



***U.S. Department of Energy
FreedomCAR & Vehicle Technologies
Advanced Vehicle Testing Activity***

NYPA/TH!NK Clean Commute Program



***NYPA/TH!NK Clean Commute
Program Report –
Inception through February 2003***

*Don Karner
James Francfort
Seth Leitman*

August 2003

*Idaho National Engineering and Environmental Laboratory
Bechtel BWXT Idaho, LLC*



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**Don Karner¹
James Francfort²
Seth Leitman³**

August 2003

**Electric Transportation Applications
Phoenix, Arizona**

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

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¹ Principal Investigator, Electric Transportation Applications

² Principal Investigator, Idaho National Engineering and Environmental Laboratory

³ Market Development and Policy Specialist, New York Power Authority

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ABSTRACT

The Clean Commute Program uses THINK *city* electric vehicles from Ford Motor Company's electric vehicle group, THINK Mobility, to demonstrate the feasibility of using electric transportation in urban applications. Suburban New York City railroad commuters use the THINK *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 THINK *city* vehicles is located at the commuters' private residences as well as seven train stations. Eighty-seven commuters are using the THINK *city* vehicles, with 80% actively providing data to the U.S. Department of Energy's Advanced Vehicle Testing Activity. Participants have driven the vehicles nearly 150,000 miles since Program inception, avoiding the use of almost 7,000 gallons of gasoline. The THINK *city* vehicles are driven an average of between 180 and 230 miles per month, and over 95% of all trips taken with the THINK *city* vehicles replace trips previously taken in gasoline vehicles. This report covers the period from Program inception through February 2003.

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1. PROGRAM DESCRIPTION

The 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 use 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, and provide maintenance service and basic vehicle instruction. The electric vehicle 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 (USDOE).

The USDOE, through its Advanced Vehicle Testing Activity (AVTA) and the AVTA subcontractor Electric Transportation Applications, provides data collection, analysis, and reporting support for the Clean Commute vehicle operations. This report is the first report issued to analyze the Clean Commute Program's vehicle operations and covers the period from Program inception through February 28, 2003.

2. DATA COLLECTION PROGRAM

2.1 Program Objectives

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

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

2.2 Program Participants

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

2.3 Collection Methodology

Data collection for the Clean Commute Program began in April 2002. Data are collected primarily through the Internet. Once participants have taken delivery of their TH!NK *city* vehicle, they are sent an e-mail directing them to a Web page where an initial survey is completed. Appendix A presents a sample initial survey. Data from the survey is automatically entered into a Clean Commute participant database. The first group of initial surveys was completed in May 2002. Initial survey data continues to be collected. Seventy of the 87 participants have completed the initial survey to date. Effort is being made to collect data from the remaining 17 participants. The 10 participants that returned their vehicles had provided only minimal data and those responses have been deleted from the database.

After completing the initial survey, participants are requested by e-mail to complete a monthly survey detailing their Clean Commute Program experience. Appendix B presents a sample monthly survey. The data from these monthly surveys are also automatically entered into the Clean Commute participant database. The first monthly surveys were transmitted in June 2002 to collect data for May.

Clean Commute Program participant demographic data obtained from the initial survey are presented in Section 3.1. Data for initial survey collection efficiency are presented in Section 3.2.

2.4 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:

- Section 3.3 Projected Performance Parameters – Projected Vehicle Use
- Section 3.4 Measured Performance Parameters – Actual Vehicle Use
- Section 3.5 Derived Performance Parameters – Petroleum Abatement and Emissions Reductions.

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

3. DATA ANALYSIS

3.1 Participant Demographics

Participant demographics were obtained from the initial survey (Appendix A). Figures 1 through 4 present demographic data for TH!NK *city* lessees completing the initial survey. Figure 1 presents gender data, which were provided by all 70 of the active Clean Commute Program participants.

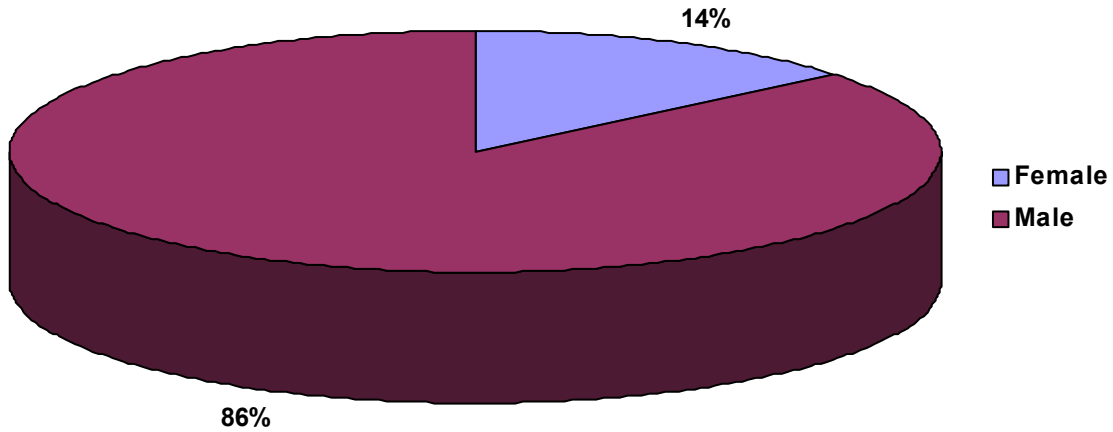


Figure 1. Participant gender.

Figure 2 presents participant age distribution data, which were provided by 57 of the 70 active Clean Commute Program participants.

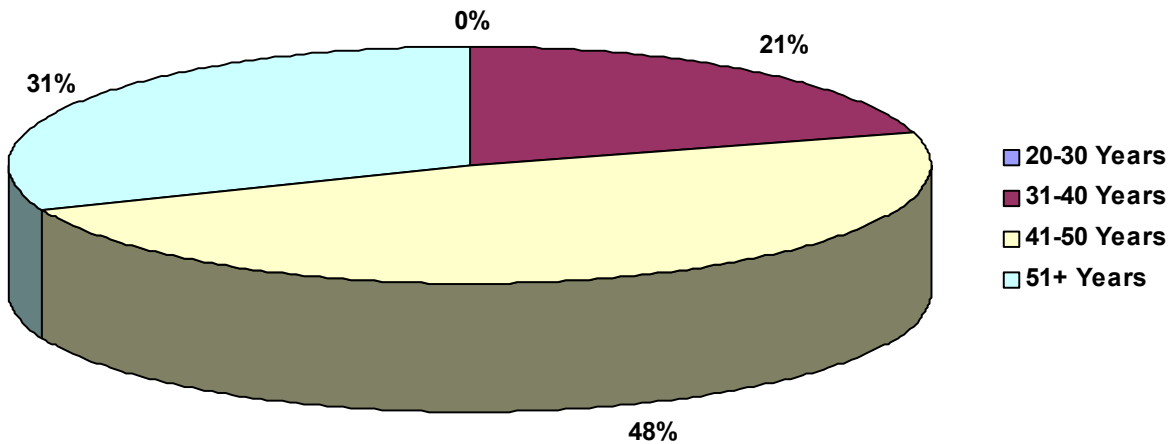


Figure 2. Participant age distribution.

