Smart Mobility: Factors Driving the Future of Transportation

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December 2015
The Challenge

Current trajectory (not including large-scale burning of biomass) would probably result in a greater than 4°C rise in average global surface temperature.

Proposed pledged reductions from the Paris summit would bring levels to 54 by 2030, still far above what is needed to prevent a 2°C rise.

Levels needed to avoid a 2°C temperature rise over preindustrial levels.
Carbon Budget

On current trends the global budget will be fully exhausted in approximately 25 years, meaning that exceeding the 2°C target becomes increasingly inevitable. Only dramatically reducing emissions can change this reality.
Global freight will more than quadruple by 2050 (by a factor of 4.3)
We will create the equivalent of one new city of one million people every 5 days between now and 2050.

--International Geosphere-Biosphere Programme
Even with our GHG Rules

Light Duty GHG Emissions

We’re Headed Here

But We Need To Go Here

2025 2030 2035 2040 2045 2050
U.S. GHG/Fuel Economy standards provide significant benefits to climate, oil, consumers

Light Duty Vehicles

U.S. GHG/Fuel Economy standards provide significant benefits to climate, oil, consumers

Midterm Evaluation

163 g/mi CO₂

54.5 mpg
(if all reductions from fuel economy)
Light Duty Vehicles

GHG Compliance … Good News So Far

<table>
<thead>
<tr>
<th>Model Year</th>
<th>Compliance</th>
<th>Standard</th>
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</thead>
<tbody>
<tr>
<td>2012</td>
<td>11 g/mile</td>
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</tr>
<tr>
<td>2013</td>
<td>12 g/mile</td>
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</table>
Light Duty Vehicles

Vehicles are meeting future standards with a variety of technologies

<table>
<thead>
<tr>
<th>Powertrain Type</th>
<th>Vehicle Class</th>
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</thead>
<tbody>
<tr>
<td>CNG</td>
<td>Pickup Trucks</td>
</tr>
<tr>
<td>EV</td>
<td>HEV</td>
</tr>
<tr>
<td>HEV</td>
<td>Gasoline</td>
</tr>
<tr>
<td>Diesel</td>
<td>Large Car</td>
</tr>
<tr>
<td>Small Car</td>
<td>Midsize Car</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Engine</th>
<th>Trucks</th>
<th>SUVs</th>
<th>Cars</th>
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</thead>
<tbody>
<tr>
<td>Diesel</td>
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</tr>
<tr>
<td>Turbocharging</td>
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</tr>
<tr>
<td>High Compression Atkinson</td>
<td></td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>GDI</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Cylinder Deactivation</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stop-start</td>
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<table>
<thead>
<tr>
<th>Transmission</th>
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<th>SUVs</th>
<th>Cars</th>
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<tbody>
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<td>8+ Speed Transmissions</td>
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<td></td>
<td></td>
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<tr>
<td>CVT</td>
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</table>

<table>
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<th>Road Loads</th>
<th>Trucks</th>
<th>SUVs</th>
<th>Cars</th>
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<td>Mass Reduction*</td>
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<td></td>
</tr>
<tr>
<td>Tires**</td>
<td></td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Aero**</td>
<td>X</td>
<td>X</td>
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</tbody>
</table>

*compared to MY2008 curb weight
** Top 25% of class + other active/passive features

Light Duty Vehicles
MY 2015 Fleet Volume That Meets MY 2020 Standards

Vehicles are meeting future standards with a variety of technologies

Trucks | SUVs | Cars
<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td>Ford F-150</td>
<td>Ram 1500</td>
<td>Chevy Silverado</td>
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<tr>
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<tr>
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Midterm Evaluation – Overview

• Technical review of longer term standards for 2022-2025

• In coordination with NHTSA and CARB

• EPA’s decision could go one of 3 ways:
  ▪ Standards remain same
  ▪ More stringent
  ▪ Less stringent
Freight has fastest-growing transportation GHGs in US and globally worldwide

- Worldwide, freight projected to outstrip passenger vehicle GHG emissions within several decades

- Rapid demographic, geo-economic and technical change will disrupt freight patterns in US and globally

- United States and EPA must lead
Heavy Duty Trucks

GHG (MMT CO$_2$eq)

Calendar Year

Phase 1 Reduction

Phase 2 Proposal Reduction
The Phase 2 program builds on the success of Phase 1, with similar design and vehicle categories – and, for the first time, including fuel efficiency standards for trailers.

