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Steps into Postfossil Mobility
A Vision and Policy Plan for Sustainable Transportation

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Session 5, Keynote Lectures: "Future Technologies II: Mobility"
Our Common Future, Essen, November 4, 2010

Slide Presentation

Our Common Future, Hannover/Essen, 2-6 November 2010 (www.ourcommonfuture.de)

Steps into Post-Fossil Mobility

Transforming Transportation



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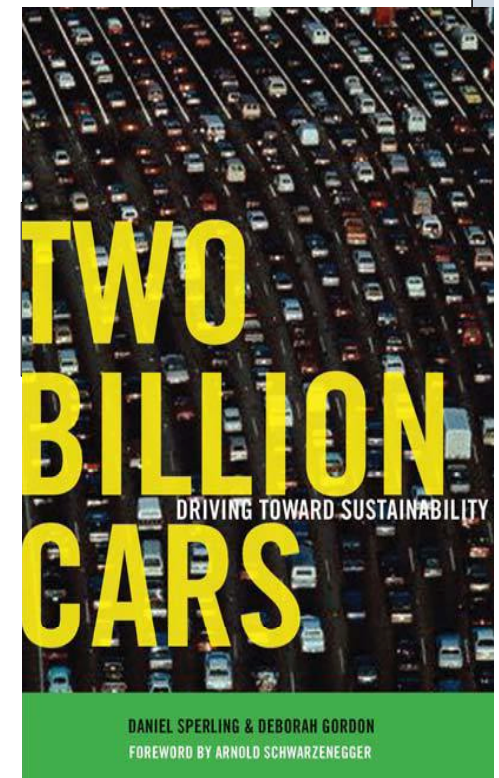
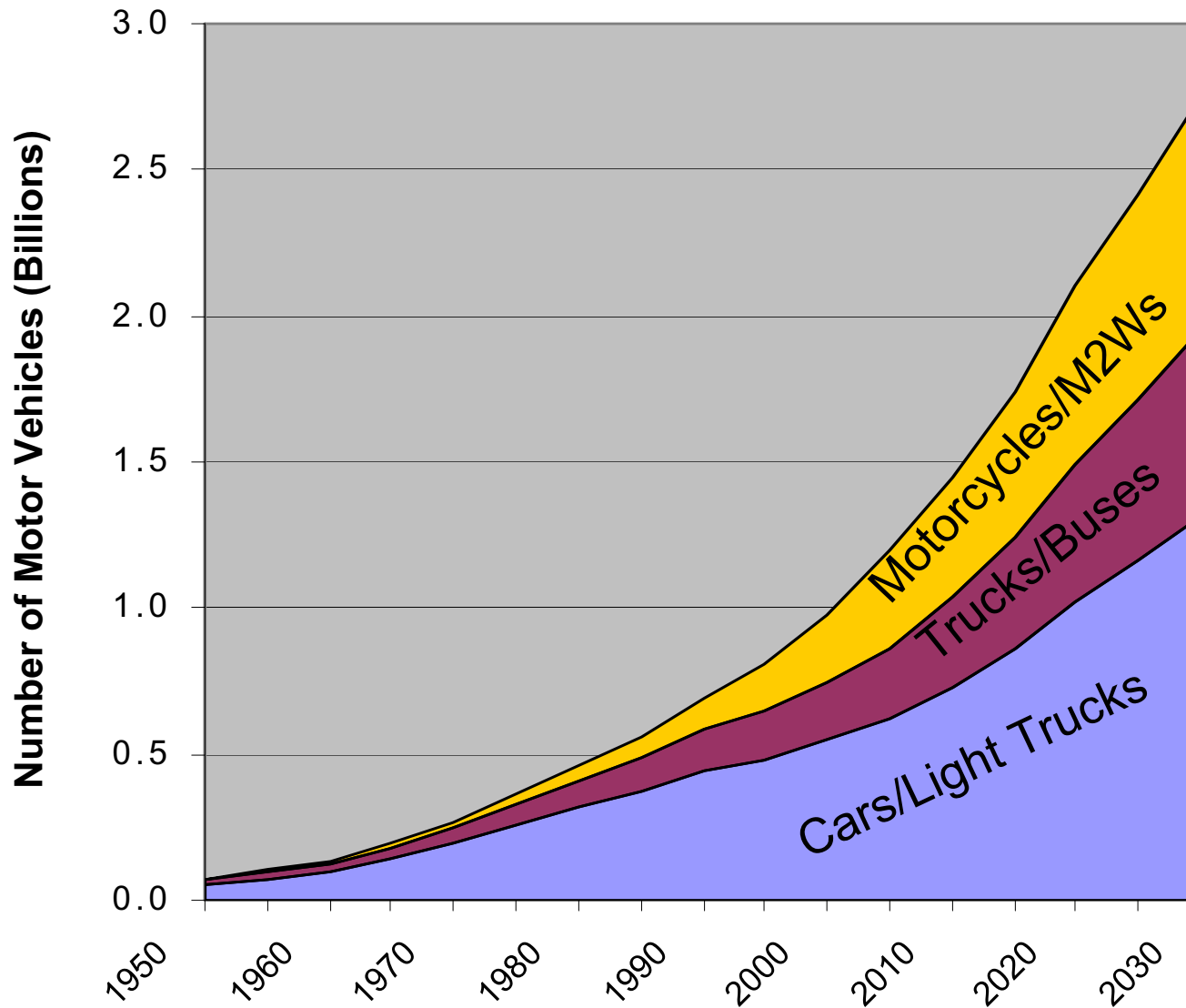
4 November 2010

