

# Evaluation of Coal-derived Diesel Fuels

Governor Tomblin's Energy Summit



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October 6, 2016

# Center for Alternative Fuels, Engines and Emissions (CAFEE)

- Non-Profit Research Center Operating Within Academic Surroundings
- Established in 1989, to Coordinate and Stimulate research in the following areas:
  - Transportation Energy
  - Heavy-Duty Power Systems
  - Alternative Fuels
- \$4-5 million Annually in Externally Funded Research
- 9 full-time faculty, 10 full-time engineers, 5 technicians, 1 facility manager and more than 30 Ph.D. and M.S. graduate students.



# Center for Alternative Fuels, Engines and Emissions (CAFEE)



# CAFEE Key Contributions

- USDOE HD vehicle technology policy– fuels, engines, and emissions
- Consent Decrees (HDDE) – in-use emissions measurement technology and procedures
- Novel HD vehicle technologies (Hybrid vehicles)
- Development of on-highway and off-highway emissions measurement technology and protocols
- Verification and certification of technologies
- Leader in mobile emissions measurement



# VW Emissions Scandal

U.S. EPA found that Volkswagen had intentionally programmed turbocharged direct injection (TDI) diesel engines with a “defeat device”.



Source: Getty Images, BBC

The programming caused the vehicles' NO<sub>x</sub> output to meet US standards during regulatory testing but **emit up to 40 times more NO<sub>x</sub> in real-world driving.**

# VW Emissions Scandal



# VW Emissions Scandal



## Representative of real-world use



# VW Emissions Scandal



TIME



The New York Times

AP Associated Press

THE HUFFINGTON POST



nature



**150+ DIRECT  
MEDIA  
INQUIRIES**

since the story broke from international,  
national, state and local media outlets.



**100+ INTERVIEWS  
CONDUCTED  
(AND COUNTING)**

in person, by phone, satellite uplink, radio and  
Skype, and continue with today's scheduled  
in-person live interview on NBC's Today Show.

Thousands of

**SOCIAL MEDIA  
IMPRESSIONS**



WV Public News @wvpublicnews · Sep 21

WVU Researchers Help Bust Volkswagen  
for Pollution Violations  
[wvpublic.org/post/wvu-resea...](http://wvpublic.org/post/wvu-resea...)

👁 55 ⭐ 46 ... View summary



TribLIVE.com @TribLIVE · Sep 21

West Virginia University uncovers VW's emission-rigging plot. [bit.ly/1tIScub](http://bit.ly/1tIScub)  
#TribFrontPage

👁 1 ⭐ 2 ... View photo



Over

**3,500 STORIES**

appeared in news outlets from as far away  
as Qatar, Australia, Indonesia, England,  
Canada, India, South Korea, Norway,  
Germany, France and Japan.



