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Advanced Vehicle Testing Activity

TH!NK city – ELECTRIC VEHICLE DEMONSTRATION PROGRAM

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Idaho National Engineering and Environmental Laboratory
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ABSTRACT

TH!NK, Ford Motor Company's brand dedicated to emission-free vehicles, initiated the TH!NK *city* Electric Vehicle (EV) Demonstration Program in 2001 in partnership with federal (including the U.S. Department of Energy's Advanced Vehicle Testing Activity), state, and municipal agencies and commercial partners. Goals of the Program include:

- Enhancing public awareness of Urban EVs
- Defining the unique Urban EV market and niche applications
- Enhancing EV infrastructure
- Investigating economic sustainability of Urban EVs.

The TH!NK *city* is a two-door, two-passenger pure EV. Through the Demonstration Program, 340 TH!NK *city* EVs have been placed in California (185), New York (100), Georgia (15), and Michigan (40). The Demonstration Program is the largest Urban EV demonstration program in the United States.

TH!NK has been able to generate significant positive publicity about the *city* EVs, especially in the New York City area through its New York Clean Commute Program (in partnership with the New York Power Authority and the U.S. Department of Energy's Advanced Vehicle Testing Activity).

Vehicle performance and driver opinions are being tracked and collected for the TH!NK *city* EVs in the New York Clean Commute Program. The Advanced Vehicle Testing Activity's qualified vehicle tester, Electric Transportation Applications, is collecting this information. The information will be reported, and it will support the goal of defining the Urban EV market.

The New York Clean Commute Program and the Vandenburg Air Force Base's Shared-Use Vehicle Management System, in particular, have already supported the goal of increasing EV infrastructure. While the Vandenburg system is only available to the Base's military personnel, the Clean Commute Program includes installation of EV charging infrastructure at eight suburban New York City commuter train stations.

This report discusses the economic viability of the TH!INK *city* EVs in the New York Clean Commute Program. To date, the TH!NK *city* Urban EVs require various and significant subsides for consumers to choose an Urban EV over a comparable gasoline-fueled vehicle.

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The TH!NK *city* Electric Vehicle (EV) Demonstration Program was initiated in 2001 in partnership with federal, state, and municipal agencies and commercial partners. Goals of the Program include:

- Enhancing public awareness of Urban EVs
- Defining the unique Urban EV market and niche applications
- Enhancing EV infrastructure
- Investigating economic sustainability of Urban EVs.

Phase I of the Program—placing vehicles with customers—is now almost complete. The Program has successfully placed all but 10 of a total of 340 TH!NK *city* EVs nationally, including

- 185 in California (various applications)
- 100 in New York (New York Power Authority/TH!NK Clean Commute Program)
- 15 in Georgia (station car program)
- 40 in Ford's internal operations in Dearborn, Michigan.

The Program is the largest operating Urban EV demonstration program in the United States, representing over 2-years of effort in preparation and implementation.

Phase II of the Program—ongoing monitoring of an operational field fleet—has been initiated. The Department of Energy's (DOE) Advanced Vehicle Testing Activity and its qualified vehicle tester, Electric Transportation Applications (ETA), is monitoring the operations of the 100 TH!NK *city* EVs in the New York Power Authority/TH!NK Clean Commute Program (Clean Commute Program). Both ETA and the Advanced Vehicle Testing Activity will report the Clean Commute Program results separately. The remainder of the field fleet will be monitored through TH!NK's internal operations.

This report, for the DOE Advanced Vehicle Testing Activity, is the first of three TH!NK *city* Electric Vehicle Demonstration Program annual reports that summarize the activities and accomplishments toward the above goals.

2. BACKGROUND

TH!NK is Ford Motor Company's brand dedicated to emission-free vehicles. It was launched in January 2000 at the North American International Auto Show (NAIAS). Two main TH!NK products were announced at NAIAS for future production—the TH!NK neighbor low-speed vehicle EV (LSV) and the TH!NK *city* Urban EV.

