

GRIDbot Electric Vehicle Service Equipment Installation

Task #3 Deliverable Report

for:

**New Technology Research and Development
Program**

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Submitted by:

GRIDbot, LLC

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Abstract/Executive Summary

This demonstration includes installing 28 charging stations in one centralized location to support the City of Houston's (the City) centralized fleet concept. The location is an underground parking garage in downtown Houston that encompasses 18 city blocks of parking space, is three levels deep, and contains over 3,000 parking spaces. The City is purchasing all the vehicles that will make up the fleet, and this demonstration project is providing and installing all the components of the charging infrastructure.

The interim evaluation of the first group of charging stations, and the charging sessions of the first all electric LEAF vehicles and Prius plug-in hybrid electric vehicles (PHEV) have provided this project with an opportunity to run various communications and data tests on the software and firmware contained in the GRIDbot products. Some modifications were needed to streamline the reporting of charging data to the Houston Advanced Research Center (HARC) for their modeling and analysis. In addition, small modifications have been made in the manufacturing and installation protocols. The charging stations are confirmed to be compatible with all the electric vehicles tested.

Modeling and analysis of this interim data has been completed by HARC, to demonstrate mileage, tail-pipe emissions and point source emissions, time of charging sessions, and length of time charging. All this information will continue to be analyzed to determine the additional savings that may be available by shifting the charging time to off-peak.

Introduction / Background

The City developed a plan to reduce the number of fleet vehicles owned by the City and used by employees located in the downtown Houston area. Part of this plan is to increase the per vehicle use of a smaller fleet, and to replace the current gasoline vehicles with electric vehicles (EV) to reduce the tail-pipe emissions of the fleet. The City determined that the concept of a "pooled fleet" would enable them to monitor the vehicles more efficiently through an online reservation system and enable easy access for various departments.

This demonstration includes installing 28 charging stations in one centralized location to support the City's centralized fleet concept. The location is an underground parking garage in downtown Houston that encompasses 18 city blocks of parking space, is three levels deep and contains over 3,000 parking spaces. The City is purchasing all the vehicles that will make up the fleet, this demonstration project is providing and installing all the components of the charging infrastructure.

Key to this demonstration, information will be collected from the staff, the vehicles, and the charging stations to analyze the emissions reductions, and charging requirements of the various vehicles. Additional information from the staff will assess their acceptance of the centralized fleet concept, acceptance of dedicated electric vehicles over traditional combustion engine vehicles, and the use of the charging stations. All of these components and findings will be demonstrated, analyzed, and reported as part of this project.

GRIDbot's first EVSE product, model UP 100J, was developed to target this type of fleet installation. It has both a level-1 outlet which supports PHEV conversions and scooters and a level-2 outlet which will provide faster charging for vehicles developed for the mass market, such as the Nissan LEAF or Chevy Volt. It also incorporates networking and reporting

capabilities that will continue to enhance the fleet management of these vehicles beyond this demonstration. This product is now ready for full commercialization.

Project Objectives / Technical Approach

From the grant contract Grant Activities (Scope of Work):

“1.2 The objectives for this work are:

1.2.1. Demonstrate the effectiveness and acceptance of GRIDbot’s electric vehicle charging station technology in conjunction with a dedicated electric vehicle fleet.”

GRIDbot, Good Company Associates (Good Company), and HARC agreed to partner with the City to provide charging infrastructure for 25 dedicated electric vehicles which the City will purchase in 2011, as well as other plug-in electric vehicles included in the City’s fleet. The City’s goal is to consolidate its fleet, as well as replacing standard combustion engine vehicles with electric vehicles. This project’s infrastructure will provide the electric charging for the City’s entire electric and support many of their PHEVs and will be located in the City parking facility at Tranquility Park.

Good Company is providing project management for the installation of the equipment and providing equipment user training to the City staff. Once the equipment is in use, Good Company will collect information from the staff to evaluate user acceptance of the centralized fleet, the dedicated electric vehicles, and charging equipment.

The HARC is collecting information from the vehicles and the charging equipment and analyzing this data regarding charging station performance, vehicle use, and vehicle emissions, and will extrapolate the emissions impact based on this data using air quality modeling.

GRIDbot is providing the necessary technical oversight for all production, performance, and installation of the charging stations for the various contractors involved in the project. In addition, GRIDbot will work with the City staff to modify the customer interface and network operation based on project findings. This demonstration will enable GRIDbot’s first EVSE product, the model UP 100J, to move quickly to broad product commercialization.

Task 3: Interim Evaluation of First Group of Charging Stations

With the completion of the initial installation of 14 charging stations, GRIDbot began beta testing on the communications and reporting software and firmware from the stations. While waiting on the delivery of the first two LEAFs, the City’s Fleet Management worked with staff to reassign three of its Prius PHEVs to the Tranquility Garage. These five vehicles have provided enough information to complete the interim evaluation and proceed with the second installation.

