Decarbonizing with Natural Gas

February 25, 2025

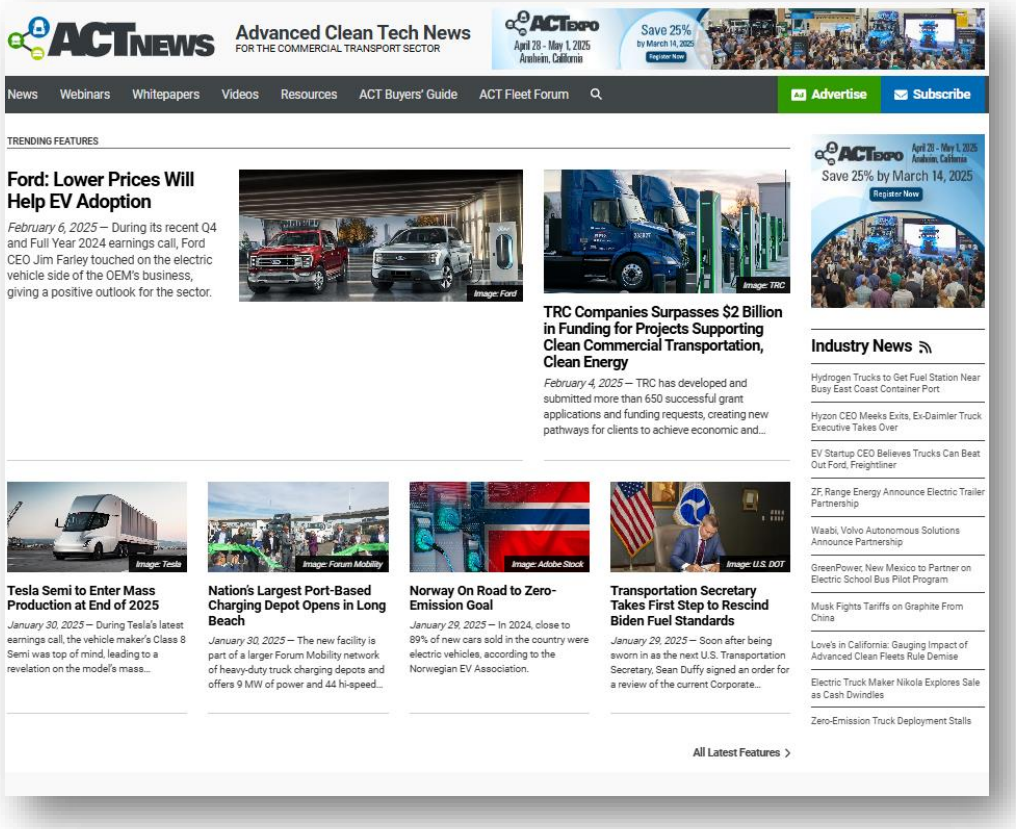
MESSY MIDDLE BOOTCAMP

RUN ON LESS MESSY MIDDLE

NACFE
NORTH AMERICAN COUNCIL FOR FREIGHT EFFICIENCY

Follow the Industry at ACT News.com

Advanced Clean Tech News For the Commercial Transport Sector



Subscribe today at www.act-news.com/subscribe

Join Us at ACT Expo 2025

The Largest Advanced Commercial Vehicle Technology Show

Driving Economic & Environmental Fleet Sustainability

Booth #6033

NACFE
NORTH AMERICAN COUNCIL FOR FREIGHT EFFICIENCY

Use Code 25AE-NACFE-50 at
www.actexpo.com/register
For $50 off Full Conference pass

Conference: April 28-May 1, 2025 | Expo: April 28-30, 2025
Anaheim, CA | Anaheim Convention Center

Messy Middle Bootcamp Series

Diesel Drop-In Alternatives: Ultra-Low Sulfur, Bio-, and Renewable (February 11th) ✓

Decarbonizing with Natural Gas (February 25th)

Future Prices & Availability of Existing Infrastructure: What's Next? (March 11th)

DIESEL AND NATURAL GAS WORKSHOP (March 25th)

The Current State of HD BEV: Technologies and Capabilities (April 8th)

Strategizing Successful HD BEV Adoption (April 27th)

Charging Depots, Networks & the Economics of Fleet (May 6th)

HD BEV WORKSHOP (May 20th)

The Production Processes of Hydrogen Fuel (June 3rd)

Moving Hydrogen from Here to There: The Distribution and Storage of Hydrogen Fuel (June 17th)

The Opportunities and Challenges of Selling Hydrogen to the Industry (July 1st)

HYDROGEN FUEL CELL WORKSHOP (July 15th)

2023 Bootcamp is still available at: https://runonless.com/electric-depot/

2025 Messy Middle Fleets

Update from The Run Planning…

Follow the Fleets, Drivers, providers, and more on:

RunOnLess.com and on Twitter @RunOnLess

RUN ON LESS MESSY MIDDLE

NACFE
NORTH AMERICAN COUNCIL FOR FREIGHT EFFICIENCY

Today's Bootcamp Sponsor

RUN ON LESS
MESSY MIDDLE

MESSY MIDDLE
BOOTCAMP

Quiz for Today's Session

Completing Today's Quiz:

- Go to runonless.com and click back into the session
- Click 'Take Quiz' button
- Create username and password to keep track of your progress
- Provide your name and email to enter a drawing for a Run on Less - Messy Middle swag bag

What You Should Know

Q&A

Submit your questions to the host using the Q&A box in the upper right-hand corner

Recording

A recording of today's webinar will be available on runonless.com

Technical Issues

Contact Stephane Babcock at

sbabcock@trccompanies.com

Today's Bootcamp Speakers

Decarbonizing with Natural Gas

Dan Deppeler
Vice President of Maintenance
Paper Transport

David King
Product Manager, On-Highway Natural Gas Engine Portfolio
Cummins

Matt Tomich
President
Energy Vision

Marty Tufte
Corporate Fleet Director
WM

RUN ON LESS MESSY MIDDLE

MESSY MIDDLE BOOTCAMP

From Organic "Waste" to Sustainable Vehicle Fuel: Renewable Natural Gas (RNG)

U.S. Trends and Emerging Opportunities

Matt Tomich, President, Energy Vision

Run on Less – Messy Middle – Feb 25, 2025

Energy Vision – What We Do

- An independent NGO exploring environmental solutions: to advance low-carbon strategies viable today and essential for a sustainable future
- Research technologies, policies, & market developments: publish reports, hold workshops, and educate the public through talks, op-eds, & media
- Key focus on transforming **methane** from a climate liability into a clean fuel solution

Energy Vision

Program & Impact

Major focus on accelerating circular economy solutions – especially "waste-to-value" – through research, education, media and advisory

Hosted the first national "Waste to Wheels" workshop on RNG in 2010 in collaboration with DOE Clean Cities (and 25+ regional "Power of Waste" workshops since)

Published numerous reports, case studies, articles and op-eds all aimed at spurring interest and action

ENERGY VISION

What is “Biogas”?

When organic wastes decompose in an oxygen-free environment (like a landfill), they release *biogas*. This process is called ***anaerobic digestion***.

Biogas is 50% - 65% methane (depending on the source).

ENERGY VISION

Historically, biogas has been used to produce electricity and/or heat

CHP system at landfill, Quebec

CHP system at Coney Island WRRF, NYC

ENERGY VISION

Biogas can also be *upgraded* to **renewable natural gas (RNG)**

- 95+% methane
- "Pipeline quality"
- Flexible, multi-purpose

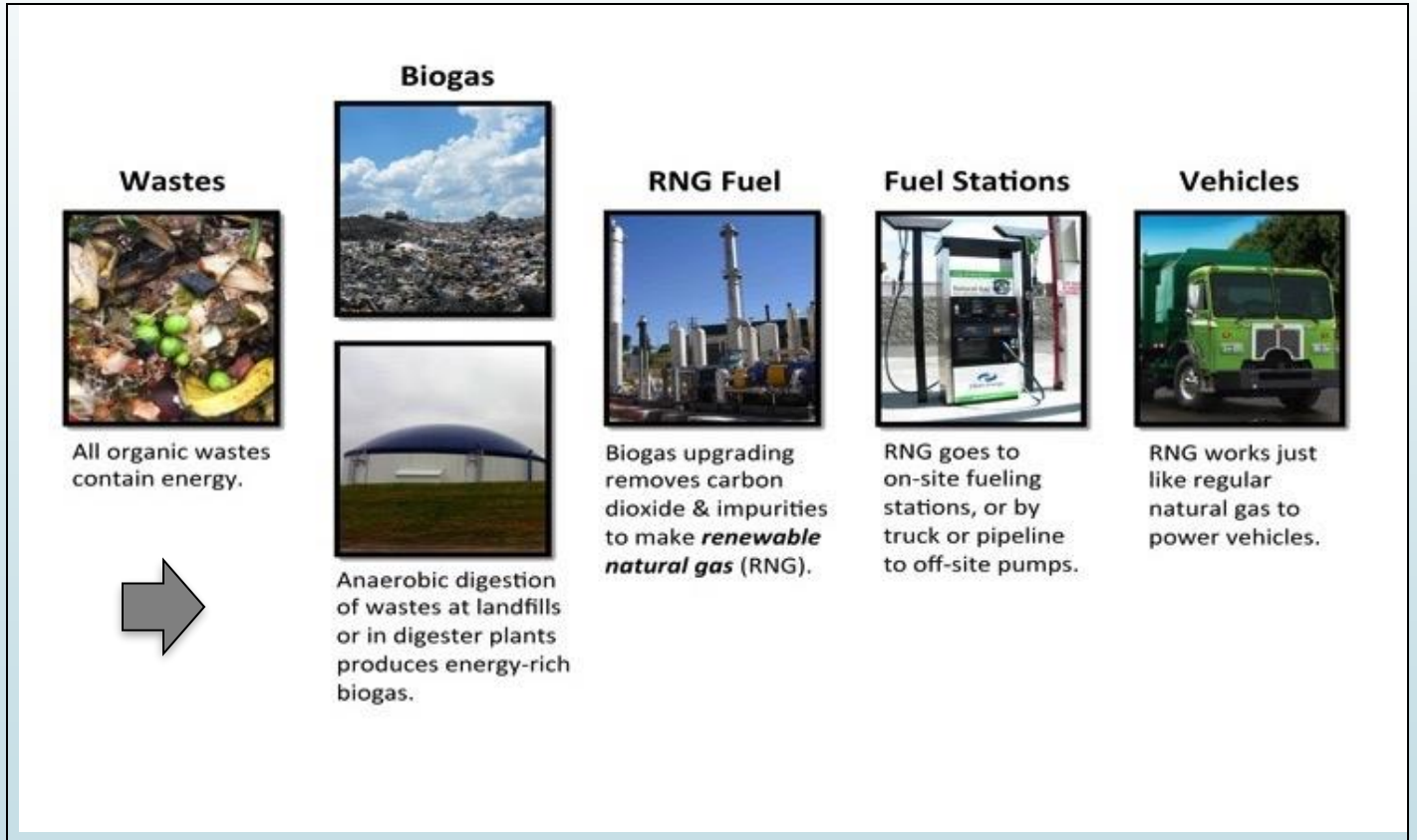
RNG is a versatile energy source that can readily displace fossil fuels in a variety of applications:

