CLEAN FUELS PROGRAM ADVISORY GROUP AGENDA
JANUARY 30, 2025, 9:00 AM – 3:30 PM
Conference Room GB
21865 Copley Drive
Diamond Bar, CA 91765

TELECONFERENCE LOCATIONS

Mridul Gautam University of Nevada, Reno 1664 N. Virginia St, Ross Hall 201, Reno, NV 89557

A meeting of the South Coast Air Quality Management District Clean Fuels Program Advisory Committee will be held at 9:00 a.m. on Thursday, January 30, 2025, through a hybrid format of in-person attendance in Conference Room GB at the South Coast AQMD Headquarters, 21865 Copley Drive, Diamond Bar, California, and remote attendance via videoconferencing and by telephone. Please follow the instructions below to join the meeting remotely. Please refer to South Coast AQMD's website for information regarding the format of the meeting, updates if the meeting is changed to a full remote via webcast format, and details on how to participate:

INSTRUCTIONS FOR ELECTRONIC PARTICIPATION
Join Zoom Webinar Meeting - from PC or Laptop
https://scaqmd.zoom.us/j/91964955642
Zoom Webinar ID: 919 6495 5642 (applies to all)
Teleconference Dial In +1 669 900 6833
One tap mobile +16699006833, 91964955642#

Audience will be allowed to provide public comment through telephone or Zoom connection.

INSTRUCTIONS FOR ELECTRONIC PARTICIPATION AT BOTTOM OF AGENDA

AGENDA

Members of the public may address this body concerning any agenda item before or during consideration of that item (Gov't. Code Section 54954.3(a)). If you wish to speak, raise your hand on Zoom or press Star 9 if participating by telephone. All agendas for regular meetings are posted at South Coast AQMD Headquarters, 21865 Copley Drive, Diamond Bar, California, at least 72 hours in advance of the regular meeting. Speakers may be limited to two (2) minutes each.

Welcome & Overview
9:00 AM – 10:00 AM

(a)	Welcome and Opening Remarks	Aaron Katzenstein, Ph.D., Deputy Executive Officer*
(b)	Goals for the Day	Vasileios Papapostolou, Sc.D., Technology Demonstration Manager*
(c)	Incentives, Grants Updates and Opportunities	Aaron Katzenstein, Ph.D.
(d)	Low Load Ocean-Going Vessels Emissions and Measurements	Johan Mellqvist, Ph.D., Chalmers University of Technology, Sweden & FluxSense, Inc.
(e)	Feedback and Discussion	Advisors and Experts
(f)	Public Comment (2 minutes/person)	

1.	Battery Electric Vehicles - Powertrain 10:15 AM – 12:00 PM	
(a)	Practical Electrification of Heavy-Duty Fleets with Range Energy Electric-Powered Trailer	Jason Chua, Chief Product Officer, Range Energy, Inc.
(b)	Commercial Advancement of Mobile Fuel Cell Generators	Jurgen Schulte, Chief Engineer, RockeTruck, Inc.
(c)	Reducing Commercial Vehicle Emissions Responsibly and Rapidly by Deploying Circular™ Solutions	Bill Beverley, Co-Founder, Co-CEO & CTO, Evolectric, Inc.
(d)	Meeting Class 3 Work Truck Demands with Minimal Charging Infrastructure	George Gebhart, CEO, Voltu Motor, Inc.
(e)	Feedback and Discussion	Advisors and Experts
(f)	Public Comment (2 minutes/person)	
	Lunch **12:15 PM – 1:15 PM**	
2.	**Battery Electric Vehicles - Grant** **1:30 PM – 2:30 PM**	
(a)	Battery Electric Truck Deployments across Southern California: Joint Electric Truck Scaling Initiative (JETSI) and SWITCH-ON Projects	Sam Cao, Ph.D., Program Supervisor*
(b)	Empowering Local Environmental Change through Replacing Internal Combustion with Battery Electric Class 6 or 7 Vehicles (ELECTRIC) and Clean Air Rides for Kids (CARE4Kids)	Krystle Martinez, Program Supervisor* & Yuh Jiun Tan, Program Supervisor*
(c)	Feedback and Discussion	Advisors and Experts
(d)	Public Comment (2 minutes/person)	
3.	**Wrap-up** **2:30 PM – 3:30 PM**	
(a)	2025 Clean Fuels Plan Update & Wrap-up	Vasileios Papapostolou, Sc.D.
(b)	Advisor and Expert Comments	All
(c)	Public Comment (2 minutes/person)	

