The Development of California Light-Duty Vehicle (LDV) Requirements to Support Climate Stabilization: Fleet-Emission Rates & Per-Capita Driving

Paper 2014-A-30793-AWMA

Mike Bullock
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The Climate Problem

Any Earth Science text book* contains the following facts:

- **Atmospheric CO2 traps heat**
  - CO2 Molecules absorb and then emit, in a random direction, infrared radiation, heat given off by the Earth's surface
  - This effect is significant
- **Combustion of fossil fuels adds great quantities of CO2 to our Earth's atmosphere**
  - The amount of C02 in the atmosphere is well known
  - Our yearly emissions are well known

* For example, Page 539 of *Earth Science*, Tarbuck and Lutgens, Tenth Edition, published by Prentice Hall, 2003.

How Bad Could It Get?

- *Scientific American* June 2008 issue
  - 550 PPM CO2 possible in several decades
  - This could (5% probability) lead to 8 Deg. Celsius of warming
  - 8 Deg. Celsius could lead to "a devastating collapse of the human population, perhaps even to extinction"
- December 24/31 2012 Issue of Nation magazine:

A recent string of reports from impeccable mainstream institutions-the International Energy Agency, the World Bank, the accounting firm of PricewaterhouseCoopers-have warned that the **Earth is on a trajectory to warm by at least 4 Degrees Celsius**

[4 Degrees Celsius] would be *incompatible with continued human survival*.

Winter, *UU World* magazine (p. 57) " Lags in the replacement of fossil-fuel use by clean energy use have put the world on a pace for 6 degree Celsius by the end of this century. Such a large temperature rise occurred 250 million years ago and extinguished 90 percent of the life on Earth. The current rise is of the same magnitude but is occurring faster. We must reduce or eliminate all uses of fossil fuels.

Governor's Executive Order S-3-05

California's S-3-05 C02_e Emissions, MMT Per Year
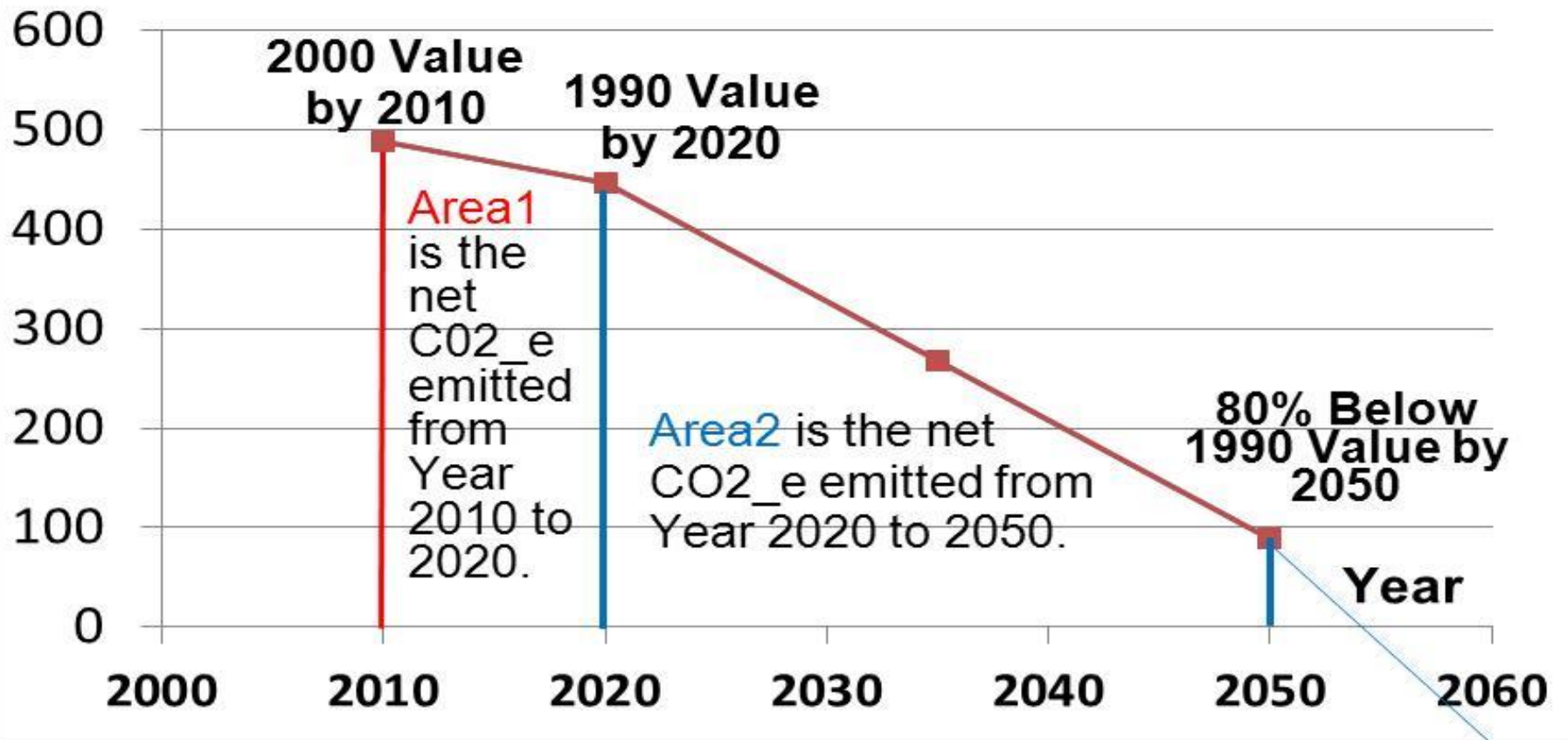
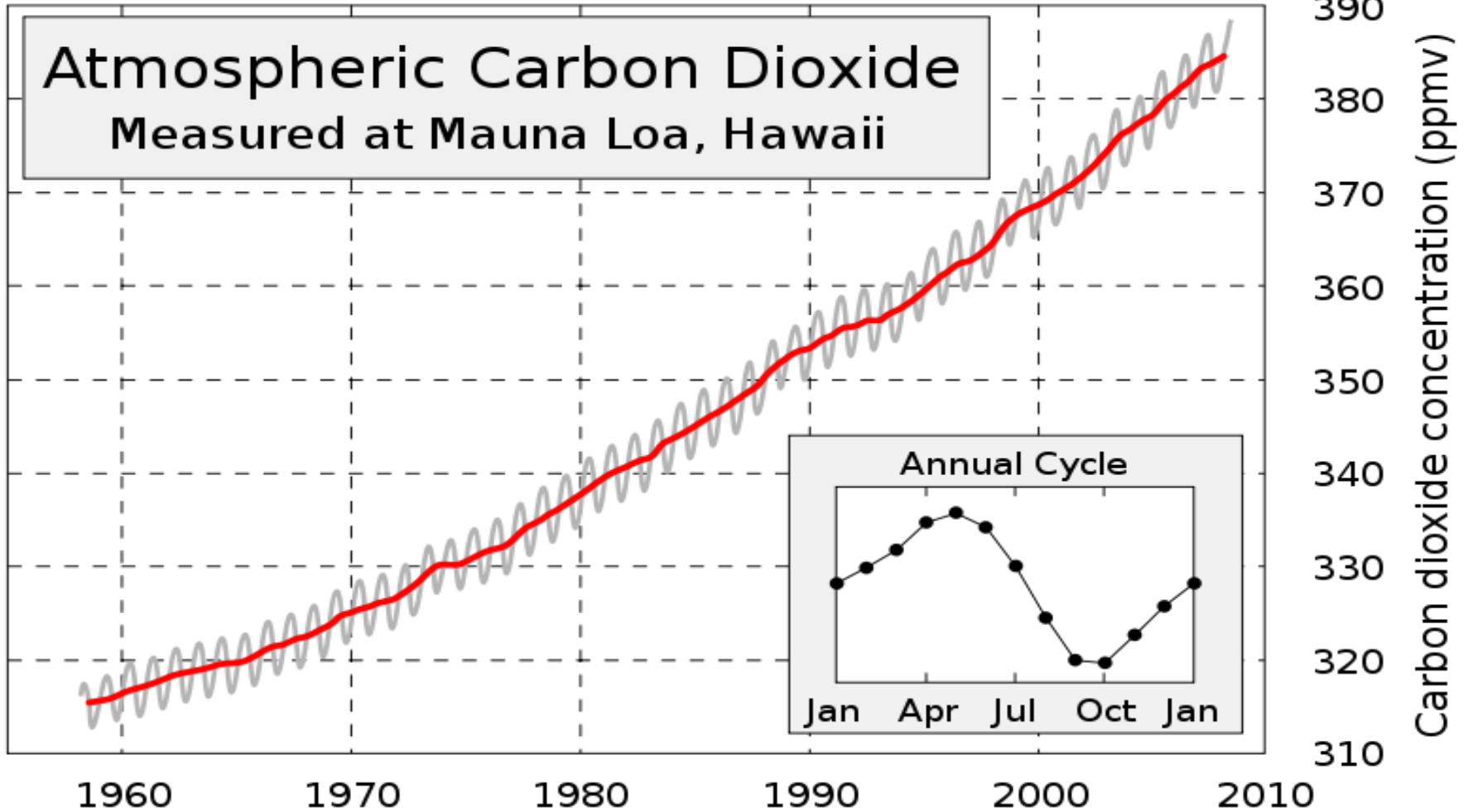# Climate Data

- Keeling Curve:
  http://en.wikipedia.org/wiki/An_Inconvenient_Truth#Scientific_basis

Our Climate Crisis

- Earth & Space Research (ESR) website:
  http://www.esr.org/outreach/climate_change/mans_impact/man1.html

Current level = 400 PPM

S-3-05's Goal is to cap C02 at 450 PPM, which is off this chart.