- Power Generation
- Industrial Uses
- Heating/Cooling/Cooking
- **Transportation** (vehicles with natural gas engines)
  - ***Has much lower lifecycle emissions: 50% to 300+%***




ENERGY VISION

The Major Market for RNG: On-Road Transportation



The Pathway from Organic Waste to RNG Vehicle Fuel

Favorable RNG economics supported by state/federal policy

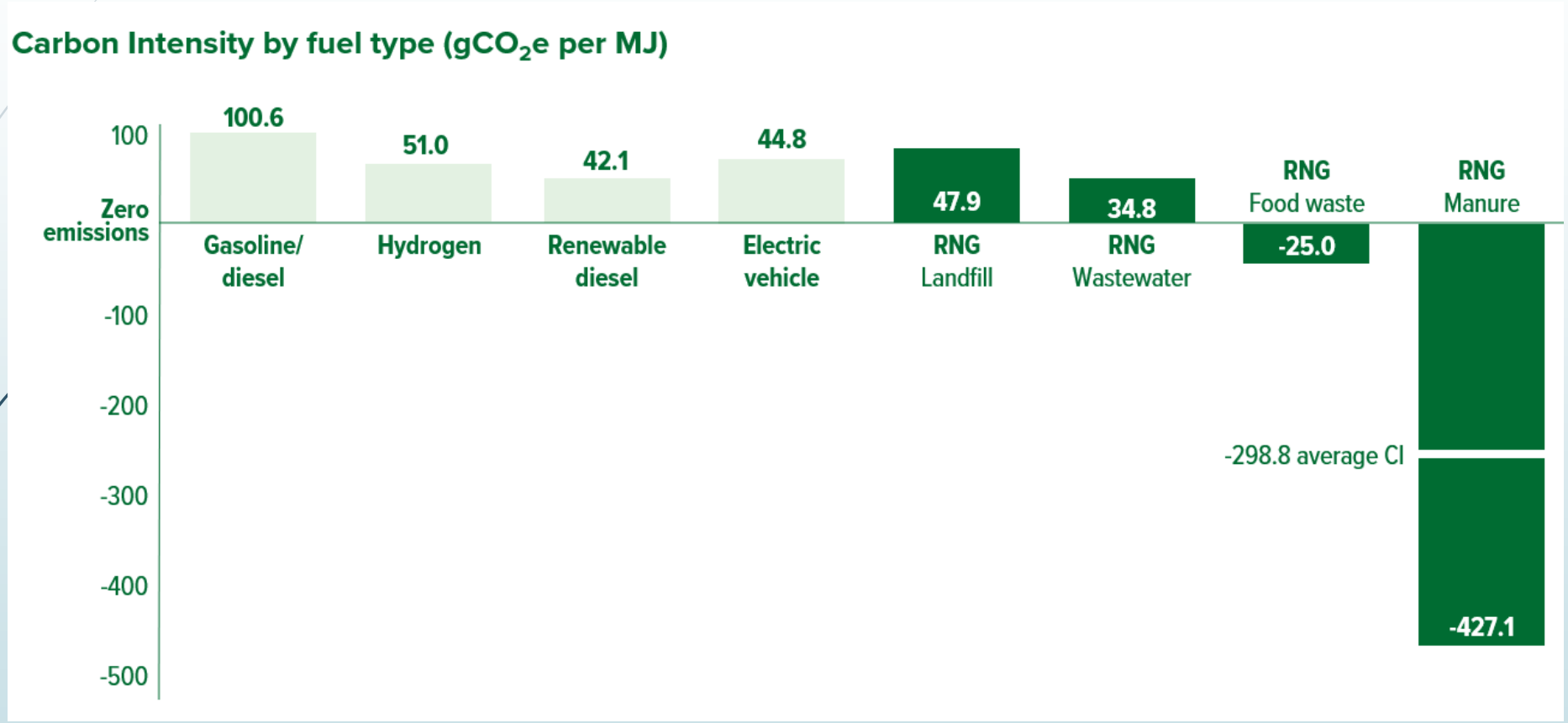
- Federal **Renewable Fuel Standard** (RFS)
- California **Low Carbon Fuel Standard** (LCFS)
- Oregon & Washington State **Clean Fuels Program(s)**

- ***RNG*** *is typically being offered at parity with fossil CNG due to existing policy.*

ENERGY VISION

The Climate Case for RNG in Transportation

Lifecycle Carbon Intensity of Primary On-Road Fuel Options

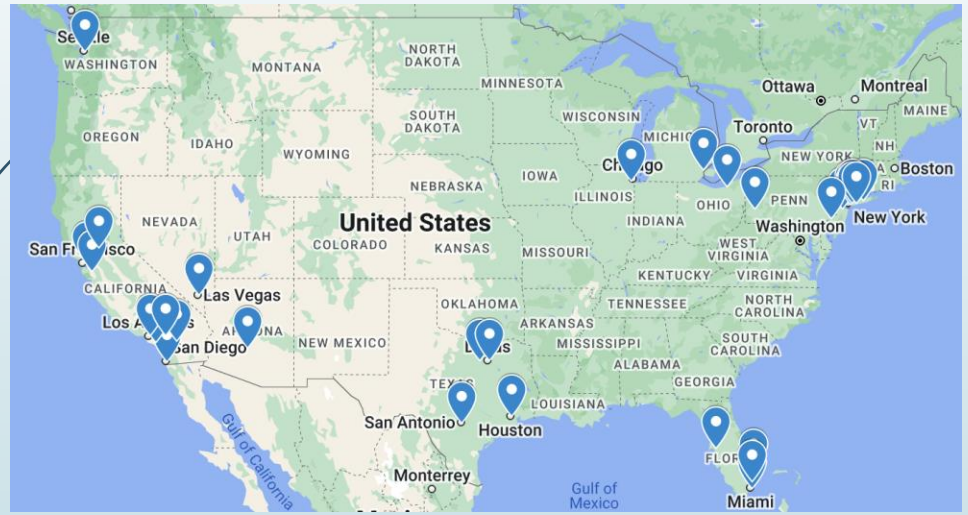


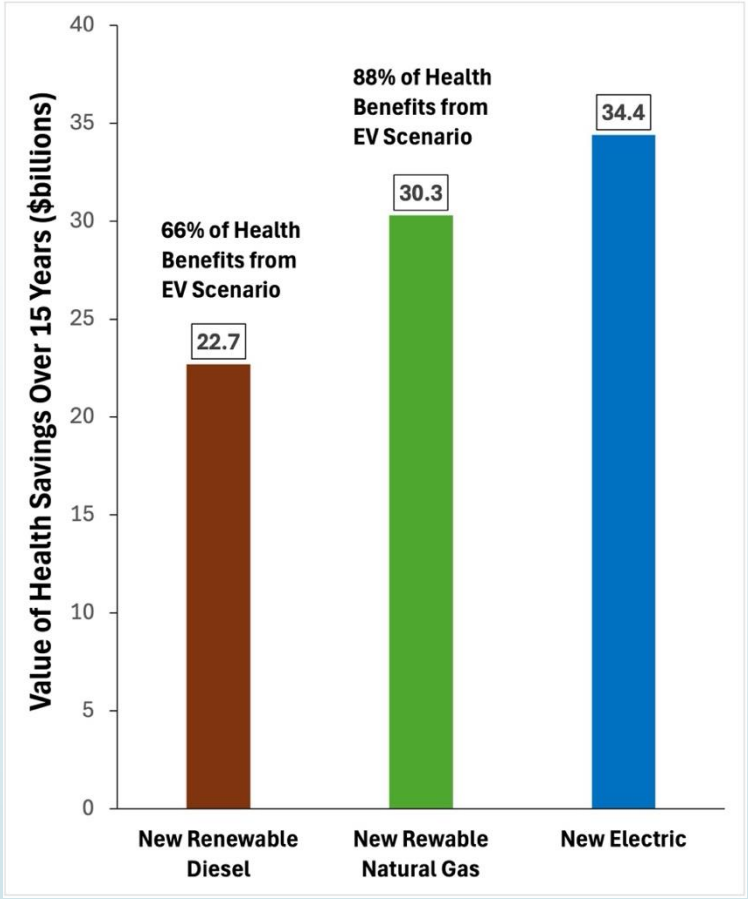
Source: California Resources Board 2024 LCFS Data

ENERGY VISION

The Public Health Case for RNG in Transportation

Forthcoming EV Report Compares Public Health Benefits of Replacing the Oldest 20% of Diesel Trucks with New RD, RNG, Electric Models in 31 Highly Populated Counties





Source: Energy Vision calculations

- 130,000 highly polluting vehicles to be replaced
- **RNG is a clear winner** with almost as deep emissions cuts as electric but widely available and far less expensive
- We estimate that **RNG adoption would save ~$2bn per year in avoided health care costs in the US**

ENERGY VISION

RNG Projects Nationwide

>350 RNG projects operating today in the US, up from just 60 projects in 2017; ~200 more under development

ENERGY VISION

Still a Largely Untapped Opportunity

Food waste

~65 million tons per year generated in the US

Wastewater

~1,500 candidate sites

Landfills

~500 candidate sites

Agriculture

Dairy, swine and poultry manure + additional ag residue "feedstocks" are abundant; many remain untapped

- ***US RNG supply potential = ~25% of current on-road diesel demand***

ENERGY VISION

Contact Info:

Matt Tomich, President

email: tomich@energy-vision.org
tel: 212.228.0225
web: www.energy-vision.org

ENERGY VISION


1955
PTI
PAPER TRANSPORT
GREEN BAY, WI
US DOT 380482
VIN SJ140808
T680
KENWORTH
CNG

WHAT IS READY NOW?

