INEEL/EXT-03-00846

U.S. Department of Energy FreedomCAR & Vehicle Technologies Advanced Vehicle Testing Activity NYPA/TH!NK Clean Commute Program Report – Inception through February 2003

Don Karner
James Francfort

July 2003

Idaho National Engineering and Environmental Laboratory
Bechtel BWXT Idaho, LLC

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Don Karner[1]
James Francfort[2]

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[1]**Electric Transportation Applications**
Phoenix, Arizona

[2]**Idaho National Engineering and Environmental Laboratory**
Transportation Technology and Infrastructure Department
Idaho Falls, Idaho 83415

Prepared for the
U.S. Department of Energy
Assistant Secretary for Energy Efficiency and Renewable Energy
Under DOE Idaho Operations Office
Contract DE-AC07-99ID13727

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[1] Principal Investigator, Electric Transportation Applications
[2] Principal Investigator, Idaho National Engineering and Environmental Laboratory

Abstract

The Clean Commute Program uses TH!NK *city* electric vehicles from Ford Motor Company's electric vehicle group, TH!NK Mobility, to demonstrate the feasibility of using electric transportation in urban applications. The primary Program partners are the New York Power Authority (NYPA) and Ford. The other Program partners providing funding and other support include the Metropolitan Transportation Authority, Metro North Railroad, Long Island Railroad, New York State Energy Research and Development Authority, Long Island Power Authority, New York State Department of Transportation, New York City Department of Transportation, and the U.S. Department of Energy's Advanced Vehicle Testing Activity (AVTA). The data in this report is being collected via an internet-based questionnaire system by the AVTA through its subcontractor Electric Transportation Applications.

Suburban New York City railroad commuters use the TH!NK *city* vehicles to commute from their private residences to railroad stations where they catch commuter trains into New York City. Electric vehicle charging infrastructure for the TH!NK *cities* is located at the commuters' private residences as well as seven train stations. Eighty-seven commuters are using the TH!NK *city* vehicles, with 80% actively providing data to the AVTA. The participants have driven the vehicles nearly 150,000 miles since Program inception, avoiding the use of almost 7,000 gallons of gasoline. The TH!NK *city* vehicles are driven an average of between 180 and 230 miles per month, and over 95% of all trips taken with the TH!NK *city* vehicles replace trips previously taken in gasoline vehicles. This report covers the period from Program inception through February 2003.

Contents

Program Description

The New York Clean Commute Program was launched in October, 2001 by the New York Power Authority (NYPA) and Ford Motor Company's electric vehicle group, TH!NK Mobility, in conjunction with the Long Island Power Authority and the Metropolitan Transportation Authority. The Program is designed to reduce air pollution and traffic congestion as well as promote national energy independence by using electricity for transportation.

The Program goal is to lease 100 emission-free TH!NK *city* electric vehicles to suburban rail commuters for a period of 34 months. Ford has leased 97 TH!NK *city* electric vehicles to commuters from Westchester, Putnam, Rockland, Queens, Nassau and Suffolk counties for $199 per month. To date, 10 of the lessees have returned their vehicles to Ford and no longer participate in the Clean Commute Program. Reasons given for leaving the Program include relocation out of the Program area, change in employment status, change in commuting status, and in a few cases, dissatisfaction with the vehicle. Clean Commute participants use charging stations at rail station parking lots, where their vehicles are charged during the workday. Rail stations currently participating in the Clean Commute Program and the number of vehicle chargers at that station are as follows:

- Brewster North, Putnam County — 10 Chargers
- Chappaqua, Westchester County — 20 Chargers
- Hicksville, Nassau County — 16 Chargers
- Huntington, Suffolk County — 22 Chargers
- Little Neck, Queens County — 8 Chargers
- North White Plains, Westchester County — 8 Chargers
- White Plains, Westchester County — 10 Chargers

The rail station at Nanuet, Rockland County originally participated in the Clean Commute Program. However, none of the current Program participants currently utilize this station. Participants also have charging equipment installed at their homes to increase the opportunity for vehicle use.

The TH!NK *city* is a two-passenger electric vehicle with a range of approximately 50 miles and a top speed of 55 miles per hour. Local Ford dealers lease the TH!NK *city* directly to consumers, provide maintenance service and basic vehicle instruction. It was manufactured by Ford's TH!NK Nordic subsidiary in Norway.

NYPA, in partnership with the Metropolitan Transportation Authority, Metro North Railroad and Long Island Rail Road, coordinate activities to ensure sufficient rail station parking and charging stations. Additional support and funding are provided by the New York State Energy Research and Development Authority, the Long Island Power Authority, the New York State Department of Transportation, New York City Department of Transportation and the U.S. Department of Energy (DOE).

The DOE, through its Advanced Vehicle Testing Activity (AVTA) and the AVTA subcontractor Electric Transportation Applications, also provides data collection, analysis, and reporting support for the Clean Commute Program. This report is the first report issued by the AVTA to

analyze the Clean Commute Program's vehicle operations and it covers the period from Program inception through February 28, 2003.

Data Collection Program

Program Objectives

The objective of Clean Commute data collection is to gather data from Clean Commute Program customers to allow determination of the following Program accomplishments:

- Clean Commute Program vehicle utilization
- Clean Commute Program emissions reductions
- Clean Commute Program petroleum fuel use reductions
- Clean Commute customer satisfaction with vehicle and infrastructure
- Long term Commute Program viability.

Program Participants

As of February 28, 2003 the Clean Commute Program included 87 participants. These participants have leased a TH!NK *city* vehicle and have taken delivery of such vehicle. An initial questionnaire has been completed by 70 of the 87 Clean Commute Program participants. These participants are considered active in the Clean Commute Program.

Collection Methodology

Data collection for the Clean Commute Program began in April 2002. Data are collected primarily through use of the Internet. Once a participant has taken delivery of their TH!NK *city* vehicle, they are sent an e-mail directing them to a web page where an initial questionnaire (Appendix A) is completed. Data from the initial questionnaire is automatically entered into a Clean Commute participant database. The first group of initial questionnaires was completed in May, 2002. Initial questionnaire data continues to be collected, with 70 of the 87 participants completing the initial questionnaire to date. Efforts continue to collect data from the remaining 17 participants. The 10 participants that returned their vehicles had only provided minimal data and any responses have been deleted from the database.

Subsequent to completion of the initial questionnaire, participants are requested by e-mail to complete a monthly questionnaire (Appendix B) detailing their Clean Commute Program experience. These data are also automatically entered into the Clean Commute participant database. The first monthly questionnaires were transmitted in June 2002 to collect data for May.

Clean Commute Program participant demographic data obtained from the initial questionnaire are presented in the Participant Demographics Section. Data collection efficiency for the Clean Commute Program is presented in the Data Collection Efficiency Section.

Analysis Protocols

Data collected and stored in the Clean Commute participant database are analyzed to determine various measures of Program performance. These measures are presented in the following sections:

- Projected Performance Parameters
- Measured Performance Parameters
- Derived Performance Parameters

Results of these analyses are reported and monitored on an ongoing basis to provide guidance for the Program.

Data Analysis

Participant Demographics

Participant demographics were obtained through use of an initial questionnaire. Figures 1 through 4 present demographic data for TH!NK *city* lessees completing the initial questionnaire. Participant Gender data are presented in Figure 1 and were provided by all 70 of the active Clean Commute Program participants.

