Implications of Defining and Achieving California's 80% Greenhouse Gas Reduction Goal

Steven R. Schiller

Senior Advisor, California Institute for Energy and Environment
University of California, Office of the President
http://ciee.ucop.edu/

ciee

Study Objectives

- The California Institute for Energy and Environment (CIEE) has undertaken this small, heuristic study to direct attention, encourage discovery, and stimulate further investigation on the implications of the 2050 goal.

- The study points out the magnitude of the goals and implications for:
  - Required reductions
  - RD&D and investment policy
  - Policy directions
  - State goal setting options

Starting Point

On June 1, 2005 Governor Arnold Schwarzenegger announced greenhouse gas (GHG) emission reduction targets for California at the United Nations World Environment Day in San Francisco. The Governor signed Executive Order S-3-05, which establishes these GHG targets and charges the California Environmental Protection Agency (Cal/EPA) secretary with the coordination of the oversight of efforts to achieve them. One of the goals is a reduction of GHG emissions to 80% below 1990 levels by 2050.

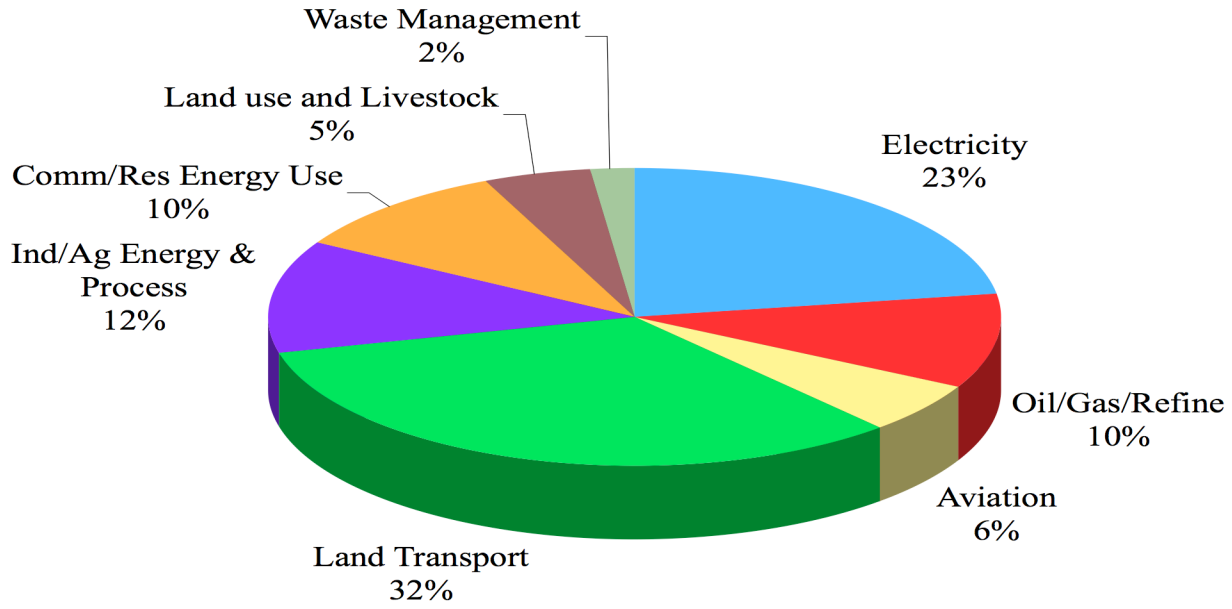
-

Presentation Topics

- California's GHG footprint
- Estimated magnitude of reductions required to meet 2050 goal
- Why an 80% reduction goal
- How might the goal be reached
- Implications of the reduction goal

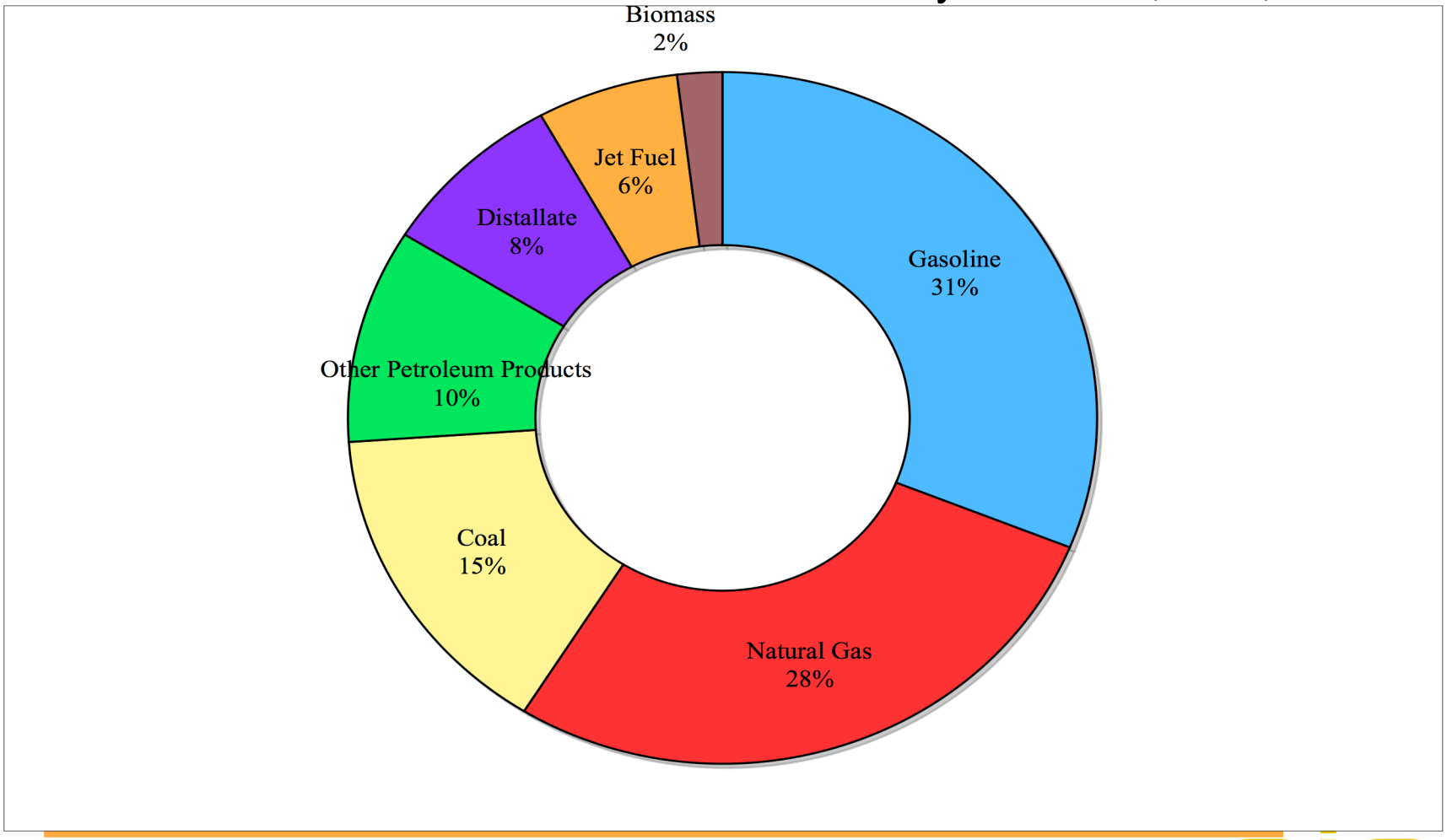
California's GHG Footprint
Primary Uses

Source: CARB CA GHG Inventory for 1990 (8/27/07)