"THE MESSY MIDDLE"

Coined by the North American Council for Freight Efficiency (NACFE), the Messy Middle describes the time between now and when the trucking industry gets to the zero-emission movement.

The table to the right depicts what is available now and what is being developed.

ICE Renewables tap into the existing diesel, natural gas, and propane infrastructures for access and distribution.

POWERTRAIN ALTERNATIVES

Estimate of Technology Readiness by 2025

	SUSTAINABILITY			FLEET OPERATIONAL		INFRASTRUCTURE	INTEGRATION CHALLENGES	MATURITY
	ZEV	Well-to-Wheels	NOx/PM	Range	Route Flex			
DIESEL	○	○	○	●	●	●	●	●
ICE RENEWABLE *	○	◐	◐	◔	◐	◔	◐	◔
NATURAL GAS	○	◔	◐	◔	◐	◐	◐	◔
HYDROGEN ICE	○	◔	◐	◔	◐	◔	◐	◐
BATTERY ELECTRIC	●	◐	●	○	○	◔	○	◐
HYDROGEN FUEL CELL	●	◔	●	◔	◐	◔	○	○

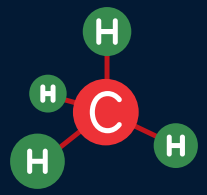
* **ICE Renewables** = Renewable Natural Gas, Renewable Diesel, Renewable Propane, etc.

○ = UNFAVORABLE ● = FAVORABLE

NACFE

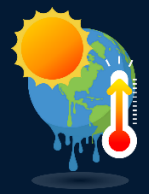
Source: "Framework for Powertrain Decision Making," NACFE, https://nacfe.org/wp-content/uploads/2023/02/Powertrain-Alternatives-FINAL.pdf

WHAT IS NATURAL GAS?

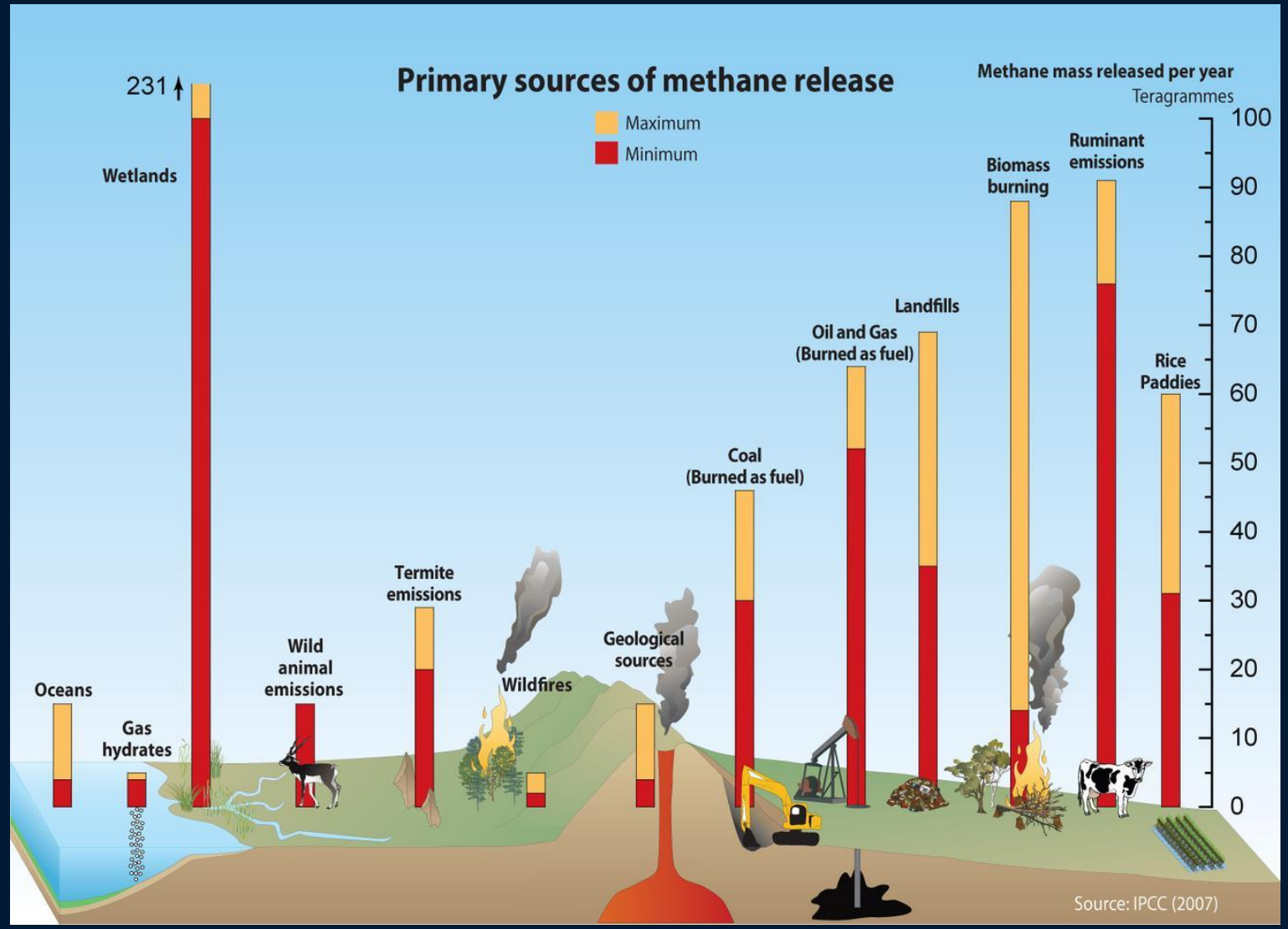


Natural Gas is methane.

Methane comes from a variety of natural and manmade sources.



Over a 20-year period, methane is 80 times more potent at warming than carbon dioxide.



RNG INFRASTRUCTURE

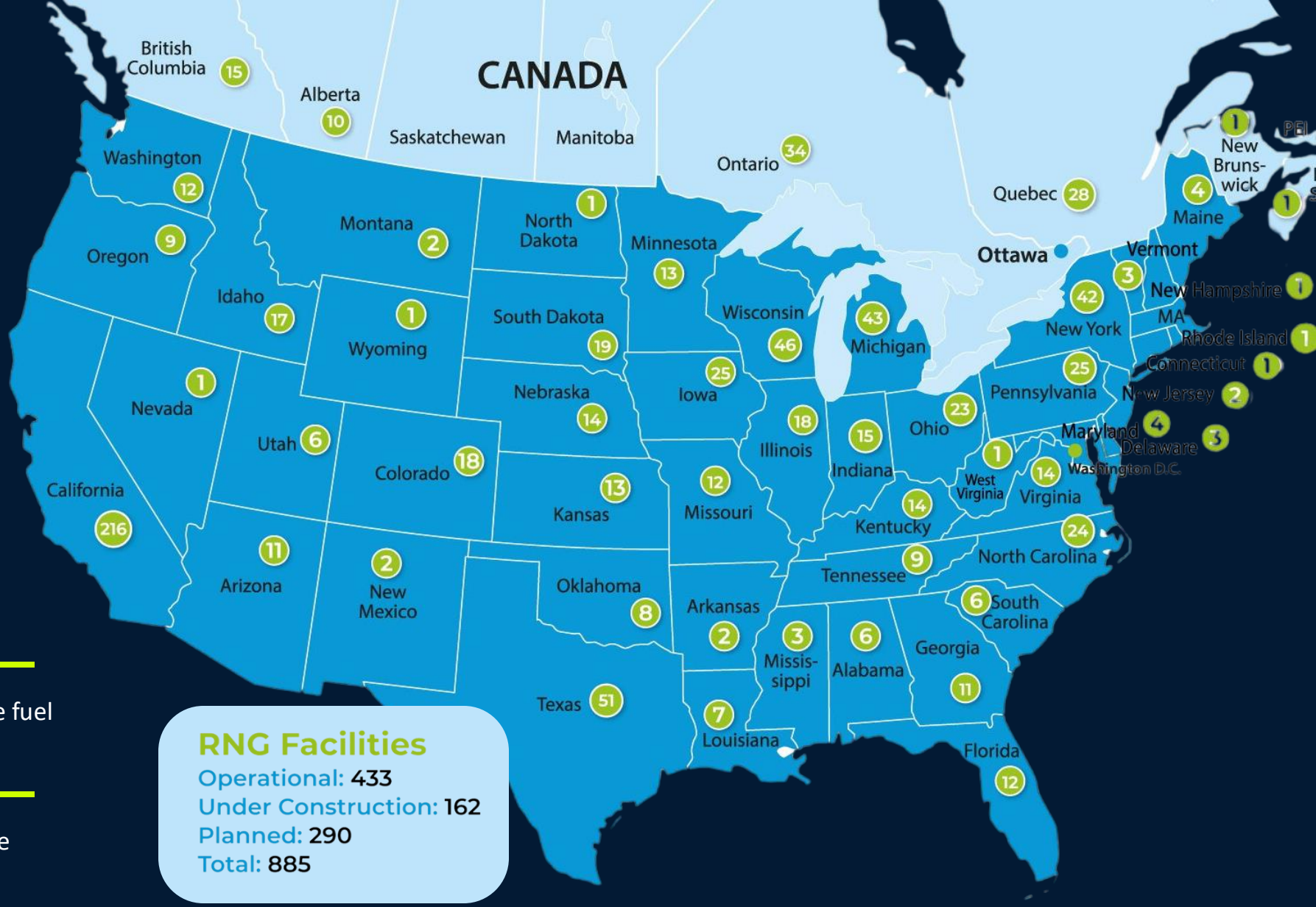
Established infrastructure is ready now, supporting shippers to reduce Scope 3 emissions in transportation and distribution.

