COMPRESSED NATURAL GAS (CNG) FLEETS IN SOUTHERN CALIFORNIA: VARIATIONS IN VEHICLES AND ROUTE TYPES

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ABSTRACT

A number of vehicle fleets around the world have transitioned to compressed natural gas (CNG), but public refueling stations remains sparse away from fleet depots. Given the varied vehicle and route types of fleets, empirical data on their use of public infrastructure refueling is important to understand, because like consumers, fleet drivers face range anxiety and their driving and refueling habits inform key assumptions important to station location. We surveyed 127 drivers of CNG fleet vehicles in Los Angeles at six stations across the metropolitan area. The key survey questions concerned the stops immediately before and after refueling, habituality of refueling away from base and fuel tank levels before refueling. We demonstrate that regardless of fleet or vehicle type, drivers deviate up to six minutes in order to refuel, and they also do not exhibit significant differences in fuel tank levels at the time of refueling. We also observe that 35% of fleet drivers surveyed indicated they were solely reliant upon away-from-base refueling for their operations, but there is variation between vehicle types. These findings demonstrate that fleet drivers do consider station locations away from their base when refueling, and they also indicate that assumptions made within facility location models with respect to fuel tank level and deviation thresholds do not necessarily have to consider the differences in vehicle or route type when employed at a metropolitan or regional scale.

Key Terms: alternative fuel, station, infrastructure, fleet, deviation, fuel tank

INTRODUCTION

It is becoming clear that the world's transportation system is not sustainable in its current form. The singular reliance upon petroleum fuel for transportation energy leaves economies at risk and carries a host of social and environmental problems: nearly 94% of all transportation energy consumed by Americans is petroleum-based, and the increasing automobility demanded by a burgeoning middle class in China and India is moving those countries toward a similar predicament. Uncertain future petroleum prices and supplies, worldwide climate change, and unstable geopolitical situations in oil-producing regions are some of the key issues facing the future of energy and transportation. Experts have advocated for changes in traveler behavior and development of alternative fuel vehicles (AFVs) as the two most promising solutions to the current problem (*1*).

While public transportation and changes in commuting patterns are suitable alternatives for urban dwellers, passenger vehicles will continue to play an important role in transportation for the coming decades due to slow-changing consumer habits and a massive amount of sunk infrastructure for automobile travel. The major automakers are now producing vehicles capable of running on electricity, hydrogen, compressed natural gas (CNG), and biofuels, among others (*2*), all which offer promising futures in the form of economic stability, improved air quality and health, and domestic energy production.

While full-fledged consumer adoption of AFVs may be slow to change, there are other arenas in the nearer term in which AFVs can flourish. From a policy standpoint, vehicle fleets are frequently recommended as a promising markets for initial AFV adoption (*3*). Legislation geared toward increased AFV adoption for fleets began with the Energy Policy Act of 1992 (EPACT), which required federal and state fleets to deploy certain numbers of AFVs: prior to this, the Alternative Motor Fuels Act of 1988 provided incentives to manufacturers to produce the vehicles (*4*). Fleets were targets of initial AFV adoption for several reasons, including: a) government incentives and mandates, b) the fact that auto manufacturers can offer special deals to fleets, c) on-site refueling and infrastructure expertise could help increase local adoption rates, and d) competitive fuel prices are very important to fleet owners (*5*).

These and other policies, combined with increasing gasoline prices and tightening air quality standards, have led to an increase in AFV fleets operating in recent years. Fleets adopting alternative fuels have turned to natural gas in particular as a result of the fuel's relatively low cost, competitive driving range, and lower emissions compared to liquid petroleum-based fuels (AFDC 2014). With the increase in fleet adoption of AFVs, a limited number of studies have emerged that analyze AFV fleet travel patterns and driver behavior (*3,5,6,7,8*). Each of these explore different facets of AFV fleet driving patterns, discovering key barriers to eventual widespread AFV adoption by specifically asking drivers what they found advantageous or not about their AFVs. Another national-scale study found that limited refueling infrastructure was the biggest barrier to CNG fleet development in Canada in the 1980s (*6*). This reinforces the idea that refueling station construction is the critical first step needed to overcome the so-called "chicken and egg" problem, the phenomenon of hesitancy that exists between AFV manufacturers and AFV station owners when each is reluctant to sink capital into production before the other does (*9,10*). Two decades after Flynn noted the problem, the limited refueling infrastructure remains the most critical hurdle to AFV adoption (*9*).

