

Hydrogen in Transportation Applications

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OVERVIEW

- Project background and description
- Investigation of codes and standards for hydrogen and CNG for fueling facilities, testing facilities, storage and infrastructure.
- ADVISOR modeling software
- CNG and HCNG vehicle performance and emissions testing.
- Next Steps

H₂ Transportation Project Description

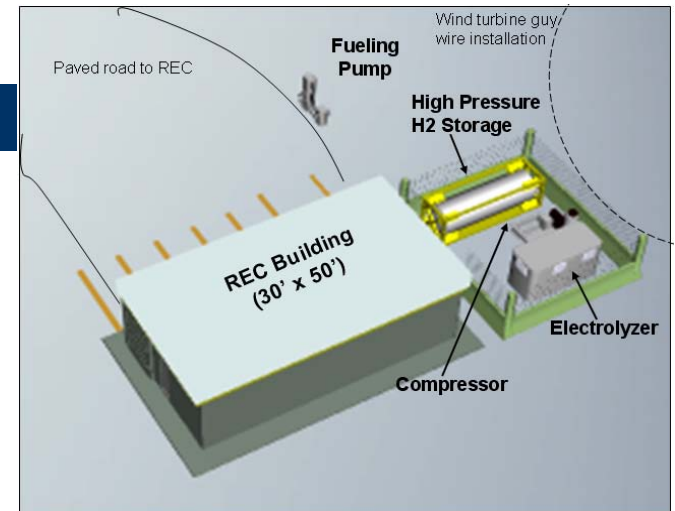
- Funded by NREL through the NSWEP Program.
- Investigate practical aspects of hydrogen production, storage and use in transportation applications.
 - Infrastructure assessments
- Investigate performance and emissions tradeoffs of CNG and HCNG.
- Collaborate with NREL to contribute data to technical data archive, update vehicle modeling tool.
- Collaborate with Washoe County Regional Transportation Commission (RTC) in their efforts to deploy hydrogen fueled fleet.
- Coordinate with NSWEP DRI REC project.

Partners/ Collaborators

- Washoe County Regional Transportation Commission (RTC)
 - Vehicles
 - Fuel (CNG)
 - Maintenance and Support
- Collier Technologies
 - HCNG conversion
 - Testing support and data analysis
- Jones West Ford
 - Use of chassis dynamometer
 - Maintenance

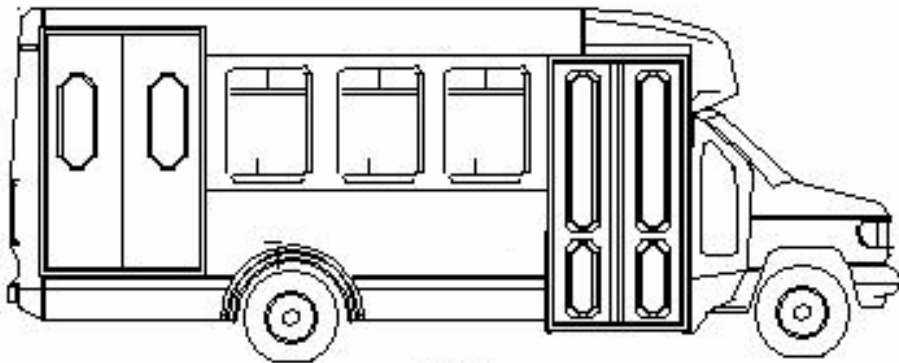
Infrastructure Assessment

- Infrastructure assessment for location of H₂ production, fueling or vehicle testing facility at DRI-REC
 - Permitting requirements
 - Codes and Standards
 - Station layout and suggested design
- Assessment of feasibility of various hydrogen production approaches at DRI-REC.
- Cost assessment and additional requirements for indoor testing facility.



Vehicle Description

- RTC donated two vehicles from their retired Paratransit fleet.
- 1998 Ford E-350 5.4L V8 ICE CNG, after-market conversion.
- 3,600 psi, 5 tanks store about 100 nominal gallons ~ 100-180 miles.
- Wheelchair lift requires additional 200 Amp alternator and 12 V battery.
- 250,000 + miles.



Testing and Modeling Overview

- 4 Phases of Performance and Emissions Testing
 - Two CNG vehicles “as-is”
 - Two baseline CNG vehicles with rebuilt engines.
 - One supercharged CNG vehicle.
 - One HCNG converted vehicle.
- Data collected will be interpreted into fuel and emissions maps that can be used in ADVISOR.
- Validate model with test results.



