U.S. DEPARTMENT OF ENERGY

Office of ENERGY EFFICIENCY & RENEWABLE ENERGY

# Technology Integration

## 2018 Annual Progress Report

Vehicle Technologies Office

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We would also like to express our appreciation to Allegheny Science and Technology (AST) for their technical support in preparing, editing, compiling, and publishing the 2018 Technology Integration Annual Progress Report.

# Acronyms

| | |
|---|---|
| AAA | American Automobile Association |
| AAPEX | Automotive Aftermarket Products Expo |
| ADAS | Advanced Driver Assistance Systems |
| AEO | Arkansas Energy Office |
| AFDC | Alternative Fuels Data Center |
| AFLEET Tool | Alternative Fuel Life-Cycle Environmental and Economic Transportation Tool |
| AFPR | Alternative Fuel Price Report |
| AFV | alternative fuel vehicle |
| AHJ | authority having jurisdiction |
| API | application programming interface |
| ARA | Automotive Recyclers Association |
| ASME IMECE | American Society of Mechanical Engineers, International Mechanical Engineering Congress and Exposition |
| ASU | Arizona State University |
| AVTC | Advanced Vehicle Technology Competition |
| BEV | battery electric vehicle |
| BMV | Bureau of Motor Vehicles |
| CARB | California Air Resources Board |
| CAV | connected and automated vehicles |
| CH2 | compressed hydrogen |
| CNG | compressed natural gas |
| CSULA | California State University Los Angeles |
| CSU | Colorado State University |
| CTE | Center for Transportation and the Environment |
| CTS | Contract Transportation Services |
| CVEF | Clean Vehicle Education Foundation |
| DC | direct current |

| | |
|---|---|
| DCFC | direct current fast charger |
| DFWCC | Dallas-Fort Worth Clean Cities |
| DOE | Department of Energy |
| DOER | Department of Energy Resources |
| DOT | Department of Transportation |
| E&EC | emissions and energy consumption |
| EEL | energy efficient logistics |
| EEMS | energy efficient mobility systems |
| EERE | Energy Efficiency and Renewable Energy |
| EIA | Energy Information Administration |
| EISA | Energy Independence and Security Act of 2007 |
| EPA | Environmental Protection Agency |
| EPAct | Energy Policy Act of 1992 |
| ERAU | Embry Riddle Aeronautical University |
| EV | electric vehicle |
| EVI-Pro | Electric Vehicle Infrastructure Projection |
| EVSE | electric vehicle supply equipment |
| F4F | Fleets for the Future |
| FAST Act | Fixing America's Surface Transportation Act |
| FCDICE | Fire College Department of Insurance Continuing Education System |
| FCG | Filling Critical Gaps |
| FDACS OOE | Florida Department of Agriculture and Consumer Services, Office of Energy |
| FEI | Fuel Economy Information |
| FEMA | Federal Emergency Management Agency |
| FHWA | Federal Highway Administration |
| FOA | funding opportunity announcement |
| FSEC | Florida Solar Energy Center |
| FSFC | Florida State Fire College |

| | |
|---|---|
| FY | fiscal year |
| GHG | greenhouse gas |
| GIS | geographic information system |
| GM | General Motors |
| GNA | Gladstein, Neandross & Associates |
| GNHCCC | Greater New Haven Clean Cities Coalition |
| GREET | Greenhouse gases, Regulated Emissions, and Energy use in Transportation |
| GT | Georgia Tech |
| GTI | Gas Technology Institute |
| H2 | hydrogen |
| HDV | heavy duty vehicle |
| HEV | hybrid-electric vehicle |
| IAEM | International Association of Emergency Managers |
| ICC | International Code Council |
| IEEE | Institute of Electrical and Electronics Engineers |
| INCOG | Indian Nations Council of Governments |
| INL | Idaho National Laboratory |
| iREV | Initiative for Resiliency in Energy through Vehicles |
| iREV-T | iREV Tracking Tool |
| L2 | level 2 |
| LCF | Louisiana Clean Fuels |
| LDV | light duty vehicle |
| LNG | liquefied natural gas |
| LPG | liquefied petroleum gas (propane) |
| LSCFA | Lone Star Clean Fuels Alliance |
| M2M | Michigan to Montana |
| MAC | McMaster University |
| MACPP | Mid-America Council for Public Procurement |

| | |
|---|---|
| MAPC | Metropolitan Area Planning Council |
| MARC | Mid-America Regional Council |
| MEC | Metropolitan Energy Center |
| Midwest EVOLVE | Midwest Electric Vehicle Opportunities: Learning eVents, Experience |
| MOVES | Motor Vehicle Emission Simulator |
| MPG | miles per gallon |
| MPH | miles per hour |
| MPO | metropolitan planning organization |
| MSADA | Massachusetts State Auto Dealers Association |
| MSU | Mississippi State University |
| MWCOG | Metropolitan Washington Council of Governments |
| MSRP | manufacturer's suggested retail price |
| MY | model year |
| NAFTC | National Alternative Fuels Training Consortium |
| NAFTD | North American Fire Training Directors |
| NARC | National Association of Regional Councils |
| NASA | National Aeronautics and Space Administration |
| NASEO | National Association of State Energy Officials |
| NASPO | National Association of State Procurement Officers |
| NATA | North American Towing Academy |
| NCCETC | North Carolina Clean Energy Technology Center |
| NCTCOG | North Central Texas Council of Governments |
| NDEW | National Drive Electric Week |
| NESCAUM | Northeast States for Coordinated Air Use Management |
| NFPA | National Fire Protection Association |
| NGA | National Governors Association |
| NGV | natural gas vehicle |
| NHTSA | National Highway Traffic Safety Administration |

| | |
|---|---|
| NIRPC | Northern Indiana Regional Planning Commission |
| NOI | notice of intent |
| NOx | oxides of nitrogen |
| NREL | National Renewable Energy Laboratory |
| NTEA | National Truck Equipment Association |
| OEM | original equipment manufacturer |
| ORNL | Oak Ridge National Laboratory |
| OSU | Ohio State University |
| PAG | Pima Association of Governments |
| PDF | portable document format |
| PEV | plug-in electric vehicle |
| PGE | Portland General Electric |
| PHEV | plug-in hybrid electric vehicle |
| PI | principal investigator |
| PIA | Plug In America |
| PSU | Pennsylvania State University |
| PY | project year |
| RPC | Regional Planning Commission |
| RFI | request for information |
| RFP | request for proposals |
| SADI | Southeast Alternative Fuel Vehicle Demonstration Initiative |
| SAE | Society of Automotive Engineers |
| SAFE | Securing America's Future Energy |
| SCORM | Shareable Content Object Reference Model |
| SCOS | Smart Columbus Operating System |
| SDOT | Seattle Department of Transportation |
| SEAFDP | Southeast Alternative Fuel Deployment Program |
| SEMA | Specialty Equipment Market Association |

| | |
|---|---|
| SMART | Systems and Modeling for Accelerated Research in Transportation |
| STEM | science technology engineering and mathematics |
| SUV | sport utility vehicle |
| TA | technical assistance |
| TC4 | Twin Cities Clean Cities Coalition |
| TCO | total cost of ownership |
| TIC | Technologist in Cities |
| TJCOG | Triangle J Council of Governments |
| TRB | Transportation Research Board |
| TRS | Technical Response Service |
| UA | University of Alabama |
| UCCC | Utah Clean Cities Coalition |
| UCF | University of Central Florida |
| UF | utility factor |
| USU | Utah State University |
| UT | University of Tennessee, Knoxville |
| UU | University of Utah |
| UW | University of Washington |
| UWAFT | University of Waterloo Alternative Fuels Team |
| VT | Virginia Tech |
| VTO | Vehicle Technologies Office |
| VW | Volkswagen |
| WSU | Wayne State University |
| WTW | well to wheels |
| WVU | West Virginia University |
| ZEV | zero emission vehicle |

# Executive Summary

The FY 2018 Technology Integration Annual Progress Report covers 28 multi-year projects funded by the Vehicle Technologies Office. The report includes information on 21 competitively awarded projects, ranging from training on alternative fuels and vehicles for first responders, to safety training and design for maintenance facilities housing gaseous fuel vehicles, to electric vehicle community partner programs. It also includes seven projects conducted by several of VTO's national laboratory partners, Argonne National Laboratory, Oak Ridge National Laboratory and the National Renewable Energy Laboratory. These projects range from a Technical Assistance project for business, industry, government and individuals, to the EcoCar 3 Student Competition, and the Fuel Economy Information Project.

The projects involve partnerships between private industry, the public sector and, in many cases, non-profit organizations, and incorporate an educational component designed to enable the sharing of best practices and lessons learned. Data collected from these projects is used to inform the future direction of VTO-funded research.

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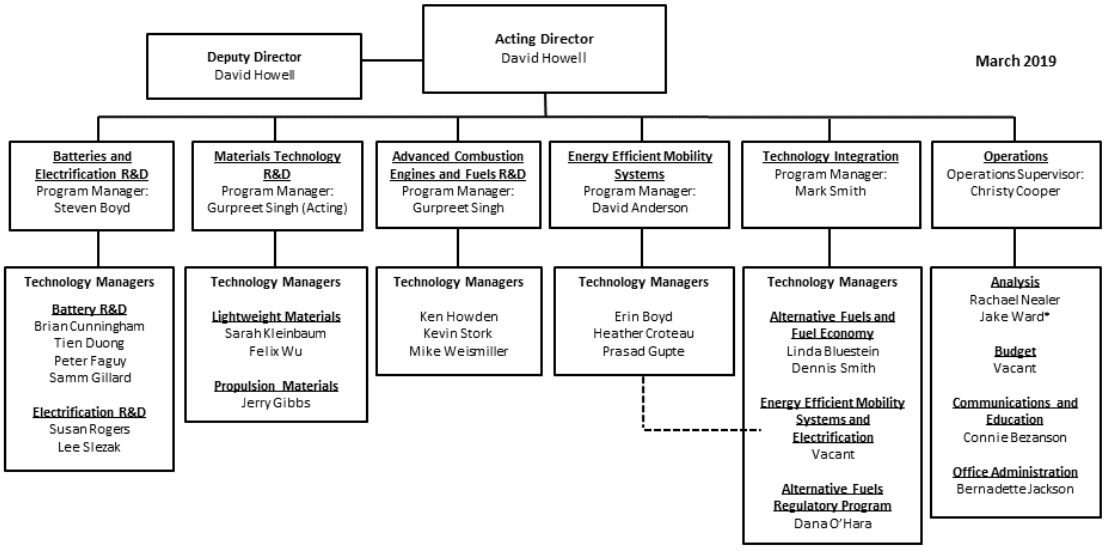
# Vehicle Technologies Office Overview

Vehicles move our national economy. Annually, vehicles transport 11 billion tons of freight[1] – more than $32 billion worth of goods each day[2] – and move people more than 3 trillion vehicle-miles.[3] Growing our national economy requires transportation and transportation requires energy. The transportation sector accounts for 70% of U.S. petroleum use. The United States imports 20% of the petroleum consumed – sending more than $15 billon per month[4] overseas for crude oil. The average U.S. household spends nearly one-sixth of its total family expenditures on transportation[5], making transportation the most expensive spending category after housing.

To strengthen national security, enable future economic growth, improve energy efficiency, and increase transportation energy affordability for Americans, the Vehicle Technologies Office (VTO) funds early-stage, high-risk research on innovative vehicle and transportation technologies. VTO leverages the unique capabilities of the national laboratory system and engages private sector partners to develop innovations in electrification, including advanced battery technologies; advanced combustion engines and fuels, including co-optimized systems; advanced materials for lighter-weight vehicle structures; more efficient powertrains; and energy efficient mobility systems.

VTO is uniquely positioned to address early-stage challenges due to strategic public-private research partnerships with industry (e.g. U.S. DRIVE, 21st Century Truck Partnership) that leverage relevant expertise. These partnerships prevent duplication of effort, focus DOE research on critical R&D barriers, and accelerate progress. VTO focuses on research that industry does not have the technical capability to undertake on its own, usually due to a high degree of scientific or technical uncertainty, or it is too far from market realization to merit industry resources.

# Organization Chart




[1] Bureau of Transportation Statistics, DOT, 2016. Table 3-1 Weight and Value of Shipments by Transportation Mode https://www.bts.gov/archive/publications/transportation_statistics_annual_report/2016/tables/ch3/table3_1
[2] Ibid.
[3] Transportation Energy Data Book 37th Edition, ORNL, 2018. Table 3.8 Shares of Highway Vehicle-Miles Traveled by Vehicle Type, 1970-2016.
[4] EIA Monthly Energy Review https://www.eia.gov/totalenergy/data/monthly/pdf/mer.pdf
[5] Bureau of Labor Statistics, Consumer Expenditure Survey, 2017. Average annual expenditures and characteristics of all consumer units, 2013-2017. https://www.bls.gov/cex/2017/standard/multiyr.pdf

# Technology Integration Program Overview

## Introduction

VTO's Technology Integration Program supports a broad technology portfolio that includes alternative fuels, energy efficient mobility systems and technologies, and other efficient advanced technologies that can reduce transportation energy costs for businesses and consumers. The program provides objective, unbiased data and real-world lessons learned to inform future research needs and support local decision making. It also includes projects to disseminate data, information, and insight, as well as online tools and technology assistance to cities and regions working to implement alternative fuels and energy efficient mobility technologies and systems.

## Goals

The Technology Integration Program's goals are to strengthen national security through fuel diversity and the use of domestic fuel sources, reduce transportation energy costs for businesses and consumers, and enable energy resiliency with affordable alternatives to conventional fuels that may face unusually high demand in emergency situations.

## Program Organization Matrix

The Technology Integration Program's activities can be broken out into several distinct areas:

*Technology Integration Tools and Resources*

- The Alternative Fuels Data Center provides information, data, and tools to help transportation decision makers find ways to reduce cost and improve energy efficiency.
- FuelEconomy.gov provides access to general information, widgets to help car buyers, and comprehensive fuel economy data.
- Energy Efficient Mobility Systems (EEMS) envisions an affordable, efficient, safe, and accessible transportation future in which mobility is decoupled from energy consumption.
- The Clean Cities Coalition Network supports the nation's energy and economic security by building partnerships to advance affordable, domestic transportation fuels and technologies. The Technology Integration Program assists this network of nearly 100 coalitions nationwide through its tools and resources.
- Advanced Vehicle Technology Competitions

For more than 25 years, the Vehicle Technologies Office has sponsored advanced vehicle technology competitions (AVTCs) in partnership with the North American auto industry to educate and develop the next generation of automotive engineers. VTO's advanced vehicle technology competitions provide hands-on, real-world experience, and focus on science, technology, engineering, and math, to support the development of a workforce trained in advanced vehicle technologies.

Launched in 2014, EcoCAR 3 was the latest iteration of the advanced vehicle technology competitions. EcoCAR 3 challenged 16 teams from North American universities to redesign the Chevrolet Camaro into a hybrid-electric car that would increase fuel efficiency, while maintaining the muscle and performance expected from this iconic American car.

These teams were tasked to incorporate innovative ideas, solve complex engineering challenges, and apply the latest cutting-edge technologies. Teams had four years (2014-2018) to harness those ideas into the ultimate energy-efficient, high performance vehicle. The Camaro kept its familiar body design, while student teams

developed and integrated energy innovations that maximized performance, while retaining the safety and high consumer standards of the Camaro.

- Alternative Fuels Regulatory Activity

The Alternative Fuels Regulatory activity provides technical and analytical support for the implementation of federal legislation related to the deployment of alternative fuels and fuel-efficient fleet vehicles. Relevant legislation includes the Energy Policy Act (EPAct) of 1992, EPAct 2005, the Energy Conservation Reauthorization Act of 1998, the Energy Independence and Security Act (EISA) of 2007, and other amendments to EPAct.

EPAct regulated fleets include State & Alternative Fuel Provider Fleets and Federal Fleets (managed by the Federal Energy Management Program).

# I. Alternative Fuel Vehicle Initiatives

## I.1 Alternative Fuel Vehicle Curriculum Development and Outreach Initiative (West Virginia University Research Corporation)

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Start Date: June 1, 2015 End Date: December 31, 2018
Total Project Cost: $800,000 DOE share: $598,489 Non-DOE share: $201,511

### Project Introduction

For the Alternative Fuel Vehicle Curriculum Development and Outreach Initiative project, the National Alternative Fuels Training Consortium (NAFTC) will develop curricula and conduct training related to alternative fuel and advanced technology vehicles, for a wide range of individuals and organizations. This project focuses on developing training materials that do not yet exist in critical areas, such as for towing and recycling operators, and vehicle repair facilities. In addition to the educational materials, the NAFTC will conduct marketing and outreach activities to promote this training, specifically, and greater alternative fuel vehicle (AFV) adoption in general. Through online courses and train-the-trainer workshops, the project will have a national impact and establish resources and materials that will last beyond the project's completion date.

### Objectives

The Alternative Fuel Vehicle Curriculum Development and Outreach Initiative project has three broad tasks, with a series of subtasks under the latter two. The objectives are to:

- Develop curricula and conduct AFV and electric vehicle (EV) training, covering underserved (and critical) areas:
    - collision repair
    - fueling, repair, maintenance and conversion facilities
    - online training for towing and roadside assistance personnel
    - online training for automotive recycling personnel
- Market and promote the dissemination of project-related curricula and training materials, while leveraging existing resources.

### Approach

The NAFTC uses an award-winning [1] and industry-endorsed [2] curriculum development process. This process includes working closely with the US DOE, content experts, and project partners to define the purpose,

scope, objectives, and expectations for project curricula. The NAFTC uses the information garnered from this process to compose objectives; create topical and detailed outlines; and research and create course content. Following the development of these initial documents, the NAFTC develops materials for use with the instructor's manual, including presentations, lesson plans, practical exercises, learning activities, and review questions.

After drafts have been developed, the materials go through an internal (alpha) review process. Following the internal review, NAFTC recruits subject matter experts and incorporates their recommendations in the materials. Once these materials are completed, NAFTC's national trainer conducts a beta test with selected audiences. The data, feedback, and comments from these trainings will be used to make further revisions. NAFTC will create the final draft of the instructor's manual and participant's manual/booklets, for use with each classroom curricula. This curriculum development process will be followed for the above-listed classroom curricula.

Online course development builds upon the classroom curriculum development process by leveraging materials that have been/will be developed for the classroom curricula. These leveraged materials will be used to develop online training utilizing a SCORM-compliant approach. SCORM is a set of technical standards for eLearning products. As with the classroom curricula, the activities for online course development are the same for all of the above-listed online training.

NAFTC develops the marketing and outreach materials with oversight of a national advisory committee, then creates initial materials and reviews them internally, with external expertise solicited as needed. NAFTC then presents the developed materials to the advisory committee for review. After collecting the comments from the reviewers, NAFTC communications staff finalize the materials and organize them in an online toolbox for use by trainers and project partners.

### Results

During FY 2018, the NAFTC made substantial progress on the various components of the Alternative Fuel Vehicle Curriculum Development and Outreach Initiative project. The project continues to be managed per institutional reporting requirements and generally accepted accounting principles. Following the 2017 retirements of Bill Davis and Judy Moore, the NAFTC's longstanding director and assistant director for communications, respectively, the four remaining NAFTC staff have established offices on the West Virginia University (WVU) campus.

Under the task to develop curricula and conduct AFV and EV training:

- NAFTC finalized the content for the following curricula, and completed draft layouts.
    - Online AFV/EV Training for Towing and Roadside Assistance Personnel and
    - Online AFV/EV Training for Automotive Recycling Personnel
- NAFTC finalized the narratives for the following and completed draft layouts.
    - AFV/EV Collision Repair Training and
    - AFV/EV Fueling, Repair, Maintenance and Conversion Facility Training

Both the online courses and classroom courses will be presented at the NAFTC Expo II, our biennial membership meeting, in Las Vegas on October 28–29, 2018. The feedback from our members—most of whom are automotive faculty teaching in community colleges—will be incorporated into the final course materials by the end of the calendar year.

Under the task to market and conduct outreach for the curricula, the NAFTC continued to promote the project at various national conferences and meetings, including:

### *Energy Independence Summit*

The NAFTC presented information about the four courses at this DOE conference in Washington DC, February 12–13, 2018.

### *NTEA/Green Truck Summit 2018*

The NAFTC held the Clean Cities Coordinator Seminar for this project at the NTEA/Green Truck Show in Indianapolis, March 6–8, 2018.

### *Automotive Aftermarket Product Expo/Specialty Equipment Market Association (AAPEX/SEMA)*

The NAFTC has taken a key role in promoting alternative fuels and alternative fuel vehicles at the annual AAPEX show in Las Vegas. With more than 180,000 attendees, and held in conjunction with SEMA, this is one of the largest automobile-related trade shows in the world. This year, the NAFTC is heading up the three days of trainings related to AFVs at the show, October 30 – November 1, 2018. Prior to this, we will hold our member meeting and deliver the four courses in this project to our members.

### *Online Toolbox/Materials*

The NAFTC, in conjunction with the DOE project officer, finalized materials for the Online Toolbox micro-site. The toolbox will go live to coincide with the launch of the four curricula described above and will be promoted heavily through the NAFTC's communications vehicles (website, eNews, social media). An Internal Advisory Committee, consisting of Clean Cities Coalition partners, met four times via conference call; the discussions resulted in numerous promotional materials to help publicize the four curricula cited above. The online toolbox will serve as the central point for these materials, including flyers, posters, press releases, audience profiles, media placement tips, radio spots, and more.

### *National AFV Day Odyssey*

The 2017 National AFV Day Odyssey took place April 20, 2017. The signature event, attended by the NAFTC, was held in Dallas, in conjunction with the three-day Earth Day Texas festivities. More than 100,000 people attended this celebration. For the more 55 local and regional events held around the country, NAFTC developed information and provided it to site coordinators on a host of topics including materials about AFVs, event planning, public relations, and working with media. Plans are currently underway for the next Odyssey, which occurs every other year, providing a national forum for continued promotion of the project courses.

## Conclusions

The NAFTC has made substantial progress on the Alternative Fuel Vehicle Curriculum Development and Outreach Initiative project. Despite the challenges of moving and the loss of personnel, the project will be completed in 2018.

The training materials and related promotional items fill key gaps in the extant literature related to alternative fuel vehicles. Providing education for those working in the towing and recycling industries is a key component to safely dealing with AFVs. Providing information about facility requirements and details about repairing AFVs will result in more repair facilities being able to accommodate this growing segment of the automotive industry.

## References

[1] Automotive Training Managers Council, and MarCom, which honors excellence in marketing and communication, and is administered by the Association of Marketing and Communication Professionals

[2] National Biodiesel Board, American Automobile Association (AAA), and Automotive Recyclers Association (ARA)

# I.2 Southeast AFV Demonstration Initiative (SADI) (Triangle J Council of Governments)

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Start Date: July 15, 2015 End Date: January 14, 2018
Total Project Cost: $382,226 DOE share: $190,248 Non-DOE share: $191,978

## Project Introduction

The Southeast Alternative Fuel Vehicle Demonstration Initiative (SADI) was a project funded by the Department of Energy (DOE) aimed at increasing the number of alternative fuel and advanced technology vehicles in North Carolina, South Carolina and Tennessee. Working with key partners, Triangle J Council of Governments (TJCOG) acted as the lead agency and is providing administrative oversight of the project.

SADI's goal was to provide best practices, objective data, and informational materials to potential end-users, to promote acceptance of advanced vehicles and alternative fuels. Additionally, project partners supported pioneering use of market-ready vehicles and alternative fuels in key markets.

Education partners included four Clean Cities coalitions: Land of Sky Clean Fuels Coalition (Asheville, North Carolina.); Centralina Clean Fuels Coalition (Charlotte, North Carolina); Palmetto Clean Fuels Coalition (South Carolina) and Tennessee Clean Fuels; as well as the North Carolina Clean Energy Technology Center (NCCETC).

Technology partners included Alliance AutoGas, ICOM NA, Johnston North America, Lightning Hybrids and Mainstay Fuel Technologies.

## Objectives

SADI's objective was to create and implement high impact and highly innovative approaches to increasing the acceptance and use of alternative fuel vehicles (AFVs), through hands-on experiences. This was accomplished by:

- Providing technology partners with opportunities to demonstrate AFVs, while providing stakeholders with opportunities to test different technologies, to help inform their future vehicle procurements;
- Providing expertise and guidance to fleets considering alternative fuel and vehicle options;
- Helping fleets overcome barriers to alternative fuel adoption;
- Providing a neutral third party to work through vehicle procurement options for fleets, and to be a trusted resource for fleet managers.

SADI supported the DOE Energy Efficiency and Renewable Energy (EERE) Strategic Plan's Goal 1 - Accelerate the Development and Adoption of Sustainable Transportation Technologies. This was done through

Pathway 2 - Replacing conventional fuels with cost-competitive, domestically produced, sustainable alternatives (alternative fuels) that reduce pollution.

## Approach

### *Task 1: Overall Project Management and Planning*

As the primary grant administrator, TJCOG worked to manage and execute the SADI program through securing contracts with program participants, including technology and education partners.

### *Task 2: Implement Demonstration Projects*

Technology partners conducted AFV demonstration projects over a 3-state region, in North Carolina, South Carolina and Tennessee. In total, the project reached 76 unique fleets, with over 244 individual drivers participating in the demonstrations. The education partners in each region were responsible for identifying fleets to participate in the demonstration opportunities. The fleets initially selected were based on existing contacts and partnerships formed through Clean Cities coalitions, and by determining users with fleet profiles that matched the available vehicle offerings. The Clean Cities coalitions spread the word about the demonstration opportunities through coalition meetings, email marketing, presentations at local conferences and individual outreach. This organically led to additional vehicle placements, through regional contacts that were established. Although not a formal partner, PSNC Energy, a natural gas provider, also worked with the education partners to publicize the demonstration projects, and to provide access to compressed natural gas (CNG) for project vehicles.

Technology partners provided CNG, liquefied petroleum gas (also known as LPG, or propane) and hybrid-electric vehicles for demonstration, as follows:

- Alliance AutoGas
    - Ford F-150 (LPG)
    - Ford Explorer Police Interceptor (LPG)
    - Ford Transit (LPG)
- ICOM North America
    - Ford Explorer (LPG)
    - Chevy Transit (CNG)
- Johnston North America
    - VS651 Street Sweeper (CNG)
- Lightning Hybrids
    - Ford E450 shuttle bus (hybrid retrofit)
    - Freightliner M2 box truck (hybrid retrofit)
- Mainstay Fuel Technologies
    - Freightliner Cascadia (CNG)

The project was originally designed to include three Nissan Leafs and two propane-powered school buses in the demonstrations, and to track the use of 24 commuters riding in E85 vanpool vans operated by Enterprise; however, it proved more difficult than anticipated to bring all the potential technology partners on board.

### *Task 3: Conduct Driver Training*

NCCETC created an EcoDriving training video that was shown to all project participants. For the Ford and Chevy vehicles, the education partners demonstrated how the bi-fuel switchover system worked, while fueling station personnel conducted fueling demonstrations for each user. For the Freightliner trucks and the VS651 street sweeper, the technology partners conducted a more in-depth training on the fuel system and proper operation of the vehicles. Depending on the vehicle, the education partners also distributed handouts containing vehicle specifications.

### *Task 4: Collect Vehicle Usage Data*

Education partners submitted information on fleet participation to TJCOG on a quarterly basis. TJCOG was responsible for data management, and tracked which fleets were participating in demonstrations, how many drivers participated, and how long they had the vehicle(s). TJCOG also followed up with drivers using a participant survey, to determine their knowledge about alternative fuels before and after the demonstrations, and to ask about any questions or concerns they had about the vehicles. Approximately 80 drivers responded to these post-demonstration inquiries. The education partners then had the opportunity to go back to the drivers and address any issues they had raised and correct any misconceptions they may have had about alternative fuels.

### *Task 5: Publicize Successes, Best Practices, & Lessons Learned*

Each education partner created at least one case study, based on a demonstration conducted by a fleet in its region. These case studies were posted on individual education partner websites and distributed via social media, and were also posted on the SADI website, as a way to share success stories and provide educational resources for ongoing engagement with potential AFV users.

## Results

At project close, milestones included the following:

### *Technology Provider Commitments Obtained*

TJCOG coordinated contract development and obtained commitments to participate in the project from Alliance Autogas, ICOM NA, Mainstay Fuel Technologies, Lightning Hybrids and Johnston North America. Attempts to obtain commitments from Nissan to include three Leafs in the project were unsuccessful. Nissan required that TJCOG provide insurance, and TJCOG eventually concluded that it could not take on the liability associated with having the Leafs participate. Similarly, the original plan to include two propane school buses in the demonstrations had to be modified. One bus company had a school bus it had planned to include in the project, but it found a buyer for that vehicle, so it was unavailable. Another company determined that North Carolina was not a hot market for alternative fuel school buses, as the Department of Instruction was not on board, and it also declined to participate in the project. After a legal review, Enterprise also declined to participate in SADI, so no E85 vanpool vans were included.

### *Data Management Plan Completed*

TJCOG worked with the project partners to develop and execute a data management plan, and submitted it to DOE on June 16, 2016.

### *Marketing Plans Developed*

The project partners developed customized marketing materials for each vehicle and region, based on the demonstration schedule, and TJCOG submitted the marketing plan to DOE on June 16, 2016.

### *Data Collection Website Developed*

TJCOG developed a data collection system with project partners and updated stats on total participation throughout the demonstration deployment. In total, 76 fleets and 244 individual drivers participated in the demonstrations, within the 3-state region (North Carolina, South Carolina, and Tennessee). See section below (Test Drive Data Obtained) for information on the post-demonstration participant surveys).

### *Test Drive Data Obtained*

The original plan called for the use of telematics on the demonstration vehicles; however, many of the participating fleets already used telematics on their vehicles, and had access to the data on vehicle and fuel use.

At the start of the project, it was the intention to have telematics on all the vehicles. However, due to cost concerns and general fleet interest, the telematics were discontinued. After the first few demonstrations, the education partners were told that most fleet managers were more interested in driving the vehicles and seeing how they performed, than in the data gathered by the telematics.

### *Driver Training Conducted*

As part of SADI, the education partners also wanted to be sure all participants received eco-driving training, so that no matter which type of vehicle was being driven, fuel reducing techniques could be used. NCCETC created an eco-driving training video that was shown to all project participants. [1]

The type of additional driver training that was provided varied by the vehicle being demonstrated, the technology partner involved, and the AFV knowledge of the driver. For example, the Johnston CNG street sweeper is a complicated vehicle requiring a Commercial Driver's License for operation; therefore, Johnston staff was very involved in every demonstration, providing fueling, driver, and maintenance training for each driver. A more common vehicle, such as the ICON Explore, could be driven by anyone with a basic driver's license and needed very little, if any, specialized training; education partners typically delivered this vehicle.

### *School Bus Report*

As the anticipated participation of one or more school bus technology partners did not occur, this deliverable was no longer applicable.

### *Participation Targets Modified*

SADI's original participation targets called for 900 individual driver demonstrations. This number relied heavily on the availability of three Nissan Leafs that were to be rotated among new fleets, including state and local government agencies and elected officials, every three days, for a total of 250 demonstrations. Original plans also called for having up to 60 school districts participate in the propane school bus demonstrations, and for including E85 vanpool vans. As the mix of available vehicles was different than what was originally anticipated, the project partners had to revise the participation targets accordingly. In total, 76 fleets and 244 individual drivers participated in the demonstrations, within the 3-state region (North Carolina, South Carolina and Tennessee).

SADI was originally designed with the requirement that technology partners would to commit to providing demonstration vehicles for a year or more. This requirement was difficult for most vendors to meet, due to the availability of demonstration vehicles throughout the country, and changing inventory. The project partners determined that conducting shorter-term demonstrations would result in more technology partners, and a wider range of vehicles being made available. An additional concern, heard many times from both technology partners and potential participants, was driver liability. Many vendors did not have insurance to cover so many varied drivers, and many fleets were concerned that their organizations' insurance would not cover a demonstration vehicle. This resulted in fewer vehicles being available for demonstrations and fewer fleets participating.

### *Vehicle Purchases*

As of the project close in January 2018, no vehicles had been purchased. We anticipate, however, that as funds become available from the Volkswagen Clean Diesel settlement, fleets will proceed with procurement. SADI participation was heavily weighted toward local government agencies and universities, and the timeline for their vehicle purchases is strongly based on budget cycles and available purchasing incentives. Notably, providing access to alternative fuels through this demonstration project has made fleets regionally more comfortable with these technology applications and more apt to consider an alternative fuel when procuring new vehicles. Multiple regional transit agencies in the Triangle region have started to add both electric and CNG buses to their fleet. Although these specific vehicle types were not available during the demonstration period, it is possible that introducing these fuel types through SADI made the fleets more comfortable with these procurement decisions.

## Conclusions

The SADI project was completed in early January 2018. As a result of this project, Clean Cities Coalitions, AFV vendors and fleet managers have developed new partnerships. These partnerships and collaborations helped to bolster adoption and support of alternative fuel technologies throughout the Southeast, and will extend beyond the project period. The team is encouraged by the level of interest this demonstration helped to generate, and staff will use lessons learned from this deployment to inform future procurement opportunities.

SADI has worked to remove barriers to alternative fuel fleet adoption, market these opportunities and build synergies with fleets and private industry; however, the requirement for technology partners to commit to a one and a half year time period discouraged many potential partners from participating. The project partners have determined that conducting shorter-term demonstrations would result in more technology partners, and a wider range of vehicles, being made available.

## References

[1] The video can be viewed at https://youtu.be/LWEnzW0x8F0.

# I.3 Creating an Alternative Fuel Training Network for Florida (University of Central Florida)

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Start Date: September 1, 2015 End Date: February 28, 2019
Project Funding: $750,000 DOE share: $600,000 Non-DOE share: $150,000

## Project Introduction

This project addresses the lack of technical expertise with new fuels and vehicle technologies in the emergency response sector, by establishing a network of instructors trained to teach first responder safety training to Florida's firefighters. It also addresses consumer reluctance to purchase new technologies by alleviating concerns about safe operation of alternative fuel vehicles (AFVs). This project was designed to ramp up the ranks of Florida first responders who are trained to handle emergency events involving AFVs.

In Florida, prior to the implementation of this project, there were less than 100 first responders, and even fewer instructors, who had received some level of training in this area. Florida is poised for a significant growth spurt in AFVs, and the associated refueling infrastructure, in the consumer and fleet markets, and the growth of a trained public safety workforce is essential to maintain that trend. Providing first responders with the knowledge and tools that they need when responding to an emergency event involving an AFV is essential for their level of comfort, and the residual effect of their confidence on the drivers of those vehicles is significant.

The project partners are the key to the successful deployment of this project, and include the four designated Florida Clean Cities Coalitions (Central Florida, North Florida, Southeast Florida, and Tampa Bay), and three training partners: the National Alternative Fuels Training Consortium (NAFTC), the Florida State Fire College (FSFC), and the North American Towing Academy (NATA). The University of Central Florida (UCF), Florida Solar Energy Center (FSEC) houses the Central Florida Clean Cities coalition, and served as the Principal Investigator. NAFTC has developed a comprehensive curriculum on Alternative Fuel Safety, including several courses targeting first responders and their instructors. The FSFC oversees and accredits all firefighter training on behalf of the Florida State Fire Marshal. NATA provides professional training and certification programs for tow truck operators.

## Objectives

The primary objective of this project is to establish an AFV training network for the state of Florida that provides alternative fuel safety and technical training to current and future emergency first responders, public safety officials, and critical service providers. The project will provide multiple levels of training and assessment to assure that the effort will achieve a broad impact across the alternative fuel user community. This project will:

- Create and implement high impact and highly innovative approaches to increasing the acceptance and deployment of AFVs, through safety related training.

- Establish an AFV training network for the state of Florida that provides safety and technical training on electric drive, CNG and propane vehicles to current and future emergency first responders, public safety officials, and instructors at educational institutions that prepare the first responder workforce
- Integrate AFV Safety First Responder Training into the curriculum approved by the Florida State Fire Marshall.
- Increase awareness of the value of AFVs in disaster planning, response, and mitigation. This objective was recently incorporated into the project as a result of the National Association of State Energy Officials' Initiative for Resiliency in Energy through Vehicles (iREV) initiative, and Florida's propensity for hurricanes.

## Approach

The initial approach to project implementation was modified immediately after convening the project team and partners. The Florida State Fire College was not expected to be actively engaged until initial training was offered. However, FSFC was an enthusiastic partner at the outset and had an early impact in terms of securing Fire Marshal approval of the training curriculum through the Fire College Department of Insurance Continuing Education System (FCDICE). FCDICE is run by the Bureau of Firefighter Standards and Training, which reviews and approves courses for firefighters, maintains class rosters, and approves instructors, as well as training providers. The next steps to implementation (with the task participants identified) included:

- Identify Training Participants (Coalition Partners)
- Obtain Florida State Fire College Approvals via FCDICE (UCF)
- Schedule and Promote Train the Trainer Workshops (UCF)
    - Secure Demonstration Vehicles (UCF, Coalition Partners)
    - Conduct Training (NAFTC, Coalition Partners)
    - Enroll Firefighter Instructors (UCF)
    - Assess Training (UCF)
- Create Directory of First Responder AFV Safety Training Instructors (UCF)
- Schedule Firefighter Workshops (Trained Instructors)
    - Secure Demonstration Vehicles (Coalition Partners)
    - Conduct Training (Trained Instructors)
    - Assess Training (UCF)
    - Conduct Tow Operator Training (UCF, NATA and NAFTC)
- Develop public education toolkit for first responders using Clean Cities outreach materials (UCF)
- Identify Workforce Board Funding Opportunities (UCF, Workforce Consultant)

Since the inception of the project, adjustments were made to the partnerships to improve effectiveness and increase participation. Changes include the addition of the National Fire Protection Association (NFPA) as a training partner for both first responders (firefighters) and second responders (tow operators). NATA's chief

instructor suffered from an illness and passed away before he was able to complete his tasks. The North Florida Clean Fuels Coalition assigned the NATA tasks to the Principal Investigator.

During the course of the project, the NFPA rolled out its AFV Safety Training for Firefighters, and UCF/FSEC was asked to facilitate two workshops in Florida in cooperation with the Virginia Clean Cities Coalition. These two courses were well attended and received excellent reviews. As a result, UCF/FSEC engaged NFPA to conduct a first responder workshop and a tow operator workshop, since NATA was no longer available to fulfill the tow operator deliverable.

## Results

The project has established a comprehensive database of Florida's fire departments and public safety training institutions that served as the basis for creating a network of certified AFV safety training instructors. The Coalition Partners supported the development of the database. We are continuing to coordinate the training efforts of certified instructors. We conducted tow operator training in July 2018.

The most significant achievement, which was considered initially to be the greatest challenge, was the program approval by the Florida State Fire College, and our recognition within the FCDICE System, of the following:

- Approved Educational Provider
- Approved Train the Trainer course
- Approved First Responder course
- Approved course instructors.

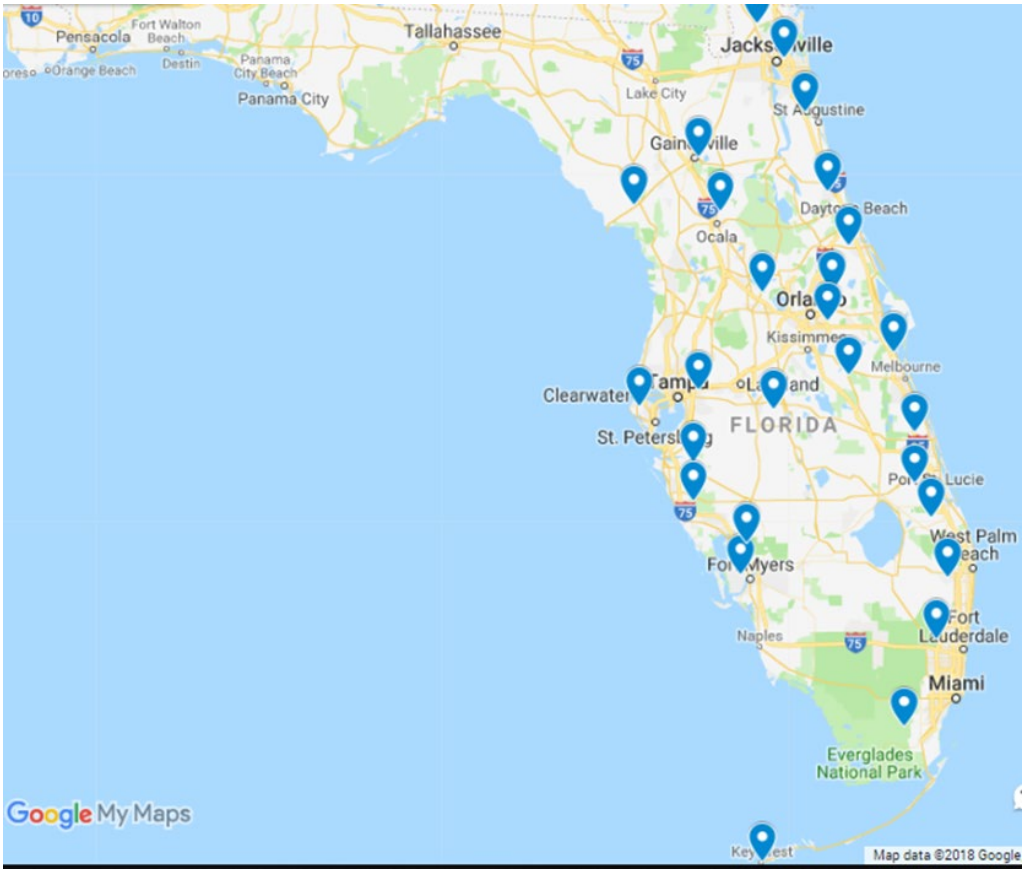


Figure I.3.1. Map of fire departments with NAFTC trained instructors

The four designated coalitions were responsible for coordinating the NAFTC training conducted in their regions, as well as the subsequent outreach to the trained instructors, to assist them in conducting workshops for their fellow firefighters. The map displayed in Figure I.3.1 shows that most of the Florida peninsula now has trained and certified instructors. The panhandle was not included, because the West Florida coalition is not yet an officially designated Clean Cities coalition, and as a result was not included in the project funding. Additionally, the workshops offered were somewhat remote from this region.

It proved challenging to track the training performed by the certified instructors, as much of the training conducted by fire departments is done on an informal basis within each department. The training also occurs in shorter increments than the 8-hour NAFTC course. Periodic outreach to trained instructors yielded little in the way of feedback. At the suggestion of the DOE contract manager, we distributed a survey to all participants, to ascertain how many had conducted follow-on training. We prepared and sent the survey via Survey Monkey to all trained firefighters on April 2, 2018. While only nine responses were received, that was a better result than was received through email contact. The responses were varied, but it is safe to say that the participants would welcome more training to prepare them to teach the course. Many of the instructors felt that they would benefit from additional instruction as a refresher, or to reinforce the initial training. Since they would be serving as instructors, it was important for them to have a solid understanding of the material. On the other hand, several instructors noted that they would approach teaching the course by reviewing the instructor manual and training materials provided, which is how they prepare to teach their other courses.

Only a handful of instructors reported that they have actually provided instruction to their fellow firefighters; however, anecdotal reports have indicated that more training is being conducted than is being reported. For example, one fire department solicited the community via Facebook for electric vehicles (EVs) for demonstration during an in-service training for firefighters. Another department that had attended the training held a high profile press event with the Florida State Fire Marshal announcing safety training for firefighters, in the aftermath of a tragic EV-related traffic fatality. This project brought the AFV Safety Training to the attention of the Florida State Fire Marshal. It is not always easy to document, or take credit for, the program's impact, however.

The following milestones were achieved with the support of the project's partners:

- Scheduled and promoted workshops and arranged for demonstration vehicles
- Completed Train the Trainer Workshops in each Coalition Region and at the state level
- NFPA conducted one additional Train the Trainer Workshop, with two more planned
- Trained 104 instructors state-wide
- Compiled workshop evaluations showing a high level of satisfaction
- Created a database of trained instructors
- Monitored the workshops taught by instructors trained to teach First Responder AFV Safety Training
- Identified opportunities for training at high profile firefighter training events
- NFPA conducted Tow Operator training, with one more planned
- Covered 28 of 67 counties, as shown in Tables I.3.1 and I.3.2

### Table I.3.1. Roster of Fire Departments with NAFTC Trained Instructors, by County and Coalition Region

| Fire Department | County | Coalition |
|---|---|---|
| Flagler County Fire Department | Flagler | Central Florida Clean Cities Coalition |
| High Springs Fire Department | Alachua | |
| Marion County Fire Rescue | Marion | |
| Melbourne Fire Department | Brevard | |
| NASA/KSC Fire Rescue | Brevard | |
| Orange County Fire and Rescue | Orange | |
| Rainbow Lakes Fire Department | Marion | |
| St. Cloud Fire Rescue | Osceola | |
| St. Lucie County Fire District | St. Lucie | |
| The Villages Public Safety Dept. | Lake | |
| Jacksonville Fire and Rescue | Duval | North Florida Clean Fuels Coalition |
| Nassau County Fire Rescue | Nassau | |
| St. Johns County Fire Rescue | St. Johns | |
| State of Florida Fire Marshal Office | Duval | |
| Boca Raton Fire Rescue | Palm Beach | Southeast Florida Clean Cities Coalition |
| Broward Sheriff Office Fire Rescue | Broward | |
| City of Lauderhill Fire Department | Broward | |
| Delray Beach Fire Rescue | Palm Beach | |
| Islamorada Fire Rescue | Monroe | |
| Miami Dade Fire Rescue | Dade | |
| Miramar Fire Department | Broward | |
| Sunrise Fire Rescue | Broward | |
| Bradenton Fire Department | Manatee | Tampa Bay Clean Cities Coalition |
| Cape Coral Fire Department | Lee | |
| Cedar Hammock Fire Department | Manatee | |
| City of Tampa Fire Marshal's Office | Hillsborough | |
| Dunedin Fire Department | Pinellas | |
| Hillsborough County Fire Rescue | Hillsborough | |
| Levy County Department of Public Safety | Levy | |
| Manatee Technical College | Manatee | |
| North Port Fire Rescue | Sarasota | |
| Palm Harbor Fire Rescue | Pinellas | |
| Public Safety Specialists | Hillsborough | |
| Polk County Fire Rescue | Polk | |
| Southern Manatee Fire Rescue | Manatee | |
| St. Petersburg Fire Rescue | Pinellas | |
| Tampa Fire Rescue | Hillsborough | |

Table I.3.2. Roster of Fire Departments with NFPA Trained Instructors, by County and Coalition Region

| Fire Department | County | Coalition |
|---|---|---|
| Brevard County Fire Rescue | Brevard | Central Florida Clean Cities Coalition |
| Cocoa Fire Department | Brevard | |
| Titusville Fire Department | Brevard | |
| Indian River County Fire-Rescue | Indian River | |
| Ocala Fire Rescue | Marion | |
| State Fire Marshal | Marion | |
| Martin County Fire Rescue | Martin | |
| Orlando Fire Department | Orange | |
| Osceola Tech College | Osceola | |
| Longwood Fire Department | Seminole | |
| City of Lake Mary Fire Department | Seminole | |
| Deltona Fire Department | Volusia | |
| Jacksonville Beach Fire Department | Duval | North Florida Clean Cities Coalition |
| Francis Volunteer Fire Department | Putnam | |
| Lauderhill Fire Department | Broward | South Florida Clean Cities Coalition |
| Broward Sheriff's Office Fire Rescue | Broward | |
| City of Sunrise Fire Rescue | Broward | |
| City of Pembroke Pines Fire Rescue | Broward | |
| Palm Beach Fire Rescue | Palm Beach | |
| Englewood Area Fire Control District | Charlotte | Tampa Bay Clean Cities Coalition |
| Hillsborough County Fire Rescue | Hillsborough | |
| Levy County Fire Department | Levy | |

Since money to support training programs is not always readily available, and program sustainability is a desirable outcome, one project objective was to identify alternative means of funding first responder training. The project retained a workforce agency consultant to identify opportunities to access formula funding available from the US Department of Labor to support new and incumbent worker training to upgrade their skills, particularly in areas of new technology. Through a series of interviews and questionnaires, the consultant determined that the prospects were good to pursue utilizing workforce funds for first responder AFV safety training. All pertinent occupations are currently included in the State and local workforce board issued Targeted Occupations List, a prerequisite for accessing training funds. The consultant concluded that meeting this major criteria could be the stimulus for garnering industry support to move forward to complete the remaining criteria to access workforce funding. The consultant also recommended a strategy for developing a stronger relationship with the local workforce boards, to secure funding. (See Figure I.3.2). The consultant made a presentation at the 2017 Clean Cities Coordinator Workshop to describe this approach and to encourage other coalitions to become engaged with their state and regional workforce boards, if they had not yet done so.

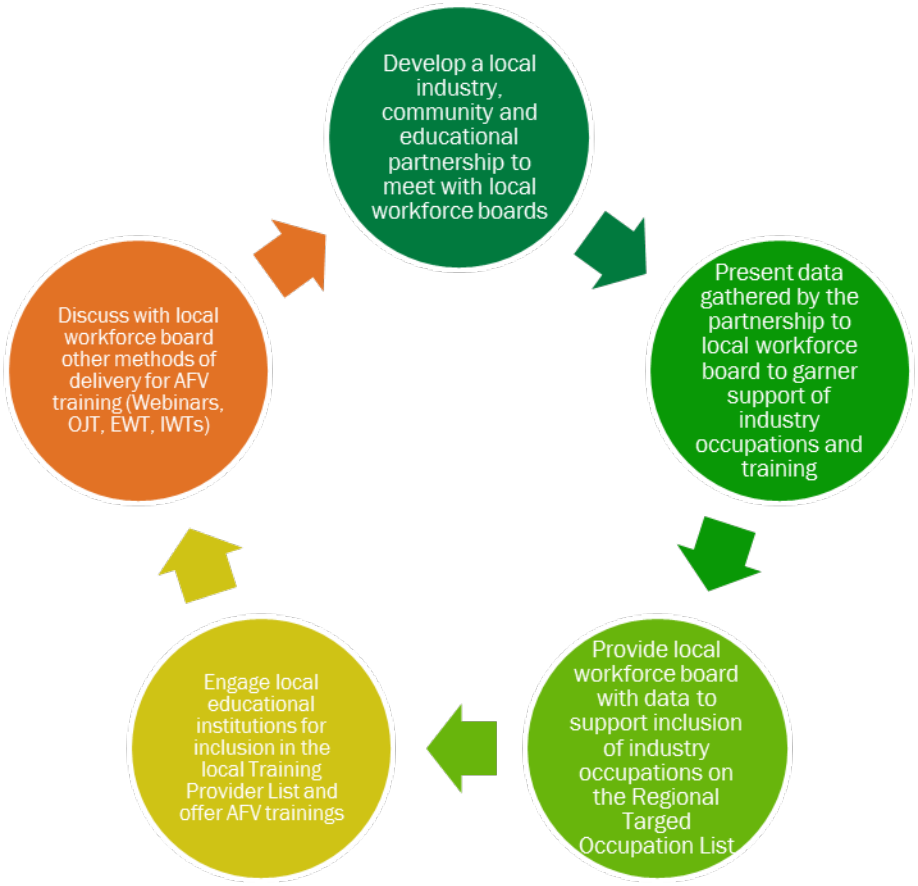


Figure I.3.2. Workforce Board Engagement Strategy

## Conclusions

This project successfully established Florida's AFV Safety Training Network of Firefighters with the approval of the Florida State Fire Marshal. The designated Florida Clean Cities coalitions have collectively created a database of Florida Firefighter Training Institutions and Certified Instructors, and have facilitated AFV Safety Training workshops. The project also identified Workforce Development Board funding as a source of training funding for program sustainability. The project has provided AFV Safety Training to Florida's tow operators, in cooperation with the National Fire Protection Association (NFPA). NFPA has also conducted additional AFV Safety Training workshops.

