# Reducing Greenhouse Gas Emissions from U.S. Transportation

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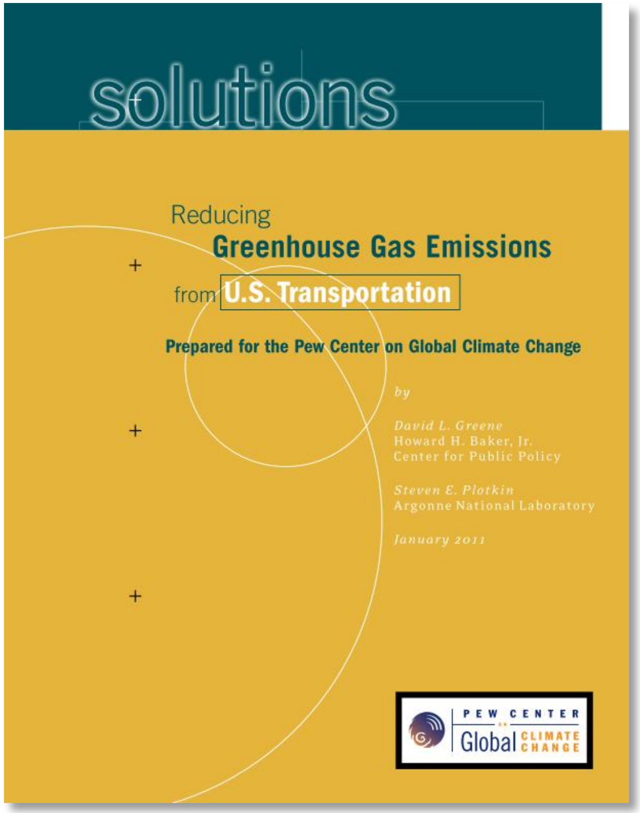

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Reducing Greenhouse Gas Emissions from U.S. Transportation

Prepared for the Pew Center on Global Climate Change

by

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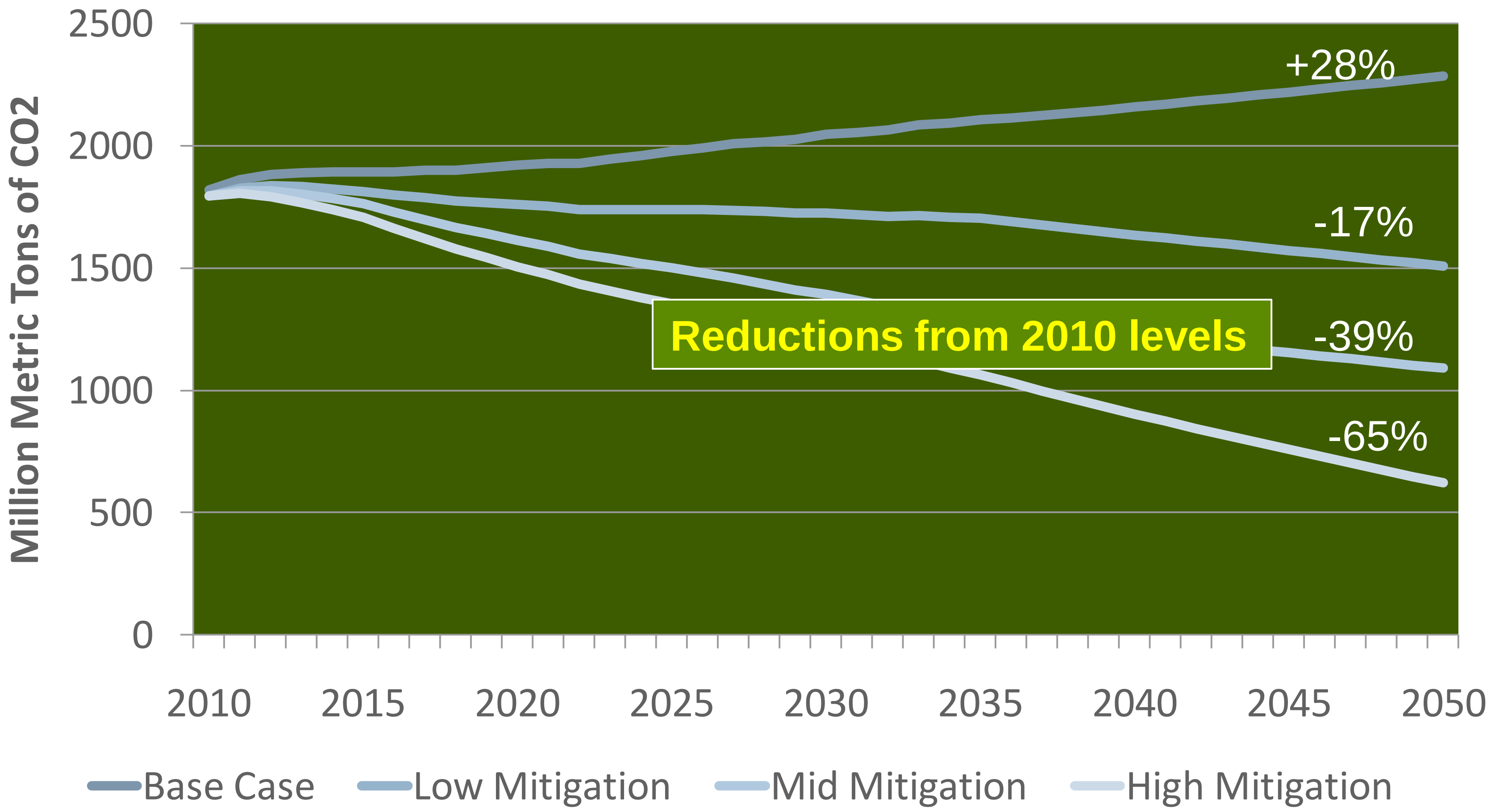
# Overview

