

# "Can we accelerate technology change in transport to reduce carbon emissions?"



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April 29, 2009

## Strategy #1



## Strategy #2

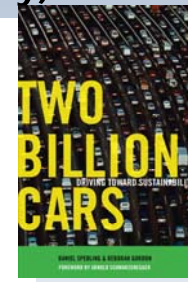
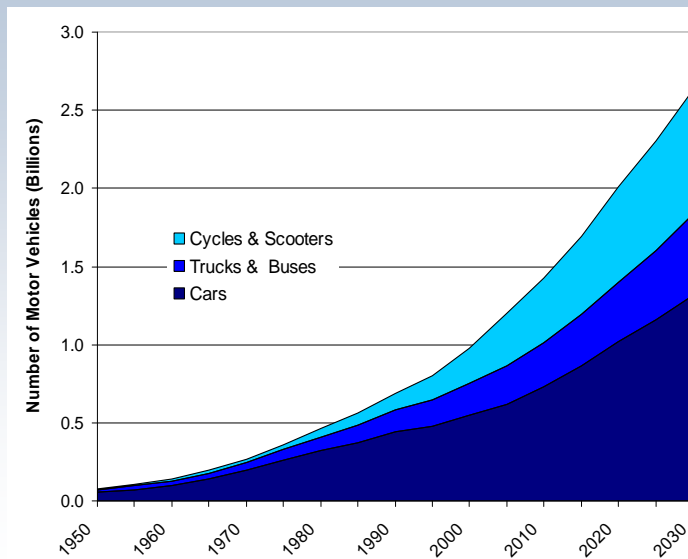


1949 ConvairCAR Flying Car

## Strategy #3



## 2 Billion Vehicles in 2020 (globally)!



Source: Sperling and Gordon (2009), based on DOE, JAMA, other projections

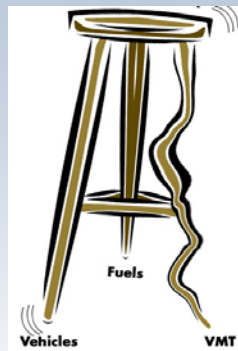


### **“Detroit churches pray for ‘God’s bailout’ of auto industry”**

SUVs on altar of Greater Grace Temple, a Pentecostal church in Detroit, as congregants prayed to save the auto industry. NY Times, 12/7/08

**...SUV sales increased that month (Dec 2008)**

## **Transforming Transportation**



- Transforming vehicles (*“easiest”*)
- Transforming fuels (*hard*)
- Transforming mobility (*hardest*)

## Transforming Vehicles and Fuels

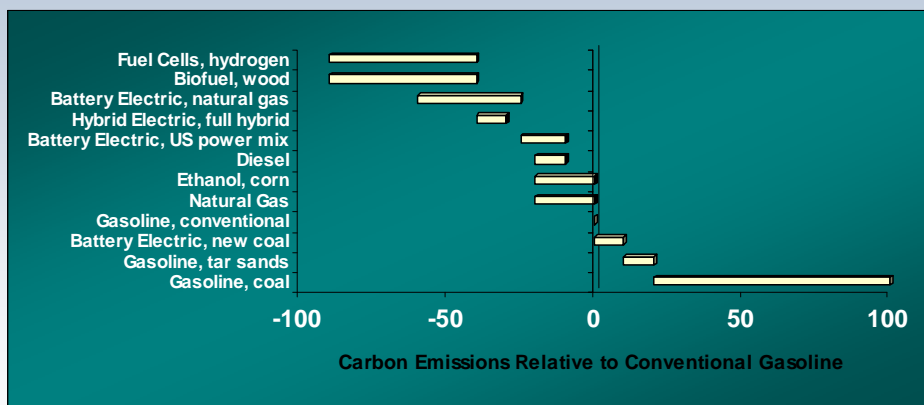
Most promising alternatives:

- Biofuels
- Electricity
- Hydrogen
- *[Efficiency]*

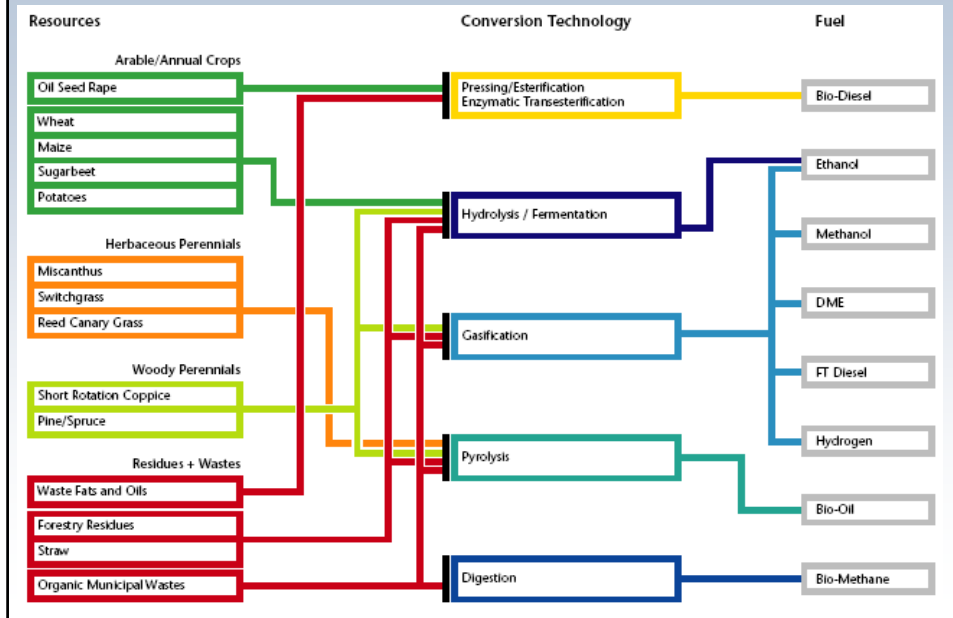


## Many Promising Replacements

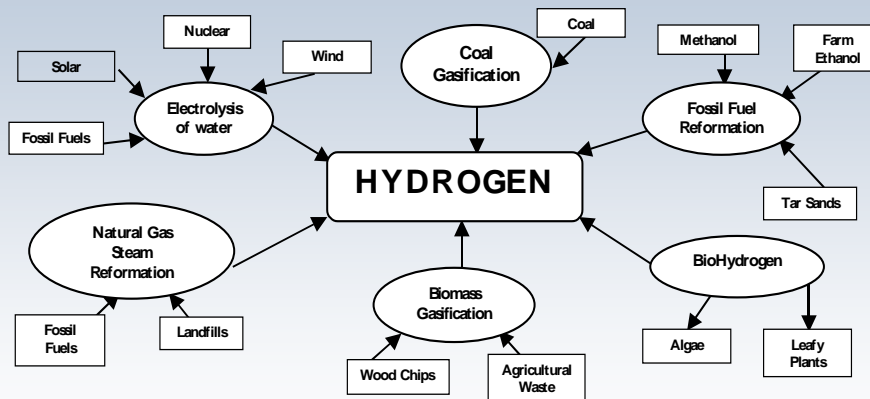
Some better than others...



## Many Potential Biofuels Production Pathways



## Many Potential Sources of Hydrogen



Source: Authors' representation.

## Unfortunately, Government Succumbs to the Fuel *du jour*

In the US ...

- 30 years ago – Synfuels (oil shale, coal)
- 20 years ago – Methanol
- 15 years ago – Electricity (Battery EVs)
- 5 years ago – Hydrogen (Fuel cells)
- 2 years ago – Ethanol
- Today – Electricity (Plug-in hybrid vehicles)
- *What's next?*

***Durable, robust policies are needed that rely on performance standards and market instruments. Government should not try to pick winners (e.g., biofuel mandates).***

***Electric vehicle experiment of 1990s largely failed ... but led to improved batteries and electric drivetrains which are now making comebacks in hybrids, fuel cell vehicles... and battery-electric vehicles!***