## Key Publications

"Four Florida Coalitions Bring AFV Training to First Responders Across the State," Fuels Fix, Winter 2017.

"Review and Engagement of Florida's Workforce Development Boards for the Purposes of Implementing Alternative Fuel Vehicle Safety Training for First Responders." Presentation at Annual Clean Cities Coordinator Workshop session on Diversified Funding Strategies. July 2017.

# I.4 Initiative for Resiliency in Energy through Vehicles (iREV) (National Association of State Energy Officials)

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Start Date: May 15, 2015 End Date: March 31, 2019
Total Project Cost: $1,251,528 DOE share: $1,000,000 Non-DOE share: $251,528

## Project Introduction

Vehicles that run on alternative fuels – such as biodiesel, electricity, natural gas, and propane – can help build system resilience by diversifying an emergency response fleet. In the aftermath of Hurricane Sandy, gasoline and diesel were in short supply throughout New York and New Jersey. Communities that had access to alternative fuel vehicles (AFVs) were able to use those vehicles to evacuate residents, transport clinic patients to medical treatments, help those staying behind gather emergency goods such as food and water, and assist with post-hurricane cleanup operations. Integrating AFVs into emergency operations and related plans can allow jurisdictions to rely on a diversified pool of fuel resources in the event of a gasoline or diesel fuel disruption. The Initiative for Resiliency in Energy through Vehicles (iREV) project provides information on alternative fuels and vehicles to the emergency planning and response communities; this information can then assist emergency managers in developing plans to activate AFV fleets to perform essential services, in the event that a storm or other emergency disrupts a state's primary fuel supply. In addition, building capacity among the nation's Clean Cities coalitions to engage local emergency managers, raise awareness of AFVs, and work with their communities to better integrate alternative fuels into emergency response plans will offer a sustained mechanism for enhancing resilience.

## Objectives

iREV is a nationwide project to equip emergency planners with the tools, information, and intra- and inter-state coordination strategies needed to incorporate alternative fuels into emergency management and preparedness operations, including state and local energy security and assurance efforts. iREV will accomplish three objectives:

- Create customized tools and information for emergency management decision-makers to examine the potential costs, benefits, and trade-offs of incorporating alternative fuels into their plans. This includes the iREV-Tracking Tool (iREV-T) to help state and local governments optimize their investments in AFVs.
- Promote intra- and interstate coordination and education among emergency planning and response entities at the local, state, and regional levels on key issues and strategies associated with incorporating alternative fuels into their plans, and strengthen coordination and education among Clean Cities Coalitions – who are key partners in leading to program success.
- Increase the prevalence of alternative fuels in existing and future state and local emergency planning and response operations using a multi-pronged approach: one-on-one partnerships with state and local emergency planning and response entities; direct engagement with energy assurance and emergency

management education and certification programs; and targeted communications and messaging to key stakeholder groups.

## Approach

The third year of the iREV project has built on previous successes by expanding access to iREV resources, delivering Policy and Planning Toolkits to jurisdictions across the country, and equipping Clean Cities Coordinators and others with the tools they need to speak with local emergency managers and strengthen resilience in their communities. Specific tasks that have been delivered over the past year include:

- *Incorporate iREV tools and recommendations into emergency preparedness and response channels.* The National Association of State Energy Officials (NASEO) created iREV Policy and Planning Toolkits for two jurisdictions (Lancaster County, Pennsylvania, and the State of Tennessee). These toolkits included a review of each jurisdiction's emergency plans and local AFV data, and offered customized recommendations for ways that the jurisdiction can integrate AFVs into their local fleets and emergency planning process. While both jurisdictions have made strides to implement recommendations from the Toolkit, the State of Tennessee is actively incorporating AFV language into their emergency plans, and is exploring opportunities to host exercises and other emergency planning workshops to better incorporate AFVs into the planning and response process.

- *Build capacity among Clean Cities coordinators to engage emergency managers and incorporate AFVs in their emergency planning processes.* NASEO has worked with Clean Cities coordinators to identify emergency managers and other relevant stakeholders; facilitate information exchange by coordinating, planning, and presenting at meetings, workshops, webinars, and teleconferences; provide training, outreach, and technical assistance on the use of AFVs and related infrastructure that is reliable and resilient, in case of emergencies and disasters, including training on iREV materials and tools; and develop additional training materials, tools, templates, and resources. While several tools are still under development, NASEO has worked one-on-one with each of the ten participating Clean Cities coalitions to identify emergency managers within their jurisdiction and provide customized technical support.

- *Support AFV and infrastructure planning and coordination between State Energy Offices and Clean Cities coalitions.* NASEO has continued to work with State Energy Offices, Clean Cities coordinators, and other key partners to provide technical support to key stakeholders on AFV program design under the Volkswagen settlement, and identify opportunities for building AFV capacity in jurisdictions across the country.

## Results

As noted above, iREV has released a series of materials to support the objectives of this project. NASEO identified two jurisdictions – Lancaster County, Pennsylvania, and the state of Tennessee – that served as "pilot" communities for the project. For each jurisdiction, NASEO created iREV Policy and Planning Toolkits, which reviewed their emergency plans and local fleet and infrastructure data and made customized recommendations for ways the community can integrate AFVs into local fleets and future emergency plans. For each pilot community, NASEO worked with the local or state emergency manager to learn about the local planning process; partnered with the local Clean Cities coalition to collect AFV and infrastructure data and incorporate this data into the iREV-T tool [1]; and presented recommendations for ways that the jurisdiction can incorporate AFVs into their local plans and local fleets in a "Policy and Planning Toolkit."

In addition, NASEO worked with select Clean Cities coordinators to engage emergency managers and explore opportunities to further incorporate AFVs into the emergency planning process. NASEO held a series of one-on-one calls with each participating Clean Cities coalition to ascertain their level of knowledge, direct them to appropriate resources, identify points of contact within their jurisdiction, and answer questions as they arose. Additional communication continued between NASEO and the Coalitions throughout the project period. In addition, NASEO participated in workshops, webinars, and teleconferences with coalitions to provide

information on alternative fuels and resilience. Examples of these activities include giving presentations at the Sustainable Transportation Forum in Tennessee (hosted by Tennessee Clean Fuels) and a workshop hosted by Capital District Clean Communities in Albany, New York; presenting on several Clean Cities-hosted webinars and calls; and setting up a series of informational webinars for participating Clean Cities coalitions.

To further build capacity, NASEO is developing additional materials to support Clean Cities and emergency planning. These include a checklist that Clean Cities coalitions can follow when reaching-out to emergency managers in their jurisdiction, as well as a template that jurisdictions can use to create their own Policy and Planning Tools. NASEO is also exploring the possibility of undertaking one to two additional pilots.

Finally, NASEO continues to provide technical support to states and Clean Cities coalitions on the Volkswagen settlement, specifically discussing ways the settlement may be used to enhance resiliency.

The efforts listed above build on previous products developed under iREV, including:

- Four case studies that provide basic information on biodiesel, electric, natural gas, and propane vehicles for emergency planners and provide key context for why alternative fuels should be considered during the emergency planning process, and used during emergencies
- A Baseline Assessment that reviews the current status of alternative fuel vehicles in emergency plans, and recommends ways that states may include alternative fuel vehicles in future plans
- An Alternative Fuel Vehicle and Infrastructure Tracking Tool to help emergency planning entities understand the various alternative fuel vehicles and infrastructure assets and options at their disposal, and optimize planning and investment based on their specific fuel supply, geography, and risk-profile
- Three regional workshops for emergency managers
- Other customized products for NASEO's partners, such as "issue briefs" disseminated to the International Association of Emergency Managers (IAEM) and the National Governors Association (NGA) for raising awareness among their members.

## Conclusions

NASEO will be finalizing remaining deliverables by March 31, 2019, and hopes to continue the important work begun under iREV. Key findings that resulted from this project are:

- *Additional education for new audiences is needed.* Through one-on-one calls with the Clean Cities coalitions and continued engagement with NASEO's State Energy Office members, NASEO continued to find that the emergency management community was largely unfamiliar with alternative fuels and has not considered them as an asset for emergency planning.
- *There is significant opportunity to further engage the emergency management community, provide them with basic information on alternative fuels, and discuss ways that AFVs can be integrated into emergency plans.* Additional states and communities have expressed interest in launching an "iREV Pilot" in their jurisdictions. NASEO is hoping to further engage other communities to help them build resiliency through the use of AFVs, ideally by targeting one or two additional jurisdictions that have strong existing relationships between the State Energy Office, State Emergency Management Agency, and the local Clean Cities coalition.

NASEO looks forward to finalizing work under this portion of the project and identifying opportunities to continue to incorporate alternative fuel vehicles into emergency planning.

## Key Publications

Powers, C. iREV Policy and Planning Toolkit: Tennessee. April 2018

Powers, C. iREV Policy and Planning Toolkit: Lancaster County, Pennsylvania. April 2018

## References

[1] https://irev.ctc.com/Account/Login?ReturnUrl=%2FProtected%2FMap.aspx

# I.5 Alternative Fuel Vehicle Demonstration and Enhanced Driver Experience (Penske Truck Leasing Co., L.P.)

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Start Date: July 15, 2015 End Date: July 15, 2018
Project Funding: $182,588 DOE Share: $35,453 Non-DOE Share: $147,135

## Project Introduction

Penske Truck Leasing Co., L.P. (Penske) deployed a targeted alternative fuel vehicle (AFV) demonstration project that allowed new drivers and fleets to "try out" cost-effective and clean-burning heavy-duty natural gas vehicles via Penske's rental services. All of the project vehicles ran on compressed natural gas (CNG). The demonstration units provided by Penske were 2015 Freightliner Cascadia 113" tandem axle day cabs. One CNG unit was available at each of the demonstration locations (Baltimore, Maryland; Baton Rouge, Louisiana; and Neenah, Wisconsin). The vehicle specifications were provided to participants, and are shown in Table I.5.1, below.

Table I.5.1. Freightliner Cascadia 113" Specifications

| | |
|---|---|
| **MPG** | 5.0-5.5 |
| **Chassis Weight** | 17,397 lbs. |
| **Range** | 490-539 miles, 115 DGE |
| **Engine** | Cummins ISX 12G 11.9L 400HP 1450 lb/ft torque |
| **Transmission** | Allison automatic 4000HS 6-speed or manual |
| **Wheelbase** | 192" |
| **Turning Radius** | 28' 0" |
| **Overall Added Length** | 25" for back of cab tank monitoring |

The project directly supported the goals of the Vehicle Technologies Office by demonstrating a cutting-edge alternative transportation program that ultimately reduced reliance on imported petroleum and lowered greenhouse gas emissions, while providing an opportunity for overall operational savings.

The project was a hands-on, high impact, highly innovative AFV demonstration for fleets that was designed to increase the acceptance of alternative fuels and spur the market for AFVs. Penske's commitment to a highly visible, widespread demonstration sent a strong signal to tens of thousands of U.S. fleets (as well as other stakeholders and agencies) that AFVs are critical to the rapidly evolving transportation sector. In a market study completed by project partner Gladstein, Neandross & Associates (GNA), an overwhelming 84% of the fleets currently using CNG anticipated increasing their use of natural gas in the future. These findings strongly suggested that the key to developing a self-sustaining, thriving AFV market is exposing fleets to the technologies and then enabling fleets to use the technology in everyday operations.

The project was meant to generate success stories based on the fleets that participated in the full-service AFV demonstration. As fleet managers often rely heavily on the experiences of their peers, these successes, along

with the resulting data and expanded AFV knowledge among local technicians and fleet managers, were expected to amplify the project's impacts, contributing towards broader regional acceptance of AFVs.

The main project partners were GNA and the Clean Cities coalitions located closest to the Penske branches offering the rental program: Wisconsin Clean Cities, Louisiana Clean Fuels, Southeast Louisiana Clean Fuel Partnership, and the Maryland Clean Cities Coalition (managed by the Maryland Energy Administration).

## Objectives

The demonstration's technical objective was to accelerate the market penetration of AFVs through rentals in three strategically selected geographic areas that had high potential for AFV acceptance, but little exposure to them. The project leveraged Penske's existing CNG fueling infrastructure and maintenance garages to enable successful demonstrations that would lead to long-term AFV adoption, an increase in the use of domestically produced fuels, and overall cost savings for fleets. Despite major advances in the technology and an increase in the adoption of AFVs, Penske has seen first-hand the challenges faced by some customers as they try to integrate AFVs into everyday operations. These fleets face issues including determining the proper vehicle specifications, understanding if and when AFVs are operationally compatible, locating fueling infrastructure, financing the high incremental cost of AFVs, and learning how to use the vehicles to maximize benefits.

A second project objective was to address the market barriers to introducing AFVs in regions with high potential for using alternative fuels, but where fleets do not traditionally use AFVs in their daily operations. Penske took a comprehensive approach that brought together AFV marketing, demonstration, customer support, data analysis and education. This approach enabled Penske to pursue a more aggressive strategy to target potential AFV fleets and ultimately lead to cost savings and diesel fuel use reduction for American fleets.

## Approach

The specific project areas were the regions of Neenah, Wisconsin; Baltimore, Maryland; and Baton Rouge, Louisiana. Penske provided the equipment and facilities used for the project, including the trucks and Penske's garages, all of which are AFV-capable. In the years prior to the project, Penske had developed processes at each of the sites for the safe maintenance of natural gas vehicles (NGVs). With over 25 years of experience with alternative fuels, all vehicle maintenance for the program was completed by Penske mechanics; for fleet managers and drivers, Penske provided a video, participant handbook and brochure with operating guidelines and vehicle information, as well as contact information for any questions or concerns.

Penske's approach was formed to directly address the common barriers to adoption of AFVs. Penske developed a proactive marketing plan to target the most probable fleets, provide comprehensive technical support, educate fleets about AFV benefits, and finally, to measure progress of acceptance and integration of AFVs into fleet operations. An example of the rental flow is as follows:

1. Penske created and shares marketing and education materials with Clean Cities coalitions and Penske branch locations
2. Clean Cities coalitions and branch locations distributed the materials to interested fleets
3. Customer contacted local Penske branch location
4. Penske qualified the customer
5. Customer rented the unit and returned it
6. Customer completed the follow up survey
7. Penske followed up as needed and, in some cases, requested a case study

The project was conducted in three 1-year budget periods that were generally aligned with the major go/no go decision points. Budget Period 1 saw the data analysis of existing Penske customers, customer need classifications, applications, and infrastructure, to begin deployment of AFVs in the targeted regions. This phase also included the creation of marketing and educational materials, as well as the beginning of an email marketing campaign and partnership efforts. In Budget Periods 2 and 3, Penske initiated demonstrations of the AFVs in the targeted geographies, and surveying, data collection and training efforts ramped up. Penske distributed follow-up surveys to the participating fleets and used this information to create three case studies of findings and lessons learned. Penske's partner, GNA, worked with Penske's marketing team to assemble the case studies, which were shared on a webinar with the Clean Cities coalitions.

Penske offers services to almost every goods movement and logistics industry, but it typically targets the following customers: bottled and canned soft drinks; groceries; manufacturing industries; owner-operation (individual); and roasted coffee. In April 2017, GNA used the FleetSeek database used to gather information on fleets within a 200 mile radius of each project location. This resulted in over 58,000 real contacts of fleet owners and operators. GNA used this contact list to launch a highly automated email campaign utilizing Eloqua that encouraged responses by:

- Emailing again with a different subject line within five days of the first email, if the first email was never opened or deleted
- Emailing again, with a different subject line and the same content, within five days of the first email, if the first email was opened
- Emailing again within five days of the first email, if the email was opened and the contact us form was clicked on but not filled out

Penske continued to use this tool to remind fleets of the program and to generate new interest from recently added or updated contacts.

The Clean Cities coalition partners provided direct outreach to prospective fleets. During monthly calls, Clean Cities partners provided suggestions on how to grow and promote the program, as well as updates from visiting and meeting with their local Penske branches. GNA organized the monthly check-in calls and acted as project manager for the demonstration project. Examples of GNA's tasks included: quarterly report and invoice preparation, development of email campaigns, and coordination with Clean Cities coalitions, Penske branch staff, and prospective customers.

## Results

During year one, fiscal year (FY) 2016, Penske focused on setting up the rental program, and built relationships with Clean Cities coordinators in each of the three selected locations. Penske conducted preliminary research on AFVs, infrastructure, and potential users, to lay the groundwork for a successful demonstration program.

The units arrived at the three locations in late 2016 and early 2017. During year two (FY 2017), Penske created materials, including a Participant Handbook (see Figure 1.5.1), to introduce consumers to AFVs and equip them with information to ensure a successful rental experience. Demonstrations began during this timeframe, but they had a slow start, due, in part, to the relatively low price of diesel fuel during much of the term of the program. As such, DOE extended the term of the program for a third year to enable more demonstrations to occur.

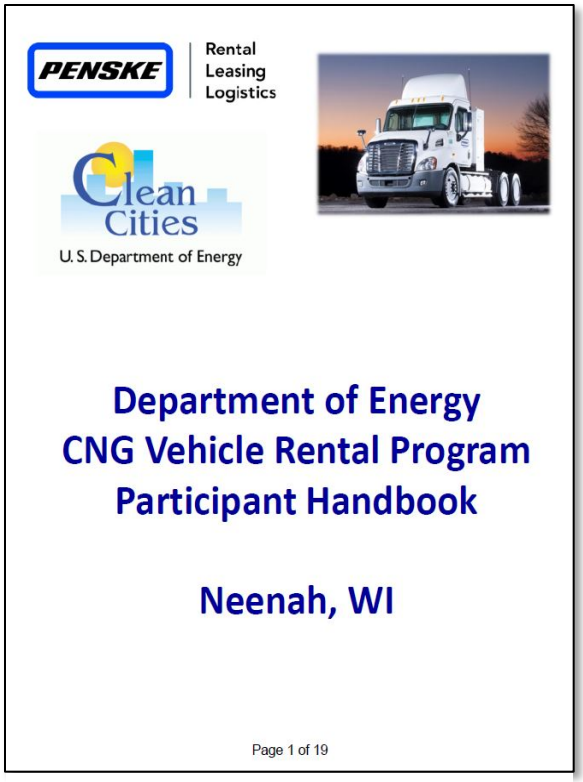


Figure I.5.1. Department of Energy CNG Vehicle Rental Program Participant Handbook for Neenah, WI (Source: Penske Truck Leasing Co., L.P.)

Penske utilized several channels externally and internally to increase program awareness with consumers and to train local sales teams at each branch. These channels enabled Penske sales team members to share program details and to be very proactive on outreach, providing information to potential fleet participants within a 200 mile radius of each Penske location.

FY 2017 focused on marketing and increasing rental numbers, and this focus carried over into FY 2018. Additionally, Penske developed case studies and utilized other opportunities, such as the Advanced Clean Transportation Expo, and an informational webinar, to share the program's successes and generate more interest.

Three demonstrations took place in 2016; 25 occurred in 2017, and 9 occurred in 2018. During year three (FY 2018), Penske reached its technical milestone of 50% of the anticipated demonstrations. The demonstration project concluded in July 2018 with a total of 37 rentals completed at an average of 5 days each. Table I.5.2 displays the anticipated and actual completion dates of the project's milestones.

**Table I.5.2. Project Milestones and Descriptions with Anticipated and Actual Completion Dates**

| Milestone | Description | Anticipated Completion Date | Actual Completion Date |
|---|---|---|---|
| **Map** | Finalize and vet local infrastructure map | 1/2016 | 3/2016 |
| **AFV Market Assessment** | Market assessment completed | 3/2016 | 3/2016 |
| **Identify AFVs** | Create list of AFVs to be used for the project | 4/2016 | 4/2016 |
| **Select Fleets** | Finalize selections; list submitted to DOE | 4/2016 | 6/2016 |
| **Demonstrations** | 50% demonstrations complete | 12/2016 | 1/2018[6] |
| **Case Studies** | Complete case studies based on initial demonstrations | Q1 2017 | 7/2018 |
| **Demonstrations** | 100% demonstrations complete | 7/2017 | 7/2018[7] |
| **Outreach** | Conduct webinar or speak at industry events(s); press releases issued and all content posted on website | Q2 2017 | 7/2018 |

[6] Penske had anticipated completing 60-80 demonstrations during the project period; however, due to setbacks and a lack of interest in long term rentals, Penske had completed 37 demonstrations (62%) by the project period end date.
[7] Ibid.

Initially, rental periods were intended to range between 30 and 90 days. Penske found, however, that the CNG technology was so new to potential project participants that many only wanted to try an NGV for a brief period, while one of their diesel vehicles was out for maintenance. As a response to customer feedback, Penske removed the rental period requirement, making short-term rentals possible. This led to a significant increase in interest in the program.

Penske's accomplishments included completing key data analysis and building strong relationships with the local branch locations and Clean Cities coalitions; completing 37 rental demonstrations; producing and presenting case studies; and disseminating results via an educational webinar. The Neenah, Wisconsin branch saw the most rental activity, compared to the other two branches. One of the Neenah renters converted into a long-term lease. Furthermore, the automated email campaign released in April 2017 caused over 20 new fleets to indicate interest in the program.

Several factors accounted for the lower than anticipated number of demonstrations. There were delays in delivery, as the project vehicles were active rental units housed with current customers, who initially wanted to keep them. There was an additional, and perhaps more significant, delay due to the amount of time required to assess targeted fleets for project suitability, which was longer than anticipated. This resulted in less time to conduct the actual demonstrations. While the Neenah unit was consistently in use, activity in Baltimore and New Orleans did not pick up as expected. In New Orleans, Penske found that there was a lot of concern among fleets about the availability of refueling infrastructure. There was a perception among fleets that there were not enough places to refuel. The New Orleans vehicle was out of service for a period of time, due to maintenance issues. Additionally, in Baltimore, there was a greater interest in propane vehicles, as there were more fueling locations available.

## Conclusions

The project began in July 2015 and ended on July 15, 2018. The key challenges included a slow start due to market conditions, delays in vehicle demonstration unit deliveries, and a lack of interest in taking the units out for longer than a few days at a time. As alternative fuels began to gain traction in a diesel-dominated industry, Penske, GNA, and the Clean Cities coalitions worked diligently to drive interest to the program. Penske also found through the email campaign that there was a lot of interest outside of the pilot areas, and that some of the Penske branch locations had more interest in AFVs than others. Penske's approach to facing these challenges included conducting outreach, as a precursor for growth into other areas, requesting and receiving approval for shorter rental periods, building on the collaboration with Clean Cities and Local Motor Carriers, and conducting automated email campaign efforts. Availability and lack of knowledge of fueling locations were also found to be key factors.

As rentals were completed, Penske collected customer information, allowing us to aggregate data on each customer's experience to create case studies, and develop best practices and lessons learned. The data and demonstrations showed that certain areas of the country are more of a hot bed for AFV activity than others, and that these types of demonstration programs can provide a huge uptick in awareness and acceptance of the technology. Furthermore, access to reliable fueling stations is critical when it comes to adoption of AFVs, as are price point flexibility and rental timeline flexibility. Rentals continue to provide a great way to test and validate new technology for duty cycles. These lessons will move Penske toward achieving its overall goals of exposing fleets to AFV operations with lower upfront costs, and increasing the integration of AFVs into fleets that currently utilize long-term leases for traditionally-fueled vehicles. In fact, this program's lessons learned will be leveraged for the Daimler Innovation Fleet project in Southern California, whereby 15-30 electric Freightliner M2s and Cascadias will be deployed via short-term leases.

## Key Publications

*CNG Vehicle Rental Program Participant Handbook*, available upon request via email, or at the Neenah, Wisconsin; Baltimore, Maryland; or Baton Rouge, Louisiana Penske branch locations.

*CNG Vehicle Rental Program Case Studies*, available at https://3dabnn2de32435t6mq2hy5ya-wpengine.netdna-ssl.com/wp-content/uploads/2018/07/Penske-Case-Study.pdf

# I.6 Filling Critical Gaps through Innovative Cradle-to-Grave Training (North Central Texas Council of Governments)

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Start Date: June 15, 2015 End Date: October 14, 2017
Project Funding: $701,308 DOE share: $514,638 Non-DOE share: $186,670

## Project Introduction

The North Central Texas Council of Governments (NCTCOG) and the Dallas-Fort Worth Clean Cities (DFWCC) Coalition began implementing the Filling Critical Gaps (FCG) grant in 2015. This project has enhanced and provided training on alternative fuels and alternative fuel vehicles (AFVs) to mechanics/technicians, first responders, public safety officials, and other critical service providers across a multi-state region. The project's goal was to remove barriers to the use of AFVs, such as the lack of technical expertise with new fuels and vehicle technologies, and consumer reluctance to try these technologies, thereby helping to reduce US dependence on foreign oil, increase the viability and use of renewable energy technologies, and increase energy efficiency.

The trainings were necessary to increase the number of professionals qualified to work with AFVs, improve technical knowledge, and increase consumer confidence with new fuels and AFVs. The grant provided 20 training classes with the National Alternative Fuels Training Consortium (NAFTC) for mechanics and first responders, and 10 training classes with FS Circle, focused on public safety officials, for a total of 30 classes. These classes were held in four states in the South Central Clean Cities Region: Arkansas, Louisiana, Oklahoma, and Texas. Project sub-recipients were the Arkansas Energy Office (AEO), Louisiana Clean Fuels (LCF), Regional Planning Commission (RPC), Indian Nations Council of Governments (INCOG), Lone Star Clean Fuels Alliance (LSCFA), and NAFTC.

## Objectives

The objective of this project was to expand access to training on alternative fuels and AFVs, for mechanics/technicians, first responders, public safety officials, and other critical service providers across a multi-state region. This project was intended to demonstrate the need for regular training, and to create opportunities for these classes to continue, by using a Train the Trainer format.

## Approach

The project team utilized existing AFV curricula for trainings for first responders, public safety officials, and critical service providers, so that funding could be concentrated on training implementation, rather than curriculum development. The project team worked with vocational and community college instructors and institutions to include relevant AFV curricula in their regular course offerings, so that the trainings would be sustained after the project period ended. In addition to training on AFVs and alternative fuels, the project also included compressed natural gas (CNG) station safety training for fire marshals and code officials, to deepen their understanding of CNG stations. During fiscal year (FY) 2018, Momentum Fuel conducted one additional training, as an in-kind service, and NCTCOG closed out the project.

The project team used a variety of methods to market the trainings, including meetings, newsletters, email correspondence, social media, website updates, paid advertising, and exhibits at conferences. Figure I.6.1 shows marketing efforts from DFWCC and its sub-recipients during the grant period.


Figure I.6.1. Per cent of project marketing resources spent on each outreach activity/channel

Overall, DFWCC and the sub-recipients were pleased with the attendance numbers. More than 350 first responders, alternative fuel technicians/mechanics, public safety officials, and other critical service providers registered and attended these AFV and CNG safety classes. By analyzing the successes and shortcomings of each event, DFWCC and the sub-recipients were able to develop best practices for hosting similar training.

The Train-the-Trainer courses benefited the region because post-grant, the trainers that have attended the courses can go on to perform their own trainings and host their own classes. Trainings could be hosted more frequently, and in more rural areas, allowing for more potential attendees from niche markets.

During the grant period, several community and technical colleges expressed interest in becoming NAFTC Associate Training Centers, but due to funding and staffing issues, these plans fell through. The fee for membership is $2,500 per year, and the colleges were unable to work through the financial obstacles, despite DFWCC offering subsidies. DFWCC is continuing to investigate becoming an NAFTC Government Member, which would allow it to manage and host the trainings at a reduced cost.

DFWCC and the sub-recipients are looking at ways to pay for additional trainings, in the absence of federal grant money. DFWCC and the sub-recipients have expressed interest in finding sponsors to fund future trainings, and in collaborating with local gas and electric utilities to leverage their training facilities. The trainer could provide the training pro-bono, or it could be funded through the trainer's organization and provided as in-kind to the DFWCC or potentially through a Federal Emergency Management Agency (FEMA) grant.

## Results

DFWCC and its sub-recipients struggled with participant attendance at first, as the training topics were considered a lower priority than safety and hazmat training, and attendee work schedules (shift work for first responders) made participation difficult. After working with first responder associations, and making a few adjustments in the course hours, registration peaked slightly. The project team also worked with state agencies such as Departments of Health, State Fire Marshals and Police Academies to ensure that the courses would qualify for continuing education credits, which caused registration for the first responder courses to increase. The classes were originally structured as Train the Trainer courses, but they were opened up to additional non-trainer attendees from the participating organizations, to fill the initial classes. Approximately 90% of the attendees were trainers.

DFWCC surveyed the grant's sub-recipients to obtain feedback and recommendations for potential improvements to future trainings. Recommendations included expanding the reach to include more fire departments from smaller communities, as well as volunteer groups; developing partnerships with additional technical colleges, universities and police and fire associations; more online classes, especially for police and fire departments and other first responders; and more funding to provide lunch, make training more interactive and include vendor showcases (see Figure I.6.2).

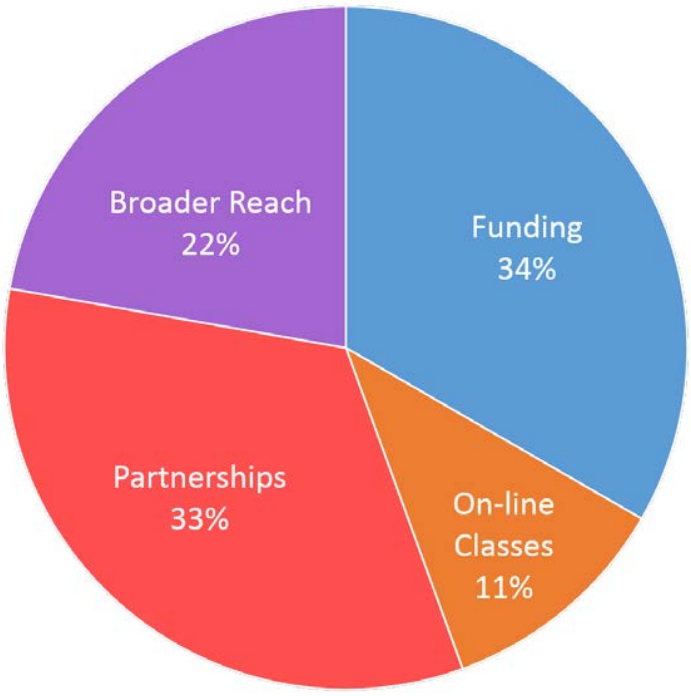


Figure I.6.2. Breakdown of grant subrecipients' recommendations for potential improvements to future trainings

## Conclusions

Overall, training participants found the first responder courses to be beneficial. DFWCC and its sub-recipients asked participants to complete course evaluations after taking each training. Questions pertained to, among other things, the instructor's knowledge, ability to communicate complex topics, ability to present in a clear and effective manner, and responsiveness to attendees' questions. The attendees were also asked about the quality of course materials, whether they added to understanding of the topic, the relevance of the content, learning objectives and course structure. They were asked to indicate, on a scale of 1 to 5, with 1 being "Strongly Disagree" and 5 being "Strongly Agree", whether they agreed with positive statements about the

various aspects of the trainings, e.g., "The instructor was knowledgeable". The results of the evaluations of trainings hosted by DFWCC are shown in Table I.6.1.

Table I.6.1. Training Evaluation Response Summary

| Evalutation Response Summary | Strongly Agree | Agree | Unsure | Disagree | Strongly Disagree | Number of Courses |
|---|---|---|---|---|---|---|
| AFV First Responder Safety Training | 86% | 12% | 1% | 0% | 0% | 5 |
| Part I: The Instructor | 93% | 7% | 0% | 0% | 0% | |
| Part II: Course Materials | 82% | 15% | 3% | 1% | 0% | |
| Part III: General Teaching and Learning | 74% | 23% | 2% | 1% | 0% | |
| Part IV: Course Facilities | 98% | 2% | 0% | 0% | 0% | |
| Part V: I took this course for... | | | | | | |
| Work | 23 | | | | | |
| Academic | - | | | | | |
| Personal | 3 | | | | | |
| Learn More | 3 | | | | | |
| Other: | - | | | | | |
| | | | | | | |
| CNG Fuel System Inspector Safety Training | 91% | 6% | 2% | 0% | 0% | 2 |
| Part I: The Instructor | 95% | 5% | 0% | 0% | 0% | |
| Part II: Course Materials | 82% | 12% | 6% | 0% | 0% | |
| Part III: General Teaching and Learning | 92% | 4% | 4% | 0% | 0% | |
| Part IV: Course Facilities | 96% | 4% | 0% | 0% | 0% | |
| Part V: I took this course for... | | | | | | |
| Work | 15 | | | | | |
| Academic | 4 | | | | | |
| Personal | 2 | | | | | |
| Learn More | 3 | | | | | |
| Other: | - | | | | | |

For the AFVs First Responder Safety trainings, 86% of attendees indicated they "Strongly Agree" and 12% indicated they "Agree" with positive statements about the trainings. The CNG Fuel System Inspector Safety trainings received a 91% "Strongly Agree" and 6% "Agree" response to positive statements. Less than 2% in each training category rated "Unsure" and no attendees indicated that they "Disagree" or "Strongly Disagree" when responding to positive statements about the training. Evaluations from trainings hosted by the sub-recipients in other regions showed similar responses.

Based on the training course evaluations, DFWCC concluded that the grant provided successful trainings to first responders, alternative fuel technicians/mechanics, public safety officials, and other critical service providers in the four states in the Clean Cities South Central region where training occurred. Additionally,

participants have expressed the desire to continue having these safety trainings in the near future to educate first responders and technicians on the ever-changing and evolving vehicle technologies.

## Key Publications

DFW Clean Cities Newsflash Article, February 2016

DFW Clean Cities Newsflash Article, March 2016

DFW Clean Cities Newsflash Article, May 2016

DFW Clean Cities Newsflash Article, June 2016

DFW Clean Cities Newsflash Article, July 2016

DFW Clean Cities Newsflash Article, August 2016

DFW Clean Cities Newsflash Article, April 2017

DFW Clean Cities Newsflash Article, May 2017

DFW Clean Cities Newsflash Article, July 2017

DFW Clean Cities Newsflash can be found online at https://www.dfwcleancities.org/publications

# I.7 Drive Electric Orlando (Florida Department of Agriculture and Consumer Services, Office of Energy)

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Start Date: July 16, 2015 End Date: January 14, 2019
Project Funding: $849,060 DOE share: $400,000 Non-DOE share: $449,060

## Project Introduction

There are generally three barriers to widespread adoption of electric vehicles (EVs): technology cost and performance, charging infrastructure availability, and consumer acceptance. Drive Electric Orlando seeks to address this third barrier by providing an opportunity for consumers to experience an EV risk-free, for an extended period. By utilizing Drive Electric Orlando's fully-integrated EV rental network, Orlando visitors have an opportunity to become familiar with the capabilities and benefits of EVs, in the process increasing consumer acceptance and adoption. While geographically limited to the greater Orlando area, Drive Electric Orlando will have a national impact, as this area hosted over 72 million people just last year.

Drive Electric Orlando's overall goal is to create extended test drive (rental) experiences that will substantially increase consumer awareness of the benefits and capabilities of EVs, with a long-term objective of increasing the likelihood that program participants will consider purchasing an EV the next time they are in the market for a passenger car.

To introduce consumers across America, and around the world, to electric vehicles, Drive Electric Orlando is harnessing the power of its greatest asset—the Orlando tourism industry. By offering EVs as rental cars, Drive Electric Orlando can familiarize people with the benefits of this technology and advance its adoption nationwide.

## Objectives

The objective of this project is to provide scalable consumer education and vehicle demonstrations to allow visitors to Orlando, Florida to experience the benefits of EVs, and to increase the acceptance and adoption of Alternative Fuel Vehicles (AFVs).

## Approach

The Drive Electric Orlando team consists of the Florida Department of Agriculture and Consumer Services, Office of Energy; the Electrification Coalition; and the Central Florida Clean Cities Coalition. The project would not be possible without the dedication and support of all the Drive Electric Orlando volunteer partners: General Motors (GM), Enterprise Rent-A-Car (Enterprise), Disney, Universal Studios, and many more. Together, the Drive Electric Orlando team and its volunteer partners are building public and private partnerships, creating incentives for EV rental, elevating program awareness, and measuring success. See Figure I.7.1.


Figure I.7.1. Drive Electric Orlando Partners

### *Maintain and Expand Public-Private Partnerships*

The Drive Electric Orlando team worked with its volunteer partners to increase the availability of Electric Vehicle Supply Equipment (EVSE) in the greater Orlando area, and to ensure that it is properly installed. The Drive Electric Orlando team also provided training that covers basic charging, and vehicle range information, to its partners. The training included short videos, PowerPoint presentations, fact sheets, and sample maps that show the network of available charging infrastructure in Orlando. In addition, the Drive Electric Orlando team also conducted outreach to greater Orlando area businesses to develop interest in, and awareness of, workplace charging, to support a network of business travelers.

### *Create Incentives for EV Rental*

To meet its objective, the Drive Electric Orlando team worked with Enterprise Rent-A-Car (Enterprise), its rental partner, to gain a commitment to offer EVs at a price comparable to that of similarly sized internal combustion engine vehicles. Enterprise also agreed to develop protocols that make it easy for customers to utilize EVSE and to access payment options. The Drive Electric Orlando team worked with theme park and hotel partners that offer incentives that contribute to a positive EV rental experience for their visitors, as well as promote EVs and the Drive Electric Orlando program to other theme park and hotel guests.

### *Elevate Program Awareness*

The Drive Electric Orlando team developed a marketing strategy with the Clean Cities coalitions from the largest national Orlando tourism feeder markets. These selected Clean Cities coalitions engaged their partners, consumers, issue experts, and others to elevate awareness of the Drive Electric Orlando program, and to educate consumers on the latest EV technologies and the benefits of driving electric. The Drive Electric Orlando team also worked with national travel networks to create outreach programs that engage consumers as early in the vacation planning and decision-making process as possible.

### *Measure Success*

The Drive Electric Orlando team is in the process of evaluating and analyzing the project impact on a subset of those who have been exposed to Drive Electric Orlando and/or rented an EV through the program, to understand consumers' changes in perception of EVs. The analysis will also identify which incentives and advertising messages were effective in motivating drivers to rent EVs, and determine how that might impact the likelihood of them purchasing EVs in the future.

## Results

### *Milestone: Electric Vehicle Rental Inventory*

The Drive Electric Orlando team exceeded its initial deliverable goal to have 15 rental cars available. Since the program began in 2015, volunteer partners Enterprise and GM have demonstrated their commitment by twice replacing older model year vehicles with the newest model year EVs available (see Figure I.7.2). This swap-out was an important inflection point for the program, as the newer model Chevy Volts offer an increased electric range, have a more aesthetically-pleasing exterior design and include a number of interior upgrades that make it easier for first-time EV drivers to understand the operations of the cars.

Figure I.7.2. 2019 Chevrolet Volt

To ensure that renters have a seamless and superior rental experience, the Drive Electric Orlando team has worked with Enterprise to map out a comprehensive employee training and accountability program. To date, 250 Enterprise employees based at the Orlando International Airport have been trained.

### *Milestone: Marketing Approach Developed*

In October 2016, the Drive Electric Orlando team successfully ran a pilot test of creative advertisement that targeted three major visitor feeder markets (New York, Boston, Chicago), and focused on travelers planning for winter/holiday trips. The Drive Electric Orlando team paused the pilot campaign after thirty days to analyze the results and address barriers, to create the most effective marketing campaign possible.

In Fiscal Year 2018, the Drive Electric Orlando team successfully deployed a second phase of the marketing and advertising campaign. This phase utilized Clean Cities coalitions in Orlando's top visitor feeder markets (Washington D.C., New England, New York City, and Atlanta), to promote Drive Electric Orlando to their respective stakeholders. To assist in that promotion, the Drive Electric Orlando team, with input from participating coalitions in each market area, developed a Clean Cities coalition-specific electronic "toolkit" that includes all the messaging and assets that Clean Cities coalitions would need to conduct a marketing and advertising campaign. See Figure I.7.3.


Figure I.7.3. Drive Electric Orlando brochure

### *Milestone: Rental Partner Incentives*

Enterprise made the commitment to tie the rental price of the Chevy Volts in the company's fleet to the rental price of a standard midsize vehicle. Additionally, Drive Electric Orlando renters do not pay for any EVSE charging. Each vehicle has been equipped with a ChargePoint key fob that allows drivers to charge their vehicles at any ChargePoint station for free. While many hotels and other locations offer free charging to Drive Electric Orlando renters, in the instances where there is a "charge to charge," Securing America's Future Energy (SAFE) covers any fees incurred by drivers using the ChargePoint key fob.

The Drive Electric Orlando team has worked with local theme parks to develop the following "major" renter incentives:

- Drive Electric Orlando renters received a special VIP pass that provided front of the line access to the Test Track ride presented by Chevrolet at Disney's Epcot Center, and access to the ride's VIP lounge. This perk was discontinued in spring 2018 due to lack of uptake in use of this incentive coupled with the strain on Enterprise employee resources to distribute the passes.
- Up-front parking at Disney's Magic Kingdom
- Up-front parking at Disney's Epcot Center

- Up-front parking at Disney's Animal Kingdom
- Up-front parking and free charging at Universal Orlando Resort

The current perks that are offered from hotels for Drive Electric Orlando renters with charging stations are as follows:

- 44 hotels have a charging station on the property
- 30 hotels offer free parking to EV drivers
- 27 hotels offer free charging to EV drivers
- 19 hotels offer premier up-front parking to EV drivers
- 1 hotel offers free valet to EV Drivers

### *Milestone: Tracking EV Utilization Rates*

The Drive Electric Orlando team continues to work with our rental car partner, Enterprise, to comprehensively track and report on the electric cars rented through the Drive Electric Orlando program at the Orlando International Airport. See Table I.7.1.

**Table I.7.I. Cumulative EV Utilization Rates for Fiscal Year 2018**

| 2018 | Total No. of EV Reservations | Number of EV Rentals | Cumulative EV Reservations (DAYS) | Total Miles Driven by EVs |
|---|---|---|---|---|
| Total | 450 | 99 | 2,212 | 36,977 |

## Conclusions

The Drive Electric Orlando team continues to work towards its objective of providing scalable consumer education and electric vehicle demonstrations for travelers to Orlando, Florida, to encourage them to experience the benefits of EVs. This fiscal year, the Drive Electric Orlando team continued its work with Orlando's major theme parks and hotels to refine, expand, and share information about the various incentives they have committed to providing to EV renters. The team has worked with Duke Energy Florida's Park & Plug program manager and the University of Central Florida to install Level 2 and direct current fast chargers in support of the program. The Drive Electric Orlando team also successfully launched a grassroots marketing and advertising campaign with the Clean Cities coalitions in Orlando's top visitor feeder markets.

The Drive Electric Orlando team is currently examining the results of the grassroots marketing and advertising campaign. The Drive Electric Orlando team is also in the process of crafting the final report for this project that will document the process, fully explore the lessons learned, and provide solutions for the challenges encountered. The Drive Electric Orlando team believes this will result in more people experiencing the benefits of EVs, thereby increasing their acceptance and adoption rate.

# I.8 Aggregated Alternative Technology Alliance (National Association of Regional Councils)

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Start Date: March 15, 2016 End Date: September 14, 2018
Project Funding: $2,224,651 DOE share: $1,758,599 Non-DOE share: $466,052

## Project Introduction

The Aggregated Alternative Technology Alliance, known as Fleets for the Future (F4F), is a national partnership of regional councils, Clean Cities coalitions, and industry experts tasked with coordinating five regional and one national procurement initiative designed to consolidate bulk orders and streamline procurement of alternative fuel vehicles (AFV) and fueling infrastructure. The National Association of Regional Councils (NARC), the lead organization on this project, represents regional councils and metropolitan planning organizations across the United States. Through regional cooperation, NARC members work on a variety of different issues, ranging from transportation to aging to the environment, to address community planning and development opportunities and issues. By utilizing its regional council members' outreach to their respective local government members and communities, NARC is spreading the word about the opportunities this project provides.

Collectively, the project partners recognized that there are multiple barriers in both the public and private sectors that they wanted to address through the F4F project. The key objective of the project was to reduce the high upfront costs of AFVs and electric vehicles for fleet managers and individual consumers. The team also strove to address consumers' lack of knowledge and technical expertise regarding AFVs and infrastructure, and overcome their reluctance to purchasing new technologies. Additionally, the project team wanted to address manufacturer concerns about demand for AFVs and technologies across the United States.

## Objectives

The goal of F4F was to "positively impact the AFV market in a 24-month period through the deployment of replicable fuel-neutral best practices and cooperative procurement templates that will enable competitive pricing and lower the upfront cost by 5-15% for AFV acquisition in local, regional, and state jurisdictions, as well as for private fleets through five large regional and one national procurement initiatives."

Additional objectives were as follows:

- Aggregate regional and national demand for propane, electric, and natural gas-powered vehicles, hybrid electric vehicles, and refueling or charging infrastructure
- Reduce the cost of these vehicles for private and public fleets using bulk cooperative procurement to obtain competitive pricing

- Develop best practices guides and create templates to assist regional councils of government in implementing cooperative procurement of these vehicles
- Plan and implement five regional procurements and one national procurement
- Develop a web-based toolkit to educate public fleets and procurement officers, and enable future cooperative procurement initiatives

These project objectives supported the following DOE Vehicle Technologies Office goals:

- Support pioneering technology integration of market-ready vehicles and alternative fuels in key early markets
- Provide best practices, objective data, and informational materials to potential end-users and investors, to promote acceptance of advanced vehicles and alternative fuels

## Approach

NARC brought together the following organizations to form the F4F project team:

- Regional Councils of Governments
    - Mid-America Regional Council (MARC), (Kansas City, Missouri)
    - Metropolitan Area Planning Council (MAPC), (Boston, Massachusetts)
    - North Central Texas Council of Governments (NCTCOG), (Dallas-Fort Worth, Texas)
    - Pima Association of Governments (PAG), (Tucson, Arizona)
    - Metropolitan Washington Council of Governments (MWCOG), (Washington, D.C.)
- Technical Partners
    - Cadmus Group (formerly Meister Consultants Group)
    - Electrification Coalition
    - Yborra & Associates
    - Propane Education & Research Council
    - ICM, Inc.
- Clean Cities Coalitions
    - Clean Communities of Central New York
    - Tucson Regional Clean Cities Coalition
    - Utah Clean Cities
    - Western Washington Clean Cities
    - Clean Fuels Ohio
    - Kansas City Regional Clean Cities

- Tulsa Clean Cities
- Southeast Louisiana Clean Fuel Partnership
- Triangle Clean Cities Coalition
- Centralina Clean Fuels Coalition

To increase outreach regarding the program, F4F added four more Clean Cities coalitions as partners in fiscal year (FY) 2018: Tulsa Clean Cities, Southeast Louisiana Clean Fuel Partnership, Triangle Clean Cities Coalition and Centralina Clean Fuels Coalition.

The F4F team created the following tasks to carry out the project objectives listed in the previous section:

*Task 1: Create replicable procurement best practices and templates*

- Review current research and best practices and convene technical leads to develop key best practices for alternative fuel vehicle procurement
- Develop and finalize templates for regional and national procurements.

*Task 2: Launch pilot procurement program in the Kansas City Metro Region*

- Develop and launch the regional procurement pilot program with the Mid-America Regional Council and the Kansas City Regional Clean Cities coalition, based at the Metropolitan Energy Center in Kansas City, Missouri early in Year 1, and document results of the program and outreach success.

*Task 3: Design and deploy regional procurement initiatives*

- Design and implement a procurement initiative in each of the four other participating regions with their respective regional councils of governments: Metropolitan Area Planning Council in Boston, Massachusetts; North Central Texas Council of Governments in Dallas-Fort Worth, Texas; Pima Association of Governments in Tucson, Arizona; and Metropolitan Washington Council of Governments in Washington, D.C.
- Provide training opportunities for regional councils and implement a marketing strategy in each region.

*Task 4: Design national procurement initiative with business plan for implementation*

- Consult subject matter experts and convene an expert panel to develop a business plan and implementation strategy for the national procurement initiative
- Create relationships on both the public and private sides for launching the national procurement and implementing a nationwide outreach plan

*Task 5: Collect data and results of both the regional and national procurements to evaluate success*

- Report quantitative and qualitative data from regional campaigns, including number of vendors, contracts, and sales projections as well as the results of outreach and education campaigns for the national initiative.

## Results

Below is the progress that has been achieved on each task during the past year:

*Task 1: Create replicable procurement best practices and templates*

In addition to the four best practices guides created in prior years, the project team created a fifth best practice guide that catalogued municipal electric vehicle charging resources. The team continued to spread awareness and provide education on the best practice documents through webinars, calls, and meetings. The Mid-America

Regional Council created an evaluation report for its procurement program, detailing lessons learned, results, and recommendations for future procurements.

### *Task 2: Launch pilot procurement program in the Kansas City Metro Region*

Key results and findings from the pilot include:

- The involvement of the Fleets for the Future team provided significant value to the metro Kansas City vehicle bid process.
- The project team successfully integrated AFV options into the metro Kansas City vehicle bid process that should be sustainable through subsequent bid processes.
- Final bid proposals included multiple AFV options on 35 of the 44 vehicle categories awarded. Thirteen dealerships secured contracts with Johnson County, Kansas, covering all eight classes of vehicles. Eighteen compressed natural gas (CNG), 14 propane, 4 hybrid electric vehicles (HEV) and 3 plug-in hybrid electric vehicle (PHEV) options are now available under the Mid-America Council for Public Procurement (MACPP) vehicle bid.
- The project achieved higher levels of awareness and AFV knowledge on the part of fleet managers, as well as dealership sales and service staff.
- The cost savings derived from purchasing vehicles through a cooperative procurement program are noteworthy. The most significant savings can be seen in the reduction of transaction and administrative costs and the savings extended by volume pricing.
- Through dealership and fleet interviews, the F4F project team confirmed that the MACPP vehicle bid is an attractive option because of its simplicity. Further streamlining can only enhance the appeal of this process.

### *Task 3: Design and deploy regional procurement initiatives*

The other four regional council partners each explored AFV procurements in their regions. They convened local stakeholders, surveyed potential participants, conducted gap analyses in their areas regarding alternative fuel vehicles, finalized their lists of vehicle platforms, and identified requirements and vehicle specifications. Two successful regional procurements were launched in these regions, while two were unsuccessful.

#### *Metropolitan Area Planning Council (MAPC):*

MAPC launched the Green Mobility Group Purchasing Program that leveraged the innovative contracting features of the statewide Advanced Vehicle Technology procurement contract (VEH102), and built on existing partnerships with state agencies to reduce the cost of clean vehicle technologies for public fleets. In FY 2017, ten vendors were selected among three categories: 1) electric vehicle supply equipment (EVSE), 2) idle reduction technology, and 3) aftermarket conversion technology. Public entities in Massachusetts and across the United States can procure these technologies through piggy-back language on the VEH102 contract. In FY 2018, MAPC continued to raise awareness of the contract across the state and nationwide, with help from project partners.

MAPC also collaborated with the Commonwealth of Massachusetts on a purchasing agreement with XL Hybrids to aggregate state and municipal purchases of aftermarket hybrid electric conversion systems. This pricing agreement started July 28, 2017 and ran through January 31, 2018. The opportunity offered both bulk and accelerated time-frame discounts for purchase orders submitted through the state contract, and was available to public entities in Massachusetts and nationwide. The agreement pricing included hybrid electric conversions for class 2 Ford and GM vans; class 3-6 Ford, GM, and Isuzu chassis; and plug-in hybrid electric conversions for Ford F-150 pickup trucks. During the first 30 days of the agreement, 26 hybrid electric

retrofits for class 2 and class 3-6 vans were purchased. The four participating fleets received discounts of 11-19% off their purchase orders, saving upwards of $1,000 per vehicle retrofit.

In 2018, MAPC launched a pilot using telematics to assess EV suitability within the Town of Natick's municipal fleet, to identify future clean vehicle technology purchasing opportunities. MAPC also created a one-page decision guide to assist communities in understanding aftermarket conversion technology opportunities.