Japan Broadcasting Corporation



THOMSON REUTERS



ABC



ALJAZEERA

GESTIONARADIO <sup>G</sup>

Los Angeles Times



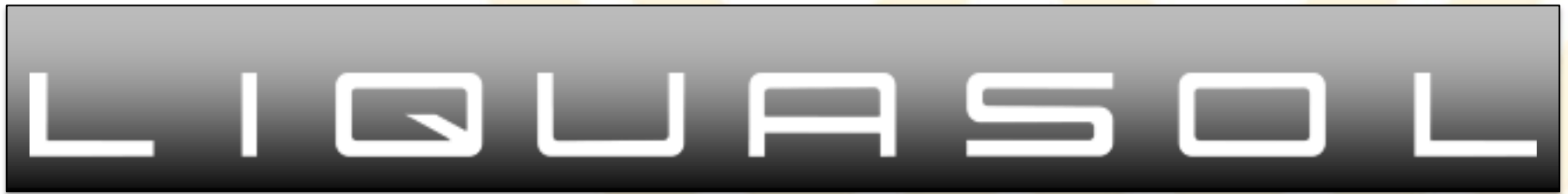
Deutsche  
Welle



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# Coal-to-diesel Fuels

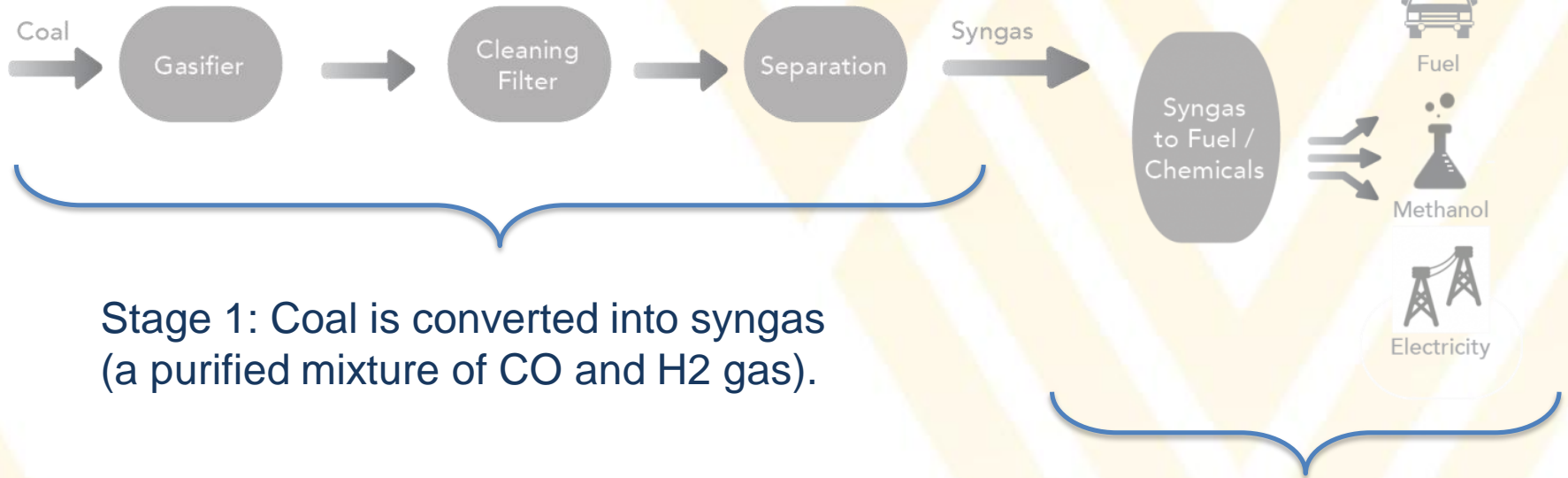
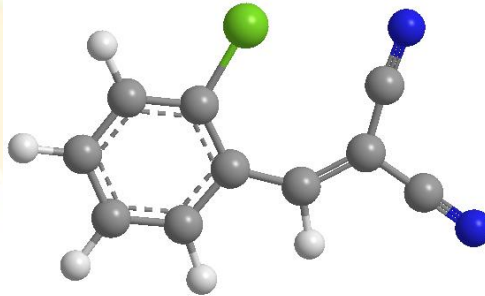


Alternative uses of coal: coal-to-diesel fuel

Test: Volkswagen vehicle

Performance: Fuel-economy, Emissions

# Coal-to-diesel Process



Stage 1: Coal is converted into syngas  
(a purified mixture of CO and H<sub>2</sub> gas).