ITS-Davis Profile

- Founded: 1991
- 50 Professors and Researchers
- 130 Graduate students (1/2 PhDs)
- Centers within ITS-Davis:
 - Plug-in Hybrid Vehicle Center (created by State of California)
 - Sustainable Transport Center (created by US DOT)
 - Energy Efficiency Center (1st univ center on energy efficiency in US)
 - Urban Land Use and Transportation Research Center
 - China Center on Energy and Transportation

Good news and bad news

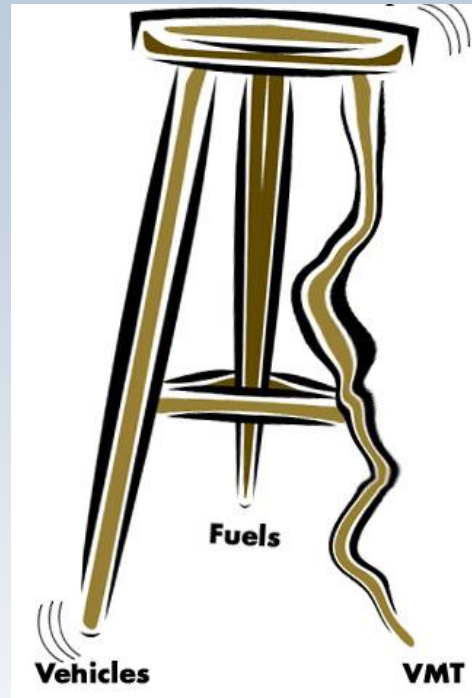
Soaring Global Demand for Vehicles (and Oil)



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



Transforming Transportation



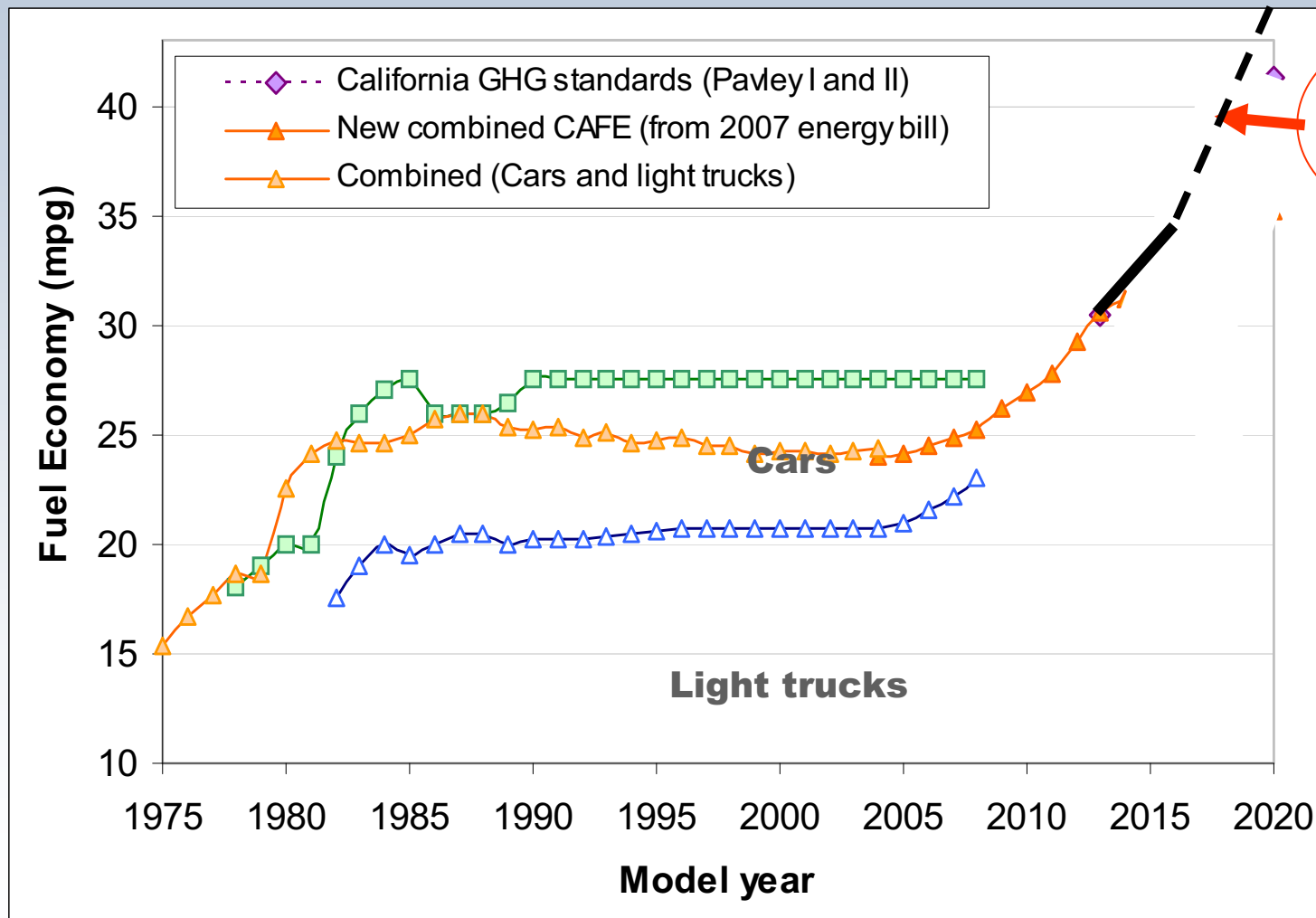
- Transforming vehicles (*“easiest”*)
- Transforming fuels (*hard*)
- Transforming mobility (*hardest*)