Other smaller-scale empirical studies of AFV fleets operating at different geographic scales and in more recent times have corroborated this key barrier (*3,7*). For this reason, AFV fleets often operate within a relatively confined geographical area and have their own refueling infrastructure, typically located at the fleet base, (e.g. school district vehicles, city buses, taxis, or forest service vehicles). To specifically address the restricted nature of AFV fleet travel and identify future solutions, (*5*) surveyed a number of fleet operators in Southern California, and found that they considered off-site refueling a critical factor in their willingness to invest more heavily in AFVs. This need for a public refueling infrastructure beyond the fleet depot or base, then, parallels the chief barrier to consumer AFV adoption.

To construct an effective refueling infrastructure for AFVs, an understanding of refueling behavior and what drivers consider to be convenient refueling locations is important. These data can help to facilitate AFV refueling station placement decisions and allow drivers overcome so-called "range anxiety." A limited number of studies exist that present empirical findings on fleet AFV refueling behavior with a public refueling infrastructure, since fleet drivers have a limited choice set of refueling stations outside of their dedicated stations at their base or depot, though this varies across metropolitan areas. Some work has focused on consumer AFV refueling behavior, but little to none for fleet drivers operating across a metropolitan or regional scale. For consumers, proximity to home and fuel price were the factors cited as reasons for choosing a refueling station (*11,12*), though they stated that high-traffic commuting routes between home and work locations could be good candidate sites for early refueling infrastructure since commuting trips had a higher than expected frequency linked to refueling, though the transferability to fleet refueling remains unknown.

In particular, fleet refueling behavior away from their base location has been sparsely noted in previous literature, largely because few metropolitan-scale AFV refueling infrastructures exist. Buses, taxis, delivery shuttles, municipal vehicles (such as trash collection), and mail and parcel distribution routes all differ in daily travel patterns and trip frequency. Similarly, the numerous vehicle types operated by fleets have differing ranges, which could impact the sensitivity of a driver's willingness to refuel and the fuel tank level at the time of refueling. Understanding how this mixture of drivers and vehicles uses the same AFV refueling infrastructure is important to station location modelers and station developers alike.

Based on empirical data collected from CNG fleet drivers using a public refueling infrastructure in the greater Los Angeles area, we ask the general research question: how do AFV fleet drivers access CNG refueling stations outside of their fleet bases in Southern California? Specifically, are there variations in how drivers access and refuel at these stations based on the nature of the vehicle or route type? Fleet and station operators alike have an economic stake in this question, along with policy-makers across the region and in other cities interested in construction of an AFV refueling infrastructure.

This paper begins with a description of the survey conducted and the methodology used to answer the research questions. Next, the results of CNG fleet driving and refueling are presented, followed by statistical findings of interest. The discussion and conclusion sections explore the implications of the study to future AFV refueling infrastructure placement for fleets at a metropolitan or regional scale.

DATA AND METHODS

Southern California offered a viable site for assessing AFV refueling behavior, due to the relatively high number of AFVs and refueling stations compared to other metropolitan areas. The CNG fleet refueling survey was administered in the summer of 2011, with some follow-up surveys in the winter. We chose an intercept survey methodology, asking drivers to respond to questions while refueling their fleet vehicles. This is the same method employed by (*11,12*), in order to obtain more reliable responses by interviewees.

Different kinds of fleets vary in vehicle and route types, and these differences are not trivial for the purposes of analyzing driving and refueling behavior. To explore this variation, we asked drivers to identify the type of route that they represented out of five choices:

- A regular route covering every street in a service area (e.g., mail, trash, meter reading)
- Multi-stop, return-to-base route to a set of unique or regular stops (deliveries, pickups, repairs, airport shuttle)
- Single-stop, return to base route from an origin to a destination and back (single delivery or service call)
- A refueling stop in between two unique, one-way trips (between taxi fares, etc.)
- Regular, back-and-forth route to a regular set of stops (bus route, etc.)

