The Current State of HD BEV: Technologies and Capabilities

April 8, 2025

MESSY MIDDLE BOOTCAMP

RUN ON LESS MESSY MIDDLE

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NORTH AMERICAN COUNCIL FOR FREIGHT EFFICIENCY

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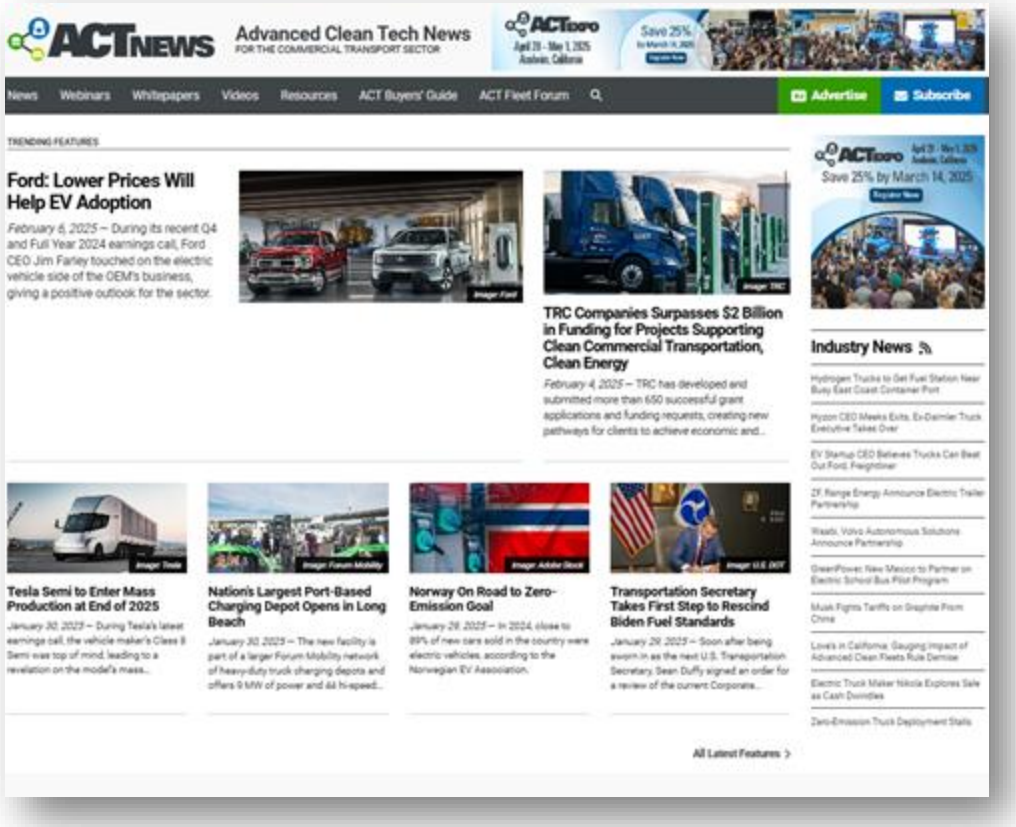

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Messy Middle Bootcamp Series

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

Run on Less – Messy Middle FLEETS ANNOUNCED

- **Albert Transport** out of Laredo, Texas is operating a highly efficient 2022 Freightliner Cascadia sleeper tractor with a Detroit DD 15 engine running on diesel
- **Frito-Lay** out of Topeka, Kansas is operating a Volvo VNL sleeper tractor with an Optimus Technologies system using B99 biodiesel.
- **To Be Determined** operating a heavy-duty tractor on renewable diesel.
- **Mesilla Valley Transportation** out of Las Cruces, New Mexico is operating an International LT sleeper tractor with a Cummins X15 2027 NOx engine running on diesel.
- **Kleysen Group Ltd.** out of city, province is operating a Kenworth T680 sleeper tractor with a Cummins X15N using natural gas.
- **UPS** out of Salt Lake City, Utah is operating a Kenworth T680 day cab tractor with a Cummins X15N engine using natural gas
- **Wegmans** out of Rochester, New York is operating a Peterbilt 360 day cab tractor with a Cummins X15N engine using natural gas.
- **4Gen** out of Rialto, California is operating a Volvo VNR day cab electric tractor.
- **JoyRide Logistics** out of Phoenix, Arizona, is operating a battery electric Windrose day cab tractor.
- **Nevoya** out of Colton, California is operating a battery electric Freightliner eCascadia day cab tractor.
- **Saia** out of Stockton, California is operating a battery electric Tesla Semi day cab tractor.
- **Pilot Travel Centers** out of Bloomington, California is operating a Hyundai XCIENT hydrogen fuel cell day cab tractor.
- **Penske Logistics** out of Katy, Texas operating a Hyundai XCIENT hydrogen fuel cell day cab tractor.

RUN ON LESS MESSY MIDDLE

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Today's Bootcamp Sponsor

EDF
ENVIRONMENTAL
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Finding the ways that work

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

The Current State of HD BEV: Technologies and Capabilities

Trisha Dello Iacono
Head of Policy
CALSTART

Wen Han
Founder, Chairman, and CEO
Windrose EV Trucks

Dan Priestley
Senior Manager, Semi Truck Engineering
Tesla

Jared Ruiz
Regional Vice President Western U.S. and Electromobility Leader
Volvo Trucks North America

