

**Ardent Solutions/Allegheny County**  
April 19, 2023

# *Reducing Emissions & Costs with Propane Autogas*

**Stephen Whaley - Propane Education & Research**



# Propane Autogas Transit Fleets



# Shuttle Buses



# Propane Autogas Transit Fleets





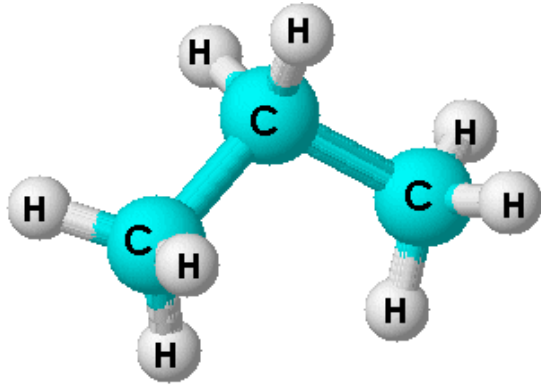
# WHAT IS PROPANE?

- Affordable, Clean, American-Made Fuel
  - C<sub>3</sub>H<sub>8</sub>
  - Byproduct of natural gas processing.
  - 100% Domestic
  - Commonly used for space and water heating, cooking, and as engine fuel.
- Using Propane
  - 48 million Households
  - 900,000 Farms
  - 600,000 Forklifts
  - 25,000 Commercial Mowers

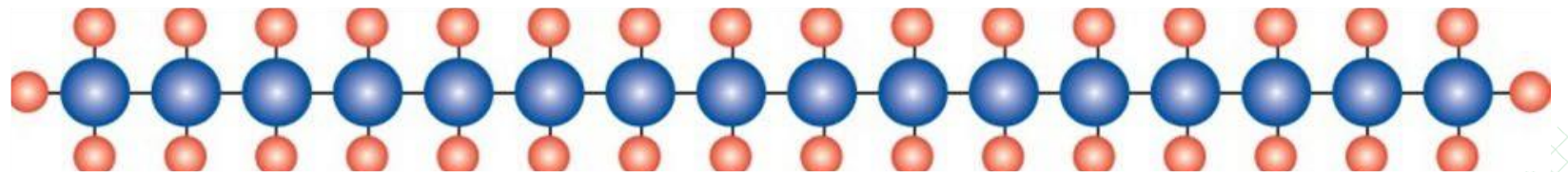
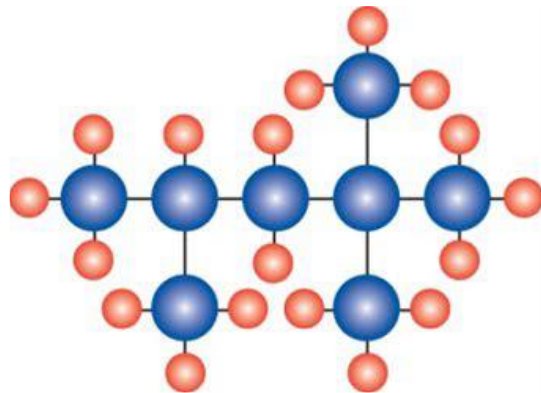
# What is Propane?

- Liquid state below minus 42 degrees Fahrenheit
- 100 PSI at 60-degree ambient temperature
- Heavier than air
  - No expensive ventilation systems needed for maintenance facilities

# What is Propane?



Low Carbon – Hydrogen Rich Energy





A green-tinted photograph of a farm. In the foreground, a large white propane tank is lying on its side in a grassy field. The tank has a label that reads "PROPANE" and a diamond-shaped hazard warning symbol. In the background, a center pivot irrigation system is visible, with multiple wheels and pipes extending across a field. The sky is overcast, and there are trees and hills in the distance.

**Propane comes from organic as well as renewable sources.**

**It's nontoxic, meaning it does not contaminate air, soil, or water resources.**



# Path to Zero Emissions

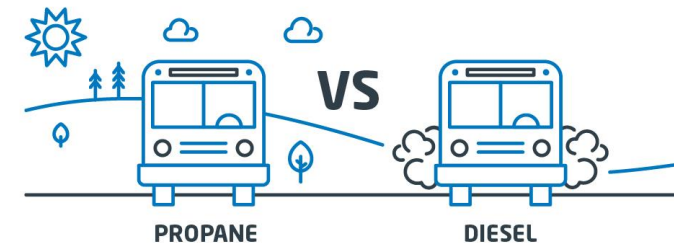
# Path to Zero

- Particulate Matter
  - Virtually zero
- NOX
  - 96% reduction from best in class diesel
  - Certifying to .02, operating at 0.01, full duty cycle
- GHG
  - New technologies 25% reduction from next best technology

# 96%

## NOx REDUCTION VERSUS CLEAN DIESEL BUS

Duty cycle: Low speed, stop-and-go route



Source: 2018 West Virginia University study, comparing 2015 LPG Blue Bird school bus (6.8L, 10 Cylinder) with 2014 ultra-low sulfur diesel Blue Bird school bus (6.7L, 6 cylinder).

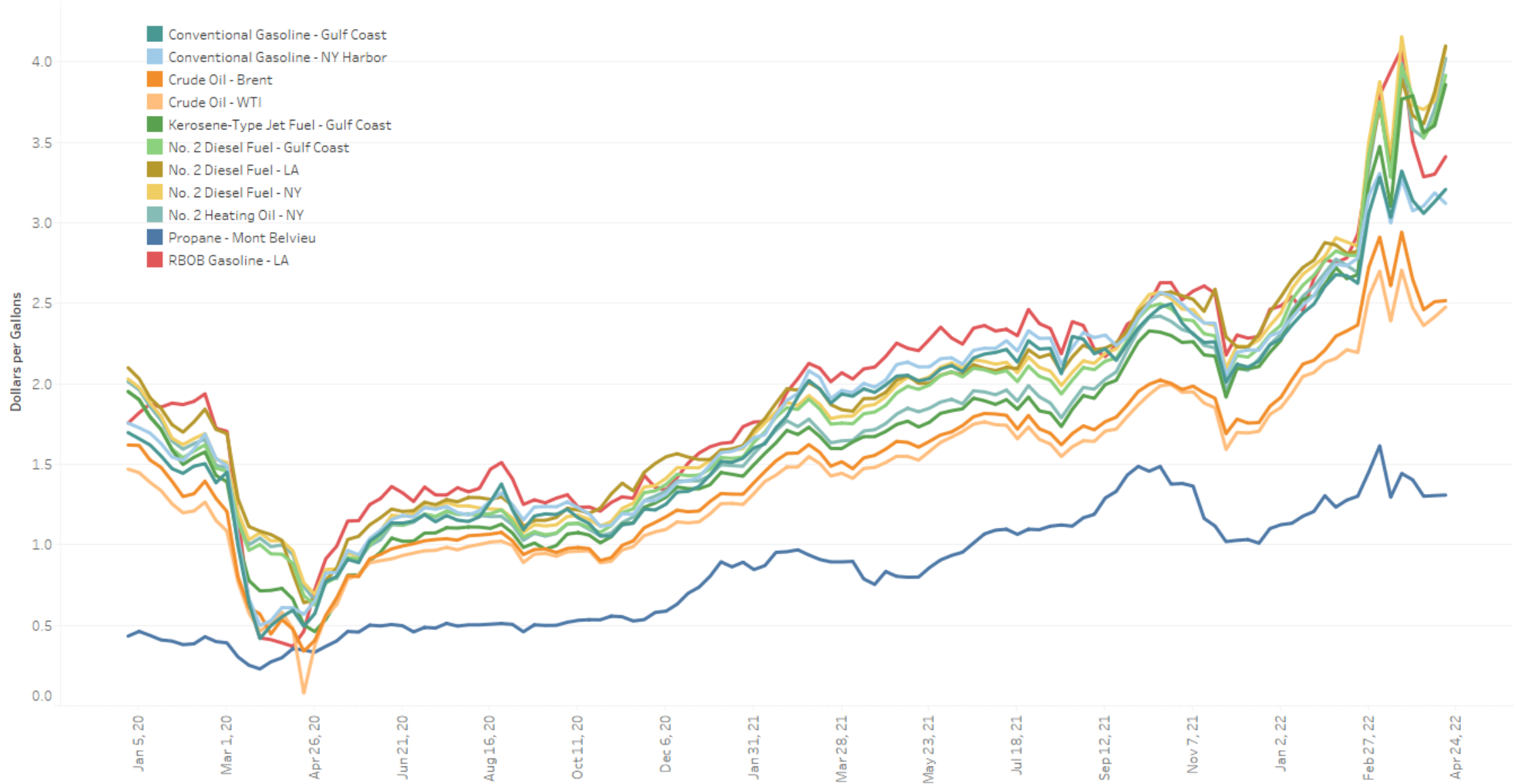
[PROPANE.COM](http://PROPANE.COM)



# Fuel & Maintenance Cost Reductions

# US ENERGY PRICE COMPARISON

Average Weekly Energy Prices



# Today's Propane Autogas

## Average Price Per Gallon for the week of March 24, 2023

These prices are based on National averages. To receive a custom quote with your local autogas pricing, contact us today.

Learn more about the savings and stability of autogas.

\*Autogas price estimates do not reflect the current federal tax credit.