MAPC also carried out initial outreach for Round II of the Green Mobility Group Purchasing Program through a survey, and received interest from 18 public fleets. This group purchase was focused on electric vehicle charging stations on behalf of eight communities in the region. MAPC issued a Request for Quotes for electric vehicle charging station equipment (software and hardware) off the VEH102 statewide contract, and awarded low bid contracts to two vendors. If the communities purchased charging stations by the end of November 2018, they were able to save 13 percent off the Manufacturer's Suggested Retail Price (MSRP) for Level II Dual Head stations and 7 percent off the MSRP for Level III/DC Fast Charging Dual Head stations. MAPC continued to contact the VEH102 vendors to receive required reporting information on sales. MAPC also developed an internal method for reviewing, evaluating, and analyzing the outcomes of the purchasing program.

***Metropolitan Washington Council of Governments (MWCOG):***

Because of the F4F project, MWCOG was able to garner enough interest to include AFVs and infrastructure in their regional cooperative purchasing program. They engaged with 26 public sector fleets and 16 policy and technical groups throughout the procurement process. MWCOG also issued a Request for Information to 200 area and national dealerships, to gauge level of interest for the Invitation to Bid that soon followed. They had much interest in their aggregate vehicle bid and awarded contracts to three vendors. Sixteen vehicle types are available through the contracts and the period of pricing is one year, from April 9, 2018 to April 9, 2019. MWCOG also organized an aggregate infrastructure bid for the D.C. region; however, they are unsure when they will be able to release the bid.

***North Central Texas Council of Governments (NCTCOG):***

NCTCOG planned to create a region-specific cooperative procurement program focusing on select AFVs. Through significant fleet outreach, surveys, stakeholder group meetings, and requests for proposals (RFPs), they found that an additional regional cooperative procurement would not add value to the market, given the strength of Texas-based cooperative procurement entities and the precedent for fleets already using them and other cooperatives. Therefore, NCTCOG and Dallas-Forth Worth Clean Cities turned their efforts toward promoting and highlighting the national and nationally-available procurements being conducted through F4F.

***Pima Association of Governments (PAG):***

PAG started with the concept of aggregated procurement for school buses. Ultimately, aligning interests and funding resources proved difficult for the alternative fuel school bus procurement. Each school district had different vehicle requirements, such as make/model, seat belts, fuel type, air conditioning, WIFI, etc. Additionally, many school districts decided to wait for the release of delayed Volkswagen (VW) Settlement monies before acquiring buses.

PAG also prepared, solicited, and evaluated a request for information (RFI) for an electric vehicle fleet share program in urban Tucson. The RFI received one response from a potential vendor; however, due to personnel changes within municipal partners, interest in the concept lost traction and has not progressed at this time.

### *Task 4: Design national procurement initiative with business plan for implementation*

The F4F national procurement initiative was initially divided into two parts: public sector and private sector. The project partners were unable to get the private sector procurement off the ground, so the focus shifted to the public sector procurement.

#### *National Public Sector Procurement:*

After researching national cooperative entities and assessing the value of strategic partnerships, the F4F team partnered with Sourcewell (formerly the National Joint Powers Alliance), a government entity that facilitates a competitive solicitation and awards process nationally. Membership is free to state and local government agencies, public and private education institutions, and other non-profit organizations. Sourcewell has hundreds of contracts that members can take advantage of at any time, including those from industry-leading vehicle and leasing vendors offering alternative fuel options.

The partnership with Sourcewell yielded immediate opportunities to access AFVs throughout the nation. The F4F team assisted in elevating the opportunities of the AFV options to the Sourcewell national membership, promoted the visibility of the AFV technology, and provided technical expertise for new contract solicitations.

The national project partners held 25 events and webinars to promote Sourcewell alternative fuel contracts, with 23 Sourcewell vendors providing AFVs and/or infrastructure. Since the partnership began, Sourcewell membership increased by 15,291, from 50,000. Five EVSE contracts were issued, with a total of $1.3 million in sales during the term of the project.

During the spring and summer of 2018, the national team worked with Sourcewell on its fleet management solicitation, which aimed to provide comprehensive fleet management services including leasing, vehicle repair and replacement, and preventative maintenance.

Based on project partners' input, the scope of this solicitation had a heavy focus on AFVs. F4F partners defined industry-specific questions, to enable Sourcewell to determine the degree to which vendors were willing to pass along the federal EV tax credit to public purchasers. The team also notified prospective vendors about the solicitation and informed them that their willingness to pass along a percentage of the tax credit would be considered a value-added attribute.

While F4F could not obtain comprehensive information about the volume of AFV purchases versus conventional vehicle purchases on the contracts, F4F received anecdotal evidence that fleets know and trust Sourcewell, have learned more about the AFV options available on Sourcewell because of the project, and are conducting purchases using the platform.

### *Task 5: Collect data and results of both the regional and national procurements to evaluate success*

The project team continuously tracks metrics such as the number of participants on webinars, number of Twitter impressions, and number of blog post, email, and e-newsletter recipients. Cumulative metrics for F4F outreach throughout the project duration are as follows: 32,421 project website views; 254,446 individuals reached through e-newsletter articles; 33,952 individuals reached through in-person events; over 113,544 impressions through social media (Twitter/Facebook); over 3,661 webinar participants; and 127,333 individuals reached through online mail e-blasts.

On the regional side, MARC collected data and results on the impact of the F4F pilot procurement. Their metrics can be found under Task 2 in the Results section, above. The other regional partners are also continuing to keep track of how many organizations they are in contact with, how many soft commitment requests they collect, and what AFVs and infrastructure are generating the most interest. Some of their metrics data can be found under Task 3 in the Results section, above.

## Conclusions

The F4F team wrote five best practice guides, the 7-step strategic procurement process, and a national procurement plan, all of which provided the needed framework to launch the cooperative purchasing initiatives. The project generated advancements in alternative fuel and advanced vehicle technology markets through its work to improve and enhance public aggregated procurement processes. At the end of the grant period, there are a larger number and wider variety of AFV options available in most vehicle classes, in regional and national cooperative purchasing programs, compared to those available prior to the project start in 2016.

Through the project's procurement initiatives, F4F created opportunities for fleet managers to have access to reduced incremental costs on AFVs and infrastructure. The partners used outreach and education to disseminate knowledge and best practices on application, usage, and procurement strategies for the selected vehicles and infrastructure. These actions have provided fleet managers and consumers with the knowledge and tools that they need to understand the benefits of AFVs and to become motivated to purchase them. By beginning to aggregate demand for AFVs this year on the regional and national level, AFV and related infrastructure manufacturers that are working with the project can clearly see that there is a growing demand for AFVs and infrastructure in the U.S.

Key elements of the F4F initiative have a strong likelihood to sustain the overall project goal established during the course of the grant. The regional, national, and industry partners will continue to engage their local government stakeholders through their support networks. The best practices guides will continue to be promoted through partners' websites, including the project site hosted by NARC. Specific online resources that were developed by F4F partners will also be maintained and promoted, such as the Sourcewell alternative fuels landing page [1], and the MARC Fleets for the Future webpage [2]. The F4F team will also encourage and assist their member local governments in exploring alternative fuel vehicles in years to come.

## Key Publications

The following publications are available on the Fleets for the Future website, http://www.fleetsforthefuture.org/f4f-best-practices/

- Electric Vehicle Procurement Best Practices Guide
- Fleet Transition Planning for Alternative Fuel Vehicles
- Gaseous Fuel Vehicle Procurement Best Practices Guide
- Guide to Financing Alternative Fuel Vehicle Procurement
- Guide to Municipal EV Charging Resources
- Kansas City Pilot Evaluation Report

## References

[1] https://news.sourcewell-mn.gov/simplifying-the-procurement-of-alternative-fuel-vehicles-afvs/

[2] http://www.marc.org/Environment/Energy/Alternative-Fuel-Vehicles/Fleets-for-the-Future

# I.9 AFV Aggregated Purchasing Initiative: Increasing Nationwide ZEV Adoption - Enhanced Joint Procurement Process for Public Fleets (CALSTART)

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Project Funding: $1,545,081 DOE share: $1,199,076 Non-DOE share: $346,005

## Project Introduction

The adoption of zero-emission electric vehicles (ZEVs) has been on the rise, as more ZEVs become available and the vehicles become more cost-effective. Public fleets want to lead by example, by switching their fleets to clean ZEVs. However, higher up-front costs, lack of adequate charging infrastructure, and long and complex procurement processes all present barriers for public fleets. This project aimed to remove these existing barriers, and develop a replicable procurement model that would better meet the diverse needs of public fleets.

This aggregated purchasing project is known as EV Smart Fleets. Project partners were California Department of General Services, Northeast States for Coordinated Air Use Management (NESCAUM), Georgetown Climate Center, Atlas Public Policy, and Ross Strategic. The project partners also worked closely with the following nine Clean Cities coalitions: Columbia-Willamette (Oregon); Denver Metro; Granite State (New Hampshire); Long Beach (California); New Jersey; Greater New Haven (Connecticut); Ocean State (Rhode Island); Sacramento (California); and Western Washington. The project focused on 16 states but was open to all interested states.

## Objectives

The main objective of EV Smart Fleets was to develop an innovative, replicable, multi-state procurement model that would provide public fleets across the country access to a wider range of ZEV models, with a 15% purchase price reduction and improved access to charging. The hypothesis was that using a single solicitation and contract would be more efficient than if individual jurisdictions developed their own solicitations, and would result in a larger aggregate volume of ZEVs being purchased. The specific objectives included the following:

- Conduct multi-stakeholder outreach and engagement
- Understand critical procurement barriers and evaluate fleet purchases
- Establish a mechanism for competitive aggregated ZEV purchasing
- Develop a flexible and multi-state ZEV procurement process
- Roll out a program solicitation

## Approach

EV Smart Fleets relied on several important features. First, the development of the solicitation was based on criteria established through extensive research and case studies of aggregated purchases of ZEVs in different regions and cities. Second, project partners engaged with, and conducted outreach to, a network of state and municipal government fleet procurement officials, to ensure the involvement of the largest possible number of government partners and buyers in the process. Third, the project engaged with automobile dealers and automakers to inform the development of the cooperative procurement process. Finally, the project included outreach and education on the benefits of ZEVs, and the business case for purchasing them, throughout the different phases of the project. The National Association of State Procurement Officers (NASPO) and its Value Point program led the procurement solicitation.

## Results

The project team conducted research to learn the capabilities and interest by the vehicle industry and what value, if any, a nationwide contract for EVs would provide state and local government entities. Through Original Equipment Manufacturer (OEM)/dealer outreach, market research, case studies, and sourcing team input, the following barriers and concerns were revealed:

- OEMs with franchised dealers are prohibited from direct bidding because of dealer franchise laws and agreements.
- OEMs prefer that their franchised dealers sell vehicles locally in their states, and do not understand the need for nationwide contract.
- There was very little interest from dealerships in participating in a nationwide procurement, even after a nationwide outreach effort.
- State governments are reluctant to, and/or are prohibited from, purchasing vehicles from out-of-state dealers.
- Awarding contracts to dealers in each participating state is not a viable option as it would be impractical and extremely challenging to manage.
- A nationwide contract for EVs will not provide dramatic cost savings from OEMs. EV sales nationwide, in comparison to vehicles with internal combustion engines, are extremely low, and do not provide the desired profit margins that OEMs seek.
- Drop fees, delivery fees and administrative fees for dealerships managing a nationwide contract may increase the purchase price of EVs, making a nationwide contract less attractive for government purchases.
- A federal tax credit for EVs is not guaranteed. Due to many variables, dealers are reluctant to offer such a discount.
- Price is usually a primary factor for government entities when purchasing vehicles. If a nationwide contract does not provide lower prices than from a local dealer, it will not be utilized.

Table I.9.1 is a list of recommended procurement elements for an EV solicitation, based on the research we conducted.

Table I.9.1. Elements of Potential Solicitation for a Multi-state EV Agreement

| Procurement Element | Initiative Goal Addressed |
|---|---|
| Encourage capture of the federal electric vehicle (EV) tax credit and all available state EV incentives | Achieve cost savings for fleets |
| Provide flexibility to lease or own vehicles | Achieve cost savings for fleets<br>Be useful to a wide variety of public fleets<br>Increase a fleet's access to a wider range of plug-in hybrid and battery electric vehicle models |
| Allow fleets to finance vehicles through a third party | Achieve cost savings for fleets<br>Maximize the number of eligible EVs. |
| Require pricing from the dealer's cost up and seek discounts | Achieve cost savings for fleets<br>Be replicable in future years |

The project concluded in February 2018, and the NASPO ValuePoint Management Board unanimously voted to end the nationwide EV procurement solicitation. The board members were encouraged, instead, to look at their own states' cooperative relationships with their political subdivisions and consider developing their own statewide EV contracts.

## Conclusions

Interest in ZEVs among public fleets is high; however, conducting an aggregated nationwide procurement solicitation encountered insurmountable barriers, led by very low interest from dealerships to participate in a nationwide procurement. Based on feedback from vehicle manufacturers and dealers, increasing nationwide ZEV adoption will require multi-year, state-level policy commitments to purchasing ZEVs at targeted levels.

## Key Publications

All the publications and tools developed have been shared on the website: www.evsmartfleets.com

Fleet Procurement Analysis Tool. 2017. http://evsmartfleets.com/materials/fleet-procurement-analysis-tool/

Capturing the Federal EV Tax Credit for Public Fleets. April 2017. http://evsmartfleets.com/materials/capturing-the-federal-ev-tax-credit-for-public-fleets/

Public Sector Fleet EV Procurement Examples. June 2017. http://evsmartfleets.com/wp-content/uploads/2017/06/Public-Sector-Fleet-EV-Procurement-Examples.pdf

# I.10 Midwest Electric Vehicle Opportunities: Learning eVents, Experience (Midwest EVOLVE) (American Lung Association in Minnesota)

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Start Date: October 1, 2016 End Date: September 30, 2019
Total Project Cost : $1,960,157 DOE share: $949,977 Non-DOE share: $1,010,180

## Project Introduction

The Midwest Electric Vehicle Opportunities: Learning, eVents, Experience (Midwest EVOLVE) project is a three-year, seven-state effort to introduce electric vehicles (EVs) to the general public, workplaces, corporate fleets and auto dealership staff. Midwest EVOLVE projects are planned for the following states: Illinois, Indiana, Michigan, Minnesota, North Dakota, Ohio and Wisconsin. The project is coordinated by the American Lung Association in Minnesota, dba Twin Cities Clean Cities Coalition (TC4). The Midwest is often overlooked as a market for EVs. As a result, the number of available vehicles, charging stations and educational opportunities have been limited in the very place where the American automobile industry was born, and where it flourishes today. The goal of Midwest EVOLVE is to change this narrative, and to help the Midwest rediscover the automobile, this time with a plug.

## Objectives

The objective of the project is to promote and demonstrate plug-in electric vehicle (PEV) use by establishing local showcases that provide a hands-on test drive experience. Incorporating a variety of locally available PEVs will make it easier for consumers to determine the best vehicle and charging options for their personal or fleet needs. Showcases will provide consumers with an in-depth education in a variety of conveniently located, brand-neutral settings.

This project has scheduled test drives at special events in major Midwest cities, and combines a targeted vehicle ride and drive project with a driver/fleet education experience.

The following targets have been set for the project:

- 25 macro (larger) ride and drive showcase events
- 53 micro (smaller) ride and drive showcase events
- 16 EV dealership training events
- 52 workplace charging challenge showcase events
- 34 extended test drive programs
- 39 EV forum events

- Pre-, post- and follow-up surveys to be collected
- Targeted outreach for an estimated 111,750 people to attend the various Midwest EVOLVE events.

## Approach

The approach and methodology for the Midwest EVOLVE project utilize the expertise and existing partnerships and networks of the seven participating Clean Cities coalitions and three unique partners, in advancing EV awareness and use, and building strong multi-sector partnerships for success. The project activities are a direct outgrowth of the work carried out to date, and strong knowledge of what is needed to move the EV market forward in the industrial Midwest region.

All seven coalitions involved in the Midwest EVOLVE project provide strong experience in building markets and increasing consumer and fleet awareness, and acceptance of alternatives to traditional petroleum fuel. The approach uniquely intertwines a variety of audiences including utilities, automobile dealerships, public and private fleets, businesses and the general public into one multi-faceted program. Activities will include:

- At least 25 large-scale ride and drive events, coupled with a formal educational component. These are part of larger events such as the Twin Cities Auto Show, Chicago Auto Show, Detroit Auto Show and National Drive Electric Week. In addition to these larger events, at least 53 smaller-scale ride and drive events are being held and planned.
- A minimum of 16 auto dealership staff training workshops are helping sales staff and management better understand the unique aspects of EVs, and how to make the sale. This program continues to build on the success of a program developed and implemented in Minnesota.
- Encouraging charging at the workplace is an important part of Midwest EVOLVE. The project includes at least 52 workplace charging challenge events for both large and small employers. Approximately 34 of these events will include extended test drive programs, so both employers and employees get a true experience of what driving electric can mean.
- A minimum of 39 meetings and/or events are developing and taking place for EV owners to connect, learn, and share their experiences. These meetings are for anyone who owns a PEV, and for those who are interested in owning a PEV.
- We estimate that more than 111,750 people will attend the various Midwest EVOLVE events.

## Results

As of September 30, 2018 the following numbers of events have been executed:

- 17 macro ride and drive showcase events
- 61 micro ride and drive showcase events
- 12 EV Dealership Training Events
- 29 workplace charging challenge showcase events
- 10 extended test drive programs
- 27 EV forum events
- 90+ wrap around/educational outreach events have taken place, in addition to the planned events
- Over 90,000 attendees have had opportunities to participate.

- Over 4,500 attendees have taken test drives.
- 21% of attendees that completed a follow-up survey have purchased or leased a PEV.

Each of the event categories are promoted via a targeted marketing campaign developed by project partners. The campaign has included key messaging, advertising, social media and development and launch of a region-wide website, to attract potential EV owners to the variety of event opportunities.

Pre- and post-education surveys are being collected at ride and drive events. Data is continually compiled and analyzed for changes in attitudes, marketing and EV sales. Over 3,700 surveys have been completed in pre-, post- and follow-up education.

Several major event highlights included the following at the Chicago Auto Show, Milwaukee Auto Show, Twin Cities Auto Show & Ohio Auto shows.

### *2018 Chicago Auto Show*

Consumers attending the 2018 Chicago Auto Show, held February 10-19, had a chance to test drive all-new electric and hybrid PEVs. Vehicles available for the outdoor test drives included the 2018 Nissan LEAF, 2018 Chrysler Pacifica Hybrid, and 2018 Mitsubishi Outlander plug-in hybrid electric vehicle (PHEV). The Chicago Area Clean Cities Coalition hosted the test drives. The Chicago Auto Show is the largest auto show in North America, spanning more than one million square feet of production, concept and exotic vehicle exhibit space. Despite having some of the worst snow storms in years this season, over 1,000 people visited the Midwest EVOLVE display, just over 400 people actually participated in the ride and drive, and about 320 surveys were collected. All our surveys were collected via paper at the event. There were 29 different PHEV models on display here. Midwest EVOLVE and Chicago Area Clean Cities set up a great test drive and received great media coverage. [1]

### *Milwaukee Auto Show*

For nine days, the Milwaukee Auto Show promoted The Electric Room, which was staffed by Wisconsin Clean Cities and coalition volunteers, and featured the latest in electric and hybrid vehicles and charging stations. Attendees had the opportunity to explore the latest models and technologies and learn about the many economic, environmental and respiratory health benefits of electric and hybrid vehicles, as well as how they contribute to our nation's energy security. Among the vehicles displayed in The Electric Room were the Honda Clarity, the BMW i3, the Hyundai Ioniq and the Nissan LEAF. AeroVironment and ClipperCreek were on site with EV charging station displays. The exhibit also provided information on the EVolution tool, developed by Argonne National Laboratory, and available to help consumers interested in purchasing an EV with the decision making process. Ride and drives in the Chevy Bolt were available through Chevrolet; staff directed attendees to test drive the EV throughout the show dates. Midwest EVOLVE created and distributed social media posts throughout the event. The Electric Room was also featured on Milwaukee FOX News. An estimated 3,000+ consumer came through the electric room.

### *Twin Cities Auto Show*

The 45th Annual Twin Cities Auto Show was a hugely successful event held March 10-18, 2018, in Minneapolis, Minnesota. Midwest EVOLVE partnered with Twin Cities Mitsubishi dealers to introduce the "Mitsubishi Minnesota Mile," an indoor test drive based on Minnesota's two seasons: "winter and road construction." More than 2,600 people experienced the exhibit, which included demonstrations and rides in a Mitsubishi's Outlander PHEV. Lung Association staff and volunteers collected more than 1,200 surveys on consumer knowledge of, and opinions about, EVs. Early results showed 13 percent of participants had never experienced an EV before. North Dakota Clean Cities staff provided support for the event. Also at the Auto Show was The Electric Room with eight different EVs displayed, as well as charging equipment demonstrations and "Carpool Car-eoke" in the new 2018 Chevy Bolt. The Electric Room was sponsored by Great River Energy and the main project partners were the Minnesota Automobile Dealers Association,

Midwest EVOLVE, Drive Electric Minnesota, PlugInConnect, Minnesota PEV Owners' Circle and Fresh Energy. An estimated 5,000+ attendees went through these two specific areas of the show.

### *Ohio Auto Shows*

Drive Electric Ohio, Clean Fuels Ohio's statewide EV program, had a presence at four of the five major auto shows in Ohio this year. Working with partners throughout the state, there were EVs at the shows in Toledo, Dayton, Cleveland, and Columbus. Each region had a different space that was staffed by the local EV Ambassador groups that have emerged from the Drive Electric Ohio mission. The Midwest EVOLVE program was prominently displayed at the Columbus Auto Show. Attendees had the opportunity to learn all about the details of the Midwest EVOLVE program from Clean Fuels Ohio staff and passionate EV ambassadors and volunteers. At the Columbus auto show, several hundred interested individuals stopped by to learn about the Midwest EVOLVE program. There was also an EV ride and drive with Smart Columbus that was well attended.

### *Other Educational Activities*

Project partners have produced a number of concept papers, in conjunction with PlugInConnect, and shared them with coalitions and partners throughout the United States. They continue to be requested and expanded on to fit local needs. Concept paper topics include: Minnesota Plug-in Vehicle Owners' Circle structure; working with dealerships; and hosting an extended test drive. More concept papers are planned for 2019, including one on EVs at the workplace.

As part of this project, Argonne National Laboratory successfully launched the EVolution Consumer Choice Tool which provides facts about EVs and how they relate to individual driving needs. More specifically, this tool helps consumers understand the different powertrain technologies, and the benefits these technologies offer, in comparison to conventional vehicles, as well as daily travel needs and charging availabilities. Zip code level information is utilized to customize results. This platform connects consumers to extensive information about EV adoption from the DOE-supported Alternative Fuels Data Center [2] and Fuel Economy.gov [3] websites, and incorporates research on topics such as weather effects on PEV range, charging level accepted by each model, and upstream Greenhouse Gas emissions by region. The tool currently utilizes information from the seven states participating in Midwest EVOLVE, and in 2019 will be including states throughout the nation.

Project partners developed state-specific EV factsheet tri-fold brochures that have been excellent handouts. Each state continues to utilize the brochures at events and meetings. The EV factsheet tri-fold brochures are updated on a regular basis, and thoroughly reviewed by the project partners.

The Midwest EVOLVE website highlights macro and micro events, and features news, blogs, and links to additional information about the performance and health advantages of EVs. Search-engine optimization was included.

In 2018, approximately 125 news stories about Midwest EVOLVE, its Electric Vehicle Ride & Drive events, and partners' related activities were picked up by more than 80 news outlets. Highlights included TV news segments in Chicago; Minneapolis; Milwaukee; Lansing and Traverse City, Michigan; South Bend, Indiana; and Fargo, North Dakota.

The stories have demonstrated the excitement surrounding EVs in the Midwest and showcased many of the ride and drives that the Midwest EVOLVE team, its partners, and Clean Cities coalitions have conducted. For 2019, the Midwest EVOLVE communications strategy is to continue to focus on getting news coverage for events, and for the performance and clean air advantages of EVs. In addition, we will look for fresh, new and unique story angles about EVs, to continue to gain the attention of news reporters. While most Midwest EVOLVE stories are generated through media relations and news releases, the project team has also utilized PR Newswire to help generate stories.

In addition to our media relations, public relations, blogging, and other grassroots marketing efforts, we have utilized social media throughout the project, to support Midwest EVOLVE events, EV news and new products, and to promote EV initiatives throughout the Midwest, including those of our project partners. Since the beginning of 2018, the project's Facebook page has had roughly 250,000 total impressions and has increased its number of Facebook followers from 140 to more than 720. In 2018, Midwest EVOLVE secured 400,000 impressions of Tweets and gained 300 new followers. Currently, Midwest EVOLVE has 600 followers. Midwest EVOLVE's LinkedIn page currently has 32 followers and had roughly 3,500 overall impressions.

## Conclusions

Geographically, the Midwest EVOLVE Project is expansive, crossing the metropolitan areas of the seven-state region including, but not limited to, Akron, Cincinnati, Cleveland and Columbus, Ohio; Chicago, Illinois; Detroit and Lansing, Michigan; Duluth, Minneapolis, Rochester, Saint Cloud and Saint Paul, Minnesota; Fargo, North Dakota; Gary and South Bend, Indiana; and La Crosse, Madison, and Milwaukee, Wisconsin. Working with seven Clean Cities coalitions and project partners, the project has promoted PEVs to a larger audience of potential buyers and is beginning to bring about significant and sustainable use of EVs.

Government and private fleet managers and drivers, auto dealerships, and individual consumers are now starting to actively contact partners to receive in-depth education and exposure to EVs. Growth in the Midwest region market is becoming measurable, and results from post-ride and drive and follow-up surveys show a 21% increase in consumers saying pure EVs are "better than" gasoline vehicles. Survey data shows that 66% of attendees who participated in ride and drives took further action, such as visiting a dealership, talking to a local EV owner or doing more online research. Data show that 13% of attendees had never experienced an EV before attending a Midwest EVOLVE event. Providing consumers with opportunities to experience EVs first hand, to learn about the benefits, and to share their experiences, has furthered the adoption of, and demand for, these vehicles in this region. The most exciting data to report is that just over 21% of those surveyed have actually purchased a PEV since attending an event.

Midwest EVOLVE is a partnership of seven Clean Cities coalitions serving a seven-state region. Each state continues to experience different challenges and various levels of adoption of EVs and EV infrastructure. With this project, we have built an exceptional support and educational system that has taken off.

## Key Publications

The EVolution Consumer Choice Tool: https://evolution.es.anl.gov/

The Midwest EVOLVE Project website: http://www.midwestevolve.org/

Social media accounts on Twitter, Facebook & LinkedIn: @MidwestEvolve

## References

[1] http://abc7chicago.com/3071457/

[2] https://afdc.energy.gov/

[3] https://www.fueleconomy.gov/

# I.11 Northwest Electric Showcase Project (Forth, formerly Drive Oregon)

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Start Date: October 1, 2016 End Date: October 1, 2019
Project Funding: $2,290,240 DOE share: $993,450 Non-DOE share: $1,296,790

## Project Introduction

Forth is a non-profit with the mission of advancing electric, smart and shared transportation in the Pacific Northwest and beyond, through innovation, demonstration projects, advocacy and engagement. The Northwest Electric Showcase Project seeks to transform the market for plug-in electric vehicles (PEVs) in the Pacific Northwest from early adoption to early mainstream, putting Oregon and Washington on a sustainable path to increasing PEV sales more than tenfold, to at least 15% of all new cars sold by 2025. Forth (formerly Drive Oregon) will lead this effort through the creation of a physical vehicle showcase, mobile "pop up" showcases, and a "virtual" showcase online, as well as targeted multimedia outreach campaigns. The project will also build a sustainable long-term model, to continue beyond the project period.

As a leader in per-capita PEV sales, the Pacific Northwest is in a unique position to make the leap from early adopter to early majority, pushing toward the "tipping point" for PEVs. Since the region is already starting with a high per capita level of PEV adoption, with effective engagement tactics, the project can achieve greater PEV penetration and provide a roadmap for other regions.

The target market includes the cities of Portland, Oregon and Seattle, Washington. The market similarities of the two states mean they can benefit from some regional marketing and messaging tactics; however, automakers treat these two states differently, due to zero emission vehicle (ZEV) regulations. Oregon is a ZEV state, having opted to be a part of California's Zero Emission Vehicle Program, and receives new models of electric vehicles before Washington does, as Washington is not a ZEV state.

While the variety and availability of electric vehicles continue to grow in many cities, it remains to be seen how we can move past the "early adopter" market and grow mainstream consumer appeal. Automakers and dealerships have their own strategies for developing the plug-in car segment, but must also market their gas and diesel offerings. The Northwest Electric Showcase Project sets out to promote PEVs to the masses by educating consumers, stimulating electric vehicle sales, and accelerating the buying process.

The following partners have substantively contributed to the project success: The City of Portland, Oregon Auto Dealers Association, Brink Communications, Columbia-Willamette Clean Cities, Western-Washington Clean Cities, American Honda Motor Company, Clipper Creek, Telefonix, eMotorWerks, Collaborative Efficiency, Chinook Book, TechSoup, ReachNow, World Trade Center Properties, Metro Portland New Car Dealers Association, EV Box, Aerovironment, Delta-Q, Kuni BMW, The City of Seattle, and Point Defiance Zoo & Aquarium. In addition, the following utility partners have been integral to the project's success:

Portland General Electric, Pacific Power, Eugene Water & Electric Board, Clark Public Utility District, Puget Sound Energy, and Tacoma Power.

## Objectives

The key project objective is to double PEV adoption rates in the Pacific Northwest by 2019, which translates to annual sales of 9,000 PEVs per year in Washington and 5,500 per year in Oregon. This would equate to total PEV sales of 33,000 in the two states over the three-year grant performance period. Secondary objectives include securing at least 5 million consumer impressions through direct interaction and marketing campaigns; potential PEV purchasers completing at least 5,000 test drives; at least 5,000 consumers subscribing to project emails; at least 12 new Northwest fleets taking the West Coast Electric Fleets pledge; and Forth securing at least $750,000 in cash or in-kind contributions to the Showcase Project over the project period.

## Approach

The Showcase Project will deploy a number of innovative tactics to engage consumers and drive PEV adoption. These include development of an electric vehicle showroom; long-term test drives facilitated through car sharing; mobile "pop-up" showcases; and focused programs and targeted campaigns aimed at low and moderate-income drivers. Forth has developed a multimedia campaign in conjunction with Brink Communications that will focus on well-defined market segments and use social media to generate traffic to the physical showcase.

A key project component is the coordination and staging of numerous ride and drive events throughout Oregon and Washington. Forth is working directly with a variety of community stakeholders, leveraging their relationships and expertise, to engage local consumers in cities around the Pacific Northwest. The region's electric utilities have been especially receptive to collaboration, and the project has emphasized working with them, to communicate the benefits of PEVs to their customers. Other partners in the ride and drives include regional Clean Cities coalitions and electric vehicle owners' groups. While some utilities have well-defined transportation electrification plans, many do not; our aim is to support any partner who is willing to participate, regardless of how new they are to these concepts.

## Results

Upon award of the U.S. Department of Energy (DOE) grant, Forth began the search for a suitable place to house the showcase. Portland General Electric (PGE), the largest utility in Oregon, has been a supporter and member of Forth's Board of Directors since its inception. PGE occupies most of the Portland World Trade Center group of buildings in downtown Portland, and had a rental space available that was an ideal location for the showcase.

In Fiscal Year (FY) 2017, Forth created an electric vehicle showroom, called the 'Go Forth Electric Showcase,' at the World Trade Center location. The showcase is open six days a week, and is staffed by educated volunteers and staff members who are on site to respond to consumers' questions, and guide walk-ins and scheduled visitors through the different elements of electric vehicle ownership. A variety of PEVs are available for test drives, sample electric vehicle charging stations are on display, and a selection of brand-neutral PEV educational material is available to consumers. Forth leases the majority of vehicles used for the electric vehicle showroom, and ride and drives outside out of the area are supported by participating local auto dealerships.

One of the most common questions from showcase visitors is 'How do I charge an electric vehicle?' Charging methods, locations and options are still a mystery to many potential PEV owners. New PEVs, with improved driving ranges of 200 miles per charge, help to assuage consumers' range anxiety, but charging a car is still a new and unfamiliar experience for most people. PEV charging also takes longer than filling up a gasoline car, so many people are wary at first. Most visitors are surprised, however, and reassured to learn that nearly 80% of charging occurs at home. To educate consumers about PEV charging, Forth has installed several different charging units, also known as electric vehicle supply equipment (EVSE), at the showcase, for visitors to view

and handle. In seeking EVSE unit displays for the showcase, Forth relied upon existing relationships with PEV manufacturers. This led to the project receiving more than enough units, allowing us to rotate the EVSE in the charging display, to give exposure to a variety of different manufacturers and new EVSE models. The EVSE display also educates consumers about the benefits of 'smart,' network-enabled EVSE units. All of the EVSE being used have been donated to the project.

As Forth engages with partners and the consumer public, a key component of our work has been creating an easy way to explain and relate charging and electric transportation to a broad audience. We developed an 'EV 101' flier and related educational materials, including a 'Workplace Charging' flier, that have been used by numerous organizations that are either partnering on the project or are supportive of the effort to advance electrification. (See Figures I.11.1 and I.11.2.) Having brand neutral educational materials that speak to the benefits of driving and charging a PEV, without endorsing particular models of PEVs or charging equipment, has been an important tool needed to continue to grow the awareness for the viability of electric mobility. As the project progresses, we will continue to evaluate the need for these communication tools and adapt and modify them as needed, with a goal of reaching a variety of audiences that may consider purchasing or leasing a new or used electric car.

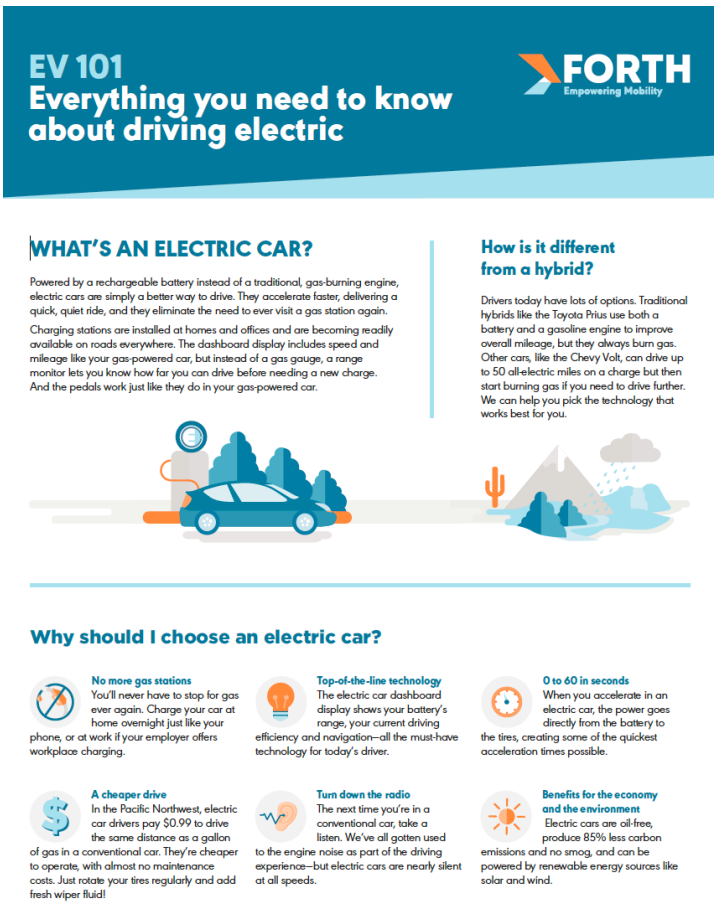


Figure I.11.1. EV 101 Flier, produced by Forth/Brink Communications


Figure I.11.2. Workplace Charging Flier, produced by Forth/Brink Communications

As of October 1, 2018, more than 3,500 people have visited the Showcase location, leading to more than 800 test drives completed on and offsite. The Showcase project activities have led to numerous interactions related to owning, shopping for, and buying a plug-in electric vehicle. The awareness activities of the showcase, combined with the increasing variety of battery electric and plug-in hybrid vehicles, are leading to an increase in vehicle registrations in the states of Oregon and Washington (see Table I.11.1), and to additional programs led by project partners that can continue to reinforce consumer and business buying behavior (see Table I.11.2).

Table I.11.1. Registered PEVs in Oregon/Washington*

| *Values are estimates based on the best available state data | 2016 Registered EVs | 2017 Registered EVs | 2018 Registered EVs | Project Goal |
|---|---|---|---|---|
| Oregon | 8,200 | 14,000 | 20,000 | 30,000 |
| Washington | 18,000 | 30,000 | 41,000 | 50,000 |

Table I.11.2. Ride & Drive events held in 2018

| Date | Partner / Location |
|---|---|
| Febuary 20, 2018 | Capitol Ride & Drive, Olympia WA |
| April 17, 2018 | Tektronix Ride & Drive, Portland, OR |
| April 21, 2018 | Earth Day Fair Ride & Drive, Bend OR |
| April 28, 2018 | Clark Public Utilities Home & Garden Fair, Vancouver WA |
| May 12, 2018 | Western Washington University Ride & Drive, Bellingham WA |
| June 6, 2018 | Avista Ride & Drive, Spokane WA<br>Portland General Electric & Uber Ride & Drive, Portland OR |
| August 7, 2018 | Ribbon Cutting of DCFC in Tacoma Washington |
| September 1, 2018 | Gateway Business Association, Portland OR |
| September 8, 2018 | Clark Public Utilities, Vancouver WA |
| September 9, 2018 | Eugene Water Electric Board, Eugene OR |
| September 15, 2018 | Oregon Electric Vehicles Association, Portland OR |
| September 16, 2018 | Central Oregon Environmental Center, Bend OR<br>Seattle Electric Vehicles Association, Issaquah WA |

## Conclusions

This project has been designed around creating a sustainable physical, mobile, and virtual public engagement platform for increasing the annual plug-in vehicle sales in the Pacific Northwest. As we enter into the last budget year of the project, an emphasis on utility engagement will inform much of our 2019 activities as we plan for the continuation of this project, without federal funding and beyond the project period.

In Oregon, a $2,500 cash rebate is now available, with plans for it to be marketed to consumers after Oregon's Department of Environment Quality selects a contractor to operate the program. There is a reasonable expectation that an increase in plug-in vehicle sales can be forecasted for 2019, thanks to this marketing effort and the attractive financial incentive. This rebate can provide for $2,500 off the purchase or lease of a battery electric vehicle when purchased new in Oregon. A $1,500 rebate is also available for qualifying plug-in hybrid vehicles. This rebate will be available at the point-of-purchase of the vehicle and will be available to be used as the down payment immediately at the dealership.

With the state of Washington's sales tax exemption for plug-in vehicles having expired, a slowing of plug-in vehicle sales can be forecasted, based on similar market parameters in other regions around the country. This incentive provided a sales tax exemption for the purchase or lease of a new battery electric vehicle purchased in the state of Washington. The exemption expired when 7,500 electric vehicles had been registered in the state and applied to up to $32,000 of an eligible new electric passenger car or light-duty truck. New legislation is being pursued to either extend this exemption or to design an electric vehicle rebate, to continue accelerating electric vehicle adoption in Washington state.

Forth will maintain an effort to address the challenges and opportunities that both of these situations offer, while maintaining an objective subject matter expertise when advising on charging equipment and car purchasing decisions.

## Key Publications

https://forthmobility.org/showcase

https://forthmobility.org/why-electric/electric-cars-101

**Acknowledgements**

The team at Forth would like to acknowledge and thank the many Showcase project volunteers for showing up, being patient, and sharing their knowledge and experience for electric mobility in relation to this project. We would also like to thank Dan Nardozzi and Linda Bluestein who made this all possible.

# I.12 Accelerating PEV Adoption in New England (Plug In America)

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Start Date: October 1, 2016 End Date: September 30, 2019
Total Project Cost: $1,000,000 DOE share: $500,000 Non-DOE share: $500,000

## Project Introduction

Introducing potential consumers to plug-in electric vehicles (PEVs) through dynamic test drive experiences has proven effective in boosting consumer awareness and spurring adoption by individuals. Well-designed and produced events overcome consumer confusion about PEVs, help educate them about the cars' specific attributes and provide a launch point into adoption. Ride and drive events are a critical element of this program, coalescing important pieces of the puzzle. Ride and drive events allow salespeople to practice their PEV customer engagement skills in a controlled environment, and they create sales leads for dealers, which can increase their willingness to participate in future events.

Dealerships' lack of engagement in PEV sales remains an ongoing issue. Recent reports and studies from UC Davis, Consumer Reports [1], the Sierra Club [2], and Ipsos RDA [3], note a widespread lack of familiarity with PEVs by sales staff, longer sales cycles for PEVs, and real or perceived impacts on dealer profitability. Customer satisfaction with the PEV purchase experience suffers, relative to conventional vehicles [4].

For many automakers, PEVs are at least a generation or two away from profitability. Consequently, many automakers calibrate their marketing and sales efforts for regulatory compliance and containment of corporate losses. Auto dealers, on the other hand, see PEV sales as involving a lot of extra work for potentially little reward. As volume-based businesses that are dependent on high-profit trucks and SUVs, many dealers simply cannot, or will not, divert the resources needed to develop or grow PEV sales. Finding quality and effective programs to prepare salespeople for PEV sales can be challenging. Automaker programs are often model-specific, may omit or skim over potentially influential government and utility incentive programs, and may overlook many of the systemic challenges that dealers face.

For this project, Plug In America (PIA) [5] partnered with Clean Cities coalitions from Massachusetts, Connecticut, Vermont and Rhode Island to develop and conduct ride and drive events intended to spur electric vehicle (EV) consideration across the New England region. PIA, along with the Massachusetts Department of Energy Resources (DOER), also partnered with the Massachusetts State Auto Dealers Association (MSADA) [6] to develop and implement an EV training program for dealerships to be piloted in the greater Boston metro area.

## Objectives

The project's primary objective is to raise awareness and increase consumer adoption of PEVs in the partner New England states. This is accomplished through "PEV showcase events" that feature an experiential "ride and drive" component and involve interactions between consumers and available EV models, their owners, and salespeople from dealerships offering EVs to consumers and fleets. A second objective is to experiment with methods for engaging more dealers and improving the consumer's PEV purchase experience through dealer training. A final project objective is to create a sustainable PEV Showcase model that can be replicated in and beyond the New England region after project completion.

Project goals included developing training materials and recruiting approximately 10-20 dealers to participate in training. The project's first year witnessed the execution of 17 showcase events. It also marked the development and deployment of a half-day EV training session for over a dozen Boston area dealerships.

Second year goals included organizing and conducting an additional 23 events for a total of approximately 40 showcase events over the life of the project. The year two plan called for approximately six (6) fleet, ten (10) workplace and seven (7) public engagement events.

## Approach

### *PEV Showcase Events*

The project partners developed a working document that catalogs current best practices for exposing consumers to PEVs through experiential events. PIA furnished each of the funded partners with the ride and drive best practices guide. This document guided the project partners in the conduct of their own showcase events, while ensuring a standardized and replicable approach across regions. At the completion of each event, partners are responsible for preparing a report, including feedback and lessons learned, that can be incorporated into the best practice document, to guide future efforts.

Project partners conducted a mix of fleet, workplace and community PEV Showcase Events across the four New England states of Connecticut, Massachusetts, Rhode Island and Vermont. Partner REACH Strategies has conducted a total of 16 workplace events since April 2017. In September 2018, PIA organized community showcase events for National Drive Electric Week (NDEW), as part of the 2017-2018 budget. PIA has also designed and continues to refine a dealer PEV training program.

### *Dealer Training*

During the first year of the project, PIA, in concert with its Massachusetts partners, developed a pilot training program for the greater Boston metropolitan area that integrates auto dealers into the PEV Showcase model. The partners chose Boston and the Route 128 Technology Corridor to support the launch of the "e-Star" program, a specialized program to train and support dealers selling PEVs. e-Star consists of three primary activities: (1) qualifying new car dealers to meet industry-wide standards for PEV sales and customer support; (2) equipping these dealers with additional training, tools and resources, to support more PEV sales and an improved purchase experience; and (3) connecting customers interested in PEVs to participating PEV dealers who are being supported by the coordinated promotional efforts of program partners. For the latter, PIA partnered with the Massachusetts Green Energy Consumers Alliance [7], which featured e-Star trained dealers on their DriveGreen platform. DriveGreen provides pre-negotiated discounts to purchase or lease a PEV, as well as educational resources and test-drive opportunities for PEV considerers.

## Results

For the life of the project, PIA and the project partners designed and implemented 42 PEV Showcase events in the New England region. These comprised 19 community, 16 workplace and 7 fleet events. Table I.12.1 shows the distribution of the events conducted by the project partners and indicates that the total number of events exceeded the plan. These delivered a total of more than 1,750 individual test ride and drive experiences during the two year period and exposed over 72,500 individuals to PEVs.

Table I.12.1. Distribution of PEV Showcase Events by Project Partner (Plan versus Actual) Over the Life of the Project

| | Plug In America | | REACH Strategies | | MA | | CT | | RI | | VT | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Plan | Actual | Plan | Actual | Plan | Actual | Plan | Actual | Plan | Actual | Plan | Actual |
| **Fleet** | 0 | 0 | 0 | 0 | 3 | 3 | 1 | 2 | 1 | 1 | 1 | 1 |
| **Workplace** | 0 | 0 | 16 | 16 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Community** | 10 | 12 | 0 | 0 | 3 | 3 | 2 | 2 | 2 | 1 | 1 | 1 |
| **Total** | 10 | 12 | 16 | 16 | 6 | 6 | 3 | 4 | 3 | 2 | 2 | 2 |

In the past year, PIA and its Clean Cities partners designed and executed a total of 25 PEV showcase events. In the sections that follow, we review overall findings and then examine findings from the different types of events in turn.

Figures I.12.1 and I.12.2 depict the *pre-drive survey* and *post-drive survey* respondents' opinions of pure electric vehicles compared to conventional gasoline vehicles.

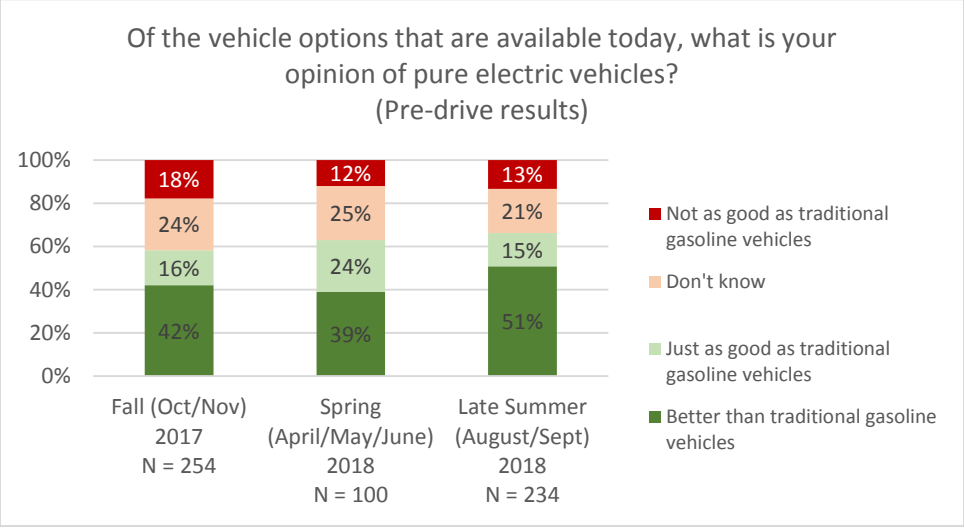


Figure I.12.1. Time series evaluation of pure electric vehicle compared to conventional gasoline vehicles for pre-drive survey

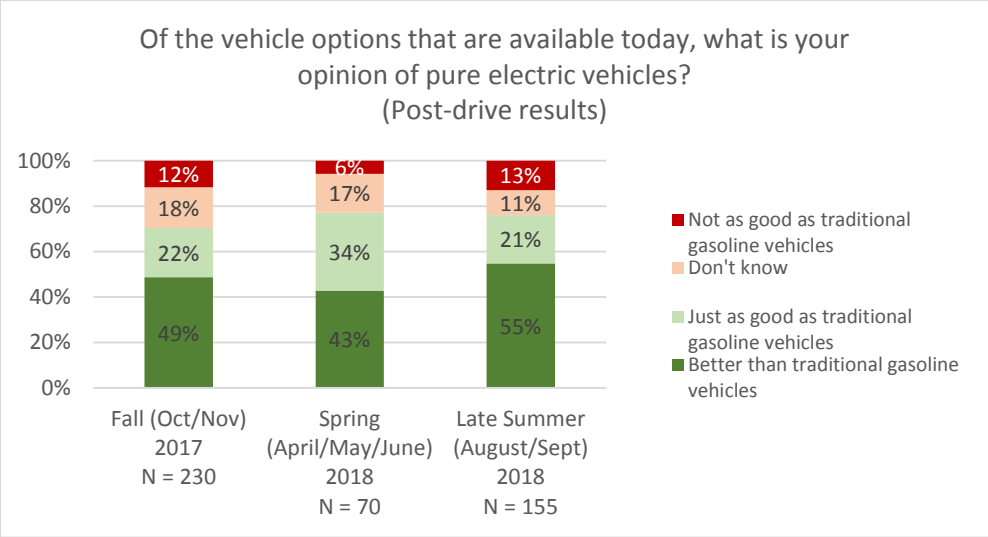


Figure I.12.2. Time series evaluation of pure electric vehicles compared to conventional gasoline vehicles for post-drive survey

The most notable change across the three-time periods is the shift toward greater consumer awareness. In the pre-drive surveys, 24%, 25%, and 21% of survey takers selected "Don't Know," respectively, suggesting they had no prior awareness upon which to make a judgment about pure electric vehicles. In the post-drive surveys, those percentages dropped to 18%, 17%, and 11% respectively, while the combined percentage of those who selected "Just as good as" or "better" than traditional gas vehicles increased by 13%, 14% and 10%, respectively. This is exactly the type of shift that the PEV showcases set out to accomplish. The findings demonstrate that once exposed to the technology, those who are unfamiliar with the technology can be educated about the benefits of electric vehicles. The Late Summer results, however, suggest that those who believe that PEVs are inferior to conventional gasoline vehicles are not inclined to change their opinion after a test drive.

As shown in Figure I.12.3, post-drive results in Late Summer 2018 indicated higher post-drive consideration than those from Fall 2017. 72% of the post-drive survey respondents from the first events in October and November 2017 indicated that they expected to at least consider a pure electric vehicle for their next vehicle purchase or lease. By August/September 2018, that percentage had risen to approximately 77%.