Stage 2: Syngas is converted into light hydrocarbons using  
Fischer-Tropsch synthesis

# Testing Methodology



## Real-world Driving

Pre-designed test routes

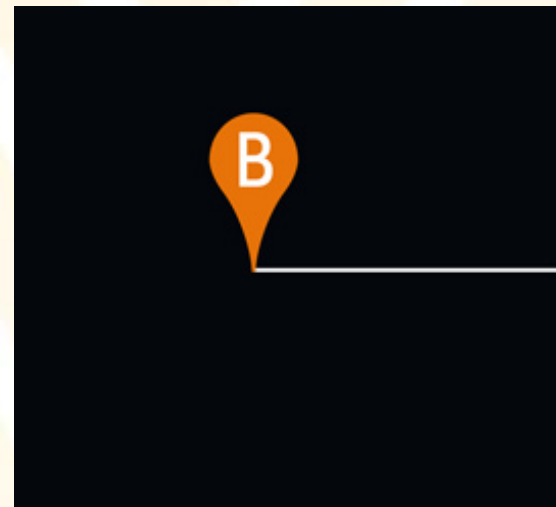
Portable emissions equipment



## A-to-B comparison

Establish baseline emissions

Repeat test protocol with  
Liquasol fuel

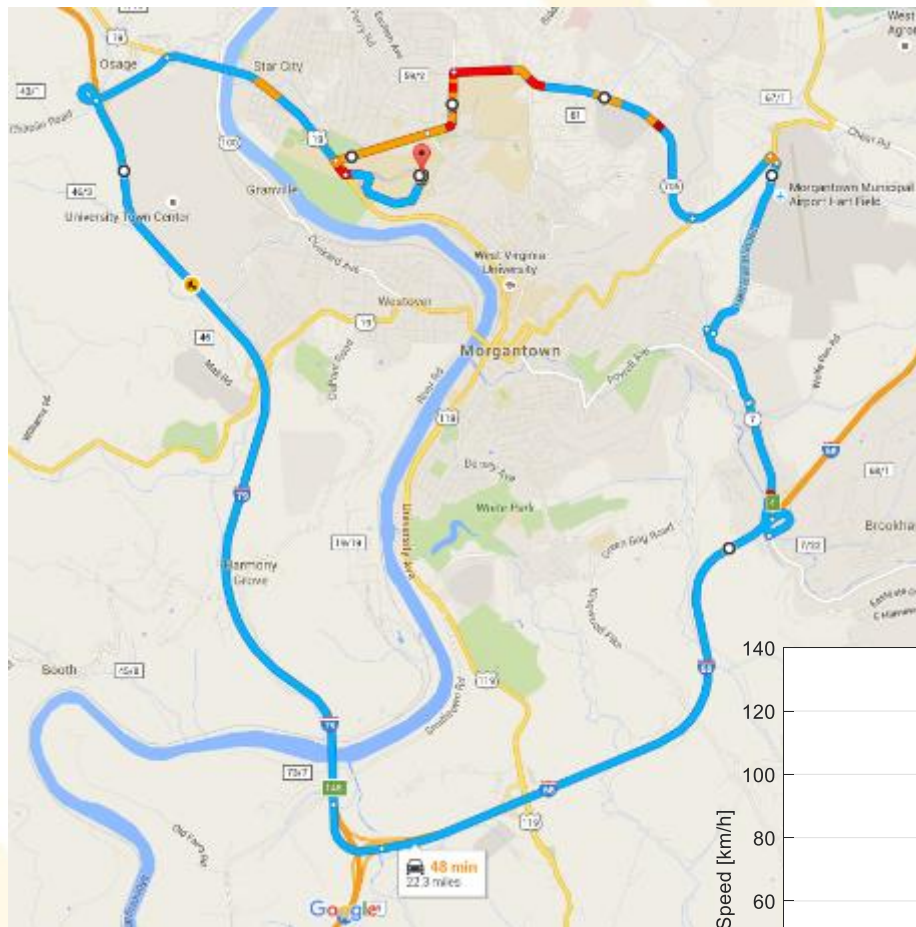


# Testing Methodology



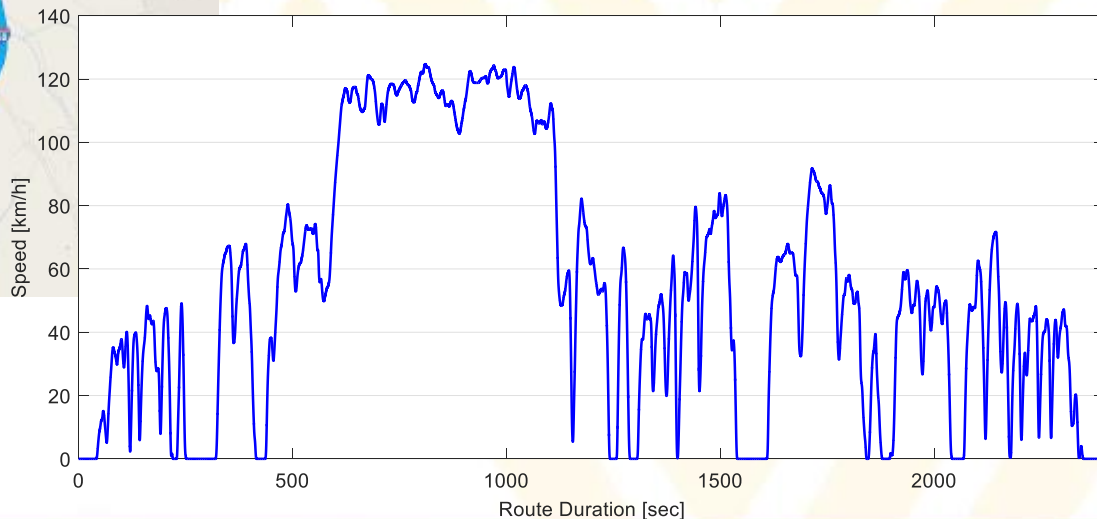
Portable Emissions Measurement System (PEMS)