Figure 3 presents participant annual income distribution data, which were provided by 64 of the 70 active Clean Commute Program participants.

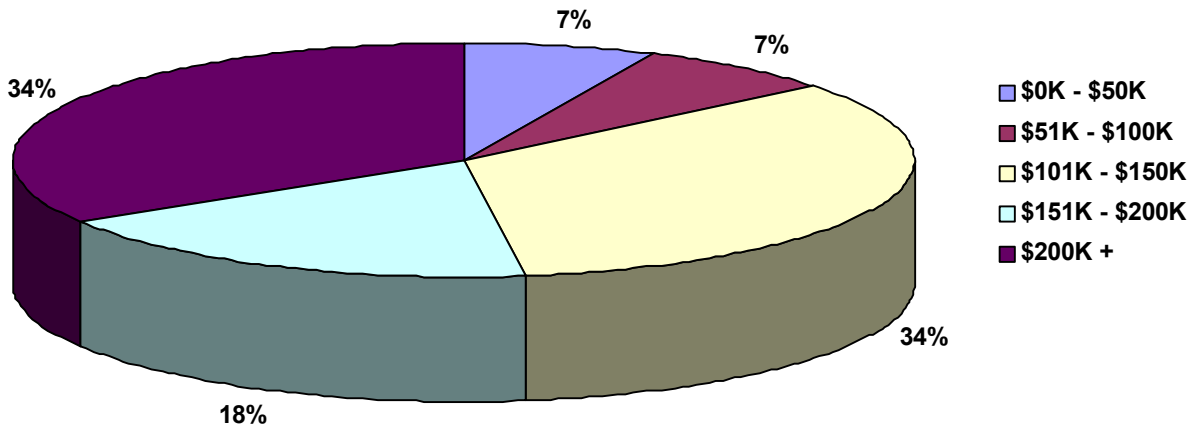


Figure 3. Participant household annual income distribution.

Figure 4 presents data detailing the number of vehicles in participant families other than THINK city, which were provided by 69 of the 70 active Clean Commute Program participants.

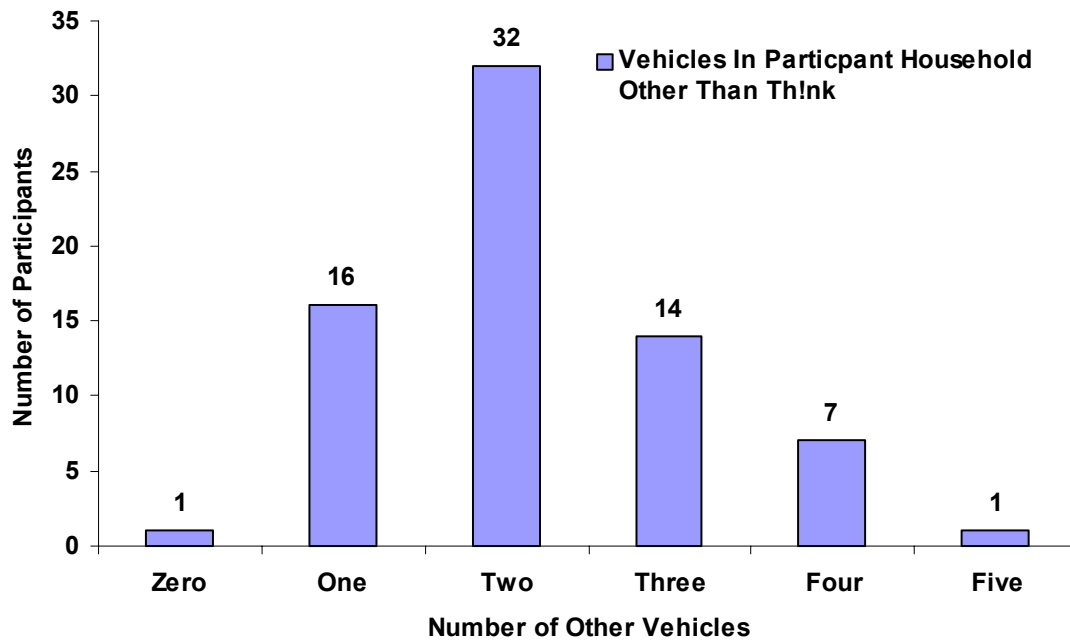


Figure 4. Number of vehicles in participant household other than THINK city.

3.2 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 had completed the initial survey (Appendix A) as of February 28, 2003. Figure 5 presents the percentage of the 87 lessees completing the initial survey and, therefore, defined as active participants.

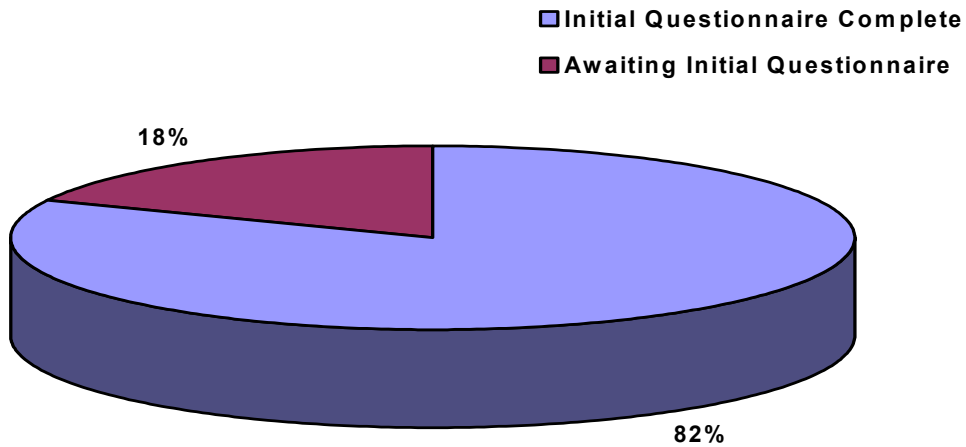


Figure 5. Efficiency of data collection.

