## South Coast Air Quality Management District 21865 Copley Drive Diamond Bar, CA 91765

## Controlling Global Warming and Local Air Pollution– Identifying Synergies, Conflicts, and Priorities Technology Forum/Roundtable (Held on June 28, 2007)

## Forum Summary and Report

#### Introduction

California's landmark global warming legislation, AB32, requires that the state's greenhouse gas emissions be reduced to 1990 levels by 2020, with significant additional reductions by 2050. South Coast Air Quality Management District (SCAQMD) hosted this forum to explore the impact of greenhouse gas reduction strategies on criteria and toxic pollutants. Efforts need to be prioritized to maximize synergies and avoid negative impacts. SCAQMD staff moderated the forum and discussed their own efforts in achieving reductions through control measures from the 2007 Air Quality Management Plan (AQMP).

Participants of the forum included Chung Liu, Elaine Chang, Henry Hogo and Jill Whynot of the SCAQMD and the following panel members:

- 1) Bart Croes, California Air Resources Board (CARB)
- 2) V. John White, Center for Energy Efficiency and Renewable Technologies (CEERT)
- 3) Mark Jacobson, Stanford University
- 4) Patricia Monahan, Union of Concerned Scientists
- 5) Curtis Moore, Consultant and Author

Bart Croes, from CARB, discussed background information on the impact of climate change in California, emphasizing the significant changes that have occurred in the past 100 years and the need for additional greenhouse gas reductions to avoid the most harmful global warming outcomes.

V. John White, from CEERT, spoke on clean energy technologies and California's access to world class renewable resources in geothermal, solar, and wind energy, and the critical need to start building this renewable energy infrastructure immediately.

Mark Jacobson, from Stanford University, analyzed the effects of different alternative fuels such as E85, cellulosic ethanol, and the associated negative health impacts and increases in  $CO_2$  and ozone, advocating the greater use of renewable energy sources.

Patricia Monahan, from Union of Concerned Scientists, spoke on the need to consider a full fuel cycle approach that considers upstream and downstream emission impacts to implement more beneficial transportation policies for cleaner vehicles and smarter cities, including the use of clean fuels, clean cars and trucks, and smart growth.

Curtis Moore, consultant and author, reiterated the need for immediate and more dramatic action, contending that industry has used government as a shield from engaging in more technical innovation in energy technologies. He promoted the idea of incremental as opposed to significant change.

After their presentations, speakers further discussed these issues in a panel discussion, followed by comments from the public.

### **Summary of Presentations**

**Jill Whynot**, from SCAQMD, framed the issues for the day. AB32 sets a large mandate on establishing greenhouse gas reductions. Ideally, California can accelerate and promote strategies that will also achieve reductions in criteria and toxic pollutants. At this critical juncture, California needs to play a leadership role. In order to meet the 2020 and 2050 reduction goals, California will need to move beyond conventional technologies and into the realm of modifying consumer behavior, changes in agricultural and forest management, new mass transit strategies and cleaner vehicles. Ideally, California can accelerate and promote strategies that will also achieve greater reductions in criteria and toxic pollutants. A key priority is additional efforts in the reductions of greenhouse gases, but SCAQMD wants to ensure that reductions in greenhouse gases do not compromise reductions in criteria and toxic pollutants.

**Henry Hogo,** from SCAQMD, discussed the 2007 AQMP mobile source measures. The 2007 AQMP control strategy includes SCAQMD stationary and mobile source control measures, suggested state and federal control measures for marine vessels and railroad locomotives including CARB Statewide Strategy, SCAQMD proposed additional state and federal measures, Southern California Association of Governments (SCAG) transportation control measures from their Regional Transportation Plan, and long term strategy control measures.

SCAQMD stationary and mobile source control measures include facility modernization; energy efficiency and conservation; good management practices; market incentives and compliance flexibility; area source programs; emission growth management; and mobile source programs.

The CARB Statewide Strategy includes smog check enhancements; heavy-duty truck fleet modernization; goods movement; off-road equipment; personal water craft; off-road recreational vehicles; consumer products; and evaporative emissions from fuel tanks and hoses.

SCAQMD proposed additional state and federal measures consist of a more aggressive implementation schedule and reduction targets; accelerated fleet modernization; greater penetration of clean engine technologies; and greater use of cleaner fuels.

