



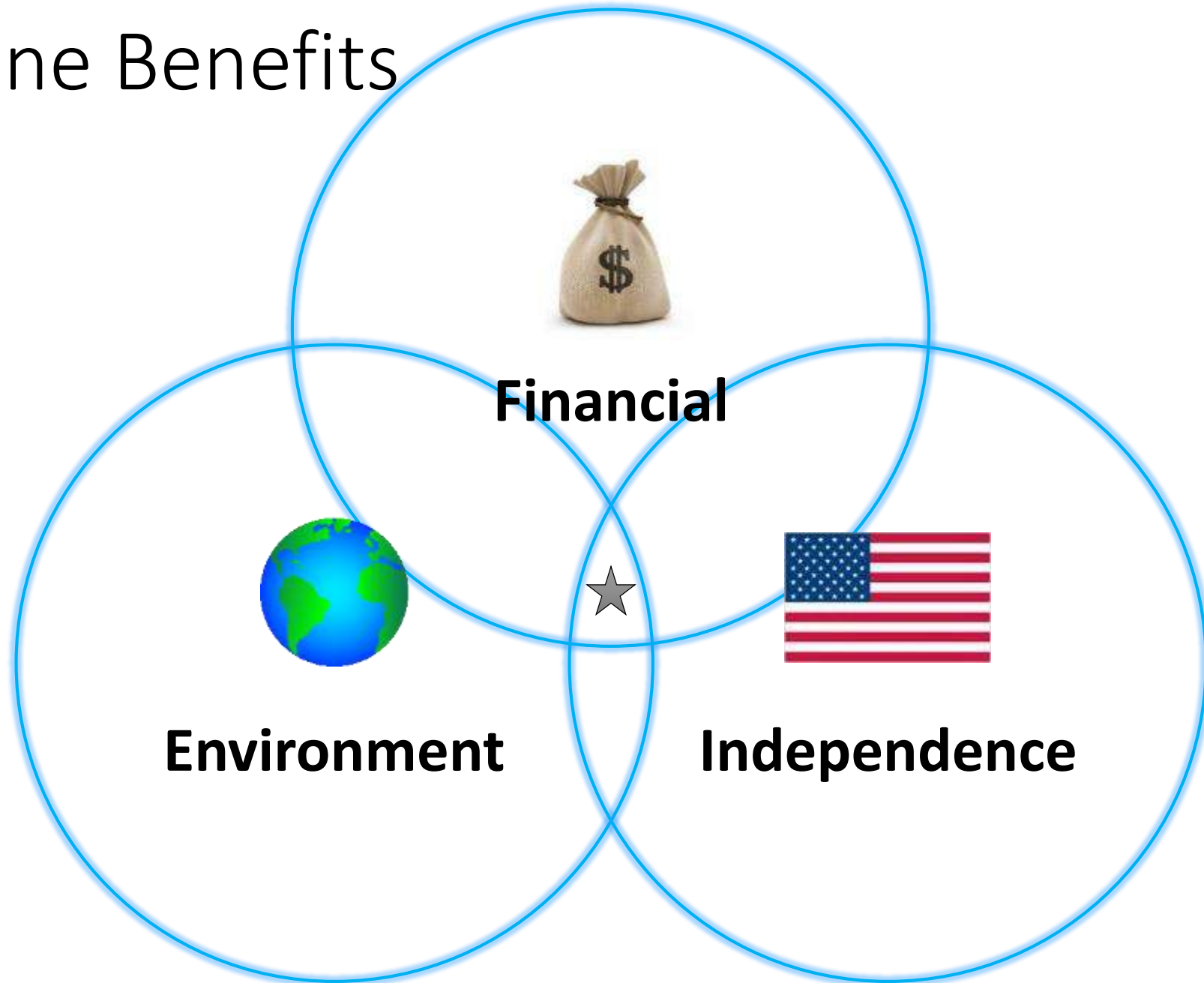
## Environmental Benefits

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CLEANTECH



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# Propane Benefits



# Benefits: Environmental



Diesel  $C_{15}H_{32}$



Gasoline  $C_8H_{18}$



Propane  $C_3H_8$



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# Roush Status of Low NOx



June 7<sup>th</sup> 2017 ROUSH CleanTech announces achievement of very low NOx with the 6.8L V10 Engine.

- For the 2017 MY RCT LPG Blue Bird Buses are now certified to **0.05 g/bhp-hr NOx**.
- This is achieved with **no extra hardware or increased variable cost**.
- The low NOx levels were achieved through careful, significant calibration changes and a CSSR (cold start spark retard) approach.



