



**SUSTAINABLE
FLEET
TECHNOLOGY**

CONFERENCE & EXPO 2023

**Track B Session 2:
Sustainable Trucking Solutions**

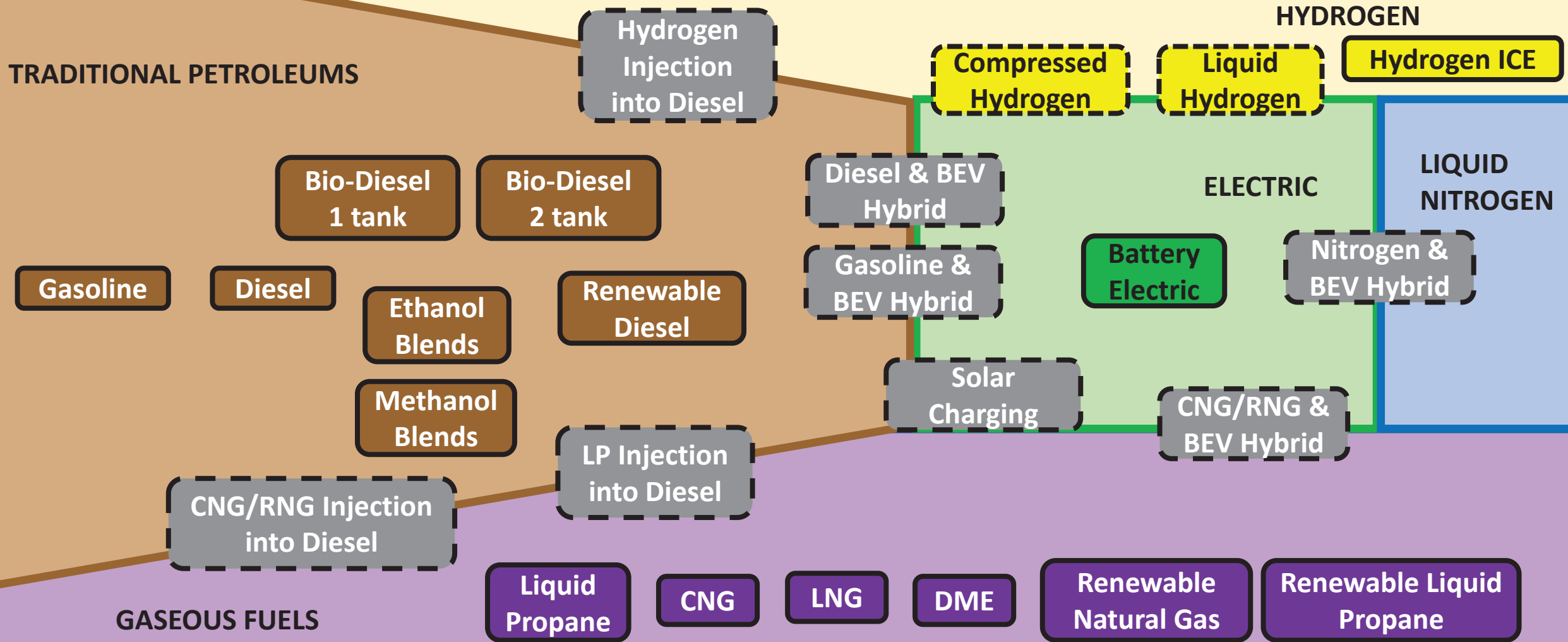
August 15, 2023



Sustainable Trucking Solutions

1. BIODIESEL: Colin Huwyler, Optimus
2. RENEWABLE NATURAL GAS: Mark Riley, Clean Energy
3. BATTERY ELECTRIC: Dave Schaller, NACFE
4. INNOVATION: Mark Childers, Freightliner Custom Chassis/Daimler

Alternative Fuels



THE MESSY MIDDLE: A TIME FOR ACTION

PRESENT

- Technology immature
- Many unknowns & challenges



"MESSY MIDDLE"

- Many optimization solutions
- Growing infrastructure
- Multi-fuel choices
- Innovation & maturation
- Facts replacing estimates
- Learning curves

FUTURE 2050

- Fast charging
- Hydrogen everywhere
- Long-life, low-cost batteries
- Acceptable weights & costs



- Legacy Diesels
- Natural Gas

- Diesel Advancements
- Natural Gas
- Hybrids
- Hydrogen ICE

- Battery Electric
- Hydrogen Fuel Cells
- Renewable Natural Gas & Diesel
- More

- CBEV & HFCEV from Clean Energy

THE PATH FORWARD

Each fleet will need to consider a variety of factors on its path through the messy middle.

FLEET SIZE

Very Small, 1-10
Small, 11-100
Medium, 100-500
Large, 500+

DUTY CYCLES

Favorable
Less Favorable
Unfavorable
Repeatability of Duty Cycle

REGULATORY FACTORS

ZEV Rules
Incentives
Fleet/Warehouse Rules

ENERGY/FUEL PRICING

RNG
LCFS
Credits Electricity Pricing
Optimal Charge Time and Pricing
Green vs. Non-Green Costs

GEOGRAPHICAL OPERATIONS (DEPOTS)

All Trucks in One Region
Depots in 2-5 Regions
Depots in 6+ Regions

WELL-TO-WHEEL IMPACT FACTORS

BEV Green	RNG
BEV 50%	CNG
BEV 25%	Renewable Propane
Hydrogen Green	Propane
Hydrogen Blue	Renewable Diesel
Hydrogen Grey	Biodiesel
	Diesel

CUSTOMER/SHIPPER GOALS

ESG
Cost
Sustainability
On-Time Delivery
Scope 3 Emissions Reduction

TRUCK LIFE AND BUYING PATTERNS

Purchase New Trucks Every 5 Years
Purchase New Trucks Every 7 Years
Keep Trucks for 10+ Years
Lease vs. Purchase

ENERGY/INFRASTRUCTURE

Availability
Complexity
Readiness
Cost

OTHER CONSIDERATIONS

Return on Investment
Total Cost of Ownership
Maintenance and Service Tools
Second Life Considerations
Capital Spend Willingness (for a good TCO)
Ability to Change Operations
Own or Lease Depot
Truck Life
Corporate Philosophy



Decarbonizing Heavy-Duty Assets with 100% Biodiesel

2023 Sustainable Fleet Technology Conference & Expo

Colin Huwyler, CEO || c.huwyler@optimustec.com || 412.727.8228 x2

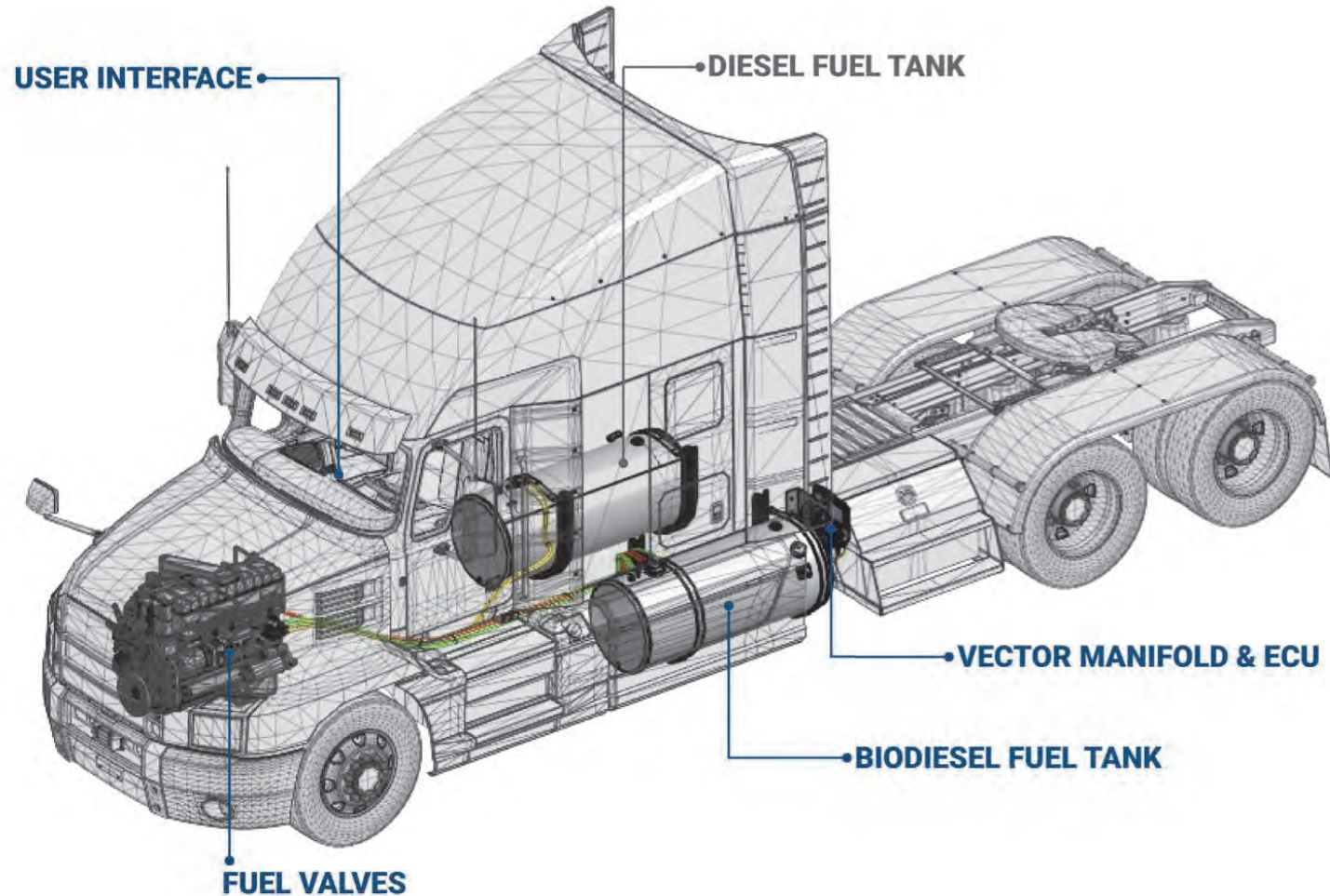
Why Biodiesel?