# Testing Methodology

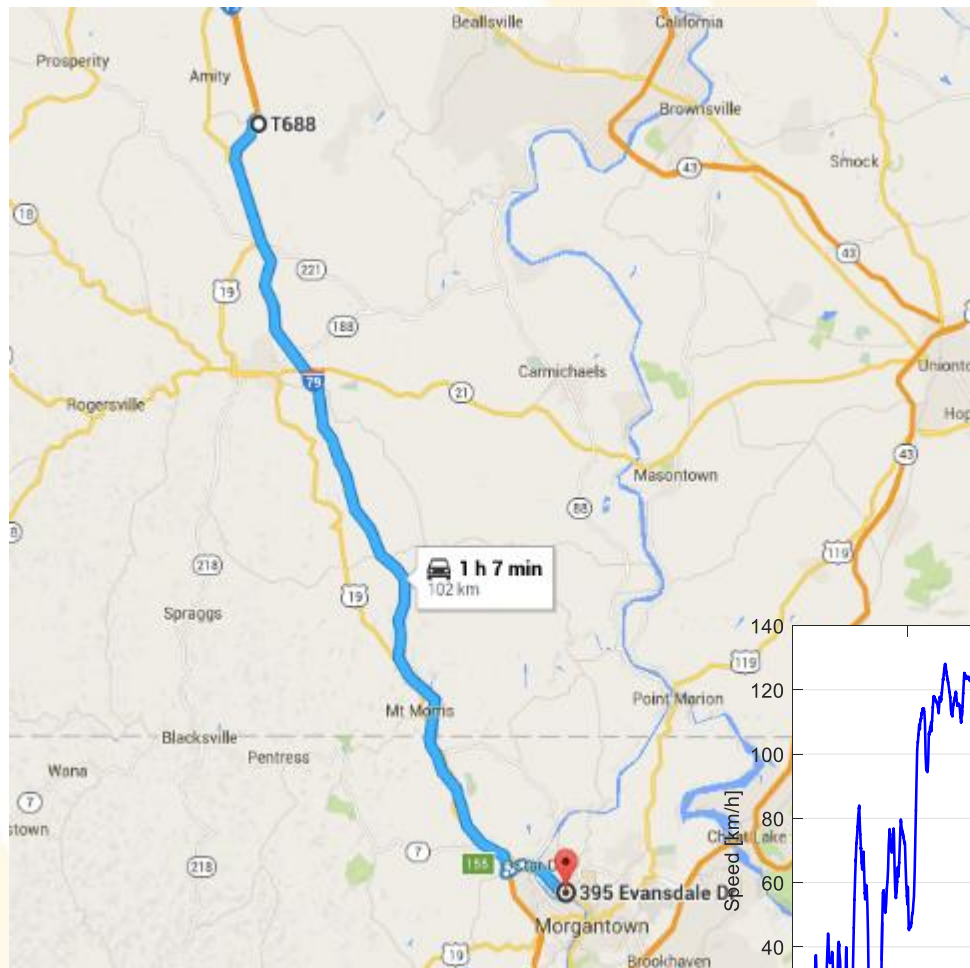


Morgantown route

Mix of urban, suburban and highway driving around Morgantown, WV.

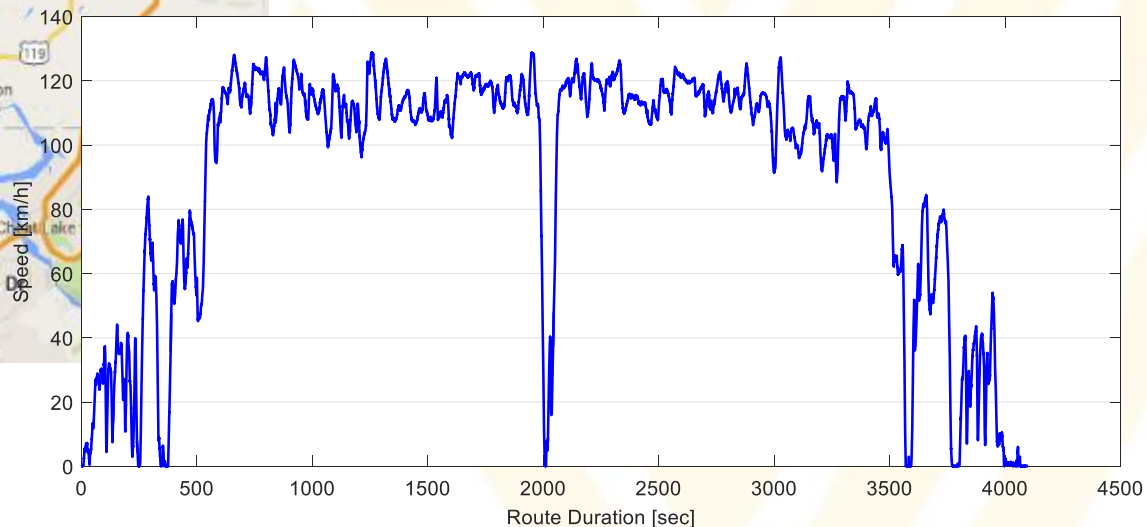


# Testing Methodology



Washington, PA route

Highway driving with occasional road gradients between Morgantown, WV and Washington, PA.