# Emissions – Optional Low NOX Advantage



	NMHC	NOX	CO	PM	HCHO
Standard	0.14	0.2	14.4	0.01	0.01
LPG - Blue Bird	0.07	0.05	2.2	0	0
LPG - Thomas	0.1406	0.1599	5.392	0.0013	0.00154
LPG - IC	0.08	0.1	5.6		0.004
CNG - IC	0.027	0.102	5.6	0	0.00106
CNG/LNG	0.1	0.1	7.8	0	
Diesel - ISB	0.02	0.19	0.1	0	
Diesel - ISL	0.01	0.2	0.1	0	
Diesel - MF7	0.085	0.495	3.247	0.006	
Diesel - DTE	0.016	0.386	6.069	0.0016	

Definitions:

- NMHC – Non Methane Hydrocarbons
- NO<sub>x</sub> – Nitrogen Oxide
- CO – Carbon Monoxide
- PM – Particulate Matter
- HCHO - Formaldehyde



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**Ford, as OEM, meets or exceeds gov't emission requirements**

# Benefits: Environmental



- ❖ Propane poses no harm to groundwater, surface water, or soil
- ❖ Propane autogas is a nontoxic, non-carcinogenic, and non-corrosive fuel
- ❖ Emissions reductions compared to diesel:
  - 60% less NO<sub>x</sub> emissions
  - 80% reduction in Hydrocarbons
  - 100% reductions in Particulate Matter
- ❖ Today we meet the next level of EPA emissions





