calibrating it in the vehicle, etc.), they will be significant for people who may not be enthusiastic about changing their driving style to begin with.

In light of these results, this report details several recommendations for maximizing the fuel savings that could be realized through drive cycle improvements. These include considering opportunities for increasing driver receptiveness to actually make behavior changes. Examples include commercial fleets where employers have some influence over vehicle operators and/or partnering with usage-based insurance for personal vehicles so that drivers could save both on insurance premiums and on fuel cost by modifying how they drive.

Another recommendation focuses on simplifying feedback to combine basic training advice with useful reference points that utilize a vehicle's existing instrument display. Section 5 gives an example of how this could be done simply by placing stickers around a typical analog speedometer.

The final suggestion discusses leveraging intelligent vehicle advancements (lane keep assist, intelligent cruise control, active collision avoidance, etc.) to enable drivers to request active "eco-assist" from their vehicles. Recent examples exist of companies retrofitting vehicles with component technologies (developed through road safety/capacity and military research) to enable fully autonomous driving mixed with regular traffic. As highlighted, further advancement and deployment of autonomous driving technology could deliver even more dramatic and compounding fuel savings.

2 Quantifying Fuel-Saving Opportunities from Specific Driving Behavior Changes

2.1 Savings from Improving Individual Driving Profiles

2.1.1 Drive Profile Subsample from Real-World Travel Survey

The interim report (Gonder et al. 2010) included results from detailed analyses on five cycles selected from a large set of real-world global positioning system (GPS) travel data collected in 2006 as part of a study by the Texas Transportation Institute and the Texas Department of Transportation (Ojah and Pearson 2008). The cycles were selected to reflect a range of kinetic intensity (KI) values. (KI represents a ratio of characteristic acceleration to aerodynamic speed and has been shown to be a useful drive cycle classification parameter [O'Keefe et al. 2007].) To determine the maximum possible cycle improvement fuel savings, the real-world cycles were converted into equivalent "ideal" cycles using the following steps:

1. Calculate the trip distance of each sample trip.
2. Eliminate stop-and-go and idling within each trip.
3. Set the acceleration rate to 3 mph/s.
4. Set the cruising speed to 40 mph.
5. Continue cruising at 40 mph until the trip distance is reached.

To compare vehicle simulations over each real-world cycle and its corresponding ideal cycle, a midsize conventional vehicle model from a previous NREL study was used (Earleywine et al. 2010). The results indicated a fuel savings potential of roughly 60% for the drive profiles with either very high or very low KI and of 30%–40% for the cycles with moderate KI values.

Table 2-1 takes the analysis of these five cycles from the interim report a step further by examining the impact of the optimization steps one at a time in isolation. As indicated by other simulations from the interim report (Gonder et al. 2010), acceleration rate reductions can deliver some small fuel savings, but avoiding accelerations and decelerations (accel/decel) altogether saves larger amounts of fuel. This suggests that driving style improvements should focus on reducing the number of stops in high KI cycles, and not just the rate of accelerating out of a stop.

Table 2-1. Simulated fuel savings from isolated cycle improvements

Cycle Name	KI (1/km)	Distance (mi)	Percent Fuel Savings			
			Improved Speed	Decreased Accel	Eliminate Stops	Decreased Idle
2012_2	3.30	1.3	5.9%	9.5%	29.2%	17.4%
2145_1	0.68	11.2	2.4%	0.1%	9.5%	2.7%
4234_1	0.59	58.7	8.5%	1.3%	8.5%	3.3%
2032_2	0.17	57.8	21.7%	0.3%	2.7%	1.2%
4171_1	0.07	173.9	58.1%	1.6%	2.1%	0.5%

Figure 2-1 extends the analysis from eliminating stops for the five example cycles and examines the additional benefit from avoiding slow-and-go driving below various speed thresholds.

