UCDAVIS

SUSTAINABLE TRANSPORTATION ENERGY PATHWAYS

An Institute of Transportation Studies Program

A Portfolio Approach Toward Sustainable Transportation

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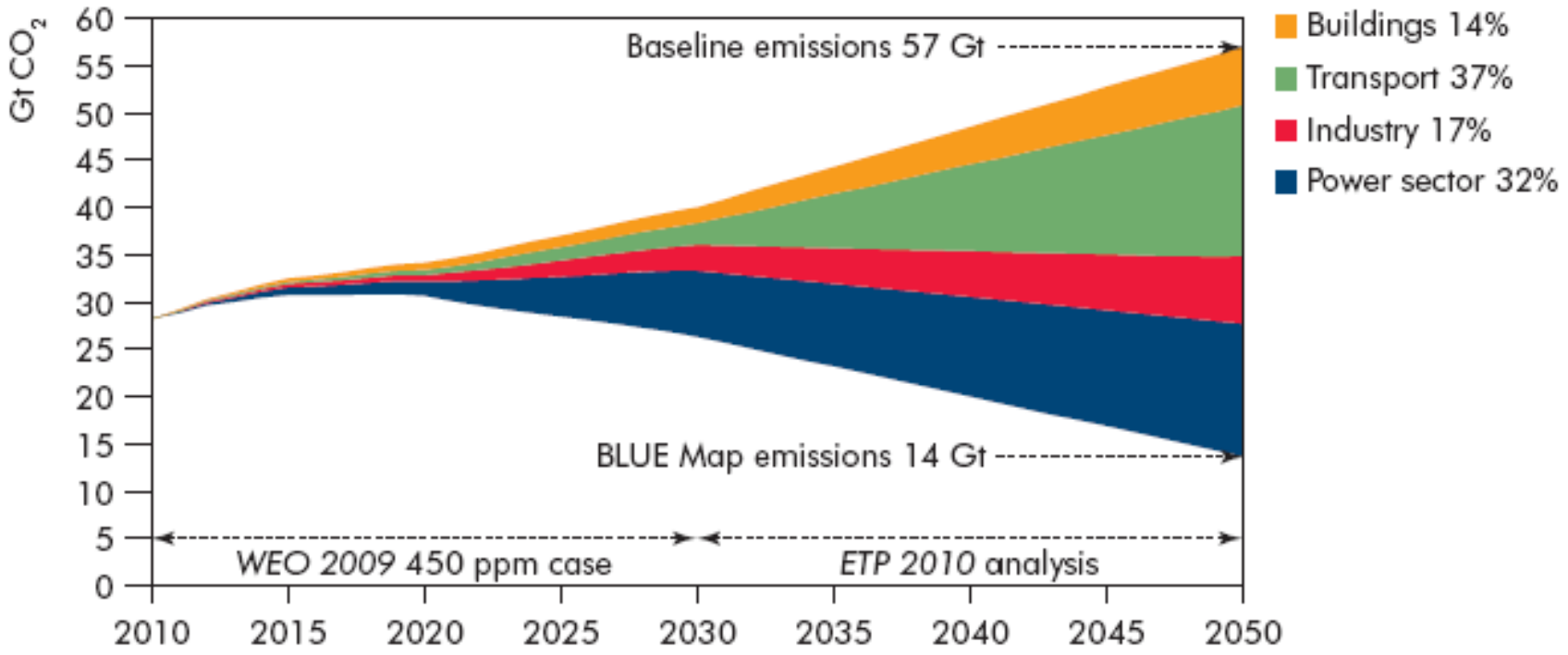
Transport Sector Key To Reach Economy-wide Goals for Low Carbon Energy Future

Figure 2.3 ▶ CO_2 emissions reductions in the BLUE Map scenario by sector



Achieving climate policy goals 80% GHG emission reduction by 2050 => **deep cuts** in transport GHGs

Diverse Options for Addressing Transportation Energy Challenges

Climate change, Air quality, Energy security

Transportation Efficiency

- Vehicle fuel economy
- Congestion relief
- Road design
- Intelligent Transportation Systems (ITS)