Establish installation costs

From the grant contract Grant Activities (Scope of Work):

“2.3.1. The PERFORMING PARTY will establish the costs incurred for the installation of the GRIDbot charging stations, and finalize installation diagrams for the stations.”

Installation costs will vary greatly from location to location and we have found the largest variable is the availability of necessary power on site. We were able to confirm the availability of adequate power for the 28 stations on site. However, access to that power required the installation of a transformer and two breaker-boxes, which required extensive coring through

garage floors and conduit from the source of power to the parking location. Additional coring through garage floors from the lower level at each charging station required x-ray evaluation to avoid rebar, electrical lines, or other materials imbedded in the concrete. We were able to install all 28 stations for approximately \$3,000 per unit.

The initial installation of 14 stations allowed us to work with electricians and other vendors to determine what information they needed to plan and complete the installations. As a result, small additions to the installation plan and to the installation manual were made for the second row of 14 stations.

Customer interface modifications

From the grant contract Grant Activities (Scope of Work):

“2.3.2. The PERFORMING PARTY will make modifications to the charging station customer interface as necessary based on feedback from station users and project partners (the City, HARC, and Good Company). The PERFORMING PARTY may also communicate with vehicle manufacturers to insure charging station compatibility with other electric vehicles.”

With the arrival of the first all-electric vehicles the learning began. We had compiled all the information available from Nissan, but until we plugged the LEAFs in we didn't know exactly how they would respond to the chargers or how the drivers would respond to the vehicles. During the month of September we were able to communicate with various users and study the data from the charging stations and the various charging sessions. Changes were made to the interface to simplify the driver's or user's instructions.

Reporting data was determined to be compiled and reported to HARC every 30 minutes with a secure interface developed between GRIDbot and the HARC to enable the download of this information automatically. Reporting formats and the information provided to the City's Fleet Manager was further developed into an expandable format which allows either a quick glance at total usage numbers or an expanded database identifying every charging session on every charging station. The HARC is visiting the installation site weekly to download vehicle data.

The charging stations are compatible with the Prius, LEAF, and Volt, and we see no reason it will perform differently with any other electric vehicle.

Second installation location confirmed

From the grant contract Grant Activities (Scope of Work):

“2.3.3. The PERFORMING PARTY will identify the second location for charging infrastructure to support the City's centralized electric fleet.”

With much of the conduit and infrastructure installed with the first stations and the modifications to the installation manuals, we confirmed the second row of charging stations would be directly adjacent to the first row (rows F and G of the Aqua Level of Tranquility Garage). This second row installation was completed by a second vendor in September, and the entire electrical inspection was completed on September 29, 2011. GRIDbot immediately ran performance testing on the charging units and they are ready for use.

From the grant contract Grant Activities (Scope of Work):

“2.3.4. The PERFORMING PARTY will work with Good Company to incorporate installation diagrams for the GRIDbot charging stations and guidelines and usage instructions into an installation manual and an operational manual. The manuals will include a troubleshooting process.”

GRIDbot provided copies of the installation manual and the UP 100J product operation manual for inclusion in an owner's manual for the City. Good Company collected all the installation diagrams, the permitting and inspection information, as well as vendor information for the cameras, wheel-stops, signs, transformer, breakers, installation and warranty information. User's educational materials and an Owner's Quick Troubleshooting Guide were developed for the staff training and were also included in an owner's manual. An Owner's Manual was provided to the City Fleet Manager and to the Tranquility Garage Operations Manager.

HARC air modeling of interim data

From the grant contract Grant Activities (Scope of Work):

"2.3.5. The PERFORMING PARTY in conjunction with HARC will perform air modeling runs using the interim data collected to assess the initial impact on emissions."

HARC is compiling data on charging, from GRIDbot stations, on-board diagnostic (OBD) data loggers, and CARWINGS online reports, to create a summary report on charging activity by station and by vehicle. They have also acquired Houston-Galveston-Beaumont non-attainment area (HGB) emissions factors for MOBILE6 and MOVES models, and the most recent eGRID data for emissions estimates.

Although electric vehicles eliminate tailpipe emissions, there are emissions from the production of electricity that charges the vehicle's battery system. Several models are being analyzed to determine NO_x emissions associated with electricity production. The most recent eGRID values for the Texas electric power grid are available for 2007. These are being analyzed for emission factors for the entire Texas grid, nearby power plants, current (2010) emissions, projected emissions for future years, and emissions that reflect renewable power purchases in Houston.