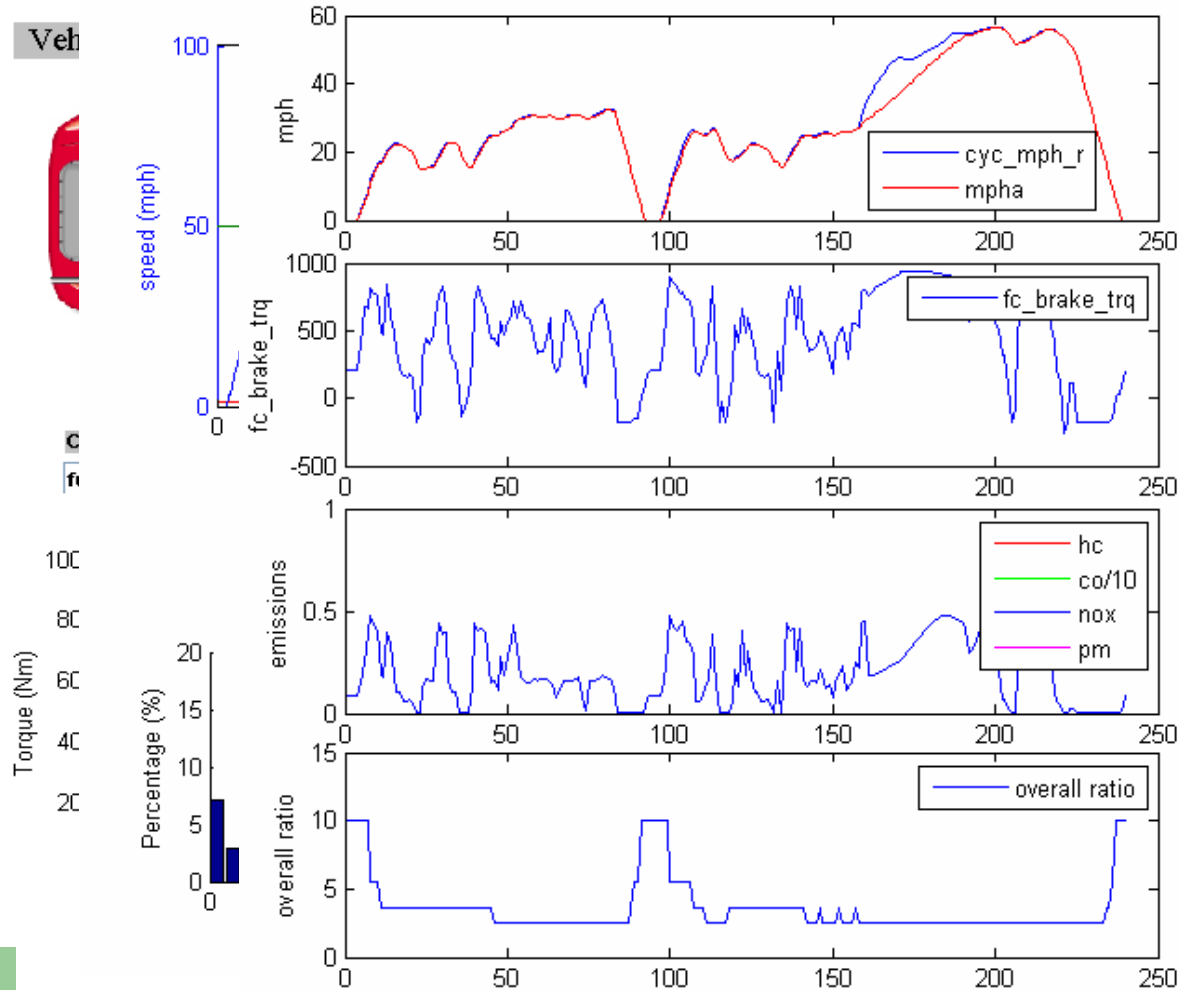
HCNG Conversion

- Collier Technologies
- HCNG– 30% Hydrogen by volume
- Supercharger w/ EGR, timing
- Emissions benefits, performance drawbacks.