Alternative Fuels & Vehicle Technology

- Hydrogen
- Biofuels
- Electric drive vehicles
- Advanced ICE engines
- Low-carbon liquid fuels

Reduced Vehicle Kilometers Traveled (VKT)

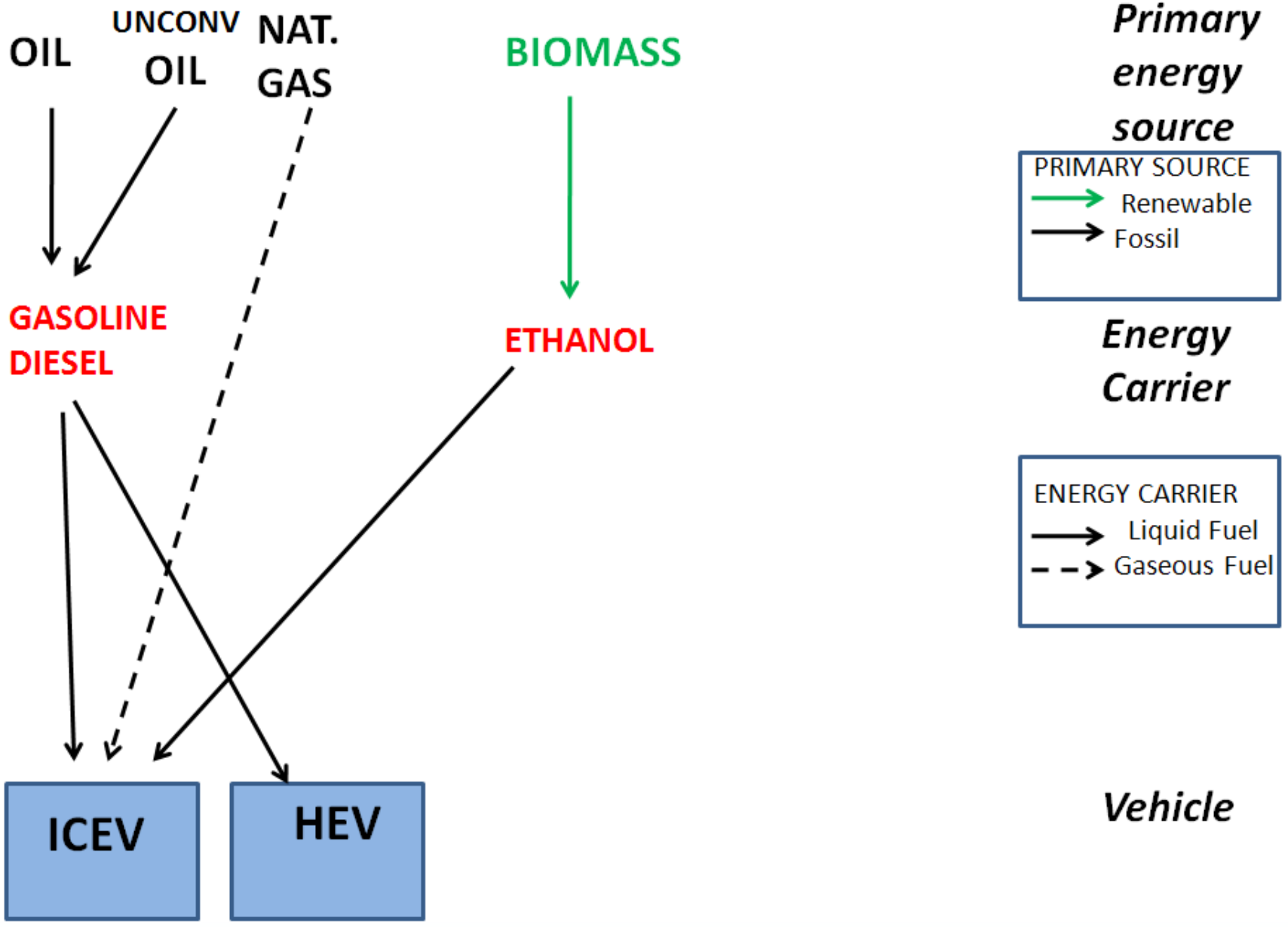
- Carpooling
- Mass transit
- Urban design