- **Combination Tractors**
  - 65% of HD Fuel Consumption and GHG Inventory (together)
  - Standards in g/ton-mile and gallons/1000 ton-miles

- **Trailers Pulled by Combination Tractors** (currently unregulated Federally)

- **Vocational Vehicles**
  - 21% of HD Fuel
  - Standards in g/ton-mile and gallons/1000 ton-miles

- **Large Pickups & Vans**
  - 14% of HD Fuel Consumption and GHG Inventory
  - Standards in g/mile and gallons/100 miles
Aircraft

U.S. Contributions

• 11% of U.S. transportation GHGs
• Largest remaining transportation category not yet regulated for GHGs
• 3% of total U.S. GHG contributions

Global Contributions

• 2% today, but future growth is very high
• If ranked as a nation, would be 9th, just behind Germany
• U.S. aircraft GHG emissions are ~7 times higher than China’s GHG emissions (second ranked country for aircraft GHG emissions & fastest growing)
Renewable Fuels
It is not just about GHGs
Success

There is no such thing as a failed experiment, only experiments with unexpected outcomes.

—R. Buckminster Fuller

SCIENTIFIC METHOD

PURPOSE
State the problem.

RESEARCH
Find out about the topic.

HYPOTHESIS
Predict the outcome to the problem.

EXPERIMENT
Develop a procedure to test the hypothesis.

ANALYSIS
Record the results of the experiment.

CONCLUSION
Compare the hypothesis to the experiment's conclusion.
Technology alone will not save us
The Promise
The Reality
Today’s Cars

• 80% empty

• 95% stationary

• 99% owned
Red = Surface Parking
Yellow = parking garage
Green = Parks
Transportation Sector GHG Emissions
Tailpipe + Upstream

IPCC AR4 Category I reduction envelope

Year

BAU

Reductions
Pipeline
Nonroad
Rail
Marine
Aircraft
MDHD
LDV

MMT CO2-equivalent

2005 2010 2015 2020 2025 2030 2035 2040 2045 2050
Transformational Change is Possible
CAVs and the Environment

- Vehicle Efficiency
- Fuels and Electrification
- Vehicle Connectivity
- Built Environment
- Personal Connectivity
**CARSHARING IMPACTS**

- **25%** sold a vehicle
- **25%** postponed a vehicle purchase

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1 carsharing vehicle replaces 9-13 vehicles

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- **.58 - .84** metric tons Reduction of GHG emissions per year for one household (mean observed and full impact)
- **34% - 41%** Reduction of GHG emissions per year for one household (mean observed and full impact)
- **27% - 43%** Reduction of VMT per year, considering vehicles sold and purchases postponed

More carsharing users increased their overall public transit and non-motorized modal use (including bus, rail, walking, bicycling, and carpooling) than decreased it.
- For every 5 members that use rail less, 4 use it more.
- For every 10 members that ride the bus less, 9 ride more.

**$154 - $435** Monthly household savings per US member after joining carsharing

*Figure 2: Impacts of Roundtrip Carsharing (graphic excerpted from Shaheen and Chan (2015))*
RIDESOURCING IMPACTS

How would you have made this trip if Uber/Lyft/Sidecar were not available?

- 92% would still have made this trip
  - 8% induced travel effect
- 33% would have taken public transit (bus or rail)
  - Named transit station as origin/destination, suggesting some use ridesourcing to access transit
- 4% avoided driving after drinking

Figure 4: Impacts of Ridesourcing/TNCs (graphic excerpted from Shaheen and Chan (2015))
Private Autonomy

Shared Autonomy

Today

Shared Mobility

autonomous

private

owner

driver

human

shared
Some combination of these factors can lead to:

- Equitable access to mobility
- Space for people, not cars
- Slowing the rate of climate change
We cannot solve our problems with the same thinking we used when we created them.

We need to rethink the mobility paradigm.
“There is such a thing as being too late when it comes to climate change.”

- President Obama, August 3, 2015