Visions of a Sustainable Future

Transition to a Hydrogen Future: Scenarios for the U.S.

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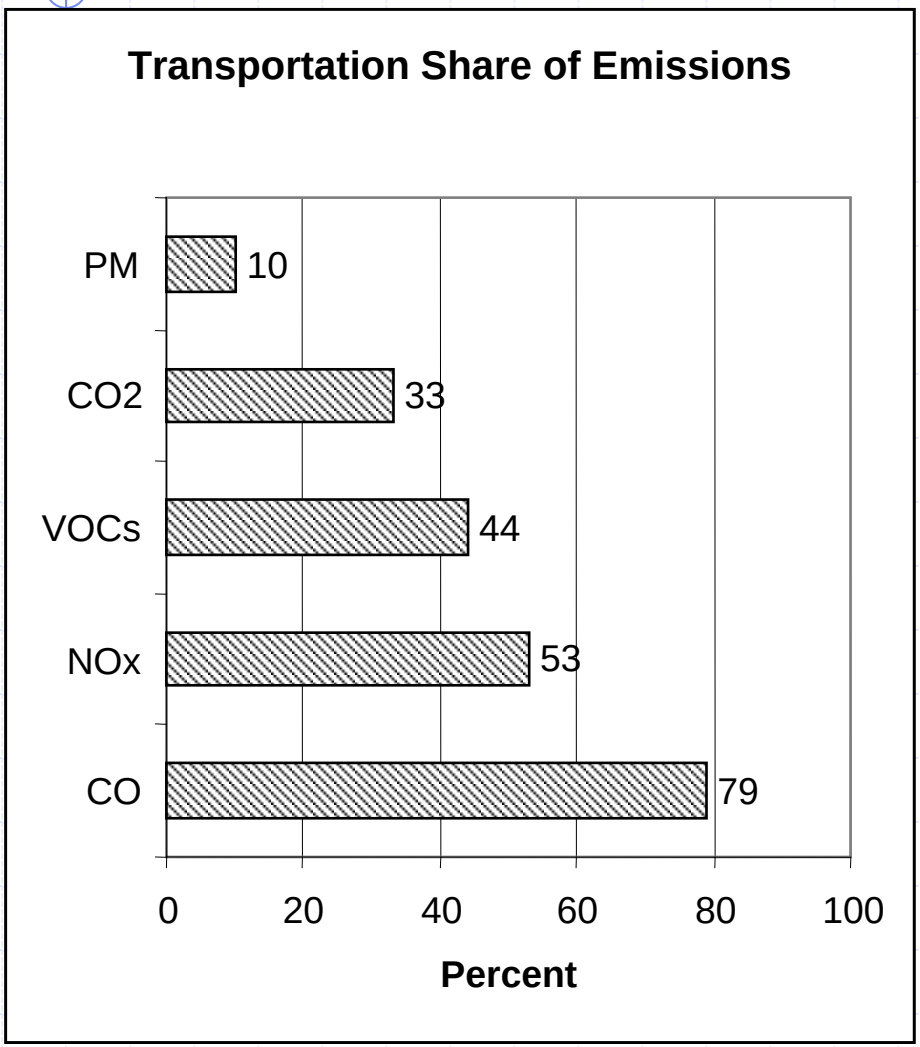
Overview