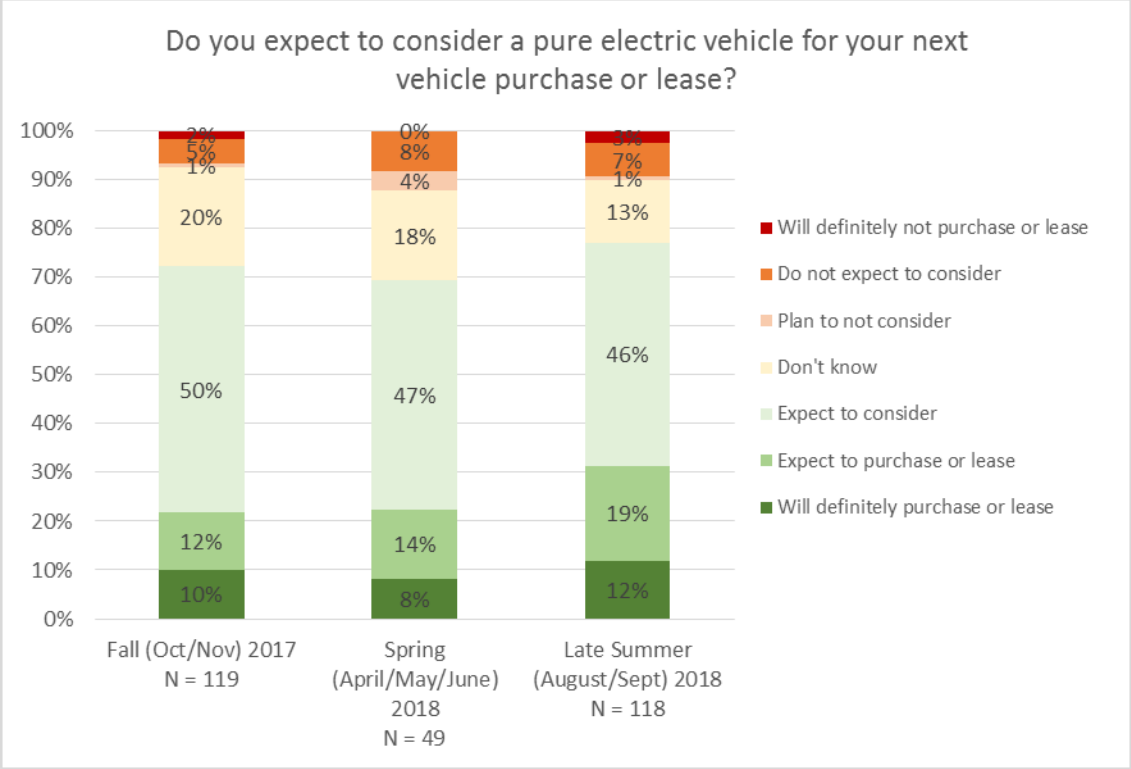


Figure I.12.3. Post-drive consideration of a pure electric vehicle over time

### *Workplace Events*

The project team executed 16 workplace events across Massachusetts, Vermont, and Rhode Island. The 16 events attracted nearly 2,500 attendees, accounted for 62,000 estimated exposures, and produced more than 925 ride and drive experiences. The workplace events were held midweek during business hours, typically on Tuesday, Wednesday, and Thursday. The events included no fewer than three (3) brands and five (5) test drive vehicles. Events also included a range of additional informational booths from local utilities, electric bicycle companies, solar providers and more.

As part of the Ride and Drive experience, participants were given a survey before and after their test drive or ride. The survey included several questions that asked the participant about their interest in purchasing a plug-in hybrid electric vehicle or a pure electric vehicle. Figures I.12.4 and I.12.5 present graphs comparing the pre-drive and post-drive results for workplace ride and drive events for plug-in hybrid electric vehicles and pure electric vehicles, respectively.

In Figure I.12.4, it appears that some exposure to plug-in hybrid electric vehicles has a small but positive impact – more individuals indicate an interest in these vehicles for their next purchase. Figure I.12.5 presents a similar graph representing interest in purchasing a pure electric vehicle – a vehicle that runs solely on electricity. In Figure I.12.5, the results are more promising. A higher percentage of those who responded to the survey expect to at least consider a pure electric vehicle for their next vehicle purchase or lease. Initially, a total of 61% of respondents indicated in the pre-drive survey that they at least expected to consider a pure electric vehicle for their next vehicle purchase or lease. After driving and riding in a pure electric vehicle that percentage rose to 73%.

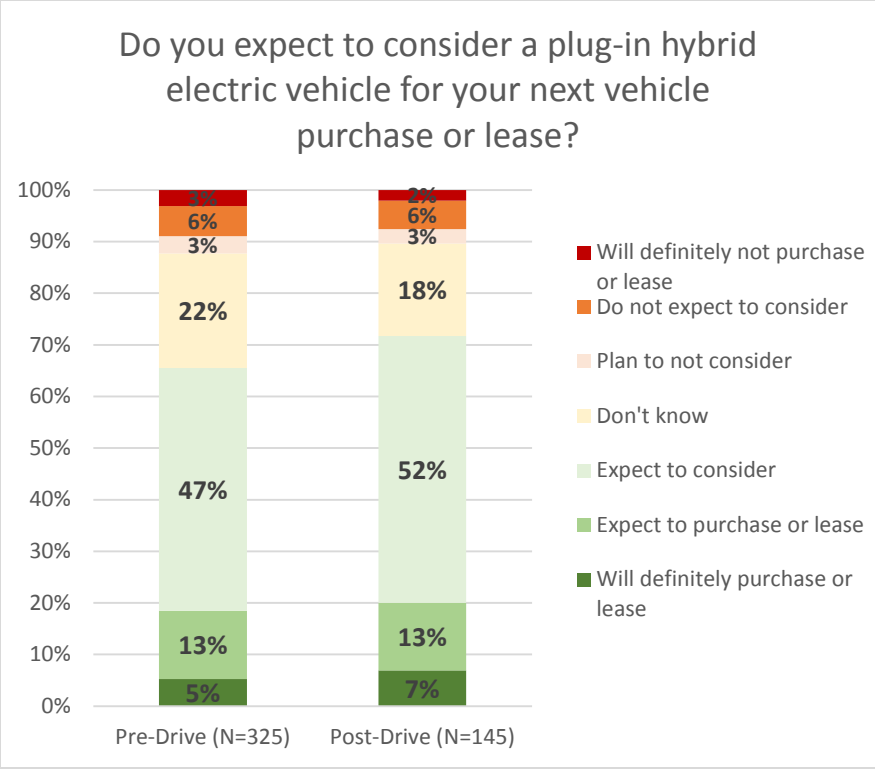


Figure I.12.4. Workplace Ride and Drive Survey Results - Interest in a Plug-in Hybrid Electric Vehicle

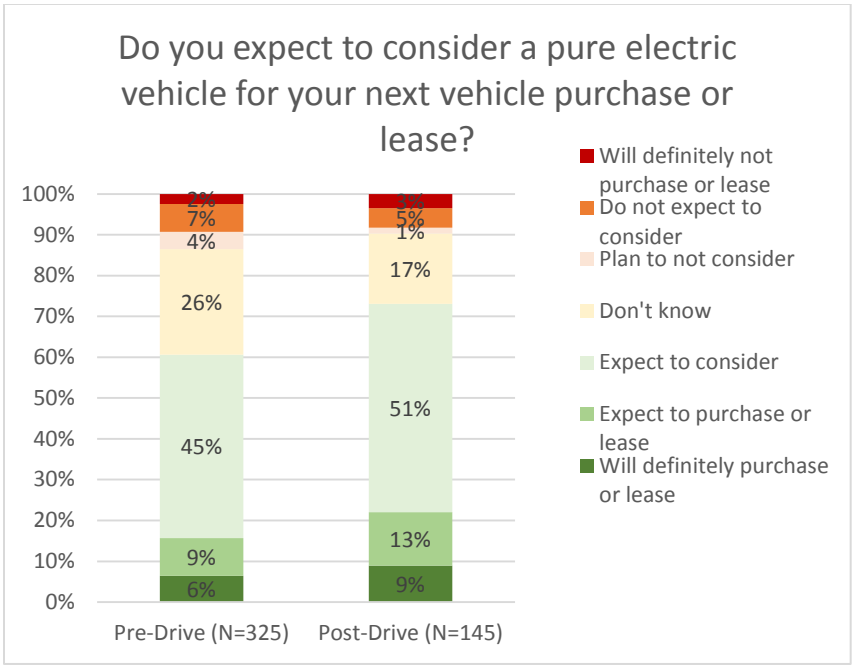


Figure I.12.5. Workplace Ride and Drive Survey Results - Interest in a Pure Electric Vehicle

Exposure and information about electric vehicles is paramount to their success. While it is an unfortunate reality that electric vehicles may not be the right vehicle choice for everyone (e.g. lack of towing, four-wheel drive, and available cargo space), a brief introduction and positive experience with electric vehicles make them more attractive to potential consumers. Ride and drive participants were also asked to compare plug-in hybrid

electric vehicles and pure electric vehicles with traditional gasoline vehicles. Figures I.12.6 and I.12.7 present the findings for the pre-drive and post-drive surveys for plug-in hybrid electric vehicles and pure electric vehicles, respectively.

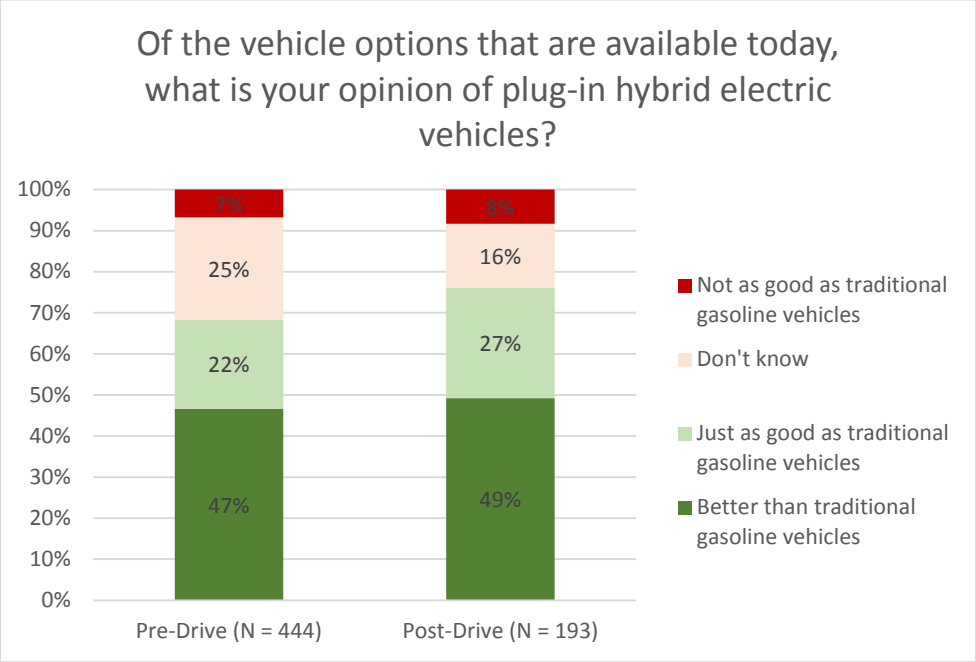


Figure I.12.6. Workplace PEV Showcase - Opinion of Plug-in Hybrid Electric Vehicles

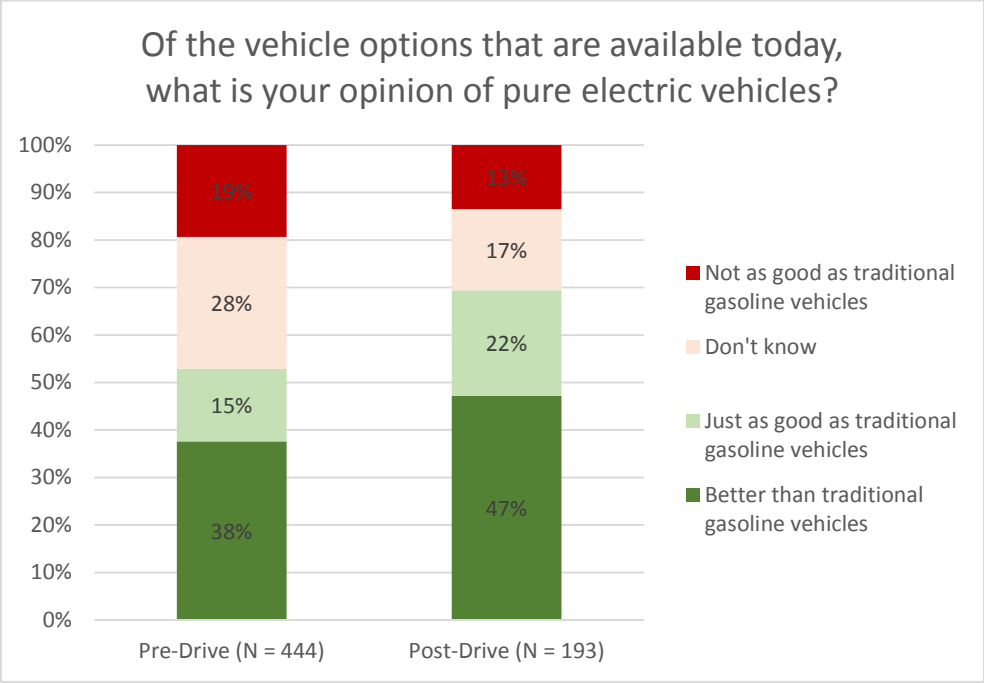


Figure I.12.7. Workplace PEV Showcase - Opinion of Pure Electric Vehicles

Following a ride and drive experience, more survey respondents indicated that plug-in hybrids were at least as good as conventionally-powered vehicles, though to a lesser degree than those who drove or rode in a pure EV. In many respects, plug-in hybrids can be treated as conventional vehicles if they are never charged but they

have a "bonus" range if the owner chooses to do so. Likewise, due to the similarities between plug-in hybrids and conventional gasoline vehicles, many individuals may be more comfortable with the former. This would explain the lesser impact of ride and drives on the opinions of those who drove or rode in a plug-in hybrid.

Every category saw a shift towards preferring pure electric vehicles to traditional gasoline vehicles among ride and drive participants. The largest shift occurred for those who had no opinion about pure electric vehicles; the information gathered during the ride and drive event pushed many individuals toward a more favorable view of electric vehicles. The idea of moving away from gasoline, enjoying a cabin free from engine noise, smooth and responsive acceleration, or the environmental benefits of pure electric vehicles may be why this shift has occurred. Furthermore, fewer participants are familiar with pure electric vehicles, which is why more than a quarter of pre-drive respondents indicated that they did not know how a pure electric vehicle compares with a traditional gasoline vehicle.

Another finding is that it can be difficult to obtain dealer support for public events, as they are generally held on weekends, the busiest time for car dealers. Workplace events, however, do not encounter this same difficulty, as the events are usually held mid-day, during weekdays, the slowest times for dealerships. Additionally, the Massachusetts dealerships are now in the fourth year of participating in the MASS DRIVE CLEAN program and are very familiar with the value of participating in such events.

In this regard, workplace events offer the distinct advantage of providing a targeted channel to consumers with a high likelihood to purchase, in a setting that is most amenable to allowing those consumers to materially advance their PEV sales search process - a midday test drive experience during the workday. Beyond offering the ability to target certain demographics in a way that is difficult to achieve in other event settings, it is likely that consumers are voting with their feet in participating in a vehicle test drive while at work. Consumers closest to needing a new vehicle are likely among those with the greatest interest in allocating time during the workday to participate in a workplace test drive event.

### *Community Events*

One of the aims of the project is to equip project partners with information and resources to implement their own PEV Showcase events, borrowing from best practices shared among the partners. The Electric Vehicle Showcase and Ride & Drive Event held in Fairfield, Connecticut is one such example. The Greater New Haven Clean Cities Coalition (GNHCCC) partnered with the Fairfield Clean Energy Task Force, and the Southwestern Connecticut Clean Cities Coalition on September 9, 2017, during the 2017 National Drive Electric Week, to provide education and exposure to plug-in electric vehicles to the community.

The event brought together local car dealers, electric car club members, local PEV owners, state legislators, and the public to view the newest PEV models and learn about the current state of technology. The local dealers provided battery electric vehicles and plug-in hybrid electric vehicles for test drives, and displays included vehicles from BMW, Chevrolet, and Ford. In addition to the vehicles, several e-bike riders participated in the event to showcase their bicycles. The nearby Westport Electric Car Club made a strong showing at the event, with members bringing their plug-in electric vehicles as static displays and giving their testimonials to engaged attendees. Excluding the e-bicycles, there were 17 models on display in the static PEV showcase.

As an incentive to complete the Ride & Drive process, participants were able to turn in their wristbands for a free ice pop from one of the local food trucks at the event. To demonstrate support for PEVs, Fairfield's state delegation along with Fairfield's First Selectman spoke about how PEVs emit zero tailpipe emissions and provide economic opportunity and jobs. As shown by the Fairfield example, community PEV showcases are a great way to engage local community members to drum up interest in PEVs. The Fairfield event had a total of 58 ride and drive experiences where at least three ride and drives included passengers. The 19 community events saw over 600 ride and drive experiences which assisted in educating the public about electric vehicles.

Figures I.12.8 and I.12.9 show interest in purchasing plug-in hybrid electric vehicles and pure electric vehicles pre-drive and post-drive, respectively.

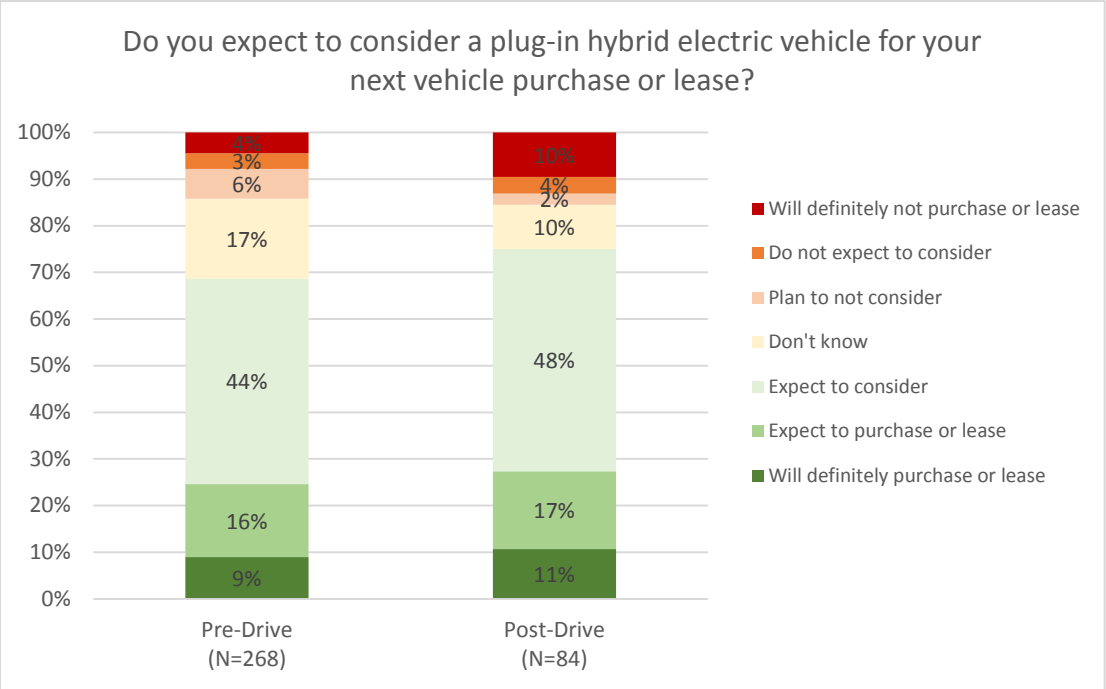


Figure I.12.8. Ride and Drive Survey Results - Interest in a Plug-in Hybrid Electric Vehicle, Community Events

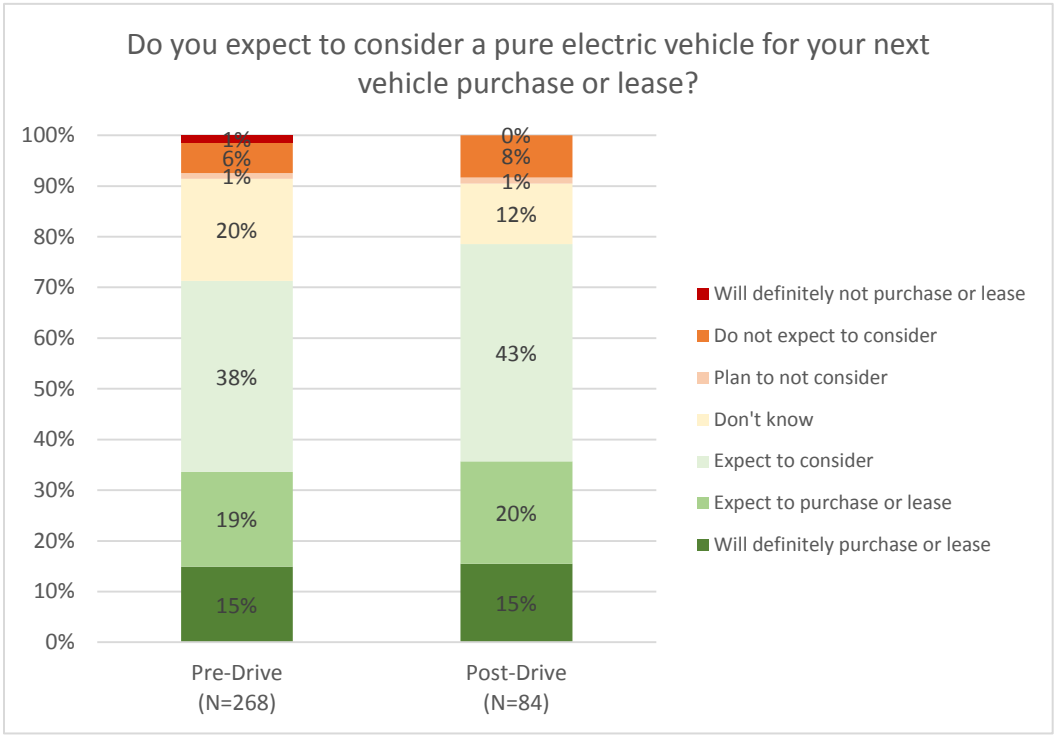


Figure I.12.9. Ride and Drive Survey Results - Interest in a Pure Electric Vehicle, Community Events

Figures I.12.8 and I.12.9 show the pre-drive and post-drive survey results for all the community PEV showcases held from Fall 2017 through Fall 2018. As shown in Figure I.12.8, there is an observable decrease in respondents answering "Don't know" in the post-drive surveys, as compared to the pre-drive surveys. There was an increase in respondents remarking that they would definitely not purchase or lease a plug-in hybrid vehicle; however, this shift could be due to respondents preferring a pure electric vehicle, or the lack of models or vehicle classes (i.e. SUVs) that fit their lifestyle.

As shown in Figure I.12.9, when comparing the pre-ride and post-ride survey results, approximately the same percentage of respondents expect to purchase or lease a pure electric vehicle; however, there was an increase in respondents in the post-drive survey who indicated they expect to consider purchasing a pure electric vehicle.

Figures I.12.10 and I.12.11 present the opinions of the community PEV showcase participants pre-drive and post-drive. A comparison of survey responses from the community PEV showcases in Figures I.12.10 and I.12.11, and the workplace PEV showcases, previously shown in Figures I.12. 6 and I.12.7, there is a distinct difference in opinion regarding both plug-in hybrid electric vehicles and pure electric vehicles, versus gasoline vehicles. As shown in Figure I.12.10, in the pre-drive surveys, 65% of the public PEV showcase ride and drive participants indicated that they believed plug-in hybrid electric vehicles were better than traditional gasoline vehicles, compared to 47% of the workplace PEV showcase pre-drive surveys.

As shown in Figure I.12.10, there was a very small increase in the number of individuals from pre-drive to post drive who indicated that plug-in hybrid electric vehicles are better than traditional gasoline vehicles; however, there was a much larger increase in individuals who think that plug-in hybrid electric vehicles are just as good as traditional gasoline vehicles. Furthermore, after participants engaged in the ride and drive, they indicated they were less unfamiliar with plug-in hybrid electric vehicles than they were before the ride and drive event. Arming general consumers with knowledge allowed them to see the benefits of plug-in hybrid electric vehicles.

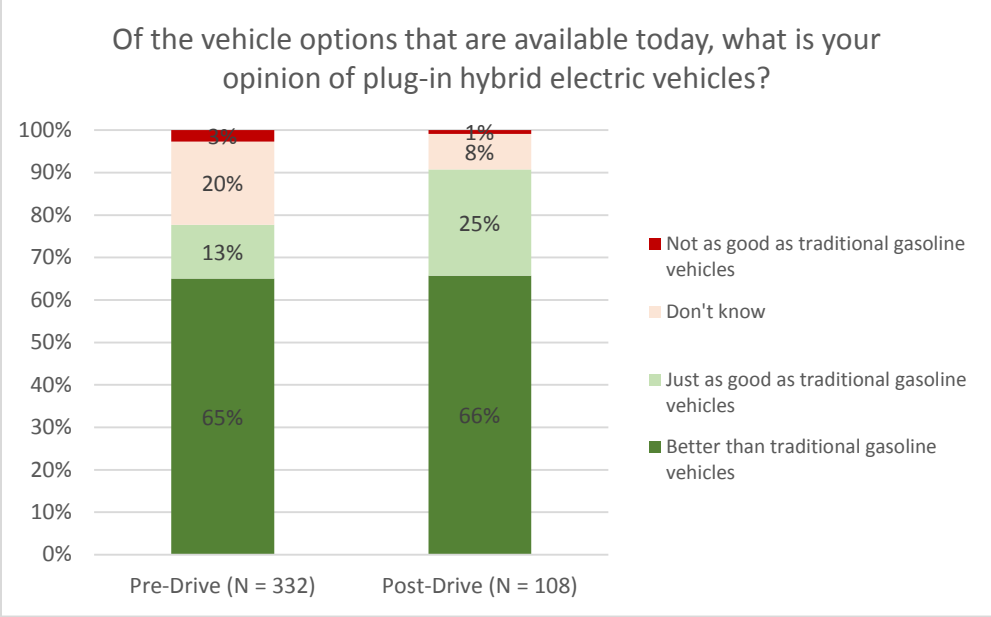


Figure I.12.10. Community PEV Showcase - Opinion of Plug-in Hybrid Electric Vehicles

Similarly, as shown in Figure I.12.11, a majority of the community ride and drive participants indicated that pure electric vehicles were better than conventional gasoline vehicles. Approximately 55% of the individuals

surveyed before they drove an electric vehicle at the community PEV showcases indicated that pure electric vehicles were better than conventional gasoline vehicles, whereas only 38% of those who attended the workplace PEV showcases believed the same. Generally, community PEV showcase events saw more electric vehicle enthusiasts than workplace PEV showcase events. Furthermore, the community PEV showcase attendees seemed to have much higher opinions of plug-in electric vehicles than the workplace PEV showcase attendees; however, there may be some self-selection bias, as those who attend the community events may already be electric vehicle owners or interested in purchasing electric vehicles.

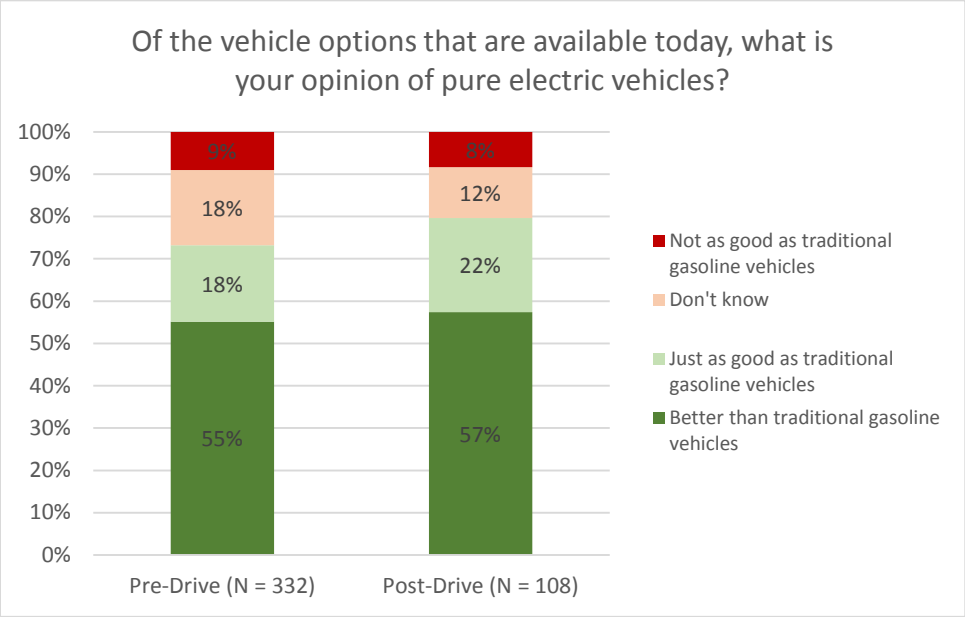


Figure I.12.11. Community PEV Showcase - Opinion of Pure Electric Vehicles

### *Dealer Training*

Year one of the project witnessed the development of training content, recruitment of dealers for the Boston area pilot, and delivery of training instruction to these dealers. Trainee survey data was collected, analyzed and reported in last year's Annual Progress Report.

In mid-April 2018, a PIA field representative traveled to Boston to conduct three in-dealership PEV training sessions. The purpose of in-dealership training is multi-fold: (1) To accommodate dealers that are unable or less able to free salespeople to attend offsite training sessions conducted by PIA; (2) They allow for more make-specific training while covering core content (government PEV incentives, charging and utility programs, and PEV sales best practices); and (3) In-dealer visits help forge longer-term relationships with dealerships.

During the visits, PIA provided instruction on how to access the PEV Dealer Dashboard, a dealer-facing tool that delivers key information on PEV incentives, utility rates, equipment options and qualified installers for dealers to share with their customers. In total, 11 sales staff were trained.

## Conclusions

Engaging dealers to support events held on weekends is often challenging. Successful PEV showcases are organized early and have strong partnerships with the state auto dealer associations or groups that encourage dealers to support these events with vehicles and staff, despite community events being held on a Saturday, a

day which is usually very busy for many dealerships. In terms of PEV placement, PEVs should be situated in area with prime foot traffic, with a registration tent posting clear and visible signage.

Each PEV showcase event yielded lessons learned. To ensure all participants complete the pre-drive survey, organizers should require that participants be fitted with a colored wristband at the registration tent. Only customers with wristbands should be allowed behind the wheel. Locating the registration tent adjacent to or nearby the PEVs and their dealer representatives further prevents attendees from bypassing the registration process. Organizers should convene a meeting with the dealer representatives in advance of the showcase to review the ground rules and to emphasize the wristband requirement.

To facilitate a speedy registration process, the registration desk should be adequately staffed and equipped with a sufficient number of cellular-enabled tablet computers preloaded with pre- and post-test drive survey links. Staff should be positioned at the end of the route to ensure that participants complete the post-test drive survey as they exit the course. Prior to the event start, organizers should test the tablets to ensure a robust signal is available at the event site. Having printed surveys on hand is a good back-up measure when all else fails.

The timing of the showcase events also impacted the project. The partners strategically back-loaded the PEV Showcase events, conducting many in the mid- to late-summer period, to coincide with the 2017 and 2018 NDEW campaigns in mid-September. Although the goal was to increase the visibility of the events, the timing also made for logistical challenges, including a shortage of tablet computers for the surveys in 2017. Additionally, the surveys did not include a field for event name and location, so it is difficult to associate survey data with particular events. Timely accounting of event expenses was also negatively impacted. These represented areas of risk that organizers could work to mitigate when planning future events.

In all, the partners captured 901 pre-drive and 561 post-drive survey responses. The data from the project indicates that exposing consumers to PEVs through showcase events that includes interaction with PEV advocates, and time behind the wheel of available PEVs, improved public perception and increased consumers' willingness to consider a PEV for their next vehicle purchase. While running PEV showcase events alongside larger community events can draw more traffic and expose more people, workplaces offer a more contained and controlled experience that can target customer segments more likely to consider a PEV in the first place; however, community-facing showcase events proved more impactful in shifting public perceptions of PEVs. The project findings also suggest that a third-party salesperson training program, similar to the kind the project delivered for the Boston region, is well-received by dealerships and deepens salesperson knowledge of key considerations important to customer's considering a PEV.

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[5] https://pluginamerica.org/eStar/

[6] https://issuu.com/massstateautodealers/docs/massautodealeraugust2017/6

[7] https://www.greenenergyconsumers.org/drivegreen

**Key Publications**

PEV Showcase Guidance Document

Presentation to DOE at the 2017 PEV Roadmap Conference

Presentation at the 2017 Behavior, Energy and Climate Change Conference

PEV Showcase Event Final Reports

# I.13 Safety Training and Design, Permitting and Operational Guidance for Garage Facilities Maintaining and Parking Natural Gas, Propane and Hydrogen Vehicles (Marathon Technical Services USA, Inc.)

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Start Date: September 01, 2016 End Date: August 31, 2019
Project Funding: $940,912 DOE share: $750,000 Non-DOE share: $190,912

## Project Introduction

This project is focused on vehicle maintenance and storage facilities for gaseous fuel vehicles. The gaseous fuel types include compressed natural gas (CNG), liquefied natural gas (LNG), liquefied petroleum gas (propane or LPG) and compressed hydrogen (CH2).

Design codes for stations that dispense gaseous fuels are mature and provide relatively clear, understandable, and constructible standards; however, this is not the case with the codes that are commonly referenced for design and upgrade of vehicle maintenance and storage garages. There are gaps and discrepancies between codes, resulting in facilities that are either unsafe or over-designed and prohibitively expensive. This weakness in code guidance results in a heavy dependence on local engineering judgment and limited knowledge of best practices. Often, consultants hired by maintenance facility or garage owners have little or no experience with facilities designed for gaseous fuel vehicles, so implementation issues persist. Similarly, local code officials may have little firsthand experience with designing facilities for gaseous fuel vehicles and may be uncomfortable reviewing and approving plans related to these projects.

There is a current lack of easily understood and applied facility design resources. Lay people and even code officials need a reference document and training to assist them in understanding what is the best industry practice to provide safe upgrades to facilities, why these upgrades are done, and how upgrades may differ depending on regions and fleet types.

## Objectives

The objective of this project is to provide safety training and guidance related to garage facility upgrades and building modifications that will support the use of commercially available natural gas, propane, and hydrogen alternative fuel vehicles (AFVs), as defined by the Energy Policy Act of 1992 (EPAct).

There have been several efforts to alleviate problems in interpreting codes that apply to gaseous fuel facilities, and to support the dissemination of best practices. These efforts have included a code review and summary by the Clean Vehicle Education Foundation (CVEF) and the publication of project case studies in trade

magazines. Technical training that is focused on end users and code officials is also available, from Marathon Technical Services USA, Inc. (Marathon), and others. While these efforts have been beneficial, there is a need for a more evolved and widely promoted program to organize and disseminate this information. There is limited benefit to simple regurgitation of current code requirements. Instead, this project provides a more interactive and hands on approach to interpreting codes, by way of case studies of various facilities, to guide fleets and safety officials through current and future gaseous fuel facility development.

This project is focused on facility owners, consulting engineers, fire marshals and code officials, to increase their general knowledge of gaseous fuel risks, which differ from conventional fuel risks; raise stakeholder awareness of code requirements; and provide a wide variety of case studies for various gaseous fuels in differing climates and fleet types. This approach provides practical knowledge and industry experience for stakeholders with no first-hand experience with gaseous fuels.

Overall, the goal of this project is to enhance the safety of gaseous fuel vehicle garages, while controlling the cost of facility upgrades. The project will address perceived and real problems of gaseous fuel safety and affordability.

## Approach

For this project, Marathon has teamed with Clean Fuels Ohio and seven other Clean Cities coalition partners: Kansas City Regional Clean Cities, Long Beach Clean Cities, Sacramento Clean Cities, Tucson Clean Cities, Virginia Clean Cities, Clean Communities of Western New York (Buffalo), and Western Washington Clean Cities (Seattle). These partners provide the local connections, knowledge and support to identify and interact with fleets, and to support the local training sessions in year two.

The project team has recently completed the second year of a three-year project term. In the past year, the team has finalized the development of training materials and has successfully completed approximately half of the classroom training sessions, with strong reviews by attendees. Marathon has continued to execute the plan developed in the first year and has added coverage of additional fuels to three of the local training sessions to address local demand.

As planned in the first year, the training manuals were developed in-house then subjected to a peer review and a Beta trial, with subsequent edits and a final outside polishing of the four training manuals before use in the remaining training sessions. The final product consists of one easy-to-read manual for each fuel type that provides users with the background theoretical and code knowledge to understand why upgrades are required, how the upgrades add safety, which upgrades are code mandated and which are best practice, and why certain new operating procedures have been implemented.

These training manuals are the basis for the on-site training sessions taking place over 15 days in the cities represented by our Clean Cities partners. These training sessions include classroom time supported by tours of selected local garages that showcase best practice upgrades and operating procedures. Ohio and New York were selected as the locations for the beta training, due to the proximity to core team members.

In year three of this project, training and best practice materials will be converted to an online format, and will be made available to a broader audience, after the site trainings have been completed.

It should be noted that DOE awarded two projects under this Funding Opportunity Announcement (FOA) topic, one being managed by Marathon Technical Services and one managed by the Gas Technology Institute (GTI). Although the overall goals, objectives, and approaches are somewhat similar, they have formed different teams of subject matter experts and will be focusing on different geographic regions for their training workshops and site tours. However, Marathon and GTI are actively collaborating to share technical information and coordinate workshop scheduling and site tours, to avoid overlap and duplication and to assure consistency with regard to technical content and recommended best practices for facility upgrades.

## Results

The team is currently progressing based on its original plan and is meeting its goals.

Marathon has invested significant time to author and produce training materials that are interesting, well-illustrated and useful to personnel from a wide variety of backgrounds. These materials were peer reviewed by several industry experts, then published as Beta versions that were used in the Ohio and New York training sessions in June 2018. Based on further user and expert feedback, the manuals were edited again for content, as well as grammar and spelling. In the midst of this effort, three of the major reference codes were revised to 2018 versions that introduced significant changes to the code treatment of these projects; this required a significant rewrite to update the manuals.

Clean Fuels Ohio located and contracted with a graphic arts company to assist in polishing the edited manuals to a final professional state – resulting in the four training manuals that are listed in the publications section below. Marathon produced the manuals in a format that will allow us to easily and inexpensively perform further revisions to address future code or best practice changes.

Clean Fuels Ohio has set up a Google drive to support the overall team, including the regional Clean Cities partners, to disseminate information to all team members and ensure that they all have the latest document versions. In addition, there are frequent emails and calls to support and coordinate the team.

Clean Fuels Ohio has also created a website, SafeGasGarage.com, to provide public-facing outreach, including information on the training content and format, and the ability to register for various training sessions. This website also hosts training materials that are available for download to the public. Clean Fuels Ohio has established and is maintaining an "Eventbrite" online registration system for attendees. Once registered, Clean Fuels Ohio disseminates agendas and reminders to attendees prior to each event.

By the end of fiscal year (FY) 2018, Marathon had completed 7 of 15 total days of training. The remaining classroom training sessions will be completed in the first quarter of FY 2019. Marathon has developed a two-page course evaluation that students complete in class at the end of each training session. This evaluation system consists of a "poor" to "excellent" scale that allows attendees to rate and comment on all aspects of the training, including registration, the training facility, food, training materials, the trainer, the sponsor presentation, the tour(s) and what could be improved. Scores recorded to date have generally been in the "above average" to "excellent" range, with the lowest scores being "average". Marathon and Clean Fuels Ohio have converted these evaluations into a 5-point numerical scale; the average score has typically been 4.5+.

It has been the team's goal to provide training and food at no cost to all attendees. One element in this effort has been to use sponsors who pay for breakfast, coffee and lunch. These sponsors are then given an opportunity to provide a presentation of their goods and services to the attendees. Sponsors are typically gas detection manufacturers, contractors or consultants, all of whom bring their own gaseous fuel garage upgrade knowledge and experience to the attendees. Marathon has found that having different voices describing their approaches has been beneficial to the attendees.

## Conclusions

This project is still in process. Since this report only covers the second work period of a multi-year project, conclusions listed below are based on activities conducted to date. In addition, we have noted challenges that the project team identified and addressed along the way.

- The project remains on track to achieve its initial goals. The team has adapted the schedule to shift more training to the fall of calendar year 2018 to address delays experienced in FY 2017. Other than the shift in training schedule, the approach and project schedule originally proposed are still being applied.
- Marathon and Clean Fuels Ohio have developed a "new from the ground up" training manual for each of the four fuels. This manual is written as a training manual rather than a technical paper and is rich in

pictures and diagrams to explain concepts and applications. The training materials have been very well-received by attendees at the training sessions, as noted by comments and scores taken from the training evaluations.

- As noted in last year's report, Marathon encountered strong support for this program from government fleets, but private fleets were less open to hosting tours of their facilities, citing protection of trade secrets as the primary concern. This being the case, Marathon has built the training and tours plan around primarily public fleets that continue to be very receptive and welcoming to this initiative.

- At the outset of this project, the team expected that there would be an abundance of existing CNG garage upgrades, and this indeed proved to be the case. Additionally, there has been a transition in the industry away from LNG in transit and garbage fleets, and even in the day-tractor Class 8 truck fleets, so there is a very limited number of LNG garages available for study. Marathon located a new garage built for LNG in the Seattle area, so the training for that city was expanded to include LNG, bringing the total number of LNG training sessions to three.

- Hydrogen fleets are still few, so the team knew that it would be a challenge to locate a significant facility that has already been upgraded for hydrogen; however, the team located one such facility and promoted this training session nationally, and not just regionally. Marathon received significant feedback from the California partners that they needed more training in hydrogen garages due to the push locally toward hydrogen as a transportation fuel. Although code sources differ, hydrogen and CNG upgrades are very similar, so Marathon was able to add hydrogen to the two California CNG/LNG training sessions, which helped to increase the number of attendees.

- LPG garages are plentiful; however, these garages have consistently had no LPG-specific upgrades, although several garages had LPG-specific operating procedures. There is interest in LPG training, but typically at a lower level than for CNG. Marathon has adapted to this by promoting the LPG training as providing a strong background for training for conventional fuels, since the code requirements are the same. Having a compliant conventional fuel garage is a positive first step when upgrading for other fuels.

- The Marathon team will conclude classroom training in the first quarter of FY 2019. The next step will be to adapt the training materials for use online.

## Key Publications

The published documentation for this project was completed in Beta form in the second quarter and in final form in the fourth quarter of FY 2018, timed to coincide with the beta training in June and regular training sessions in the fall of calendar year 2018. The published documentation is distributed electronically in pdf form to training session attendees in advance of each training session, and will be posted to the project website SafeGasGarage.com in December 2018, after the final training session. The training manuals include:

Adams, Rob, September, 2018. Compressed Natural Gas (CNG) Vehicle Maintenance and Storage Garage Modifications: Requirements and Best Practices.

Adams, Rob, September, 2018. Liquefied Natural Gas (LNG) Vehicle Maintenance and Storage Garage Modifications: Requirements and Best Practices.

Adams, Rob, September, 2018. Gaseous Hydrogen ($GH_2$) Vehicle Maintenance and Storage Garage Modifications: Requirements and Best Practices.

Adams, Rob, September, 2018. Liquefied Petroleum Gas (LPG, LP-Gas or Propane) Vehicle Maintenance and Storage Garage Modifications: Requirements and Best Practices.

# I.14 Training For Cost-Effective, Code-Compliant, Maintenance Facilities for Gaseous Fuel Vehicles (Gas Technology Institute)

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Start Date: October 1, 2016 End Date: September 30, 2019
Project Funding: $834,782 DOE share: $749,965 Non-DOE share: $84,817

## Project Introduction

As the commercial introduction of alternative fuel vehicles continues to grow and businesses begin to consider investing in significant sized fleets of alternative fuel vehicles, the cost and complexity of maintenance facility modifications must be considered, as they can influence a company's decision to adopt alternative fuel vehicles.

The alternative fuel vehicle industry has largely focused its efforts on development of vehicles and fueling infrastructure, while leaving issues related to any needed upgrades to maintenance facilities and operational changes to fleet owners, who have used their internal staff and/or consultants to interpret the intent of the applicable codes. Any designs for facility upgrades will ultimately have to be approved by the local authority having jurisdiction (AHJ), which is sometimes a difficult process, as the codes are performance documents, with little design guidance. The codes also use language and phrasing that may require expert interpretation to properly evaluate and remedy any expected hazardous conditions and associated risks.

Additionally, engineering and design firms inexperienced with alternative fuels may exacerbate the issue by providing plans that are overly conservative and that typically include high construction costs to modify or build a maintenance facility. Some AHJs may not allow upgrades at all because of a lack of knowledge about gaseous fuels.

## Objectives

The objective of this project is to present guidance and practical solutions to facility owners, AHJs, designers, fire officials, and other stakeholders that are interested in permitting maintenance or repair facilities, to allow for servicing of alternative fuel vehicles. This will be done by showing how codes are applied in real-world cases, as well as by openly discussing how the codes are interpreted today. The project team will develop guidance that provides a better understanding of the intent of the code committee allowing for those codes to be appropriately incorporated in the design of maintenance facilities.

## Approach

The project will accomplish these objectives through the use of multiple outreach and training tools: on-site training seminars, facility tours, reports, and online resources. This collection of tools will cover three fuels – natural gas, hydrogen, and propane. In-depth reports will cover applicable codes and standards for maintenance facilities that service alternative fuel vehicles, and will address issues with these codes and best practices that a facility can implement to become code compliant.

In addition, the project team will develop materials in support of six workshops that will be held in 2018 and 2019 throughout the United States. The workshops will include a half-day classroom review of applicable codes and compliance strategies, as well as a tour of an upgraded maintenance facility. The reports, workshop materials, and educational tools will be available to the public on a website for the project. Gas Technology Institute (GTI) will work with project partners and subject matter experts Clean Energy (natural gas), Frontier Energy (hydrogen) and Superior Energy Systems (propane), as well as local Clean Cities coalitions.

It should be noted that DOE awarded two projects under this Funding Opportunity Announcement (FOA) topic, one being managed by Marathon Technical Services and one managed by GTI. Although the overall goals, objectives, and approaches are somewhat similar, they have formed different teams of subject matter experts and will be focusing on different geographic regions for their training workshops and site tours. However, Marathon and GTI are actively collaborating to share technical information and coordinate workshop scheduling and site tours, to avoid overlap and duplication and to assure consistency with regard to technical content and recommended best practices for facility upgrades.

## Results

GTI has met with industry experts, garage owners, and safety officials to gather information on the key technical areas that present issues for fleet owners during garage upgrades. The team of subject matter experts has aided GTI during development of in-depth reports on code compliance for natural gas, hydrogen, and propane. These reports cover both current and recent versions of the following codes from the International Code Council (ICC) and the National Fire Protection Association (NFPA):

- International Fire Code
- NFPA 30A: Code for Motor Fuel Dispensing Facilities and Repair Garages
- NFPA 2: Hydrogen Technologies Code
- NFPA 58: Liquefied Petroleum Gas Code

Key topic areas discussed in these reports include gas detection, ventilation, electrical classification compliance, heating devices, alarm system configuration, and the behavior of lighter-than-air fuels.

Through conversations and visits with industry experts, equipment suppliers, design firms, and garage owners, GTI has collected industry best practices, and has incorporated these into the reports and workshop training material. These best practices represent methods and strategies that can be implemented to meet the code requirements, while reducing the expense and complication of a facility upgrade. The best practices will be available as standalone resources to provide a quick introduction to individual topic areas.

GTI's education team has developed a workshop structure that will encourage presentation of material in different formats to encourage engagement. The education team has helped develop consistent presentation of the key issues for maintenance garage modification in simple, easy to understand language. Topics that are important to one audience segment may not necessarily be relevant to another. The education team's contributions have led to the definition of learning tools and strategies that cater to a wide audience. GTI's education team has conducted early information-sharing with the Chicago Area Clean Cities coalition, and will continue to work with other Clean Cities coalitions in the cities where the remaining workshops will be held.

GTI has worked with web and graphic designers at Frontier Energy to allow public access to the developed educational materials and online resources via the project's website, www.AltFuelGarage.org. All of the reports, best practices, and workshop presentation material have been available since the workshops began. In addition, a graphic model is in development. This graphic model will present a digitized image of a typical garage and will provide information about the key issues of facility modification via a rollover feature.

During fiscal year (FY) 2018, GTI and project partners executed four workshops: Chicago, Emeryville (CA Bay Area), Los Angeles, and Pittsburgh. All workshops have included a natural gas educational module. The Emeryville workshop also included the hydrogen module, and the Pittsburgh workshop included the propane module. All of the workshops included a morning of classroom education, lunch, and then a tour of an upgraded facility (see Figures I.14.1, I.14.2 and I.14.3).

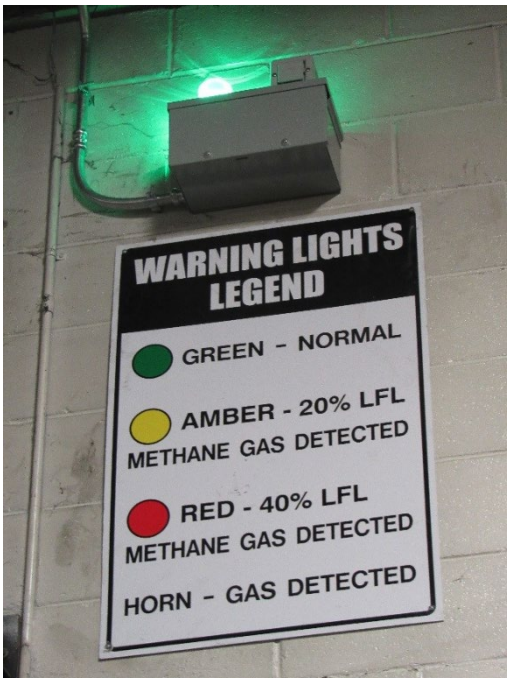


Figure I.14.1. A typical alarm system indicator (Clean Energy Fuels)

Figure I.14.2. Classroom portion of Chicago Workshop (GTI)

Figure I.14.3. Tour of Cummins Maintenance Facility (GTI)

In total, over seventy people registered for the four workshops, with roughly 40% of the registrations consisting of those who own, manage, or work in a maintenance facility. Less than 10% of those registered consisted of fire departments or building code professionals. The remaining 50% was roughly equal parts equipment suppliers, facility design and construction professionals, and industry advocates.

Outreach prior to each workshop included LinkedIn and Twitter campaigns that began roughly two months prior to the workshop date, continuing every five to ten days until the date of the event. GTI published information on its own company LinkedIn and Twitter and leveraged those of Frontier Energy, the California Fuel Cell Partnership, and Clean Energy, and through individual LinkedIn accounts.

In addition to online outreach, GTI engaged Clean Cities coordinators in or adjacent to the regions in which the workshops were held so that they could distribute an e-mail based notification about the training to their distribution lists. The same e-mail based notification was sent through the distribution lists at Frontier Energy, the California Fuel Cell partnership, Sierra Monitor Corporation, Superior Energy, and Clean Energy. GTI estimates that news of each workshop reached over 2,000 individual stakeholders.

GTI also worked to obtain lists of contact information for fleets, fire marshals, city permitting officials, and suppliers of equipment to the natural gas and maintenance facility industry. GTI reached out through phone and email channels to over 300 individuals with more personalized messaging, based on the type of individual contacted.

GTI and partners in this project have also worked to distribute the educational materials outside of the workshop format. The documents have been loaded onto flash drives and have been handed out at industry conferences and trade shows, including the Work Truck Show/Green Truck Summit in Indianapolis, Indiana in March 2018, and the Alternative Clean Transportation Expo (ACT Expo) in Long Beach, California in May 2018. Team members will also feature the material while participating in the Northern California Clean Technology Summit & Equipment Expo in October 2018, and the North Central Clean Cities Regional Meeting in Chicago in October 2018. The www.AltFuelGarage.org website continues to collect visits and is recording downloads of the reports, best practice documents, and workshop presentation material. There were almost 500 unique visitors and over 120 downloads by September 2018.

## Conclusions

This project is still in process, however there has been meaningful progress. The code reports, best practices, and workshop curriculum material has been finalized and released to the public, via the website. The reports and best practices will be updated as the need arises before conclusion of the project, as will workshop presentation materials. The website continues to be an effective channel for information distribution, and non-workshop outreach will continue. Planning for the remaining workshops continues, and coordination with the facilities that will be toured is ongoing. The key elements of the graphic model have been identified, and concepts for the digitized image have been reviewed.

