CALIFORNIA AIR RESOURCES BOARD
TECHNICAL ASSESSMENT
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COMPARISON OF GREENHOUSE GAS REDUCTIONS UNDER CAFE STANDARDS AND ARB REGULATIONS ADOPTED PURSUANT TO AB1493

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EXECUTIVE SUMMARY

In public comments explaining his denial of a waiver under Sec. 209(b) of the Clean Air Act for California to enforce its regulations implementing AB1493, U.S. EPA Administrator Steven Johnson makes the claim, without supporting documentation, that California's motor vehicle greenhouse gas emissions (GHG) rules are less effective than the recently adopted national CAFE standards in reducing global warming pollution. The California Air Resources Board's (ARB) staff analyzed this claim and prepared and documented its own technical evaluation.

California standards regulate GHG emissions; federal CAFE standards are aimed at reducing the nation's fuel consumption. This study makes the necessary calculations to allow the two programs to be evaluated so that the reductions in GHG gases under the California rules can be compared to those expected from implementation of the CAFE portion of the 2007 Energy Bill. The results show that the Administrator's claim that the federal CAFE program is better than California's program at reducing GHG emissions from motor vehicles is wrong, both in California and in those states that adopt the California standards (See Table ES-1).

This apples-to-apples comparison of total tons of GHG emissions reduced under the new federal CAFE standards versus those that would occur with full implementation of the California rules reveals the following results:

- In calendar year 2016, our State standards (referred to as the California standards or the Pavley rules) will reduce California's GHG emissions by 17 million metric tons (MMT) of carbon dioxide. This is more than double the 8 MMT reduction produced by the federal rules.

- By 2020, California is committed to implement revised, more stringent GHG emission limits (the Pavley Phase 2 rules). These increase the stringency of the current rules and would reduce California GHG emissions by 33 MMTs of carbon dioxide, 74 percent more than the 19 MMTs from the federal rules in 2020.

- Our analysis estimates the effects of the federal CAFE standards on GHG emission rates. This allows a comparison of the impact of the two programs on vehicle efficiency. Since the California rules are significantly more effective at reducing GHGs than the Federal CAFE program, they also yield a better fuel efficiency – roughly 44 mpg in 2020 for the California vehicle fleet as compared to the new CAFE standard of 35 mpg.

- The cumulative benefits of our standards have also been estimated (See Figure ES-1). Between 2009 and 2016, the California standards will prevent emissions of 58 MMTs of CO_2. This is almost three times the 20 MMTs expected if only the new federal CAFE standards were implemented. By 2020, the full California rules would prevent 167 MMT

of CO_2 emissions, more than twice the 76 MMTs reductions of CO_2 expected if only the federal standards were implemented.

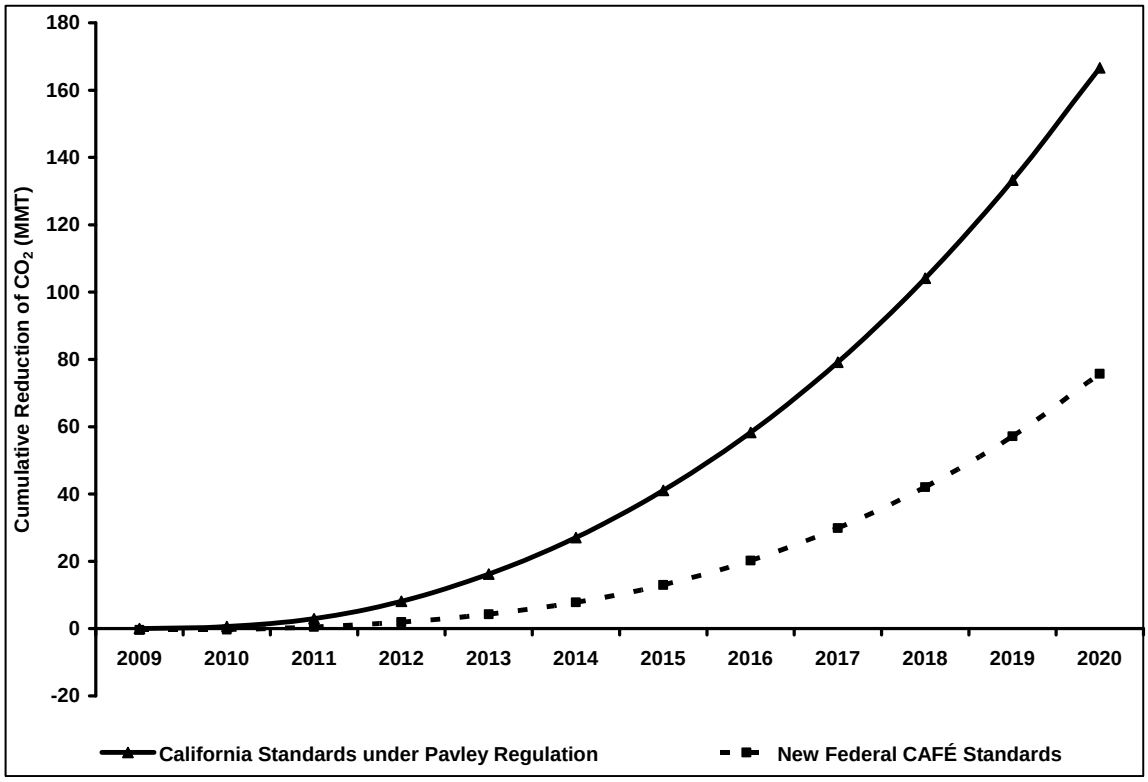
- There are also significant benefits for the other states that adopt the California standards. Twelve states have done so to date. In those states in 2020, California's more stringent limits will reduce GHG emissions in those states by 59 MMTs of carbon dioxide, a 59 percent improvement over the federal standards in 2020.