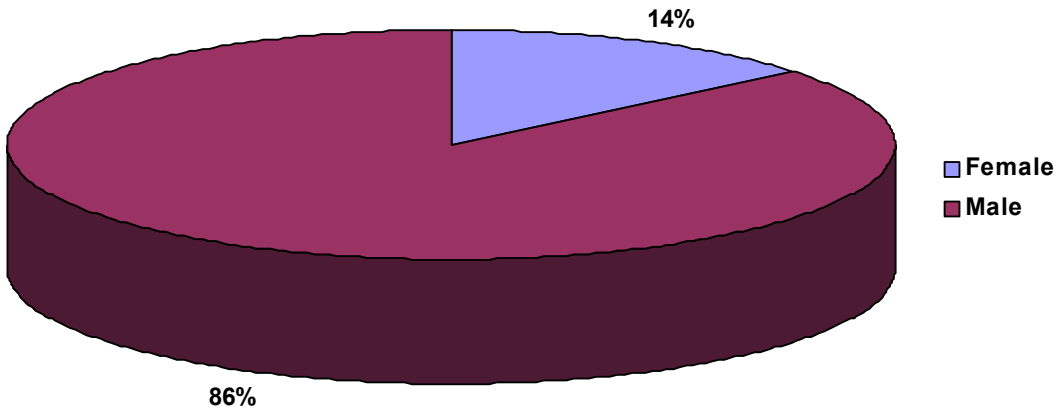


Figure 1. Participant Gender

Participant Age Distribution data as presented in Figure 2 were provided by 57 of the 70 active Clean Commute Program participants.

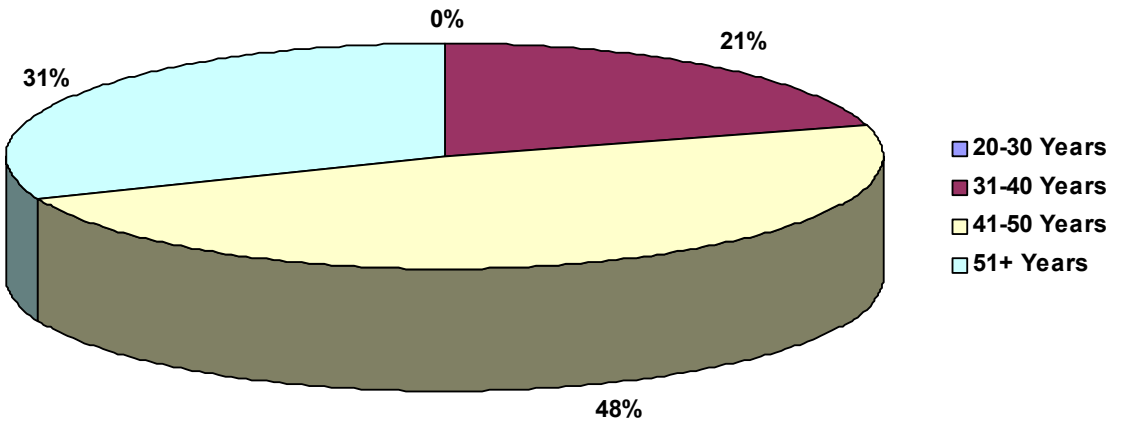


Figure 2. Participant Age Distribution

Participant annual Income Distribution data are presented in Figure 3 and were provided by 64 of the 70 active Clean Commute Program participants.

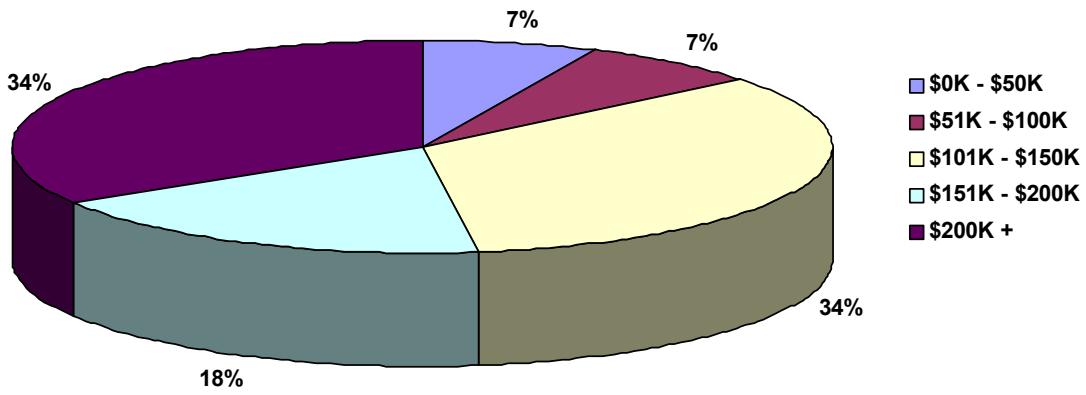


Figure 3. Participant Household Annual Income Distribution

Data detailing the number of Vehicles In Participant Families Other Than TH!NK *city* are presented in Figure 4 and were provided by 69 of the 70 active Clean Commute Program participants.

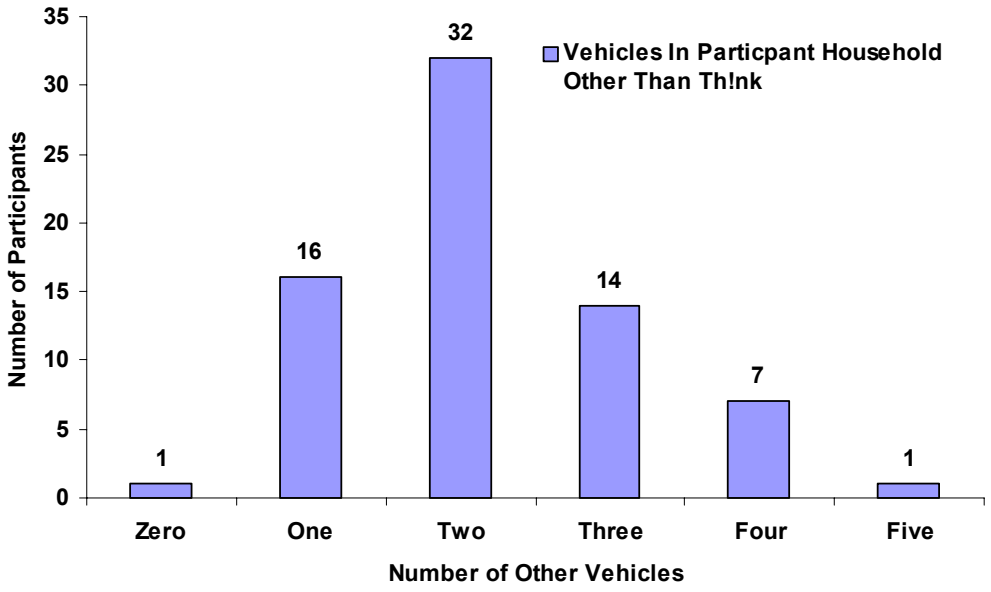


Figure 4. Number of Vehicles In Participant Household Other Than TH!NK *city*

Data Collection Efficiency

TH!NK *city* lessees having taken delivery of their vehicle are considered participants in the Clean Commute Program. Through February 28, 2003, there were 87 participants in the Clean Commute Program. Of these 87 participants, 70 participants had completed the initial questionnaire as of February 28, 2003. Figure 5 presents the percentage of the 87 lessees completing the initial questionnaire and, therefore, defined as active participants.

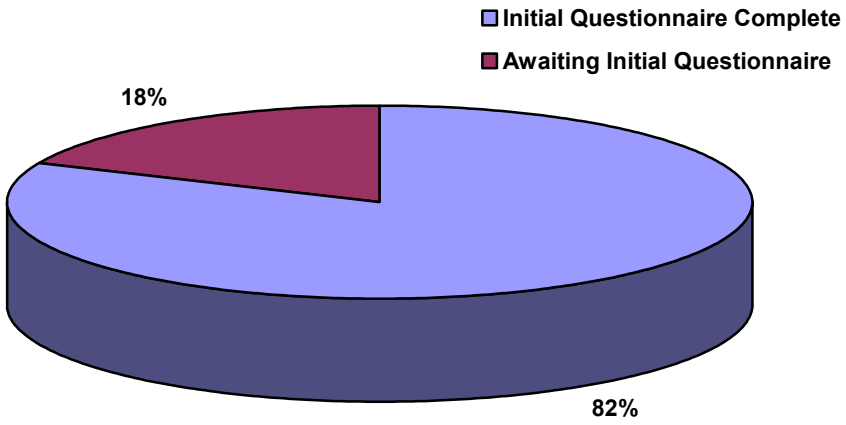


Figure 5. Data Collection Efficiency

Projected Performance Parameters

Based on data provided by Program participants in the initial questionnaire, the projected use of TH!NK *city* vehicles is presented in Figures 6 and 7. Data projecting the type of trips to be taken in their TH!NK *city* are presented in Figure 6 and were provided by 69 of the 70 active Clean Commute Program participants.