RUN ON LESS MESSY MIDDLE

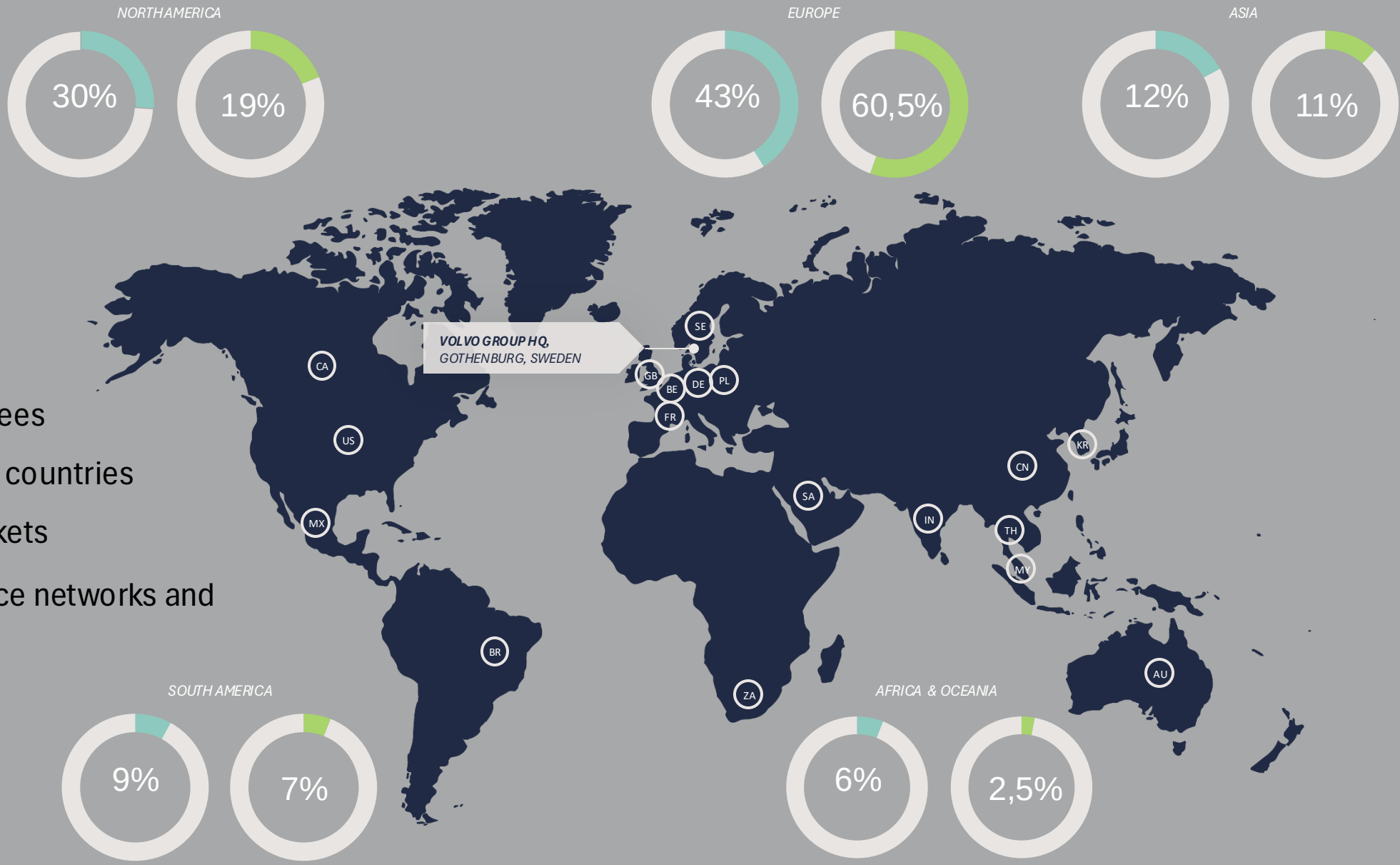
MESSY MIDDLE BOOTCAMP

JARED RUIZ

Vice President, Volvo Trucks North America, West Region

Global presence

- 104,000 employees
- Production in 18 countries
- Almost 190 markets
- Worldwide service networks and dealerships



Share of net sales by market (2023)

Share of total employees (2023)

Countries with Volvo Group production

Volvo Group North America

- **30%** of Group's net sales (2023)
- More than **18,600** employees
- **16** major manufacturing sites

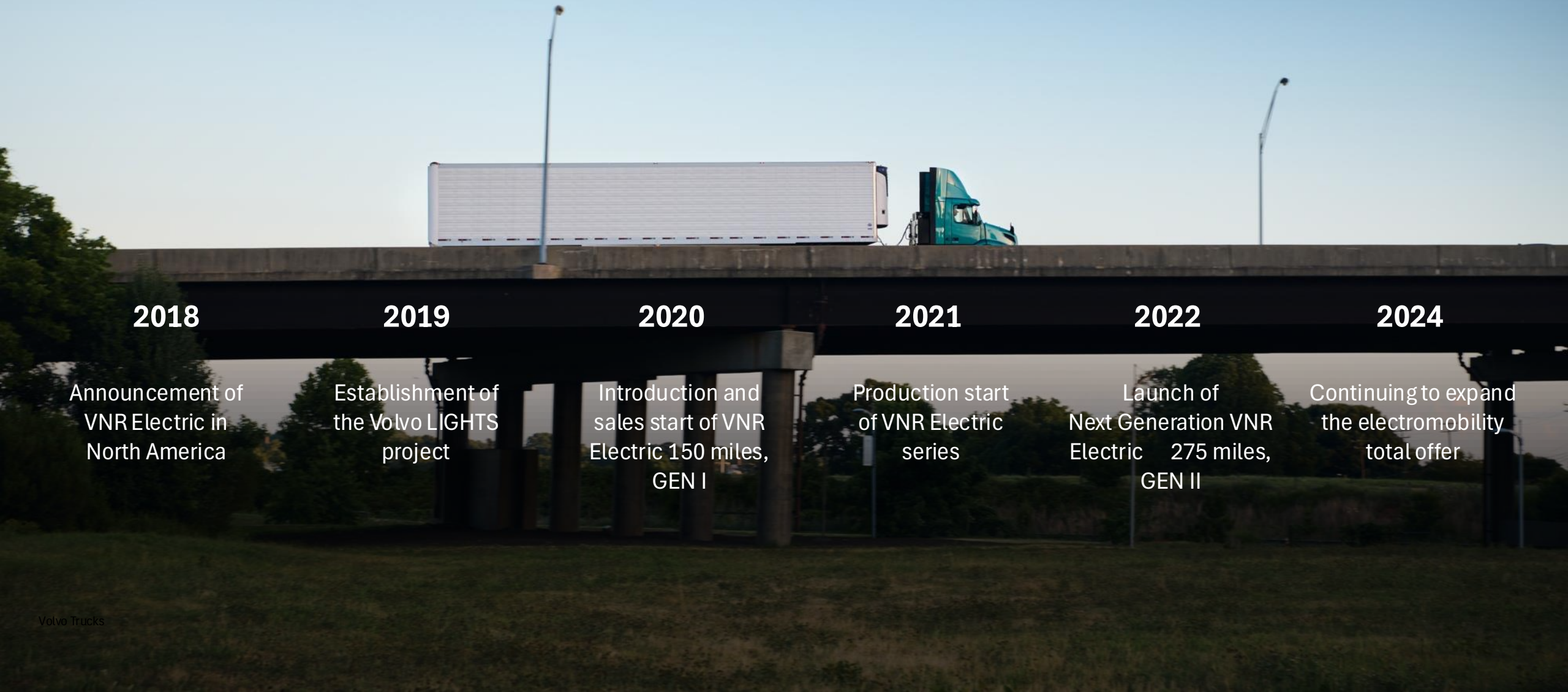
VOLVO

HD BEV Market

HISTORICAL EVOLUTION

VOLVO

FIRST TO MARKET – ACCUMULATING WEALTH OF MARKET KNOWLEDGE OVER 5 YEARS

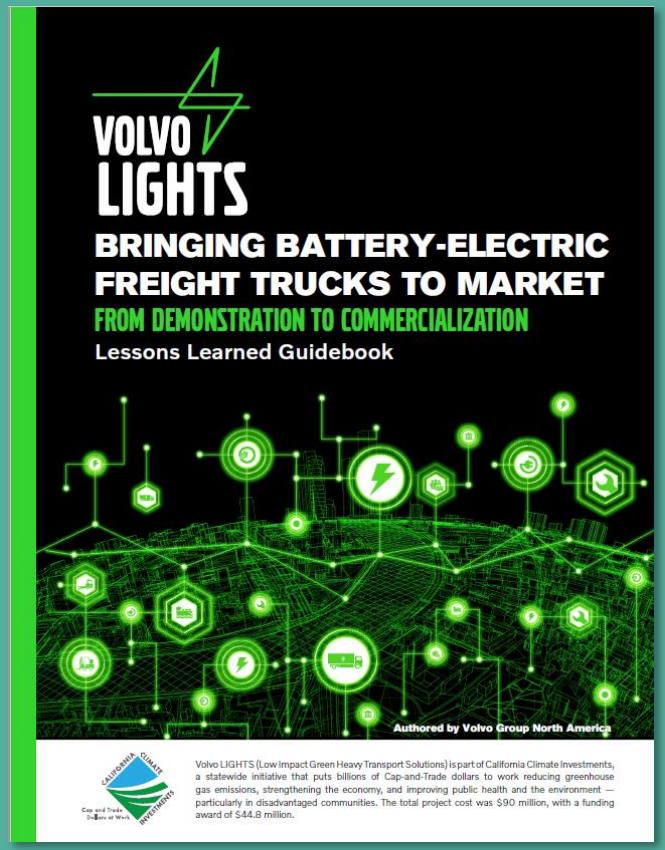


2018	2019	2020	2021	2022	2024
Announcement of VNR Electric in North America	Establishment of the Volvo LIGHTS project	Introduction and sales start of VNR Electric 150 miles, GEN I	Production start of VNR Electric series	Launch of Next Generation VNR Electric 275 miles, GEN II	Continuing to expand the electromobility total offer