# Alternative Fuel Tax Credit

- Annual tax credit included in federal budget to promote alternative fuel adoption
- Currently approved through 2024
- Propane is funded at \$.37 per gallon
- Included in federal budget since 2006

# The Future of Diesel:

## THE NEW PHASE II INTEGRATED SYSTEM CONCEPT

### HOW IT WORKS

- The integrated Rotary Turbine Control enables exhaust gases to bypass the turbine stage and enter the Close Coupled Unit after the gas has been injected with urea by the new Cummins UL4 injector.
- When combined with the Single Module™ chassis mounted aftertreatment, the concept integrated system has the potential to improve emissions, particularly for cold start and urban driving operations.



Combining Engineering Expertise to Help Customers Address Future Emissions Control Standards

2010



Figure 1. EPA 2010 aftertreatment system layout.

.2 NOx

2024

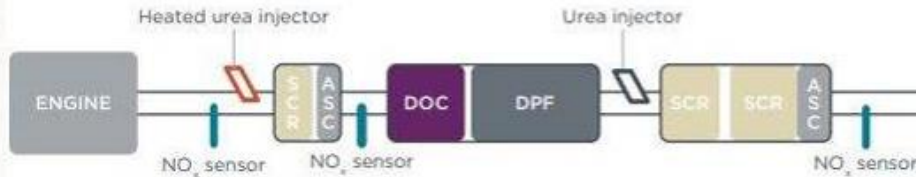


Figure 3. Potential aftertreatment configuration (No. 2) of a CARB 2024 compliant system.

.05 NOx

2027

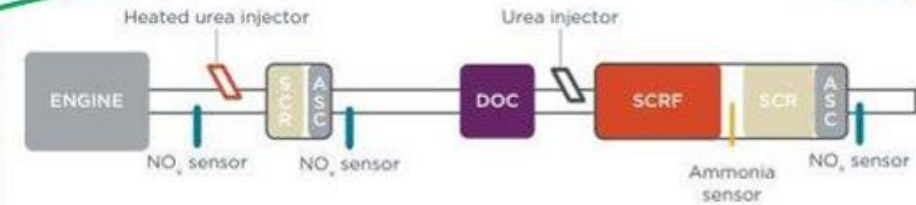
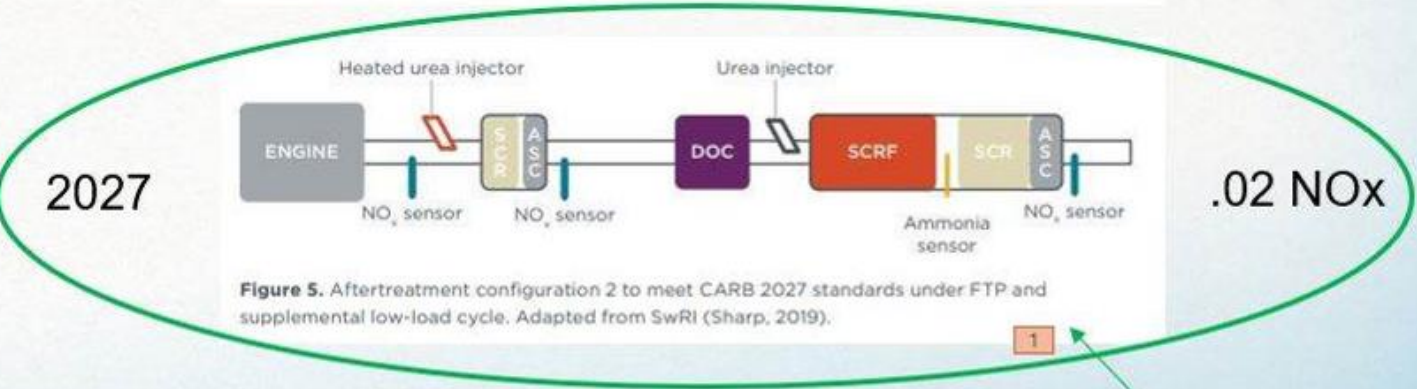


Figure 5. Aftertreatment configuration 2 to meet CARB 2027 standards under FTP and supplemental low-load cycle. Adapted from SwRI (Sharp, 2019).

.02 NOx



Source: "ESTIMATED COST OF DIESEL EMISSIONS-CONTROL TECHNOLOGY TO MEET FUTURE CALIFORNIA LOW NOX STANDARDS IN 2024 AND 2027"  
<https://theicct.org/sites/default/files/publications/HDV-emissions-compliance-cost-may2020.pdf>

LPG Meets This Today





# Current Autogas Vehicle Offerings



# OEM Propane Options

- Light & medium duty Ford trucks & vans, school bus.
- Factory Ford warranty maintained.
- No loss of HP / torque / towing capacity.
- Serviceable with existing diagnostic equipment.
- EPA & CARB Certified.

**ROUSH**<sup>®</sup>  
**CLEANTECH**



Ford F-53 / F-59



Ford E-350/450



Ford F-450/550



Ford F-650/750



Blue Bird Vision

Micro Bird G5

# Transit Customer Adoptions

**THE RAPID**

**MTA**

**DART**  
A Division of DelDOT  
Getting There Starts Here

**My Way There**

**B**

**BENZIE BUS**

**CARTS**

**5 RIDE SMART**

**GT**

**Votran**  
We drive a great bargain

**BROWARD COUNTY**  
*Transit*

**CATA**

**RTA**

**Clinton**  
transit

**King County**  
**METRO**

INDIANA  
**La Porte**  
THE HUB OF *Awesome*

**mits**

**THE COMET**  
CENTRAL WISCONSIN TRANSIT

**Kitsap Transit**  
Connecting Communities

**Palm Tran**

**LEE COUNTY**  
SOUTHWEST FLORIDA

# Transit Bus – Vehicle Profile

## Model Years

2023

## Engine Size

7.3L V8

## Applications

158" / 176" / 186" / 190" / 208" wheelbases.

6-speed automatic transmission.

## Fuel Tank Capacity

Aft-axle: 41 gallons (usable)

Extended range: 64 gallons (usable)

## Technical Specifications

EPA and CARB approved.

GVWR: < 14,500 lbs.

Requires "91G" gaseous fuels prep. package.

## Order Availability

Ford Ship Through.

## Ford E-450 Cutaway & Strip Chassis

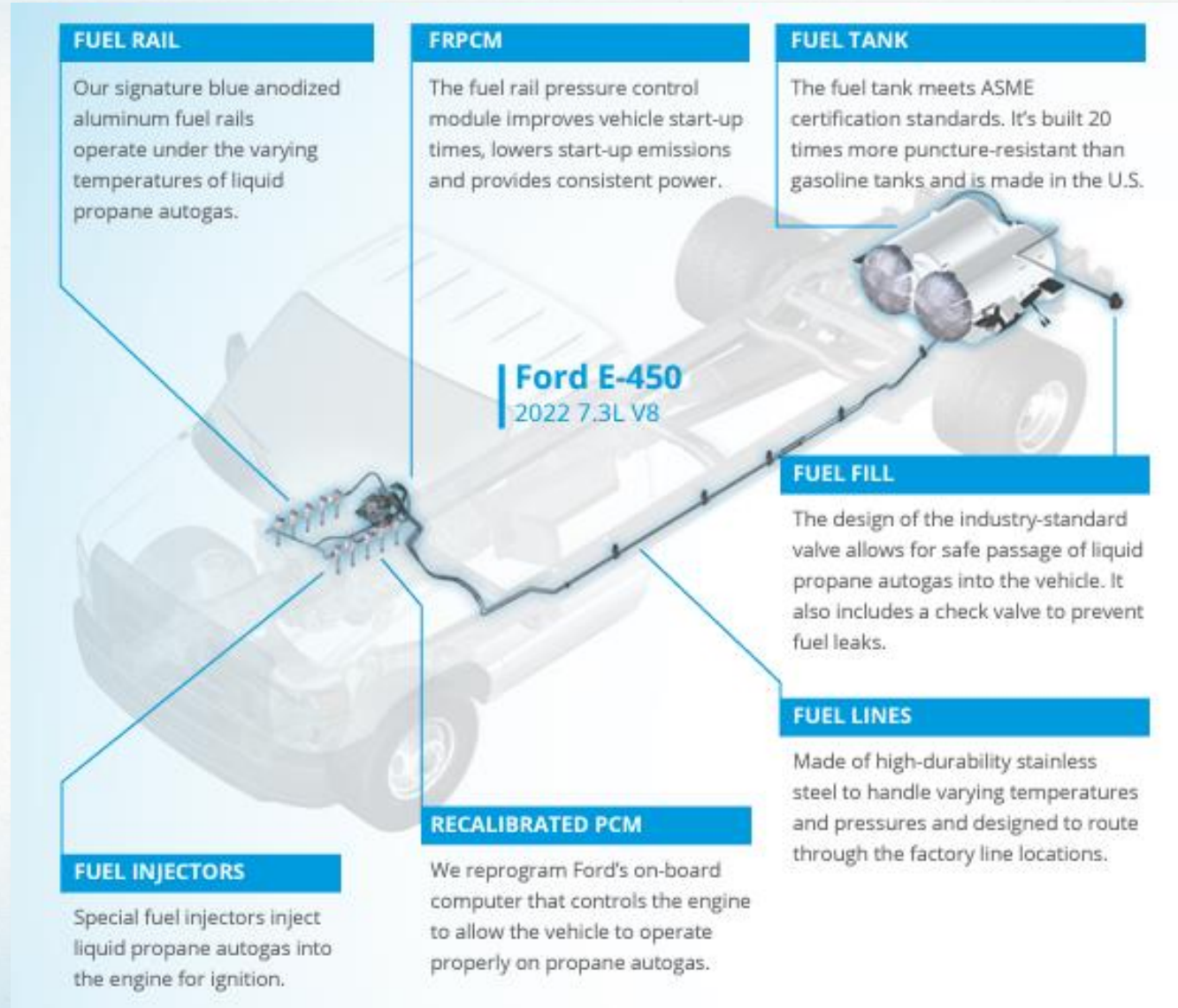


# System Layout and Function



ROUSH CleanTech is a Ford QVM developer and installer of dedicated propane autogas fuel systems.

