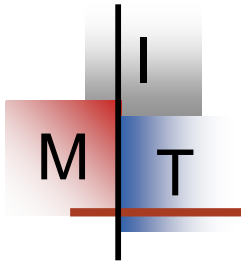

More Sustainable Transportation: Opportunities and Challenges

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Propulsion System, Vehicle Technology, and Fuels Assessment at M.I.T.

10-year ongoing effort to project light-duty vehicle fuel consumption and GHG emissions 30 years into the future.

Expanded analysis to U.S. and European in-use fleet projections: requires on-road performance and sales fraction for likely technologies versus year.

Increasingly including non-conventional petroleum and biofuels in our assessments.

Define “scenarios” that address key questions: e.g., How could the fuel consumption of the 2035 new car fleet be halved?

A 30-50% reduction in light-duty vehicle fuel consumption is feasible over the next 20-40 years, at an increased cost. Such a reduction in fuel consumption can be achieved by a combination of:

- Improved gasoline and diesel engines, and transmissions, as well as gasoline hybrids in the nearer-term (20 years)
- Vehicle weight, size, and drag reductions
- Plug-in electric hybrids and hydrogen fuel cells in the longer-term (40 years)

Fuel Consumption/Performance/Size Trade-Off

A critical question is the extent to which the benefits of more efficienct technologies go to reduce actual fuel consumption.

Quantify this with a ***degree of emphasis on reducing fuel consumption*** (ERFC).

$$\text{ERFC} = \frac{\text{Fuel consumption (FC) reduction realized}}{\text{FC reduction attainable with constant performance and size}}$$

Policies to reduce vehicle fuel consumption must recognize and then deal with the trade-off between vehicle performance, size (and weight) and fuel consumption.

In the U.S., over the past 20-25 years, performance increases have dominated and average fuel consumption has not improved.

In Europe, over the past 10 years, fuel consumption improvements have occurred in parallel with performance and weight increases.

Due to slow rates of vehicle turnover in the in-use fleet, fuel consumption of mainstream technology vehicles will determine nearer-term fuel use and GHG emissions profiles. Directing the efficiency improvements towards reducing fuel consumption of high-sales-volume vehicle technologies is critical.

Such fleet studies are an essential tool in analyzing the impacts of various scenarios or strategies on fleet fuel consumption and GHG emissions.

Due to high initial cost and strong competition from mainstream gasoline vehicles, market penetration rates of low-emissions diesels, and gasoline hybrids are likely to be slower than is widely believed. As a result, in the U.S., diesels and gasoline hybrids have only a modest, though growing potential for reducing fleet fuel use before 2025.

In the longer-term, the impact of steadily increasing sales of advanced technology vehicles will indeed be far larger than their near term impact. Since the time-scales to impact of new automotive technologies are long, advanced vehicle technology introduction needs to start as soon as possible if significant reductions in long-term fuel use and GHG emissions are to be realized.

Example: Scenario that Halves 2035 New U.S. LD Vehicle Fleet Fuel Consumption

1. Assess propulsion system, vehicle technology, fuel consumption, and sales mix in 2035 (25-years ahead).

2. Factor of two reduction requires:

   a. 75% emphasis on reducing fuel consumption (last 20 years in the U.S. its been zero).

   b. 20% weight reduction (average vehicle weight has been rising)

   c. Improved naturally aspirated gasoline engines 17%, turbo gasoline 15%, diesels 15%, hybrids 54%, more efficient transmissions.

3. Extra cost of better fuel consumption 15-20% of new vehicle cost; fuel savings more than offset this.