



Next Generation Natural Gas Vehicle Drive Information Systems

AMR Project ID: TI107

DOE Project Award #DE-EE0008802

PI: Devin Halliday

Gas Technology Institute

June 23, 2021

Overview

Timeline

Project start date: October 2019

Project end date: June 2023

Percent complete: 20%

Budget

Total project budget: \$2M

Total recipient budget: \$600k

Total federal share: \$1M

Total DOE funds spent*: \$270k

*As of 04/30/2021

Barriers

High cost of ownership due to oversized fuel system or frequent fueling

Poor user experience due to mistrust in fuel level information

Partners

Argonne National Laboratory

Ozinga Brothers Concrete

Chicago Area Clean Cities

Project Objectives

- Develop and demonstrate improved Driver Information System for NGV
 - Miles-to-empty prediction within 5% or 25 miles
 - Incorporate traffic, weather and projected route
 - System will allow optimization of fleet fuel management

Technology Integration Goals

National Security

- Domestic Fuel Sources

Economic Growth

- Growing Alt Fuels Industry

Affordability to Business and Consumers

- Lower Vehicle Cost of Ownership

Reliability/Resiliency

- Improved Vehicle Range Prediction

Barrier Impact

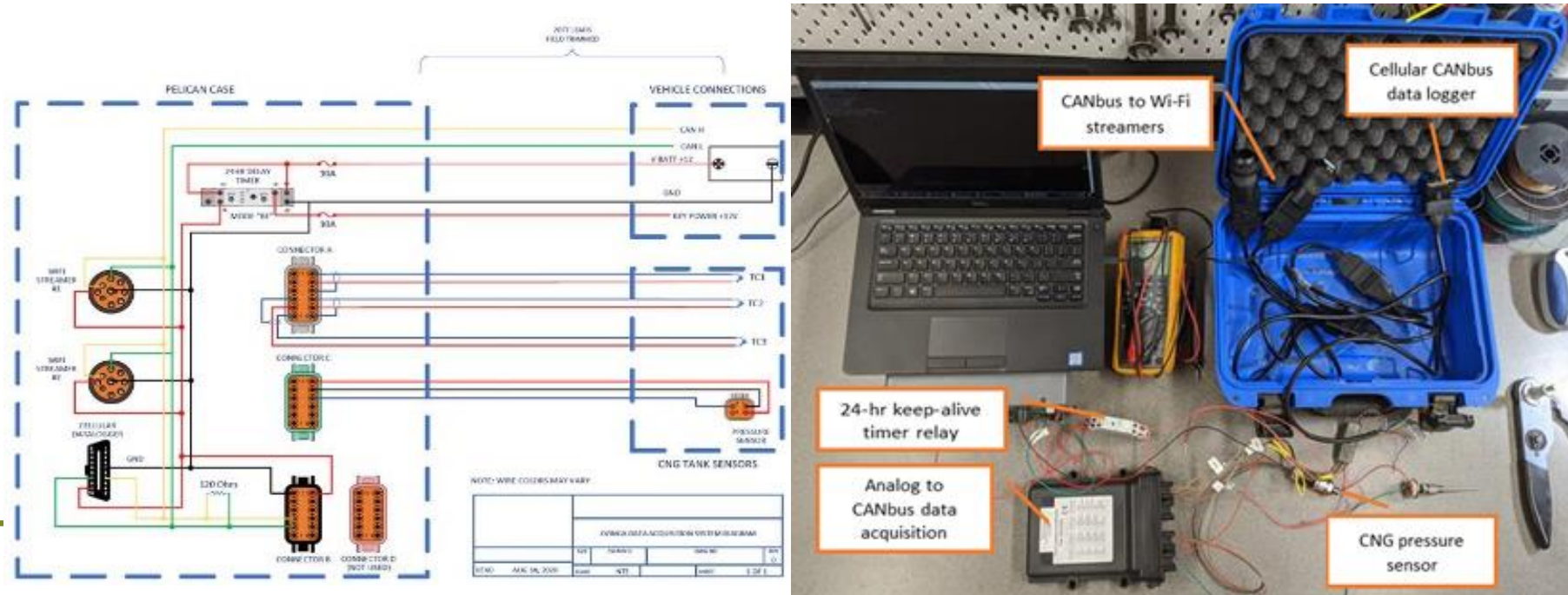
- Smaller, lower-cost fuel systems due to higher utilization of capacity
- Optimized fleet operations to minimize refueling
- Better user experience – leads to improved reputation and increased adoption