Some of these control measures also have potential concurrent reductions of greenhouse gases through the accelerated penetration of advanced technology partial zero-emission vehicles; shore-side power of marine vessels; electrification of airport ground support equipment; replacement of wood burning fireplaces; truck fleet modernization to LNG; accelerated retirement of older high-emitting vehicles and off-road equipment; gasoline and diesel fuel reformulation; diesel fuel alternatives; and ocean-going vessel speed reductions. Activities such as facility modernization; enhanced energy efficiency programs; good management practices; emissions growth management; advanced zero-emission transportation systems; and regional transportation control measures could also result in potential reductions of greenhouse gases.

## **Comments and Questions**

A school district representative stated that economic analysis is needed regarding alternative fueled fleet vehicles. Decreasing transport speeds results in decreased efficiency.

A Los Angeles County Sanitation representative asked for SCAQMD staff's help with considering energy efficiency in setting Best Available Control Technology (BACT).

A consultant mentioned that fuel switching may have resulted in increased greenhouse gas emissions. She wanted to know how SCAQMD viewed the implication that fuel switching may increase greenhouse gas emissions. Elaine Chang, from SCAQMD, responded by saying that these issues are currently under discussion.

**Bart Croes,** from CARB, spoke on the impacts of climate change on California. There is a growing body of evidence that we live in a particularly vulnerable ecosystem. In the past 100 years, global temperatures have risen by 1.3 degrees F, there has been a 7 inch sea level rise, 12 percent decrease in the fraction of runoff between April and July, snowmelt and spring blooms advancing by 2 days per decade since 1955, and a four-fold increase in wildfire frequency in the past 34 years. The Lyell Glacier in Yosemite National Park is an example of the effect of global warming. He also mentioned that in a peerreviewed panel report requested by Governor Schwarzenegger titled *California Climate Change Scenarios Assessment*, potential climate change impacts were analyzed. This report provided key scientific input to California's landmark greenhouse gas reduction legislation, AB32. This peer-reviewed report will also be published later this year in the journal *Climactic Change*.

Projected climate impacts on California between 2070-2099 indicate three possible ranges of consequences from global warming based on a lower warming range of 3-5.5 degrees Fahrenheit, a medium warming range of 5.5-8 degrees Fahrenheit, and a higher warming range of 8-10.5 degrees Fahrenheit. The higher warming range level of impacts assumes a business as usual approach, with no change in greenhouse gas reductions. The higher level of impacts would result in 3-4 times as many heat wave days, 22-30 inches of sea level rise, 90 percent loss in the Sierra Mountain snow pack, and a 20 percent increase in energy demand. If the developing world meets Governor Schwarzenegger's target of greenhouse gas reductions by the year 2050, then this would result in the lower level of impacts. However, even the lower level of impacts would involve 2-2.5 times as many heat wave days, 6-14 inches of sea level rise, 30-60 percent loss in the Sierra Mountain snow pack, 7-14 percent decrease in pine forest yields, 10-35 percent increased risk of large forest fires, and a 3-6 percent increase in energy demand. There would be a sizeable decrease in the snow pack in the Sierra Nevada. At the lower warming range, almost 60 percent of the snow pack would remain, while at the higher warming range, only approximately 20 percent of the snow pack would remain.

Greenhouse gases and global warming have important implications for air quality, particularly in the San Joaquin Valley and the South Coast Air Basin. There is a strong correlation between ozone and temperature. Looking at data from Riverside and Fresno from 2003-2005 indicates that increasing temperature also increases the chemical reactions forming ozone. As a result, climate change will make attainment of the ozone standards more difficult and likely result in increased control costs. The relationship between temperature and PM<sub>2.5</sub> is not as clear, but preliminary results indicate that an increase in temperature of five degrees Celsius results in an increase of PM<sub>2.5</sub> of 30 ppb. Historical levels of background ozone indicate an increase in background ozone of 70 ppb. Looking at non-Kyoto Protocol climate forcers in California, scientific evidence is still emerging, so only broad ranges of climate impacts can be determined.

California is already affected by climate change and future warming threatens public health, water supply, and agriculture. Impacts on background ozone, ozone chemistry, and meteorology all indicate that the ozone standard will be more difficult to attain with climate change. However, the overall impact of climate change on  $PM_{2.5}$  and  $PM_{10}$  is unclear. Research also indicates that diesel PM reductions would clearly be beneficial for air quality control.

## **Comments and Questions**

Curtis Moore mentioned that if attention was given to shorter lived greenhouse gases, the impacts of reductions would be significant. When global warming potentials are expressed as 100 years, it masks the benefits of reducing compounds with shorter lives that have significant negative impacts.