We then asked drivers to identify their fleet vehicle type from the following choice set:

- Car
- Bus
- Delivery van
- Passenger van
- Minivan
- Pickup truck
- Specialty truck

To collect information on spatial driving and refueling patterns, drivers were asked to provide locations of stops immediately before and after refueling, along with the approximate location of their fleet base. From these responses, we interpolated driving routes and generated service areas in GIS. The survey also collected information about the fuel tank level before refueling, reasons for choosing the station, frequency of refueling at the station, and frequency of refueling at a station other than the fleet base.

CNG stations in Southern California

Though many of the CNG refueling stations in Southern California are accessible to consumers for refueling, their primary purpose when built was to service CNG fleets. Some fleets have dedicated refueling facilities that are not accessible to other drivers, but many of the stations built by Clean Energy, Trillium, and other companies in the area are open to public refueling, both for other fleet drivers and consumers. These are the facilities of interest to the study.

These six stations at which surveys were conducted represent a variety of geographic settings, which could be advantageous for particular route or vehicle types. Trillium operates the Anaheim station, chosen for its proximity to freeways, at a location where multiple freeways meet. Clean Energy's Downtown station is next to Los Angeles's central business district (CBD), potentially serving fleet drivers based across the metropolitan area who are conducting business there. The Santa Monica facility is located on arterial streets not directly accessible from freeway exits, providing possible data on how fleet drivers use facilities away from freeways. Clean Energy also operates the Burbank and Santa Ana stations, both of which are near airports and major employment centers, representing refueling options for taxis or shuttles frequenting these locations. The Burbank and Santa Ana stations could also serve fleet drivers using freeways for longer distance trips across the metropolitan area. Finally, the Pomona station represents fleet travel in a more suburban environment, located in the Inland Empire. Additionally, because of its location in a bus depot, data gathered from this site potentially provides information on bus fleet travel.

Route calculations

To locate the survey respondents' stops immediately before and after refueling, we geocoded the cross-streets or exact locations they provided in ArcGIS 10. ArcGIS's Network Analyst computed shortest paths using travel time as the primary unit of impedance. Travel times for the network were generated using arc lengths, speed limits, and global turn penalties. We then calibrated the network by comparing route times against the GoogleMaps API. To compute the deviation required to refuel, we first calculated the travel time of the direct path between locations immediately before and after refueling, and compared this result to the travel time of the route that also included the stop at the CNG refueling station. These calculations provide us with a deviation metric, a key consideration when employing station location models. Models and scripts built within the ArcGIS and Python environment allowed us to automate the calculations that compared routes in absolute (miles and minutes) and relative (percentage increase in miles and minutes) terms.

To analyze the differences of driving and refueling behavior between route types and vehicles, a series of statistical tests were performed, using mainly cross-tabulation and ANOVA tests.

RESULTS

A total of 133 surveys were collected, and six of these respondents indicated that their fleet was based at the station where the survey was conducted. The remaining 127 represent the population of fleet vehicles that are reliant on the public refueling infrastructure outside of their fleet depot for at least some of their refueling needs, which is the behavior of interest to this study. Burbank was the most-frequented CNG station in total by fleet vehicles in the study, accounting for roughly 30% of the surveyed population (Table 1). Anaheim and Downtown received relatively high traffic, too, while a lower number of surveys were collected at the Santa Ana CNG station.

Descriptive findings

Variation exists across vehicle types refueling at the particular station. The majority of Anaheim respondents (76%) were refueling cars, which was the greatest percentage of any station (Table 1). All bus drivers were surveyed at the Burbank station. Pomona, while situated at a bus depot, allowed refueling for delivery vans and specialty trucks, and the Downtown station served a mixture of cars, vans, and trucks.