First Leg Transforming Vehicles

Cars of future will be far more efficient and will be powered mostly by electric-drive



Energy Efficiency of Conventional Vehicles Will Continue to Improve



Proposed California and US GHG standards

Coming Next: Plug-In Vehicles (PEVs)!

Manufacturers' Announced Plans for Electric Vehicles (partial list)

BMW	PHEV 50 km (31 mi) range in electric mode. 98 lithium polymer cells with a 2.5-hour charge time.
Ford	PHEV scheduled for 2011.
General Motors/Chevrolet	Volt scheduled for release in late 2010. PHEV 40 mile range in electric mode. 8-hour charge time at 120 V (3 hr at 240 V). 220 Li-ion battery cells.
Honda	PHEV scheduled for 2015.
Toyota	PHEV scheduled for 2012.
Nissan	EV scheduled for 2011.
Mitsubishi	EV released in Japan in 2009.
Hyundai	PHEV 40 mile range in electric mode.
BYD Co. (Chinese)	PHEV 60 mile range in electric mode. Special charging stations will charge to 70 percent in 10 minutes.

Vehicles With Batteries Will Continue to be Expensive

Estimates of Future Vehicle Costs in 2035 (USA)

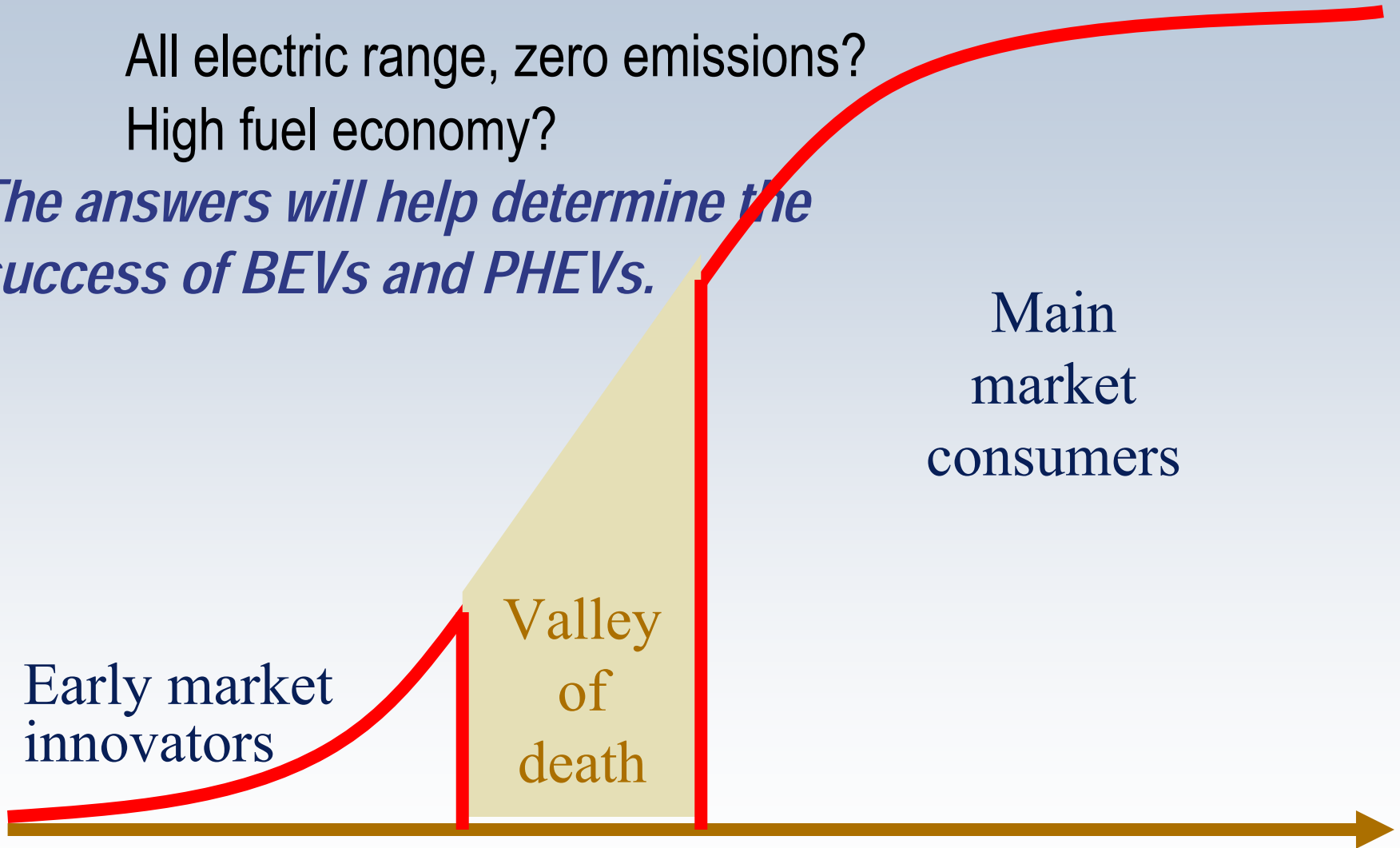
VEHICLE TYPE	RETAIL PRICE INCREASE [\$2007]	
	Cars	
<i>2008 Gasoline ICE retail price</i>	<i>\$19,600</i>	
Increment in 2008 over Gasoline ICE:		
Diesel	+ \$1,700	
Current Turbo Gasoline	+ \$700	
Current Hybrid	+ \$4,900	
Gasoline SIE	+ \$2,000	
<i>2035 Gasoline ICE retail price</i>	<i>\$21,600</i>	
Increment in 2035 over Gasoline ICE:		
Diesel	+ \$1,700	
Turbo Gasoline	+ \$700	
Hybrid	+ \$2,500	
Plug-in Hybrid	+ \$5,900	
Battery Electric	+ \$14,400	
Fuel Cell	+ \$5,300	

And how will consumers value...

All electric range, zero emissions?

High fuel economy?

The answers will help determine the success of BEVs and PHEVs.



Development of market

EVs must be perceived as “better” than ICEVs, and thus marketable at higher prices

