SMARTDRIVE

Public Transit Fuel Efficiency Study

The SmartDrive Public Transit Fuel Efficiency Study looks at the impact of eco-driving techniques on fuel consumption in public transit fleets. The study followed several hundred transit buses and drivers in a broad range of locations to accurately assess fuel consumption and determine the impact of fuel-efficient training combined with in-vehicle instant feedback on improving fuel economy.

When the results were analyzed they revealed that 84.8% of the areas for improvement in fuel economy come from softer accelerations, decelerations and turns. In addition, it found that drivers with the best eco-driving practices improved driving performance significantly, by an average of 18.7%, indicating an average reduction in fuel cost of $3,392 per vehicle annually.

Eco-Driving Practices Reduce Fuel Consumption

The term eco-driving describes driving practices that optimize fuel use and minimize environmentally harmful emissions, and is being promoted by the U.S. EPA, DOT and industry organizations, including public transit.

Public Transit Eco-Driving Best Practices

Accelerate and Decelerate Smoothly: Softer acceleration and deceleration make more efficient use of bus power

Reduce Excess Idling: Turning off the engine while the bus is parked reduces fuel consumption, improving overall MPG

Avoid Hard Turning: Anticipating turns and smoothly decelerating into the turn (taking advantage of the bus's forward momentum), and smoothly accelerating out of it improves fuel efficiency

Maintain Consistent Vehicle Speed: Operating within posted speed limits and anticipating the flow of traffic maximizes the ability to maintain a consistent speed and optimum fuel efficiency

Eco-Driving Directly Impacts Costs and Emissions

By changing driving behavior to eliminate or reduce the incidence of fuel-wasting driving habits, fleets can:

- Realize significant improvement in fuel mileage and reduce operating expenses
- Reduce hydrocarbon, carbon monoxide, carbon dioxide and nitrogen oxide emissions (and meet emissions mandates)

SmartDrive Systems

SmartDrive delivers innovative solutions that make it easy for fleet managers to improve driver safety and reduce operating cost. SmartDrive records comprehensive video-based data from the road, then thoroughly reviews and scores critical events and recommends action for fleet managers to quickly respond and deliver sustainable savings – all through an easy-to-use managed service.

The company has compiled the world's largest storehouse – more than 34 million events – of real-time, risky-driving incidents. SmartDrive is based in San Diego, CA, and employs over 375 people worldwide. For more information, please visit **www.smartdrive.net**

SMARTDRIVE

PUBLIC TRANSIT FUEL EFFICIENCY STUDY

Overview

In May 2011, SmartDrive began ongoing fuel economy studies involving its fleet customers. This white paper focuses on fleets in the public transit sector, including Veolia Transportation, a leading operator of public transit vehicles throughout the United States and the rest of the world. The study is based on data collected by SmartDrive's in-vehicle sensors and recorders and analyzed by the SmartDrive review panel of safety and efficiency experts.

What was measured:

The study looked at several key indicators and driving maneuvers which are known to impact fuel use and economy:

- **Actual fuel use:** as measured in miles per gallon from the Engine Control Unit (ECU)
- **Idling time:** how much time was spent with the engine running while no movement was recorded for greater than three minutes
- **Acceleration:** the incidence, frequency and severity of quick starts and sudden acceleration during travel as measured by accelerometer and ECU
- **Braking:** hard braking defined by speed from the ECU, duration of deceleration and G-force effect measured by the accelerometer
- **Turning:** hard turning/cornering measured by speed from the ECU and G-force from the accelerometer

How driving performance was measured:

The SmartDrive Safety and Operations solution consists of in-vehicle systems for collecting data and providing real-time feedback to the driver, plus data review, analysis and recommendations. The on-board hardware includes a variety of sensors, recorders and a driving prompt, including:

- **Multi-axis accelerometer (G-force) sensor** detects inefficient vehicle maneuvers
- **High-sensitivity GPS receiver** for real-time tracking of location, time, speed, and direction
- **ECU connection to** access a broad range of data on engine performance, including speed, odometer, fuel level, fuel consumed and additional vehicle information
- **LED multi-light bar** for real-time driver feedback

The multi-stage study process:

- **Establishing baseline metrics:** data collection of driving performance for all vehicles in the study during a control period
- **Determining fuel efficient operating standards** for idling, braking, acceleration and cornering based on vehicle type and typical operation
- **Analyzing data to identify type and severity** of maneuvers during control period
- **Providing driver training on eco-driving** best practices and the SmartDrive in-vehicle Instant Driver Feedback (IDF) system
- **Analyzing data after training** and after the IDF lights were activated; comparing results to the control period

About the SmartDrive Instant Driver Feedback system:

The SmartDrive IDF system uses data from SmartDrive's sensors and the vehicle's engine computer to record hard acceleration, hard braking, hard turning, idling and speeding. Proprietary algorithms determine these maneuvers, which trigger LED lights on the in-cab device. This immediate feedback helps drivers understand the impact of their driving as it happens and make immediate adjustments as needed.

