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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

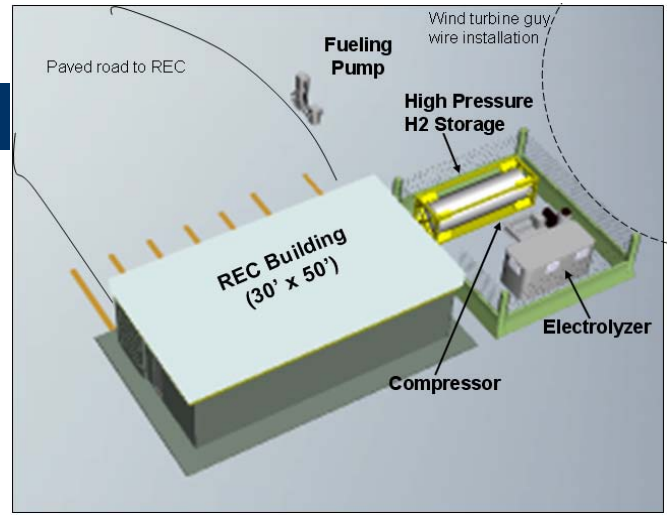
H_2 Transportation Project Description

- 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

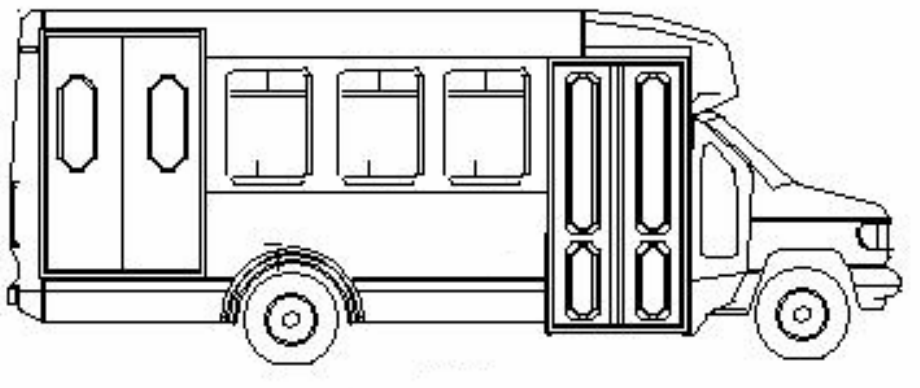
Infrastructure Assessment



- Infrastructure assessment for location of H_2 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.



