Reducing Vehicle Emissions to Meet Environmental Goals

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California Air Resources Board

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Less Summertime Smog

	# of Smoggy Days		
	1989	2008	Change
South Coast	205	134	34%

Less Particle Pollution

	Decrease in Particle Pollution[1] 2000-2007
San Bernardino	**32%**
Roseville	**32%**
Visalia	**15%**

[1] PM2.5

What More is Needed to End Urban Pollution?

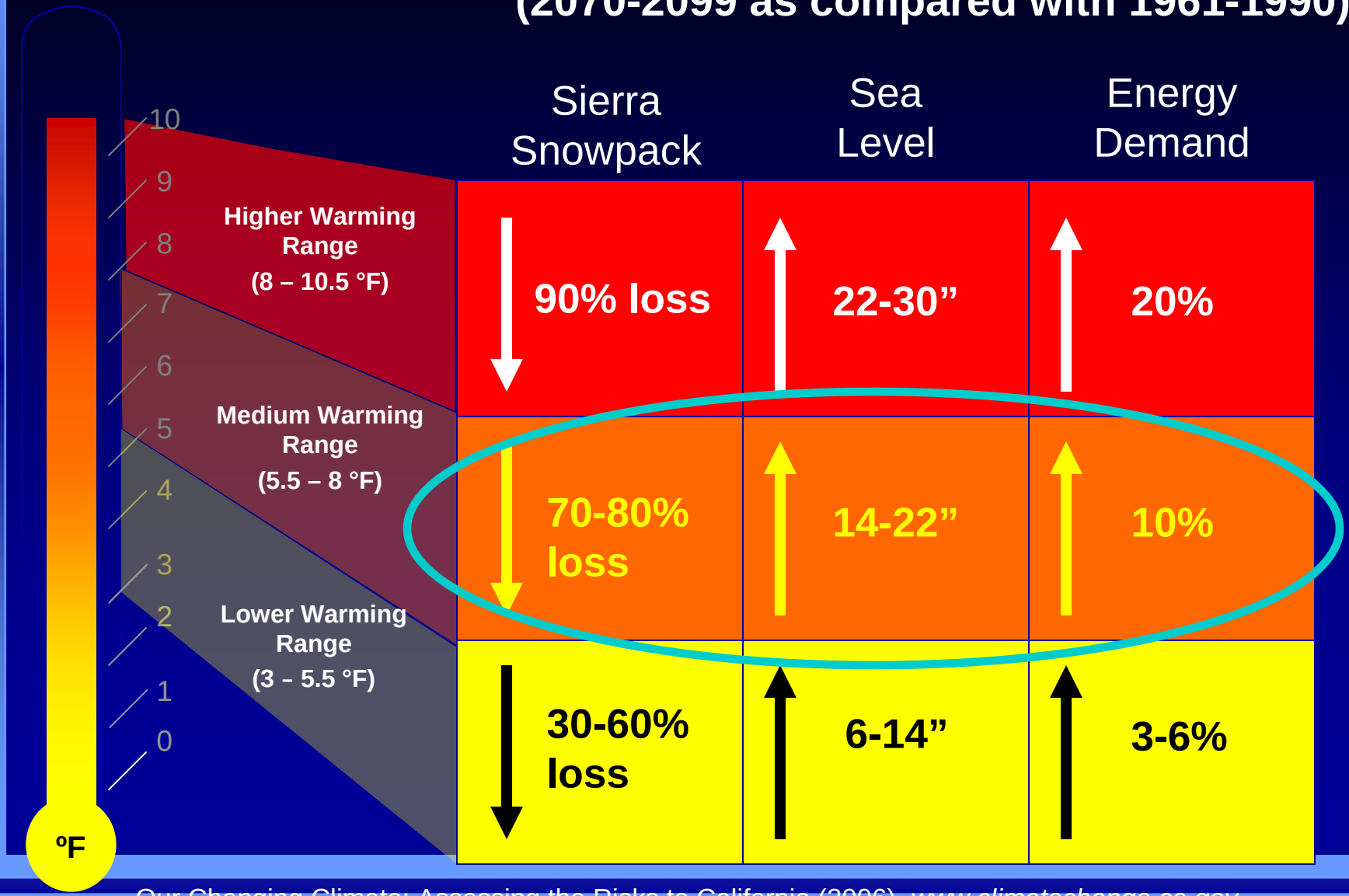
- Future passenger vehicles as clean as the best today (SULEV)
- New Diesel trucks/equipment 95+% cleaned up
- Accelerated turnover
  - $50+ million/yr scrapping passenger vehicles
  - Retrofit 90+% of legacy diesel vehicles
- Clean up many remaining smaller sources
- Clean ambient air standards will be met
  - PM2.5 by 2015
  - Ozone by 2023