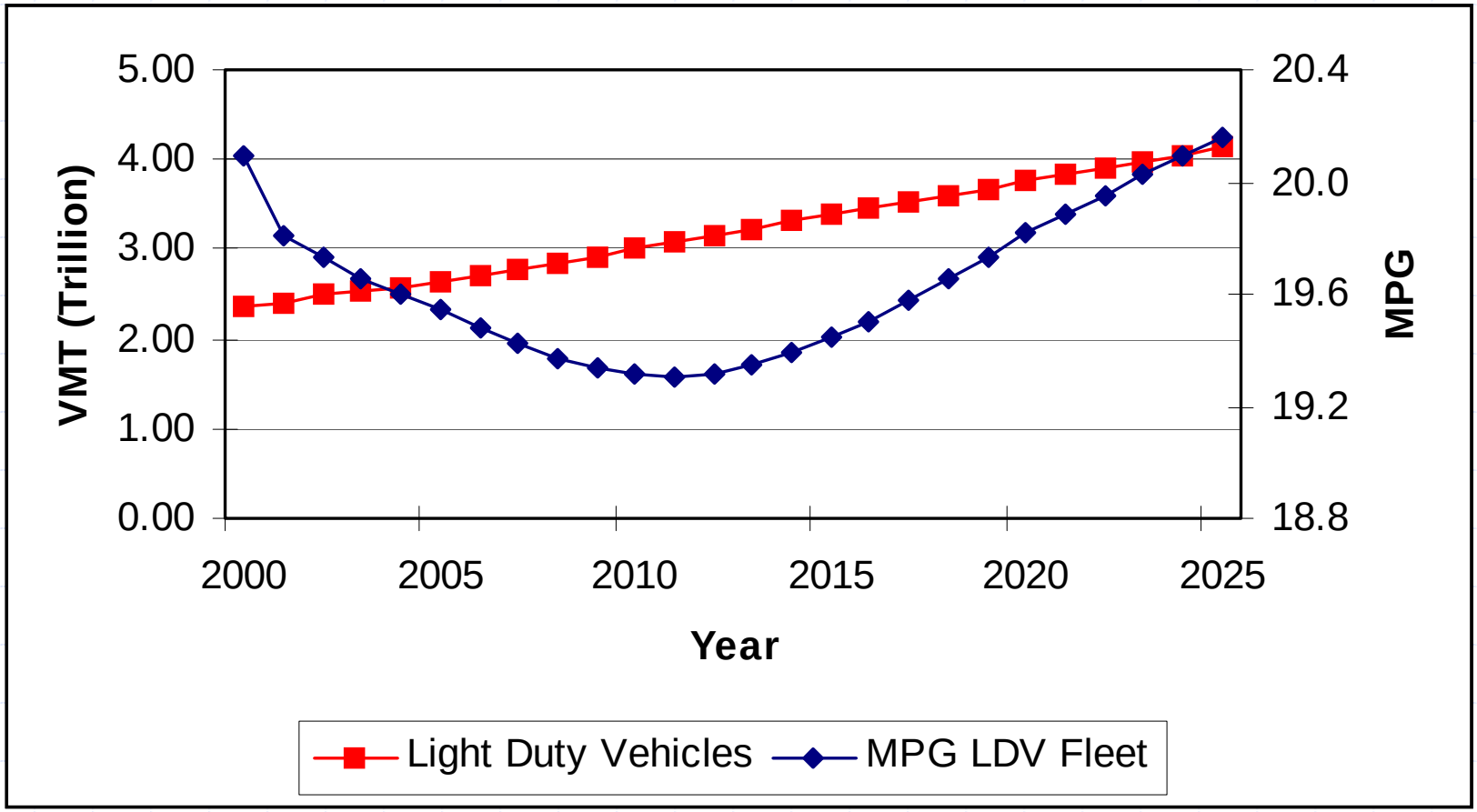
- Problems in the U.S.
- Future solutions
- The use of scenarios
- Questions for consideration
- Future research needs
- Conclusion