Table ES-1 Summary of Benefits of the California Program for California and Other States

Metric	Year	Fed. Law[1]	Calif. Program	% Benefit of Calif. Program Over Fed. Law
GHGs reduced in California, MMT[2]	2016	8	17	113%
	2020[3]	19	33	74%
GHGs reduced in 12 Other States[4], MMT[2]	2016	16	28	75%
	2020[3]	37	59	59%

1: Based on CAFE standard. 2: Million metric tons. 3: Based on current and planned standards.
4: Includes states that have adopted California's standards (New York, New Jersey, Connecticut, Maine, Massachusetts, Oregon, Pennsylvania, Rhode Island, Vermont, Washington, Maryland, and New Mexico.)

Figure ES-1 Comparison of Cumulative CO_2 Benefits of Pavley Regulation and New Federal Fuel Economy Standards if Implemented in California



I. BACKGROUND

On December 19, 2007 U.S. EPA Administrator Steven Johnson announced his agency's decision to deny the California Air Resources Board's (ARB) request for a waiver to allow California to enforce the State's motor vehicle greenhouse gas emissions rules adopted in 2004 pursuant to State legislation, AB1493, passed in 2002 (also known as the Pavley Bill).

Administrator Johnson's letter (see addendum) referenced HR6, the 2007 Energy Bill[1] that mandates improved national standards for fuel economy (Corporate Average Fuel Economy [CAFE] Standards). These standards require a fleet wide average of 35 miles per gallon (mpg) for light duty vehicles sold in 2020 and beyond. The Administrator's letter claimed that California's AB 1493 standards[2] (also known as the Pavley rules) would result in an equivalent fuel economy measurement of 33.8 mpg[3].

ARB staff had never seen this figure before, and it was not clear how the USEPA had arrived at this estimate. What was clear, however, was the importance of this number: Administrator Johnson's letter suggested that because U.S. EPA had concluded that California's GHG rules produced a lower miles per gallon result than the newly enacted CAFE 2020 standard of 35 mpg, that the federal CAFE program mandated by the 2007 Energy Bill would therefore be a more effective approach to reducing greenhouse gas emissions.

In order to ensure a fair comparison of California's program to the 2007 Energy bill, and to assess U.S. EPA's claims concerning the relative effectiveness of the California program and the new federal CAFE requirements in reducing GHG emissions, ARB staff prepared this technical study[4].

ARB's approach is to employ both the miles per gallon metric used in the 2007 Energy Bill and the GHG emissions rates that are the basis of California's regulation. ARB staff translated, as best as possible, miles per gallon into to equivalent GHG emission rates. These emission rates could then be used in comparison analysis. ARB staff then used the EMFAC on-road emissions inventory model[5] to develop an apples-to-apples comparison of tons of greenhouse gases reduced under the federal CAFE standards to those that occur under the Pavley rules.

Our analysis also looks at GHG emission reductions achievable not only in California with the existing Pavley rules (the Pavley Phase 1 rules) but also those expected when the ARB extends the existing requirements to obtain further reductions in the 2017 to 2020 timeframe[6] (referred to

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[1] Full text of HR6 is at http://energy.senate.gov/public/_files/HR6BillText.pdf

[2] California requires reductions in greenhouse gas emissions from vehicles weighing less than 10,000 pounds. The standards start in model year 2009, and ramp up to a 30 percent reduction in greenhouse gas emissions for vehicles sold in model year 2016 and beyond. These rules were subsequently adopted by 12 additional states which, with California, represent about one-third of the nation's registered automobiles.

[3] California's standards are stated as grams of greenhouse gases per mile and not in miles per gallon. They require greenhouse gas emissions to be reduced and do not regulate fuel economy. Moreover, these rules constitute only one element of a comprehensive approach to reduce greenhouse gases in the mobile sector. This approach includes a Low Carbon Fuel Standard which is being designed to produce at least a ten percent additional reduction in vehicle GHG emissions by 2020. The State is also pursuing extensive efforts to promote alternative fuel vehicles. Together, this package of initiatives will result in greater greenhouse gas reductions than those presented in this study which are based solely on the Pavley regulations.

[4] While ARB believes the Administrator's comparison is legally irrelevant to and not a proper basis for his decision, we are providing this analysis on an issue of public concern.

[5] EMFAC is the U.S. EPA approved model used by California to assess the effectiveness of its vehicular emission control rules.

[6] In March 2006, the California Climate Action Team completed a comprehensive report on the strategies needed to reduce GHG emissions in California. This report recommended amendment of the current Pavley rules to produce an additional 4 MMTs of GHG benefits by 2020. Additionally, in June 2007, the ARB affirmed its commitment to develop Phase 2 of the Pavley rules by including this measure in the "Early Action Plan" adopted pursuant to Assembly Bill AB 32, the California Global Warming Solutions Act of 2006.

as the Pavley Phase 2 rules). Finally, staff performed additional analyses to estimate the benefits of application of California's GHG vehicle emission reduction rules in the 12 States that have adopted the California program.

II. METHODOLOGY AND RESULTS

A. Methodology

The 2007 Energy Bill directs the National Highway Traffic Safety Administration (NHTSA) to increase the fuel economy of passenger vehicles and light trucks[7] starting no sooner than 2011 and to reach a final fleet annual average fuel economy target for passenger cars and light trucks of 35 mpg by 2020. It leaves it up to NHTSA to determine the appropriate phase-in schedule to achieve this goal. How NHTSA will define the phase-in is unknown at this time. The ARB analysis assumes NHTSA would begin to implement new standards in 2011, the soonest it is allowed to do so. The analysis also conservatively assumes the standards would be phased in using a steady proportional increase of 3.37% per year in the fuel economy of both passenger cars and light trucks until the final standard of 35 mpg is reached in 2020.