Urban EVs are pure-electric passenger vehicles with top speeds of about 55 mph and a per-charge range of about 50 miles. Unique benefits of Urban EVs include easier parking and driving characteristics. Urban EVs usually have two doors and a hatchback, and are designed to carry two or four passengers. The National Highway Traffic Safety Administration classifies Urban EVs as regular passenger vehicles, subject to the same Federal Motor Vehicle Safety Standard testing as full-size electric and gasoline-powered passenger vehicles. In other words, they are the same as

traditional full-size passenger vehicles but in a smaller package. They are ideal for urban applications

The TH!NK *city* is manufactured in an emission-free Ford Motor Company production plant located in Norway. Over 1,000 TH!NK *city* EVs have been produced for sale in Europe and for placement in the U.S. Demonstration Program. The Demonstration Program TH!NK *city* vehicle meets all European certification standards but not all U.S. standards. It is imported to the United States for the Demonstration Project in a special federal importation Program.

A new United States-certified version of the TH!NK *city* may to be launched in certain North American markets in the future.

The Demonstration Program TH!NK *city* is a two-seat, battery-electric Urban EV, with a hatchback for convenient access to its cargo area. The vehicle has a top speed of 56 mph and an urban range of 46 miles per full charge. The *city* has a modular design for maximum recyclability. The vehicle body is constructed from recyclable thermoplastic.

The TH!NK *city* Demonstration Program was initially targeted for Northern California only, but was expanded in 2001 to include Programs in New York, Georgia, and Southern California. The expanded program is the largest Urban EV Demonstration Program in the United States. And it includes some notable first-time users of TH!NK *city* vehicles in shared use, including Vandenburg Air Force Base's Shared-Use Vehicle Management System (SUVMS) (Figure 1), the New York Power Authority Clean Commute Program, Long Beach Bike Station Mobility Center, Hertz BART Shared Car Program, and San Francisco City Car Share.

The Demonstration Program targeted a wide scope of customer applications for the TH!NK *city* cars and emphasized placing vehicles with retail customers to gather consumer feedback. These unique applications, including both station and shared car projects, are well matched to the TH!NK *city* and its target market of urban commuting. The Demonstration Program was designed to take advantage of the *city*'s convenient size, ability to maximize battery technology, and use of recyclable materials.

Figure 1. Vandenburg Air Force Base's TH!NK *city* EVs.

3. PROGRAM STATUS – GOAL ATTAINMENT

3.1 Enhancing Public Awareness of Urban Electric Vehicles

The TH!NK *city* Demonstration Program has achieved a high level of public awareness, especially in the areas where the vehicles are located. This high awareness is a result of significant and focused effort on behalf of Ford and its Program partners. Increased public awareness has mainly resulted from two factors: (1) Demonstration Program press coverage and (2) TH!NK *city* EV marketing programs.

3.1.1 Demonstration Program Press Coverage

The Demonstration Program was launched in phases consistent with the availability of vehicles in specific locales. For example, the Clean Commute Program was launched in October 2001 with a press event in Grand Central Train Terminal in downtown Manhattan. This and subsequent events in New York have generated nationwide press coverage of the Demonstration Program and EVs, thereby enhancing the public's awareness of EVs. Organizations that highlighted and provided coverage of the Demonstration Program included:

- *The New York Times* (newspaper)
- Today Show (TV)
- Good Morning America (TV)
- CNN (TV)
- FOX (TV)
- CBS (TV)
- NBC (TV)
- PBS (TV)
- PBS (radio)
- Yahoo (Internet).

In addition to event-driven press coverage, TH!NK focused a press campaign to highlight the TH!NK *city* vehicle in the media. This involved specific press events and loaning TH!NK *city* EVs to interested journalists seeking to cover the story. The TH!NK *city* was demonstrated by numerous press media, including *The New York Times* and *Los Angeles Times*, resulting in additional positive press coverage in the United States.

Program press coverage also reached an international audience, including Japan and Europe. The international press was most interested in the commuter-based transit programs such as the Clean Commute Program and its EVs.