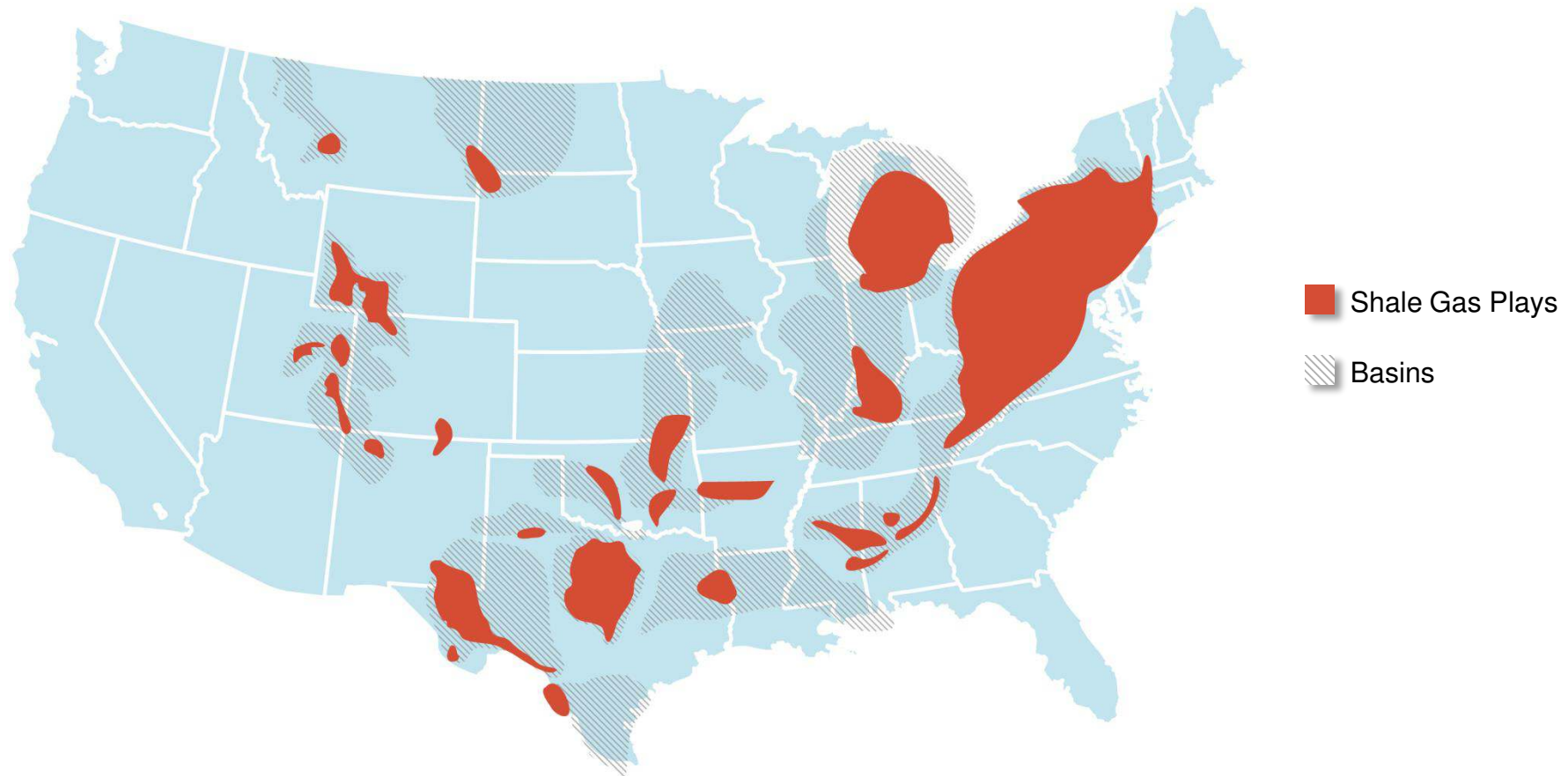
## Energy Security

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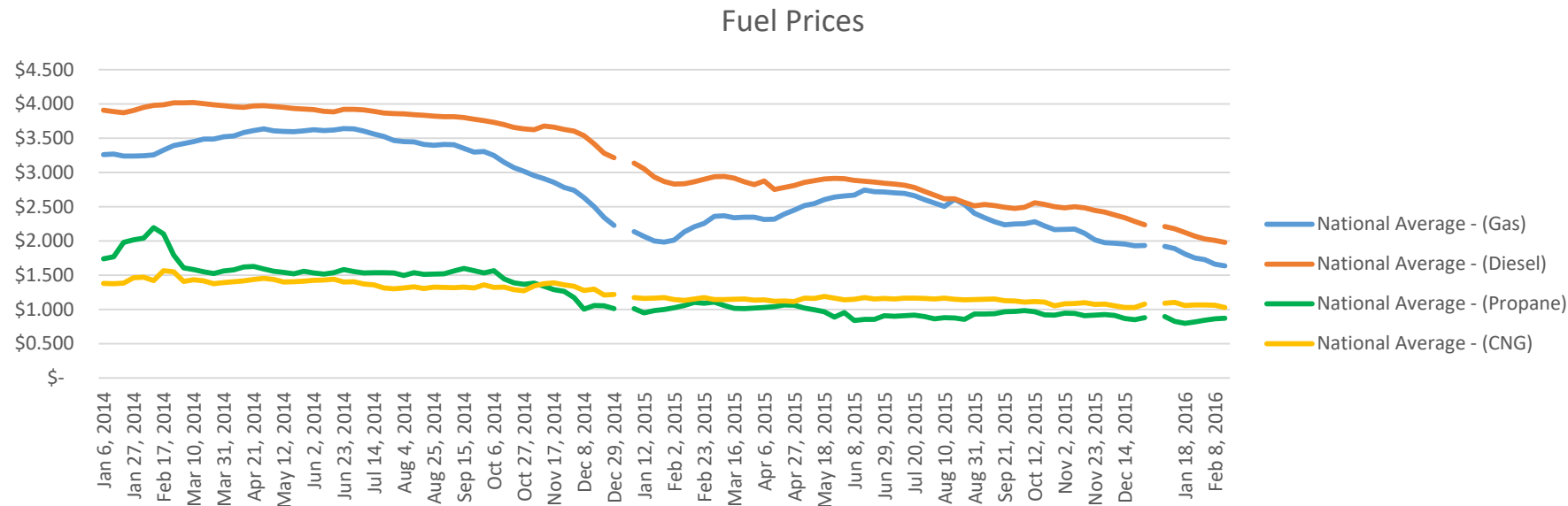
# Shale Map of U.S.



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**Over 100 year supply of propane identified and more being identified every year**

# Fuel Budget



- ❖ Propane has a stable price history
  - Price trends 40% less than gasoline
- ❖ Price lock contracting for multiple years
- ❖ Eligible for rebates, bringing District dollars back



**Budget Friendly Fuel**



## Ease of Converting Fleet

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# Propane School Bus Deployments