3.3 Projected Performance Parameters – Projected Vehicle Use

Based on data provided by Program participants in the initial survey (Appendix A), Figures 6 and 7 present the projected use of TH!NK *city* vehicles. Figure 6 presents the data projecting the type of trips to be taken in their TH!NK *city*, which were provided by 69 of the 70 active Clean Commute Program participants.

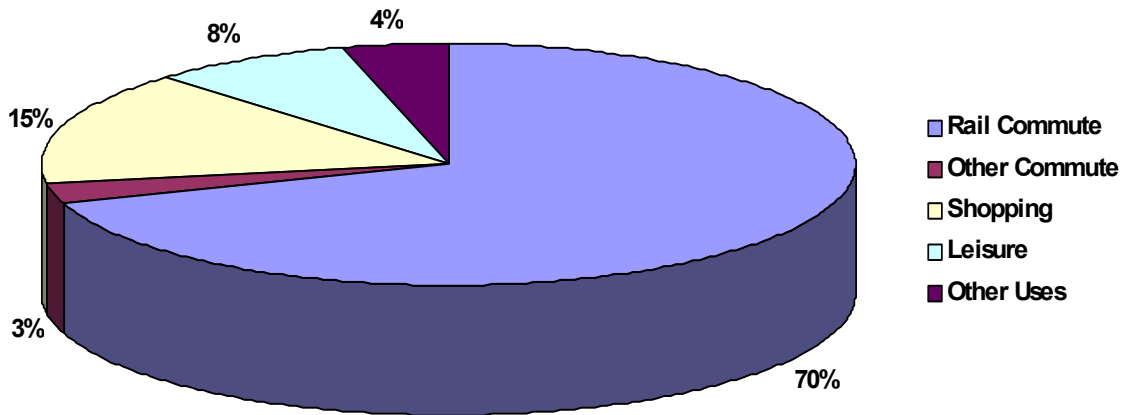


Figure 6. Projected use by trip type.

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

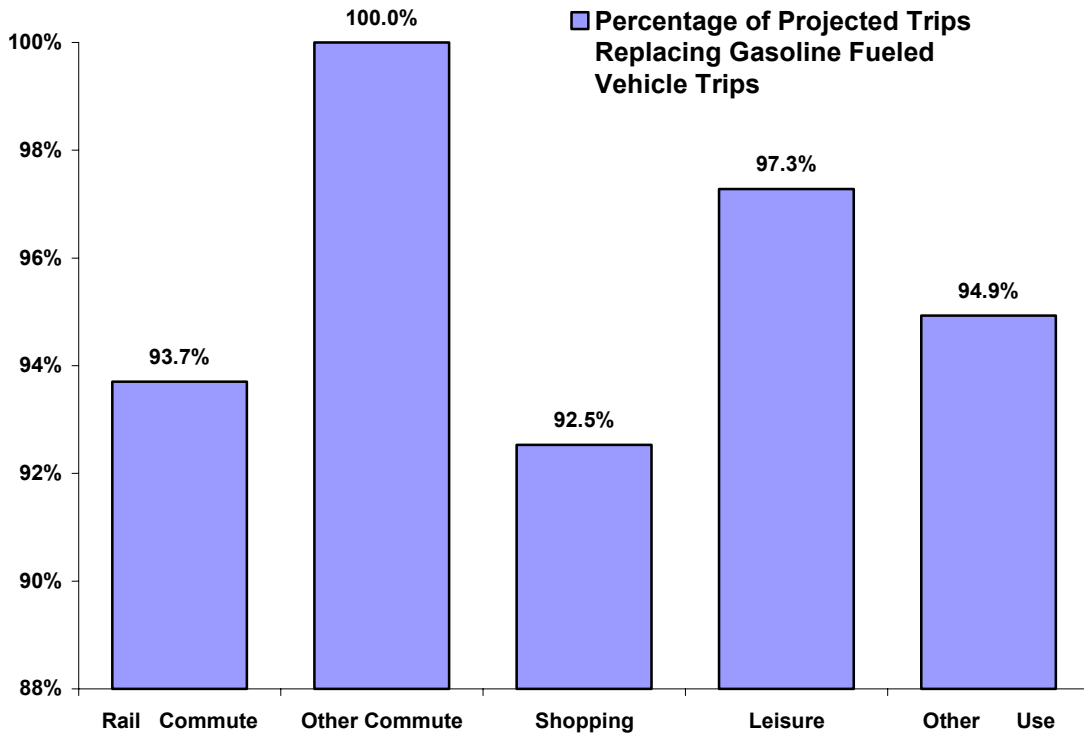


Figure 7. Percentage of projected trips replacing gasoline-fueled vehicle trips.

Figure 8 presents data detailing the prior methods of rail station commute for Clean Commute Program participants, which were provided by all 70 of the active Clean Commute Program participants.

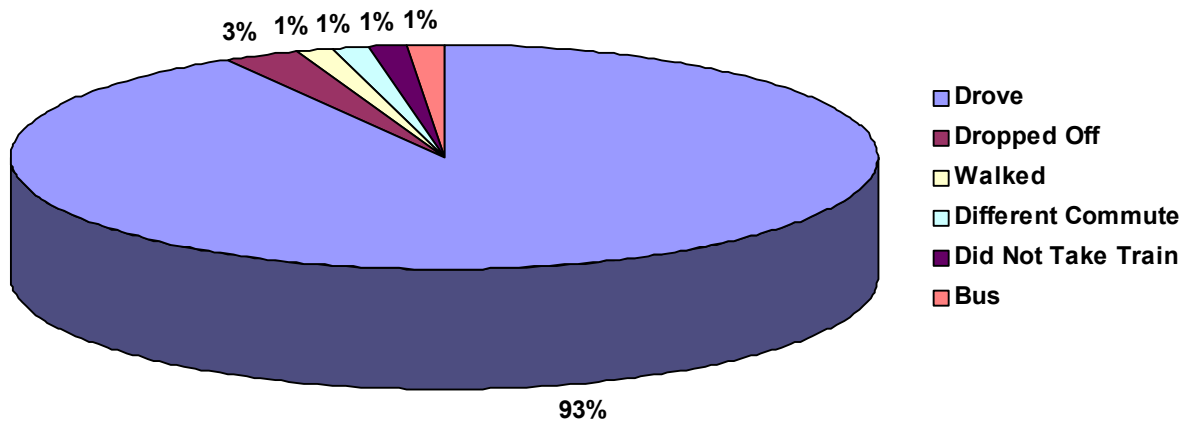


Figure 8. Prior methods of rail station commute.