On board electricity
and new lifestyle uses

Mobile electronics,
tools & appliances

Emergency
electricity



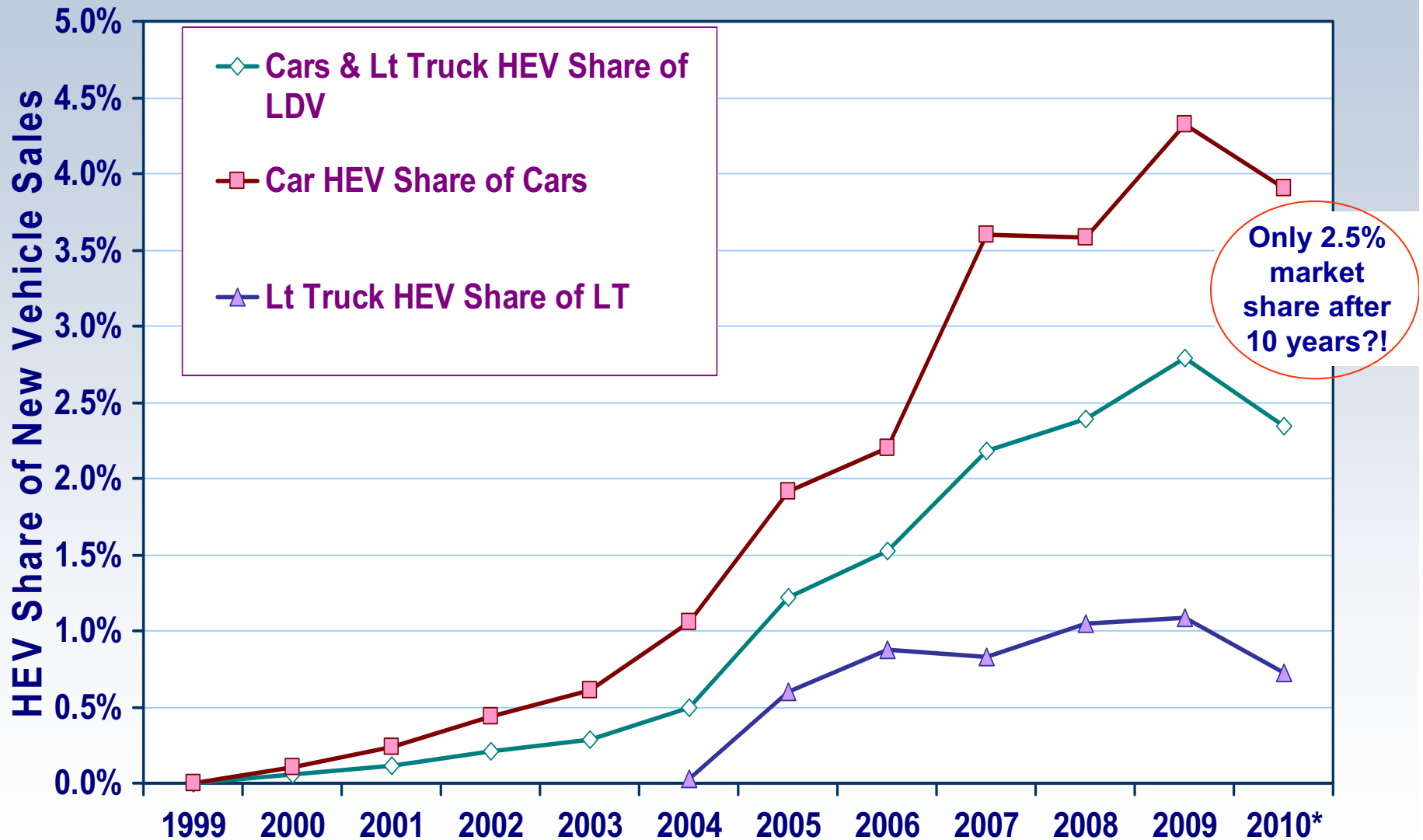
Low emissions,
energy use

Vehicle to grid
power

New vehicle
designs

Electric-drive feel

A cautionary note from US ... What does slow HEV growth imply for PEVs?



