# Measuring Fuel Efficiency, Efficiently

*Testing Services Case Study*

## The Problem

A municipal solid waste fleet in the San Joaquin Valley wanted to compare the in-use fuel efficiency of their new, hydraulic-hybrid refuse haulers to their older vehicles. They had been comparing fuel trends using an automatic recording service to track daily trends, but without taking the different duty-cycles of the vehicles into account.

## Our Solution

Recognizing that the older vehicles, with their different drivetrains, payload and usage patterns, would be difficult to compare to the newer vehicles on a "apples-to-apples" basis, carbonBLU personnel recommended a test program that used data the fleet was already collecting to compare fuel efficiencies accurately.

The program used three independent methods (PEMS, PAMS, and automatic daily logs) to determine fuel efficiency as the refuse haulers performed their daily routes. Fuel efficiencies calculated from these data were inter-compared for accuracy, cost, ease of collection, and ease of analysis to draw conclusions about their values (e.g., cost-effectiveness) for internal research and fleet decision making.

The three, independent data collection methods used were Zonar, UniCAN Data Logger and SEMTECH DS PEMS (Portable Emissions Measurement System).

### ZONAR

The subscription service (Zonar) automatically recorded travel distance and fuel fill volumes each day for each vehicle. That method captured daily-totals, but lacked the more real-time" duty-cycle data of the other two methods.

### UniCAN Data Logger

The PAMS (portable activity measurement system) method was used to record real-time" duty cycle data for typical vehicles in the fleet. During approximately one month in early 2013, PAMS data loggers were installed and recorded the second-by-second engine control and GPS data of how those vehicles were driven, the loads on their engines, fuel consumption rates and other parameters important for determining duty-cycle and accurate fuel consumption rates. Then those PAMS data were analyzed to determine a "typical" duty-cycle for the main types of vehicle used in the fleet. Once the typical duty-cycles had been determined, it was possible to measure more accurate real-time exhaust emissions and fuel consumption data and then to develop a system for cost-effectiveness comparisons.

222 Judah Street Roseville CA 95678
www.carbonblu.com
916.543.5230

## SEMTECH DS PEMS

During two days in July of 2013 portable emissions measurement systems (PEMS) and portable activity measurement systems (PAMS) data were collected for two of the refuse haulers as they operated over a single, typical route.

One of the vehicles was a new hydraulic-hybrid fueled by diesel (Tier 4i, with DPF and without SCR) and the other was a conventional diesel (Tier 3). These second-by-second data for exhaust emissions and engine control unit data were recorded and analyzed by carbonBLU personnel.

## The Results

The aforementioned sources of data yielded:

- one source of daily distance traveled and daily fuel consumption for each vehicle in the fleet;
- one source of matched, second-by-second distance traveled and fuel consumption data for four typical vehicles from PAMS only; and
- one source of matched, second-by-second distance traveled and fuel consumption data for two typical vehicles from PEMS and PAMS.

These sets of data were analyzed (both a daily and a use-mode basis) to calculate fuel efficiency in three different (and independent) ways for the two typical vehicles. The results were then inter-compared so that a less costly method could be "calibrated" to produce results as accurate as the costliest method.

## Conclusion

By intercomparing those independent results fleet management could see how the lower cost method could be used as a more sensitive and accurate, yet cost-effective tool for tracking fuel consumption trends for each vehicle on a "apples-to-apples" basis.

The fleet now has the capability of making more informed and accurate decisions based upon much smaller variations in fuel consumption than they could previously detect, without spending much more on data collection and analysis.

**Residential refuse hauler typical daily service ("yard waste" days):**

| | Activity | Driving Mode |
|---|---|---|
| 1 | Start truck and warm up | Idling |
| 2 | Drive to pick up trash | Urban driving |
| 3 | Pick up trash (route 1) | Start/stop/pickup bin, etc. |
| 4 | Drive to dump trash at land fill | Urban and highway driving |
| 5 | Dump trash at land fill | Idling, start/stop, urban |
| 6 | Drive to pick up recycling/yard waste | Highway and urban driving |
| 7 | Pick up recycling/yard waste (same route 1) | Start/stop/pickup bin, etc. |
| 8 | Drive to dump at recycling/yard waste facility | Urban and highway driving |
| 9 | Dump at recycling/yard waste facility | Idling, start/stop |
| 10 | Drive back to truck yard | Highway and urban driving |
| 11 | Refill fuel and clean truck | Off, start/stop |
| 12 | Park | Off |

222 Judah Street Roseville CA 95678
www.carbonblu.com
916.543.5230