- ***100% Biogenic Carbon***
- ***Utilizes Existing Infrastructure***
- ***Renewable, Sustainable, & Scalable***
- ***Low Cost***
- ***Safer & More Efficient than ULSD***

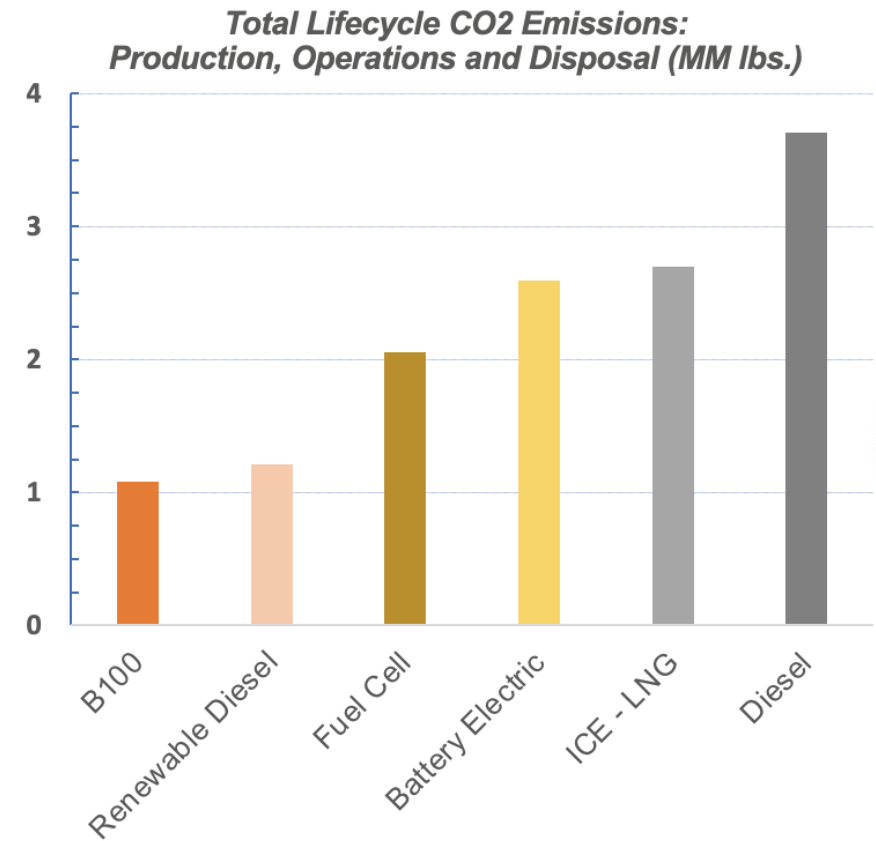


Today's engines only allow use of biodiesel blends up to 20% (B20).

Optimus' Vector System upgrades engines to use 100% biodiesel (B100).



If a class 8 truck powered by 100% biodiesel is replaced with a BEV using the current US electricity generation mix, the net carbon emissions output as a result would be increased by 2.5x.





“The Iowa Department of Transportation is becoming a global leader in carbon reductions while taking the next steps forward toward the state’s sustainability goals, this is coming to fruition as a result of Optimus’ advanced technology coupled with fuels produced right here in Iowa.”

- Todd Cogdill, Fleet Manager



“Biodiesel gives us the ability to immediately reduce the carbon emissions in our fleet... The truth is, for these bigger vehicles that carry huge loads and run long hours, electrification just isn’t ready or widely available yet...

The Optimus Vector System offers a path forward that is available today.”

- Mahanth Joishy, Superintendent of Fleet Services





“The Preferred Choice”

“DC Mayor Muriel Bowser says cutting carbon isn’t an option. It is something we must do... Heavy-duty electric options are extremely expensive and aren’t ready for wide deployment yet. Optimus has given us the ability to cut our carbon beyond our reduction goals.”

- Christine Davis, Former Director DC Public Works



“This study [*Immediate Decarbonization of Class 8 Trucking*] helped to give us and other fleets the data they need to feel secure in implementing the Vector System with B100 to enhance sustainability efforts without sacrificing efficiencies.”

- Steve Finn, ADM Vice President of Transportation



1.3MM Mile Fleet Study – ADM Trucking

IMMEDIATE DECARBONIZATION OF CLASS 8 TRUCKING

A 1.3 Million Mile Evaluation of 100% Biodiesel

V1.3 © 2024 by Optimus Technologies, Inc.



ADM unlocks the power of nature and transform crops into ingredients and solutions for foods, beverages and supplements for people all around the world, and we provide a complete range of solutions and services for livestock, aquaculture and pets.

adm.com



The American Lung Association's mission is to save lives by improving lung health and preventing lung disease. We do this through education, advocacy, and research.

cleanairchoice.org



Clean Fuels serves as the industry's central coordinating entity for technical, environmental, and quality assurance programs and will be the strongest voice for its advocacy, communications, and market development.

cleanfuels.org



Decatur Mack is Mack Truck's multiple award-winning central region dealer of the year, consistently striving for customer service second to none.

decaturmack.com



ESW America is a leading CARB / EPA recognized independent emissions testing facility operating a variety of engine and light & heavy-duty chassis dynamometers. ESWA is focused on diesel OBD validation, manufacturer self-testing, certification and emission control system validation. In addition, ESWA offers accelerated aging of catalysts / DPFs as well as component modification services.

eswgroup.com



The Illinois Soybean Association (ISA) is a statewide organization that strives to enable Illinois soybean producers to be the most knowledgeable and profitable soybean producers in the world. The project is funded by the Illinois Soybean Association Checkoff Program.

ilsoy.org



Mid Continent Testing is built on the commitment to prompt, accurate results by utilizing state-of-the-art equipment in a highly automated lab. MCT provides clients with rapid, reliable data and ensures the integrity of data by actively participating in lab certification programs to keep standards high.

thechemistrylab.com



The Missouri Soybean Merchandising Council is a statewide, farmer-led organization working to improve opportunities for Missouri soybean farmers through a combination of research, outreach, education and market development efforts supported by the soy checkoff.

mosoy.org



Optimus Technologies is a clean energy technology company based in Pittsburgh, Pennsylvania. Optimus manufactures the Vector System, an advanced fuel system technology that enables diesel engines to operate on 100% biodiesel.

optimustec.com



To accomplish its farmer profit mission, the soy checkoff is dedicated to growing the preference for U.S. Soy. Setting market-focused objectives with a clear plan of action is how we get there.

