



Caltrans Division of Research,  
Innovation and System Information

# Research



# Results



Maintenance

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**Project Title:**  
Street Sweepers Evaluation

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## Evaluation of Hybrid Electric Street Sweepers

A study to evaluate the hybrid electric street sweeper powered by hydrogen fuel cell (HFC) technology as a suitable zero-emission alternative to the street sweeper technologies currently implemented by Caltrans.

### WHAT WAS THE NEED?

The South Coast Air Quality Management District does not allow the use of diesel street sweepers, which has led Caltrans to deploy compressed natural gas (CNG) sweepers. California has also enacted several policies to transition state owned vehicles from traditional fuels to Zero Emission Vehicle (ZEV) platforms. CNG sweepers have traditionally been less reliable and have lower production rates relative to diesel sweepers. Caltrans' Divisions of Equipment (DOE) and Division of Maintenance (DOM) are exploring alternatives to using CNG and diesel powered sweepers. One of these zero-emission alternatives is a hybrid electric street sweeper powered by a hydrogen fuel cell (HFC) which is a first of its kind.

### WHAT WAS OUR GOAL?

The goal of this research effort was to evaluate the HFC street sweeper relative to the traditional street sweeper technologies currently implemented by Caltrans, namely diesel and CNG. Results from this research were intended to quantify benefits and identify limitations related to the HFC street sweeper.

### WHAT DID WE DO?

- Fleet management software activity data was collected for all active Caltrans street sweepers, analyzed, and compared.
- Several street sweepers were instrumented with global positioning system (GPS) enabled engine control unit (ECU) data loggers and 1Hz activity data was collected over



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several months. Activity data was analyzed and compared relative to street sweeper fuel technologies.

- Portable Emission Measurement System (PEMS) real-world emission testing was performed on two diesel and two CNG street sweepers. Time lapse pictures were used to identify modes of operation. Emission and ECU data was categorized by operating mode and compared.
- Chassis dynamometer energy and emission testing and analysis was performed on diesel, CNG, and HFC street sweepers. The impact of cold-start emissions and regenerative braking were quantified.
- Street sweeper operator surveys and maintenance surveys were administered to key Caltrans staff. Responses for all three street sweeper technologies were recorded and summarized.
- Work orders were evaluated to help characterize reliability and downtime of various street sweeper technologies in the Caltrans fleet.

## WHAT WAS THE OUTCOME?

This research project generated a variety of metrics and results relating to the diesel, CNG, and HFC street sweepers. Some of the key metrics include the following:

- Estimates of emission reductions associated with replacing CNG and diesel with HFC street sweepers,
- Regenerative braking energy captured by the HFC street sweeper,
- Operator and mechanic impressions of HFC performance and reliability relative to conventional technologies,
- Observed operating range of the street sweepers,
- Impact of cold-start on diesel and CNG emissions

## WHAT IS THE BENEFIT?

The research results show that HFC street sweepers are a viable alternative to current street sweeper technologies, with certain advantages and caveats. This is beneficial, since hydrogen can be sourced from renewable based hydrogen.

## LEARN MORE

To view the evaluations:

[gscora@cert.ucr.edu](mailto:gscora@cert.ucr.edu)

## IMAGES



Image 1: PEMS instrumentation installed on Caltrans diesel street sweeper.



Image 2: Chassis dynamometer emission testing of Caltrans diesel street sweeper.



Image 3: Chassis dynamometer emission testing of Caltrans HFC street sweeper.

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