Autogas Answers

December 17, 2020
10 – 11:30 a.m.
Webinar
Autogas Answers for School Districts
DFWCC and Propane Council of Texas

Your microphones will be muted.

Please submit QUESTIONS in the Q&A at bottom.

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Autogas Answers for School Districts
DFWCC and Propane Council of Texas

This meeting IS being recorded.

December 17, 2020
10:00 - Welcome and Overview – Amy Hodges, D/FW Clean Cities Coalition

10:05 - Propane Benefits and Technology Overview – Steve Whaley, Business Development Director, Propane Education and Research Council (PERC)

10:30 – Mowers – Matt McDonald, Director of Off-road Business Development, PERC

10:40 – Technology and Propane Bus – Tom Hopkins, Business Development Manager, Roush CleanTech

10:55 – Prosper ISD Introduction

11:00 – Grant Availability in Texas – Heather Ball, Grants Advisor, Propane Council of Texas

11:15 – Discussion/Questions & Answers

11:30 - Closing Remarks – D/FW Clean Cities Coalition
Amy Hodges
Dallas/Fort Worth Clean Cities
Sr. Air Quality Planner
Welcome and Overview
Who and What is NCTCOG?

Regional Planning Agency
North Central Texas Council of Governments

Metropolitan Planning Organization (MPO)

DFW Clean Cities Coalition
Clean Cities Portfolio

- Light-, Medium-, and Heavy-Duty Vehicles
- Alternative and Renewable Fuels and Infrastructure
- Idle Reduction Measures and Fuel Economy Improvements
- New Mobility Choices and Emerging Transportation Technologies
Coalition projects have resulted in a cumulative impact in energy use equal to nearly
10 billion gasoline gallon equivalents resulting from reduced fuel use and increased fuel diversity.¹

Coalition projects have helped to put nearly
1 million alternative fuel vehicles on the road.²

---

96 million gasoline gallon equivalents of energy were saved through fuel economy improvement projects like telematics, driver training, and outfitting fleets with idle reduction equipment.²
Technology Integration Program

Provide objective/unbiased data and real-world lessons learned that inform future research needs and support local decision-making
Steve Whaley
Propane Education & Research Council (PERC)
Director, Business Development
Propane Benefits and Overview
Autogas Answers
Dallas / Fort Worth Clean Cities

Stephen Whaley
Director of Autogas Business Development
Stephen.Whaley@propane.com
864-606-2290
Successful Alternative Energy Adoption
What Makes an Alternative Energy Adoption Successful?

- Reduced emissions without increasing cost or losing efficiency.
- TCO reduction or ROI realized before the end of the lifecycle.
- Similar (or better) performance than the original fuel without compromising range.
- High-volume supply of energy domestically sourced.
How Does Autogas Fit Into The Conversation?

- Most cost-effective energy source to reduce NOx emissions.
- Lowest total cost-of-ownership of any fuel.
- Comparable or improved performance without compromising range.
  - 9 billion used domestically.
  - 19 billion gallons exported.
WHAT IS PROPANE?

• Affordable, Clean, American-Made Fuel
  • C3H8
  • 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
Propane comes from organic as well as renewable sources.

It’s nontoxic, meaning it does not contaminate air, soil, or water resources.
WHY FLEETS CHOOSE PROPANE AUTOGAS

Total Cost-of-Ownership
Lower Emissions
Reduce Noise
Less Maintenance/Increased Uptime
Improve Corporate Image
Employee Morale/Driver Retention
Path to Zero Emissions
• Particulate Matter
  • Virtually zero
  • Zero with renewable propane

• 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
Fuel & Maintenance Cost Reductions
Today's Propane Autogas

Average Price Per Gallon for the week of December 1, 2020

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.

- $1.53 West Coast
- $1.43 Rocky Mountain
- $1.37 Gulf Coast
- $1.47 Midwest
- $1.48 Lower Atlantic
- $1.53 Central Atlantic
- $1.48 New England
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.
OEM Propane Options

- Updated and improved to increase reliability.
- The entire powertrain is sold, warranted, and supported by Freightliner Custom Chassis.
2020 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)
**Icom’s certified Medium Duty Platforms**

The Icom JTG II system is EPA Certified & CARB approved for over 1,200 2009-2019 vehicle platforms including many Ford and GM models.

**The Total Solution for any Type of Fleet!**

- **E450** - CARB approved 2016-2017
- **F350 F450 F550**
  - *FORD NEW 7.3L engine available Spring 2020! Taking orders now!
- **F53 F59** (BAKERY, LINEN, FEDEX TYPE BOX TRUCKS)
- **6.0L HD**
  - Please confirm with Icom engine family
- **F750**
- **Chevy Cutaway**
  - Coming soon!
CAMPBELL PARNELL AND ISUZU NPR

- Bi-Fuel conversions Pre or Post delivery
- 5 year warranty and maintenance packages available
- Plug and Play for ease of installation and service
- CP works directly with the OEM for product development
- EPA and Carb Certification
Propane School Bus Testimonial: Northside Independent School District
SNAPSHOT OF PROPANE AUTOGAS SCHOOL BUS MARKET

1,250,000
STUDENTS TRANSPORTED
DAILY

1,000
DISTRICTS & CONTRACTORS
OPERATE PROPANE AUTOGAS BUSES

14
STATES WITH
500+ BUSES

21,000+
PROPANE AUTOGAS BUSES ON THE ROAD
Similarly Equipped Blue Bird Type C Bus