Future of EVs is small urban vehicles?
Small EVs from GM-China



Second Leg

Transforming Fuels

The Stone Age did not end for lack of stone, and the Oil Age will end long before the world runs out of oil.

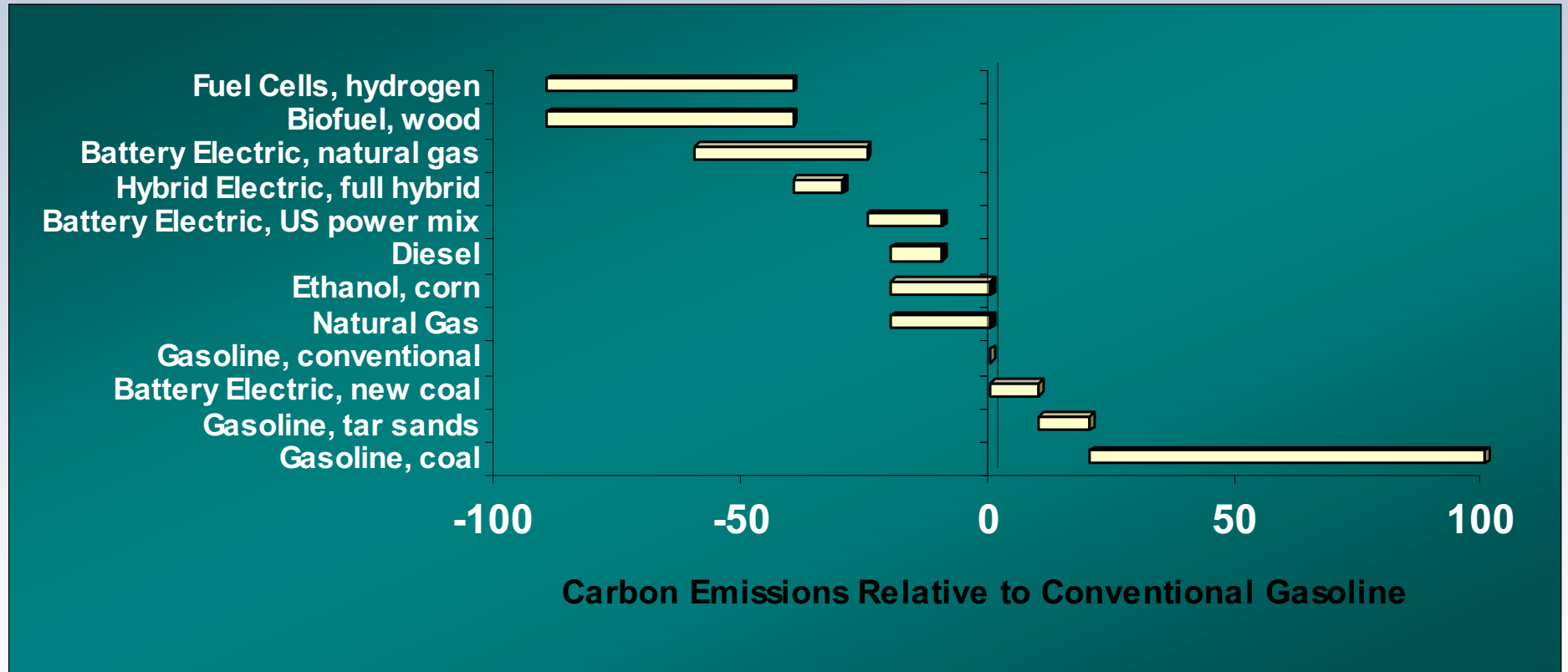
Sheikh Zaki Yamani, Saudi Arabian oil minister for 3 decades