* South Coast AQMD Technology Advancement Office

Other Business

Any member of the Advisory Group, or its staff, on his or her own initiative or in response to questions posed by the public, may ask a question for clarification; may make a brief announcement or report on his or her own activities, provide a reference to staff regarding factual information, request staff to report back at a subsequent meeting concerning any matter, or may take action to direct staff to place a matter of business on a future agenda. (Gov't. Code Section 54954.2)

Public Comment Period

At the end of the regular meeting agenda, an opportunity is provided for the public to speak on any subject within the Advisory Group's authority that is not on the agenda. Speakers may be limited to two (2) minutes each.

Document Availability
All documents (1) constituting non-exempt public records; (ii) relating to an item on the agenda for a regular meeting; and (iii) having been distributed to at least a majority of the Advisory Group after the agenda is posted, are available by contacting Donna Vernon at 909-396-3097 from 7:00 a.m. to 5:30 p.m., Tuesday through Friday, or send the request to dvernon@aqmd.gov.

Americans with Disabilities Act
Disability and language-related accommodations can be requested to allow participation in the Clean Fuels Program Advisory Group meeting. The agenda will be made available, upon request, in appropriate alternative formats to assist persons with a disability (Gov't Code Section 54954.2(a)). In addition, other documents may be requested in alternative formats and languages. Any disability or language-related accommodation must be requested as soon as practicable. Requests will be accommodated unless providing the accommodation would result in a fundamental alteration or undue burden to South Coast AQMD. Please contact Donna Vernon at 909-396-3097 from 7:00 a.m. to 5:30 p.m., Tuesday through Friday, or send the request to dvernon@aqmd.gov.

INSTRUCTIONS FOR ELECTRONIC PARTICIPATION

Instructions for Participating in a Virtual Meeting as an Attendee
As an attendee, you will have the opportunity to virtually raise your hand and provide public comment.

Before joining the call, please silence your other communication devices such as your cell or desk phone. This will prevent any feedback or interruptions during the meeting.

Please note: During the meeting, all participants will be placed on Mute by the host. You will not be able to mute or unmute your lines manually.

After each agenda item, the Chairman will announce public comment.

Speakers will be limited to a total of three (3) minutes for the Consent Calendar and Board Calendar, and three (3) minutes or less for other agenda items.
A countdown timer will be displayed on the screen for each public comment.

If interpretation is needed, more time will be allotted.

Once you raise your hand to provide public comment, your name will be added to the speaker list. Your name will be called when it is your turn to comment. The host will then unmute your line.

Directions for Video ZOOM on a DESKTOP/LAPTOP:
- If you would like to make a public comment, please click on the **"Raise Hand"** button on the bottom of the screen.
- This will signal to the host that you would like to provide a public comment and you will be added to the list.

Directions for Video Zoom on a SMARTPHONE:
- If you would like to make a public comment, please click on the **"Raise Hand"** button on the bottom of your screen.
- This will signal to the host that you would like to provide a public comment and you will be added to the list.

Directions for TELEPHONE line only:
- If you would like to make public comment, please **dial *9** on your keypad to signal that you would like to comment.

Remote emission measurements of ships in real traffic

Johan Mellqvist

[1] Chalmers University of Technology, Göteborg, Sweden

[2] FluxSense Inc, San Diego

johan.mellqvist@chalmers.se or johan.mellqvist@fluxsense.com

CHALMERS

Background

- Since 2006, Chalmers has been involved in the development and utilization of both airborne and stationary measurement tools for monitoring compliance with sulfur regulations and emissions of NOx, particles, and CH4,
- Initial efforts include the Swedish project IGPS and field campaigns conducted in Rotterdam in 2008 (Sirenas-JRC), which featured the use of both fixed and airborne sniffers, including measurements taken from helicopters and UAVs.
- Following this, they have participated in multiple EU projects and others, such as BSR-Innoship, CompMon, EnviSum, Cshipp, Scipper, and SCAQMD-LA.
- They also constructed an airborne sniffer for the Royal Belgian Institute.
- In Denmark, they conducted airborne surveillance for the Danish EPA over a two-year period from 2015 to 2016.
- Long-term fixed measurements have been carried out for 5 to 10 years at locations including the Göteborg ship channel, Great Belt bridge, and Öresund, in collaboration with the Danish EPA and the Swedish transport agency.