For September and October 2011, the Prius PHEVs had average charging events of 19.6 hours during the primary phase of charging (Phase 1). Vehicles continue to draw a small amount of power for battery cooling (0.23 kilowatt-hours Phase 2). The vehicles averaged 2.54 kilowatt-hours for the 52 charging events. Total electricity use amounted to 121.81 kilowatt-hours.

During this same period, the LEAFs had average charging events of 1.9 hours. The vehicles averaged 4.69 kilowatt-hours for the 53 charging events. Total electricity use for charging these vehicles amounted to 220.42 kilowatt-hours.

For the LEAFs, 72% are plugged in at noon or later, and 34% start at 3 pm or later. For the Prius PHEVs, 75% are plugged in at noon or later and 26% are plugged in at 3 pm or later. This early information indicates that more than half of the current charging could be moved into the overnight hours to avoid peak day use.

Timeline and Deliverables

From the grant contract Grant Activities (Scope of Work):

"2.3.6. Schedule: The PERFORMING PARTY shall complete this task within 4 months of the signed Notice to Proceed Date as issued by TCEQ."

Due to the delay in delivery of vehicles we have worked with all parties to adjust the installations of charging stations to better coincide with the availability of vehicles. We have submitted an amended timeline to the TCEQ, requesting a 60 day extension in which we feel we will be able to complete all tasks of this project. And because we have been on budget, we have proposed to install the final two stations at another City site, all within the current budget.

From the grant contract Grant Activities (Scope of Work):

2.3.7. Deliverables: The PERFORMING PARTY shall submit a report to the TCEQ upon completion of this task. This report will include but is not limited to a report on the cost of installations, any necessary customer interface modifications, a copy of the installation manual, a copy of the operational manual, and a copy of the interim modeling report.

Copies of the above mentioned reports have been provided to the TCEQ ([Appendix A](#)) but contain information that is specific to this location and vendors and so will not be made public. Information from GRIDbot regarding the specifications, installation and operation of their products are readily available on the website www.gridbot.net.

Discussion/Observations

Objectives vs. Results

Other than timing changes there have been no significant issues or barriers to the success of the project. As with all new technologies, the project team is learning through this field demonstration and solutions have been incorporated into this project plan.

Critical issues

Due to the slow acquisition of vehicles, the City has delayed some decisions such as the fleet management software for the project. We have adapted to the slow introduction of vehicles, and the delay in the fleet management system by adapting our schedule to their availability. We are told that vehicles will be available very soon and that a Request for Proposals (RFP) for the fleet management systems will be open to vendors in early December 2011.

We found that the data loggers that have been developed for tracking trip information on Prius' do not work on LEAFs, so we are depending on the CARWINGS system which is an on-line program that reports vehicle use to the driver who logs into the site. Once the cars were registered with CARWINGS, the data seemed to be very sporadic. We discovered that there is a user "opt-in" that a user must accept for the data to be uploaded. We have reached out to the drivers to please cooperate so that this information can be accessed. The data appears to be flowing now.

Technical and commercial viability of the proposed approach

The manufacturer has identified several small changes to their production line that have been identified through this demonstration project. The benefit to the commercial viability of this product cannot be underestimated. This project has enabled GRIDbot to field test a large number of charging stations in one location, which would have been unlikely otherwise. The cooperation of the various principals has been very helpful. GRIDbot is now offering three variations of the product in limited supplies on the commercial market while developing a distribution framework for the USA and Canada.

Scope for future work

Due to the limit of electrical capacity for charging stations in the Tranquility Garage for the City's Centralized Fleet, we have available funding within this project for two more stations. We are working with the City to install two stations at their new Green Building Resource Center, which is an LEED building that houses the Permitting and Green Building Departments. We have submitted an amendment request to the TCEQ to extend the time of our project by 60 days

and to allow for the installation of these two stations in order to broaden the support for the City fleet and to provide additional data for the project modeling.

Intellectual Properties/Publications/Presentations

No new IP has been developed, no publications identified, and no presentations planned at this time.

Summary/Conclusions

With this deliverable report, GRIDbot has demonstrated the ability to bring together the appropriate technologies, resources, and personnel to proceed with the field demonstration. The HARC has identified the data sources needed and provided the preliminary findings and analysis of the emissions estimates for these electric vehicles. GRIDbot is looking forward to the next step toward realizing this vision and demonstrating this new technology and its viability in future markets.

Acknowledgements

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- Mayor Anise Parker's Office,
- Office of Sustainability,
- Finance Department,
- Fleet Management Department,
- Convention Facilities Department, and
- Electrical Permitting Division.

Appendices

Appendix A: Confidential Installation and Owners Manuals and Interim Reports

The information in this appendix was claimed by the grantee as Proprietary and/or Confidential. To view this information please contact the New Technology Research and Development program at:

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