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TECHNOLOGY CENTER

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DRIVING BEYOND B20: HOW FLEETS ARE ACCELERATING THEIR DECARBONIZATION EFFORTS WITH BIODIESEL

Jennifer Weaver

OEM Market Development Manager

November 14, 2023



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ROAD MAP FOR TODAY

- Vehicle Market Overview
- The Time Value of Carbon
- Biodiesel Fuel Quality
- OEM Support for Biodiesel
- Optimus Technologies & B100
- Wrap Up and Q&A





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THE MD / HD VEHICLE MARKET TODAY:

DIESEL VEHICLES STILL DRIVE THE ECONOMY



Class 3



Class 4



Class 5



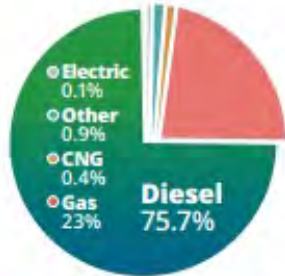
Class 6



Class 7

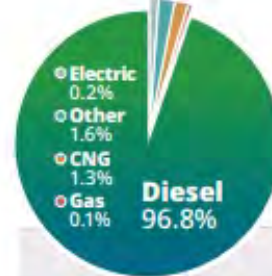


Class 8



76%

of all commercial vehicles in the U.S. are Diesel Powered (Class 3-8)



97%

of the Largest Commercial Trucks (Class 8) are Diesel Powered

56%

are powered by newest generation of advanced diesel technology

↑3%

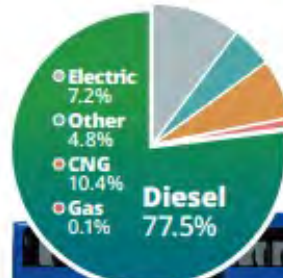
increase from 2021



Top 10 States with the Highest Percentage of Advanced Technology Near-Zero Emissions* Diesel Powered Trucks (Class 3-8, MY 2010+)

Ranking

1	Indiana	73%	6	Oklahoma	63%
2	Utah	66%	7	Florida	62%
3	Pennsylvania	66%	8	Illinois	61%
4	District of Columbia	65%	9	Louisiana	59%
5	Texas	64%	10	Wisconsin	59%



77%

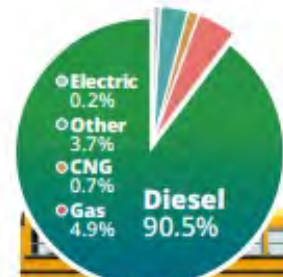
of Transit Buses are Diesel Powered

51%

are powered by newest generation of advanced diesel technology

↑3%

increase since 2021



90%

of School Buses are Diesel Powered

62%

are powered by newest generation of advanced diesel technology

↑4%

increase since 2021





WORK TRUCKS HAVE A LONG LIFE SPAN

In the past year, commercial vehicles have kept aging and the average commercial vehicle age between 10–15 years increased by 24%.

Figure 6 Truck age by application market

		Construction	Delivery/ cartage	Government/ municipal	Utility/ telecom	Rental/ lease	Transportation/ warehousing	Other	Total
Truck age range (years)	<5	39%	14%	12%	7%	100%	20%	42%	19%
	5–10	46%	58%	56%	53%	0%	60%	33%	51%
	10–15	15%	14%	30%	40%	0%	20%	25%	27%
	>15	0%	14%	2%	0%	0%	0%	0%	3%
	Total	100%	100%	100%	100%	100%	100%	100%	100%

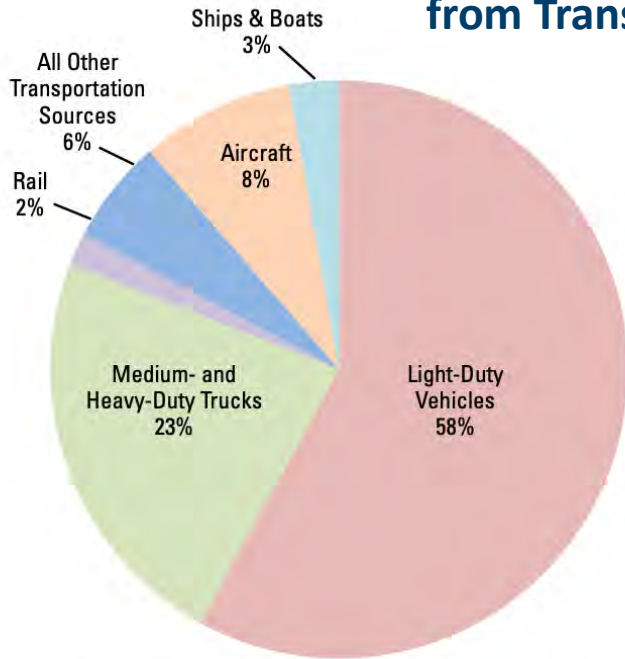
Source: NTEA 2023 Fleet Purchasing Outlook Survey

BOTH LEGACY VEHICLES AND NEW TECHNOLOGY DIESEL ENGINES CAN RUN
CLEANER ON BIODIESEL BLENDS OR RENEWABLE DIESEL WITH
NO MODIFICATIONS REQUIRED



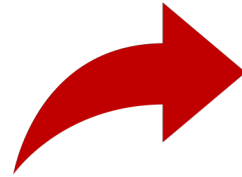
TRANSPORTATION IMPACTS ON GLOBAL WARMING

31% of US GHGs from Transportation



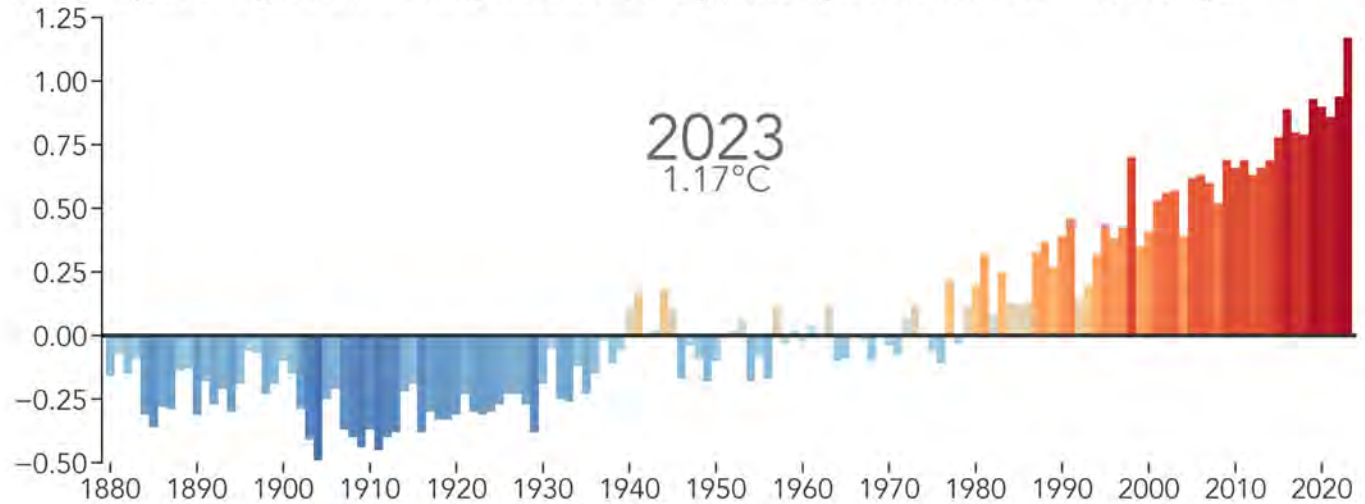
Share of U.S. Transportation Sector
GHG Emissions by Source, 2021^{4,5}

Note: Totals may not add to 100% due to rounding.



Summer 2023 Continues Long-Term Warming Trend

June, July, and August Global Temperature Anomaly (°C compared to the 1951-1980 average)



- Summer of 2023 was Earth's hottest since global records began in 1880, according to scientists at NASA's Goddard Institute of Space Studies (GISS) in New York.

THE TIME VALUE OF CARBON

When evaluating emission reduction strategies, there are 2 essential elements to consider: the **amount** of the reduction, and **when** it happens.