**Cautionary Note:  
Battery Progress is Impressive, but Next  
Generation Batteries are Still Expensive**



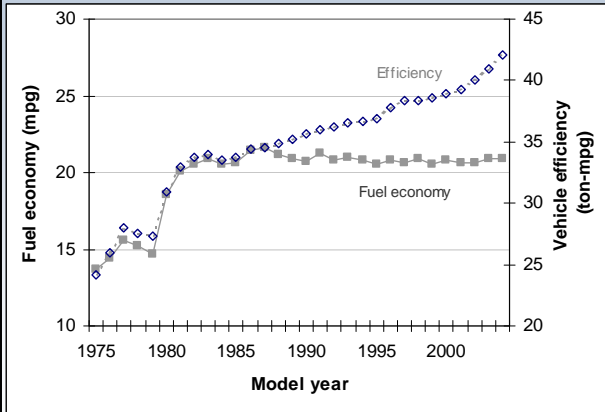
LFP= lithium iron phosphate (cathode); LTO= lithium titanium oxide (anode);  
NCM= lithium (nickel, cobalt, manganese) (cathode)

*A System Transformation With Strong Consumer Appeal*

**Connecting Vehicles to Buildings and  
Electricity Grid**



## ...But it's also about fixing today's cars



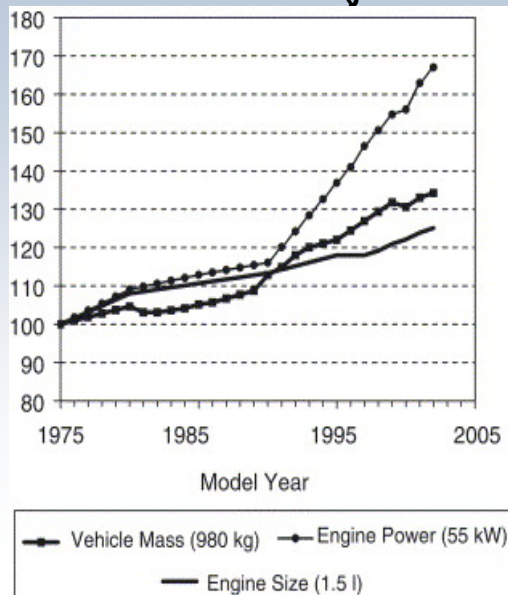
Most studies now say that 50% improvement is possible with gasoline ICEVs by 2030, with much greater improvements provided by hybrids, diesel, BEVs, PHEVs, and FCVs



Source: Lutsey and Sperling, 2007

Can we stop the horsepower race and use efficiency innovation for improved fuel economy? Policy plays key role!

## New Cars in Europe Getting Bigger, Heavier, and More Powerful (just as in US)



Theodoros Zachariadis, *Energy Policy*, Sept 2006

## Third Leg: Transforming Mobility (and Land Use)

*In U.S. and increasingly elsewhere, we've created a transportation monoculture. Many opportunities for innovation!*