In addition, TH!NK sponsored campaigns targeted to enhance the press coverage of the Program. For instance, TH!NK sponsored a trek for a team of Norwegian journalists in a customized TH!NK *city* from San Diego to the 2001 Winter Olympic Games in Park City, Utah. The trek covered a significant portion of the Southwest. Progress and trip-logs were tracked on the Internet, and international interviews with the Norwegian journalists were given by cell phone while

on the road. The trek concluded with an arrival party in Utah and with the TH!NK *city* being displayed throughout the Olympic Games at the Norwegian House in Park City.

3.1.2 TH!NK *city* EV Marketing Programs

Public awareness of the Demonstration Program was further enhanced by marketing the TH!NK *city* to the general public in California and New York.

The California Program included directly marketing the TH!NK *city* to the general public in San Francisco, Santa Barbara, Los Angeles, and San Diego. In order to maximize effectiveness, different marketing approaches were undertaken for each locale, based on demographical research. For instance, San Francisco included direct advertising by the local dealer in local newspapers, whereas San Diego included dealer-based TV advertising. TH!NK also implemented a direct mail campaign to 20,000 targeted California retail customers, announcing the availability of the Demonstration Program, leasing arrangements, and participating dealerships.

TH!NK developed and aired two unique TH!NK *city* commercials in support of the Program and Ford's overall environmental messages. These commercials were aired on cable and network TV in a specific campaign at the beginning of the Program. The commercials targeted the general public through daily news programming, and presented a serious message in an entertaining and lighthearted manner.

In addition, TH!NK sponsored numerous auto shows in 2001 and 2002 to enhance public awareness of EVs and the Demonstration Program. Some of the largest auto shows included the following:

- Los Angeles Auto Show
- San Diego Auto Show
- North American International Auto Show
- New York Auto Show.

As an example of the public awareness impact from auto shows, over 20,000 pieces of Demonstration Program literature were distributed to the general public at the New York Auto Show.

The New York Clean Commute Program included a multifaceted direct marketing program, with over 40 special marketing events held at the eight participating suburban rail stations—each including a marketing team and Demonstration Program vehicle from 5 a.m. to 9 a.m. and from 4 p.m. to 7 p.m., to coincide with peak commuter load times. Billboards were erected at the train station platforms announcing the availability of the Program. Print advertisements were placed for the Program in local (e.g., *White Plains Watch*) and regional (e.g., *Journal News* and *Newsday*) newspapers targeted specifically at commuters in these areas.

The New York marketing program also sponsored a special Clean Commute Program booth at the New York Auto Show. The purpose of this unique placement was to enhance public awareness of the Program in support of the Demonstration Program goals.

3.2 Defining the Unique Urban EV Market and Niche Applications

The TH!NK *city* EV is a unique vehicle, and it is anticipated to have a unique niche customer base. While the customer base for Urban EVs is largely unknown at present, the TH!NK *city* Demonstration Program seeks to better define Urban EV customer profiles.

It is anticipated that the customer profiles will broadly fit the following customer segments:

- Commuter vehicles – driven either in conjunction with existing mass-transit systems (e.g. station cars), or driven directly to the worksite.
- Local driving – driven around town, city, or neighborhood by retail customers for local mobility needs (e.g., errands, taking children to school).
- Shared vehicles – driven as part of a fleet that is shared among a group (e.g., company pool fleet, car sharing service).

3.3 Enhancing Electric Vehicle Infrastructure

Each TH!NK *city* Demonstration Program EV comes with a single-vehicle conductive charging power distribution box, model EVI DS-50, that was typically installed by the customer or their electrical contractor at the customer's residence. This installation permits the customer to drive locally and recharge at home, independent of the availability of a public conductive charging infrastructure.

Demonstration Program test sites typically have limited public conductive charging available. In particular, San Francisco, has a variety of publicly available charging locations, although most are located in city garages, which require customers to pay for parking while recharging their vehicles. Locations where substantial public charging is available are anticipated to have higher Demonstration Program vehicle use and higher average vehicle mileage.