TRANSPORT STYRELSEN

Ministry of Environment of Denmark
Environmental Protection Agency

EnviSuM

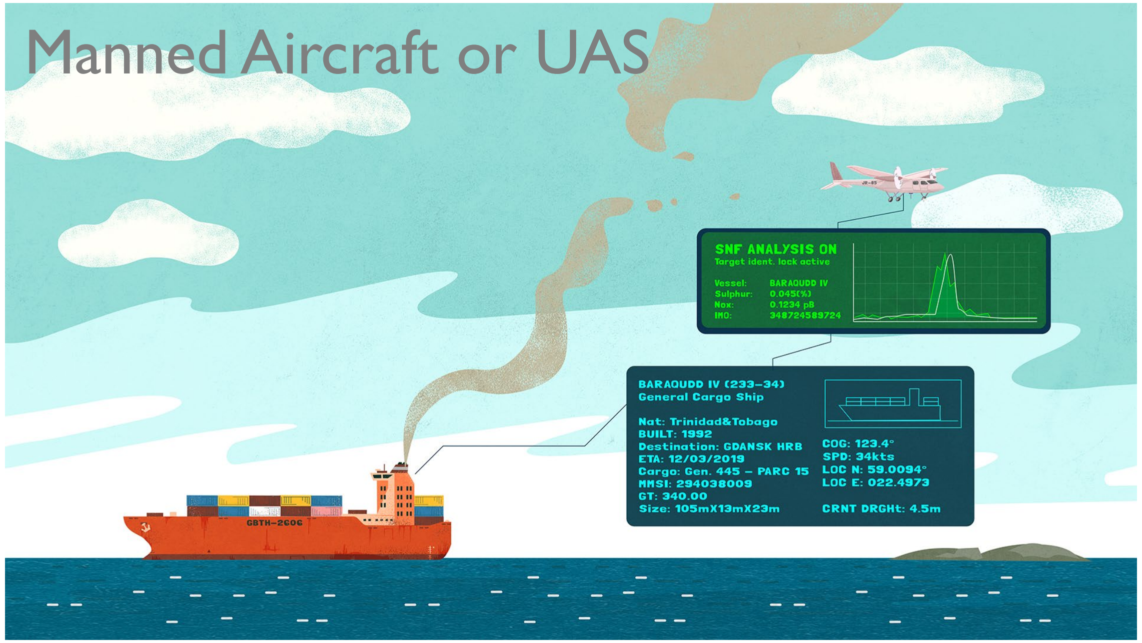
Interreg
Baltic Sea Region

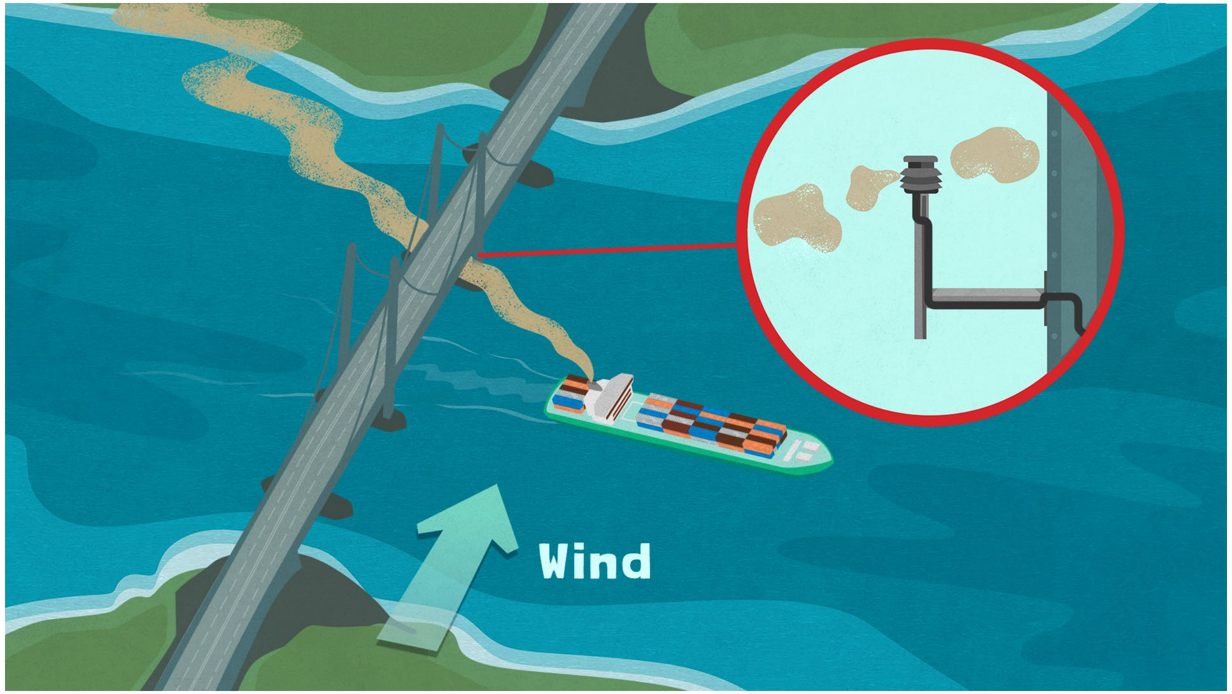
EUROPEAN UNION
EUROPEAN REGIONAL DEVELOPMENT FUND