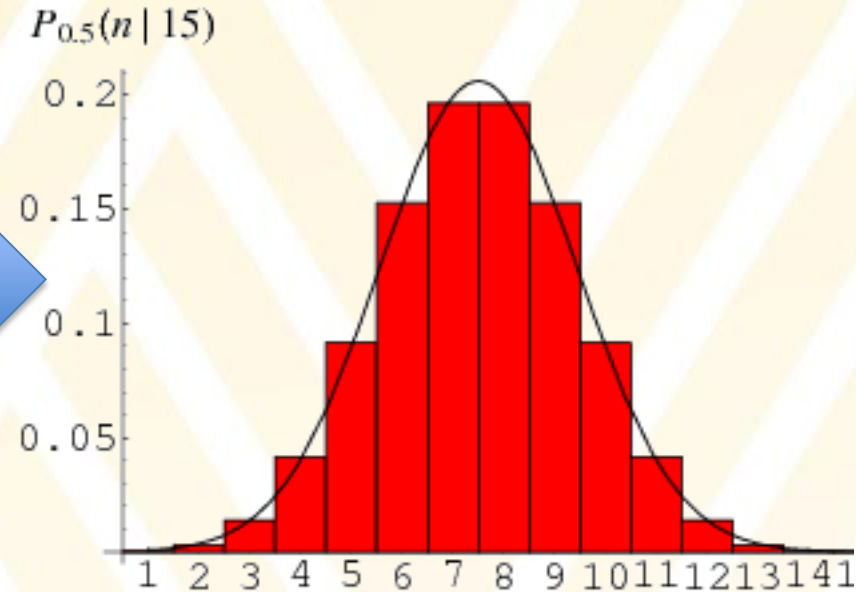
# Testing Methodology

## Variability

- Weather
- Traffic
- Road Conditions
- Driver Mood
- Instrumentation



## Significance



## Mitigation

Consistency in preparation, execution  
Iterative testing

# Emissions of Interest



- $\text{NO}_x$  reacts with volatile organic compounds in the presence of sunlight to form ozone. Ozone can cause adverse effects such as damage to lung tissue and reduction in lung function mostly in susceptible populations (children, elderly, asthmatics)
- The American Lung Association estimates that nearly 50 percent of United States inhabitants live in counties that are not in ozone compliance



- Primary Greenhouse Gas
- In 2009, the EPA made two important findings: 1) greenhouse gases in the atmosphere may reasonably be anticipated to endanger both public health and public welfare; 2) GHG emissions from mobile sources contribute to the total greenhouse gas air pollution, and thus to the problem of climate change.
- GHG regulations are emerging for nearly all applications

