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Fuel economy, cost, and greenhouse gas results for alternative fuel vehicles in 2011

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ABSTRACT

This paper presents in-service data collected from over 300 alternative fuel vehicles and over 80 fueling stations to help fleets determine what types of applications and alternative fuels may help them reduce their environmental impacts and fuel costs. The data were compiled in 2011 by over 30 organizations in New York State using a wide variety of commercial vehicle types and technologies. Fuel economy, incremental vehicle purchase cost, fueling station purchase cost, greenhouse gas reductions, and fuel cost savings data clarifies the performance of alternative fuel vehicles and fuel stations. Data were collected from a range of vehicle types, including school buses, delivery trucks, utility vans, street sweepers, snow plows, street pavers, bucket trucks, paratransit vans, and sedans. CNG, hybrid, LPG, and electric vehicles were tracked.

1. Introduction

Alternative fuel vehicles provide fleet operators novel opportunities to conserve fuel costs and reduce greenhouse gas emissions. The range of available technology includes compressed natural gas, hybrid electric, plug in hybrid electric, electric, and propane. However, fleet operators may be unfamiliar with the performance and costs associated with these vehicles. Moreover, vehicle and fuel dealers may exaggerate claims about the cost of ownership or payback periods of these vehicles. This information gap forms a barrier to adoption and makes it more difficult for fleet operators to select the most suitable technology. To help bridge this gap, this paper presents data collected from 332 alternative fuel vehicles and 84 alternative fuel stations that were purchased in 2010 and 2011 in New York State.

2. Methodology

The alternative fuel vehicles and alternative fuel stations were purchased with grant funding under New York State Energy Research and Development Authority's (NYSERDA) administration of the Department of Energy's (DOE) Clean Cities FY09 Petroleum Reduction Technologies Projects for the Transportation Sector funded by the American Recovery and Reinvestment Act (ARRA). Clean Cities is the DOE's flagship alternative-transportation deployment initiative, sponsored by the Vehicle Technologies Program. Clean Cities advances the nation's economic, environmental, and energy security by supporting local actions to reduce petroleum consumption in transportation through the efforts of more than 8400 stakeholders participating in nearly 100 Clean Cities coalitions across the US. This grant funded up to 100% of the incremental costs of vehicles (the cost above a comparable vehicle that uses conventional fuel). This grant also funded up to 50% of the cost to

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purchase and install alternative fuel stations. Grant recipients included local governments, schools, utilities, and private companies in New York State. Grant recipients were free to propose the alternative energy technology and vehicle type that best satisfied their fleet's needs. DOE selected NYSERDA's proposal as one of 25 projects nationwide.

Grant recipients chose vehicles that use five alternative fuels or advanced technologies. This included 215 compressed natural gas (CNG) vehicles, 61 hybrid electric vehicles (HEVs), three plug in hybrid electric vehicles (PHEVs), eight electric vehicles (EVs), and 45 propane (LPG) vehicles.[1] For the fueling stations, electric fueling stations comprised 79 of the stations, CNG comprised three, and LPG two. This uneven distribution means that some results represent small sample sizes.

The grant recipients agreed to provide quarterly mileage and fuel use data for each vehicle purchased or converted under the grant. For the analysis, the same quarter's data for each vehicle were used to avoid seasonal fluctuations in performance. This avoided comparing one vehicle's summer performance when operating its air conditioner with another vehicle's fall performance when little or no air conditioning was needed. The quarter selected was the period of October to December 2011.[2] Vehicle performance in the fall quarter is less influenced by heating and cooling demands than the summer or winter quarter. This was the most recent quarter for which data were available at the time of this analysis. Furthermore, because the deployment of vehicles was staggered over 2010 and 2011, this was the quarter for which the greatest number of grant recipients reported data on vehicle usage.

3. Results

3.1. Fuel economy

The business case for purchasing an alternative fuel vehicle rests heavily on the incremental cost of the alternative fuel vehicle, the expected price of fuel over time, and the vehicle's fuel economy. The incremental cost can be reliably determined from local vehicle dealers. The expected price of fuel can be estimated using the current price of fuel, historical prices, or projections such as those published by the US Energy Information Administration. But the real world fuel economy of the alternative fuel vehicles can be difficult to determine. While the US Environmental Protection Agency publishes fuel economy data for light duty vehicles, it currently does not publish similar data for medium- or heavy-duty vehicles or fuel conversion kits. Fuel economy is also a key factor in the greenhouse gas reduction potential of alternative fuel vehicles.

Table 1 shows the fuel economy of the alternative fuel vehicles funded by this grant calculated using the October to December 2011 mileage and fuel use data. This data were self-reported by the grant recipients. Although this reporting was a grant requirement, the fuel economy results did not impact recipients' grant amount so as to avoid creating an incentive for misreporting. The sample size for each type of vehicle is listed so as to acknowledge that some data points may represent only a few or even one vehicle. However, the fuel economy numbers presented in this table cannot be directly compared across fuels. For example, the result that LPG vans averaged 16 miles/gallon of LPG and the CNG vans averaged 8.5 miles/GGE (gasoline gallon equivalents) of CNG does not mean that the LPG vehicle has better fuel economy. The LPG van may use 6 gallons of LPG to travel 100 miles and the CNG vans may use 12 GGE of CNG to travel 100 miles, but this does not indicate whether using 6 gallons of LPG emits more or less greenhouse gas or cost more or less than using 12 GGE of CNG. The exception to this is HEV vehicles. Because HEV use the same fuel as conventional vehicles, diesel or gasoline, fleet operators need only know their current fleet's fuel economy to judge the results for the HEV vehicles.

To compare fuels, the fuel economy averages must be converted into the same unit of measure, fuel cost per mile driven. Fuel cost per mile is calculated as the fuel price per gallon divided by the vehicle's average miles per gallon from Table 1. The price per gallon of alternative fuel can be found by contacting local suppliers. The DOE's Alternative Fuels Data Center provides an interactive Alternative Fueling Station Locator, an online map showing the location and contact information for alternative fuel stations across the US. By contacting local suppliers, and consulting the fuel economy listed in Table 1, fleet operators can easily calculate the fuel cost per mile driven for alternative fuel vehicles in their area. This allows fleet operators to reliably compare the fuel options available against each other and against the fleet operator's current conventional fuel fleet's fuel cost per mile.

3.2. Fuel cost per mile

Nationwide average fuel prices can be used to calculate an approximate fuel cost per mile, providing a convenient way to compare results across fuels. It is important, however, to emphasize that fuel prices vary geographically, e.g., in January 2012 the price per GGE of CNG ranged from $1.69 in the lower Atlantic region to $2.42 in New England (US Department of Energy, 2012a).[3] Furthermore, over time the prices of gasoline, diesel, CNG, propane, and electricity change and the price advantage one fuel may offer today may not last over the service life of the vehicle. In addition, these average prices do not reflect the Federal

[1] An explanation of these technologies can be found at: http://www.afdc.energy.gov/afdc/vehicles.

[2] The exception to this is the data for the neighborhood electric vehicles, where cumulative data since vehicle deployment was used because of the high variability between the miles per kW h data for these vehicles over these 3 months.

[3] The lower Atlantic region includes West Virginia, Virginia, North Carolina, South Carolina, Georgia, and Florida. The average fuel price per GGE of CNG for the Central Atlantic region which includes NY was $2.28 (US Department of Energy, 2012a).