Partial ZEV Credits

An Analysis of the California Air Resources Board LEV II Proposal to Allow Non-ZEV's to Earn Credit Toward the 10 % ZEV Requirement of 2003

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ABSTRACT

In November 1997, the California Air Resources Board proposed modifying the Zero Emission Vehicle (ZEV) mandate such that certain vehicles with measurable tailpipe emissions would be allowed to earn partial credit toward the 10% requirement of 2003. This proposed change in the ZEV mandate would provide automakers with greater incentive to bring a broad range of very low-emitting vehicles to market, and would reduce the need to sell as many battery electric vehicles. Partial credits would be given to vehicles with very low tailpipe emissions, all-electric driving capability, and that use inherently clean fuels. Even very clean-burning gasoline vehicles could earn credits. This report describes the proposed methods and conditions for granting partial ZEV credits, along with illustrative examples. The implications of the proposed changes are analyzed, and the views of different stakeholders briefly characterized.

The following sources were used on preparing this report: "Draft Preliminary Staff Report: Proposed Amendments to California's Low-Emission Vehicle Regulations, LEV II", released November 7, 1997; CARB presentation at the December 9, 1997 workshop on LEV II; CARB and public comments at the December 9, 1997 workshop; and an updated March 15, 1998 CARB presentation.

TABLE OF CONTENTS

LIST OF FIGURES AND TABLES

California's LEV Program

The California Air Resources Board's (CARB) mission is to "promote and protect public health, welfare and ecological resources through the effective and efficient reduction of air pollutants while recognizing and considering the effects on the economy of the State." To help accomplish this goal, CARB created the Low Emission Vehicle (LEV) program in 1990. This program was designed to give automakers flexibility in their use of pollution control technologies, propulsion technologies, and fuels. The LEV program contained two important elements: much more stringent emission standards, and much more flexibility. Instead of requiring every vehicle to meet the same exact emission requirement (as is still true with the federal emission standards), each manufacturer was now allowed to certify a vehicle for any one of several sets of emission levels. When the rules took effect in 1994, automakers were allowed for the first time to meet the standards by averaging emission rates across their fleet (using the emissions associated with each emission certification category), and could sell or bank emission credits if they exceeded the requirement, or buy them if they fell short.

Initially, four LEV categories were created: Transitional Low Emission Vehicles (TLEVs), LEVs, Ultra Low Emission Vehicles (ULEVs), and ZEVs. To be certified in one of these four categories, the hydrocarbon, carbon monoxide, and nitrogen oxide emissions from the vehicle were to be less than or equal to the maximum level for that category. Once a vehicle was certified at a particular level, the fleet average emissions were calculated for hydrocarbons alone, assuming that the vehicle's hydrocarbon levels were at the maximum level for its category. For example, a vehicle with hydrocarbon emissions (measured as NMOG) less than 0.040 grams per mile was classified as ULEV and considered to have 0.040 grams per mile in the fleet average emissions calculation. The maximum amount of hydrocarbon pollution allowed is 0.25 grams per mile, consistent with the uniform federal standard.

The only vehicle category with a required minimum percentage for each manufacturer continues to be the ZEV. A ZEV is defined as a vehicle that produces no tailpipe emissions – in practice, only battery electric vehicles (BEVs) and perhaps hydrogen fuel cell vehicles are likely to meet this criterion in the near future. In the original 1990 LEV program, the seven largest vehicle suppliers were required to "make available for sale" 2% of their vehicles as ZEVs in 1998 and 5% in 200 1. In 2003, the percentage was to increase to 1 0%, and applied to a much larger group of companies – to all those selling 3,000 or more vehicles per year in the state. In March 1996, CARB removed the first two requirements, leaving only the 10% requirement for 2003 in place. The main impetus for this decision was the continued high cost and low performance of batteries. In exchange for eliminating the ZEV sales requirements through 2002, automakers agreed to produce and test a smaller specified number of ZEVs by 2000 (up to 3,750 total) and to sell LEVs nationwide in 2001, three years before the US EPA might adopt similar ("Tier II") standards. California would benefit from clean car sales in other states, since about one fifth of all vehicles registered in California are first sold elsewhere (CARB Press Release, February 8 1996).

Toward SULEVs

In November 1997, CARB proposed a set of revisions to the LEV program to create what has become known as LEV II. One proposed change is to add a new emissions category – super-ultra low-emission vehicles (SULEV) – in recognition of rapid advances in reducing emissions from gasoline vehicles and to assure continued progress. The proposed LEV II vehicle emissions categories are described in Table 1.

Table 1: Current and Proposed CARB Emission Categories

Vehicle Emission Category	Durability Vehicle Basis	NMOG	CO	NO_x	PM (for diesels)
TLEV	50,000	0.125	3.4	0.4	
	120,000	0.156	4.2	0.6	0.04
LEV	50,000	0.075	3.4	0.05	
	120,000	0.090	4.2	0.07	0.01
ULEV	50,000	0.040	1.7	0.05	
	120,000	0.055	2.1	0.07	0.01
SULEV	120,000	0.010	1.0	0.02	0.01

In addition to creating a new category, other important elements of the proposal are to extend the distance over which the standards are in effect (to 120,000 miles), reduce NO, certification levels for LEVs and ULEVs (to levels shown in Table 1), and require light trucks to meet the same standards as cars. CARB proposes to steadily tighten the required fleet average standard beyond 2003 so as to assure the sale of increasing percentages of ULEVs and SULEVs.

Partial ZEV Credit Program

As 2003 approaches with ZEV sales by major automakers still under 1,000 vehicles, it is clear that the jump to 10% ZEVs in 2003 (amounting to over 100,000 sales per year) will be difficult. As a means of smoothing the transition, CARB is proposing to allow automakers to meet a portion of the 10% mandate with a broad array of clean vehicle technologies. Pure ZEVs would still be required, but half or more of the mandate could potentially be met with low-emitting vehicles.

In proposing the creation of partial ZEV credits, CARB is acknowledging the potential role to be played by a variety of new vehicle technologies in cleaning the state's air, and the need to create incentives for their manufacture and sale. These new technologies include hybrid electric vehicles, reformer-equipped fuel cell vehicles, natural gas vehicles, and conventional gasoline vehicles with advanced emissions control systems. Through the LEV II amendments, CARB would offer partial ZEV credits to manufacturers that sell qualifying vehicles in the state.

By proposing partial ZEV credits, CARB is not abandoning pure ZEVs. CARB has made it clear in a variety of ways that it continues to be committed to the development and commercialization of non-degrading vehicle systems – that is, those without combustion engines.

