



The Road to a Cleaner Future

Maintaining a strong Zero Emission Vehicle Program will save billions in health costs, reduce air pollution and help achieve the state's global warming goals.

March 2008

A report by the American Lung Association in California and technical analysis by TIAX, LLC

The Road to a Cleaner Future

Background and Overview

With the California Air Resources Board (CARB) considering significant changes to the state's Zero Emission Vehicle program, the American Lung Association in California set out to investigate the public health and global warming costs and benefits that would accrue from a transformation of California's motor vehicle fleet to completely zero emission vehicles (ZEVs) or completely ultra-low emitting gasoline vehicles (partial zero emission vehicles or PZEVs). The American Lung Association in California contracted with TIAX LLC to conduct the technical analysis that provides the basis for the important findings in this report.

The American Lung Association's study finds that if California implemented a rapid conversion of motor vehicles to zero emission technologies, the result would be tremendous public health and societal benefits. Converting the automobile fleet from gasoline to completely zero emission technologies would save \$142 billion in the 2010 – 2030 timeframe, or \$96 billion more than relying on the cleanest gasoline technologies. This savings includes savings from reduced air pollution health impacts and reduced global warming impacts to the society (including impacts to air, water, energy forests and other sectors). The conversion to ZEV technologies would also provide California with a significant portion of the emission reductions needed to meet AB 32 (Nunez/Pavley) greenhouse gas reduction targets in 2020 and the long term greenhouse gas reduction targets set by Governor's Executive Order S-3-05 for 2050.

The study also found that California can avoid at least \$2.2 billion per year in health costs from exposure to directly emitted fine particulate matter (PM 2.5) by converting the motor vehicle fleet to ZEVs instead of relying on cleaner gasoline technologies, in addition to reducing exposure to other pollutants. Three hundred cases of premature deaths could be avoided annually or a total of 6,000 premature deaths could be avoided by 2030 by a complete transformation to zero emission vehicles. In addition, over 260 cases of chronic bronchitis, over 7,000 asthma attacks and over 18,000 cases of upper and lower respiratory symptoms could be avoided each year by a complete transformation of California's motor vehicle fleet to zero-emission vehicles.

The California Zero Emission Vehicle program, as it was first developed, required a more rapid conversion to zero emission technologies than experienced in the last decade. It required auto companies to produce and sell zero emission vehicles beginning at 2% in 1998 and ramping up to 10% in 2003. That requirement would have translated into 750,000 – 850,000 pure ZEVs on California roads today and 150,000 – 170,000 new ZEVs in the fleet each year. Unfortunately, California has fallen far short of these goals. At 2,500 "pure ZEV" or "gold" vehicles required in the 2009-11 timeframe, ZEV requirements are a small fraction of the numbers originally required in 1990. Even with the current program's ramp up to 25,000 vehicles by 2012-14, the number of pure ZEVs in 2014 would only be 3% of what was originally required by 2003, and the current CARB staff proposal would reduce the numbers much lower.

At the same time, California has adopted aggressive targets for reducing greenhouse gases in the 2020 and 2050 timeframe, and has recognized that the transition to non-petroleum fuels is critical to achieve these targets. The State's Alternative Fuels Plan lays out a 2050 vision with 40 percent of transportation fuels derived from electricity or hydrogen and 30 percent is derived from other alternative fuels. The Environmental and Technology Advancement Advisory Committee (ETAAC), charged by the Governor with advising state agencies on implementation of AB 32 (Nunez/Pavley) the Global Warming Solutions Act, stated in their final report that California must transition away from carbon based fuels and must rely on zero or near-zero emission energy sources by 2050 to meet global warming targets.