# A Growing Trend

OVER  
**12,000**  
SCHOOL  
BUSES



OVER  
**750**  
SCHOOL  
DISTRICTS

**ROUSH**<sup>®</sup>  
CLEANTECH



# Indiana Propane School Bus Deployments

OVER  
**150**  
SCHOOL  
BUSES

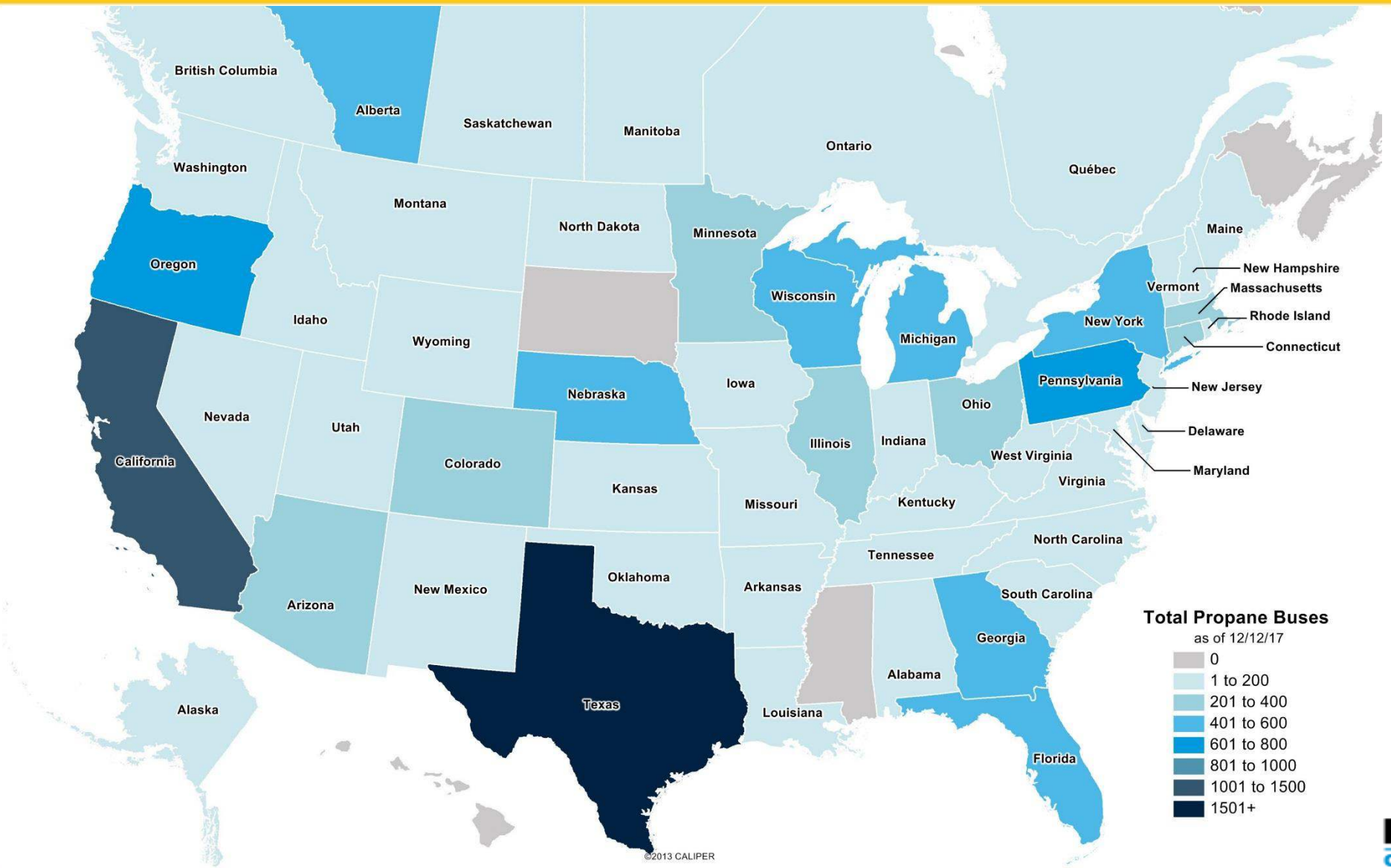


OVER  
**20**  
SCHOOL  
DISTRICTS

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# Propane Deployments



# MSD Warren Township



# MSD Wayne Township



# Southwest Allen Co



# Avon Community Schools





## Why Convert?

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# Preventative Maintenance



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Ford V10  
Gas and Propane  
7 Quarts