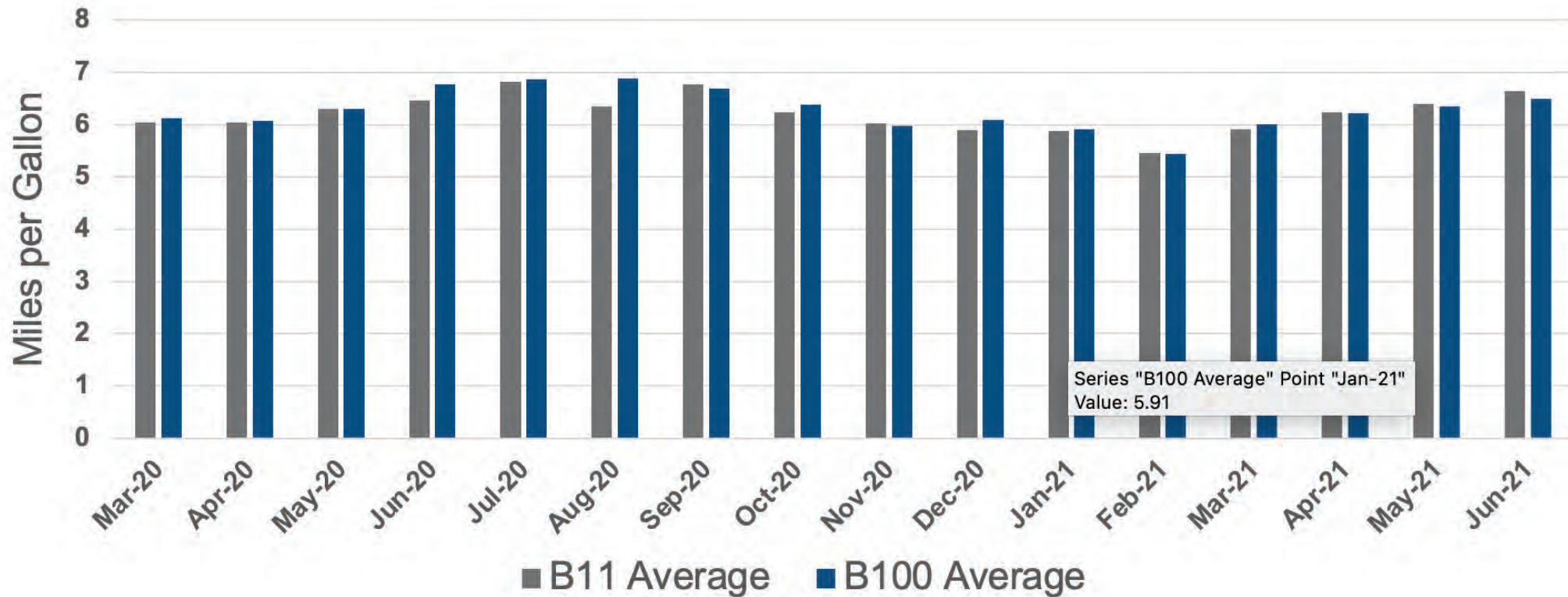
unitedsoybean.org

Fuel COA Key Parameters

Cetane Number (ASTM D613)	Water & Sediment (ASTM D2709)	Water "Karl Fischer" (ASTM D6304)	Sulfur (ASTM D5453)	Acid Number (ASTM D664)	Oxidation Stability @110°C (EN14112)	Calcium & Magnesium (EN14538)	Sodium & Potassium (EN14538)	Phosphorus (ASTM D4951)
48	0.00 % Volume	258 mg/kg	0.3 mg/kg	0.38 mgKOH/g	7.8 Hours	<1 mg/kg	<1.00 mg/kg	0.001 mg/kg

- Weighted Average of 77,424 Gal.
- Commercial fuel from ADM Mexico, MO facility
- Refinery → Distributor → ADM Trucking Bulk Tank