- Presentation based on recent report from the Pew Center on Global Climate Change
- Task: Assess the potential to substantially reduce transportation's GHG emissions by 2035 & 2050.
- Base Case: Annual Energy Outlook 2010 Reference Case, extended to 2050
- Three scenarios with differing assumptions about technological progress, policy initiatives, and public attitudes
- Rely on existing studies to estimate impacts
- Scenario analysis uses Kaya method to integrate policy impacts and avoid double counting.

# Mitigation Scenario Assumptions

| | Low | Mid | High |
|---|---|---|---|
| **Public Attitude Towards Climate Change** | Majority think climate change is serious; unwilling to change behavior; support modest pricing policies | 60-75% think climate change is serious; some preference shift; support pricing policies | Public very concerned about climate change; preferences and habits change |
| **Public Policy Context** | Carbon price; RFS, biofuel subsidies, fuel economy & emissions standards | Low + local and State governments complement federal actions | Mid + Treaty commits U.S. to reductions; feebates; stricter standards |
| **Rate of Technological Progress** | RDD&D continues at current rate | Public $ on RDD&D doubles; alternative vehicles costs fall dramatically; CCS is prevalent | NRC optimistic scenario for FCVs/EVs; clean electricity sector; highway automation |

# All 3 scenarios illustrate a large potential for transportation GHG mitigation.



# We consider our scenarios to be plausible....but there are no guarantees

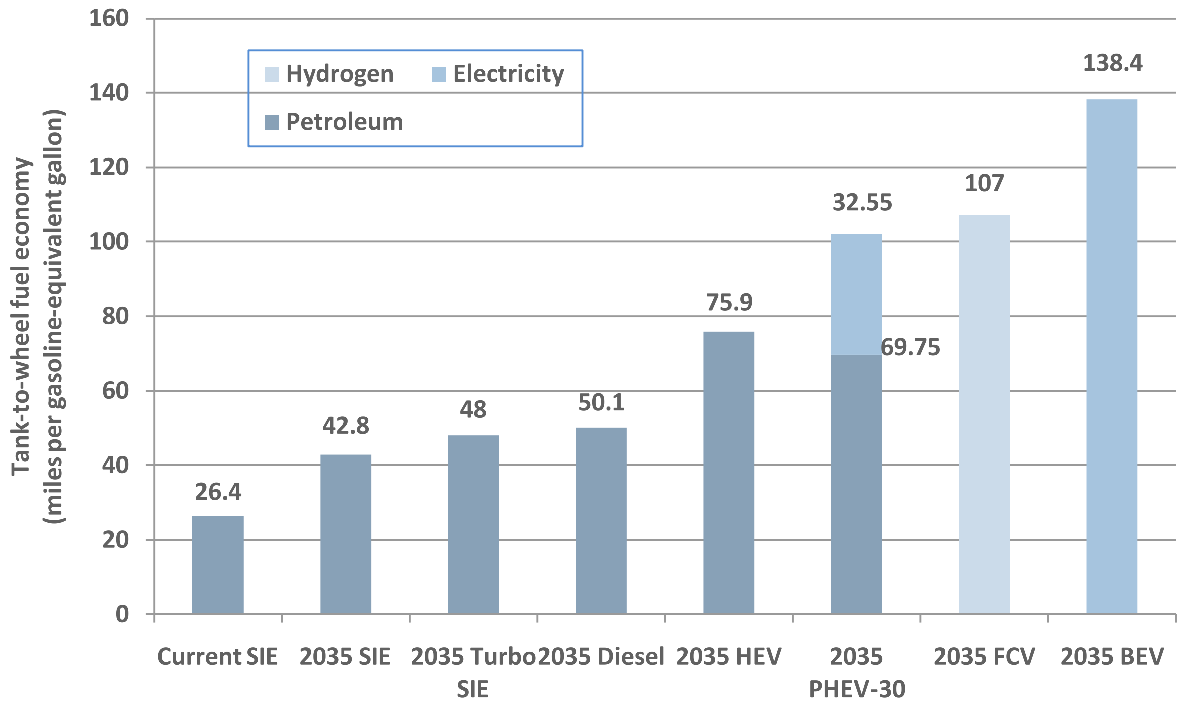
- In particular, the High scenario demands major improvements in biomass fuels and in batteries and/or fuel cells.....and widespread public acceptance of EVs and/or FCVs
- Maintaining high levels of RD&D is crucial; R&D success can never be guaranteed, but a portfolio approach will greatly reduce the risks of failure