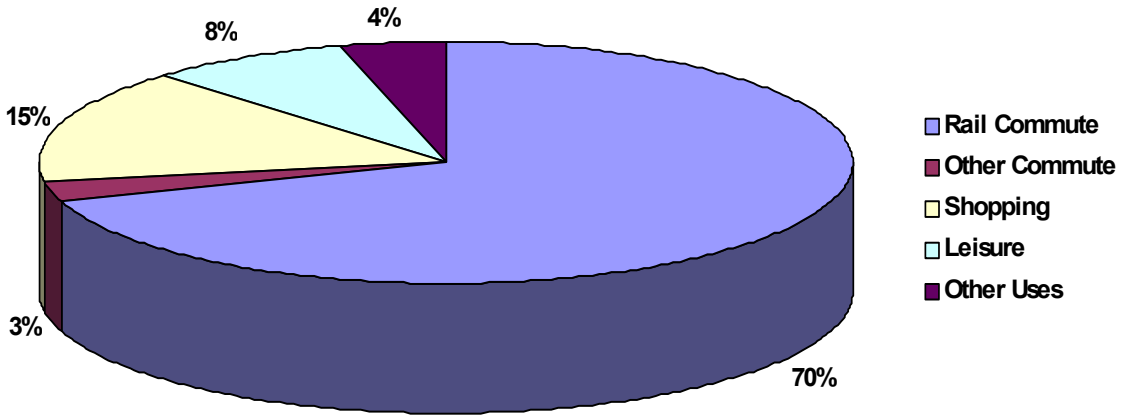


Figure 6. Projected Use By Trip Type

The percentage of TH!NK *city* trips presented in Figure 6 that would otherwise have been taken in a gasoline fueled vehicle are presented by projected trip type in Figure 7.

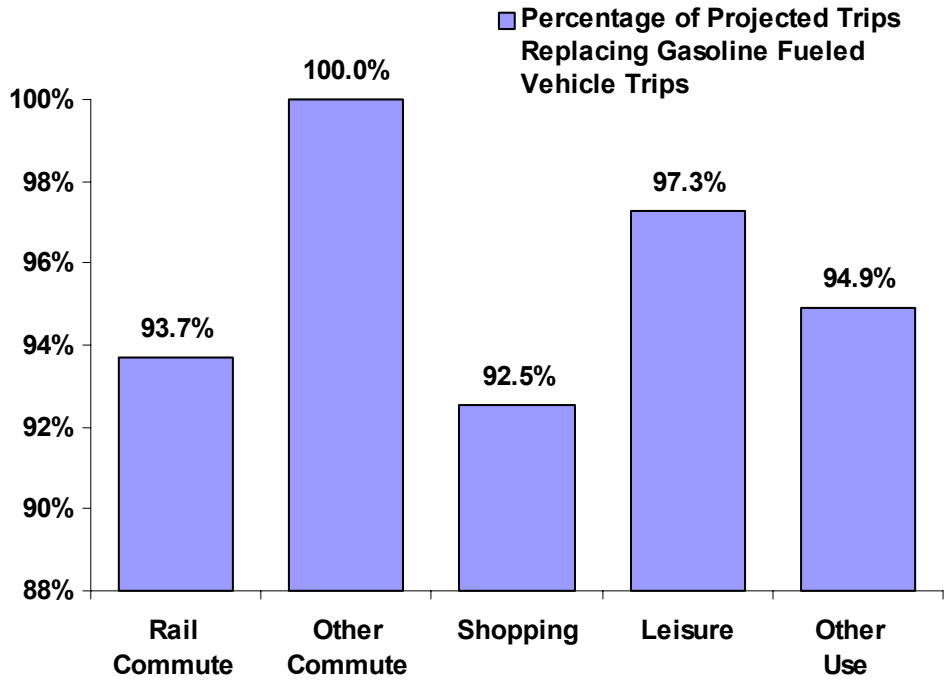


Figure 7. Percentage Of Projected Trips Replacing Gasoline Fueled Vehicle Trips

Data detailing the Prior Methods Of Rail Station Commute for Clean Commute Program participants are presented in Figure 8 and were provided by all 70 of the active Clean Commute Program participants.

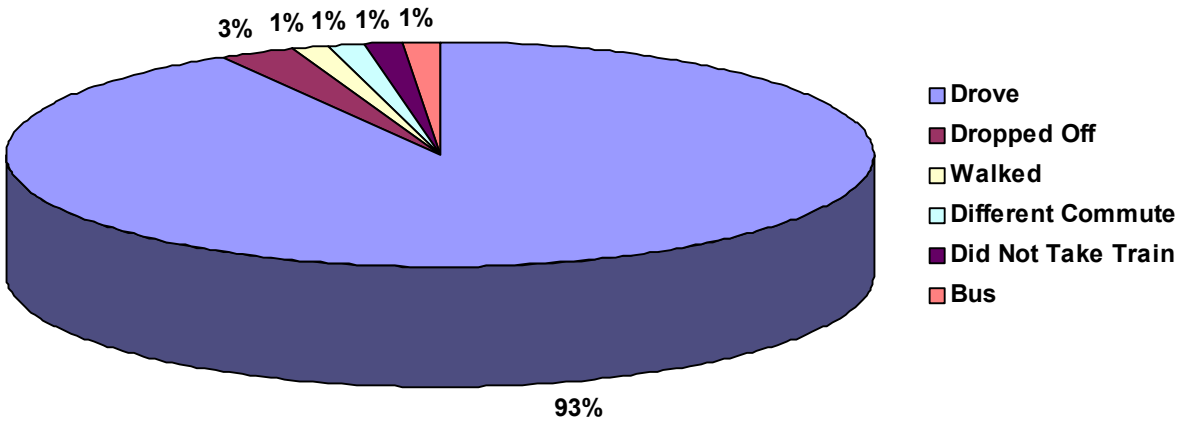


Figure 8 Prior Methods Of Rail Station Commute

Measured Performance Parameters

Using data collected from the monthly questionnaires, performance of the TH!NK *city* vehicles using various metrics is presented in Figures 9 through 12. Data from some participants were not available as of February 28, 2003. Therefore, the actual performance parameters may vary slightly from those reported herein. For example, the miles driven in the months immediately preceding February, 2003 do not fully reflect the actual miles driven as some participants have not yet reported mileage in these months. This difference will resolve in later reports as data from the participants is collected.

Figure 9 presents the Total Program Vehicle Usage by month for all active participants in the Clean Commute Program. Data are reported beginning in February, 2002, using manual sources of data such as delivery and service records. A significant number of vehicles were added to the Program during the months of March and April, 2002, resulting in large increases in miles driven in these months. Data for May, 2002 and beyond were collected using the internet-based monthly questionnaire. Total monthly mileage data for January and February, 2003 are lower than actual miles driven in these months as some participants have not yet reported mileage data for these months.