3.4 Measured Performance Parameters – Actual Vehicle Use

Using data collected from the monthly surveys (Appendix B), Figures 9 through 12 presents performance of the TH!NK *city* vehicles using various metrics. 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 variance 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 survey. Total monthly mileage data for January and February 2003 are, however, lower than actual miles driven in these months. This occurred because some active participants, as of the date of this report, had not yet reported mileage data for these months.

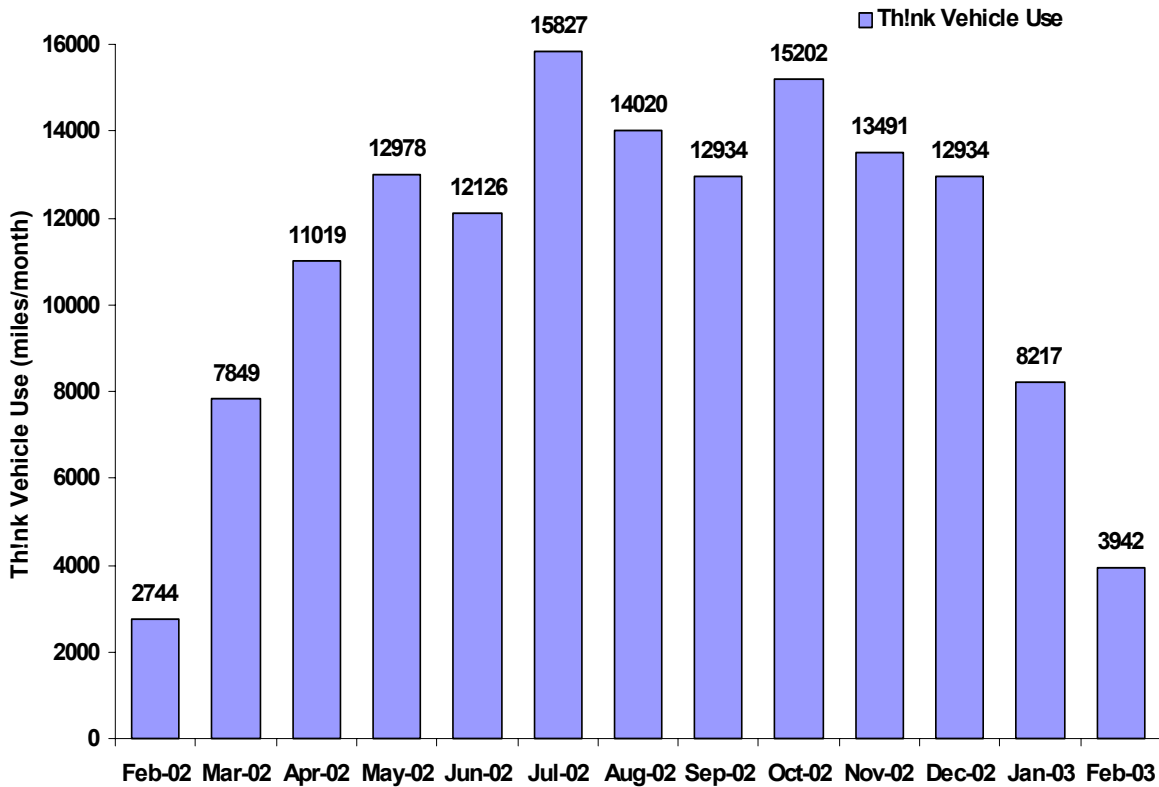


Figure 9. Total Program vehicle usage (miles).

Through February 28, 2003, Clean Commute Program active participants reported a total of 143,283 miles of TH!NK *city* operation. Section 3.5 presents the impacts on air emissions and fuel utilization of traveling the miles reported using an electric vehicle rather than a gasoline-fueled vehicle.

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's homes. Table 1 reports the electrical demand for chargers located at rail stations.

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

Station Name	Charger 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	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	N/A
Huntington	22	N/A	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	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 were collected for June 2002.

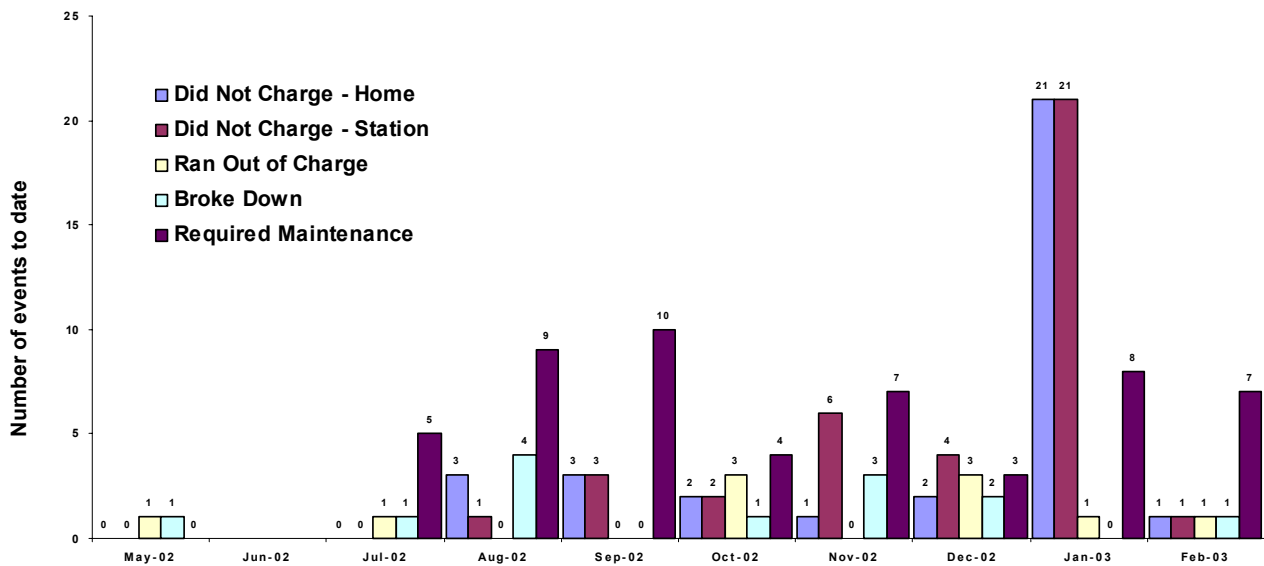


Figure 10. Operation events, Program inception through February 2003.

Maintenance for the TH!NK *city* vehicles is reported by vehicle system and the type of maintenance (scheduled preventative maintenance or maintenance required to correct a specific problem). 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 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 leveling of the nickel cadmium traction battery.