## Key Publications

Project Website: www.AltFuelGarage.org

# I.15 U.S. Fuels Across America's Highways - Michigan to Montana (Gas Technology Institute)

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Start Date: January 19, 2017 End Date: June 27, 2020
Project Funding: $ 10,479,623 DOE share: $ 4,999,983 Non-DOE share: $ 5,479,640

## Project Introduction

Interstate 94 (I-94) is the primary connection between the major metropolitan areas in the Upper Midwest. With a strategically placed network of DC fast chargers, compressed natural gas (CNG), and propane stations, travel between any of these cities could be accomplished seamlessly on any of these alternative fuels that are commercially available today. The main goal of the Michigan to Montana (M2M) Corridor project, however, is not to install infrastructure in every gap that will be identified; it is to create the necessary team to guide the creation of an alternative fuel corridor, commission select stations and vehicles, and provide education and training to establish a sustainable alternative fuel and advanced vehicle market. This will allow the M2M Corridor to continue growing well beyond the end of the project term. The project focuses on I-94 from the international border at Port Huron, Michigan, across America's heartland to Billings, Montana. Significantly growing the availability and use of alternative fuels and advanced vehicles in key markets is critical for the long-term success of these technologies.

A key factor for the project's success is the ability of the team members and community partners to provide leadership, and to guide the organization and implementation of project elements, to ensure sustainability beyond the project term. Gas Technology Institute (GTI) is a not-for-profit with 75 years of research, development, and technology integration experience, including several large projects to increase adoption of alternative fuel vehicles and the installation of fueling stations. The other team members include several of the most motivated and active DOE Clean Cities coalitions, as well as key industry leaders with experience in alternative fuel vehicles (AFVs) and infrastructure development. These team members include: Greater Lansing Area Clean Cities, South Shore Clean Cities, Chicago Area Clean Cities, Wisconsin Clean Cities, Twin Cities Clean Cities, North Dakota Clean Cities, Yellowstone-Teton Clean Cities, Kwik Trip, Trillium CNG, ZEF Energy, Landmark Services Cooperative, and Contract Transportation Services (CTS).

## Objectives

The objectives of the project are to establish community-based partnerships; accelerate the adoption of AFVs; and develop related fueling infrastructure needed to support those vehicles along I-94 from Port Huron, Michigan to Billings, Montana. The project focuses on alternative fuels and vehicles including electric drive, CNG, biofuels, and propane. Specifically the project will:

- Provide leadership through community-based partnerships to create a successful and sustainable alternative fuel corridor

- Commission approximately 15 fueling stations, i.e., 12 electric vehicle (EV) DC fast chargers; 2 CNG stations; 1 propane station; and approximately 60 CNG long-haul trucks
- Identify and fill gaps in alternative fuel station locations and identify partners with anchor fleets of AFVs that will create the consistent demand necessary for a sustainable industry
- Provide outreach, education, and training to critical stakeholders, i.e., fleets, communities, utilities, permitting officials, first responders, and fire marshals
- Create a model for establishing future alternative fuel corridors across the country by identifying key stakeholders and documenting successes and best practices
- Leverage and expand on existing Smart Mobility programs in this region and implement new "smart infrastructure" initiatives to increase connectivity across the corridor

## Approach

A key factor in the project's success will be the degree to which AFVs have consistent access to fueling options. Ensuring this access will remove range anxiety and allow light-duty plug-in electric vehicle (PEV) owners to travel longer distances, while also expanding commercial fleets' abilities to utilize PEVs and AFVs for regional and long-haul applications. The project will create a sustainable corridor as it leverages past projects to prepare for and to accelerate adoption of alternative fuel infrastructure and vehicles.

The project team will work closely with several community-based stakeholders in all phases of this project. It is essential to the project's success that each task include direct input from partners at State Energy Offices, state and municipal departments of transportation (DOTs), metropolitan planning organizations (MPOs), utilities, and the private sector. The project team will also focus on providing outreach, education, and training to our community-based partners, to support the long-term growth of alternative fuels along the corridor.

## Results

A wide range of activities has been accomplished by the project team, including the following specific items:

### *Needs Analysis*

The M2M Team has analyzed the current strengths and resources along the corridor, as well as the greatest needs. To evaluate gaps in the fueling infrastructure along the corridor, it is important to define the critical distances that are needed between sites. There have been several studies that analyzed these distances and provided recommendations. A number of the studies and distances are cited below to illustrate the values that the team considered.

- FHWA considered distances for when a corridor is "signage ready" and determined that they were fuel specific, including no greater than 50 miles for DCFC, no greater than 150 miles for CNG and propane, no greater than 200 miles for liquefied natural gas (LNG), and no greater than 100 miles for hydrogen.
- Mid-America Alternative Fuels Corridor Study, from May 2016, considered several alternative fuels for a corridor and stated that the industry standard for station spacing is between four and one-half hours and nine hours driving time.
- There were several data points given in the National Plug-In Electric Vehicle Infrastructure Analysis, by the National Renewable Energy Laboratory (NREL) from September 2017. Items included:
    - "Three scenarios were proposed for nominal station spacing (100, 70, and 40 miles), providing various levels of support for longer- and shorter-range BEVs."
    - "Electrify America announced an average station spacing of 70 miles for its DCFC corridor network (Electrify America 2017). This spacing is almost identical to the Tesla supercharger

network; nearest-neighbor analysis was performed on the Tesla Supercharger station locations publically available in the Alternative Fuels Data Center data set (DOE 2017), revealing an average Tesla station spacing of 67 miles."

- "Additionally, Navigant Research proposes two station spacing scenarios in its DC Charging Map for the United States: 130 miles for long-range BEVs, and 75 miles to also support short-range BEVs (Navigant Research 2016)."

The M2M Team is following the FHWA suggested distances because their analysis overlaps with many of the goals for the M2M project. This includes considering several alternative fuels as well as their large-scale, corridor-specific interest.

The M2M team has created a map of the existing infrastructure along the corridor, and identified the gaps in the location of fueling infrastructure (see Figure I.15.1, below). This analysis of the gaps in infrastructure highlights several areas that will be focused on as the project progresses. At a high level, these gaps include western Michigan, central Wisconsin, and areas along I-94 west of Minnesota, including most of North Dakota and Montana. There are currently 42 public DC Fast Chargers (11 of which are maintained by M2M team members), 36 public CNG stations (14 owned by M2M team members), and 23 public propane stations along I-94. The M2M team is also assessing additional strengths and needs, including information on existing anchor fleets, station providers, and stakeholders that will be key to creating a sustainable corridor.


Figure I.15.1. Infrastructure Gap Analysis and Station Locations (Blue – DCFC, Red – Propane, Green – CNG)

Note: Red ovals denote major gaps in fueling infrastructure on I-94

A major accomplishment of this project has been to start filling in some of the major infrastructure gaps along the corridor. In fiscal year (FY) 2018, ZEF Energy installed a DC Fast Charger (DCFC) in Tomah, WI and initiated site work in Moorhead, MN, which are key locations denoted in the red ovals in Figure I.15.1, above. Furthermore, although not part of this project, a propane station was added in Kalamazoo, MI, another key gap.

Another part of our evaluation considered that beyond the gaps listed above, there are unique needs in different settings across the country. While a distance of 150 miles between CNG stations on a highway may be sufficient, the critical distance needed between fueling stations in urban areas is dramatically reduced. Urban fleets tend to stay closer to home base, and must contend with traffic that increases the time needed to travel

shorter distances, compared to highway driving. As a specific example, there is a gap less than five miles south of Chicago, along I-94, for EV drivers. Even though there are several charging locations in the city of Chicago, including on the south side, discussions with EV drivers and DCFC network providers have uncovered that the sites do not promote travel out of the city, particularly along the corridor east of Chicago. It is very difficult to establish a specific critical distance for urban environments, as those distances are unique to the given locations, so the team is concentrating on identifying and eliminating gaps that raise major barriers to adoption, and not suggesting a specific urban critical distance.

One last note is that redundancy is something that is critical to a robust and sustainable corridor. Fleets and municipalities, especially those in critical vocations, such as waste haulers, taxi drivers, and police officers, often mentioned that having redundant fueling sites is necessary to the widespread adoption of alternative fuels. Therefore, station locations will not be limited to "filling gaps" but will also be determined by the needs of the end users and the impact on overall adoption.

### *Sustainable Corridor Planning*

The M2M team members have worked on creating a model for developing a sustainable I-94 Alternative Fuel Corridor that can then be used by other communities as a guide for future corridor development.

The Fixing America's Surface Transportation (FAST) Act of 2015 required the Secretary of Transportation to identify the need for, and location of, EV charging infrastructure and natural gas, propane and hydrogen fueling infrastructure along designated interstate highway corridors, to improve the mobility of passenger and commercial vehicles that employ these technologies. The Fixing America's Surface Transportation Act (FAST Act) of 2015 established a process for nominating corridors for designation, which the Federal Highway Administration (FHWA) is implementing. FHWA designated several sections of I-94 following the initial two round of nominations. There are plans to have additional sections designated as "corridor ready" or "corridor pending" for electric charging, propane, and CNG in the third round, which is ongoing. The type of designation depends on the distance between available refueling or recharging stations. M2M team members have been coordinating their efforts, and are working with state DOT representatives and other key stakeholders. Through efforts of project team members, Michigan DOT installed Alternative Fuel Corridor signage along I-94 in Michigan. See figure I.15.2.


Figure I.15.2. Corridor Signage on I-94 in Michigan

Minnesota DOT had previously installed signage along I-94 in Minnesota. In early September, MDOT deployed alternative fuels corridor signage at the following locations:

- I-94 East Bound at New Buffalo – EV

- I-94 East Bound at US-127- EV
- I-94 West Bound at US-127 – EV
- I-94 East Bound at US-23 - EV and CNG
- I-94 West Bound at Port Huron - EV and CNG

Leveraging capabilities and experience of the existing network is a key focus, to promote continued sustainability. Outreach is another key aspect of developing a sustainable alternative fuels corridor. In FY 2018, members of the project team held meetings with dozens of potential stakeholders (i.e., fleets, station site owners, government entities, utilities) and also presented at several auto shows, conferences, and workshops to promote the M2M project and alternative fuel corridors. Specific events included:

- Natural Gas for Transportation Roundtable, Appleton, WI – November 2017
- Wisconsin Metropolitan Planning Organization Conference - November 2017
- Wisconsin Partners for Clean Air Meeting – November 2017
- Wisconsin Sustainable Business Conference - December 2017
- Transportation Research Board (TRB) Annual Meeting, Washington D.C – January 2018
- Renew Conference, Madison, WI - January 2018
- We-Energies Electric Consumer Forum, Mequon, WI - January 2018
- Chicago Auto Show – February 2018
- Milwaukee Auto Show - March 2018
- Work Truck Show, Indianapolis, IN – March 2018
- Green Fleet Radio Show (Lake Shore Public Radio) – March 2018
- Northern Indiana Regional Planning Commission (NIRPC) 2050 Planning Workshop – March 2018
- Lake Michigan Consortium Winter Webinar Series: Providing Environmental Security Through the I-94 Corridor - April 2018
- Sustainability Summit and Exposition, MATC, Milwaukee, WI – April 2018
- Eau Claire Government Summit – April 2018
- Wisconsin Energy Innovation Summit, Madison, WI – May 2018
- Green Drives Conference and Expo, Naperville, IL – May 2018
- US Dept. of Energy Annual Merit Review, Washington D.C. - June 2018
- Federal Highway Administration (FHWA) Convening, Minneapolis, MN - June 2018
- Citizens Local Energy Action Network Workshop, Bismarck, ND – June 2018
- School Transportation Association of Indiana Annual Conference, Ft. Wayne, IN – June 2018

- Propane Educational Research Council and National Park Service Workshop, Portage, IN - August 2018
- Tri-County's Sept 12 Planning for Autonomous Vehicles Forum – September 2018
- Indiana MPO Conference, Evansville, IN – September 2018

### *Technology Integration Activities*

M2M team members have begun several technology integration activities that are highlighted below, and shown in Figures I.15.3 through I.15.5:

- In FY 2018, CTS placed an additional 10 CNG trucks (2018 Kenworth Model T680) into service, for a total of 30 CNG trucks. The CTS trucks have traveled well over 5,000,000 cumulative miles on CNG, displacing over 1,000,000 gallons of diesel.


Figure I.15.3. CTS Kenworth Truck


Figure I.15.4. CTS Truck

Figure I.15.5. ZEF Energy DCFC Tomah Site – Ribbon Cutting

- ZEF Energy installed a DCFC site in Tomah, Wisconsin, and initiated site work in Moorhead, Minnesota.
- Trillium CNG has begun initial planning activities for its first CNG stations.

## Conclusions

The M2M Corridor Project has been very successful to date and is on track to accomplish all of its goals and objectives. The project focus on organization and planning involving team members and community partners has created a pathway to establishing a sustainable alternative fuel corridor along I-94.

# I.16 WestSmart EV: Western Smart Plug-in Electric Vehicle Community Partnership (PacifiCorp)

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Start Date: January 19, 2017 End Date: January 18, 2020
Project Funding: $11,548,617 DOE share: $3,532,333 Non-DOE share: $8,061,287

## Project Introduction

The WestSmart EV Project is designed to accelerate adoption of plug-in electric vehicles (PEVs) in communities located within PacifiCorp's electric service territory across the Intermountain West. This will be accomplished by developing a large-scale, sustainable PEV charging infrastructure network, coupled with PEV adoption programs. The program is led by PacifiCorp, a locally managed, wholly-owned subsidiary of Berkshire Hathaway Energy Company. PacifiCorp is one of the leading electric utilities in the western United States, with service territory in six states: Utah, Wyoming, Idaho, California, Oregon, and Washington.

PacifiCorp has built a first-class Project Team of strategic partners and leading experts to successfully execute the program. Team members include the Idaho National Laboratory (INL), Salt Lake City, Utah Clean Cities Coalition (UCCC), Breathe Utah, Park City, Utah State University (USU), and University of Utah (UU). Additional community partners include Yellowstone-Teton Clean Cities, Rogue Valley Clean Cities, Forth Mobility, and University of Nevada. The program also has committed partnerships with key private businesses including ABB, the world's largest charging equipment manufacturer; Maverik gas stations, the largest independent fuel retailer in the Intermountain West; and NV Energy, the largest electric utility in Nevada.

## Objectives

The primary objective of WestSmart EV is to increase the adoption rate of PEVs across the intermountain multi-state region covering Utah, Idaho, and Wyoming. A secondary objective of WestSmart EV is to spur additional growth of PEVs among the broader western states, including Washington, Oregon, California, Nevada, and Colorado.

The overall target is to double the growth rate for PEVs in communities in PacifiCorp's electric service territory, from 20% to 40%, leading to more than 50,000 PEVs within 10 years. This three-year project will launch a multi-pronged approach to help meet these targets.

## Approach

To accomplish the primary project objective of increasing PEV adoption across the intermountain multi-state region, this project has implemented a three-year, strategically phased, directed, and coordinated implementation plan, as shown in Figure I.16.1.

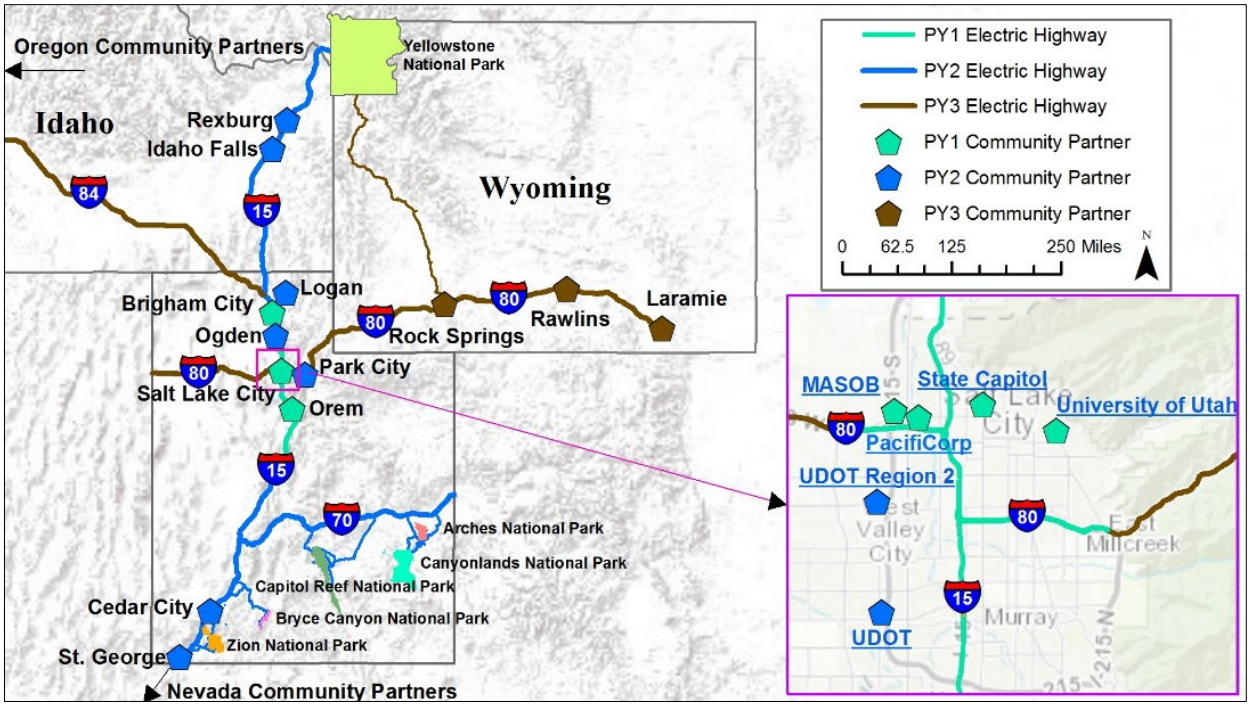


Figure I.16.1. WestSmart EV Three-year Project Implementation Plan

The three annual phases for all project tasks include the following:

- Project Year 1 (PY1): Pilot year for initial implementation and initiation of data collection
- Project Year 2 (PY2): Expansion year for ramping up efforts and beginning strategic flow of data results back into project components
- Project Year 3 (PY3): Rollout year to reach full project capacity and incorporate lessons learned while disseminating best practices

The phased approach to building PEV growth through the WestSmart EV project includes 6 major tasks, as depicted in Figure I.16.2. They include (1) developing over 1,500 miles of electric highway corridors along I-15, I-80, I-70, and I-84 in Utah, Idaho, and Wyoming; (2) advancing Workplace Charging within the corridors; (3) targeting fleet operators and incentivizing conversion of fleet vehicles to PEVs within the corridors; (4) building community partnerships and incorporating Smart Mobility programs to align efforts with long-term transportation planning; (5) collecting, processing, and applying data from across all activities through the WestSmart EV Central task to inform project reporting, develop new tools for utility integration of charging infrastructure, and detail lessons learned and best practices, and (6) coordinating outreach, education and dissemination of best practices through a series of workshops across seven states, and one-on-one meetings with business leaders though community partners.

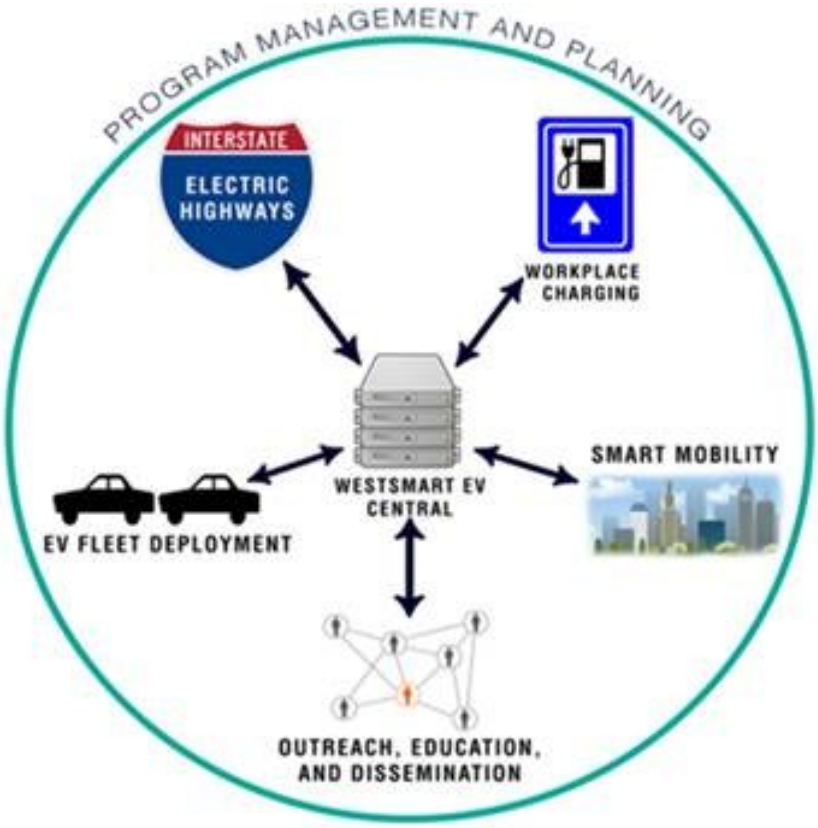


Figure I.16.2. WestSmart EV Major Task Diagram

### *Task 1 - Electric Highways*

WestSmart EV will electrify over 1,500 miles of interstate highways in three states, with DC fast chargers every 50-100 miles along the corridors and AC level 2 (L2) chargers covering every major community across the region. The project will create two primary electric interstate highway corridors along I-15 and I-80. In addition, the project will include portions of I-70 running east from I-15 in southern Utah to the Colorado border, I-84 from Utah to western Idaho, along with off-corridor highways leading to the national parks.

### *Task 2 - Workplace Charging*

With the strong support of local air quality managers, municipalities, state agencies, business groups, and public interest advocates, WestSmart EV will aggressively push workplace charging through a combination of public events, workshops, and awareness campaigns. The project will incentivize installation of over 600 AC L2 chargers at workplace locations.

### *Task 3 – EV Fleet Deployment*

The program will strategically target fleet operators with incentives to convert fleets to PEVs. All vehicles will use data loggers that enable data sharing and development of lessons learned and best practices. In all, the program will incentivize the purchase of over 200 PEVs.

### *Task 4 – Smart Mobility*

WestSmart EV will pilot, expand, and roll out innovative concepts for zero local emission smart mobility in urban living along the Wasatch Front (a 100-mile segment of the I-15 corridor running north and south of Salt Lake City) and at university campuses throughout the region. This task focuses on eliminating the need for personal vehicles and providing all-electric solutions in the first-mile and last-mile trips for commuters. The lead pilot program in Park City will include electric buses (ebuses), electric bikes (ebikes), micro transit programs, and an electric vehicle (EV) ride hailing program with 100 PEV mobility service drivers.

### *Task 5 – WestSmart EV Central*

This task involves centralized data collection, analysis, modeling, and tool development, to inform investment and policy decisions. INL will lead efforts on data collection for vehicles and chargers; USU will lead the collection of behavioral data; and UU will lead the collection of utility infrastructure data.

### *Task 6 - Outreach and Education*

In this task, partners develop education and outreach materials, including a website, and conduct workshops throughout seven western states.

## Results

### *Overall Project Results for fiscal year (FY) 2018:*

The budget period 2 continuation application and revised budget were approved March 21, 2018.

Successfully published two research papers regarding dynamic charging, EV charging installation, and residential utility utilization.

Successfully launched a social media campaign and www.liveelectric.org website.

### *Task 1 - Electric Highways Results:*

- 16 DC Fast Chargers (DCFC) were installed in FY 2018:
    - Two at local universities
    - Two at Kimball Junction
    - Six at Maverik gas stations
    - One Park City ebus charger
    - Two at Packsize
    - Three at EV dealerships.

### *Task 2 - Workplace Charging Results:*

- 426 workplace L2 chargers were installed in FY 2018.

### *Task 3 – EV Fleet Deployment Results:*

- 92 EVs were purchased in FY 2018.
    - 17 EVs were sold using the program's EV buy-down program.
    - 75 EVs were sold through the Rocky Mountain Power and Nissan FY 2018 incentive program.

*Task 4 – Smart Mobility Results:*

- Forth Mobility is initiating an EV ride hailing program with Lyft, supported by Salt Lake City and Park City.

*Task 5 – WestSmartEV Central Results:*

- Coordinated data collection consensus with ChargePoint, EVgo, BTCPower, and GreenLots.
- Conducted successful site visit with DOE HQ Technology Manager, 9/18/18 – 9/19/2018.
- Utility Integration – released study results from residential study.
- Enhanced EV Adoption Model formulation/data collection.

*Task 6 – Outreach and Education Results:*

- Awareness and branding campaign continues, led by Doglatin Media.
- www.liveelectric.org website is online; social media and public relation plans established.
- Conducted multiple EV workplace challenge workshops in the region.

## Conclusions

Forth incorporated lessons learned and best practices from the first year's results into the FY 2019 strategy to expand efforts across primary objectives and insert strategic flow of data results back into project components. We have successfully implemented the key activities associated with all primary objectives of the WestSmart EV project's second year. Efforts to achieve milestones have in some cases exceeded year 1 goals, or are on track for completion by the end of FY 2019 or shortly thereafter. Data collection for Tasks 1-4 has continued. The upcoming year will incorporate the lessons learned and best practices from the second year's results to proceed with year 3 roll out efforts.

## Key Publications

Palomino, Alejandro (Student Member, IEEE) and Masood Parvania (Member, IEEE). 2018. "Probabilistic Impact Analysis of Residential Electric Vehicle Charging on Distribution Transformers." 2018 North American Power Symposium.

Liu, Zhaocai and Ziqi Song. 2017. "Robust planning of dynamic wireless charging infrastructure for battery electric buses." *Transportation Research Part C: Emerging Technologies*, vol. 83, 77-103.

# I.17 Electric Last Mile (Pecan Street, Inc.)

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Start Date: October 1, 2017 End Date: March 31, 2019
Project Funding: $2,000,000 DOE share: $1,000,000 Non-DOE share: $1,000,000

## Project Introduction

Electric Last Mile (ELM) is a research and demonstration project managed by Pecan Street Inc., carried out in partnership with Austin's transit agency, Capital Metro, and funded by a grant from the Department of Energy's Vehicle Technologies Office. The goal of the Electric Last Mile project is to study public transit ridership in pilot neighborhoods using electric shuttles (eShuttles) that reduce greenhouse gas emissions and traffic congestion. This will be done via cost-effective public-private partnerships that provide opportunities to demonstrate and evaluate technology solutions to transit problems.

## Objectives

Pecan Street will pursue this goal through the following five objectives:

- Conduct pilot tests of a last-mile transit solution using all-electric, six-person shuttles from a private vendor, Electric Cab of North America, in three Austin neighborhoods, for eight months each;
- Collect data on consumer engagement, vehicle performance, traffic impacts, and feasibility of new technologies through surveys, community charrettes, and hardware installed on the vehicles;
- Pilot a fully autonomous eShuttle for neighborhood circulator service, to demonstrate the benefits and challenges of applying this technology to local connections;
- Develop best practices for public-private partnerships for first- and last-mile transit solutions that achieve the following:
    - Reduce reliance on personal vehicles for daily trips
    - Increase the appeal of using a public transit option by reducing transit time and overcoming the well-documented stigma of riding buses and shuttles
    - Quantify the community value of various options and weigh theme against the costs of each tested model
- Assist other communities in replicating the successful aspects of this program through lessons learned and case studies

## Approach

The project team has established three ELM pilot routes in Austin neighborhoods. Maps of the three neighborhood service areas can be found in Figures I.17.1 through I.17.3. These neighborhoods were selected to test applicability of the ELM model to different neighborhood types and varying transit needs. Specifically, the Kramer/Domain route tests the ELM model as a solution for first- and last-mile connectivity to a major shopping, restaurant, and entertainment destination. The Downtown route tests the ELM model as a solution for commuter transit. The Mueller route tests the ELM model as a solution for neighborhood connectivity between residences, public transit stops, medical facilities, and local retail. The Kramer/Domain route began on November 24, 2017, the Downtown route began on January 8, 2018, and the Mueller route began on May 21, 2018. Two shuttles were in use in each neighborhood.

The neighborhoods were selected based upon several factors:

- High rates of traffic congestion
- Lack of available parking
- Proximity to major transit points
- Proximity to major retail, employment, medical, dining, and employment centers
- Potential for business sponsorship to ensure sustainability beyond a subsidized pilot period

Routes in each neighborhood were designed based on several factors:

- Identification of desired drop-off/pick-up points in each area
- Keeping the routes to under 3 miles, to ensure shuttle frequency of at least every 15 minutes
- Ensuring the eShuttles would be on streets where the speed limit is no higher than 35mph

## Results

In its first year of operations, the ELM project accomplished a number of significant milestones:

- Provided 29,206 rides
- Created a telematics kit that monitors vehicle operations and vehicle occupancy, and transmits real-time Global Positioning System (GPS) and occupancy data via cellular network
- Fostered collaborations with local neighborhood associations, real estate developers, housing commissions, public transit agencies, utilities, and micro-transit providers to run and promote last-mile transit connections and low-emissions neighborhood transportation alternatives
- Created a mobile trip request app and website with the following features:
    - Integrated trip planner for trips using both eShuttle and public transit
    - Pop-up survey questions on price sensitivity and transportation habits
    - Payment for eShuttle service
- Compiled initial lessons learned, best practices, and case studies based on data collected through sophisticated sensors, user surveys, community charrettes, and individual interviews, as well as engagements with community organizations, public transit agencies, and micro-transit providers

- Laid groundwork for implementation of the first publicly-accessible autonomous vehicle pilot on public roads in Texas

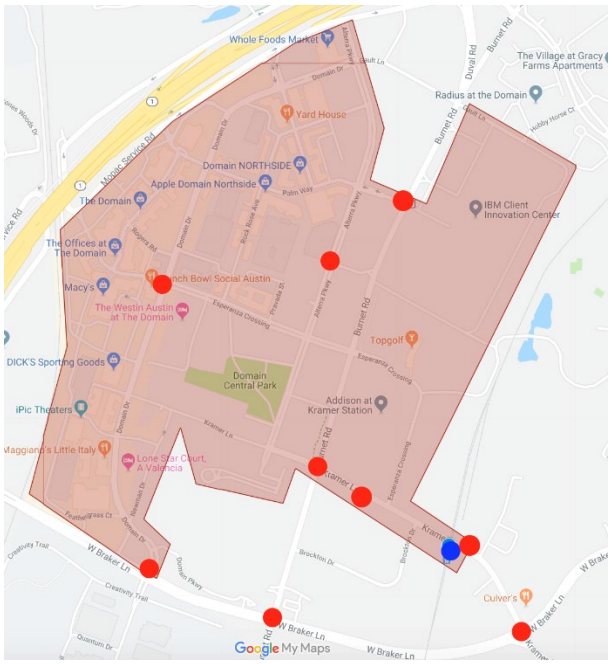


Figure I.17.2. Kramer-Domain Service Area. Red Dots = Bus Stops, Blue Dot = Train Stop

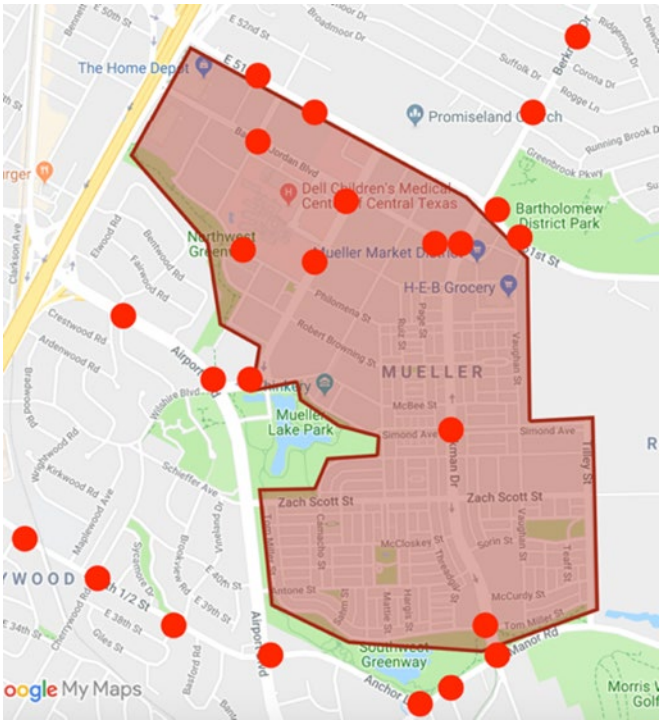


Figure I.17.2. Mueller Service Area. Red Dots = Bus Stops

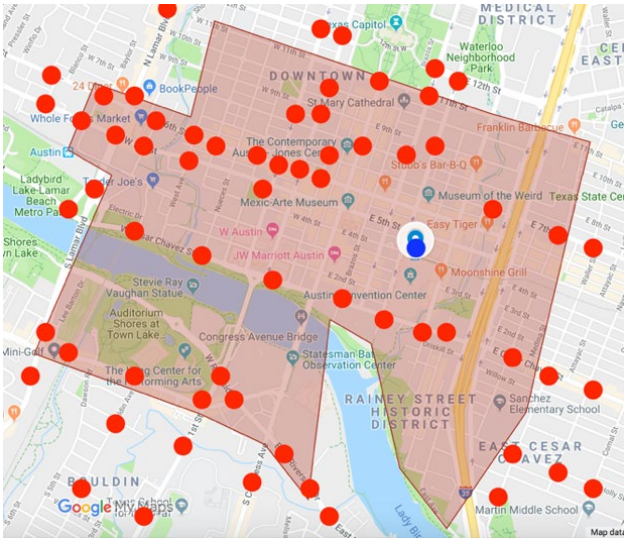


Figure I.17.3. Downtown Service area. Red dots indicate Capital Metro stops. Blue dot indicates train stop

### *Kramer/Domain*

Two eShuttles operated Monday through Friday, from 7 a.m. to 12 p.m., and from 3:15 p.m. to 7:15 p.m. Between April 2 and July 24, 2018, we recorded 3,367 miles traveled with passengers in the vehicle. If this were extrapolated to one year, it would equate to 10,101 miles driven. If 45% of these trips replaced trips that would have been taken in a gas-powered car, 4,545.45 gas-powered vehicle miles would have been averted through the eShuttle program. This translates to 3.6 "well-to-wheels" barrels of petroleum and 2.1 short-tons of greenhouse gases (GHGs) saved per year. About 18 pounds of direct vehicle operation GHGs would have been averted over this period. If 100% of eShuttle trips replaced personal vehicle trips, 8 "well-to-wheels" barrels of petroleum, 4.7 short-tons of GHGs, and 39.9 pounds of direct vehicle operation GHGs would be saved per year.

### *Mueller*

Two eShuttles operated Monday through Friday, from 8 a.m. to 8 p.m., and Sunday, from 10 a.m. to 3 p.m. Between July 1 and August 31, 2018, we recorded 2,235 miles travelled with passengers in the vehicle. If this were extrapolated to one year, it would equate to 13,410 miles driven. If 45% of these trips replaced trips that would have been taken in a gas-powered car, 3,355.2 gas-powered vehicle miles would have been averted through the eShuttle program. This translates to 4.8 "well-to-wheels" barrels of petroleum and 2.8 short-tons of GHGs saved per year. About 23.8 pounds of direct vehicle operation GHGs would have been averted over this period. If 100% of eShuttle trips replaced personal vehicle trips, 10.7 "well-to-wheels" barrels of petroleum, 6.2 short-tons of GHGs, and 53 pounds of direct vehicle operation GHGs would be saved per year.

### *Downtown*

Two eShuttles operated Monday through Friday, from 1:45 p.m. to 6:45 p.m. Between April 2 and August 31, 2018, we recorded 2,267 miles traveled with passengers in the vehicle. If this were extrapolated to one year, it would equate to 5,462.4 miles driven. If 45% of these trips replaced trips that would have been taken in a gas-powered car, 2,458.08 gas-powered vehicle miles would have been averted through the eShuttle program. This translates to 2 "well-to-wheels" barrels of petroleum and 1.1 short-tons of GHGs saved per year. About 9.7 pounds of direct vehicle operation GHGs would have been averted over this period. If 100% of eShuttle trips replaced personal vehicle trips, 4.3 "well-to-wheels" barrels of petroleum, 2.5 short-tons of GHGs, and 21.6 pounds of direct vehicle operation GHGs would be saved per year.

## Conclusions

Two of the three pilot eShuttle routes (Downtown and Kramer/Domain) have concluded for this program, with the third route (Mueller) wrapping up in December 2018. Taking lessons learned from ridership on the three routes reveals some best practices that can be transferred to other areas considering a similar program.

First, understanding the needs of each community with first- and last-mile transit gaps will help identify the appropriate solution. The categorization chart shown in Table I.17.1, developed through discussions with Capital Metro, is a useful tool for solutions planning:

**Table I.17.1. Matrix of last-mile and micro-transit solutions for community needs, developed with Capital Metro**

| Neighborhood Category | Solution Description | Challenges |
|---|---|---|
| High-density residential and mixed-use | 15-person capacity vehicles; electric neighborhood circulator and public transit connection; operate on high-frequency fixed route; cross-subsidized by advertising revenue, public transit and/or area businesses; vehicles can charge overnight in business parking spaces using standard outlets or charging stations. | Cost barriers to procure large electric vehicles; ensuring appropriate charging infrastructure |
| Low-density residential | 6 to 15-person capacity vehicles; fixed route; provided by private operator that costs up to $35/hour; contracted by public transit agency through bulk purchase of service; personal entry and exit doors on both sides of vehicle; runs every 15 minutes; electric vehicle ideal if distances traveled are within range. | Long ranges make many electric vehicles unfeasible; lack of available vehicles on market |
| Market districts | 6 to 12-person vehicles that circulate locally and connect to public transit; electric shuttles; low-speed (up to 30 mph); can charge overnight at market district using standard outlet or charging stations. | More small vehicles require more drivers, increasing cost |
| Para-transit | Small to mid-size vehicles; on-demand service that can be hailed via a mobile app or by phone; operated by transit agency; long-range electric vehicles would be suitable if cost-competitive with gas-powered shuttles. | Lack of cost-competitive long-range, ADA-compliant EVs |
| Suburban business campuses | Small to mid-size shuttles; private operator; run on high-frequency fixed route to connect employees with public transit stops; subsidized by employers. | Convincing employees to use public transit w/o parking shortages |

## Acknowledgements

Pecan Street would like to acknowledge the funding and support from the U.S. Department of Energy, as well as participation, information guidance, and data from Austin Capital Metro.

# I.18 Collaborative Approaches to Foster Energy-Efficient Logistics in the Albany - New York City Corridor (Rensselaer Polytechnic Institute)

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Start Date: October 1, 2017 End Date: September 30, 2020
Project Funding: $4,000,342 DOE share: $1,999,999 Non-DOE share: $2,000,343

## Project Introduction

The goal of the Collaborative Approaches to Foster Energy-Efficient Logistics in the Albany - New York City Corridor project is to foster the adoption of Energy Efficient Logistics (EEL) along the supply chains operating in this corridor, in a way that benefits the range of stakeholders and agents involved in, and affected by, those supply chains, i.e., shippers, carriers, and receivers. The project aims to fully exploit the potential of collaborative approaches that will induce carriers to adopt energy efficient Technologies and Operations (Tech/Ops), and induce shippers and receivers to change their demand patterns to exploit the synergies with Tech/Ops, thereby achieving EELs.

## Objectives

Reaching this goal will require achieving a number of objectives, as outlined below:

- To conduct research and develop behavioral models, to understand the most effective methods to foster changes in the behavioral patterns of shippers, carriers, and receivers towards greater energy efficiency, by adopting energy efficient Tech/Ops, and implementing changes in their demand patterns
- To broaden the focus when assessing energy scenarios, to consider both demand and supply, and the roles played by all participants in supply chains (shippers, carriers, and receivers)
- To exploit the synergies and mutually reinforcing effects among EEL initiatives
- To provide public-sector decision makers with the procedures and analytical tools they need to determine the best ways to reduce freight energy use in their jurisdictions.
- To gain insight into the potential, and the real-life barriers to implementation, of EEL initiatives, using advanced modeling techniques and pilot testing.

## Approach

The team's chosen approach to meet these objectives combines novel supply-side Tech/Ops with freight demand management techniques that will induce energy efficient freight demand changes. A selected group of EEL initiatives will be pilot-tested in the Albany-NYC corridor, the project's living lab, to: (1) gain insight into the barriers and obstacles for EELs; (2) identify ways to overcome those barriers; and (3) demonstrate the real-life benefits of EEL initiatives to stakeholders.

The key outcomes of the project will be an energy management guidebook with actionable information and a practice-ready approach to fostering EEL initiatives at the city, Metropolitan Planning Organization (MPO), and state levels; and an Integrated Transport-Energy Model (ITEM) to estimate the impacts of collaborative measures on adoption of Tech/Ops and demand changes.

The project consists of four major thrusts, as follows:

- Thrust 1: The team will develop a catalog of EEL initiatives to be considered, and conceptually design the initiatives and collaborative measures to be piloted.
- Thrust 2: The team will develop tools and algorithms to assess the initiatives, and develop an energy management guidebook.
- Thrust 3: The team will assess the impacts of collaborative measures on initiative adoption, assess the initiatives' effectiveness, and design pilot tests.
- Thrust 4: The team will conduct and assess the pilot tests.

Thrusts 1, 2 and 4 roughly correspond to fiscal year (FY) 2018, FY 2019 and FY 2020, respectively, while Thrust 2 is expected to be completed across the duration of the project.

## Results

The team prepared an initial list of EEL initiatives based on the Transportation Research Board's National Cooperative Freight Research Program (NCFRP) Report 33 Planning Guide (Holguín-Veras et al. 2015) [1]. The initial list included the 54 initiatives of the NCFRP 33. During FY 2018, the team reviewed additional initiatives related to new technologies, as well as other initiatives that can foster energy efficiency, such as reuse of brownfields, overlay zones, hybrid zoning codes and greenfield new communities, that were not included in the NCFRP 33 Planning Guide. The team also removed those that do not provide any significant energy efficiencies, resulting in a list of 52 initiatives.

The initiatives considered can be classified into two major clusters. One group corresponds to those that affect the supply side of the logistics process, such as infrastructure provision, including major and minor infrastructure developments; parking and loading areas; vehicle-related initiatives (e.g., emission standards), and traffic management, including access and vehicle-related restrictions, time access restrictions, traffic control and land management. The other group of initiatives identified corresponds to those that affect the demand side of the supply chains. These initiatives were sub-grouped into finance-related initiatives (such as incentives, pricing, and taxation), logistics management initiatives (such as consolidation, intelligent transportation systems (ITS) and last-mile delivery practices), and finally, demand management and land use-related initiatives (see Figure I.18.1).

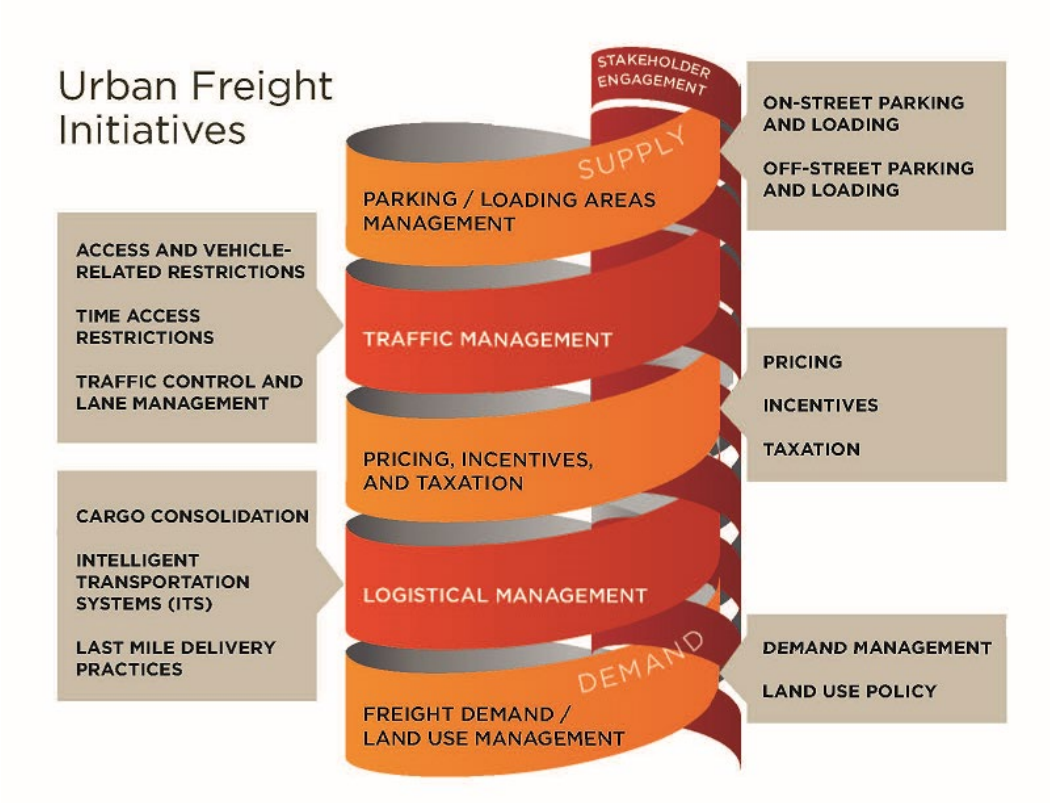


Figure I.18.1. Schematic representation of the clusters of categories considered

Energy efficiency in transportation is usually defined as the distance traveled by passengers or goods, divided by the energy used to move those passengers or goods. Common measures used in the literature are passenger-miles per unit of energy consumed (e.g., Joule), for passenger transportation and ton-miles per unit of energy consumed for freight. The inverse of this ratio is the energy consumption. Thus an increase in energy efficiency in transportation can be obtained by consuming less energy (fuel) for a given distance. After careful analyses, the team concluded that this definition lacks the specificity needed to consider the multiple factors that affect energy efficiency of supply chains. Such factors need to be identified to better assess the extent to which a given initiative could reduce energy consumption.

The team concluded that the frameworks available for qualitative assessment of energy efficiency in the literature have been developed for person-travel decisions but are not necessarily aligned with the decisions made in logistics. Thus, the team proposed a framework that considers the following components of efficiency: vehicle efficiency, travel efficiency (routing, traffic, and driving), mode efficiency, and demand/land use efficiency. See Figure I.18.2. The potential impacts of each one of the sources is presented in Table I.18.1.

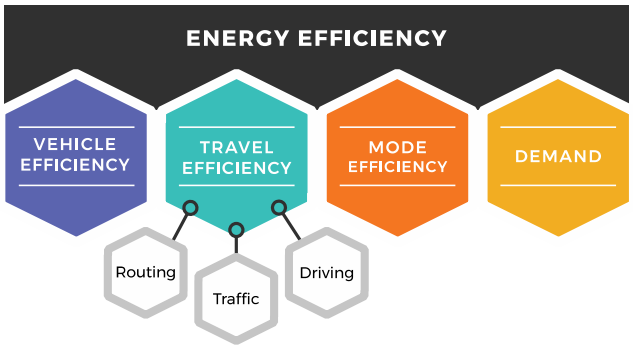


Figure I.18.2. Adopted framework for the identification of Energy Efficient Initiatives

**Table I.18.1 Potential Impacts of Each Source of Energy Efficiency**

| Potential effects in terms of energy efficiency | Source of Energy Efficiency | | | | | |
|---|---|---|---|---|---|---|
| | Vehicle | Travel | | | Mode | Demand |
| | | Routing | Driving | Traffic | | |
| Reduction in number of vehicles/modes using fossil fuels | ✓ | | | | ✓ | ✓ |
| Reduction in fossil fuel consumption per vehicle and per unit of distance and time | ✓ | | ✓ | | ✓ | |
| Reduction in tour lengths (in terms of distance) per vehicle | | ✓ | | ✓ | ✓ | ✓ |
| Reduction in traffic stops or total travel times per vehicle | | ✓ | ✓ | ✓ | ✓ | ✓ |

The performance evaluation criteria are shown in Table I.18.2.

**Table I.18.2. Criteria to Qualitatively Assess the Performance of the Initiatives**

| Efficiency | Driver |
|---|---|
| Vehicle | Technology aimed at reducing the fuel consumption or favoring the use of alternative sources of energy<br>(Partial) replacement or change of the fleet to introduce novel technology |
| Routing | Reduction of the tour lengths (in terms of distance)<br>Use of alternative routes to avoid congestion |
| Driving | Implementation of protocols to drive according to pre-defined efficiency standards or to favor platooning |
| Traffic | Reduction of travel times within a specific delivery tour<br>Implementation of signal coordination to avoid number of stops and sudden changes in acceleration/deceleration regimes |

| Efficiency | Driver |
|---|---|
| **Mode** | Increase share of more efficient modes in the total number of trips made<br>Increase of occupancy rate (load factors) of freight vehicles |
| **Demand/Land Use** | Consolidation measures to increase the shipment size and the occupancy rates<br>Change in the time windows employed for deliveries<br>Switch to more efficient destinations<br>Definition of freight efficient land use policies |

To facilitate the analyses of the 52 initiatives in the catalog, the project team summarized their performance in one-page descriptions. The one-pagers describe the attributes of the initiatives in terms of their potential contributions to EEL, and the factors that ought to be taken into account to assess feasibility for implementation.

The team evaluated the initiatives selected for consideration with the assistance of a multi-criteria matrix. The initiatives were first classified according to their geographical coverage (N: National, R: Regional, U: Urban), and then, based on its expertise, the team evaluated their performance according to the impact they have on the main stakeholders, i.e., shippers, carriers, receivers, communities, the rest of the traffic stream, the real estate sector, in the short and in the long term, and their overall ability to improve energy consumption (energy efficiency). The team also presented information related to implementation time and cost.

The performance of the various initiatives with respect to the evaluation criteria was evaluated by means of a qualitative scale, ranging from three positive signs (+++) to three negative signs (−−−). Any positive evaluation means that the initiative is beneficial or very effective, while any negative evaluation is associated with a harmful or counter-productive effect. The number of signs presented (either positive or negative) reflects the magnitude of the effect. Blank cells are associated with negligible or no effects. The implementation costs and times are always reported with negative signs; the higher the effort in terms of cost or time, the greater the number of negative signs.

The analyses provided the basis for the selection of the key alternatives to be considered for potential pilot testing in the Albany-NYC Corridor. To this effect, the team undertook a two-stage process. During the first stage, the team produced a preliminary selection of potential alternatives based on the potential net benefits in terms of energy efficiency gains vis-à-vis implementation cost and effort. The second stage involved a focus group discussion with selected members of two advisory groups. The Agency Advisory Group (AAG), consisted of representatives from public sector agencies, such as the New York State Energy Research and Development Authority (NYSERDA), New York Department of Transportation (NYDOT) and MPOs, and the Industry Advisory Group (IAG), consisted of representatives from private sector businesses. The first discussion took place on May 30, 2018.

As part of this discussion, the team gave a presentation on the preliminary findings and the initial selection of initiatives. As an example, initiatives such as voluntary Off-Hour Deliveries, engine restrictions and mode shift programs have medium cost with medium to high impact on energy efficiency. The project team distributed a short survey to members of both advisory groups, and asked them to rank the initiatives according to three criteria: feasibility of implementation, energy savings, and likelihood of public-private collaboration. The results of the survey showed that, for the members of the advisory groups, the most promising initiatives are:

- Receiver-led consolidation
- Parking loading zones/parking reservation
- Off-Hour Deliveries
- Parking pricing
- Pickup and delivery at alternative locations

The IAG also recommended improving coordination and collaboration between the private and public sectors, as the magnitude of the challenge is such that no single sector could achieve EEL on its own. Collaboration is essential.

## Conclusions

The team has made substantial progress on the project and is on track for achieving the objectives.

The findings of the first exploratory literature review and qualitative assessment represent a key contribution to practitioners and policy planners interested in developing a more energy efficient environment for the freight transportation systems/supply chains. As envisioned by the team in the proposal, and confirmed by the members of the advisory groups, changes in behavior and cooperation among the different stakeholders is essential to achieve sustainable changes in the overall energy consumption of the transportation system.

The insights provided by the first project tasks will inform the design of modeling tools to simulate the impact of selected initiatives, and the execution of the pilot testing phase.