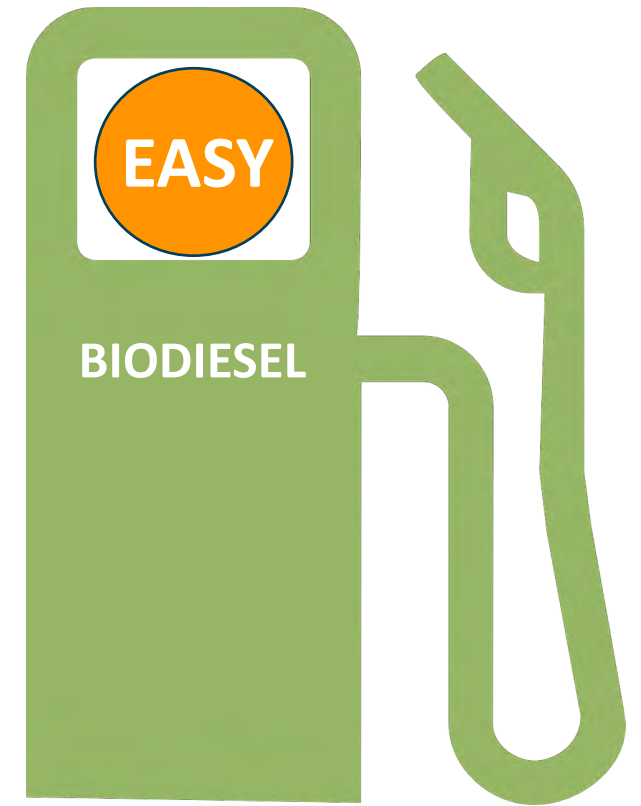
- Carbon emissions are persistent and accumulate
- Increased levels of carbon dioxide (CO₂) in the atmosphere contribute to global warming now, and for decades to come
- A reduction in CO₂ emissions now can avoid decades of associated heating, thus having significantly more value than carbon reductions made later

The Time Value of Carbon is key,
and the next decade is critical.



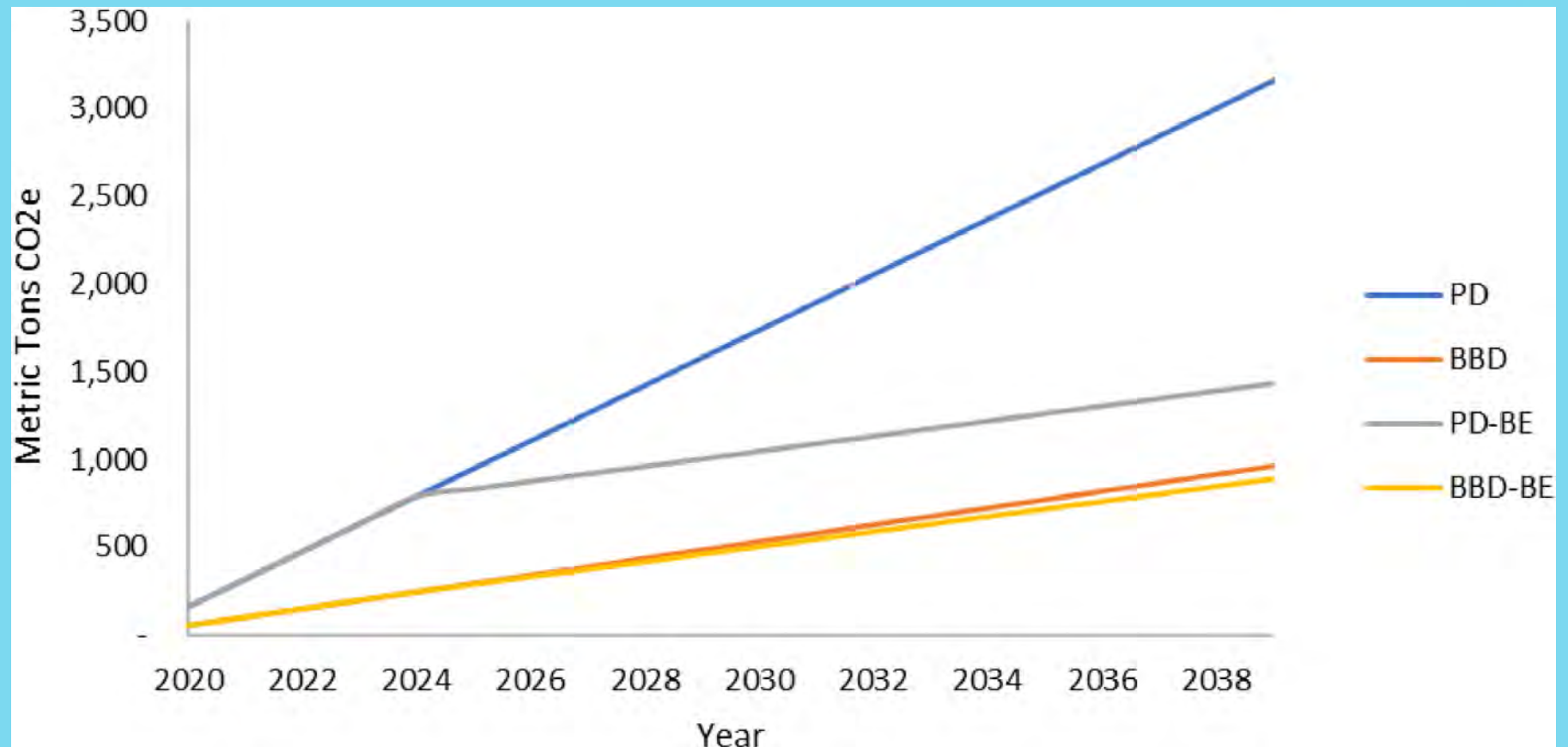
DECARBONIZATION DOESN'T HAVE TO BE DAUNTING... ADVANCED BIOFUELS ARE HERE TODAY

- OEMs and Fleets are taking a fresh look at biodiesel and renewable diesel as **better, cleaner, advanced biofuels that are available now** for use in their existing diesel engines, allowing them to make immediate reductions in their carbon emissions, easily and affordably
- EPA defines **Advanced Biofuels** as renewable fuels that have **lifecycle greenhouse gas emissions** that are at least **50 percent less** than baseline lifecycle greenhouse gas emissions from diesel fuel
- **B100 reduces GHG emissions by more than 70%** on average compared to ULSD



CUMULATIVE GHG EMISSIONS BY FUEL SYSTEM

- Investing in Biomass Based Diesel (BBD) in combination with Battery Electric (BE) technologies achieves the greatest reductions in total GHG emissions over the next 20 years.
- Both BBD and BBD+BE surpass the carbon reduction benefits of continuing to use Petroleum Diesel (PD) while waiting for BE



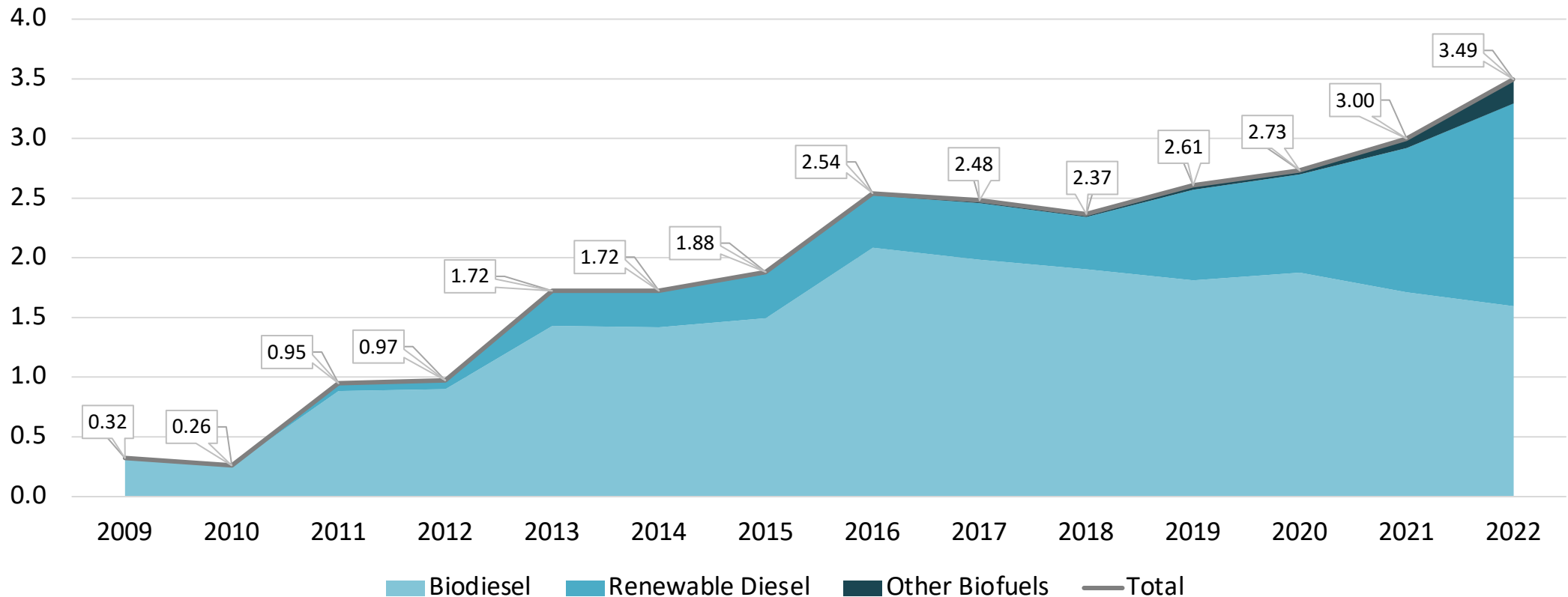
SOURCE: <https://www.sciencedirect.com/science/article/pii/S2666052021000108#fig0001>
SUNY Study – Quantifying the Comparative Values of Carbon Abatement Scenarios Over Time