Problems: Environmental Impacts



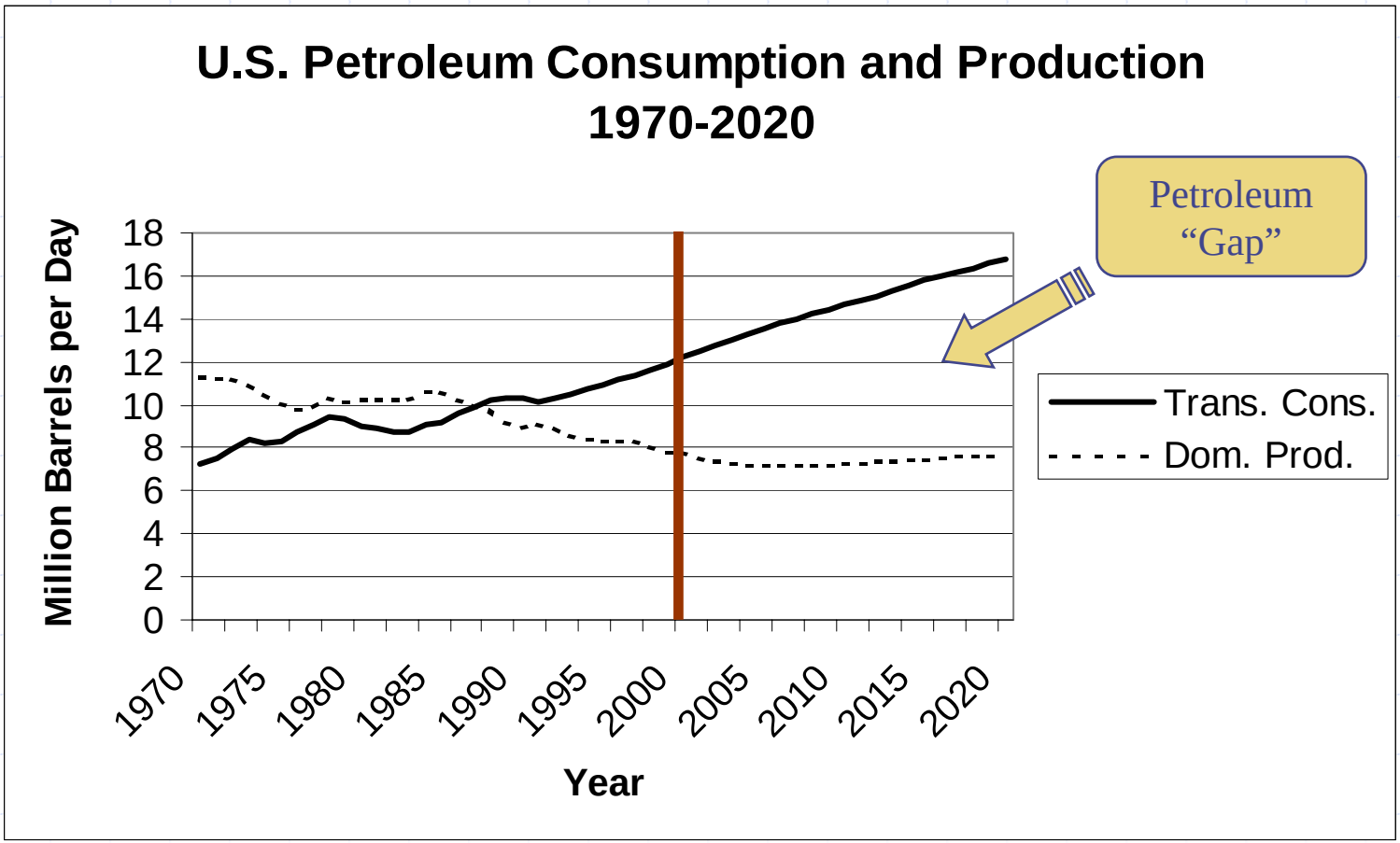
Still a major contributor, despite reductions in new vehicle emissions achieved over the last decade.

U.S. Forecast VMT and MPG



Source: EIA, *Annual Energy Outlook 2003,* DOE/EIA-0383(2003), January 2003.