Organizations with QVM status from Ford create the engine calibration, complete the on-dynamometer calibration testing, comply with all Ford engineering requirements, and develop a vehicle component package.



# Transit Bus – Vehicle Profile

## Model Years

2019 – 2021 – Retrofit

## Engine Size

6.8L V10 (2V) superseded by 7.3L V8

## Applications

Various wheelbases

5-speed automatic transmission.

## Fuel Tank Capacity

Aft-axle: 65 gallons (usable)

## Technical Specifications

EPA and CARB approved.

GVWR: < 14,500 lbs.

Requires “91G” gaseous fuels prep. package.

## Order Availability

Available retrofit only

## Ford F-550 Cutaway & Strip Chassis



# OEM Offering

## Model Year

2021 - 2023

## Engine Size

6.8L V10 (3V) Ford Engine with exclusive ROUSH CleanTech Propane Fuel System

## Applications

169" / 189" / 217" / 238" / 252" / 273" / 280"  
wheelbase configurations

6-speed automatic transmission

## Fuel Tank Capacity

Short: 47 gallons (usable)

Standard: 67 gallons (usable)

Extended: 93 gallons (usable)

## Technical Specifications

EPA and CARB approved.

GVWR: 33,000 lbs.

Up to 81 passengers



## Blue Bird Vision (Type C)



**BLUE BIRD**







## 2021 Model Year Products



**F150**  
3.3 PFDI  
5.0 PFDI  
2.7/3.5 PFDI  
(SUMMER 20)

**F250-F350**  
6.2 PFI

**F450-F750**  
7.3 PFI (2021 MY)

**E450**  
6.2 PFI  
7.3 PFI (2021 MY)

**TRANSIT**  
3.5 PFDI  
3.5 ECOBOOST  
(FALL 20)

**EXPLORER**  
3.3 PFDI



**SILVERADO 1500**  
5.3 DI

**SILVERADO**  
2500/3500  
6.6 DI

**EXPRESS/SAVANA**  
6.0 PFI



**DURANGO**  
5.7 PFI

**CHARGER**  
3.6 PFI

**RAM** 5.7 PFI  
3.6 PFI  
(SUMMER 20)





SCHOOL BUS

SCHOOL

SCHO

SCHOOL BUS

SCHOOL BI

STOP

R415

R415

R389

# SNAPSHOT OF PROPANE AUTOGAS SCHOOL BUS MARKET

**1,250,000**

STUDENTS TRANSPORTED

DAILY

STATES WITH

**14**



**500+ BUSES**

**1,000**

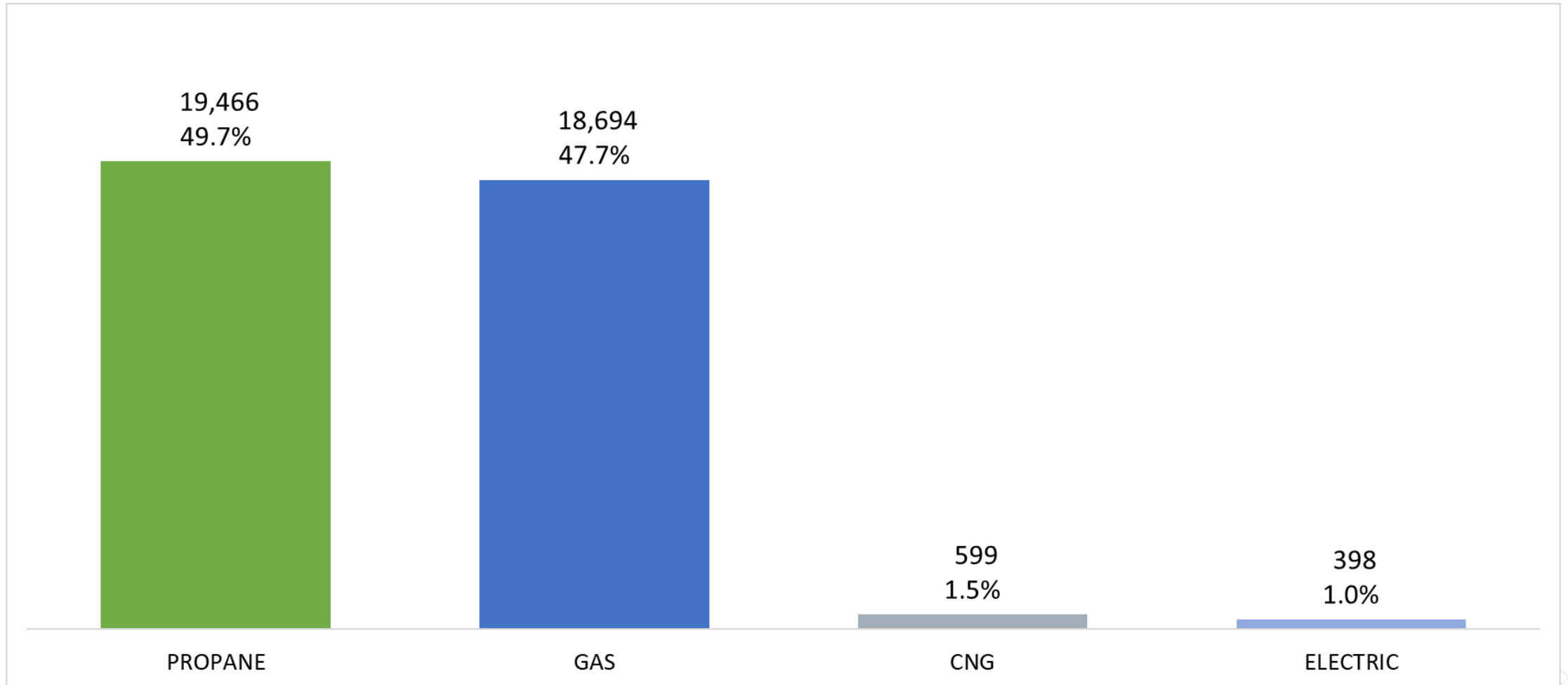
DISTRICTS &  
CONTRACTORS  
OPERATE PROPANE  
AUTOGAS BUSES

**22,000+**

PROPANE AUTOGAS BUSES

ON THE ROAD

# Non-diesel Type C School Buses (thru Q2 2022)



Source: IHS Polk data - vehicles in operation)



# High Growth Vehicle Markets

## EMERGING MARKETS

# Parcel/Package

- USPS has 92,000 routes for moving mail.
  - **Over 70,000 routes are performed by independent contractors.**
- There are approximately 10,000 class 6-7 straight box trucks operated by USPS contractors.
- Contractors bidding on USPS routes score higher with alternative fuel vehicles.
- 1,000 gallons/month average fuel consumption.



## EMERGING MARKETS

# Food/Beverage

- Major companies have already validated propane autogas in this market.
  - ReadyRefresh by Nestlé Waters.
  - Schwan's Home Delivery.



## EMERGING MARKETS

# Paratransit

- 51,000 paratransit vehicles nationwide.
- 600 gallons per month average fuel consumption.
- ADA requires every county in the U.S. to provide service.





# Same Equipped 14 Passenger Shuttle Bus

Gasoline (300 mi)	\$165k
Propane (300 mi)	\$195k
Electric 88kWh Battery (*150 mi)	\$400k

\*An existing NY EV fleet claims minimum 40% reduction in range during cold climate operation.