—— Temperature in degrees centigrade (compared with 1960-1990 baseline)

—— Atmospheric carbon dioxide (CO2 in parts per million)

CO2 (ppm)

Temperature (difference)

Years Before Present
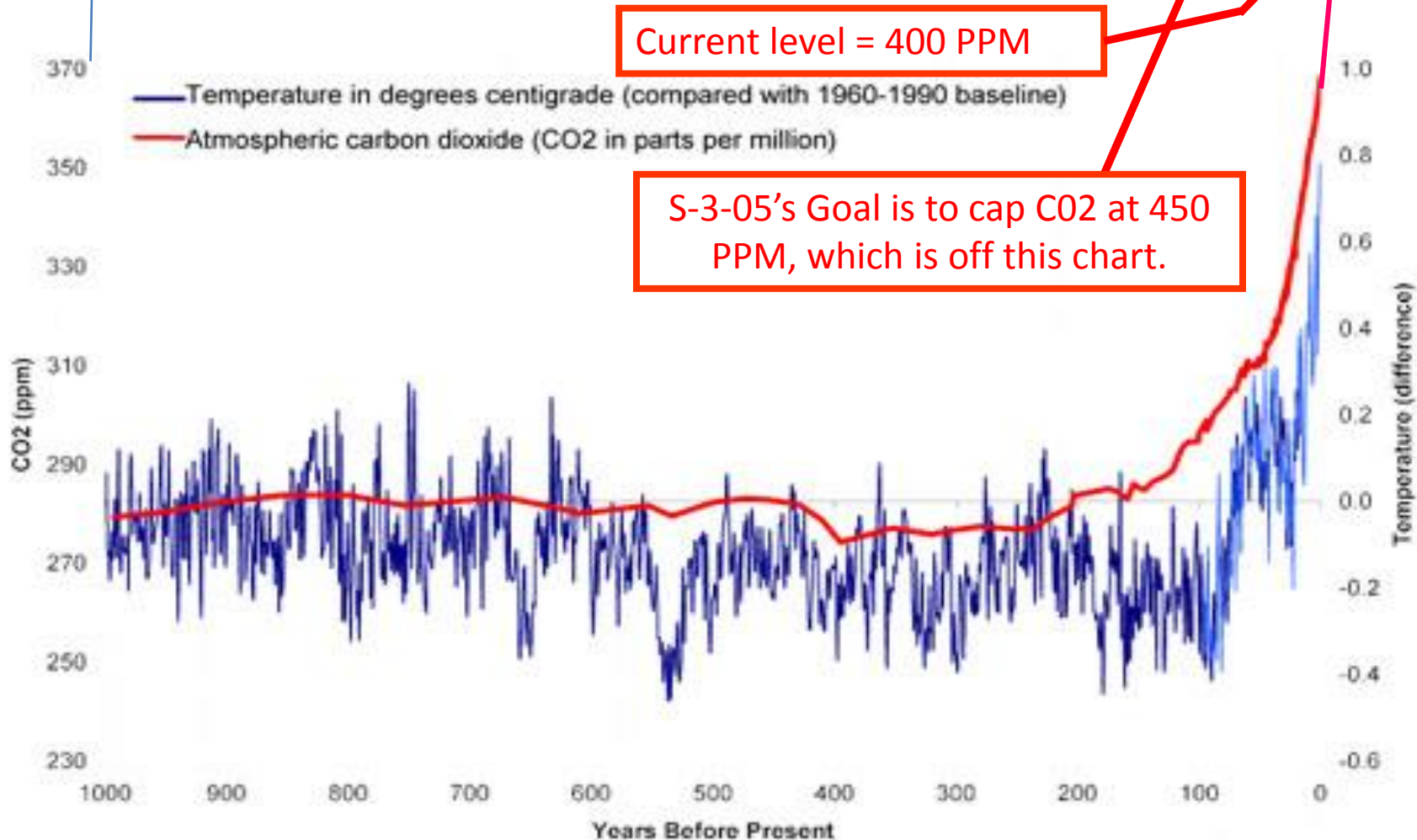
Our Climate Crisis

- From: http://en.wikipedia.org/wiki/An_Inconvenient_Truth#Scientific_basis

S-3-05's goal is to cap C02 at 450 PPM

Current Level of C02 is 400 PPM

S-3-05 Achievement Outcomes
 X% chance > 4 (Extinction?)
 30% chance > 3 (very bad)
 50% chance > 2 (bad)
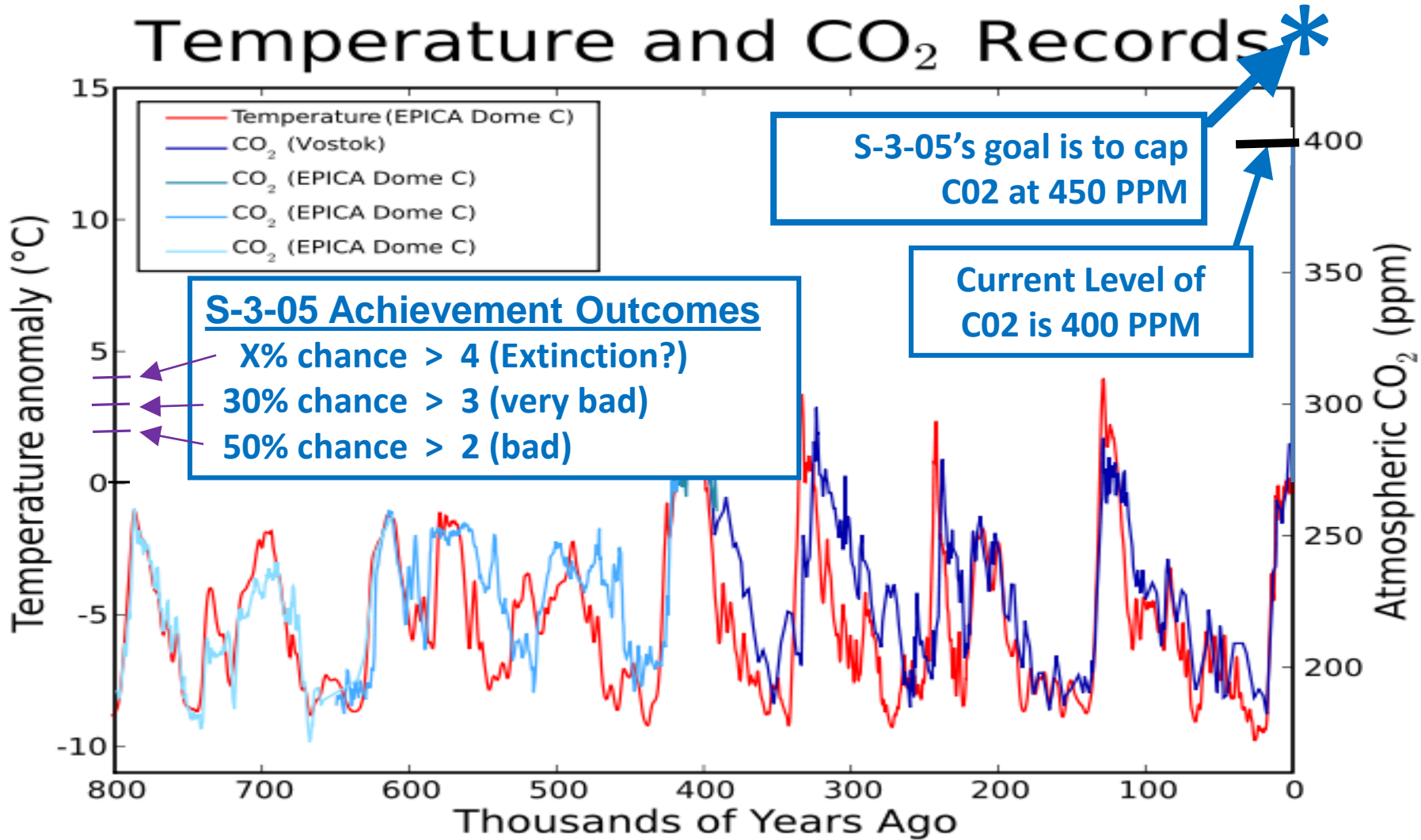
BRIEF OF SCIENTISTS AMICUS GROUP AS *AMICI CURIAE* IN SUPPORT OF PLAINTIFFS-APPELLANTS SEEKING REVERSAL

DANIEL M. GALPERN
Law Offices of Charles M. Tebbutt, P.C.
941 Lawrence St. Eugene, OR 97401-2815