This commitment to ZEV technology is motivated by the observation that as combustion engines and their emissions control technologies age, emission systems degrade and emissions increase. In contrast, BEVs and hydrogen fuel cell vehicles show no increase in tailpipe emissions over the life of the vehicles. Emissions deterioration in non-ZEVs is due to a number of factors including emissions catalyst aging and poisoning, emission control system malfunctions, user tampering, and the unresponsiveness of owners to on-board diagnostic system warnings. The relative ineffectiveness of Inspection and Maintenance programs means that emission deterioration is difficult to monitor and regulate. Pure ZEVs are favored also because emissions associated with BEVs are located at only a limited number of sources, the power-plants, rather than the millions of vehicle tailpipes. Such pollution tends to be easier and less expensive to control.

It is for these reasons that CARB proposes to offer only partial ZEV credits to vehicles with internal combustion engines and fuel reformers, and to limit the total fraction of the ZEV requirement that can be satisfied through these partial ZEV credits. In summary, the current proposal (as of March 24, 1998) is as follows:

- For a vehicle to be considered for any partial ZEV credit it must meet certain baseline criteria.
- Each vehicle can potentially receive 1 .O ZEV credits if, and only if, it meets the baseline criteria, uses a clean fuel and can provide 120 miles of pure ZEV range.
- Vehicles that meet the baseline criteria, but not all of the others, will be limited to receiving less than 1 .O ZEV credits, even if the complete fuel cycle emissions associated with that vehicle are less than those of BEVs.
- Vehicles with no ZEV range will not be able to satisfy the full 10% ZEV sales volume requirement. The initial proposal was to allow such vehicles to satisfy up to 40% of a manufacturer's 10% ZEV requirement (CARB November 17, 1997 Draft Preliminary Report), but CARB has decided to reconsider the level of this limit.
- Vehicles with some ZEV range can satisfy up to 60% of the ZEV requirement and, therefore,
- Pure ZEVs must account for at least 40% of the 10% sales requirement.

The requirement of 40% pure ZEVs as a minimum has been established by CARB to ensure that production volumes of BEVs, hydrogen fuel cell vehicles, and other pure ZEVs remain high enough to enable them to be priced competitively with conventional vehicles in the 2005 to 20 10 time frame. Although CARB has not determined the maximum fraction of the 10% ZEV requirement that can be satisfied by SULEVs with no ZEV range, it is likely that the level will be set lower than 60%, the amount available to 'those with some ZEV range. An underlying philosophy for allowing vehicles with some ZEV range to meet more of the requirement than SULEVs with no ZEV range is that they use electric-drive technologies, such as batteries and electric motors. These technologies are also required for BEVs and hydrogen fuel cell vehicles; therefore the production of these vehicles enhances the production volumes and prospects of BEVs as well. This illustrates CARB's intention to continue accelerating the development and commercialization of pure ZEVs and electric-drive vehicle technology.

Qualifying for Partial ZEV Credit

The method for determining partial ZEV credits can be understood to have three primary categories (see Table 2). The first is a baseline or minimum qualification level, and the second and third are for additional credit. The second is directly related to the ZEV range of the vehicle, while the third is associated with the emissions produced in supplying the fuel to the vehicle (fuel-cycle emissions).

Table 2: Distribution of Maximum Possible Partial ZEV Credits

Emissions Qualification	Maximum Partial ZEV Credit
1. Baseline	0.2
2. ZEV Range	0.6
3. Fuel-Cycle Emissions	0.2

1. Baseline Qualifications

A vehicle must meet the baseline qualifications to be considered for any partial ZEV credits. If they do, they earn two-tenths (0.2) of a ZEV credit. The specific requirements are as follows:

- Certifiable to Super Ultra Low Emissions Vehicle (SULEV) standards for tailpipe emissions (see Table 1).
- Meet SULEV standards over 150,000 miles (rather than standard 120,000 miles required for SULEV certification).
- Meet On Board Diagnostic (OBD II) and zero-evaporative/refueling emissions requirements (established in other parts of the LEV II amendments).
- 150,000-mile warranty on the vehicle emissions control and diagnostic systems.

The baseline qualifications are intended to ensure that not only are tailpipe emissions minimal when new, but that they are kept to a minimum over their useful life. Vehicles qualifying in this category will continue to be counted as SULEVs for the fleet average emissions requirements established with the LEV and LEV II regulations. In a sense, by helping satisfy overall fleet average emission requirements as well as ZEV mandate requirements, these very clean non-ZEVs are receiving a double incentive.

2. **ZEV Range Qualifications**

Once the vehicle has passed the baseline qualifications, the more detailed characteristics of the operation and fueling of the vehicle are considered. First among these considerations is whether the vehicle has the capability to function without directly or indirectly producing any tailpipe emissions for some part of its daily use. The vehicle would be directly producing tailpipe emissions if the engine or on-board reformer is operating, and would be indirectly producing tailpipe emissions if operating on electricity produced by the on-board engine or on-board reformer and fuel cell system. The number of miles the vehicle can travel without producing tailpipe emissions of any type is defined as its ZEV range.

Two types of vehicles other than battery electric vehicles (BEVs) have the potential for significant ZEV range: hybrid electric vehicles (HEVs) and fuel cell vehicles (FCVs). The amount of partial ZEV credit available to the various vehicles depends on the length of their ZEV range.

HEVs provide ZEV range when operating only on energy obtained off the electricity grid and stored in batteries or flywheels. The additional partial ZEV credits available to these vehicles is 0.6 (beyond the 0.2 for baseline qualification). As part of LEV II, CARB has proposed HEV test procedures that allow partial credit for ZEV range only if the HEV has the capability for off-vehicle charging. Many proposed HEVs do not have such capability, including Toyota's Prius.

Thus, the ZEV range of the hybrid vehicle would be based on the amount of driving that could be done using energy supplied by the electricity grid. Once this range has been determined, the level of credit is allocated based on the share of the vehicle miles of travel that this ZEV range could satisfy. CARB's calculation was made using data from the 1990 National Personal Transportation Survey, which showed that 50% of the total vehicle miles traveled accrue during trips of 20 miles or less, and nearly 100% of all vehicle miles traveled are accumulated by trips of 120 miles or less (Figure 1).