Fleet-based Demonstration Programs, such as the New York Clean Commute Program and the Vandenburg Air Force Base SUVMS, have a unique infrastructure framework (Figure 2).

Figure 2. Vandenburg Air Force Base charging infrastructure.

The New York Clean Commute Program is a station car program at eight suburban rail stations in New York State. One hundred customers drive TH!NK *city* Demonstration Program EVs from their residences to the eight suburban train stations. The customer has a charging station at his or her residence and another at the train station, which permits maximum commuter distance from home to participating train stations, thereby maximizing usage of the TH!NK *city* EV and miles traveled.

The initial infrastructure plan started with a one-on-one structure (one charger per vehicle) at the station to ensure charging availability for all program participants. Each station was assigned an allocation of vehicles, and the same number of parking spaces and charging units. As the program proceeded and stations sold out their allotted number of vehicles, it became apparent that all customers did not commute every day, and there were empty parking spaces with available chargers. Consequently, the remaining available Program vehicles could be offered to stations that had already sold out, without incurring the expense of installing additional charging units.

Residential charging infrastructure in the Clean Commute Program was deemed necessary for the success of the Demonstration Program, but the residential infrastructure may receive less-than-anticipated utilization. Observation of vehicles arriving at the station indicates that vehicles arrive in the morning at relatively low states of charge. Given that most customers live relatively close to the station, these vehicles were likely not recharged at home before coming to the station. This may be due to reluctance of customers to incur the cost of residential electricity when it is available for free at the train stations. Future analysis and data collection may offer further insight into consumer use of residential charging infrastructure.

All conclusions on the Clean Commute Program are preliminary. It is expected that the DOE Advanced Vehicle Testing Activity customer data collection and reporting program implemented by ETA on the Clean Commute Program will provide further information and insight into these areas of study.

Shared-use vehicles, in which vehicles are shared among a presubscribed membership (e.g., Vandenburg Air Force Base SUVMS), have special infrastructure requirements. One charger per vehicle is fundamentally required to ensure proper charging and recharging of the vehicle for maximum use of the vehicle. The one-to-one vehicle-to-charging unit relationship ensures that EVs maintain the highest level of charge, and therefore state-of-readiness, for membership mobility.

Service of the EVI charging units used in the Demonstration Program is complex due to the interrelationship of the charging unit and the vehicle. When a vehicle fails to charge, the root cause could be the charging unit, installation of the charging unit, or the vehicle itself. A process was developed to diagnose the issue and direct the appropriate solution.

The customer contacts the toll-free EVI service hotline and reports the problem. The hotline representative then walks the customer though diagnostic steps to help isolate the root-cause. Table 1 presents some of the sources of problems and the actions taken to solve them.

Table 1. Examples of potential electric vehicle and infrastructure problems, and recommended actions.

Problem Source	Action Taken to Address the Problem
Charging unit	The EVI selected local service provider is dispatched to repair the unit.
Charging unit installation	The customer is given repair options, including • Dispatch of the EVI local service technician to repair faulty installation, at the customer's expense • Reporting the problem to the original installation contractor for repair under original warrantee.
Vehicle	The customer reports the problem to the local Ford TH!NK dealer for service and repair.

3.4 Investigating Economic Sustainability of Urban EVs

Despite the availability and utilization of public grants and incentives, the Demonstration Program as a whole does not represent a sustainable market for EVs. However, several selected applications do offer better economic sustainability than others.

The TH!NK *city* EVs used in the Demonstration Program were purpose-built, urban, and small—developed to maximize consumer value given the current state of battery technology. The vehicles have a base MSRP (manufacturer's suggested retail price) of $26,000 and an air-conditioned version MSRP of $30,000. The author believes that these vehicles represent the lowest priced highway legal EVs available in the United States to date (excludes neighborhood and low-speed EVs) (The actual cost of an EV has historically been difficult to definitively quantify.)

In order to test economic sustainability of EVs under optimum conditions, TH!NK offered the vehicles only in States with EV incentives. In addition, second-tier public grants [e.g., AQMD (Air Quality Management District), CMAQ (Community Multiscale Air Quality), etc.] were proactively acquired to support placement of these vehicles.

