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Title

Improved Energy Feedback to Drivers Can Dramatically Reduce On-road Fuel Consumption

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Improved energy feedback to drivers can dramatically reduce on-road fuel consumption

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Issue

“Actual results will vary for many reasons including... how you drive....” This notice on the official fuel economy sticker on every new car and truck sold in America informs consumers they may not achieve the vehicle’s government-approved measure of miles per gallon (MPG). This policy brief discusses how, if given better real-time feedback, drivers can improve their vehicle’s on-road fuel economy by *eco-driving*, that is, adjusting accelerations, speeds, and coasting.

Policy Implications

The US Department of Transportation recently announced new corporate average fuel economy (CAFE) standards. For model year 2025, the cars, trucks, vans, and SUVs households and businesses drive must get 54.5 miles per gallon (mpg) averaged across all the vehicles sold by each manufacturer. This is double today’s standard.

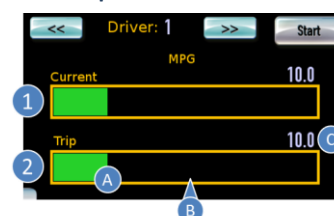
The narrow policy implication is whether and how enhanced energy feedback to drivers may be incorporated into the federal fuel economy program as well as programs that regulate tailpipe carbon dioxide emissions. More broadly, what are the lessons for the design of all energy feedback systems and thus any policies whose outcomes are subject to user behavior? Are the effects of feedback durable? Do different users respond differently? If so, can we identify those groups and customize feedback for them?

Research Findings

To examine the effect of improved energy feedback on fuel consumption and eco-driving behavior, researchers at UC Davis collected two months of driving data from 118 drivers (140 driver-vehicle combinations) residing along the Interstate-80 corridor from San Francisco, CA to Reno and Sparks, NV.

During the first month, their vehicles had no enhanced energy feedback instrumentation. During the second month, drivers were randomly assigned to one of the three feedback designs shown in Figure 1.

Figure 1: The three experimental feedback display designs



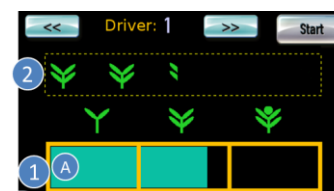
Display design 1: Numbers

Real-time “current” MPG (1) and trip average MPG (2) shown as green bar chart (A); mid-point (B) set to EPA city-highway rating for each vehicle. Values also shown numerically (C).



Display design 2: Accelerator

Trip average MPG shown as a “bar” chart made up of leaves (1); mid-point (A) set to EPA city-highway rating for each vehicle. Real-time acceleration/deceleration (2); rightward swing shows acceleration, leftward swing shows deceleration.



Display design 3: Shrubberty

Real-time (1A) and trip average (2) MPG shown as bar chart calibrated by same “leaf” scale; mid-point set to EPA city-highway rating for each vehicle (B).

The three designs were selected from a review of fuel economy feedback done by the National Highway Traffic Safety Administration. The three displays were selected from nine “prototypical” fuel economy display designs to 1) reduce cognitive load by limiting the amount of information per display, 2) improve driver comprehension, and 3) increase user satisfaction.

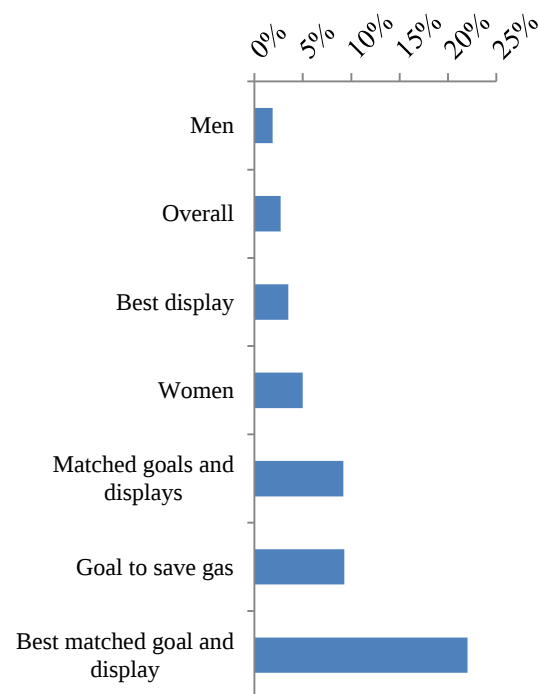
Both prior to and following the two months of vehicle data collection, the researchers also collected data on drivers’ attitudes about cars and energy, personality measures, their sense of their personal control over fuel use, and their goals for driving, for example, to travel faster, get good gas mileage, or drive safely.

Figure 2 shows that averaged over 140 driver-vehicle combinations, three display types, and six cities in three distinct metropolitan areas, (Overall) on-road fuel consumption was lower by 2.7% during the with feedback period than the no feedback period. The 95% confidence interval around this average is a 2.0% to 3.4% reduction. Driving behaviors that produced these reductions included slower median trip speeds and lower mean acceleration rates.

Differences from the Overall average shown in Figure 2 suggest that fuel consumption reductions could be even greater. In particular, if it had been possible to align drivers’ stated goals for their driving with the best feedback design for that goal, then dramatic reductions are possible. The user group with the best match between driving goal and display—drivers who had a goal to save gasoline and who saw Display 2 (Fig. 1)—achieved an average 22% reduction in fuel use. Had it been possible to pre-assign every driver to the best feedback design for her or his driving goal (stated prior to their vehicle data collection), the estimated average reductions would have been over 9%—more than three times the observed Overall average effect. (In the experiment, it wasn’t possible to pre-assign drivers to their optimal feedback because the relationship between driver goals and feedback designs hadn’t been estimated yet.)

Improving energy feedback may also increase drivers’ fuel economy literacy, and thus improve the durability of improvements seen in the research. Prior to their participation, few households had good knowledge of how they might affect their vehicle’s on-road fuel use. Half the participating drivers could name only two or fewer driving behaviors that they thought would reduce on-road fuel use.

Figure 2: Average improvements in fuel consumption, g/m.



(Note: As fuel consumption (g/m) is the inverse of fuel economy (mpg), longer bars mean less fuel use.)

Further Reading

This policy brief is drawn from the full report, “Eco-drive I-80: A large sample fuel economy feedback test: Final Report” by Kenneth S. Kurani, Tai Stillwater, Matt Jones, and Nicolette Caperello, available here: http://www.its.ucdavis.edu/research/publications/publication-detail/?pub_id=1992