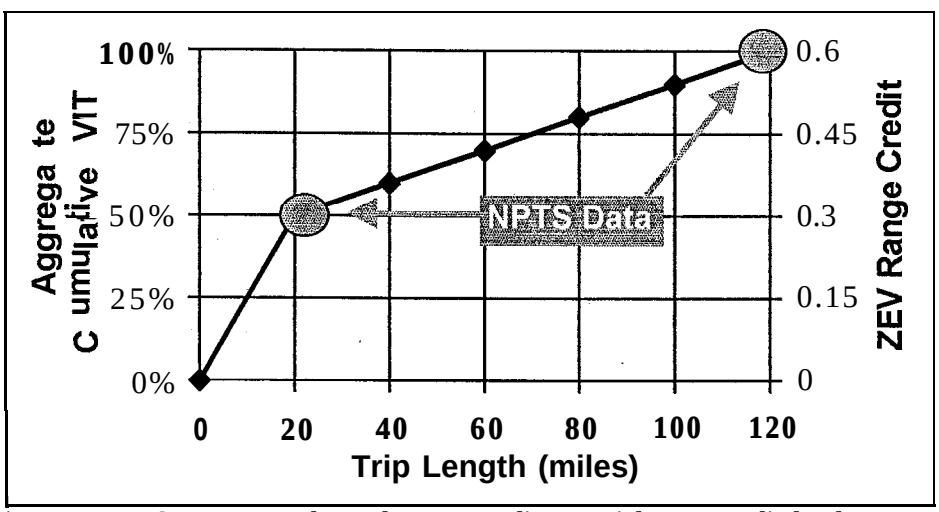

Figure 1. NPTS survey results and corresponding partial ZEV credit levels.
Source: California ARB and 1990 NPTS.

CARB has established two linear relationships for determining the level of ZEV range credit for HEVs, as shown in Figure 1. For vehicles with ZEV ranges between 0 and 20 miles, the credit varies linearly between 0% and 50% of the maximum partial credit of 0.6. In this lower mileage range, credits are calculated as 0.015*ZEV range. That is, a vehicle with 15 miles of ZEV range earns 0.225 credits (0.015*15). For vehicles with ZEV ranges between 20 and 120 miles, the credit varies linearly between 50% and 100% of the 0.6 additional credits. For these vehicles with longer ZEV ranges, the range credit is calculated as 0.24 + 0.003*ZEV range. That is, a vehicle with 80 miles of ZEV range would earn 0.48 credits (0.24+0.003*80). The implication of these range calculations is that each incremental mile of range up to 20 miles earns more credit than each incremental mile beyond 20 miles, and ranges beyond 120 miles earn no additional credit. As shown in Table 3, a hybrid vehicle with a ZEV range of 10 miles will receive

0.15 additional ZEV credits, an HEV with a 20-mile ZEV range will receive 0.3 additional credits, and one with 120 miles of range will earn an additional 0.6 credits – the latter qualifying as a full ZEV since this 120 mile ZEV range also guarantees receipt of the fuel cycle credits (see the fuel cycle emissions section below).

Table 3. Additional Partial ZEV Credit for Hybrid Electric Vehicles with ZEV Range or ZEVs with Trailer Engine/Generators.

	Very Short ZEV Range	Short ZEV Range	Medium ZEV Range	Long ZEV Range	Very Long ZEV Range
ZEV Range (mi.)	10	20	40	80	120
% of VMT Met (Fig. 1)	25	50	60	80	100
Additional Partial ZEV Credit*	0.15	0.3	0.36	0.48	0.6

*Assuming meets baseline requirements.

CARB has noted that there is some room for flexibility in the setting of the exact level of ZEV range credit for HEVs if the software that controls the operation of the vehicle promotes off-vehicle charging. CARB has indicated that if the vehicle has less than a 120-mile ZEV range, but the manufacturer can prove that their vehicle control strategy would promote the use of electricity produced from the grid rather than the on-board engine, that vehicle could receive more ZEV range credits. CARB has not specifically defined which strategies would qualify; candidate strategies include charge depleting HEVs and those HEVs with very convenient recharging procedures.

CARB utilizes the same system for defining partial ZEV credits for battery electric vehicles that haul a trailer containing an engine/generator meeting SULEV standards. These HEVs are essentially standard ZEVs that have the option of providing range extension through recharging with the attached engine/generator. Because these vehicles will be nearly identical to conventional ZEVs, credit will be given based on whether they have the option of using a trailer, not whether a trailer is actually purchased with the vehicle. Further, the trailer that could be used must be pre-specified to provide the necessary information to calculate the proper level of credits (i.e., to ensure it meets the baseline requirements and to evaluate the level of fuel cycle credit). This last step is also necessary under current laws, which make it illegal to alter a vehicle's emissions control equipment, as would be the case if a trailer were added to a ZEV that had not been pre-specified. Using the same methodology as that for the HEVs above, Table 3 indicates some possible levels of additional credit for these trailered vehicles.

The final category of vehicles that can provide all-electric range is fuel cell vehicles (FCVs). These vehicles can be divided into three primary categories: FCVs with on-board storage of hydrogen, FCVs with internal reforming (e.g., direct methanol fuel cells), and FCVs with on-board reformers. FCVs with on-board hydrogen storage produce only water from the tailpipe and would therefore be considered to have unlimited ZEV range; accordingly, hydrogen-fueled FCVs would be eligible for the maximum partial credit for ZEV range. FCVs with internal

reformation, such as direct methanol fuel cells, use liquid fuels, rather than hydrogen, but are expected to produce only water and carbon dioxide. Direct methanol fuel cells are still **only** in the laboratory stage, so much remains unknown about their emissions characteristics. However, if predictions hold, these vehicles would also qualify for the maximum credit available in the ZEV range category.

Vehicles that use on-board reformers to produce the necessary hydrogen are expected to produce some tailpipe emissions. Many reformer technologies, including steam reformation and partial oxidation, and many fuels, including gasoline, methanol, and natural gas, are potential candidates for hydrogen production, but the technologies are relatively new and the associated emissions levels are currently unknown. If LEV II is adopted, fuel cell vehicles with on-board reformers might be categorized as follows:

- SULEVs with no ZEV range, obtaining no ZEV range partial credit, but still receiving baseline and potentially fuel cycle credit;
- HEVs with some ZEV range in which batteries are used for energy storage, earning the appropriate fraction of credit as determined for HEVs;
- Fuel cell vehicles with internal reformation, receiving full ZEV range credit if they emit only water and carbon dioxide, though this is unlikely.

Due to the immature state of many of these fuel cell technologies, CARB has not decisively defined the maximum level of credit it will allow, as it has for HEVs and BEVs with trailers. CARB is proposing that the maximum ZEV range credit for fuel cell vehicles be the same as that for hybrid electric vehicles, 0.6. Since FCVs with on-board hydrogen storage or internal reformation produce zero tailpipe emissions, these vehicles will generally receive the full available credit. This would allow some FCVs to qualify as full ZEVs – that is, to earn a full ZEV credit (if they also met the fuel cycle requirement discussed in the next section). The possible levels of credit associated with FCVs of different types are presented in Table 4.

Table 4. Possible ZEV Range Credit for Various Fuel Cell Vehicle Types.