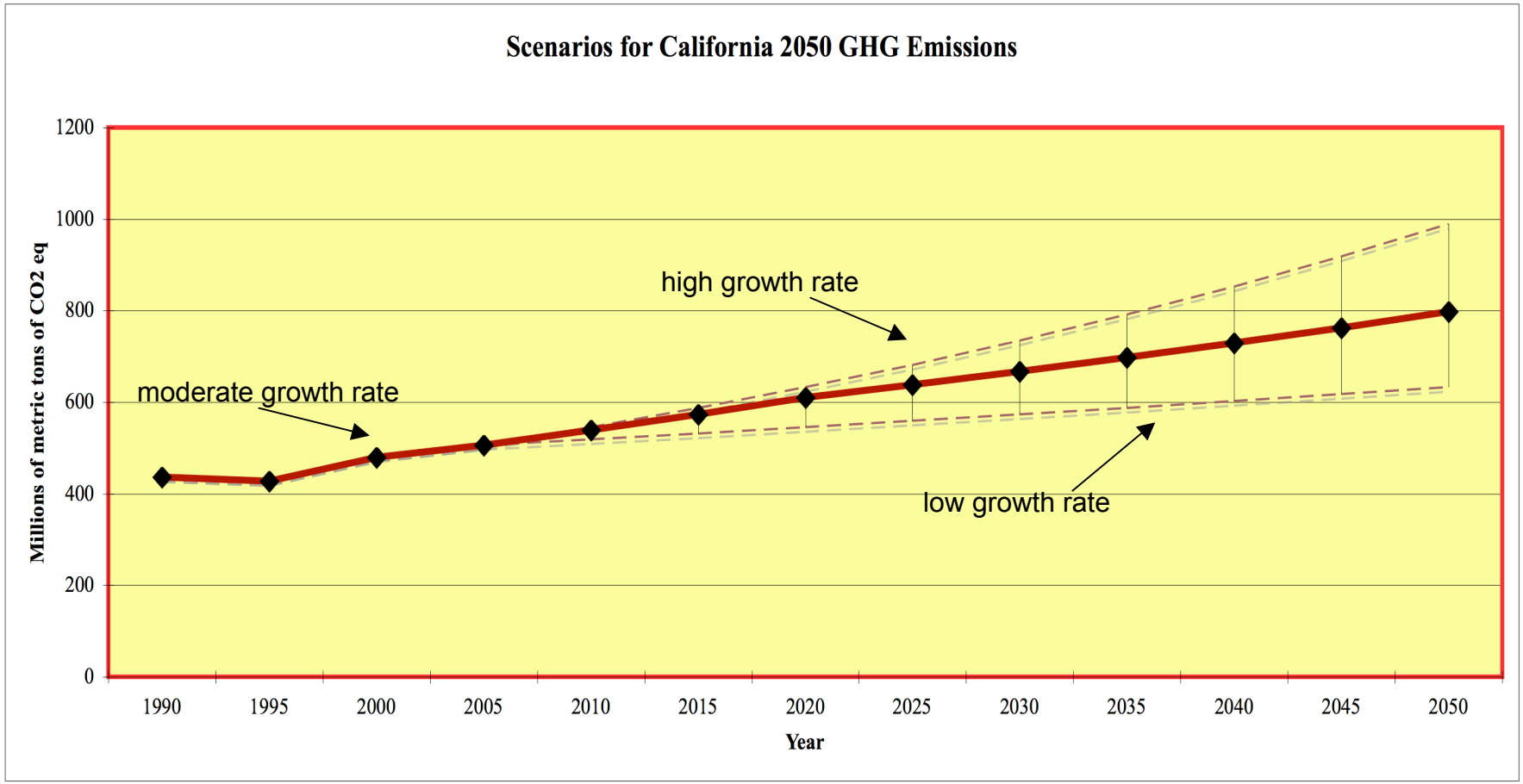
California's GHG Footprint
Fuel Types

Source: CARB CA GHG Inventory for 1990 (8/27/07)



California's GHG Footprint - 2050 Projection

data up to 2004 from CARB August 2007 draft inventory, 2020 values from CAT/Tellus 2005 estimate, 2020 to 2050 based on simple projections



- California's GHG footprint

- *Estimated magnitude of reductions required to meet 2050 goal*

- Why an 80% reduction goal
- How might the goal be reached
- Implications of the reduction goal

Reductions to Meet 2050 Goal

Values in million metric tons of CO_2 (eq)/yr

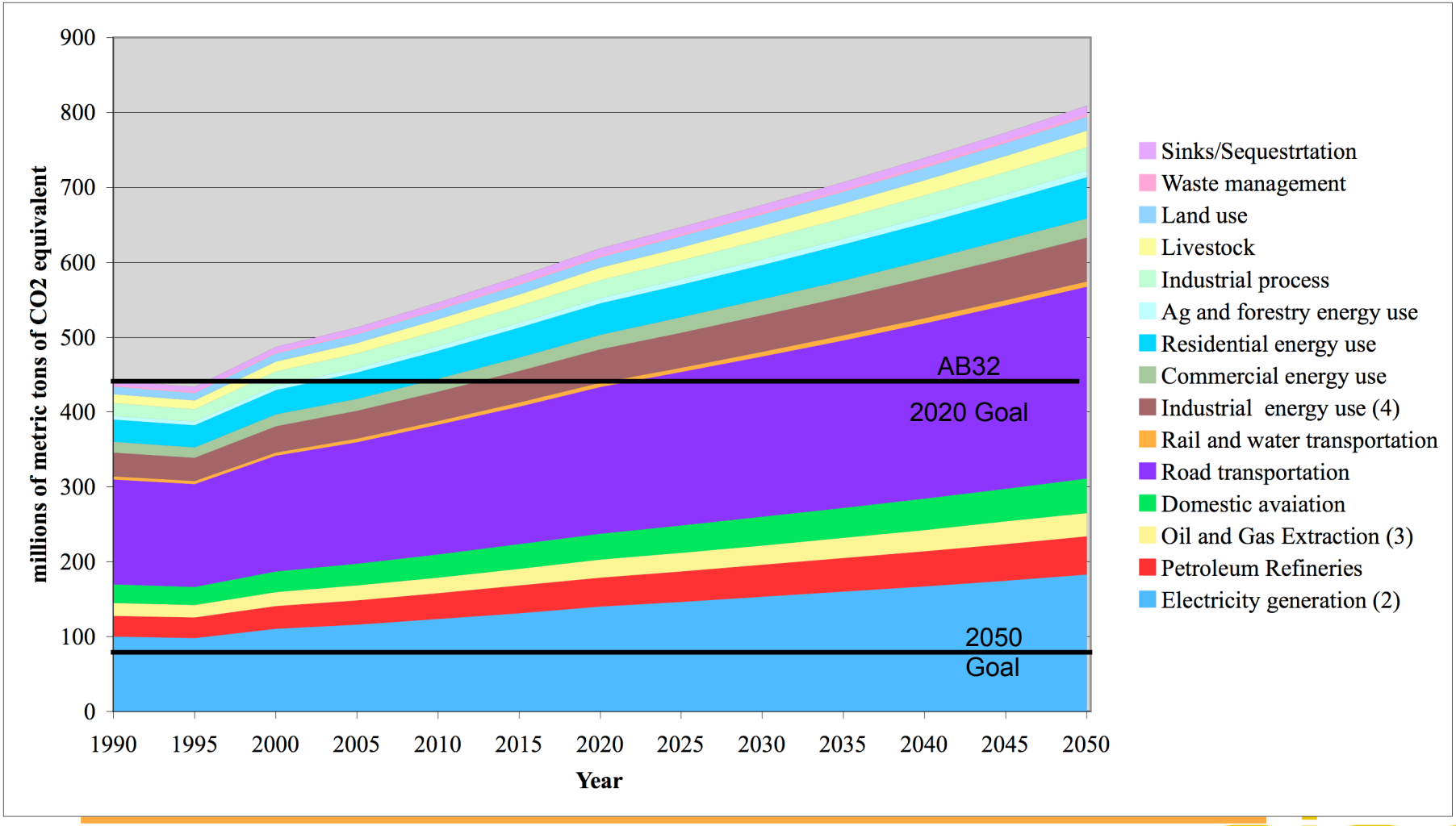
- 1990 Baseline = ~436
- 20% of 1990 Baseline = ~90