U.S. BIOMASS-BASED DIESEL CONSUMPTION

U.S. BBD Consumption

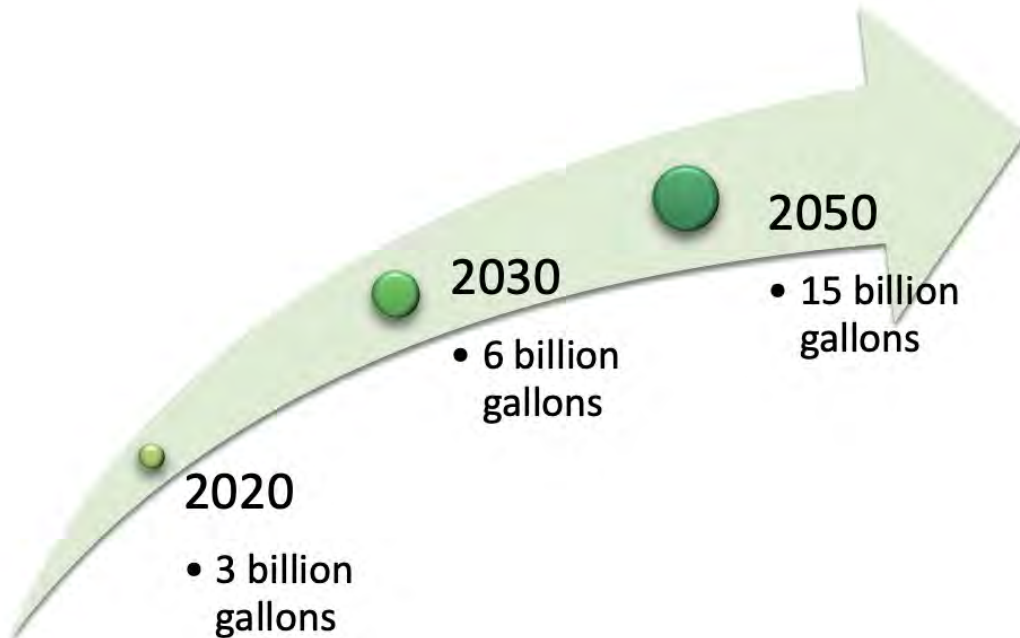
Billion Gallons



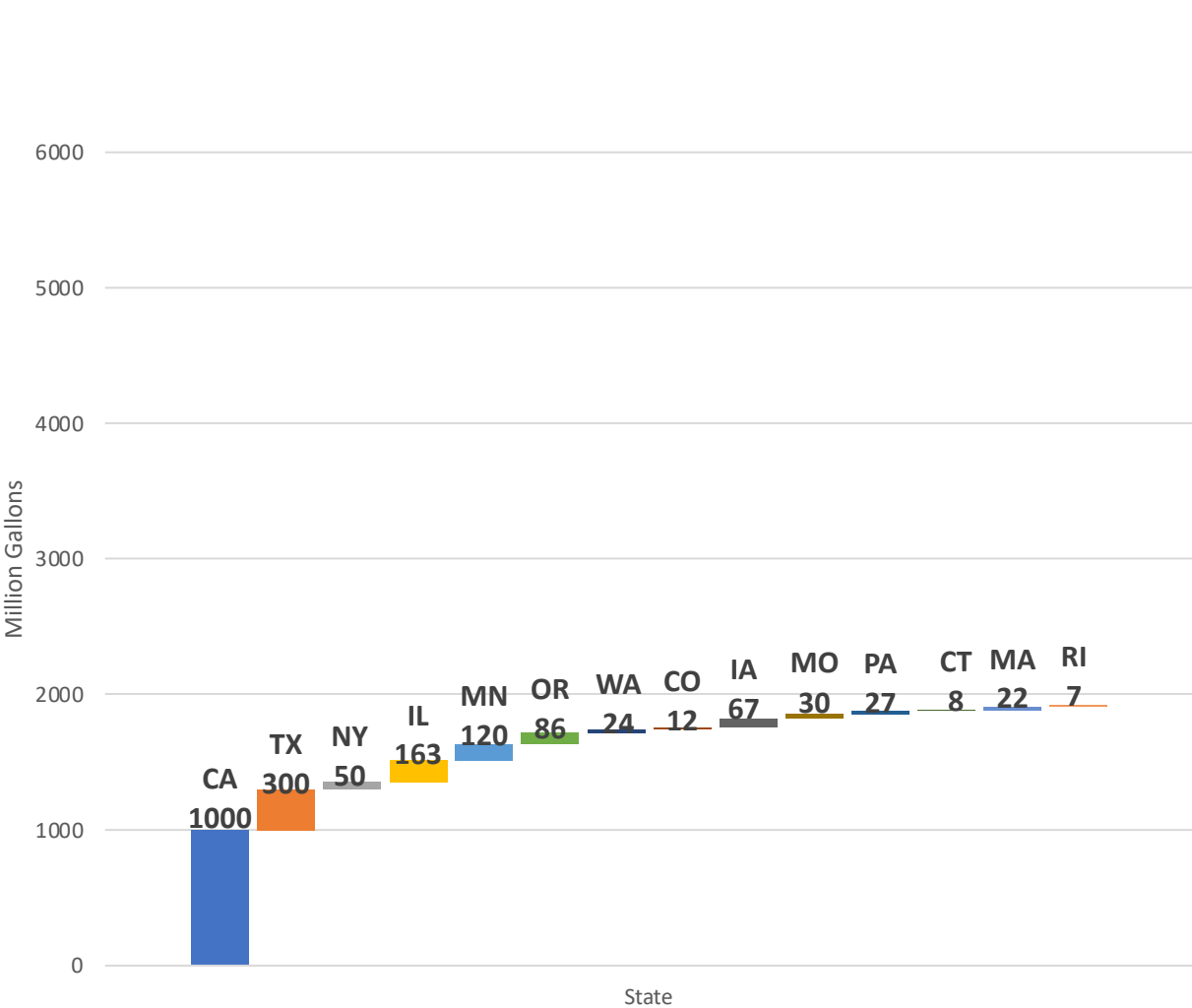


CLEAN FUELS ALLIANCE AMERICA INDUSTRY VISION

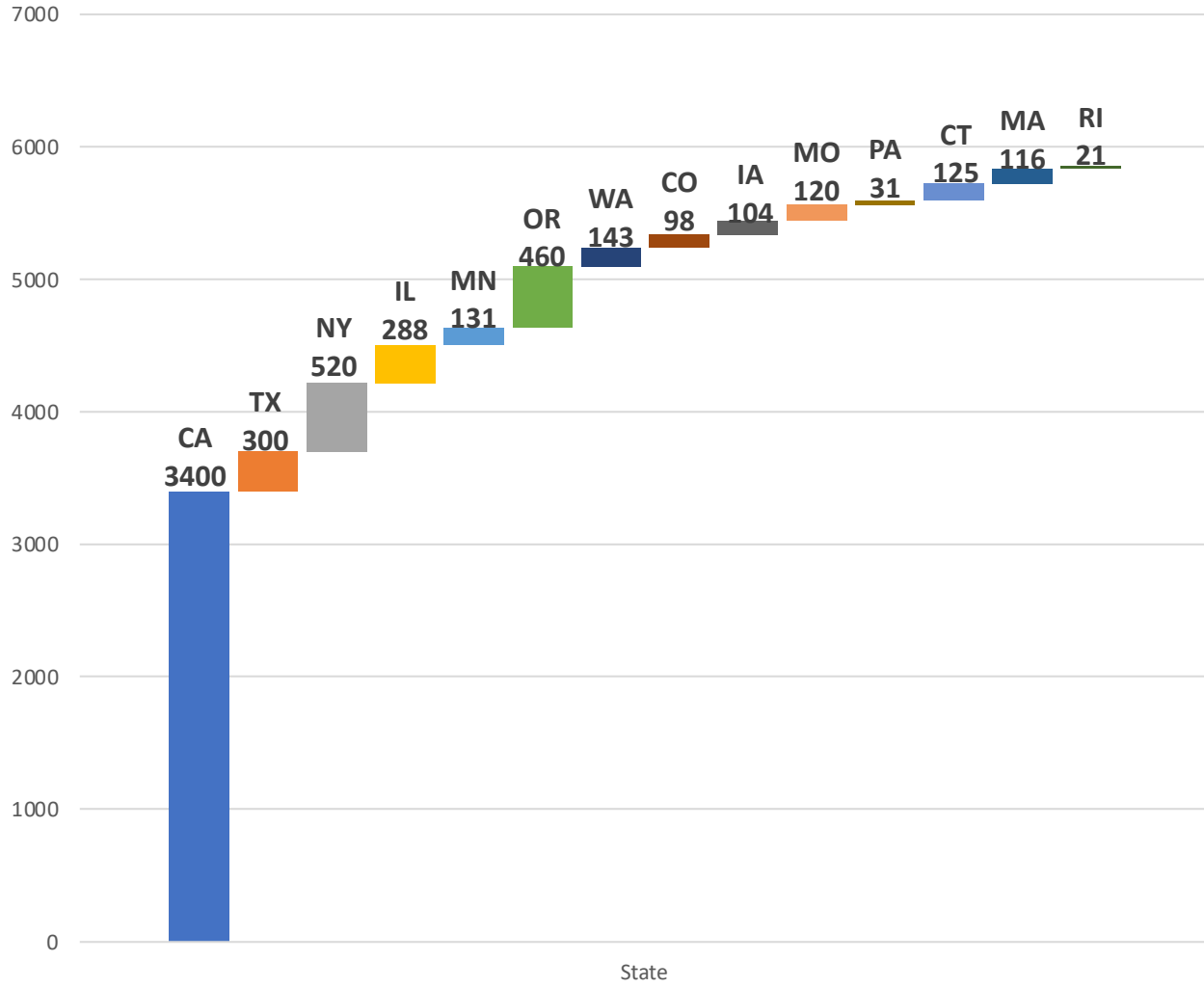
Biodiesel, renewable diesel and sustainable aviation fuel will be recognized as mainstream low-carbon fuel options with superior performance and emission characteristics. In on-road, off-road, air transportation, electricity generation and home heating applications, use **will exceed 6 billion gallons by 2030, avoiding over 50 million metric tons of CO₂ equivalent greenhouse gas emissions annually.** With advancements in feedstock, use will reach **15 billion gallons by 2050.**



2020 1.9 Billion Gallon State Market



2030* 5.9 Billion Gallon State Market



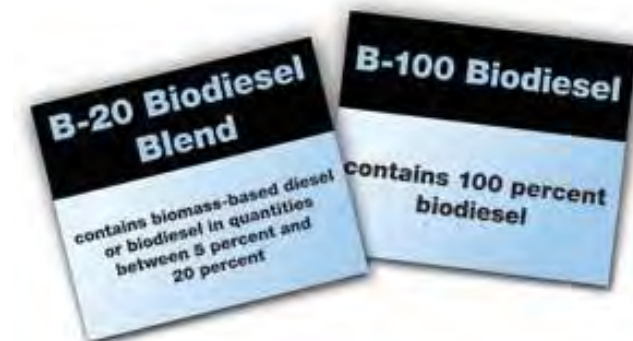
***Potential growth based on established or proposed requirements**



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BIODIESEL INFRASTRUCTURE

- Biodiesel and biodiesel blends available nationwide at more than 2,400 public locations
- Existing trucks, tanks, dispenser pumps and blending facilities can be used for B20 and lower
- Find retailers offering B20 & higher blends at: <https://afdc.energy.gov/stations/#/find/nearest?fuel=BD>
- Blends higher than B20 may require strategic partnerships with fuel suppliers, many already in development through the High Blend Infrastructure Incentive Program (HBIIP) & available for fleets with centralized fueling facilities





MAJOR DIESEL FUEL INDUSTRY CHANGES

- Carbon reduction is now driving the market
- B20 is simply not enough for many policy targets and corporate ESG goals

Industry Is Telling Us:

- B20 minimum in On/Off road Engines, moving toward B30/B50/B100
- B50/B100 in Home Heating Oil
- Marine Fuels Want B50/B100
- Railroads Want Over B20
- Interest in Low Carbon Electrical Generation

Continuous evolution of Biodiesel fuel quality specifications to address OEM and end-user questions



CONTINUOUS UPDATES TO D6751:

- Originally published in 2002: ASTM D6751-02
- -03: **Added 15 ppm sulfur grade**
- -03a: Modified 'middle distillate' term, lubricity note
- -06: **Reduced AV from 0.8 to 0.5; added limit on Na+K.**
- -06a: **Added limit on Ca+Mg**
- -06b: **Addition of oxidation stability**
- -07: Modified language and added test methods
- -07a: Added alcohol control and modified flashpoint
- -07b: Added DCN and sulfur test methods