- The Mid and especially the Low scenarios depend less on new technologies.....but demand changes in incentives and public attitudes

# (New) passenger car and light truck fuel economy can be doubled (or more) by 2035.

- 2035 conventional midsize cars can be 50 mpg and hybrids can be 75 mpg (both on road)
- 2035 total stock fleet can be 15-40% higher fuel economy than base case rising to 35-80% by 2050
- Plug-in hybrids, EVs & FCVs can all contribute, but **a 75 mpg hybrid is difficult competition to overcome**:
  - Uses 187 gallons of gasoline/yr @ 14,000 miles/yr
  - < $1,000/yr in fuel costs even at $5 gasoline!

**Conclusion: need dramatic cost reductions, performance improvements *and public acceptance* for new fuels to have a large impact**

# Advanced technologies (beyond HEVs) can boost MPG, but reducing GHGs further requires low-carbon fuels.




Well-to-tank fuel economy, $mpg_{equiv}$

| MPG | L/100 km |
|---|---|
| 26.4 | 8.9 |
| 42.8 | 5.5 |
| 48.0 | 4.9 |
| 50.1 | 4.7 |
| 75.9 | 3.1 |
| 102.3 | 2.3 |
| 107.0 | 2.2 |
| 138.4 | 1.7 |

Source: On the Road in 2035

**Note: a graph of *well to wheel* fuel economy and GHG emissions may look *very* different, depending on hydrogen and electricity production.**

# So a transition to hydrogen or electricity must deal with many issues:

- Advanced *petroleum-fueled* vehicles will be tough competition
- Without low-carbon hydrogen or electricity, EVs, PHEVs and FCVs have GHG emissions similar to advanced HEVs
- Can a transition to hydrogen occur without a firm government commitment….i.e., picking hydrogen as the "winner"?
  - Solving the "chicken and egg" problem demands a long term commitment
  - Early buyers are getting "local" vehicles only….similar to EVs, but without home refueling, perhaps with less range anxiety
  - Potential vehicle buyers must believe fueling stations are permanent
- How do EVs cope with a major traffic jam? (think DC during this winter's afternoon snow storm)
- How does one deal with refueling EVs or FCVs in an emergency?