CompMon
Compliance Monitoring for Marpol Annex VI

THE SCIPPER PROJECT

Sniffer Method for remote measurements



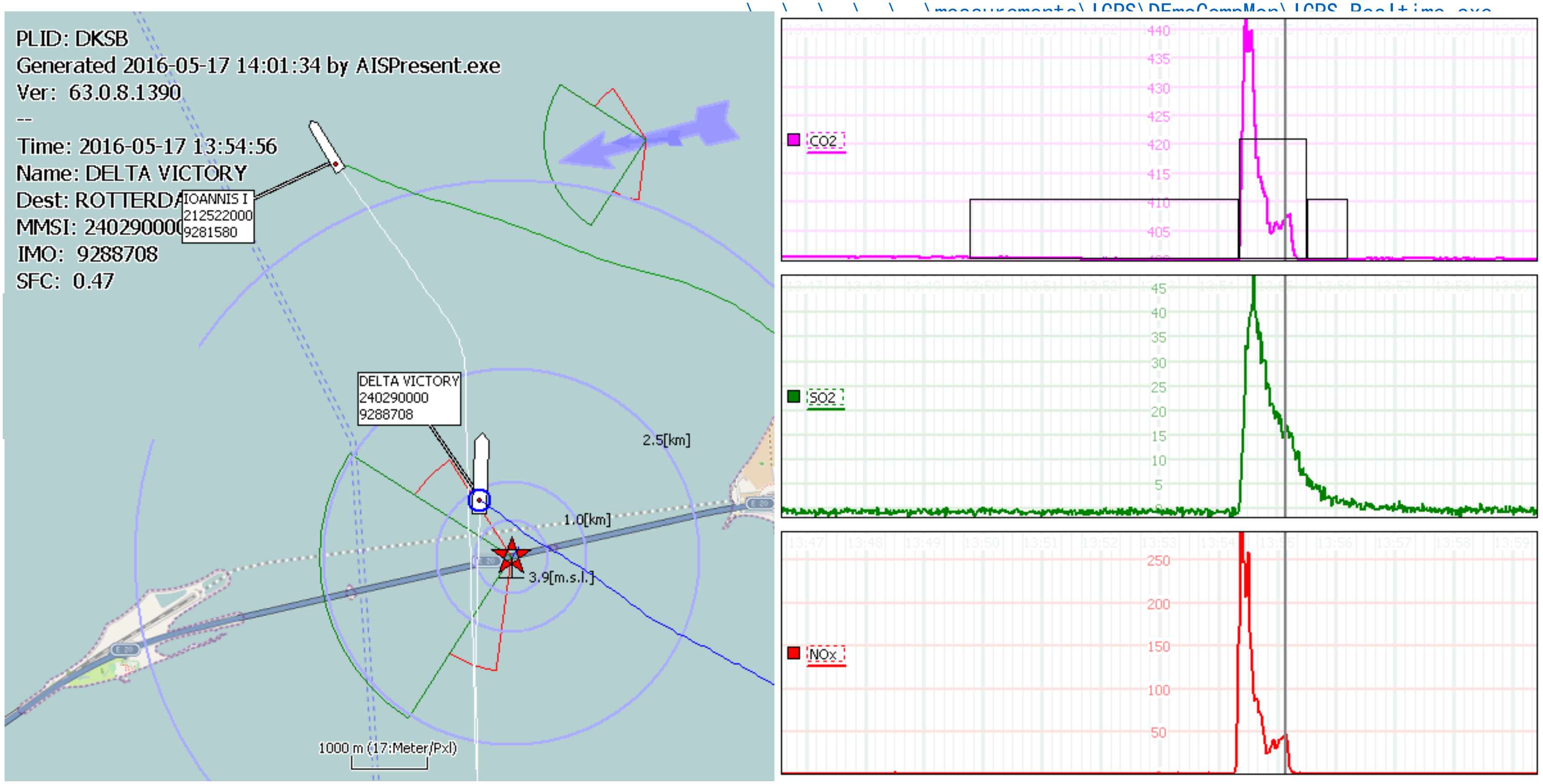


$$FSC_{\%S_{m/m}} = \frac{\mathrm{M(S)}_{g/mol} \times \int [SO_2]_{ppb} - [SO_{2,bgd}]_{ppb}\, dt}{\frac{\mathrm{M(C)}_{g/mol}}{0.87} \times \int [CO_2]_{ppm} - [CO_{2,bgd}]_{ppm}\, dt} = 0.232 \times \frac{\int [SO_2]_{ppb} - [SO_{2,bgd}]_{ppb}\, dt}{\int [CO_2]_{ppm} - [CO_{2,bgd}]_{ppm}\, dt}$$

NOx, CH4, BC, Particles mass and number measured in a similar way

Emission factor measurements from remote

An automated system detects vessels and determines the sulfur content in fuel by analyzing SO2/CO2 and NOx emissions per kWh, using NOx/CO2 ratios and estimated specific fuel oil consumption. This information is then transmitted to a database, which generates alerts for elevated values that may require prompt intervention.