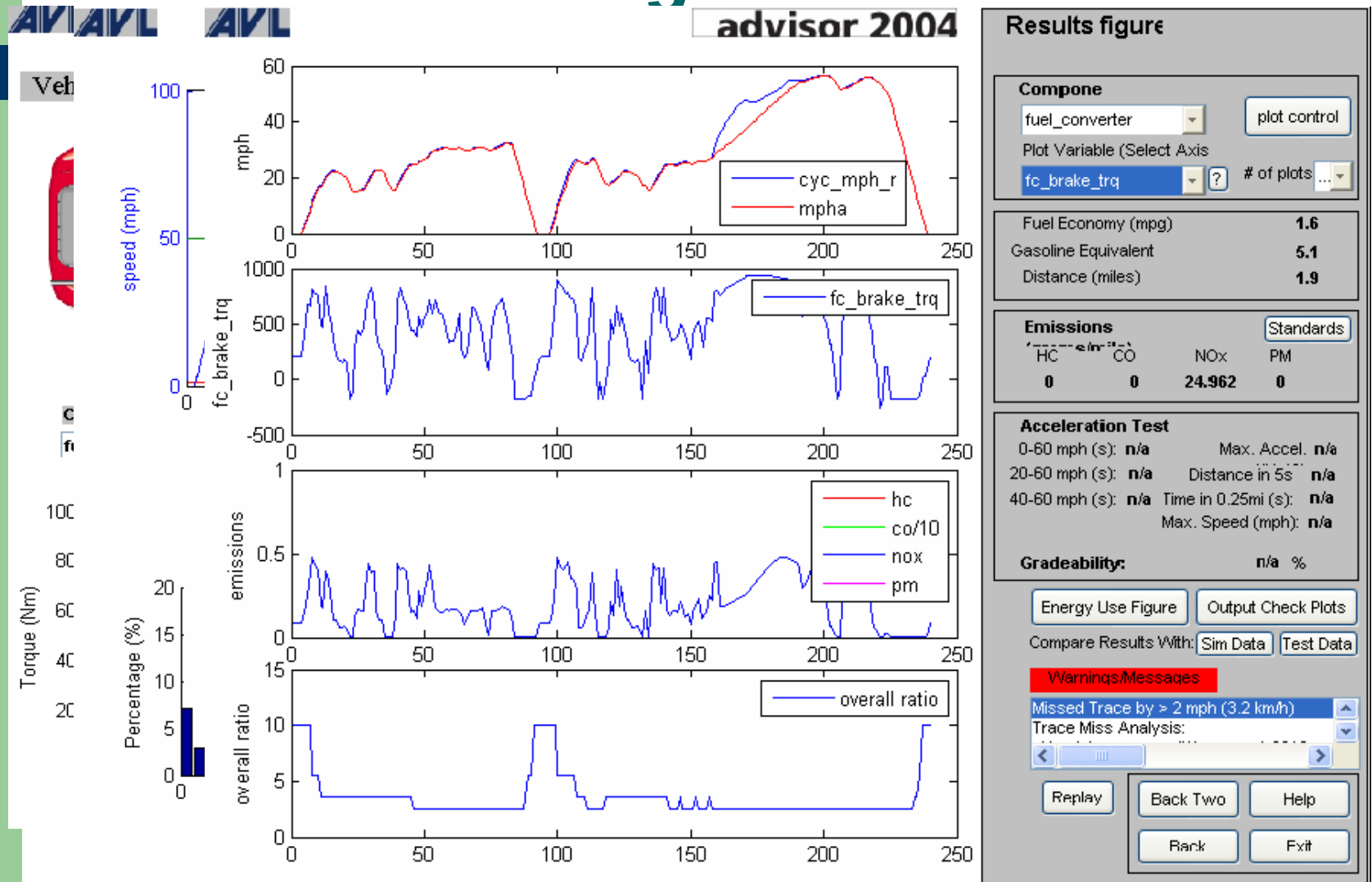
Testing and Modeling Overview

- 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



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

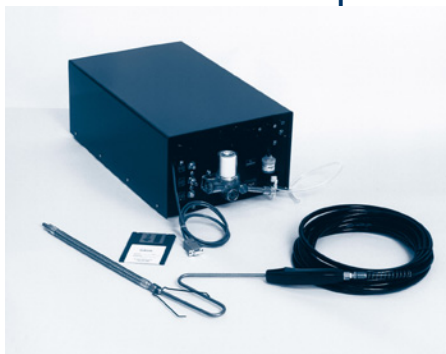
Vehicle Testing

- 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.

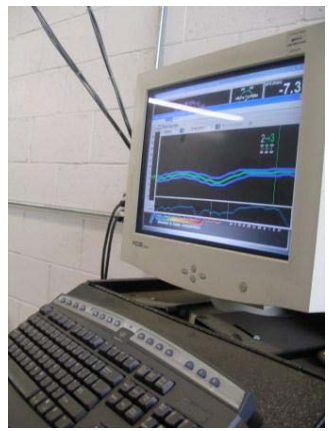
Testing Equipment

- AutoEnginuity OBDII Scanner
  - Vehicle Speed
  - Engine Speed
  - Mass Air Flow
  - Throttle Position

- 5 Gas Analyzer
  - CO_2
  - CO
  - O_2
  - 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.

THANKS!

