 with the aim of producing a passenger car with a fuel economy of 80 mpg (National Research Council, 1996; DOE, 2002). Over the years, various commentators have debated the real effectiveness of the PNGV program (which was terminated in 2002 to make way for the FreedomCar program) in advancing the development of HEVs (Sperling, 2002; Malakoff, 1999).

[20] In light of the potential of fuel cells to power zero emission vehicles and given the similarity of certain components that exist both in battery- and fuel cell-powered vehicles (the electric drivetrain for instance), the CARB mandate was instrumental in persuading venture capitalists to invest money in companies such as Ballard (Rasul, 2001).

[21] See Rienzeman, 1995 and Henriksen et al., 1996 for a review of the main features of rechargeable battery technology and battery-powered motor vehicles.
[22] Note that the LEV program was subject to a biennial review designed to confirm the requirements or alter those that were bound to face problems of technological feasibility.
[23] Oil companies do not shy away from soliciting and accepting hundred million dollars in subsidies (Hwang, 1995).
[24] Curiously, the ad was intended to comfort readers with the assertion that "at current consumption rates there is enough oil to support our planet's petroleum needs for about 45 years. "Indeed the estimates of world total oil proven reserves collected by the *Oil & Gas Journal* over the period 1990-2000 averaged at about 1000 billion barrels. Assuming that demand does not increase, i.e. at current consumption levels (~ 75 million barrel/day), the world would run out of *relatively cheap* oil in 41 years. According to Mobil's own literature the world's oil reserves will be severely depleted before 2050. Yet, interestingly, Mobil, was confident that a 45 year time horizon would reassure the general public.
[25] One ad (Mobil, 1995) reported the findings of a study carried out at Carnegie-Mellon University widely considered very partial against EVs. See Socolow and Thomas, 1997 for a critical review of the study and also section 4.2 following.
[26] Astroturf refers to the synthetic grass product. By means of this strategy, corporations conceal their involvement in lobbying initiatives behind the guise of grassroots movements.
[27] CALPIRG estimated that WSPA gave $1 million to Woodward & McDowell over a period of 20 months (Kasnitz and Maschke, 1996).
[28] Such negative concerns were never voiced by real emergency response workers (Mendelson, 1997).
[29] Unlike automobile manufacturers and oil companies, California's electric utilities were not hostile to the ZEV mandate. Utility companies assumed that most of EV charging would occur at night thus opening a new market exploiting idle off-peak generation capacity (Nesbitt et al., 1992). As in many other states in the U.S., California could benefit from replacing ICEVs with EVs since the state electricity is produced from relatively clean fuel sources. In the mid 1990s, more than 32 percent of the electricity consumed in the state was produced by renewable resources, almost 15 percent came from nuclear energy and about 15 per cent from natural gas (California Energy Commission, 2002).
[30] The bleak conclusions reached by SR about the effectiveness of the ZEV regulations were cited by several organizations hostile to the mandate, including some astroturf groups in their comments during the public workshops sponsored by CARB in 1995 (Mangels, 1995; Dale, 1995). During the workshop that took place on November 8 1995 both Anita Mangels, executive director of CAHT and Larry Larry Dale of Larry Dale Associates backed up their statements on the supposedly disastrous consequences of the ZEV mandate with figures and arguments drawn from the Sierra Research reports.
[31] The title of the article implied that all EVs use lead-acid batteries, whereas it is generally known that lead-acid batteries are only one type of the batteries that power EVs.
[32] The technological assessment carried out at Carnegie-Mellon was partly funded by Green Design Consortium, a coalition of industrial groups that included Exxon Research and Engineering, GM-Delco Chassis, GM-Packard Electric, Mobil R&D, and Shell Development (Kasnitz and Maschke, 1996).
[33] The Impact and the EV1 are the same car. Believing that the first name lacked consumer appeal GM renamed the car.
[34] Lave, Hendrikson and McMichael proceeded to carry their analysis further in *Environmental Science and Technology* (Lave *et al*., 1996) where they purported to demonstrate that the health hazards derived by the use of EVs powered by PbA batteries compared unfavorably with those once associated with the use of vehicles powered by leaded gasoline. The EST article became the subject of a thorough assessment carried out at the Center for Energy and Environmental Studies at Princeton University. The authors of the assessment, challenged the conclusions reached by Lave et al. by underlining that treating the hazards provided by lead-acid batteries and lead additives in gasoline on the same footing was misguided (Socolow and Thomas, 1997).
[35] Among the many other studies assessing either the ZEV mandate or some aspect of EV technology see Moomaw et. al, 1994; Hall et. Al., 1995; Gordon and Richardson, 1995 and Dixon and Garber, 1996.
[36] The US is known for its inclination to resolve public policy issues by means of formal, adversarial processes where, unlike most industrialized countries, judicial intervention is the rule rather than the exception. For a comprehensive critical analysis of American "adversarial legalism" see Kagan, 2001.

