

A Multipronged Approach to Curbing Gasoline Use

The key to curbing America's ever-growing appetite for petroleum is not just fuel-efficient vehicles or high gasoline taxes or huge surcharges on gas-guzzling models. It is all of those measures and more, carefully combined into a set of self-reinforcing policies that affects everyone who makes, buys, or uses vehicles and their associated fuels.

This multidimensional approach to tackling the US petroleum consumption problem was outlined by Professor John B. Heywood and graduate student Anup P. Bandivadekar at a March 18 lunchtime seminar hosted by the Laboratory for Energy and the Environment (LFEE).

The United States consumes almost a quarter of the world's petroleum, and current projections suggest that by 2025 it will use 40% more petroleum than it does now (see the table below). About 70% of that petroleum will be imported, and almost three-quarters of it will be used for transportation.

Such tremendous growth in petroleum use has serious environmental implications, Professor Heywood noted. In addition, it sets

the stage for possible petroleum system shocks that could disrupt the transportation system on which the US economy and lifestyle depend.

"We've had one or two such shocks, but they were isolated and our economy recovered. What happens if they come more frequently?" Professor Heywood said.

Developing better engine and vehicle technologies and fuels could cut petroleum use and make our transportation system more robust, he said. A recent comprehensive assessment by Professor Heywood, Dr. Malcolm A. Weiss, and others at MIT concluded that even "evolutionary" improvements in "mainstream" gasoline and diesel technologies could yield a 35% reduction in fuel consumption in new vehicles in 20 years—and at moderate cost (see references 2 and 3 in the References section).

But better technology alone may not help. Indeed, over the past 20 years, vehicle efficiency increased by 30%, but any potential fuel savings disappeared because people bought bigger, heavier vehicles and drove them farther and faster.

According to Mr. Bandivadekar, gains will come only when we tackle all aspects of the problem simultaneously. "A simple way to think about it is that petroleum use and greenhouse emissions depend on how fuel-efficient our vehicles are, how much we drive, and how carbon-intensive our fuel is. We need to target all those pieces of the puzzle," he said.

As an illustration, Mr. Bandivadekar and Professor Heywood looked at the impacts on fuel consumption of increasing fuel efficiency, of reducing vehicle-kilometers traveled, and then of making both of those changes simultaneously. Using a spreadsheet-based model and data from the automotive industry and other sources, they examined four possible scenarios. Those scenarios and the analytical results are presented in the figure on the next page.

The curves in the figure show that tackling two pieces of Mr. Bandivadekar's puzzle—vehicle efficiency and distance traveled—can substantially reduce fuel use by 2035. But those results also demonstrate the difficulty of reducing transportation fuel use significantly in the near future. Climate-change targets are often defined in terms of 1990 levels of consumption. Even with all the changes assumed in the most-aggressive scenario, the estimated consumption in 2035 does not return to 1990 levels—and the researchers believe that the estimates they used in their analysis were optimistic.

What are the best ways to spur the needed changes? To answer that question, the researchers examined all the available policy options—economic incentives such as taxes and subsidies, regulatory actions such as emissions standards and fuel requirements, and public investment, for example, in alternative-fuel development. For each option they

Fuel Use by Light-Duty Vehicles

	2003	2025 (projected)
Total consumption	20 million bbl/day	28 million bbl/day
Imported	55%	70%
Consumed for total transportation	69% (760 billion liters/yr)	73% (1200 billion liters/yr)
Consumed by light-duty vehicles	42% (500 billion liters/yr)	45% (750 billion liters/yr)

If the United States is to reduce its rapidly increasing dependence on petroleum, it must focus on its transportation sector, in particular, on light-duty vehicles. In 2003, Americans owned some 230 million cars and light trucks, and close to 90% of all the kilometers they traveled were in those vehicles. As the table shows, without intervention, petroleum used for transportation is going to expand significantly. While most of the percentages in the table do not change dramatically from 2003 to 2025, the absolute quantities consumed jump by as much as 60%. (Sources: US Department of Energy, International Energy Agency.)

asked a series of questions. How much will it cost? Who will have to pay? How will it affect oil consumption, greenhouse-gas emissions, traffic congestion, vehicle-miles traveled? Will it be politically acceptable? Are there major implementation barriers?

Not surprisingly, the answers varied dramatically from policy to policy—and that variation is key to the researchers' proposal. They believe that the key to success is combining a variety of measures so that they work together. For example, one proposal is a "feebate" system in which customers pay an extra fee to buy big gas-guzzlers but get a rebate if they buy small, fuel-efficient models (a measure that can be designed to be revenue-neutral). The feebate system combines well with stricter corporate average fuel economy (CAFE) standards. Auto manufacturers will be required to make smaller, more efficient cars—and that is what their buyers will want. Adding higher fuel taxes to the package will both discourage additional driving and add further incentive for customers to buy fuel-efficient models. Tax credits elsewhere can offset the added fuel costs so vehicle users will feel no extra financial burden.

As an example, Professor Heywood and Mr. Bandivadekar put together a package that combined stricter CAFE standards, feebates, a gasoline tax that increases by about 2¢ per liter per year, and a requirement for increased biomass-derived content in fuels. According to their best estimates, if we enact that package of policies now, petroleum use and carbon dioxide emissions will be 32% lower in 2035 than if we do nothing. The reduction in total distance traveled will be just 15%—not too much of a hardship for transportation users.

Professor Heywood and Mr. Bandivadekar are now gearing up to take their message to the business community and ultimately to Washington. They believe that an integrated policy package will have more chance of implementation than individual proposals have had. Lobbying groups are less likely to be able to defeat a policy package that spreads responsibility broadly.

"This approach will make people realize that it's not my problem or your problem or Detroit's problem—it's everybody's problem, and everybody will have to do something about it," said Mr. Bandivadekar.

The researchers' final warning: don't wait to take action. A few years' delay now will mean a significantly higher level of petroleum use in 20 or 30 years—and a significantly greater problem to be solved by hydrogen fuel cells or whatever technology we come up with for the long term.

"We need to find ways to change attitudes as well as technologies. It's not clear we'll win, but we'd better try," Professor Heywood said.

John B. Heywood is the Sun Jae Professor of Mechanical Engineering and director of the Sloan Automotive Laboratory. Anup P. Bandivadekar is a PhD candidate in MIT's Engineering Systems Division. Malcolm A. Weiss is a visiting engineer in the LFEE. This research was supported by the Alliance for Global Sustainability (AGS) and the MIT/AGS Consortium on Environmental Challenges. Further information can be found in reference 1. Information on the comprehensive assessment of vehicle and fuel technologies can be found in references 2 and 3.

References

1. Bandivadekar, A., and J. Heywood. *Coordinated Policy Measures for Reducing the Fuel Consumption of the US Light-Duty Vehicle Fleet*. LFEE Report No. 2004-001. June 2004.
2. Weiss, M., J. Heywood, A. Schafer, E. Drake, and F. AuYeung. *On the Road in 2020: A Life-cycle Analysis of New Automobile Technologies*. LFEE Report No. EL 00-003. September 2000.
3. Weiss, M., J. Heywood, A. Schafer, and V. Natarajan. *Comparative Assessment of Fuel Cell Cars*. LFEE Report No. 2003-001. February 2003.

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