June 26, 2014 A&WMA's Sustainable Transportation Session AM

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(1789 – 26 = 1763 words, 3 minutes)

Good morning.

I have 20 handouts. I would be happy to email you all the slides, my notes, and my report.

[Slide 1] *The Development of California Light-Duty Vehicle (LDV) Requirements to Support Climate Stabilization: Fleet Emission Rates and Per-Capita Driving*. I am a systems guy. I know that almost any problem can be solved with a good set of system requirements. I start by trying to grasp the nature of the problem.

[2] Here's the cause: We have a climate crisis because atmospheric CO2 traps heat ***and*** we are adding ***great quantities*** of CO2 to our atmosphere.

[3] I have 3 sources regarding how bad it could get. One says, [quote] "the Earth is on a trajectory to warm by more than 4 degrees Celsius [and this] would be ***incompatible with continued human survival***" [end quote].

[4] This is the California Governor's Executive Order S-3-05, in million-metric tons per year. "***S-3-05***", is based on the reductions the climate scientists told us, in 2005, the industrialized world would need to achieve. It's similar to the Kyoto Accords. Its targets are 2000 levels by 2010, 1990 levels by 2020, and 80% below that, by 2050. The plan would have capped atmospheric CO2 at 450 parts per million by 2050.

[5] This is the world-famous Keeling Curve of atmospheric CO2 over the last 50 years.

[6] This shows global average atmospheric temperature, in blue, and CO2, in red, over the last thousand years. It shows what our industrial revolution has done, with the steep run up in CO2, starting in the 1800's. The S-3-05 planned cap level is indicated off the chart. Capping the "C" "O" "Two" means the steep slope would be reduced to zero, by 2050. The world's current level is shown.

[7] This is the plot from Vice President Gore's ***Inconvenient Truth***, with 3 added notes. The temperature anomaly scale is on the left; the Atmospheric CO2 scale is on the right. The plotted ***blue*** line is atmospheric CO2, from ice-core samples. The plotted ***red*** line is average atmospheric temperature, where the average is over the year and over the planet, derived using measurements of isotopes. The data starts 800,000 years ago. Our species is 200,000 years old. 400 parts per million is shown, as is S-3-05's goal of 450 parts per million by 2050. Consider the temperature change that seems to correspond to these values. Unthinkable! These are apparently the steady-state temperatures, given the heat trapping of the atmospheric CO2. However, it takes time to melt ice and warm ocean water before the steady-state average temperature is reached. The probabilities and temperature changes are shown. They would have applied, if the world could have achieved S-3-05, which would have included bringing the atmospheric CO2 levels down to safe values, soon enough to avoid a worse outcome. As shown, even achieving S-3-05 would have been very risky. There would have been a 50% chance that the temperature anomaly would have exceeded 2 degrees, where exactly 2 degrees is a bad (but not catastrophic) outcome. There would have also been a 30% chance that the temperature anomaly would have exceeded 3 degrees, where exactly 3 degrees is a very bad (but still not catastrophic) outcome. And the

probability of at least a 4 degree outcome, where a 4 degree outcome ***is*** catastrophic, would not have been as small as we would have liked.

[8] This is document supports the calculation of a target that must replace S-3-05's 2050 target.

[9] 15% per year means that the factor of point-eight-5 is applied, year after year. Over 10 years, the factor ***is***: point eight five, to the 10^{th} power, which is point two.

[10] So here is the climate-stabilization-supporting target.

[11] The paper develops the LDV requirements, as follows:

[12] Here are most of the variables used. More will follow. "e" is emission, "L" is Low Carbon Fuel Standard factor; "C" is "C" "O" "2" per mile driven; "p" is population; "D" is per-capita driving; "m" is mileage and "N" is the pounds of 'C" "O" "2" per gallon of fuel.

[13] Here are the fundamental equations. The emission is "C" "O" "2" per mile driven times the per-capita driving times the population, for any year. The ratios or factors can be used as shown. Mileage, or equivalent mileage, will be used, to keep things heuristic or intuitive. For that factor, the base year is in the numerator and the future year is in the denominator, opposite of the use of the "C" "O" "2" per mile driven.

[14] Here's how these values are used. The emission factor is from the climate-stabilization-supporting target and past and mandated emission factors. The car efficiency factor comes from past and existing mileages and the requirements defined in this report. The per-capita driving factor is the independent variable

and becomes a key reported requirement. The population factor comes from California Department of Finance.

[15] Here are some methodology notes. The base year follows a California law, SB 375, specifying driving reductions to be achieved in Regional Transportation Plans. An intermediate year of 2015 is selected. Car efficiency from 2005 to 2015 is taken from the shown report. The car efficiency factor, from 2015 to 2030, is derived here, and results in the car-efficiency-related requirements. Finally, it is assumed that cars last 15 years.