RNG use as a transportation fuel grew 16% over 2022 volumes, increasing 92% over the last five years.

RNG offset a total of 6.96 million tons of CO2e in 2023.

RNG made up 79% of total natural gas vehicle fuel used (675mm GGE) in 2023.

As of 2024, more than 400 RNG facilities were operational, with an additional 130 under construction and 233 planned.



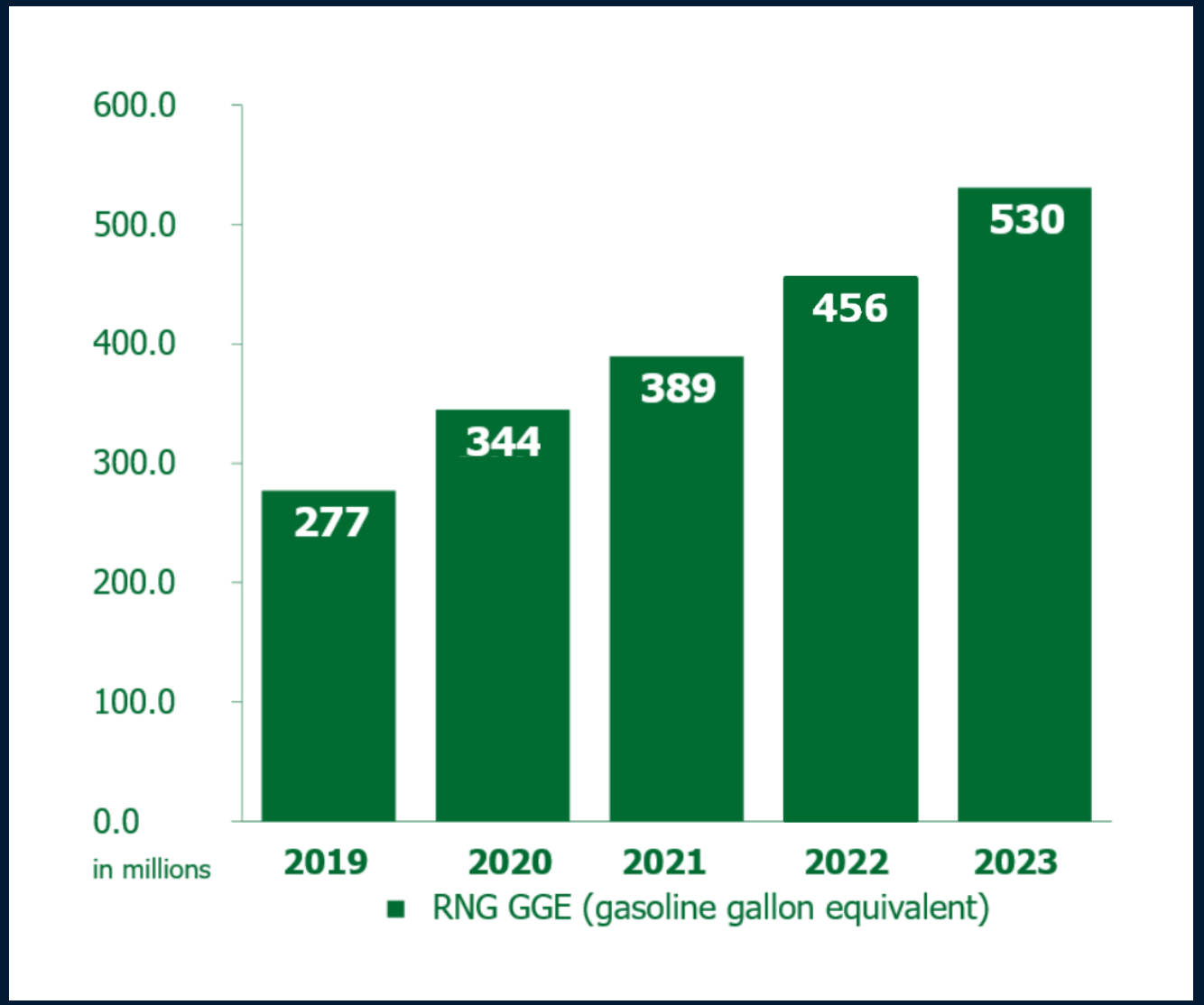
RNG GROWTH

RNG use as a transportation fuel grew 16% over 2022 volumes, increasing 92% over the last five years.

RNG offset a total of 6.96 million tons of CO2e in 2023.

RNG made up 79% of total natural gas vehicle fuel used (675mm GGE) in 2023.

Established infrastructure is ready now, supporting shippers to reduce Scope 3 emissions in transportation and distribution.



Source: The Coalition for Renewable Natural Gas and The Transport Project

15+ YEARS NATURAL GAS EXPERIENCE

FIRST NATURAL GAS CARRIER

Paper Transport is the first carrier outside of California to adopt natural gas in 2010

OVER 77 MILLION NATURAL GAS MILES

In 2024, Paper Transport reached over 77 million natural gas miles, displacing the equivalent of 12.5 million gallons of diesel

IDEAL OPERATING SCENARIOS

INTERMODAL DRAYAGE

- 24/7 access to freight – drives high fuel use
- Operates from a hub – helps ensure fuel access

SHORT-HAUL APPLICATIONS

Target high-velocity applications to drive use of the low-cost fuel

LONG-HAUL APPLICATIONS

- Great fit if interested customers and fuel are available
- Closed loop dedicated fleets

ADDITIONAL SUSTAINABILITY EFFORTS

PAY-FOR-SUSTAINABILITY PROGRAM

PTI is rewarding drivers for efficient driving and fuel conservation to save 114,285 gallons of annual fuel consumption through best-in-class efficiency by the end of 2024.

LATE-MODEL EQUIPMENT

Average age of fleet < 3 years old, equipped with idle-free technology, automatic idle shutdown, adaptive cruise control, and governed speed of 63-65 mph.

MAKE EVERY MILE COUNT

By the end of 2024, PTI aims to load 80 percent of empty dedicated miles, turning 715,000 gallons of would-be burned empty miles into loaded miles.

SmartWay®

TIER 1

2024 HIGH PERFORMER

TOP GREEN FLEETS
HDT
HEAVY DUTY TRUCKING
2024

NACFE

NORTH AMERICAN COUNCIL FOR FREIGHT EFFICIENCY

WISCONSIN CLEAN CITIES
Celebrating
30
YEARS


1955
PTI
PAPER TRANSPORT
GREEN BAY, WI
US DOT 380482
VIN SJ140808
T680
KENWORTH
CNG

Natural Gas Engines For The Heavy-Duty Truck Market

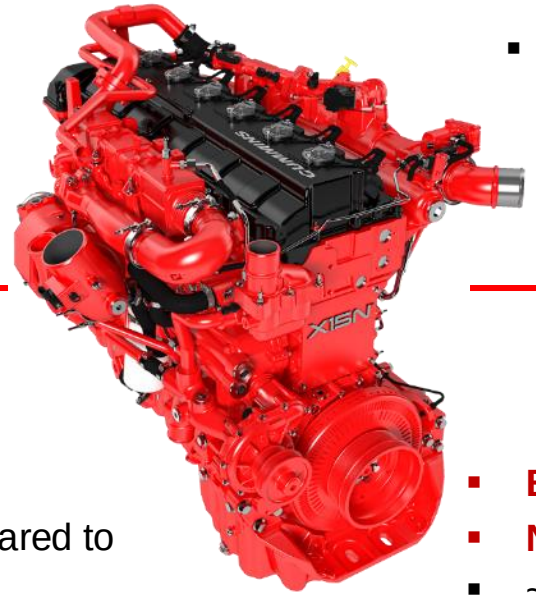
X15N™

RELIABLE AND DURABLE

- **Power, torque and performance for the HD market**
- Built on **30+ years** of natural gas experience
- Integrated powertrain for a full Cummins solution
- **Full OE network and Cummins service channel support**
- Known maintenance practices
  - Simple aftertreatment
  - Familiar engine technology
  - **X15N** Extended Service Intervals vs. ISX12N
- **X15N** Reliability improvements over ISX12N

SCALABLE

- **Natural Gas is the least disruptive alt fuel technology**
- **1-to-1 vehicle replacement for diesel**
- Established supply chain for product production
- Over 800 + public stations
  - Behind the fence refueling options
- Known technology
  - Familiar engine architecture
  - Incremental technician training