Scope and Methodology

TIAX LLC compiled information using a full fuel cycle or "well to wheel" (WTW) model of greenhouse gas emissions and criteria air pollutants developed by the California Energy Commission and contractors for the AB 1007 (Pavley) process to develop the state Alternative Fuels Plan. The WTW model incorporates results from Argonne National Laboratory's Greenhouse gases, Regulated Emissions, and Energy use in Transportation (GREET) model that had been modified specific for California fuels. TIAX developed estimates of the criteria pollutant and greenhouse gas emissions from the existing mix of vehicles in the motor vehicle fleet (fleet average) and two other fleet scenarios, a fleet scenario with 100 percent ZEVs and a fleet scenario with 100 percent PZEVs in the 2010 – 2030 timeframe. The contractors also used the EMFAC2007 model to calculate the total emissions of criteria pollutants from the downstream, tank to wheel (TTW) portion of the fuel cycle. With the help of both models, TIAX developed information on emissions from both the upstream, well to tank (WTT) and downstream, tank to wheel (TTW) portions of the fuel cycle for all three fleet scenarios.

TIAX used the emissions factors derived from these models to calculate the total emissions of greenhouse gases and criteria pollutants each year for each scenario, and then determined the costs to society for the projected criteria pollutant human health damages and global warming damages. TIAX used methodologies developed for AB 1007 process and the ARB Goods Movement Emission Reduction Plan to develop the damage estimates for each pollutant. The criteria pollutant health damages include damages associated with secondary formation of particulate matter from oxides of nitrogen. While costs of criteria pollutant damages from California vehicle choices are estimated on a California basis, costs of global warming damages are estimated on a global basis. Global warming damages were estimated as a percentage of Gross Domestic Product for the world, and include a wide range of damage estimates for agriculture, energy, forests, water, air quality and other sectors. The global warming damage estimates are essentially the same as those used in the California Energy Commission's AB 2076 report that developed a California strategy to reduce petroleum dependence. For purposes of this calculation, this study assumes ZEVs to be only battery electric vehicles; however ALAC and contractors assume that other ZEV technologies will develop and have similar benefits in this timeframe.

The TIAX technical analysis provides a stark comparison of California's future transportation choices: pursuing the existing pathway of primarily gasoline vehicles or pursuing a dramatic

change to rely on all electric-drive technologies.

Key Findings: Public Health and Societal Costs and Benefits

Benefits of Moving To Electric Drive Technology

- If the California motor vehicle fleet is totally replaced by zero emission vehicle technologies in 2010, the benefit to society in terms of the savings from avoided human health and global warming impacts would total \$142 billion dollars in 2030.
- If the California motor vehicle fleet is totally replaced by the lowest emission gasoline technologies (PZEVs) in 2010, the benefit to society would be around \$46 billion in 2030.
- \$96 billion in cumulative benefits to society or approximately \$4.8 billion per year in benefits would result from converting the motor vehicle fleet to ZEV technologies rather than the lowest emission gasoline technologies (PZEVs).
- \$2.2 billion per year in particulate matter (PM 2.5) related health benefits (from avoidance of direct PM 2.5 emissions) can be achieved with ZEVs compared to PZEVs. This reduction in particulate matter means that California would avoid each year three hundred cases of premature death, more than 260 cases of chronic bronchitis, more than 7,000 asthma attacks and more than 18,000 cases of upper and lower respiratory symptoms by going to ZEV technology. These estimates are conservative because they do not include the health costs from indirect PM 2.5 emissions.
- Approximately 110 million tons of greenhouse gas per year could be avoided if all California vehicles were replaced with ZEVs in 2010, resulting in total greenhouse gas emissions of about 35 million tons/year from light-duty vehicles by 2030. (The 2050 goal is 30 million tons/year for cars and light duty trucks.) This level of greenhouse gas reduction would provide significant progress toward the state's 2050 greenhouse gas reduction goal. This finding assumes that the current and future electricity mix remains the same and California pursues a 33% Renewable Portfolio Standard by 2030.

Costs of Gasoline Motor Vehicle Use

- The total cost to public health and society of the existing motor vehicle fleet (fleet average) is more than \$10 billion in 2010. Even with expected reductions in emissions through fleet turnover, this cost only reduces to \$7 billion over the 20 year timeframe of the study.