**V. John White,** from CEERT, spoke on clean energy technologies and the California Global Warming Solutions Act of 2006. California needs to consider near term reductions, such as diesel retrofits for trucks in the ports, and the state legislature needs to consider how to best spend the one billion in bond funding available for goods movement measures. This would include retrofitting all of the post 1994 port trucks in the next three years and retrofits for construction off-road equipment. The challenge will be how to get greenhouse gases to 1990 levels by the year 2020, given the fact the electricity sector is the fastest growing industrial sector in California.

Fossil fuels cause 70 percent of California's greenhouse gas emissions and California's electricity supply will need to increasingly come from sun, wind, and geothermal technologies. Investing in renewable energy resources will help minimize fossil fuel consumption. We need to find improved energy storage technologies and take advantage of California's world class resources in the renewable energy sector. California needs to develop non-fossil fuel resources quickly and to have renewable energy generation become a major part of future fuel acquisition, requiring substantial new infrastructure. To eliminate the use of coal and keep gas usage constant requires three times the amount of renewable energy sources. Estimated new generation capacity for geothermal, wind, and solar energy is 2,400 MW, 10,000 MW, and 11,000 MW, respectively. This will require 6,500 1.5 MW wind turbines, 110 square miles of solar collectors, and 16 high voltage transmission lines plus a collection system to be developed.

The lack of integration between private and public utilities is problematic in building the necessary transmission network to create new renewable energy generation capacity. Examples of renewable energy generation sources already in operation include the Solar Two Power Tower in Barstow, California; the one MW Arizona Trough Plant; the 64 MW Solargenix Solar Electric Plant in Boulder City, Nevada; wind turbines in Riverside County; and parabolic trough, flat plate, and evacuated tube collectors used for advanced solar thermal generation. The Solar Two Power Tower pioneers energy storage technology using molten salt, storing energy during the day and negating the need for gas transmission of electricity during the night. Wind turbines produce energy at slower speeds and there is increasing awareness of the need for sufficient preconstruction monitoring to understand and minimize the impacts on avian species. Solar collectors are relatively simple technologies that require good manufacturing expertise. Advanced solar thermal generation is widely used in Europe but not the United States for the past 20 years, using hot water to heat and cool buildings, displacing the use of gas and electricity. Stationary fuel cells are ready to go but are more expensive than traditional technology using high efficiency fossil fuel use. However, they have zero emissions and can run all of the time.

The benefits of renewable energy technologies go far beyond the electricity produced. The value of fuel cell use in California ranges from 5.8 - 15.8 cents per kWh. Much of this is due to the value of health benefits, avoided generation fuel costs, avoided generation capacity capital costs, value of fossil fuel price hedging, and the value of avoided generation capacity fixed operation and maintenance costs. Air quality agencies typically focus on individual permits but need to become more flexible in formulating policies that encourage renewable energy generation.

## **Comments and Questions**

V. John White was asked how the health benefits in his last slide were calculated. The data was from Dr. Lori Shell at UC Irvine. A recent European Union energy externality analysis has also been done to look at the full life cycle.

A Sierra Club member discussed a recent Los Angeles Times article on an Oxnard peaker plant. The Coastal Commission has ordered 250 MW of power by this summer. He asked why peaker plants are needed. V. John White responded by saying that peakers are used for on-and-off- power needs, for peak needs, not base loads. It is necessary to green the peak, integrate resource planning, and dispatch based on environmental concerns.

Curtis Moore commented that these types of facilities are being put in as dealing with seasonal needs, but it is a camel's nose under the tent situation. These units could become base load plants in the future. Start up and shut downs have NOx and PM emissions that are not analyzed by SCAQMD. If fossil fuel is permitted in the district, it should be combined cycle cogeneration. Mark Jacobson stated that there are three ways to help the energy situation: renewable energy; back up power such as hydro electric; and vehicle to grid.

**Mark Jacobson,** from Stanford University, spoke on comparative effects of vehicle fuels/technologies on air pollution and climate. Global warming is mostly associated with greenhouse gas formations and to a lesser extent on fossil fuel soot particles and urban heat island effects. Research indicates that  $CO_2$  clearly has a causal effect on mortality. An increase in water vapor or temperature results in increases of ozone in urban areas but causes little ozone change in rural areas.