- -08: **Addition of cold soak filterability**
- *Introduction of B5 into D975 and publication of D7467 (B6 to B20 Standard)*
- -09: Added cloud point test methods
- -09a: Added cloud point test methods
- -10: Added EN15751 as referee method for stability
- -11: Added test methods and appendix on low temperature operability
- -11a: Replaced cold soak filterability annex with D7501
- -11b: Added new test methods
- -12: **Addition of 1B Grade, updated scope, new test methods**



D6751: New Low Metals (LM) Grade For New Technology Diesel Engines

- Cooperative program at SwRI with OEMs on Long-Term DPF Durability in New Technology Diesel Engines (NTDE)
- 4 ppm B100 metals levels, ~1000-hour durability testing
- B20 with doped metals compared to conventional diesel fuel provided the same performance in the DPF
 - SAE paper numbers: 2023-01-0296, 2023-01-0297
- **New D6751 LM Grade Limits, May 2023: 4 ppm maximum Na+K+Ca+Mg**
 - Average today (1 ppm) is far less than the successful durability test
 - ASTM D6751-23a

➤ Provides further confidence w/ B20 and higher blends

CONFIDENCE IN HIGHER BIODIESEL BLENDS

- Increasingly stringent ASTM specs and robust BQ-9000 quality program have led to extremely high-quality biodiesel today and eliminated issues formerly attributed to B20
- Today's biodiesel has ultra-low metals, high oxidation reserve (stability), very low minor components (No.1-B low metals grade)
- Tips for Success:
 - Require ASTM grade fuels
 - Buy from high quality BQ-9000 Certified suppliers
 - Be proactive with cold flow management in winter months or use Optimus system



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OEM BIODIESEL SUPPORT

- Biodiesel is registered as a legal fuel and fuel additive at any concentration
- The vast majority of new diesel engines in the on-road and off-road markets now have full OEM support for B20 or higher biodiesel blends meeting ASTM standards (ASTM D6751 / ASTM D7467)
- Many OEMs also recommend that biodiesel be sourced from a BQ-9000 certified supplier
- See Toolkit at www.cleanfuels.org for a summary of OEM Support Positions on Biodiesel and Renewable Diesel





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GROWING OEM SUPPORT FOR HIGHER BLENDS



“B20 is already in our lives today with many engines capable of running on it; the next step towards lowering emissions will be to have our engines run on B40 and then on B100, pure biodiesel.”