The 2007 Energy Bill also provides for a fuel economy credit for vehicles that are capable of operating on alternative fuels such as high blend ethanol known as E-85. This credit currently allows manufacturers to lower the fuel economy of their actual vehicle production by up to 1.2 mpg compared to the standard. The 2007 Energy Bill directs that the credit be gradually reduced in 0.2 mpg increments beginning in 2015 until it is eliminated in 2020.

Since manufacturers have indicated that they will produce large numbers of flex-fuel vehicles capable of operating on E85, ARB staff believes that manufacturers are likely to take full advantage of the credit between 2011 and 2019. Our analysis includes this assumption in our calculation of the benefits of the new CAFE standards on GHG reductions[8,9].

ARB staff used the EMFAC2007 version 2.3 (November 1, 2006) emissions estimation model to estimate the tons of CO_2 reduction from the California standards and the federal CAFE standards and the equivalent grams per mile CO_2 emissions. The EMFAC model reflects the current and projected vehicle fleet in California, based on data from the Department of Motor Vehicles, the Smog Check inspection and maintenance program, and local and regional transportation planning agencies. The emission rates in the EMFAC model are derived from testing of in-use vehicles. Documentation and downloadable copies of the EMFAC model are available at http://www.arb.ca.gov/msei/onroad/latest_version.htm.

California's standards address all light-duty vehicle greenhouse gas emissions, including emissions from air conditioning systems, and are expressed in grams per mile CO_2 equivalent. They can not be directly converted into fuel economy units of miles per gallon. Therefore, to compare the relative effectiveness of the 2007 Energy Bill to AB1493 rules, the federal fuel economy requirements were converted to grams per mile CO_2. The resulting grams per mile for passenger cars and trucks were then applied to the fleet mix in EMFAC to reflect the GHG emission reduction benefit of the new federal CAFE standards in California.

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[7] Referred to as "non-passenger" vehicle in the 2007 Energy Bill.

[8] For example, the fleet fuel economy standard in 2009 was calculated as 23.5 mpg rather than 24.7 mpg that would be expected if there were no credit. This 1.2 mpg reduction was also applied to the fuel economy standards for years 2010 through 2015, and smaller reductions were applied to years 2016 through 2020 as calculated using the phase-out schedule.

[9] The 2007 Energy Bill also requires large increases in renewable fuels that will produce significant GHG reductions. Those benefits are most appropriately attributed to the fuels provisions of the Act, and are not an independent benefit of the new CAFÉ program.

CO_2 emissions are estimated based on the emissions rates in EMFAC and the miles traveled. The total vehicle miles traveled (VMT) used in EMFAC are estimated by local transportation planning agencies. The total VMT is then distributed among the vehicle classes using DMV population data and mileage accrual rates obtained from the Smog Check program. For calendar years 2016 and 2020, the vehicle VMT distribution is shown in Tables 1 and 2, respectively.

Table 1. Year 2016 Vehicle Class* VMT Distribution in EMFAC2007

LDA	LDT1	LDT2	MDV	Total Light Duty
58%	11%	22%	9%	100%

Table 2. Year 2020 Vehicle Class* VMT Distribution in EMFAC2007

LDA	LDT1	LDT2	MDV	Total Light Duty
57%	12%	22%	9%	100%

CO_2 grams/mile rates are estimated using both VMT and vehicle population data. The vehicle population data in EMFAC for future years are based on calendar year 2005 DMV registration data, adjusted for growth and VMT matching. The distribution of the population among the vehicle classes is based on an analysis of the calendar year 2005 DMV data. For calendar years 2016 and 2020, the light duty vehicle population distribution is shown in Table 3 and 4, respectively.

Table 3. Year 2016 Vehicle Class* Population Distribution in EMFAC2007

LDA	LDT1	LDT2	MDV	Total Light Duty
59%	11%	21%	9%	100%

Table 4. Year 2020 Vehicle Class* Population Distribution in EMFAC2007

LDA	LDT1	LDT2	MDV	Total Light Duty
58%	12%	21%	9%	100%

B. Comparison of Year-by-Year Emission Rates

Table 5 provides CO_2 emission rates and estimated fuel economy for each vehicle class in the California fleet between calendar years 2009 and 2020, as well as a base year of 2002. The fleet mix was assumed to be 70% PC/LDT and 30% LTD2/MDV, consistent with the EMFAC vehicle class distributions shown in Tables 3 and 4. The CO_2 reductions from the California standards were estimated using emissions data from EMFAC2007 with percent CO2 reductions estimated for the current Pavley rules using the results of modeling done by the Northeast States Center for a Clean Air Future (NESCCAF). The benefits of the enhanced Pavley rules, an increase in effectiveness from 31 percent average reductions in 2016 to 43 percent by 2020, are also reflected, These result in the fleet average CO_2 emission rates decreasing from 354 g/mi in 2002 to 243 g/mi in 2016 and 203 g/mi in 2020. This translates into an increase in fleet average fuel economy from 25.1 mpg in 2002 to 36.6 mpg in 2016 and 43.9 mpg in 2020.