- Today: Transport is 97% dependent on oil
- Future: Wide mix of fuels to power mobility



Many Promising Replacements

Some better than others...



Fuel *du jour* Phenomenon

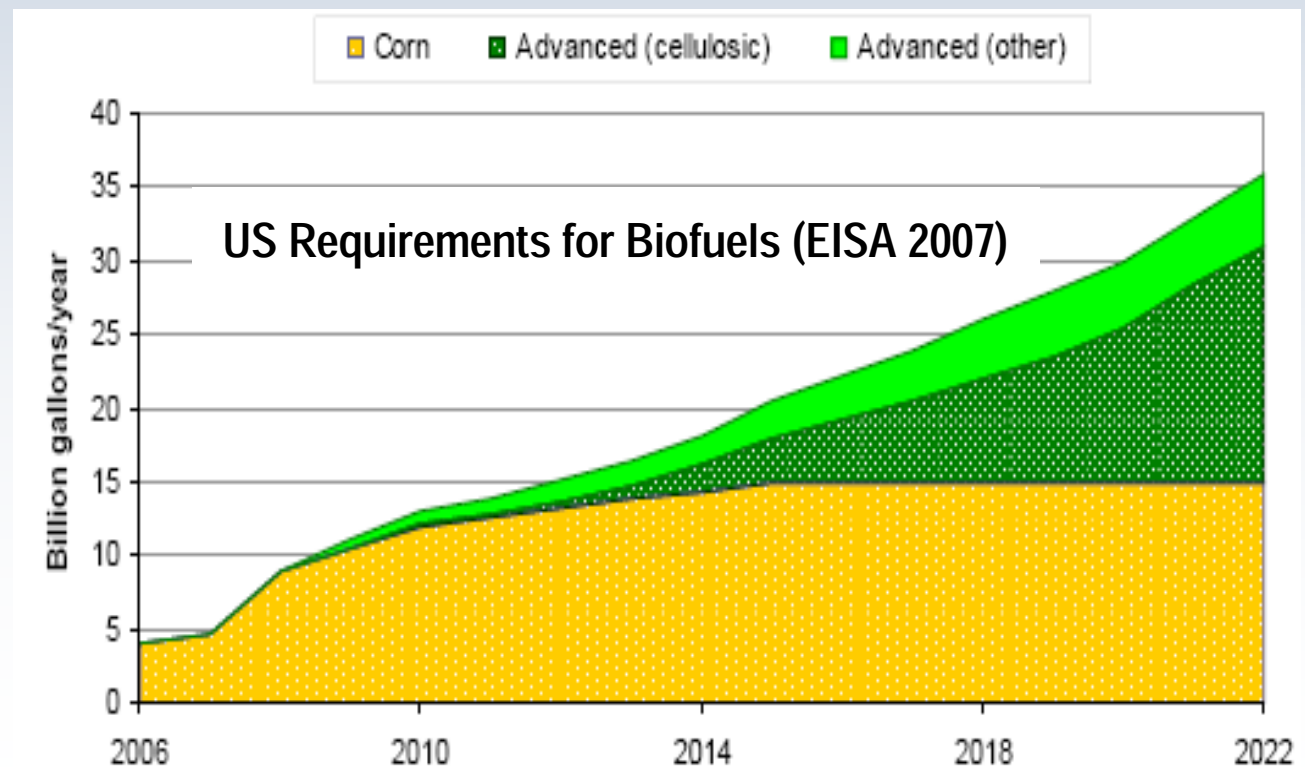
Disruptive and wasteful

- 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?*

**GOVERNMENT POOR AT PICKING WINNERS ...
NEED DURABLE POLICY SUCH AS LOW CARBON FUEL STANDARD**

Faltering Fuel Policy

- **EU: Small biofuels mandate adopted but under attack**
- **US: Biofuels mandate (“renewable fuel standard”) (adopted 2007)**
 - 36 billion gallons by 2022 (almost all corn ethanol so far)
- **California: Low carbon fuel standard (adopted 2009 but sued by oil and ethanol industries)**
 - 10% reduction in carbon intensity by 2020



Third Leg: Transforming Mobility (and Land Use)