Though the additional savings at any given speed threshold are not consistent across the five cycles, each cycle does show some additional savings from reducing slow-and-go in addition to stop-and-go driving. One way for drivers to reduce stop- and slow-and-go driving is to select routes with fewer stops and drive at less congested times of day. However, drivers can also reduce stops over the course of a given driving route by watching far enough ahead to anticipate when maintaining speed will result in a stop at a red light or traffic bottleneck. If the driver instead eases off of the gas pedal to start gradually decelerating early, the light could change and the traffic could clear before the driver gets there. Such an approach not only decreases accel/decel rates but also (and more importantly) their frequency of occurrence. The report will use the term “reducing accel/decel” to refer to this combination, which the results here suggest can be an important factor, particularly for high KI/city-type driving.

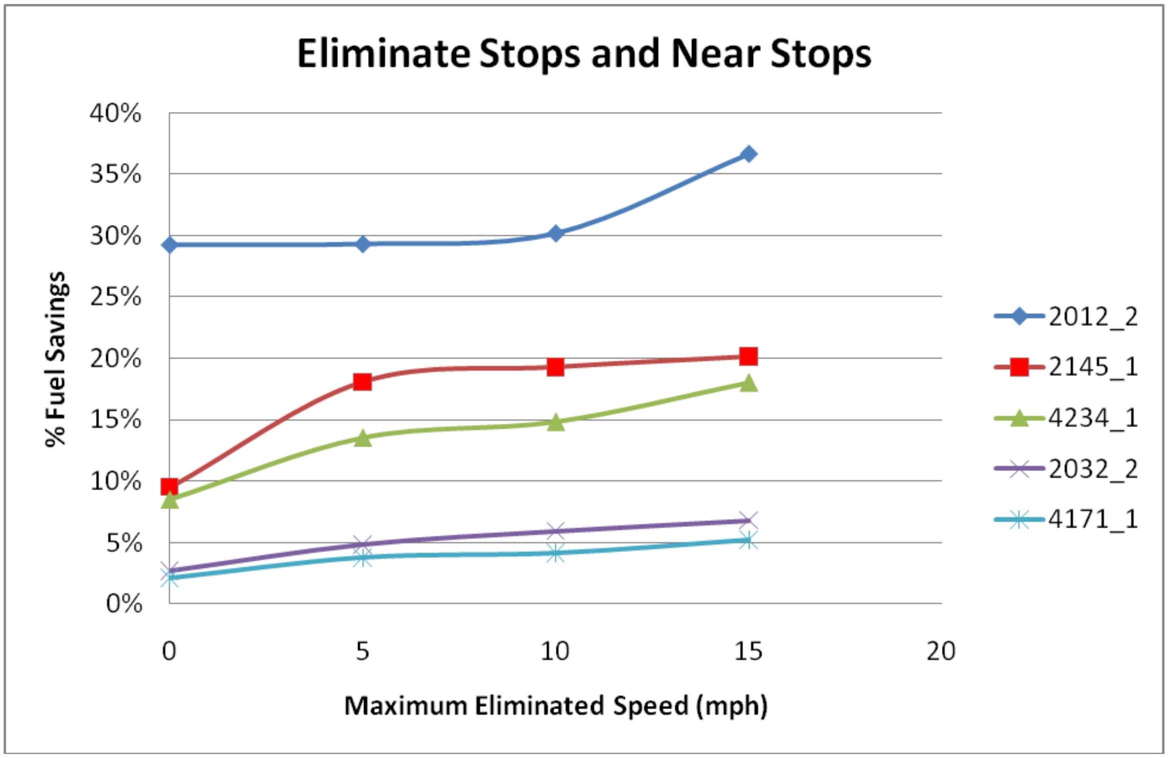

Figure 2-1. Fuel savings from eliminating stop- and slow-and-go driving

Table 2-1 also points to the importance of cruising speed optimization, particularly with respect to low-KI/highway-type driving. Figure 2-2 examines the fuel savings from speed improvement a little more closely and clarifies that the very large values in the corresponding Table 2-1 column result from significantly reducing very high driving speeds. High speeds contribute to very high fuel use because aerodynamic drag increases with the square of vehicle velocity. As a result, even more modest reductions from high speeds to around 60 mph still result in significant fuel savings.

The Table 2-1 results for eliminating idle even during short stops may be more representative of savings that a start-stop hybrid vehicle could deliver rather than what would be practical for a driver to do with a conventional vehicle. Analysis later in this section will further explore more realistic savings that a driver could realize by turning off the engine for long duration stops.