* Definition of EMFAC 2007 light duty vehicle classes: LDA – all passenger cars, LDT1 – trucks up through 3750 lb. gross vehicle weight rating (GVWR), LDT2 – trucks from 3751 to 5750 lb. GVWR, MDV– trucks from 5751 to 8500 lb. GVWR

Table 5. California Emission Standards and Estimated Fuel Economy for CA Fleet Mix[1]

California GHG Emission Standards - California Fleet Mix									
Year	PC/LDT1			LDT2			Fleet		
	CO_2 (g/mi)	% Red	mpg	CO_2 (g/mi)	% Red	mpg	CO_2 (g/mi)	% Red	mpg
2002	312	-	28.5	443	-	20.1	354	-	25.1
2009	323	0.0%	27.5	439	0.9%	20.2	360	0.0%	24.7
2010	301	3.5%	29.5	420	5.2%	21.2	338	4.6%	26.3
2011	267	14.4%	33.3	390	12.0%	22.8	304	14.2%	29.2
2012	233	25.3%	38.1	361	18.5%	24.6	271	23.5%	32.8
2013	227	27.2%	39.1	355	19.9%	25.0	265	25.1%	33.5
2014	222	28.8%	40.0	350	21.0%	25.4	260	26.6%	34.2
2015	213	31.7%	41.7	341	23.0%	26.1	251	29.0%	35.4
2016	205	34.3%	43.4	332	25.1%	26.8	243	31.4%	36.6
2017	195	37.5%	45.6	310	30.0%	28.7	229	35.2%	38.7
2018	185	40.7%	48.0	285	35.7%	31.2	215	39.2%	41.3
2019	180	42.3%	49.4	270	39.1%	32.9	207	41.4%	42.8
2020	175	43.9%	50.8	265	40.2%	33.5	203	42.8%	43.9

[1] California fleet mix is 70% passenger cars (PC) and light duty trucks (LDT1) and 30% light duty trucks (LDT2).

Table 6 shows the new federal fuel economy standard applied to the California fleet. A comparison of the two tables shows that CO_2 emission rates are higher and fuel economy is lower than under the Pavley rules. For example, fleet average CO_2 emission rates would decrease from 354 g/mi in 2002 to 291 g/mi in 2016 and 249 g/mi in 2020 while fuel economy would increase from 25.1 mpg in 2002 to 30.5 mpg in 2016 and 35.7 mpg in 2020.

Table 6. Federal Fuel Economy Standards and Estimated CO_2 Emissions for CA Fleet Mix[1]

Federal FE Standards - California Fleet Mix									
Year	PC/LDT1			LDT2			Fleet		
	CO_2 (g/mi)	% Red	mpg	CO_2 (g/mi)	% Red	mpg	CO_2 (g/mi)	% Red	mpg
2002	312	-	28.5	443	-	20.1	354	-	25.1
2009	347	0.0%	25.6	406	8.4%	21.9	366	0.0%	24.3
2010	346	0.0%	25.7	399	10.0%	22.3	363	0.0%	24.5
2011	335	0.0%	26.5	385	13.1%	23.1	350	1.3%	25.4
2012	324	0.0%	27.4	372	16.1%	23.9	338	4.6%	26.3
2013	313	0.0%	28.4	359	19.0%	24.8	327	7.8%	27.2
2014	303	3.0%	29.4	347	21.7%	25.6	316	10.9%	28.2
2015	291	6.9%	30.6	332	25.0%	26.7	303	14.5%	29.3
2016	279	10.5%	31.8	319	28.0%	27.9	291	17.9%	30.5
2017	268	14.0%	33.1	306	30.9%	29.0	280	21.1%	31.8
2018	261	16.3%	34.0	298	32.8%	29.8	272	23.2%	32.7
2019	248	20.5%	35.8	282	36.2%	31.5	259	27.0%	34.4
2020	239	23.5%	37.2	271	38.7%	32.7	249	29.8%	35.7

[1] California fleet mix is 70% passenger cars (PC) and light duty trucks (LDT1) and 30% light duty trucks (LDT2).

The analysis shows that the California CO_2 emission standards are 16 percent more stringent for 2016 models and 18 percent more stringent for 2020 models than under the new federal CAFE.

ARB staff also compared the California and federal standards if they were applied to the mix of vehicles in the Federal fleet instead of the California fleet. Based on default VMT data in the MOBILE6 model and sales data from the U.S. EPA, the Federal fleet is assumed to have a significantly lower fraction of passenger cars than is found in the California fleet. Specifically, the Federal fleet is assumed to have 50 percent passenger cars/LDT1 trucks and 50 percent LDT2 trucks. This compares to 70 percent passenger cars/LDT1 trucks and 30 percent LDT2 trucks for the California fleet[10]. The benefits of the California and federal standards when applied to the Federal fleet are provided in Tables 7 and 8, respectively.

Table 7. California CO_2 Standards and Estimated Fuel Economy for Federal Fleet Mix[1]

California GHG Emission Standards - Federal Fleet Mix									
Year	PC/LDT1			LDT2			Fleet		
	CO_2 (g/mi)	% Red	mpg	CO_2 (g/mi)	% Red	mpg	CO_2 (g/mi)	% Red	mpg
2002	312	-	28.5	443	-	20.1	375	-	23.7
2009	323	0.0%	27.5	439	0.9%	20.2	381	0.0%	23.3
2010	301	3.5%	29.5	420	5.2%	21.2	361	3.9%	24.7
2011	267	14.4%	33.3	390	12.0%	22.8	329	12.4%	27.1
2012	233	25.3%	38.1	361	18.5%	24.6	297	20.8%	29.9
2013	227	27.2%	39.1	355	19.9%	25.0	291	22.4%	30.5
2014	222	28.8%	40.0	350	21.0%	25.4	286	23.7%	31.1
2015	213	31.7%	41.7	341	23.0%	26.1	277	26.1%	32.1
2016	205	34.3%	43.4	332	25.1%	26.8	269	28.4%	33.1
2017	195	37.5%	45.6	310	30.0%	28.7	253	32.7%	35.2
2018	185	40.7%	48.0	285	35.7%	31.2	235	37.3%	37.8
2019	180	42.3%	49.4	270	39.1%	32.9	225	40.0%	39.5
2020	175	43.9%	50.8	265	40.2%	33.5	220	41.3%	40.4

[1] CA fleet is 70% passenger cars (PC) & light duty trucks (LDT1) & 30% light trucks (LDT2).