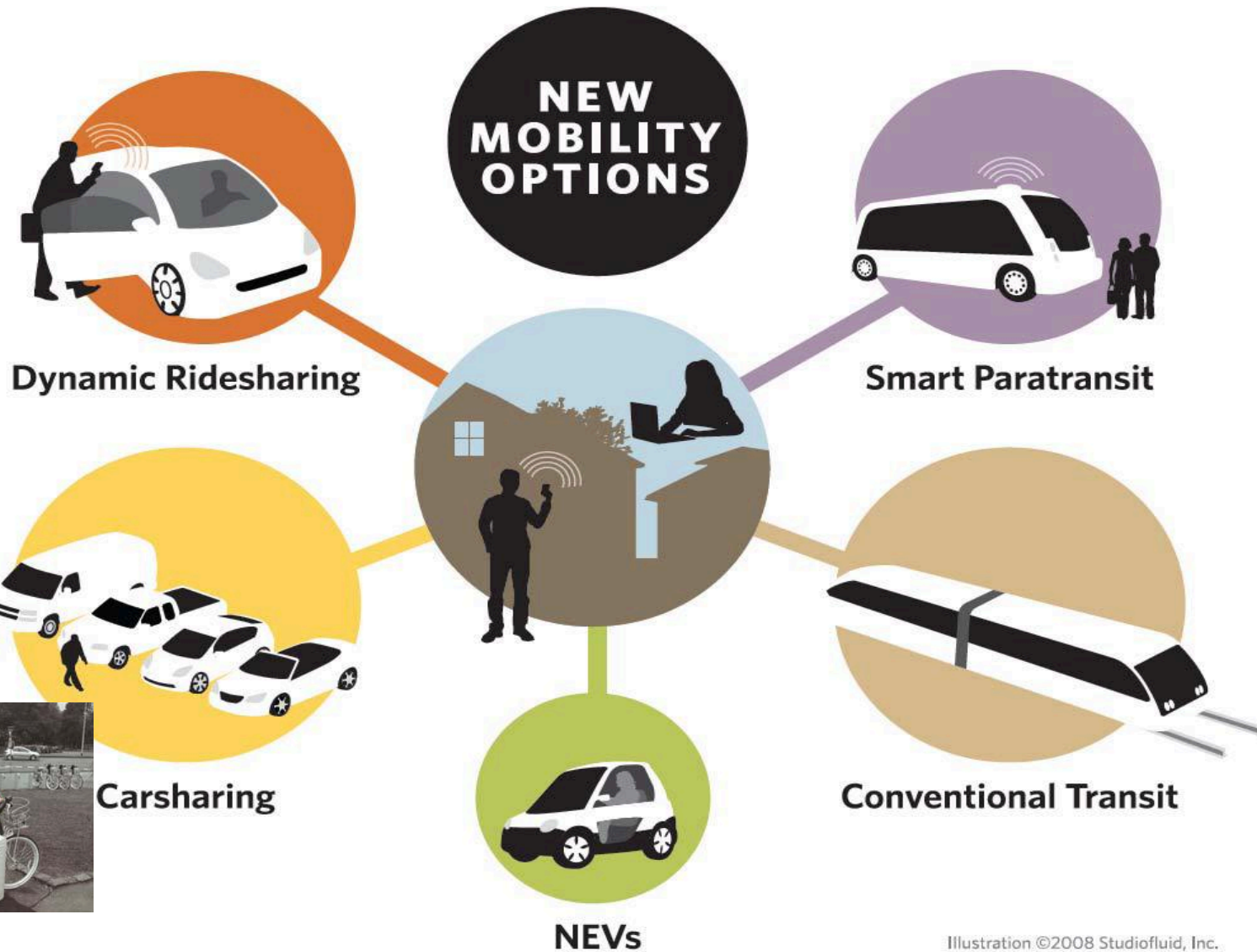
*In U.S. and abroad,
we've created a
transportation
monoculture where
"sprawl is the law."
Many opportunities for
innovation!*



Not all vehicle trips are "high value"!



Key Strategy: Expand Traveler Choice



Reduced Vehicle Use Has Many Economic and Environmental Co-Benefits (Especially in Developing Countries)