[37]The involvement of the French government in the generation, distribution, and sale of electricity is unique in Western Europe.

[38] In 1998, 76,5% and 12,2 % of electricity were generated by nuclear and hydroelectric power respectively (IEA, 2001a)

[39] Despite massive mobilizations, the French antinuclear movement is not organized in a national lobby as similar movements are in Germany or Sweden. Regulatory process provided virtually no opportunity for public participation and French law did not permit challenges to nuclear-power-site decisions in the courts (Touraine et al., 1980; Nelkin and Pollak, 1981; Kitschelt, 1986).

[40] Concerns for the unsolved problem of nuclear waste disposal notwithstanding. See Touraine et al. 1980.

[41] Two small environmental groups which had no problem in endorsing nuclear energy sources for EVs: l'Association des Écologistes pour le Nucleaire close at the time to the right wing party Le Front National (Comby, 2002) and Le Mouvement National Lutte pour Environnement affiliated with the Parti Communiste Française (Prince, 2003).

[42] The skepticism of the French environmental movement towards EV technology is summarized fairly well in an editorial by Les Amis de la Terre (Samuel, 1995)

[43] An *ad hoc* consortium set up to foster the development of EVs

[44] Procotip, a shared-use vehicle program, had already been tested in 1971 in Montpellier with modest results (Benezra, 1995).

[45] After an experimental phase initiated in 1993, the city of La Rochelle established in 1999 LISELEC, another EV car-sharing project that is still active (Benezra, 1995; Hoogma and Simon, 1998). A notable impulse towards EV development in La Rochelle was the personal involvement of the late Michel Crépeau the city mayor and former Minister of the Environment (1981-1984). After PSA shut down a factory in the region in the early 1980s, Crépeau strived to make La Rochelle an industrial center for EV technology with the dual aims of cleaning the air and reducing unemployment (Pasquet, 1996; Hoogma and Simon, 1998). Similar *car-sharing* programs have been set up in several US cities (Shaheen and Meyn, 2002).

[46] At the end of 2002 there were about 3500 EVs in the rest of Europe (GIVE, 2003)

[47] In 1996, *R&D*, Renault magazine, described the progress on its hybrid prototype in the following terms: "Renault has invented a revolutionary new concept car that was unveiled in 1995, the Next… The Next has been specially designed with the aim of breaking all fuel economy records. It burns 3.4 L/100 km of petrol. However attractive such a solution, though, it remains a futuristic dream" (*R&D*, 1996).

[48] Until the spring of 2003 fewer than 200 Toyota Prius had been bought since their introduction on the French market in 2000 (Boyer, 2003).