- The health costs alone generated by the existing motor vehicle fleet (fleet average), in terms of hospitalizations, premature deaths and illnesses, add up to over \$7.4 billion per year (2010) including \$4.4 billion per year linked to one pollutant, nitrogen oxide (NOx). Even with expected reductions in emissions through fleet turnover, health costs would only fall to approximately \$4.4 billion per year in 2030 if California continues to use vehicle technologies similar to today.
- While the lowest emission gasoline technologies can get us significant reductions in GHG emissions in the near term, those reductions would level off by 2020 under current regulations as the vehicle population increases. California would need to adopt additional vehicle greenhouse gas reduction requirements such as an enhancement of the current AB 1493 (Pavley) clean car program to continue to achieve reductions.
- The total greenhouse gas (well-to-wheel) emissions from the existing motor vehicle fleet are estimated at 150 million tons per year and are projected reduce to 140 million tons per year in 2030 through existing programs and vehicle turnover, however this is far from the total reduction that is needed to meet California's greenhouse gas reduction goals.
- On an annual basis, the lowest emitting gasoline technologies (PZEVs) have a cost to society 6-8 times greater than ZEVs including the costs of both health and global warming impacts.

Health Impacts of Air Pollution from Motor Vehicles

California suffers from some of the worst air pollution in the nation and pollution from motor vehicles makes up the majority of the problem. In the American Lung Association's latest State Of The Air Report, nine California cities were on the list of worst polluted areas in the country along with 16 California counties. Major air pollutants caused primarily by cars and trucks are: ozone (produced in the atmosphere through a photochemical reaction of hydrocarbons and nitrogen oxides, both emitted from motor vehicles), nitrogen oxides, particulate matter (respirable, fine and ultra-fine particles), and carbon monoxide. Ozone pollution is worse during the hottest days of the summer, when high temperatures facilitate the chemical reaction that produces ozone. Additionally, the release of carbon dioxide and other greenhouse gases from automobiles contributes to global climate change and can exacerbate ozone pollution.

Health impacts from exposure to air pollution, depending on the type of pollutant, may include breathing difficulties, lung tissue irritation and damage, reduced lung function, lowered resistance to respiratory infections, exacerbation of cardiac and respiratory diseases including asthma, lung cancer and premature death. Research conducted as part of the CARB "Children's Health Study" in Southern California has found a significant lag in lung function growth in children living in highly polluted areas, and has for the first time linked high air pollution levels to the onset of asthma.

Numerous studies have linked fine particle pollution to a range of respiratory symptoms, elevated hospital admissions, emergency room visits, and premature death. A key study showed that prolonged exposure to fine particulate air pollution increases the risk of dying from lung cancer and cardiopulmonary causes, based on a study of 500,000 adults from more than 100 American cities. Emerging scientific studies have identified additional health concerns linked to the emission of "ultra-fine" particles from vehicles.

The health consequences of air pollution particularly impact sensitive populations, including persons with chronic heart and lung disease, emphysema and asthma, the elderly, infants and children. People who live in low-income communities suffering from multiple sources of pollution are also disproportionately impacted. Today there are nearly five million Californians who suffer from asthma, including half a million children, and for them exposure to air pollution can exacerbate their asthma and trigger asthma episodes.

In addition to creating a majority of the smog problem, mobile sources account for 40 percent of the global warming gases generated in California. The rising temperatures and weather conditions caused by global warming are expected to worsen air quality and public health by increasing the potential for ozone formation, especially in the highest polluted areas of the state, increasing air pollution emissions from sources such as power plants and fuel evaporation as well as increasing heat related illnesses. These effects will likely make it even more difficult for California to achieve and maintain air quality standards.

Conclusions

While the ZEV program has been viewed as solely a criteria pollutant strategy in the past, there are dramatic global warming benefits that can be achieved through converting vehicles from petroleum based fuels to zero emission and electric drive technologies including fuel cells and battery electric vehicles. Now that CARB is considering another set of regulatory changes to the ZEV Program, it is a critical time to recognize the important benefits to public health and society of zero emission technologies and to ensure this program is expanded and accelerated to fully support the state's goals for both cleaner air and global warming reduction.