Table 8. Federal Fuel Economy Standards and Estimated Emissions for Federal Fleet Mix[1]

Federal FE Standards - Federal Fleet Mix									
Year	PC/LDT1			LDT			Fleet		
	CO_2 (g/mi)	% Red	mpg	CO_2 (g/mi)	% Red	mpg	CO_2 (g/mi)	% Red	mpg
2002	312	-	28.5	443	-	20.1	375	-	23.7
2009	352	0.0%	25.2	406	8.4%	21.9	379	0.0%	23.4
2010	351	0.0%	25.3	399	10.0%	22.3	375	0.1%	23.7
2011	339	0.0%	26.2	385	13.1%	23.1	362	3.5%	24.6
2012	327	0.0%	27.2	372	16.1%	23.9	349	6.8%	25.4
2013	316	0.0%	28.1	359	19.0%	24.8	338	10.0%	26.3
2014	305	2.1%	29.1	347	21.7%	25.6	326	13.0%	27.3
2015	293	6.1%	30.3	332	25.0%	26.7	313	16.6%	28.4
2016	281	9.8%	31.6	319	28.0%	27.9	300	20.0%	29.6
2017	270	13.3%	32.9	306	30.9%	29.0	288	23.1%	30.8
2018	263	15.7%	33.8	298	32.8%	29.8	280	25.2%	31.7
2019	250	19.9%	35.6	282	36.2%	31.5	266	29.0%	33.4
2020	237	24.0%	37.5	271	38.7%	32.7	254	32.2%	35.0

[10] In estimating the GHG emission reductions expected from the CAFE standards applied to the federal fleet mix, staff used the national fleet mix assumed by the U.S. EPA MOBILE6 model for base year but made adjustments to future year fractions. MOBILE6 assumes that approximately 45 percent of the new vehicles in 2007 were passenger cars but that by 2020 only 32 percent of vehicles sold will be passenger cars. However, the 32 percent passenger car assumption for 2020 appeared unreasonable given the recent change in consumer vehicle purchases and vehicle offerings, in large part attributable to increases in gasoline prices. Therefore, staff froze the fraction of lighter vehicle at 2009 levels. Similar forecast assumptions are applied in EMFAC for the California fleet.

[1] Federal fleet is 50% passenger cars (PC) and light trucks (LDT1) and 50% light trucks (LDT2). Comparison of the two tables shows that when applied to the Federal fleet, the California CO_2 emissions standards are 10 percent and 13 percent more effective for 2016 models and 2020 models, respectively. California's emissions standards result in 12 percent and 15 percent better fuel economy for 2016 and 2020 model Federal vehicle fleets, respectively. The benefits of the California standards are not as large when applied to the Federal fleet mix (relative to the California fleet mix) due to the higher fraction of LDT2 trucks assumed in the Federal fleet.

C. GHG Emission Reductions in 2016 and 2020

To estimate the CO_2 benefits of the California standards applied to the California fleet, staff used EMFAC2007 to develop baseline estimates and the Pavley rules percent reductions (as shown in Tables 5 and 6) to calculate the weekday ton reductions for each model year. Table 9 shows the emission reductions expected from the adopted Pavley rules in 2016. By 2016, the California standard is expected to reduce the 473,000 tons per day of CO_2 emitted by light duty vehicles in California by 11 percent or 52,000 tons per day. This is equivalent to an annual reduction[11] of 17 million metric tons (MMT) of CO_2 in 2016.

The 2020 reductions are based on a more stringent emission limit than the current California standards, called the Pavley 2 rules, as set forth in the California Climate Action Plan and committed to by the ARB in its Early Action Measures under AB32. For this analysis, ARB staff applied more stringent emission reductions beginning in 2017, and becoming progressively more stringent through 2020.

Table 9. Emission Reductions from Adopted Pavley 1 Regulation in California in 2016

CY 2016 CO_2 in 1000 tons per day from EMFAC2007 version2.3 (Nov 1 2006)						
	PC/LDT1			LDT2		
Model Year	Baseline	% Reduction	Tons Reduction	Baseline	% Reduction	Tons Reduction
2008 and older	123.73	0.0%	0.00	100.62	0.0%	0.00
2009	13.42	0.0%	0.00	9.39	0.9%	0.08
2010	14.62	3.5%	0.52	9.58	5.2%	0.50
2011	15.87	14.4%	2.29	9.88	12.0%	1.18
2012	17.38	25.3%	4.40	10.57	18.5%	1.96
2013	19.21	27.2%	5.23	11.72	19.9%	2.33
2014	21.19	28.8%	6.11	12.75	21.0%	2.68
2015	24.31	31.7%	7.71	14.71	23.0%	3.39
2016	27.50	34.3%	9.43	16.34	25.1%	4.09
Total All MYs	**277.23**		**35.70**	**195.56**		**16.21**
	Baseline		Tons Reduction	Million Metric Tons Reduced		
Total Lt Duty	**472.79**		**51.90**	**17.2**		

[11] This analysis provides emissions estimates in standard tons for a average weekday. To convert weekday emissions to annual estimates the weekday result was multiplied by 365 and by 0.91 to convert from tons to metric tonnes. (Note that weekend day traffic is slightly less than average weekday, so this method slightly over estimates annual emissions. This has no effect, however, on the relative comparison of the effectiveness of the different programs.)