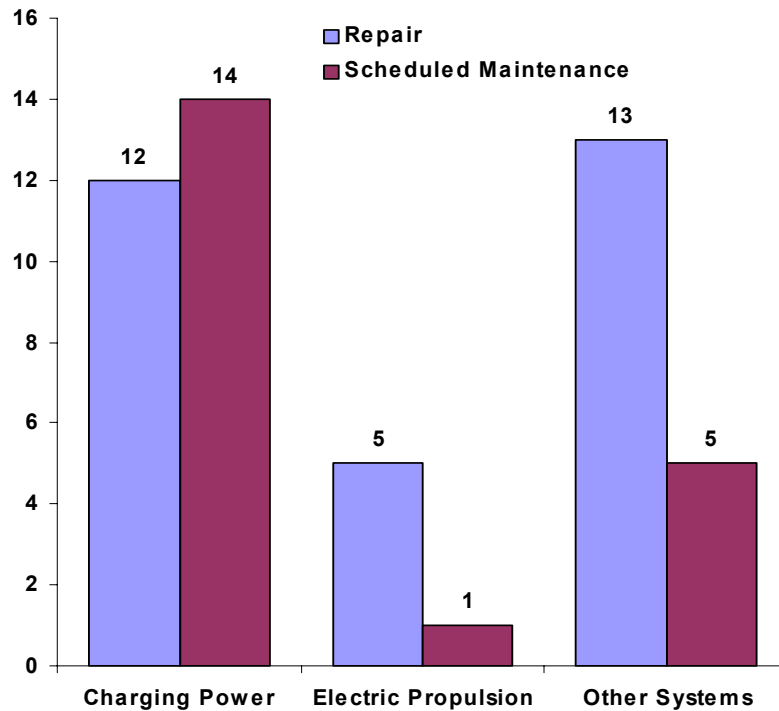


Figure 11. Vehicle maintenance activities by system.

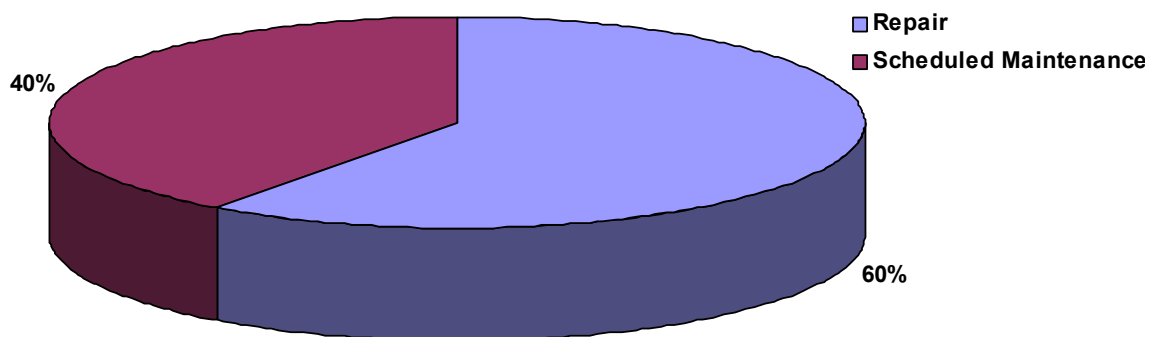


Figure 12. Vehicle maintenance by type.

Participants report their satisfaction with the Clean Commute Program monthly. Figure 13 presents the average participant Program satisfaction monthly 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.

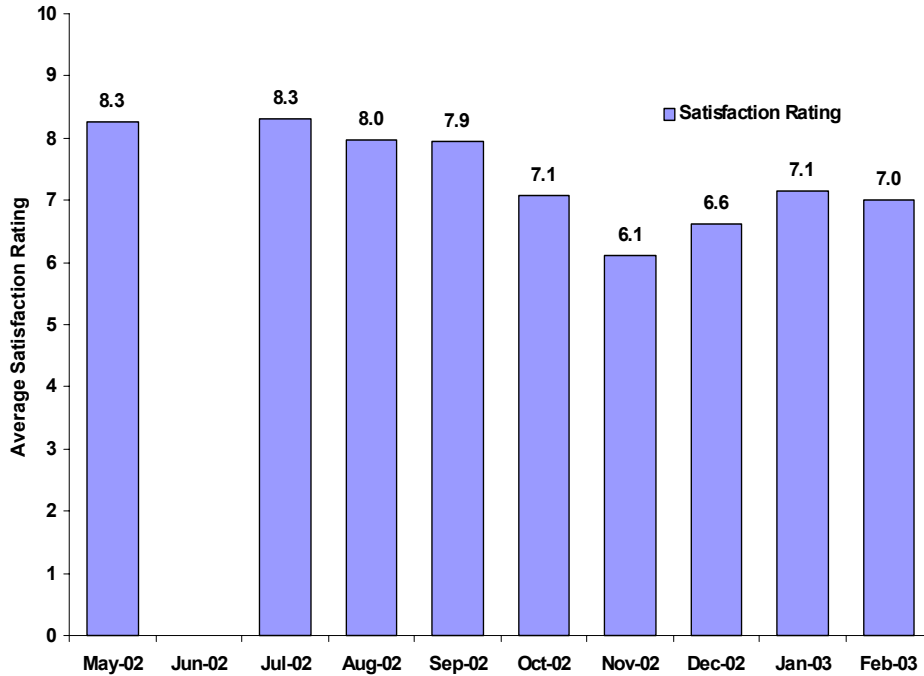


Figure 13. Participant Program satisfaction, Program inception through February 2003.

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.