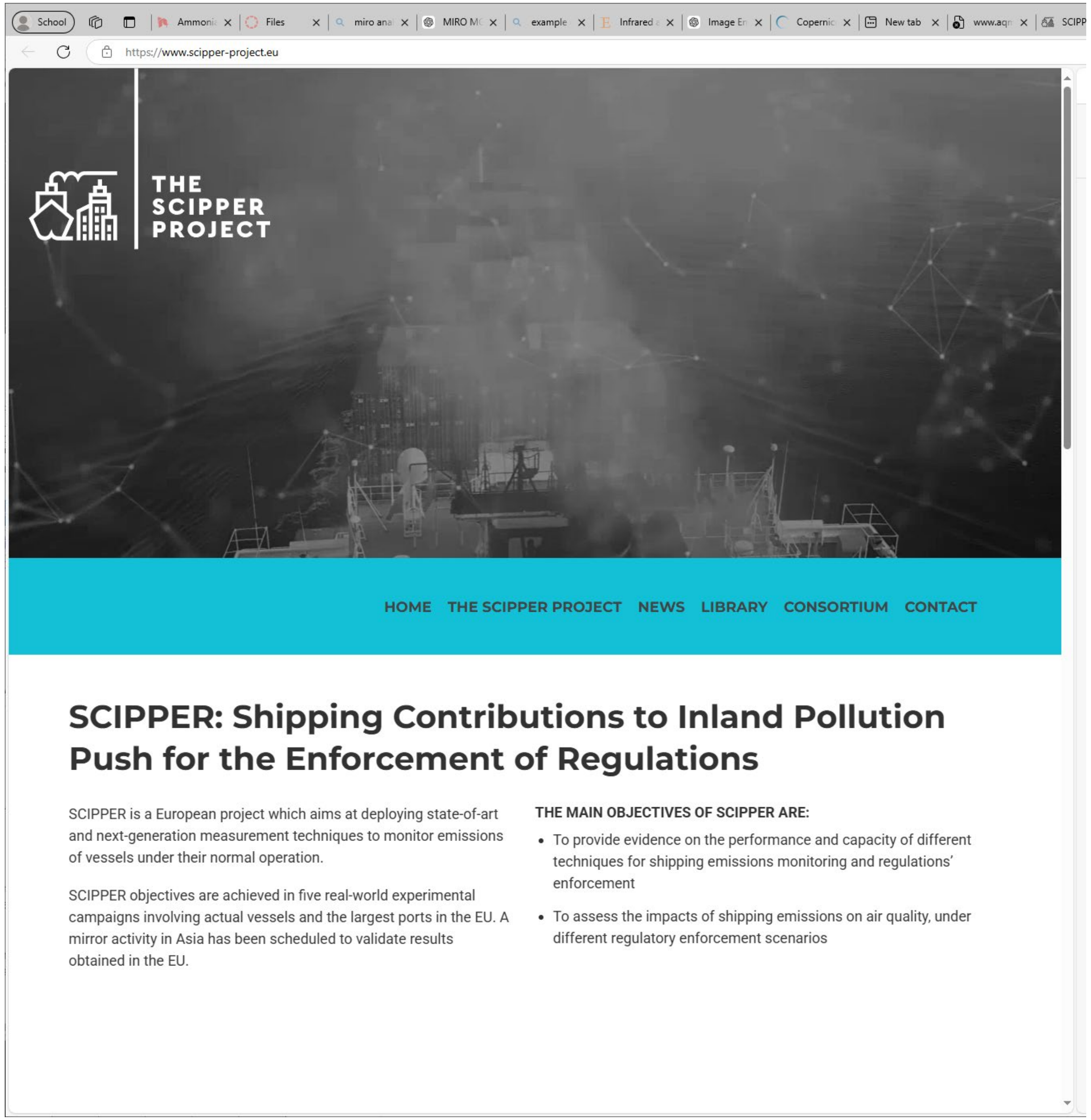


Project 1: Scipper EU Horizon 2020 project

- SCIPPER is a European project which aims at deploying state-of-art and next-generation measurement techniques to monitor emissions of vessels under their normal operation.
- SCIPPER objectives are achieved in five real-world experimental campaigns involving actual vessels and the largest ports in the EU.A

The main objectives of SCIPPER are:

- To provide evidence on the performance and capacity of different techniques for shipping emissions monitoring and regulations' enforcement
- To assess the impacts of shipping emissions on air quality, under different regulatory enforcement scenarios



Objectives WP2 Remote measurement methods

- Develop and demonstrate a toolbox of next-generation techniques for remote measurements of gaseous and particle emissions from ships. (D2.1 and D2.2)
- Compliance monitoring in ship lanes in North, Baltic and the Mediterranean Seas, the latter before and after the 0.5% sulphur limit is implemented. (D2.4)
- Quality assurance work and harmonisation of uncertainty reporting for different remote sensing techniques. (D2.3)
- Methodology work to prepare for compliance monitoring of NOx and PM/aerosol by comparison of various methods. D2.3, D5.5
- Emission factors of SO2 and other pollutants, (NOx, BC, PN, PM2.5, PM10) as input to modelling and preparation for the Baltic/North Seas NECA and future particle regulation. D2.3
- Research and validation campaigns Marseille 2019 (C1) , On board ferry and Kiel (C2), Hamburg (C3) , Marseille 2021 (C4) , English channel (C5)