Fuel Economy Results



Diesel



6.24 MPG avg



651,424 mi



100% Biodiesel

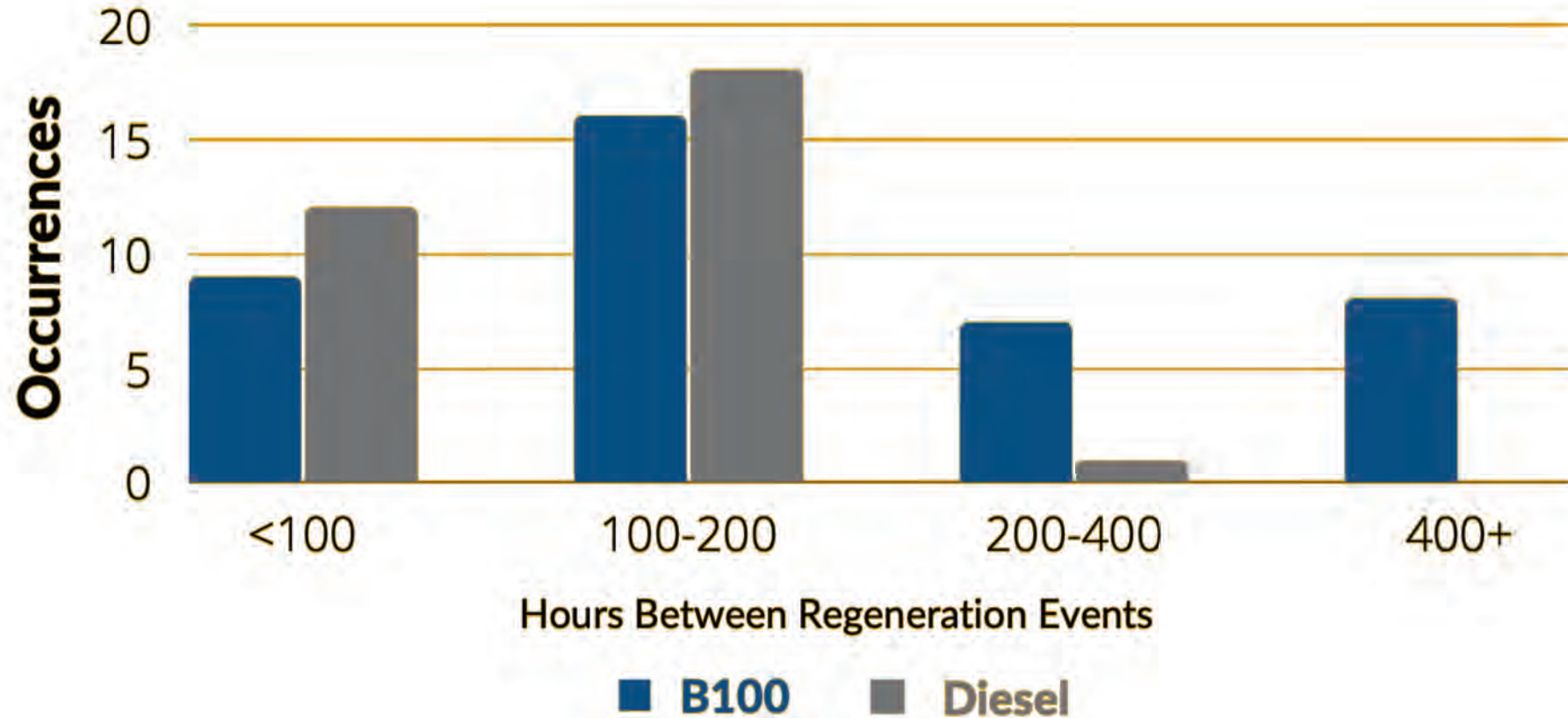


6.32 MPG avg

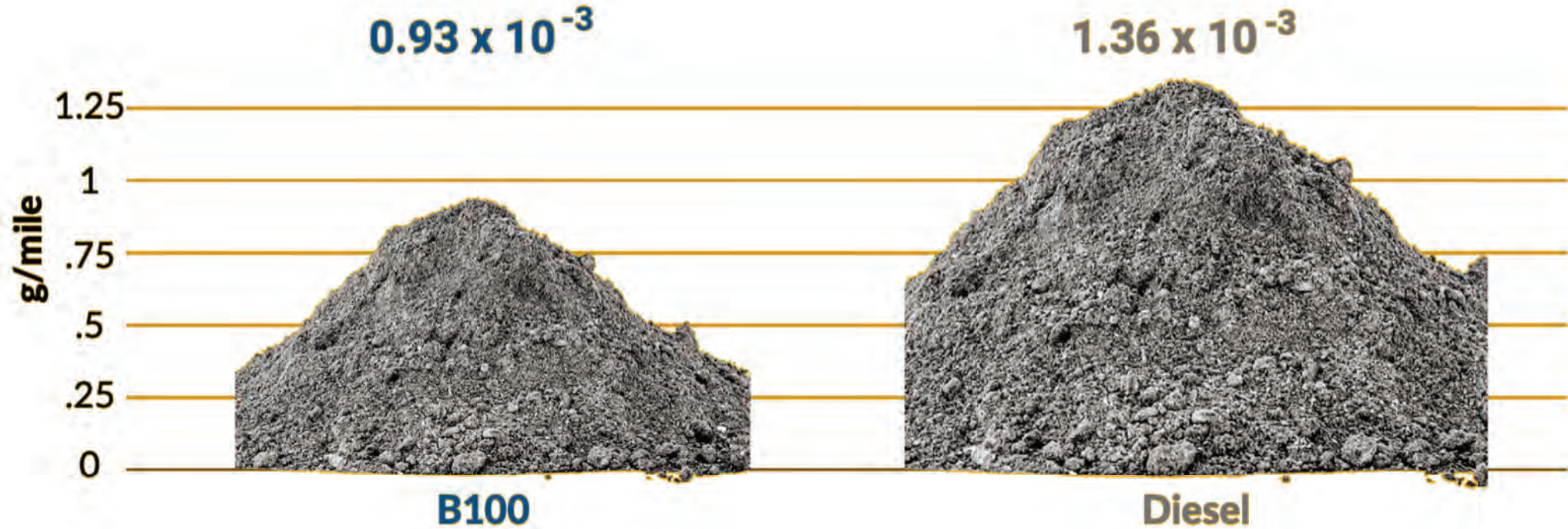


636,034 mi

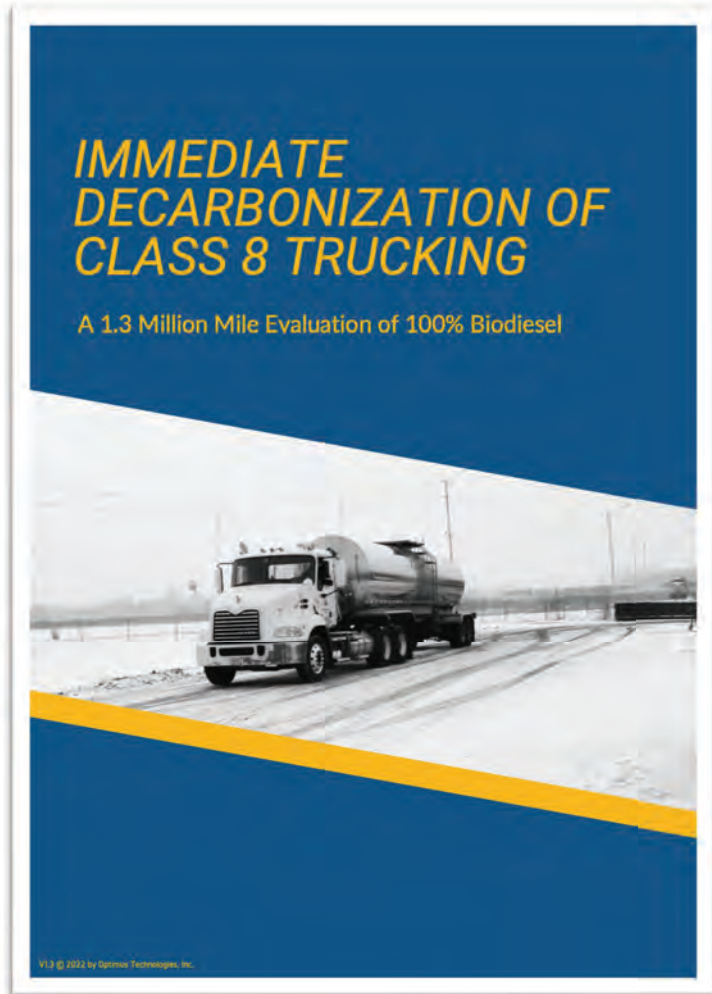
DPF Regeneration Intervals



DPF Ash Accumulation & Clean Out



1.3MM Mile Fleet Study – ADM Trucking



Renewable Natural Gas

The Pathway to Net Zero
Carbon Emissions

Sustainable Fleet
Technology Conference
& Expo 2023

Mark Riley
Vice President, Business
Development



What is renewable natural gas?



Replacement for diesel

RNG is an alternative fuel for heavy-duty trucks, buses and other large vehicles

Not a fossil fuel

Reduces carbon by an average of 300% versus diesel and gasoline.

Renewal

We capture the naturally-occurring biomethane released from landfills and dairies and turn it into RNG.

Decarbonizing fuel

RNG reduces carbon both at the source where it's made and on the road, making it the only fuel that can be carbon-negative.



Here's how RNG is made



Farm

Organic waste is collected and taken to a digester.

Digester

The digester processes the waste and captures the biogas.

Upgrading

The biogas is purified into RNG and injected into the local pipeline.

CE stations

CE distributes the RNG to our stations nationwide, including 200+ in California.

The remaining digestate can be used as fertilizer and dry bedding for the farm.

RNG benefit points, for fleets:



Sustainable:

lowers carbon emissions by an average of 300%



Renewable:

made from organic waste, not drilling



Cleaner air:

reduces smog-forming NO_x emissions by 90%



Accessible:

extensive network of fueling stations nationwide



Affordable:

stabilized prices and lower maintenance costs



Proven:

Trusted by companies like Amazon, UPS, WM, and major transit fleets in NY & LA



Quieter:

quiet, odorless natural gas engines



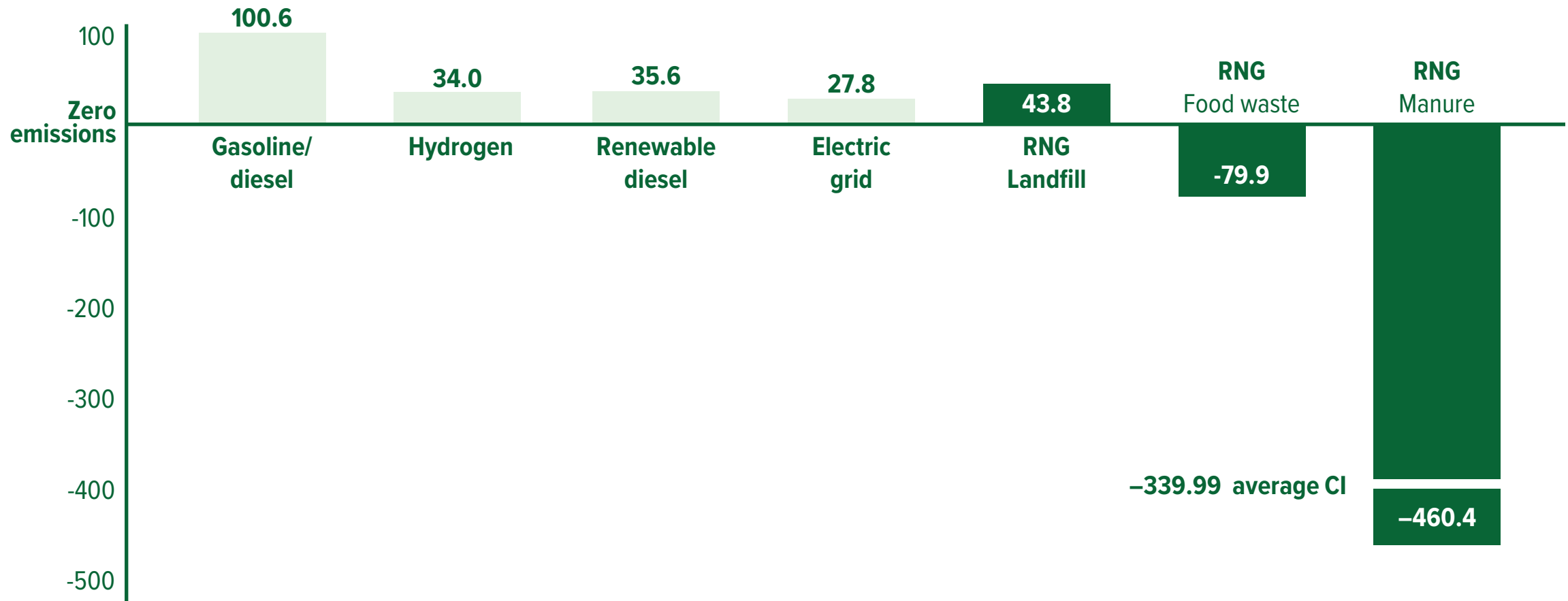
Less maintenance:

No high maintenance DPF-SCR diesel emissions control system

RNG is the lowest carbon alternative fuel



Carbon emission by fuel type (gCO₂e per MJ)



Source: California Air Resources Board, Q1 2022 LCFS data, and certified pathways as of June 18, 2022.

Who is using RNG?