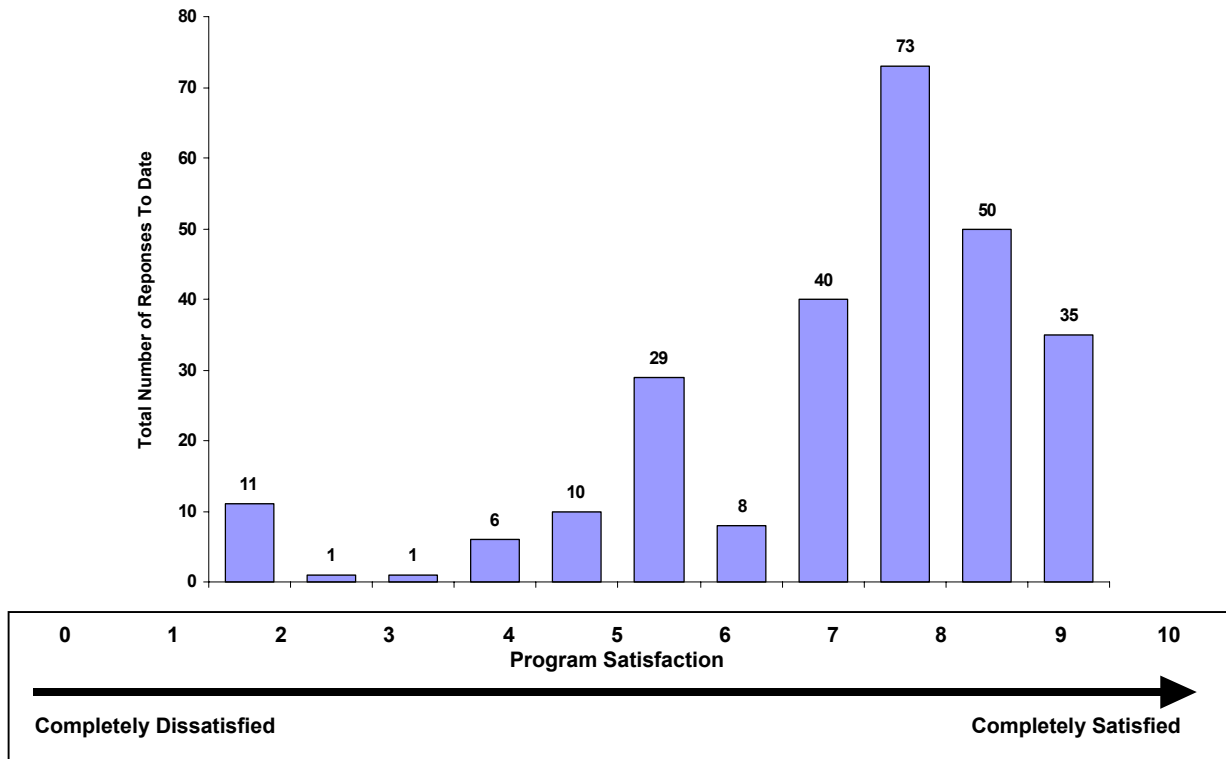
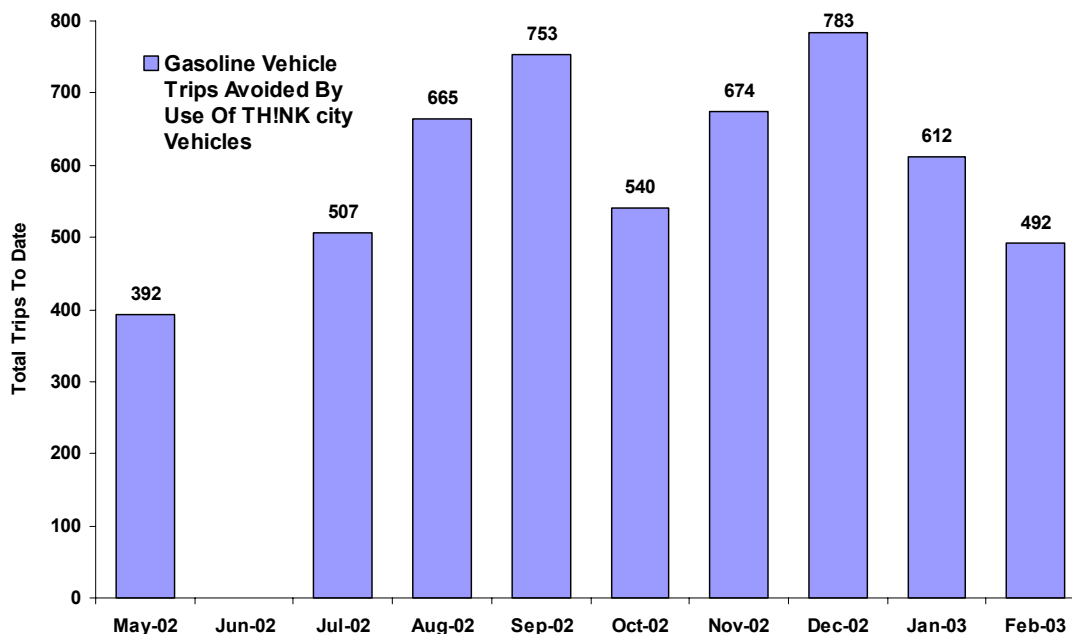


Figure 14. Participant satisfaction distribution, Program inception through February 2003.

3.5 Derived Performance Parameters – Petroleum Abatement and Emissions Reductions

Using the data collected from the monthly survey (Appendix B), 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. The actual derived performance parameters, therefore, may vary slightly from those reported herein. This difference will resolve in later reports as data from all participants become 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 extrapolated backwards for February, March and April 2002 based on mileage data collected during May.

As shown in Figure 15, Clean Commute Program participants avoided 5,418 trips that, without the Clean Commute Program, would have been driven using an internal combustion engine-powered vehicle. Clean Commute Program participants reported 143,283 miles driven for these 5,418 trips, for an average distance traveled per trip during the reporting period of 26.4 miles. Cold starts and hot soaks produce a significant fraction of the air emissions associated with a driving trip. As shown in Figure 16, Clean Commute Program participants avoided 10,836 cold starts and hot soaks by driving their TH!NK *city* vehicles. Clean Commute Program participants also avoided the use 6,664 gallons of gasoline (Figure 17) by driving their TH!NK *city* vehicles rather than gasoline fueled vehicles. By avoiding cold starts and hot soaks and by avoiding the use of gasoline, Clean Commute Program participants reduced emissions of pollutants into the atmosphere, as quantified in Figure 18.



1. Initial vehicle deliveries in January 2002.
2. Not all current Program participants were active in February, March, and April, 2002.

Figure 15. Estimated avoided gasoline vehicle trips (5,418 trips total).