Vehicle Modeling in ADVISOR



advisor 2004



Results figure

Compone

fuel_converter

Plot Variable (Select Axis)

fc_brake_trq # of plots

Fuel Economy (mpg)	1.6
Gasoline Equivalent	5.1
Distance (miles)	1.9

Emissions

Standards			
HC	CO	NOx	PM
0	0	24.962	0

Acceleration Test

0-60 mph (s):	n/a	Max. Accel.:	n/a
20-60 mph (s):	n/a	Distance in 5s:	n/a
40-60 mph (s):	n/a	Time in 0.25mi (s):	n/a
		Max. Speed (mph):	n/a

Gradeability: n/a %

Compare Results With:

Warnings/Messages

Missed Trace by > 2 mph (3.2 km/h)

Trace Miss Analysis:

Vehicle Modeling

- Preliminary CNG and HCNG modeling.
 - No data specific for 5.4L CNG
 - No data for HCNG
 - Data from an 8.1 L CNG/ HCNG converted engine was input and used.
- Update model with performance and emissions data from testing of both CNG and HCNG.
 - Fuel consumption/ efficiency maps
 - Emissions maps

Vehicle Testing

- Four phases of testing
 - Baseline testing of CNG vehicles prior to installation of rebuilt engines
 - CNG testing both vehicles with rebuilt engines
 - Supercharged CNG testing—one vehicle
 - HCNG testing— one vehicle
- Chassis dynamometer testing
 - IM240 drive cycle
 - Steady point tests to develop maps
 - Maximum power curve testing.
- Road testing –0-55 mph performance testing.



Testing Equipment

- AutoEnginuity OBDII Scanner
 - Vehicle Speed
 - Engine Speed
 - Mass Air Flow
 - Throttle Position
- 5 Gas Analyzer
 - CO₂
 - CO
 - O₂
 - NO_x
 - HC
 - Lambda
 - RPM
 - Exhaust Temp
- Dynamometer Software
 - Engine RPM (via tach.)
 - Horsepower (from rollers)
 - Vehicle speed (roller speed)



Results To-Date

- Testing of baseline CNG vehicle.
- Testing of supercharged CNG vehicle.
- Conversion to HCNG.

Next Steps

- Testing of HCNG vehicle.
- Developing engine and emissions map to update ADVISOR model
- Modeling hybrid vehicles.



Southwest Energy Partnership

Creating Renewable Energy Centers in the American Southwest

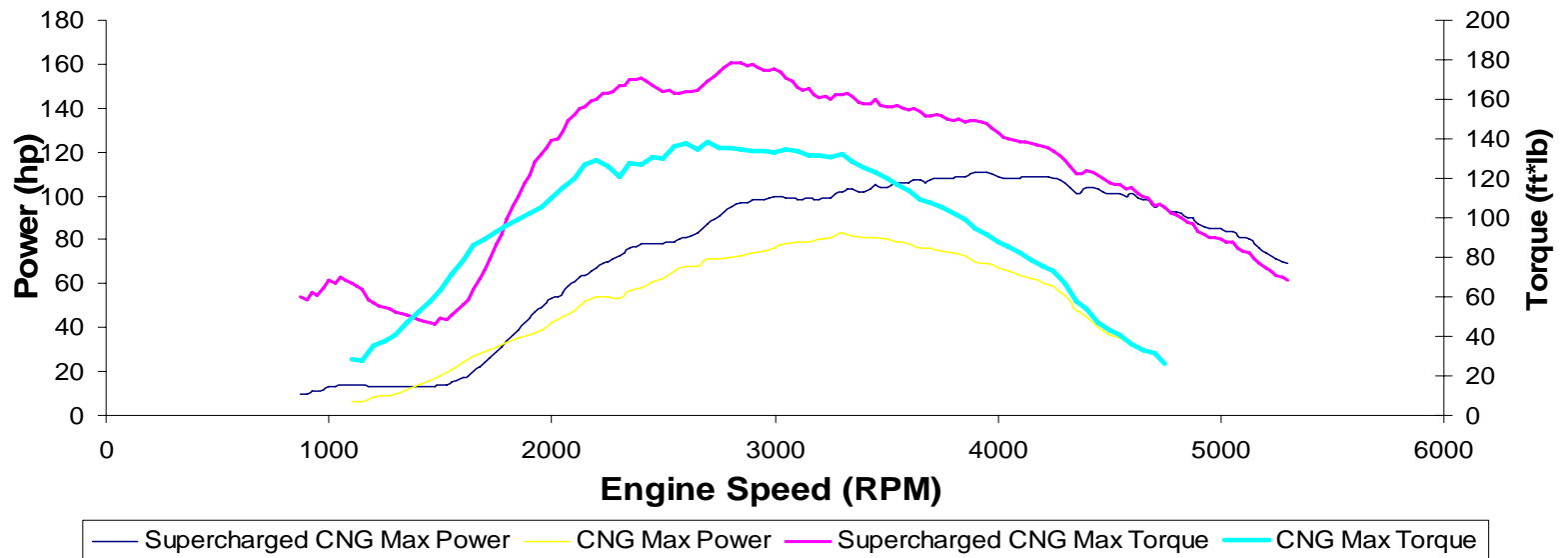


THANKS!