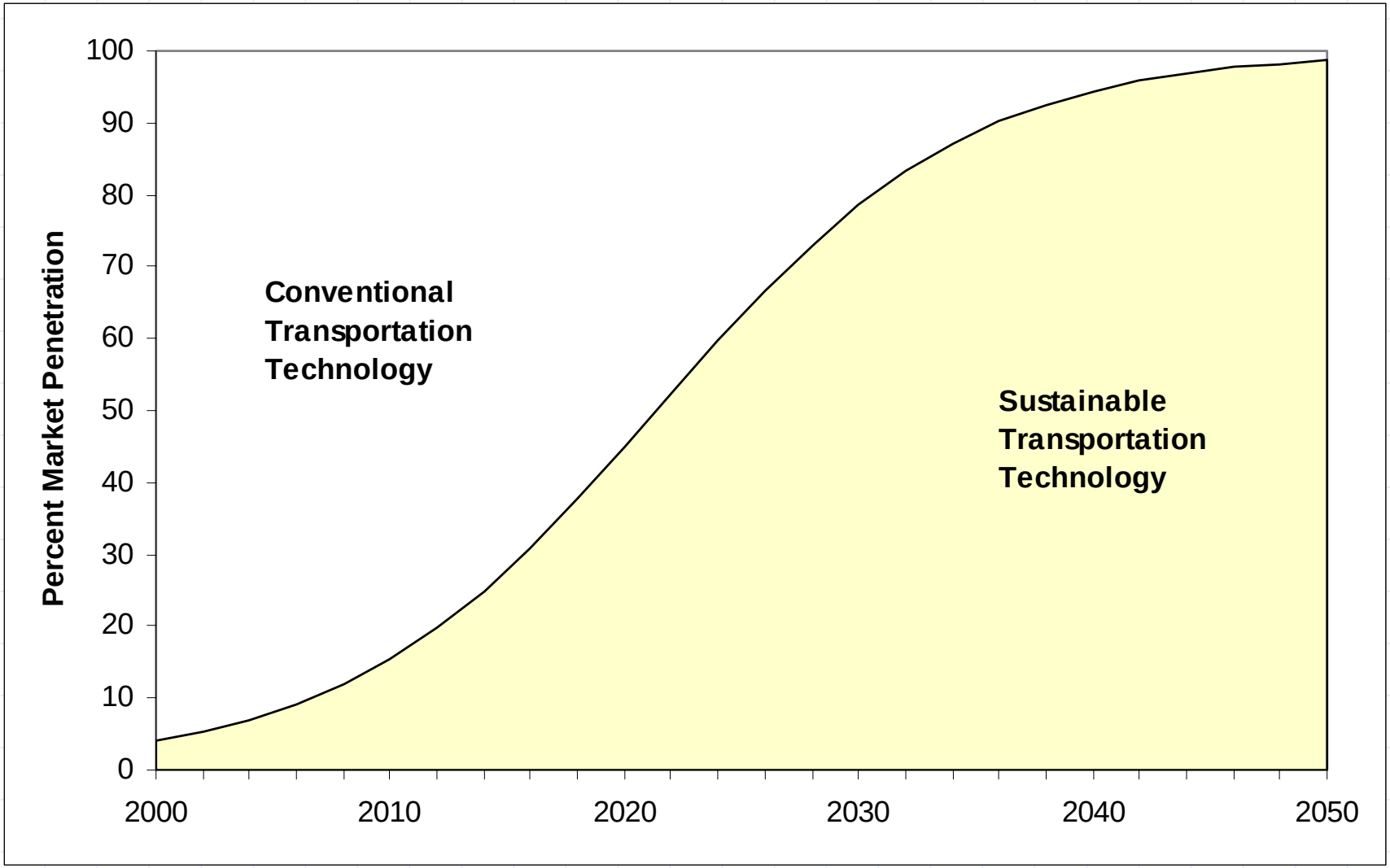
Problems: Petroleum Dependence



Source: EIA, *Annual Energy Outlook 2003,* DOE/EIA-0383(2003), January 2003.

Some Solutions

- Improved efficiency
- Alternative fuels
- Pure electric
- Hybrid-electric vehicles
- Hydrogen fuel cell vehicles
- Others?



But how do we get from HERE...

...to THERE?

U.S. Federal R&D Focus

- FreedomCAR
  - “Affordable full-function cars and trucks that are free of foreign oil and harmful emissions, without sacrificing safety, freedom of mobility, and freedom of vehicle choice.”
- FreedomCAR Focus
  - Reduce vehicle weight
  - Improve energy production and storage
  - Advancing ICE
  - Building electronic components
  - Developing hybrid electric drivetrains

U.S. Policy Focus

- Existing Tax incentives for HEVs and AFVs
- Energy Policy Act of 2004?
  - Grant programs and demonstrations
  - CAFE standards
  - Fuel cell vehicle program
- International Partnership for the Hydrogen Economy

