Fuel Efficiency and Climate Change

By: Stephen Heckeroth

Vehicle Type	$ Gas 50 Mi. /Day	kWh 50 Mi. /Day	$/Month 50 Mi. /Day	Tons of CO_2/Year Tailpipe	+Tons of Upstream CO_2/Year*
10 MPG Gas	12.50	200	375.00	21	27.3
20 MPG Gas	6.25	100	188.00	10.5	13.6
30 MPG Gas	4.17	67	125.00	7	9.1
40 MPG HEV	3.13	50	94.00	5.2	6.8
50 MPG HEV	2.50	40	75.00	4.2	5.5
40 MPG PHEV with 25 Mile EV Range	1.56 for 25 Miles	10 for 25 Miles	62.00	2.5	3
PHEV with 50 Mile EV Range		22	33.00	ZERO	.4
EV-1, 120 Mile Range (built & crushed by GM)		12	18.00	ZERO	.2

A quick study of the chart above shows the overwhelming advantages of plug-in hybrid (PHEV) and battery electric vehicles (EV). EVs are zero emission and can be charged from zero emission renewable energy sources like the sun and wind.

The obvious question is: Why aren't we all driving zero emission battery electric vehicles?

As we approach the peak of world oil production (extraction) it is important to reflect on how it came to pass that the developed world would base its entire economy on finite resources. It is also important to realize that corporations are not conscious beings and, for the most part, are incorporated for one reason… To make money. This gives us, the consumer, the ultimate power to be the corporate conscience by choosing how we spend money. It is also up to us to insure that laws and regulators protect essential resources like; air, water and soil.

For the last 35 years, my private, public and business activities have been focused on finding ways to live comfortably while reducing the use of finite polluting resources. The following pages will explore some of the history of zero emission vehicles (ZEVs) and the barriers to their widespread use. My hope is that readers will use this information to demand transportation choices that can be fueled by unlimited clean renewable energy.

Inventors first started tinkering with small EVs in the late 1830s right after the invention of the electric motor in1833. It wasn't until 1859 that the development of the first rechargeable lead acid battery made it possible for EVs to be more than a novelty. In the 1880s the first electric cars were patented by inventors in the US and Europe. In 1890 the first golden age of electric cars started in Des Moines, Iowa when William Morrison's electric car traveled 182 miles on a single charge. For the next two

decades electric vehicle manufactures like GM, GE, Studebaker, Baker and scores of relatively unknown companies led the race for the successor to the horse as the preferred mode of transportation. EVs held the land speed record until 1902 and many of the inventions that made gas cars popular, like rack and pinion steering and pneumatic tires, were introduced on electric cars.

Quiet, clean EVs out-sold loud, smoke-belching gas cars at the turn of the century and were assumed by most to be the car of the future. In 1900 Thomas Edison started work on a new alkaline battery and by 1909, using much of his own fortune, he was manufacturing nickel iron cells that had almost double the power to weight ratio of the lead acid batteries of the day. Having the strength to turn the crank to start the engine was a prerequisite for driving Henry Ford's Model T. So almost all of the cars that rolled off the assembly line in 1908, at the low price of $850, were purchased and driven by men. Ironically, it took the invention of the electric starter motor in 1912 to convince 'respectable people' that longer range was worth giving up the elegant silence of electric automobiles. Edison stopped his work on batteries in 1910 and GM made its last electric truck in 1916 and a cloud of smoke became a symbol of power and progress.

Electric street cars and light rail continued to develop as a clean and convenient way to get around in and between towns and cities until the Great Depression. During the 20s and 30s the auto industry, along with the oil industry that fueled it and the tire industry that gave it wheels, became the most powerful companies on earth. In the late 20s GM, Standard Oil and Firestone Tire collaborated in a plan to eliminate all forms of transportation that competed with rubber tired, fossil fueled vehicles. They lobbied all levels of government to eliminate all public funding of any electric rail projects, and at the same time supported funding of vast road building projects. After the quality of rail service declined because of lack of funds, the oily cabal offered to buy out the transit system. They sometimes promised to improve service but in the end they always ripped up the tracks as soon as the sale was final. By 1940 the rubber tire alliance had systematically ripped up every light rail system in the country, forcing everyone into private pollution machines. Never mind that rail can be zero emission and that it is hundreds of times more efficient than 8 lanes of traffic idling on the freeway.