COMMERCIALLY VIABLE

- **Over 1,000-mile range for line-haul applications**[2]
- Lower incremental acquisition cost for the vehicle compared to BEV and fuel cell
- **Multi-shift operation capable**
  - No additional downtime
  - Fast fill refueling time
- **Stable, low-cost fuel means price predictability**
- Natural Gas is available NOW!
  - **100,000+ NG vehicles operating in North America today**

SUSTAINABLE

- **Best well-to-wheel GHG reduction option**
- **Net carbon negative solution when using RNG**
- ~ 750 new RNG production projects coming online[3]
- **X15N** Up to 10% fuel economy & GHG improvements over ISX12N[4]
- **X15N** CARB and EPA emissions solution for ’24 at launch

1 Driver education needed
2 Dependent on tank configuration, driving behavior
3 Includes sites that are currently operational, under construction or planned
4 With equivalent rating and comparable duty cycle

Natural Gas Applications

The Natural Gas Power/Torque Landscape

200/520 240/560

B6.7N

250/730 320/1000

L9N

Bus

Midrange Truck

Vocational Truck

Refuse Bus

Coach

400/1450

ISX12N

Vocational Truck

Refuse

500/1850

X15N™

Regional Haul / P&D / City Tractor

Line Haul – Sleeper Cab

Target Applications for X15N

CL6/7 **CL7/8** **CL8** **CL8**

X15N ENGINE WALKAROUND

FUEL EFFICIENCY | MAINTENANCE | REGULATORY | RELIABILITY

Base Engine:

- Sculpted Cast Iron Block - Reduced Weight
- Rear Gear Train
- Premium & Robust Cylinder Head w/ improved cooling

Air Handling:

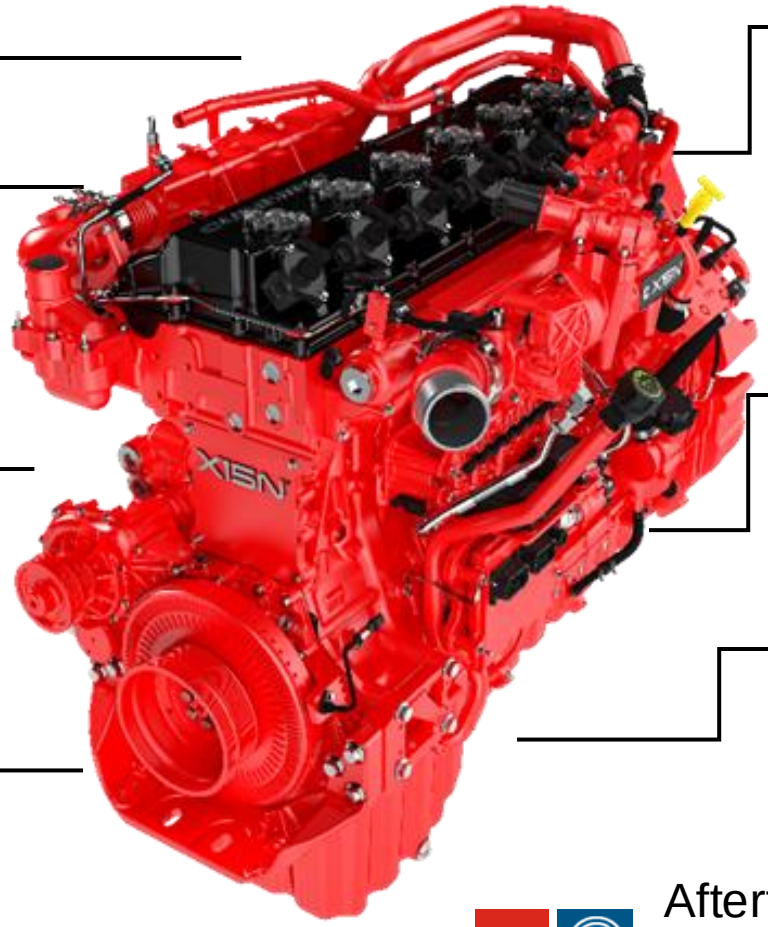
- Dual Wastegate Turbocharging
- Advanced Cooled EGR

Power Cylinder:

- Steel Pistons, improved cooling with improved combustion and oil control

Lube & Cooling:

- Improved Closed Crankcase Breather
- Elimination of Coolant Filter
- Integrated Water Pump & Oil Pump



Fuel System:

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

Ignition System:

- New integrated ignition and injector control system Improved spark plug w/ increased ceramic strength and electrode geometry and material for improved spark plug life

Electronics:

- CM2380 ECM
- Next generation connectivity solutions
- Enhanced powertrain features

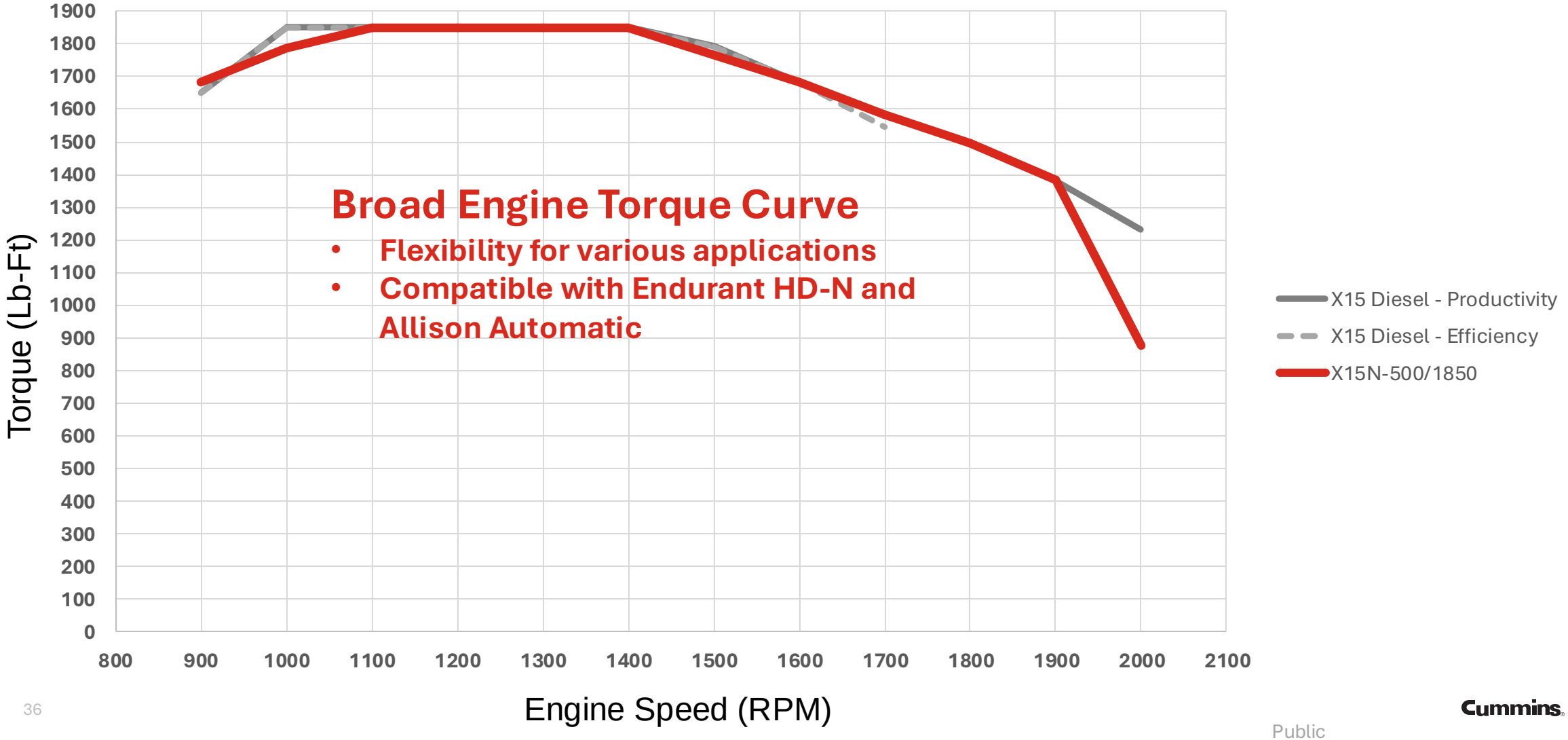
Aftertreatment:

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

*All changes referenced are in relation to the ISX12N

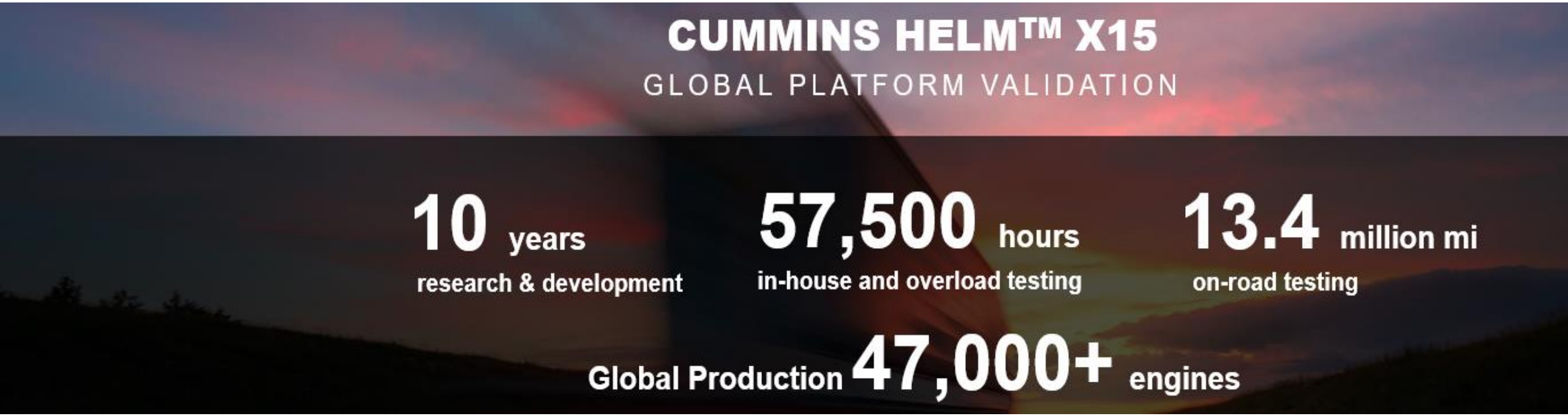
Cummins

X15N™ COMPARISON TO X15 DIESEL (500 hp / 1850 lb-ft)