- Srikanth Padmanabhan –
President, Engine Segment, Cummins

<https://www.cummins.com/news/2022/02/17/reducing-commercial-transportation-emissions-reach-destination-zero>

“The vast majority of our engine models now accept B100, and we have updated Caterpillar’s Diesel Engine Fluids Recommendations to highlight B100 use.”

- Hind Abi-Akar –
Engineering Technical Steward, Caterpillar

https://www.cat.com/en_US/articles/for-owners/what-is-biodiesel-fuel-of-the-future-fuel-of-today.html

HOW DOES USING BIODIESEL AFFECT THE ENGINE WARRANTY?

The Magnuson Moss Warranty Act

- Passed by Congress in 1975
- Federal law that governs consumer product warranties

A vehicle's warranty cannot be voided solely due to the use of biodiesel. Even if the manufacturer recommends a blend of 20% biodiesel and a customer uses a higher blend such as 30% or 99% biodiesel, this does not void the warranty. If a customer uses a blend of biodiesel that is not recommended, that in and of itself, does not void the warranty. If the biodiesel is not the cause of the engine or parts failure, the warranty must be honored (assuming the failure is not the result of another external factor).

“

Cummins engine warranty covers failures that are a result of defects in material or factory workmanship. Engine damage, service issues, and/or performance issues determined by Cummins to be caused by the use of biodiesel fuel not meeting the specifications outlined in the Fuels Service Bulletin (3379001) are not considered to be defects in material or workmanship and are not covered under Cummins engine warranty.

This is no different from Cummins' position with regular diesel fuel. Cummins does not cover the damage caused by non-Cummins products that are of insufficient quality. It is important to ensure when using diesel fuel or a biodiesel blend with a Cummins engine that the fuel meets industry acceptable quality standards.



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FLEETS ARE MOVING BEYOND B20

Forward-looking fleets are using higher biodiesel blends to maximize the reduction in their carbon footprint using their new and existing diesel vehicles



REDUCE FUEL COSTS. REDUCE EMISSIONS. EASILY.



- cleanfuels.org -



OPTIMUS
TECHNOLOGIES



How to Immediately Decarbonize Heavy-Duty Vehicles

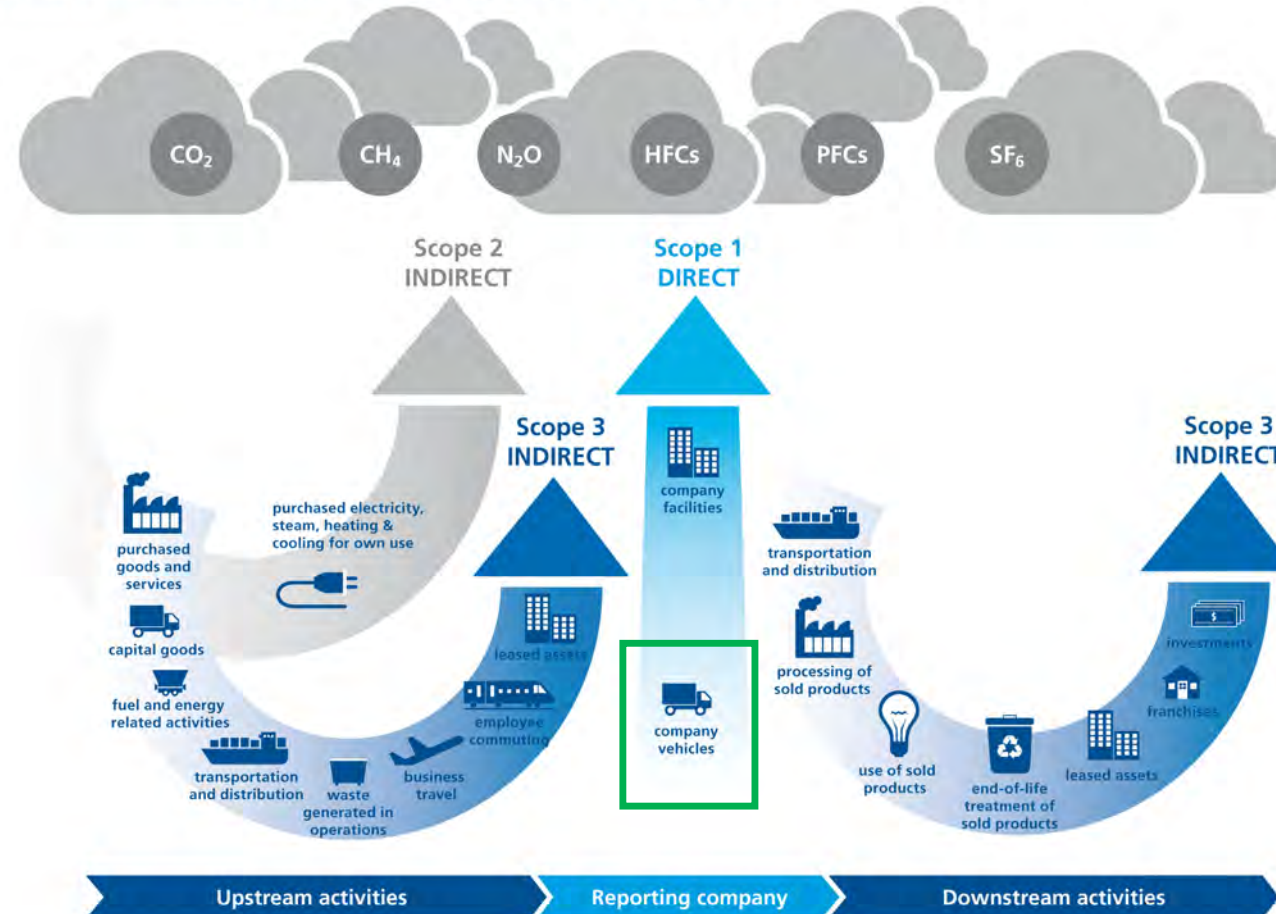
Lori Dunn, COO | l.dunn@optimustec.com | 909.227.7600



NEAR-ZERO CARBON

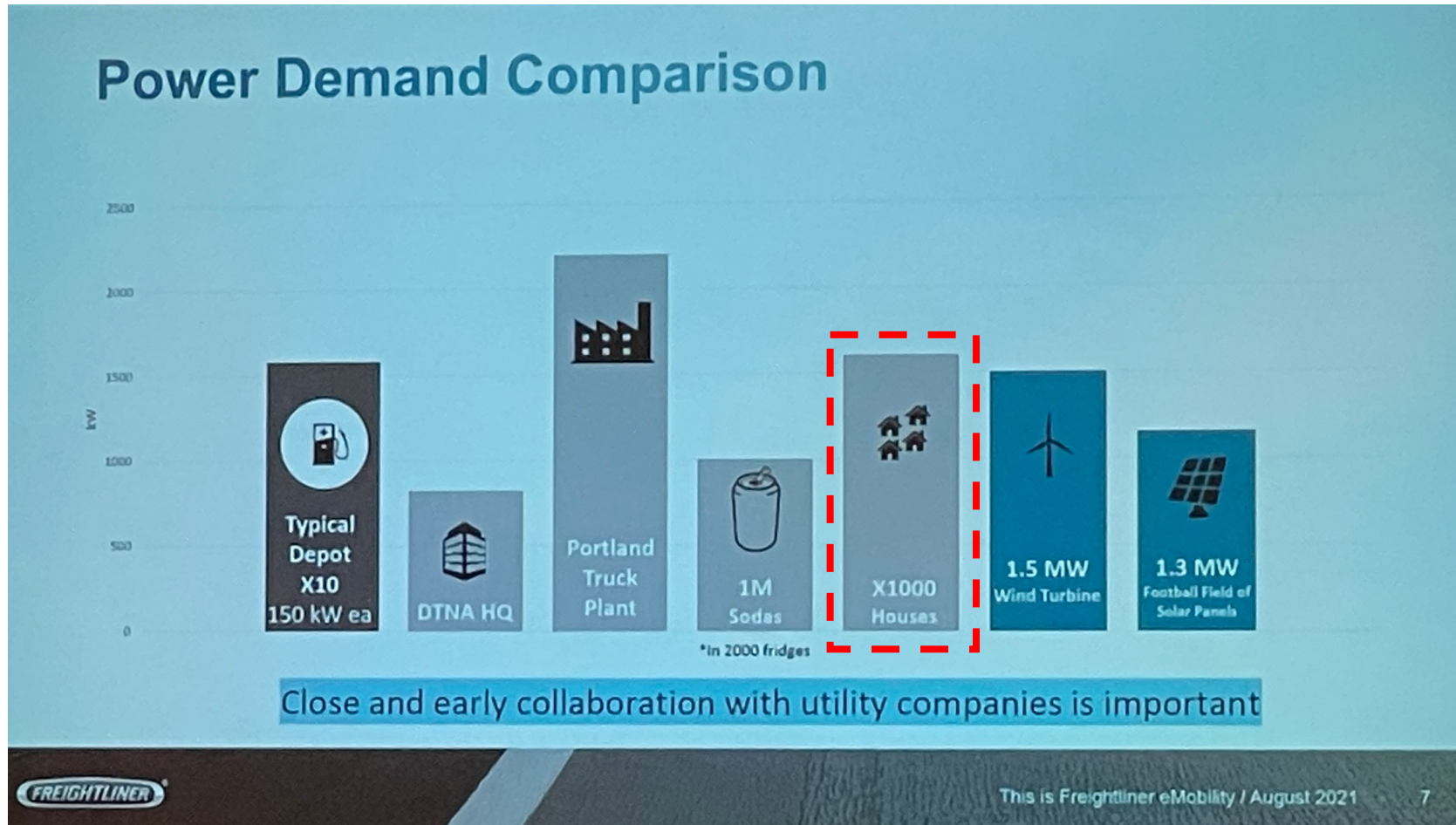
Biogenic CO₂ from B100 results in 100% reduction in scope 1 carbon emissions.