Key Question for U.S. Markets

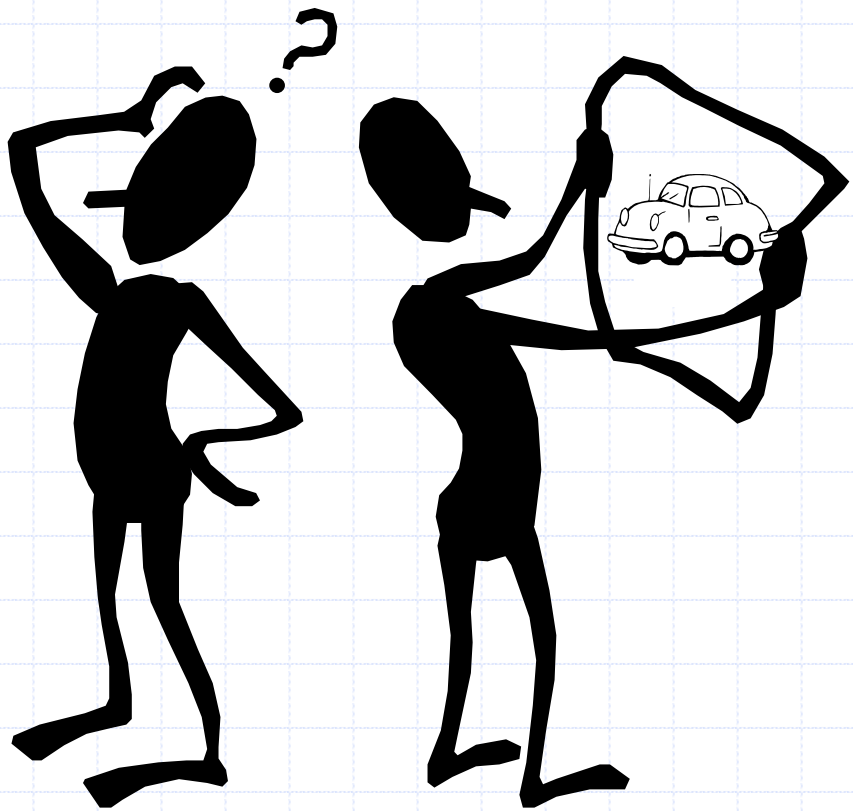
- TECHNICAL:
  - What technologies will drive this transition?
  - What “technology sequence” will occur?
  - How will new technologies support or compete with each other? (For example, will hybrids support or supplant the need for hydrogen?)
- ECONOMIC:
  - What economic factors will affect markets and consumer preferences?
  - How will prices for oil and alternatives affect markets?
  - How will vehicle production costs affect market development?

Key Questions (continued)

- ENVIRONMENTAL:
  - How will environmental issues affect technology development and acceptance?
- POLITICAL:
  - How will government policies affect new technology market development?
  - How will government R&D expenditures be spent?
  - How will mandates or incentives be used?
- SOCIAL/DEMOGRAPHIC:
  - How do U.S. demographics affect the technology transition?
  - How do global economic development and population growth affect market development in the U.S. and abroad

The Most Challenging Question

How does a company plan for the future under these uncertainties?



The Use of Scenarios

- Different from traditional forecast planning
- “A tool for ordering one’s perceptions about alternative future environments in which decisions might be played out.” (Schwartz, 1996)
- Purpose: “To generate projects and decisions that are more robust under a variety of alternative futures.” (Van der Heijden, 1996)
- “Scenario building helps an organization envision a future in order to develop plans, programs, or policies that allow it to respond to, change, or create that future.” (Winebrake, 2003)