# There are excellent options for Medium- & Heavy-Duty vehicles

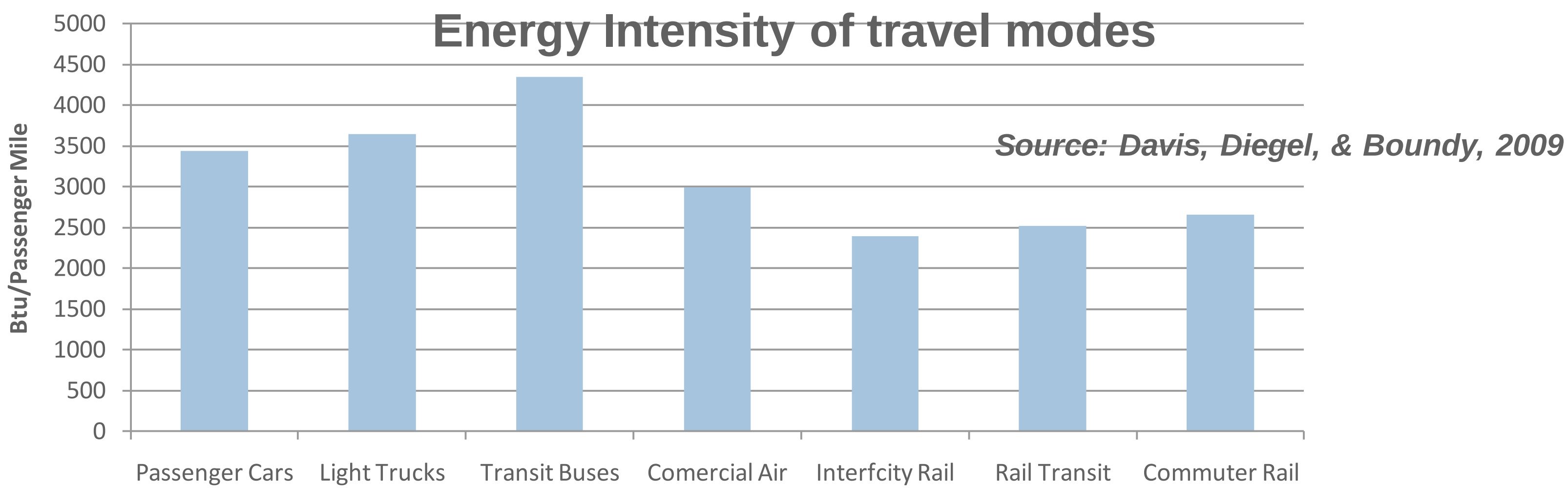
- 18% of transportation GHG emissions and growing
- 2/3 of trucking's energy use from tractor-trailers
- Recent National Academy report and others conclude that fuel use from tractor trailers can be reduced by half, other trucks by almost that much
- Technology options include sharp aerodynamic improvements; better drivetrain systems, including heat recovery and hybridization; improved tires; and better driving.

# The fuel economy of most heavy trucks can be cost-effectively increased by 40-50%.

| Vehicle Class | Fuel Consumption Reduction | Capital Cost | Breakeven Fuel Price ($/gallon) |
|---|---|---|---|
| Tractor-trailer | 51% | $84,600 | 1.10 |
| Class 6 box truck | 47% | $43,120 | 4.20 |
| Class 6 bucket truck | 50% | $49,870 | 5.40 |
| Class 2b pickup | 45% | $14,710 | 4.80 |
| Refuse truck | 38% | $50,800 | 2.70 |
| Transit bus | 48% | $250,400 | 6.80 |
| Motor coach | 32% | $36,350 | 1.70 |

# Compact development and more transit will help, but *national* GHG impact is unclear

- Transit today provides about 1% of U.S. passenger miles…..so doubling or tripling it will make a modest change in national travel patterns…and
- On average, U.S. transit is not much more efficient than private vehicles