TABLE 1 CNG fleet refueling station location by vehicle type

KEY	Anaheim	Burbank	Downtown	Pomona	Santa Ana	Santa Monica	TOTAL
Bus	0	11	0	0	0	0	11
Car	22	15	10	2	3	2	54
Delivery Van	1	3	4	7	2	6	23
Minivan	3	0	0	0	0	0	3
Passenger Van	3	1	3	0	0	0	7
Pickup Truck	0	0	4	0	2	2	8
Specialty Truck	0	7	4	6	1	1	19
No Answer	0	2	0	0	0	0	2
TOTAL	**29**	**39**	**25**	**15**	**8**	**11**	**127**

Of interest to station developers is how often fleet vehicles rely on refueling stations aside from the ones at their base depots. Across all vehicle types, a majority of surveyed CNG fleet drivers (61%) indicated that they were reliant on public refueling stations away from their base for over half of their refueling needs (Figure 1), and 42% of drivers reported that they refuel away from the base over 90% of the time . Only 21% of drivers indicated that they rarely refuel away from their fleet base. In terms of loyalty to a particular station, 90% of drivers refueled at the surveyed station greater than half of the time, while 33% of drivers refueled at that particular station 80-100% of the time. Not only do fleet drivers refuel at CNG refueling stations away from their home base, but some refuel at these particular stations regularly.

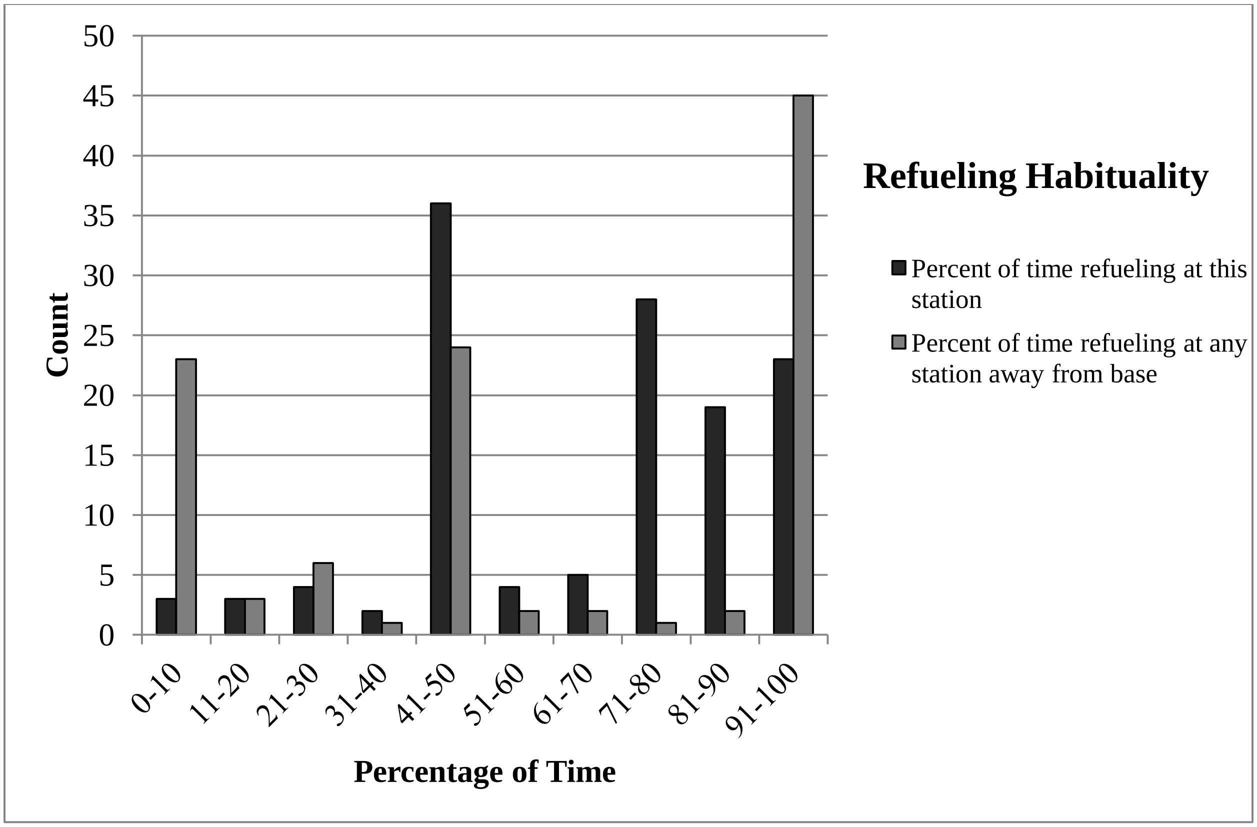


FIGURE 1 Habituality of refueling at a) the surveyed station, and b) any station away from the fleet depot

Fleet drivers were also prompted to choose the factor most important to them in deciding to refuel at a particular refueling station. Of the stated responses provided, 77% noted the station's “convenient location” (Table 2) as the primary reason they chose the station. Drivers who refuel at Trillium's Anaheim station cited lower fuel price as the primary reason for choosing the station at a higher rate than others, but convenient locations were the most-cited reason at all six stations, regardless of station operator. Though these data come from fleet drivers, they continue to support the notion in the consumer-based AFV adoption literature that a convenient refueling infrastructure is most important barrier to address (*9*,*10*).