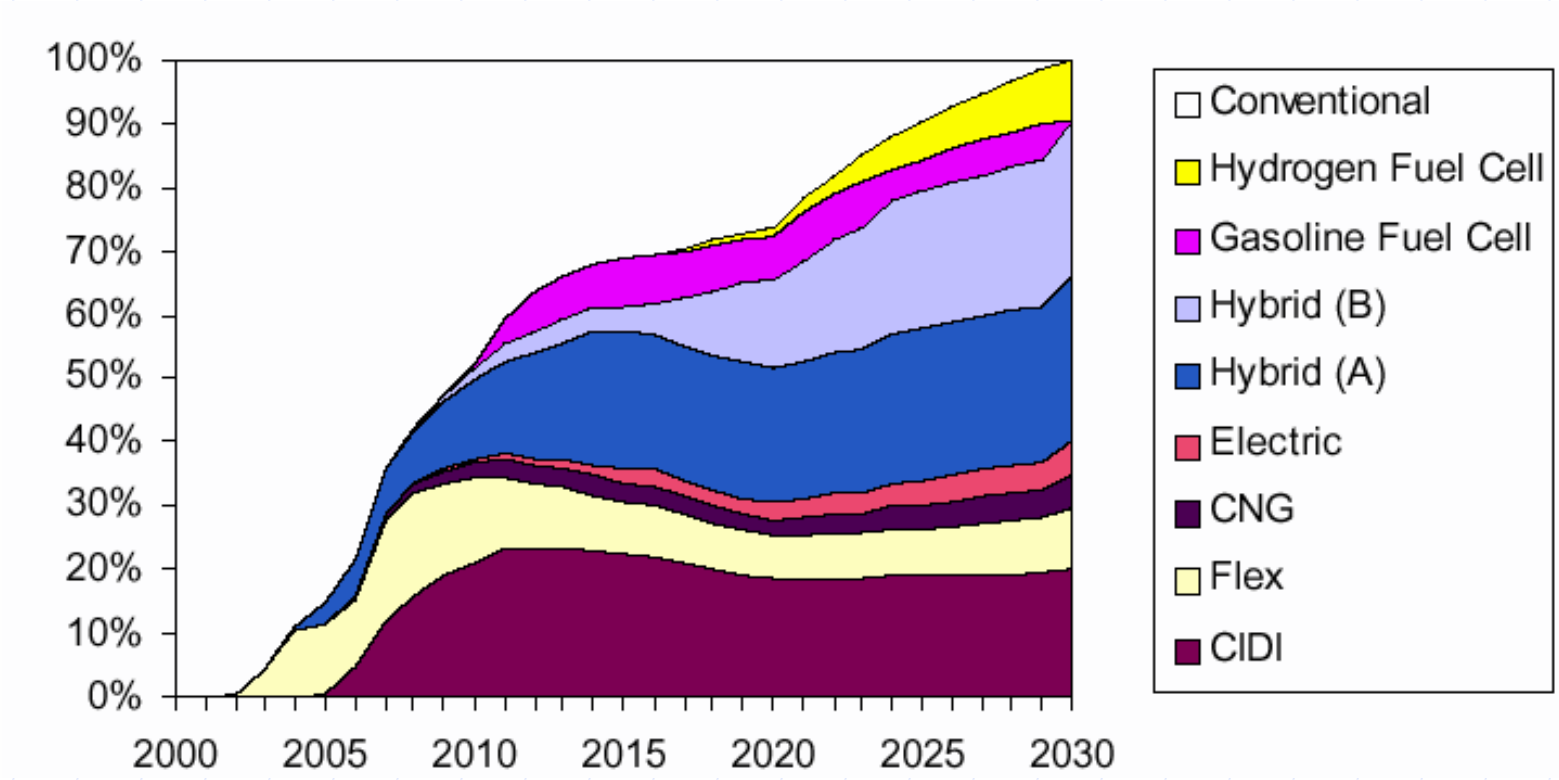
Process of Scenario Building

- Formal process
  - Identify focal issue
  - Identify driving forces or variables
  - Rank forces by importance and uncertainty
  - Select scenario logics
  - Flesh out the scenarios
  - Determine implications—robust decisions
  - Select leading indicators and “signposts”