New Challenge - Climate Change

- Goal: stabilize global temperature

Climate Change: Impacts on CA

(2070-2099 as compared with 1961-1990)



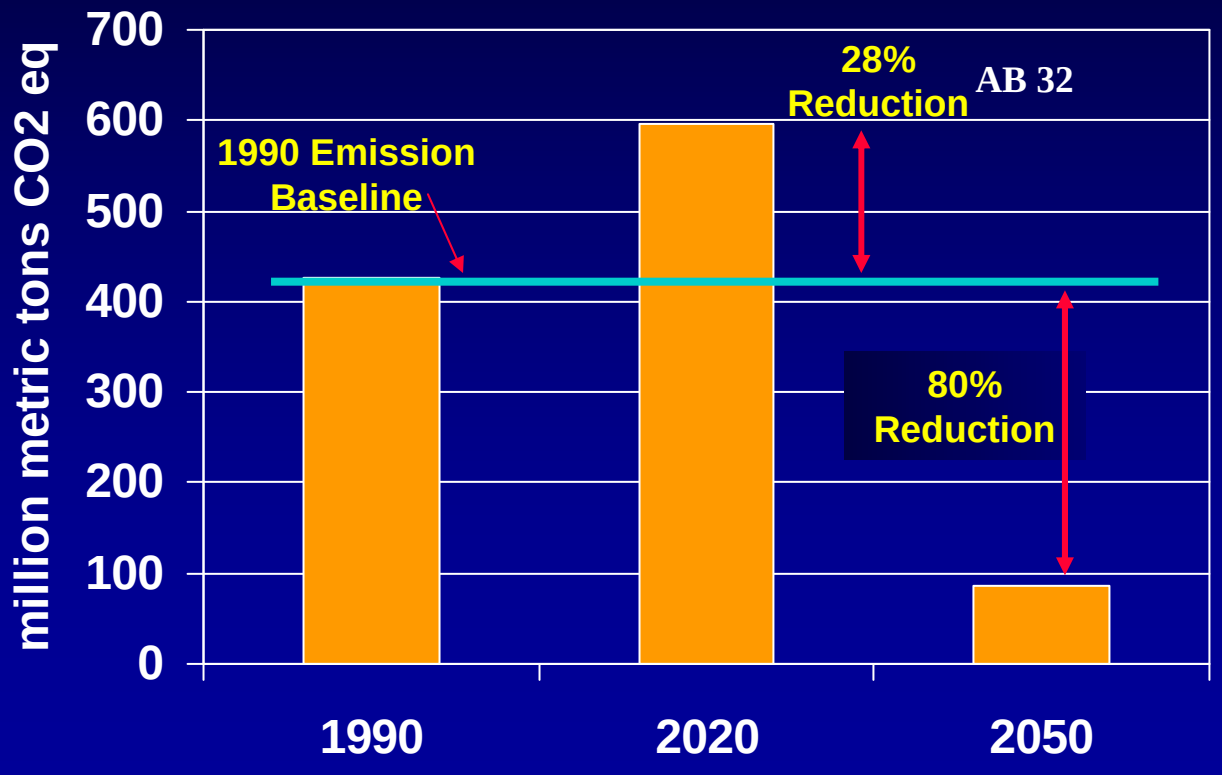
Our Changing Climate: Assessing the Risks to California (2006), *www.climatechange.ca.gov*

New Challenge - Climate Change

- Goal: stabilize global temperature
- 80% reduction in CO_2e emissions by 2050

Magnitude of the Challenge

All Sources



California

Climate Change - Formula for Success

- Basic formula for success:
  1. Increase vehicle efficiency by ~3X

Efficient Technologies - Three Phases

Model Years	Regulatory Driver	GHG Reduced*	Technology
Now -2016	Pavley 1	30%	Conventional drive trains – off the shelf technologies

* From baseline

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     - Few vehicles in 2050 still use high carbon fuels

Efficient Technologies - Three Phases

Model Years	Regulatory Driver	GHG Reduced*	Technology
Now -2016	Pavley 1	30%	Conventional drive trains – off the shelf technologies
2017-2025	Pavley 2	40-50%	Hybrid drive trains Less weight
2015-2050	ZEV 2	80+%	Electric drive Ultra low carbon fuels