VOLVO

VOLVO LIGHTS PROJECT

2019-2022



Early ZEV Deployments: Lessons Learned

- Single largest challenge for the heavy-duty ZEV market is charging infrastructure
- Engage utilities and local officials early in the infrastructure design process
- TCO is currently dependent on public funding for vehicle purchase & infrastructure
- Fleet ownership of property eases facility planning and investments
- Divergent priorities of multiple stakeholders must be managed
- Consider identifying a dedicated point of contact within your organization

https://www.lightsproject.com/downloads/

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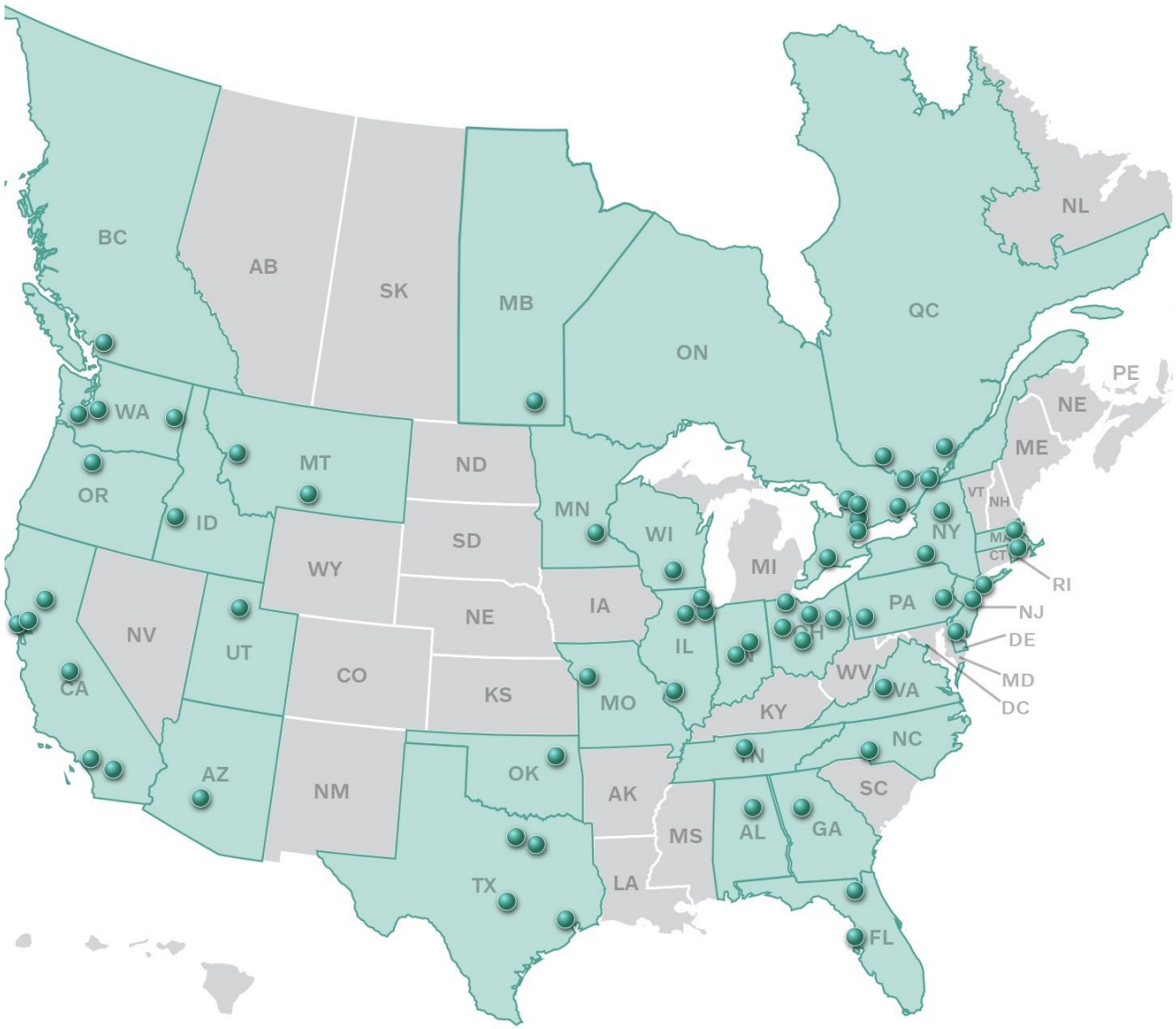
VOLVO


Certified EV Dealerships
Energy Efficiency Monitoring
Route Simulations
Over the Air Connected Services
TCO Tool
Volvo Gold Service & Repair Plan
Funding Analysis
Truck & Infrastructure Financing
Charging Infrastructure Partnerships
Insurance
Wide range of VNR Electric configurations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TN