Approach

<u>Budget Period 1 (2019): Preliminary Expander Design</u>	<u>Progress</u>
1.1 Completed design of data acquisition system	100%
1.2 Completed installation of 10 data acquisitions systems	10%
1.3 Completed parametric modeling	100%
1.4 Parametric model validated with laboratory data	100%
Go/No-Go: Usable fuel calculation capable of achieving project targets (accuracy within 5% or 25 miles)	TBD
<u>Budget Period 2 (2020): Detailed Expander Design and Build</u>	
1.1 Beta test version of application completed	0%
1.2 Application functionality validated	0%
1.3 Validate usable fuel model with fleet data	0%
1.4 Usable fuel model accurate	0%
Go/No-Go: Useable fuel model predictions within 5% of true fleet vehicle operation	TBD
<u>Budget Period 3 (2021): Operation</u>	
3.1 Complete functionality testing	0%
3.2 Validate 'miles-to-empty' prediction	0%
3.3 Quantify changes in driver behavior	0%
3.4 Commercialization Plan Complete	0%

Progress: Data Acquisition Systems Designed

- Data acquisition system designed for heavy-duty CNG vehicles
 - Utilizes HEM devices to collect and export CAN bus data
 - Data exported to cloud server and mobile device in cab
 - Pressure and temperature sensors also installed



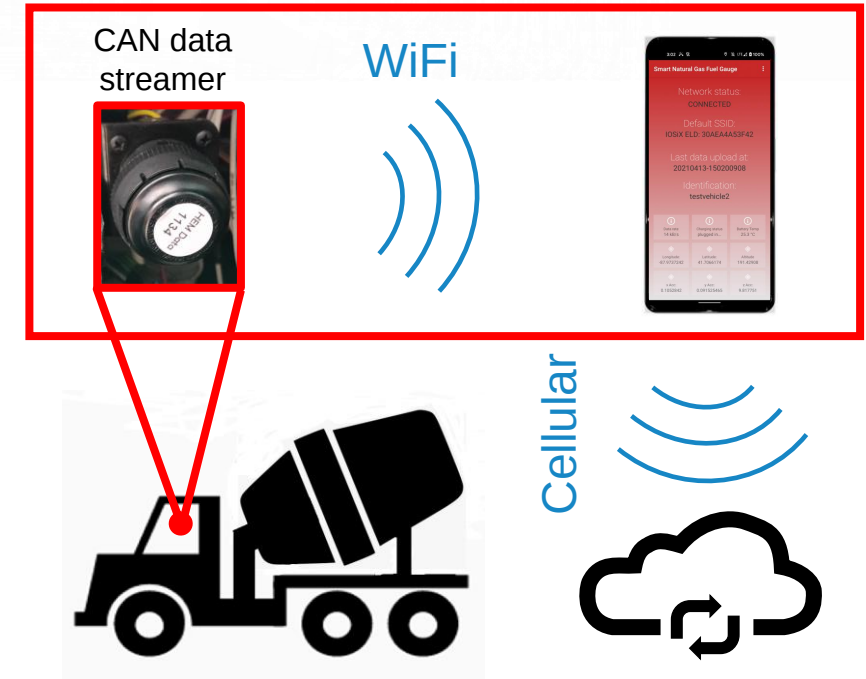
Progress: Data Acquisition Systems Installed

- One data acquisition system installed in December 2020
 - Over 500 hrs of operating data collected
 - Remaining systems will be installed in late May
 - Team developing automated data processing to filter out select information from 1,000s of hours of operation