Global-regional nested simulation models indicate that  $CO_2$  alone increases temperature, water vapor, ozone, and PM. Mark Jacobson estimates that in the United States this results annually in 500 ozone related deaths per 1K increase in temperature, 640 PM2.5 deaths, and 1,140 deaths in total. Globally, there are a total of 24,000 deaths annually from  $CO_2$ , and 1 to 2 million deaths per year from air pollution. Air pollution is a significant problem already and climate change only exacerbates it. One example is the usage of ethanol (E85) as an alternative to gasoline. Recent CARB and other research studies indicate E85 results in significant changes in NOx and hydrocarbons. E85 increases non methane hydrocarbons, an ozone precursor 19.6 - 45 percent, decreases NOx by 29.7 - 30 percent, and increases acetaldehyde by 2,000 to 4,500 percent. E85 also results in large decreases in benzene (64 - 79 percent), 1,3-butadiene (10 - 66 percent), but increases in formaldehyde (60 - 200 percent). Mark Jacobson showed maps illustrating some of these impacts spatially.

Research also indicates that complete conversion from gasoline to E85 may cause an equal or greater number of deaths than gasoline related to ozone, including 0-120 additional ozone related deaths per year, 0-650 additional hospitalizations from respiratory illnesses, 0-770 additional emergency room visits from asthma, and -3.5 to 0.3 cancer deaths in Los Angeles alone. For the United States, complete conversion to E85 may cause an increase of 0-185 ozone related deaths annually, 0-990 additional hospitalizations, 0-1,200 additional emergency room visits, and 3 to -29 cancer deaths compared to gasoline. As a basis of comparison, annual deaths from on-road vehicle emissions in the United States are 10,000 for gas/diesel, up to 10,200 for corn ethanol, and up to 10,200 from cellulosic ethanol. The percentage of total anthropogenic carbon dioxide reductions in the United States (assuming land constraints) resulting from the replacement of 30 percent of vehicles from gasoline may be 0.62 percent for corn ethanol, 13.6 percent for cellulosic ethanol theoretically, but 1.3-4 percent practically due to land-use constraints, 25.5 percent for batteries or hydrogen fuel cells using wind power, and 23.5 percent for solar batteries. Converting all gasoline vehicles in the United States from gas to E85 would not resolve health effects associated with air pollution, possibly increasing deaths by 0-200 deaths per year.

Professor Jacobson presented a map illustrating the amount of land needed to power 100 percent of United States on-road vehicles. Information on the number of 5 MW wind turbines needed to displace 100 percent of the  $CO_2$  emissions in the United States was provided. One path to satisfy all energy needs in the United States and reduce  $CO_2$  by 80 percent would be a mix of existing fossil and biofuels and renewable energy sources: onshore and offshore wind 50 percent, existing fossil and biofuels 20 percent, solar PV and thermal 15 percent, greater efficiency 10 percent, hydroelectric geothermal wave, tidal, and existing nuclear 5 percent. There is a significant source of untapped wind power with average 80 m/s wind speeds in North America. The percentage of land and near shore stations with annual wind speeds

greater than 6.9 m/s is second highest in North America, next to Oceania. The fast winds in Northern California could facilitate significant offshore wind development and aggregate wind farms could help smooth out the power supply. A 2,645 MW capacity wind farm, such as the one in the Eureka Wind Park could produce 8.2 percent of California's carbon based electricity. While there are environmental impacts to avian species associated with wind farms, these are minor compared to the number of avian deaths from other sources: 10,000 - 40,000 per year from wind turbines vs. 50 million per year from communication towers. Maps were shown to provide a sense of the land area needed for providing wind power, and where California has the capability suitable for off shore wind development. Mark Jacobson concluded his presentation by stating the following key points:

- Global warming will hasten as aerosol pollution decreases. CO<sub>2</sub> increases air pollution mortality due to its effect on temperature, water, vapor, and atmospheric stability, which increase ozone and particulate matter in urban areas.
- 80 percent reduction in current emissions are needed to stabilize CO<sub>2</sub>. Corn ethanol cannot practically reduce CO<sub>2</sub> in the United States by more than 0.07 0.2 percent; cellulosic ethanol cannot reduce CO<sub>2</sub> by more than 1.3 4 percent, based on current understanding.
- Wind-battery electric vehicles can reduce United States CO<sub>2</sub> by 25.5 percent; solar-battery electric vehicles can reduce it by 23.4 percent. Wind turbines require 30 times less land than corn ethanol and 20 times less land than cellulosic ethanol for the same power.
- Sufficient wind and solar are available worldwide to supply all electric and non-electric energy needs simultaneously several times over.
- Converting all United States gasoline vehicles to ethanol (E85) vehicles will not improve air quality. At 100 percent penetration, it may enhance air pollution mortality from 0 to 200 per year deaths above the 10,000 per year due to gasoline in 2020. At 10-30 percent penetration, deaths may still be 0 to 20-60 per year above 10,000 per year.
- The long lifetime of unburned ethanol may result in a global source of acetaldehyde and ozone.
- Each ethanol or gasoline vehicle developed from now on will enhance air pollution and climate problems significantly compared with each renewable-powered battery-electric or hydrogen fuel cell vehicle produced.