USCA Case #13-5192 Document #1465822 Filed: 11/12/2013

A. Parties and *Amici*. Except for the following, all parties, intervenors, and *amici* appearing before the district court and in this Court are listed in the Brief for Plaintiffs-Appellants. **James Hansen**, David Beerling, Paul J. Hearty, Ove Hoegh-Guldberg, Pushker Kharecha, Valérie Masson-Delmotte, Camille Parmesan, Eelco Rohling, Makiko Sato, Pete Smith, and Lise Van Susteren are *amici curiae* in this appeal (referred to hereinafter as "Amici Scientists.").
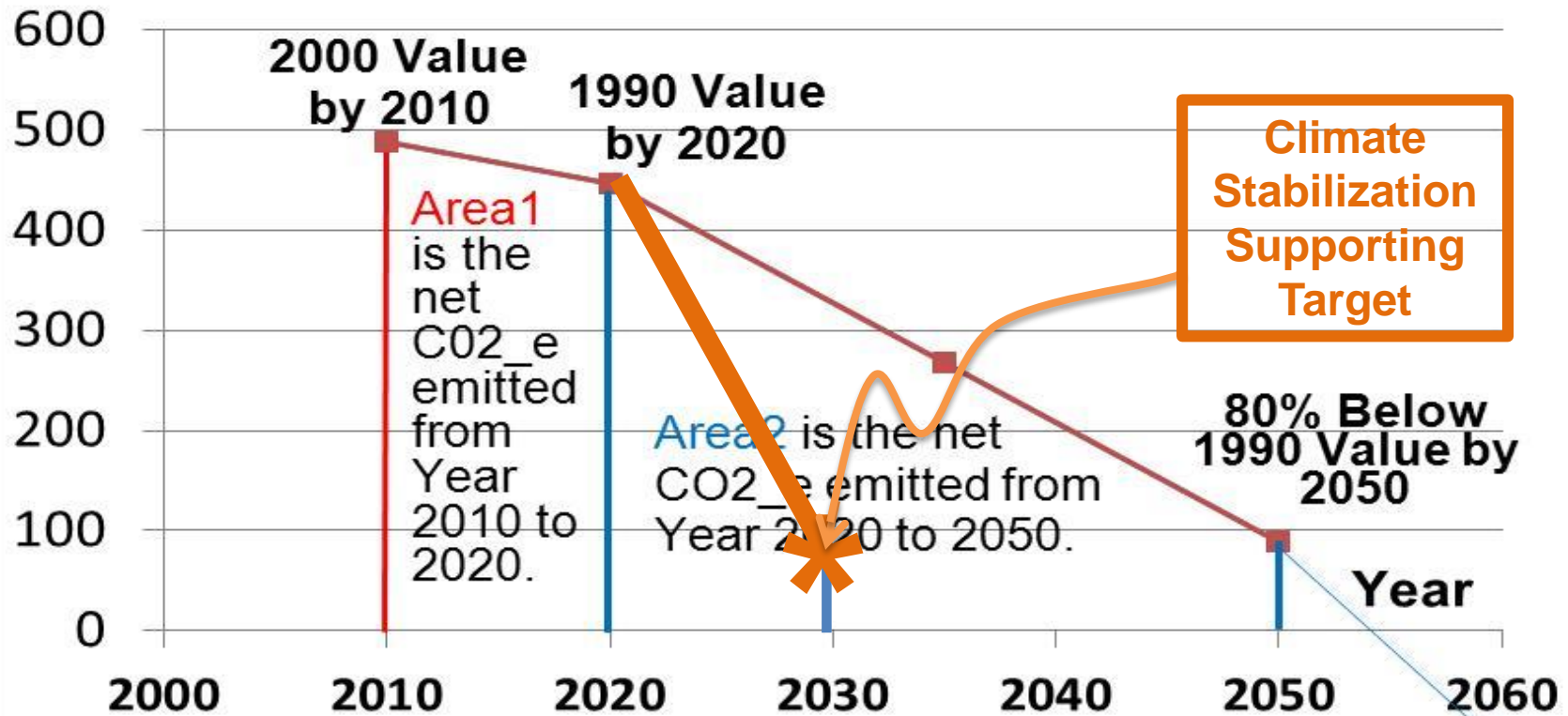
From the Climate Scientists

From Page 21: . . . the required rate of emissions reduction would have been about 3.5% per year if reductions had started in 2005, **_while the required rate of reduction, if commenced in 2020, will be approximately 15% per year._**

- ## My math:
  - 15% means a factor of 0.85, year after year
  - Consider the 10 years from 2020 to 2030
  - $(.85)^{10} = .20$, which is 80% down
  - Other articles, describing Hansen's work: "**decarbonization by 2030**"

New **Prescription** for Climate Stabilization

California's S-3-05 C02_e Emissions, MMT Per Year

- 2000 Value by 2010
- 1990 Value by 2020
- Area1 is the net C02_e emitted from Year 2010 to 2020.
- Area2 is the net CO2_e emitted from Year 2020 to 2050.
- 80% Below 1990 Value by 2050
- **Climate Stabilization Supporting Target**

Year

How, for LDVs:

The Development of California Light-Duty Vehicle (LDV) Requirements to Support Climate Stabilization: Fleet-Emission Rates & Per-Capita Driving

Paper 2014-A-30793-AWMA

Variables

	Definitions
e_k	LDV Emitted C02, in Year "k"
L_k	Low Carbon Fuel Standard (LCFS) Factor that reduces the Per-Gallon CO_2 emissions, in Year "k"
C_k	LDV CO_2 emitted per mile driven, average, in Year "k", not accounting for the Low Carbon Fuel Standard (LCFS) Factor
c_k	LDV CO_2 emitted per mile driven, average, in Year "k", accounting for the Low Carbon Fuel Standard (LCFS) Factor
p_k	Population, in Year "k"
d_k	Per-capita LDV driving, in Year "k"
D_k	LDV Driving, in Year "k"
M_k	LDV Mileage, miles per gallon, in Year "k"
m_k	LDV Equivalent Mileage, miles per gallon, in Year "k" accounting for the Low Carbon Fuel Standard (LCFS) Factor, so this is M_k/L_k
N	Number of pounds of CO_2 per gallon of fuel but not accounting for the Low Carbon Fuel Standard (LCFS) Factor

Fundamental Equations

Year k: $$e_k = c_k * d_k * p_k$$

Year i: $$e_i = c_i * d_i * p_i$$

$$\frac{e_k}{e_i} = \frac{c_k}{c_i} * \frac{d_k}{d_i} * \frac{p_k}{p_i}$$

To work with mileage: $$\frac{m_i}{m_k} = \frac{c_k}{c_i}$$

Solution

Car Efficiency Factor
From existing mileage requirements and the *requirements defined herein*

From existing and predicted population

$$\frac{e_k}{e_i} = \frac{m_i}{m_k} * \frac{d_k}{d_i} * \frac{p_k}{p_i}$$

From existing emission levels and **Climate-Stabilization-Supporting Target**

The Independent Variable
It becomes the ***required per-capita driving reduction with respect to 2005 driving***

Notes on Methods

- Base year 2005

- Intermediate year 2015

From a California law (**SB 375**) giving per-capita driving reduction targets to be achieved in Regional Transportation Plans

- Car Efficiency Factor from 2005 to 2015
  - Steve Winkelman's data
  - http://www.nrdc.org/globalWarming/sb375/files/sb375.pdf

Report on **SB 375** See its Table 1.

- Car Efficiency Factor, 2015 to 2030
  - Derived in paper
  - Results in car efficiency requirements

- Cars last 15 years

Older cars are so few in number that they can be ignored.

Requirements Defined to Achieve 2030 Fleet Equivalent-Mileage

- Low-Carbon Fuel Standards (LCFS)

  Both California's existing and extended, "L_k"

- Corporate Average Fuel Efficiency (CAFÉ) Standards from 2015 to 2030

  Existing, to 2025
  Specified to 2030

- Driving Reduction Factors (f_n) for bad-mileage years (Year n)

  - For example, 0.75 means 25% less driving
  - **Cash for Gas-guzzlers?**

Two More Requirements Defined to Achieve 2030 Fleet Equivalent-Mileage

- CAFÉ Standards only apply to Internal Combustion Engine (ICE) LDVs

- New Requirement: Fraction of fleet sold that must be ***Zero Emission Vehicles*** (ZEVs)

Define "*z*" to be the fraction of fleet sold that must be ZEVs

Fleet Mileage for Intermediate Year 2015

LDV Set	Years Old	Model Year	CAFE MPG	LCFS Factor L_{Year}	Factor Driven f	Gallons Used Per f*100 Miles
1	14-15	2001	24.0	1.0	1.0	4.17
2	13-14	2002	24.0	1.0	1.0	4.17
3	12-13	2003	24.0	1.0	1.0	4.17
4	11-12	2004	24.0	1.0	1.0	4.17
5	10-11	2005	25.0	1.0	1.0	4.00
6	9-10	2006	25.7	.9933	1.0	3.87
7	8-9	2007	26.3	.9867	1.0	3.75
8	7-8	2008	27.0	.9800	1.0	3.63
9	6-7	2009	28.0	.9733	1.0	3.48
10	5-6	2010	28.0	.9667	1.0	3.45
11	4-5	2011	29.1	.9600	1.0	3.30
12	3-4	2012	29.8	.9533	1.0	3.20
13	2-3	2013	30.6	.9467	1.0	3.09
14	1-2	2014	31.4	.9400	1.0	2.99
15	0-1	2015	32.6	.9333	1.0	2.86
Sum of Gallons:						54.29
Miles = 100*Sum(f's):						1500
MPG = Miles/(Sum of Gallons):						27.63

ZEV Derivation Variables

Variable	Definition
m_z	ZEV Equivalent mileage
m_{zr}	ZEV Equivalent mileage if the electricity is from renewables
m_{zf}	ZEV Equivalent mileage if the electricity is from fossil fuels
r	fraction of electricity generated from sources not emitting CO2
G	Gallons of equivalent fuel used
D	Arbitrary distance travelled
Num	$m_{zr} \times m_{zf}$
Den	$r \times m_{zf} + (1 - r) \times m_{zr}$

ZEV Derivation

$$G = \frac{r \times D}{m_{zr}} + \frac{(1-r) \times D}{m_{zf}}$$

$$m_z = D/G = D/(\frac{r \times D}{m_{zr}} + \frac{(1-r) \times D}{m_{zf}})$$

$$m_z = m_{zr} \times m_{zf}/\left(r \times m_{zf} + (1-r) \times m_{zr}\right)$$

$$m_z = Num/(Den)$$

m_{zr}	m_{zf}	r	1-r	Num	Den	m_z
5000	70	0.8	0.2	350000.00	1056.00	331.44

"Heroic Measures" Assumptions & Mileage

| Year | ICE Parameters and Calculations | | | | | | ZEVs | | | Yearly Totals | | |
	CAFÉ MPG	LCFS	Eq. MPG	f	D_i	G_i	z	D_z	G_z	Total Miles	Total Gallons	2030 MPG
2016	34.3	.9267	37.01	.3	30.0	.8105	0	0	.000	30.0	.8105	37.01
2017	35.1	.9200	38.15	.4	40.0	1.0484	0	0	.000	40.0	1.0484	38.15
2018	36.1	.9133	39.53	.5	47.5	1.2018	.05	5	.015	52.5	1.2168	43.14
2019	37.1	.9000	40.92	.6	54.0	1.3197	.10	10	.030	64.0	1.3498	47.41
2020	38.3	.8500	42.56	.7	52.5	1.2337	.25	25	.075	77.5	1.3091	59.20
2021	40.3	.8000	47.41	.8	48.0	1.0124	.40	40	.121	88.0	1.1331	77.66
2022	42.3	.8000	52.88	.9	40.5	.7660	.55	55	.166	95.5	.9319	102.48
2023	44.3	.8000	55.38	1.0	30.0	.5418	.70	70	.211	100.0	.7530	132.81
2024	46.5	.8000	58.13	1.0	15.0	.2581	.85	85	.257	100.0	.5145	194.36
2025	48.7	.8000	60.88	1.0	5.0	.0821	.95	95	.287	100.0	.3688	271.18
2026	51.2	.8000	64.00	1.0	5.0	.0781	.95	95	.287	100.0	.3648	274.16
2027	53.7	.8000	67.13	1.0	5.0	.0745	.95	95	.287	100.0	.3611	276.92
2028	56.2	.8000	70.25	1.0	5.0	.0712	.95	95	.287	100.0	.3578	279.48
2029	58.7	.8000	73.38	1.0	5.0	.0681	.95	95	.287	100.0	.3548	281.87
2030	61.2	.8000	76.50	1.0	5.0	.0654	.95	95	.287	100.0	.3520	284.10
Sum of Miles and then Gallons of Equivalent Fuel:										1247.5	11.23	
Equivalent MPG of LDV Fleet in 2030:											*111.12*	
Sum of ZEV Miles = **860**. Fraction of Miles Driven by ZEVs = **68.9%**												