## References

[1] Holguín-Veras, J., J. Amaya-Leal, J. Wojtowicz, M. Jaller, C. González-Calderón, I. Sánchez-Díaz, X. Wang, D. Haake, S. Rhodes, S.D. Hodge, R.J. Frazier, M.K. Nick, J. Dack, L. Casinelli, and M. Browne. 2015. NCFRP Report 33: Improving Freight System Performance in Metropolitan Areas. In *National Cooperative Freight Research Program*. Washington, D.C.: Transportation Research Board.

# I.19 Southeast Alternative Fuel Deployment Partnership (Center for Transportation and the Environment)

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Start Date: October 1, 2017 End Date: September 30, 2020
Total Project Cost: $10,881,211 DOE Share: $4,621,781 Non-DOE Share: $6,259,430

## Project Introduction

The Center for Transportation and the Environment (CTE) has assembled a team of local and regional organizations throughout the Southeastern states of Georgia, Alabama, and South Carolina to create the Southeast Alternative Fuel Deployment Partnership (SEAFDP). Project team members represent entities from private, public, and non-profit sectors that are engaged in and actively support the deployment of alternative fuel vehicles (AFVs) and infrastructure. SEAFDP members include: Clean Cities – Georgia (CC-G), Alabama Clean Fuels Coalition (ACFC), Palmetto State Clean Fuels Coalition (PSCFC), Southern Company, UPS, Waste Management, DeKalb County, City of Atlanta, McAbee Trucking, and Clean Energy.

Alternative fuel vehicles can provide multiple operational benefits, including lower fuel costs, lower or no emissions, and positive public image; however, the up-front capital costs are still often significantly higher than gasoline and diesel vehicles, especially for all-electric vehicles and medium- and heavy-duty (M&HD) vehicles. Infrastructure is costly, and often times the lack of it is what prevents fleet owners from adopting AFVs into their fleets, so providing access to fueling infrastructure through incentives is key to ensuring successful and meaningful adoption of AFVs. This project is essential to offset the capital cost of new fueling and charging stations and the incremental cost of AFVs, as compared to equivalent diesel or gasoline vehicles, as these costs are often the last barrier to AFV adoption.

This program also encourages partnerships and promotes collaboration within the AFV industry. CTE will study a mix of fleets that are experienced with AFV adoption, along with fleets that are new to alternative fuels. This will provide the opportunity to develop relationships and share best practices and data, which may otherwise not occur under normal circumstances. The team has the opportunity to leverage peer-to-peer exchanges, to help educate and mentor fleets new to AFV acquisition and operation. Veteran fleets that are expanding their alternative fuel adoption will also have the chance to explore the opportunities and challenges associated with scale-up.

Finally, there are several risks associated with the adoption of AFVs. In particular, EVs in the medium and heavy duty markets have unique charging profiles. It is important for fleets considering these vehicles to understand their operational characteristics, as well as the relevant utility rate structures, to ensure the most efficient and cost-effective operation. Additionally, AFV adoption requires that operators, technicians, and first responders be properly educated and trained on these new vehicle systems, which takes time, money, and expertise. The SEAFDP project makes it possible for CTE to consult with project partners on these activities and better prepare them for successful outcomes.

Successful adoption of these vehicles and refueling/recharging infrastructure will do the following:

- Demonstrate the viability of these technologies, compared to other fleets
- Develop the technical skills and expertise of operators, integrators, and component providers, and
- Increase the size of the AFV market, increasing volume of sales, adding competition, and driving down costs.

## Objectives

The objective of the project is to accelerate the deployment of commercially available alternative fuel fleet vehicles and infrastructure in niche markets throughout the Southeast. To accomplish this objective, CTE will work with SEAFDP members to develop a series of case studies, to strategically identify best practices, policies, and procedures resulting from three major activities:

- Purchase of Alternative Fuel Vehicle (AFV) Fleets and Infrastructure
- Development of Alternative Fuel Corridors
- Development of Strategic AFV Fleet Partnerships

## Approach

The SEAFDP will purchase a mix of commercially available AFVs, including compressed natural gas (CNG), plug-in hybrid electric (PHEV), and 100% battery electric vehicles (EVs), in various fleet applications, including package delivery, waste/recycling haulers (both public and private), freight haulers, and municipal/county fleets. DOE funding will pay for 40% of the incremental costs of purchasing AFVs, as well as a portion of refueling or recharging infrastructure costs. The project will accelerate the growth in these niche AFV fleet markets by championing the efforts of fleets already committed to AFVs in their daily operations, as well as fleets new to the industry. CTE will rely on the enthusiasm of its fleet partners to utilize and study these vehicles in different operating environments, evaluate an AFV fleet's ability to perform at the same level of operation as similarly sized gasoline and diesel fleets, and calculate reductions in vehicle emissions and petroleum consumption, based on actual operation.

Participating partners represent a diverse group of organizations at different stages of the AFV adoption cycle. Through a comprehensive analysis of the best practices, policies, procedures, and scalability of each of these unique applications, the project team plans to draw conclusions that will prove relevant for organizations of all types, sizes, and experience levels, which will increase the likelihood of replication throughout the Southeast and the U.S.

Specifically, CTE and SEAFDP members will:

- Reduce emissions and petroleum consumption in the Southeast by putting into service approximately 300 AFV fleet vehicles in niche fleet markets in Georgia, Alabama, and South Carolina
- Collect AFV operational and maintenance data during an approximately 12-month evaluation period
- Educate fleet owners on the technical and financial feasibility of various AFV technologies and applications, and how they compare to their gasoline and diesel counterparts
- Identify infrastructure gaps for CNG fueling stations and electric vehicle supply equipment (EVSE), to support creation of alternative fuel corridors and extended range AFV travel throughout the Southeast;
- Facilitate local and regional partnerships between AFV market players throughout the supply chain, to alleviate barriers to AFV adoption. and provide consultation for organizations as they enter the market; and

- Using findings from project activities, develop best practices, policies, and procedures case studies, to accelerate the deployment of commercially available AFVs and infrastructure in niche fleet markets across the U.S.

## Results

### *Deployment of AFV Fleets and Infrastructure*

During fiscal year (FY) 2018, CTE conducted the following key activities towards the completion of this objective:

- Completed the Project Management Plan
- Developed and issued a Request for Information (RFI) and Notice of Intent (NOI), to find a replacement partner for an intended CNG station in Birmingham, AL
- Executed project partner subcontracts
- Developed and distributed a pre-deployment questionnaire to participating fleets
    - The information gathered allows CTE to estimate fuel economy, fueling requirements, and operating costs for each partner. Estimating these now will help ensure that expectations are clear and realistic. This information also helps ensure that vehicle and infrastructure deployment, training, and data collection plans are in place.
- Submitted quarterly reports to DOE.
- Coordinated vehicle and fueling infrastructure equipment purchase orders and delivery, as outlined below

### *City of Atlanta*

The City of Atlanta was having maintenance concerns about their current CNG refuse fleet, operated by the Office of Fleet Services, and City Council was questioning the reliability of CNG vehicles. This caused the original scope of the City's CNG vehicle purchase under this project to be reduced by 80%. The City of Atlanta did procure two CNG mini-rear loaders to be used by their Parks Department. The purchase order was placed December 6, 2017, and the vehicles have been built and delivered.

The City refocused on light duty EVs, and CTE is currently working with the City to evaluate locations for light-duty EVSE, based on available real estate and department vehicle needs. The City expects procurement planning to begin later this year with vehicle deliveries expected mid-2019.

### *DeKalb County*

During FY 2018, DeKalb County took delivery of 12 CNG front loader and 7 manual side loader refuse trucks. DeKalb County also completed internal operator training prior to taking delivery of the vehicles. CTE is currently working to evaluate initial key performance indicator (KPI) data for these vehicles.

### *McAbee Trucking*

McAbee Trucking had originally planned to purchase two heavy-duty CNG AFVs in FY 2018 and two in FY 2019; however, beginning November 3, 2017, Freightliner took a six-month production break to work on integration of Cummins' new lower emission twelve-liter CNG engine. Freightliner did not begin taking orders for these vehicles until July 2018, which will result in McAbee Trucking purchasing all four (4) AFVs in FY 2019, instead.

### *UPS*

During FY 2018, UPS took delivery of 20 Workhorse PHEV delivery vans, 10 each in Montgomery, AL, and Doraville, GA. CTE is currently working to evaluate initial KPI data for these vehicles. To receive greater economies of scale, UPS's Capital Planning Group determined it was in their best interest financially to combine the CNG vehicle purchase under this program with their planned 2018 purchase, as opposed to placing a separate order for these vehicles in 2017. Also, UPS originally planned to purchase their CNG vehicles from Freightliner; however they recently reached an agreement with Ford to provide CNG vehicles under the project. UPS has also delayed the purchase and delivery of 10-20 Workhorse all-electric delivery vans, due to additional time needed for engineering and design changes for the next generation vehicle.

### *Waste Management – Hardeeville, South Carolina*

In early 2018, Waste Management (WM) experienced unexpected delays in the construction of its planned CNG station in Hardeeville, due to additional time needed to obtain land disturbance approvals and permits, as well as building permits. This resulted in an approximate three-month delay in station construction. Since then, WM has completed a 90% design review of the CNG fueling facility. WM's contractor also submitted for a building permit and met with the local Fire Marshall to give an overview of fueling system operation. Onsite, land grubbing and storm water pond installation have been completed, and the hauling facility building pad has been rolled. The contractor is currently waiting for the building permit from the City of Hardeeville, and once the building permit is received, the contractor will begin steel building construction. Twenty (20) CNG trucks have been ordered for Hardeeville Hauling, and are expected to arrive in the second quarter of 2019.

### *Clean Energy & Waste Management – Birmingham, AL*

In response to one of the original partners withdrawing from the project, CTE put out a Request for Information (RFI) and Notice of Intent (NOI) to install a CNG refueling station in the Birmingham, Alabama area. The RFI/NOI process resulted in CTE being able to spread funding across two stations, instead of one, resulting in an increased AFV scope of work in Birmingham. Clean Energy and Waste Management will each receive a share of the funding originally allocated to this task, upon review and approval from DOE. Clean Energy currently owns and operates a liquefied natural gas (LNG) station that is situated in a signage-ready location off the I-65 corridor in Birmingham, AL, and is proposing to integrate CNG equipment into the existing station. WM is proposing to install CNG fueling infrastructure for their private fleet at an existing facility located at 700 Clow Road in Birmingham. WM's proposed CNG station is located near the Birmingham-Shuttlesworth International Airport; thus, this project will reduce emissions in an area that has a disproportionate share of the state's emissions from high traffic volumes.

### *Development of Alternative Fuel Corridors and Strategic AFV Fleet Partnerships*

CTE has partnered with the Clean Cities coalitions in Georgia, Alabama, and South Carolina to develop a detailed scope of work to:

- Identify gaps for CNG and EVSE infrastructure, and support creation of alternative fuel corridors and extended range AFV travel throughout the Southeast. The scope of work should align with current goals for corridor development in the Southeast, but not consist of current activities funded by the DOE under the Clean Cities program. The project team intends to identify and study priority locations, and local companies and entities that frequent the local routes. We will then target those locations and companies for outreach regarding AFV adoption, and identify potential sites and owners of future alternative fueling stations. CTE has requested that the partners submit a final scope of work by early 2019.

- Facilitate local and regional partnerships between AFV market players, such as vendors and vehicle dealers, throughout the supply chain, to alleviate barriers for AFV adoption and provide consultation for organizations as they enter the market. The project team has discussed development of a mentorship program that would be useful for new market entrants. The final scope of work is due by early 2019.

## Conclusions

The three-year project began on October 1, 2017, and is on track for completion in September 2020. The majority of the tasks in Year 1 were dedicated to contracting, project planning, and finalizing purchase orders for alternative fuel vehicles and associated infrastructure. To date, the project team has documented the following lessons learned from project activities:

- Federal funding assistance greatly increases an organization's willingness and ability to purchase and deploy AFVs and infrastructure, due to higher capital costs compared to diesel or gasoline equivalents. This is especially true for small to medium size organizations and municipalities, where local funding may be scarce, and budgets based on historic, conventional vehicle prices.

- While federal funding assistance greatly increases participation in AFV programs, maintaining project partner commitments throughout the project life can be a challenge, primarily due to time constraints and federal contract requirements. Specifically, the limited time provided during the initial application process sometimes makes it difficult to engage all relevant parties/departments within an organization and obtain the necessary sign-offs from councils or boards. This was especially a challenge with our municipal partners that must follow a lengthy process for formal commitment to the project scope of work and allocation of local funds. In addition, timing associated with administrative and contract requirements may take too long, or the terms and conditions of the contract may not align with team member or legal expectations, causing partners to withdraw.

# I.20 Making the Business Case for Smart, Shared, and Sustainable Mobility Services (Seattle Department of Transportation)

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Project Funding : $1,015,079 DOE share: $388,430 Non-DOE share: $626,649

## Project Introduction

The transportation sector is expected to undergo more change in the next decade than in the three previous decades combined. The automotive and energy industries are actively investing in zero emission vehicles and alternative fueling infrastructure in response to public policy, new technologies, and market forces. New companies in the mobility arena are also transforming the way we look at personal transportation and vehicle ownership, shifting the mobility marketplace from an ownership model to a shared transportation model that will be driven largely by electric vehicles (EVs).

With urban populations projected to rise throughout the United States in the coming decades, the challenges associated with mitigating transportation impacts on air quality, the environment, and urban livability could intensify, without concerted action.

This project, led by the City of Seattle and Atlas Public Policy, brings together the U.S. Department of Energy and major industry stakeholders with the City and County of Denver, City of New York, and Forth, to test different electric shared mobility interventions. Project teams in each city will focus on one type of market intervention and analyze the impact on EV adoption and electric vehicle miles traveled (eVMT) by car share and ride hail services. The project will serve as a replicable blueprint, highlighting intervention results and providing pathways for other cities to electrify shared fleets across the country.

## Objectives

The objective of this project is to identify effective pathways to accelerate the electrification of shared mobility services. By piloting a series of programs in several widely varied urban environments, the project will develop, test, and prove market-viable techniques for EV adoption. The project will leverage the pollution reduction benefits and low operating costs of EVs and the network efficiency benefits of shared mobility services, through a series of pilot programs that will:

- Accelerate adoption of EVs in shared mobility applications in four major U.S. markets by:
    - Facilitating the deployment of new EVs and Electric Vehicle Supply Equipment (EVSE);
    - Providing operational evidence in support of EV and EV charging business models for shared mobility applications across the diverse geographies and demographics of the participating cities;
    - Demonstrating sustainability beyond the grant period and highlighting the operational advantages of deploying EVs in other markets.

- Focus on unique barriers to EV adoption present in each metro region, by targeting interventions to overcome those barriers, and evaluating each intervention.
- Summarize our findings in an EV Shared Mobility Playbook, which will provide a comparative analysis of each city's program, including significant factors that affect the success of these shared mobility programs in each metropolitan region. This playbook will be a resource for others across the country seeking to accelerate the adoption of EVs.

## Approach

Each regional partner is applying unique interventions, in partnership with local car share and/or ride hailing services, and other regional partners, as described below, and shown in Table I.20.1. Each intervention will be evaluated and compared throughout the course of the project and in the EV Shared Mobility Playbook.

**Table I.20.1. Project Interventions by Regional Lead, Including Focus Region, Strategy, Action, and Key Partners**

| Regional Lead | Region | Strategy | Action | Key Partners |
|---|---|---|---|---|
| **Seattle Department of Transportation (SDOT)** | Seattle, WA | Increase EVSE access at or near Shared Mobility Hubs—key locations where people connect between transit and other mobility options and/or access a diverse set of mobility options. | Identify priority locations for EVSE at Shared Mobility Hubs. Install DC Fast Chargers at hubs and partner with local shared mobility companies to support implementation, utilization, and evaluation | Eluminocity, ReachNow, Seattle City Light, Seattle Office of Sustainability & Environment, Western Washington Clean Cities Coalition |
| **City of New York (NYC)** | New York, NY | Provide EVs and supportive charging infrastructure to ride hail drivers. | Deploy 150 EVs for use by ride hail drivers along with exclusive use of 4-8 new DC Fast Chargers. | EVgo, General Motors/Maven, NYC Mayor's Office of Sustainabiliy, NYC Department of Transportation, NYC Taxi & Limousine Commission, Empire Clean Cities |
| **City and County of Denver (Denver)** | Denver, CO | Provide EVs directly to ride hail drivers, and supply charging infrastructure. | Deploy up to 150 EVs in ride hail services which are not otherwise offered in the Denver Metro Region. Install 4-6 DC Fast Chargers to exclusively support these EVs. | EVgo, General Motors/Maven, American Lung Association in Colorado |
| **Forth** | Portland, OR | Promote EV use to ride hail drivers, coupled with access to free, unlimited charging. | Partner with ride hail service provider to pilot a program that systemically encourages drivers to use EVs; work with local utilities to educate and train ride hail drivers to promote plug-in vehicles to consumers. | Uber, Portland General Electric, Brink |

## Results

In fiscal year (FY) 2018, project partners conducted background research, compiled resources, finalized partnership agreements, and refined intervention strategies that will be deployed, evaluated, and adjusted in FY 2019 and FY 2020. The following key milestones were accomplished during FY 2018:

- **Developed informational materials and published on project website (Atlas Public Policy)** - Key resources include a literature review and two case studies that serve as resources for project partners and the public.

- **Developed draft Strategic Deployment Plan** - This is a living document that will be refined over the course of the project, to compare regional interventions and highlight significant regional factors that affect the success of each program. The initial draft Strategic Deployment Plan highlights each region's model operating policies and procedures, methodology, infrastructure and vehicle deployment targets, and evaluation plans.

- **EVSE Roadmap development is underway (SDOT)** - SDOT is developing an EVSE Roadmap to inform siting EVSE at Shared Mobility Hubs (key locations where people connect between transit and other mobility options and/or access a diverse set of mobility options), to increase the EV adoption rate of shared mobility services. The first step was to develop a geographic information system (GIS)-based prioritization model for siting EVSE at Shared Mobility Hubs that incorporated research on EVSE placement considerations, and feedback from key city staff, shared mobility service providers, and community stakeholders. The model helped inform the identification of Deployment Phase 1 sites for the Seattle region. Additionally, the EVSE Roadmap will incorporate guidance from community and stakeholder feedback to site and install EVSE in a way that is feasible, effective, and context-sensitive, while addressing air pollution, improving access to transit, and reducing barriers to EV adoption. Key learnings from EVSE Roadmap development thus far include:

    - Prioritize DC Fast Chargers over Level 2 (L2) chargers at Shared Mobility Hubs, to minimize vehicle downtime. To do this, Seattle has adjusted its plan to replace planned L2 charger installations with DC Fast Chargers.

    - Focus on mitigating displacement risk in communities of color, which could be exacerbated by EVSE deployments. To do this, Seattle has included a screening layer in its EVSE siting model to identify priority regions for EVSE deployment that are also regions experiencing a high risk of displacement. Potential sites in these areas are identified for a separate and more robust outreach, engagement, and deployment process that incorporates community guidance and stakeholder consultation.

    - Begin site selection discussions as early as possible and incorporate community input early and often, with specialized programming and planning in areas experiencing displacement.

    - Provide guidelines that address differences in ride hail or car share service models. The guidelines, shown in Table I.20.2, are based on different operating conditions for the two respective shared mobility service providers:

Table I.20.2. SDOT's EVSE Siting Considerations for Car Share and Ride Hailing Services

| | |
|---|---|
| **Car Share EVSE Siting Proximity Considerations** | |
| **Ideal distance is one to two blocks from Shared Mobility Hub (330-660 feet)** | Park & Ride planning guidelines identify optimal distance for parking space placement [1] |
| | On-street space directly adjacent to a Shared Mobility Hub should be prioritized for public transit. |
| | Clear wayfinding and signage is necessary to direct users from a Shared Mobility Hub to a car share EVSE location. |
| | EVSE should be sited near or at the car share parking spaces. |
| **Ride Hail EVSE Siting Proximity Considerations** | |
| **Ideal distance is a quarter- to half-mile from Shared Mobility Hub** | Charging locations should be within a 5- to 10- minute walk of amenities (shopping, restroom, etc.). [2] |
| | Ride hailing providers' and passengers' optimal wait time for customer pick-up is approximately three minutes. |
| | Maximum distance of EVSE to a Shared Mobility Hub is a half-mile to provide optimal wait times and to not use on-street spaces directly adjacent to Shared Mobility Hubs for ride hail vehicle charging. |

- **Selected potential Phase 1 sites (SDOT, NYC, Denver)** - Based on the results of the EVSE Roadmap and extensive stakeholder feedback, Seattle selected the first 10 Shared Mobility Hubs that will be prioritized for electrification in Phase 1. NYC and Denver also selected multiple potential sites in collaboration with regional EVSE partner, EVgo, and will be finalizing their Phase 1 site(s) shortly.

- **Hosted initial outreach event (Forth)** - In June 2018, Forth hosted its first ride hail outreach event, in partnership with Uber and Portland General Electric. The event had 68 attendees and facilitated 16 test drives. Partners learned future events should have shorter programming and better communication prior to the event. Overall, the event was positively received and can serve as a template to build upon for future events.

Key milestones in FY 2019 will include:

- **Engage with External Stakeholders** - The project partners will engage with external stakeholders, share lessons learned, and gather feedback on our approach to inform the development of the EV Shared Mobility Playbook and deployment of the pilot projects.

- **Develop Data Dashboards** - Atlas Public Policy will create dashboards to share data trends and allow stakeholders to better understand the pilot projects.

- **Create EV Shared Mobility Analysis Tool** - Atlas Public Policy will create this tool to help evaluate the business case for the use of EVs in car sharing and ride hailing services tailored to the local market conditions and enabling cities and companies to determine the conditions needed for EVs to be financially viable in shared mobility applications.

- **Install Charging** - SDOT, NYC, and Denver will install charging stations at agreed upon locations.

- **Deploy EVs -** NYC, Denver, and Forth will introduce initial tranche of EVs into ride hail or car share fleet operations as appropriate for each city-specific project.

- **Conduct outreach and marketing** – All project partners will launch a coordinated outreach and marketing program to encourage the use of EVs by shared mobility drivers and users.

Project partners will continue to work collaboratively on implementing their respective strategies. Future efforts will focus on frequent communication, evaluation of the strategies, and making data-driven adjustments, as needed, to achieve project objectives.

## Conclusions

In complex multi-regional projects such as this, partnership development and strategic planning are critical, and require significant resources and time. In FY 2018, the project team focused primarily on these efforts. For example, regional partners needed to discuss cross-cutting evaluation metrics that could apply to all or most regional interventions and collaborate on data asks to private partners, to inform the project evaluation and data dashboard. Additionally, in conducting background research and finalizing partnership agreements, it became clear that Level 2 charging stations, which were originally part of the project's deployment plans, should be replaced with DC Fast Charging stations to enable quick turnover of vehicles and ensure vehicles are in-service for a majority of the time. Learnings from FY 2018 informed each region's draft Strategic Deployment Plan and will also be included in the EV Shared Mobility Playbook.

## Key Publications

Seki, Stephanie and Nick Nigro. 2018. "Electrifying Carshare Services: A Case Study on car2go's All-electric Fleet in San Diego." http://evsharedmobility.org/resource/electrifying-carshare-services/.

Seki, Stephanie and Nick Nigro. 2018. "Electrifying Ride-hail Services: A Case Study on Maven Gig's Use of Chevrolet Bolt EVs." http://evsharedmobility.org/resource/electrifying-ride-hail-services/.

Seki, Stephanie Seki. 2018. "EV Shared Mobility Literature Review and State of Play." August 2018. http://evsharedmobility.org/resource/ev-shared-mobility-literature-review-and-state-of-play/.

Atlas Public Policy. "EV Shared Mobility – Making the Case for Smart, Shared, and Sustainable Mobility Services" website. http://evsharedmobility.org/.

## References

[1] Coffell et al. 2012. "Transit Cooperative Research Program Report 153: Guidelines for Providing Access to Public Transportation Stations." Transportation Cooperative Research Program. https://nacto.org/wp-content/uploads/2016/04/1-4_Coffell-et-al_Guidelines-for-Providing-Access-to-Public-Transportation-Stations_TCRP-153_2012.pdf .

[2] Gnosis Research. "Uber: Electric Vehicle Focus Group Topline Report." June 14, 2018. Seattle, WA.

# I.21 Accelerating Alternative Fuel Adoption in Mid-America (Metropolitan Energy Center, Inc.)

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Project Funding : $7,630,417 DOE share: $3,803,793 Non-DOE share: $3,826,624

## Project Introduction

There are significant gaps in the I-70, I-29, and Highway 54 compressed natural gas fueling corridors in Kansas. I-70 and I-29 are major shipping corridors, and Highway 54 is in the middle of the Beef Belt. Insufficient fueling infrastructure is inhibiting alternative fuel adoption throughout the Midwest. The goal of this project is to expand the use of alternative fuels and fueling infrastructure in Kansas and Missouri.

## Objectives

Our objectives are to establish compressed natural gas (CNG) corridors through the state of Kansas, expand access to gaseous fuels and electric vehicle infrastructure in Kansas and Missouri, and reduce greenhouse gas emissions by converting diesel and gasoline-powered vehicles to alternative fuels.

## Approach

The Metropolitan Energy Center (MEC) facilitates partnerships between local governments, fleets and other local stakeholders; assists project stakeholders with resource development and change management; provides training and technical support; and creates accountability and rapport for and among our stakeholders and project partners. Grant subrecipients include the cities of Kansas City, Missouri, Garden City, Kansas, and El Dorado, Kansas; the Grain Valley and Blue Springs School Districts in Missouri; Kansas City International Airport; Sparq Natural Gas, Stirk CNG, and 24/7 Travel Stores. DOE funding covers 45% of the costs of purchasing alternative fuel vehicles and purchasing and installing refueling infrastructure; the remaining 55% is paid for by the grant subrecipients.

Our relationship management approach involves project coordinators working directly with assigned subrecipients as single points of contact, organizing monthly status calls (which serve a secondary purpose of facilitating relationships and a shared informational record among subrecipients), and fostering a consultative relationship that allows us to connect subrecipients with resources and prospective vendors, and generate public-private partnerships.

Using our guidance and their internal guidelines and policies, subrecipients are responsible for sourcing and implementing their own alternative fuel projects with comprehensive reporting and tracking to MEC. Through the course of project implementation, each subrecipient also hosts an alternative fuel workshop, which serves many functions. Workshops educate myriad stakeholders, build community support for the projects, and provide opportunities to develop relationships and engender additional AFV adoption projects.

## Results

At this stage in the project, the project partners have deployed 2 fueling stations (one propane and one 12-stall electric); conducted 3 informational/networking workshops (see Figure I.21.1); and replaced 4 diesel shuttles with natural gas equivalents (see Figure I.21.2). Our subrecipients in Grain Valley Public Schools erected propane fueling infrastructure and have seen a complete return on investment in less than one calendar year (see Figure I.21.3). This was due to creative use of funding opportunities and wide use of the infrastructure by vehicles with high mileage accrual (vehicle miles traveled, or VMTs). Grain Valley acquired their propane school buses using another funding source.

MEC conducted three alternative fuel workshops, and reached an audience of 70 diverse stakeholder companies and agencies. Each of these workshops generated follow-on activities related to alternative fuels. For example, the Wakeeney, KS, workshop on CNG led to conversations with Dodge City on the conversion of city vehicles to CNG, as well as the prospect of building the CNG fueling infrastructure to support fleet adoption. This new project is already in the works and partially funded using an additional funding source.


Figure I.21.1. Panel discussion at a workshop in Garden City, KS. (Photo Credit: Natalie Phillips)


Figure I.21.2. A CNG Bus from Kansas City International Airport's fleet. (Photo credit: Kelly Gilbert)

Figure I.21.3. Tour of Grain Valley School District's propane fueling infrastructure. (Photo Credit: Kelly Gilbert)

## Conclusions

Our approach is seeing anticipated results, both in planned deployments and in new project development; however, we have seen delays for CNG fuel station development and for heavy-duty vehicle deliveries, either of which could unavoidably delay an on-time delivery of the final project. Project staff are monitoring opportunities to lessen these delays and are preparing mitigating actions as necessary.

### *Lessons Learned:*

- Public fast-fill infrastructure projects are vulnerable to the competitive price of diesel. Such projects have faced challenges retaining anchor fleets that are necessary for a reasonable return on investment.
- Vehicle replacement projects are subject to manufacturing delays resulting from supply chain interruptions, which may be due to fluctuations in trade policies and their effects on the price and availability of components.

# II National Laboratory Projects

## II.1 Alternative Fuels Data Center (National Renewable Energy Laboratory)

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Start Date: October 1, 2017 End Date: September 30, 2018
Project Funding (FY18): $1,100,000 DOE share: $1,100,000 Non-DOE share: $0

### Project Introduction

The U.S. Department of Energy (DOE) launched the Alternative Fuels Data Center (AFDC) in 1991 as a repository for alternative fuel vehicle (AFV) performance data. Since that time, it has evolved to become an indispensable resource for a diverse set of users including fleets, fuel providers, policymakers, Clean Cities coalitions, and others working to find ways to reach their energy and economic goals with alternative and renewable fuels, advanced vehicles, and other energy/fuel-saving measures. The AFDC has achieved this level of engagement because of the many successful public and industry partnerships built in the past 27 years that have contributed to the quality and quantity of information contained on the AFDC website.

AFDC data, information, and tools enable transportation stakeholders to reduce total operating costs, and improve emissions impacts, while improving transportation energy efficiency using alternative fuels and other advanced vehicle technologies. Alternative fuel use can provide substantial benefits to the country's economy, energy security, and environment. As a trusted third-party data provider, the AFDC is used in multiple ways to support both public and private industry.

The AFDC provides extensive information on alternative fuels, including biodiesel, electricity, ethanol, hydrogen, natural gas, and propane. Users can learn about considerations when using alternative fuels, vehicle operation and availability, fuel properties, production, distribution, and prices, as well as station locations,

emissions benefits, and more. The website features information not only on the vehicles and engines that use these fuels, but also on the unique fueling infrastructure necessary to dispense them. Thanks to partnerships with other DOE national laboratories like Argonne National Laboratory and Oak Ridge National Laboratory (which maintains FuelEconomy.gov), the AFDC is able to offer content on fuel-saving strategies like idle reduction, fuel economy improvements, and efficient driving practices. The site's diverse group of users can also examine long-term trends, conduct cost estimates, estimate emissions benefits, and identify fuels and technologies that are appropriate for their operational needs and geographic locations by using the site's many tools.

In sum, the AFDC's vast collection of information, tools, and robust data empowers fleets and individual drivers to identify the strategies and technologies that will best help them meet their environmental and energy goals in the most cost-efficient manner.

## Objectives

The AFDC's primary objective is to be a leading, trusted site for information and data on alternative fuels and advanced vehicle technologies. The AFDC provides a wide range of accurate content that is updated and maintained on a continuous basis through in-depth reviews by subject matter experts, the identification of changing market conditions, and timely responses to those changes. This enables the AFDC to maintain its position of credibility within the public and private sectors, while continuing to grow its use among key stakeholders.

## Approach

The AFDC has become an expert resource because of its approach to producing, updating, and sharing content that is supported by technical expertise in alternative fuels and advanced vehicles. While multiple in-house experts are tapped to review new and existing content, the site ensures accuracy and objectivity by often relying on close industry partnerships to identify and fill any critical gaps. Behind its user-friendly interface, the AFDC also contains an extensive set of neutral, accurate, and vetted data. That data is rigorously maintained and presented in an accessible format to ensure target audiences get the information they seek in the most efficient manner possible. Multiple pathways (outlined below) safeguard the effective delivery of credible and objective information and data, which remain the foremost focus of the AFDC's content and tools.

### *Efficient Delivery*

There are many ways to deliver data and information, and each has its own advantages. A diversified delivery strategy ensures that information is easily accessible in a variety of formats, for a variety of devices. The AFDC approach is to provide information and data in the following ways:

- **AFDC Website**: Data and information are accessed directly through the content and tools on the AFDC website. The data is also accessed via referral links from other organizations. Linking to the site as the trusted third-party, objective resource helps organizations demonstrate that their information or product is developed from vetted, factual information.
    - **Tools**: A host of calculators, interactive maps, and data searches make up the site's set of tools.
    - **Content**: The AFDC provides up-to-date content on commercially available alternative fuels and fuel-saving methods.
- **Application Programming Interface (API)**: Several of the AFDC's datasets are available via an API and are used both internally (to support analysis and tools) and externally by public and private enterprises. API data is delivered from computer to computer and updated automatically on a continuous basis. This kind of data delivery is primarily used by organizations wanting to build their own applications with the data.

- **Data Downloads**: AFDC data is also available for download. Data downloads are most often used by organizations wanting to build applications and upload the data into those applications, or by analysts doing research related to alternative fuels.
- **Mobile Apps**: The Alternative Fueling Station Locator is available as a native app for iPhone and Android. The AFDC website is also designed to function on various mobile devices, such as tablets and smartphones.
- **Widgets**: Several of the AFDC tools are available as widgets, which are snippets of code that let users embed AFDC content on their websites, blogs, or social networking sites. This allows users to include the content in their own websites without the expense of building their own tools. See Figure II.1.1, below, for an example of an AFDC widget.

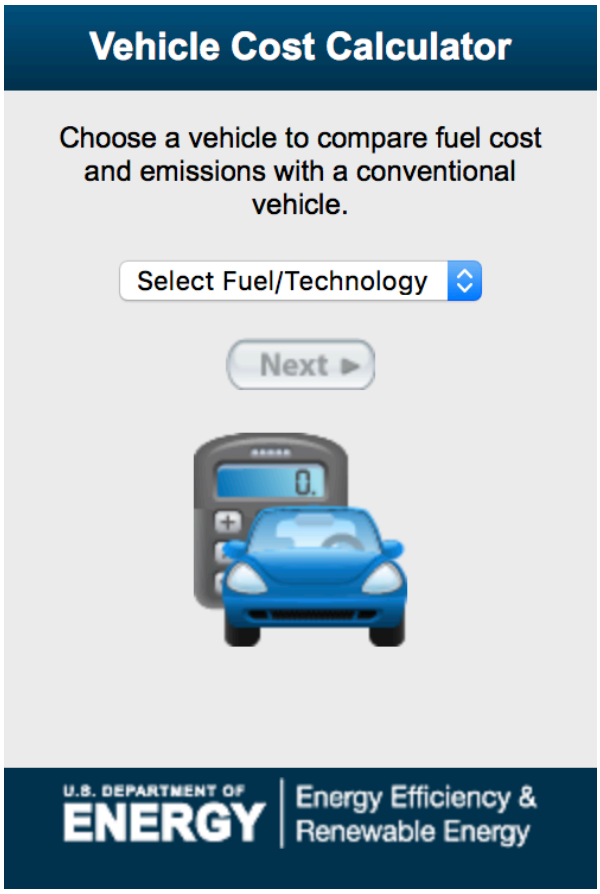


Figure II.1.1. Vehicle Cost Calculator Widget

Depending on the type of organization accessing the AFDC, its business strategy, and use case, any combination of the data sourcing strategies above may be preferred. By providing multiple pathways for using and obtaining the information and data, the AFDC provides a valuable service to help organizations meet their policy or business goals. By measuring how the data endpoints are used, the National Renewable Energy Laboratory (NREL) can quantify their value to the market and the AFDC's partners.

### *Credible and Objective Data*

To ensure the integrity of the information and data, the AFDC undergoes an in-depth annual content review. During this process, subject-matter experts from multiple national laboratories review the content using evidence-based research, their expertise in the industry, and information on identified changes in the market. NREL maintains a cadre of experts who ensure the AFDC is accurate and robust.

## Results

The AFDC continues to grow as a relevant and trusted resource. In fiscal year (FY) 2018, the AFDC boasted a 20% increase over FY 2017 in page views, with more than 2.3 million visitor sessions and 1.7 million unique visitors. Those visitors accessed pages on the AFDC website more than 7.7 million times. Visits to the site included an average of 13% returning visitors and 87% new visitors.

The AFDC has long been a top-performing website within the Office of Energy Efficiency and Renewable Energy's (EERE) informational portfolio. In fact, 31% of all EERE website page views are from AFDC pages. Additionally, 10 of the top 30 most-viewed pages in the EERE portfolio are AFDC pages.

### *Referral Quality*

The AFDC serves the fleet and transportation industry audience, and one way to measure its effectiveness is to look at the quality and quantity of referrals to the AFDC. (A referral is a website that directly links to AFDC content and tools.) One goal is to gain referrals from sites where the AFDC audience spends time, such as utility or industry association websites.

DOE and NREL have been consistently building partnerships with industry and attracting quality referrals for many years. For example, an evaluation of the top 40 referrals in FY 2018 shows that the fleet and industry audiences continue to be the main referral base. In addition, a significant number of visits to the AFDC are direct traffic from fleet and industry audiences (i.e., people in this group who bookmark the AFDC or go directly to known AFDC pages from their browsers, without using a search engine or a link from another website). **Error! Reference source not found.**2 shows a breakdown of sources of AFDC visits, based on the top 40 referrals.

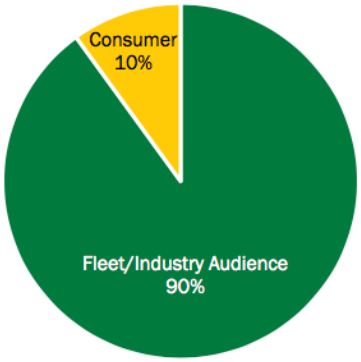


Figure II.1.2. Sources of AFDC visits based on the top 40 referrals

Some of the top referrers in FY 2018 included several vehicle Original Equipment Manufacturer (OEM) sites linking to the laws and incentives information, with Honda and Chevrolet leading the referral count. In FY 2018, the laws and incentives data saw a 40% increase in use over FY 2017, particularly via referrals from numerous vehicle manufacturers. During the fiscal year, there were more than 5,700 websites linking to the AFDC that resulted in more than 475,000 sessions, which indicates the number of times users visited the site after clicking on a link from a referral website. Referrers include companies and organizations of every size and type, such as utilities, major corporations (including vehicle OEMs and equipment manufacturers), small startups, non-profits, cities and states, and search engines. See Table II.1.1.

Table II.1.1. Top 20 Referrers to the AFDC Website in FY 2018

| Referrer | Sessions |
|---|---|
| automobiles.honda.com | 109,963 |
| chevrolet.com | 50,512 |
| smartusa.com | 18,335 |
| fueleconomy.gov | 13,125 |
| fuelfreedom.org | 10,744 |
| oringcng.com | 8,864 |
| search.usa.gov | 8,497 |
| audiusa.com | 8,410 |
| com.google.android.googlequicksearchbox | 8,262 |
| duckduckgo.com | 6,687 |
| courses.edx.org | 6,562 |
| energy.gov | 6,440 |
| cleanngreenfuel.com | 6,363 |
| chevyevlife.com | 6,322 |
| bmwusa.com | 5,173 |
| energysage.com | 5,041 |
| kmov.com | 4,944 |
| westcoastgreenhighway.com | 4,879 |
| vw.com | 4,666 |
| accessrvrental.com | 4,473 |

### *AFDC Content Interest*

The interest in AFDC data shifts among the tools and fuels, depending on policy developments and market economics. By continuously providing the best, most current data and information on all types of fuels and technologies, the AFDC is able to remain relevant, despite changing interests based on trends.

The AFDC contains six main areas of content based on the alternative fuels defined by the Energy Policy Act of 1992 (EPAct). These content areas include biodiesel, electricity, ethanol, hydrogen, natural gas, and propane. Historical data shows that the most frequently accessed pages vary from year to year. In FY 2018, electricity was the most popular topic in terms of page views for fuels and vehicles information.

Figure II.1.3: 3 depicts the interest in types of content by fuel in FY 2018. The interest in fuels and vehicles information stayed about the same compared to FY 2017, accounting for 31% of the total page views on the AFDC, compared to 27% in FY 2017.

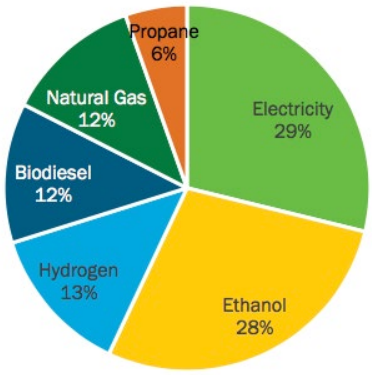


Figure II.1.3. Interest in fuels and vehicles information by subject based on page views in FY 2018

When looking at interest in stations information, the popularity of fuel type shifts, as shown in Figure II.1.4: Interest in stations information by subject based on page views in FY 2018. Although electricity tallied the most page views for fuels and vehicles information, ethanol was the most queried fuel for station location information, accounting for about 7% more of the page views for stations information compared to FY 2017.

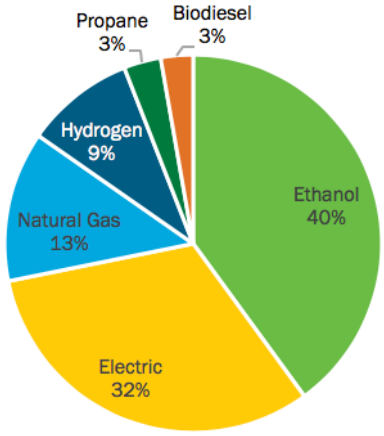


Figure II.1.4. Interest in stations information by subject based on page views in FY 2018

### *Tools*

The tools on the AFDC range from those that are broad and appeal to multiple audience segments, to specialty tools designed for more focused audiences. The tools directory page [1] received more than 10,700 views in FY 2018; however, a user's discovery of the tools more commonly comes from links on other AFDC pages or referrals from other sites. Direct traffic—meaning visitors that bookmark the page or come to the site without

clicking on a link within the AFDC or another site—also provided a significant number of page views for the tools.

Table II.1.2: Page views for the Primary Tools on the AFDC Website shows primary tools on the AFDC website by popularity. Compared to FY 2017, the Vehicle Cost Calculator saw an 80% increase in page views in FY 2018. The Alternative Fueling Station Locator, the Laws and Incentives Search, and the State Information Search all saw about a 40% increase in page views compared to FY 2017. The number of page views for the rest of the tools did not fluctuate significantly. Together, these tools account for 66% of the total page views on the AFDC compared to 60% in FY 2017.

**Table II.1.2. Page views for the Primary Tools on the AFDC Website**

| Tool | FY 2018 Page Views | FY 2017 Page Views | % Change |
|---|---|---|---|
| Alternative Fueling Station Locator | 2,418,635 | 1,761,058 | 37% |
| Laws and Incentives Search | 1,690,491 | 1,208,125 | 40% |
| Maps and Data Search | 503,483 | 535,338 | -6% |
| Vehicle Cost Calculator | 252,510 | 139,908 | 80% |
| Vehicle Search | 108,684 | 110,161 | -1% |
| Publications Search | 34,959 | 40,644 | -14% |
| State Information Search | 31,566 | 21,507 | 47% |
| Case Studies Search | 28,257 | 29,296 | -4% |
| Fuel Properties Comparison | 16,257 | 16,056 | 1% |
| EVI-Pro Lite* | 3,404 | N/A | N/A |

* This tool was launched in May 2018 and does not include statistics for the entire fiscal year.

### *Data, APIs, and Downloads*

A significant growth area for the AFDC has been sharing data and tools with a wider audience. Table II.1.3: API Requests, Users, and Downloads in FY 2018 summarizes the data activity in FY 2018 by showing the total number of API requests (people searching or using the dataset on other websites or systems), the number of unique API users, and the number of data downloads, which are offered on the data downloads page [2] and provide a snapshot of various data offerings at any point in time.

**Table II.1.3. API Requests, Users, and Downloads in FY 2018**

| Data | API Requests | Unique API Users | Downloads |
|---|---|---|---|
| Alternative Fueling Stations | 7,960,222 | 5,758 | 6,268 |
| Laws and Incentives | 560,413 | 25 | 2,182 |
| Vehicles | N/A | N/A | 5,307 |

Stations data downloads and requests via the web service, also known as an API, have expanded use of AFDC data over time. The alternative fueling stations API (a live data feed of stations data) received more than 7.9 million requests in FY 2018, which was up from about 5.4 million requests in FY 2017. The Alternative Fueling Station Locator widget had 238,272 page views while embedded on other websites in FY 2018, accounting for 10% of the total stations traffic.

The laws and incentives API received more than 560,000 requests in FY 2018, which was up significantly from about 47,000 requests in FY 2017. Many OEMs now link to the laws and incentives site. This is a growing opportunity for outside users to filter the laws and incentives data using the API, which increases the value of their own websites. Beyond data downloads, the most downloaded document on the AFDC in FY 2018 was the fuel properties comparison chart, with more than 106,000 downloads, followed by the Alternative Fuel Price Reports with more than 43,000 downloads.

### *Alternative Fueling Station Locator Redesign*

NREL conducted a major makeover of the Alternative Fueling Station Locator in FY 2018. With more than 2.4 million page views per year, this tool has a long history of offering the most reliable and comprehensive data in the country for alternative fueling stations. The overhaul of this tool improved the user interface, by making the map easier to interact with, simplifying user inputs, and displaying more station details.

This redesign effort leveraged work to build a Canadian version of the tool, through NREL's partnership with Natural Resources Canada. The Canadian stations project was part of an overall $120-million investment by the Canadian government to expand their network of electric vehicle charging and alternative fueling stations.

### *Alternative Fuel Corridor Mapping Tool*

In FY 2018, NREL developed a corridor resources page [3] on the AFDC to help states nominate alternative fuel corridors, which are segments of interstates and other major national highways designated by the Federal Highway Administration (FHWA) under section 1413 of the Fixing America's Surface Transportation Act (FAST Act) of 2015. This effort is the result of a long-standing partnership with FHWA that ensures projects with common goals use shared resources for successful outcomes. The goal of the FHWA effort is to create a national network of alternative fueling and charging infrastructure that allows highway travel to improve the mobility of passenger and commercial vehicles that use electric, hydrogen fuel cell, propane, and natural gas fueling technologies. The data from the AFDC Alternative Fueling Station Locator is key to FHWA accomplishing its goal.

The resources on the AFDC help with the corridor nomination process by providing data downloads from the Alternative Fueling Station Locator by state and fuel type, with filters automatically applied to meet the FHWA criteria for corridors. The page also provides shapefile downloads to help people visualize the data in their own geographic information system (GIS) software, as well as links to interactive maps that help people explore potential corridors.

### *EVI-Pro Lite Tool*

The Electric Vehicle Infrastructure Projection Tool (EVI-Pro) Lite [4] helps cities and states estimate how much electric vehicle charging capacity they might need. Between May 2018, when the tool was launched, and the end of the fiscal year, people viewed the tool more than 3,400 times. This indicates that users are interacting with the tool and running multiple scenarios to explore their electric vehicle charging needs.

## Conclusions

The AFDC provides robust and relevant information to advance the goals of DOE's Vehicle Technologies Office, as is evident by the fact that usage continues to grow every year, gaining referrals from public and private industry. This underscores the need for credible, objective, third-party data and information in the growing market of alternative fuels and advanced vehicles. Through many partnerships, the AFDC helps ensure that the content and tools are relevant and reach the right audience by providing information and data in

a variety of formats, including web applications, APIs, data downloads, and embeddable widgets. This valuable resource continues to lead EERE websites as a content provider and forward-thinking driver of data and tools to help people find transportation solutions.

## Key Publications

AFDC home page: afdc.energy.gov

Alternative Fueling Station Locator: afdc.energy.gov/stations

Laws and Incentives Search: afdc.energy.gov/laws

Maps and Data Search: afdc.energy.gov/data

Vehicle Cost Calculator: afdc.energy.gov/calc

Vehicle Search: afdc.energy.gov/vehicles/search

Publications Search: afdc.energy.gov/publications

State Information Search: afdc.energy.gov/states

Case Studies Search: afdc.energy.gov/case

Fuel Properties Comparison: afdc.energy.gov/fuels/fuel_properties.php

EVI-Pro Lite: afdc.energy.gov/evi-pro-lite

Data Downloads: afdc.energy.gov/data_download

Widgets: afdc.energy.gov/widgets

Developer APIs: developer.nrel.gov/docs/transportation/alt-fuel-stations-v1

## References

[1] afdc.energy.gov/tools

[2] afdc.energy.gov/data_download

[3] afdc.energy.gov/corridors

[4] afdc.energy.gov/evi-pro-lite

# II.2 AFLEET Tool (Argonne National Laboratory)

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Start Date: October 1, 2016 End Date: September 30, 2017
Project Funding (FY18): $230,000 DOE share: $230,000 Non-DOE share: $0

## Project Introduction

This project updates and expands the existing Alternative Fuel Life-Cycle Environmental and Economic Transportation (AFLEET) Tool first released in 2013. Researchers at Argonne National Laboratory (Argonne) developed the AFLEET Tool for the U.S. Department of Energy (DOE) Vehicle Technologies Office's (VTO's) Technology Integration Program to estimate petroleum use, emissions, and cost of ownership of light-duty vehicles (LDVs) and heavy-duty vehicles (HDVs), using simple spreadsheet inputs. AFLEET examines both the environmental and economic costs and benefits of conventional, alternative fuel, and advanced technology vehicles for 18 different fuel and vehicle pathways, 7 major vehicle types and 23 different vocations. The tool has both a Simple Payback calculator, to examine the payback of a new conventional vehicle versus an alternative fuel vehicle (AFV), and a Total Cost of Ownership (TCO) calculator that examines the costs during the entire life of the vehicle.

Argonne had previously updated AFLEET in 2017 and included changes that matched results to Argonne's Greenhouse gases, Regulated Emissions, and Energy use in Transportation (GREET) 2017 model; incorporated upstream air pollutants and vehicle production petroleum use and emissions from GREET; added low-NOx engine and diesel in-use multiplier options; and developed calculations to estimate the economic and environmental costs and benefits of idle reduction equipment. Since AFLEET's inception, the number of users has grown to 8,000 individuals. The primary audiences for this tool are Clean Cities coordinators, industry, fleet managers, academia, and policymakers at all levels of government. The tool can be accessed directly from Argonne's web site or from the Alternative Fuels Data Center website. The tool has been used to examine real-world fleet data for several VTO case studies, authored by Argonne.

## Objectives

In fiscal year (FY) 2018, the AFLEET Tool had several factors that needed updating. In working with Clean Cities Coordinators on how to improve AFLEET, stakeholders requested a user-friendly online version to supplement the spreadsheet version. Similar to the 2017 revision, AFLEET required an annual update to match new modeling results from GREET [1] and MOVES [2]; new fuel price data from the Alternative Fuel Price Report (AFPR) [3], and the Energy Information Agency (EIA) [4]. The coordinators indicated that a user-friendly version that simplifies the process to input assumptions and that generates results would benefit new users and other stakeholders who are not proficient in using spreadsheets.

## Approach

Argonne used the GREET 2018 model as the basis of new features added to the tool, to update existing data in AFLEET, and to update default fuel economy and electricity consumption data for both LDVs and HDVs. To create AFLEET online, we needed to develop a front-end, a database, and a back-end. The front-end is the user

interface (UI) where inputs are entered and options are selected to enable the calculation. The front-end also displays the results of the calculation. The database is where AFLEET's data is stored in preparation for a calculation. The back-end is the application's programming that takes the user inputs and AFLEET data to generate results, which are sent back to the front-end to display to the user.

We used two JavaScript libraries for the development of the front-end. The first was the Semantic UI development framework. This framework comes with a wide variety of modern and up-to-date responsive UI elements and cascading style sheet (CSS) bootstraps that allow for quick, easy, clean and readable implementations for basic dialog and table layouts. The second was the Charts.js library. As the AFLEET tool uses a variety of different graphs offered by Excel to organize output data, the web application needed a way to replicate these graphs. Charts.js is a robust and customizable JavaScript library for designing and laying out different web-based charts, which can replicate all the necessary graphs.