Cummins

X15N™ Reliability & Durability



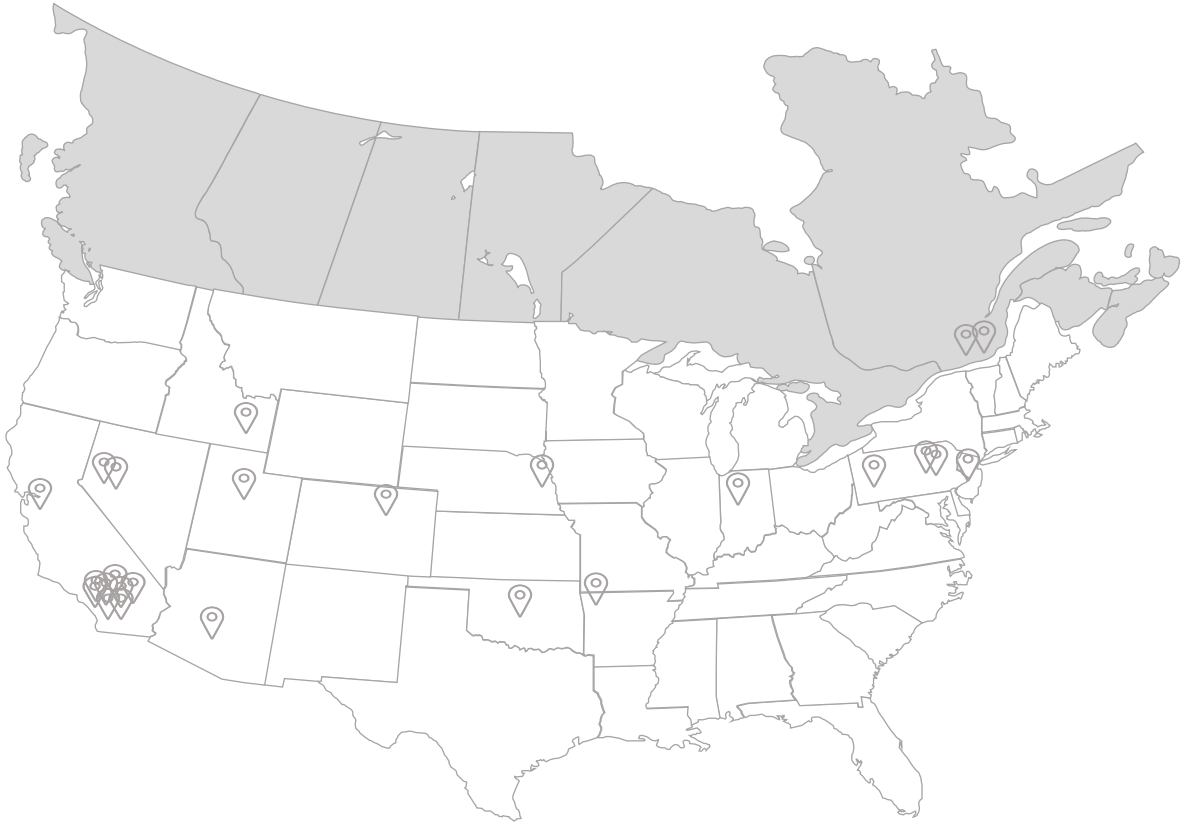
Natural Gas 15N Platform

58 K+ Production engines operating globally

7.3 B+ Miles logged by production engines globally

**As of January 2025*

X15N™ NORTH AMERICA FIELD TEST UNITS



3 Applications

- Linehaul
- Regional Haul
- Vocational - Refuse

24 Units

16 Fleets

2.2+ Million miles* driven

*Mileage accumulation as of Jan 2024

Cummins

Cummins Integrated Powertrain

Renewable Fuels

Equipment and Infrastructure

February 2025

Fleet Operations

Renewable Fuels Agenda

1. CNG Journey
2. Overall CNG Fleet
3. RNG Statistics
4. RNG and Lowering NOx Emissions
5. Overall CNG Infrastructure/Truss
6. Fleet Options

WM's CNG Evolution

1995 — WM launches first 14 CNG trucks in Palm Desert, CA.

1997 — WM launches 120 LNG truck project in San Diego, CA.

2000 — WM deploys 8 LNG trucks in Lancaster, PA.

2000-2006 — WM announces aim to increase fleet fuel efficiency by 15% by 2020.

2007 — WM deploys more than 400 natural gas trucks in Southern CA.

2009 — WM hits 1,000 CNG truck milestone.

2011 — WM deploys 122 CNG trucks in Seattle, WA, the largest natural gas vehicle launch in the waste industry at the time.

2017 — WM reaches goal of 6,000 natural gas vehicles in operation and 100 CNG filling stations.

2020 — WM has 10,000+ CNG trucks in operation.

2024 — WM operates more than 12,000 alternative fuel vehicles and operates more than 200 CNG stations.

WM's CNG Fleet Stats at a glance

- Natural Gas Vehicles: 13,189
- NG fueling stations: 213
- Stations open to Public: 25
- Over 110 MM gals of Diesel displaced in 2024.
- Over 2000 technicians CNG trained
- Over 10,000 drivers CNG trained

- Over $4 Billion invested in NGVs and infrastructure.
- 6000+ NGV's running under the adopted 2027 US EPA GHG standard since 2016.
- Over 75% of the routed fleet is running on Natural Gas with 47% of that being RNG.

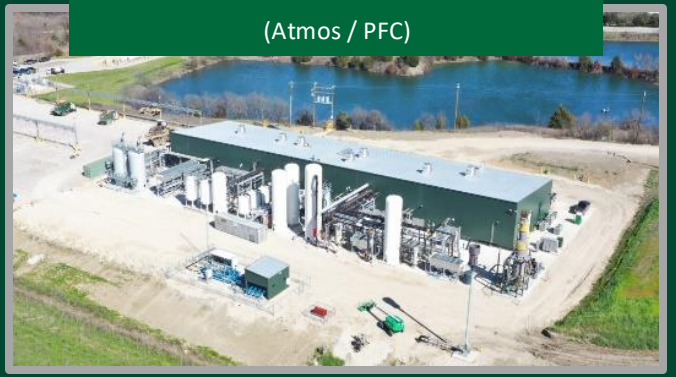
Goal: 100% of the fleet will be fueled by 2026 from WM landfills (estimated 150M DGE annually)

WMRE RNG Operations

- 7 Operating RNG Facilities
- Current RNG Volume = 5.5 BCF = 39.6M DGE
- 17 Facilities in Construction by 2026
- 2026 RNG Production = 28 BCF = 201.6M DGE
- Carbon Intensity Score = -126

WM Skyline RNG

(Atmos / PFC)



WM Milam RNG

(Ameren LDC)