UCD Research:
"Portfolio Approach" Needed To Meet Goals

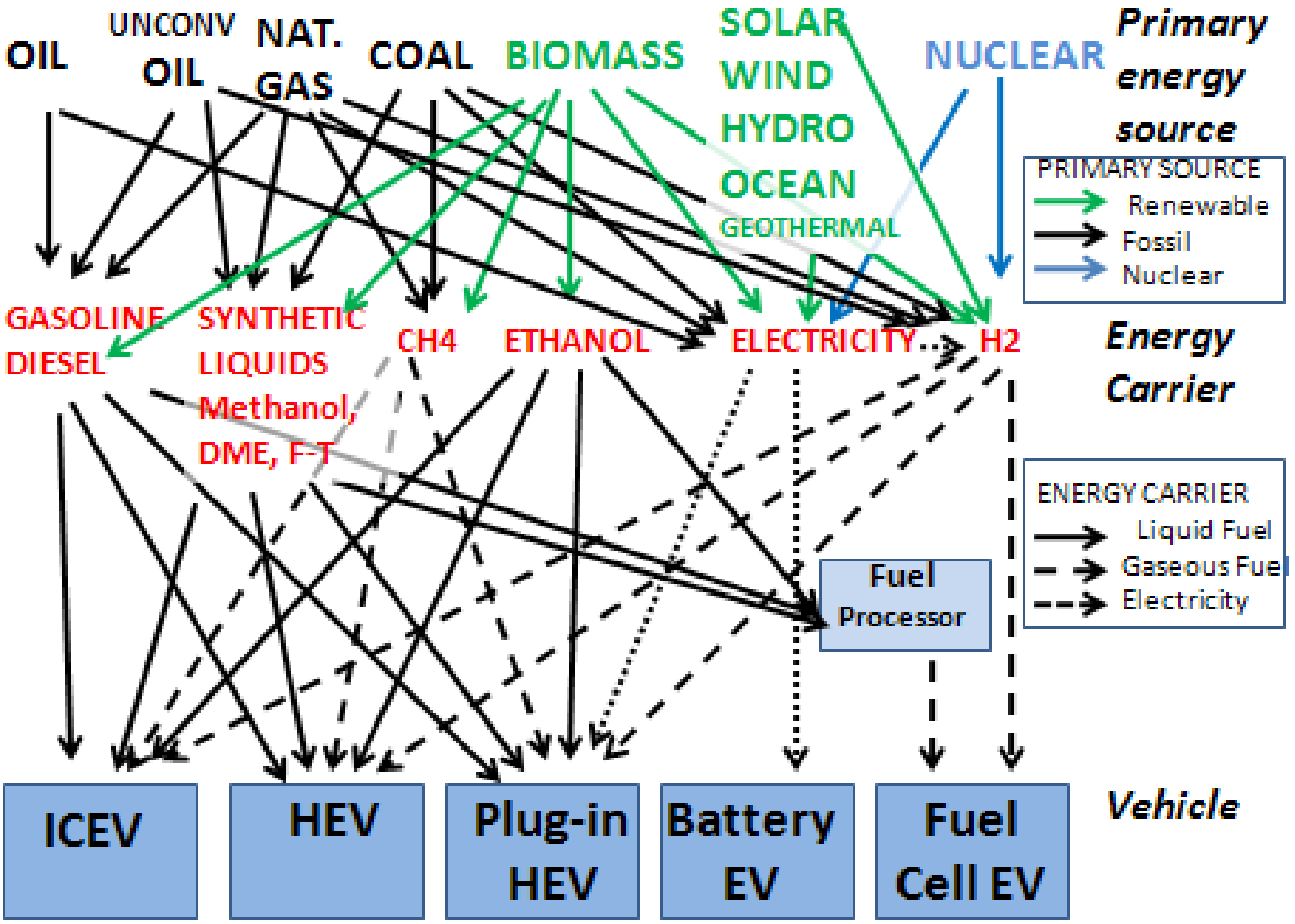
PORTFOLIO = Demand reduction + higher eff. + low carbon fuels (biofuels, elec, H2)