Fuel Cell Vehicle Type*	ZEV Range Credit
On-Board Hydrogen Storage	0.6
Internal Reformation	0.6
On-Board Reformation**	0.0 - 0.6

*Assuming meets baseline requirements.

**The emissions levels of on-board reformers are uncertain, but will probably be non-zero and therefore a value of 0.6 is unlikely.

3. Fuel-Cycle Emissions Qualifications

The final consideration in determining the total ZEV credits allowed for each vehicle is the emission level associated with the production and delivery of its fuel. These emissions are termed fuel-cycle emissions because they consider the complete cycle involved in providing the fuel to the vehicle. Adding "upstream" emissions from power-plants, refineries, fuel storage tanks, and so on, with tailpipe (and vehicle evaporative and refueling) emissions, gives the total emissions associated with that vehicle's use – full fuel-cycle emissions. By considering the complete fuel cycle, through tailpipe and evaporative/refueling standards as well as fuel cycle credits, CARB can ensure that a fuel that is clean on-board the vehicle, but still produces significant pollution elsewhere, does not gain undeserved credit. Alternatively, a fuel that is clean both on and off the vehicle is encouraged for its potential to improve air quality.

The maximum available credit for low fuel cycle emissions is 0.2. To acquire these credits, the vehicle manufacturer must show that fuel cycle emissions are lower than the non-methane organic gas (NMOG) emissions associated with BEVs. The BEV emissions are those that are produced both at the electric powerplants and from the production, processing, and delivery of the fuels to the power-plants. Fuel-cycle emissions at or below this level must be demonstrated assuming near-term fuel production facilities and fuel supply infrastructure. The fuel-cycle nitrogen oxide (NO,) and carbon monoxide (CO) emissions are not considered in the establishment of this credit because NO, and CO emissions associated with the production and distribution of likely automotive fuels are very low in comparison to tailpipe or power-plant emissions. For vehicles using more than one fuel, including hybrids (and possibly fuel-flexible methanol and bi-fuel natural gas vehicles), the amount of credit will be scaled according to the fraction of daily driving that is done using each fuel.

In their initial assessment, CARB has classified fuels into either "yes" or "no" categories relative to their fuel-cycle emissions: either a fuel has fuel-cycle emissions lower than those associated with generating electricity for a ZEV, or it does not. The only place where partial credit is available is for multi-fuel vehicles – such as hybrids which use both gasoline and electricity. Based on the fuel economy of current vehicles, gasoline and diesel fuels would not receive fuel-cycle credits, though CARB may make them available for vehicles with very high fuel economy. For example, a vehicle with triple the fuel economy of a current vehicle would have a third of the upstream emissions and so might fall below BEV levels. Natural gas has been designated by CARB to receive the full fuel cycle credit, but no determination has yet been made for methanol.

A hybrid electric vehicle (or BEV with an engine/generator trailer) which uses a fuel that has fuel-cycle emissions above power-plant levels, but has some all-electric range, will receive fuel-cycle credits in accordance with the fraction of ZEV range credits it is approved for. These vehicles can satisfy some fraction of their daily driving using only electricity from the grid, and therefore produce no tailpipe and no non-power-plant fuel-cycle emissions during that time. For example, a gasoline HEV with a 20-mile range would receive ½ of the maximum ZEV range credits and therefore ½ of the fuel-cycle credits (½ X 0.2 = 0.1). Table 5 provides some examples of the credits that would be available to the various fuels and fuel combinations for vehicles already meeting the baseline requirements.

Table 5. Fuel-cycle Credits for Fuels.

	Maximum Fuel-Cycle Credit for the Fuel*	Range Using Low Fuel-Cycle Emissions Fuel	Available Fuel-Cycle Credit
Gasoline Conventional Vehicle	0.0	0%	0.0
Diesel Conventional Vehicle*	0.0	0%	0.0
Methanol Conventional Vehicle	0.0 or 0.2	0% or 100%	0.0 or 0.2
CNG Conventional Vehicle	0.2	100%	0.2
Gasoline HEV (20-mile ZEV range)	0.2	50%	0.1
Diesel HEV* (80-mile ZEV range)	0.2	80%	0.48
Direct Methanol Fuel Cell Vehicle	0.0 or 0.2	0% or 100%	0.0 or 0.2
On-board Hydrogen supplied by Off-board CNG Reformer FCV	0.2	100%	0.2

*Assuming meets baseline requirements, which will be difficult for diesel fueled vehicles.

Examples of Partial ZEV Credit for Various Vehicles

To summarize the partial ZEV credit rules, this section presents the total fraction of ZEV credits available to the various vehicles. Each vehicle is given a basic description and then the level of credit for each category is established.

Conventional SULEV Vehicles with No ZEV Range

This broad category of vehicles encompasses conventional internal combustion vehicles. If these vehicles are certified at SULEV emission levels at 150,000 miles, have OBD II, zero evaporative/refueling emissions, and a 150,000 mile emissions control and diagnostic system warranty, they will earn 0.2 credits. Of internal combustion vehicles, diesel fueled vehicles may have the most difficulty meeting this minimum requirement, but are included below and in other examples since technologies currently under development may allow them to qualify. No batteries or other energy storage devices are used in these vehicles (other than for starting), so none will, receive any ZEV range credit. The only additional credit available is in the fuel-cycle area, and then only if non-petroleum fuels are used. Partial ZEV credits available to internal combustion engine vehicles are presented in Tables 6a-c.

Table 6a. Gasoline or Diesel Vehicle with Tailpipe Emissions Less than SULEV Standard.

	Meets Standard at Some Level?	ZEV Credit
Baseline	YES	0.2
ZEV Range	NO	0.0
Fuel-Cycle Emissions	NO	0.0
TOTAL ZEV Credit		**0.2**

Table 6b. Methanol Vehicle with Tail i e Emissions Less than SULEV Standard.

Baseline	YES	0.2
ZEV Range	NO	0.0
Fuel-Cycle Emissions	???	0.0/0.2
TOTAL ZEV Credit		**0.2/0.4**

Table 6c. CNG Vehicle with Tailpipe Emissions Less than SULEV Standard.

	Meets Standard at Some Level?	ZEV Credit
Baseline	YES	0.2
ZEV Range	NO	0.0
Fuel-Cycle Emissions	YES	0.2
TOTAL ZEV Credit		**0.4**

SULEV Hybrid Electric Vehicles

Hybrid vehicles with SULEV emissions meet the minimum requirements, but also have the possibility of receiving additional credits for ZEV range and low fuel cycle emissions (see Tables 7a-d). The primary difficulty in defining the level of credits for these vehicles is determining the ZEV range and deciding which control strategies will tend to promote off-vehicle charging. "Charge sustaining" and "charge depleting" control strategies seem to provide a useful framework for specifying ZEV ranges of hybrid vehicles.