TABLE 2 Primary reason for choosing station, by station location

KEY	Brand loyalty	Convenient location	Low fuel price	Running out of fuel	Use of credit cards	Other	TOTAL
Burbank	1	32	4	2	0	0	**39**
Santa Ana	0	8	0	0	0	0	**8**
Santa Monica	1	7	0	3	0	0	**11**
Pomona	3	12	0	0	0	0	**15**
Downtown	0	21	0	2	1	1	**25**
Anaheim	0	18	10	1	0	0	**29**
TOTAL	**5**	**98**	**14**	**8**	**1**	**1**	**127**

Travel time and Deviations

The mean travel time from previous stop to refueling station to next stop was 23.6 minutes and 12.8 miles (Table 3), but variations do occur by station. The Clean Energy CNG refueling stations in Burbank and Santa Ana were used by drivers operating on shorter trips than those in Downtown and Pomona. Across all CNG fleet drivers, mean travel times for refueling trips are 23.6 minutes, and mean deviations in order to refuel are 6.06 minutes (Table 3).

TABLE 3 Mean travel times, distances, and deviations for fleet drivers at surveyed CNG stations

Station	n	Travel time (minutes)	Travel distance (miles)	Deviation to refuel (minutes)
Burbank	39	15.06	6.66	6.85
Santa Ana	8	18.63	8.17	5.14
Santa Monica	11	25.44	15.21	5.09
Pomona	15	31.14	16.09	11.82
Downtown	25	30.57	19.21	8.05
Anaheim	29	25.79	14.23	3.2
OVERALL	127	23.58	12.81	6.06

Drivers show a willingness to tolerate up to 6 minutes of deviation in order to refuel before a sharp drop in frequency (Figure 2), with a slight rise again around the 8-10 minute interval. This roughly s-shaped deviation decay curve exhibited by CNG fleet drivers is very similar to the one noted by in a companion study of consumer CNG refueling (*13*). The similarity of fleet and consumer drivers' willingness to deviate from their shortest paths in order to refuel is noteworthy given the differing nature of fleet trips and consumer trips.