Fractions of Fleets Sold in California that are Zero Emission Vehicles AND Required Driving Reduction, For 2 Different Cases

Zero Emission Vehicle (ZEV) Fleet Per-Cent & Required Driving Reduction, Per-Cent "Heroic Measures" Case Versus the "Extra Heroic Measures"					
Year	*2016*	*2017*	*2018*	*2019*	*2020*
Heroic Measures	0%	0%	5%	10%	25%
Extra Heroic Measures	0%	10%	30%	50%	70%
Year	2021	2022	2023	2024	2025 to 2030
Heroic Measures	40%	55%	70%	85%	95%
Extra Heroic Measures	90%	95%	95%	95%	95%

	% Reduction in Per-Capita Driving, with Respect to 2005
Heroic Measures	**32%**
Extra Heroic Measures	**0%**

Calculation of Net Driving Decrease with Respect to 2005 Driving

(Per-Capita Driving Factor) x (Population Factor) = Net Driving Factor

$$(.68) \quad \mathbf{x} \quad (1.23) \quad = \quad .84$$

Even though the population will grow 23%, __net driving must decrease by 16%__.

Therefore, why add lanes?

Measures to Get 32%

Estimated Reduction

- Predictions, Regional Transportation Plans — **10%**
- Stop expanding most roads and all freeways — **2%**
  - No need, Eliminate congestion with less driving
- Reallocate freeway-expansion $$$ to **transit** — **2%**
- **Pricing**, to increase fairness & choice
  - Demonstration projects: unbundle parking cost
  - **Legislation**
    - Unbundle the cost of most "free" or underpriced parking **8%**
    - Equitable and environmentally-sound road-use fees **8%**
- **Smarter growth**, complete streets, bike classes **2%**

32%

An Important Pricing Strategy

A Privacy-Protecting, Road-Use-Fee Pricing & Payout System to Help Solve Climate, Congestion, Deferred Road Maintenance, and the Social Inequity of Using General Funds to Maintain Roads, Since that Money is Needed for Such Things as Transit, Food Stamps, and Education

THEREFORE, BE IT RESOLVED, that DEMCCO supports a road-use fee pricing and payout system that (1) would cover all road-use costs, including the environmental and health costs caused by driving; (2) could still include a fuel tax or fee; (3) would mitigate impacts on low-income users; (4) would protect privacy; (5) would include congestion pricing when that technology becomes feasible; (6) would keep the per-mile price incentive to drive energy-efficient cars at least as large as it is with today's fuel excise tax; and (7) would send its earnings to all citizens and institutions that are losing money under the current system, with the goal being to achieve a full and just compensation.

Another Important Pricing Strategy

Funding for a Demonstration Project of an Equitable and Environmentally-Sound Car-Parking Policy

THEREFORE, BE IT RESOLVED, that DEMCCO supports funding the development and prototype installation of car-parking systems with at least the last two features (numbered 7 and 8), so as to demonstrate useful feasibility, with the full set of features as follows: (1) have full-cost base pricing; (2) have congestion pricing; (3) have charge and payout policies that will minimize money lost by non-drivers, due to parking facilities; (4) will support sharing of parking facilities; (5) will provide retrievable knowledge of the use of each parking space; (6) have a data interface that will support on-demand predictions of parking-space price and availability; (7) have automatic car detection; and (8) will do efficient mailing of invoices, containing both parking charges and parking earnings.

Background Charts

Questions?

Governor's Executive Order S-3-05*

Slide 1 of 4

http://www.dot.ca.gov/hq/energy/ExecOrderS-3-05.htm

- Signed in 2005
- Greenhouse gas (GHG) Emission Trajectory
  - 2000 levels by 2010
  - 1990 levels by 2020**
  - 80% below 1990 levels by 2050
- Achieved by Plans & Status

* **All Laws, Ballot Propositions, and Executive Orders in this paper are for the state of California**

** **AB 32 law mandate. Prop 23 (2010 ballot measure) would have suspended this.**

Governor's Executive Order S-3-05

- Designed to limit C02 to 450 PPM, by 2050

  – Requires other countries to achieve similar reductions

  – Most developed countries have a similar plan

  – 450 PPM must then be brought down to safe levels

> **2050_Level = 2010_Level + f * (Area1 + Area 2)**
> **Area1 = the Area under the S-3-05 trajectory from 2010 to 2020**
> **Area2 = the Area under the S-3-05 trajectory from 2020 to 2050**
> **f = the fraction of emissions that go into the atmosphere**
> **1-f = the fraction of emissions that go into the ocean**

S-3-05 Achievement
Temperature Change (S-3-05 Slide 4 of 4)

- A **50% chance** that temp change stays below 2°C
  - 2°C means
    - Loss of 97% of Coral Reefs
    - 1 to 3 Billion (of 7B or 8B) people experience water stress
    - Elimination of summer ice at North Pole
    - 58% unstable tundra

- **30% chance** of more than 3°C
  - **Exponentially worse than 2°C**

James Hansen: Present level of C02 "already in the dangerous zone" (385 PPM when written)

Car Efficiency Factor

To work with

Equivalent Mileage:

$$\frac{m_i}{m_k} = \frac{c_k}{c_i}$$

To Get the HM* Reductions

GHG Reductions from Cars & Light-Duty Trucks to Support Climate Stabilization
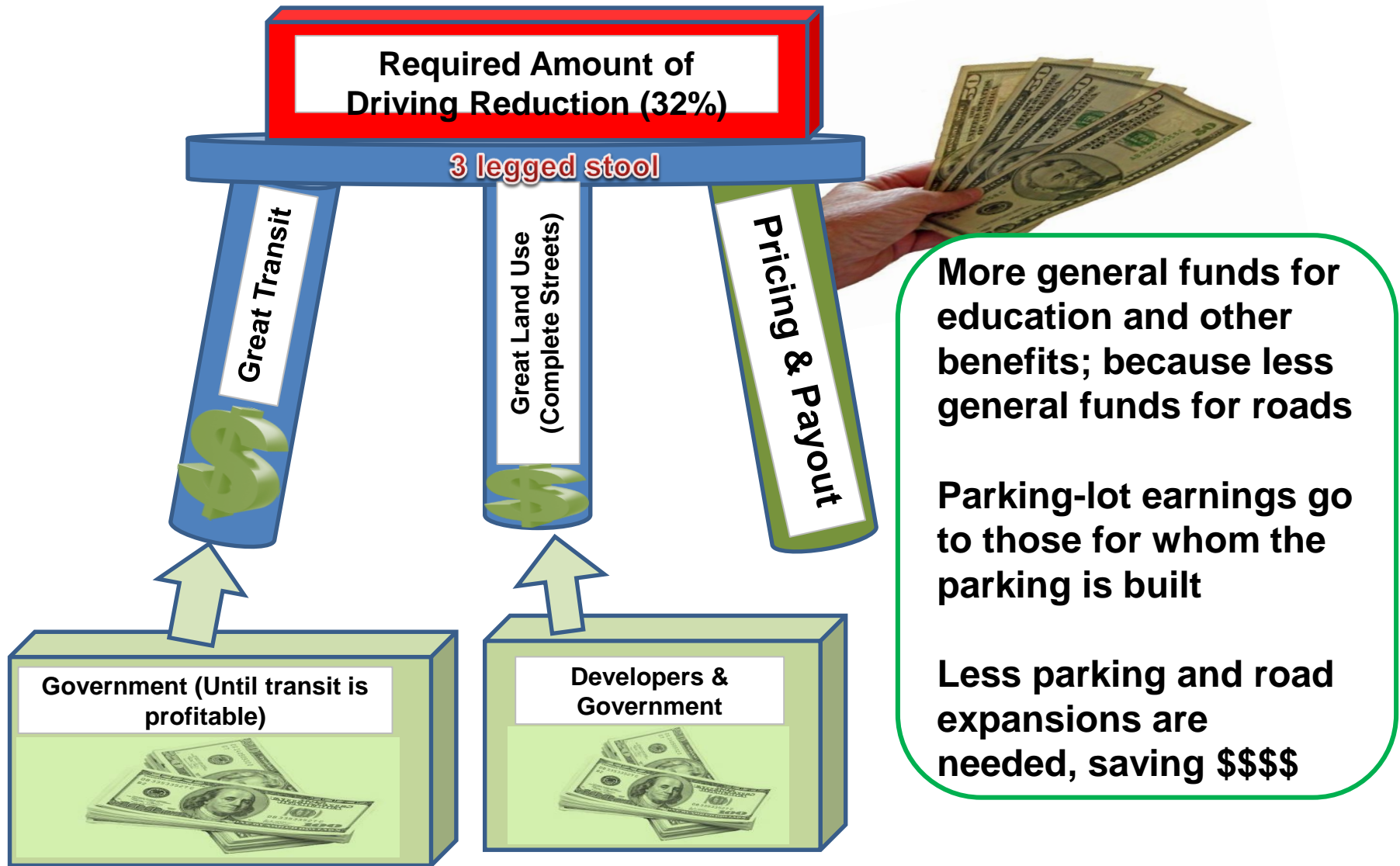
3 legged stool