[16] Here are values to be specified in requirements: Low Carbon Fuel Standards, both California mandates and extended values; Corporate Average Fuel Efficiency (CAFÉ) standards, both existing national mandates to 2025 and extended values to 2030; driving reduction factors, for bad-mileage years, which may require a “cash-for-gas-guzzler program”.

[17] Here are two more requirements: First, Corporate Average Fuel Efficiency (CAFÉ) standards will only apply to Internal Combustion Engine cars. Second, each corporation’s yearly sold fleet of LDVs must include a specified fraction of Zero Emission Vehicles, or ZEVs.

[18] Here is the calculation of the fleet mileage for 2015. It is assumed that all the cars in any given year, collectively; travel a nominal amount of 100 miles. Although this is preposterously low, it doesn’t matter, because this assumed distance is cancelled out of the final mileage calculation, which is equivalent gallons used, which is proportional to distance, divided by total miles. As shown, the driving reduction factors are set to 1, meaning that no

reductions are used. The 2015 fleet equivalent mileage is nearly twenty eight miles per gallon.

[19] Here are the variables used for ZEVs: ZEV equivalent mileage; ZEV equivalent mileage if the electricity were all from renewables; ZEV equivalent mileage if the electricity were all from fossil fuels; the fraction of electricity that is from renewables; the gallons of equivalent fuel used; the arbitrary distance, used to keep the work heuristic; and a grouping of variables, called “numerator” and “denominator”.

[20] This shows the derivation of the formulae for the equivalent ZEV mileage. It also shows the needed assumed values, which also become requirements and the final result, which is over three hundred and thirty three miles per equivalent gallon. This calculation reflects a very optimistic set of assumptions about ZEV performance and the ability to manufacture ZEV and ZEV parts, least it seems to me.

[21] This shows a case I have named ***heroic measures*** because it reminds me of our nation converting car-production lines to tanks and other weapons, in world war two. The brown shows the internal combustion engine calculations. The driving reduction factors are significant and critical. The green shows the ZEV calculations, were the lower case “z” is the fraction of yearly fleet that is ZEVs. The yellow is the total. The 2030 mileage of the different years may be of interest but is not actually used. The total miles and total gallons are used to compute the 2030 mileage of just over one hundred and eleven miles per gallon.

[22] This shows nearly all of the significant results of this work. Beside the “Heroic Measures Case” it shows the results of another

case shown in the paper, called the “Extra Heroic Measures” case. The “Extra Heroic Measures” case shows the fraction of ZEVs required so we can drive at the 2005 per-capita level. For the Heroic Measures case, we don’t need the 5% ZEV fraction until 2018. However it doubles to 10% by 2019 and is one-fourth of cars sold in 2020. It requires that over half the cars in 2022 be ZEVs. Clearly, heroic measures will be needed. The Extra Heroic Measures case is much more difficult. The Heroic Measures Case requires that in 2030 our per-capita driving be 32% less than in 2005. As advertised, the Extra Heroic Measures Case supports driving at the 2005 per-capita level.

[23] This calculation shows that the “Heroic Measures” Case per-capita driving reduction is large enough that the ***net miles*** driven in California must be reduced by 16%, compared to 2005 levels. Since we have more lanes now than we had in 2005, it appears that no more lanes should be built. Instead, we need good practical measures that will reduce driving as needed.

[24] Here’s a list of measures that might achieve the needed per-capita driving reduction. The first bullet is an estimate of what the Regional Transportation Plans (RTPs) might achieve by 2030. The SB 375 targets they have been given, for year 2035, are generally larger than this so I hope this is reasonable. All the other reductions are in addition to what is planned in the RTPs. Since most RTPs include road expansions, driving can be reduced some by not building those expansions, as shown in the second bullet. The next bullet is reallocating that money to transit. This assumes the federal government will recognize our climate crisis and allow this. The fourth bullet says we will improve the way we pay for roads and for car parking. They can increase fairness, besides

reducing driving. The final bullet is to do more of what many Regional Transportation Plans are already doing.

[25] Here's an important pricing policy. The resolution was passed by a roomful of regular people, who had managed to educate themselves about our climate crisis, to the point, where they knew that substantial change was needed. Metropolitan Planning Organizations do RTPs and should understand climate. They should advocate for this policy, at the state level. Governor Brown would listen.

[26] Here's another important pricing policy. The resolution was passed by the same group as the last policy. In this case, the Metropolitan Planning Organizations should reward their member municipalities for taking these actions. Unbundling the cost of parking is, for example, a key element of Carlsbad's Climate Action Plan.

I hope there are questions. [21] Thank you