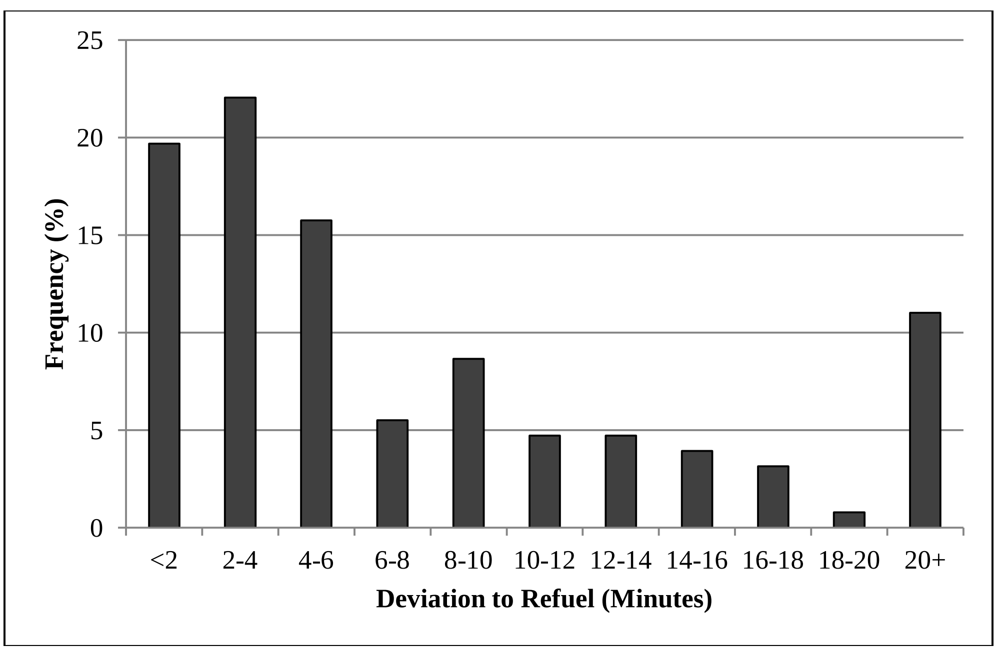


FIGURE 2 Deviation decay of CNG fleet drivers

Comparisons of Route and Vehicle Types

Though over half of the surveyed drivers refueled when fuel levels reached less than ¼ tank, one-factor ANOVA test significance scores are not significant (p=.33 and p=.09, α=.05) between fuel tank level at the time of refueling and fleet route type and vehicle type, respectively. Excepting the multi-stop routes such as deliveries and shuttles, greater than half of all route types refueled when their vehicles reached fuel levels between ¼ and ½ tank.

There is a statistically significant difference in travel time and deviations from shortest path in order to refuel across the surveyed stations. One-factor ANOVA test significance scores are p=.017 and p=.001 (α=.05), for mean travel time of the fleet vehicle's trip between previous and next stops, and deviation, respectively. The Pomona and Downtown stations exhibit higher mean travel times and deviations than the other stations, in addition to their larger service areas.

Differences in travel times across fleet route types would not be surprising given the nature of their trip purposes, and we do find a statistically significant difference in mean travel time across fleet types, but not with respect to deviations (Table 4). Table 4 shows three noticeable clusters of means of travel times between previous and next stops. Regular routes such as municipal services and buses showed similar travel, as did multi-stop return to base routes and a refueling stop between one-way trips, such as taxis and shuttles, while single stop return to base routes, such as deliveries, are greater than all others.

TABLE 4 One-factor ANOVA, refueling trip travel time vs. route type. *p*<0.01, df=4, F=3.997, one-factor ANOVA, deviation time to refuel vs. route type. *p*=0.882, df=4, F=0.294

KEY	N	Travel Time (minutes)	Standard Deviation (minutes)	N	Deviation (minutes)	Standard Deviation (minutes)
"Mail/Trash"	20	13.89	10.17	19	6.23	6.38
"Bus"	14	13.68	7.30	11	4.92	6.65
"Taxi"	47	24.16	14.56	44	5.54	5.03
"Delivery/Shuttle"	39	24.55	15.69	31	6.73	10.01
"Service Call"	7	31.02	13.52	7	7.70	4.61
TOTAL	**127**	**21.93**	**14.39**	**112**	**6.06**	**7.01**