Overview of GHG Protocol scopes and emissions across the value chain



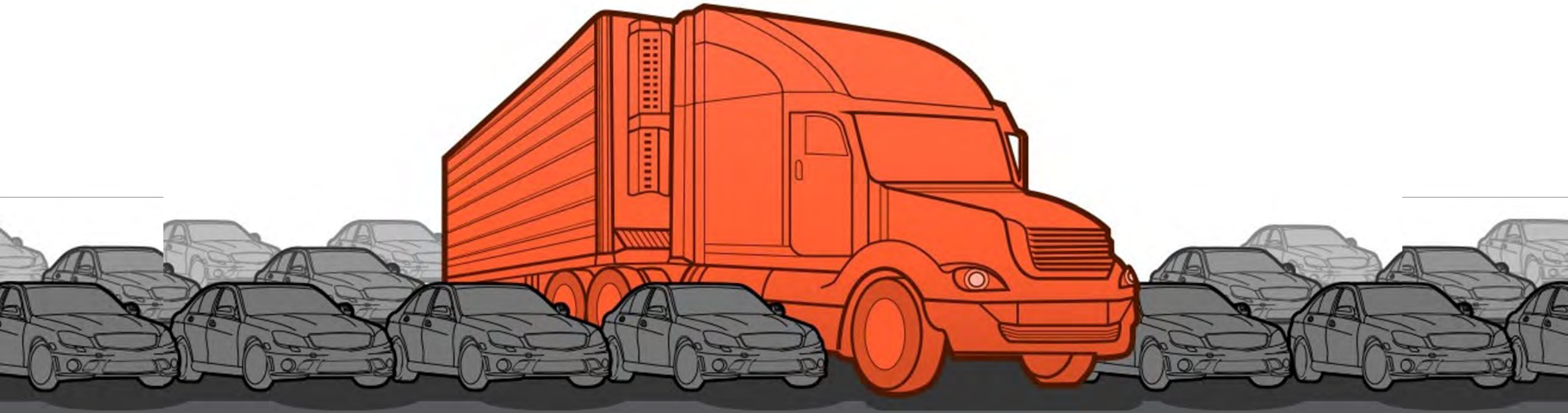
CARBON REDUCTIONS ARE NEEDED TODAY

High cost of vehicles (~3x), limited range/payload, long equipment life and massive infrastructure challenges will limit broad scale adoption of heavy-duty EV's for the next 10-20 years.



Heavy-duty trucks consume **25%** of all the fuel we use...

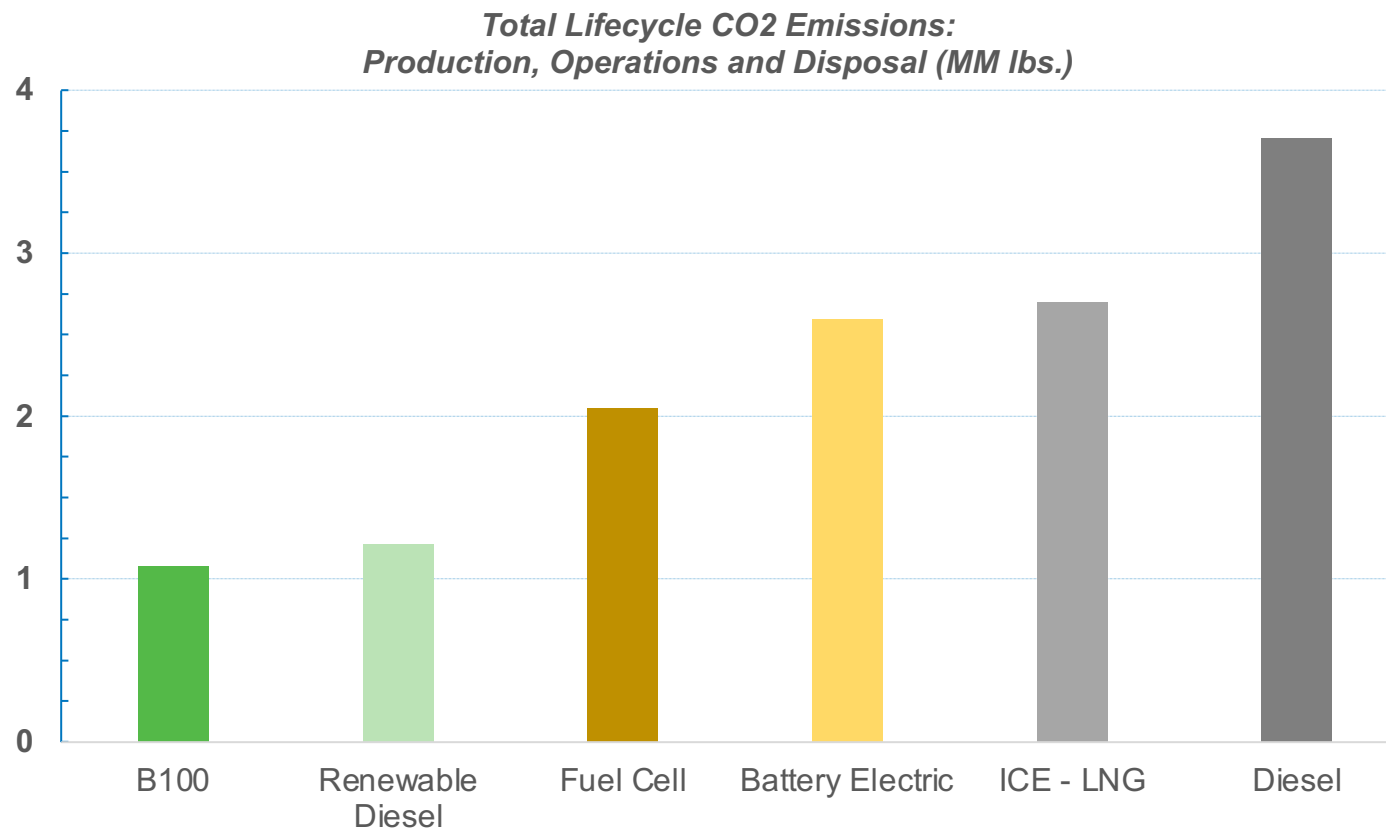
...yet account for only **7%** of vehicles on the road



Optimus offers a **low cost** and **near-zero carbon** option applicable for **all fleet assets** both existing and new.