	2050 Baseline (average annual growth from 1990)	Reduction to meet 20% of 1990 baseline	Reduction as percent of 2050 baseline
Low Growth	~630 (0.6%)	~540	~86%
Moderate Growth	~800 (1.0%)	~710	~89%
High Growth	~990 (1.2%)	~900	~91%

ciee

California's GHG Footprint and Reduction Goals -

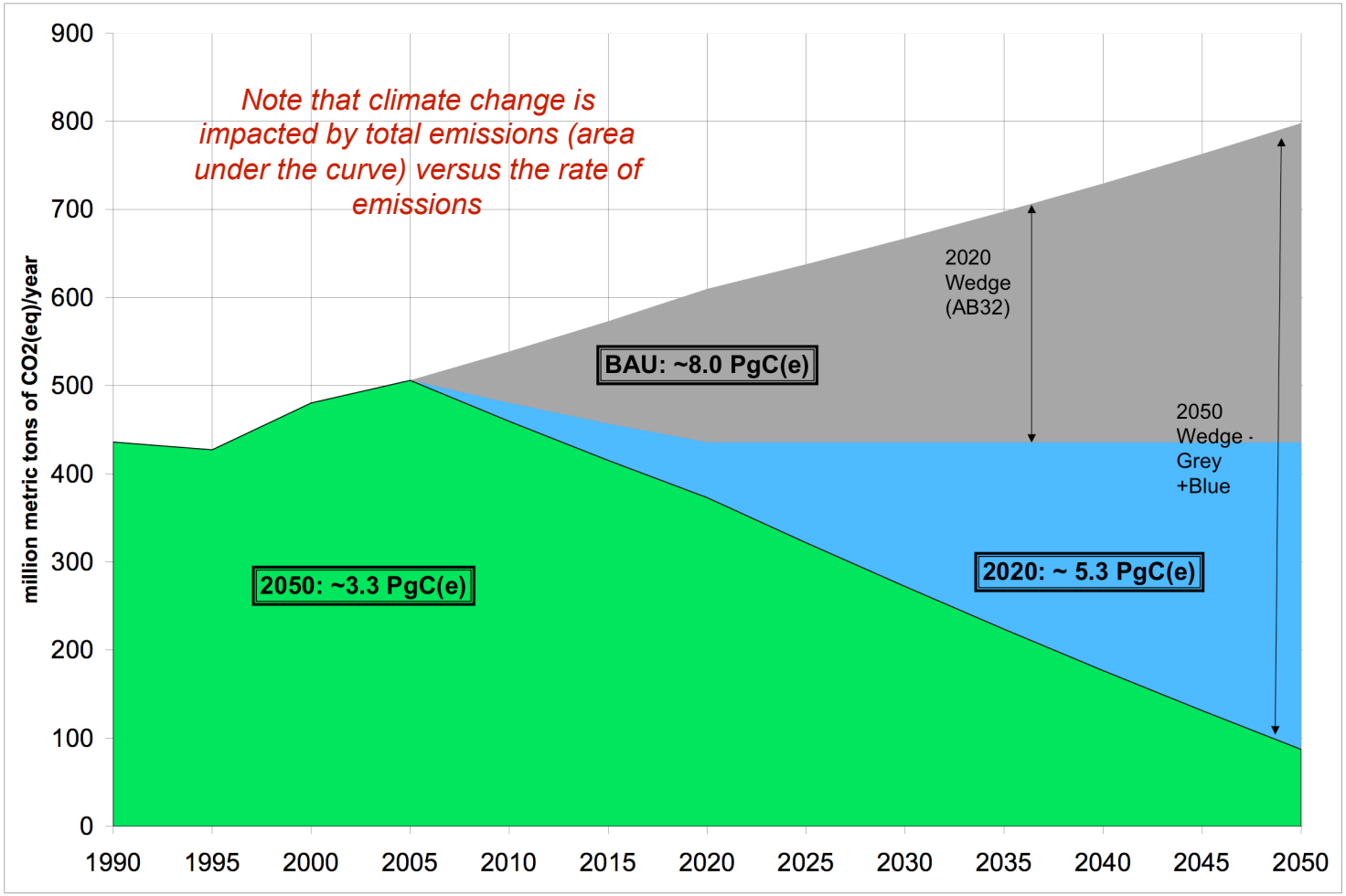
Assuming Moderate Growth Levels



ciee

California GHG Wedges to Meet 2020 and 2050 Goals

assuming moderate GHG emissions growth

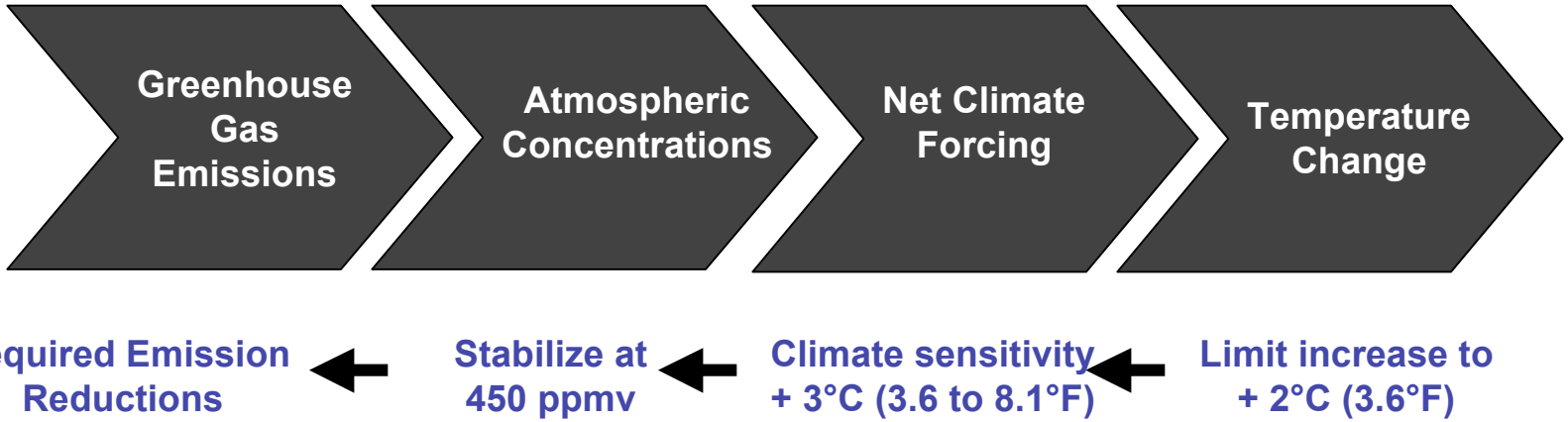


- California's GHG footprint
- Estimated magnitude of reductions required to meet 2050 goal

- *Why an 80% reduction goal*

- How might the goal be reached
- Implications of the reduction goal

Emissions ←→ Temperature Link

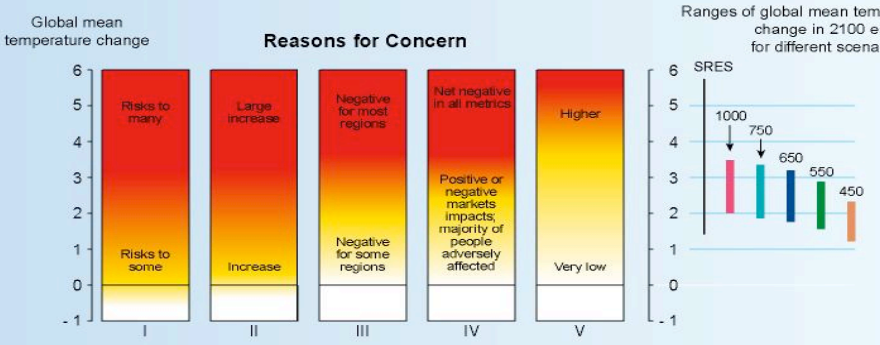


- "Best estimate" of meeting 2°C objective indicates that atmospheric concentrations should be stabilized at long-term concentration of 450 ppmv CO_2eq

- "In order to stabilize the concentration of GHGs in the atmosphere, emissions would need to peak and decline thereafter. The lower the stabilization level, the more quickly this peak and decline would need to occur. Mitigation efforts over the next two to three decades will have a large impact on opportunities to achieve lower stabilization levels", IPCC 4th Assessment Report, Working Group III.

Impact of Temperature Rise - Limit Rise to 2°C

Risks of climate change damages would be reduced by stabilizing CO_2 concentrations



I. Unique and Threatened Systems