The maximum economic sustainability in the Demonstration Program resulted from a combination of all available sources: 10% federal tax incentive, state incentives, a $300,000 DOE grant, and locally available grants. Under these conditions, these vehicles did not achieve economic sustainability.

Demonstration Program vehicles leased in California included the federal 10% tax credit, a California $8,500 cash incentive, and locally available grants. These vehicles may represent a significant per-vehicle loss to the manufacturer when leased in California at $199/month, for 35 months, with $0 down.

The New York Clean Commute Program had optimum conditions for economic sustainability, but they also did not realize this goal. The New York vehicle MSRP was $30,000 (including air-conditioning) and were leased at $199/month with $0 down. The net lease point reflected the 10% federal tax incentive, the $5,000 New York State tax incentive, and a per-vehicle grant from the New York Power Authority (NYPA), yet it never actually realized the goal of economic sustainability.

The author does not have access to the complete details of the economics of the New York Clean Commute Program. However, by extrapolating from what details are available, the cost per vehicle can be estimated. Given the assumptions in Table 2, the monthly cost for a TH!NK *city* is $659. However, this does not take into account the unknown value of the NYPA grant. The difference between the monthly lease rate of $199 and the rough-estimated monthly cost of $659 is $460 per month, per vehicle. This equates to a total vehicle-funding shortfall of $1.6 million. (The costs to install the chargers at the train stations and commuters' homes are not included.)

Table 2. Approximate economics of TH!NK *city* electric vehicle and lease costs for the New York Clean Commute Program.

$30,000	Assumed vehicle cost based on $30,000 average MSRP for vehicles equipped with air conditioning, used in the New York Program.
-$3,000	Federal 10% tax incentive
-$882	DOE grant of $300,000/340 vehicles
-$5,000	New York State tax incentive
$21,118	Vehicle cost
$659	Monthly cost per vehicle $21,118 / 35 (assumes 35 month leases and financing rate of 6%).
-$199	Clean Commute participant monthly lease payment
$460	Cost shortfall per vehicle
$1.6 million	$460 x 35 months x 100 vehicles

This estimate does not include any residual value for the TH!NK *city* EVs, as they must be returned to Norway per waiver agreement with the National Highway Safety Traffic Administration. Even if the *city* EVs could remain in the United States, the residual values of EVs and other advanced technology vehicles has been very low. Recent surveys in England suggest that the one-year depreciation on hybrid electric vehicles has been as high as 50%.

If a residual value of $5,000 and a cost of money of 6% are assumed, the cost to finance $16,118 ($21,118 - $5,000) for 35 months would be $503 per month. This still equates to a potential program shortfall of $1.1 million.

TH!NK completed market studies with focus groups in California and New York. The method involved a preinterview, a customer drive, and a postinterview in group settings. While results of these market studies are confidential and not available as part of this report, the $199 lease point used in the Demonstration Program was a direct result of these studies.

Even at consumer-driven price points, direct EV sales to consumers are much more complex and time-consuming than regular gasoline vehicles; in California, it took over 1 year to successfully place 170 EVs; in New York it took over 9 months to place 100 EVs. Optimistically, it can be argued that Urban EVs are an emerging niche market that can be very difficult to effectively target with media and press campaigns.

On a fully accounted basis, one that includes marketing, and research and development costs, it can be argued that Demonstration Program vehicles are even further removed from economic sustainability. Traditionally, vehicle manufacturers recover marketing, and research and development costs with the after-manufacturing per-unit profits made on each individual vehicle sold. Inasmuch as Demonstration Program EVs are not profitable, no such investment recovery was possible.

In addition, unique investments in support of Demonstration Programs are often required. For example, Ford designed a unique air conditioning system for the 115 Demonstration Program vehicles in the Georgia and New York Programs. Such an unique investment for limited numbers of vehicles is a significant financial hurdle facing future Demonstration Programs.