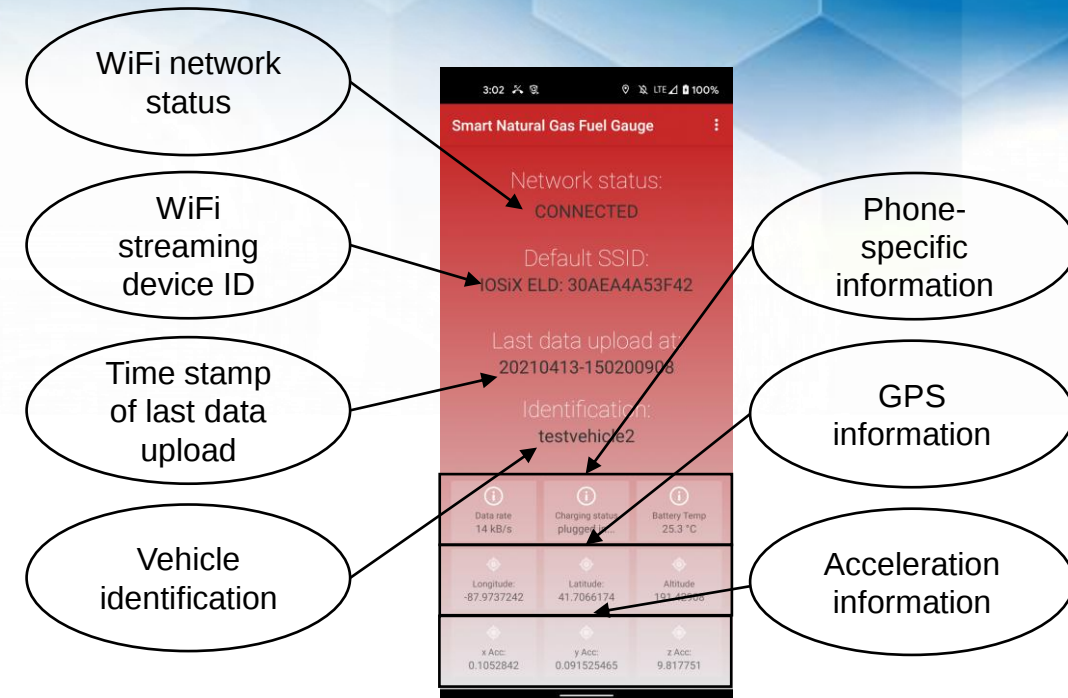
Progress: Application Development

- Developed android application which transforms conventional phone to a low-cost data acquisition platform
 - Utilizes phone's WiFi and cellular service for data acquisition and transmission
 - Combines CAN bus data and phone-specific data prior to upload to cloud
 - Capable of real-time data monitoring
- Path forward
 - Leverage data to help develop 'miles-to-empty' model
 - Display 'miles-to-empty' once ready, then evaluate refueling behavior

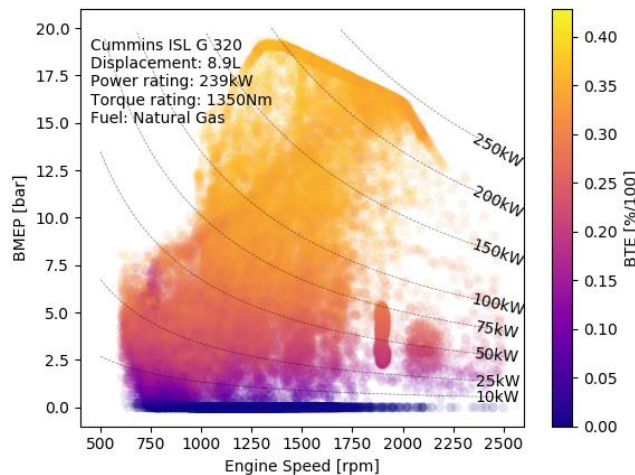


Progress: Data Acquisition

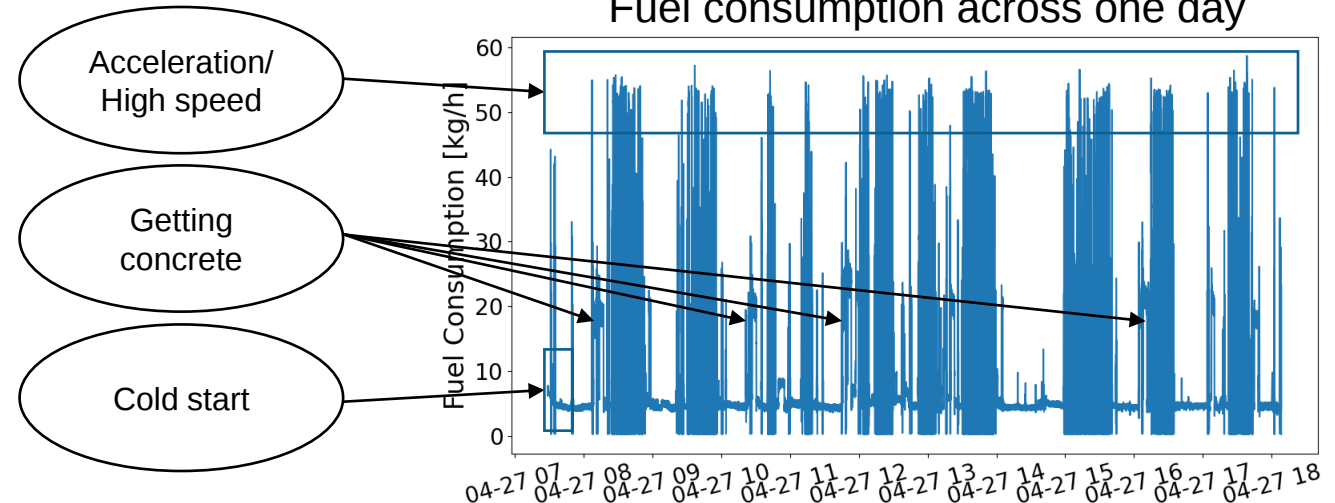
- Android application successfully installed on Ozinga truck in Chicago
- Currently analyzing data to understand
 - Duty cycle
 - Factors impacting fuel consumption