Extinction of species.
Loss of unique habitats, coastal wetlands.
Bleaching and death of coral.

II. Extreme Climate Events

Health, property, and environmental impacts from increased frequency and intensity of some climate extremes.

III. Distribution of Impacts

Cereal crop yield changes that vary from increases to decreases across regions but which are estimated to decrease in most tropical and subtropical regions.
Decrease in water availability in some water-stressed countries, increase in others.
Greater risks to health in developing countries than in developed countries.
Net market sector losses estimated for many developing countries; mixed effects estimated for developed countries up to a few degrees warming and negative effects for greater warming.

IV. Global Aggregate Impacts

Estimates of globally aggregated net market sector impacts are positive and negative up to a few degrees warming and negative for greater warming.
More people adversely affected than beneficially affected even for warming less than a few degrees.

V. Large Scale, High Impact Events

Significant slowing of thermohaline circulation possible by 2100.
Melting and collapse of ice sheets adding substantially to sea-level rise (very low likelihood before 2100; likelihood higher on multi-century time scale).

SYR - FIGURE 6-3

IPCC | INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE

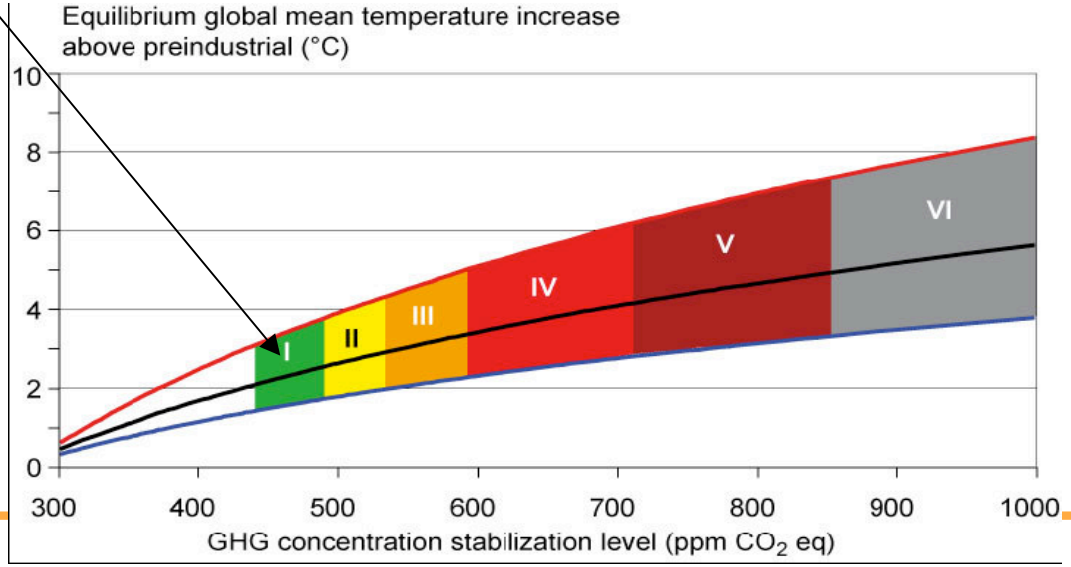
WMO UNEP

ciee

Impact of Temperature Rise - Limit Concentration to 450 ppm CO_2(eq)