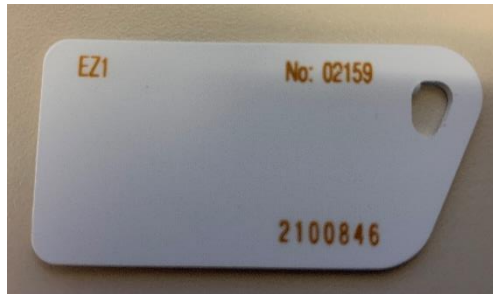
# CASE STUDY









## Broward County Transit

Paul Strobis, Director  
Paratransit Operations



# Fueling Infrastructure

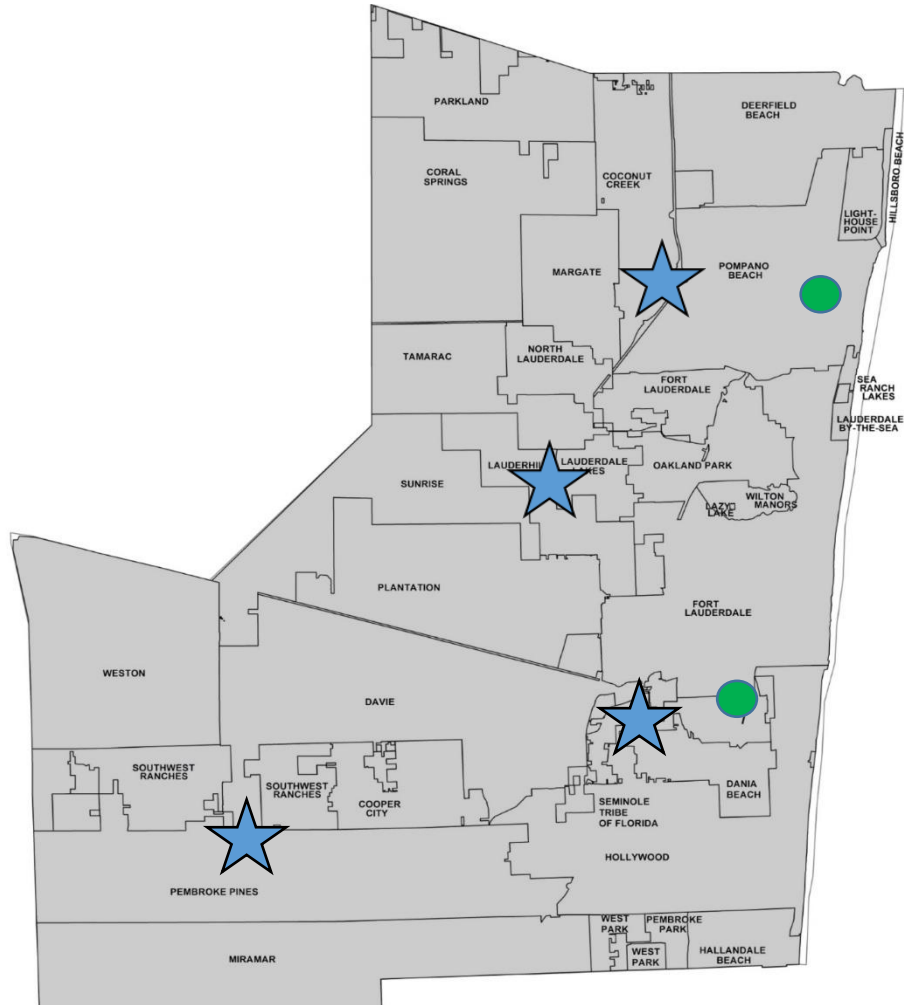


-  Tickets
-  Reports
-  Diagnostic
-  Manage
-  Registration
-  Sign Out
-  Website Instructions
-  Co

Location	Employee	Vehicle	Odometer	Equipmen	Date/Time	Product	Ticket	Gross	Net
LSF	{unknown}	P0099	268533	PAFD00019	22-03-07 08:21	PROPANE	34432	27.67	27.67
LSF	{unknown}	P0335	95507	PAFD00019	22-03-07 07:45	PROPANE	34431	17.27	17.27
LSF	{unknown}	P0054	258907	PAFD00022	22-03-07 07:43	PROPANE	86783	38.34	38.34
LSF	{unknown}	P0235	125356	PAFD00019	22-03-07 07:34	PROPANE	34430	11.88	11.88
LSF	{unknown}	P0113	262676	PAFD00019	22-03-07 07:19	PROPANE	34429	29.79	29.79
LSF	{unknown}	P0018	280042	PAFD00019	22-03-07 07:14	PROPANE	34428	22.79	22.79
LSF	{unknown}	P0135	242983	PAFD00019	22-03-07 07:10	PROPANE	34427	15.94	15.94
LSF	{unknown}	P0020	264863	PAFD00019	22-03-07 07:05	PROPANE	34426	34.36	34.36
LSF	{unknown}	P0100	264768	PAFD00022	22-03-07 07:00	PROPANE	86782	35.96	35.96
LSF	{unknown}	P0386	94564	PAFD00019	22-03-07 06:57	PROPANE	34425	16.40	16.40
LSF	{unknown}	P0008	282060	PAFD00019	22-03-07 06:54	PROPANE	34424	2.93	2.93



# Fueling Infrastructure



Broward County, FL  
471 Sq. Miles



# Vehicle Type – OEM/After-Market Conversion



**Ford E-450 DRW Cutaway - 65 Qty**

**Model Years:** 2014 - 2015  
**Engine Size:** 6.8L V10 (2V)  
**Tank Size:** Aft-Axle: 41 usable gallons  
**Fuel System:** Roush Cleantech – Propane \$17K



**Ford Transit Cutaway - 162 Qty**

**Model Years:** 2019 - 2020  
**Engine Size:** 3.7L V6/ 3.5L Turbo  
**Tank Size:** 24 usable gallons  
**Fuel System:** ICOM North America – Propane  
**FDOT Cost \$16K**



**Purchased Off  
FDOT TRIPS Contract**



# Benefits the environment

## It's Clean

- 24% reduction in Greenhouse Gas (GHG) emissions.
- 20% reduction in Nitrogen Oxide (NOx) emissions.
- 60% reduction in Carbon Monoxide (CO) emissions.

and

**It's getting cleaner!**



# Budget impact

	Propane Gallons	Gasoline Equivalent (85%)	Savings
2015	1,226,048	1,042,141	
2016	1,415,286	1,202,993	
2017	1,474,924	1,253,685	
2018	1,571,064	1,335,404	
2019	1,516,090	1,288,677	
2020	681,890	579,607	
2021	609,929	518,440	
2022	778,564	661,779	
<b>Total Gallons</b>	9,273,795	7,882,726	-1,391,069
<b>Total Cost</b>	\$12,194,009.98	\$21,835,150.66	\$9,641,140.68
<b>Cost per Gallon</b>	\$1.31	\$2.77	\$1.46
<b>Alteranative Fuel Tax Credit</b>	(\$3,743,467.00)	0	(\$3,743,467.00)
<b>Total Net Cost</b>	\$8,450,542.98	\$21,835,150.66	\$13,384,607.68
<b>Net Cost per Gallon</b>	\$0.91	\$2.77	\$1.86



# Kitsap Transit - Bremerton, WA

- 3.5 million riders each year
- Started adopting propane autogas 2015
- 47 propane autogas buses
  - 11 remaining diesel buses to be replaced with current order of propane buses
- Fuel Costs per mile
  - Diesel \$.48/mile
  - Gasoline \$.50/mile
  - Propane \$.20/mile
- GHG Emissions for 8-hour route period
  - Diesel bus – 2.4 metric tons
  - Propane bus - .014 metric tons







# Autogas Infrastructure

# Fueling Infrastructure – Mobile Refueling



# Temporary Refueling Set-up



# CATS Propane Autogas Fueling Station



# Standard Private Station



# Standard Private Station





# Fueling Infrastructure Cost for 10 Shuttles

- Propane = \$50k
- CNG = \$200k (ten fixed time fill hoses)
- Electric = \$480k (ten fixed plug in lines)





