

Natural Gas Vehicle Technology Forum 2019 Meeting Summary

The 2019 [Natural Gas Vehicle Technology Forum](#) (NGVTF) was held on April 16 and 17, 2019, in Salisbury, North Carolina. Following is a summary of the meeting. The National Renewable Energy Laboratory (NREL) hosted the forum in partnership with the U.S. Department of Energy's (DOE) Office of Energy Efficiency and Renewable Energy's (EERE) Vehicle Technologies Office (VTO), the California Energy Commission, South Coast Air Quality Management District, and Agility Fuel Solutions.

Day One: April 16, 2019

Welcome and Opening Remarks

Ron Eickelman and Seung Baik, Agility Fuel Solutions

Ron welcomed new CEO Seung Baik. Seung spoke to the company's full fuel system perspective, which was seen on the tour that followed later in the day.

EERE/VTO Natural Gas Vehicle Research Activities

Bob Marlay, VTO

Bob presented information on the rationale for the DOE interest in advancing natural gas vehicles (NGVs), which includes the fuel's abundance and positive economic and environmental impact. He discussed research priorities for VTO to boost engine efficiency while reducing the cost of storage, natural gas engines, and fueling infrastructure.

NGVTF EERE/VTO Update

Dennis Smith, VTO

Dennis discussed several current VTO funding opportunities, many of which resulted from NGVTF feedback. One opportunity provides \$16.5 million for gaseous fuel research and technology integration for medium- and heavy-duty (MD/HD) vehicles. This includes advanced storage for gaseous fuels, waste to energy (including renewable natural gas), an NGV maintenance cost study, compressed natural gas (CNG) tank affordability, smart CNG refueling, and CNG driver information systems that provide better fuel monitoring to support range and maintenance decisions. Another opportunity provides \$17.5 million for alternative fuels and mobility services including infrastructure for resiliency and emergency preparedness, new mobility services in rural America, alternative fuel proof of concept demonstrations, electric vehicle data collection, and an open topic on alternative fuel vehicles and mobility. Many of these projects encourage participation with Clean Cities Coalitions and partnering is required for the open topic.

MD/HD NGV Technologies Awards

Margo Melendez, NREL

Margo presented an overview of the NGV Consortia project. Nine projects were selected for funding by reviewers from South Coast Air Quality Management District (SCAQMD), California Energy Commission (CEC), EERE/VTO, and NREL. Projects will commence later in 2019.

SCAQMD Technology Program Overview

Naveen Berry, SCAQMD

Air quality in the south coast region is a big driver for MD/HD NGVs. The average age of California Class 8 trucks is older than the national average. This is in spite of the fact that the state has numerous programs to replace older trucks to improve air quality. SCAQMD is fuel neutral, meaning they accept any fuel or technology that improves air quality. In the short term, near-zero NOx internal combustion engines and plug-in hybrid electric vehicles are being used. Longer-term, battery electric and hydrogen fuel cell vehicles with zero tailpipe emissions are of interest. SCAQMD works to develop and progress technology into commercialization. Core technology programs include hydrogen vehicles and infrastructure, electric/hybrid vehicles and infrastructure, ultra-low emissions NGV, fueling and infrastructure implementation, and studies on the transportation market, emissions, and health effects. Key CNG projects include the Cummins Westport Inc. (CWI) 9L and 12L development and commercialization. They were excited to partner with CEC and VTO on the 2018 solicitation through NREL. This effort helps put a national emphasis on NGV technologies.

South coast production of renewable natural gas is expanding. Dairy digesters produce significantly lower carbon impact than any other types of natural gas or renewable natural gas. SCAQMD provided incentives for over 380 CWI ISX 12N, 580 CWI L9N, and 175 Agility 366NG. They are working proactively with the OEMs to advance technology and commercialization.

Natural Gas Pathways, Vehicles, Storage, and Infrastructure Development

Dennis Smith, VTO

Clean Cities Coalitions have hosted about 100 listening sessions to inform VTO about implementation barriers for alternative fuel vehicles and mobility projects. Interesting feedback received includes the need for more accurate fuel gages for NGVs and unbiased information about facility upgrades. VTO used this feedback to inform recently issued funding opportunity announcements that will address these issues.

The Many Face of Agility

Chet Dawes, Agility Fuel Solutions

Chet provided an overview of the host organization. Agility employees more than 500 people, most of whom are technical. They focus on energy storage and delivery, CNG cylinders, powertrain systems, and electric vehicle systems. Agility also offers training for customers. As part of Hexagon Composites, Agility comprises a propane, CNG, and hydrogen business. Today, in-house manufacturing is Type 4, but they still use Type 3 procured from other vendors.

CNG Tank End of Life Testing

Lauren Lynch, NREL

Lauren discussed future work to include examination of an expired (time) tank that was never used, continue Modal Acoustic Emission (MAE) testing, and continue hydraulic fatigue cycle testing on a Type 3 and Type 4 tanks. The group discussed lifetime exposure for tested tanks. The LA Metro tanks had a generally “easy” lifecycle and demonstrated minimal issues at end of life. The group recognized next steps to identify applications that operate in a harsher environment for further investigation.