By the 1960s a cloud of smoke was engulfing most American cities. I was born and raised in Southern California in the late 40s through early 60s. As a young boy I thought smog was a natural phenomenon. I remember my lungs and eyes burning when I ran track and cross country alongside a freeway in high school and thinking that the pain was not natural. I helped organize the first Earth Day events in 1970 at Arizona State University where I was studying Architecture. Earth Day shook me out of the smoky haze in which I was raised. It forever changed the way I perceived the definition of the word finite and the importance of air, water and soil quality. I was committed to live my life reducing my dependence on finite resources.

My first wife and I purchased a piece of land in Northern California and started building a self-sufficient homestead for our growing family. Our first shelter was a Tipi made on a treadle sewing machine from plans in the very first issue of The Mother Earth News. I hand-dug a well, put up a salvaged 1925 Aeromotor wind pump and built our water tower home from trees I felled with an ax and hewed with an adze. I put up a 1kW wind generator for power and all our heat still comes from either the sun or wood. We planted fruit trees and had a large enough garden to supply all the vegetables we could eat and more. We gathered more recycled and hand-hewn materials and posted an announcement for a barn raising at the local grocery store (see barn raising announcement). Over 100 neighbors showed up to help get most of the barn up in one day. We then had room for chickens and a cow. The next project was to dig a pond dug for ducks, fish and irrigation so I traded work with a local heavy equipment operator. We grew enough corn, potatoes, beans and carrots in the terrace garden below the pond to last the whole year. I rode my bike to my day job as a surveyor for a few years until I built a wood shop and could make a living at home building furniture. Our kids were home-schooled using the Montessori Method with the homestead as their classroom. We had almost totally eliminated the need for fossil fuel by limiting our need to get in a car. We still pumped a lot of gas into our VW Bus for trips to see friends and family so I wasn't satisfied.

When the oil embargo hit in 1973 there was suddenly great interest in re-learning how to live simply on the land. I started teaching classes on alternative energy and self-reliant living nights at the local college. The classes were always full and I always learned a lot more than I taught by having guest lectures. Luminaries like Windy Dankoff, who carved wind generator blades for the class and later started a successful renewable energy business, and Jeanie Darlington who wrote a book on organic gardening shared their wealth of knowledge with me and my students. During this time I met Michael Hackleman who had written half a dozen books on renewable energy topics and was starting a new book on electric vehicles. I became convinced that electric vehicles charged from renewable sources would not only be the best transportation solution for me but would reduce pollution and conflict over finite resources world wide.

When the second oil embargo hit in1977 I thought everyone would see the writing on the wall and there would be a national effort to improve battery technology and switch to renewable energy. After all… domestic oil discoveries had been falling since 1930 and domestic oil production (extraction) had peaked in 1970. Worse yet, there was a cartel that controlled 80% of the world oil reserves and was organizing into a force to be reckoned with. By this time I was designing and building off-grid passive solar homes with wind generators and gravity feed water systems. Our own place was run off of batteries, with 12 volt lights, refrigerator, converted wringer washer and a good car stereo in the living room, we had almost every thing we needed. I started doing research on batteries and soon discovered that the technology had not improved much in more than 100 years. In fact the improvements that Edison had made 80 years before were almost all but forgotten. I was not alone in my interest in electric vehicles. Michael Hackleman finished his book titled ”Electric Vehicles” in 1977. My research that same year found that there were about a dozen start-up EV manufactures in the US and Europe in limited production mostly for commercial delivery use. The surprising fact was that the nation who landed people on the moon and safely returned them to earth had done little to improve EV performance since the turn of the previous century.

In 1978, the federal gas guzzler tax that levied a fee on cars with poor fuel economy, along with continued higher gas prices made more efficient foreign cars increasingly popular. Japanese car sales increased dramatically and for the first time oil imports decreased in 1979 and the early 80s. I served for several years on a Citizen Advisory Committee on the County General Plan update and Offshore Oil Task Force. I drafted an Energy Element for the General Plan with goals and policies that encouraged a smooth transition to clean renewable energy and placed a moratorium on offshore oil development.

Just as I thought a smooth transition to renewable energy might be possible, a new Hollywood president captured the election. Ronald Reagan’s campaign success included the tactic of embarrassing President Carter by using money from the sale of weapons to the Nicaraguan Contras to bribe Iranians into delaying the release of hostages until after the election. When Reagan made statements like “our oil in the Middle East” my hopes for world peace also evaporated. The 80s turned into the dark ages as the solar collectors were taken off the White House and the nation that once prided itself on its independence went deeper and deeper in debt to pay for its increasing dependence on foreign oil.