CURRENT EXPERIENCE

OPERATIONAL EXECUTION

PACT Members

VOLVO

OPERATIONAL FINDINGS

- ELECTRIFYING VOLUMES
- MAINTENANCE FINDINGS
- HOT & COLD CLIMATES
- DRIVER BEHAVIOR

VOLVO

OPERATIONAL FINDINGS

- AUXILIARY POWER
- ROUTES
- OPPORTUNITY CHARGING

VOLVO

FUTURE TECHNOLOGY

FORWARD LOOKING MARKET DEVELOPMENT

VOLVO

MARKET EVOLUTION

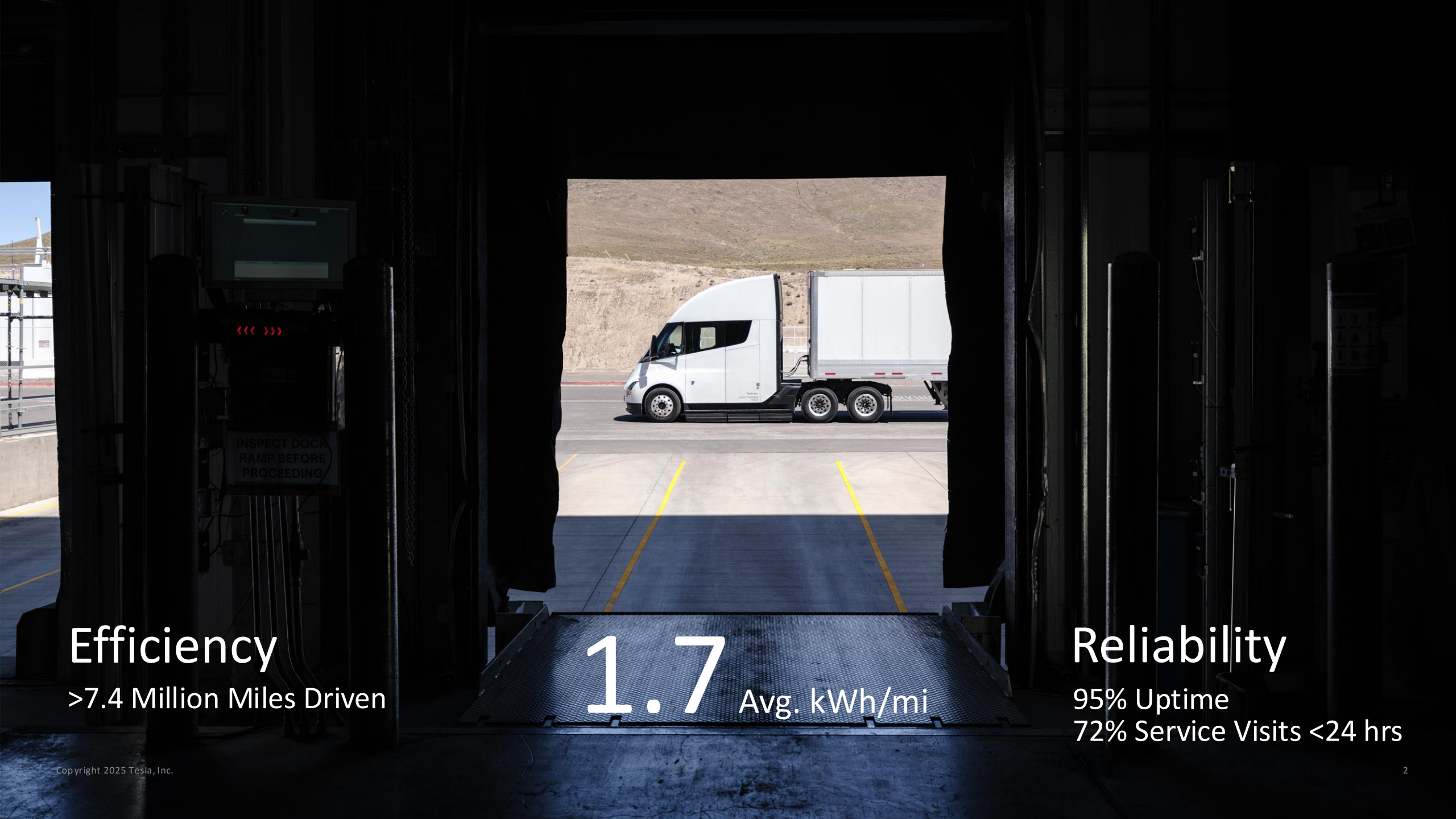
- TRUCK MODELS
- CHARGING SOLUTIONS
- FUNDING SOLUTIONS

VOLVO


TESLA

Semi

	Standard Range	Long Range
Est. Range	300 mi	500 mi
Vehicle Weight	< 20,000 lbs	< 23,000 lbs



Efficiency

>7.4 Million Miles Driven

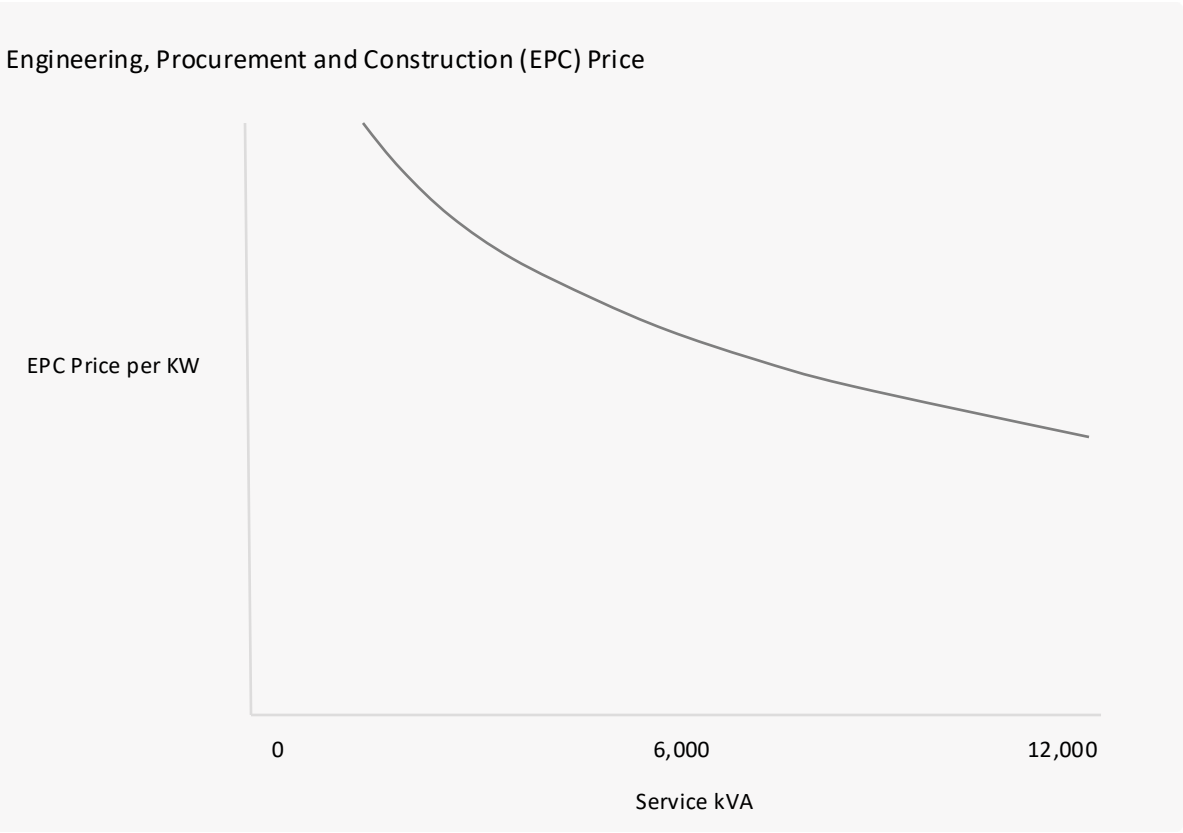
1.7 Avg. kWh/mi

Reliability

95% Uptime
72% Service Visits <24 hrs

Commitment to Scaling Semi

Customer Site Economics Unlocked with Scale




TESLA


KERRY LOGISTICS
DECATHLON
Wyeth
RÉMY COINTREAU
RITTAL
Gilbert De Clercq
MOVING BUSINESS FORWARD, SINCE 1957
ROKIN 荣庆物流
ETRUCKS
WINDROSE
WINDROSE GIANTS ANTWERP
WINDROSE
100% ELECTRIC • 670 Km autonomy Full load • + 400km autonomy in 35 minutes • 1.400hp
UNDP
ZF
Goodman
BorgWarner
smappee
SINEXCEL
orange
CALB
TELD 特来电
mondo
FLYINGGROUP
DEKRA