Charge-sustaining HEVs are defined by CARB as those vehicles whose battery state-of-charge (SOC, a measure of the amount of electricity stored in the battery) returns to the same level at the end of a standardized test as it was at the beginning. These vehicles can have some ZEV range, but the range will tend to be small due to the inclination to use smaller battery packs and rarely to recharge batteries from the electricity grid. Charge-depleting HEVs are defined by CARB as those vehicles whose battery SOC steadily declines as the vehicle is driven and ultimately falls low enough to diminish the acceleration performance of the vehicle. The size of the battery pack in charge-sustaining HEVs can vary significantly, but will generally provide substantial ZEV range.

Table 7a. Gasoline (or Diesel) Charge-Sustaining HEV with Tailpipe Emissions Less than the SULEV Standard and No ZEV Range

	Meets Standard at Some Level?	ZEV Credit
Baseline	YES	0.2
ZEV Range	NO	0.0
Fuel-Cycle Emissions	NO	0.0
TOTAL ZEV Credit		**0.2**

Table 7b. CNG Charge-Sustaining HEV with Tailpipe Emissions Less than SULEV Standard and 20-mile ZEV Range.

	Meets Standard at Some Level?	ZEV Credit
Baseline	YES	0.2
ZEV Range	YES at 50%	0.3
Fuel-Cycle Emissions	YES	0.2
TOTAL ZEV Credit		**0.7**

Table 7c. Gasoline (or Diesel) Charge-Depleting HEV with Tailpipe Emissions Less than the SULEV Standard and 80-mile ZEV Range.

	Meets Standard at Some Level?	ZEV Credit
Baseline	YES	0.2
ZEV Range	YES at 80%	0.48
Fuel-Cycle Emissions	YES at 80%	0.16
TOTAL ZEV Credit		**0.84**

Table 7d. BEV with Gasoline (or Diesel) Fueled Trailer and 100-mile ZEV Range.

	Meets Standard at Some Level?	ZEV Credit
Baseline	YES	0.2
ZEV Range	YES at 90%	0.54
Fuel-Cycle Emissions	YES at 90%	0.18
TOTAL ZEV Credit		0.92

Fuel Cell Vehicles

The two types of fuel cells considered here are those which use on-board hydrogen storage or internal reformation. Those that use on-board reformation will be considered either equivalent to the examples below or the previous SULEV or HEV examples. For the vehicles included below, all baseline criteria are assumed to be met. The primary consideration is the amount of credit allowed in the ZEV category and the original fuel used – issues discussed in previous sections. See Tables 8a-c for maximum credit obtainable by fuel cell vehicles.

Table 8a. FCV with On-board Hydrogen Storage Supplied by Off-board Gasoline (or Diesel) Reformer.

	Meets Standard at Some Level?	ZEV Credit
Baseline	YES	0.2
ZEV Range	YES	0.6
Fuel-Cycle Emissions	NO	0.0
TOTAL ZEV Credit		**0.8**

Table 8b. FCV with On-board Hydrogen Storage Supplied by Off-board CNG Reformer.

	Meets Standard at Some Level?	ZEV Credit
Baseline	YES	0.2
ZEV Range	YES	0.6
Fuel-Cycle Emissions	YES	0.2
TOTAL ZEV Credit		**1.0**

Table 8c. Direct Methanol FCV.

	Meets Standard at Some Level?	ZEV Credit
Baseline	YES	0.2
ZEV Range	YES	0.6
Fuel-Cycle Emissions	???	0.0/0.2
TOTAL ZEV Credit		**0.8/1.0**

Summary of ZEV Credit Levels

Table 9 summarizes some of the possibilities for obtaining ZEV credit for the various clean technologies. The table is intended to show the typical value, or range of values, that would be appropriate for each technology and fuel choice. The values for HEVs and BEVs with trailers can vary over a wider range than shown, but should tend to fall within the expected values. Vehicles using methanol as a fuel have some uncertainty because CARB has not determined the level of fuel-cycle credit appropriate for this fuel. The same holds for FCVs where CARB has not established firm credit levels due to the unknowns associated with some of the technologies. Overall, values separated by a '/' indicate pending CARB decisions regarding credit for methanol and certain fuel cell vehicle technologies.

Table 9. Summary of ZEV Credits for Various Vehicle and Fuel Choices.

Vehicle Type	Primary Fuel	Secondary "Fuel"	ZEV Credits
Conventional SULEV	Gasoline or Diesel*	None	0.2
	Methanol	None	0.2/0.4
	CNG	None	0.4
Charge Sustaining SULEV HEV	Gasoline or Diesel*	Electricity	0.2 to 0.6
	CNG	Electricity	0.4 to 0.7
Charge Depleting SULEV HEV	Gasoline or Diesel*	Electricity	0.6 to 0.85
BEV with Trailer	CNG, Gasoline or Diesel*	Electricity	0.6 to 1.0
FCV	Direct Methanol	None	0.8/1.0
	Off-board Gasoline Reformer	None	0.8
	Off-board CNG Reformer	None	1.0
	On-Board Reformer	None	0.2 to 0.4**

*Diesel may not meet baseline requirements.

**It is unlikely that on-board reformers will eliminate tailpipe emissions. Unless they do, they will not qualify for ZEV range credits.

Views of Stakeholders

The following discussion highlights issues and concerns with the proposed partial ZEV credit program that have been raised by various interest groups. Direct quotes are from statements made at a public hearing on LEV II in El Monte, California on December 9, 1997.

The major automakers have not focused much attention on the proposed changes, at least publicly, because they are more concerned (at this point) with other elements of the proposed LEV II program, especially regarding the proposal to treat cars and light trucks equally. In general, though, major automakers continue to feel that the ZEV mandate, even with the proposed changes, represents excessive intervention in their business. They are concerned that they will be obligated to sell vehicles at a financial loss. If government is to intervene, they prefer that regulators provide more flexibility and use market instruments. Steve Douglas, speaking for the American Automobile Manufacturers Association at a public hearing, requested that CARB "just provide us with the standards and we will make the technology choices." He added, "partial ZEV credits are only necessary if there is no market [for electric vehicles]." Because they are proposing partial ZEV credits that essentially allow automakers to maneuver around their regulations, Mr. Douglas assumes that CARB believes this is the case. The automaker argument follows that, if this is so, CARB should scrap the ZEV mandate altogether or make it voluntary. CARB's response is that they will not revisit the ZEV mandate and that the partial credits are intended to give automakers greater versatility, while nurturing the infant ZEV industry.