*HM = Heroic Measures Case

Clean cars

Clean fuels

Less Driving (32%)

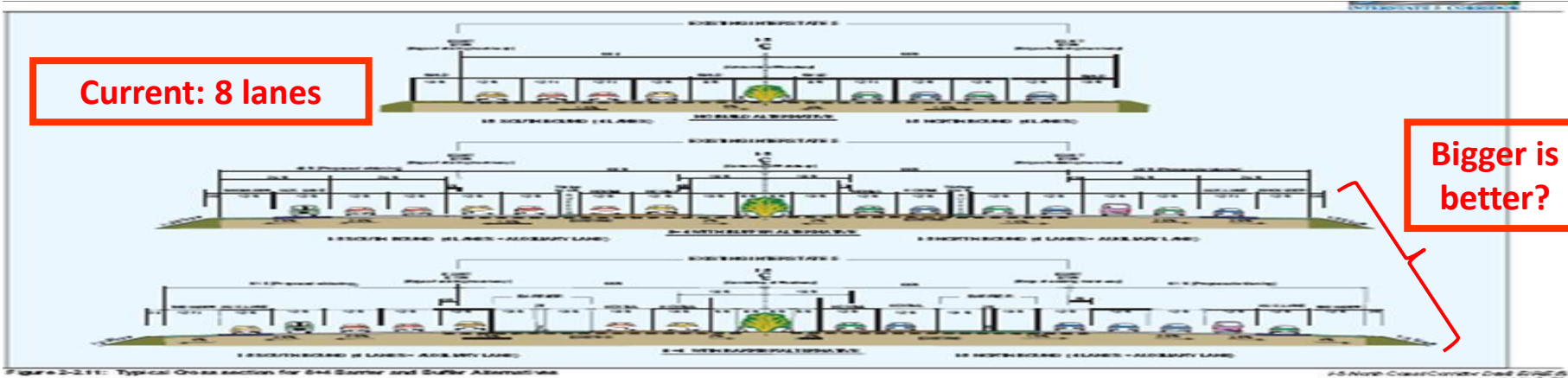In San Diego County, 41% of GHG emissions come from cars and light-duty trucks.

Paper 2013-A-13309-AWMA

Three Solution Categories

Required Amount of
Driving Reduction (32%)

3 legged stool

Great Transit

Great Land Use
(Complete Streets)

Pricing & Payout

Government (Until transit is
profitable)

Developers &
Government

More general funds for
education and other
benefits; because less
general funds for roads

Parking-lot earnings go
to those for whom the
parking is built

Less parking and road
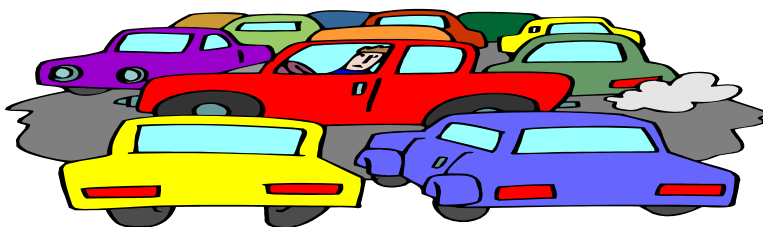expansions are
needed, saving $$$$

Interstate 5

Current: 8 lanes

Bigger is better?

Description, Controversy, Status, and Climate-Change Context

Mike Bullock

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Sierra Club, San Diego Chapter

Project Description

- Four Additional "Managed", AKA "Express" lanes, with Direct Access Ramps (DARs) for Selected Intersections
  - For High Occupancy Vehicles (HOVs), Buses*, and Single Occupancy Vehicles (SOVs) that pay a toll
  - 27 miles, Camp Pendleton to La Jolla Village Drive

- Also has SB 468 Provisions
  - Transit more or less concurrent
  - Requires Coastal Commission Approvals

About $4 Billion.
Does NOT include the I-5/SR-78 intersection

*Why a Bus Rapid Transit (BRT) line, right next to the Coaster? (The Coaster needs to be electrified and automated, to operate 24/7.)

Congestion Controversy

- ## How much congestion & uncertainty is tolerated?
  - ### The same level that is there *now*, on 8 lanes
    - Proof: the people that decide to drive, do so, given the current conditions
      - In spite of congestion
      - In spite of the travel-time uncertainty
  - ### Same level that will (fairly soon) be there, on 12 lanes
    - Potential for driving: LA/Orange County ⟷ SD &Mexico
      - LA and Orange County = 10 Million cars
      - 2 additional lanes in each direction = only 3,200 cars per hour
      - Millions of cars in San Diego County

50% more congested lanes means 50% more driving and 50% more GHG emissions

CALTRANS says congestion will be reduced

Congestion Controversy

- As with I-5, CALTRANS always finds that freeway expansions will "solve congestion"

- Repeated Los Angeles freeway expansions

- LA has the most freeway-lane miles per unit area, resulting in:
  - A Long average commute length
  - High levels of per-capita driving
  - The most air pollution and **congestion**
  - The most per-capita GHG emissions from driving

I-5 Status

- The Final Environmental Impact Report (FEIR) for its Regional Transportation Plan (RTP) *Certified Complete* by SANDAG

Suit brought by Cleveland National Forest Foundation, joined by the Sierra Club and AG Harris. **Certification set aside in Superior Court.** Ruled to be "Impermissibly dismissive of S-3-05". SANDAG is appealing. *CLIMATE PROBLEM*

- Project FEIR *Certified Complete* by CALTRANS

Dec. 2013, Cleveland National Forest Foundation has sued, using the same law firm, *Shute, Mihaly, & Weinberger*, that filed the RTP suit. *CLIMATE PROBLEM*

- SB 468 in Progress; Coastal Commission may decide by August

Adaptation and Mitigation concerns *CLIMATE PROBLEM*

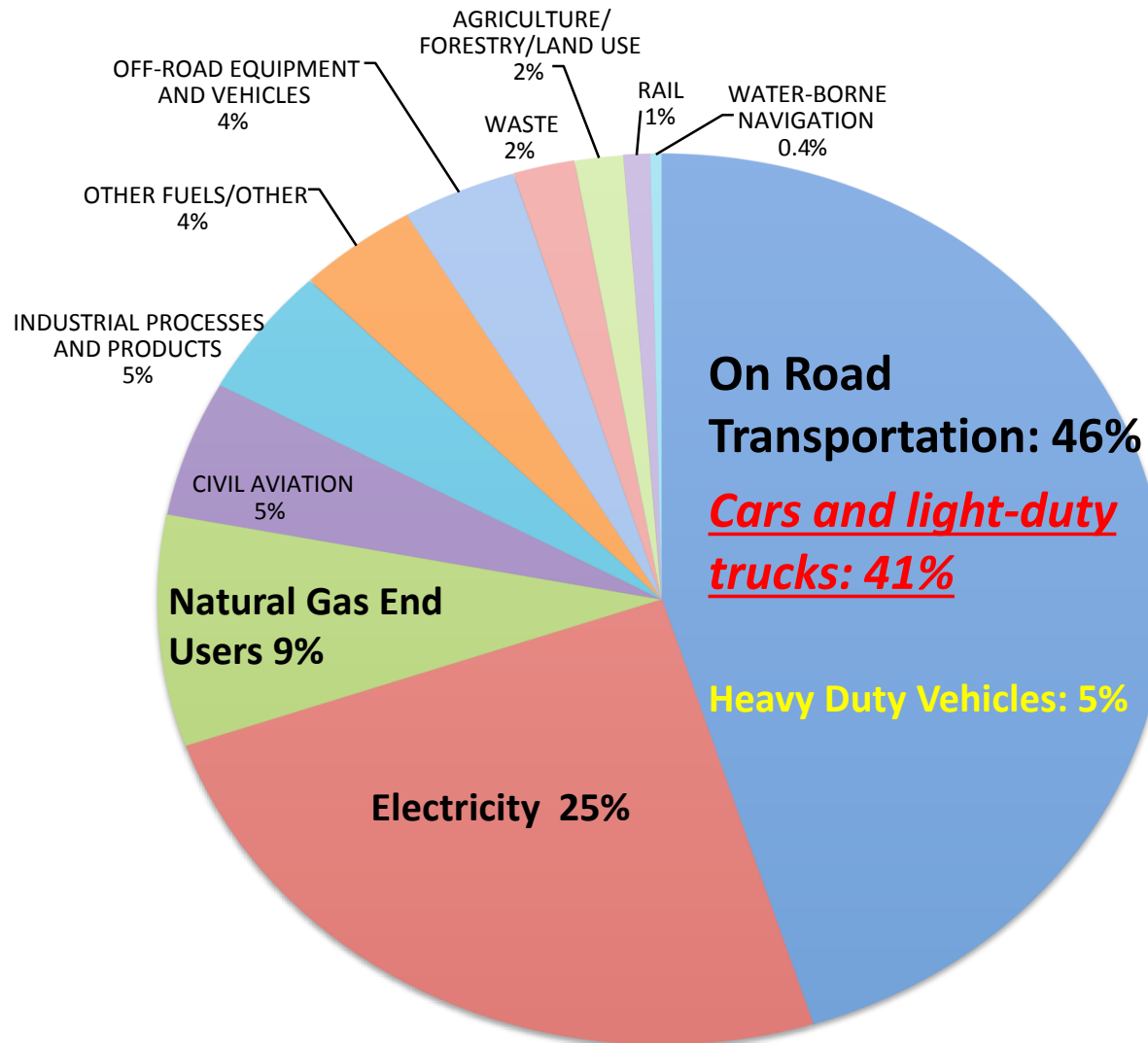# The Coastal Commission's Responsibility Regarding Climate Change

http://www.coastal.ca.gov/climate/whyinvolved.html

The [Coastal Act](#) mandates the California Coastal Commission to "**_protect_**, conserve, restore, and enhance" the state's coastal resources. As a result, the Commission **_must consider climate change_**, including global warming and potential sea level rise, through its planning, regulatory, and educational activities, and **_work to reduce greenhouse gas emissions_** and the detrimental impacts of global warming on our coast.