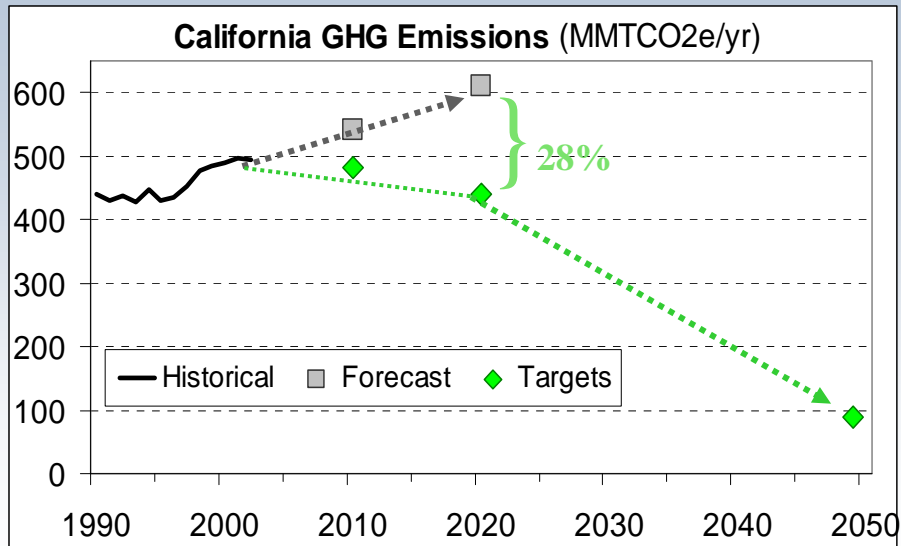


## Key Strategy: Expand Traveler Choice





## California's GHG Goals



## The California Model

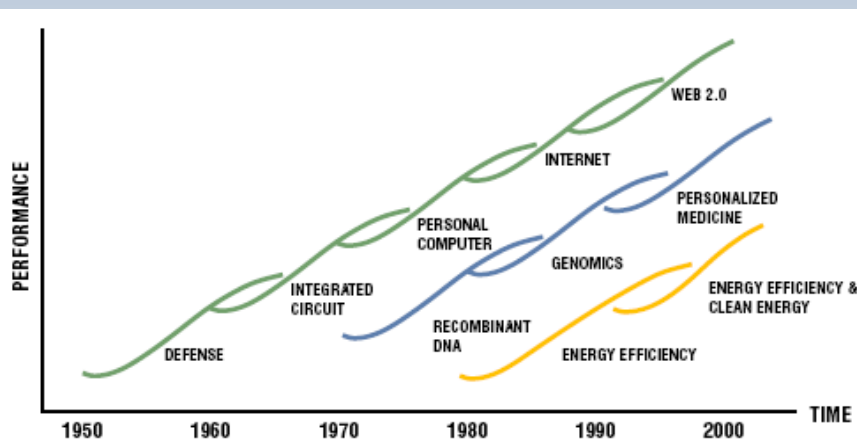
- Model and leader, not island (just like UK?!)
- **Stimulate innovation in technology, behavior, institutions**
- Economy-wide approach, mix of short and long term strategies
- Target specific GHG reductions with broad array of rules and incentives
  - Energy efficiency stds, Renewables Portfolio Standard, Low Carbon Fuel Standard, etc
- Overlay cap-and-trade program (and offsets) to create price signal for carbon and to equilibrate costs across sectors (and gain additional reductions)

## Transportation GHG Policy in California (mostly within AB32 "Global Warming Solutions Act of 2006)

- Vehicles (cars and trucks) **39 MM tons (reduction from BAU by 2020)**
  - Light-duty vehicle GHG stds (Pavley I and II)
  - ZEV mandate + ZEV incentives ("ZEV" = BEVs, PHEVs, ...)
  - Feebates?
  - Truck technology
    - Aerodynamic design (cabs, trailer skirts)
    - Hybridization of urban and short-haul trucks
- Fuels **16+ MM tons**
  - Low Carbon Fuel Standard
- VMT and goods movement **5-10 MM tons**
  - VMT reduction via land use, transit, pricing (SB375)
  - Low-emission req'ts at ports, eco-driving, tire inflation, etc



## Technology Leadership = Economic Leadership California's Waves of Technological Innovation



Source: *California Green Innovation Index*, 2008 Inaugural Issue (Palo Alto, CA: Next 10, 2007), [www.next10.org](http://www.next10.org).

## 5 Point Program to Transform Transportation (policy + technology)

### 1. Increase R&D investments (and train next generation of scientists and engineers)

- Batteries, fuel cells, and lightweight materials

### 2. Accelerate advanced vehicle commercialization

- Near-zero emissions requirement (California ... and US?)
- EU 50 g/km incentive
- Tax credits for hybrids, fuel cell, battery-electric vehicles

### 3. Performance Standards for fuel/GHGs

- CAFE, California Pavley Law, EU g/km stds
- LCFS (to accelerate use of low-carbon fuels in vehicles)

### 4. Market instruments to align regulations with market

- Feebates
- Fuel price floor

### 5. Reform institutions and realign incentives to reduce sprawl and VMT

- Reward reduced GHG/VMT and stimulate investment in new mobility services
- Remove incentives for sprawl (fiscalization of LU, zoning, engineering rules)

## Question of Will and Vision, More Than Cost??

- Consider hydrogen and fuel cells, which many think is most expensive and difficult transition ...
  - \$55 billion extra over 15 years for vehicles and fuels, to get to 10% market penetration (NRC/NAS, 2008)
- Meanwhile, US spends ~\$10 billion/year on subsidies for corn ethanol

## It won't be easy ...

*"We stand at a crossroads. One path leads to despair, the other to destruction. Let's hope we choose wisely."*  
**Woody Allen**

I'm more optimistic despite much evidence to the contrary...