# AmeriGas®

*America's Propane Company*

## *AutoGas Refueling Infrastructure*

*Chris Ransom – National Account Manager AutoGas*



# AutoGas Refueling - Onsite Station\*



**\*Eligible for Alt Fuel Credits @ \$.367**

# AutoGas Refueling - Onsite Station\*



**\*Eligible for Alt Fuel Credits @ \$.367**





**What gets measured, gets improved.**

Stäubli Nozzle

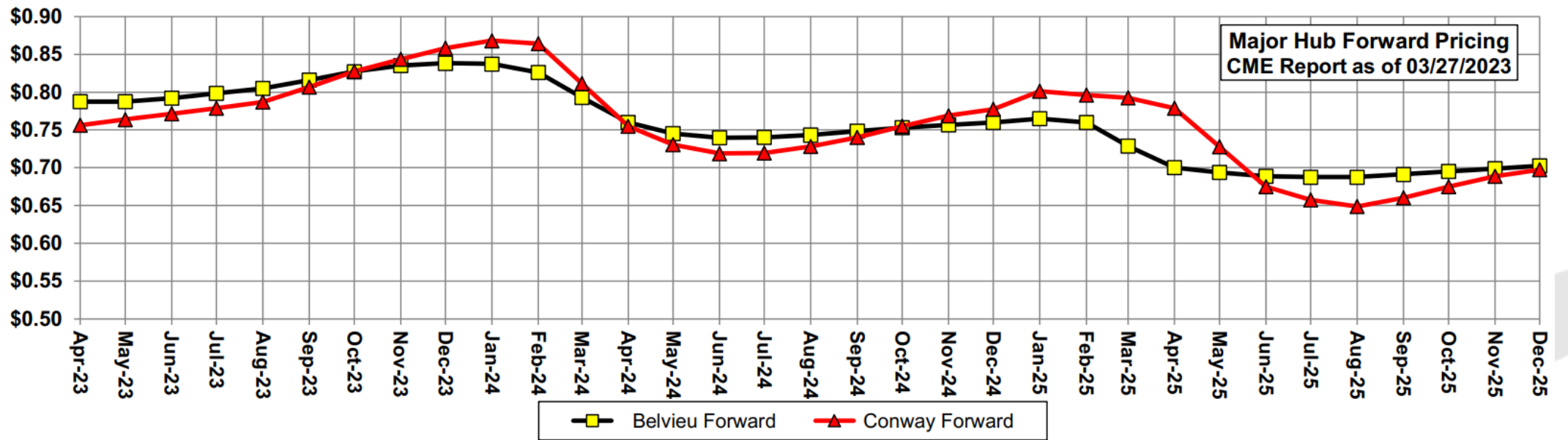


# The New Hotness!











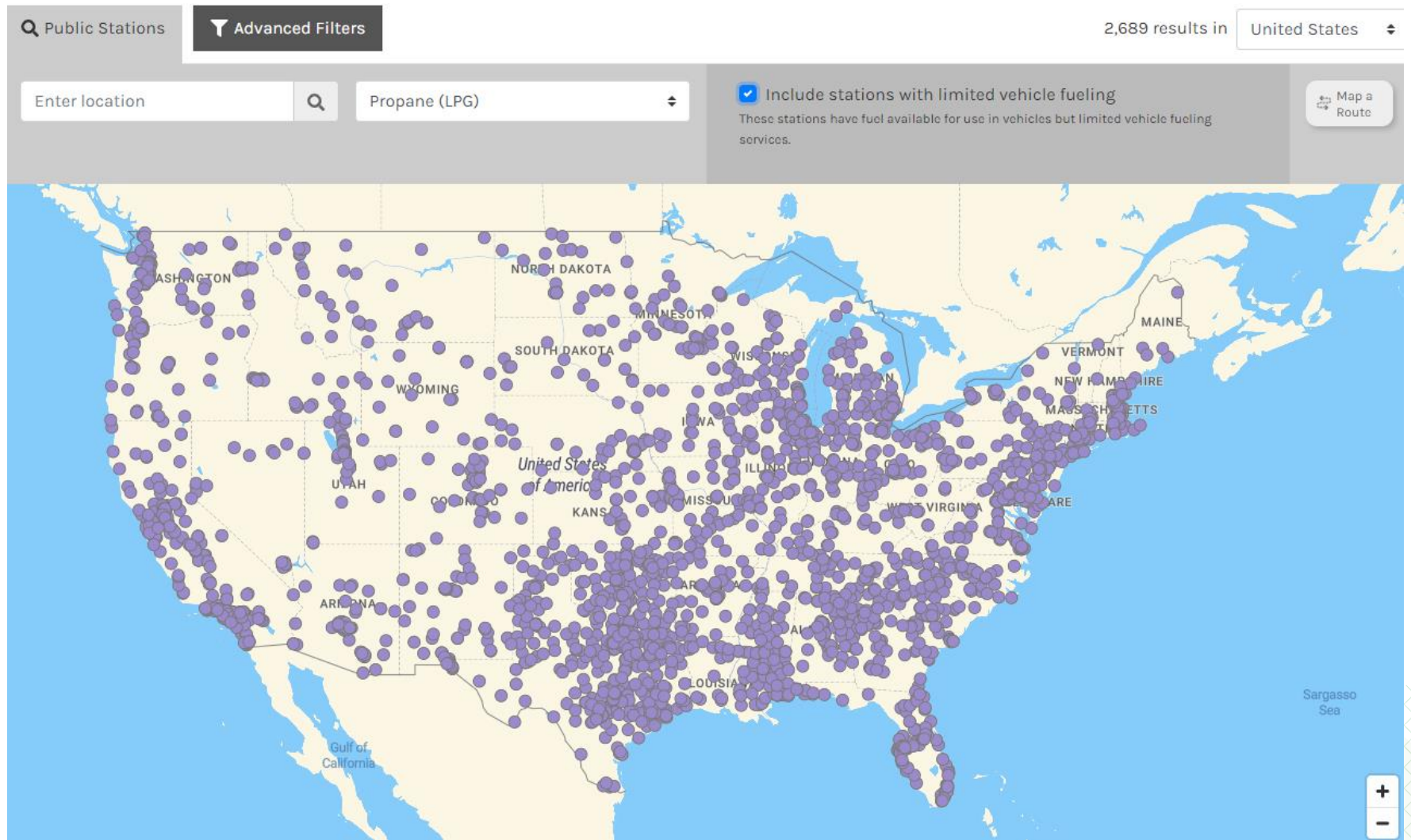
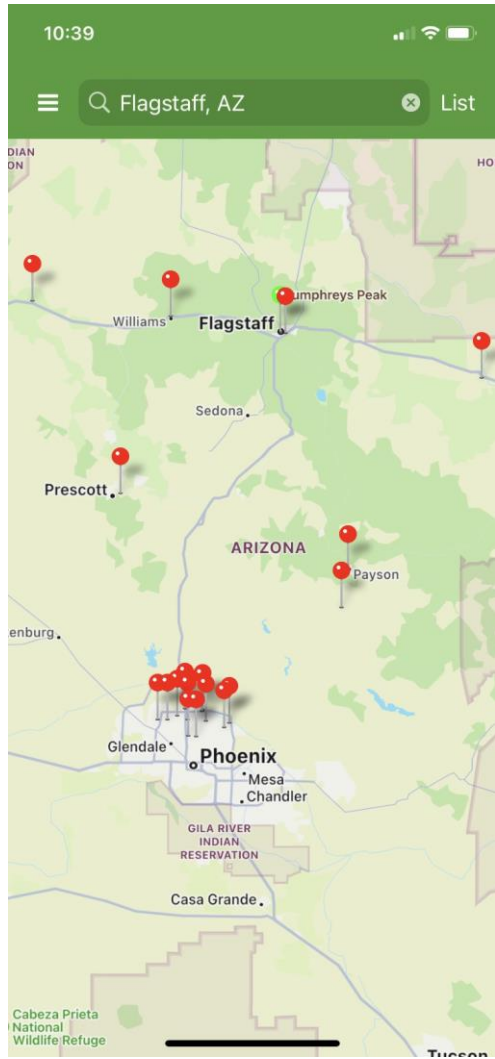
*Thank You!*