Unfortunately, the CARB proposed changes to the ZEV program would substantially reduce requirements on auto companies. The staff proposal cuts gold numbers from 25,000 to 2,500 in the 2012-2014 timeframe, and also cuts the requirements for the 2014 – 2016 timeframe in half. These changes would result in a benefit to the auto companies of between \$.8 billion to \$1.3 billion annually from 2012-2017 (depending on the strategies pursued), or an average of \$1 billion per year. This totals \$6 billion in benefits to auto companies over the six year period. At the same time, as demonstrated by this study, California's continued reliance on gasoline vehicle technologies will cost more than \$18 billion to society in the year 2010 alone.

While California cannot rely completely on use of zero emission transportation technologies to meet greenhouse gas reduction goals, these technologies can make tremendous progress towards the 2050 targets. Given the pressing need of addressing both California's urgent air pollution problems and achieving greenhouse gas reductions, CARB should dramatically expand

the ZEV Program by requiring a substantial increase in “pure ZEV vehicles” by 2020 and establishing a goal of integrating electric drive technology in every new vehicle as soon as possible. A range of vehicle technologies can include electric drive such as conventional gas hybrids, plug-in hybrids, hydrogen fuel cells and battery electric vehicles.

Recommendations:

CARB should establish a bold new vision for the ZEV program and substantially ramp up requirements for production of ZEVs and integration of electric drive technology into the new vehicle fleet. California needs to ramp up the volumes of ZEVs quickly to capture the huge greenhouse gas reduction, air quality and public health benefits of getting these technologies on the streets. In addition, a rapid increase in volumes will assist in reducing costs of the technologies. In order to do this, CARB should consider the following strategies

1) CARB Should Restructure The ZEV Program To Integrate Goals Of Reducing Greenhouse Gases and Criteria Pollutants

While the ZEV Program has generally been viewed as a criteria pollutant program, the state’s far reaching greenhouse gas reduction targets call for CARB to integrate the ZEV program together with the state’s global warming reduction plan. The key criteria for the ZEV program should be the level of technology advancement and deployment needed to achieve air quality and public health goals as soon as possible and to achieve the state’s 2050 greenhouse gas reduction targets.

2) CARB Should Maintain Strong Pure ZEV Floor To Spur Technology Advancement

The board should develop a plan that includes a solid ramp to at least achieve the original 10% pure ZEV requirement by 2020. These numbers can be achieved, especially given the rapid recent advancement of battery technology and the staff’s proposal to allow more equal treatment of battery electric vehicles.

3) CARB Should Establish Aggressive Goals For Fleet-wide Introduction Of Electric Drive Technologies

The more electric drive technology in use in California, the greater the benefits to California and society. In addition to the technology push provided by “pure ZEV” requirements, CARB should establish aggressive new goals across the vehicle fleet for reducing greenhouse gas emissions from passenger vehicles, including targets for integration of electric drive technology in 100 percent of the new passenger car fleet by the end of the next decade.

4) CARB Should Link ZEV Program and Fueling Infrastructure Requirements

The ZEV program must be supported by adequate fueling infrastructure for hydrogen fuel cell vehicles and electric and plug-in hybrid-electric vehicles. To accomplish this, the Board should establish requirements for ZEV fueling infrastructure within the Low Carbon Fuel Standard or direct staff to revise the Clean Fuels Outlet regulation to require availability of fuel for zero emission vehicles.

TIAX is a five year-old privately held company formerly operating as the century-old Arthur D. Little Technology & Innovation business. The foundation of TIAX's California operations is a group formerly known as Acurex Environmental, which has provided consulting work to California's alternative fuels and environmental stakeholders since the 1970s. Over the last 30 years, the Acurex Environmental group has successfully completed hundreds of projects specializing in deployment and assessment of non-petroleum fuels, emission reduction strategies, and advanced transportation technologies for a wide variety of government and private-sector clients, including the California Energy Commission (CEC).

The American Lung Association in California thanks the Energy Foundation for their financial assistance in the development of this report.