***But these averages hide many highly efficient systems!***

# Reducing travel can be accomplished with technology and compact development

- National Academy says doubling urban density with accompanying transit improvements can yield a 5-25% reduction in vmt (the higher end is controversial)
- Land use is locally-controlled….and strongly debated
- Lots of examples of compact development, but also of continued sprawl

**Conclusion:** A nationwide push for compact development may vary greatly in effectiveness from place to place

- Technology can reduce vmt also; ITS can have a significant impact on trip-planning and route efficiency reducing VMT by almost 10%

# Much can be done by changing the way vehicle travel is priced, even without increasing its cost.

| | Pricing Mechanism | Targeted Consumer Response | 2050 GHG Impact vs. BAU |
|---|---|---|---|
| Carbon Pricing | Carbon-based Fuel Charge | Consume less carbon-based fuel | Efficiency +4%<br>VMT -2% |
| PATP Insurance | Fuel Charge | Increase energy efficiency, reduce VMT | Efficiency +5%<br>VMT -1% |
| Road user tax on energy | Fuel Charge | Increase energy efficiency, reduce VMT | Efficiency +2%<br>VMT -1% |
| Feebates | Vehicle Purchase Subsidy/Charge | Increase vehicle efficiency and promote advanced vehicle technologies | Vehicle emissions rates -10% |
| Congestion pricing | Time and place varying fees | Reduced VMT | Up to 3% nationwide VMT reduction |

# A comprehensive policy strategy is needed.

- Improving current technology – reducing vehicle loads, improving engines, etc. – still has lots of potential, but needs the right incentives
- The deepest reductions in transportation GHG emissions require a transition to electricity or hydrogen or both as a major new energy source…..and attaining such a transition will require
  - Cheaper, higher energy density batteries
  - Cheaper, more durable fuel cells
  - Advanced biofuels for vehicles that require liquid fuels
- As a consequence, sustained investment in research, development, demonstration and deployment is essential.

# A comprehensive policy strategy is needed (2).

- Given high uncertainty about technology development (and uncertain public acceptance), deployment strategies must be highly adaptive
- Creating walk-able, bike-able, communities well-served by public transit are more likely to be done for quality of life concerns, but can produce important GHG reductions as a co-benefit.
- Market and regulatory approaches are both needed…get the prices right, use fuel economy standards as well, consider feebates and other economic incentives.  A pricing policy worth considering: an energy-based tax indexed to fleet efficiency, so revenues don’t disappear as efficiency increases.

## The HIGH mitigation case differs from the LOW case by greater technological progress, more extensive and intensive policies, and some degree of behavioral change.

- Greater fuel economy improvement over base case:
  - LDVs: +80% vs. +35%
  - HDTs: +40% vs. + 25%
  - Aircraft fuel burn: -70% vs. -40%
- Greater reductions in the carbon intensity of energy:
  - LDVs: -47% vs. -5%
  - HDVs: -38% vs. -10%
  - Aircraft: -44% vs. -10%
- Feebates and Pay-at-the-Pump insurance added to carbon pricing and an indexed road user toll on energy.
- Greater success in improving system efficiencies and reducing VMT by means of automated highways, traffic flow improvement, trip planning and routing efficiencies, land use and infrastructure development and ridesharing.
- **But a LOT more uncertainty!**

Conclusion: by pushing on *all* levers - improving conventional technology, moving to new fuels, and reducing travel - through a full portfolio of policies -- RD&D, pricing, targeted subsidies, fuel economy standards, land use policy, etc. - and focusing on all transport modes -- 2050 U.S. transport GHG emissions could be well below current levels, compared to a 28% *increase* for Business as Usual.

The scenarios in this analysis yield 16 to 65 percent reductions from 2010 levels.

We consider these outcomes to be *plausible*, though with increasing uncertainty from the Low to the High scenarios.

# THANK YOU FOR YOUR ATTENTION

## The full report can be accessed at:

**www.pewclimate.org**

# Improving vehicle efficiency via technological change is the largest single source of $CO_2$ reductions, though more comes from the full range of other policies and strategies.