*Chris Ransom – National Account Manager AutoGas*

*(231) 638-3184*

*chris.ransom@amerigas.com*

# Dept of Energy Alt Fuel Station Locator





# Resiliency

# Resiliency

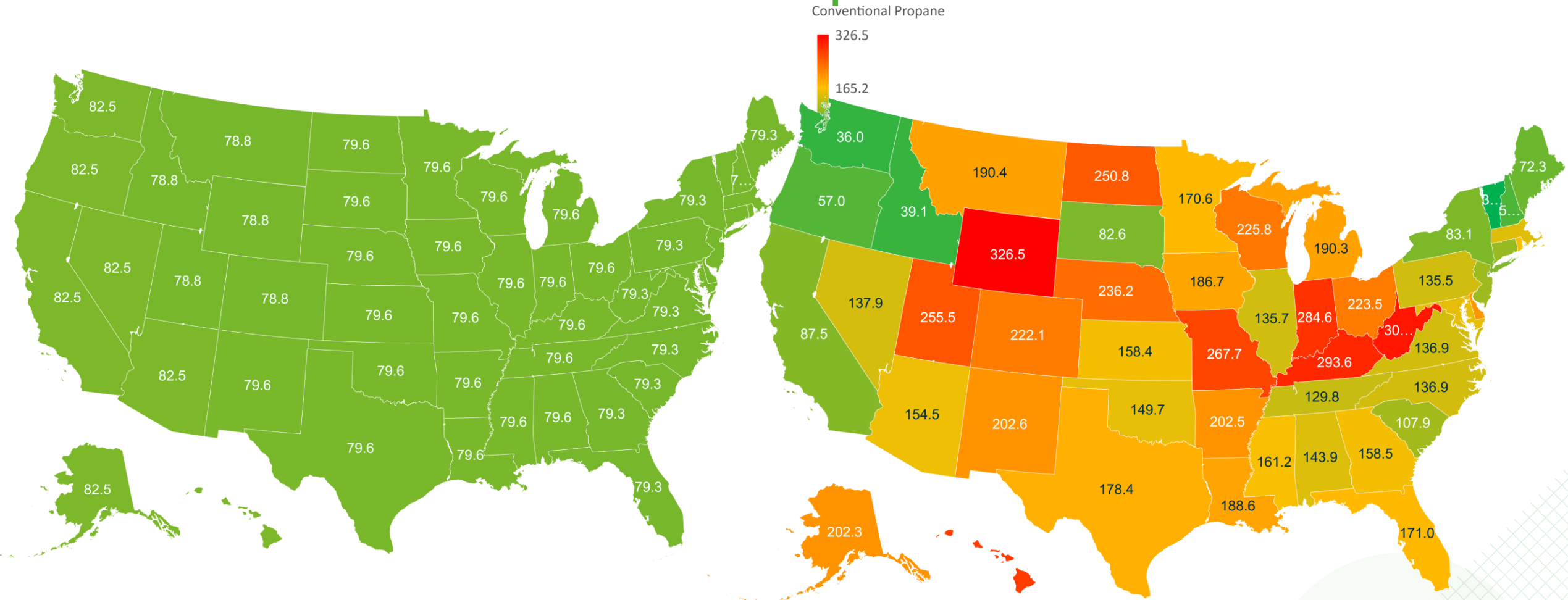




Renewable Propane

# The Future of Propane Autogas

# Well-to-Wheels Carbon Intensity Comparisons of “Fuel” (gCO<sub>2</sub><sub>eq</sub>/MJ)



**Propane – 79**  
(National Average)

Powered by Bing  
© GeoNames

**Grid Electricity – 154**  
(National Average)

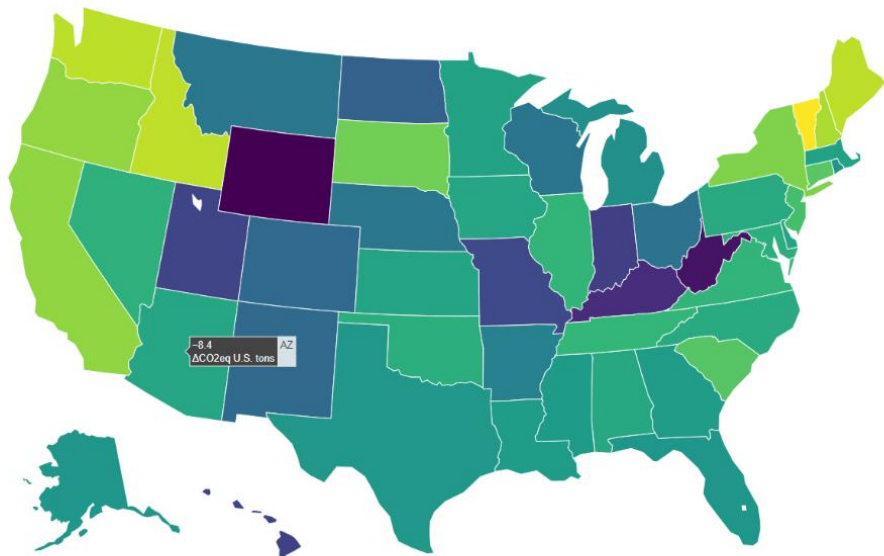
Powered by Bing  
© GeoNames



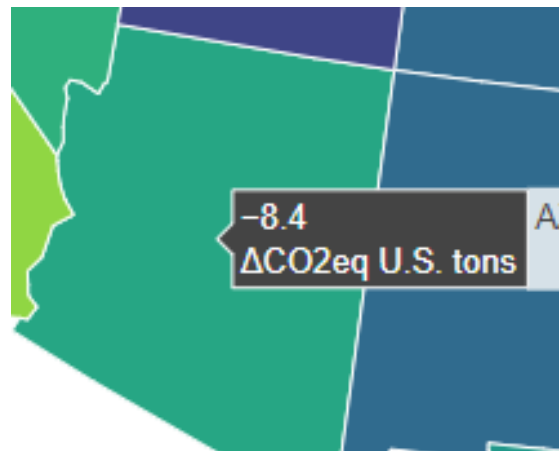
# Propane is less than EV Life Cycle Emissions

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News - Breakin... HubSpot Login National Paratransit... Autogas Hootsuite Paycor Secure Acce... Fidelity Time Cards... Grant Management... Expensify | Receipt... Login | Tableau Onli... Home - Asana Autogas Ans

$\Delta$ CO<sub>2</sub>e<sub>q</sub> between a Medium-Duty Propane and EV (Average grid emissions)  
Propane vehicle is better when value is negative and vice-versa  
(Hover over a state for value)

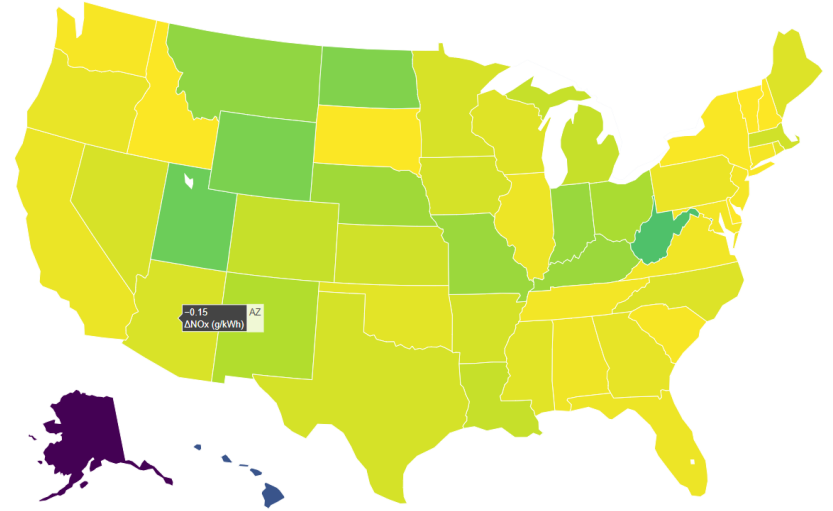


## CO<sub>2</sub> Reductions

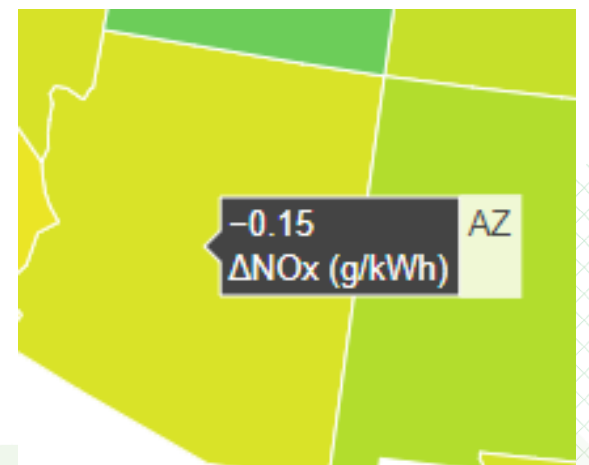


\_grid\_emissions.html | NO<sub>x</sub>\_comp\_avg\_grid\_emissions | comp\_marginal\_grid\_emissions | NO<sub>x</sub>\_comp\_marginal\_grid\_emissions | +  
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- Breakin... HubSpot Login National Paratransit... Autogas Hootsuite Paycor Secure Acce... Fidelity Time Cards... Grant Management... Expensify | Receipt... Login | Tableau Onli... Home - Asana Autogas Answe

$\Delta$ NO<sub>x</sub> between a Medium-Duty Propane (ultra-low NO<sub>x</sub>) and EV (Average grid emissions)  
Propane vehicle is better when value is negative and vice-versa  
(Hover over a state for value)