## **Comments and Questions**

A representative from the Sierra Club stated that there are dangers to wind turbines on land and therefore there must be bigger danger for off-shore wind turbines. Dr. Chung Liu asked Dr. Jacobson if he had a preference for the Governor's low carbon fuel standard for renewables or electricity. Dr. Jacobson commented that his preference for the Governor's low carbon fuel standard is electricity.

**Patricia Monahan,** from Union of Concerned Scientists, spoke about win/win transportation policies. Ms. Monahan stated that full fuel cycle accounting allows for broader options for deriving fuel by considering the impacts of production, processing, product storage, bulk fuel transportation, bulk storage, transportation and distribution, and vehicles. A transportation emissions profile considers fuel, emissions in the fuel, vehicle miles driven, and vehicle efficiency. Today's transport has congestion and long commutes with single passenger trips. It is dependent on petroleum, highly polluting, and poorly planned. Shifting to sustainable transport results in co-benefits beyond clean air. Sustainable transport is fast and efficient, uses clean and renewable fuels, is low-polluting, mode shifting, and incorporates smart growth principles. The three main factors to consider in the full fuel cycle are the type of fuel used

(including full life cycle emissions per gallon), vehicle efficiency (miles per gallon), and miles traveled per year.

Transportation policies have the potential for significant co-benefits resulting in cleaner vehicles and smarter cities. Such beneficial transportation policies include the use of clean fuels with a low carbon fuel standard; clean cars using a fee-based clean car discount; clean trucks with electrification, anti-idling devices, fuel switching, "smartway" retrofits; and smart growth.

Cleaner fuels using a low carbon fuel standard would be consistent with the Governor's January 2007 Executive Order for at least a 10 percent reduction per gallon in greenhouse gases by 2020. A low carbon fuel standard protects against high greenhouse gas fuels such as liquid coal, and promotes low greenhouse gas fuels such as electricity, hydrogen, and cellulosic ethanol. Looking at greenhouse gases from a full fuel cycle perspective by considering emissions upstream in the fuel production indicates that conventional gasoline produces the greatest amount of greenhouse gases in tailpipe and upstream emissions at over 400 grams per mile, while electric vehicles produce slightly more than 100 grams per mile. Corn ethanol and cellulosic ethanol produce around 300 grams per mile of greenhouse gases. This is based on results from the GREET model developed by Argon Laboratories. On the other hand, corn ethanol produces 2 grams per mile of criteria pollutants (VOC, NOx, and PM10) while conventional gasoline produces up to 0.5 grams per mile and cellulosic ethanol produces approximately 0.75 grams per mile of criteria pollutants.

There is some uncertainty in the results produced from full fuel cycle models on the impact on greenhouse gases depending on whether a GREET or LEM model is used, particularly for biodiesel fuel derived from soybeans. Investigating the true impacts of cleaner fuels on the environment requires the development of sustainability criteria and additional breakthroughs in advanced fuels such as cellulosic ethanol. The use of low-blend ethanol, biodiesel or E85 could add some air quality concerns. The availability of cleaner fuels requires the appropriate investment in advanced fuel technology by driving more investment into this sector; conducting more research on upstream emissions and carbon accounting; sustainability criteria for protecting the environment and food resources; and no backsliding on air quality standards.

There are several ways to achieve air quality and greenhouse gas benefits. The use of anti-idling devices; electrification of ports, truck stops, airports, and refrigeration units; and medium-duty delivery truck hybridization could result in 30-50 percent greenhouse gas reductions. Additionally, "smartway" retrofits would improve fuel economy and soot reduction through low resistance tires, aerodynamic panels, weight reduction, auxiliary power, and particulate filters. These technologies reduce NOx and are available today. AB493 proposes a Clean Car Discount with rebates for new clean car purchases and fees for cars with higher greenhouse gas emissions. Smart growth policies could result in a win-win situation by the appropriate expenditure of bonds for transportation infrastructure on smart growth policies. Cleaner fuels, cleaner trucks and cars, and smart growth, can provide benefits in many areas.