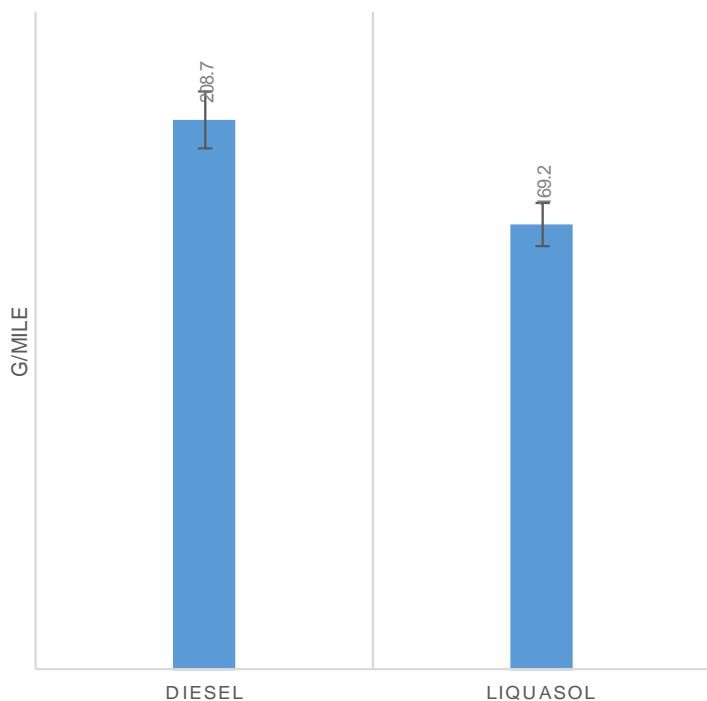
# Testing Results

Washington Route

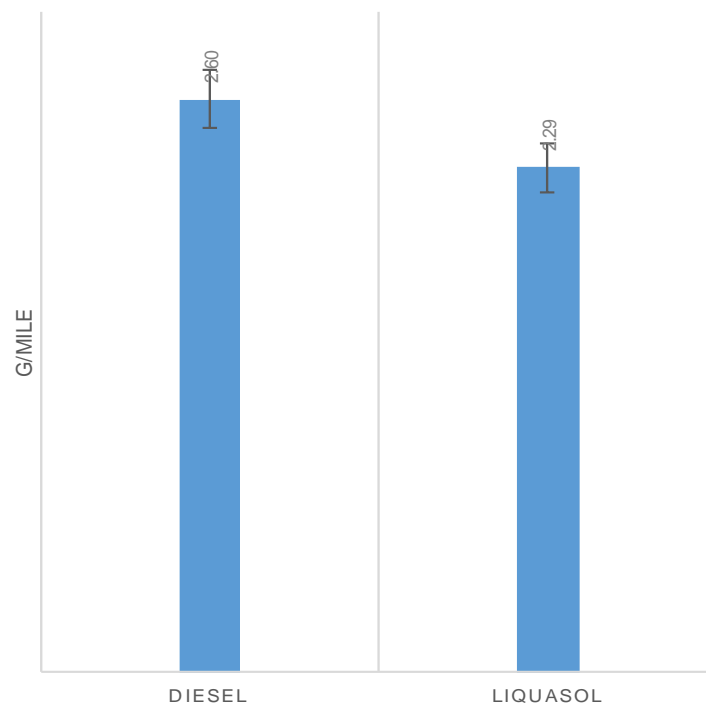
Highway Driving

	Washington CO2 [g/mile]	NOx [g/mile]
Diesel	208.7	2.60
Liquasol	169.2	2.29
Reduction	-19%	-12%

**CO2 EMISSIONS  
WASHINGTON ROUTE,  
MEAN**



**NOX EMISSIONS  
WASHINGTON ROUTE,  
MEAN**



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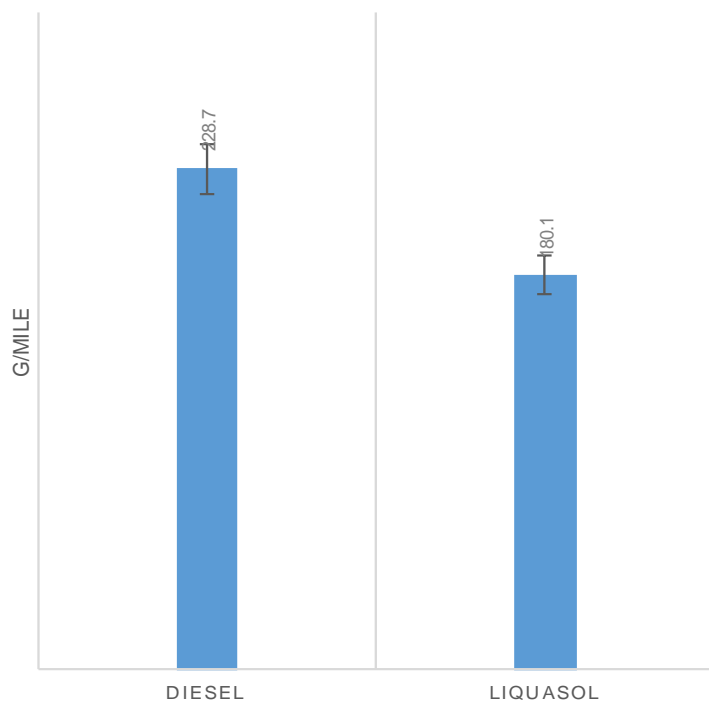
# Testing Results