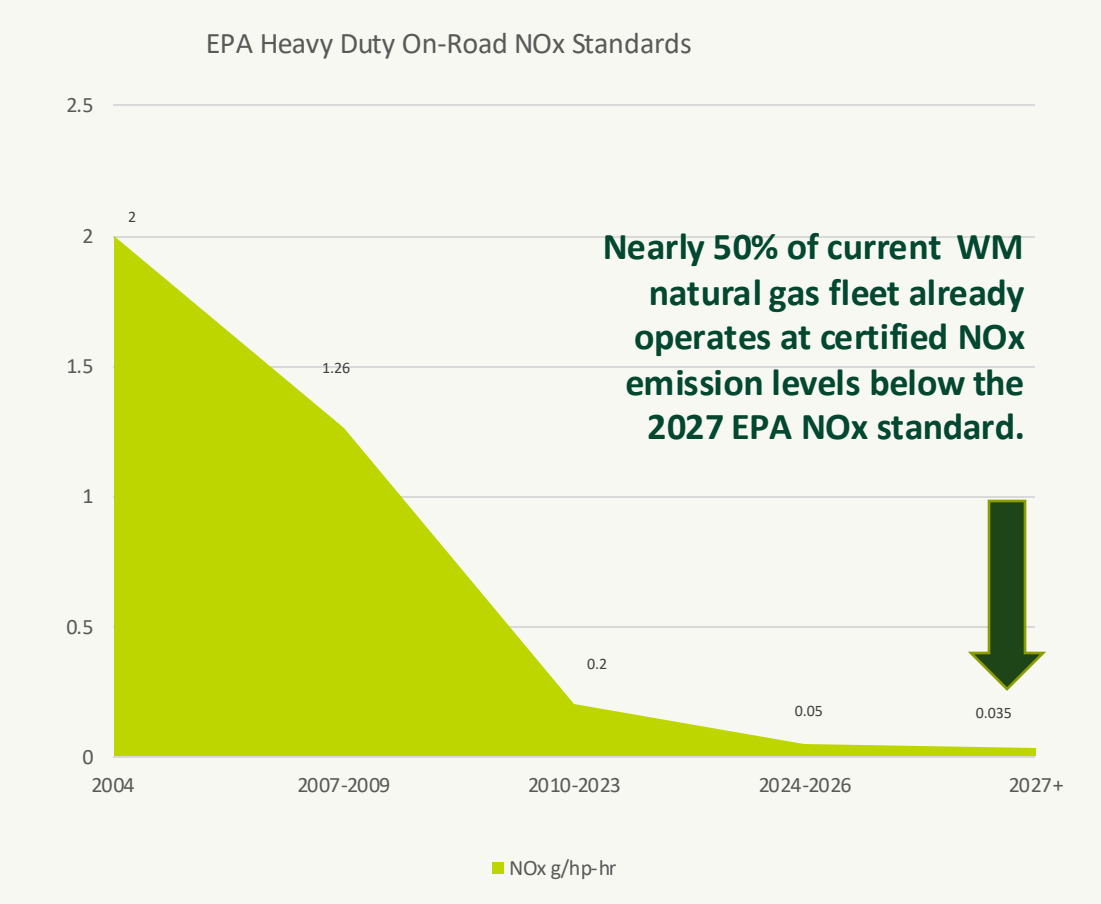
WM Outer Loop RNG

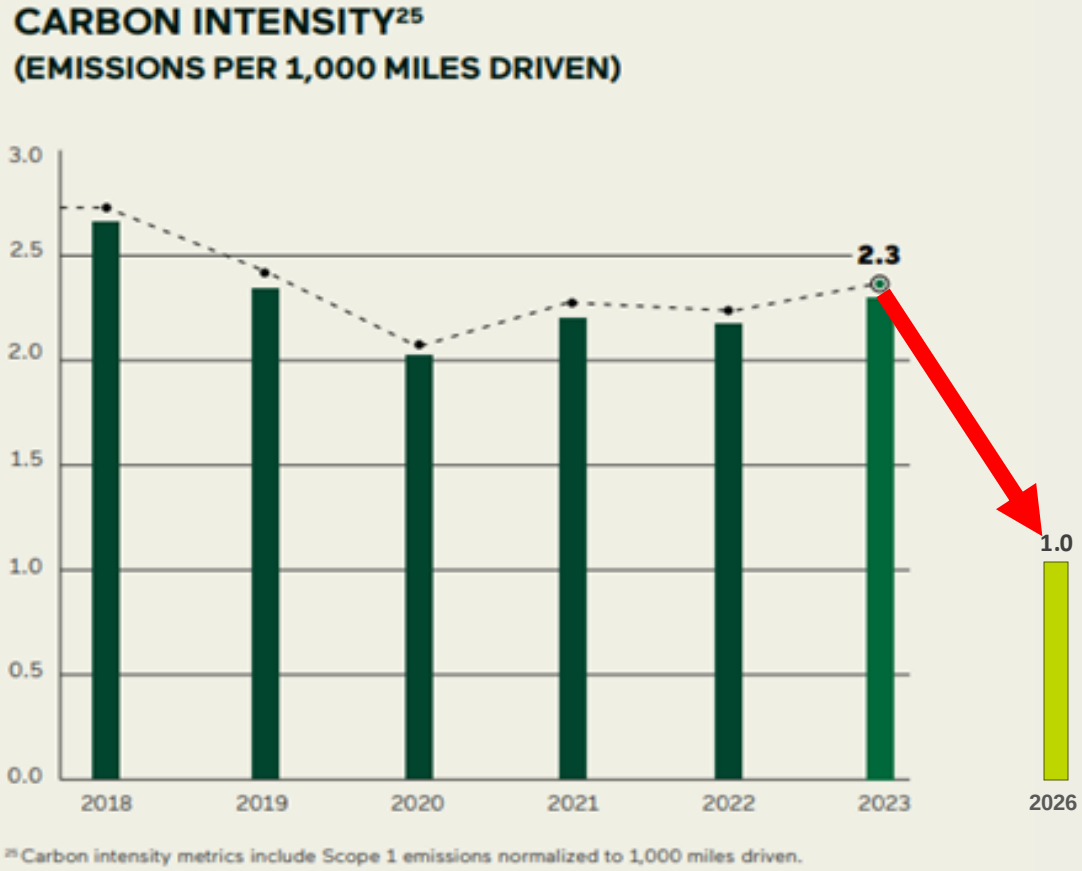
(Texas Gas - Boardwalk)

WM East Oak RNG

(Southern Star)

Lowering NOx Emissions

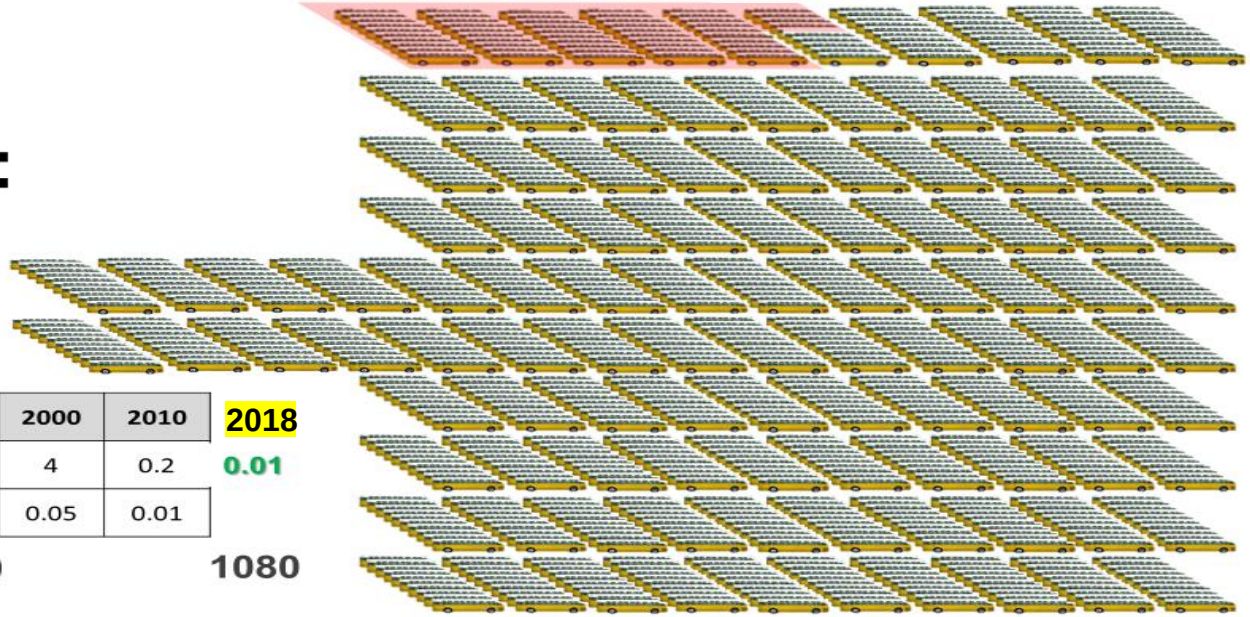




Lowering NOx Emissions

Emissions Reduction Impact - NOx

=



	1985	1990	1991	2000	2010	2018
NOx (g/hp-hr)	10.8	6	5	4	0.2	0.01
PM (g/hp-hr)	0.59	0.59	0.25	0.05	0.01	

54 540 1080

7

Westport

WM has more than 5,000 trucks that meet the 2018 emissions standard.

The ”math” of renewable gas

Diesel Carbon Intensity: 100

Combusting 1 gallon of diesel creates 28.4 lbs of CO2

RNG Carbon Intensity: -126*

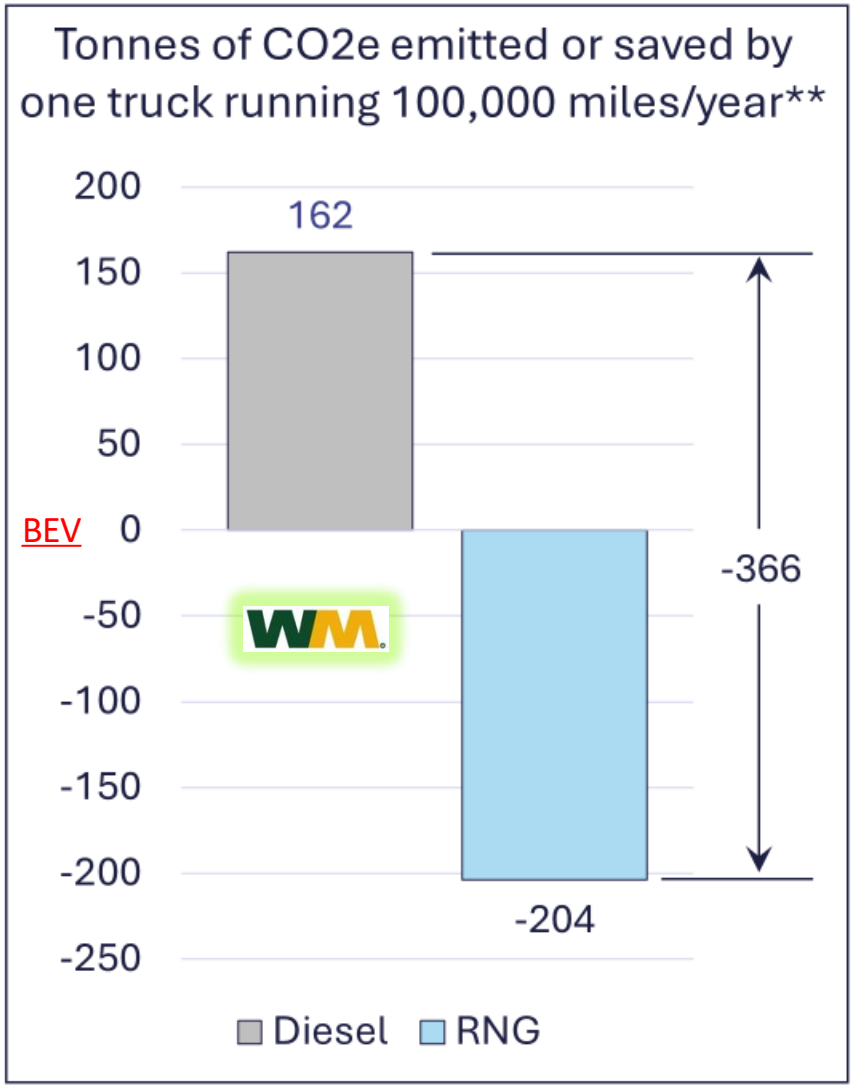
Combusting 1 DGE of RNG reduces 35.8 lbs of CO2e

Impact of 1 DGE of RNG vs 1 gallon of diesel is 64.2 lbs of CO2e reduced

* California LCFS average CI score for bioCNG

** 100,000 miles at 8 mpg = 12,500 gallons consumed
12,500 x 28.4 lbs = 355,000 lbs = 162 metric tonnes

Source: The Transport Project analysis



BEV trucks can be, at best, zero CO2e emissions, meaning they reduce a maximum of 162 tonnes per truck per year compared to diesel**.