A second major concern of automakers is that the proposed changes will force automakers to conduct multiple distinct paths of research. They argue that this will increase their costs and will especially hurt the smaller manufacturers. CARB's response is that each manufacturer has the option to produce solely ZEVs; alternatively they can also produce vehicles that obtain partial ZEV credit if it seems viable. CARB argues that automakers will only proceed along multiple path if it appears more cost-effective to sell ZEVs and near-ZEVs than it is to sell ZEVs alone. CARB argues that small manufacturers may focus on a single type of ZEV and not double invest.

It is not clear at this time whether the industry will present a unified front. Clearly, each company is pursuing an independent strategy – with respect to choice of vehicle technologies, aggressiveness in pursuing those technologies, timing of investments, inclination to develop the technology in-house, and long-term global strategies.

The petroleum industry has not yet responded publicly to the proposed partial ZEV credit program. The industry has strongly opposed the ZEV mandate to date, since oil companies have determined that BEVs provide little business opportunity. The proposed changes lessen the emphasis on BEVs, but the ZEV mandate remains an intrusion into the fuels marketplace and a threat to their existing business. Some oil companies are beginning to mount serious fuel cell vehicle research programs, but none is likely to endorse a fuel-related mandate of any type. In general, the oil industry expects to supply whatever gaseous or liquid fuels succeed in the marketplace. As with the automakers, each company is also developing an independent strategy, with some recently announcing "partnerships" with particular automakers.

The natural gas industry has responded more favorably to the partial ZEV credit proposals, and done so publicly. A representative of the Natural Gas Vehicle Association speaking for natural gas suppliers said, "the coalition supports all aspects of LEV II.. . [because] what is good for clean air is good for natural gas." Indeed, automakers may well use CNG (or possibly methanol) to meet SULEV (and ULEV) emission levels and gain partial ZEV credits. Because CARB considers CNG to be a clean fuel for its fuel cycle inventory, natural gas can gain substantial ZEV credit as a primary or secondary fuel. The natural gas industry apparently does not wish to argue for any additional changes in the ZEV mandate for fear of undermining or slowing the approval process. Although they would prefer more credit to be allowed for meeting the baseline criteria and fuel-cycle emissions, they apparently intend not to pursue those issues.

The electric industry is more ambivalent than the automakers and other energy industries. On the one hand, they are concerned that the requirement for BEVs is being eroded – from 10% in 2003 to a proposed 4%. This represents a significant loss of electricity demand, most- of which would have been off-peak (allowing them to load level their supply). At the same time, they realize the benefits of natural gas use, since compression is very electricity-intensive. The industry has not, so far, expressed a strong reaction.

The environmental public interest community has mixed reactions to the proposed changes as well. The more pragmatic groups are supportive, believing opposition to the 10% mandate would be undermined, thus assuring accelerated commercialization of electric-drive and ultra-clean vehicles. Others, however, feel that offering any ZEV credits to gasoline vehicles is a mistake since actual emissions will continue to be high (from upstream sources, deterioration, and malfunctions), and because gasoline vehicles incur other large social costs, such as oil spills, climate change, and water pollution. This latter segment of the environmental advocacy community tends to prefer retention of a large requirement for pure ZEVs.

The Natural Resource Defense Council (NRDC) has been among the chief environmental groups studying the implications of the proposed changes to the ZEV mandate (providing written and oral testimony). They argue that, while they appreciate that CARB "is commendably striving to make the LEV/ZEV regulations as flexible as possible in order to reward developers" of very clean technologies, they believe that ZEV credit should only be given "where total vehicle-related emissions are demonstrated as equal to (or less than) emissions from power plants associated with charging battery electric vehicles." They believe that gasoline vehicles will not be able to achieve this stringent standard because of high upstream emissions. NRDC feels that for a vehicle to achieve any ZEV credits, CARB must achieve two conditions: 1) "ARB should require a promise of manufacturer responsibility, through warranty, for keeping the emissions near-zero throughout the actual life of the vehicle," recognizing the 150,000 mile warranty requirement as a step in the right direction; and 2) the total emissions inventory of a vehicle applying for partial ZEV credit must be "significantly less than emissions associated with charging battery electric vehicles." For vehicles whose environmental benefits depend on their future use, such as HEVs, the NRDC recommends that credit be given initially, but only until the actual driving characteristics can be determined (Janet Hathaway, NRDC, February 4, 1998).

Analysis and Unresolved Issues

How Much Credit for Vehicles with Internal Combustion Engines?

Allowing conventional vehicles (powered solely by internal combustion engines) to earn ZEV credit is certainly the most fundamental proposed change to the principles of the ZEV mandate. As of now, only battery electric vehicles, and possibly fuel cell vehicles with on-board hydrogen storage, can meet the ZEV requirement of no tailpipe emissions. The strict ZEV requirement of 1990 was intended to accelerate the development and commercialization of a new generation of inherently clean propulsion technology, one not prone to in-use emissions deterioration

Recent successes with very clean conventional vehicles have made CARB reconsider its stance. A vehicle certified as SULEV would be nearly as clean as a BEV, even considering only the in-basin emissions from recharging. Because a SULEV could therefore clean up the air nearly as much as a BEV on a per mile basis, CARB reasoned that it deserved some partial ZEV credit. Given that such a vehicle would not have the range limitations of a BEV, it would have the added attraction of possibly accruing more VMT per car and probably selling in greater numbers. Such vehicles could thus clean up the air in California more than a BEV. Still remaining, however, are questions regarding degradation of emissions as the vehicles age. Two responses to that concern are the proposed 150,000-mile warranty and advanced on-board diagnostics systems. Reasoning that extended warranties and OBD systems do not guarantee against unmitigated failure, and seeking to promote inherently cleaner technologies, CARB may likely limit the maximum fraction of the 10% ZEV requirement that SULEVs with no ZEV range can satisfy.

Some debate will likely focus around the maximum credit allowances for SULEVs. Should they be allowed to earn as much as HEVs or should they be limited to a value such as 40% of the 10% ZEV requirement? Automakers will approach this question by determining the relative cost of adding another increment of technology to vehicles to move from ULEV to SULEV. Is this cost less than the marginal cost of building pure ZEVs? The answer in the short term is clearly yes -- pure ZEVs, because of the newness of the technology and the absence of scale economies, will not be cost-competitive for some time. Automakers will therefore generally prefer not to build ZEVs, at least in large quantities. Furthermore, since automakers will have to sell up to five SULEVs for one ZEV credit, their NMOG fleet average will also drop (or stay the same if they choose to increase their numbers of TLEVs and LEVs), thus providing an additional incentive for automakers to manufacture SULEVs rather than ZEVs.