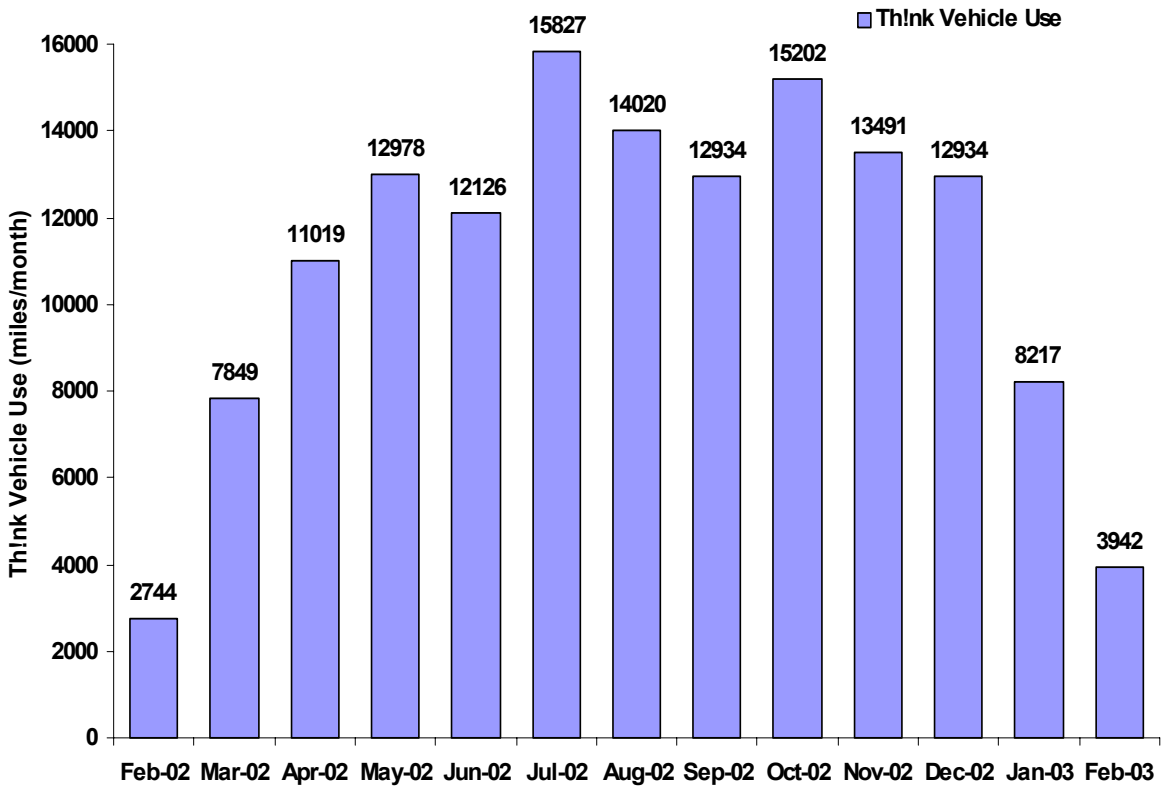


Figure 9. Total Program Vehicle Usage (miles)

Through February 28, 2003, Clean Commute Program active participants reported a total of 143,283 miles of TH!NK *city* operation. The impact on air emissions and fuel utilization of

traveling the miles reported using the electric vehicle rather that a gasoline fueled vehicle are presented in the Derived Performance Parameters Section.

The TH!NK *city* onboard battery charger demands approximately 2.5 kW at full power. Charging energy is provided by vehicle chargers located at Clean Commute Program rail stations and at Program participant homes. Electrical power peak demand (the maximum load during a specified period of time) for chargers located at rail stations has been reported in Table 1.

Table 1. Charging power peak demands at Clean Commute Program rail stations.

Station Name	Chargers At Station	2002 (kW)								2003 (kW)	
		May	June	July	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Brewster North	10	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Chappaqua	20	19.20	19.20	16.80	15.20	22.40	20.00	22.40	22.40	21.60	20.80
Hicksville	16	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Huntington	22	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Little Neck	8	14.80	14.80	14.80	14.80	10.40	10.80	8.40	8.40	9.60	8.00
White Plains	10	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
North White Plains	8	5.04	2.16	2.16	2.16	4.32	7.02	8.10	9.36	9.36	9.90
N/A - Data currently not available											

Each month Clean Commute Program participants report the occurrence (if any) of the following events.

- Vehicle failed to charge on the home charger
- Vehicle failed to charge at the rail station charger
- Vehicle ran out of charge while in operation
- Vehicle broke down on the road
- Vehicle required either preventative or corrective maintenance

Figure 10 presents the number of occurrences of each of these events on a monthly basis from May 2002 through February 2003. No data was collected for June 2002. The high number of home and station charging problems (21 each) during January were reported by only two or three participants most likely having operator issues as the problems did not reoccur in February with no action taken.

Maintenance for the TH!NK *city* vehicles is reported by vehicle system and the type of maintenance (routine scheduled maintenance or maintenance required to correct a problem with the vehicle). Figure 11 presents the number of repair incidents for the electric propulsion system, the charging power system and all other vehicle systems. The large number (13) of "Other Systems" repairs was related to non-electric vehicle component repairs such as wiper blade problems. Figure 12 presents the type of maintenance work performed, either repair or scheduled maintenance. Scheduled maintenance is currently required every 3,000 miles for the TH!NK *city*. The primary maintenance activity required is levelizing of the nickel cadmium propulsion battery.