GHG Emissions, SD County
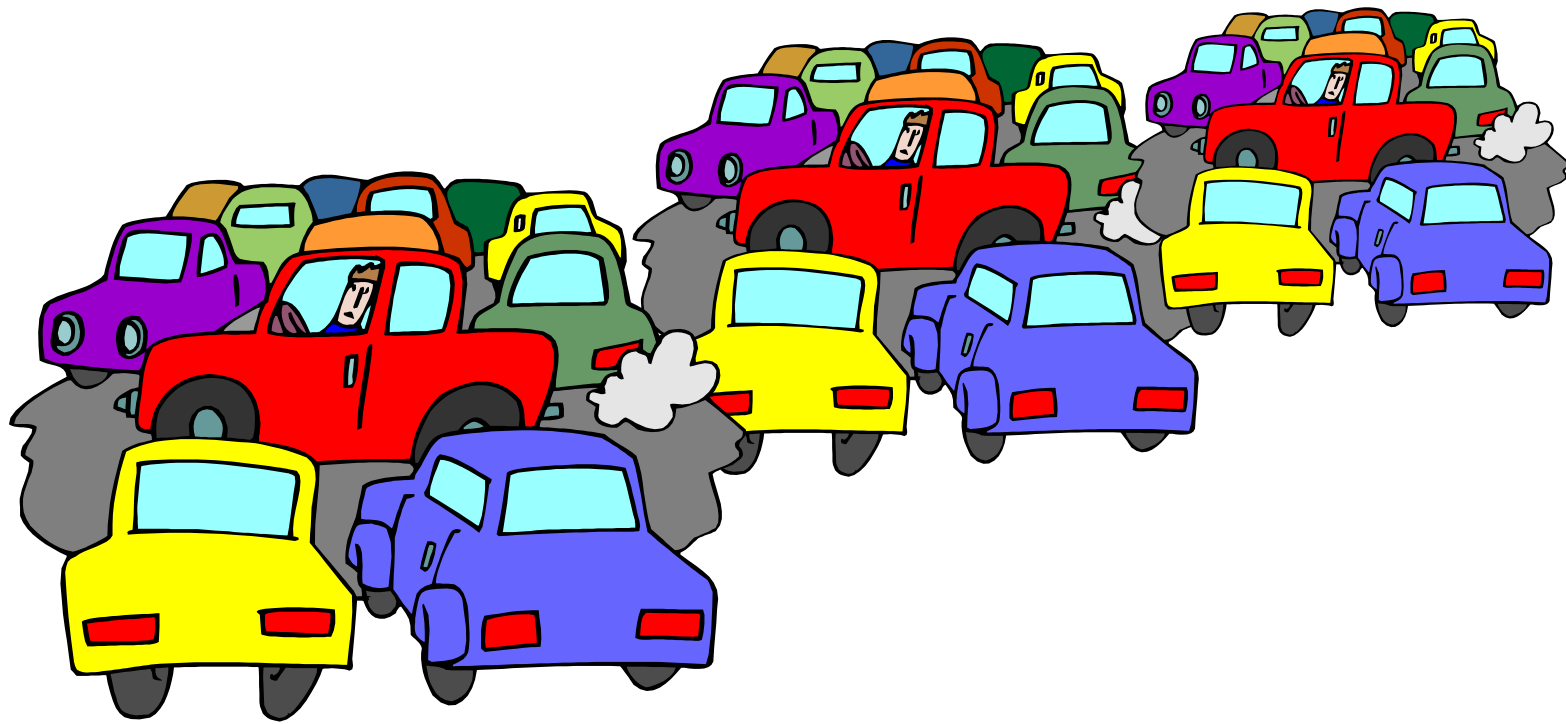
Source: Energy Policy Initiatives Center (EPIC, USD)

http://www.sandiego.edu/EPIC/ghginventory/GHG-On-Road1.pdf.pdf

Pie chart categories:

- **On Road Transportation: 46%**
  - *Cars and light-duty trucks: 41%*
  - Heavy Duty Vehicles: 5%
- **Electricity 25%**
- **Natural Gas End Users 9%**
- CIVIL AVIATION 5%
- INDUSTRIAL PROCESSES AND PRODUCTS 5%
- OTHER FUELS/OTHER 4%
- OFF-ROAD EQUIPMENT AND VEHICLES 4%
- WASTE 2%
- AGRICULTURE/FORESTRY/LAND USE 2%
- RAIL 1%
- WATER-BORNE NAVIGATION 0.4%

A Plan to Efficiently and Conveniently Unbundle Car Parking Costs

- **Motivation (1 slide)**
- **Goals (2 slides)**
- **Definitions and Methods (7 slides)**
- **Implementation (2 slides)**

American drivers park "free*" at the end of 99% of their vehicle trips**.

the cost is bundled, reducing wages and/or increasing other costs, such as rent

**http://bikesiliconvalley.org/content/1155

Motivation

- Fairness to individuals
  - Costs no longer hidden
  - Costs mostly recovered, by not using parking
- Less driving, to reduce environmental harm
  - Motivates choosing alternative modes
  - Less driving to find parking
- More Efficient Development
  - Less parking needed reduces land and building costs

Results of 3 Actions, Including Cashout

Case (#1), Reference Patrick Siegman's article in Bicycle Pedestrian Federation

- Company: CH2M Hill
  - Location: Bellevue, Wa (Seattle suburb)
  - Engineering Firm with 430 employees

- Actions
  - $54/month (1995 $'s), *to not drive*
  - Improved Transit
  - Improved Bike/Pedestrian facilities

CH2M Hill Work Trips		
Mode	*Before*	*After*
Drive Alone	**89%**	**54%**
Carpool	**9%**	**12%**
Bus	**1%**	**17%**
Bike, Walk	**1%**	**17%**
	100%	*100%*

This case is not used in the tabulation of pricing results (next chart)

It shows that double-digit reductions in driving can cause triple-digit increases in transit usage. (Quadruple digit here: 1,600%.)

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	100%	*100%*

This case is not used in the tabulation of pricing results (next chart)

It shows that double-digit reductions in driving can cause triple-digit increases in transit usage. (Quadruple digit here: 1,600%.)

Cashout Results

(11 Locations, 3 Groups, 1995 Dollars)

Money Matters !!!!!

- Reference: *How to Get Paid to Bike to Work: A Guide to Low-traffic, High- Profit Development* by Patrick Siegman*. Published in *Bicycle Pedestrian Federation of America*, 1995.

- 3 Largest Responses
  - 38%, 36%, 31%
- 3 Smallest Responses
  - **15%** , 18%, 24%

*Patrick Siegman, of Nelson Nygaard

Impact of Financial Incentives on Parking Demand			
Location	**Scope**	**1995 dollars per mo.**	**Parking Use Decrease**[1]
Group A: Areas with little or no public transportation			
CenturyCityDistrict, West Los Angeles	3500 employees at 100+ firms	$81	15%
Cornell University, Ithaca, NY	9000 faculty & staff	$34	26%
San Fernando Valley, Los Angeles	1 employer, 850 employees	$37	30%
Costa Mesa, CA		$37	22%
Average for Group		**$47**	**23%**
Group B: Areas with fair public transportation			
Los Angeles Civic Center	10000+ employees, several firms	$125	36%
Mid-Wilshire Blvd., Los Angleles	1 mid-size firm	$89	38%
Washington DC Suburbs	5500 employees at 3 worksites	$68	26%
Downtown Los Angeles	5000 employees, 118 firms	$126	25%
Average for Group		**$102**	**31%**
Group C: Areas with good public transportation			
University of Washington, Seattle Wa.	50,000 faculty, staff & students	$18	24%
Downtown Ottowa, Canada	3500+ government staff	$72	18%
Bellevue, WA	1 firm with 430 employees	$54	39%[2]
Average for Group, but not Bellevue Washington		**$45**	**21%**
Over All Average, Excluding Bellevue Washington			**25%**

[1]**Parking vacancy would be higher!** [2]**Not used, since transit & walk/bike facilities also improved.**

Cashout Results References

At **http://moderntransit.org/cashout/cashoutref.html**

- Reference: *How to Get Paid to Bike to Work: A Guide to Low-traffic, High-profit Development* by Patrick Siegman*. Published in *Bicycle Pedestrian Federation of America,* 1995.
- Above reference listed the following references:

1.) Cornell University Office of Transportation Services. 1992. "Summary of Transportation Demand Management Program," Unpublished.

2.) Garcia, Roul. 1993. "TDM at Rockville Center," Urban Land, Nov. 1993, 21-23.

3.) Miller, Gerald K. . 1991. "The Impacts of Parking Prices on Commuter Travel," Metropolitan Washington Council of Governments, Washington, DC.

4.) Shoup, Donald and Don Pickrell. 1980. "Free Parking as a Transportation Problem," (Washington D.C.: U.S. Department of Transportation).

5.) Shoup, Donald 1992. "Cashing Out Employer-Paid Parking," Report No. FTA-CA-11-0035-92-1 (Washington D.C.: U.S. Department of Transportation).

6.) Shoup, Donald and Richard W. Willson.. 1992. "Employer-Paid Parking: The Problem and Proposed Solutions," Transportation Quarterly, Vol. 46, No. 2, 169-192.

7.) Surface Transportation Policy Project. 1994. "Employers Manage Transportation: State Farm Insurance Company," Surface Transportation Policy Project, Washington DC.

8.) United States Department of Transportation. 1990. "Proceedings of the Commuter Parking Symposium," USDOT Report No. DOT-T-91-14, Washington, DC.

9.) Williams, Michael E. and Petrait, Kathleen L.. 1994. "U-PASS: A Model Transportation Mangement Program That Works," Transportation Research Record 1404, 73-81.