IPCC Fourth Assessment Report, Working Group III

Category	Radiative Forcing ($W/m^{2)}$	CO_2-eq Concentration (ppm)	Global mean temperature increase above pre-industrial at equilibrium, using "best estimate" climate sensitivity (^oC)	Peaking year for CO_2 emissions	Change in global CO_2 emissions in 2050 (% of 2000 emissions (%)
I	**2.5-3.0**	**445-490**	**2.0 - 2.4**	**2000 – 2015**	**-85 to -50**
II	3.0-3.5	490-535	2.4 - 2.8	2000 – 2020	-60 to -30
III	3.5-4.0	535-590	2.8 - 3.2	2010 – 2030	-30 to +5
IV	4.0-5.0	590-710	3.2 – 4.0	2020 - 2060	+10 to +60



ciee

Reductions to get to 2°C

- Meeting the 2°C objective requires global GHG emissions to peak before 2015, followed by global emission reductions of 50-85% by 2050 compared to 2000 (IPCC)

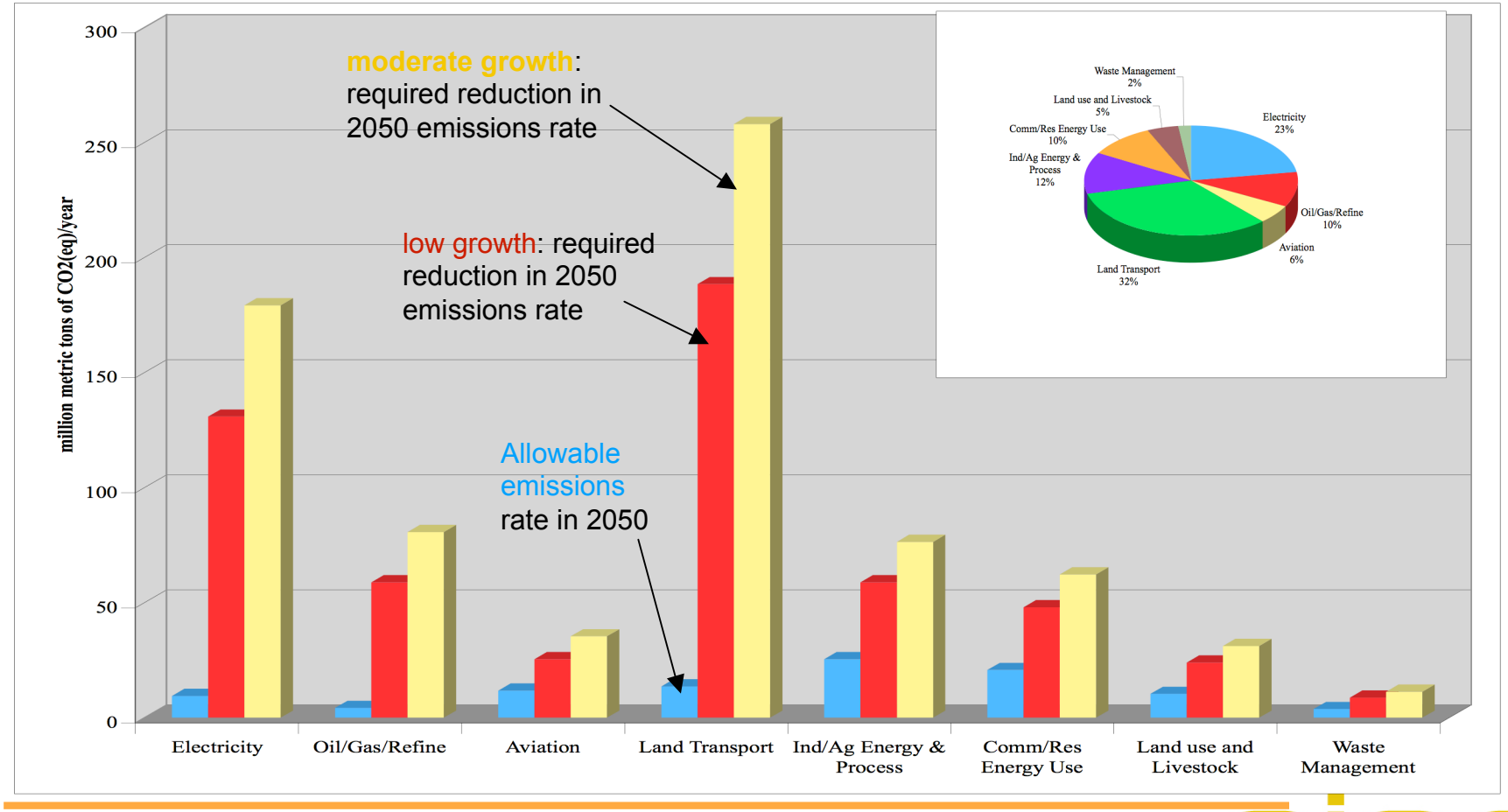
- EU has proposed developed countries to achieve:
  - 30% reduction by 2020 (compared to 1990)
  - 60% to 80% reduction by 2050

- California's GHG footprint
- Estimated magnitude of reductions required to meet 2050 goal
- Why an 80% reduction goal