- Diesel, Cummins, ISB, 6.7L $98,500.00
- LPG, Ford/Roush, 6.8L $107,000.00
- CNG, Ford/Roush, 6.8L $134,000.00
- Electric, Cummins $385,000.00
VW: School Bus Funding & No. of Buses Through July 20, 2020

Source: Propane Education & Research Council
Study: Comprehensive Alt-Fuel Approach Better Than Single Technology Focus

<table>
<thead>
<tr>
<th></th>
<th>Texas</th>
<th>California</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>On-Road Funds Spent</td>
<td>$561 million</td>
<td>$816 million</td>
<td>CA spent 46% more</td>
</tr>
<tr>
<td>NOx Reduced</td>
<td>61,610 tons</td>
<td>35,299 tons</td>
<td>CA accomplished 43% less</td>
</tr>
<tr>
<td>Total # of Investment Years (2005-19)</td>
<td>15 years</td>
<td>15 years</td>
<td>TX reduced more emissions while spending less</td>
</tr>
</tbody>
</table>

California regulators spent 46% more public money while accomplishing 43% less than Texas.

https://www.worktruckonline.com/10129055/study-shows-comprehensive-alternative-fuels-approach-achieves-greater-emissions-reductions-than-single-technology-focus
Emerging Vehicle Markets
Top Targets For Alternative Fuel Adoptions

- Medium duty trucks.
  - Class 3-7.

- High volume fuel consumption.
  - 300 to 900+ gallons per month.

- Regional routes.
  - 75 to 300+ miles per day.
EMERGING MARKETS

Food/Beverage

• Major companies have already validated propane autogas in this market.
  • ReadyRefresh by Nestlé Waters.
  • Schwan’s Home Delivery.
Paratransit

- 25,000 paratransit vehicles nationwide.
- 600 gallons per month average fuel consumption.
- ADA requires every county in the U.S. to provide service.
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 per month average fuel consumption.
Autogas Infrastructure
Fueling Infrastructure - Mobile Refueling

- **Best Option:** Fleet has limited space for on-site infrastructure.

Your fleet can take advantage of propane autogas even if your plans are uncertain about investing in infrastructure in the near future.

- Mobile refueling is arranged with your local propane retailer.

- At a scheduled time, your retailer will refuel your fleet vehicles on-site, one by one.

*Costs and situations vary; talk to an area propane retailer for more details.*
Temporary Refueling set-up

- **Best Option:** Fleet is in the process of building permanent refueling infrastructure.

- **Includes:** Exact setup varies, but generally includes a dispenser and fuel tank mounted on a trailer.

  This option keeps fleets fueled with a temporary, self-contained refueling setup.

- A propane retailer owns all the equipment, and your fleet refuels using the tank and dispenser for as long as necessary.

  *Costs and situations vary; talk to an area propane retailer for more details.*
Temporary Refueling set-up
Standard private station

• **Best Option:** Fleet of 50 vehicles or fewer.

**Includes:** A 1,000-3,000-gallon tank, plus a single autogas fuel dispenser.

Like an advanced private station, you or your propane provider own the infrastructure.

• If your propane provider owns the infrastructure, you’re responsible for site preparation (crash protection and electrical).
  • Propane provider owns the infrastructure — Your cost: $1,500-$15,000 (site preparation)

• If you own the infrastructure, you purchase the propane tank, pump, motor, and dispenser for a convenient central refueling location.
  • Fleet owns the infrastructure — Your cost: $1,500-$15,000 (site preparation) + $20,000-$60,000 (infrastructure)
Standard private station
Standard private station
Standard private station
**Advanced private station**

- **Best Option**: Fleet of 50 vehicles or more.

**Includes**: A high-capacity tank, a canopy, and multiple fuel dispensers.

With this setup, either you or your propane provider own the infrastructure:

- If your propane provider owns the infrastructure, you’re responsible for site preparation (crash protection and electrical).
  - Propane provider owns the infrastructure — Your cost: $5,000-$75,000 (site preparation)
- If you own the infrastructure, you pay for the cost of a canopy, propane tank, pump, motor, and dispenser with card lock and vehicle tracking capability.
  - Fleet owns the infrastructure — Your cost: $5,000-$75,000 (site preparation) + $60,000-$225,000 (infrastructure)
Advanced private station
Custom Advanced private stations
Dispenser Options

- Credit card reader
- Transaction receipt printer
- Hose retractor
- Quick connect (Euro) nozzles
- Fully integrated, customizable fuel management system
- Third party fuel management system connections
- Telemetry
Fueling infrastructure cost for 10 Shuttles

- Diesel = $0k (already existing)
- Propane = $40k
- CNG = $200k (ten fixed time fill hoses)
- Electric = $250k (ten fixed plug in lines)
Dept of Energy Alt Fuel Station Locator

[Map showing locations of fuel stations across the United States]
Technological Innovations
CUMMINS 6.7L PROPANE DEMONSTRATION ENGINE
B6.7 PROPANE DEMONSTRATION ENGINE ARCHITECTURE

**Base Engine**
- 6.7L Displacement
- 107 mm Bore x 124 mm Stroke
- 12:1 CR
- Late Intake Valve Closing cam
- 4 Head Bolt Gray Iron Block
- Dual Overhead Camshaft Valve Train
- 4 Valve Aluminum Cylinder Head
- 174 bar PCP Limit
- High Efficiency Pent Roof Combustion Chamber
- High Tumble Charge Motion Intake Ports
- Leverages B6.7 Diesel Components Where Applicable for Increased Reliability and Durability