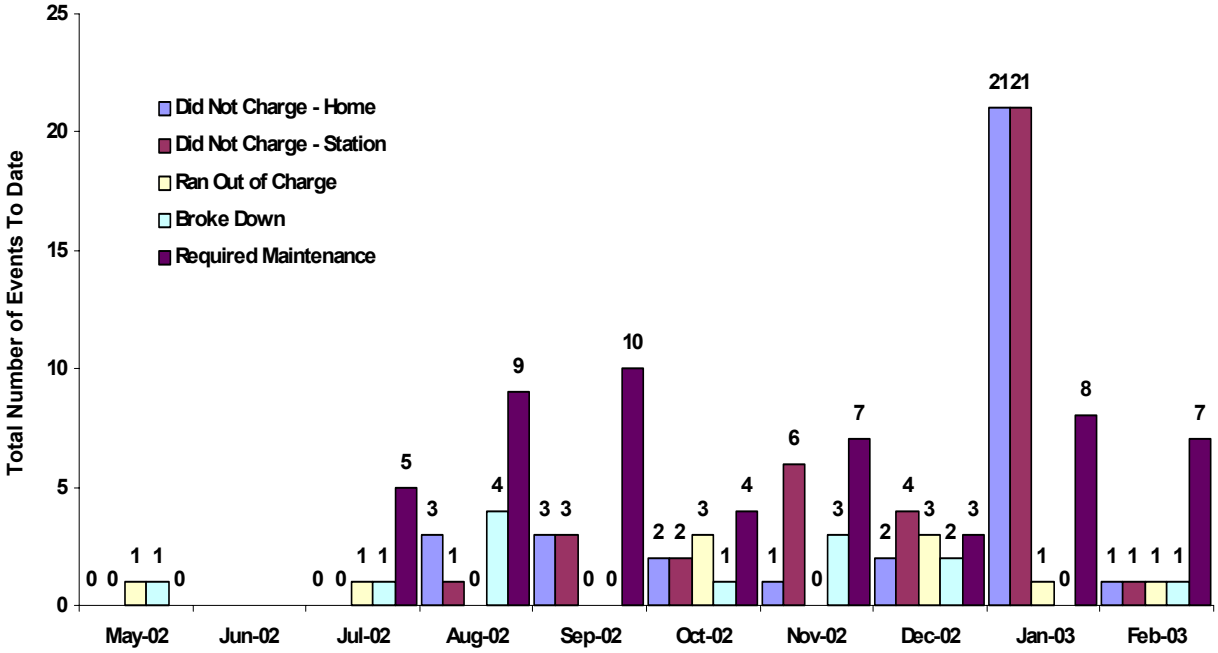


Figure 10. Operation Events, Program Inception Through February, 2003

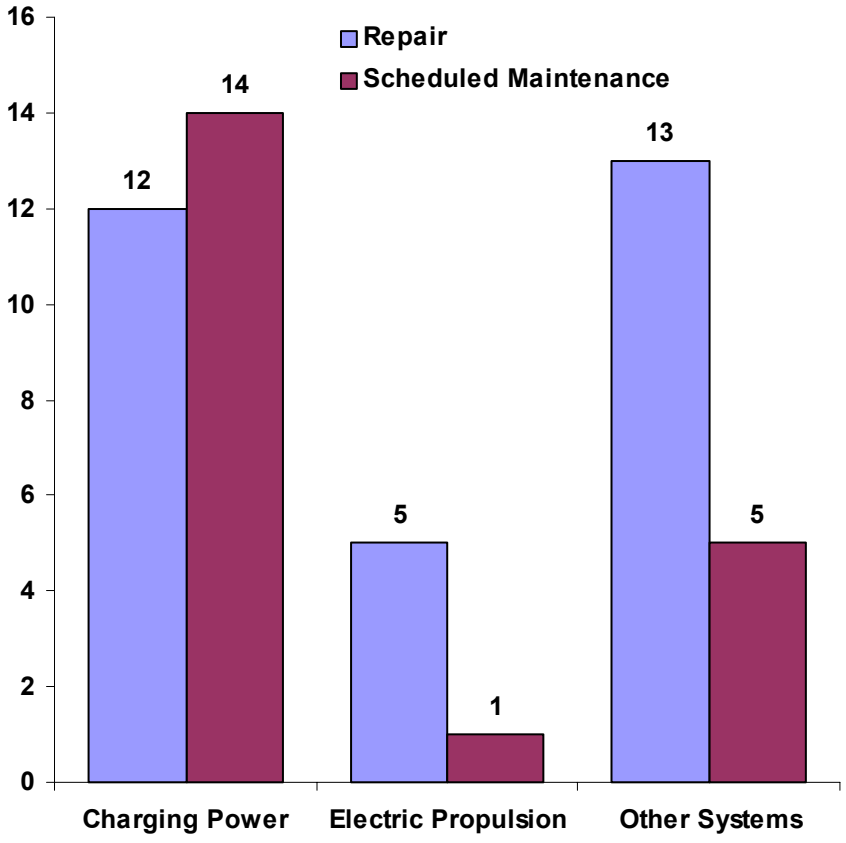


Figure 11. Vehicle Maintenance Activities By System

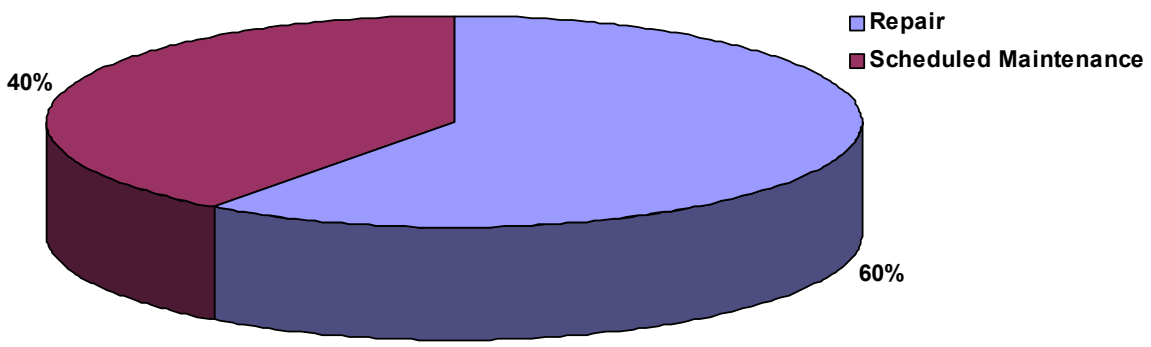


Figure 12. Vehicle Maintenance By Type

Participants report their satisfaction with the Clean Commute Program on a monthly basis. Figure 13 presents the average Participant Program Satisfaction on a monthly basis from Program inception through February 2003. Zero represents a participant who is completely dissatisfied. Ten represents a participant who is completely satisfied. No data were collected in June 2002.

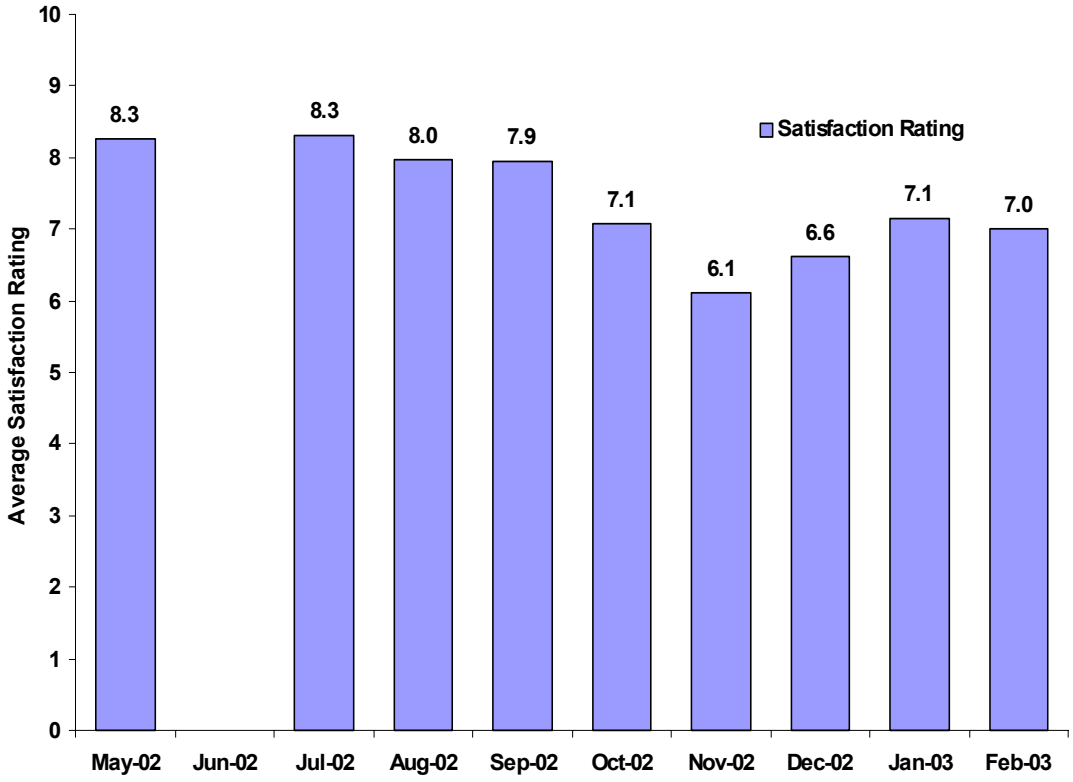


Figure 13. Participant Program Satisfaction, Program Inception Through February 2003

Figure 14 presents the distribution of all participant Program satisfaction indices reported from Program inception through February 2003 with some participants responding more than once.