The role of government is to determine whether the non-market benefits of pure ZEVs (including greenhouse gas reduction, energy security, and other energy-related costs) might exceed the private cost differential between SULEVs and ZEVs, and if so, whether it will be in the near future. Unfortunately, this calculus is too complex to be easily solved. No one can claim to know the answer to these questions. And, of course, an added difficulty is the fragmentation of government responsibility: CARB's mission, for instance, is limited to air pollution reduction. Thus, debate is assured. One response by CARB, as indicated earlier, is to encourage experimentation with a variety of technologies. That, indeed, is one implication and intention of the partial ZEV credit program: to encourage automakers to pursue different technological (and marketing) pathways.

Issues in Moving: toward Full Fuel-Cycle Standards

Vehicles meeting the baseline criteria can receive up to 0.2 partial ZEV credits if their fuel cycle emissions are lower than those of a comparable BEV. CARB is giving either full credit or no credit to single-fuel vehicles, based on their considerations of the fuel source. CNG would get 0.2 credits and gasoline would get none. CARB has not made a final determination regarding methanol, apparently deferring to auto manufacturers (and the methanol industry) to make the case that methanol results in less emissions than a BEV. Depending upon the assumptions and methods used, quite different answers, could be found.

The intention is to account for emissions through the entire fuel cycle, including emissions from vehicles, refueling, fuel transport and storage, and fuel recovery and processing. To gather information about all these emissions is the equitable and rational way to judge a vehicle. But many issues remain in conducting such an analysis. For instance, do out-of-basin emissions count, since they don't affect local air quality? Are all pollutants treated equally? Is time-of-day of emissions important, since human exposure at night is much lower than during the day?

For the now-abandoned equivalent zero emission vehicle (EZEV) program (see below), CARB considered only in-basin power-plant emissions in determining the BEV baseline. In the South Coast Air Basin, for instance, they assumed that 33% of the electricity was generated in-basin, which they calculated to be equivalent to 0.001 grams of reactive organic gasses (ROG) per mile for a typical battery electric vehicle.

Allocating; Credit to Electric Vehicles with Trailer Range-Extenders

The difficulty with proposing regulations for trailer/generators is that neither automakers nor CARB can be sure of the public's view of them. It is difficult to imagine consumers buying and using such an inconvenient (and expensive) device when conventional vehicles are available to own or rent for longer trips. The trailer would take extra effort to hook up, would require extra storage space, and would hamper driving and parking. However, it is possible that future consumers will find them useful and value them. If so, the ability to hook a trailer to a BEV would definitely increase the BEV's marketability. In that case, the automobile industry would be presented with a choice: make ZEVs without trailer hookups and thereby maximize their ZEV credits received per vehicle, or install the hookups, lose some ZEV credits per vehicle, but possibly increase the marketability of the vehicles?

CARB has chosen to regulate these vehicles based on the presence of trailer/generator hookups because of the inherent difficulty in regulating the sale of aftermarket trailer/generators. While there is no satisfactory solution to such a problem, the course that CARB has chosen means that anyone buying a BEV with a trailer hookup is considered to be using a trailer/generator for a portion of their journeys, whether they purchase one or not. This procedure tends to penalize the automaker, perhaps unduly, especially if drivers were to use trailer/generators sparingly. There is a great deal of uncertainty involved with the potential use and marketability of ZEVs with trailer/generators. CARB may eventually update this portion of the regulations as more is learned about consumer response.

How Much Credit for Hybrid Electric Vehicles?

The proposed partial ZEV credit program creates a mechanism for granting full ZEV credit to hybrid electric vehicles -- if they meet SULEV standards, use a clean fuel, and have 120 miles of all-electric range. If an HEV has 20 miles of ZEV range, the vehicle receives half the 0.6 available range credits, with the remaining 0.3 allocated in a linear fashion up to 120 miles. The logic supporting this methodology is that an HEV traveling 50 miles without the engine provides many of the benefits of a BEV with a 50-mile range, and therefore deserves substantial credit.

The problem is ensuring that the HEV recharges its batteries from the electricity grid rather than from its engine. While for many people the ability to recharge at home or work, rather than going to gasoline stations, will be a substantial benefit, others could choose to use little or no grid electricity. Thus, the emission benefits of HEVs depend greatly on the driver's behavior.

In order to influence this behavior, CARB is more amenable to giving partial ZEV credit to hybrid vehicles that have software installed to promote off-vehicle charging. This could be accomplished by using charge-depleting vehicles where the battery drains as the vehicle is driven and is not replenished by the engine. In a hybrid vehicle this would reduce the performance of the vehicle once the battery is nearly drained. While this would encourage drivers to plug in their vehicles at the end of their trips, it would make the vehicle itself less attractive to consumers and would most likely be bought in smaller numbers. A charge-sustaining hybrid vehicle would be one where the engine would also work as a generator to maintain the charge in the battery. This would improve the performance but would allow little opportunity to recharge with electricity from the grid. One option that balances driver preferences with societal desire for clean air might be for users to input expected VMT each day and then defer to computer-designed operating strategies that maximize use of battery energy. Other ways to encourage off-vehicle charging include rewarding manufacturers who create vehicles that are simple to recharge, or that provide consumers with accessory equipment to use at their homes.

How can regulators be assured that the full available ZEV range is used on a regular basis, and how do they assign credits if it cannot be clearly demonstrated that driving is in the ZEV mode? The current procedure is to assume that the available ZEV range is used frequently, and to provide extra credit only if evidence can be provided that the vehicle is likely driven as a ZEV within its available daily ZEV range. Would it be more reasonable to provide the full ZEV range credit of 0.3 for a hybrid vehicle with a 20 mile ZEV range only if a control strategy to encourage off vehicle charging were included – that is, to apply a higher standard for awarding the ZEV range credit? CARB is presumably taking a more pragmatic position, attempting to create a mechanism for encouraging both HEVs and pure ZEVs.

In Pursuit of the Holy Grail: Toward Hydrogen Fuel Cells

The current problem with assigning partial ZEV credit to fuel cell vehicles is that the technology is highly immature and emissions are poorly understood. It may be that the most polluting FCV design, using gasoline as its fuel, may still be considerably cleaner than conventional gasoline cars, but that is impossible to know at this point. At issue is the extent to which regulations should encourage the development and use of fuel cells that use very clean on-board fuels, especially hydrogen.

On one side is the argument that development and commercialization of any fuel cell system, including gasoline fuel cells, is positive and to be encouraged; that doing so would accelerate the introduction of fuel cell technology into the market. The opposing argument is that rewards should be targeted only at those technologies that genuinely provide strong air quality and other energy benefits. CARB has designed the process to reward cleaner FCVs with more partial ZEV credit, but it is unclear how significant those marginal credits will be in influencing industry investments.

What about Multi-Fuel ICE Vehicles?