Table 10 shows the emission reductions expected from the existing and anticipated Pavley rules in California in 2020. By 2020, the combination of the adopted Pavley 1 and anticipated Pavley 2 rules are expected to reduce the 496,000 tons per day of CO_2 emitted by light duty vehicles in California by 20 percent or 101,000 tons per day. This is equivalent to 33 MMT less CO_2 in 2020.

Table 10. Emission Reductions from Anticipated Pavley 2 Regulation in California in 2020

CY 2020 CO_2 in 1000 tons per day from EMFAC2007 version2.3 (Nov 1 2006)						
	PC/LDT1			LDT2		
Model Year	**Baseline**	**% Reduction**	**Tons Reduction**	**Baseline**	**% Reduction**	**Tons Reduction**
2008 and older	80.19	0.0%	0.00	72.40	0.0%	0.00
2009	10.09	0.0%	0.00	7.49	0.9%	0.07
2010	11.17	3.5%	0.39	7.71	5.2%	0.40
2011	12.25	14.4%	1.77	7.98	12.0%	0.95
2012	13.46	25.3%	3.41	8.52	18.5%	1.58
2013	14.79	27.2%	4.03	9.35	19.9%	1.86
2014	15.95	28.8%	4.60	9.91	21.0%	2.08
2015	17.33	31.7%	5.50	10.89	23.0%	2.51
2016	18.25	34.3%	6.26	11.27	25.1%	2.82
2017	20.05	37.5%	7.52	12.43	30.0%	3.73
2018	22.12	40.7%	9.00	13.84	35.7%	4.94
2019	25.25	42.3%	10.68	15.76	39.1%	6.15
2020	29.37	43.9%	12.90	18.36	40.2%	7.38
Total All MYs	**290.27**		**66.06**	**205.91**		**34.47**
	Baseline		Tons Reduction	Annual Million Metric Tons Reduced		
Total Lt Duty	**496.18**		**100.53**	**33.4**		

The CO_2 reductions from the federal CAFE standards were estimated using emissions data from EMFAC2007 and percent CO_2 reduction estimates based on the modeled phase-in schedule used to achieve the final fuel economy target of 35 mpg by 2020. The exact phase-in is unknown at this time. ARB staff has assumed a proportional increase in fuel economy of 3.37 percent per year.

Table 11 shows the emission reductions expected from the new Federal CAFE Standards in California in 2016. By 2016, the new Federal standard is expected to reduce the 473,000 tons per day of CO_2 emitted by light duty vehicles in California by 5 percent or 23,000 tons per day. This is equivalent to a reduction of 8 MMT of CO_2 in 2016.

Table 12 shows the emission reductions expected due to the full implementation of the new Federal CAFE standards in California in 2020. By 2020, the new Federal standard is expected to reduce the 496,000 tons per day of CO_2 emitted by light duty vehicles in California by 11 percent or 57,000 tons per day. This is equivalent to a reduction of 18.9 million metric tons (MMT) of CO_2 in 2020. This analysis indicates that if the new Federal CAFE standards were implemented in place of the current Pavley 1 and anticipated Pavley 2 rules in California, almost 10 MMT more CO_2 would be emitted in 2016 and about 15 MMT more CO_2 in 2020.

Table 11. Emission Reductions from New Federal CAFE Standards in California in 2016

CY 2016 CO_2 in 1000 tons per day from EMFAC2007 version2.3 (Nov 1 2006)						
	PC/LDT1			LDT2		
Model Year	**Baseline**	**% Reduction**	**Tons Reduction**	**Baseline**	**% Reduction**	**Tons Reduction**
2008 and older	123.73	0.0%	0.00	100.62	0.0%	0.00
2009	13.42	0.0%	0.00	9.39	8.4%	0.79
2010	14.62	0.0%	0.00	9.58	10.0%	0.96
2011	15.87	0.0%	0.00	9.88	13.1%	1.30
2012	17.38	0.0%	0.00	10.57	16.1%	1.70
2013	19.21	0.0%	0.00	11.72	19.0%	2.22
2014	21.19	3.0%	0.64	12.75	21.7%	2.77
2015	24.31	6.9%	1.67	14.71	25.0%	3.67
2016	27.50	10.5%	2.89	16.34	28.0%	4.58
Total All MYs	**277.23**		**5.20**	**195.56**		**17.99**
	Baseline		Tons Reduction	Million Metric Tons Reduced		
Total Lt Duty	**472.79**		**23.20**	**7.7**		