[49] See NO_x trespassing level 3 (400 mg/m^3) in

[50] Note that the president of the Fédération française des automobiles-clubs (which adopted the slogan *"Non au PDU, oui à la voiture*") has argued that "Pollution will be curbed by means of technological development and not through traffic-volume reductions (Hopquin, 2002)"

[51] See Shoenfield, 1965 and Crozier, 1970 for two eloquent analyses of the nature of the *dirigiste* model. Michel Crozier contributed a psychological explanation for the French model. In his view, the French people have shied away from face-to-face confrontations and rather than resolving problems among themselves, they have traditionally sought refuge in a higher authority, i.e. the state, since an inclination to avoid open conflicts created a strong need to establish the state as a principal rule-maker and arbiter (Crozier, 1970).

[52] On the pressures exerted by automakers to weaken the air pollution legislation see also Lepage, 1998.

[53] A rare and notable exception is a cost-benefit analysis that concluded: "the cost of air pollution is not enough to give EV a clear advantage against all conventional cars, even in Paris" (Funk and Rabl, 1999).

[54] At least two forces are weakening the twin traditions of Colbertisme and dirigisme: on the one hand, the regulatory competence that once rested with national governments is increasingly shifting towards the European Union (Bailey, 1997) and on the other, the formation of new transnational business alliances (see, in the automobile sector, the agreements between leading Japanese firms like Nissan and Toyota with national automakers (Kewley, 2002).

[55] French institutional arrangements discourage citizens from solving social problems by means of litigation and the symbiotic relationship between the French government and industry makes litigation very rare (Jacob *et al*., 1996).

[56] Even those achievements have been subject to sharp criticism. See Salomon, 1986.

[57] To appreciate how grand technological projects, in particular the nuclear energy program, served to define the French national identity in the second half of the XX century, see Hecht, 1998.
[58] There are several historical accounts that show how, even unsuccessful projects (cf. the Concorde airplane) tend, by and large, to receive quasi-unanimous approval. See Bess, 2003. Whereas we have seen that American national pride does not necessarily coalesce around technological projects. If anything, in the U.S., technological fixes (cf. Prozac, SDI, EVs) tends to divide the nation rather than bring it together.
[59] For a recent view of the weakness of the Ministry of the Environment see Morand Deviller, 1990.
[60] See Baumgartner, 1996 for an elucidation of this point.
[61] To be sure, the California legislature has not given CARB authority over moving people and goods on its roads and highways. This authority remains with the State Department of Transportation as well as with regional, county and city transportation agencies (Kopp, 1997). However, the overall effect is that as a state agency with great authority over drafting policies to reduce air pollution, CARB can send recommendations to these bodies, which, in turn, are obliged to give them strong consideration.
[62] The influence of free-market ideology in the U.S is often more rhetorical than real. Indeed, in many areas of consumer, environmental and safety regulation US government agencies have traditionally used command-and-control instruments that are far more stringent and meddlesome than the market-based tools customarily employed in Europe. See Harris and Milkis, 1996 and Vogel, 2003.
[63] It must be noted that some scholars contend that driving an EV can change peoples driving habits (for instance, due to the EVs' limited range, drivers tend to plan their trips more carefully) as well as general attitudes toward transportation issues. For a discussion of the civic values of EV technology see Brown, 2001.
[64] There is evidence of this in many contexts of American life. Popular culture provides many examples: the popularity of magazines (*Popular Mechanics*, *Popular Science*, etc.) that probe the minutiae of technological advancement and films like *Apollo 13* in which technological ingenuity - a precious national virtue - represents the ability to overcome mortal challenge. For scrutiny and skeptical views of American technological optimism see Marx, 1987; Hughes, 1989; Nye, 1994 and Segal, 1994.
[65] Ozone levels in California have dropped significantly throughout the 1990s whereas progress in other regions of the U.S. has not been as dramatic. Nevertheless, in 2002 the 16 most severe violations of the EPA ozone 1-hour standard were all in California (EPA, 2003c).
[66] This trend, as strong as it is in Europe, occurs at a greater rate in the United States. In Europe transportation by car has increased from 73% in 1965 to 83% in 1989 and conversely train and bus usage has declined from 14% and 13% to 7% and 7% in the same years.

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