**Fuel and Ignition System**
- Direct Propane Injection
- 200 bar Rail Pressure Capability
- High Pressure pump w/ recirculation
- M14 Spark Plug w/ single coil on plug inductive ignition system

**Air Handling System**
- Twin Entry, Dual Scroll, Wastegate Turbocharger with Command WG

**Electronics/Controls**
- SI Specific ECM

**Cummins Aftertreatment System**
- On-Engine Close Coupled Three Way Catalyst

**Vehicle Integration**
- System Weight Improved Over B6.7 Diesel
- Customer Interfaces Similar to B6.7 Diesel
TORQUE CURVE COMPARISON

![Graph showing torque curve comparison for different engines at various speeds and horsepower levels. The graph compares:
- CMI B6.7L Diesel
- CMI 6.7L DI LPG
- Ford 6.8L V10
- S2G 8.0L LPG
- GM 6.0L Gasoline
- PSI 8.8L LPG

Speed (RPM) on the x-axis ranges from 600 to 4000, with torque (Nm) on the y-axis ranging from 0 to 1200.

Key points:
- 320 hp engines show a peak torque around 2400 RPM.
- 350 hp engines have a higher peak torque around 2200 RPM.
]
Renewable Propane
The Future of Propane Autogas
Comprehensive Carbon Goals
Comprehensive Carbon Goals

>50% U.S. Population
>50% U.S. GDP
>40% of on-road fuel
>90% of heating oil
Renewable Propane

- Low carbon intensity.
- Inexpensive feedstock.
- Abundant feedstock.
- Low energy conversion.
- Final product competitively priced.
Current Renewable Propane Sources
Greenhouse Gas Life Cycle Analysis

Comparisons between Propane and Electric Medium Duty Vehicles
STATE OF THE ELECTRICAL GRID

2019 Electrical Grid Source Energy Mix – Fossil and Biomass
Well-to-Wheels Carbon Intensity Comparisons of “Fuel” (gCO₂ₑq/MJ)

Note: They are compared on the same scale

CARB approved value = 82.92. Higher value here as charging losses are accounted for.
## Simulated Cases

<table>
<thead>
<tr>
<th>Case</th>
<th>Detail</th>
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</thead>
<tbody>
<tr>
<td>Case I</td>
<td>Comparison of conventional propane vehicle vs. MDEV</td>
</tr>
<tr>
<td>Case II</td>
<td>Comparison of renewable propane vehicle vs. MDEV</td>
</tr>
<tr>
<td>Case III</td>
<td>Comparison of propane/renewable DME blend (80%-20% by mass) vehicle vs. MDEV</td>
</tr>
<tr>
<td>Case IV</td>
<td>Comparison of renewable propane/renewable DME blend (80%-20% by mass) vehicle vs. MDEV</td>
</tr>
<tr>
<td>Case V</td>
<td>Comparison of renewable propane/renewable DME blend (80%-20% by mass) vehicle vs. MDEV (Decarbonized electric grid scenario)</td>
</tr>
</tbody>
</table>

- Renewable fuel and components production CIs assumed the same as status-quo even under decarbonized electric grid scenario. In reality, the CI of renewable fuels and production CIs will be lower due to cleaner electricity. Calculation of these are out-of-scope.
- Propane vehicle fuel economy has been kept the same as status-quo even under decarbonized electric grid scenario. In reality, the fuel economy will improve significantly due to evolution of engine technologies (~25 years from now).
Case-I: $\Delta CO_2_{eq}$ for One Truck:

Green - Propane is Better, Red – MDEV is better

Today, Propane is a cleaner solution for 38 states and DC

Numbers represent $\Delta LC$ CO2 emissions in US tons per MD vehicle
Case-II: $\Delta CO_2_{eq}$ for One Truck:

Green – R-Propane is Better, Red – MDEV is better

Numbers represent $\Delta LC$ CO2 emissions in US tons per MD vehicle

Today, Renewable Propane is a cleaner solution for all states (and DC) but Vermont
**Propane/Renewable DME Blend vs. Full Electric**

**Case-III: \( \Delta \text{CO}_2_{eq} \) for One Truck:**

Green – Propane/R-DME is Better, Red – MDEV is better

Today, Propane/R-DME blend is a cleaner solution for all states (and DC) but Vermont.
RENEWABLE PROPANE/RENEWABLE DME BLEND VS. FULL ELECTRIC

Case-IV: $\Delta CO_2_{eq}$ for One Truck:

Green – R-Propane/R-DME is Better

Today, R-Propane/R-DME blend is a cleaner solution for all states and DC

Numbers represent $\Delta LC$ CO2 emissions in US tons per MD vehicle
Green – R-Propane/R-DME is Better

Even with decarbonized electric grid, renewable propane/renewable DME blend vehicle is a cleaner solution than MDEV for all states and DC.
References

- https://ww2.arb.ca.gov/resources/documents/lcfs-pathway-certified-carbon-intensities
- GREET3.0
- https://www.eia.gov/dnav/pet/pet_sum_snd_d_r50_mbbl_a_cur-3.htm
- https://www.eia.gov/electricity/state/unitedstates/
- https://batteryuniversity.com/learn/article/bu_1003a_battery_aging_in_an_electric_vehicle_ev
- Effects of battery manufacturing on electric vehicle life-cycle greenhouse gas emissions, ICCT Briefing (2018)
Benefits of Propane/Renewable Propane

