What do greenhouse gas scenarios tell us?

Dawn Manley, Amy Askin, Garrett Barter, Tom Stephens, Jake Ward, Joann Zhou

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Scenario analyses explore possible futures and pathways

- What mix of technologies can achieve aggressive GHG reduction or fuel economy targets?
- How do the different projections compare with respect to 2030 and 2050 goals?
- Why do analyses on the “same” topic yield different findings?
- What should we consider as we compare and contrast scenario results?
  - Context/intent
  - Key questions
  - Scope
  - Assumptions
  - Methods and approach
Consider context of recent studies with scenarios for GHG emissions & petroleum consumption reduction

- National Petroleum Council – Advancing Technology for America’s Transportation Future
  - Request from DOE Sec. Chu to NPC. Included participation from over 300 individuals with primary leadership from oil & gas industry
- DOE EERE – Transportation Energy Futures
  - DOE study conducted by national laboratories (ANL, NREL, ORNL)
- National Resource Council – Transitions to Alternative Vehicles and Fuels
  - Convened by NRC in response to Congressional mandate in Senate FY2010 energy & water appropriations bill
- Energy Information Agency Annual Energy Outlook 2013
  - Annual best projection by EIA of key energy production, demand, and prices through 2040
Key questions and scope for these major US studies

- **NPC** – entire transport sector
  - What actions can industry and government take to stimulate technological advances (alternative fuels and advanced vehicles) and market conditions to reduce lifecycle GHG by 50% relative to 2005 by 2050?

- **TEF** – entire transport sector with emphasis on underexplored opportunities
  - What combination of strategies could achieve deep reductions in petroleum consumption & GHG emissions?

- **NRC** – LDV efficiency, biofuels, electrification, H2
  - What combination of policies could achieve substantial reductions – 50% by 2030 and 80% by 2050 – in petroleum consumption & GHG emissions?

- **AEO** – entire energy economy
  - Where will the US energy economy likely be in 2040?
Pathways through scenarios highlight factors that influence outcomes.

Inputs & Assumptions:
- Technology
- Consumer attributes
- Policy/incentives
- Energy Prices
- Population/economic growth
- Infrastructure

Analysis & Intermediates:
- Vehicle prices & attributes
- Consumer Choice
- Vehicle/Fuel Sales
- Vehicle Miles Traveled

Output metrics:
- Fuel Consumption
- GHG Emissions
Unpacking scenarios highlights additional complexity: AEO forecasts.
Inputs & models used to generate scenarios vary:
VISION, LVChoice, fuels & infrastructure for NPC


Vehicle prices & attributes  Payback, Range anxiety  Fuel cost/mile

VMT/ vehicle  Feedback  Population/economic growth

LDV Fuel Consumption  HDV Model [NPC]  HDV Fuel Consumption  GHG intensity  GHG emissions

Rail, Maritime, Aviation, Pipeline Models  Other Transportation Fuel Consumption

Consumer Choice  Sales  LDV stock  Scrappage
Inputs & models used to generate scenarios vary: VISION, Autonomie, MA3T for TEF

- Technology [Autonomie]
- Consumer attributes
- Policy [On books]
- Energy Prices [AEO2011]
- Refueling & recharging Infrastructure
- Proscribed Growth
- Population /economic growth

- Vehicle prices & attributes
- Payback, Range anxiety
- Incentives
- Fuel cost/mile
- TEF Low Carbon
- ARRA tax credits
- VMT/vehicle
- LDV Fuel Consumption
- HDV Model [NPC]
- Other Transportation Fuel Consumption
- GHG intensity
- GHG emissions

- Scrappage
- LDV stock
- Sales
- Consumer Choice
- Population /economic growth

- Rail, Maritime, Aviation, Pipeline Models
- Other Transportation Fuel Consumption
- GHG intensity
- GHG emissions
Inputs & models and spectrum of scenarios vary:
VISION, LAVE-Trans with policy for NRC

- Technology [Scenarios]
- Consumer attributes
- Policy [Scenarios]
- Energy Prices [AEO2011]
- Refueling & recharging Infrastructure
- Population /economic growth [AEO2011]

- Vehicle prices & attributes
- Payback, Range anxiety
- Incentives
- Fuel cost/mile
- VMT/vehicle
- Fuels & carbon tax, mileage fee, infrastructure subsidies

- Consumer Choice
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- LDV Model
- LDV stock
- Sales
- Scrappage

- HDV Model
- HDV Fuel Consumption
- GHG intensity
- GHG emissions

Rail, Maritime, Aviation, Pipeline Models
Other Transportation Fuel Consumption
Key difference: Input policy assumptions and impacts

AEO incorporates current policies & assumes that current laws/regulations are largely unchanged (including sunset dates)

- ARRA tax credits
- CAFÉ standards
- RFS2
- CA AB32, LCFS, Low Emission Vehicle Program

NPC focused on technology rather than policy

- Incorporated infrastructure costs in fuel price rather than subsidies
- Technology cost included in vehicle cost

TEF: Assumed vehicle subsidies with ARRA tax credits (courtesy of Changzheng Liu, ORNL)

NRC Figure 5.31: Assumed BEV & PHEV subsidies in optimistic EV technology scenario

- Fuels & carbon tax, mileage fee, infrastructure subsidies
Intermediate difference: Light duty vehicle mix

- AEO Figure 73: Sales of LDV using non-gasoline technologies
- TEF Project Overview and Findings Slide 10: Advanced vehicles have the potential to dominate the LDV market by 2050
- NRC Figure 5.32: LDV sales for optimistic plug-in electric vehicle scenario
- NPC Figure 2-10: Ranges of 2050 LDV share in 2050 including all fuel-vehicle systems
Difference in output: Fuel consumption

AEO Figure 6: Transportation energy consumption by fuel (quadrillion BTU)
Projected 2050 Petroleum Use and Potential Reductions

NPC Figure ES-10: Range of 2050 on-road fuel consumption assuming all alternatives commercialized

TEF Project Overview & Findings Slide 18: Projected 2050 petroleum use & potential reductions

NRC Figure 5.33: Changes in petroleum use & GHG emissions versus 2005: Optimistic plug-in EV scenario
Difference in output: GHG emissions

AEO Figure 111: Energy-related CO2 emissions in two cases with three levels of emissions fees (MMT)

NPC Figure ES-11: Range of impact of demand, fuel efficiency improvements, & alternative fuel-vehicle systems on 2050 LD fleet GHG emissions

TEF Project Overview & Findings Slide 19: CO2 emissions (MMT)

NRC Figure 5.33: Changes in petroleum use & GHG emissions versus 2005: Optimistic plug-in EV scenario
Observations

- Consider context, key questions, scope of scenario analyses
- Examine assumptions, inputs, intermediates
  - These can be embedded in methods/models
- Presentation of results vary
  - Side-by-side comparisons of inputs, intermediates, outputs aren’t necessarily apples-to-apples
- Scenario interpretation is complicated
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