The only bright spots for me in the 80s were Stanford Ovshinsky, Paul MacCready and Professor Andrew Frank. Ovshinsky invented the Nickel Metal Hydride Battery, which is now used in almost all hybrid and pure electric vehicles. Ovshinsky’s accomplishments also include the Triple-Junction Thin-film Amorphous Solar Cell which can be used to charge the batteries in an EV. Paul MacCready engineered the Gossamer Albatross, a pedal powered flying machine and later the sun-powered Solar Challenger. Both successfully flew across the English Channel to capture prize money and the imaginations of a new generation of engineers. Professor Frank very quietly started working with his students at the University of California at Davis to build, what we now call, PHEVs (Plug-in Hybrid Electric Vehicles). Ovshinsky was named a “Hero of the Planet” by *Time Magazine* and MacCready was named Engineer of the Century by the American Society of Mechanical Engineers. Andy Frank’s inventions have not yet received the national attention they deserve, but the idea that over 90% of

vehicle miles could be zero emission while still allowing hybrid drive for long trips, will make him one of the heroes of this century.

In 1987, the next phase of EV development started when top management at GM was trying to put a positive spin on their recent purchase of Hughes Aircraft and heard about a solar car race across Australia. An inter-office envelope sent from GM headquarters containing only an invitation arrived on Howard Wilson's desk just 10 months before the event. Wilson was a VP close to retirement at Hughes in Los Angles. Hughes made solar cells for satellites and had also worked with very expensive high-energy silver zinc batteries, but neither GM nor Hughes had worked on the very light-weight aerodynamic kind of car that would be necessary to win the race.

Wilson knew that loosing was not an option so he visited AeroVironment, Paul MacCready's small R&D firm in the San Gabriel Valley to see if the "Engineer of the Century" would secretly take on the project. Alec Brooks, MacCready's protégé at AeroVironment knew about the race and was already very interested in entering but knew it was way beyond his means. When they were offered the resources of the largest corporation in the world to enter the race both Brooks and MacCready immediately said yes. Wilson flew back to Detroit where his request for funds was turned down by middle management. On his way out of the office, he noticed Bob Stempel at his desk. Stempel had just been promoted to Vice President of Truck and Bus, which included GM's Australian operation. He asked if Stempel could spare a couple of minutes and 15 minutes later, he had Stempel's approval to spend $75,000 on a feasibility study.

Back at AeroVironment Brooks and Alan Cocconi, another of MacCready's talented young engineers, immediately started work on what would be called the "GM Sunracer." Brooks employed his skills in aerodynamics and Cocconi made a DC to AC inverter that would work in reverse to do regenerative braking. In less than two months, Brooks, MacCready and Wilson went back to Detroit to present their design, which included something called a 'peak power tracker' invented by Cocconi. 'The peak power tracker' enabled the car's batteries and motor to draw optimum power from the solar cells. Bob Stempel again was the deciding vote in moving forward with the project. He commented the project should be used as a teaching tool and two cars should be made so one could be used both as a backup and to educate twice as many school children when the race was completed. The race began in November 1987 and the Sunracer immediately took the lead over the 23 other entries and easily won the 3,000 mile race across Australia with an average speed of 41.6 mph powered only by energy from the sun.

The publicity from GM Sunracer's success had the desired effect of showing the value of the Hughes acquisition and improving the company's image, but GM management was happy to quickly return to business as usual. Alec Brooks viewed the Sunracer as a foot in the door to work with largest auto manufacturer in the world to develop a practical electric car. He presented his ideas to Wilson and together in early 1988, they presented the concept of a sporty two-seater electric car to Stempel and other executives in Detroit. The project was originally turned down by then GM CEO Roger Smith. Stempel and vice chairman Don Atwood who had previously worked on the Apollo spacecraft navigation system had to lobby for the project for three months before Smith reluctantly approved a $3 million concept prototype with a fifteen month deadline.

Brooks headed the team and pushed the GM designers to let styling be determined by aerodynamics, which was a very novel idea at the time. Cocconi worked alone to build two 50 kW inverters that would take the car from 0 - 60 mph in 8 seconds and also provide regenerative breaking, as well as act as a battery charger. The Delco Remy division of GM worked to shoe horn an 850 pound advanced sealed lead-acid battery pack into the smallest space possible.