Refueling Away from Base

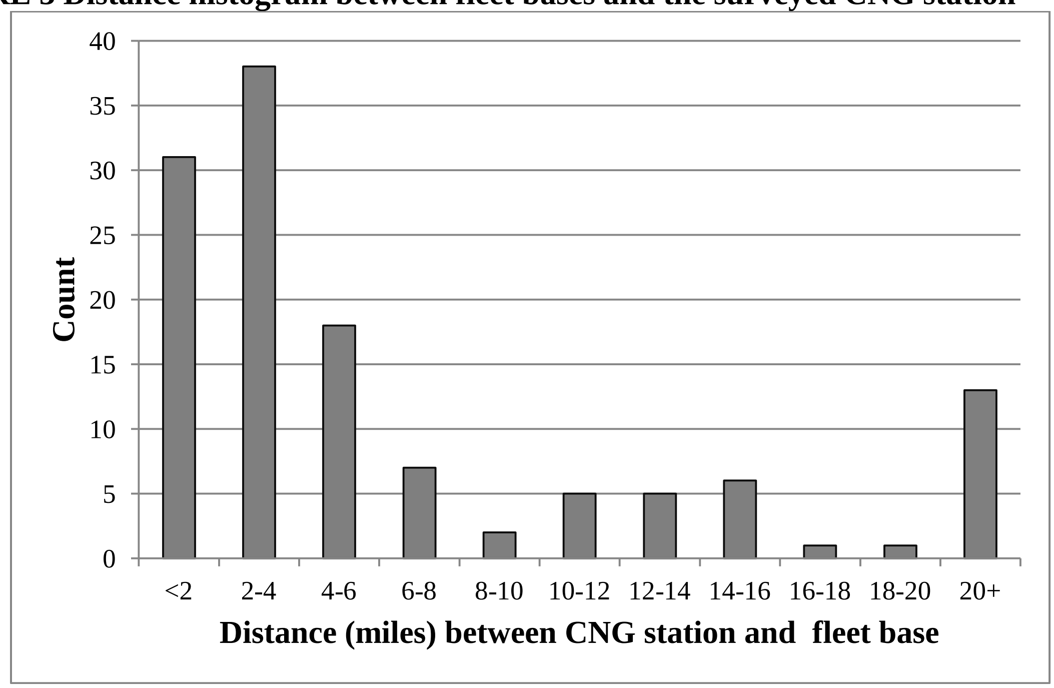
Table 5 shows that there is a statistically significant difference between mean refueling percentages at CNG refueling stations other than the fleet depot for differing vehicle types, with two clear clusters. Buses, which operate on regular back-and-forth routes, were reliant on away-from-base refueling greater over 90% of the time, and cars refueled away from their fleet base 64% of the time. Vans and specialty trucks, such as trash or mail trucks, were only reliant on external refueling up to about half of the time. That differing fleet route types and vehicles are more likely to need CNG refueling facilities external to their fleet base is of key importance to current or prospective station owners in the area.

TABLE 5 One-factor ANOVA. Percentage of refueling events at a station other than fleet base vs. vehicle type, excluding 19 "No Answer" respondents. p=0.02, df=4, F=2.46

Vehicle Type	N	Mean	St. Dev.
Bus	9	94.4	16.7
Car	43	64.3	40.5
Van	29	53.4	40.0
Pickup Truck	8	59.4	36.1
Specialty Truck	19	46.1	32.5
Total	**108**	**60.3**	**38.74**

With respect to fleet depot locations relative to the surveyed CNG station, the mean and median distances were 7.1 miles and 3.1 miles, respectively. Figure 3 exhibits an s-shaped distance decay curve of fleet depot locations relative to surveyed stations, similar to that of driver deviation. Nearly half of all fleet depots were within 4 miles of the CNG station, but 13 were greater than 20 miles away. In particular, the drivers located 20 or more miles away from base can use the public infrastructure as a means to increase the fleet's possible extent of activity.

FIGURE 3 Distance histogram between fleet bases and the surveyed CNG station



There were 37 CNG fleet drivers who reported that they relied upon away-from-base refueling for 100% of the time, which represented 29% of the surveyed fleet population. We can assume that these drivers either completely lack the ability to refuel at their fleet depot, or that perhaps the refueling infrastructure there is unreliable or very inconvenient. One hypothesis for the relatively high number of CNG fleet drivers without on-base refueling is that fleets bases or depots are located near existing CNG refueling infrastructure provided by companies such as Clean Energy or Trillium.

Using the distances from all fleet depots to the surveyed refueling station generated in ArcGIS, we find that the mean distance away from base at the time of refueling was 4.4 miles for those drivers *without* a refueling station on-site. For the 90 fleet drivers *with* a refueling station at the fleet depot, the mean distance away from base at the time of refueling was 8.2 miles, while 20 drivers provided no answer to how often they refueled away from the fleet base. A t-test shows that there is a statistically significant difference in distances between refueling station and the fleet base for those with and those without refueling capabilities on-site ($p = .01$). This would support the hypothesis that those fleets without refueling at their depot locate nearer to existing CNG stations. Interestingly, though, 22% of respondents without a refueling station at their base indicated that their fleet depot was within two miles of the refueling station, while 25% of fleet drivers with on-site refueling stated that their base was within two miles of the station, but the latter population is offset by a number of fleet locations located far away from the surveyed CNG stations.