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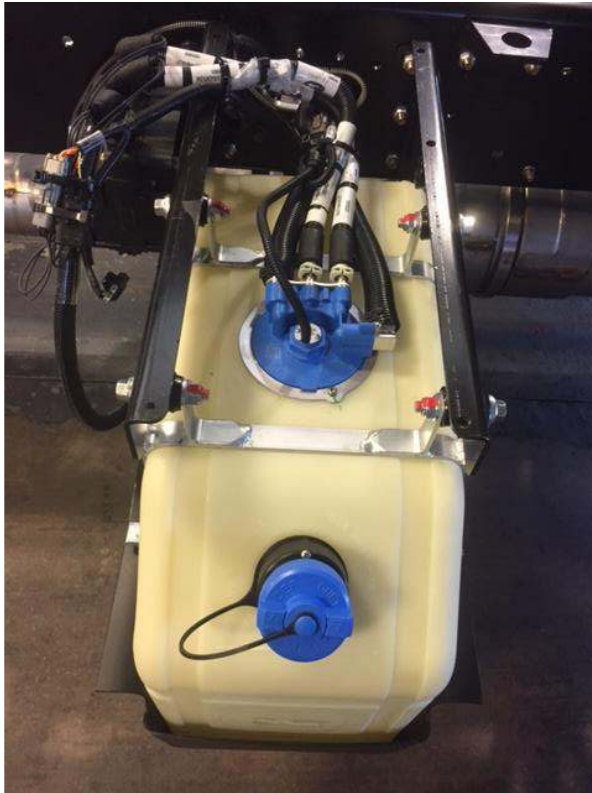
Various Engines  
Diesel  
17 – 30 Quarts



# Increased Inventory



- ❖ Gas and Propane eliminate the need for DEF and the possibility of putting the wrong fluid in a tank.

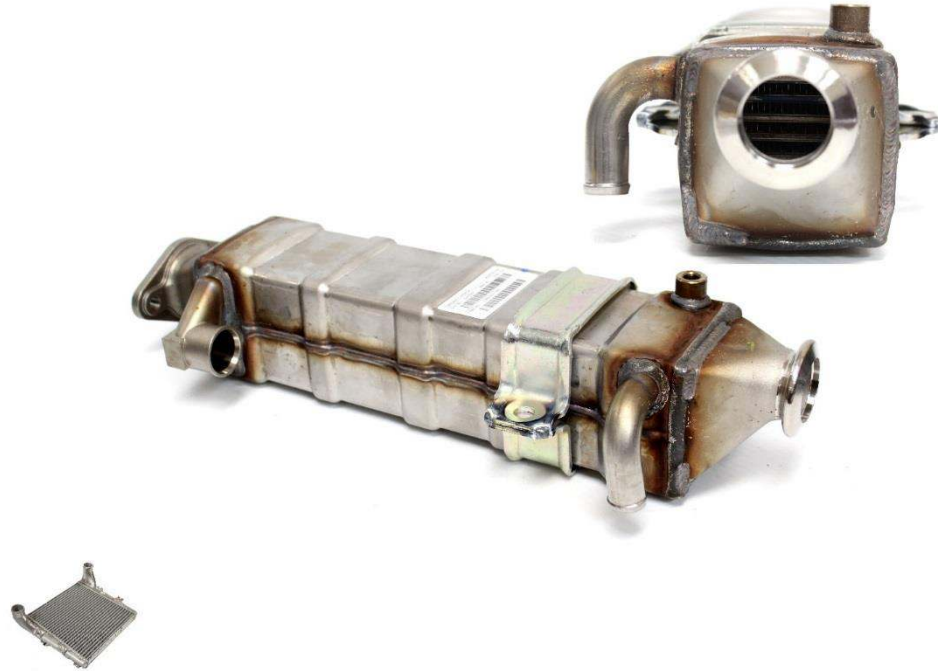


Average diesel needs around 40 gallons / year

# Modern Diesel – Eliminated with Propane



EGR Cooler



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# Modern Diesel – Eliminated with Propane



EGR Valve



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# Modern Diesel – Eliminated with Propane



Pre-Oxidation Catalyst



# Modern Diesel – Eliminated with Propane



Dosing Module



# Modern Diesel – Eliminated with Propane



Assembly for DEF Tank









[illegible]

[illegible]