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement Nr.814893

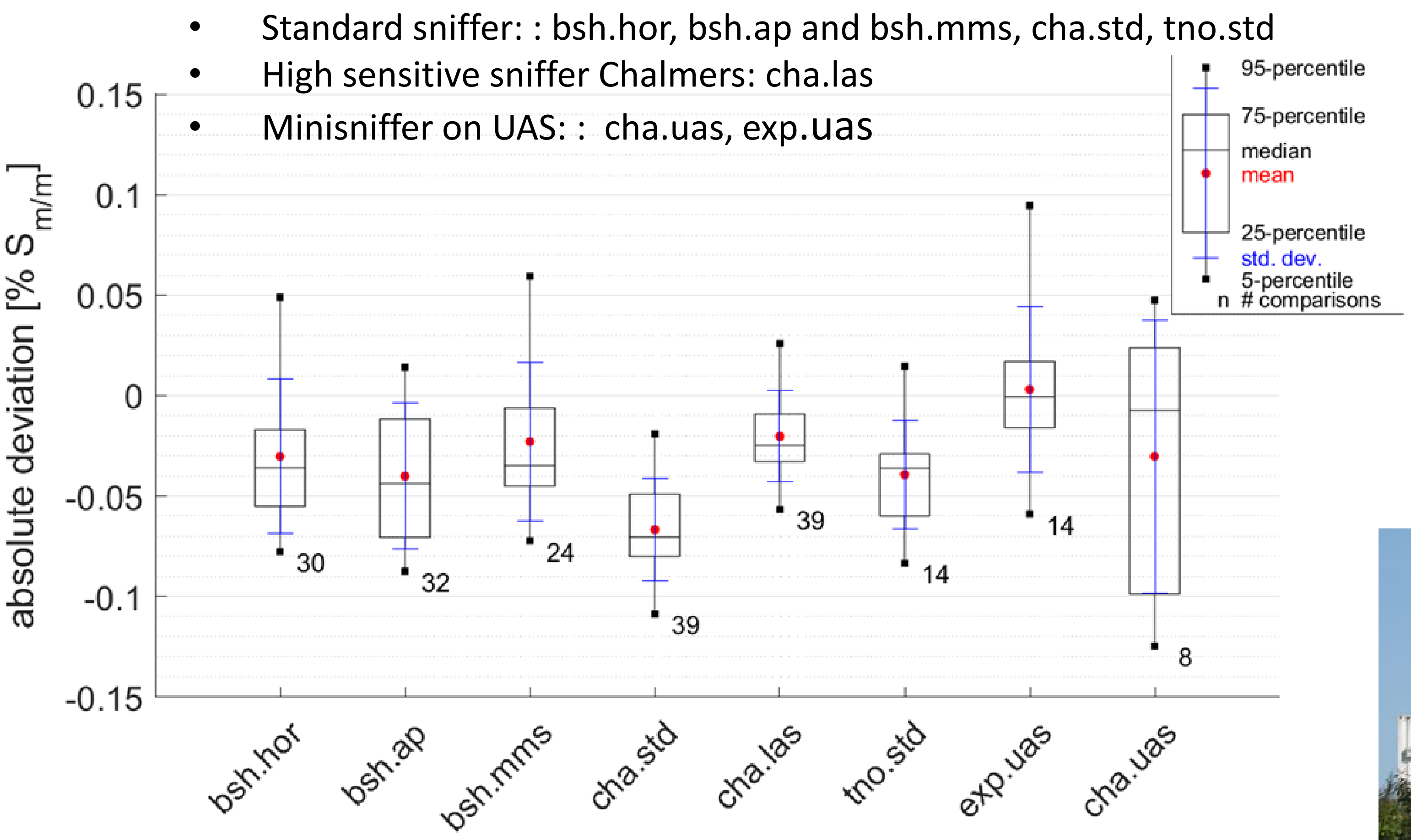
Use of different sensor systems

Sensors	Typical sensitivity	Platforms	Dist. ships	FSC principle	Meas principle
High sensitive sniffer(TDLS)	SO_2 0.06 ppb CO_2 0.2 ppm	Fixed shipborne (Airborne)	>1 km	ΔSO2/ΔCO2	Laser absorption
Standard sniffer	SO_2 2 ppb NO 0.5 ppb NO_2 0.5 ppb CO_2 0.2 ppm	Fixed shipborne Airborne,	1 km	ΔSO2/ΔCO2 ΔNOx/ΔCO2	UV fluorescence NDIR
Mini-sniffer	SO_2 20 ppb NO 100 ppb NO_2 20 ppb CO_2 10 ppm	UAS	50-100 m	ΔSO2/ΔCO2 ΔNO2/ΔCO2 ΔNO/ΔCO2	Electro chemical NDIR
Optical remote sensing (UV/VIS)	*SO_2: 1 ppmm* *NO_2 1 ppmm*	*Fixed, shipborne Airborne, satellite*	*1 km*	*ΔSO2/ΔNO2* *ΔNO2*	*DOAS* *300 -450 nm*
Optical remote sensing (IR)	*TBD*	*Fixed*	*50-200 m*	*ΔSO2/ΔCO2*	*Passive FTIR*

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement Nr.814893

Validation work FSC Wedel Sep 2020 C3

Measurement error corresponding to absolute difference between remote FSC measurements and laboratory-analysed fuel samples (main engine) for about 40 measured ship plumes (blind exercise).