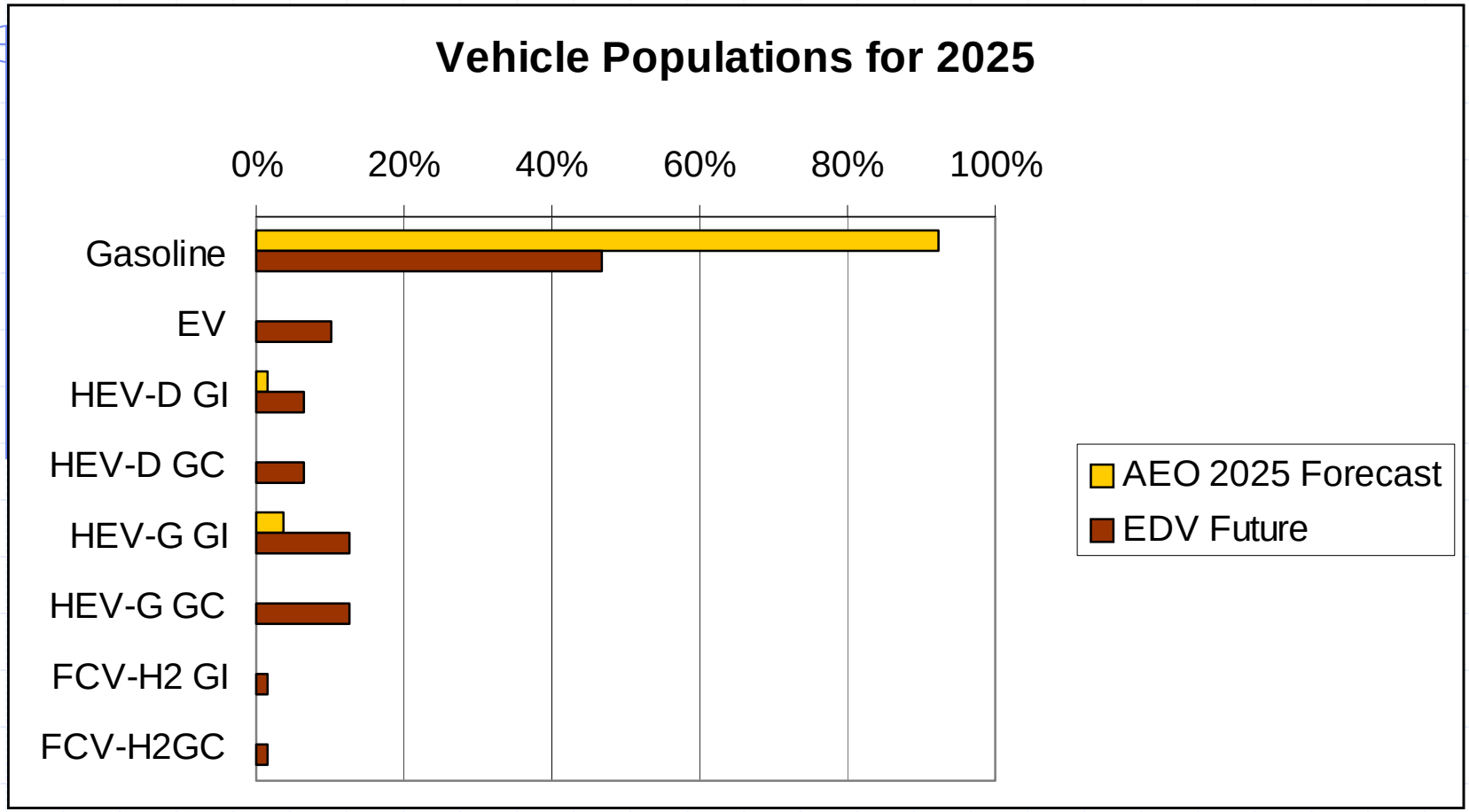
Scenarios from the Energy Field

- American Public Transit Association
- DOE: (1) Energy 2050, (2) Quality Metrics, (3) Five-Lab Study
- IIASA/WEC: Global Energy 2100
- IPCC: Emissions Scenarios
- Shell Oil: Scenarios to 2050
- WBCSD: Future Energy
- EPRI (EDV Futures)

U.S. Department of Energy Quality Metrics Work



Annual Energy Outlook 2025 v. EPRI Study



EV=battery electric; HEV=hybrid electric vehicle; D=diesel; G=gasoline
GI=grid-independent; GC=grid connected; FCV=fuel cell vehicle; H2=hydrogen

Problems with Recent Examples

- Lack of systematic analysis relevant to automakers' concerns
- No focal decision considered (e.g., Where should my company focus R&D investment?)
- Transition period not well-investigated ("time-warp" problem)
- Dialogue among decision-makers and experts often weak—scenario building should be used to frame debate
- Indicators and signposts rarely identified
- More like alternative forecasts than a true scenario building process

Research Needed

- Scenario building targeted at automakers' decision making during the transition period between now and a potential hydrogen future
  - Development of scenario building framework
  - Development of mechanism for dialogue among business and government leaders about the future
  - Identification of signposts, leading indicators, and perhaps a "road map" for planning purposes

Questions and Discussion