- **Cost Effectiveness**
  - MD Propane averages 15% of vehicle cost
  - MD EV averages 300% of vehicle cost

- **Payload**
  - MD Propane – no loss of payload
  - MD EV – heavy battery weight diminishes payload capacity

- **CO2 Greenhouse Gas**
  - MD Propane produces less carbon in 38 states than EV today
  - MD Renewable Propane best blend produces less carbon in all states than EV’s best grid in 2035
https://propane.com/for-my-business/school-transportation/
STEVE WHALEY

DIRECTOR OF AUTOGAS BUSINESS DEVELOPMENT
PROPANE EDUCATION & RESEARCH COUNCIL
STEPHEN.WHALEY@PROPANE.COM
864-606-2290
Matt McDonald
PERC
Director of Off-road Business Development
Mowers
Propane Mowers Can Do That
Current Challenges for Landscape Contractors

   - Daily operating costs.
   - Seasonal labor issues.
   - Expensive equipment.
   - Oversaturated markets driving down margins.

2. Emissions restrictions.
   - Either requested or required by customer.

3. Downtime is a revenue killer.
How Propane Helps Commercial Landscapers

1. Reduces fuel costs.
   • Between 30-50% savings over gasoline & diesel.

2. Improved emissions profile.
   • Qualify for more bids.
   • Ability to operate on more days (Ozone Action Days).

3. Increase in productivity.
   • Faster refueling & on-site refueling options.
Reduced Emissions

1. Emissions matter to the contractor and their customers.
   • Could even be *required* by a bid.

2. Being “green” enables contractors to reach new or niche audiences.
   • Schools, municipalities, etc.

3. Contractors can leverage propane’s low-emissions status in their marketing efforts.
Increased Productivity w/ Refueling

Less time spent refueling or dealing with fuel-related issues and more time spent mowing.
Increased Productivity w/ Refueling

Best for small mowers fleets (1-10 mowers)

Best for larger mower fleets (10+ mowers)
A Growing Market

Propane Mower Sales

- 2018
- 2017
- 2016
- 2015
- 2014
- 2013
- 2012
- 2011
- 2010
- 2009
- 2008

OEM  Conversion
Propane Options from Brands Contractors Prefer
Calculate Your Savings

• Input variables specific to your fleet to determine the amount of savings propane equipment can provide your business.

• Available in tablet, smartphone, and desktop applications.

Propane.com/Mower-Calculator
Need Help Finding an Equipment Dealer or Conversion Specialist?

- The only locator of its kind, directing contractors who want to buy propane equipment to the dealers who sell it.

Propane.com/Where-To-Buy/Find-Equipment-Dealer
Tom Hopkins
Roush CleanTech
Business Development Manager
Technology and School Buses
<table>
<thead>
<tr>
<th></th>
<th>D</th>
<th>GAS</th>
<th>PROPANE</th>
<th>CNG</th>
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<tbody>
<tr>
<td>Ease of Adoption</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
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<td>Energy Independence</td>
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<td>NOx Emissions</td>
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Disruptive Growth in Alternative Fuels

FY 2012: 9% alternative fuels, 91% traditional fuels
FY 2014: 17% alternative fuels, 83% traditional fuels
FY 2016: 26% alternative fuels, 74% traditional fuels
FY 2018: 38% alternative fuels, 62% traditional fuels
FY 2019: 49% alternative fuels, 51% traditional fuels
Our Progress

- OVER 16,000 SCHOOL BUSES ON THE ROAD
- ACCUMULATED OVER 500 MILLION MILES
- OVER 950 SCHOOL DISTRICTS

800.59.ROUSH ROUSHcleantech.com
38 School Districts
• 1146 Propane Buses
### Blue Bird Vision

<table>
<thead>
<tr>
<th><strong>Model Year</strong></th>
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<tbody>
<tr>
<td>2021</td>
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<table>
<thead>
<tr>
<th><strong>Engine Size</strong></th>
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<tbody>
<tr>
<td>7.3L V-8 (2V) Ford Engine with exclusive ROUSH CleanTech Propane Fuel System</td>
</tr>
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<thead>
<tr>
<th><strong>Applications</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>169” / 189” / 217” / 238” / 252” / 273” / 280” wheelbase configurations</td>
</tr>
<tr>
<td>6-speed automatic transmission</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Propane / Gas Fuel Tank Capacity</strong></th>
</tr>
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<tbody>
<tr>
<td>Short: 47 gallons (usable)</td>
</tr>
<tr>
<td>Standard: 67 gallons (usable) / 60 gallons</td>
</tr>
<tr>
<td>Extended: 93 gallons (usable) / 100 gallons</td>
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<thead>
<tr>
<th><strong>Technical Specifications</strong></th>
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<tbody>
<tr>
<td>EPA and CARB approved.</td>
</tr>
<tr>
<td>GVWR: 33,000 lbs.</td>
</tr>
<tr>
<td>Up to 77 passengers</td>
</tr>
</tbody>
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<tr>
<th><strong>Order Availability</strong></th>
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<tbody>
<tr>
<td>Blue Bird dealers</td>
</tr>
</tbody>
</table>
## Micro Bird Type – A