The team was falling behind schedule when Smith, now very excited about the project, announced that he wanted to unveil the EV at the L.A. auto show just 5 months away in early January 1990. All the top management at GM, including advocates like Bob Stempel, who would soon take over as GM's CEO, were in favor of keeping the car a secret long enough to fully consider what might happen when the car was seen by the California Air Resources Board (CARB). They wondered, if GM showed that a

prototype electric car could be built, what would stop the regulators from making them build a production model. After another tough year of dwindling market share and factory closings Smith was intoxicated with the idea of GM being out in front and basking in the glow of public excitement.

It was only the dedication of the AeroVironment team that made it possible to meet the deadline. On the opening day of the show it was not only ready for people to see but there were also videos showing the car zooming around the track. The car, now with the unfortunate name of 'Impact' soon to be re-named the EV-1, went from 0 – 60 in 7.9 seconds, which was faster than most gas sport cars and had a very respectable range of 124 miles at 55 mph. The Hughes press conference and the L.A. auto show opening the following day were both great successes for Smith and from all appearances the car was built entirely by GM and Hughes, there was no mention of AeroVironment.

Later in 1990, the worst fears of the GM management were realized when CARB announced the Zero Emission Vehicle (ZEV) Mandate. The program, as originally conceived, required that at least 2 % of new car sales by the major manufacturers would be zero-emissions by 1998. The requirement would be 5 % by 2001and 10 % by 2003. The ZEV mandate provided a long term vision that spurred technology development around the world and resulted in successful zero-emission and near-ZEV technologies, including battery electric vehicles and hybrid vehicles, as well as super-ultra-low emission vehicles. None of this happened, however, without a great deal of resistance from the auto and oil industry, not to mention the Federal Government.

When I heard about the ZEV mandate, I immediately gathered some friends together with various welding and electronics skills and announced that I was going into the EV business. I borrowed a lot of money, set up a shop and started converting all the appropriate vehicles I could get my hands on (see shop photo). Battery weight was a big disability in a car, but a tractor needed weight for traction. I soon became the largest electric tractor manufacturer in the world, but that, as they say, is another story.

Trying to optimize the performance of an electric car led me to the conclusion that none of the cars built in the US were good candidates for three main reasons; 1. They were too heavy; 2. They were not very aerodynamic; and 3. They could not carry a lot of battery weight.

My first conversion was done on a '62 VW Type 3 Karmann Ghia and was for my own use. The Type 3 Ghia was a fairly rare and valuable car that was worth the money spent on restoration. It only weighed 1,800 pounds and the suspension could also be easily upgraded to carry an extra 1,200 pounds of battery weight. I purchased the Ghia with no engine and a lot of spare parts for only $800. The major components included a 20 hp DC motor, an adapter plate to hook the motor to the transmission, a DC motor controller, a pack of 20 - 6 volt golf cart batteries, and a 120 volt battery charger. The cost for all these components purchased in very small quantities was about $7,500. Building the battery boxes and fitting all the components took about 100 hours. The restoration took about another 150 hours. Depending on how I valued my time, the completed cost of the car was $12,000 - $15,000. The car could go about 60 miles between charges (range) and the first battery pack lasted 5 years. I also enjoyed not worrying about oil and coolant changes, tune-ups, muffler and belt replacement or catalytic converters and, of course, the price of oil and gasoline.

My next conversion was a VW Vanagon with a 500 watt PV array mounted on the pop top (see photo). It could easily carry the 1,400 pound 144 volt battery pack and if I drove very carefully I could make the 60 mile trip to help build the Real Goods Solar Living Center. I parked the Van with the pop top facing the sun in the day and then sleep in it at night. After about 3 days the batteries were charged up to make the trip home. It was a 2 ton solar car?

My first sale was a Fiero conversion which I thought would be an ideal conversion but it weighed 400 pounds more than the Ghia. When it was fitted with the same components as the Type 3, it had less than a 50 mile range. Weight was obviously a big factor and more specifically the ratio of battery weight to total vehicle weight.