* From baseline

Most vehicles need to be like these by 2050

Transportation Vision: 2050
One Possible Scenario

GHG 2050

Reduce passenger vehicle GHG by 87%

Conventional

% veh.	10%
mpg	40 mpg

Biofuel/HEV

% veh.	18%
mpg	60 mpg

Electric/H2

% veh.	72%
mpg	80+ mpg

Timing: Introduction of Ultra-Low Carbon Vehicles

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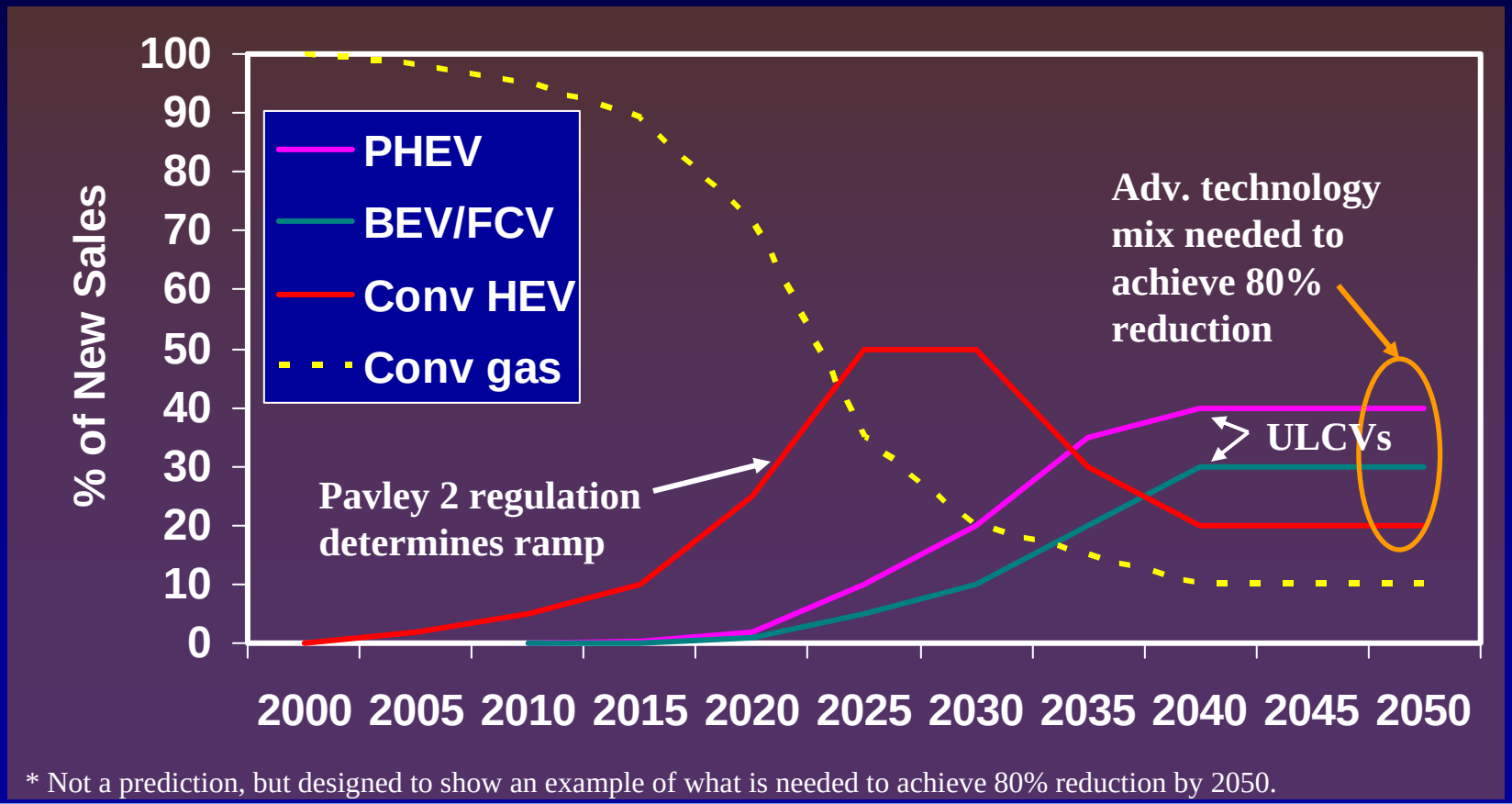
Commercial expansion	~1% → max. market acceptance	15 (2035)
Fleet turnover	Remain at max. market acceptance	15 (2050)

Example of Possible* Ultra Low Carbon Vehicle Introduction Rates



* Not a prediction, but designed to show an example of what is needed to achieve 80% reduction by 2050.

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  2. Transition from petroleum to ultra low carbon-fueled vehicles
     - Few vehicles in 2050 still use high carbon fuels
  3. Reduce VMT (~20%)
  4. Do the same for all other sources (including rest of transportation)

Summary

- Conventional technologies provide near-zero smog emissions
  - Will solve urban pollution problem
- New technologies required to address climate change
  - High efficiency (3X current) - electric drive necessary
  - Ultra-low carbon fuels e.g. e^- and H_2
    - Multiple transportation fuels likely
  - Commercialization must start in next decade