- **Studies suggest that future sustainable transport system will have variety of highly efficient vehicle types and low carbon fuels,**
  - **PEVs (plug-in electric vehicles) and H2 FCVs (fuel cell vehicles) in light duty sector**
  - **heavy duty/aviation using low carbon liquid fuels**
- **Variety of primary sources for fuels (not just petroleum!)**

CURRENT FUEL/VEHICLE PATHWAYS (ROAD VEH)



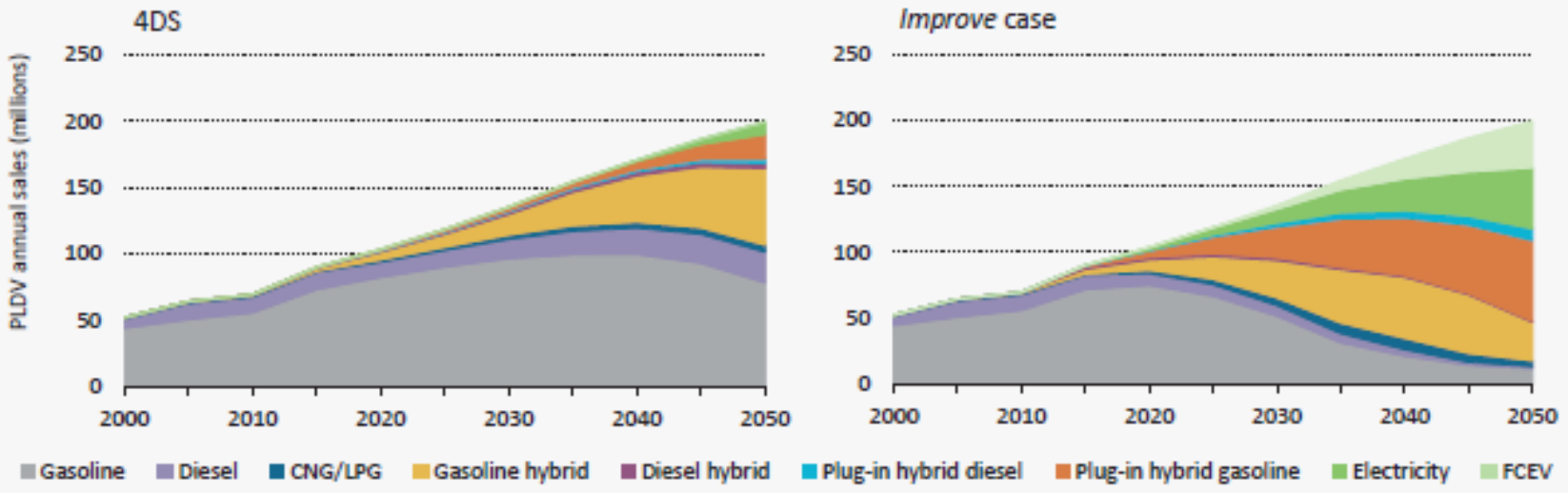
FUTURE FUEL/VEHICLE PATHWAYS (ROAD VEH.)



Meeting 2050 GHG Reduction Goals => Light Duty Sector w/ Major Use Of Elec. Drive

(Hybrid, Plug-in electric & H2 Fuel Cell)