- *How might the goal be reached*

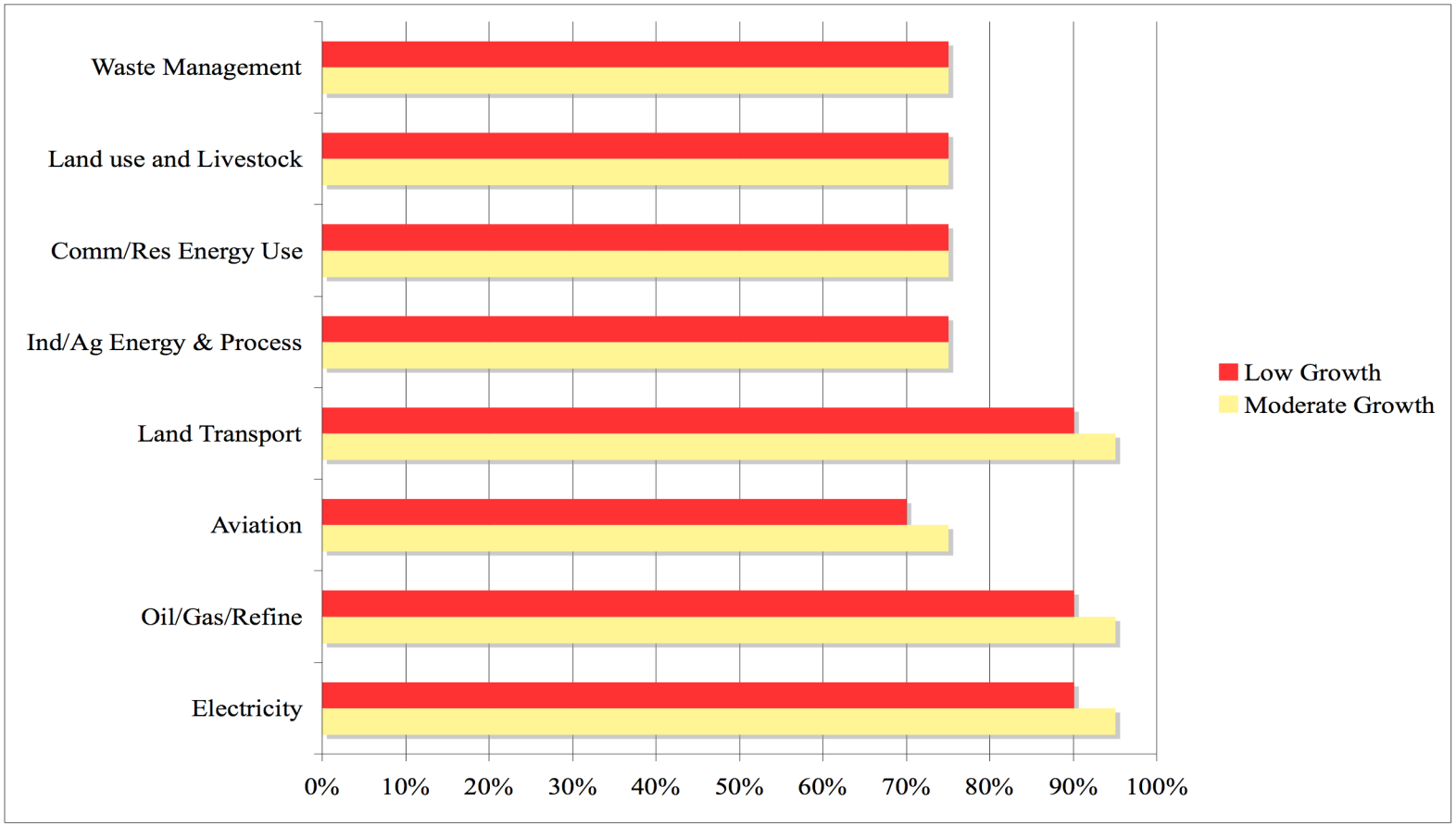
- Implications of the reduction goal

Reductions and Allowable Emissions (Moderate and Low Growth in Emissions to 2050)



Percent Reduction (from 2050 emissions rate) Required to Meet 2050 Goal

- Low and Moderate Emissions Growth -



ciee

- California's GHG footprint
- Estimated magnitude of reductions required to meet 2050 goal
- Why an 80% reduction goal
- How might the goal be reached?

- *Implications of the reduction goal*

Implications of Reductions 1:
Meeting Goal Requires HUGE Reductions

- Probably requires essentially:
  - Eliminating carbon from electricity production and road transportation
  - Major reductions in carbon use for all other applications

- This also probably requires:
  - Commitment to energy efficiency as the approach that is clearly on the low end of the cost curve (see Rosenfeld presentation)
  - A societal response that addresses how transportation, energy use, and behaviors can change in a carbon-constrained world
  - Innovation

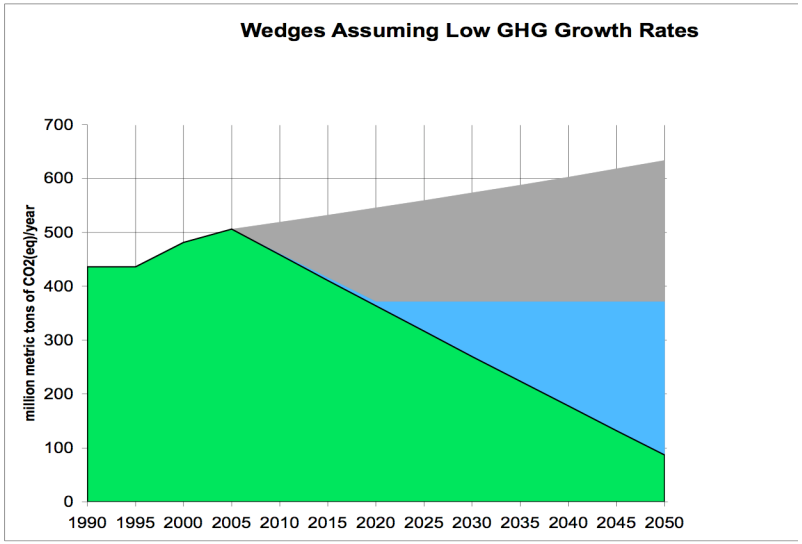
- And, as no obvious technological or behavioral approach is apparent to reach the magnitude of savings, sequestration options may simply be "necessary"

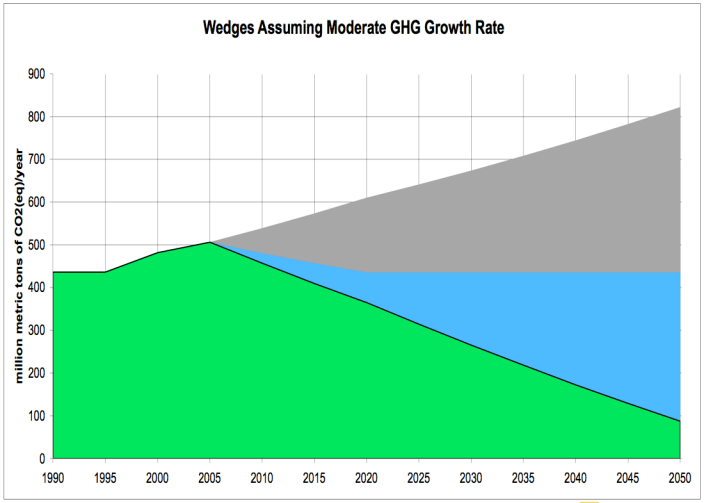
Implications of Reductions 2:
AB32 and 2050 Goals are not the same

- Only by assuming low GHG growth rates will the trajectory for meeting the AB32 2020 goal get us to the 2050 goal

- Assuming moderate growth in GHG emissions, between 1990 and 2050:
  - AB 32 goal implies ~35% less total GHG emissions
  - 2050 goal implies ~60% less total GHG emissions