I started looking for the lightest car that could carry the most weight and ran across Porsche Spyder replica kits that weighted only 1,000 pounds without the engine. Even better, they were built with VW running gear just like dune buggies and there was a huge selection of after market suspension upgrades for added carrying capacity. I got my first order from John Schaffer, the founder and president of Real Goods, and delivered the first silver Electric Spyder for $23,000 in late 1993. I used the same components as the Ghia, but the E-Spyder had an amazing 100 mile range with 100-year-old battery technology.

I quickly sold three more Spyders and then another Type 3 Ghia. I cut the cost of the components by 30% with quantity purchases and started thinking I might be able to eventually make a profit. The Spyder owners started entering and winning all the electric car races and rallies in their class. The Yellow Spyder was supped up with sealed lead-acid batteries and went head to head with an EV-1 with a 0 – 60 mph time of 8 seconds. I was encouraged, a car built in my shop in 100 hours and for less than $25,000 went head to head with a car GM had spent millions of dollars and 7 years developing. My favorite record was set by the Van when we filled it with 12 people and went a very slow 84 miles for 1008 person miles on one charge. The closest competitor went less than 400 person miles.

The dream of auto industry leadership on fuel efficiency and zero emissions dimmed when Bob Stempel's term as CEO at GM was cut short in part because of his support for the EV-1. The auto industry instead started heavily promoting passenger trucks for several reasons. 1. Passenger vehicles that qualified as trucks were not included in calculating the percentage of ZEVs manufacturers were supposed to build; 2. The 1978 Gas Guzzler tax did not apply to trucks; 3. Trucks did not have to qualify for the same fuel economy, safety or emission standards as cars; 4. If the passenger trucks were heavy enough there were almost no standards at all; and 5. These heavy trucks (Excursion, Hummer, etc) qualified for federal tax credits that would essentially make them free to anyone with a large enough tax burden.

Trucks were cheaper to build than cars because the fuel economy, safety or emission standards were low or none-existent, and it was relatively easy to make people think they were getting more for their money because they were huge. The average suggested mark up over manufactured cost on cars is about $3000. On passenger trucks the mark up is as much as $20,000. Once customers got used to the high prices the $5,000 cash back deals seamed too good to pass up. Did you ever wonder why there were no cash back deals on reasonably sized cars? Only when the carnage from rollovers and high bumpers made front page news did people consider that bigger may not be better. The book *High and Mighty* gives statistics that suggest that SUV drivers are 3 times more likely to die in single car accidents than mid-sized car drivers, because of rollovers. And in multi car accidents between an SUV and a mid-sized car, fatalities are almost 3 times more likely than in accidents between two mid-sized cars, because the bumpers on SUVs are at the head height of people in cars (see Hummer photo). Whenever sales sagged the federal government stepped in with ever bigger tax write-offs up to $75,000 for the biggest passenger trucks and luxury SUV's.

In 1990, only 4% of the passenger vehicles sold in America were classified as trucks. By 2003, passenger trucks made up over 50% of the new cars sold. For the same period, passenger vehicle fuel economy had gone from nearly 30 mpg down to the low 20's. As gas prices continue to rise, those who can afford to buy new, more efficient cars will dump their old SUV's onto second hand buyers, like first time drivers.

The 1994 bi-annual ZEV Mandate hearing was attended by an overflow crowd evenly split between young environmental lawyers and well-spoken citizen advocates on one side and 'good old boy' corporate executives and high paid industry 'consultants' on the other. There was a lot of speculation that the newly appointed CARB chair was going to do his best to stop the Mandate. The politicians spoke first at length on both sides of the issue. Next, the industry testified, taking as much time as they needed, to point out the disastrous consequences of the Mandate. Representatives from every major auto manufacturer pointed out the shortcomings of batteries, EV technology in general, the huge costs that would have to be passed on to the consumer, the lack of customer support, and the importance of

letting the free market work its magic unencumbered with mandates. The oil industry, through their slick hired guns, were much more threatening. Their long polished speeches were filled with the results of studies they had funded, which claimed everything from ‘there was no problem’ to ‘the Mandate would increase pollution.’ They would usually close with something like ‘you mandate, we sue.’