Net reduction with RNG:

366 metric tonnes of CO2e
per truck, per year

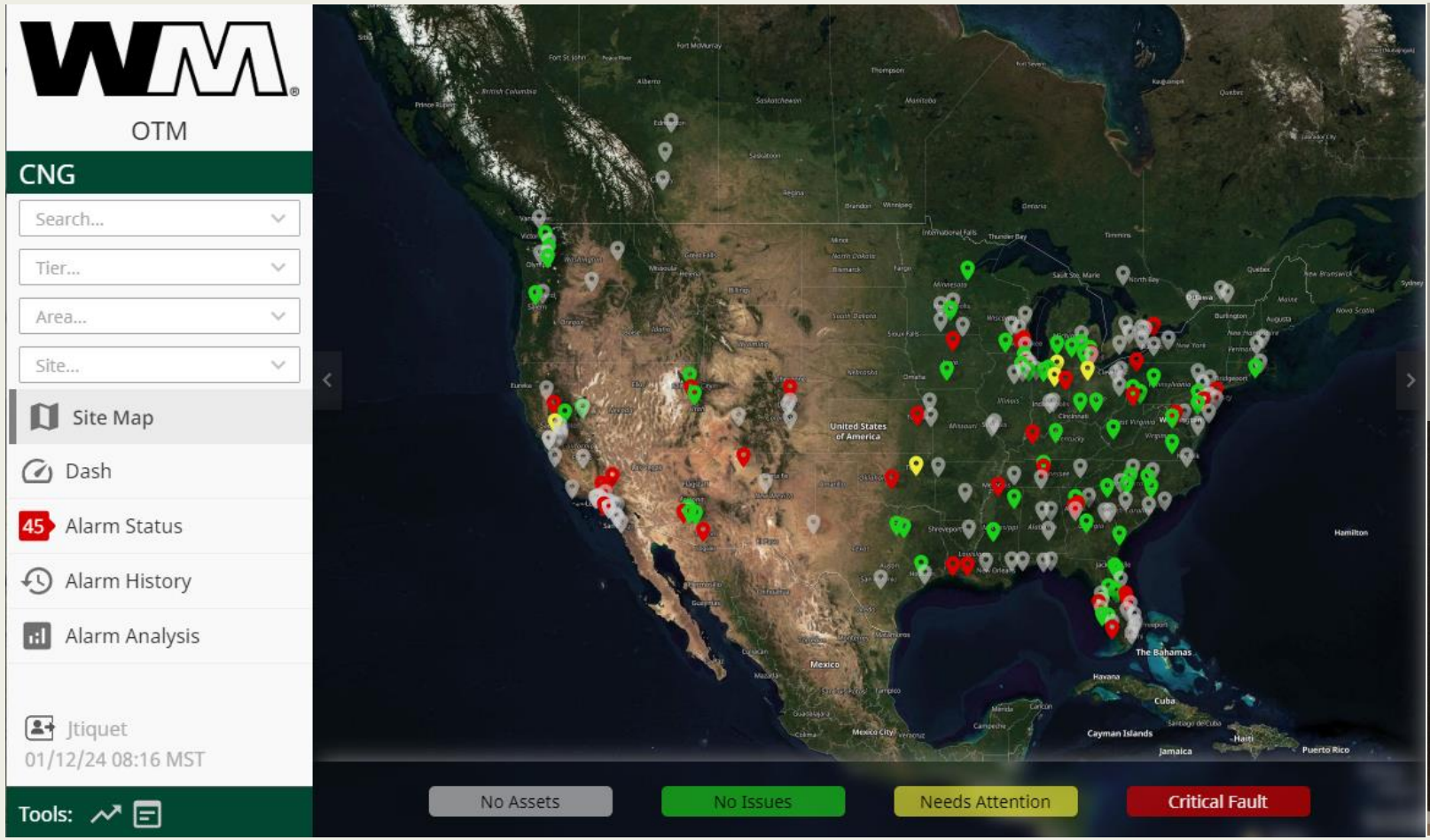
126% more saved than BEV

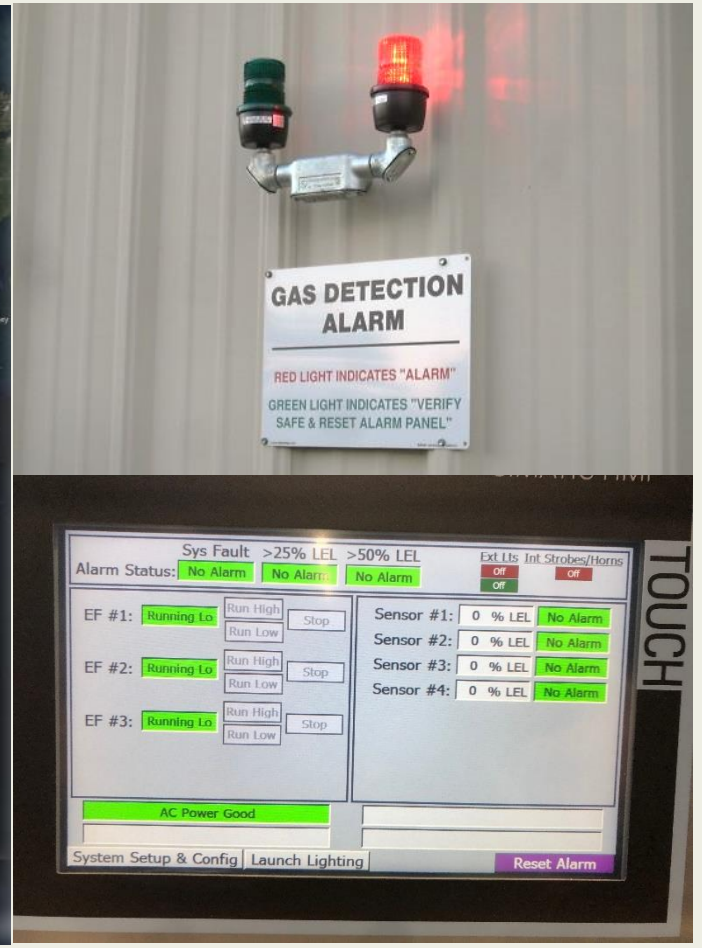
Cannot be ignored!

THE TRANSPORT PROJECT

CNG Infrastructure / Overhead Truss

CNG Infrastructure / Shop Safety





Today's CNG Options

Not started

- Run some pilots
- Retail fueling
- transportproject.org

Pilot Stage

- Get the specifications right and expand
- Research your fueling options vs Retail
- Research your maintenance support options

Current strategy

- Safety first
- Train, Train, Train
- Correct maintenance program

Questions?

mtufte@wm.com

Q&A

Decarbonizing with Natural Gas

Dan Deppeler
Vice President of Maintenance
Paper Transport

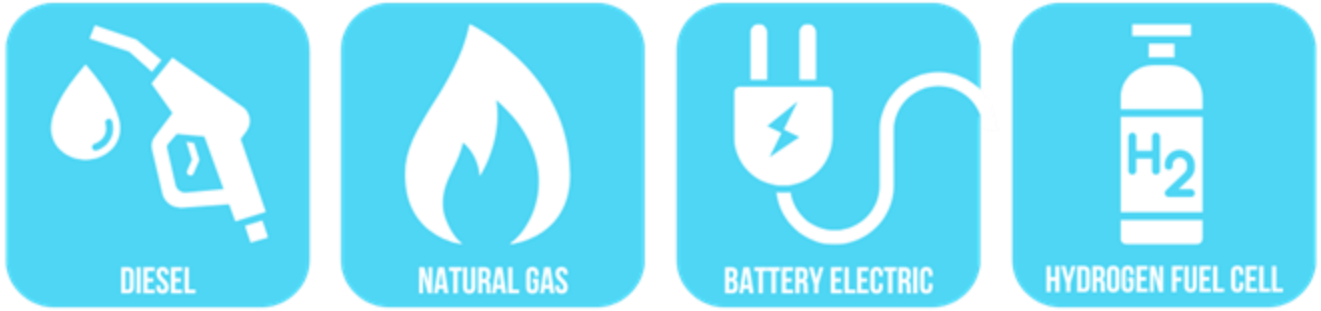
David King
Product Manager, On-Highway Natural Gas Engine Portfolio
Cummins

Matt Tomich
President
Energy Vision

Marty Tufte
Corporate Fleet Director
WM

RUN ON LESS MESSY MIDDLE

MESSY MIDDLE BOOTCAMP



Let's Stay Connected…

NACFE (& Spanish: NACFE LATAM)

NACFE

@NACFE_Freight & @RunOnLess

NACFE

NACFE
NORTH AMERICAN COUNCIL FOR FREIGHT EFFICIENCY

NACFE.org

RUN ON LESS
MESSY MIDDLE

RunOnLess.com

MESSY MIDDLE
BOOTCAMP