Wen Han – Founder, Chairman, CEO of Windrose

Wen HAN
Founder
Chairman, CEO

- **2022- Windrose Technology** *Founder, Chairman, CEO*
- **2019-2022 Plus AI** *Chief Strategy and Financial Officer*
  - Raised **$380mm+** as CSO and CFO for Plus in the largest private financing event in the autonomous trucking sector, from investors including Amazon and FTA
- **2018-2019 GSR Ventures** *Partner*
- **2013-2016 Bridgewater Associates** *Investment Professional*
- Stanford University MBA, Williams College B.A
- Donor of the $15mm ***Wen Han and Jessie Jia Fellowship*** at Stanford University;
- Wen is also a scholarship sponsor for Purdue University ($10mm) and Kettering University ($1mm)

WINDROSE

Plus 智加科技

GSR Ventures

BRIDGEWATER

Stanford University

Williams College

PURDUE UNIVERSITY

Latest updates as of 4 Apr 2025

Global media coverage

US

New York Times

US

Bloomberg

US

CNBC

Belgium

De Tijd

Belgium

Gazet van Antwerpen

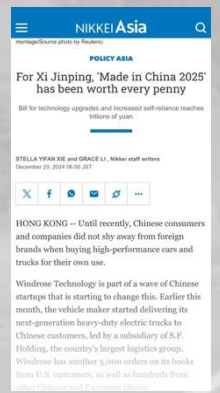
China

Forbes China

Hong Kong

South China Morning Post

Japan



Nikkei

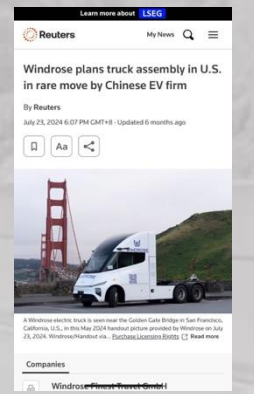
France

Le Monde

Germany

Frankfurter Allgemeine Zeitung

UK



Reuters

UK

Financial Times

Latest updates as of 6 Apr 2025

Compatibility with different trailer types of different lengths

Trailer length	Total length
~26ft	<43ft
~36ft	~54ft
~40ft	~57ft
45ft	~61ft
~69ft	~85ft
~92ft	~112ft

20ft container

20ft tanker

Crane trailer

Tanker

City trailer

40ft container

Box/Curtainside trailer

Car carrier

B-double trailer

A-double/Duo trailer

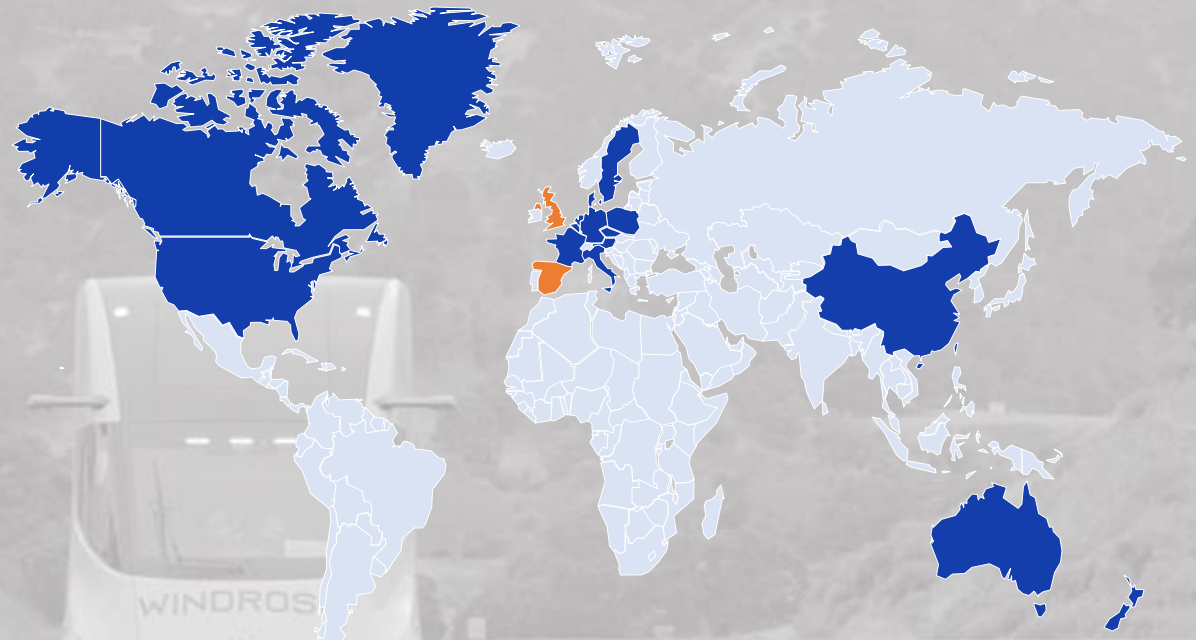
Latest updates as of 19 Dec 2024

Windrose trucks have covered major markets

GDP ranking (2023, US$bn)

Rank		
1	US	27,720
2	China	17,795
3	Germany	4,525
4	Japan	4,204
5	India	3,567
6	UK	3,381
7	France	3,052
8	Italy	2,301
9	Brazil	2,174
10	Canada	2,142
11	Russia	2,021
12	Mexico	1,789
13	Australia	1,728
14	South Korea	1,712
15	Spain	1,620

Source: World Bank



Windrose's footprint

In planning

Windrose is conducting global on-road testing, successfully tested >230 chargers

CCS1

No of public chargers successfully tested in US:

30+

MCS

CCS2

No of public chargers successfully tested in Europe:

63

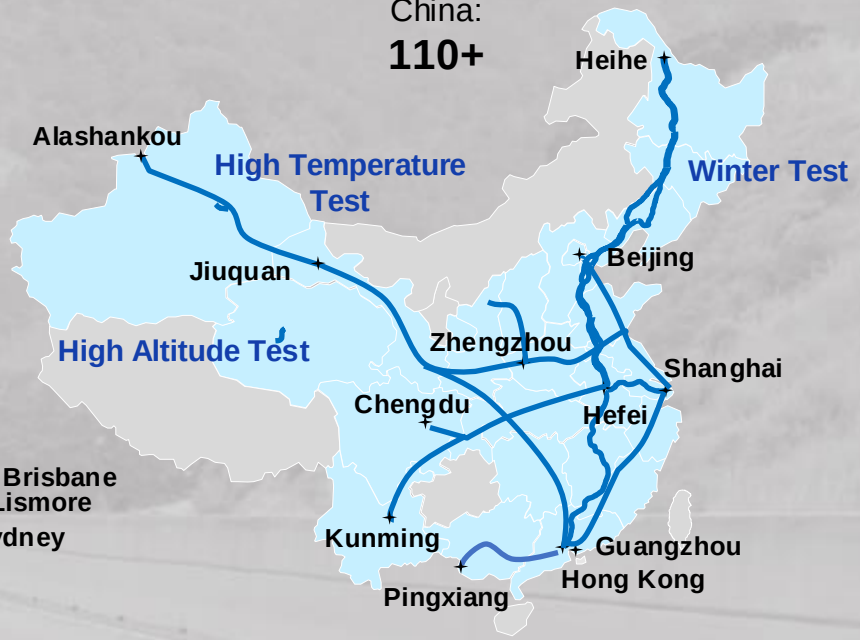
No of public chargers successfully tested in Australia:

26

GB/T

No of public chargers successfully tested in China:

110+



Latest updates as of 2 Apr 2025

Completed testing

Key locations

5,400 miles coast-to-coast trip across US

Total distance travelled: **5,400mi**

Total no. of chargers successfully tested: **18**

Operators tested

Hardware brand tested

Charging at EVGo near Kansas City

Charging at Electrify America @Indianapolis

State	No.	Operator	Hardware provider	Address	Max power
CA	1	Zeem Solution	ABB	8831 Aviation BLVD, Inglewood, CA. 90301	180kW
	2	Electrify America	Signet EV	6000 Sepulveda Blvd, Culver City, CA 90230	320kW
	3	WattEV	Charge America	18836 Highway 65 Bakersfield, CA 93308	360kW
	4	Electrify America	Signet EV	681 Leavesley Rd, Gilroy, CA 95020	450kW
	5	Electrify America	Signet EV	71808 Baker Blvd, Baker, CA 92309	450kW
NV	6	Electrify America	Signet EV	7400 Las Vegas Blvd S, Las Vegas, NV 89123	450kW
IL	7	Electrify America	Signet EV	1810 Avenue of Mid-America, Effingham, Illinois 62401	450kW
IN	8	Electrify America	Signet EV	4650 South Emerson Avenue, Indianapolis 46203	350kW
OH	9	Electrify America	Signet EV	5200 Westpointe Plaza Drive, Columbus, OH 43228	450kW
PA	10	Electrify America	Signet EV	3100 Tilghman St, Allentown, PA 18104	450kW
	11	Electrify America	Signet EV	4692 PA-51, Belle Vernon, PA 15012	450kW
IN	12	Electrify America	Signet EV	11351 E Washington St, Indianapolis, IN 46229	450kW
MO	13	EVGo	Delta	21500 Main St, Boonville, MO 65233	350kW
KS	14	Electrify America	Signet EV	4301 Vine St, Hays, KS 67601	320kW
CO	15	Electrify America	Signet EV	7800 Smith Rd, Denver, CO 80207	450kW
UT	16	Electrify America	Signet EV	1915 South State Street, Salina, UT 84654	450kW
	17	Electrify America	Signet EV	10 E. 1300 S, Richfield, UT 84701	450kW
	18	Electrify America	Signet EV	625 W Telegraph St, Washington, UT	450kW

Latest updates as of 1 Aug 2024

West-to-East cross-Europe testing trip, 12,400 miles, 63 public chargers tested

11 countries tested

~12,400mi testing distance

63 public chargers successfully tested

Typical charging power: **300 – 400kW**

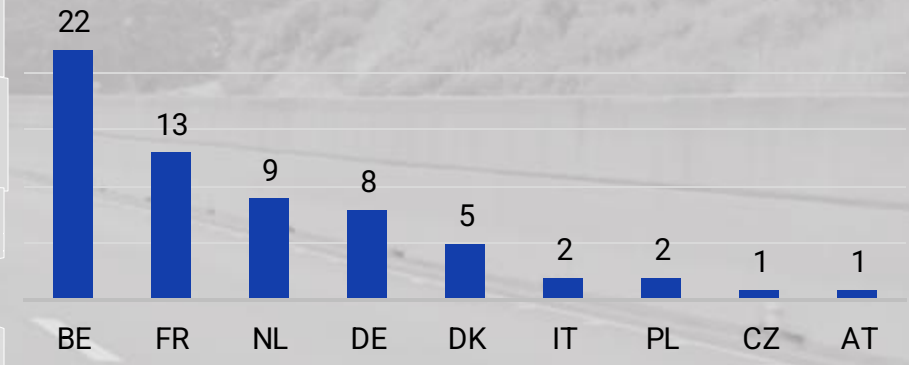
Charge point operators

Allego, Aral pulse, E-Flux by road, enel x way, Fastned, IONITY, Shell, SPARKI CHARGE & GO, TotalEnergies

Hardware providers

ABB, Alpitronic, DELTA, efacec, KEMPOWER, SIEMENS, smappee, TRITIUM

Number of chargers tested in each country



Dual-inlet charging

Latest updates as of 20 Oct 2024

Longest freight route ever performed by an EV truck globally

3096 miles travelled

Alashankou

Shenzhen

Charging partners

星星充电

中国石化 SINOPEC

TELD 300001 特来电

Li Auto

Latest updates as of 2 Apr 2025

Highly DURABLE vehicle – tested under most extreme conditions

Test conditions

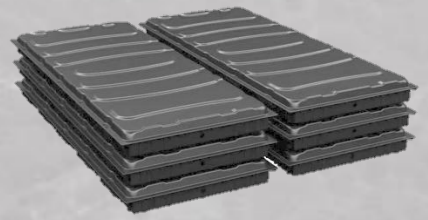
	WINDROSE	Mercedes-Benz eActros
Highest temperature	**118°F**	109°F
Lowest temperature	**-26°F**	-13°F
Altitude	**15,400ft**	7,200ft

Source: company public disclosure

Latest updates as of 1 Jun 2024

Windrose has developed cutting-edge technologies to achieve best-in-class performance

294 Patents[1)]



Tractor

0.2755
Drag coefficient

23,700lbs
Lightest weight amongst peers

Chassis

420mi
Full load range

35min
Ultrafast charging for 250mi

Batteries

729kWh
Largest battery

~205Wh/kg
High energy density

800V
High voltage platform

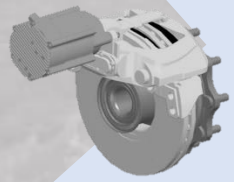
E-axles

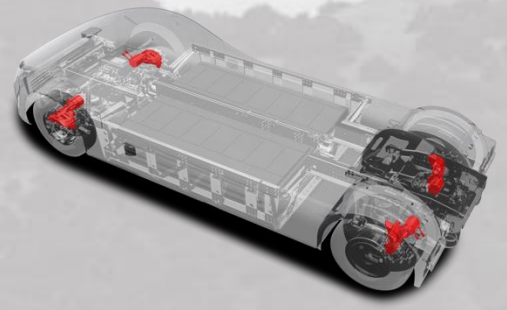
1,400hp
Peak output power

4 motors
Only truck with 4 motors

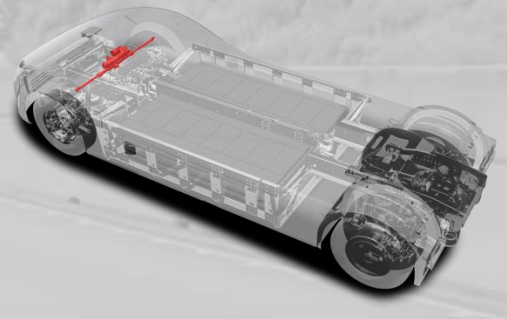
Note: 1) data as at Feb 2025

Next generation drive-by-wire “skateboard”