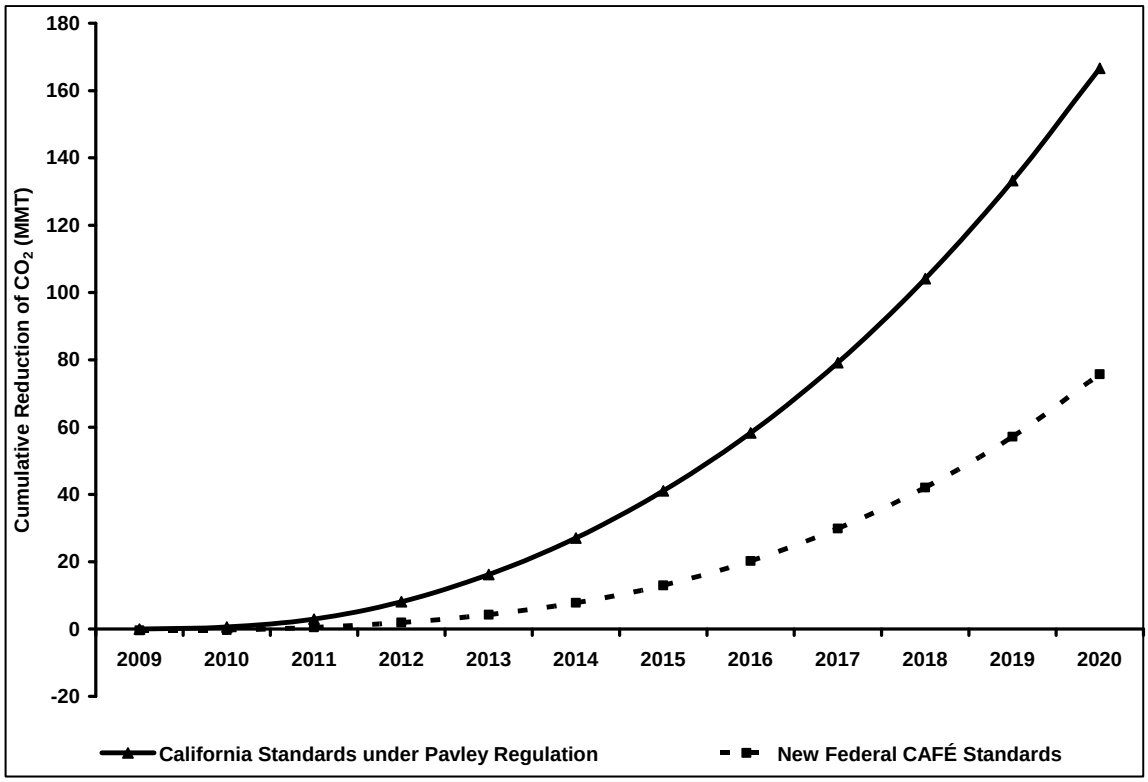
Table 12. Emission Reductions from New Federal CAFE Standards in California in 2020

CY 2020 CO_2 in 1000 tons per day from EMFAC2007 version2.3 (Nov 1 2006)						
	PC/LDT1			LDT2		
Model Year	**Baseline**	**% Reduction**	**Tons Reduction**	**Baseline**	**% Reduction**	**Tons Reduction**
2008 and older	80.19	0.0%	0.00	72.40	0.0%	0.00
2009	10.09	0.0%	0.00	7.49	8.4%	0.63
2010	11.17	0.0%	0.00	7.71	10.0%	0.77
2011	12.25	0.0%	0.00	7.98	13.1%	1.05
2012	13.46	0.0%	0.00	8.52	16.1%	1.37
2013	14.79	0.0%	0.00	9.35	19.0%	1.77
2014	15.95	3.0%	0.48	9.91	21.7%	2.15
2015	17.33	6.9%	1.19	10.89	25.0%	2.72
2016	18.25	10.5%	1.92	11.27	28.0%	3.16
2017	20.05	14.0%	2.81	12.43	30.9%	3.84
2018	22.12	16.3%	3.62	13.84	32.8%	4.53
2019	25.25	20.5%	5.18	15.76	36.2%	5.71
2020	29.37	23.5%	6.91	18.36	38.7%	7.11
Total All MYs	**290.27**		**22.09**	**205.91**		**34.82**
	Baseline		Tons Reduction	Million Metric Tons Reduced		
Total Lt Duty	**496.18**		**56.92**	**18.9**		

D. Cumulative Benefits Between 2009 and 2020

ARB staff also calculated the cumulative CO_2 benefits of the Pavley rules compared to the new Federal fuel economy standards if implemented in California. As shown in Figure 1, by 2016, the adopted Pavley rules will have prevented a total of 58 MMT of CO_2 from being emitted into the air as compared to 20 MMT if the new Federal standards were implemented. By 2020, the combination of the Pavley 1 and 2 rules will have prevented 167 MMT of CO_2 emissions from being emitted as compared to 76 MMT of CO_2 if only the Federal CAFE were implemented.

Figure 1. Comparison of Cumulative CO_2 Benefits of Pavley Regulation and New Federal Fuel Economy Standards if Implemented in California



III. SUMMARY OF RESULTS -- BENEFITS IN CALIFORNIA

- In calendar year 2016, California standards will reduce GHG emissions from cars in California by 9 million metric tons of carbon dioxide more than the federal CAFE standard. This is more than double the reduction produced by the federal standard (see Table 13).

- By 2020, California will have implemented revised, more stringent GHG emission limits, as set forth in its Climate Action Plan. As a result of these new requirements GHG emissions will be reduced by almost 14 million metric tons of carbon dioxide (77 percent) more than the federal standard in 2020 (see Table 13).

- There has been interest in how the California and Federal emission standards compare. For illustration purposes only, we have converted the federal fuel economy standards to

greenhouse gas emissions (carbon dioxide) emissions. We assumed a proportional increase of the CAFE standard between 2011 and 2020, when its standard reaches 35 mpg.

- The California standard is significantly more effective at reducing greenhouse gases than the new Federal standard, yielding an equivalent fuel economy of 44 mpg by 2020 as compared to the new CAFE standard of 35 mpg.

- The California standard is 16% more stringent for 2016 models, and 18% more stringent for 2020 models, when the planned second phase of California's standards is in place.