#### **Comments and Questions**

There were no questions for this presenter.

**Curtis Moore**, consultant and author, stated that incremental change can result in huge changes at the tipping point. New innovation replaces old technology. Mr. Moore presented information on global warming pollutant lifetimes. Almost every pollutant, except sulfur, has warming climate effects. These greenhouse gases mainly involve six pollutants, that consist of well mixed gases with the same content worldwide. The pollutant with the shortest life span is methane (twelve years) while the other pollutants have much longer life spans ranging from 50 - 50,000 years.

Persuasive evidence exists that there are critical tipping points regarding greenhouse gases and global warming. The Arctic is melting twice as fast as predicted. In Siberia, an area the size of Germany and

France has melted for the first time in 12,000 years. Areas of thawing release greenhouse gases. There are three times the levels of background ozone than in the last century. Methane and  $CO_2$  from the tundra are increasingly entering the atmosphere. The coal, oil, electric, and vehicle manufacturing industries have insulated themselves from competitive solutions with the aid of government. Power plants and vehicles employ basically the same technology as they did 100 years ago. Governments have sheltered industry in this endeavor by having policies that don't sufficiently encourage greenhouse gas reductions, such as single pollutant regulations and emissions inventory trading policies.

Technology exists now to completely eliminate air pollution. For example, Volvo developed the LCP 2000 in the mid-1980's that got 65 mpg. There are only two versions of this automobile that currently exist. In 1989, Toyota developed the AXY vehicle that got 100 mpg. They could have mass produced this model within five years, but decided not to because of the lack of profitability. The EV-1 vehicle produced zero pollution but is no longer in production.

Two decades ago, Mr. Moore visited a facility in Germany that used solar energy to power photovoltaic cells. This gives you an idea of how doable this is. You can switch fuel or increase efficiency; by increasing your efficiency from 30 to 60 percent you cut your pollution in half. There is a power plant in Stockholm that has been operating since 1991 that burns coal and operates at 92 percent efficiency, which operates downtown so that the waste heat produced by the plant is utilized. Disneyworld in Florida is heated and cooled by the waste from combined cycle turbines. The successor to the typical power plant operates at 52 percent efficiency in Tokyo. Another example is a power plant using parabolic troughs and wind turbines. There is plenty of room in this country for wind turbines and solar energy. The Germans, Swedes, and Japanese have solar photovoltaics set up to generate electricity with mini shacks to test various converter devices from competing manufacturers. There is a very remote island called Tarawa that has two sea level stations indicating significant increases in seawater levels, which has happened in the space of 70 years.

A letter signed by a number of notable scientists calling for early domestic action to reduce United States emissions of greenhouse gases dated June 1977 was shown. Mr. Moore questions why global warming is happening and why are we not making progress. Why has industry managed to insulate themselves from competitive disruptions? One way to reduce global air pollution 15-20 percent in the next two years is by making ships at sea stop burning bunker fuel.

## **Comments and Questions**

There were no questions for this presenter.

## **Panel Discussion**

Jill Whynot moderated the panel discussion. Panel members were given the opportunity to ask questions of other speakers regarding material they had presented, and to expand on the discussion.

#### Panel members asked Mark Jacobson to expand on how his E85 modeling compares with the work of other researchers.

Mark Jacobson stated that emission changes are based on several studies, but what is going to happen in the year 2020 is difficult to predict. 2020 estimates are based on the Argon Lab and CARB studies, which used current emission percentage differences from studies in 2007 and older vehicles, and then applied them to the 2020 emissions inventory. He mentioned that there are uncertainties in estimating emissions for health effects now or in the future.

V. John White commented that the strength of conclusions and credentials of the researchers gets people thinking about ethanol fueled vehicles. This is a very important topic. Mark Jacobson replied that most critics in the renewable fuels industry and environmental groups have supported E85 in comparison to

low blends. Whether considering E85 or low blends, there are important issues to be aware of. Sometimes fuel alternatives have problems that are not recognized until years later.

Bart Croes stated that flexible fuel vehicles need to meet the same emissions standards as other vehicles. CARB has initiated a study to verify emissions according to California standards. When E85 vehicles are proposed as alternatives, they are regulated according to tailpipe emissions. Ozone increases were largely driven by NOx decreases. It is important to put E85 work in context with the SIP.