Brake-by-wire system



Steer-by-wire system

Latest updates as of 14 Oct 2024

Run on Less – Messy Middle Bootcamp

Trisha Dellolacono

Head of Policy, CALSTART

April 8, 2025

CALSTART's Unique Value Proposition

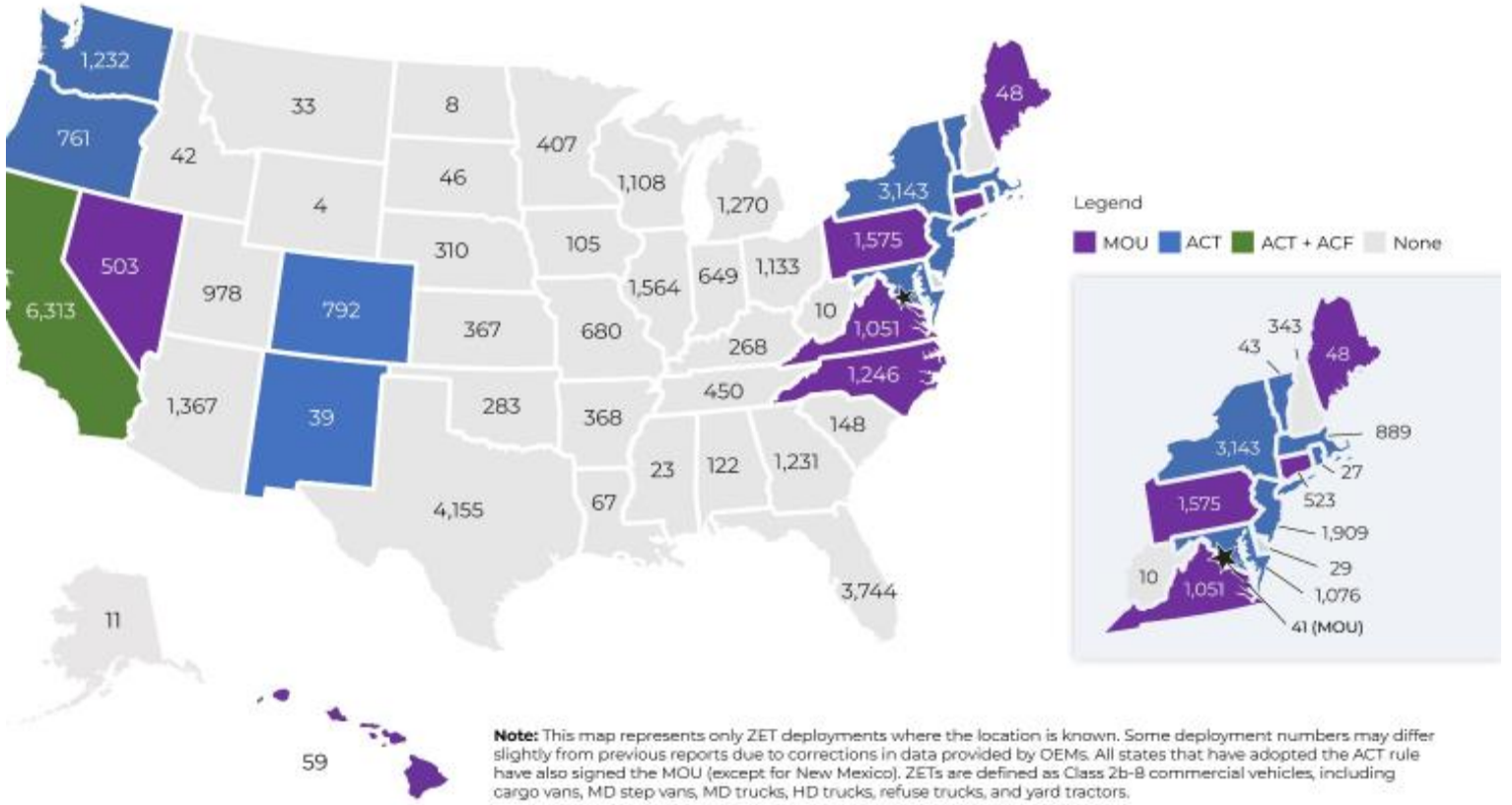
270+ ACTIVE CALSTART MEMBERS

ZEROING IN ON ZERO-EMISSION TRUCKS

S. ZET DEPLOYMENTS BY STATE

1 2 3

gure 5: State ZET Deployments and Policy Status



Note: This map represents only ZET deployments where the location is known. Some deployment numbers may differ slightly from previous reports due to corrections in data provided by OEMs. All states that have adopted the ACT rule have also signed the MOU (except for New Mexico). ZETs are defined as Class 2b-8 commercial vehicles, including cargo vans, MD step vans, MD trucks, HD trucks, refuse trucks, and yard tractors.

ZERO-EMISSION TECHNOLOGY INVENTORY

SELECT A VEHICLE PLATFORM

SELECT A VEHICLE MANUFACTURER

SELECT VEHICLE MODEL

CLICK ON MODEL NAMES

VEHICLE MODEL COMPARISON

Funding Finder

For Advanced Vehicle Technology and Infrastructure

The Funding Finder is designed to help stakeholders search and filter for medium- and heavy-duty advanced-technology vehicle and infrastructure programs.

Start by selecting one of the four categories below.

Please note that for the most accurate and up-to-date information about each program, you should visit the website and/or speak with the agency directly.

Select a Funding Category

- **Vehicles**
- **Infrastructure**
- **Tribal**
- **Federal Funding**

NAVIGATING FEDERAL POLICY SHIFTS

The Carrots

Inflation Investment & Jobs Act

- ✓ Low-No Emission Bus Grants
- ✓ Clean School Bus Program
- ✓ Reduction of Trucks Emissions at Port Facilities
- ✓ Clean Fuels and Infrastructure Program