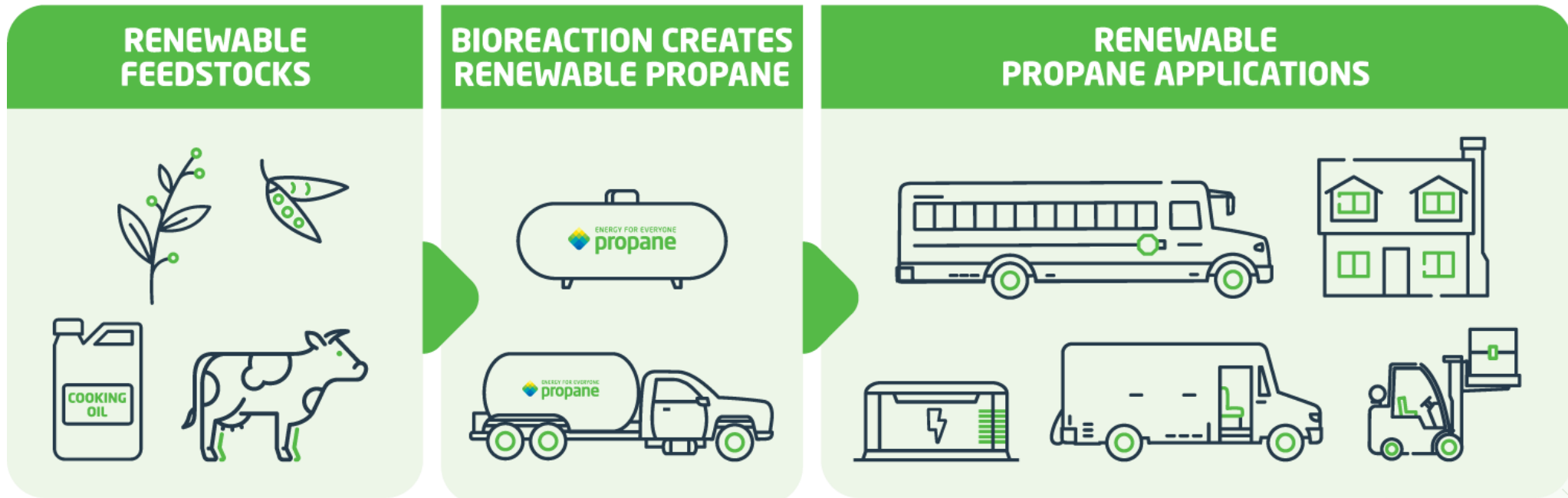


## NO<sub>x</sub> Reductions



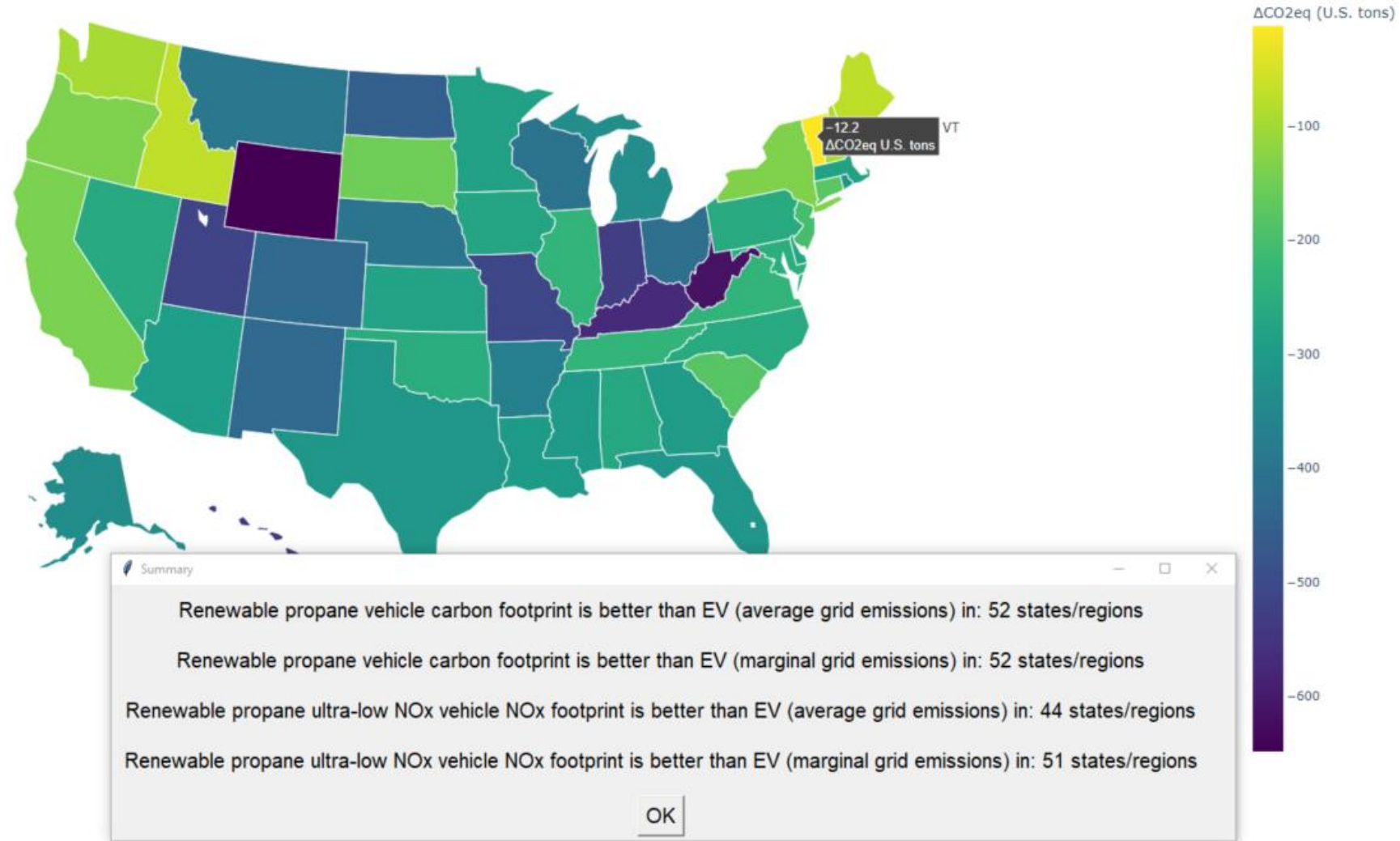
# Renewable Propane

- Low carbon intensity.
- Inexpensive feedstock.
- Abundant feedstock.
- Low energy conversion.



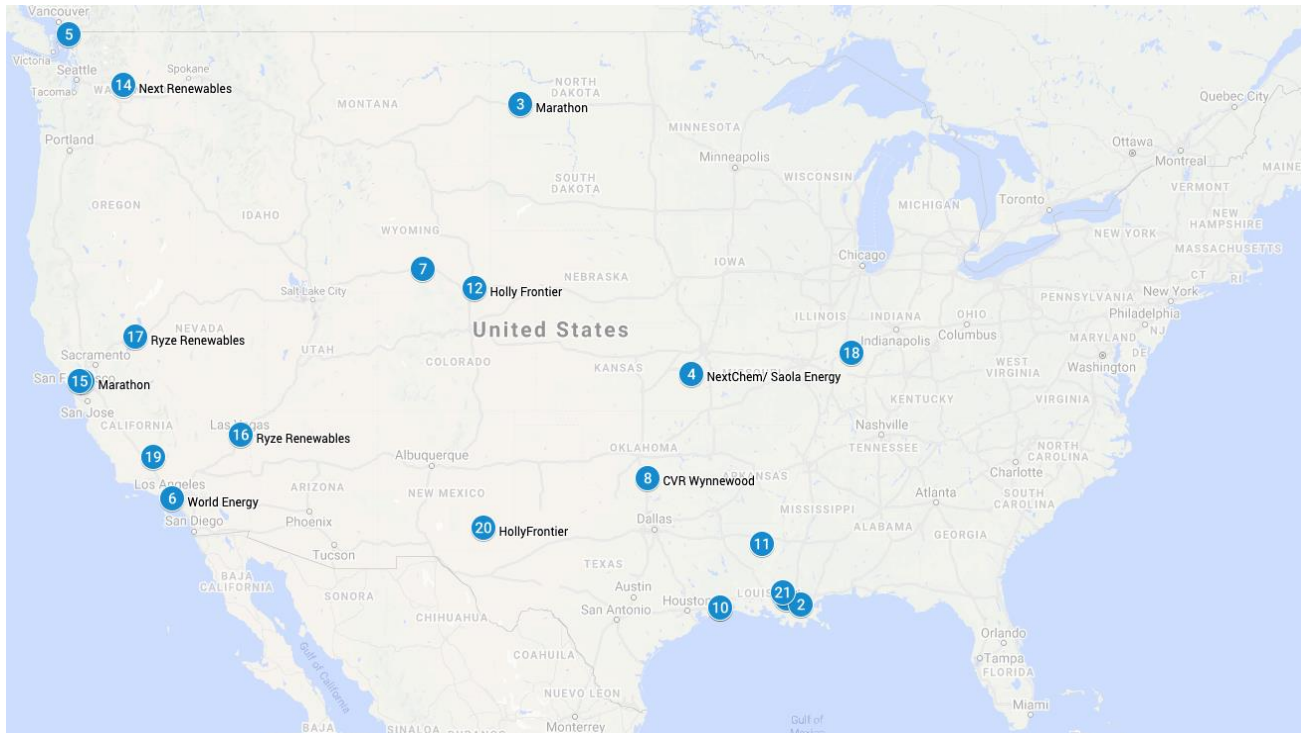
# PERC Vehicle Emission Calculator Tool: Renewable Autogas vs EV

$\Delta\text{CO}_2\text{eq}$  between a Medium-Duty Propane and EV (Average grid emissions)  
Propane vehicle is better when value is negative and vice-versa  
Click over a state for value)



# Commercial HEFA Production of RD and SAF - USA

- Over 790M Gal/y RD/SAF production in service → ~40M gallons RP potential
- Claimed growth of RD/SAF in 3-5 years ~ 4.1B Gal/y → ~200M gallons RP potential
- Highest capacity in Louisiana area > 2.5B Gal/y , California > 1.8B Gal/y
- **None on the east coast**



	Company	Location	Existing Gal/y	Additional Gal/y		Technology
1	Renewable Energy Group	Geismar, LA	90M	250M	Expanding 2023	
2	Diamond Green – Valero	Norco, LA	290M	400M	Expanding 2021	Ecofining
3	Marathon	Dickinson, ND	180M			HydroFlex
4	NextChem/ Saola Energy	Garnett, KA	5M			
5	BP Cherry Point	Birch Bay, WA	42M			
6	World Energy	Paramount, CA	35M	230M	Expanding 2023	
7	Sinclair/HollyFrontier	Sinclair, WY	150M	240M		
8	CVR Wynnewood	Wynnewood, OK		100M	Under construction	HydroFlex
9	Diamond Green – Valero	Port Arthur, TX		470M	Under construction 2024	
10	Emerald Biofuels	Port Arthur, TX		110M	Under construction	
11	Green Fuels	Port of Columbia, LA		32M	Planning 2025	
12	Holly	Cheyenne, WY		90M	Planning 2022	
13	Marathon	Martinez, CA		730M	Converting 2023	HydroFlex
14	Next Renewables	Columbia River, OR		750M	Planned 2024	
15	Phillips 66	Rodeo, CA		650M	Planning 2024	
16	Ryze Renewables	Las Vegas, NV		100M	Planning	
17	Ryze Renewables	Reno, NV		50M	Planning	
18	St Joseph Renewable Fuels	Newton, IL		90M	Planning	
19	Bakersfield Renewable Fuels	Bakersfield, CA		230M	Converting 2022	HydroFlex
20	HollyFrontier	Artesia, NM		110M	Converting 2022	
21	Grön Fuels	Baton Rouge, LA		900M	Planning 2030	
	<b>Total</b>		<b>792M</b>	<b>5,532M</b>		

# Renewable Propane Customers



NEWS

## California schools adopting propane-powered buses



BY JESSICA HICE POSTED 09.09.2019

TWITTER

In the last decade, numerous California school districts have adopted propane-based school buses in an attempt to eliminate costs and toxic emissions.

