decrease the fuel consumption of an aggressive driver, although it will likely increase the fuel consumption of most vehicles if it forces additional stop-and-go traffic flow.

A particular driver may not exhibit the same types of driving behavior all of the time. If a driver is pressed for time and in a hurry, he or she will most likely drive more aggressively. If a driver is just out driving around as a sightseeing tourist with no specific time or destination in mind, he or she will tend to drive more slowly and accelerate more slowly, making it easier to drive more efficiently.

Relative to driving aggressively, driving energy-efficiently at slower speeds and lower accelerations requires less attention from the driver. An aggressive driver constantly looks ahead for opportunities to change lanes and pass other vehicles, whereas a more fuel-efficient driver can just stay in the right lane and let other vehicles pass him or her.

For powerful vehicles, it can be difficult to go at slower cruising speeds that require maintaining very light pressure on the gas pedal. Owners of powerful/sporty vehicles would also have paid a purchase premium to get a high performance vehicle and so may be reluctant not to take advantage of its full capability. It may also be true generally that fuel-efficiency feedback will have to compete against people having “more fun” driving in a sporty manner. Note that over time the vehicle market as a whole has demonstrated consumer preferences for weight and performance rather than for less powerful/slower and inherently more fuel-efficient vehicles (EPA 2010).

While considering whether a financial hardship might lead a person to change driving habits, it was noted that they may be more likely to find alternative travel modes such as public transportation, walking, biking, carpooling, etc. A driver with an acute need to reduce fuel cost might expect greater savings from such a mode change. For instance, starting a carpool and splitting fuel cost could cut expenses in half, whereas it would be difficult to achieve 50% fuel savings just by driving more efficiently.

4 Assessing Various Driver Feedback Approaches

The interim report included a survey of various existing driver feedback approaches and general comments about their strengths and weaknesses. This section contains a more rigorous assessment of the approaches in order to compare them on the basis of their fuel saving potential. This effort inherently requires some subjectivity, so the most valuable outcome may be the process developed to make the comparisons and the key considerations it takes into account. The presented values represent the authors' best effort to impartially quantify an aggregate fuel savings range that each approach could reasonably deliver. This involved applying the insights gained throughout the project that were summarized in the previous two sections.

4.1 Estimating the Savings Potential for Three Types of Behavior Change

The first step in the assessment process involves estimating the savings a feedback device would deliver if it completely succeeds in correcting inefficient driving habits. As described in Section 2, it is useful to divide prospective efficiency improvement behaviors into three general categories: (1) accel/decel reduction and smoothing, (2) speed reduction/optimization, and (3) idle time reduction.

Table 4-1 provides ballpark savings estimates for each of these behavior categories. The very high, medium-high, and medium-low values for per cycle fuel savings and frequency of occurrence are roughly distilled from the detailed analysis in Section 2. The combination of these values produces the bold percentage under each behavior heading, which is intended to approximate the aggregate fuel savings that could be achieved from maximum adoption of the particular behavior. Note that these values are not meant to be precise, but rather to provide a reasonable reference point for use in the next sub-section.

Table 4-1. Approximate savings potential for key behavior/advice categories

		Accel/decel reduction and smoothing	Speed reduction/ optimization	Idle time reduction
Per cycle fuel savings potential	Med-low	5%	8%	0.5%
	Med-high	15%	15%	2%
	Very high	30%	35%	10%
Frequency of opportunity occurrence in general population	Med-low	30%	20%	30%
	Med-high	15%	15%	15%
	Very high	8%	10%	5%
Combined savings opportunity (per cycle magnitude * frequency of occurrence)	Med-low	1.5%	1.6%	0.2%
	Med-high	2.3%	2.3%	0.3%
	Very high	2.4%	3.5%	0.5%
	Total	**6%**	**7%**	**1%**

4.2 Organizing Pertinent Considerations to Enable Detailed Side-By-Side Comparisons between Different Driver Feedback Approaches

The interim project report presented a number of approaches to driver feedback as summarized below:

- General Advice Sources – easily accessible but provide no feedback on actual driving behavior and have no competitive theme. They have the potential for a moderate overall impact.
- Driver Training Courses – unlikely to be attended by large numbers of drivers. They provide feedback on actual driving behavior. Because of limited participation, overall impact is expected to be low.
- Conventional Dashboards – many new vehicles provide both instantaneous and average mpg readouts. These displays are accessible by large numbers of people and, while the feedback provided is not extensive, the high penetration rate and ease of accessibility means they have the potential to have broad impact.
- Hybrid Vehicle Dashboards – typically have more robust feedback mechanisms built in and are highly accessible. Current purchasers of hybrid vehicles tend to be interested in fuel economy and so may be expected to utilize such information. Impact is only expected to be moderate due to the low market penetration of these vehicles.
- Smart Phone Applications – have robust feedback and may have a competitive theme, but the barriers to use are high, requiring availability of a smart phone and purchase of software and vehicle mounting devices. Lack of direct vehicle interface in most cases means that actual fuel economy cannot be determined. Impact is expected to be low due to low adoption rates.
- GPS Navigation Systems – some recent systems have driver feedback functionality built in. Without an accelerometer, though, the feedback is low-fidelity. As with smart phone applications, users must purchase and install the device. Expected impact is low.
- Offline Feedback Systems – largely limited to fleet users and require professional hardware installation. They do provide robust feedback and have the added advantage of not requiring driver attention. Because fleets may have more influence over their drivers' behavior, the impacts for fleets that use this approach may be significant.

Two additional approaches were evaluated during the second half of the project:

- Dedicated Aftermarket Feedback Devices – These are generally dashboard-mounted devices with a wired or wireless connection to the vehicle's OBD port. The OBD connection provides the device with a high-quality data feed, including fuel flow rate, engine load, and vehicle speed. This allows the device to present throttle intensity as a surrogate for acceleration without the need for an accelerometer and the associated calibration requirements. However, these devices tend to be costly (on the order of $200) and still require installation and setup.
- Haptic Pedal Feedback – In this approach, driver feedback is provided by means of a vibrating accelerator pedal. When the driver accelerates at a rate greater than what the on-board computer deems efficient, the accelerator pedal vibrates to notify the driver to accelerate more gently. This approach would need to be built into the vehicle and would have similar advantages to original equipment manufacturer-integrated dashboard feedback.