<table>
<thead>
<tr>
<th><strong>Model Years</strong></th>
<th>2021</th>
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<tbody>
<tr>
<td><strong>Engine Size</strong></td>
<td>7.3L V8 PFI</td>
</tr>
<tr>
<td><strong>Applications</strong></td>
<td>158” wheelbase</td>
</tr>
<tr>
<td></td>
<td>6-speed automatic transmission.</td>
</tr>
<tr>
<td><strong>Fuel Tank Capacity</strong></td>
<td>Aft-axle: 41 gallons (usable)</td>
</tr>
<tr>
<td><strong>Technical Specifications</strong></td>
<td>EPA and CARB approved.</td>
</tr>
<tr>
<td></td>
<td>GVWR: &gt; 14,000</td>
</tr>
<tr>
<td></td>
<td>Requires “91G” gaseous fuels prep. package.</td>
</tr>
<tr>
<td><strong>Seating Capacity</strong></td>
<td>Up to 30 passengers</td>
</tr>
<tr>
<td><strong>Order Availability</strong></td>
<td>July 2020</td>
</tr>
</tbody>
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**Ford E-450 Dual Rear Wheel**

800.59.ROUSH

ROUSHcleantech.com
7.3L ENGINE
## 7.3L Engine Stats

<table>
<thead>
<tr>
<th>Engine RPM</th>
<th>Power</th>
</tr>
</thead>
<tbody>
<tr>
<td>Idle: 680 / Max: 4,050</td>
<td>HP: 350 / Torque: 468 ft-lbs. @ 3,900 RPM</td>
</tr>
</tbody>
</table>

Design | Compression
Dimensional Comparison

<table>
<thead>
<tr>
<th></th>
<th>6.8L 3V Triton</th>
<th>7.3L 2V Godzilla</th>
</tr>
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<tbody>
<tr>
<td>Height</td>
<td>915 mm</td>
<td>835 mm</td>
</tr>
<tr>
<td>Width</td>
<td>837 mm</td>
<td>757 mm</td>
</tr>
<tr>
<td>Length</td>
<td>755 mm</td>
<td>766 mm</td>
</tr>
</tbody>
</table>
### Service & Parts Comparison

<table>
<thead>
<tr>
<th></th>
<th>6.8L V10</th>
<th>7.3L V8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oil Change Interval</td>
<td>5,000</td>
<td>5,000</td>
</tr>
<tr>
<td>Spark Plug Interval</td>
<td>60,000</td>
<td>60,000</td>
</tr>
<tr>
<td>Oil Capacity</td>
<td>7 Quarts</td>
<td>8 Quarts</td>
</tr>
<tr>
<td>Oil Type</td>
<td>Motorcraft 5w30 Blend</td>
<td>Motorcraft 5w30 Blend</td>
</tr>
<tr>
<td>Spark Plug</td>
<td>Motorcraft SP509</td>
<td>Motorcraft SP551</td>
</tr>
<tr>
<td>Oil Filter</td>
<td>Motorcraft FL820S</td>
<td>Motorcraft FL820S</td>
</tr>
<tr>
<td>Transmission</td>
<td>6R140</td>
<td>6R140</td>
</tr>
</tbody>
</table>
Class 2 – 7

High Volume
  – >600 / day
  – 6X Competition

Wide Vocational Usage
  – Parts
  – Support
  – Experience
Buyer Motivations

- U.S. Energy Independence
- Duty Cycle Simplicity
- Financial
- Environmental
COST & COMPLEXITY
Preventative Maintenance

Ford V10
Gas and Propane
7 Quarts

Various Engines
Diesel
17 – 30 Quarts
The Diesel We Know Today
### Engine Components: Diesel

#### Cummins ISB 6.7L

<table>
<thead>
<tr>
<th>Part</th>
<th>Quantity</th>
<th>Price</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>NOx Sensor</td>
<td>1</td>
<td>$480.00</td>
<td>$480.00</td>
</tr>
<tr>
<td>NOx Sensor</td>
<td>1</td>
<td>$560.00</td>
<td>$560.00</td>
</tr>
<tr>
<td>Pressure Sensor</td>
<td>1</td>
<td>$140.00</td>
<td>$140.00</td>
</tr>
<tr>
<td>Doser Injector</td>
<td>1</td>
<td>$290.00</td>
<td>$290.00</td>
</tr>
<tr>
<td>Catalyst Assembly w/ DPF</td>
<td>1</td>
<td>$10,554.11</td>
<td>$10,554.11</td>
</tr>
<tr>
<td>Temperature Sensor</td>
<td>1</td>
<td>$78.90</td>
<td>$78.90</td>
</tr>
<tr>
<td>Temperature Sensor</td>
<td>2</td>
<td>$84.90</td>
<td>$169.80</td>
</tr>
<tr>
<td>Turbo</td>
<td>1</td>
<td>$2,731.20</td>
<td>$2,731.20</td>
</tr>
<tr>
<td>Injector</td>
<td>6</td>
<td>$755.56</td>
<td>$4,533.36</td>
</tr>
<tr>
<td>EGR Valve</td>
<td>1</td>
<td>$590.15</td>
<td>$590.15</td>
</tr>
<tr>
<td>EGR Cooler</td>
<td>1</td>
<td>$923.72</td>
<td>$923.72</td>
</tr>
</tbody>
</table>