Combinations of color LEDs are used to prompt drivers and rate their eco-driving performance in real time. Green indicates good performance, amber indicates moderately inefficient or risky driving, and red indicates more severe, wasteful driving. With this immediate feedback drivers are able to manage their own performance improvement.

Findings

Results were gathered from several hundred large buses in various regions and from various manufacturers, including: Eldorado, Flxible, Gillig, New Flyer, Orion, Prevost, Nova Bus, and Thomas Built.

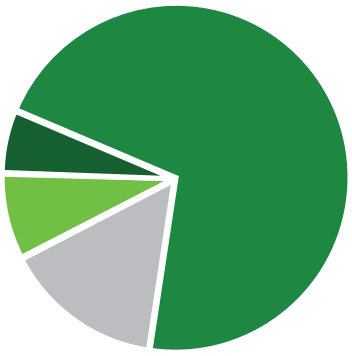
Stage One: Control Period

The first stage of the study focused on insight – gaining a benchmark view of how the study vehicles were being driven and the impact of that driving performance on fuel economy. Then, exception standards were set for idling, speed, acceleration, braking and cornering. The baseline findings revealed the following fuel-saving opportunities for large buses:

84.8% of fuel waste can be improved by softer driving

Hard Accelerations	71.1%
Hard Braking	5.4%
Hard Turns	8.3%
Idling	15.2%

8.9% of operating time the bus was idling longer than 3 minutes



Incidence of Fuel-Wasting Driving Maneuvers: During the control period, the SmartDrive system recorded the following inefficient driving maneuvers:

- 17.8 hard accelerations performed on average per hour
- 9.5 hard braking events performed on average per hour
- 3.9 hard turns performed on average per hour

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Stage Two: Initiate Training and Activate Instant Driver Feedback

Once the baseline was obtained, the study moved into stage two, delivering active feedback of driving performance. Performance rankings were then forwarded to fleet managers, providing them with visibility and recommendations for coaching drivers to improve performance.

Fuel use before and after training and instant driver feedback

Control Period (before training and IDF) Established an average MPG of 3.87 for large transit buses

Baseline MPG
3.87

Gallons 5,370
Annual Cost $21,534

By the end of the first month, with training and IDF, fuel economy rose to an average of 4.18 MPG; an 8.02% increase from baseline

MPG up 8.02%
4.18

Gallons 4,972
Annual Cost $19,937
Annual Savings $1,597

The top 25% performing drivers improved fuel economy an average of 18.70% within the first month

MPG up 18.70%
4.59

Gallons 4,524
Annual Cost $18,141
Annual Savings $3,392

Average Weekly Mileage: 399.65
Average Annual Miles Driven: 20,782 (estimated based on average weekly mileage from control period)
Annual cost based on national diesel fuel cost of $4.01 from AAA 8/3 to 8/9, 2011

Conclusions and recommendations for public transit fleets

1. **The greatest opportunity in fuel efficiency comes from the way a vehicle is operated, particularly hard driving maneuvers.** Identifying inefficient driving habits and reinforcing best practices leads directly to improved performance and reduced operating costs.
2. **Providing drivers with immediate feedback in the vehicle allows them to make quick corrections and learn over time how to most efficiently operate their vehicle.** Substantial week-to-week improvements indicate that drivers are adopting and adhering to eco-driving techniques that improve fuel efficiency.
3. **For quick results, deliver additional training with constructive guidance to the drivers that show the highest number of inefficient driving events.** The combination of real-time feedback and focused training drives significant and immediate impact on overall fleet fuel consumption. In this study, in less than a month, the top 25% of drivers with the greatest improvement in fuel economy reduced fuel use by an average of 18.7%, resulting in an annual average fuel savings of $3,392 per vehicle.