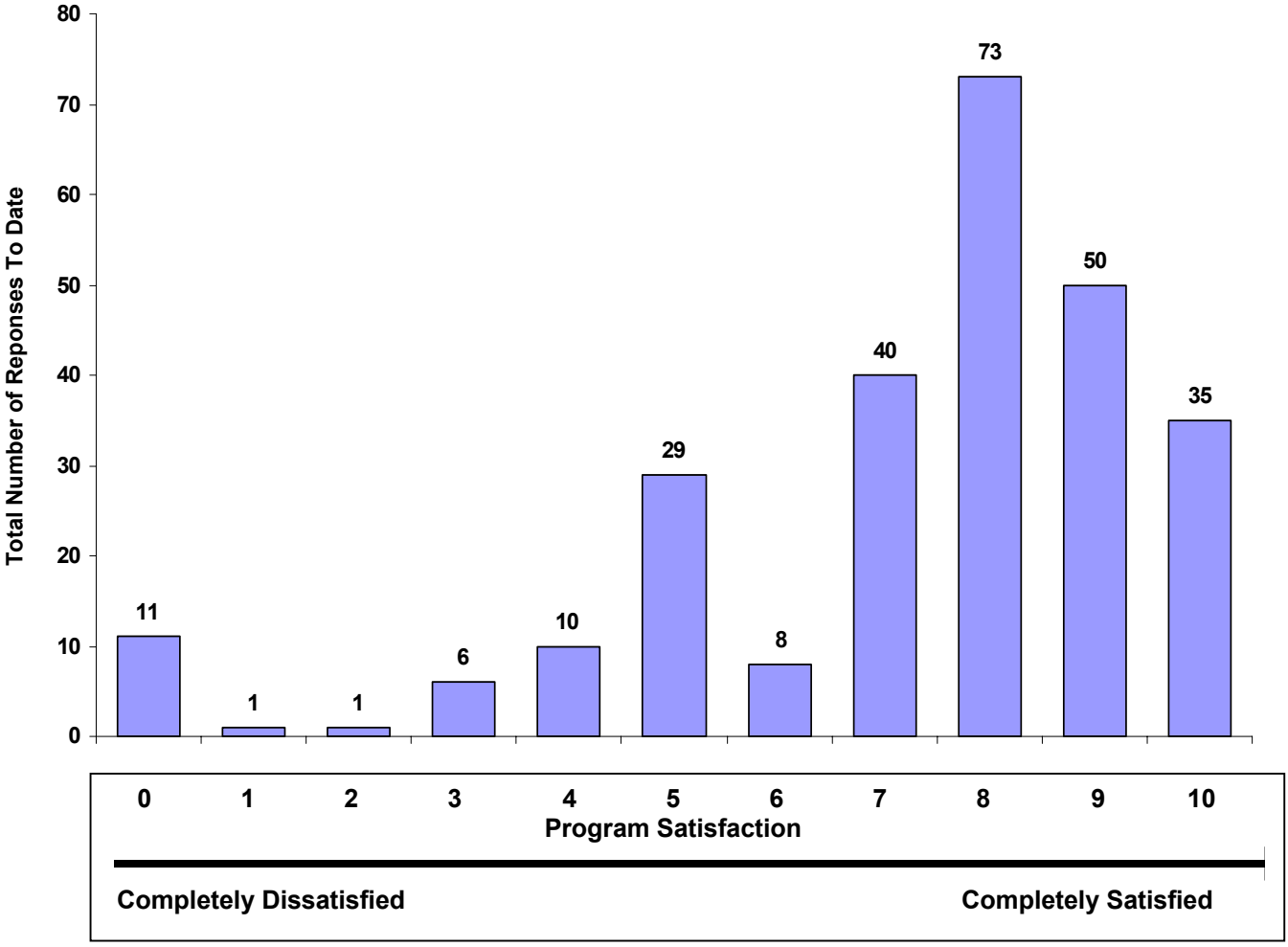


Figure 14. Participant Satisfaction Distribution, Program Inception Through February, 2003

Derived Performance Parameters

Using the data collected from the monthly questionnaire, air quality impacts from the use of TH!NK *city* vehicles are presented in Figures 15 through 18. Data from some participants were not available as of February 28, 2003. Therefore, the actual derived performance parameters may vary slightly from those reported herein. This difference will resolve in later reports as data from all participants becomes available. Because formal data collection via the Internet did not initiate until May 2002, the miles driven, and gasoline use and emissions avoided were all interpolated backwards for February, March and April 2002 based on the mileage data collected during May.

It is assumed that vehicles that are replaced by the TH!NK *city* fleet meet average annual emissions and fuel economy factors as reported by the USEPA Office of Transportation and Air Quality in their April, 2000 Report EPA420-F-00-013. These factors are as;

Nitrogen Oxides (NOx)	1.39 grams/mile
Hydrocarbons (NMHC)	2.80 grams/mile
Carbon Monoxide (CO)	20.9 grams/mile
Gasoline	0.0465gallon/mile (21.5 miles/gallon)

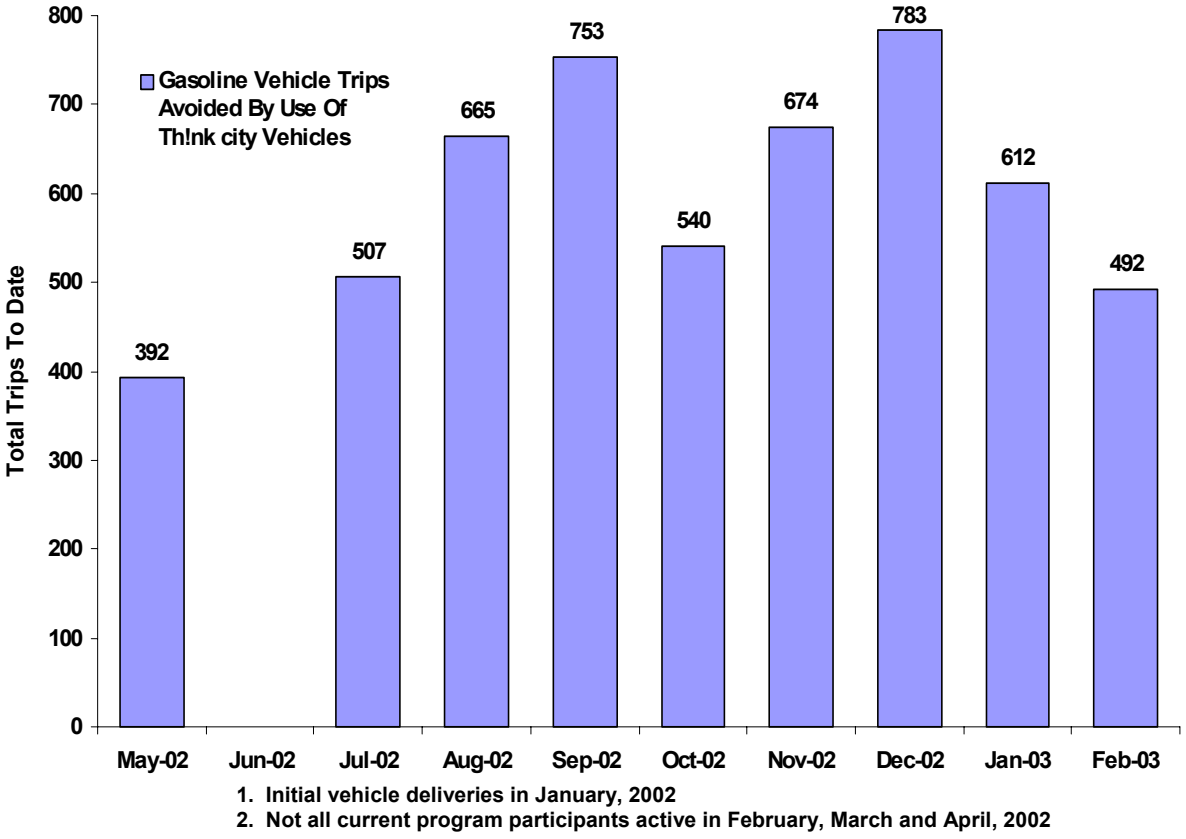


Figure 15. Estimated Avoided Gasoline Vehicle Trips.