**Total** $21,051.24
## Ford 6.8L V10

<table>
<thead>
<tr>
<th>Part</th>
<th>Quantity</th>
<th>Price</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>PCV Hoses (2)</td>
<td>1</td>
<td>$43.68</td>
<td>$43.68</td>
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<tr>
<td>Vapor Management Valve</td>
<td>1</td>
<td>$65.00</td>
<td>$65.00</td>
</tr>
<tr>
<td>Gasket</td>
<td>1</td>
<td>$5.99</td>
<td>$5.99</td>
</tr>
<tr>
<td>Injector Assembly</td>
<td>10</td>
<td>$215.00</td>
<td>$2,150.00</td>
</tr>
<tr>
<td>Converter Assembly</td>
<td>1</td>
<td>$910.00</td>
<td>$910.00</td>
</tr>
<tr>
<td>Spark Plugs</td>
<td>10</td>
<td>$7.08</td>
<td>$70.80</td>
</tr>
<tr>
<td>O2 Sensors (all 3)</td>
<td>1</td>
<td>$102.57</td>
<td>$102.57</td>
</tr>
<tr>
<td>Coil Packs</td>
<td>10</td>
<td>$29.79</td>
<td>$297.90</td>
</tr>
</tbody>
</table>

**Total** $3,645.94
Fuel filtration is the only unique maintenance item.
- Propane has a stable price history
- Price lock contracting for multiple years
- Eligible for rebates, bringing District dollars back
## Total Cost of Ownership

<table>
<thead>
<tr>
<th>Fuel</th>
<th>Propane</th>
<th>Rebates</th>
<th>Gas</th>
<th>Electric</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual Miles per Bus</td>
<td>15,000</td>
<td>15,000</td>
<td>15,000</td>
<td>15,000</td>
</tr>
<tr>
<td>Years Operated</td>
<td>15</td>
<td>15</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>Total Miles Lifetime Miles per Bus</td>
<td>225,000</td>
<td>225,000</td>
<td>225,000</td>
<td>225,000</td>
</tr>
<tr>
<td>Fuel Economy (mpg)</td>
<td>4.50</td>
<td>6.00</td>
<td>7.50</td>
<td>1.40</td>
</tr>
<tr>
<td>Gallons Used Annually per Bus</td>
<td>3,333</td>
<td>2,500</td>
<td>2,000.00</td>
<td>558</td>
</tr>
<tr>
<td>Gallons Used Total per Bus</td>
<td>50,000</td>
<td>37,500</td>
<td>30,000.00</td>
<td>8,365</td>
</tr>
<tr>
<td>Fuel Price / Gallon</td>
<td>$1.10</td>
<td>$2.17</td>
<td>$2.47</td>
<td>$4.90</td>
</tr>
</tbody>
</table>

### Preventative Maintenance

<table>
<thead>
<tr>
<th>Item</th>
<th>Propane</th>
<th>Rebates</th>
<th>Gas</th>
<th>Electric</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oil Interval</td>
<td>5,000</td>
<td>5,000</td>
<td>7,000</td>
<td>7,000</td>
</tr>
<tr>
<td>Oil Capacity (Quarts)</td>
<td>7</td>
<td>7</td>
<td>21</td>
<td>21</td>
</tr>
<tr>
<td>Oil Filter Cost</td>
<td>$5.00</td>
<td>$5.00</td>
<td>$9.36</td>
<td>$9.36</td>
</tr>
<tr>
<td>Cost per Oil Change</td>
<td>$22.50</td>
<td>$22.50</td>
<td>$618.86</td>
<td>$618.86</td>
</tr>
<tr>
<td>Lifetime Oil Change Total Cost</td>
<td>$1,012.50</td>
<td>$1,012.50</td>
<td>$1,983.36</td>
<td>$1,983.36</td>
</tr>
<tr>
<td>DEF Lifetime Cost</td>
<td>$2,268</td>
<td>$2,268</td>
<td>$2,268</td>
<td>$2,268</td>
</tr>
<tr>
<td>Fuel Filters Change Interval</td>
<td>50,000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fuel Filters Cost</td>
<td>$15.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Filters Changes</td>
<td>4</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Fuel Filter Cost Lifetime</td>
<td>$640</td>
<td></td>
<td></td>
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</tbody>
</table>

### Total Cost

<table>
<thead>
<tr>
<th>Item</th>
<th>Propane</th>
<th>Rebates</th>
<th>Gas</th>
<th>Electric</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lifetime Cost</td>
<td>$161,053</td>
<td>$143,053</td>
<td>$100,308</td>
<td>$181,551.21</td>
</tr>
<tr>
<td>Lifetime Savings</td>
<td>$19,899</td>
<td>$37,899</td>
<td>$1,164</td>
<td>($13,449)</td>
</tr>
<tr>
<td>Cost per Mile</td>
<td>$0.72</td>
<td>$0.64</td>
<td>$0.80</td>
<td>$0.67</td>
</tr>
</tbody>
</table>

### Grants

- **LPG Fuel Rebate**: $0.36
- **EV Bus Grant**: $130,000.00
- **LPG Bus Grant**: $0.00
- **Diesel Bus Grant**: $0.00
Real World Savings

“15 Cents per Mile Savings on Average”

“34 Cents per Mile Savings on Average”

“Over $7,000 per Bus Savings in First Year”