It is assumed that vehicles 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:

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)

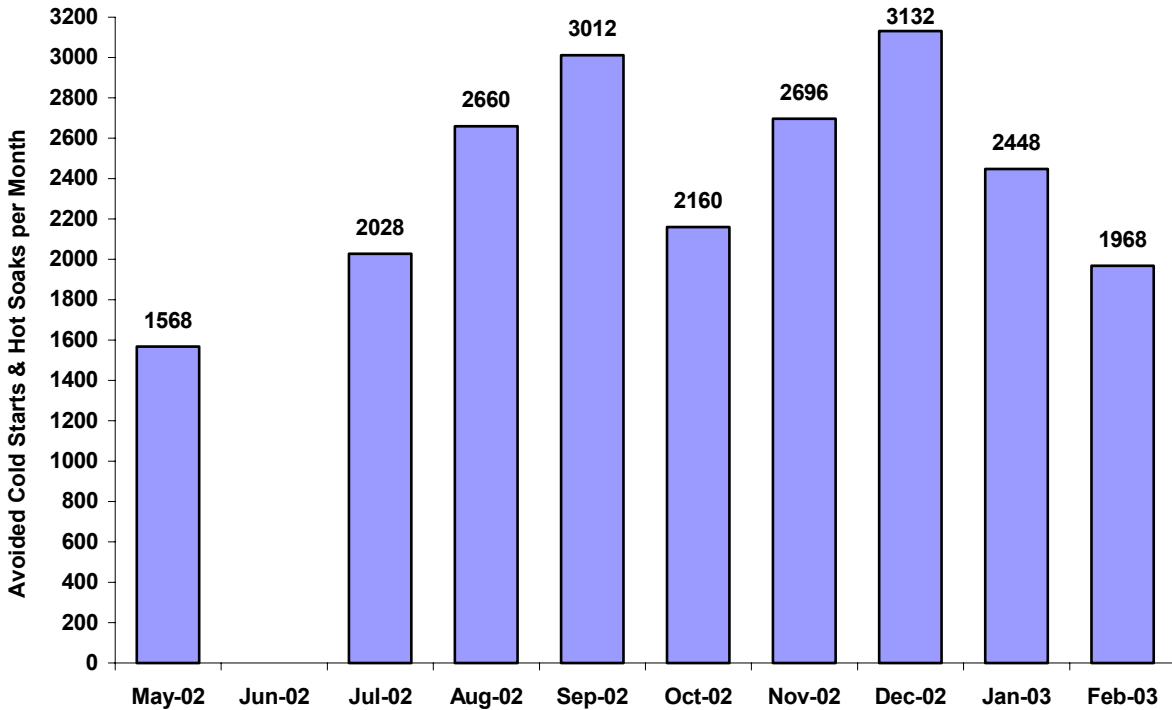


Figure 16. Engine cold starts and hot soaks avoided.

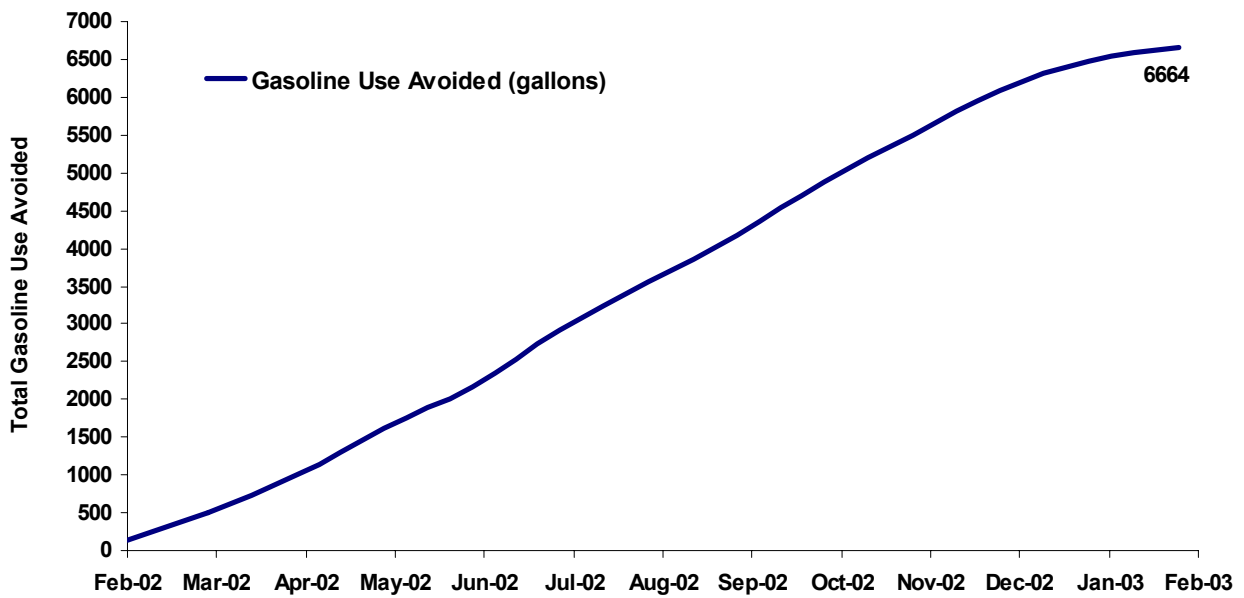


Figure 17. Petroleum use avoided.

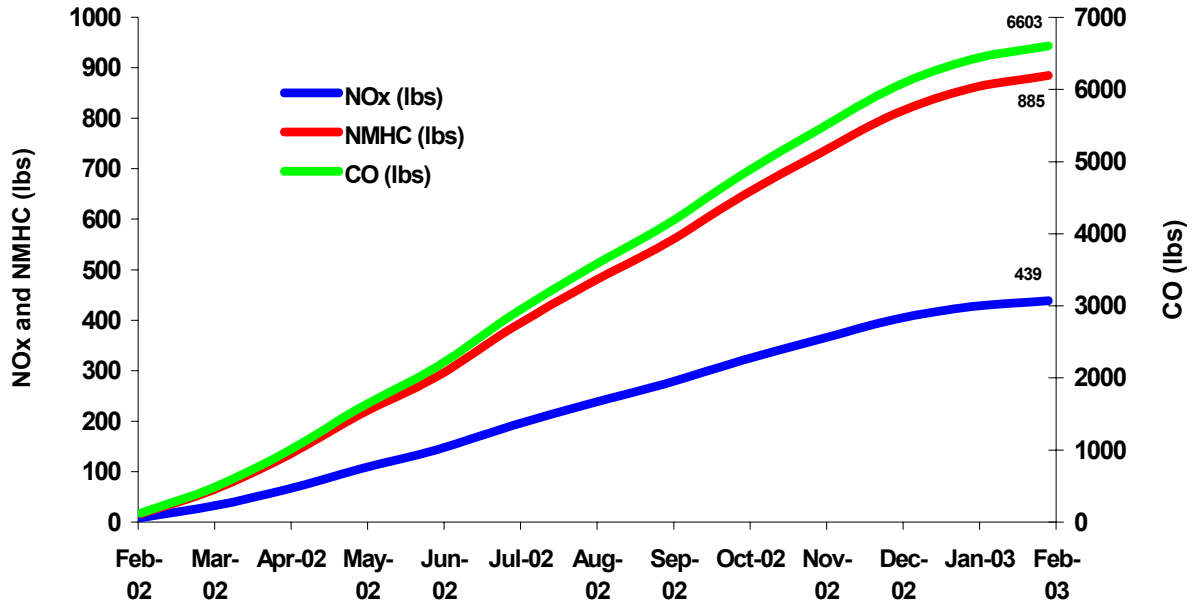


Figure 18. Air emissions avoided.