The database used in AFLEET online is Microsoft SQL server, which is compatible with Argonne servers and allows for easy testing and execution. Key data tables in the AFLEET spreadsheet were entered into SQL and will be updated in both places with data from sources such as GREET, MOVES, and the AFPR. The back-end was built using Microsoft ASP.NET web application framework and the C# programming language. For the initial release, AFLEET online uses the Simple Payback calculator methodology to estimate the payback, energy use, and emissions of new AFVs, compared to their conventional counterparts.

## Results

During FY 2018, the AFLEET Tool was downloaded nearly 1,500 times, and the accompanying AFLEET user manual more than 3,100 times. To date, 8,000 individual users have downloaded the tool. Argonne developed the new, user-friendly AFLEET online tool in FY 2018, and will continue to expand AFLEET's capabilities by adding more features, based on requests from stakeholders. As seen in Figures II.2.1 and II.2.2, this version will walk users easily through the process of selecting inputs and generating results.

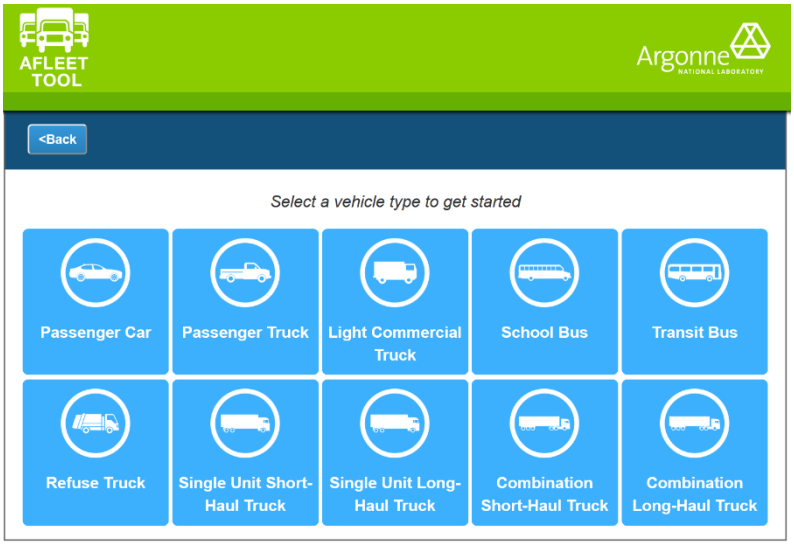


Figure II.2.1. AFLEET Online User Interface

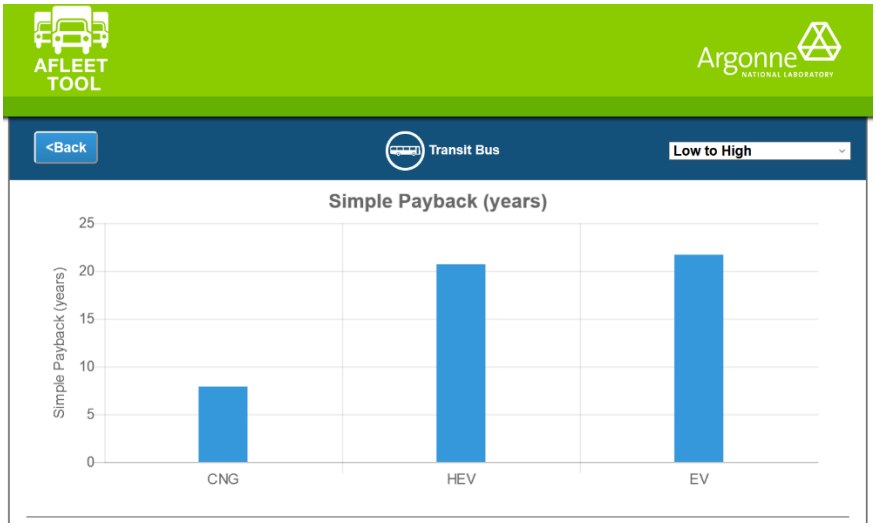


Figure II.2.2. AFLEET Online Results

## Conclusions

In FY 2018, this project addressed the stakeholder requests to continue updating AFLEET with the latest emissions and cost data, and to develop a user-friendly AFLEET online version. This version will help make it easier for stakeholders to analyze the impacts of AFVs. The front-end, database, and back-end framework allows for easy updates. In addition, AFLEET online can expand in the future to include other features in the AFLEET spreadsheet such as the TCO and idle reduction calculators.

## References

[1] Argonne National Laboratory, 2018. GREET Model - 2018 version, http://greet.es.anl.gov.

[2] Environmental Protection Agency, 2015. Motor Vehicle Emission Simulator (MOVES) - MOVES2014a version. http://www.epa.gov/otaq/models/moves.

[3] Bourbon, E., 2018. Clean Cities Alternative Fuel Price Report, https://afdc.energy.gov/publications/.

[4] Energy Information Administration, 2018. Annual Energy Outlook 2018, https://www.eia.gov/outlooks/AEO/.

# II.3 EcoCAR Advanced Vehicle Technology Competition (Argonne National Laboratory)

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Start Date: September 1, 2014 End Date: June 30, 2018
Project Funding (FY18): $8,500,000 DOE share: $8,500,000 Non-DOE share: $0

## Project Introduction

The U.S. Department of Energy and General Motors have joined forces with more than 30 government and industry sponsors to establish EcoCAR 3, a DOE Advanced Vehicle Technology Competition (AVTC). This workforce development program will seed the industry with hundreds of engineering, communications and business graduates who have hands-on experience designing, building and promoting advanced technology vehicles and emerging advanced driver assistance systems (ADAS) technologies and innovations.

Managed by Argonne National Laboratory (Argonne), EcoCAR 3 is a four-year competition series that challenges 16 North American universities to re-engineer a Chevrolet Camaro, to increase fuel efficiency using hybrid drivetrain technologies, and reduce its environmental impact, while maintaining the muscle and performance expected from this iconic American car. EcoCAR teams are following GM's Vehicle Development Process, which serves as a roadmap for designing, building and refining their advanced technology vehicles. This unique real-world engineering competition provides student engineers with hands-on research and development experience with leading-edge automotive propulsion, fuels, materials and emission-control technologies, as well as emerging technologies such as advanced driver assistance systems (ADAS). The competition just completed its fourth and final year, which focused on vehicle refinement to maximize emissions reduction, fuel efficiency and innovation results. EcoCAR 3 culminated with a competition finale in May 2018 at venues throughout Arizona and California, where teams competed in more than two dozen events for more than $100,000 in prize money.

## Objectives

- Successfully plan, manage and execute the Advanced Vehicle Technology Competition (AVTC) Program, including the current four-year EcoCAR 3 series, and ensure the competition is executed with technical integrity and fairness for all university competitors.
- Incorporate current industry codes and standards into the testing and evaluation of the competition vehicles.
- Develop safety system practices and procedures for university competitors to ensure a safe competition.
- Develop real-world multi-year training and education programs on advanced vehicle technologies for university competitors with subject matter experts from government and industry, to develop a highly skilled workforce.

- Promote and build awareness about the program and prepare the marketplace to adopt advanced technology vehicles.
- Facilitate youth outreach to increase Science, Technology, Engineering and Math (STEM) awareness, including among underrepresented minorities.

Universities participating in EcoCAR 3, and the abbreviations used in this report, include: Arizona State University (ASU), California State University Los Angeles (CSULA), Colorado State University (CSU), Embry-Riddle Aeronautical University (ERAU), Georgia Tech (GT), McMaster University (MAC), Mississippi State University (MSU), Ohio State University (OSU), Pennsylvania State University (PSU), University of Alabama (UA), University of Tennessee, Knoxville (UT), University of Washington (UW), University of Waterloo (UWAFT) [1] , Virginia Tech (VT), Wayne State University (WSU) and West Virginia University (WVU).

## Approach

Fiscal Year (FY) 2018 roughly aligned with the fourth and final year of EcoCAR 3. Over the four years, each team in the competition designed, built, and tested an advanced technology vehicle. Because the full development process covered multiple academic years, teams were given milestones for each year of the competition. These milestones served as developmental goals for the teams and their vehicles.

EcoCAR 3 also included a strong emphasis on Communications/Public Relations, diversity and STEM Outreach. Teams focused heavily on promoting the benefits of EcoCAR to the community and preparing the marketplace to adopt advanced vehicle technologies. Teams were also engaged with recruiting and STEM outreach, including outreach to underrepresented minority groups. By including communications deliverables in EcoCAR 3, the competition provided learning in areas of public relations and social media, in addition to engineering principles.

In Year 1, teams used math-based modeling tools to simulate and select vehicle powertrain configurations and design their advanced technology vehicles. In Year 2, teams sourced and secured new powertrain components and performed bench testing. Teams then re-engineered their 2016 Chevrolet Camaros, integrating their new hybrid components to achieve 50% component-level functionality. At the conclusion of Year 2, teams gathered at General Motors' Desert Proving Grounds in Yuma, Arizona for vehicle safety inspections and dynamic event testing. In Year 3, teams completed any remaining integration work and gained full functionality of all vehicle modes. The goal for Year 3 was to hit the 65% milestone of the vehicle development process, which entailed all vehicle modes and features being present and functional, but not necessarily refined.

For Year 4, the goal was a 99%, show-room quality vehicle. Emphasis was placed on quality and performance, as well as fit and finish, drive quality, and powertrain performance. Specifically, teams were given the following milestones for the Year 4 competition event:

- Vehicle integration is complete and "production-ready"
- Vehicle passes static and dynamic safety inspection with all modes functional
- Vehicle completes all closed-course testing events
- Vehicle completes the road rally testing event (167 miles, open roads)

Phase 1 of the competition for Year 4 of EcoCAR 3 was held at General Motors' Yuma Proving Ground in Yuma, AZ. The testing events conducted at competition included the following vehicle evaluations:

- 50-70 miles per hour (MPH) acceleration
- 60-0 MPH braking

- Maximum lateral acceleration
- Ride quality
- Drive quality
- Emissions
- Energy consumption

The second phase of the competition was held in Pomona, CA and included the following vehicle events:

- 0-60 MPH acceleration
- Autocross
- Consumer appeal
- Road rally event

As a whole, these events constituted a well-rounded evaluation of a consumer vehicle. Rather than focusing on a singular objective, EcoCAR 3 teams were required to design a vehicle that balances performance, emissions, energy consumption, and consumer appeal. In this way, EcoCAR 3 teams were faced with many of the same design decisions and challenges as automakers.

Additionally, each event was designed to provide a quantifiable and repeatable "apples-to-apples" method for comparing all EcoCAR vehicles against each other. The tests were also designed to follow industry-standard testing practices, to maintain relevance with the current state. As an example, the Emissions and Energy Consumption (E&EC) event incorporated elements of the EPA's 5-cycle test method and the SAE J-1711 Utility Factor standard. As part of the E&EC event, vehicles were driven over a 90 mile drive schedule that emulates the driving characteristics of the EPA's 5-cycle test method. A portable emissions measurement system was used to collect data on modal emissions, modal fuel consumption, and electric energy consumption. With this data, the J-1711 standard was used to calculate the average energy consumption a consumer could expect to experience if the vehicle were mass-produced.

Year 4 of EcoCAR 3 also featured significant integration of ADAS activities into the competition. This ADAS initiative was intended to integrate computer vision and other fundamental Connected and Automated Vehicle (CAV) concepts into AVTCs. The primary goals of the Year 4 ADAS activities were to increase familiarity and competency with CAV concepts, by integrating vision and radar sensors on team vehicles, and deploying advanced traffic sensing algorithms in real-life testing environments. Simultaneously, the ADAS initiative laid the groundwork for future research involving various levels of vehicle automation. To accomplish these goals, all EcoCAR universities received extensive training from industry experts, including advanced computer vision concepts, software prototyping using state-of-the-art MathWorks software toolboxes, and algorithm deployment to pre-production sensor fusion hardware. Additionally, Argonne, General Motors, NXP, MathWorks, and other industry leaders collaborated to design software development pathways and on-road test scenarios that would drive EcoCAR 3 University research progress in the areas of computer vision algorithm development and automated vehicle sensing technology.

Another focus area for the EcoCAR 3 competition was the Innovation Initiative. Supported by a partnership with the National Science Foundation, this initiative was designed to encourage teams to explore advanced research topics that are related to the automotive industry. The goal was to create an open environment for research, and challenge EcoCAR universities to think outside the box and explore bold new ideas. Each year, teams were expected to present the outcomes of their research, and were judged by a panel of industry experts.

The EcoCAR 3 competition series concluded with the Year 4 competition. Moving forward, the AVTC program will continue with a new competition series: the EcoCAR Mobility Challenge. This 4-year competition series launched in August of 2018 and will run through May of 2022. While the EcoCAR Mobility Challenge is the next series in a more than 30 year legacy of AVTCs, the technical goals have shifted significantly from prior AVTCs. The competition now focuses on CAV activities (~40% of engineering activities focused on CAV systems) and orienting the market focus toward a Mobility-as-a-Service application. These changes, among various other shifts, represent the largest paradigm shift for the AVTC program in its over 30 year history.

## Results

In Year 4, the field of EcoCAR 3 vehicles completed a remarkable amount of vehicle testing in preparation for the year-end competition. Over the course of the academic year, teams accumulated a total of 20,000 test miles, and 75% of teams were able to complete an endurance drive of 100 miles. Figure II.3.1 shows the team-by-team breakdown of endurance testing and mileage accumulation completed prior to Year 4 competition.

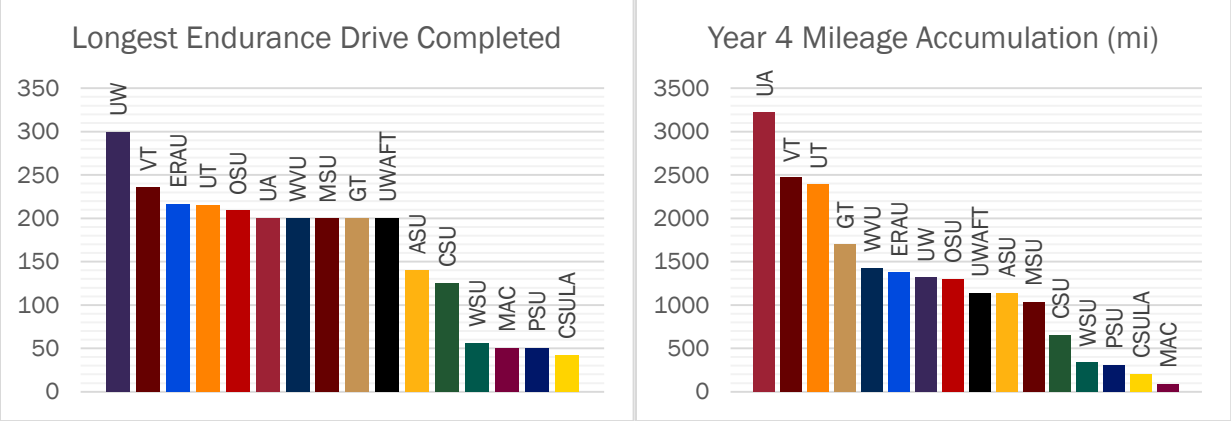


Figure II.3.3. Pre-Competition Endurance Testing and Mileage Accumulation for EcoCAR 3 Year 4

A majority of team vehicles met the stated milestones for Year 4 competition, as illustrated in Table II.3.1. This was likely due to the extensive amount of testing completed by EcoCAR teams prior to competition. In summary, almost every team delivered a vehicle with a functional powertrain and complete integration, and passed all safety criteria.

**Table II.3.1. EcoCAR 3 Year 4 Vehicle Milestone Results**

| Goal | Teams Achieving Goal |
|---|---|
| **Vehicle integration is complete and "production ready"** | 14/16 (88%) |
| **Vehicle passed static safety inspection**<br>**Vehicle passed dynamic safety evaluation** | 16/16 (100%)<br>15/16 (94%) |
| **Vehicle demonstrated the powertrain can function *as designed*** | 13/16 (81%) |
| **Vehicle participated in *all* closed-course events**<br>**Vehicle completed *all* closed-course events**<br>**Vehicle completed *all* closed-course events *running as designed*** | 11/16 (69%)<br>9/16 (56%)<br>9/16 (56%) |
| **Vehicle participated in 90-mile emissions & energy consumption event**<br>**Vehicle *competed* in 90-mile emissions & energy consumption event** | 15/16 (94%)<br>11/16 (69%) |
| **Vehicle participated in road rally event**<br>**Vehicle *completed* road rally event** | 10/16 (63%)<br>7/16 (44%) |

Of the 16 vehicles tested during Year 4 competition, all but one team (94%) passed the safety tech inspection and were able to participate in the competition test events. On an aggregate basis, teams had a participation rate of 85% and a completion rate of 78% for Year 4 events. This means that for a total of 10 events and 16 teams (160 event opportunities), there were 136 event attempts and 124 event completions by team vehicles. Table II.3.2 summarizes the number of teams that attempted and completed each of the Year 4 testing events. This table also includes the best result for each event and demonstrates that teams were able to improve on the stock vehicle in every area of the competition.

**Table II.3.2. Number of Teams Attempting and Completing Competition Testing Events**

| Event | Attempted | Completed | Best Result | Stock Vehicle |
|---|---|---|---|---|
| **Handling (Skidpad)** | 15 | 15 | 0.979 (G) | 0.78 (G) |
| **Ride Quality** | 12 | 11 | 7.8/10 | 7.73/10 |
| **Drive Quality** | 12 | 12 | 76/100 | n/a |
| **0-60 MPH Acceleration** | 15 | 15 | 5.11 (sec) | 5.4 (sec) |
| **50-70 MPH Acceleration** | 15 | 14 | 2.77 (sec) | 3.17 (sec) |
| **60-0 MPH Braking** | 15 | 14 | 104 (ft) | 124 (ft) |
| **Autocross** | 15 | 15 | 91.35 (sec) | 91.4 (sec) |
| **Utility Factor (UF)-Weighted Energy Consumption** | 15 | 11 | 561 (Wh/km) | 802 (Wh/km) |
| **UF-Weighted WTW Petroleum Energy Use** | 15 | 11 | 103 (Wh PE/km) | 809 (Wh PE/km) |
| **UF-Weighted WTW GHG Emissions** | 15 | 11 | 186 (g GHG/km) | 211 (g GHG/km) |
| **UF-Weighted WTW Criteria Emissions** | 15 | 11 | 9.2 | 10.11 |
| **Road Rally (Over-the-Road Event)** | 10 | 7 | 167/167 mi completed | n/a |

Perhaps most impressively, 15 teams attempted the challenging 90-mile energy consumption event and 11 teams were able to complete the event. In the context of AVTCs, this is an all-time high for number of teams completing the grueling energy consumption event. Additionally, several teams were able to improve upon the base vehicle's Utility Factor (UF)-weighted total energy consumption and well-to-wheels (WTW) greenhouse gas emissions (as evaluated using the SAE J-1711 utility factor weighting method for a plug-in hybrid-electric vehicle).

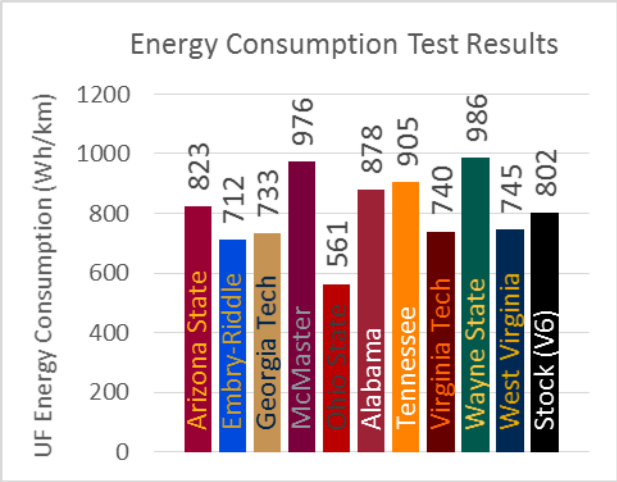


Figure II.3.2. Energy Consumption Event Testing Results from EcoCAR 3 Year 4 Competition

Figure II.3.2 and Figure II.3.3 show the energy consumption and greenhouse gas (GHG) emissions results, respectively, for the 11 teams that completed the event.

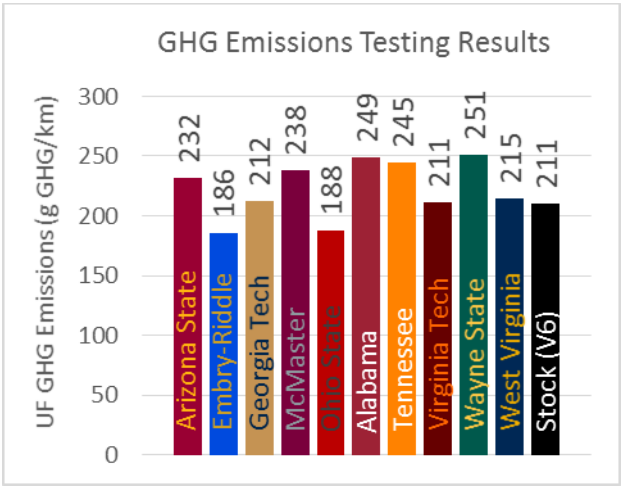


Figure II.3.3. GHG Emissions Event Testing Results from EcoCAR 3 Year 4 Competition

In addition to the powertrain development activities in Year 4, all 16 universities deployed an ADAS sensing system to their competition vehicle. The performance capabilities of each team's ADAS system were evaluated over a series of controlled test maneuvers designed by Argonne and General Motors. Almost all teams (12 out of 16) were able to get their systems functioning, and participate in the ADAS event. Of these, nine teams were able to successfully complete the event. The success of this event will be used as a springboard into the next AVTC series where CAV systems will be prominently featured.

Aside from engineering results and outcomes of Year 4 of EcoCAR 3, the competition was also successful in achieving its core objective: training the next generation of automotive engineers, communicators, and business leaders. Over the 4 years of the program, a total of 3,674 students participated in EcoCAR 3. Approximately 89% of these students were from engineering disciplines and about 90% were undergraduate students. More than 3,000 students gained a job by virtue of their participation in the program. Teams found that these students out-earned their peers by an average of $8,658 per year. Additionally, more than 100 students completed a Master's thesis or Ph.D. dissertation related to via EcoCAR 3. Students published nearly 100 papers as an outcome of research completed during the competition. The impacts of the EcoCAR 3 program are summarized in Table II.3.3.

Table II.3.3. Impacts of the EcoCAR 3 Program

| Metric | Number |
|---|---|
| **Total student participants in EcoCAR 3** | 3,674 |
| **Engineering students** | 3,267 (89%) |
| **Undergraduate students** | 3,296 (90%) |
| **Female students** | 610 (17%) |
| **Students that gained jobs as a result of EcoCAR 3** | 3,097 |
| **Average salary for EcoCAR 3 graduate (engineering)** | $71,736 |
| **Average salary for university graduate (engineering)** | $63,078 |
| **Technical publications resulting from EcoCAR 3** | 95 |
| **Masters theses completed via EcoCAR 3** | 100 |
| **Ph.D. dissertations completed via EcoCAR 3** | 7 |

In year 4 of EcoCAR 3, teams conducted 82 total youth outreach events, reaching more than 5,000 youth in grades 6 to12. Teams also executed 117 general public awareness events across the country. In addition, the teams spread awareness about their advanced technology vehicles and EcoCAR 3 by actively engaging with influencers and stakeholders including, but not limited to, U.S. Senators and Representatives, Governors, and other state and local officials. In all, more than 60 interactions with influencers occurred in Year 4, with 19 of those at the federal level. Over all four years of EcoCAR 3, teams participated in 752 presentations to community groups and 415 youth outreach events. Table II.3.4 summarizes the overall community impacts from the four-year program.

Table II.3.4. Community Impacts of the EcoCAR 3 Program

| Metric | # |
|---|---|
| No. of presentations to community groups | 752 |
| No. of people at those presentations | 442,066 |
| No. of youth outreach events | 415 |
| No. of people at those events | 24,213 |

EcoCAR 3 brought awareness to the general public, stakeholders, sponsors and participants through public relations, social media and marketing efforts. Students developed and executed a strategic plan for year four, with successful outcomes. Public relations and media outreach efforts included issued press releases, earned placements and a paid social campaign highlighting earned media.

Total media impressions for year four reached 179 million, as shown in Table II.3.5.

Table II.3.5. EcoCAR 3 Earned Media Results, Year 4

| Outlet | Impressions/Reach |
|---|---|
| Radio/Audio | 7.723 million |
| TV | 3.776 million |
| Print | 167.5 million |
| TOTAL | 179 million |

Total number of organic social engagements for year 4 reached 410,000, as shown in Table II.3.6. The top Facebook post, from the Fall Workshop, generated a 22% engagement. Likewise, the top tweets saw 7% engagement for the competition finals and the awards ceremony.

Table II.3.6. Organic EcoCAR 3 Social Media Results, Year 4

| | Total Tweets/Posts | Total Likes | Total Shares/Retweets | Impressions/Reach |
|---|---|---|---|---|
| Twitter | 93 tweets | 819 | 267 | 249,911 |
| Facebook | 81 posts | 2,811 | 399 | 160,556 |

In conjunction with the finale competition in May 2018, the project team executed a three-week paid social media campaign that featured an earned media coverage piece from Wired Magazine. The three-week campaign generated 4.1 million social media impressions and 842,000 completed video views. The campaign generated 80 percent more impressions than estimated. These impressions are not included in Table II.3.6.

## Conclusions

The EcoCAR 3 competition forged a unique public-private partnership of more than 32 government and industry organizations that joined forces to explore advanced propulsion systems, emission-control technologies and emerging technologies, such as advanced driver assistance systems. This highly successful workforce development program has seeded the industry with thousands of engineers, communications and business graduates who have hands-on experience with advanced technology vehicles and other innovative and emerging vehicle technologies. This will help transform the industry to meet the growing challenges in the transportation and energy sector. The program also continues to have a major impact on today's youth, inspiring future generations, including underrepresented minorities, to follow STEM careers. Finally, the program is helping to educate and build awareness within the community about advanced technology vehicles.

## References

[1] UWAFT is the abbreviation for the University of Waterloo Alternative Fuels Team.

## Key Publications

The EcoCAR program funded student assistant positions on each EcoCAR team. This includes engineering graduate research assistants (from multiple disciplines), as well as a Project Manager and Communications Manager. The publications produced as a result of this funding are summarized in Table II.3.7 below.

**Table II.3.7. EcoCAR 3 Team Publications (Over Four Year Program)**

| Team | Publication/Presentation Title | Lead Author Name | Conference / Journal |
|---|---|---|---|
| ASU | Vehicle Plant Model and Supervisory Control Development for a Parallel Pre-Trans Plug-In Hybrid Electric Vehicle | Sushil Kumar | SAE Congress 2016 |
| ASU | Look-Ahead Information Based Optimization Strategy for Hybrid Electric Vehicles | Mohammad Alzorgan | SAE |
| ASU | Vehicle Plant Model and Supervisory Control Development for a Parallel Pre-Trans Plug-In Hybrid Electric Vehicle | Kumar Sushil | IFAC |
| ASU | Active Battery Thermal Management within Electric and Plug-In Hybrid Electric Vehicles | Carroll Joshua | SAE |
| ASU | RadTherm for Modeling & Simulation Using Multifaceted Approach | Guaravraj Wadhwa | Annual RadTherm User Group Meeting |
| ASU | Creating Innovative Automotive Solutions for Environmental Sustainability at Arizona State University | Brian Hennesy | 11th Annual Gatekeeper Regulatory Roundup |
| CSU | Towards Improving Vehicle Fuel Economy with ADAS | Jordan Tunnel, | SAE World Congress 2018 |
| CSU | A Survey of Advanced Driver Assistance Systems and Current Challenges | Vipin K. Kukkala | 2017 IEEE (ICITE) |
| CSU | Application of systems theoretic process analysis to a lane keeping assist system | Haneet Singh Mahajan | Reliability Engineering & System Safety Journal 167 |
| CSU | "Investigation of Vehicle Speed Prediction from Neural Network Fit of Real World Driving Data for Improved Engine On/Off Control of the EcoCAR3 Hybrid Camaro." | David Baker | SAE World Congress 2017 |

| Team | Publication/Presentation Title | Lead Author Name | Conference / Journal |
|---|---|---|---|
| CSU | Introduction and Application of Lean Manufacturing Techniques in Mechanical Engineering Senior Design Practicum | Jamison Bair | ASEE 2017 |
| CSU | JAMS: Jitter-Aware Message Scheduling for FlexRay Automotive Networks | Vipin Kukkala | CODES ISSS |
| CSU | Priority-based Multi-level Monitoring of Signal Integrity in a Distributed Powertrain Control System | Vipin K. Kukkala | 4th IFAC Workshop on Engine and Powertrain Control, Simulation and Modeling |
| CSU | Prediction Error Applied to Vehicle Optimal Fuel Economy | Zach Asher | IEEE Transactions on Control Systems Technology, 2017 |
| CSU | Uncertainty Analysis and Propagation for an Auxiliary Power Module | Vipin K. Kukkala | IEEE (iTEC), 2017 |
| CSU | Weight Reduction through the Design and Manufacturing of Composite HalfShafts for the EcoCAR 3 | Eric Jambor | SAE World Congress 2016 |
| CSU | Reducing Effective Vehicle Emissions Through the Integration of a Carbon Capture and Sequestration System in the CSU EcoCAR Vehicle | Clinton Knackstedt | SAE World Congress 2016 |
| CSU | The Effect of Hill Planning and Route Type Identification Prediction Signal Quality on Hybrid Vehicle Fuel Economy | Zach Asher | SAE Technical Paper 2016 |
| CSU | The Effect of Trip Preview Prediction Signal Quality on Hybrid Vehicle Fuel Economy | Thomas Cummings | IFAC-PapersOnLine 48 |
| CSU | EcoCAR 3: Architecture Selection Validation through Vehicle Modeling and Simulation for the Colorado State University Vehicle Innovation Team | Clinton Knackstedt | E-COSM 2015 |
| CSU | Project Mangement and Implementation in EcoCAR 3 | Eric Jambor | IMECE 2015 |
| CSU | The Effect of Trip Preview Prediction Signal Quality on Hybrid Vehicle Fuel Economy | Tom Cummings | E-COSM 2015 |
| CSULA | MPC Based Power Managmenet Strategies to Reduce Power Loss in an HEV | Morgan Cook | Sustech IEEE 2017 |
| ERAU | Investigation of the Effectiveness of Carbon Fiber Additives in a Phase-Change Material Coldplate for Hybrid-Electric Vehicle Battery Thermal Management | Kevin Cwiok | ASME IMECE |
| ERAU | Electrical Optimization of a Plug-in Hybrid Electrical Vehicle | Andre Napier | ERAU Thesis |
| ERAU | Application of Fractional PHEV Utility Factor Weighting to EcoCAR On-Road Emissions and Energy Consumption Testing | Trevor Crain | SAE World Congress |
| ERAU | Parameter Estimation for Model Validation of an Energy Storage System During Operation in a Series Hybrid Electric Vehicle | Khalifi, H. | ASME IMECE |
| ERAU | Group Dynamics and Project Management in EcoCAR 3 | Waterman, S. | ASEE |

| Team | Publication/Presentation Title | Lead Author Name | Conference / Journal |
|---|---|---|---|
| ERAU | Modeling and Control Strategy Development of a Parallel-Series Plug-in Hybrid Electric Vehicle | Meng, Y. | International Federation of Automatic Control E-COSM |
| ERAU | Launching Performance of a Series Hybrid Vehicle | Khalifi, H. | International Journal of Vehicle Performance |
| ERAU | A System Efficiency Approach to Power-Split Hybrid Control Strategies | Meng, Y. | SAE World Congress |
| GT | Educating Chemical Engineers with Interest in the Automotive Industry | Gregory D. Chipman | AICHE 2016 Annual Meeting |
| GT | Optimal Control of Regenerative Braking for SPM Synchronous Machines with Current Feedback | Aravind Samba Murthy | IEEE 2016 iTEC |
| GT | Optimized Regenerative Braking of Induction Machines with Indirect Field-Oriented Control | Aravind Samba Murthy | IEEE 2016 iTEC |
| GT | Vertically Integrated Projects: Improving the Overall University Competition Experience | Gregory D. Chipman | ASME 2015 IMECE |
| GT | Modeling and Control of Power-Split Powertrains: Examining the Influence of Drive-Shaft Compliance | Sriganesh Sriram | IEEE 2015 iTEC |
| GT | Specification of a P3 Parallel Hybrid Electric Vehicle Architecture for the EcoCAR 3 Competition | Jonathan D. Cox | SAE World Congress 2016 |
| MAC | Minimizing battery wear in a hybrid energy storage system using a linear quadratic regulator | Chemali, Ephrem | IECON 2015 - 41st Annual Conference of the IEEE Industrial Electronics Society |
| MSU | A Comparison of the MSU Powertrain Architecture Control Strategies | John Corn | SAE 2016 PFL |
| MSU | A GT-Power Simulation of E-85 and Gasoline Combustion in a Two Cylinder Spark Ignition Engine | Riccardo Calza | SAE 2016 Congress |
| MSU | Determination of interior NVH levels from tire/wheel variations using a Monte Carlo process | Mohamad Qatu | SAE 2011 Noise and Vibration Conference and Exhibition |
| MSU | Exploring VR Displays for Malware Analysis | Myles Black | IS&T International Symposium on Electronic Imaging |
| MSU | Reducing vehicle weight and improving security by using plastic optical fiber | Ryan Nazaretian | Mississippi Energy Coordinators Association Conference |
| OSU | Development of a Dynamic Driveline Model for a Parallel-Series PHEV | Shawn Midlam-Mohler | SAE International |
| PSU | Motivation Tactics and Techniques for a Largely Volunteer Based Organizations | Benjamin Sattler | Project management Institute |
| UA | Effect of an Electric Vehicle Mode in a Plug-In Hybrid Electric Vehicle with a Post-Transmission Electric Motor | Travis D. Foust | Journal: The International Journal |

| Team | Publication/Presentation Title | Lead Author Name | Conference / Journal |
|---|---|---|---|
| | | | of Electric and Hybrid Vehicles |
| UA | Exploring the Career Development of Young, Racially Diverse PR Practitioners: An Application of Critical Race Theory in Public Relations | Brittany J. Galloway | Journal: Journal of Publications and Research |
| UT | Full cell simulation and the evaluation of the buffer system on air-cathode microbial fuel cell | Shiqi Ou | Journal of Power Sources |
| UT | Modeling and validation of single-chamber microbial fuel cell cathode biofilm growth and response to oxidant gas composition | Shiqi Ou | Journal of Power Sources |
| UT | Efficient Single-Phase Harmonics Elimination Method for Microgrid Operations | Saeed Anwar | IEEE Transactions on Industry Applications |
| UT | Design and Implementation of a 75-kW Mobile Charging System for Electric Vehicles | Saeed Anwar | IEEE Transactions on Industry Applications |
| UT | Operating Mode Transition Control of a SiC Integrated DC DC Powertrain Charger for Electric Vehicles | Saeed Anwar | IEEE iTEC 2017 |
| UT | Integrated DC-DC Converter Design for Electric Vehicle Powertrains | Saeed Anwar | APEC 2016 |
| UT | Investigation of cost-effective SiC based hybrid switch and improved inductor design procedure for boost converter in electrical vehicles application | Saeed Anwar | 2015 SAE Congress |
| UT | Power factor correction of LED drivers with third port energy storage | Saeed Anwar | APEC 2015 |
| UT | Harmonics compensation and power factor improvement using LED driver | Saeed Anwar | ECCE 2014 |
| UT | Efficient Single Phase Power Factor Improvement Strategy for Microgrid Operation | Saeed Anwar | APEC 2014 |
| UT | Efficient Single Phase Harmonics Elimination Method for Microgrid in Grid Connected and Islanded Mode of Operation | Saeed Anwar | ECCE 2013 |
| UT | Harmonics Elimination and Distribution Using Decentralized Control for Microgrid Applications | Saeed Anwar | IEEE EnergyTech 2013 |
| UT | Design and Implementation of a 75 KW Mobile Charging System for Electric Vehicles | Saeed Anwar | ECCE 2013 |
| UW | Development of Optimal Control Strategy for a Plug-In Series Hybrid Electric Vehicle With an On-Board Engine-Generator System for Overall Fuel Economy Improvement and Reduction in Tail-Pipe Emissions | Aman V Kalia | ASME 2017 Internal Combustion Engine Division Fall Technical Conference |
| UW | Improving Fuel Economy of Thermostatic Control of a Plug In Series Hybrid Electric Vehicle Using Driver Prediction | Brian Magnuson / Ryan Mallory | SAE |
| UW | Active Torque Vectoring in High Speed Lane Change Maneuvers | Nathaniel Steinbock | ASME |

| Team | Publication/Presentation Title | Lead Author Name | Conference / Journal |
|---|---|---|---|
| UWAFT | Comparative Safety Risk and the Use of Repurposed EV Batteries for Stationary Energy Storage | John Catton | 2017 IEEE International Conference on Smart Energy Grid Engineering (SEGE) |
| UWAFT | Extended Range Electric Vehicle Powertrain Simulation, and Comparison with Consideration of Fuel Cell and Metal-Air Battery | John Catton | SAE Technical Paper 2017 |
| UWAFT | A Hybrid Electric Camaro Case Study for Utilizing a Marginal Approach to Risk Mitigation Prioritization Based on Impact | Daniel van Lanen | The Second International Conference on Organizational Strategy, Business Models, and Risk Management |
| UWAFT | Control Analysis for Efficiency Optimization of a High Performance Hybrid Electric Vehicle with Both Pre and Post Transmission Motors | Patrik Ellsworth | SAE International, no. 2016-01-1253, 2016 |
| UWAFT | Market Mechanisms in Power-to-Gas Systems | Daniel van Lanen | International Journal of Environmental Studies |
| UWAFT | Economic and environmental analysis of a green energy hub with energy storage under fixed and variable pricing structures | Daniel van Lanen | International Journal of Process System Engineering vol. 3 |
| UWAFT | Safety Training System Design for Student Teams | Daniel van Lanen | ASEE 2015 |
| UWAFT | Internal Resistance Optimization Utilizing “Just in Time” Control | Patrik Ellsworth | SAE Technical Paper |
| VT | Simulation and Bench Testing of a GM 5.3L V8 Engine | Sam Reinsel | WCX™ 17: SAE World Congress Experience |
| VT | Passive metamaterial-based acoustic holograms in ultrasound energy transfer systems | Ahmed Elnahhas | Active and Passive Smart Structures and Integrated Systems XII |
| VT | Self-tuning Stochastic Resonance Energy Harvesting for Rotating Systems Under Modulated Noise and Its Application to Smart Tire | Jason Parker | Active and Passive Smart Structures and Integrated Systems XII |
| VT | Exact H2 Optimal Tuning and Experimental Verification of Energy Harvesting Electromagnetic Tuned-Mass Dampers | Jason Parker | ASME Journal of Vibration and Acoustics |
| VT | EcoRouting Strategy Using Variable Acceleration Rate Synthesis Methodology | Hrusheekesh Warpe | SAE 2017 |
| VT | Drive Quality Assessment of Stock Vehicles for EcoCAR Benchmarking | Sam Reinsel | SAE 2017 |
| VT | Financial Viability Analysis of an Engineering Design Team | William Dvorkin | ASEM 2016 International Annual Conference |

| Team | Publication/Presentation Title | Lead Author Name | Conference / Journal |
|---|---|---|---|
| VT | Strategies to Improve Performance at a High-Turnover Engineering Organization | William Dvorkin | Procedia Computer Science |
| VT | EcoRouting for a Performance Plug-in Hybrid Vehicle | Pramit Baul | SAE 2016 PFL |
| VT | Control Strategy Development for Parallel Plug-in Hybrid Electric Vehicle Using Fuzzy Control Logic | Eduardo Marquez | SAE 2016 PFL |
| VT | Development of Current Squared - Time Curves for Simplified Wire Size Selection for Electric Traction Systems in Automotive Applications | Eduardo Marquez | 2015 IEEE (iTEC) |
| VT | Development of a Software-In-The-Loop Model for a Parallel Plug-In Hybrid Electric Vehicle | David Mackanic | SAE 2016 Congress |
| WSU | Modeling, Simulation and Control Development of Pre-Transmission Parallel E85 PHEV for Year-1 of EcoCAR 3 Competition | Di Russo, M. | SAE Technical Paper 2016 |
| WSU | Hybrid Electric Vehicle Architecture Selection for EcoCAR 3 Competition | Zhang, Z. | SAE Technical Paper 2015 |
| WSU | Design and Simulation of Lithium-Ion Battery Thermal Management System for Mild Hybrid Vehicle Application | Uddin, A. I. | SAE Technical Paper 2015 |
| WVU | Utilizing Situational Awareness for Efficient Control of Powertrain in Parallel Hybrid Electric Vehicles | Kazemi | IEEE Int. Conf. on Ubiquitous Wireless Broadband, Workshop on V2X Communication and Applications, Oct. 2015 |
| WVU | Predictive AECMS: Utilizing ITS-based Vehicle Movement Information for Optimal Control of Hybrid Electric Vehicle Powertrain | Kazemi | IEEE Transactions on Intelligent Vehicles |

# II.4 Fuel Economy Information Project (Oak Ridge National Laboratory)

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Start Date: October 1, 2017 End Date: September 30, 2018
Project Funding (FY18): $1,755,800 DOE share: $1,755,800 Non-DOE share: $0

## Project Introduction

Oak Ridge National Laboratory (ORNL) manages the Fuel Economy Information (FEI) Program for the Department of Energy (DOE), in close collaboration with the Environmental Protection Agency (EPA). Under this program, ORNL produces and distributes the annual *Fuel Economy Guide* [1] and manages the www.fueleconomy.gov [2] website to support the DOE's statutory responsibility to provide light-duty vehicle fuel economy information to the public (under the Energy Policy and Conservation Act of 1975 – 49 USC 32908). The FEI Program supports a continually updated electronic version of the *Guide* on the website www.fueleconomy.gov, where consumers also have access to a wide array of additional information and tools. The website provides fuel economy information for over 40,000 vehicles from 1984 to present. The site also provides side-by-side comparison tools, fuel saving calculators, driving and vehicle maintenance tips, information about advanced technologies, tax incentive information, safety ratings, vehicle specifications, and more. When warranted, the FEI Program also conducts fuel economy research to support its efforts to provide timely, reliable driving tips to consumers. The project ensures that consumers have easy access to fuel economy information that is accurate, up-to-date, and useful.

## Objectives

The FEI Program has several objectives:

- Help DOE fulfill its statutory responsibility to publish and distribute an annual *Fuel Economy Guide* providing information on fuel economy and estimated annual fuel costs of operating automobiles manufactured in each model year
- Provide consumers with reliable, unbiased fuel economy information. One of the goals of the FEI Program's FuelEconomy.gov website is to be the official government source of, and leading authority on, fuel economy.
- Help improve U.S. energy security and reduce petroleum consumption by promoting fuel economy to consumers through education and outreach

- Help consumers make informed decisions when purchasing and operating vehicles by
    - Providing information about light-duty vehicle fuel economy and fuel costs
    - Educating consumers on the benefits of improved fuel economy
    - Providing tools that help consumers estimate fuel use and fuel costs
- Help DOE's Clean Cities coalitions promote alternative fuels, alternative fuel vehicles, and advanced vehicle and fuel technologies

## Approach

The FEI Program helps DOE fulfill its statutory responsibility to compile and distribute an annual *Fuel Economy Guide* by publishing the *Guide* for each new vehicle model year and maintaining an up-to-date electronic version on the fueleconomy.gov website throughout the year. Using data collected from manufacturers by the Environmental Protection Agency (EPA), the Program publishes the *Guide* in the fall and updates it weekly throughout the year as new data become available. Through model year 2017, the FEI Program distributed the print version of the *Guide* to new-car dealerships, libraries, and credit unions. In addition, it provides an electronic version of the current *Guide* (and previous model year editions) on the FuelEconomy.gov website. Electronic versions of the *Guide* for the current and recent model years are updated with new vehicle models and/or gas prices weekly. For model year 2018, the *Guide* was produced and distributed in the electronic version (except for a limited print run).

The *Fuel Economy Guide* currently contains information for more than 1,200 light-duty vehicles, including conventional gasoline and diesel vehicles, plug-in electric vehicles, flex-fuel vehicles, fuel cell vehicles, and vehicles operating on CNG, propane, and other fuels. The *Guide* provides (1) EPA city, highway, and combined fuel economy estimates, (2) annual fuel cost estimates, (3) EPA greenhouse gas (GHG) ratings, and (4) interior volumes for each vehicle. The *Guide* highlights fuel economy leaders for each vehicle class and provides fuel-saving driving and maintenance tips to help consumers save money.

In addition to the annual *Fuel Economy Guide* publication, the FEI Program developed and launched the FuelEconomy.gov website in 1999. The website was developed to leverage the power of computers and the internet to reach more consumers and provide more functionality than possible within the limitations of a paper booklet. FuelEconomy.gov has become the FEI Program's most effective tool for reaching consumers and providing them with fuel economy information. In fact, it has become so popular that the Fuel Economy and Environment sticker displayed on new cars now has a QR Code that consumers can scan with a mobile device. The code will take them directly to the FuelEconomy.gov website.

Unlike the print versions of the *Guide*, which contain vehicles for a single model year, the website contains information for vehicles going back to model year 1984—more than 40,000 vehicles in all. In addition to fuel economy, GHG ratings, and annual fuel costs, the website provides driving range, cost to fill the tank, EPA Smog Rating, annual petroleum consumption, National Highway Traffic Safety Administration (NHTSA) crash test results, and fuel economy estimates from other drivers (via the website's "My MPG" feature). Vehicle and fuel cost data are updated weekly, making the website much more up-to-date and complete than would be possible with a printed booklet. Furthermore, FuelEconomy.gov allows consumers to personalize fuel economy estimates, annual fuel costs, and other estimates based on their driving environment and fuel prices. Users can also compare fuel economy and other estimates on up to four vehicles side-by-side.

FuelEconomy.gov provides users with several search tools to help them find specific vehicles or vehicles that meet their desired search criteria. Users can search by make and model, vehicle class, fuel type, engine and transmission, and other characteristics. They can also search for EPA-certified SmartWay vehicles, and vehicles with the best and worst fuel economy in each vehicle class.

FuelEconomy.gov provides users with fuel-saving tips and allows consumers to personalize these tips to see how much money they can expect to save by following them. The fuel economy tips are based on published research, much of which was supported through the FEI Program (these research efforts are described later in this report).

FuelEconomy.gov provides many other kinds of information useful to consumers:

- Federal tax credit information for advanced technology vehicles (e.g., all-electric vehicles and plug-in hybrids)
- Lists of best and worst fuel economy vehicles
- Answers to frequently asked questions about fuel economy
- Links to national and local fuel prices and answers to frequently asked questions about fuel prices
- Detailed descriptions of EPA Fuel Economy and Environment Labels
- Discussions about the benefits of improved fuel economy, such as saving money, increasing U.S. energy security, reduced GHG emissions, and improved sustainability
- Simple explanations of how fuel economy estimates are determined, how to select the right octane for your vehicle, and how advanced vehicle technologies save fuel

Due to the significant increase in the popularity of smart phones and other mobile devices, the Fueleconony.gov website was recently re-designed in a mobile-friendly platform that displays content on any screen size from a smart phone to a desktop computer. This allows consumers to have fuel economy information at their fingertips at almost any location and at any point in the car-buying process.

FuelEconomy.gov's *My MPG* tool helps drivers calculate and track fuel economy for their vehicles. Drivers can also elect to share their real-world MPG estimates with other consumers. These shared estimates are useful to other consumers shopping for a vehicle as well. The My MPG tool employs methods to help ensure that the fuel economy estimates are as reliable as possible. This includes data checking to help drivers enter data correctly and a log-in process to help discourage users that may try to enter large amounts of erroneous data. My MPG was initially designed for use on a desktop computer. However, as mobile devices became more popular, a scaled-down version of the tool was developed for these devices. The team recently redesigned the tool to provide full functionality on both desktop and mobile devices and plans are to launch this upgrade in 2019. Other enhanced features include an improved user interface, more graphs and tables for user analysis, and the ability to enter data for all-electric vehicles.

FuelEconomy.gov provides a number of tools and calculators to help consumers make informed decisions when buying or operating a vehicle:

- *Trip Calculator*. This calculator allows consumers to calculate the fuel costs for driving a vehicle on a specified trip. Users can enter their origin, destination, and any waypoints and select up to three vehicles they are considering taking on the trip. The tool will map out the best route, provide directions, and estimate the fuel use and fuel cost for each selected vehicle. This is one of the most popular tools on FuelEconomy.gov.
- *Fuel Savings Calculator.* The fuel savings calculator began as a simple tool to help users compare the fuel costs of two vehicles with different fuel economies. The FEI Program has enhanced the tool, keeping its ease of use but also allowing users to compare specific vehicles as well as adding vehicle purchase and financing/lease costs into the equation – this is helpful for vehicles that may have a higher

initial cost but may save more money over time. The FEI program also added charts to help illustrate the results

- "*Can a Hybrid Save Me Money*?" When hybrid vehicles were first introduced, there were questions about whether their fuel savings were sufficient to outweigh their higher initial cost. Many news articles were written comparing the costs of hybrids to their conventional counterparts over time, but most of these articles had a significant flaw: they compared a hybrid model, which was typically equipped with many upgraded features, to the base model, which had very few amenities. Therefore, the results of these analyses were skewed against hybrids, without pointing out that the user was actually getting more features, and not just better gas mileage, with the hybrids. Therefore, the FEI Program added a tool to FuelEconomy.gov that compared each hybrid to a comparably equipped conventional vehicle from the same manufacturer. This allows consumers to weigh the benefits of improved fuel economy while taking unrelated features out of the equation.

- *My Plug-in Hybrid Calculator*. The fuel economy of a plug-in hybrid is highly variable and depends greatly on how it is driven and how often it is charged. This tool allows consumers to estimate the gasoline and electricity costs of a plug-in hybrid based on their driving habits, charging schedule, and gasoline and electricity prices. The tool even provides users with the choice of a simple model or a more complex model for personalizing their driving and charging patterns.

- *Used Car Label Tool*. This tool generates printable fuel economy labels that sellers can affix to their vehicles or electronic images they can include in on-line ads. A vehicle's fuel economy changes very little over time if it is properly maintained. The used car label tool helps make official EPA fuel economy ratings part of the buying/selling process of used cars, just as it is for new ones.

FuelEconomy.gov makes much of its fuel economy information available to other websites, researchers, and other organizations via web services and data download. Edmunds, CHROMEDATA (used by more than 70% of U.S. vehicle manufacturers), the California Air Resources Board (CARB), Uber, and the Florida Department of Transportation are just a few of the organizations that rely on FuelEconomy.gov for fuel economy data. In addition, EERE has two website tools that use FuelEconomy.gov's data, as does EPA's Green Vehicle Guide. The FEI Program has also developed Find-a-Car and driving tips widgets that website developers can incorporate into their sites.

Providing reliable, defensible fuel economy tips to consumers is a primary objective of the FEI Program. Studies show that driving more efficiently can improve most drivers' fuel economy by about 10%; however, to get buy-in from consumers, these tips must be accurate and up-to-date. FuelEconomy.gov's fuel-saving tips are compiled based on available literature from U.S. government agencies, auto experts, and other credible sources. As vehicle technologies evolved over time, many of these tips became dated, and in several cases over the last few years the FEI Program has supported research projects aimed at quantifying factors that can increase or decrease fuel economy. FEI research has included literature reviews, analysis of available data sets, as well as a number of vehicle experiments. Research has focused primarily on aspects of fuel economy that can be improved by driver behavior. Past research topics include (1) the effect of a dirty air filter on fuel economy and performance, (2) the effect of driving speed on fuel economy, (3) fuel economy effects of roof racks, cargo carriers, trailers, and tire pressure (4) the effect of cold weather on fuel economy, (5) the effect of driving with the windows down vs. using the air conditioner, (6) the amount of fuel consumed by idling, (7) fuel economy tips for hot and cold weather, (8) fuel economy tips for hybrids and plug-in vehicles, and (9) effect of driving style on fuel economy. Most of the fuel-saving tips on FuelEconomy.gov are now based on research performed by the FEI Program, and these tips are often cited by news outlets, car companies, consumer sites, and other entities. Publications developed as part of this program are listed at the end of this report.