“80% Lower Fuel Costs”
ENVIRONMENT & HEALTH
### ROUSH 7.3L Propane - Emissions

<table>
<thead>
<tr>
<th>Emission Constituent</th>
<th>Blue Bird Vision 7.3 LPG</th>
</tr>
</thead>
<tbody>
<tr>
<td>NOx (Nitrogen Oxides)</td>
<td>0.021</td>
</tr>
<tr>
<td>HCHO (Formaldehyde)</td>
<td>0.00</td>
</tr>
<tr>
<td>PM (Particulate Matter)</td>
<td>0.002</td>
</tr>
<tr>
<td>NMHC (Non-Methane Hydrocarbons)</td>
<td>0.051</td>
</tr>
<tr>
<td>CO (Carbon Monoxide)</td>
<td>5.85</td>
</tr>
</tbody>
</table>

**Greenhouse Gas Emissions**

| GHG Carbon Dioxide (CO₂)              | 545                      |
| GHG Methane (CH₄)                     | 0.032                    |
| GHG Nitrous Oxide (N₂O)               | 0.02                     |

- Approximate average: 70% cleaner than standards
A first-of-its-kind 2019 study released by Georgia State University links low emission on school buses to improved academic performance.

The study found students who rode to school in alternative fuel buses like propane autogas had higher test scores in math and English compared to students who rode to school in diesel buses.
SAFETY
SAFETY = #1 Priority

Crash Testing

✓ Blue Bird is certified to Canadian Motor Vehicle Safety Standard CMVSS 301.1 testing protocol, higher than US
✓ 4,000 lbs. @ 30 MPH
✓ Angled side and rear impact

Other Features

✓ Colorado Rack Test and the Kentucky Pole Test—Blue Bird is the only school bus OEM that has both tests as an engineered specification standard on all buses
  - Colorado Rack Test: Ensures that the structural integrity of the bus remains intact in the event of a rollover accident
  - Kentucky Pole Test: Ensures the strength of the school bus roof in case of a pole, or another sharp object impacts the bus during a rollover
Propane Safety

- Propane is considered as safe as any conventional engine fuel.

- Fuel tanks are 20 times more puncture resistant than gasoline.
  - Ductile steel tanks about 1/8” thick (varies slightly by tank diameter).
  - All fuel tanks are leak checked before installation.

- Colorless and odorless.
  - Ethyl mercaptan added for leak detection.
Shut-off Locations

**Tank Check Valves**
- Fill valve is back checked
- Return valve is back checked

**Supply Valve Shut-offs**
- Electronic solenoid shut-off
- Manual shut-off valve
- Excess flow check valve

**Fuel Rail Pressure Control Module**
- Supply solenoid on the FRPCM
- Check valve on FRPCM return line

**Strategy**
- Key-off isolates fuel system sections
- Fuel system isolated into three sections
  - Fuel tank
  - Fuel supply line
  - Fuel rails and return line
CUSTOMER SUCCESS
Customer Success Structure

- Customer Support
- Technical Support
- Field Service
- Technical Publications
- Training
- Warranty + Service Parts
Training Resources

Technician Training Series
Quick videos demonstrating service and diagnostic procedures

Diagnostic & Service Manuals
Updated information and procedures to simplify diagnostic steps, speed up repairs and minimize down-time
Web-Based Training

- Propane Properties and Safety
- Fuel System Components
- System Diagnostics
- Basic Warranty Information
- Technician Tip Videos
<table>
<thead>
<tr>
<th>Question</th>
<th>Rating</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Were the facilities and training equipment appropriate for the training</td>
<td>4.87</td>
<td></td>
</tr>
<tr>
<td>How useful to your job was the information you learned</td>
<td>4.87</td>
<td></td>
</tr>
<tr>
<td>Fleets Only: Based on the training session, would you recommend Roush CleanTech Vehicles for your fleet’s future purchases</td>
<td>4.76</td>
<td></td>
</tr>
<tr>
<td>Public Service Centers Only: Based on this session, how likely are you to accept future Roush CleanTech repairs</td>
<td>4.93</td>
<td></td>
</tr>
</tbody>
</table>

“Tons of info presented in a way that made sense. Bugged vehicle sessions were great”

“Fantastic Workshop, overall. Trainers did an awesome job. They were knowledgable and professional. The hospitality was great as well. Thank you!”
Propane Consideration Summary

- Simple and Robust Design
- No Duty Cycle Compromise
- Economical Operation
- Safe by Composition and Design
- Environmentally Responsible from Well to Wheels
THANK YOU!

Tom Hopkins
ROUSH CleanTech
(734) 679-5704
Tom.Hopkins@roush.com
Heather Ball

Propane Council of Texas (ProCOT)
Grants Advisor
Current Funding Opportunities
Incentives for Propane Vehicles
Propane Council of Texas

The Propane Council of Texas (ProCOT) is a non-profit 501(c) 3 dedicated to propane education and marketing.