4. CONCLUSIONS

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

- Clean Commute Program participants have driven nearly 150,000 miles since Program inception. During this period, they 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% of all Clean Commute Program participants having completed an initial survey and actively participating in data collection. Follow-up with participants failing to report monthly survey data has yielded complete mileage data. NYPA and the AVTA plan to periodically request additional information from Clean Commute Program participants. Clean Commute Program participants will be compensated to maximize the response to these requests for additional information.
- 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 rail station commuting before the Clean Commute Program was in gasoline-fueled vehicles, indicating that the Clean Commute Program can have a significant affect on gasoline usage and emissions.
- Over 95% of all trips 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.
- A few participants reported insufficient range, a large number of which incidents were within 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 to random charging failure events.
- Incidents of charge depletion on the road are infrequent, but numerous enough that some advisory materials may be required for participants to assist them in estimating trip energy requirements.
- Failure-on-the-road events were frequent (9 events/100,000 miles) compared to equivalent internal combustion vehicles. This is also high compared to electric vehicles tested by the AVTA (Toyota RAV4, 1.5 events/100,000 miles).
- Vehicle repair frequency was high (35 events/100,000 miles) compared to equivalent internal combustion vehicles.
- Vehicle repair time was 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 relate to the charge connector.
- Program participant satisfaction is skewed by a few participants frequently reporting that they were completely dissatisfied (zero rating). This significantly reduces the average satisfaction rating. Some follow up work with these participants is warranted.

- Many participants routinely reported that they are completely satisfied with the Clean Commute Program (ten rating).

Appendix A
Initial User Survey

Initial User Survey

Please have the primary Clean commuter using your THINK City answer all of the following questions.

Please Enter the Vehicle Identification Number (VIN)

1. Please describe the Clean commuter using of your THINK City
 MALE FEMALE AGE

2. Please select your approximate household income. This will help us attract future Clean Commute Program participants.

3. What was the odometer reading when you received your THINK City?
(Please provide all digits on the odometer including tenths)

4. On what date did you receive your THINK City? (mm/dd/yy)

5. What was the reading on your electricity (kWhr) meter when you received your THINK City?

6. How many motor vehicles, other than your THINK 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 characterize how you will be using the THINK 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 THINK City trips	Please check this box if these trips would be driven in a gasoline vehicle if you did not have a THINK City
Rail Commute	<input type="text" value="0"/>	<input type="checkbox"/>
Other Commute	<input type="text" value="0"/>	<input type="checkbox"/>
Shopping	<input type="text" value="0"/>	<input type="checkbox"/>
Leisure	<input type="text" value="0"/>	<input type="checkbox"/>

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

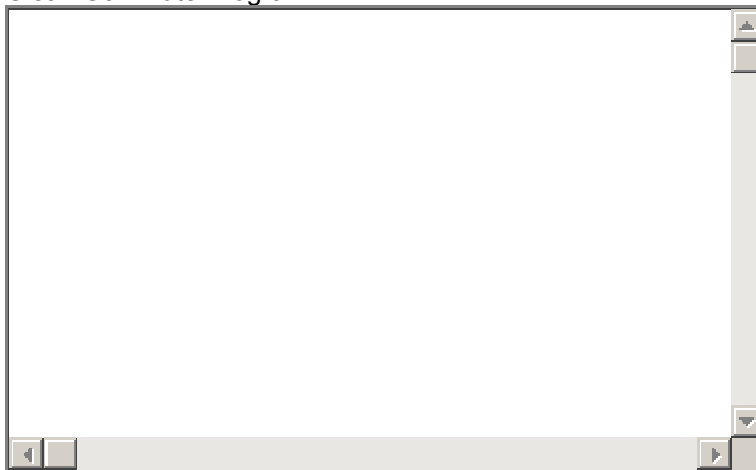
- DROVE GASOLINE VEHICLE AND PARKED
- WALKED
- BUS
- BICYCLE
- CARPOOL
- DROPPED OFF AT STATION
- DID NOT TAKE TRAIN
- OTHER

10. Will your THINK *City* be charged in the garage or outside? GARAGE OUTSIDE

11. How did you hear about the NYPA / THINK 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 THINK *City* or the NYPA/THINK Clean Commute Program?



Appendix B
Monthly User Survey

Monthly User Survey

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

1. How many miles are on the THINK *City* odometer?

(Please record all digits on the odometer including tenths)

2. On what date did you read the odometer?

3. What was the reading of the energy meter?

(Please record all digits on the meter)

4. On what date did you read the energy meter?

5. List the number of times, if any, that the following events occurred with the THINK *City* this month.

<input type="text" value="0"/>	Did not have enough range to meet my needs	<input type="text" value="0"/>	Ran out of charge on the road
<input type="text" value="0"/>	Did not charge properly at home	<input type="text" value="0"/>	Broke down on the road
<input type="text" value="0"/>	Did not charge properly at my rail station	<input type="text" value="0"/>	Required maintenance (see #6)

6.

7. If your THINK *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
<input type="text"/>	Propulsion <input type="button" value="v"/>	Repair Failure <input type="button" value="v"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
<input type="text"/>	Propulsion <input type="button" value="v"/>	Repair Failure <input type="button" value="v"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
<input type="text"/>	Propulsion <input type="button" value="v"/>	Repair Failure <input type="button" value="v"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
<input type="text"/>	Propulsion <input type="button" value="v"/>	Repair Failure <input type="button" value="v"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
<input type="text"/>	Propulsion <input type="button" value="v"/>	Repair Failure <input type="button" value="v"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
<input type="text"/>	Propulsion <input type="button" value="v"/>	Repair Failure <input type="button" value="v"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
<input type="text"/>	Propulsion <input type="button" value="v"/>	Repair Failure <input type="button" value="v"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>

8. 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)

9. How many round trips did you drive your THINK *City* this month?

10. How many of these round trips would have been driven in a gasoline-powered car if you did not have your THINK *City*?

11. Compared to last month, are you using your TH!NK *City* for more trips?

More Trips Less Trips About the same number of Trips

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

13. 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

14. Please rate your overall satisfaction with the THINK *City* and the NYPA/TH!NK Clean Commute Program with 10 being Completely Satisfied and 0 being Completely Dissatisfied