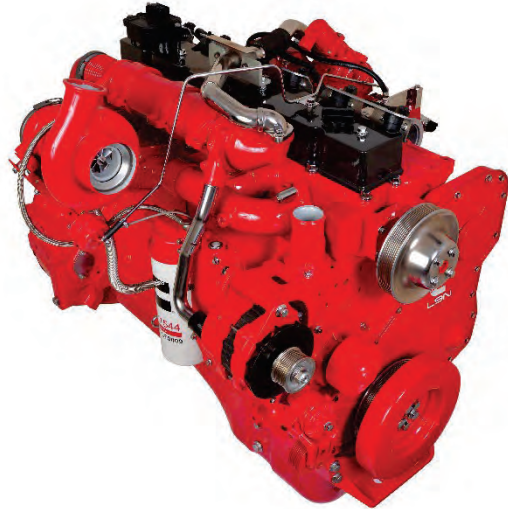


CUMMINS NATURAL GAS ENGINES

B6.7N™



L9N™



ISX12N™



X15N™



Coming in 2024

Certified Near Zero Optional Low NOx 0.02 g/bhp-hr

X15N Product Introduction

Design and deliverables to be confirmed through pending and final verification

X15N™

- ❖ Industry-first & market-defining **Big Bore Natural Gas** Powertrain
- ❖ Capable to **meet stringent CARB24/27 and future EPA** NOx regulations
- ❖ **Compact 15 Liter** – Targeting fit in ISX12N & 13L chassis installations, 500 lbs lighter than current 15L diesels
- ❖ Up to a **10% Fuel Economy/GHG improvement** over ISX12N
- ❖ 12L-15L Diesel matching ratings - **up to 500hp & 1850lb-ft** of torque
- ❖ Compact **passive TWC aftertreatment** system
- ❖ **Integrated with Industry HD transmissions** – Endurant and Allison
- ❖ Incorporates Cummins **Powertrain Features & Strategies**
- ❖ Potential for **Carbon Negative Solution with RNG**

Base Engine

- EPA and CARB
- Rear Geartrain
- Advanced combustion management

Air Handling

- Dual Wastegate Turbocharging
- Advanced Cooled EGR

Lube and Cooling

- Closed Crankcase Breather
- Elimination of Coolant Filter

Exhaust System

- Single unit, maintenance free & fluid free, chassis mounted Three-Way Passive Catalyst

Vehicle Integration

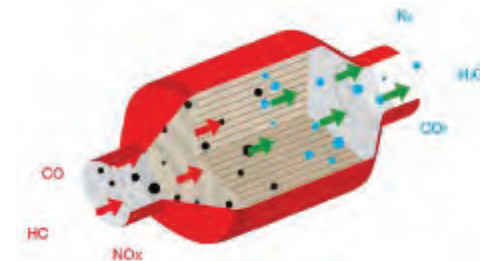
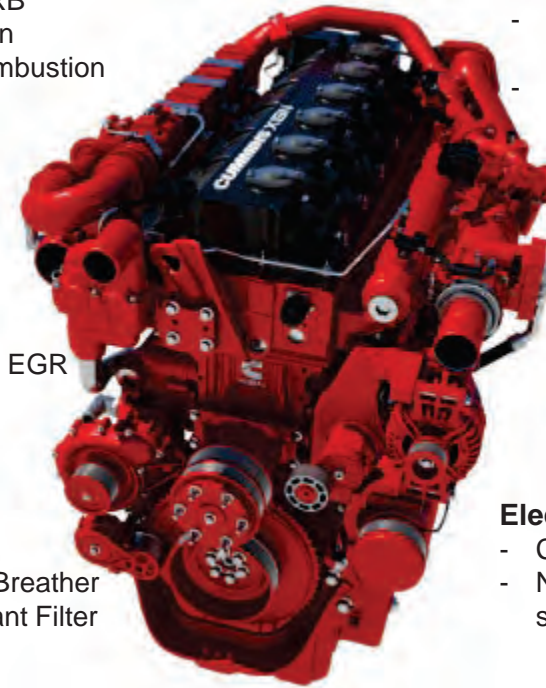
- Compact 15L design and reduced weight
- Integrated with Endurant (& Allison) transmissions
- Full powertrain feature suite

Fuel System

- Next generation fuel system
- Integrated with vehicle fuel system partners

Electronics System

- CM2380 ECM
- Next generation connectivity solutions

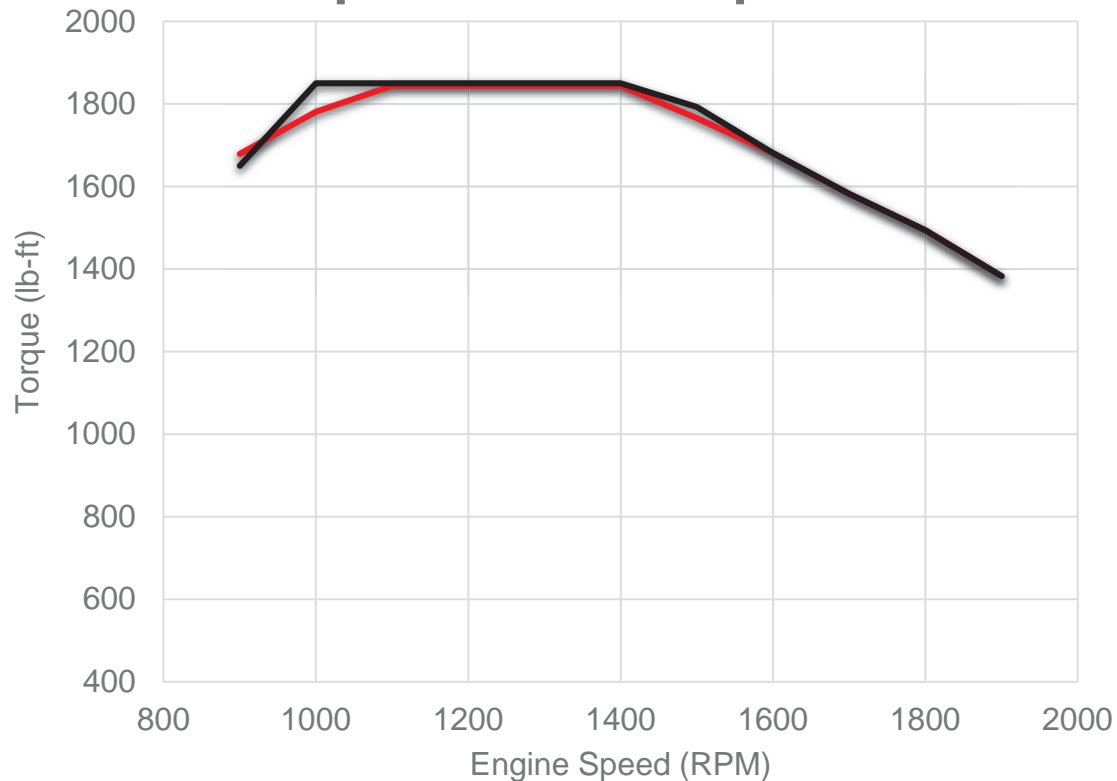


Product details are preliminary and may be subject to change at any time without notice.

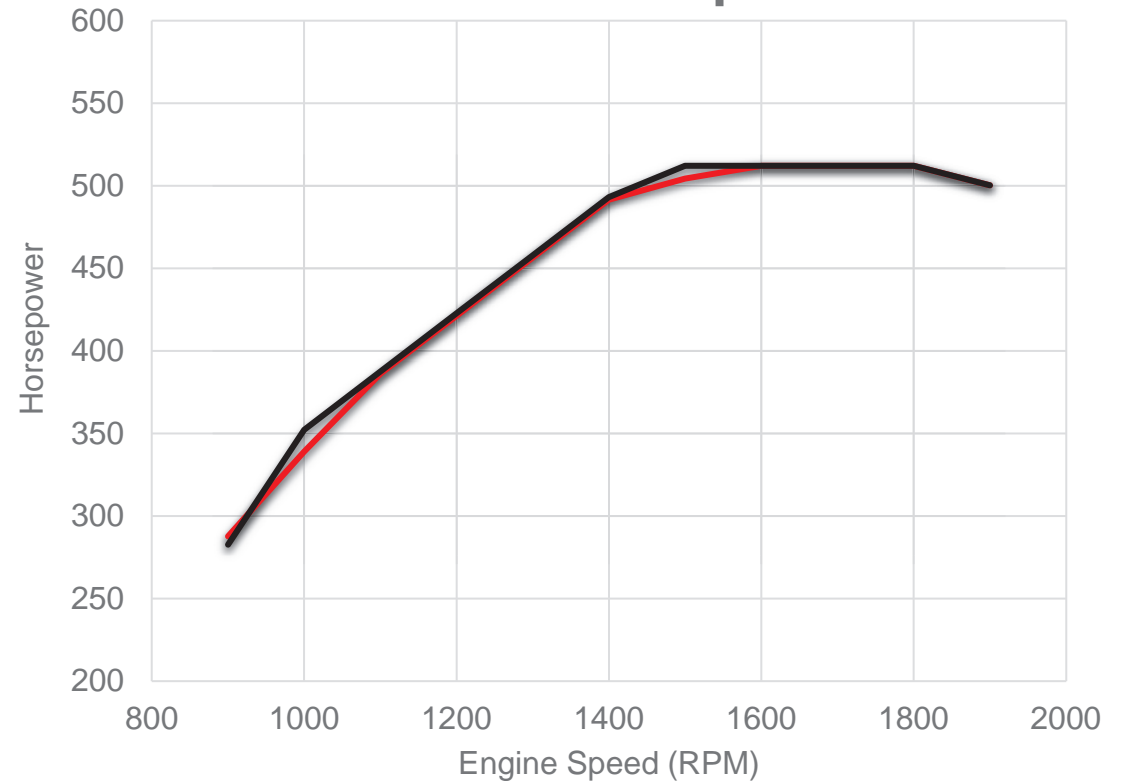
Public

DIESEL-LIKE PERFORMANCE

Torque Curve Comparison



Power Curve Comparison



— New X15N (Natural Gas)