NGV Fuel System and Fuel Container Integrity Requirements

Lauren Lynch, NREL

Lauren led a feedback session about enhancing standards. She covered inspection intervals, pressure testing, fire testing, chemical exposure, impact/drop testing, and over fueling. Focusing on system testing for safety in addition to tank testing could yield some efficiencies in approaches to safety, cost, design, and shielding, etc.

CSA Codes and Standards Update

Brent Hartman, CSA

Brent provided an overview of CSA and standards development, which typically takes around 18 months. CSA has issued several NGV publications in the past year. In addition to their general meeting, CSA planned meetings on maintenance facilities and CNG fueling systems. Recognizing that standards help bring products to market, CSA is adding topics including conformable CNG storage, mobile fueling, and a marine working group. Harmonization efforts are underway across states and provinces throughout North America and internationally.

Vehicle Incidents and Lessons Learned

Tim Standke, NGVAmerica

Tim walked attendees through real-world incidents and their remedies. Recent incidents have involved valve and pressure relief device (PRD) issues, as well as a tank rupture during fueling. He also addressed the review of recent refuse truck fires that found that PRDs have vented appropriately. This discussion highlighted the importance of firefighter training to allow emergency personnel to anticipate where PRDs may vent.

Day Two: April 17, 2019

Heavy-Duty Engine Development and Updates

Yemane Gessesse, Cummins Westport

Cummins Westport is celebrating their 100th anniversary. Yemane presented on several of their products and discussed how a typical business cycle (concept to manufacturing) is about 5 years, so the timeline to react to new regulations is about 5 years.

Natural Gas Engines for Harbor Craft and Railroad Locomotives

Jerry Wiens, NGV Stakeholder

Jerry discussed opportunities for high horsepower liquefied natural gas applications, such as marine and locomotives. The NO_x for light-duty vehicles has decreased, as it has for on-road MD/HD vehicles, which leaves MD/HD off-road vehicles as a bigger part of the NO_x inventory. Several technology options were discussed as well as fueling options. Some options may not represent the lowest NO_x levels, but this may be necessary to begin getting “lower” NO_x in this segment. Ratepayer benefits need to be justified for projects that implement high horsepower NGVs in locomotives and marine applications.

Dual Fuel in Rail and Class 8 Applications

Scott Myers, Opti Fuel Systems

The average emissions levels for locomotives in the United States are at Tier1/0. Scott discussed the challenges of balancing emissions and efficiency in newer locomotive engines, as well as challenges with new regulations having the desired air quality benefits.

Advancements in CNG Full Fills

Ted Barnes, Gas Technology Institute

Ted discussed challenges with full fills, and the new algorithm they are evaluating to help provide greater more consistent full fills. Typically, stations use a starting tank pressure and ambient temperature to target pressure for fueling. A smarter algorithm would have to estimate many more variables (gas composition, sun load, etc.). Using communication between tank and dispenser can help achieve full fill safely. GTI did a project with CEC using simulation and physical testing that shows better fueling outcomes using communication and more control of variables. Next steps are to examine how to incorporate an expander into the fueling process to improve efficiency and cost of fueling.

Overview of Alternative Fuels Risk Assessment Models (AltRAM)

Brian Ehrhart, Sandia National Laboratories

Brian discussed the benefits of using a Reduced-Order Model to quantify and compare the impact of different types of gas system leaks/releases. This can help make design decisions (trade-offs) and setback regulations. The foundation of Brian's work has been hydrogen releases (HyRAM), but he will expand this to other fuels, including natural gas.

Transient Plasma Ignition Systems for Natural Gas Engines

Sunil Murthy, Transient Plasma Systems

TPS ignition system uses ultra-fast pulses of low-temperature plasma injection to achieve higher energy, more chemical activation, and complete combustion. They have several projects ongoing with support from various entities, such as DOE, CEC, and Southern California Gas. In addition to full operation, TPS can reduce emissions by treating exhaust with plasma injections.

Advanced Laser Ignition Systems

Sreenath Gupta, Argonne National Laboratory

There are two potential applications for laser ignition technology: Stationary natural gas engines, and HD on-road engines. Lean burn and high-pressure operation require improved ignition systems. Laser ignition extends lean-ignition limit. It leads to improved ignition stability, makes high pressure easier to ignite, and can ignite leaner mixtures. Sreenath has investigated various air-cooled and water-cooled lasers for ignition applications. The laser igniter chosen has water cooling and a single sapphire lens. Potential benefits include the reduction of the cost of NGVs \$2,000/year, achievement of 20% higher power, and development of the ability to tolerate lower quality fuels.

Modeling with Computational Fluid Dynamics

Myra Blaylock, Sandia National Laboratories

Sandia is working to put some computation behind the safety codes and standards being developed for CNG and liquefied natural gas. They examined several scenarios for leaks inside of maintenance garages. Ignitable mixtures vary significantly based on ventilation.

Issues, Key Points, Next Steps, and Priorities for Next Meeting

Dennis Smith, VTO and John Gonzales, NREL

Maintenance records and data would be helpful to support the industry and identify and resolve issues. Is there a way to leverage funded projects that require maintenance data to be reported? RNG topics are a promising area for additional research and discussion about the market, clean up technologies, and other considerations. Discussion about technologies in Europe, China, and elsewhere and their experience with natural gas. Marine and rail applications should continue to be topics of discussion and research.