Figure 13.18 Global portfolio of technologies for passenger LDVs

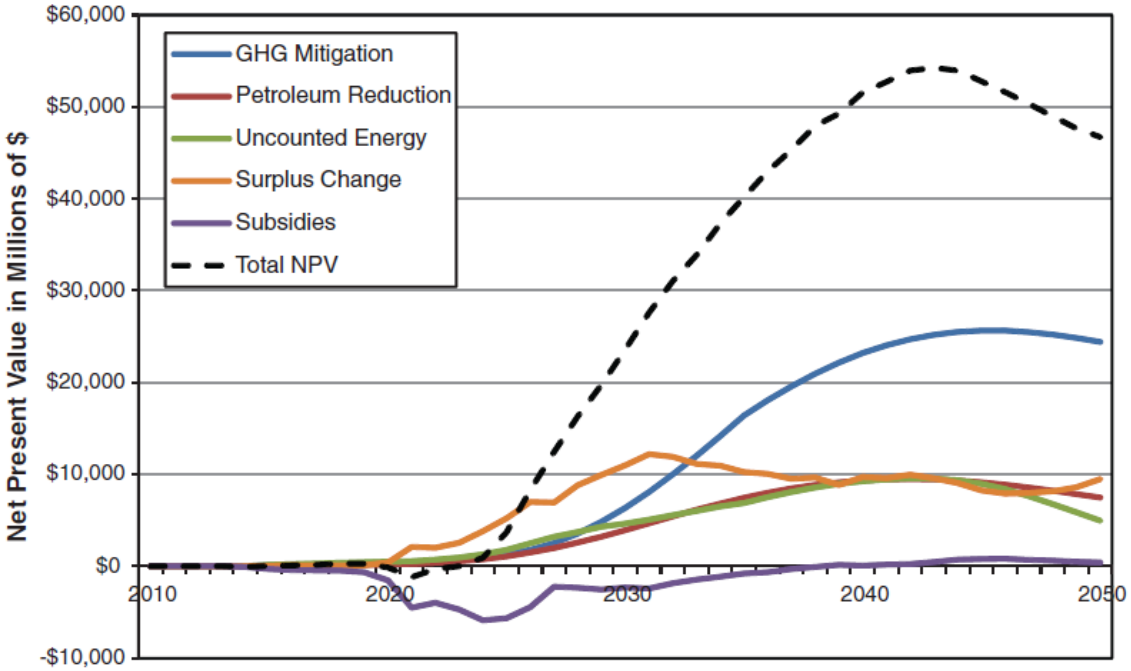


Key point *In the Improve case, electric, PHEV and FCEVs together account for nearly three-quarters of new vehicle sales in 2050.*

Source: IEA Energy Technology Perspectives (2012)

Economics of a Portfolio Strategy

- Potential to cost-effectively address climate & energy goals & meet growing mobility needs.
- NRC (2013): Long term societal benefits >> costs