— X15 Productivity Series (Diesel)

The road to net zero for a 1,000-truck fleet

	RNG	Battery Electric	H2 Fuel Cell
Carbon Intensity (CI) A uniform way to compare the total lifecycle of transportation fuels, measured in gCO ₂ e/MJ	-320.25 Average CI for duty RNG A negative CI value means that more greenhouse gas emissions are avoided than generated.	15.2 Emissions are from the California power grid to charge batteries.	10.51 Hydrogen made via electrolysis using 100% renewable electricity and the California power grid.
Percentage of fleet Percentage of fleet to be replaced in order to reach or approach net-zero lifecycle fuel emissions.	22% Switching only 22% of the fleet to RNG already fire same amount of emissions as are generated by the remaining diesel trucks.	100% The entire 1,000-truck fleet must transition to battery electric to approach net zero.	100% The entire 1,000-truck fleet must transition to hydrogen fuel cell to approach net zero.
CAPEX Capital investment needed for truck replacements to reach or approach net-zero lifecycle fuel emissions.	\$46M	\$478M	\$717M
Cost per metric ton reduced	\$212.03	\$2,317.91	\$3,372.76
Transitional time Number of years it takes to reach or approach net zero, investing the same amount of \$46M per year.	1 year	11 years	16 years
Emissions generated during transition period Metric tons of CO ₂ e generated during the time it takes to reach or approach net-zero lifecycle emissions.	0	1,084,346	1,611,612
Annual emissions after transition Metric tons of CO ₂ e generated yearly once the fleet transition is completed.	-414	10,347 Battery electric never fully reaches net-zero lifecycle emissions unless the grid is 100% renewable.	3,983 Hydrogen never fully reaches net-zero lifecycle emissions unless the grid is 100% renewable.
Land required for solar panels Square miles needed to provide 100% renewable electricity for a 1,000-truck fleet.	N/A	469 That's the size of the City of Los Angeles.	1,409 That's 5x the size of New York City.

Assumes Battery Electric and Fuel-Cell trucks achieve the same duty cycle as RNG trucks with a one-for-one replacement of diesel trucks.
 CAPEX & price banking infrastructure and grid upgrades. Grid costs estimated at \$25 per \$1 of charging infrastructure (from U.S. Electric Grid Storage).
 CI scores are from California Air Resources Board, "Current Fuel Pathways" as of May 2021.
 Vehicle truck prices are from research by Craig Hublin.
 Lifecycle emissions based on California carbon accounting.

Clean Energy at a glance



550+ Stations throughout the U.S. and Canada



Blue chip customer base



Leading RNG player in the US



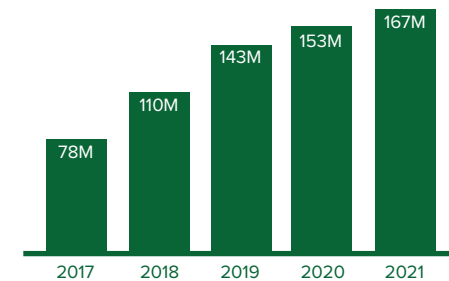
Partnerships with global energy leaders



Environmental credit leader



Growing RNG fuel volumes



Who we are



RNG Supply

- Dairy/RNG production
- 3rd party RNG supply contracts



Distribution

- 550+ stations
- Capacity to double volumes
- Fleet + marine customers
- Maintenance + construction
- 2 owned LNG plants



Clean Energy

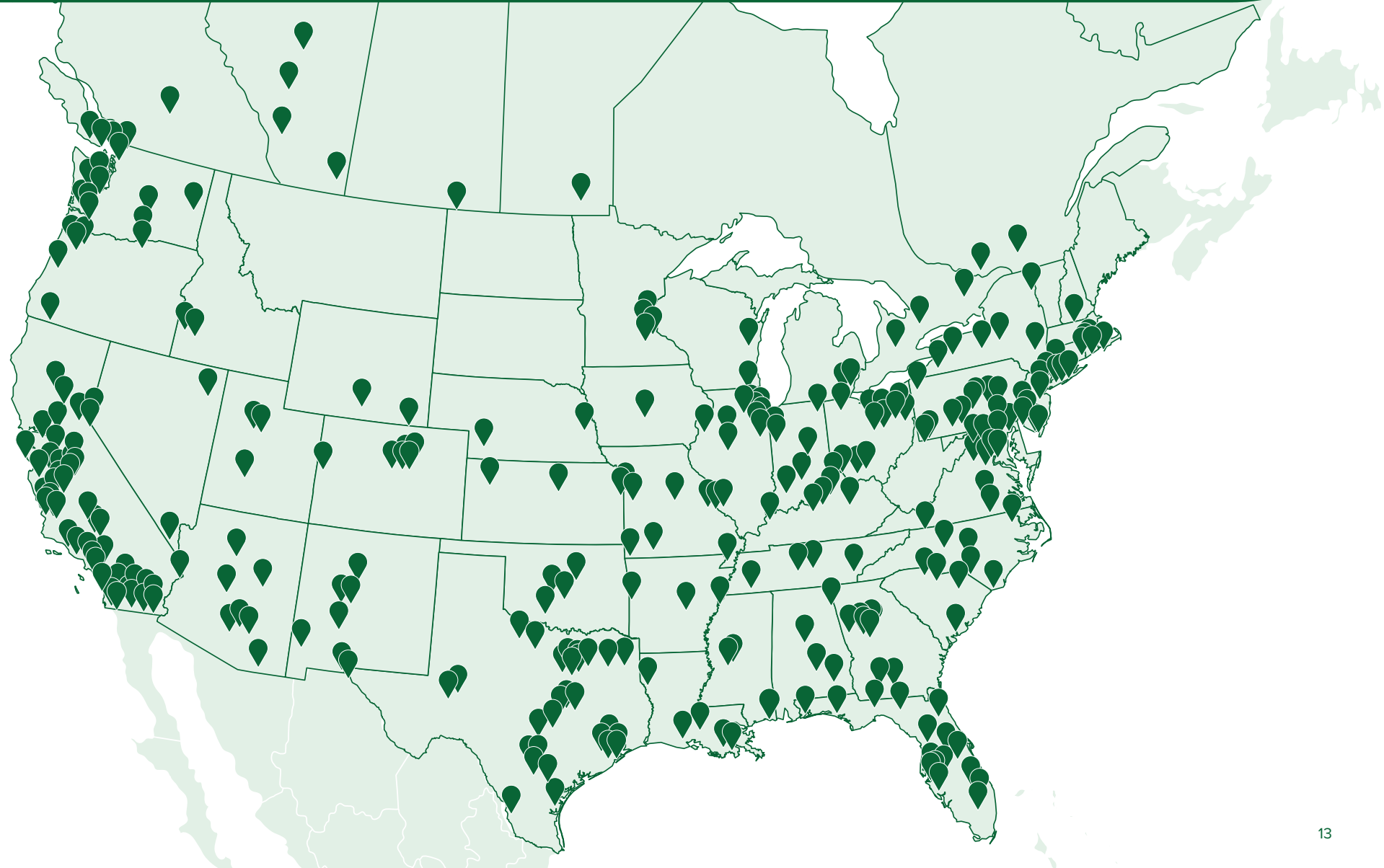
- Vertically integrated RNG solutions
- 25+ years of experience
- Invented RNG as a commercial fuel