TOTAL LIFECYCLE EMISSIONS

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



WHY BIODIESEL



Biogenic Carbon



Utilizes Existing Infrastructure



Renewable, Sustainable, & Scalable



Low Cost

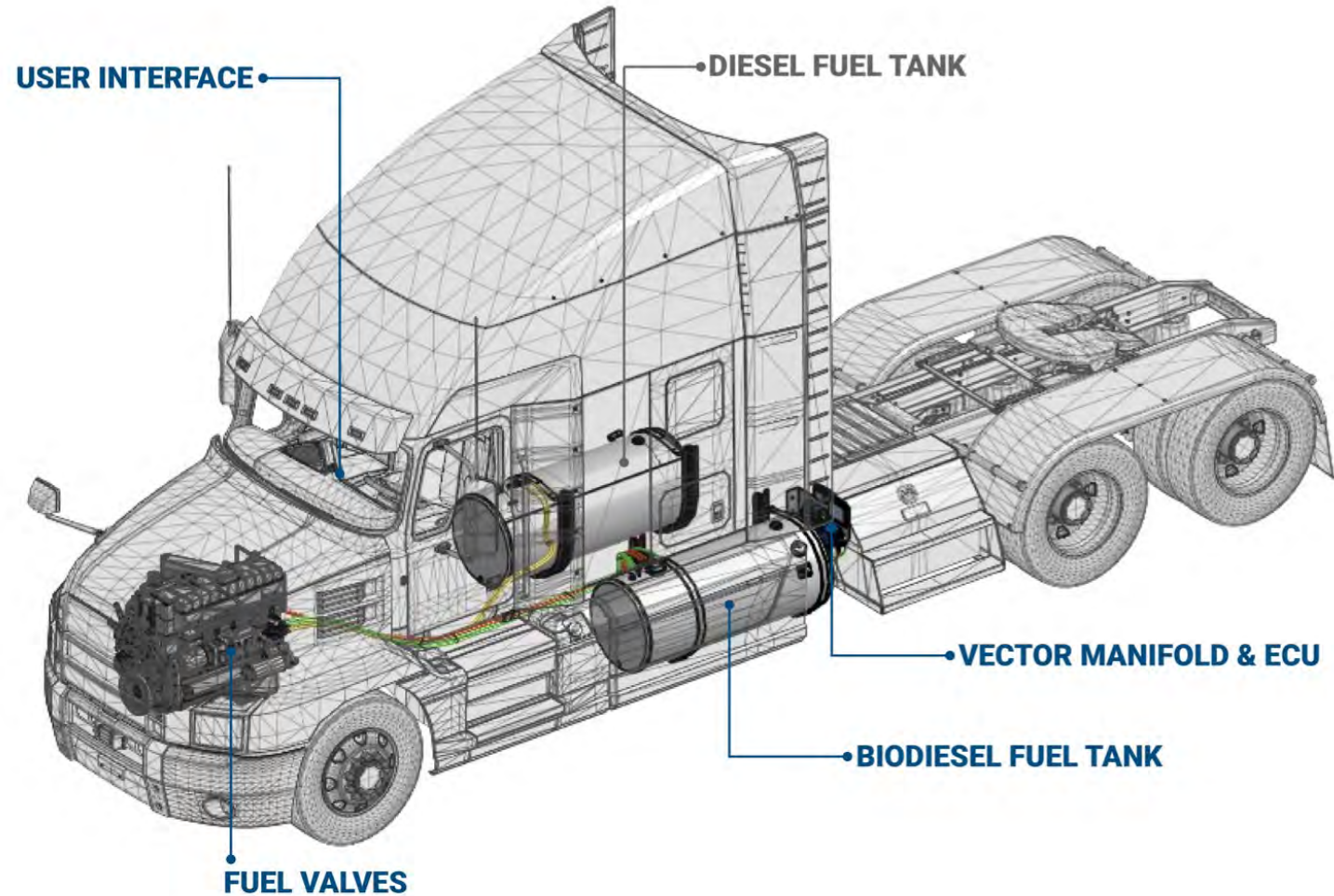


Safer & More Efficient



OPTIMUS VECTOR SYSTEM

Upgrades engines to use 100% biodiesel (B100)





“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



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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

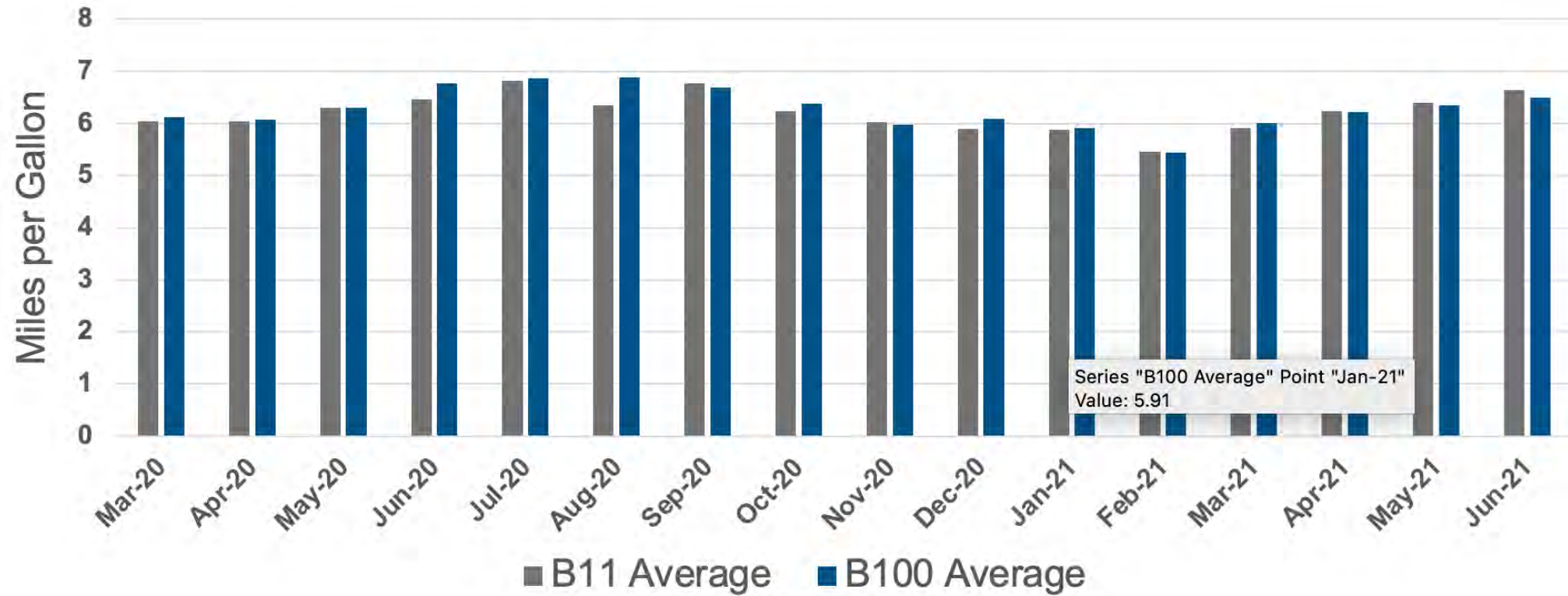
Cetane Number (ASTM D613)	Water & Sediment (ASTM D2709)	Water "Karl Fischer" (ASTM D6304)	Sulfur (ASTM D5453)	Acid Number (ASTM D664)	Oxidation Stability @110°C (EN14112)	Calcium & Magnesium (EN14538)	Sodium & Potassium (EN14538)	Phosphorus (ASTM D4951)
48	0.00 % Volume	258 mg/kg	0.3 mg/kg	0.38 mgKOH/g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

- Commercial fuel from ADM Mexico, MO facility
- Refinery → Distributor → ADM Trucking Bulk Tank

*Weighted Average of 77,424 Gal.