The FEI Program developed a *Find-a-Car* app for Apple and Android devices for those consumers that prefer to use mobile apps rather than the Find-a-Car tool on the FuelEconomy.gov website. *Find-a-Car* is the primary search tool on FuelEconomy.gov. It is used to look up fuel economy and other information for light-duty passenger vehicles. The *Find-a-Car* app has similar functionality to the website feature, but it can be downloaded to a personal device, can be accessed with the touch of a button, and allows users to save vehicle searches. The apps are available for free download from Google Play and the Apple App Store.

As part of its objective to help Clean Cities coalitions with their public outreach and education efforts, the FEI Program has worked in cooperation with Maryland Public Television over the years to develop a number of *MotorWeek* and *MotorNews* segments covering topics related to alternative fuels, fuel economy, and advanced vehicle technology. *MotorWeek* is television's longest running automotive show and airs on 92% of PBS stations nationwide. It can also be seen on cable's Velocity and V-me Spanish-language network. After airing, these segments are posted on the Clean Cities TV YouTube channel, the Fuel Economy YouTube channel, and FuelEconomy.gov. In 2018, a new *MotorWeek* segment on smart car shopping [3] was developed and aired, featuring the websites supported by the federal government: FuelEconomy.gov, the Alternative Fuels Data Center, and safercar.gov. [4]

The FEI Program developed a Fuel Economy Toolkit for Clean Cities coordinators and others to promote fuel economy and FuelEconomy.gov to the public. The toolkit includes fact sheets, fact cards, web cards, and presentations. The toolkit is available on FuelEconomy.gov.

Ensuring that consumer access to the FuelEconomy.gov website is dependable and uninterrupted is critically important. The FuelEconomy.gov servers are located at the ORNL main campus for improved security and backup, and they are maintained by the FEI Program with help from ORNL's computer network staff. Staff monitor systems around the clock to ensure that the systems are safe, functional and compliant with all applicable cybersecurity regulations.

FuelEconomy.gov is a consumer-oriented website, and the FEI Program prides itself on being responsive to consumer comments, suggestions, and questions. Consumers and media contacting FuelEconomy.gov can expect a response within a couple of business days (usually sooner), and follow-up emails or even phone calls are not uncommon if they are needed to understand a problem or resolve an issue. On average, the team responds to about 1000 emails per year.

## Results

In model year 2018, the FEI Program continued to help DOE meet its statutory requirement to produce an annual *Fuel Economy Guide* for light-duty vehicles. Model year 2018 was the first year for a primarily electronic-only *Guide*, with a limited print run (in typical years close to 200,000 guides were printed and mailed to nearly 31,000 new car dealers, more than 27,000 public libraries, and 20,700 credit unions). Instead, the FEI Program mailed letters inviting these parties to register for routine email communications about the new *Guide* for 2019, and encouraging the use of the website to view the more up-to-date *Guide* or to use Find-a-car. The electronic version of the 2018 *Guide*, which the FEI Program updates weekly, is available on-line at FuelEconomy.gov. The FEI Program began compiling data for the 2019 *Guide* in the second quarter of fiscal year (FY) 2018. The 2019 *Guide* will be finalized and distributed in the first quarter of FY 2019.

FuelEconomy.gov is one of the U.S. government's most visited websites, ranking in the top 1% of federal websites (18th out of 2,100) in 2016. Since its launch in 1999, the website has hosted more than 400 million user sessions. Traffic on the website has increased significantly since 1999, peaking at more than 58 million visitors per year in 2013 when fuel prices increased significantly (See Figure II.4.1). In FY 2018, FuelEconomy.gov hosted nearly 27 million user sessions, more than 333 million page views, and more than 73,000 daily visits on average.

FuelEconomy.gov's *My MPG* tool continues to be popular with consumers. More than 34,000 drivers have shared fuel economy estimates for more than 49,000 vehicles. This fuel economy data has become a valuable resource for both the car-buying public and researchers looking to understand the relationship between on-road fuel economy and EPA estimates. In fact, *My MPG* data has been used to evaluate EPA test methods and identify potential problems with fuel economy estimates provided to EPA by manufacturers.

The *Find-a-Car* mobile app has been successful, though not as popular as the FuelEconomy.gov website. At the end of FY 2018, over 37,000 users had installed the app (over 20,000 on Apple devices and over 17,000 Android). The app has a combined user rating of over 4.0 out of 5.0.

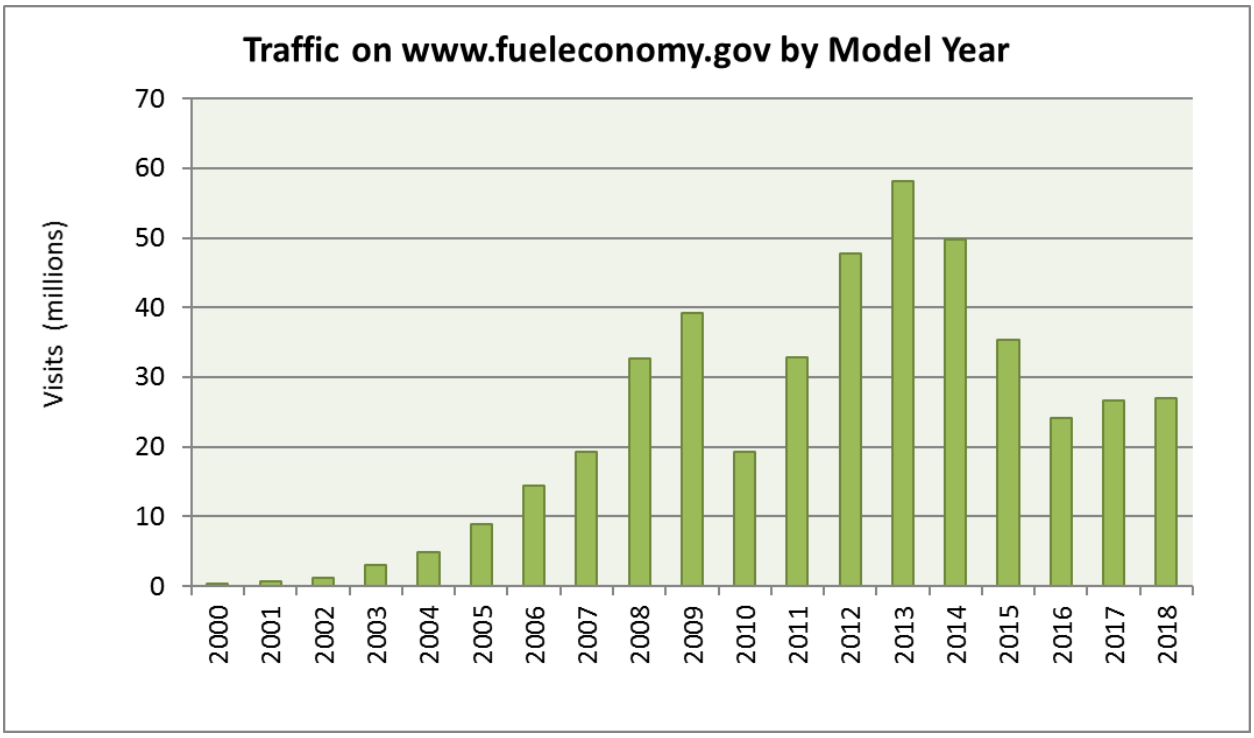


Figure II.4.1. Traffic on FuelEconomy.gov grew steadily after its initial launch in 1999, peaking in 2013 when fuel prices were high

Research by the FEI Program into driving and maintenance factors that affect fuel economy provides useful, actionable information for drivers wishing to improve their vehicle fuel economy. The fuel-saving tips pages are a popular destination on FuelEconomy.gov, and the tips are frequently featured by the news media. In FY 2018, ORNL Communications staff developed a web highlight describing a recent ORNL publication on aggressive driving and fuel economy. The story received significant media attention, and was picked up by at least 20 news sites. In addition, automotive researchers frequently use information on FuelEconomy.gov and cite the website and the reports and papers produced under the auspices of this program. To date, reports and papers from this program have been cited over 85 times in the technical literature.

In addition to its popularity with consumers, FuelEconomy.gov is a trusted resource for television, print, and online media. Over the years, information on FuelEconomy.gov has been featured in articles by national news outlets like CBS News, NBC News, USA Today, CNN, the Washington Post, and Time Magazine; financial news outlets like MarketWatch, Bloomberg.com, Forbes.com, and Fortune.com; automotive news such as Car and Driver, Automotive News, Cars.com, Motor Trend, and autoblog.com; local newspapers and television news; and college newspapers. It is also cited by Ford Motor Company Newsroom, Toyota USA, and Volkswagen of America. So, in addition to reaching consumers directly, FuelEconomy.gov also reaches them through print and online materials from other sources.

## Conclusions

In FY 2018, the FEI Program continued to meet the following objectives:

- Help DOE fulfill its statutory responsibility to produce an annual *Fuel Economy Guide* providing information on fuel economy and estimated annual fuel costs of operating automobiles manufactured in each model year
- Provide consumers with reliable, unbiased fuel economy information
- Help improve U.S. energy security and reduce petroleum consumption by promoting fuel economy to consumers
- Help consumers make informed decisions when purchasing and operating vehicles by
    - Providing information about the fuel economy and fuel costs of vehicles
    - Educating consumers on the benefits of improved fuel economy
    - Providing tools that help consumers estimate fuel use and fuel costs
- Help Clean Cities coalitions promote alternative fuels, alternative fuel vehicles, and advanced technologies

FuelEconomy.gov is an effective information resource for consumers and an effective outreach tool for promoting fuel economy and alternative fuels. Its popularity with consumers and reputation with media make it a powerful platform for educating the public about fuel economy.

FEI Program research on factors affecting vehicle fuel economy have played an important role in assuring that FuelEconomy.gov's fuel-saving tips are accurate and up-to-date. The fuel-saving tips produced from this research are one of the reasons FuelEconomy.gov is trusted by both consumers and news media as the authoritative source of fuel economy information.

The large number of media outlets that feature information from FuelEconomy.gov indicate that the website has become a primary source, and perhaps the authoritative source, for fuel economy information in the United States. Website content has also been used in research publications, which further speaks to the website's reputation for providing reliable information. This allows FuelEconomy.gov's reach to far exceed just those consumers that visit the website.

The FEI Program plays an important role in educating the public about fuel economy and providing information to consumers. Through the *Fuel Economy Guide*, FuelEconomy.gov, and its education and outreach efforts, the FEI Program continues to help increase U.S. energy security by reducing petroleum consumption.

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## Acknowledgements

The ORNL and University of Tennessee team acknowledge the steadfast support of the Department of Energy and the Environmental Protection Agency. Thanks also to auto industry partners and consumers for their valuable feedback and questions. Many consumers share their personal fuel economy on the *MyMPG* tool, which is also appreciated.

# II.5 EPAct Regulatory Programs (National Renewable Energy Laboratory)

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Project Funding (FY18): $852,100 DOE share: $852,100 Non-DOE share: $0

## Project Introduction

The National Renewable Energy Laboratory's (NREL's) Transportation Technology Integration group, within the Transportation & Hydrogen Systems Department, provides technical and analytical support to the Vehicle Technologies Office's (VTO's) Alternative Fuels Regulatory activity, which is mandated by federal legislation. Specifically, NREL supports DOE's implementation of Sections 507(o), 501, and 508 of the Energy Policy Act of 1992 (EPAct) through the provision and management of information products and other technical, program, policy, and regulatory analyses. EPAct Sections 507(o) and 501 mandate that covered state and alternative fuel provider fleets (respectively) acquire alternative fuel vehicles (AFVs) as specific percentages of their new light duty vehicles. EPAct Section 508 requires DOE to establish a vehicle credit trading program to provide compliance flexibility to covered fleets. In Fiscal Year 2018, NREL's work focused on two areas: State & Alternative Fuel Provider program support, and rulemaking and regulatory activities. In addition to project management and operational functions, NREL's role is to analyze, make recommendations and implement means to streamline this congressionally-mandated program. NREL also integrates work across several related alternative fuel programs to leverage resources and ensure that researchers have access to the latest developments and knowledge within related DOE research and development programs.

## Objectives

The key overarching objective is to ensure full implementation of the statutorily-mandated program and oversee compliance by covered entities. Within this objective there are two tasks, as follows:

Task 1: Implement legislative requirements for State and Alternative Fuel Provider (SAFP) fleets. The core activities in this task involve tracking and ensuring fleet compliance, analyzing and implementing any new legislative requirements and policies that may impact the program, and working directly with fleets, as needed, to ensure compliance. NREL developed and maintains an online reporting system and the vehicle acquisition and fleet compliance database to support this task.

Task 2: Support DOE's rulemaking activities. Tasks have included analysis and development of a revised national replacement fuel goal; development and promulgation of DOE's final private and local fleet rule determination; and development of rules to implement statutory requirements set forth in EPAct, as amended by EPAct 2005 and the Energy Independence and Security Act (EISA) of 2007. At times, support for rulemaking also requires evaluating proposed legislation that may impact SAFP fleets, and developing technical comments and suggested revisions, for communication to Congress through DOE's legislative affairs offices. This may include reviewing provisions that affect the availability and cost of vehicles, technology, and fuels; potential fuel savings; and programmatic requirements. NREL also addresses, as necessary, fuel petition review and analysis.

## Approach

NREL's Transportation Technology Integration group works to increase the use of renewable energy technologies. The NREL team provides technical and analytical support to VTO's Alternative Fuels Regulatory activity, which implements elements of federal legislation related to the acquisition of alternative fuels and advanced fleet vehicles. This involves providing VTO with strategic planning, project management, and collection and management of program data, as well as technical, regulatory, and analytical support of the program.

NREL has developed an integrated system consisting of support personnel, online program information, online reporting tools for fleets, and a database of compliance data, which has served as a repository of vehicle and fleet data since the inception of the program. NREL's strategy provides timely and accurate information to fleets and streamlines the reporting process, which ensures maximum fleet compliance, while limiting administrative burden. NREL frequently reviews and updates online information and tools as well as performing routine maintenance and archiving of program data.

## Results

Covered fleets report at the end of a calendar year for the preceding Model Year (MY), e.g., the reports submitted by December 31, 2017 covered MY 2017 vehicle acquisitions. In reports submitted at the end of 2017, the compliance rate for the State and Fuel Provider program for the more than 300 reporting entities, representing nearly 2,000 covered fleets, was 100%.

The program provides tremendous flexibility in terms of how fleets may achieve compliance, whether they select Standard Compliance or Alternative Compliance. Fleets complying via Standard Compliance may earn credits toward compliance if they acquire light-duty AFVs, purchase and use biodiesel, acquire hybrid vehicles, neighborhood electric vehicles, and medium and heavy-duty AFVs, and/or invest in alternative fuel infrastructure, non-road equipment, and emerging technologies related to electric drive vehicles. Nearly 300 fleets used Standard Compliance and exceeded their aggregate MY 2017 acquisition requirements by more than 11%. Fleets complying via Alternative Compliance do so by reducing petroleum consumption in any number of ways, including through the use of alternative fuels, buying more efficient vehicles, implementing a telecommuting program, reducing trips made, or implementing other efficiency measures. The eight covered fleets that used Alternative Compliance exceeded their aggregate MY 2017 petroleum use reduction requirements by more than 20%.

Covered fleets may earn credits for acquiring more AFVs than are required for compliance; those credits can be banked for future use in complying with EPAct requirements. Covered fleets may also meet up to half of their acquisition requirements by using biodiesel fuel. This year, several fleets reported their total biodiesel usage, even though in some cases this greatly exceeded the amount that could be counted toward credits. This resulted in an increase in the amount of biodiesel use reported, from just over 5 million gallons in MY 2016 to over 11.2 million gallons in MY 2017. DOE saw a decrease, however, in the total number of credits earned by fleets using biodiesel fuel, from 2,500 credits in MY 2016 to 2,100 credits in MY 2017.

Fleets reported a decrease in the number of reported light duty (LD) AFVs acquired, when compared to MY 2016. MY 2017 marked the fifth year that fleets complying via Standard Compliance could earn credits for acquiring an expanded range of vehicles, including hybrid-electric vehicles and neighborhood electric vehicles, and for investing in alternative fuel non-road equipment, alternative fuel infrastructure and emerging technologies. Covered fleets earned 591 credits for partial-credit vehicles and 207 credits for investments in alternative fuel infrastructure and non-road equipment MY 2017.

## Conclusions

The data for MY 2017 demonstrated 100% compliance by all entities within the program and the extent of over-compliance suggests an ongoing interest on the part of EPAct-covered state and alternative fuel provider fleets in supporting the AFV and advanced technology vehicle markets.

## Key Publications

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# II.6 Technical Assistance/Technical Response Service (National Renewable Energy Laboratory)

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Project Funding (FY18): $3,756,000 DOE share: $3,756,000 Non-DOE share: $0

## Project Introduction

The National Renewable Energy Laboratory (NREL) leads a group of in-house and contracted experts to provide technical assistance and information that helps improve transportation efficiency and advance the use of domestic fuels and technologies. The Technical Assistance project and Technical Response Service connect transportation stakeholders with objective information that can smooth integration, reduce risks, and ensure their alternative fuel and advanced technology projects are conducted efficiently and cost effectively. These efforts can also identify technology shortfalls and gaps and help inform ongoing research to improve fuels and advanced vehicle technologies, with industry and consumer needs in mind.

Fleets across the nation have made great progress integrating alternative fuels, advanced vehicles, and fuel-saving measures into their operations. These efforts have reduced transportation energy costs, improved resiliency, and earned fleet managers recognition as sustainability leaders. Yet as fleet managers evaluate their options to use alternative fuels and advanced vehicles, they frequently need additional information or expert guidance to make informed decisions or overcome barriers and technical issues they encounter. Similarly, policymakers, analysts and other transportation decision makers need objective information from expert sources to inform research investment, incentive programs, and projects. To address these challenges, the U.S. Department of Energy's (DOE's) Vehicle Technologies Office (VTO) offers technical assistance that connects stakeholders with experts who can provide objective information and answer questions about, and assist with, alternative fuels, fuel economy improvements, and other emerging transportation technologies. The type of technical assistance provided (or requested) runs the gamut from fielding one-time questions that can be answered with a list of resources, to in-person assistance from a subject matter expert on how a particular technology functions. Through these trusted, time-tested methods, DOE has helped fleets and other stakeholders deploy hundreds of thousands of alternative fuel vehicles (AFVs) and fueling stations that serve a growing market. The project is continually evolving to tackle the biggest integration barriers, contribute new expertise, and inform emerging technology research needs.

## Objectives

The objective of the technical assistance project is twofold. First, it directly assists end-users by providing a conduit to make informed decisions and solve problems. Second, it provides critical feedback to support next generation research and transportation technologies. This is accomplished by employing a few key methods:

- Providing unbiased information, resources and assistance to a broad base of transportation stakeholders, by sharing and applying practical real-world experience, lessons learned, and best practices
- Securing in-house (across national laboratories) and subcontracted experts that provide a range of expertise across fuels, vehicle types and technologies, and identifying additional technical experts as new technologies emerge in the marketplace
- Maintaining robust knowledge of the alternative fuels industry and monitoring inquiry topics, to identify knowledge and integration barriers that should be addressed
- Using results to inform future research and development efforts

## Approach

The Technical Assistance project makes varying levels of technical assistance available to transportation stakeholders, ranging from email exchanges that connect stakeholders to existing online tools and documents, to in-person consultations that address specific in-depth challenges. NREL assigns inquiries to appropriate experts, based upon the type of assistance requested and the required depth of response. Additionally, Technical Assistance can be either reactive, to respond to an urgent challenge in real-time, or proactive, to collect knowledge and develop resources that address a common issue.

A base level of Technical Assistance is offered through the VTO Technical Response Service (TRS). NREL subcontracts the TRS activity through a competitive process. TRS is a phone- and email-based service staffed by seasoned experts who help stakeholders find answers to technical questions about alternative fuels and fueling infrastructure, fuel economy improvements, idle-reduction measures, advanced vehicles, and other related resources. TRS representatives are experienced with a broad range of resources including online tools and calculators, state and federal laws and incentives, peer-reviewed research, academic publications, program-accumulated case studies, and lessons learned. While much information is available on a variety of VTO and other websites, there is still significant demand for assistance that addresses individual questions or that rapidly connects people with critical information when safety incidents or other urgent needs arise. TRS helps clients focus in on resources that address their situations. Upon receiving an inquiry, TRS experts provide a tailored response by curating a list of current, relevant resources and pinpointing the applicable material within those resources, on a case-by-case basis. Each inquiry is documented in a database, and through analytics, DOE can identify trends and information needs. TRS is an important resource that answers inquiries, but it also enables VTO to identify information gaps, technology shortfalls in the field, and other technical topics that need to be addressed.

For inquiries that require specific expertise to successfully execute a project or address a problem, DOE provides technical assistance through Tiger Teams, a group of highly skilled experts from national laboratories and industry. Industry experts are identified through a competitive process and subcontracted by NREL. These experts have deep knowledge, either in a specific area, or across the range of alternative fuels, including natural gas, hydrogen, propane, and biofuels, such as ethanol and biodiesel. They also have expertise in plug-in electric vehicles (PEVs), and emerging topics and technologies, such as electric vehicle supply equipment (EVSE) infrastructure assessment and planning and using data to better execute energy efficient transportation projects. With many years of hands-on experience, these experts work with fleet operations staff, fuel providers and fueling equipment suppliers, vehicle conversion companies, and equipment and vehicle manufacturers, to assist with all phases of a project. From concept to implementation, operation, and maintenance, Tiger Teams can help industry and fleets tackle difficult technical and implementation challenges that might otherwise cause projects to stall. Building on extensive learning opportunities from previous

consultation experiences, Tiger Teams are constantly evolving, to streamline projects and help stakeholders achieve better results, more quickly and cost-effectively. Designed to not compete with private industry, Tiger Team experts come alongside existing project teams in situations that challenge local resources, or in instances where local expertise does not exist. Acting as a neutral third-party, Tiger Teams provide technical expertise, help address problems, resolve differences, and get stalled projects moving again.

After a Tiger Team is utilized, the findings are shared with other stakeholders, either formally, through a report or a website, or more informally, through webinars and presentations.

## Results

A sampling of fiscal year (FY) 2018 TRS and Technical Assistance projects includes the following:

### *Technical Response Service Inquiries*

**Sam Spofforth, Clean Fuels Ohio**, requested a visual representation of PEV registrations per 1,000 people by state for 2016, as well as information on what PEV models are available on a state-by-state basis. TRS referred to DOE's Fact of the Week #1004 and Alliance for Automobile Manufacturers' U.S. Light-Duty Advanced Technology Vehicle Sales dashboard. TRS noted that they were not aware of a comprehensive resource that details PEV models by state. TRS offered to compile this information for Ohio, based on Original Equipment Manufacturer (OEM) information.

**Kimberley Cline, Western Washington Clean Cities**, requested information on PEV carshare programs that are focused on low income communities. TRS provided information about PEV carshare programs from industry associations, and other PEV initiatives that are focused on low income communities, sourced from the Alternative Fuels Data Center (AFDC) Laws and Incentives database.

**Michael Jones, State of Maryland Clean Cities,** requested information on what states have done to lift access restrictions in tunnels for propane, compressed natural gas (CNG), and hydrogen vehicles. TRS connected Mr. Jones with Mike Manning, Massachusetts Clean Cities and AVSG, to provide information on lifting the CNG ban in tunnels. TRS also provided supporting information on safety concerns from the National Fire Protection Association and a recommendation to connect with industry associations (e.g., Propane Education and Research Council).

**The Federal Trade Commission** inquired whether consumers or fleets are confused about how biodiesel and renewable diesel are labeled on the dispensers. Based on input from NREL, TRS explained that some renewable diesel producers have developed their own marketing materials to distinguish their fuel from biodiesel, which indicates that fuel producers see a need to establish the difference between renewable diesel and biodiesel. Additionally, TRS summarized inquiries the TRS has received regarding these fuels and referred to DOE and AFDC resources for general information.

**The Federal Trade Commission** requested data on CNG fuel providers, EVSE providers, number of AFV manufacturers, number of available AFVs models, and public CNG, hydrogen, and EVSE stations, to update the federal labeling rule for fueling and charging stations. TRS provided data on CNG fuel providers and EVSE manufacturers, sourced from the AFDC Vehicle Search. Additionally, TRS referred to the Energy Information Administration and the Alliance of Automobile Manufacturers for vehicle sales and availability data, and provided CNG, hydrogen, and EVSE station counts, sourced from the AFDC Station Locator.

**The U.S. Department of Energy (D. Smith)** requested a summary of federal, state, and local natural gas vehicle and infrastructure incentives, as well as examples of CNG station corridors where Class 8 truck fleets routinely fuel, for inclusion in a report prepared for the White House. TRS provided a two-page summary of federal incentives, federal programs, and state and local incentives, sourced from the AFDC Laws and Incentives database. TRS referred to the AFDC Station Locator data to identify CNG fueling station corridors for Class 8 trucks that align with the updated FHWA corridor guidance.

**The Kentucky Department of Agriculture** inquired why the sulfur content of diesel is different in 40 Code of Federal Regulations 1065 and the ASTM D975 standard. TRS explained the purpose of the regulation versus the standard and also stated that the regulation sets the required sulfur content for engine testing, which is lower than the ASTM standard. TRS recommended contacting the EPA directly for more information regarding fuel testing.

**A representative from a large New York non-profit** requested information on biodiesel prices, and in particular, asked about New York Harbor pricing for B2 and B5. TRS requested additional clarification about whether the organization will be purchasing heating oil or vehicle fuel, as the end use impacts the price. TRS contacted an internal ICF expert for information about New York Harbor rates. TRS explained that prices are dependent on a number of different factors, including whether the fuel is purchased at wholesale or retail price and how the fuel is delivered. TRS offered to provide more detailed information if necessary.

**United Technologies Research Center** requested information on the composition of CNG at fueling stations in the U.S. TRS referred the inquirer to SAE International's recommendation for CNG vehicle fuel composition and included the results of a national CNG vehicle fuel survey from the Coordinating Research Council.

**Philadelphia Gas Works** inquired whether six feet of clearance between a CNG time-fill post and an electrical post is compliant with building codes. TRS recommended contacting the local fire marshal and an experienced engineer to ensure that the station will comply with all applicable standards, codes, and regulations. TRS also referred the inquirer to the AFDC and state government resources for information about codes and standards that apply to CNG stations, and provided descriptions of applicable National Fire Protection Association codes.

**A large delivery company** requested information on Toyota and Kenworth Class 8 hydrogen fuel cell electric vehicles (FCEVs), as well as the general cost and commercialization status of heavy-duty FCEVs. TRS provided specific information about the status, specifications, and costs of the Toyota and Kenworth trucks, from various OEM announcements. TRS also provided a list of resources that discuss the costs and deployment status of heavy-duty FCEVs, with relevant excerpts and page references for each resource.

**A school district** requested information on best practices for the design of vehicle maintenance facilities for propane, CNG, and electricity. TRS referred the inquirer to the AFV codes and standards as well as the AFDC and industry maintenance facility guidelines and handbooks.

**A private citizen from South Carolina** inquired whether there were any funding or partnership opportunities to study the impact of using an AFV on his commute. The inquirer also requested information on available funding to install a propane fueling station and convert a vehicle to propane. TRS explained that they were not aware of a federal or South Carolina program to test AFVs used for commuting purposes. TRS suggested contacting the local Clean Cities coordinator for potential project assistance. TRS then referred him to the South Carolina Laws and Incentives page for information on propane station and conversion incentives and additional funding opportunities.

### *Technical Assistance Activities*

**John Cattles, Gunnison Transit**, located at an elevation of 7,700 ft. in Gunnison, Colorado, was experiencing misfire issues with a new MCI 45 ft. coach, with the Cummins 12L CNG engine. The agency had piggy-backed its order on a Roaring Fork Transit Authority (RFTA) bus order, because RFTA had specified high-altitude coaches.

Prior to purchase, Gunnison Transit had tested RFTA's CNG buses on the Gunnison routes, and found that they performed well. To investigate the resulting poor performance after acquiring their own buses, Gunnison Transit took a bus to RFTA headquarters in Glenwood Springs, Colorado. When the buses were fueled in

Glenwood Springs, they did not experience misfires, and operated well until they were fueled in Gunnison again. Gunnison Transit then borrowed a bus from RFTA to test their theory that misfiring was related to a difference in fuel quality in the two locations. The RFTA bus developed a misfire after being fueled in Gunnison, as well. With NREL's support, Trillium, which owns the station owner, and the Colorado Energy office had the fuel tested. The tests did not indicate any problems with the CNG quality, finding the fuel had a methane number of 95% and $CO_2$ of almost 5%.

NREL then collaborated with Cummins Westport to determine next steps. Postulating that the fuel/altitude combination was the problem, the company sent a senior engineer to Gunnison to review the calibration files. Although the fuel quality met Cummins Westport standards, the high level of methane was above their fuel specification. With minor changes to the fueling calibration table, they eliminated the misfire. A significant result of this project is that Cummins Westport will now include additional high-altitude testing in Colorado to ensure the calibrations are correct, to prevent high altitude misfires in the future. The company is excited to tackle an issue they haven't experienced before, and to ensure that future engines will be able to handle this fuel specification at this altitude. This is especially important as this engine is commonly used in Class 8 vehicles, which are driven over mountain passes, and must be able to operate under full power without misfiring.

**A School District** contacted Technical Assistance about Navistar propane school buses that were achieving very poor fuel economy. Over the course of many months, Technical Assistance consulted with Navistar and the school district to better understand the problem, and negotiated with Navistar and PSI, whose system is installed on the bus, to have Navistar support personnel sent to evaluate the buses and identify the issue. The engineers determined that Navistar did not do any high-altitude calibration work before putting the buses in high-altitude markets. Currently, the calibration cannot be changed because it would impact the emissions certificate; however, Navistar is working to change the buses' differentials, which will change their effective gear ratio. By doing this, Navistar hopes to change the operating range of the engine and thus improve performance. Technical Assistance will remain in close contact with the school district and Navistar to follow the results, and act if the performance and fuel economy issues do not resolve.

**Janna West Heiss (Denver Metro Clean Cities)**, a Refuel Coach for the State of Colorado program, was helping the City of Longmont use wastewater recovery as a methane source for their CNG refuse trucks. Technical Assistance worked with Longmont's purchasing agent to design an RFP and review proposals. Longmont planned to fuel 11 trucks initially, and ultimately purchase more. The city is interested in an indoor time-fill station, and is building a new facility to house the vehicles. A Technical Assistance employee who is a co-author of the recently published *Compressed Natural Gas Vehicle Maintenance Facility Modification Handbook* will also provide expert guidance in this regard. To ensure code compliance within the facility, a local engineering firm will be brought in to consult.

**The Natural Gas Vehicle Technology Forum**, coordinated by the Technical Assistance project, took place at Southern California Gas Company's Energy Resource Center in February 2018. There were over 70 attendees, including representatives from industry, government, utilities, and regulatory bodies. Industry is particularly interested in closing the efficiency gap between diesel and natural gas vehicles. Discussions revealed that, although the industry has progressed significantly, there are still gaps that need to be addressed. The greatest takeaway was that industry felt strongly that this annual meeting was still critical to break down barriers and discuss technology needs. The meeting concluded with considerable discussion about reducing emissions through catalyst development and enhanced natural gas quality.

**Automotive Service Excellence (ASE) H1 Transit Bus Certification Test for Compressed Natural Gas Engines.** ASE is the leader in providing accredited testing for technicians in the automotive, heavy truck, and bus industry. ASE certification testing is designed to evaluate competency in aspects ranging from auto to heavy truck repair, auto body, parts, and alternative fuels, with primary emphasis on natural gas. Technical Assistance was consulted in rewriting the Compressed Natural Gas Engines portion of the H1 Transit Bus

Certification test, which had not been updated in almost 10 years, and included outdated content and many test questions that needed to be re-evaluated and updated. Conducting this update involved collaborating with large and small transit districts around the country. Incorporating their feedback was very informative and provided for a more accurate and robust test moving forward.

**Technical Assistance** has been consulted to remedy an issue with failing exhaust manifold bolts on Blue Bird propane buses with the Roush 6.8L engine. The problem has been reported in engines that are both in and out of warranty. NREL worked with Roush to determine that this issue is isolated to Blue Bird Vision school buses. Bolts are failing because, when Blue Bird installs the engine, there is no allowance provided for vibration control. The exhaust system is fixed in place with no flex within the system, and the resulting rigidity creates flexing within the exhaust bolts, which fatigue from the strain. Technical Assistance facilitated a solution that called for replacing the exhaust bolts with new stainless-steel bolts that will not fatigue as easily. Roush also suggested adding a flex pipe to the system to boost longevity. Technical Assistance is working with Roush and Blue Bird to supply flex pipes for school districts before failure can occur. Proactive maintenance is critical, as bolt failure necessitates replacement of the exhaust studs, an 8 to16-hour repair that can take a bus out of service for several days. Technical Assistance will continue monitoring the implementation of solutions that are approved by the school districts, as service parts and technical bulletins become available.

## Conclusions

The ready availability of industry experts, through the TRS and the Technical Assistance project, make it easier to understand the complexities of integrating new transportation technologies. These experts can offer transportation stakeholders valuable insights into the various technology options, along with advice on making informed decisions, and anticipating, mitigating, or altogether avoiding common problems, thus increasing the chances of project success. Additionally, the interactions with end-users of real-world technologies provide valuable feedback that can provide a foundation for future DOE research.

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# II.7 Technologist-in-Cities (National Renewable Energy Laboratory)

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## Project Introduction

As cities around the country launch efforts to use data and mobility technology in more innovative and effective ways than ever before, smart cities are serving as proving grounds for increasing the energy efficiency and reducing the emissions of urban mobility systems, while increasing mobility services. The U.S. Department of Energy (DOE) Energy Efficient Mobility Systems (EEMS) Program envisions an affordable, efficient, safe, and accessible transportation future in which mobility is decoupled from energy consumption. Technologies that may help achieve this vision include advanced vehicles and systems that are automated, connected, efficient, and/or shared (ACES). EEMS supports research and development that investigates these technologies and other opportunities to increase mobility energy productivity [1] in communities. As a part of an interagency Memorandum of Understanding (MOU) in support of the EEMS Program, DOE and the U.S. Department of Transportation (USDOT) are working together to accelerate innovative smart transportation systems research. Through this coordination, DOE paired a Technologist in Cities (TIC) with Columbus, Ohio after the City of Columbus' Smart Columbus project won the USDOT Smart City Challenge in 2016. The TIC will work with the City and its partners throughout the life of the Smart Columbus project.

The Smart Columbus initiative is supported by two grants, totaling $50 million. A $40 million USDOT grant supports multiple projects, including smart mobility hubs, automated electric shuttles, and enhanced communications such as Dedicated Short-Range Communications (DSRC), and truck platooning. Complementing the USDOT grant is a $10 million grant from the Paul G. Allen Philanthropies (formerly Vulcan) to accelerate adoption of plug-in electric vehicles (PEVs), to enhance charging infrastructure to support PEV adoption, and to provide a cleaner and more efficient electric grid.

## Objectives

The TIC supports the City of Columbus in its Smart City endeavors, serving as a liaison on energy and mobility issues. The TIC advises the city's innovation and technology team on transportation energy efficiency and connects the city to experts throughout the DOE national laboratory system. The TIC facilitates feedback between DOE's EEMS research team and the city, to inform modeling and data analysis conducted at the national laboratories. This is done by gaining access to data streams from Smart Columbus demonstration projects, as well as transportation, infrastructure, and energy data from the City of Columbus and regional partners.

## Approach

The TIC support of Smart Columbus includes a variety of activities, methods and approaches as outlined below:

- Maintain a physical presence at adequate frequency to maintain a working relationship and serve as a liaison.
- Provide access to DOE and national laboratory resources as appropriate to meet needs within the Smart Columbus portfolio of projects.
- Advocate for energy metrics and performance measures through the Smart Columbus program.
- Encourage data sharing and access to critical data streams associated with advanced mobility, such as connected vehicle/automated vehicle (CV/AV) and Energy as a System (EAS) demonstrations.
- Support the Columbus Integrated Data Exchange, now branded the Smart Columbus Operating System, and promote access to vital regional data sets housed at the city and with the city's partners.
- Provide communications between the city and its partners to the DOE and the national laboratories.

## Results

In fiscal year (FY) 2018, the TIC program was able to carry out these objectives in a variety of ways. Select project accomplishments include:

- **Support for Smart Columbus Electrification Program (CEP) Performance Metrics Plan** (PfMP) – The TIC initiated and supported the PfMP during the first year of the program, and in the second year, the TIC transferred responsibility for maintaining and updating the PfMP to internal Smart Columbus (SC) staff. The PfMP, now fully supported internally, reports progress towards electrification goals, including the number of electric vehicles (EVs) adopted and the greenhouse gas (GHG) and energy reduction benefits resulting from various activities and projects in the CEP, including education and incentives for EV purchases. The TIC continues to support the PfMP process on an as-needed basis.
- **Ohio DOT Trip Planning and Analytics Data** – The Ohio DOT completed the procurement of cutting-edge transportation planning and analysis data sets from two companies, INRIX and Streetlight Data, at the end of calendar year 2017, and began to use it for various purposes in 2018, and to share it with the City of Columbus and other municipalities. The TIC supported the procurement effort by collaborating with Ohio DOT and reviewing bid specifications. The license agreement provides the City of Columbus, as well as other jurisdictions and cooperating research institutions, including DOE's systems and modeling for accelerated research in transportation (SMART) Mobility Consortium, access to these data resources without additional licensing charges. The National Renewable Energy Laboratory (NREL) now has access to the first two years of INRIX trip data (2016 & 2017). In terms of size and scope, the 2016 data set is approximately 320 GB (compressed) and contains data reflecting 1-2% of all trips made in the state of Ohio.
- The TIC continues to interact with the DOT and other Ohio transportation interests on the potential of the new data sources to inform research and decisions. Ohio DOT hosted a workshop on the use of this data for various applications at the state and local levels, in June 2018. The workshop highlighted use and analysis of the data products by the state, cities, and metropolitan planning organizations (MPOs). NREL presented visualization work (see Figure II.7.1), and volume estimates based on these new data sets. In FY 2019, the TIC program, in collaboration with Wayne State University, will explore the potential to use the data for arterial performance measures. Additionally, this data set contributes to SMART freight modeling analysis at both the inter-city and intra-city scales.

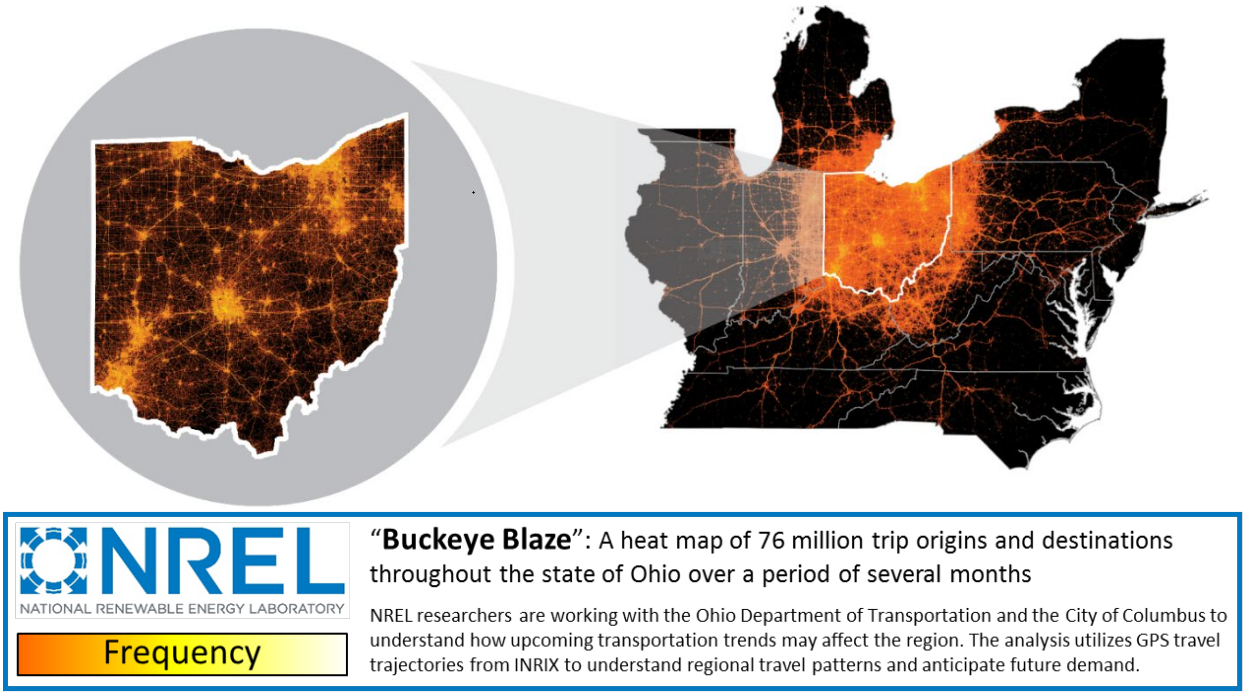


Figure II.7.1. Heat map of trip origins and destinations, from Ohio DOT workshop, June 2018

- **EVI-Pro Tool** - Beginning in 2017, NREL provided analysis support to the CEP by using the Electric Vehicle Infrastructure Projection (EVI-Pro) tool in conducting a study to estimate the number, type and location of charging stations needed to support various levels of PEV adoption within the Columbus region. This study was completed in December 2017, and results continue to be used in the CEP. NREL published a full report in February 2018, and has presented portions of the analysis at events in Columbus and at industry forums.

- **Case Study** – The TIC drafted a case study entitled, "Using Data to Achieve Energy Efficient Mobility Systems in Cities" that is currently under review by DOE's Vehicle Technologies Office. The case study highlights lessons learned from Columbus that can be replicated by other aspiring Smart Cities.

- **Smart Columbus Operating System (SCOS) – support and interaction.** The SCOS management team initiated a centralized data initiative that is core to the USDOT portfolio of projects, and is designed to support the electrification initiative, as well. The SCOS is the data repository and data transactional engine through which all the Smart Columbus projects will operate. The TIC supported the SCOS initiative by briefing the SCOS personnel on the electrification performance measures and associated data; introducing the SCOS technical personnel to stakeholders with valuable data that may be of use to the SCOS, such as the Ohio DOT trip data; and identifying collaborative opportunities with the DOE SMART initiative.

- **Ohio Vehicle Registration Data** The number of new EVs purchased as a proportion of the entire consumer fleet in Columbus is a key performance metric; however, verifying this number remains an ongoing challenge, in Columbus and in many other cities. NREL has access to some registration data through an IHS subscription that supports Clean Cities, and was able to provide estimates of EV purchases for 2014 through 2016, but in 2017, due to budget issues, NREL discontinued the IHS data subscription. Smart Columbus needed reliable, consistent and sustainable access to vehicle registration data in the long term, and in 2017, they initiated discussions with the Ohio Bureau of Motor Vehicles

(BMV) to obtain direct access to vehicle registration data. In 2018, Smart Columbus, in collaboration with the Ohio DOT, began receiving data directly from the Ohio BMV. Initial processing of the data revealed, however, that overall EV adoption was difficult to determine from point in time BMV records, without historical data, showing changes on a quarterly basis. Columbus plans to continue to receive data directly from the Ohio BMV, while still relying on periodic IHS industry summary reports. The TIC will continue to monitor this situation in FY 2019.

- **Research on Transportation Network Company (TNC) Electrification** – In mid-2018, Smart Columbus conducted a survey of drivers for TNCs (Uber and Lyft), designed to ascertain their needs, gauge their perceptions of EVs, and determine barriers to, and opportunities for, EV adoption by TNCs. NREL personnel advised on the creation of the survey. Key findings indicated that greater than 2/3 of the drivers surveyed were willing to consider EVs, provided that range and re-charging concerns were addressed. Also, nearly half of drivers who responded were willing to share their vehicle data with researchers, to help better inform placement of charging infrastructure. In mid-2018, the SCEP issued a first round of incentives of up to $3000 per vehicle, for local taxi drivers who agreed to adopt EVs. In the fall of 2018 the SCEP initiated a second round of incentives that was open to all transportation service providers (TSPs), including taxi companies and TNCs, to spur adoption of EVs. Smart Columbus will provide up to $90,000 in cash rebates (up to $3,000 per EV). This is one of the first initiatives in the country to consider incentivizing high duty cycle vehicles in TSP service to purchase EVs.

  SCEP faces challenges in providing incentives to TNC drivers. Unlike taxis, TNC vehicles are usually individually owned, and drivers use them for both personal and business purposes. For grant reporting requirements, it is a challenge to verify that the vehicle is being used for substantial TSP service. To address this issue, the TIC program has offered to provide telematics packages and data processing support for up to 30 TNC EVs, to verify TNC usage. Data collected will be used for program verification, as well as research. Approval by the City of Columbus is anticipated by October 2018. If approved, EV TNC data will start to flow as early as January of 2019.

- **Employer provided mobility benefits** – In 2018, JP Morgan Chase began a program to provide commute options to its employees, to reduce single occupancy vehicle use. Chase offers an employee carpool shuttle program, in partnership with the Ford Chariot service. Chase is motivated by a growing need to provide commute options to younger employers, and thus stay competitive for the best talent, as well as a desire to expand existing company facilities, without adding expensive structure-based parking.

- This program has led to additional research at the national laboratories on the potential for employer-provided mobility options to reduce energy use and congestion, and enhance employee productivity. It also led to discussions and collaboration with Luum, a company that provides back-office mobility software, and with the ACES Northwest Network, a proactive group of leading employers in the Seattle region that are exploring employer-provided mobility programs. Case studies from the Seattle region in which employers documented a reduction in single-occupancy vehicle commuting behavior, are encouraging the Columbus Partnership, a nonprofit, membership-based organization of more than 70 CEOs from Columbus' leading businesses and institutions, to engage the larger business community to investigate and embrace similar practices. DOE is participating by analyzing scalability of such approaches to address congestion, energy, air quality and other sustainability goals if adopted by the majority of Columbus major employers.

- **Business Travel Case Study of Ride-Hailing** - In this case study published in 2018, the cost and behavioral impacts resulting from the adoption of transportation network companies (TNCs) over traditional rental vehicle use were analyzed for the TIC's typical business travel over the course of several months, from late 2016 through mid-2017. The analysis included trips taken before and after the adoption of ride-hailing services, in lieu of vehicle rental. The analysis quantified the differences in mobility, cost, convenience, and sustainability for a single subject. Quantified metrics included vehicle

miles traveled, cost of transportation, and behavioral changes such as hotel, service preferences, and altered work routines. Although a single-subject study, this case study provided insight that led to larger data collection and analysis efforts, providing insight into measurable impacts of TNC adoption at scale at airports, including reduction in parking and rental car demand.

- In 2018, the SMART Mobility Multi-Modal pillar collaborated with the Mid-Ohio Regional Planning Commission, to obtain data for freight studies associated with **Optimization of Intra-city Freight Movement and New Delivery Methods**. This included real world baseline data working with UPS in Columbus, OH. An automated freight analysis indicated a potential 17% decrease in energy. This work, and collaboration with Columbus, will continue into 2019.

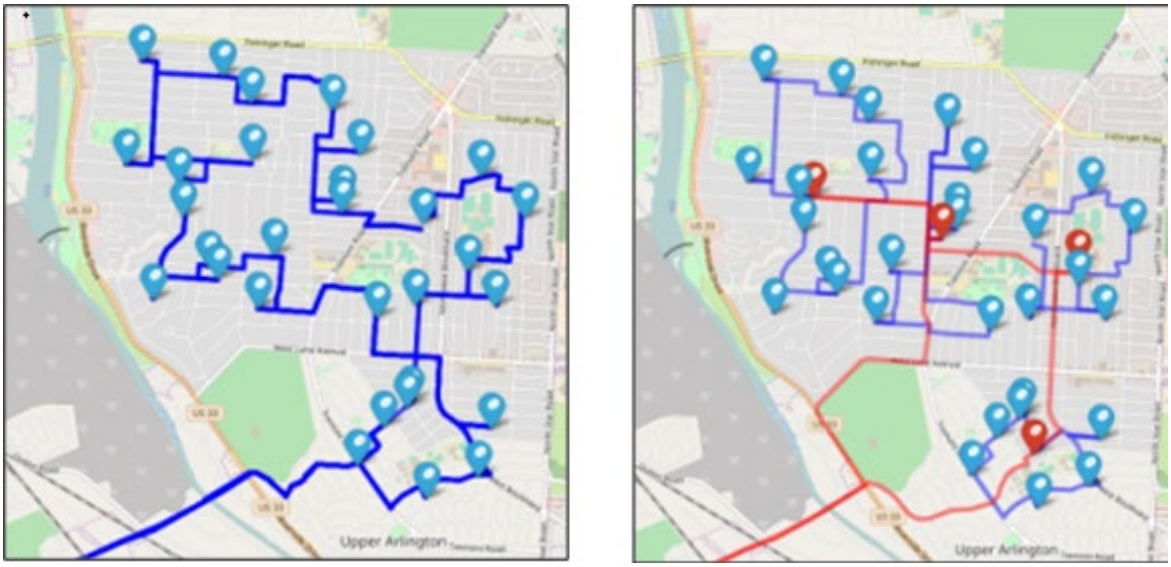


Figure II.7.2. Analysis of traditional package delivery (left) with automated hub/spoke approach (right)

- DOE funded development of **EVolution: Choices for a Smarter Purchase** [2], a consumer-facing website that helps consumers who are considering EVs to understand the costs and benefits of the various EV choices on the market. Argonne National Laboratory demonstrated Evolution to the Smart Columbus Consumer Adoption committee late in 2017. The collaboration resulted in Smart Columbus providing feedback to EVolution developers for incorporation into the site in the fall of 2018 or later.

## Conclusions

While city governance is complex and each city's experience with implementing smart city projects will be unique, relationships and data are unifying, collaborative elements of any smart city project designed to enhance mobility, while minimizing energy use. Year two activities with the TIC program reinforced this. The TIC effort in Columbus embedded an experienced transportation researcher as an adviser to the city and as a liaison to DOE. This resulted in substantial contributions to the CEP performance metric program, data and collaboration with the SCOS, and joint research opportunities, such as the TSP driver survey that strengthened a first-of-its-kind EV incentive program for Uber and Lyft drivers. The TIC program has helped Columbus gain technical insights related to transportation energy use, and access to available data and information assets, while DOE gained a greater understanding of city decision dynamics and insight into the challenges that other cities will face as they pursue similar projects. While year one concentrated primarily on relationship building, year two (FY 2018) saw substantial research and data collaboration that benefited both Smart Columbus and the DOE Energy Efficient Mobility Systems program. In the final year of the TIC program in Columbus, we anticipate greater interaction, as Columbus deploys automated electric shuttles, truck platooning technologies, and the full build-out of its leading SCOS system.

## Key Publications

Young, A., S. Young, A. Henao, "Business Traveler Behavioral Shifts from Ride-Hailing: A Before-After Case Study", Intelligent Transportation System of America, Annual meeting, June 2018.

Wood, Eric W., Clement L. Rames, Matteo Muratori, Sesha Srinivasa Raghavan, and Stanley E. Young, Charging Electric Vehicles in Smart Cities: An EVI-Pro Analysis of Columbus, Ohio. United States: N. p., 2018. Web. doi:10.2172/1421381.

## References

[1] The EEMS Program uses the term mobility energy productivity to describe the value derived from the transportation system per unit of energy consumed. Increases in mobility energy productivity result from improvements in the quality or output of the transportation system, and/or reductions in the energy used for transportation.

[2] https://evolution.es.anl.gov/

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