DISCUSSION

That deviation times to refuel do not significantly differ across fleet route types is important to note for station location models that incorporate deviation when optimally placing stations at a regional scale. Should this consistency continue to be found in other geographic areas and with other fleets, one deviation threshold could be assumed for all fleet types in an area when employing station location models such as the Deviation Flow-Refueling Location Model (*14*). Of additional interest to the simplification of station location modeling assumptions is that CNG fleet drivers do not exhibit significant differences in fuel tank levels at the time of refueling, regardless of route or vehicle type. Drivers of specialty trucks, vans, or cars appear to have the same levels of range anxiety at present, though this could change as fleet drivers become more familiar both with their CNG vehicles and the infrastructure.

Further, the 5.0 median deviation to refuel by fleet drivers is analogous to the 5.3 minute median exhibited by consumer CNG drivers in (*13*), and fleet drivers also show a similar deviation decay curve when refueling. The implication is that deviation metrics employed by consumer-based station location models could be applied to the deployment of stations for fleets. The sparse nature of this initial CNG refueling infrastructure may be forcing these similar deviation times at present, so this similarity could change as refueling infrastructure becomes more abundant. Further validation of the consistency between fleet and consumer drivers in other geographies will certainly be necessary, but this result offers the possibility that location models can assume a universal willingness to deviate, regardless of driver, fleet, or vehicle type.

The unequal numbers of surveys across stations and fleet route types must be noted as a source of bias in the results. More stratification across stations and vehicle types could have produced different results and could be worth further investigation. Additionally, the categorization of route types as presented could impact results. Simplification and combination of certain route types (such as combining airport shuttles with taxis, and buses with municipal fleets such as trash collection), could produce different metrics, but data reduction techniques like this should always be approached with caution. Finally, further exploration may be warranted into the single trip fleet route types, which showed equal frequency of selecting a refueling facility because they were running out of fuel as opposed to its convenient location, but with a limited sample size of seven, it is difficult to generalize results.

One important point to consider is that the spatial distribution of fleet bases relative to stations does not necessarily represent all total CNG fleet activity space in the region. It is possible that CNG fleets with dedicated infrastructure never need to use these publicly available stations, and were therefore not sampled in this study. We find that fleet depots without on-site refueling are located closer to CNG refueling infrastructure than those with refueling capabilities, but we do not know whether the stations were primarily placed near the fleet depots by Clean Energy or Trillium to provide a convenient refueling station for the fleets, or if fleet locations largely changed as a result of the stations. The interaction between these location decisions would be an interesting topic to consider in future research.

Further research into the likelihood of other fleet vehicles using an external refueling facility is something that would interest station owners and operators, and could be explored through future discrete choice modeling methodologies.

CONCLUSION

Clean Energy Fuels, Trillium, and other CNG refueling station owners have constructed an early AFV refueling infrastructure in Southern California, where empirical data regarding AFV driving and refueling habits of fleet drivers operating in the area can be examined at a metropolitan scale. Data collected from 127 fleet drivers who refueled at a CNG station away from their fleet base shows that although there is variation in trip length, vehicle type, and fleet route type across a number of fleets using the same CNG refueling infrastructure, there is no significant difference in deviations taken to refuel or fuel tank levels at the time of refueling. This is a significant finding for AFV station owners, facility location modelers, and policy-makers: regardless of fleet route or vehicle type, the deviation required to refuel is not significantly different, exhibiting an average of about just under minutes. If this phenomenon is found in other cities, the station location modeling process will become simplified with regards to these assumptions, so analysts would not need to worry about the differences in refueling trip deviations or fuel tank levels that drivers will tolerate before refueling between taxis, buses, mail trucks, pickup trucks, or shuttles when employing station location models.

Fleet depots without on-site refueling are observed to be located closer to CNG refueling infrastructure than those fleets that have refueling capability at their base, but the limited sample size and lack of surveys from drivers who do not refuel at any public refueling tempers this finding. Vehicle type also seems to be important to the reliance on away-from-base refueling, as buses and cars relied on the surveyed stations more than vans or trucks did. As CNG stations become more widespread across metropolitan and regional scales, fleet activity space can grow in tandem, but it is likely that station developers would need assurances from fleets that there would be a consistent number of vehicles using the station first. This "chicken and egg" cycle has been noted in the consumer AFV literature with respect to vehicles and stations, and the construction of a limited number of stations optimally in an urban area could entice vehicle fleets of any kind, operating any vehicle, to operate in parts of a city previously considered as beyond the reach of their vehicles.

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