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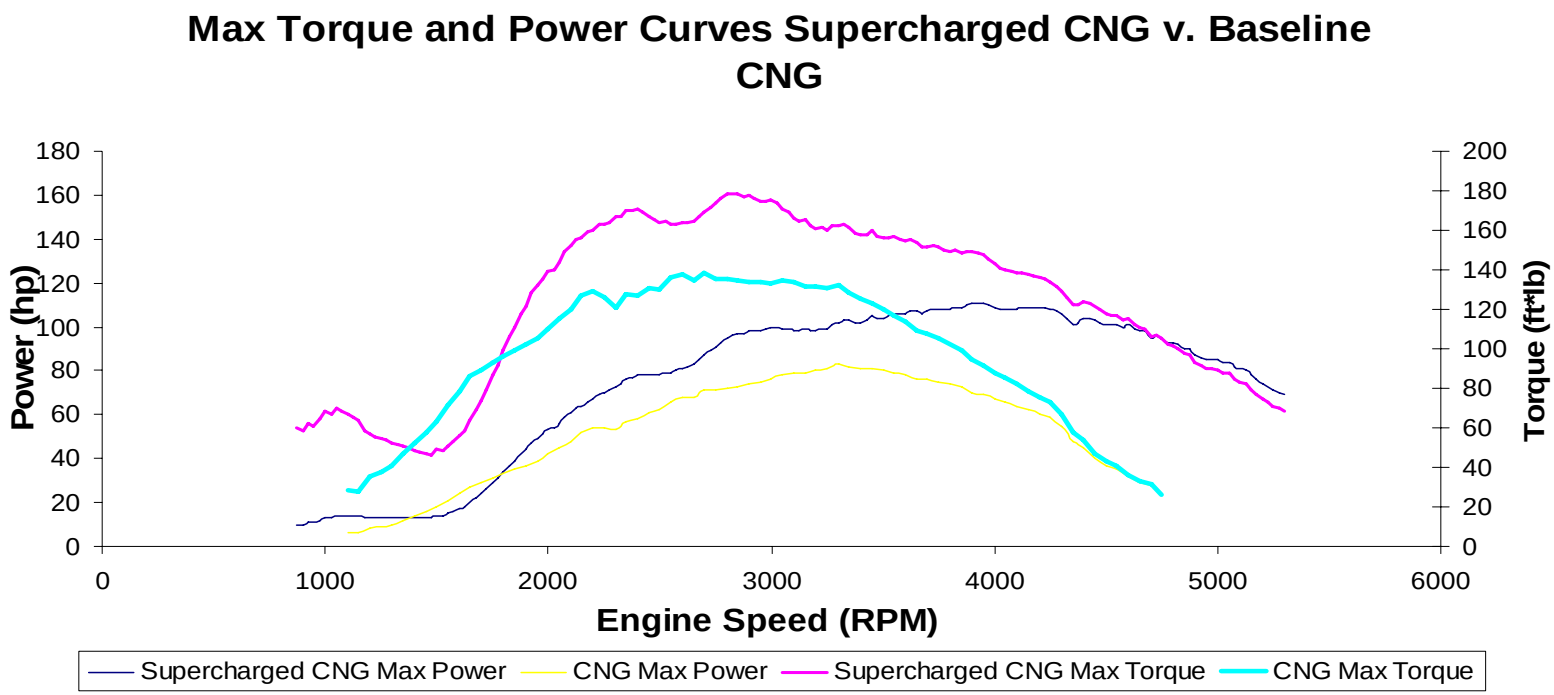
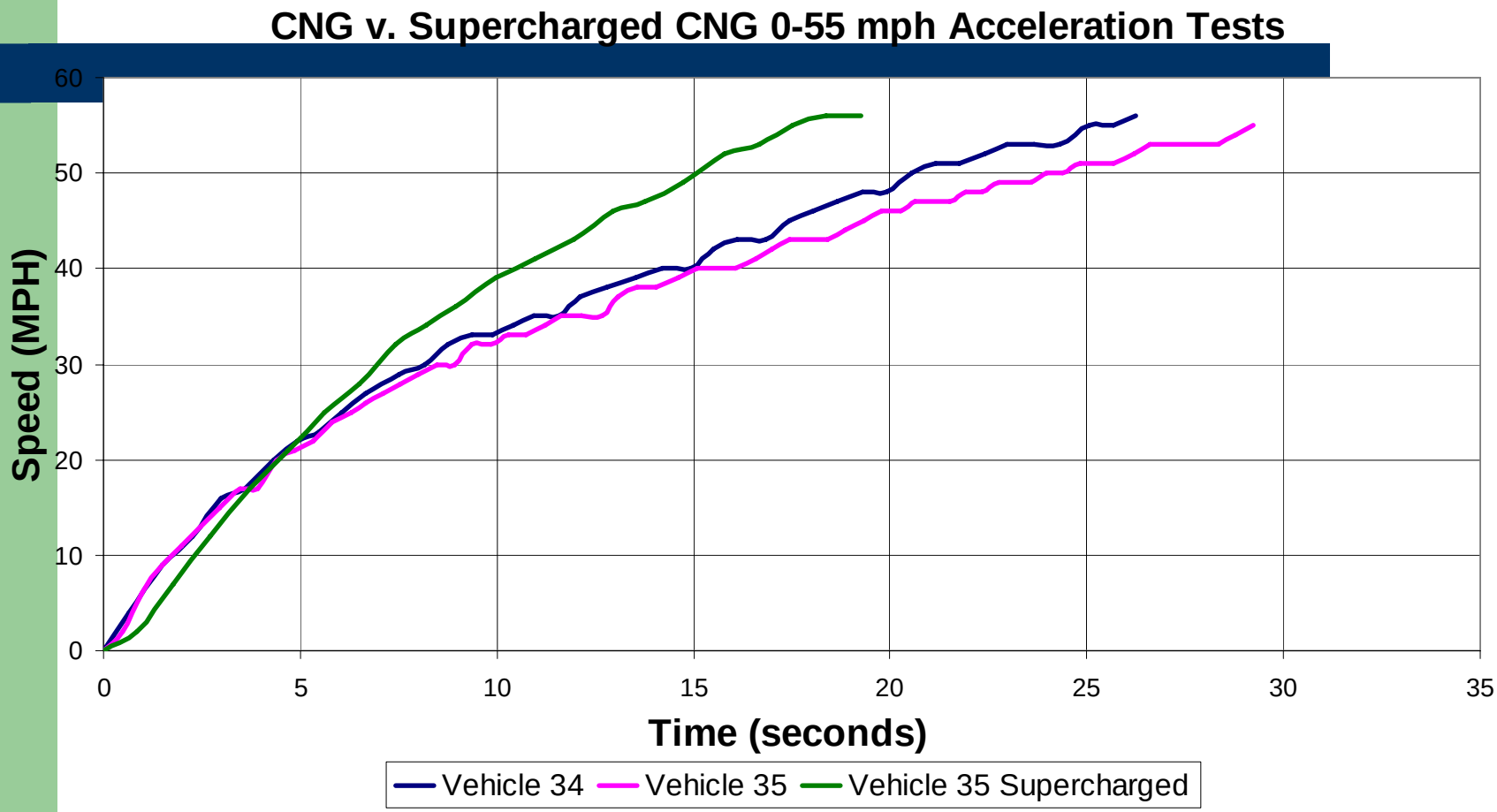