10.) Willson, Richard W. and Donald C. Shoup. 1990. "Parking Subsidies and Travel Choices: Assessing the Evidence," Transportation, Vol. 17b, 141-157.

11.) Willson, Richard W. 1991. "Estimating the Travel and Parking Demand Effects of Employer-Paid Parking," Regional Science and Urban Economics, Vol. 22 (1992), 133-145.

Goals, 1 of 2

- One agency operates all parking
- Nearly all parking is shared
- Parking costs are *in effect* (or literally) unbundled
  - From wages and rents
  - From costs of goods and services
- No change to how parking gets built
  - Generally, municipalities require & developers build

Goals, 2 of 2

- Priced right
  - Base price derived from costs
  - Driver demand determines a congestion price
- No need to search for parking
  - Directions to parking that meets user's needs
  - Accurate price predictions
- Each parking space's use is archived
  - Supports informed decisions
- Privacy and the needs of the disabled are supported
- Neighborhood interests are protected

Definitions and Methods, 1 of 7

- Definition & Examples of **_Parking Beneficiary Group_**
  - Owners
    - Private investors or governments operating public parking
  - Those losing money due to provided parking
    - Employees
    - Apartment renters or condominium owners
    - Hotel or restaurant patrons
    - Shoppers
  - Those offered specific parking
    - Driving-age students at a school with parking
    - Driving-age train riders using a station with parking

Definitions and Methods 2 of 7

- How to Unbundle
  - Price charged per unit time
    - Base price rate established to cover all costs
    - Congestion price rate
      - Dynamically set as a function of occupancy rate
      - Charge is time average, if rate changes, while car is parked
  - Parking generally available to all drivers
  - Earnings distributed to members of _Beneficiary Group_
    - Calculation of individual's earnings depends on situation

Definitions and Methods, 3 of 7

- Calculation of monthly earnings
  - If parking is provided for several groups, each group's portion of the earnings is proportional to its original contribution to cost (Mixed use case)
  - Each beneficiary group's total is divided up among its members
    - Condominium owners: proportional to spaces effectively purchased
    - Renters: proportional to spaces effectively renting
    - Shoppers: proportional to money spent
    - Employees or students of driving age: proportional to time spent at work or school
    - Train riders of driving age: proportional to time spent on round trips

Definitions and Methods, 4 of 7

- ## Definition of *Cluster of Parking*
  - 20 to 40 contiguous spaces with similar desirability
  - All spaces have the same price

Cluster Parking Space Pricing Variables Defined	
$r_{BaselineHourly}$	the computed baseline hourly rate to park
$r_{Investment}$	yearly return on investment, such as .07 ("cost of money")
$v_{Parking}$	value of a parking space, such as (parking garage) $40,000
c_{YOPD}	yearly cost of operations plus depreciation, such as $100
$n_{HoursPerYear}$	number of hours in a year = 8760
f_{TO}	fraction of time occupied (yearly), such as .55
$r_{HourlyRate}$	the computed hourly rate to park (could include multiplier)
V	the vacancy rate percent, such as 17.5, for 7 vacancies in a cluster of 40 parking spaces
B	the base of the multiplier being computed, such as 2.15

Definitions and Methods, 5 of 7

- Pricing
  - Base price $r_{BaselineHourly} = \dfrac{\left(r_{Investment} \times v_{Parking}\right) + c_{YOPD}}{\left(n_{HoursPerYear} \times f_{TO}\right)}$
    - Covers all costs
    - Report's Pages 13 & 14 provide details
  - Congestion price, for each cluster

$$r_{HourlyRate} = r_{BaselineHourly} \times \left(B^{(30-V)/5}\right), for\ V < 30;\ r_{BaselineHourly}\ ,otherwise$$

    - Hourly rate = Baseline hourly, unless vacancy falls below 30%
    - B is nominally 2; adjusted to keep vacancy above 15%
    - Report's Eq. 2 and Table 2 (Pages 14 & 15) provide details

Definitions and Methods, 6 of 7

- Pricing predictions
  - For any set of dates, start times, durations, and destinations
  - Availability of predictions
    - Broadcast into navigational units
    - Website or phone
    - Pay stations
- Help to find desired parking
  - Driver gives times and locations and stipulates . . .
    - Max price, to get space at minimum walk distance
    - Max walk distance, to get space at minimum price
  - Voice-activated navigational system for ease and safety

Definitions and Methods, 7 of 7

- Monthly statements
  - All parking charges and earnings
  - Customer selects presentation detail
    - Less detail for ease and more privacy
    - More detail to know and adjust parking decisions
  - Packaged with other statements
    - All utilities, transit use, road use

Implementation Plan, 1 of 2

- Reduced- feature, demonstration project
  - No congestion pricing and no predictions
  - Automated car detection
  - Automated monthly statements
  - Success allows next steps
- Write a requirements document to support a request for proposal (RFP)
- Winning proposal leads to design

Implementation Plan, 2 of 2

- Government agency develops and executes installation strategy
  - To minimize impact on institutions
  - To maximize early success and driving reductions
    - Large employment centers with "free" parking
    - Train stations with large, "free" parking lots
  - Supported by new laws requiring cooperation but very little effort, from . . .
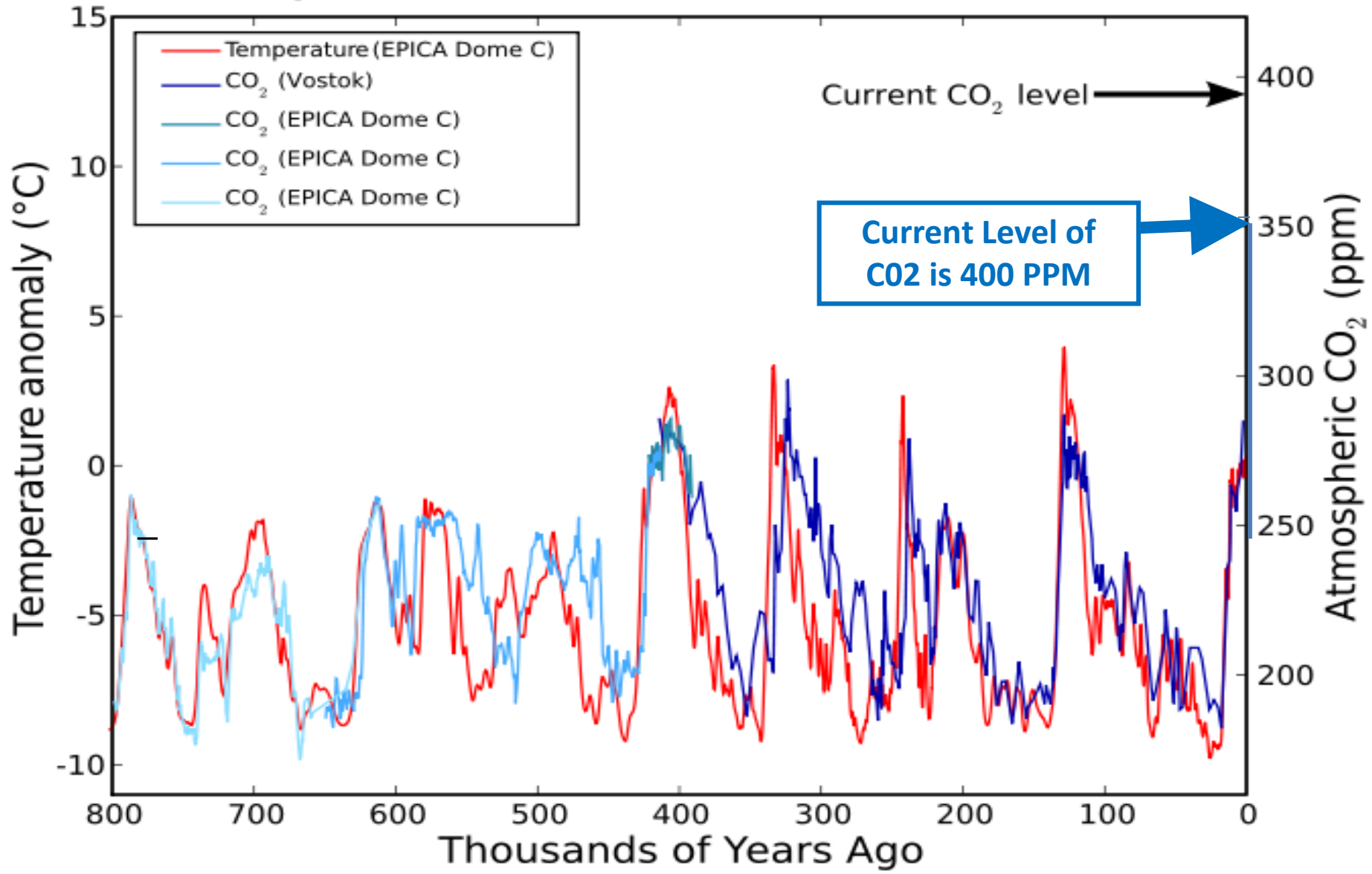   - Private and public institutions
    - Individuals

GHG From Driving

Source: Energy Policy Initiatives Center (EPIC, USD)

- http://www.sandiego.edu/EPIC/ghginventory/GHG-On-Road1.pdf.pdf

  - **In San Diego County, emissions from on-road vehicles are about 46% of regional GHG emissions.**

- 41% are from cars and light-duty trucks

Temperature and CO$_2$ Records

Legend:
- Temperature (EPICA Dome C)
- CO$_2$ (Vostok)
- CO$_2$ (EPICA Dome C)
- CO$_2$ (EPICA Dome C)
- CO$_2$ (EPICA Dome C)

Current CO$_2$ level → 400

Current Level of C02 is 400 PPM

Y-axis (left): Temperature anomaly (°C)
Y-axis (right): Atmospheric CO$_2$ (ppm)
X-axis: Thousands of Years Ago

SB 375, Passed in 2008

http://www.nrdc.org/globalwarming/sb375/files/sb375.pdf

http://en.wikipedia.org/wiki/SB_375

- For cars and Light-duty trucks
- Key provision
  - California Air Resources Board (CARB) Provides **vehicle-miles-travelled (VMT) reduction targets**
    - For years 2020 and 2035
    - To Metropolitan Planning Organizations (MPO)
    - Computed in **Regional Transportation Plans (RTP)**
    - Local MPO, San Diego Association of Governments (SANDAG), produced the first post-SB375 RTP

From the Report

Fractions of Fleets Sold in California that are Zero Emission Vehicles, For 2 Different Cases*

Cases	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	20292	2030
HM	.00	.00	.00	.05	.10	.25	.40	.55	.70	.85	.95	.95	.95	.95	.95	.95
EHM	.00	.10	.30	.50	.70	.90	.95	.95	.95	.95	.95	.95	.95	.95	.95	.95

***Heroic Measures** (EM) Case and the *Extra Heroic Measures* (EHM) Case, Which Supports 2005 Per-Capita Driving*

Case	Per-Capita Driving Reduction with Respect to 2005
HM	32%
EHM	0%

SB 375, Passed in 2008

GHG Reductions from Cars & Light-Duty Trucks to Support Climate Stabilization

In San Diego County, 41% of GHG emissions come from cars and light-duty trucks.