Clean Energy has the key RNG station infrastructure



**Public
and private
stations**

550+
Natural gas
fueling stations





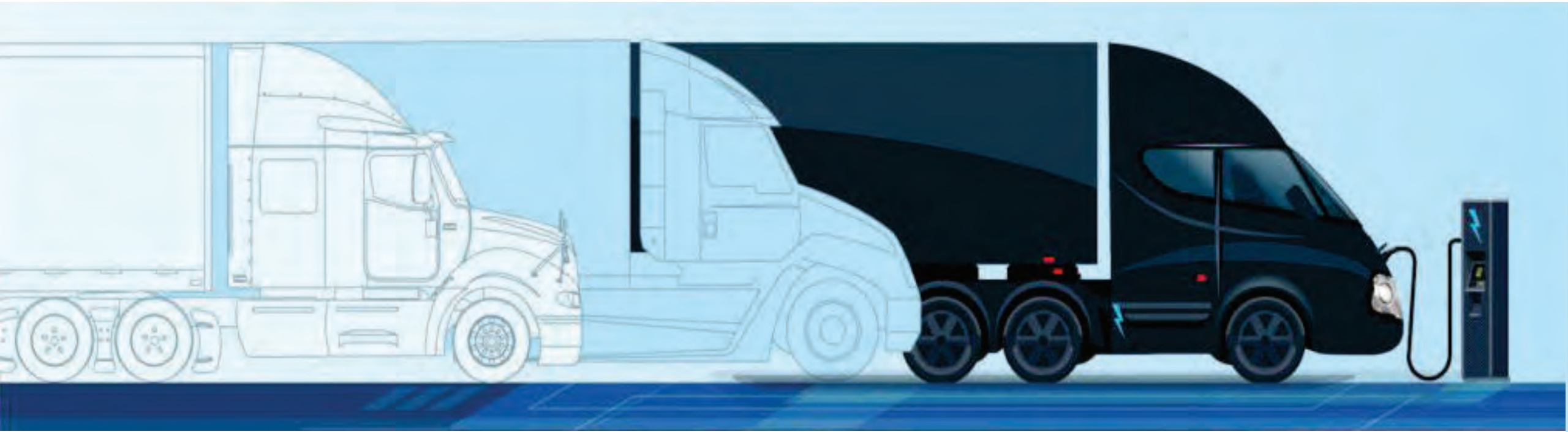
We turn sustainability goals into reality.

Thank you



EV Trucks & Run on Less

August 2023 – Dave Schaller, Industry Engagement Director



TIRE PRESSURE AERODYNAMIC
SUSTAINABILITY CONFIDENCE
MPG AUTONOMY GUIDING
EFFICIENCY BENCHMARKS
ELECTRIFICATION UNBIASED
HYDROGEN IDLE REDUCTION
FUEL AGNOSTIC NON-PROFIT

Run on Less - "Best of the Best"

2017



2019



2021



2023

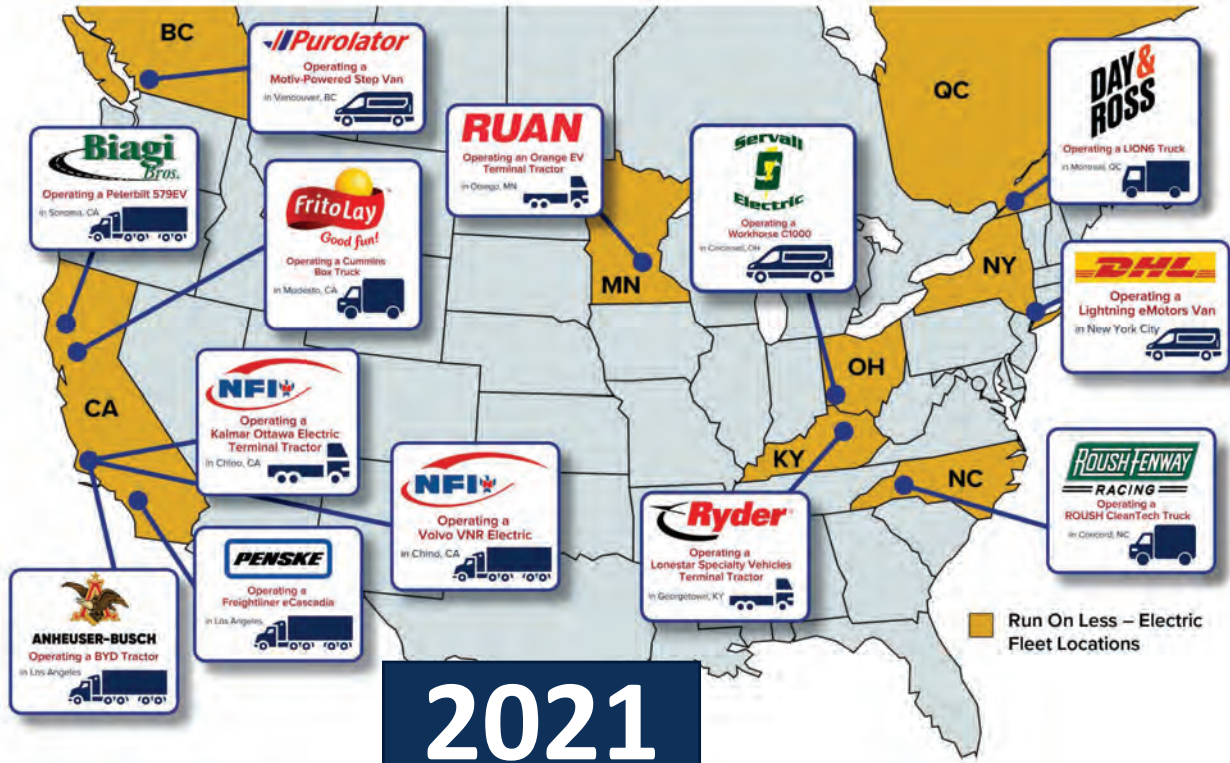


Long Haul
7 Fleets
10.1 MPG

Regional Haul
10 Fleets
8.3 MPG

All BEVs
13 Fleets
New metrics!

BEV Depots
8 Depots
Infrastructure



2021

Real-World, Real-Time Case Studies

- For each fleet & OEM
- Fleet Interviews: Drivers & Leaders
- OEM Interviews & more



1. Select any of the 13 fleets
2. Select a day or range of days
3. Select Units of Measure
4. Use the data!

Anheuser-Busch

Frito-Lay

Penske

NFI Terminal

DHL

Day & Ross

Ryder System Inc.

Purolator

Ruan

Biagi Bros.

Roush Fenway Racing

NFI Freight

Servall Electric

DAY & ROSS

Select range to change data

Showing: Day to

IMPERIAL METRIC

Total Miles: 53.3

Estimated Delivered: 3

Weather Conditions

High Temperature: 67.9° F

Low Temperature: 57.6° F

Average Wind Speed: 8.8 mph

Cumulative Precipitation: -

Battery Charge (%) & Speed (mph)

Battery Charge (%) & Distance (mi)

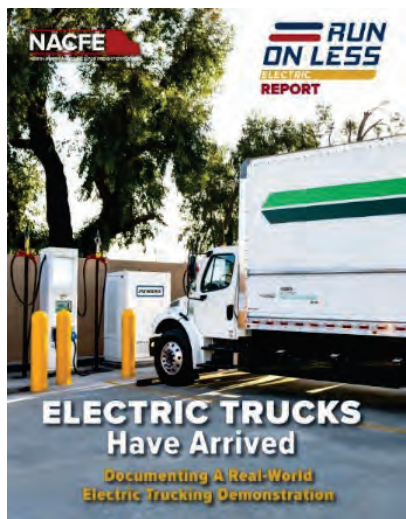
Truck Activity

Distance By Speed Range

Energy In

Energy Out

RoL-E Reports



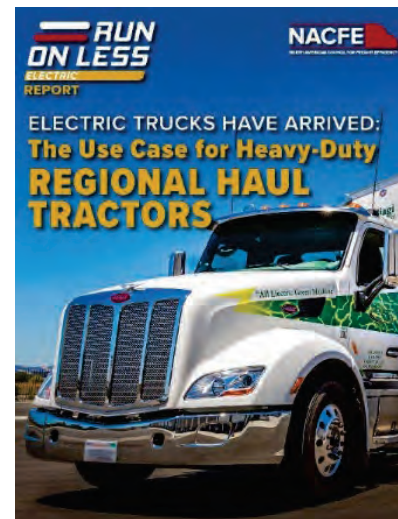
January 12, 2022
Review Of Complete
Demonstration:
[Electric Trucks Have Arrived](#)



March 6, 2022
The Use Case For
[TERMINAL TRACTORS](#)



April 11, 2022
The Use Case For
[VANS & STEP VANS](#)



May 5, 2022
The Use Case For
[REGIONAL HAUL TRACTORS](#)



June 28, 2022
The Use Case For
[MEDIUM DUTY BOX TRUCKS](#)

Other NACFE Whitepapers on Truck EVs:
<https://nacfe.org/research/electric-trucks/>



Run on Less - Electric DEPOT 2023

5 more EV OEMs

- Ford
 - BrightDrop
 - Navistar
 - Nikola
 - Tesla
- Each location has at least 15 EV trucks
 - Many have more