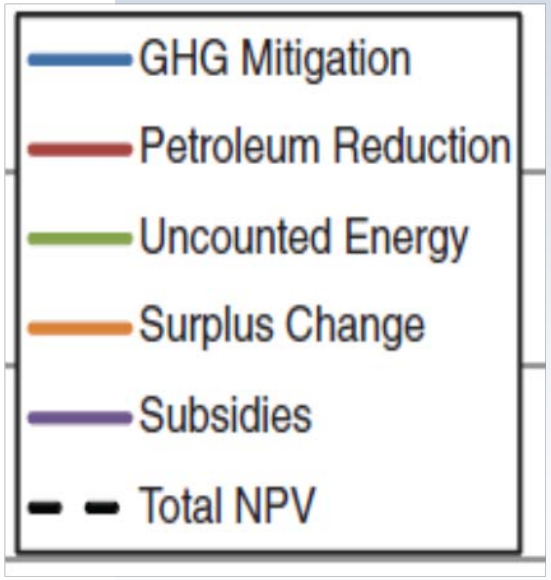
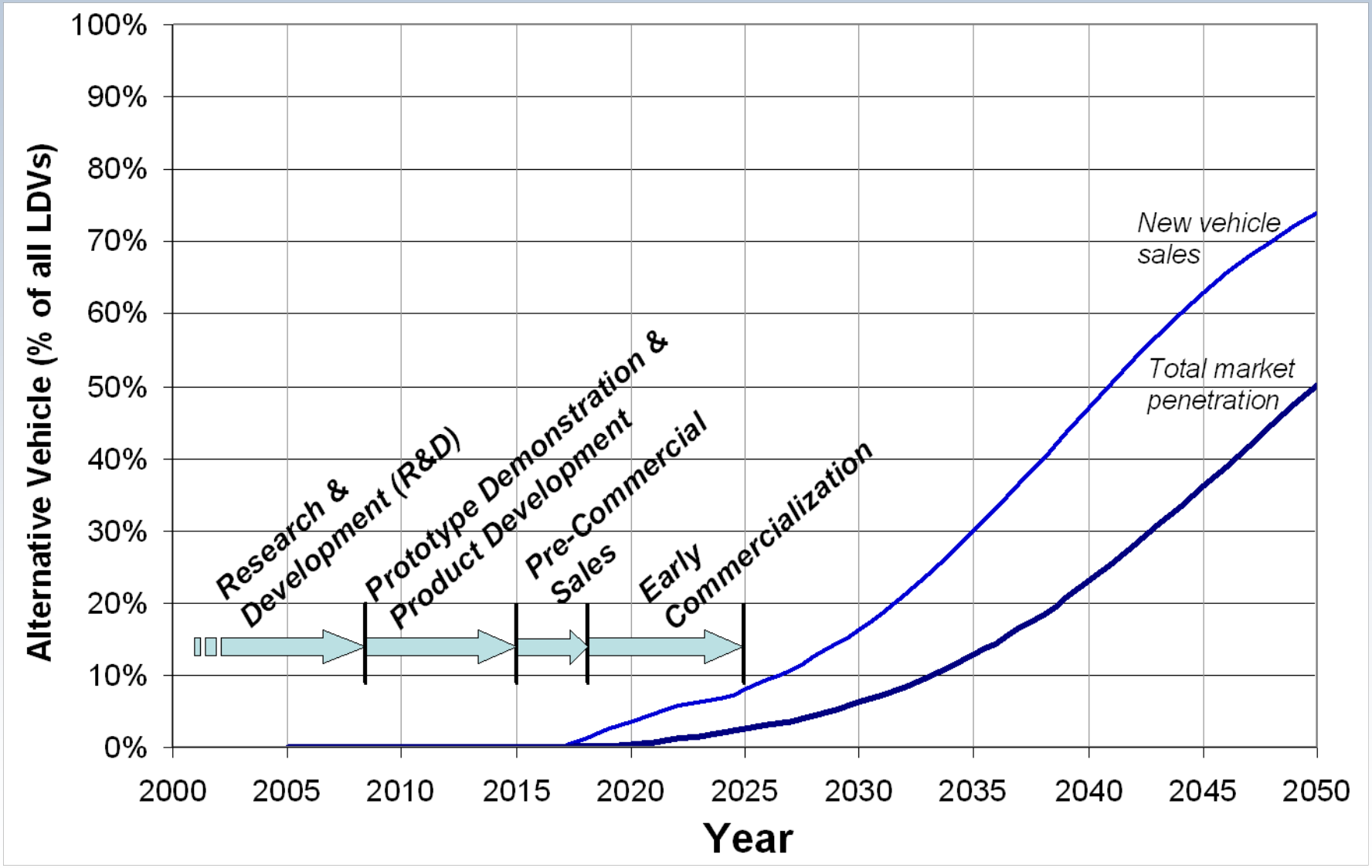


FIGURE 5.24 Present value cost and benefits of a transition to hydrogen fuel cell vehicles using midrange technology assumptions, fuel cell vehicle subsidies and additional incentives, and a low-GHG infrastructure for the production of hydrogen.

Making a Transition

- A revolution in transport technology/fuels will be required to meet GHG goals
  - New types of vehicles
  - New infrastructure
  - Incorporate low carbon primary supply
- Each of the solutions face non-trivial technical, economic, policy, political, and market challenges toward full commercialization

VEHICLE COMMERCIALIZATION TIMELINE



Source: Cunningham, Gronich and Nicholas, presented at the NHA Meeting, March 2008.