The Council is the state arm of the Propane Education & Research Council (PERC) and we are here as a resource for fleets to help connect the dots here in Texas:

- Find a fuel provider in Texas
- Find a propane vehicle or aftermarket conversion kit
- Help finding conversion centers in Texas
- Providing complimentary grant writing services
Texas Emissions Reduction Plan

Don't Wait to Apply for Grant Funding
Texas State Revenue Forecast

Good News:
Legislature created the Texas Emission Reduction Plan Trust Fund

Bad News:
Comptroller Glenn Hegar Projects a Fiscal 2021 Ending Shortfall of $4.6 Billion in Revised Revenue Estimate
## Deadlines for TERP Applications

### January 2021

<table>
<thead>
<tr>
<th>Week</th>
<th>Sun</th>
<th>Mon</th>
<th>Tue</th>
<th>Wed</th>
<th>Thu</th>
<th>Fri</th>
<th>Sat</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td>9</td>
</tr>
<tr>
<td>02</td>
<td>10</td>
<td>11</td>
<td>12</td>
<td>13</td>
<td>14</td>
<td>15</td>
<td>16</td>
</tr>
<tr>
<td>03</td>
<td>17</td>
<td>18</td>
<td>19</td>
<td>20</td>
<td>21</td>
<td>22</td>
<td>23</td>
</tr>
<tr>
<td>04</td>
<td>24</td>
<td>25</td>
<td>26</td>
<td>27</td>
<td>28</td>
<td>29</td>
<td>30</td>
</tr>
</tbody>
</table>

- **Light Duty Deadline**
- **New Year's Day**
- **MLK Jr. Day**
- **VW Deadline**

### February 2021

<table>
<thead>
<tr>
<th>Week</th>
<th>Sun</th>
<th>Mon</th>
<th>Tue</th>
<th>Wed</th>
<th>Thu</th>
<th>Fri</th>
<th>Sat</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
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<tr>
<td>02</td>
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<tr>
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<tr>
<td>05</td>
<td>28</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- **Veteran's Day**
- **President's Day**
- **Natural Gas Vehicle Deadline**
Light Duty Vehicle Grant

$5,000 per vehicle for new light-duty natural gas or propane vehicles

$2,500 for electric vehicles.
Volkswagen Grant

Up to 50% of the cost for replacement of old diesel refuse and sweeper trucks for public entities
Natural Gas Vehicle Grant

Replacement of Diesel and Gasoline Vehicles greater than 8,501
Governmental Alternative Fuel Fleet Program

New natural gas, liquefied natural gas, liquefied petroleum gas, hydrogen fuel cells, or electricity vehicles and infrastructure.
## NCTCOG – Available Replacement Programs

<table>
<thead>
<tr>
<th>Funding Agency</th>
<th>Program</th>
<th>Eligible Applicants</th>
<th>Eligible Activities</th>
<th>Old Vehicle Criteria</th>
<th>Funding Levels</th>
<th>Deadline</th>
</tr>
</thead>
<tbody>
<tr>
<td>NCTCOG</td>
<td><strong>Clean Fleets North Texas (CFNT) 2020</strong></td>
<td>Local governments or private companies that contract with local governments</td>
<td>Replace heavy-duty diesel vehicles and equipment</td>
<td>Fuel: Diesel Model Year: 1996 – 2006 (up to 2009 if replacing with electric) GVWR: &gt;16,001 lbs.</td>
<td>Up to 45% if electric Up to 35% if new engine is certified to CARB Low NOx standards Up to 25% for all others</td>
<td>First deadline January 8, 2021 with rolling deadlines every three months until October 8, 2021</td>
</tr>
<tr>
<td></td>
<td><strong>North Texas Emissions Reduction Project (NTERP) 2020</strong></td>
<td>Private entities</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
# Updated Grant Chart

**Texas Natural Gas Vehicle Grant Program**

- **Eligibility**: Vehicles greater than 50% gasoline-powered;
- **Maximum Grant**: $3,500 to $5,000.

**Emissions Reduction Incentive Grants**

- **Eligibility**: Non-road, off-road, and marine vehicles;
- **Amount**: $15,000 to $25,000.

**Governmental Alternative Fuel Fleet Program**

- **Eligibility**: Motor vehicles that operate primarily on compressed natural gas, liquefied natural gas, or liquid petroleum gas;
- **Amount**: Varies based on vehicle and fleet size.

For more information and to apply, visit [www.txng.org/available-incentives](http://www.txng.org/available-incentives).

---

**North Central Texas Council of Governments**

**Propane Council of Texas**

**Dallas-Fort Worth Clean Cities**

**Autogas Answers**

---

**Updated Grant Chart**
FAQs for Board Members
We Can Help!

Contact Heather Ball, heather@txng.org for best sources for the following:

1) Price of natural gas and propane
2) Cost to retrofit a bay to work on alt fuels
3) Cost estimate of a propane or natural gas refueling station and available grants.
4) Grant Estimates for Alternative Fuel Buses.
5) Are school districts are eligible for 50-cent per gallon tax credit on propane or natural gas dispensed at their facility? YES
6) Carbon footprint - diesel vs natural gas or propane
Contact Information

Incentives: Heather Ball, heather@txng.org

Information on fuel providers, propane vehicles solutions and grants availability, please visit https://fuelingtexas.com
OR
Email: info@propanecounciloftexas.org or Phone: (800)325-7427

DFW- area Assistance: Amy Hodges, ahodges@nctcog.org
817-704-2508
Prosper ISD

Curtis MacDonald, Supervisor of Fleet Operations
Jay Nelis, Shop Foreman
Available for Questions on School Usage
Supervisor of Fleet Operations: Curtis MacDonald

144 Propane School Buses
  • First Propane School Bus Acquired in 2009

On-site Propane Fueling Stations

Motivations:
  • Environmental Impact
  • Reliability
  • Lower Maintenance Costs

Success Story: dfwcleancities.org/successstories
THANK YOU!

D/FW Clean Cities Coalition
Amy Hodges
AHodges@nctcog.org
(p) 817-704-2508

Propane Council of Texas
Jackie Mason
JMason@TxPropane.com
512-775-9612