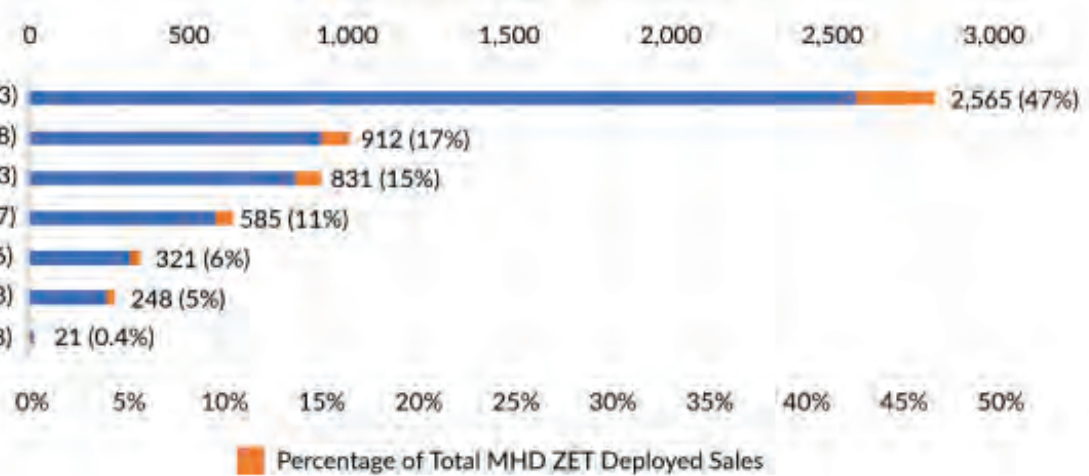


EV Truck Deployments (May '23)

- 5,483 Zero Emission Trucks Deployed 2b-8 (2021=1,895)
- 46% are in California ('21=60%)



Number of MHD ZET Deployed Sales



Legend

- ACT (MOU)*
- MOU
- Non-MOU

*Note: This map displays states that adopted ACT through 2022. Colorado has since adopted ACT.

3
4

Source: Calstart May 2023
[Zeroing-in-on-ZETs-May-2023-Market-Update.pdf](https://calstart.org/Zeroing-in-on-ZETs-May-2023-Market-Update.pdf) (calstart.org)

DEPOT Filming



DEPOTS Electric Truck Bootcamp

1. Best Practices for Utility-Fleet Relationships
2. Grants and Incentives for the Trucks and Infrastructure
3. Electric Truck Developments
4. Faster Charging — Opportunities and Challenges at 350KW and higher
5. Opportunities to Extend BEV Range (via charging technologies)
6. Electricity Resiliency and Availability (microgrids, renewable energy...)
7. Current and Future Regulations for Zero Emission Trucks
8. Managed Charging to Improve Availability, Cost and Range
9. Scaling Charging Infrastructure Equipment
10. Electric Depot Site Planning and Construction

[Register here](#)



Guidance on Electric Trucks

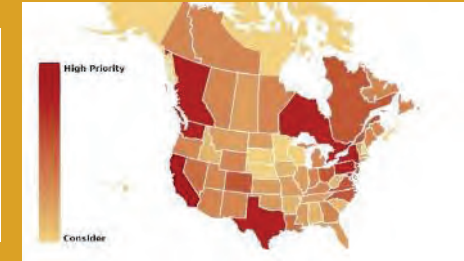
1

Electric Trucks: Where They Make Sense

May 2018



High Potential Regions



5

November 2020



MD Electric Trucks: Cost Of Ownership

October 2018

2

Viable Class 7 & 8 Electric, Hybrid & Alt Fuels Tractors



4

December 2019

Heavy-Duty Hydrogen Tractors



6 &
7

December 2020
April 2023

3
&
8

Electric Trucks: Charging Infrastructure

March 2019

June 2023



Now Free Online at <https://nacfe.org/emerging-technology/electric-trucks-2/>

CHARGING forward with electric trucks

Charging Forward GR

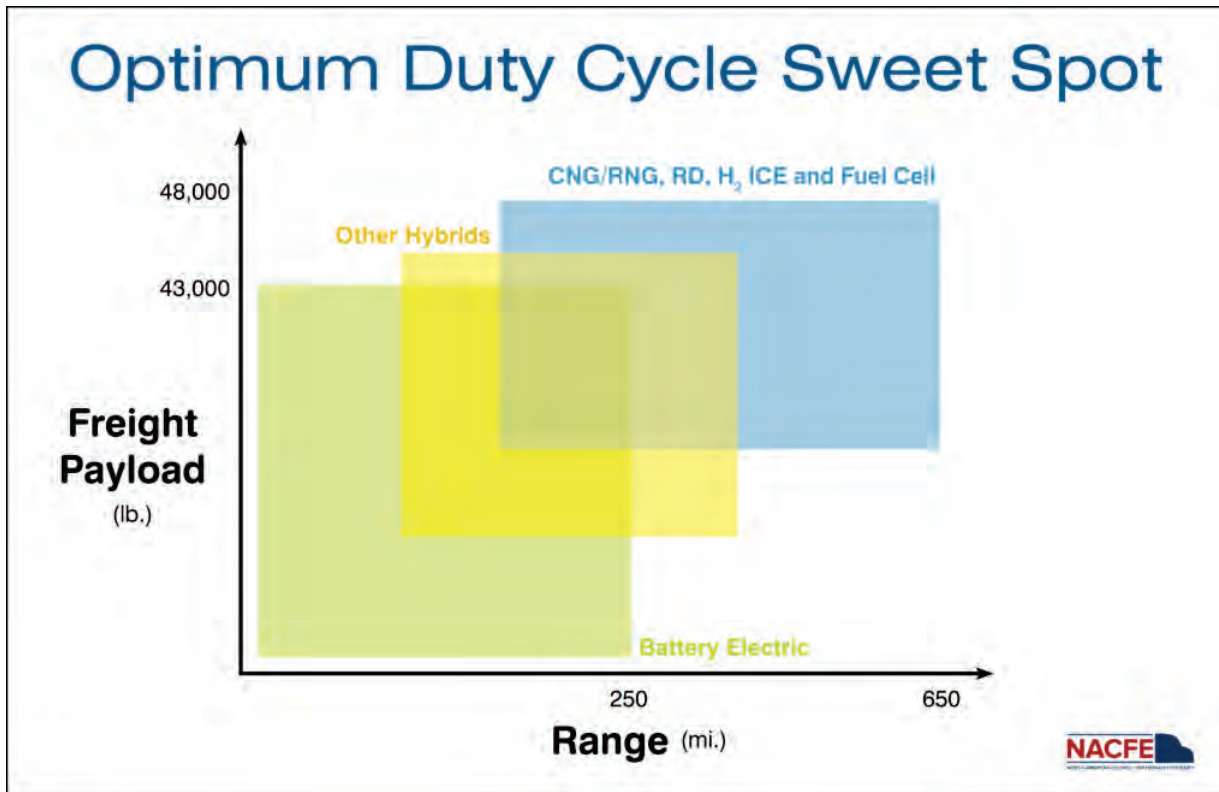
Conclusions:

- Electric trucks and chargers must work together
- Your utility is a key partner
- Use and design greatly affect charging cost
- The transition requires staff and attention
- Consider other charging business models
- Other key considerations
 - Grants & incentives
 - Microgrids
 - Landlords
 - Reliability and interoperability of chargers
 - And more...

<https://nacfe.org/research/electric-trucks/#charging-infrastructure>

Latest NACFE Electric Reports

Hydrogen Trucks: Long Haul's Future?



Published April 4, 2023; <https://nacfe.org/research/electric-trucks/#hydrogen>

Charging Forward with Electric Trucks



Published June 5, 2023;
<https://nacfe.org/research/electric-trucks/#charging-infrastructure>

How is industry changing?



June 2023



CCS1



CCS2



CHAdeMO



J1772



MCS or CharIN



NACFE.org

**Let's Stay Connected...
... And charged up!**



RunOnLess.com

LinkedIn [NACFE](#) (& Spanish: [NACFE LATAM](#))

f [NACFE](#)

t [@NACFE_Freight](#) & [@RunOnLess](#)

v [NACFE](#)



Dave Schaller
David.Schaller@NACFE.org

260-602-5713

The logo features the acronym 'NAACFE' in a bold, white, sans-serif font. It is flanked by two horizontal red lines above and below the text. To the right of the text is a large, solid red shape that resembles a stylized map of North America or a truck's cargo area.

NAACFE

NORTH AMERICAN COUNCIL FOR FREIGHT EFFICIENCY

THANK YOU