While not specifically addressed in the partial ZEV credit proposal, conventional vehicles powered by internal combustion engines but modified to run on a combination of fuels could qualify for partial ZEV credit. The principal reason CARB did not include these vehicles may be the expectation that the cost of certifying a vehicle to SULEV standards on more than one fuel will be too great to justify the expense. The cost is not just a function of making available multiple fuels, but of the many tradeoffs made in accommodating a single engine to the conflicting attributes of the two fuels.

If practical SULEV multi-fuel vehicles could be developed, applying partial ZEV credit to them would raise many of the same issues facing HEVs. Chief amongst these is that there is no way to be certain how much of each fuel is used. A gasoline/CNG vehicle, for instance, could be very clean if CNG is used primarily, or less clean if gasoline is the fuel of choice. If the fuels that go into the vehicle have different full fuel-cycle characteristics, then CARB must have a good sense of what fraction of each is used during daily driving. This can be difficult to determine. The most important determinant will be fuel price and availability. Thus one would expect CNG, because it is less expensive than gasoline, to be used more often, and that methanol and ethanol would be used less, because they are more expensive. But these are generalizations that may not hold in many situations. Further, these generalizations may not reflect strategic plans of automakers, fuel suppliers, and local governments.

For completeness, an analysis is presented below of partial ZEV credits that might be available to multi-fuel vehicles. The examples simply assume that the range with the qualifying fuel is used to determine the level of credit in the same way as vehicles that use electricity as their alternative fuel. If SULEV multi-fuel vehicles ever become a reality, CARB will need to develop specific methodologies for these types of vehicles due to the uncertainty in actual fuel use.

Table 10a. Gasoline or Diesel Flexible Fuel Vehicle with Methanol Range Greater than 200 Miles and Tailpipe Emissions Less than the SULEV Standard with both fuels.

	Meets Standard at Some Level?	ZEV Credit
Baseline	YES	0.2
ZEV Range	NO	0.0
Fuel-Cycle Emissions	?? at 100% if yes	0.0/0.2
TOTAL ZEV Credit		**0.2/0.4**

Table 10b. Gasoline and CNG Bi-fuel Vehicle with Tailpipe Emissions Less than the SULEV Standard with Both Fuels (natural gas with 120 mile range).

	Meets Standard at Some Level?	ZEV Credit
Baseline	YES	0.2'
ZEV Range	NO	0.0
Fuel-Cycle Emissions	YES at 100%	0.2
TOTAL ZEV Credit		**0.4**

Beyond EZEVs

An earlier and simpler version of the partial ZEV credit proposal described in this report was put forth by CARB in 1995. Known as the Equivalent Zero-Emission Vehicle (EZEV) standard, it proposed allowing ZEV credit to any vehicle emitting less than the power-plant emissions associated with a BEV in the Los Angeles region. The proposed standard was 0.02 grams per mile of NO, and 0.004 grams per mile of NMOG. That standard is equivalent to the current SULEV value for NO, and 40% of the SULEV value of NMOG. Under the EZEV standard, HEVs could receive partial credit, provided they had an all-electric range of at least 30 miles and their auxiliary power unit was certified as a ULEV. The longer the ZEV range, the more credit the vehicle would receive.

Although the calculating procedure was very different, the EZEV program was similar to the proposed partial ZEV credit scheme. A vehicle meeting the EZEV standard would emit 40% of a SULEV's hydrocarbons – and thus be cleaner than a SULEV – but it would receive a full ZEV credit, while a basic SULEV in the proposed program would only receive one fifth of a credit. One would expect that automakers would prefer the EZEV program over SULEVs, if they believed they could build a vehicle with 0.004 grams per mile of NMOG at reasonable cost. If such a car were not feasible, then the EZEV program would be of little interest.

The partial ZEV credit program is a more sophisticated program that encourages a larger set of technology paths, by providing incentives for advanced emissions control systems, ZEV technologies, on-board diagnostics systems, and better fuel-cycle emissions.

Transferability Beyond California

As California further amends its ZEV regulations, there will be ripple effects in other states that have adopted California's ZEV mandate. Currently New York still has the original ZEV mandate, requiring automakers to sell 2% ZEVs in 1998, while Massachusetts has kept only the 2003 component. This situation is the result of differing judicial interpretations over the ability of other states to adopt California vehicle emission standards. It is unclear whether other states will have to change their regulations as California changes theirs.

If other states adopt California's proposed partial ZEV credit program, the qualifying vehicles will at least have to meet standards for SULEV, zero evaporative/refueling emissions systems, and OBD II. While adopting these requirements for ZEVs and near-ZEVs may be

simple for other states to do, some practical issues arise. Regarding fuels, California has the strictest specifications for fuel composition, which can significantly impact the ability of vehicles to meet the baseline requirements. For example, California fuels have the lowest vapor pressure requirements in the country, enabling the zero evaporative/refueling emissions goal to be more easily met. Further, many states allow sulfur contents above California's stringent sulfur standards. This could lead to increased difficulty in achieving SULEV emission levels in these states. Finally, should other states set the requirement for partial fuel cycle credits as strictly as California, given that power-plant emissions in other states tend to be much higher?

Adopting and successfully implementing these partial ZEV credit amendments could potentially help improve air quality in other states more than in California. One of the standard arguments against BEVs is that the large amounts of coal used elsewhere in generating electricity (over 50% nationally versus 0% in California) results in BEVs generating more modest benefits elsewhere. Thus, there is a greater incentive to introduce non-grid vehicles (i.e., hybrid and fuel cell vehicles) outside California

The partial ZEV credit program may be a boon in a more general way. With greater flexibility, automakers may better match technology to the needs of different regions. For instance, automakers might supply New York with HEVs, which are less susceptible to cold weather, rather than clones of California BEVs.

Toward the Future

The ZEV mandate has attracted strong opposition from various industry groups. For good reason: much is at stake for many of the largest companies in the world. Opposition has been inspired by more than threatened interests, though. Corporations genuinely resent what they see as overly intrusive government. CARB has made an effort to accommodate those concerns – by providing more flexibility and opening the mandate to gasoline vehicles. To what extent these changes have defused the opposition remains to be seen.

The CARB proposal described here is certainly not the final word. It is possible that the entire staff proposal will be abandoned or drastically transformed. We expect not. Our assessment, based on discussions with many of the principal stakeholders, is that this partial ZEV credit proposal resonates at some level with most interested parties, and therefore is likely to survive in recognizable form. Final adoption of the 'entire LEV II proposal is-scheduled for November 1998. There is some indication that the automotive industry wishes to delay the decision to 'allow adequate time to evaluate the practicality of meeting the requirements. Final adoption could extend beyond November.