Henry Hogo looked at low blends in the context of the SIP, so looking at them in the context of E85 would be the next logical step. SCAQMD will continue to do modeling to see the impacts of E85. Elaine Chang added that an aggressive NOx-heavy-strategy would have a slight increase in ozone but a much bigger downwind benefit. She would not want to raise NOx just because of E85. V. John White said he did not recommend being cautious about encouraging NOx reductions. The San Joaquin Valley has different interactions compared to SCAQMD. Mark Jacobson responded that NOx decreases are primarily driving ozone. In the future, there are many things that can be done. The focus should not be on E85. V. John White replied that NOx reductions can help with respect to many other pollutants. A way to ensure E85 doesn't have negative air quality impacts is to give a sense of the parameters of what to look at and to investigate the emission reductions of prospective new vehicles.

# Patricia Monahan asked if LEV2 standards are sufficient and said that we need to struggle in the next five to ten years to go beyond current standards.

Mark Jacobson stated that we could be meeting the standards but still causing health problems. We should tighten the standards so they better reflect health impacts. Curtis Moore gave the analogy that this is like rearranging the deck chairs on the Titanic. We do not have 10 years to solve this problem. E85 is a ruse on the part of GM not to do more. Low carbon or CAFÉ standards are not fuel neutral. Implicit in the standards is the continued use of petroleum. We could express greenhouse gas impacts in the next 100 day time frame and would see the immediate impacts of the problem. We can produce vehicles and produce electricity with zero pollution with current technology. Every emissions trading program or single pollutant regulation has been a catastrophic failure. Curtis Moore said his statements are driven by science.

### Jill Whynot asked for clarification from Curtis Moore. Is he is saying; that we have the tools today, but not the economic or political will? Is he recommending that we focus on short lived compounds? Panel members were asked for their input.

Curtis Moore said we must focus on  $CO_2$ . The only way to get a handle on global warming is with short lived compounds and simultaneous reductions on multiple pollutants. CARB talks about averages, but specifics are extremely important. Short lived pollutants have much bigger impacts in the Arctic. V. John White concurred that revisiting short term measures is being done because of the dissatisfactions express by many. A multi pollutant strategy and particulate diesel reductions are needed. Curtis Moore stated that we cannot solve the problem one pollutant at a time. V. John White said that there is one billion dollars in Sacramento to spend on goods movement measures, and retrofitting diesel trucks should be a focus. Curtis Moore did not believe this should be the solution to global warming.

V. John White feels we need to create a sense of hope and possibility, and we need to apply a sense of urgency on specific tasks. CARB is revisiting early action measures and the number one priority should be reduction of diesel particulate matter. The construction industry has delayed work on a CARB rule, which needs to be completed. Attention should be given to the ports and appropriate use of bond money to reduce emissions from trucks and ships.

Curtis Moore stated that the problem is not the lack of solutions but that people have been driven by industry to make tiny incremental changes. A tax should be added to all emitters with rebates for non-or

low emitting vehicles and equipment. Curtis Moore is very disappointed in the lack of progress and is not optimistic that global warming problems will be corrected.

Mark Jacobson thinks wind is the answer to reduce 90 percent of dirtier energy production. More solar and other existing technologies should be used, as well. The next step is an RFP for a new wind farm in reducing  $CO_2$  emissions. Other states have approved proposals for wind energy, and now seems the time for California to move forward. We can clean up California's pollution with offshore wind.

V. John White said the first place for wind technology is in Tehachapi, a world class wind resource with 4,000 - 6,000 MW of available resources. Both utilities testified against being required to meet 33 percent renewable energy resources. We can retrofit trucks, clean fuel systems, and provide renewables at the same time.

Elaine Chang articulated that the Clean Air Act gives urgency to meet  $PM_{2.5}$  standards by 2014 and 2020. We need immediate action and need to look at criteria pollutants and global warming together, as the same technologies can help address both.

V. John White added that the criticism of trading regimes is having to make people rich to get them to do the right thing. Technology forcing standards are the reason we have done as much as we have done today.

Patricia Monahan stated that she has seen profound changes in the past 20 years. The passage of AB32 was phenomenal and we are on the cusp of dramatic changes, and more change than we've seen in a long time. ZEV standards still have stimulated the hybrid market and fuel cells have also increased.