By the time industry was through, it was late afternoon and the new CARB chairman instituted the 3 minute rule. The young lawyers from environmental organizations spoke next passionately about the risks from increased greenhouse gas emissions and threats to human health from car exhaust. The crowd was thinning and the press was gone by the time the environmental organizations were through speaking and the citizens who had missed a day of work were told to return the next day if they wanted to be heard. The next day the hearing continued with a bare quorum of the board members and no press but a room full of citizens who came to speak from their heart about what many thought were the most critical issues facing humanity. I testified in favor of the program, noting that if it wasn’t for mandates there would be no seat belts, air bags and people would still be filling rooms, like that one, with cigarette smoke. I also pointed out that when a 7 lb. gallon of gasoline is burned 23 lbs. of CO2 is created by consuming 16 lbs. of oxygen. I closed by asking if breathing might be a better use for oxygen. Every citizen that testified supported the Mandate and was anxious to purchase an EV when they were available. That evening the board voted to uphold the Mandate to the cheers of those who stayed through the two days of testimony.

Overnight it seemed like a dam had burst and new companies offering better EV components and conversion kits were popping up every day from all around the world. Michael Hackleman’s second book on EVs came out at the end of ’95 with hundreds of photos of exciting new products and projects. His book is still the best source of information on the subject. I found lightweight chargers and controllers made in Italy. The conductive chargers fit easily under the hood and allowed an EV to be charged by any 110 AC outlet anywhere any time. I could now make trips virtually anywhere without being worried about running out of juice. I never have been stranded in an EV and I still have friends I made by pulling up in front of their house and asking them if I could plug in my electric car. The controllers had regenerative breaking for DC motors. When I installed it in my Ghia the regen added 15 miles to the distance between charges in stop and go driving. It also made it possible for me to make trips over the hill to the Ukiah Valley because some of the energy I used to go up the hill was put back in the batteries on the way down the other side. Even more important, the life of mechanical brakes was dramatically extended because they were rarely used and regen had the same familiar effect of slowing down as when you took your foot off the throttle in a gas car I started getting a lot of orders for E-Spyders and knew I could knock another 20% off the cost of the kit car and other components with larger volume orders. Maybe my goal of doing well by doing good could be realized.

It usually takes at least three years for an auto manufacturer to bring a completely new model from concept to production. If the auto manufacturers were to be ready with ZEVs to meet the 2% mandate in the 1998 model year they would have to start designing them at the very latest in 1995.

In the spring of ’95 the Western States Petroleum Association and the California Manufacturers Association kicked off a well-funded media campaign to turn the public against electric vehicles. The first phase of the campaign had already started by identifying politicians, scientists and universities whose statements and research could be influenced by very large sums of money. In early spring cover stories started appearing in newspapers, magazines and even scientific journals. The articles quoted what looked like reputable studies to make the point that the EV Mandate would ruin California’s economy, raise the cost of every car sold in America by $5,000, and that batteries would cause terrible pollution and blow up and spew acid in an accident. It was later discovered that all the studies the articles referred to were as reliable as the WMDs in Iraq. For example, the battery study was based on statistics from lead-acid battery factories that operated at the turn of the last century and were totally unregulated. They also assumed that the batteries were going to be dumped in landfills. Never mind that 99% of car batteries are now recycled and new totally non-toxic Nickel Metal Hydride and lithium Ion batteries were already in use. The retractions were always buried in small print somewhere at the end of the publication.

I was appointed to the County Planning Commission in the summer of ’95 and often received anti-Mandate propaganda in official looking yellow envelopes filled with information from what appeared to be some concerned citizen groups. Inside the envelopes were letters from concerned citizens, clippings of the negative articles, pictures of people with acid burns and lists of civic organizations that were against EVs and the Mandate. Over a six-month period every elected or appointed public official in California, from the local Chamber of Commerce to the State legislature, received several yellow packets. There were special packets for fire, police and emergency workers that focused on the difficulties of dealing with hydrogen explosions, acid spills and toxic cleanup resulting from EV accidents.

As the 1996 CARB ZEV bi-annual review approached, the auto and oil (‘autoil’) industry media campaign went into high gear with new and even more effective techniques. Political campaign style TV ads started appearing between sexy SUV commercials. The ads again appeared to be produced by concerned citizen groups and suggested that unnecessary government regulation was going to cost the California tax payer $28 billion and force everyone into cars that would leave people stranded on the road when their toxic batteries died. The industry even managed to turn EVs into a class and race issue. They convinced unsuspecting civic leaders in poor communities that the poor and people of color were going to bare the burden of higher bills so that rich white folks could drive expensive electric cars.