FACEBOOK

EMAIL

Since 2013, the Elk Grove Unified School District near Sacramento has added 16 propane buses to its fleet and expects up to 12 more in the

NEWS

# Renewable propane makes NY debut near Whitehall

by: [Jay Petrequin](#)

Posted: Apr 13, 2022 / 04:57 PM EDT

Updated: Apr 13, 2022 / 04:57 PM EDT



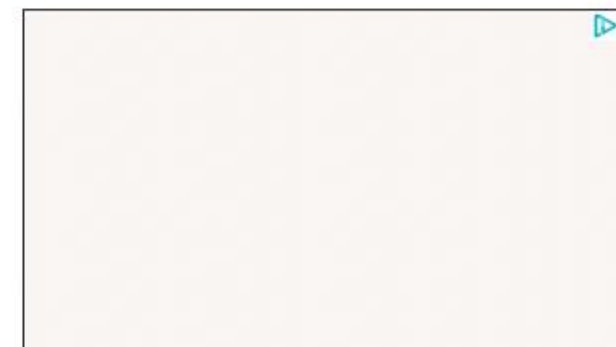
SHARE



*Ray Energy Corp. President Ken Ray points at a chart showing the relative carbon impact of renewable propane when compared to traditional propane, gasoline and...  
[Read More](#)*

HAMPTON, N.Y. (NEWS10) – This week, Ray Energy Corp.’s Hampton facility hosted a special event unveiling a new energy solution available for the first time in New York State. The wholesale propane supplier is introducing a new, renewable way for residents to heat and power their homes.

The company’s renewable propane was announced at an event at the Hampton facility, near Whitehall, on Tuesday. The alternative to traditional propane uses biomass and waste products sourced entirely within the U.S. It’s also free of any fossil fuels.





# Funding Opportunities

# Authorized Funding: Buses and Bus Facilities Formula, Competitive, and Low-No Program (Section 5339)

Program Component	FY 2022 (in millions)	FY 2023 (in millions)	FY 2024 (in millions)	FY 2025 (in millions)	FY 2026 (in millions)
<b>Formula</b>	\$603.99	\$616.61	\$632.71	\$645.78	\$662.20
<b>Buses and Bus Facilities Competitive</b>	\$375.70	\$383.54	\$393.56	\$401.69	\$411.90
<b>Low or No Emissions Competitive</b>	\$1,121.56	\$1,123.06	\$1,124.96	\$1,126.51	\$1,128.46
<b>5339 Program TOTAL</b>	\$2,101.25	\$2,123.21	\$2,151.23	\$2,173.98	\$2,202.56

*Please Note: Funding amounts before subtracting administrative and oversight takedown.*





# 2023 Low-No & Buses and Bus Facilities Competition

## Available Funding: Approximately **\$1.7 billion**

- Buses and Bus Facilities Competitive: Approximately \$469 million
- Low or No Emissions: \$1.22 billion (**\$357 million for low emission projects\***)

Important Dates	
Notice of Funding Opportunity	January 27, 2023
Applications Due	11:59pm EST April 13, 2023
Project Evaluations	April – May 2023
Award Announcement	No Later than June 28, 2023
Pre-Award Authority	Starts on date of project announcement
Available for Obligation	The year of award plus 3 years – September 30, 2026

*\*Please note: Due to less funding being requested than was available for low-emission projects in 2022, this amount includes approximately \$69 million in FY22 funds reserved for low-emission projects as required by statute.*



## Competitive Program Descriptions

### Low-No Program

“The **Low-No Program (5339(c))** provides funding for the purchase or lease of zero-emission and low-emission transit buses, as well as for the acquisition, construction, or leasing of supporting facilities and equipment.”

### Buses and Bus Facilities Competitive Program

“The **Grants for Buses and Bus Facilities Program (5339(b))** authorizes FTA to award grants to assist in the financing of buses and bus facilities capital projects including:

- 1) Replacing, rehabilitating, purchasing, or leasing buses or related equipment
- 2) Rehabilitating, purchasing, constructing, or leasing bus-related facilities”



## Low Emission Set Aside – 25 Percent

- As required by Federal public transportation law ([49 U.S.C. 5339\(c\)\(5\)](#)), a minimum of 25 percent of the amount awarded under the Low-No Program will be awarded to **low-emission projects** other than zero-emission vehicles and related facilities.
- \$69,192,987 of FY 2022 funding for low-emission projects remains available, in addition to the \$287,920,295 available for FY 2023 – totaling **\$357,113,282** total in available funds for low emission projects in 2023.
- Eligible projects include (but not limited to):
  - Hybrid Electric / Gas or Hybrid Electric /Diesel Buses
  - Compressed Natural Gas or Liquefied Natural Gas Buses
  - Ethanol, Propane, and Other Alternative Fuel Buses
  - Constructing or Leasing Facilities Specifically for Low Emission Buses
  - Rehabilitating / Improving Existing Public Facilities to Accommodate Low Emission Buses



# Benefits of Propane/Renewable Propane

## Average Price Per Gallon for the week of March 24, 2023

These prices are based on National averages. To receive a custom quote with your local autogas pricing, contact us today. Learn more about the savings and stability of autogas.

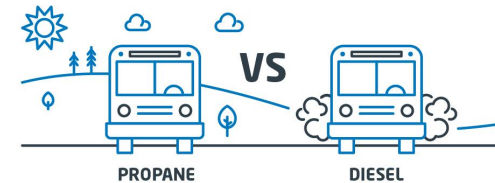
\*Autogas price estimates do not reflect the current federal tax credit.



# 96%

## NOx REDUCTION VERSUS CLEAN DIESEL BUS

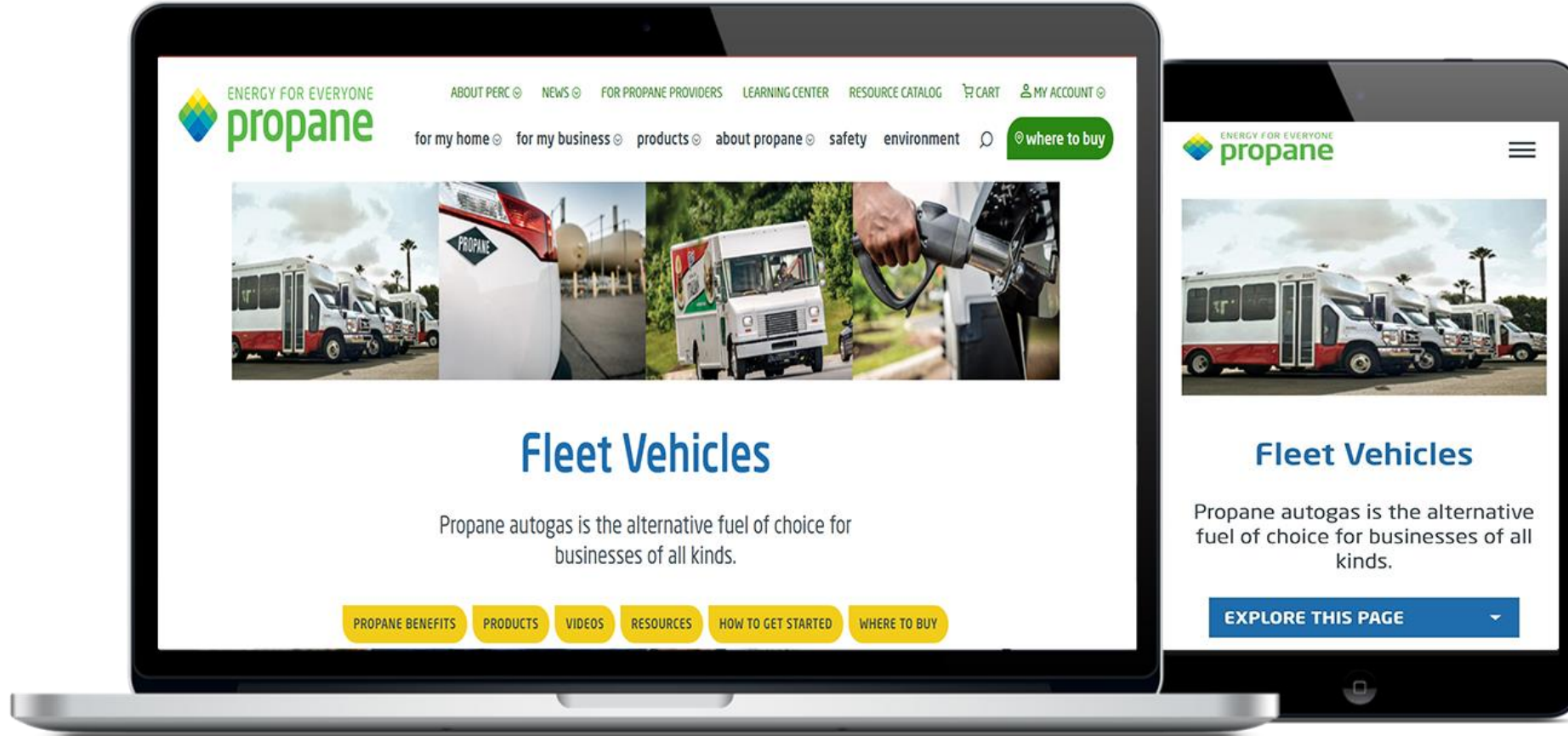
Duty cycle: Low speed, stop-and-go route



Source: 2018 West Virginia University study, comparing 2015 LPG Blue Bird school bus (6.8L, 10 Cylinder) with 2014 ultra-low sulfur diesel Blue Bird school bus (6.7L, 6 cylinder).

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