www.nswep.org

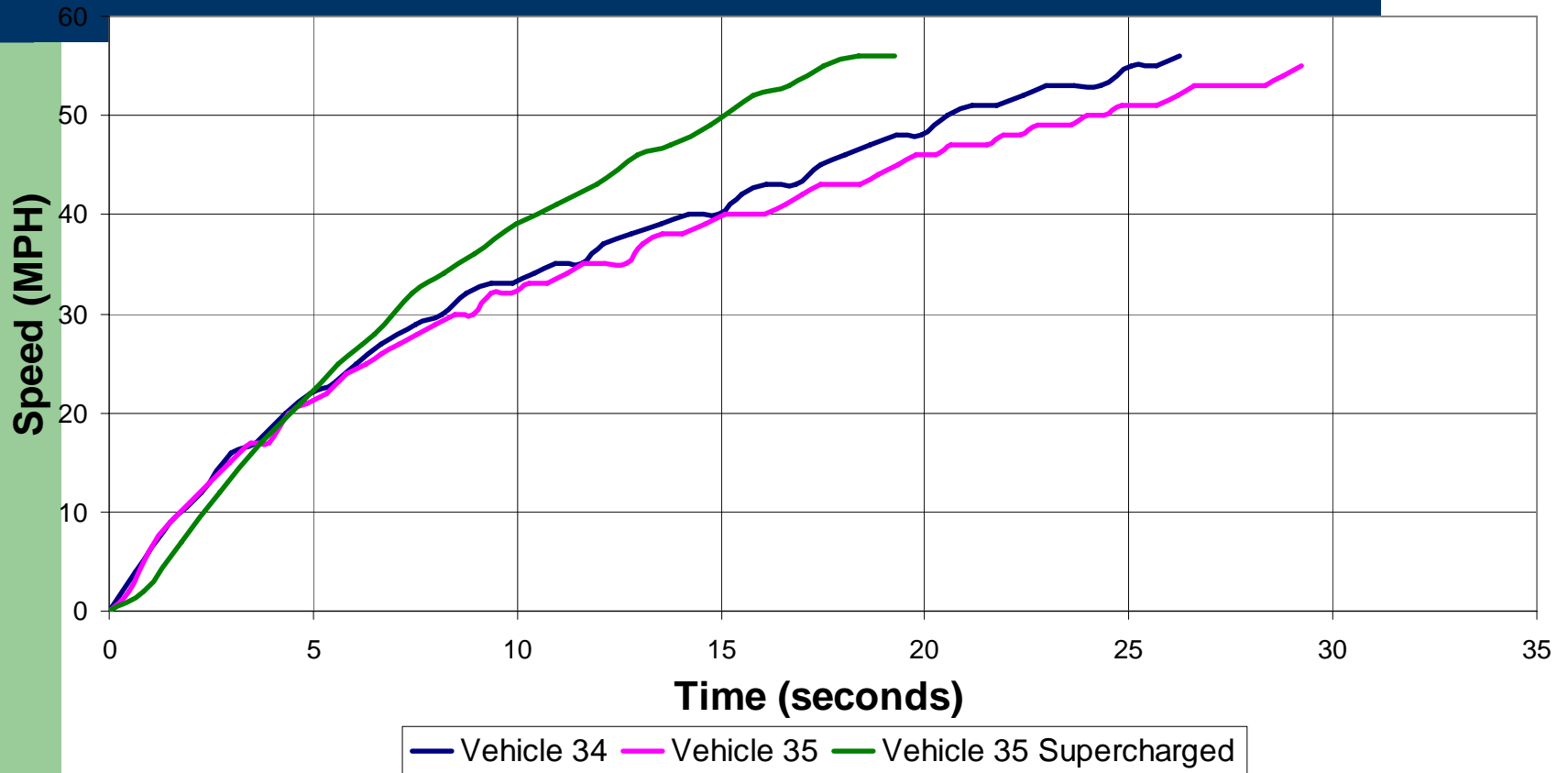
Maximum Power

Max Torque and Power Curves Supercharged CNG v. Baseline CNG

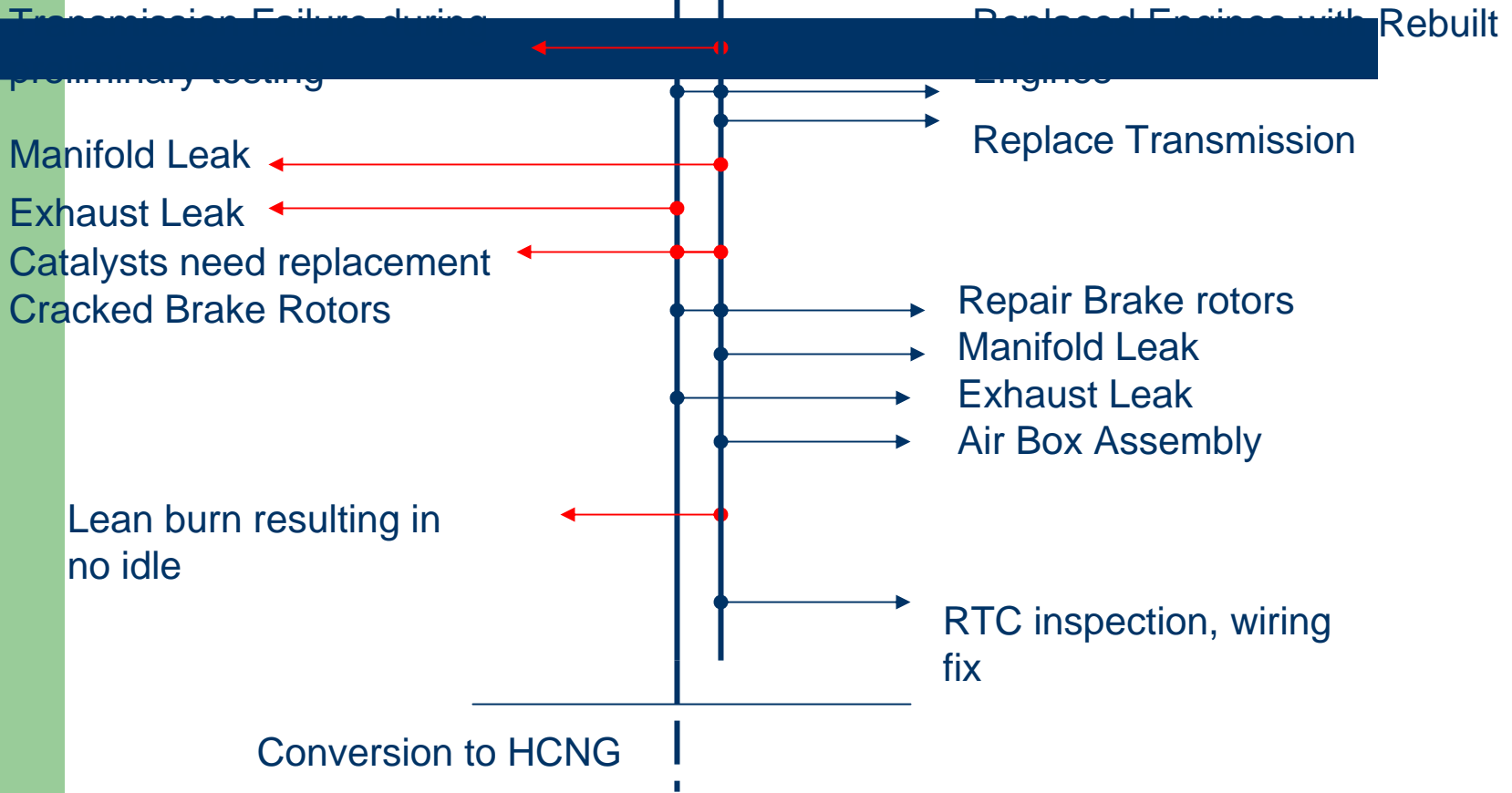


Performance Results

CNG v. Supercharged CNG 0-55 mph Acceleration Tests



Vehicle Maintenance



Additional Problems: Cold starts, batteries, ABS