The over $30 million spent in the ad campaign only amounted to a few minutes of the ‘autoil’ industry annual revenue but had an effect that surpassed even their expectations. As I mentioned in the spring of ’95 orders were pouring in for the E-Spyder and I was finding it difficult to keep up with all the new improved cost competitive technology that was being developed. I was formulating a plan to build the E-Spyders in groups of 10 which would cut the production costs almost in half. But by the beginning of summer, I started receiving calls from customers who wanted to cancel their orders. By summer’s end all the orders had been canceled and, worse yet, the hundreds of other start-up companies that were gearing up to produce EV components and kit cars started going out of business. Just six months before I had driven the Real Goods E-Spyder in the Disneyland Clean Air Rally and had been on TV 10 times surrounded by enthusiastic crowds all over Southern California. Then at the Health and Harmony Festival in the summer of ’95 the only attention I received when I drove the E-Porsche was from people telling me I was a bad person.

At the ’96 ZEV Bi-annual Review Hearings, CARB eliminated the 2% requirement for ’98 and the 5% requirement for 2001 and tried to save face by leaving the 10% ZEV requirement in place for 2003. GM had chartered busses to bring activist from poor communities to testify against the Mandate creating a confrontational and chaotic atmosphere very different from previous hearings. CARB was characterized as the big bad government regulator taking money from the poor to pay for rich peoples’ toys. It was clear, however, that the results of the hearing had been determined months before by an unchallenged negative media campaign. I lost my life savings and was stuck with a very large dept but even worse, the hope for clean transportation, charged from renewables, would have to remain a dream for a while longer.

At the 1998 Hearings, CARB continued to ask the auto makers to make a limited number of ZEVs available for lease to the public and fleet operators, but allowed partial ZEV (PZEV) credits for very low emission vehicles that were not pure ZEVs. Toyota started leasing the RAV4 EV to fleets and GM not to be outdone finished development on the EV-1. Soon after with Michael Hackleman’s help, Honda came out with the EV Plus.

By 2000, the auto industry was again in the position of having to start the design of vehicles to meet the 2003 10% Mandate. At the hearings that year there was a split in the auto industry. Ford had never been very outspoken at previous hearings, but now under the new leadership of Henry’s grandson Bill, Ford was willing to try and meet a revised 2003 requirement. GM on the other hand made a series of announcements that culminated in the recall and crushing of all the EV-1s and electric S10 trucks in California and the end of GM’s EV design and production program.

At another hearing in January 2001 CARB reduced requirement from 10% to 2% ZEV's but maintained the 2003 deadline. Soon after the hearing, GM announced a lawsuit against the State of California. The suit made the allegation that CARB could find more cost-effective ways to reduce air pollution than by imposing the burden of producing battery electric vehicles on the auto industry. The other auto manufacturers moved to comply with the reduced requirements, but Toyota was the only manufacturer to offer an EV for sale to the public. Unfortunately, it was only available for a very brief period. We purchased our RAV4 EV at the beginning of 2002 and installed a 3 kW PV roof to off set the electricity used to charge our EV. The suit was modified and joined by the Federal Government in June 2002. A federal judge soon issued an injunction that prevented CARB from enforcing the 2001 requirements. The expanded suite asserted that only the Federal Government had the right to set fuel economy standards. Never mind that the Federal Government wasn't doing its job or that California was regulating emissions, not fuel economy standards.

In April 2003, CARB abandoned the ZEV Mandate to eliminate the federal injunction and then adopted a hydrogen program that required manufacturers to build 250 fuel cell vehicles by 2008.

Instead of hundreds of thousands of competitively priced zero-emission EVs by 2003, we now have a few dozen multi-million dollar fuel cell vehicles with less range than EVs.

Last year, in response to increasing concerns about Green House Gases and Global Warming, California passed limits on CO2 emissions from cars. Again the Bush administration and this time all auto makers, including Toyota, think short-term profits are more important than long-term health and have filed suit against the State of California. Seven Eastern States have also opted to adopt the new California standards. This move by States is part of a growing grass roots effort by local governments and citizen groups to deal with issues like 'Peak Oil' and Climate Change caused by human activity. Please check out the links below to join with people in your area and across the country to maintain the quality of the resources that allow life to exist. When greed wins everyone looses.

The next phase of EV development is being assembled by Professor Andy Frank and his students at UC Davis. It's called a Plug-in Hybrid Electric Vehicle (PHEV). Hopefully this time around enough people will be able to see through the smoke and demand transportation choices that can be fueled by unlimited clean renewable energy.