Engine map

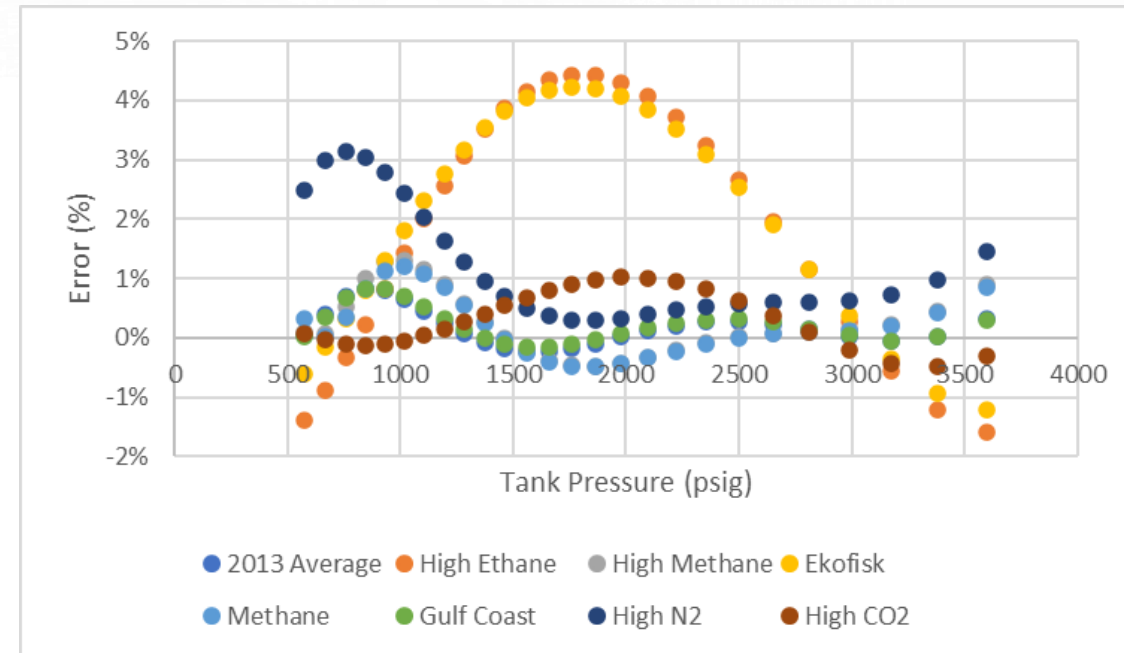


Fuel consumption across one day



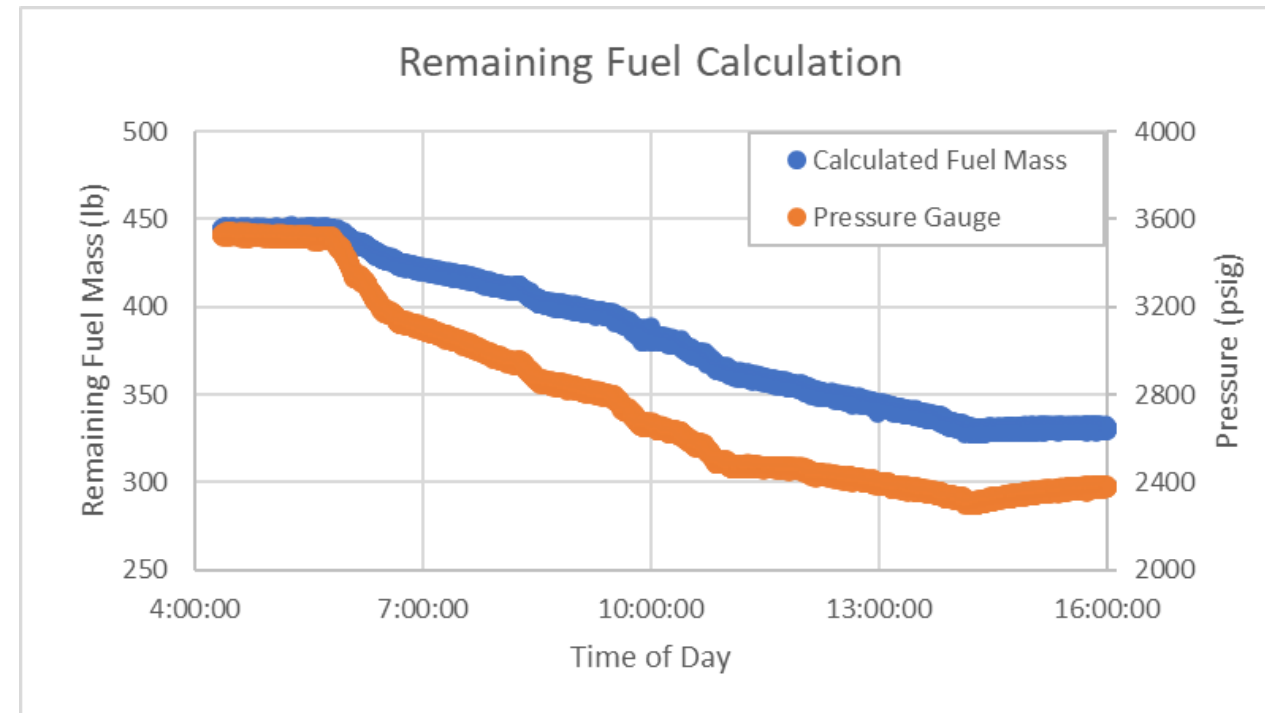
Progress: Parametric Modeling

- Challenges to accuracy
 - Temperature
 - Composition
- Model developed that achieves target accuracy
 - Extreme compositions used
 - Error remains below 5%



Progress: Validation of Model with Lab and Operating Data

- De-fueling tests under controlled scenarios show error of $<2\%$
- Initial truck data used to compare 'usable fuel' model with simple pressure gauge
 - Initial cooling results in steep pressure decline
 - Pressure increases when truck stopped



Collaboration and Coordination

Organization	Project Roles	Importance to Project
GTI	Project lead, management and coordination; de-fueling testing, design and installation of data acquisition system	Integral to the organization and direction of the project
Argonne National Lab	Application and interface design lead, support data acquisition through mobile device	Key experience in programming data systems for fleet
Ozinga Bothers Concrete	Providing fleet of heavy duty vehicles for data acquisition installation and monitoring	Large fleet of CNG vehicles. Experience with CNG stations and advocate for CNG industry.
Chicago Area Clean Cities	Conduct industry surveys to inform project team and commercialization plan	Connection with industry; potential commercialization partner; source of real-world experience

Overall Market Impact

Achievements in the first year:

- Validated remaining usable fuel model is within 5% accurate with extreme compositions
- Designed, assembled, and installed data acquisition unit
- Developed android application for data acquisition and driver interface

Remaining challenges and next steps (next 12 months)

- Installing remaining data acquisition systems is key to project progress
- Validate usable fuel model with fleet data
- Deploy Driver Information System onboard fleet vehicles

Summary

- Objective: Develop and demonstrate Driver Information System to improve trust in vehicle fuel system status and improve fuel system capacity utilization
- Approach: Developing usable fuel model to accurately determine fuel status and predict fuel that will be stranded in the system
- Developing application to determine miles-to-empty from the usable fuel, traffic, speed, and weather on the expected route
- Progress: Successfully deployed data acquisition system on a heavy duty vehicle
- Developed android application for data acquisition and future Driver Information System user interface
- Developed usable fuel model and validated with laboratory testing
- Nest Steps: Deploy data acquisition systems in at least 10 vehicles
- Validate models with fleet data
- Deploy Driver Information System in 10 vehicles



Questions?