Cost and timing of installation of the required Power Control Station complicated the customer leasing process. In order to charge their vehicle at home, customers were required to install, or make arrangements for the installation of, their power control station before taking possession of their vehicles from the dealer. Some customers encountered significant installation cost and complexity, which were often more expensive and time-consuming than anticipated.

It is important to note that cash incentives, as used in California, can be far more useful in supporting economic deployment of Urban EVs than tax incentives. Tax incentives can be utilized only by profitable, for-profit businesses and cannot be directly applied to financing mechanisms (e.g., vehicle lease agreements). The Demonstration Program used unique vehicle lease agreements to provide customers with a low-risk option and to maintain control of the Demonstration Program fleet. Changing the available tax incentives to cash incentives might further support the goal of Urban EV economic sustainability.

To continue to support economic sustainability of Urban EVs, it may be necessary to continue high levels of economic stimulus and financial support. Any reduction in available per-vehicle incentives may prove to be premature, given the current state of Urban EV economic sustainability.

In addition, nonmonetary consumer incentives can help consumers make the switch to Urban EVs. These consumer incentives help support a market-based approach to increased Urban EV use. Such incentives might include

- Single-person high occupancy vehicle lane access
- Reduced registration fees
- Reduced road-toll fees
- Preferred reserved parking
- Reduced parking fees
- Reduced home or business electric rates for EV use
- Increased public charging infrastructure.

4. SUMMARY

Phase I of the TH!NK *city* Electric Vehicle Demonstration Program is almost complete. All but 10 vehicles have been placed with customers. The Program maintains a high profile as the largest single Urban EV Demonstration Program in the United States.

Phase II, the ongoing monitoring of an operational field fleet, has been initiated. DOE's Advanced Vehicle Testing Activity is highly involved with monitoring of the Clean Commute Program EVs through its agreement with ETA, and the results will be published on the Advanced Vehicle Testing Activity's website at http://ev.inel.gov/fop. It is expected that this customer data collection and reporting Program implemented by ETA on the Clean Commute Program will provide further information and insight into these areas of study. In addition, two more annual reports will be published that report the progress of the TH!NK *city* Electric Vehicle Demonstration Program.

The Demonstration Program has achieved a high level of public awareness, especially in the areas where the vehicles are located, as a result of a significant and focused multifaceted campaign on behalf of Ford and its partners. Such high levels of media exposure are required to implement large-scale public Demonstration Programs such as the TH!NK *city* Electric Vehicle Demonstration Program Project.

Even at consumer-driven price points, however, direct sales to consumers are much more complex and time-consuming than regular gasoline vehicles. In California, it took over a year to successfully place 170 TH!NK *city* EVs; in New York it took over 9 months to place 100 TH!NK *city* EVs. Urban EVs are, at most, an emerging niche market. That market is very difficult to effectively target with media and press campaigns.

The cost and timing of installing the required Residential Power Control Stations complicates the customer leasing process. In order to charge the vehicle at home, installation of the power control station is required before taking possession of the vehicle from the dealer. Some customers encountered significant installation cost and complexity, which were often more expensive and time-consuming than anticipated. While additional installations may result in more efficient installation practices, better preinstallation consumer education may support more realistic consumer expectations.

Economic sustainability of Urban EVs has been advanced through the Demonstration Program but not fully realized. Despite the availability and utilization of public grants and incentives, the Demonstration Program as a whole does not represent a sustainable market for Urban EVs. However, certain applications do offer better economic sustainability than others. TH!NK estimates that the most sustainable component of the Demonstration Program has been the New York Clean Commute Program.

In order to continue to support the economic sustainability of Urban EVs, it may be necessary that economic stimulus and financial support be continued, as well as to continue nonmonetary incentives (e.g., preferred reserved parking, access to high occupancy vehicle lanes). Any reductions in available per-vehicle incentives would likely prove to be negative to the industry, given the current state of Urban EV economic sustainability.

While the goals of the Demonstration Program have been significantly advanced by the placement of almost 340 vehicles in four States, the development of a sustainable Urban EV market is still distant.