Table 13. Summary of Benefits of the California Program for California

Metric	Year	Fed. Law[1]	Calif. Program	% Benefit of Calif. Program Over Fed. Law
GHGs reduced in California, MMT[2]	2016	8	17	123%
	2020[3]	19	33	77%
California GHG std, vs. CAFE (converted to GHG, grams/mile)	2016	291	243	16%
	2020[3]	249	203	18%

1: Based on CAFE standard. 2: Million metric tons. 3: Based on current and planned standards.

IV. EFFECT OF CALIFORNIA GHG EMISSION STANDARDS IN OTHER STATES THAT ADOPT THE CALIFORNIA PROGRAM

Staff estimated the comparative benefits of the California CO_2 regulation and the new Federal CAFE standard for those twelve states that have adopted California's standards (See Table 14). California and the twelve other states that have adopted the Pavley regulation account for about one-third of the vehicles in the United States in 2006.

To calculate the benefits of the standards for these 12 other states, staff scaled California's CO_2 benefits, using motor vehicle gasoline consumption as a surrogate[12]. Staff used the most recent (2005 calendar year) state-specific gasoline consumption data available from the U.S. Energy Information Administration at http://www.eia.doe.gov/emeu/states/sep_fuel/html/fuel_mg.html.

California consumed 11.5 percent of the motor vehicle gasoline in 2005 as compared to 21 percent for the 12 states that have adopted the Pavley regulation. In sum, these thirteen states consumed about one-third of the nation's motor vehicle gasoline in 2005.

- In calendar year 2016, adopting California standards will reduce GHG emissions from cars in twelve states (see table 15 for list of states) by 13 million metric tons of carbon dioxide more than the federal CAFE standard. This is 79 percent greater than the reduction produced by the federal standard (see Table 15)

- By 2020, states adopting California's proposed more stringent GHG emission limits would reduce GHG emissions by 22 million metric tons of carbon dioxide (59 percent) more than the federal standard in 2020 (see Table 15).

[12] Staff considered using statistics related to population, number of vehicles and gasoline consumption. However, driving per capita and annual miles driven per vehicle vary significantly from state to state. Staff believes that state level fuel consumption data best reflects these differences, and is the best statistic to use to estimate the proportional benefits that other states will receive when they adopt the California GHG emission standards.

Table 14. Summary of Benefits of the California Program for Other States

Metric	Year	Fed. Law[1]	Calif. Program	% Benefit of Calif. Program Over Fed. Law
GHGs reduced in Other States, MMT[2]	2016	15.7	28.2	79%
	2020[3]	37.2	59.0	59%

1: Based on CAFE standard. 2: Million metric tons. 3: Based on current and planned standards.

Table 15 shows in more detail how the California GHG regulations could benefit the twelve states where it has been adopted.

Table 15. State by State GHG Benefits of California CO_2 Rules vs. Federal CAFE Standards

	Motor Vehicle Gasoline Consumption[1] (1000 Barrels)	Gasoline Use Ratio to California	GHG Reduction from CA Stds in 2016[2] (MMTs/year)	GHG Reduction from Fed Stds in 2016[2] (MMTs/year)	Benefit of CA Stds over Fed Stds (MMTs/year)	GHG Reduction from CA Stds in 2020[2] (MMTs/year)	GHG Reduction from Fed Stds in 2020[2] (MMTs/year)	Benefit of CA Stds over Fed Stds (MMTs/year)
U.S. Total	3,266,107							
California (California Fleet Mix)	**375,652**	**1.00**	**17.2**	**7.7**	**9.5**	**33.4**	**18.9**	**14.5**
California (Federal Fleet Mix)			**15.5**	**8.6**	**6.9**	**32.4**	**20.4**	**12.0**
% of U.S. Total	**12%**							
Other States with California Standards[3]								
Connecticut	37,850	0.10	1.6	0.9	**0.7**	3.3	2.1	**1.2**
Maine	17,040	0.05	0.7	0.4	**0.3**	1.5	0.9	**0.5**
Massachusetts	67,081	0.18	2.8	1.5	**1.2**	5.8	3.6	**2.1**
New Jersey	102,025	0.27	4.2	2.3	**1.9**	8.8	5.5	**3.3**
New York	134,906	0.36	5.6	3.1	**2.5**	11.6	7.3	**4.3**
Oregon	36,488	0.10	1.5	0.8	**0.7**	3.1	2.0	**1.2**
Pennsylvania	121,878	0.32	5.0	2.8	**2.2**	10.5	6.6	**3.9**
Rhode Island	9,100	0.02	0.4	0.2	**0.2**	0.8	0.5	**0.3**
Vermont	8,166	0.02	0.3	0.2	**0.1**	0.7	0.4	**0.3**
Washington	63,818	0.17	2.6	1.5	**1.2**	5.5	3.5	**2.0**
Maryland	63,544	0.17	2.6	1.5	**1.2**	5.5	3.5	**2.0**
New Mexico	22,262	0.06	0.9	0.5	**0.4**	1.9	1.2	**0.7**
Other States[3]	**684,158**	**1.82**	**28.2**	**15.7**	**12.5**	**59.0**	**37.2**	**21.8**
Total of States with CA Stds	**32%**		**45.4**	**23.4**	**22.0**	**92.4**	**56.1**	**36.3**

[1] Energy Information Administration / Department of Energy, data for 2005 (http://www.eia.doe.gov/emeu/states/sep_fuel/html/fuel_mg.html)

[2] CA fleet mix (70% LDA/T1 & 30% T2) differs from federal fleet mix (50% LDA/T1 & 50% T2). Due to this, other states have less benefit on a percentage basis than CA.

[3] Includes only those states that have already adopted California's Pavley rules. This does not include states that have committed to or are considering adopting California's rules.