FUEL ECONOMY RESULTS



Diesel



6.24 MPG avg



651,424 mi



100% Biodiesel



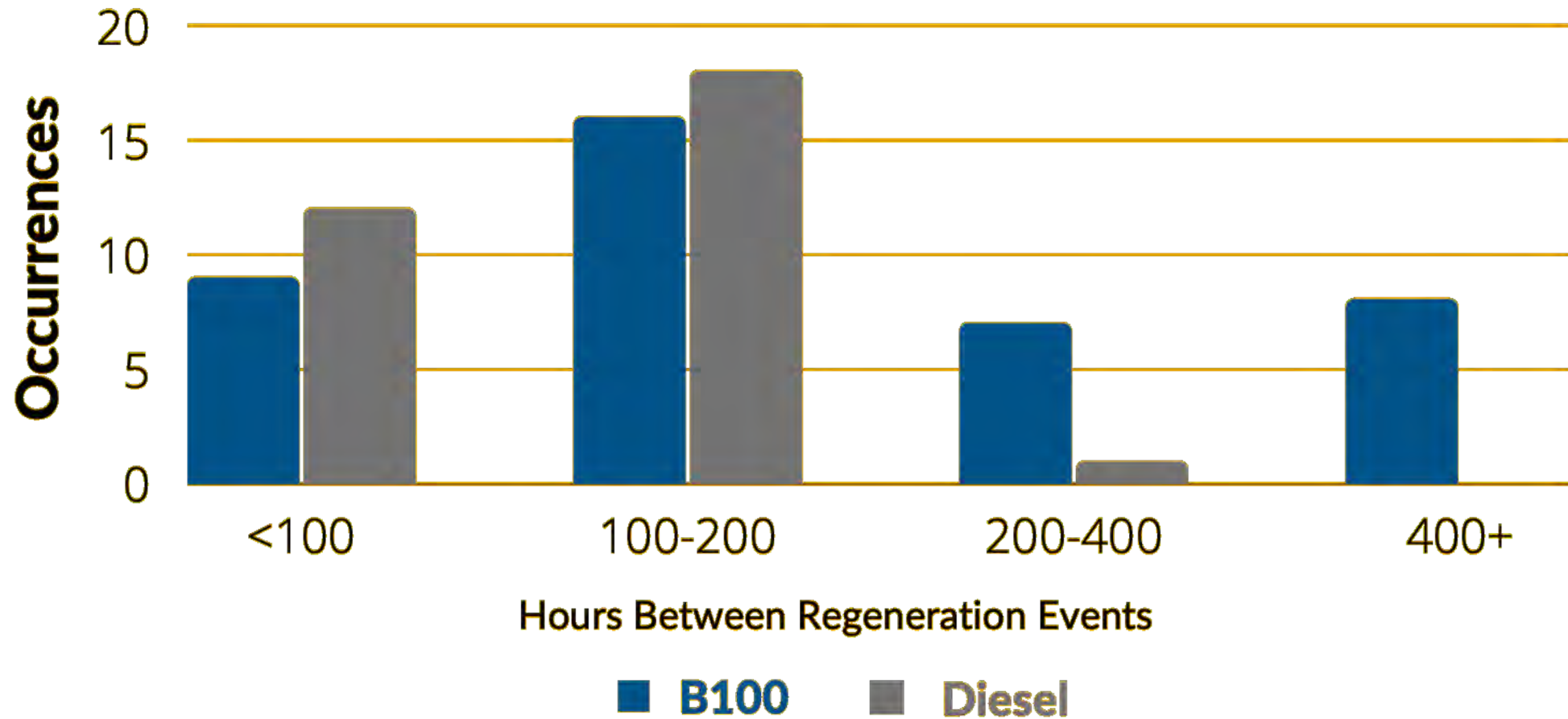
6.32 MPG avg



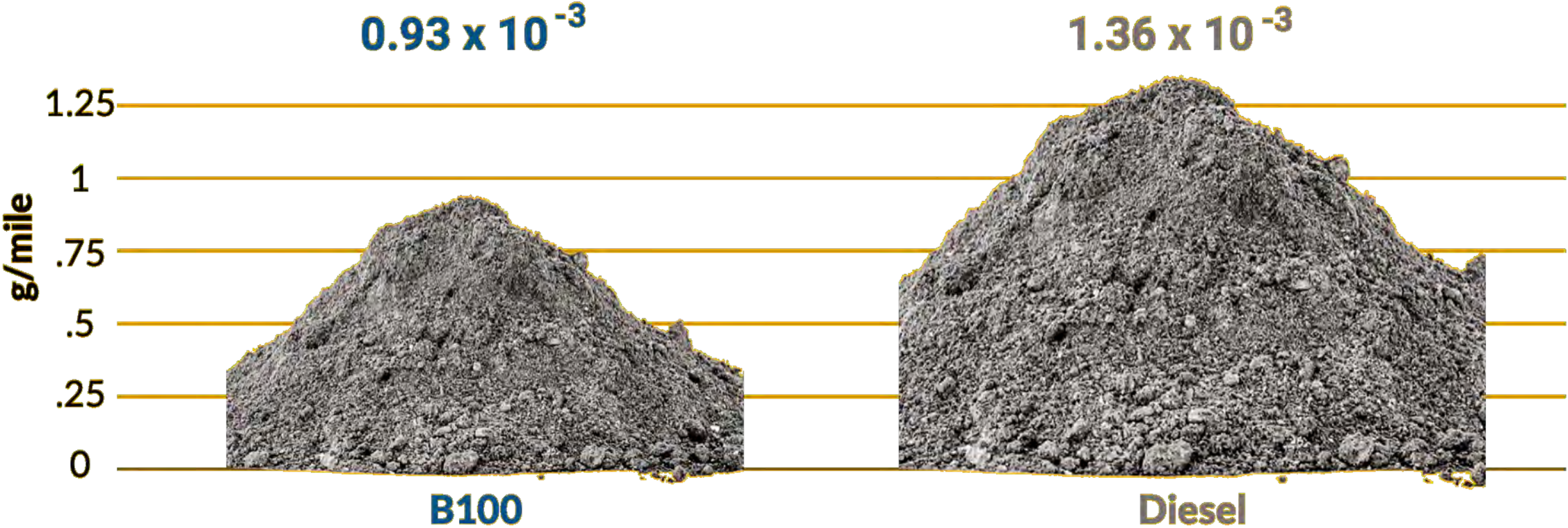
636,034 mi



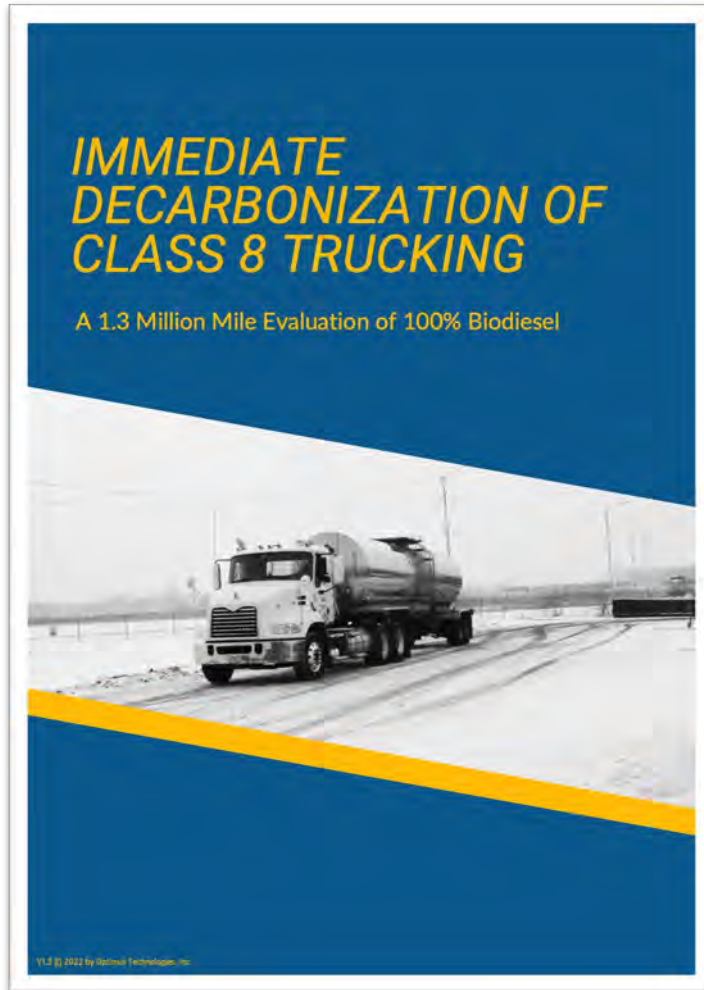
DPF REGENERATION INTERVALS



DPF ASH ACCUMULATION & CLEAN OUT



1.3MM MILE FLEET STUDY – ADM TRUCKING





“Moving forward, our intention is to only purchase heavy-duty trucks that operate on B100 technology.”

- DC DPW Fleet Associate Administrator, Ryan Frasier

“The identified strategy will be to have the Vector system as a standard add on to all future purchases.

- City of Des Moines Fleet Services Manager, Brian Bennett



“Looking to the future, the city’s goal is to run 100% of its fleet on electric vehicles or 100% biodiesel by 2030.”

- City of Madison Fleet Superintendent, Mahanth Joishy



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QUESTIONS?

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Thank You!

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REDUCE FUEL COSTS. REDUCE EMISSIONS. EASILY.

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F E B R U A R Y 5 - 8