Inflation Reduction Act

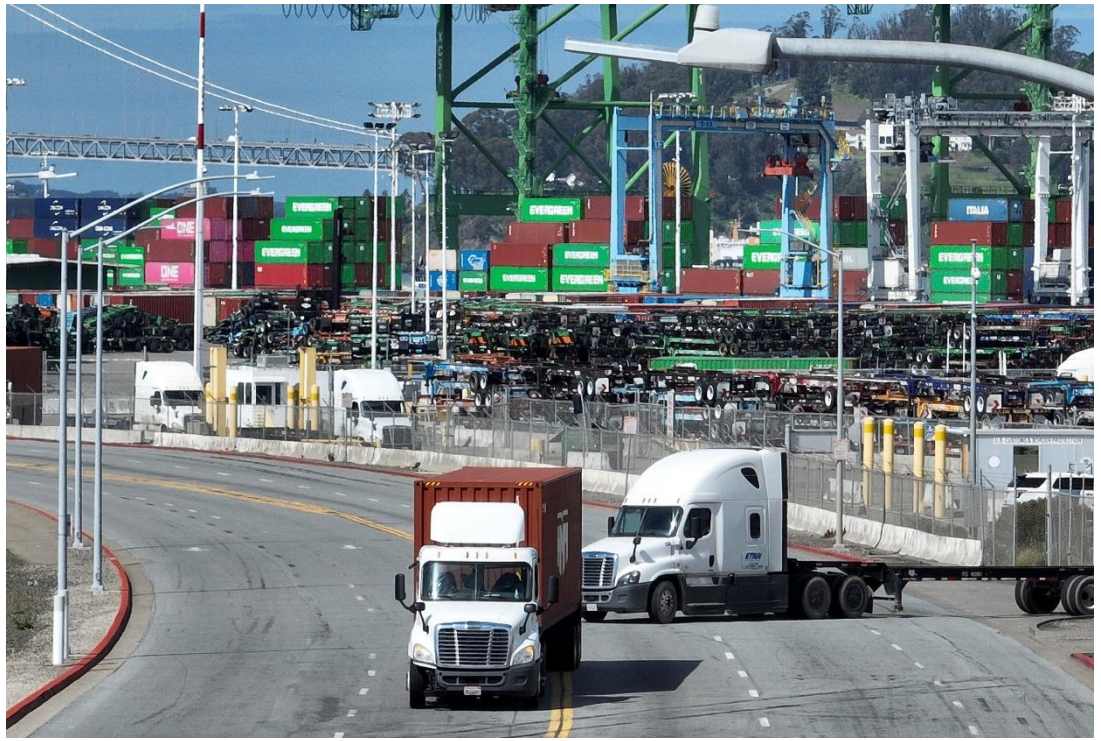
- ✓ 45W – Commercial Clean Vehicle Tax Credit
- ✓ 30C – Alternative Fuel Tax Credit
- ✓ EPA Clean Heavy-Duty Vehicles Program
- ✓ Air Pollution Reduction Grants at Ports
- ✓ Greenhouse Gas Reduction Fund
- ✓ Climate Pollution Reduction Grant

The Sticks

- ✓ EPA Phase 3 Heavy-Duty Vehicle Greenhouse Gas Emissions Standards
- ✓ California's Clean Air Waiver Authority

The Current Landscape - 2025

- Regulatory Uncertainty
- Funding Challenges
- Program Deployment Delays



OPPORTUNITIES IN STATES

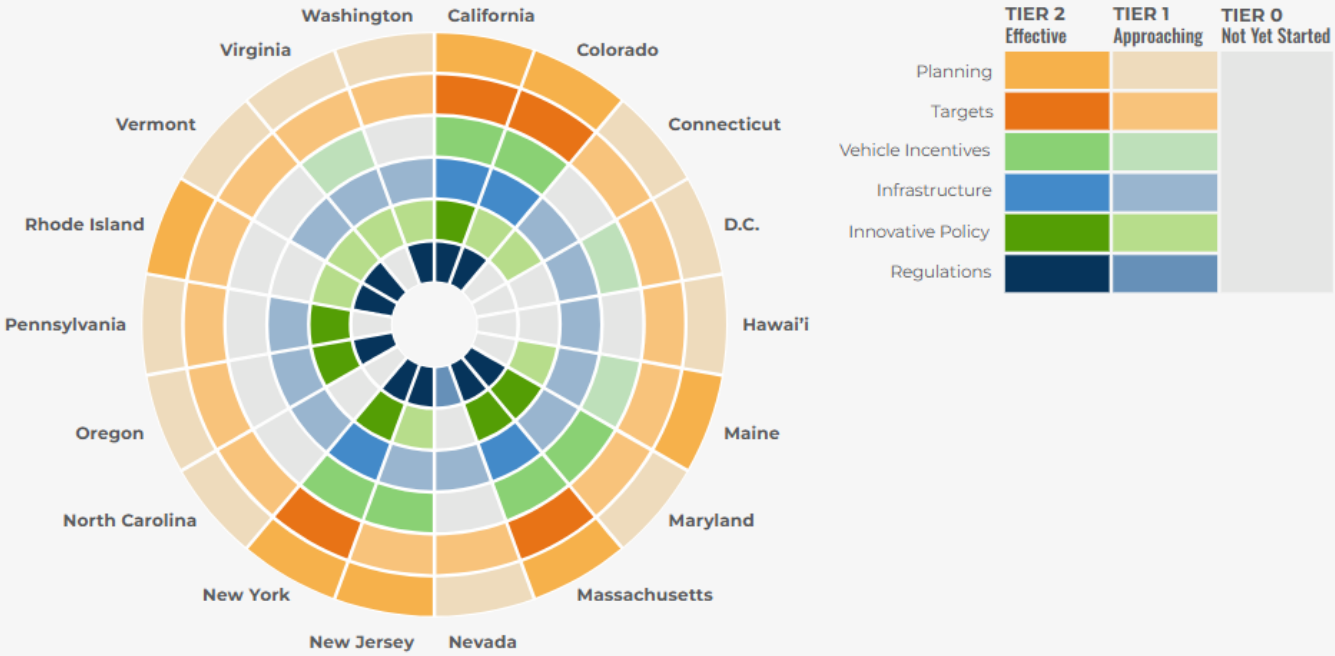
STATE ACTION DRIVING TO ZERO

THE ZET AHEAD DASHBOARD

ZET AHEAD DASHBOARD

The Dashboard currently showcases the 17 states plus the District of Columbia who have demonstrated leadership by signing the Multi-State Medium- and Heavy-Duty Zero-Emission Vehicle Memorandum of Understanding (MOU), committing to make 30 percent of medium- and heavy-duty vehicle sales be zero-emission by 2030 and 100 percent by 2050. Future iterations of the dashboard will include additional states taking action to "ZET Ahead".

This dashboard is a part of CALSTART's broader effort to chart and aggressively pursue a course to move beyond diesel pollution in the commercial vehicle sector throughout the United States.



Questions?

Trisha Dellolacono, tdelloiacono@calstart.org

Q&A

The Current State of HD BEV: Technologies and Capabilities

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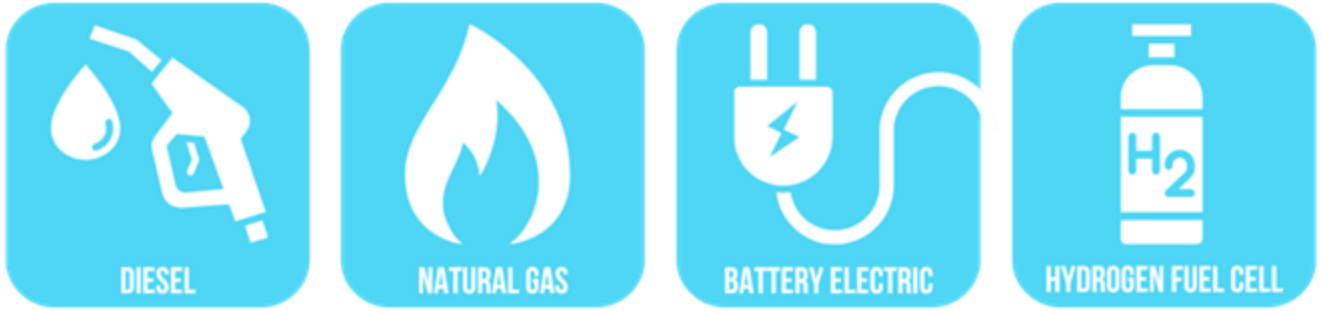
RUN ON LESS MESSY MIDDLE

MESSY MIDDLE BOOTCAMP



Let's Stay Connected…

NACFE (& Spanish: NACFE LATAM)

NACFE

@NACFE_Freight & @RunOnLess

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