Morgantown Route

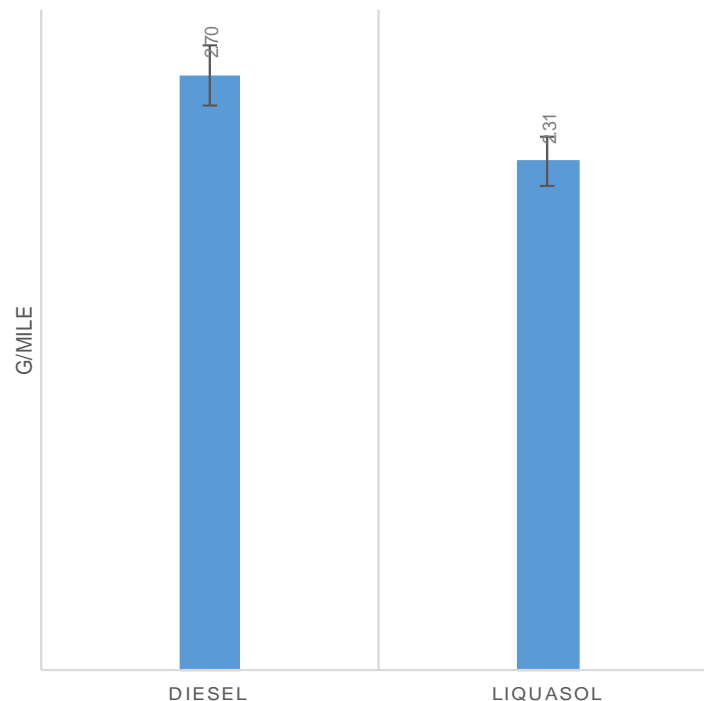
Mixed Driving

	Morgantown CO2	NOx
	[g/mile]	[g/mile]
Diesel	228.7	2.70
Liquasol	180.1	2.31
Reduction	-21%	-14%

CO2 EMISSIONS  
MORGANTOWN ROUTE,  
MEAN



NOX EMISSIONS  
MORGANTOWN ROUTE,  
MEAN



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# Testing Results

## Conclusions

Meaningful reduction in CO<sub>2</sub> emissions

- More efficient operation
- Less fuel consumed

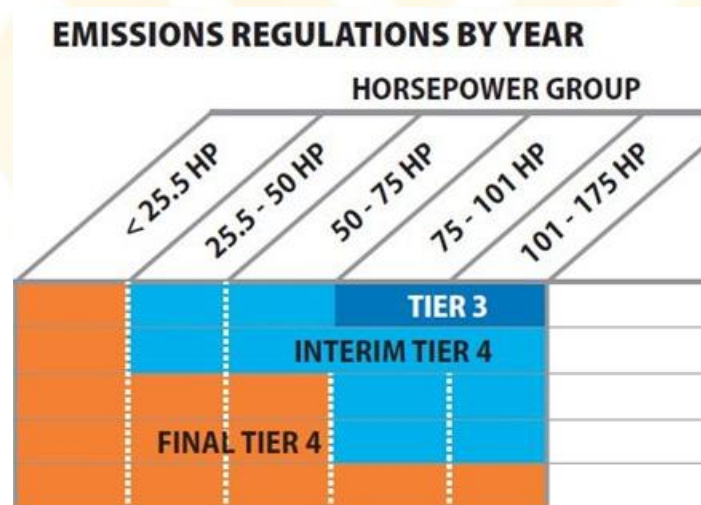
CO<sub>2</sub>

Fuel  
Consumption



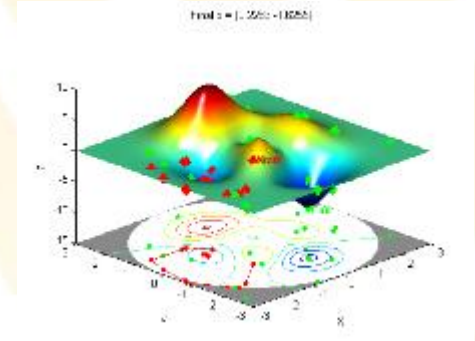
Reduced NO<sub>x</sub> emissions

- Ease technological burden in meeting emissions standards



# Areas of Continued Study

- How do these results generalize to other applications?
- Understand / optimize the benefits at fundamental level
- Well-to-wheel analysis of efficiency



## Thank You!

## Questions?