Bart Croes said that methane is a fairly short-lived greenhouse gas compound and it contributes to ozone formation. It is a part of AB32 and part of the upcoming regulations in 2009.  $CO_2$  and NOx are being greatly controlled by the local air districts. There have been dramatic reductions already in California-black carbon has gone down and there is a new 90 percent control regulation for new trucks.

# Bart Croes asked why the comments were made that CARB work on diesel PM and other programs are not enough?

Curtis Moore replied that methane, along with three early actions are all that is being done. Bart Croes responded that there are several pending actions. Curtis Moore stated that Europe is banning 134 and asked what California is doing. Bart Croes replied that credits are given for reductions for 134, but there has not been a ban. Curtis Moore asked several questions intended to highlight that more needs to be done including: How many methane capture facilities are there in California, how many landfills have methane capture equipment, and how many sewage treatment facilities do not have methane capture equipment.

V. John White stated that all of us have to find a way to pick up the pace in ways we are not used to. Collectively, our society and leadership has to get with the new program and reach beyond our traditional approaches.

Henry Hogo added that many things done at SCAQMD are partly out of global warming considerations. We can take it one step further to make it consistent with reducing air pollution and greenhouse gases. The Board has asked us to put some of the Priority Reserve funds into solar and renewable energy.

Bart Croes said that the challenge facing us is pretty enormous and there is a huge public health crisis. It is similar to where we were 40 years ago with the air pollution challenge. In the past, every other day there was a Stage one smog alert. We've achieved quite a bit. The cost is less than 0.1 percent of the Gross State Product. It took a long time to get to this point. To achieve 80 percent reductions in

greenhouse gases, if people let CARB do complete technical and economic feasibility studies, we should achieve similar success with greenhouse gases.

Elaine Chang expressed appreciation for the information shared today by the panel members. Greenhouse gases should be treated the same as other pollutants. There should be mandatory regulations to bring in greenhouse gases as part of a comprehensive plan. This would be a great planning and technical tool we can all benefit from. She recommended an open public process and that we need to push technology and creative thinking.

Mark Jacobson added that there are lower peak levels of air pollution, but pollution has spread over a larger area because of urban sprawl. There is no quantitative analysis of this, but we are still above the health standards. One major solution is the large scale use of renewables. If you have the electric grid ready, then when applications come around they can be incorporated. We need to think ahead and not incrementally.

Curtis Moore thinks it can be done in a couple of years. Pushing technical demand is what is necessary to protect people and the environment. The job of Congress is to determine what is necessary to protect people and not to let industry define what is technically and economically feasible and to shield themselves from real innovation. Baby steps kill innovation. It can be done and it's not a big deal. If California is not going to take the lead, who is?

#### **Public Comments**

A representative from the Climate Protection Campaign stated that his organization performed a greenhouse gas inventory for the cities of Sonoma County, and developed a list of model ordinances and framework. The idea was to adopt a strategic plan for greenhouse gas targets. For the SCAQMD, this could be done in partnership with SCAQMD, SCAG, and the various cities and counties.

A consultant from Hydrogen Ventures said that new power in California should be combined cycle. In response to a question from Curtis Moore, he recommended swapping these to replace old dirty units.

V. John White mentioned that we need to look at off peak demand and ways to channel energy to satisfy peak demand. For example, off peak excess could be converted to hydrogen and stored.

Mark Jacobson stated one possibility is wind power. It is less expensive to use onshore wind at 3-4 cents per Kwh while offshore wind is 6-7 cents per Kwh. However offshore wind speeds are much higher.

A representative from the Sierra Club asked about the aesthetics and relative costs of construction for land and offshore wind generation. Mark Jacobson responded that there were advantages and disadvantages with each.

A comment was made about the amount of gases released in geothermal power. Mark Jacobson said there is a small amount of  $CO_2$  released in geothermal power. Curtis Moore added that the ocean related energy source is ocean thermal energy conversion where the temperature difference in the water is exploited. Geothermal may have methane emissions and such industrial facilities should be carefully sited like any other facility.

V. John White said that hydrogen sulfide is more of an issue with geothermal energy, but can be easily controlled. He summarized that every renewable energy source has disadvantages but we still need to get them built, and we need to require a more aggressive building process with dramatic publicity and dramatic action and leadership. We also need to move forward and take action on diesel sources by requiring clean construction and considering where bond money should be spent. There is lots of work to do and we are looking forward to seeing some results.

## **Closing Remarks**

Jill Whynot thanked the panel members for an excellent job and adjourned the forum.