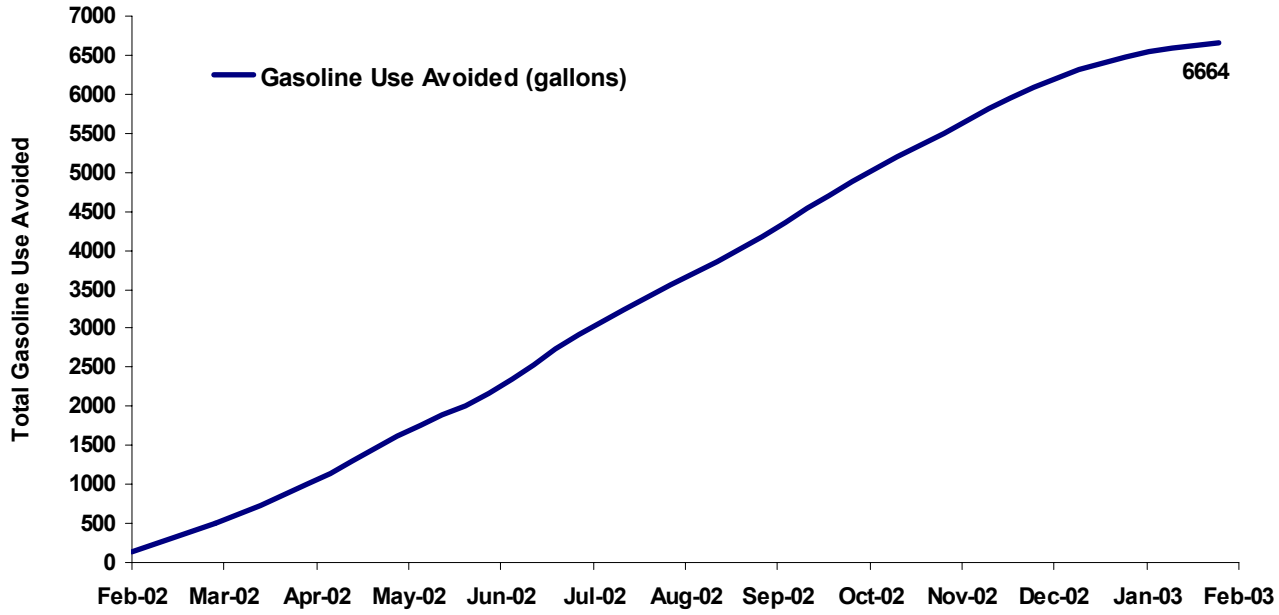


Figure 16. Petroleum Use Avoided

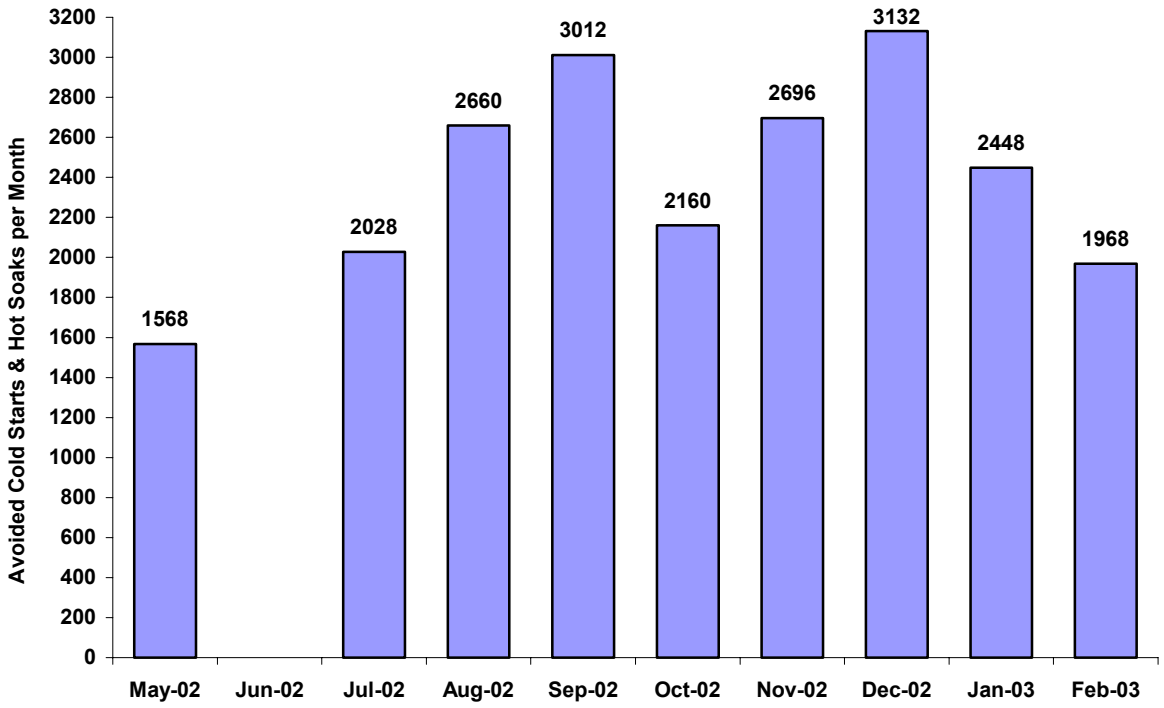


Figure 17. Engine Cold Starts & Hot Soaks Avoided

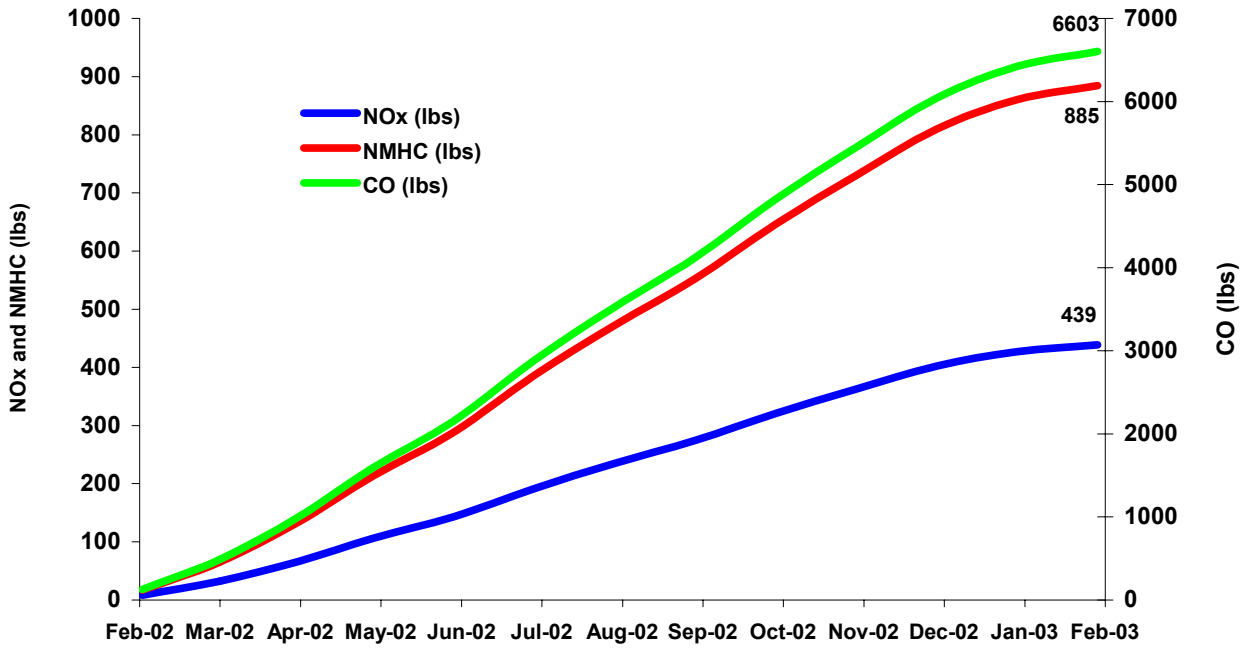


Figure 18. Air Emissions Avoided

Conclusions

Using data collected through February 28, 2003, the following conclusions can be reached in regards to the Clean Commute Program.