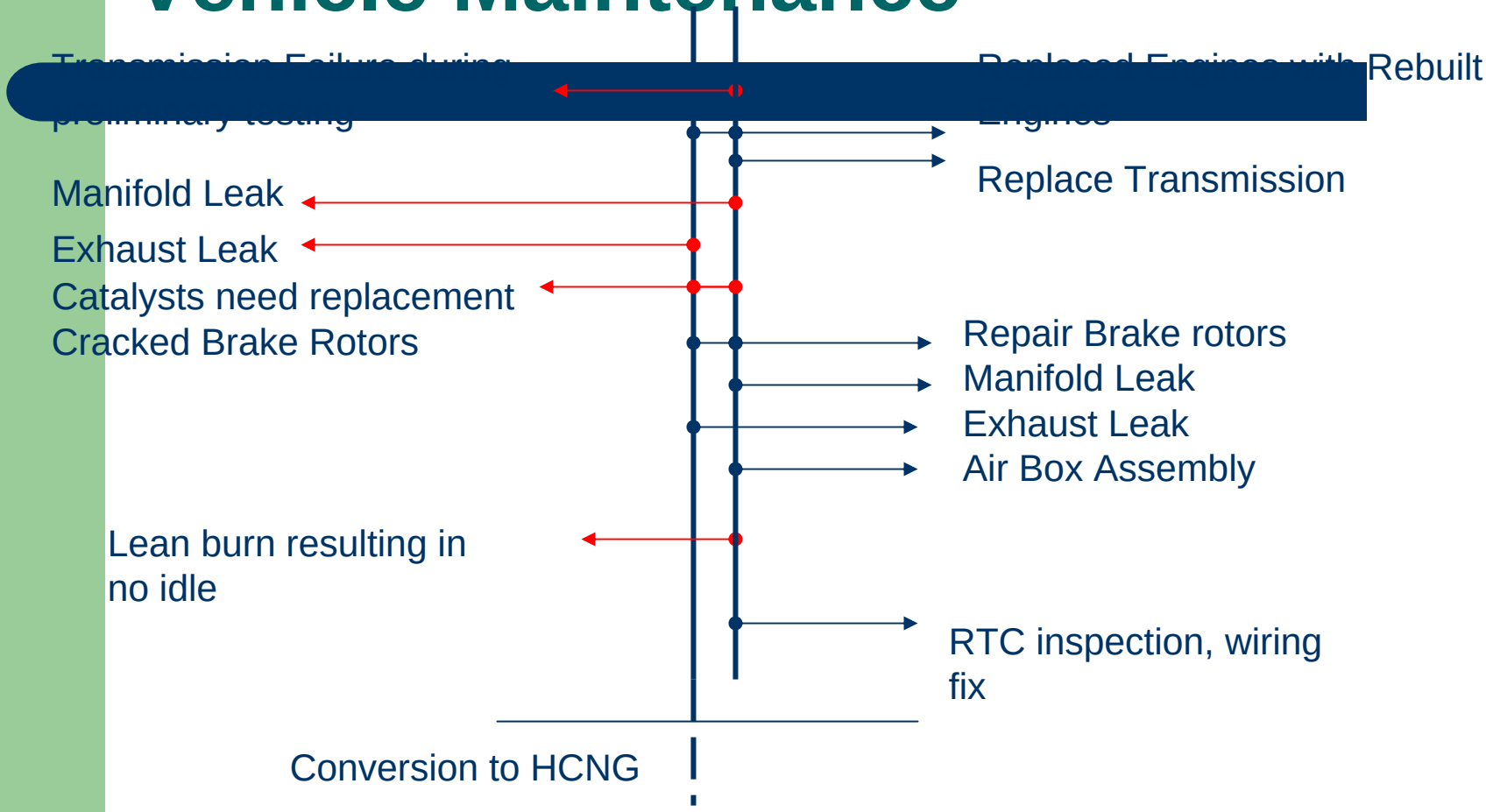
Maximum Power



Performance Results



Vehicle Maintenance



Additional Problems: Cold starts, batteries, ABS