# Parts Comparison



	PROAPNE POWERED	CUMMINS ISB
IN LINE FILTER IN FUEL FILL	\$115.19	NA
FUEL FILTERS		\$41.07
service intervals	50,000 MILES	\$27.95
		12,000 MILES
FUEL PUMP	\$327.53	\$1,458.56
FILTER IN TANK	\$42.75	NA
INJECTOR	\$85.52	\$684.56
EXHAUST MANIFOLD	\$840	\$143.29
CATYLTIC CONVERTER	\$1,312.04	NA
RADIATOR	\$1,100.25	\$939.24
DIESEL PARTICULATE FILTER	NA	\$993.32
		\$1,033.20
		\$2,494.28
DEF HEAD	NA	\$736.93
DEF LEVEL SENDER	NA	\$213.06
DPF TEMP SENSOR	NA	\$85.30
DOSING PUMP	NA	\$448.90
DOSING PUMP FILTER	NA	\$57.97
DOSING LINE 1	NA	\$125.91
DOSING LINE 2	NA	\$91.09
DOSING LINE 3	NA	\$91.09
NOX SENSOR	NA	\$437.49
EGR VALVE	NA	\$250.83
CRANK CASE BREATHER FILTER		\$74.82
TRANSMISSION FLUID	\$9/quart	\$13/quart
TRANSMISSION FILTER	\$76.72	\$86.00
transmission service intervals	Ford 6R140	Allison 2500PTS
fluid	24 mo / 150K	50K
filter	24 mo / 150K	10K first /50K after
	Whichever is first	50K second filter



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**Reduced Complexity and Cost**



- ❖ Diesel's cloud point is 23 °F
- ❖ Diesel's pour point is -9 °F

Cloud Point – Temperature at which the paraffin wax contained in diesel fuel starts crystallizing and precipitating out of the diesel (gelling)

Pour Point – Temperature at which diesel will no longer flow as a fluid



# Propane - Cold Weather Performance



- ❖ Starts in -50 °F temperature
- ❖ Does not require a block heater
- ❖ Quicker cabin heat
- ❖ Brandon winter runs
  - In-city lift bus route
  - Ambient temp: Start -24°F End -11°F
  - Wind chill: Start -47°F End -34°F
  - Cabin temp: 69°F within 20mins
  - Propane - Temp dropped to 44°F, but recovered to 73°F within 8mins
  - Diesel - Temp dropped to 17°F and took over twice as long to recover





- ❖ Manual regenerations
- ❖ Electric block heaters
- ❖ Webasto heaters
- ❖ Labor costs: coming in early to ensure buses will start in cold temperatures
- ❖ Idling buses in cold temperatures





**What next steps do  
I take?**

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# Savings Calculation (Propane vs. Diesel)



## Blue Bird Vision (Type C)



	Diesel	Blue Bird Propane	Customer Information	
FUEL COMPONENT				
Annual Miles per Bus	15,000	15,000	Propane Fuel Price	\$1.05
Years Operated	15	15	Diesel Fuel Price	\$2.12
Total Miles in Life per Bus	225,000	225,000	Gasoline Fuel Price	\$1.90
Fuel Economy(MPG)	7.00	4.50	Propane MPG	4.50 64%
Gallons Used Annually per Bus	2,142.00	3,333	Diesel MPG	7.00
Gallons Used Total per Bus	32,142.00	50,000	Gasoline MPG	5.75 82%
Diesel Price Per Gallon	\$2.12		Years Operated	15
Propane/Gas Price per Gallon		\$1.05	Annual Miles per Year per Bus	15000
PREVENTATIVE MAINTENANCE COMPONENT				
Oil Interval	5,000	5,000	 <b>ROUSH</b> CLEANTECH	
Oil Capacity (Quarts)	21	7		
Oil Filter Cost	\$9.36	\$4.00		
Oil Cost Per Quart	\$2.55	\$2.55		
Cost Per Oil Change	\$62.91	\$22		
Oil Change Total Cost Lifetime	\$2,830.95	\$983.25		
DEF Gallons Lifetime	1,124.97	0		
DEF Cost per Gallon	\$1.89			
DEF Total Cost Over Lifetime	\$2,126.19			
Fuel Filter Change Interval	15,000	50,000		
Fuel Filter Cost	\$12.99	\$43	 <b>ROUSH</b> CLEANTECH	
Total Filter Changes	15	4		
Fuel Fiter Cost Lifetime	\$194.85	\$172.00		
ACQUISITION COST COMPONENT				
Acquisition Cost	\$0.00	\$0.00	 <b>ROUSH</b> CLEANTECH	
Vehicle Rebate per Unit				
TOTAL COST of OWNERSHIP				
	Diesel	Blue Bird Propane	 <b>ROUSH</b> CLEANTECH	
Lifetime Operational Cost/Bus	\$73,293.03	\$53,655.25		
Lifetime Savings/Bus		\$19,637.78		





# Questions?

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