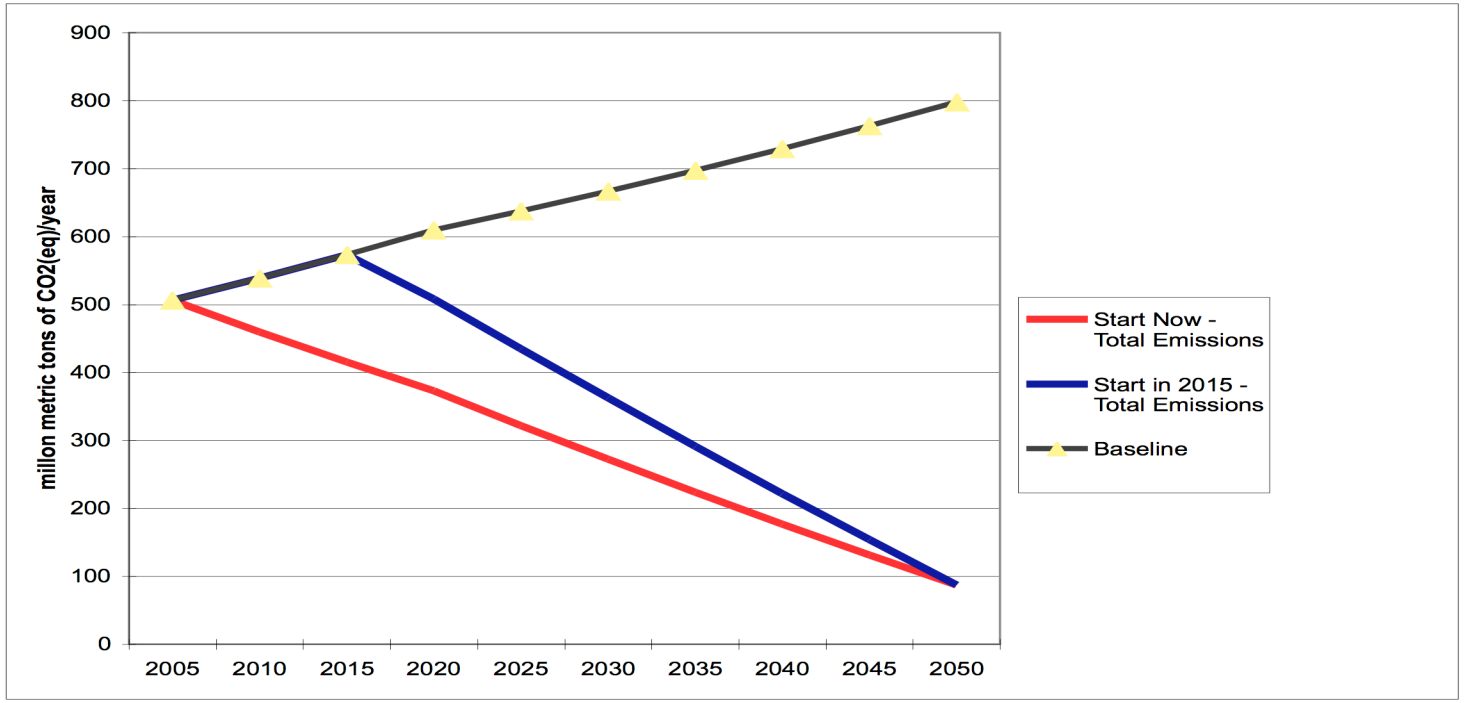
- Caution should be used to:
  - Not settle for the 2020 goal as it is not a climate stabilization goal
  - Not invest in "permanent" technologies that will create new barriers to the necessary reductions





Implications of Reductions 3:
Need to Start Now

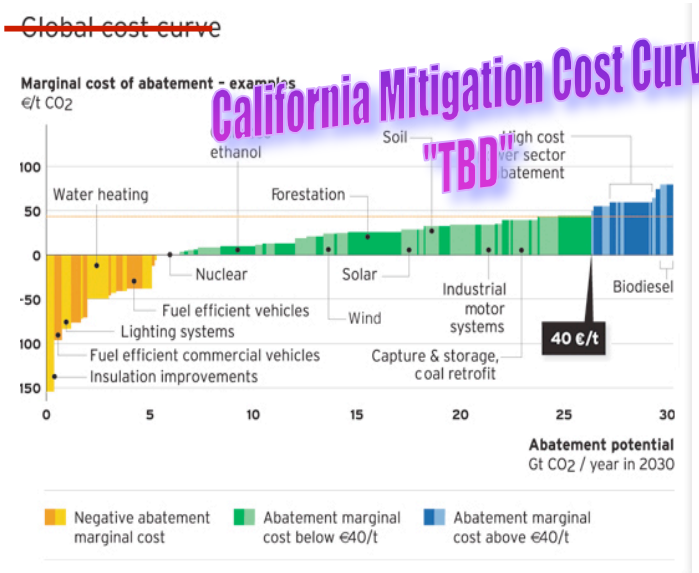
Starting now implies reductions on the order of 9 MM tons per year versus waiting, for example to 2015, and needing to reduce at rate of about 14 MM tons per year (with moderate emissions growth assumptions)

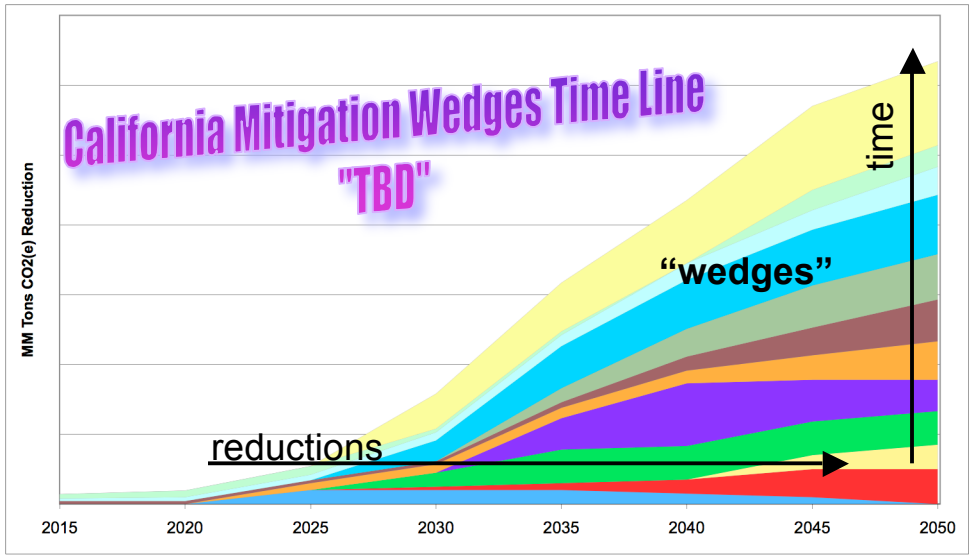


ciee

Implications of Reductions 4:
Meeting the Goal Requires a Plan with Interim Goals

California needs to establish RD&D efforts that result in a "cost curve" and time line for mitigation:



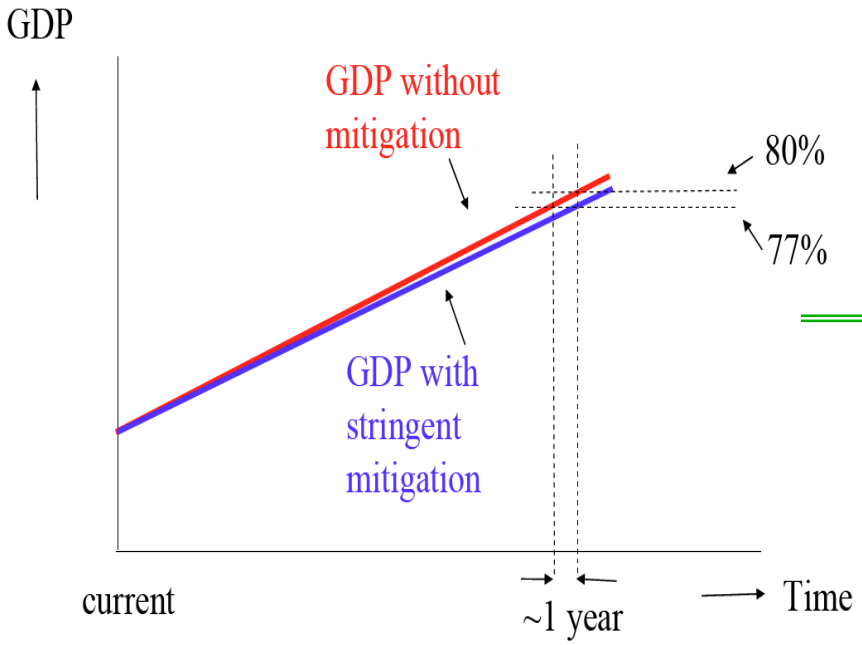


Implications of Reductions 5:

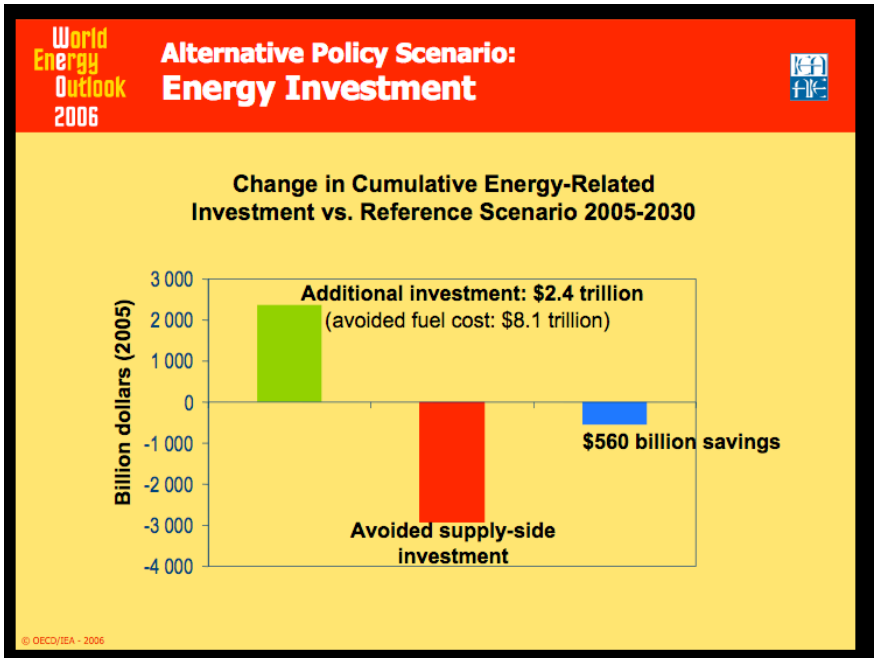
Meeting the Goal Requires Investment

Change requires investment: Even though long term mitigation economics appear neutral, in the short term there is a need for public and private investment

Macro economic perspectives indicate long term economic impacts of mitigation but hide investment requirements (and climate impact and adaptation costs) (global impacts slide from IPCC)



Investment perspective indicates how investment now is required to achieve long term benefits
(example slide from IEA)



Implications of Reductions 6:
Meeting the Goal Requires a "Low Carbon Workforce"

- Governments need to establish new regulations, research must be completed, all of the economy's sectors must undertake new programs, and all types of organizations and individuals will need to learn to operate effectively (and economically) in a low-carbon environment.

- These actions will require new workers equipped with new skills. There will be at least two categories of staffing requirements:
  - Completely new types of jobs that don't exist today
  - Supplemental training to existing positions

- Meeting these requirements requires collaborative efforts of government entities, employers and unions, technical societies, and both conventional and non-conventional members of the education community – colleges, universities, technical schools, high schools, extension services, professional societies, advocacy groups, career outreach organizations, etc.

Implications of Reduction 7:
Is the 80% Reduction Goal the Right Goal for California?

- It will be hard:
  - California energy intensity already relatively low
    - 45 states have higher per person CO_2(eq) emissions
    - 46 states have high per GSP CO_2(eq) emissions
  - Economic growth & continued population growth are main drivers of emissions growth
  - Transportation (~40%), electricity supply (generation, imports) and industry account for over 80% of emissions
  - California is an “expensive” state
- However, there are only about 10 countries that emit more GHG than California
  - Increasing ~1% annually (1990-2004)
  - Per capita is similar to EU average
  - Long term macro economic impacts of mitigation appear to be minimal

- No rational "correct" answer
- Depends on wide range of factors:
  - Principles (e.g., equity; common, but differentiated responsibility; precautionary principle)
  - Policy objectives (e.g., global leadership)
  - Criteria adopted, e.g.:
    - equity (historical contribution, ability to pay)
    - cost-effectiveness (taking into account cost of inaction and co-benefits)
  - Public sentiment
- Is our role just reductions or reductions plus leadership in technology, policy, programs, behavior, etc.?

ciee

Summary

The analysis to date points out:

- California's 2050 goal is consistent with the latest IPCC research with respect to what the level of GHG reductions are required from the "Developed World" for probably limiting the world to only moderate climate impacts

- The level of State GHG reductions required to meet the goal are "massive" and imply:
  - Essentially eliminating carbon from virtually all electricity production and non-aviation transportation
  - Eliminating about 2/3 or more of the carbon from all other applications
  - Sequestration needs to be seriously considered
  - Results will require innovation

Reprinted courtesy of Dan Piraro for this 4th Annual California Climate Change Conference presentation

ciee

Summary, continued

Conclusions drawn are:

1. We need a "mindset" of looking beyond the 2020 goals and early action:
   - Need a plan
   - Need multiple year goals
   - Need to watch for premature investment in infrastructures that will not achieve the long term desired goals may only establish future barriers to the needed solutions
2. We need to start now - be pro-active
3. <u>We need to make investments</u>

Conclusions, continued

And lastly,

- Because of the magnitude of the mitigation required, and
- Because, national and international cooperation and reductions are a crucial part of the global solution (*otherwise, California might reach 80% at great expense, but see the effect totally erased by growth in China and India - and Texas*)

We need to ask the question:

"What combination of California leadership and reductions will make the biggest impact on global climate change mitigation - while advancing the heath, welfare and economy of California"

Acknowledgements

- This was funded by CIEE under the forwarding thinking guidance of its Director, Carl Blumstein

- Materials on climate impact projections and California roles were prepared with the significant assistance of Anne Arquit Niederberger of Policy Solutions.

points to leave with audience

In the short term at least the following questions must be addressed and researched:

- What are the "right" goals for 2050?
- What is the quantified GHG emission reductions - tons of CO2 (e) - required to meet the goal, i.e. what is the baseline and what is the 2050 (and other year) emission targets?
- What is the mix of mitigation strategies technologies and strategies required to achieve the goal? What are the economics, introduction time frames, adoption rates, research needs, and policy options from the perspective of (a) what is required, (b) what is currently feasible, and (c) what is potentially feasible?
- What technology advances need to be supported in the short term to move California forward so that it has a reasonable chance of meeting the 2050 goals? What policies, research and overall support is required to enhance the probability of technology breakthroughs?