- The Clean Commute Program participants have driven nearly 150,000 miles since the Program inception. In this period they have avoided the use of nearly 7,000 gallons of gasoline and avoided nearly 5,500 round trips in gasoline fueled vehicles.
- Clean Commute participants average between 180 and 230 miles/month of vehicle use. No variation in vehicle use is currently detectable based on season of the year.
- Data collection efficiency is very good with 80% active participants. NYPA and the AVTA are investigating other methods to encourage Clean Commute Program participants to increase survey response rates.
- While the majority of trips using the TH!NK *city* are for rail station commute, one third of the trips are for other family activities, indicating that the TH!NK *city* can integrate into family transportation.
- Over 90% of participant rail station commuting prior to the Clean Commute Program was done in a gasoline-fueled vehicle, indicating that the Clean Commute Program can have a significant affect on emissions and gasoline usage.
- Over 95% of all trips taken with the TH!NK *city* replaced trips that would have otherwise been taken in a gasoline fueled vehicle, indicating that the TH!NK *city* vehicles are replacing gasoline vehicle trips, not just being used for additional trips.
- Reports of insufficient range were from a few participants reporting a large number of incidents in a single month. These participants may require additional training or have inappropriate requirements for the vehicle mission.
- Events for which the vehicle did not charge were likewise dominated by a few participants reporting a large number of events. These appear to have been related to an extended charger outage either at their home or at their rail station rather than random failure to charge events.
- Incidents of charge depletion on the road are infrequent, but numerous enough that some advisory materials may be required for the participants to assist them in estimating trip energy requirements.
- Failure-on-the-road events are frequent (9 events/100,000 miles) when compared to equivalent internal combustion vehicles. Comparing the failure-on-the-road events rate to the early full-size electric vehicles tested by the AVTA is difficult as such events were not specifically tracked. It appears that in a few applications some full-size electric vehicles may have had as high a failure rate while others such as the Toyota RAV4 only had a failure rate of 1.5 failure-on-the-road events per 100,000 miles http://avt.inel.gov/fsev/rav4/RAV4_Final_Report.pdf).
- Vehicle repair frequency is high (35 events/100,000 miles) when compared to equivalent internal combustion vehicles
- Vehicle repair time is predominantly ten days to two weeks. In only a few instances was the vehicle repaired in one day.

- Most repair problems appear to be associated with the charging system and may be related to the charge connector.
- Program participant satisfaction is skewed by a few participants frequently reporting that they are completely dissatisfied (zero rating). This significantly reduces the average satisfaction rating. Some follow up work with these participants is warranted.
- Many participants routinely report that they are completely satisfied with the Clean Commute Program (ten rating).

APPENDIX A - INITIAL QUESTIONNAIRE

NYPA / TH!NK
Clean Commute Program

Initial User Questionnaire

Please have the primary Clean commuter using your TH!NK *City* answer all of the following questions.

Please Enter The Vehicle Identification Number (VIN) 0

1. Please describe the Clean commuter using of your TH!NK *City*
   ☐ MALE ☐ FEMALE 0 AGE

2. Please select your approximate household income. This will help us attract future Clean Commute Program participants. $0 to $50,000

3. What was the odometer reading when you received your TH!NK *City*? 0
   (Please provide all digits on the odometer including tenths)

4. On what date did you receive your TH!NK *City*? (mm/dd/yy)

5. What was the reading on your electricity (kWhr) meter when you received your TH!NK *City*? 0

6. How many motor vehicles, other than your TH!NK *City* are in your household?
   ☉ **0** ☐ **1** ☐ **2** ☐ **3** ☐ **4** ☐ **5**

7. Have you ever leased a car before for use in your household? ☐ YES ☉ NO

8. Please charactarize how you will be using the TH!NK *City* and the approximate percentage of trips that will be involved with each type of use. Please provide your best guess. Example- commute 65%, shopping 25% and Leisure 10%. The percentage must total 100%

Trip Type	Percentage of All TH!NK *City* trips	Please check this box if these trips would be driven in a gasoline vehicle if you did not have a TH!NK *City*
Rail Commute	0	☐
Other Commute	0	☐
Shopping	0	☐
Leisure	0	☐

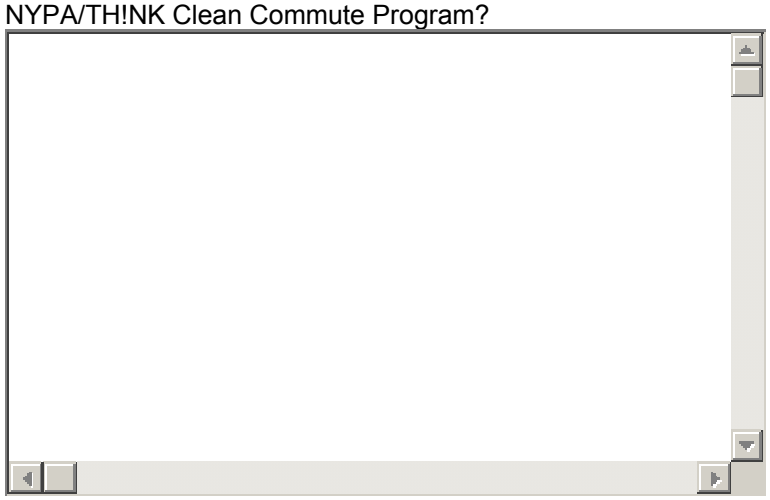
9. Before Leasing the TH!NK *City*, how did you primarily get to the train station?

- ☒ DROVE GASOLINE VEHICLE AND PARKED
- ☐ WALKED
- ☐ BUS
- ☐ BICYCLE
- ☐ CARPOOL
- ☐ DROPPED OFF AT STATION
- ☐ DID NOT TAKE TRAIN
- ☐ OTHER

10. Will your TH!NK *City* be charged in the garage or outside? ☒ GARAGE ☐ OUTSIDE

11. How did you hear about the NYPA / TH!NK Clean Commute Program?
    - ☒ INFORMATION RECEIVED AT MY TRAIN STATION
    - ☐ PRINT MEDIA
    - ☐ ELECTRONIC MEDIA
    - ☐ WORD OF MOUTH
    - ☐ OTHER

12. Please provide any general comments that you have about the TH!NK *City* or the NYPA/TH!NK Clean Commute Program?



APPENDIX B – MONTHLY QUESTIONNAIRE

NYPA / TH!NK
Clean Commute Program

Monthly User Questionnaire

Please have the primary Clean commuter using your TH!NK *City* answer all of the following questions.

1. How many miles are on the TH!NK *City* odometer? 0
   (Please record all digits on the odometer including tenths)
2. On what date did you read the odometer? 4/11/2003
3. What was the reading of the energy meter? 0
   (Please record all digits on the meter)
4. On what date did you read the energy meter? 4/11/2003
5. List the number of times, if any, that the following events occurred with the TH!NK *City* this month.

0 Did not have enough range to meet my needs	0 Ran out of charge on the road
0 Did not charge properly at home	0 Broke down on the road
0 Did not charge properly at my rail station	0 Required maintenance (see #6)

6. If your TH!NK *City* required maintenance, please provide the following information example provided

Maintenance Start Date (MM/DD/YY)	Vehicle System Repaired (SELECT)	Maintenance Type (SELECT)	Cost of Repair ($)	Days Out Of Service For Repair	Odometer Reading
	Propulsion	Repair Failure			
	Propulsion	Repair Failure			
	Propulsion	Repair Failure			
	Propulsion	Repair Failure			
	Propulsion	Repair Failure			
	Propulsion	Repair Failure			
	Propulsion	Repair Failure			

[Electric Propulsion system includes the motor, motor controller, battery and onboard battery charger. Charging power system includes off vehicle power control station, charge connector (plug) and charge inlet (receptacle)]

7. How many round trips did you drive your TH!NK *City* this month? 0

8. How many of these round trips would have been driven in a gasoline-powered car if you did not have your TH!NK *City*? 0

9. Compared to last month, are you using your TH!NK *City* for more trips?
   ○ More Trips ○ Less Trips ◉ About the same number of Trips

10. If you are using your TH!NK *City* for more or less trips, please briefly explain why.

11. If more public charging stations could be installed, please identify where you would use them.
   - ☐ Shopping Centers (the mall)
   - ☐ Movie Theaters
   - ☐ Sports Events
   - ☐ Cultural Events
   - ☐ Elementary or high schools
   - ☐ Food stores
   - ☐ Large office buildings or complexes
   - ☐ Other

12. Please rate your overall satisfaction with the TH!NK *City* and the NYPA/TH!NK Clean Commute Program with 10 being Completely Satisfied and 0 being Completely Dissatisfied
   5 - Neither Satisfied Nor Dissatisfied