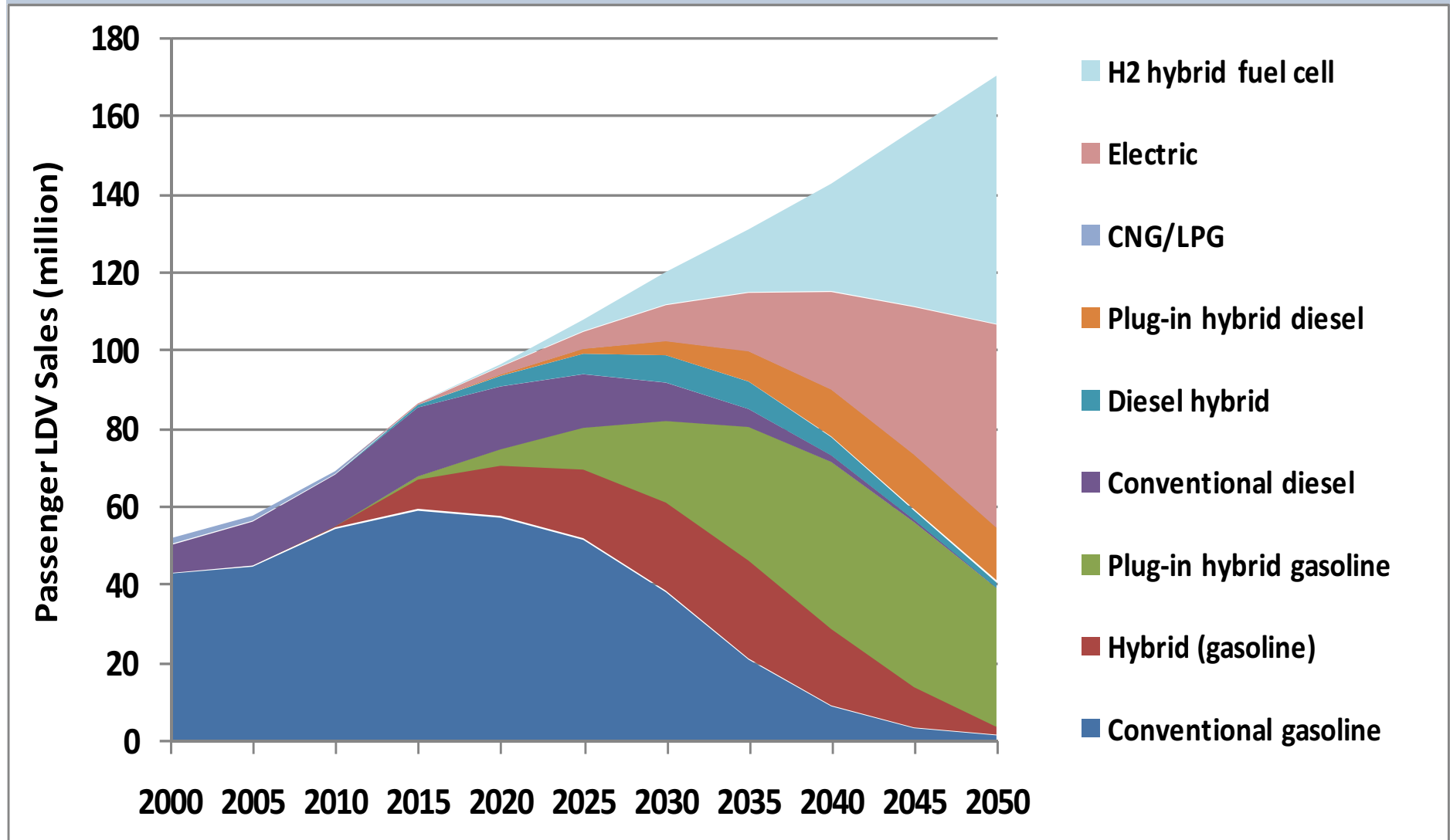
- Reduced road costs
- Reduced infrastructure costs (water, waste water, electricity)
- Reduced air pollution
- Reduced oil use
- Greater social equity
- Greater community (“livability”)?

Sperling's 5 Point Program to Transform (Surface Passenger) Transportation

- 1. GHG/CO₂ performance standards for fuels/vehicles**
 - LCFS, vehicle stds
- 2. Market instruments to align regulations with market**
 - Fuel and carbon taxes
 - Feebates
- 3. Accelerate advanced vehicle commercialization**
 - ZEV requirement
 - O g/km rating for vehicle GHG standards
 - Tax credits for hybrids, fuel cell, battery-electric vehicles
- 4. Restrain vehicle use**
 - Improve public transportation, expand mobility choices, increase the cost of driving, manage urban land use
- 5. Increased R&D investments (and training of next generation of scientists and engineers)**
 - Biofuels, batteries, fuel cells, lightweight materials

Is this IEA CO₂ (low-carbon) scenario possible?

... Almost all cars are electric-drive in 2050



IEA, 2009 (blue map scenario: 50% reduction in CO₂-e emissions by 2050)

Question of Will and Vision, More Than Cost!

- Consider hydrogen and fuel cells, which many think is most expensive and difficult transition ...
 - US National Academies (2008) estimates that \$55 billion extra over 15 years would be needed to get to 10% market penetration for hydrogen fuel cell vehicles in US
- Meanwhile, US spends ~\$8 billion/year on subsidies for corn ethanol (note \$8B x 15 years = \$120B)!!

Thus, it would be cheaper to transition to H₂FCVs than to continue subsidizing 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...

Do we have a choice?