3 legged stool
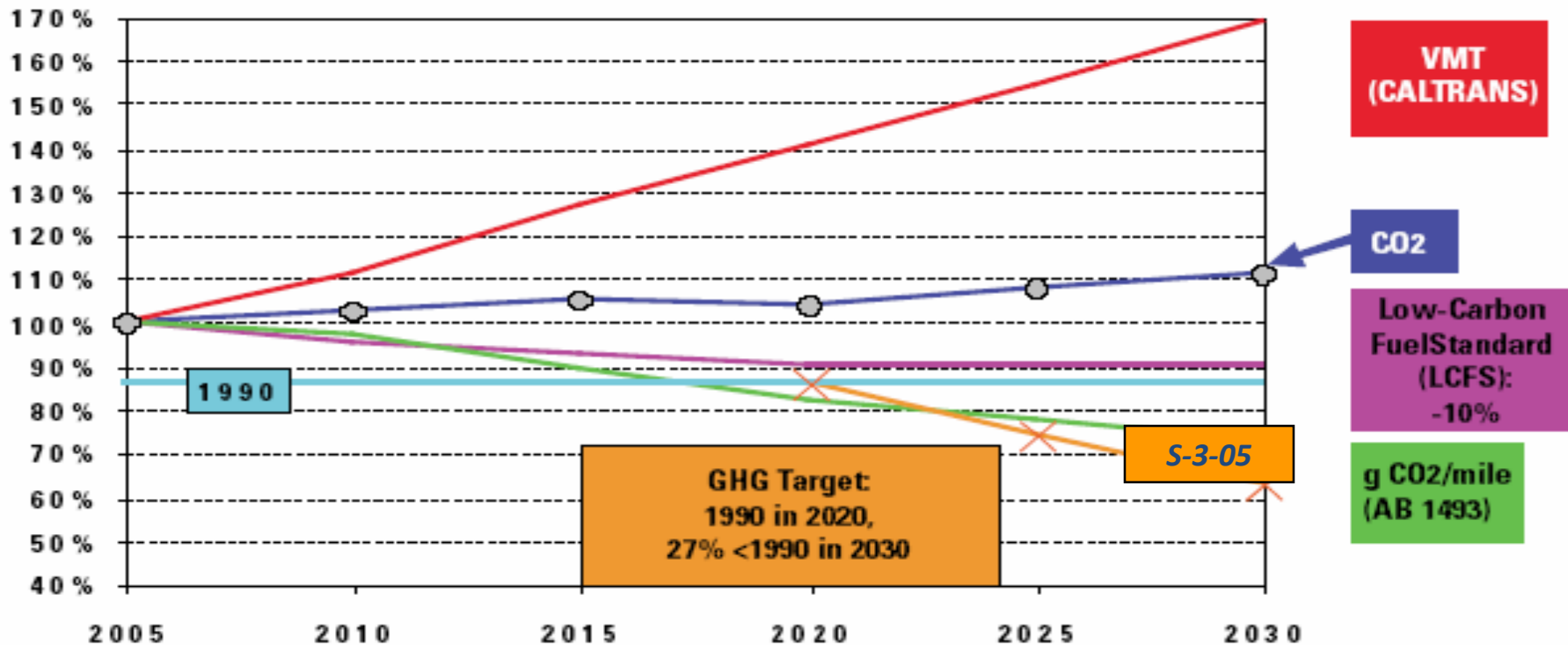
Clean cars

Clean fuels

Less Driving

Data to Support Calculations

Purple (Low carbon fuel), Green (C02/Mile), & Gold (S-3-05)

In San Diego County, 41% of GHG emissions come from cars and light-duty trucks.

From **A Guide to SB 375** comes the words and plot shown as **Figure 1**.

Figure 1: Increasing VMT Threatens to Overwhelm Greenhouse Gas Savings From Cleaner Fuels and Vehicles

VMT (CALTRANS)

CO2

Low-Carbon FuelStandard (LCFS): -10%

g CO2/mile (AB 1493)

S-3-05

GHG Target: 1990 in 2020, 27% <1990 in 2030

1990

Source: S. Winkelman.
Based on CALTRANS VMT forecast, AB 1493 and LCFS.

Center for Clean Air Policy
Dialogue. Insight. Solutions.

SB 375's Per-Capita VMT Reduction for 2035, to Support S-3-05

Variable Name	Definition	Taken From
f	net factor of the emissions of Greenhouse Gas	Gold Line[1]
f_Pavley	factor of the average statewide mileage	Green Line[1]
f_Fuel	factor of the reduction of GHG due to low-carbon fuels	Purple Line[1]
f_Population	factor of the population in the region of interest	CARB[2]
f_PerCapitaVMT	factor of per capita driving	Computed

[1]From the Chart constructed by Steve Winkleman, as shown in the "Guide to SB 375" report.

[2]Population estimates are from CARB's http://arb.ca.gov/cc/sb375/mpo.co2.reduction.calc.pdf. Namely 3,034,388 for 2005 and 3,984,753 for 2035. So f_Population = 1.314

$$f = f\_PerCapitaVMT * f\_Population * f\_Pavley * f\_Fuel$$

$$f\_PerCapitaVMT = f / (f\_Population * f\_Pavley * f\_Fuel)$$

Per-Capita VMT Reduction for 2035, as Required by S-3-05

$f\_PerCapitaVMT = f / (f\_Population * f\_Pavley * f\_Fuel)$

$f\_PerCapitaVMT = 0.525 / (1.313 * 0.685 * 0.9)$

$f\_PerCapitaVMT = \mathbf{0.649}$

This is a 35.1% decrease in per-capita VMT.

The population factor of 1.313 is specific to San Diego County.

Because .649 * 1.313 = **.8515**, in 2035, the people in San Diego County must drive 15% less than they did in 2005, even with the 31.3% increase in population. ***Therefore, why add lanes?***

The Environmental Impact Report (EIR) for SANDAG's Regional Transportation Plan (RTP)

Slide 1 of 4

- Driving reduction with respect to 2005 (SB 375 target conventions) to support S-3-05
  - As computed, **35.1%** needed (***NOT COMPUTED in EIR***)
  - As documented in **Environmental Impact Report (EIR)**, RTP only achieves 14%
  - Stated that it could ignore S-3-05

The Environmental Impact Report (EIR) for SANDAG's RTP

- Attorney General Kamala Harris (AG) letter (9/16/11): Could not ignore S-3-05 under California Environmental Act (CEQA)

- Congressman Filner's speech to SANDAG: "you will have legal problems" (10/28/11)

- Cleveland National Forest Foundation (CNFF) and the Center for Biological Diversity (CBD) Filed a Law Suit, 11/25/11

- Joined by AG & Sierra Club California, 1/23/12

The EIR for SANDAG's RTP

- County Superior Court ruling on RTP's Environmental Impact Report (EIR), 12/3/12
  - "**impermissibly dismissive of S-03-05**"
  - Can't "kick the can down the road"
  - Set aside EIR Certification

> Judge Taylor, who was appointed by a Republican Governor

- SANDAG appealed
  - Appellant Court ruling could be a month away

The EIR for SANDAG's RTP

- CEQA Problem
  - Negative impacts must be described
    - Even *cumulative*, if "project" (RTP) contributes
    - Climate destabilization is a negative impact
    - What would it take to avoid climate destabilization?
    - S-3-05 and its evaluated outcomes can show the way
  - Mitigations must be evaluated for feasibility
  - Feasible mitigations must be adopted
- Reality problem
  - Mitigations can't be worse than destabilization

Conclusion, 1 of 2

- Remedies achieve, conservatively, 25%

- Approved RTP achieves 14%

- Total (25% + 14%) exceeds the required 35.1%

- Under CEQA, "remedies" are feasible mitigations
  - A comprehensive road-use fee pricing and payout system would be feasible for the State, not a region
  - Unbundling the cost of parking
    - *Paper 2010-A-554-AWMA*, AWMA's 103rd Annual Conference and Exhibition; Calgary, Canada, June 21-24, 2010.
  - www.sandiego.gov/environmentalservices/pdf/sustainable/parkingcosts.pdf

Conclusion, 2 of 2
From the Paper

This paper shows how Steve Winkelman's data (from Reference 6) can be used to compute driving reductions that support S-3-05 and how those reductions can be achieved (the remedies). When MPO's prepare an environmental impact report for their RTP, they are taking a legal risk if they can't show, *quantitatively*, that their proposed plan supports climate stabilization. After all, climate destabilization is an overwhelming negative environmental impact. Our survival depends on all governments adopting the golden rule, applied to climate: emit GHG as you would have others emit GHG. The trajectories provided by climate scientists must be achieved in every region, state, and country; in each economic sector. Cars and light-duty trucks in San Diego County are no exception. The San Diego County Superior Court Judge was correct. SANDAG was "impermissibly dismissive of S-3-05" and **it is far too late to be "kicking the can down the road".**

Questions?