HISTORICAL DATA: MAJOR US TRANSPORTATION INFRASTRUCTURES

time constants: 30-70 years

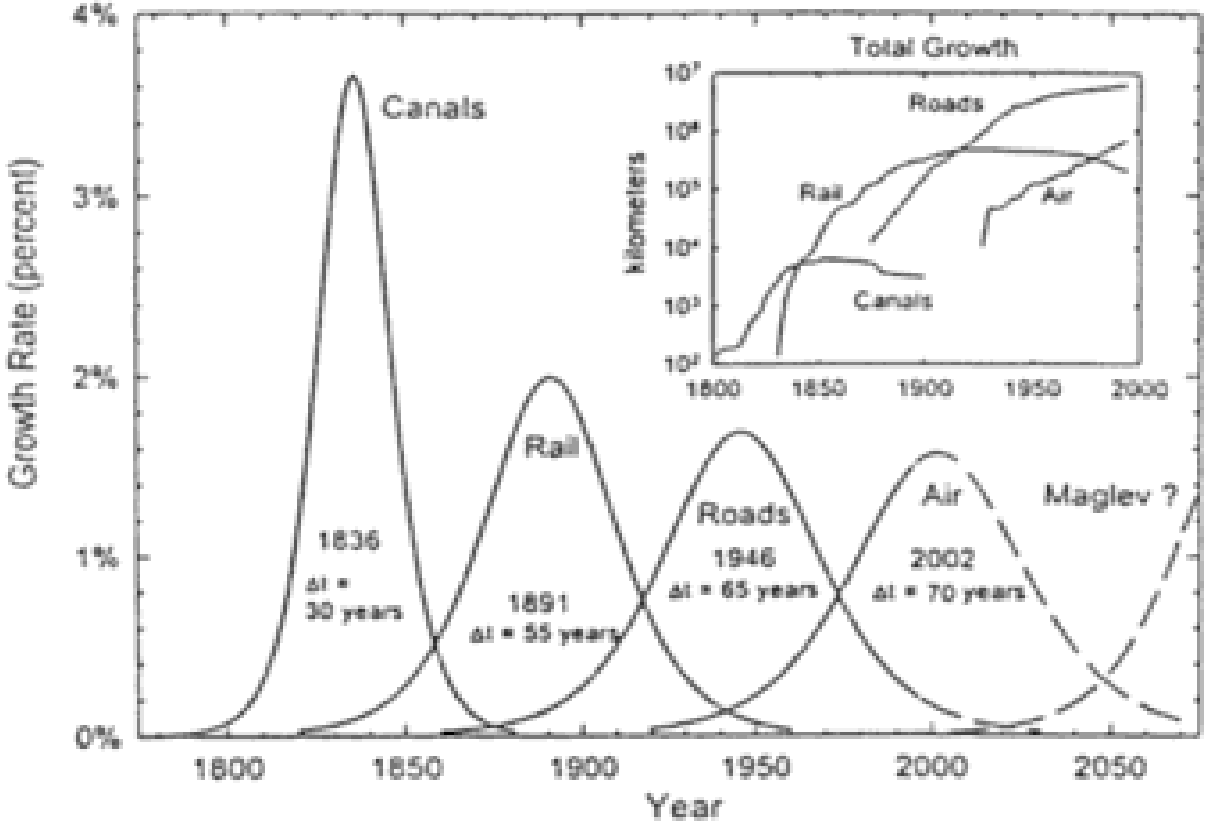


FIGURE 3.8 Penetration of major U.S. transportation infrastructures. SOURCE: Adapted from Marchetti (1985); Ausubel (1996).

Transitions take time, but need to act now

- Given the time-frames involved, actions today can have major implications for future costs/benefits
- Success will require public/private collaboration & adaptive learning and policy
- CEC's investments should consider both near term needs and long-term potential for benefits. Focus on filling gaps and leveraging private investment (e.g. H2 infrastructure leveraging OEM vehicle investment).

FINDINGS

- **A revolution in transportation technology will be needed to meet societal goals.** It appears to be technically feasible to cut transportation- related GHG emissions by 50-80% by 2050.
- **A portfolio strategy is essential**, combining energy efficiency, travel reduction and adoption of alternative fuels and vehicles.
- **No single fuel or vehicle dominates the future**. Instead, a diverse mix of fuels in different regions & transport applications.
- **Investments needed to launch new clean vehicles and fuels << money flows in the current energy system. Long term benefits far outweigh costs**.

RECOMMENDATIONS

- Near term actions to reduce transportation-related GHG emissions and oil use & enable deep cuts by 2050.
  - Increase efficiency of ICEVs, adopt lower-carbon fuels
  - Support emerging electric drive transportation technologies (batteries and fuel cells)
  - Continued R&D on “game changing” technologies
  - City-scale demonstrations to accelerate technology learning at the system level
- Ongoing science to assess impacts of different choices: GHG emissions, oil use, and water, land, air and materials
- Strong and consistent policies