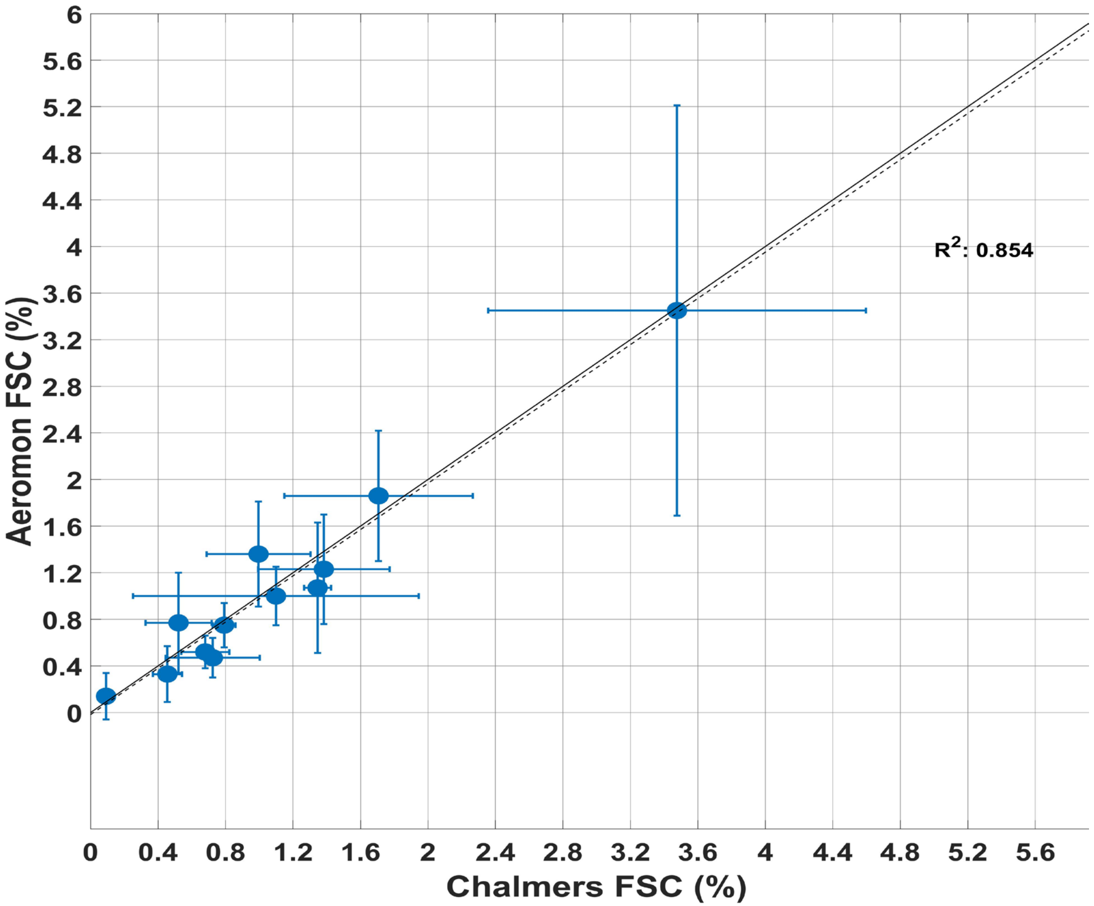
Random uncertainty varies between 0.04% to 0.13% S m/m

Systematic negative bias in the FSC data ranging from 0.02% to 0.07% S m/m for standard and high sensitive sniffer

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement Nr.814893

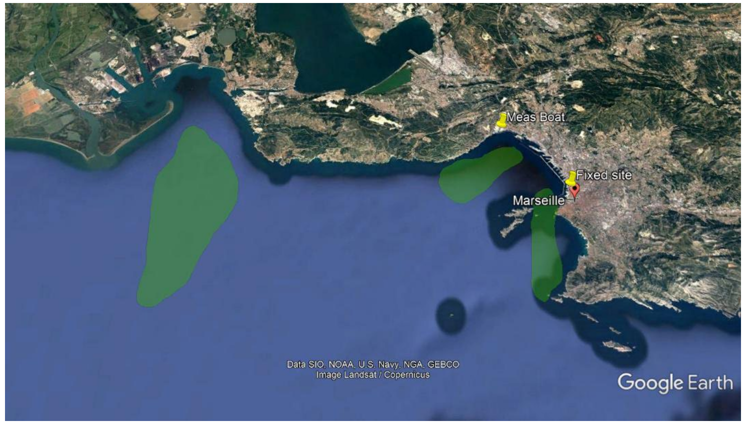
Comparison at high FSC (Marseille C1)

Comparison of shipborne and UAS-borne sniffer measurements of different ships operating on the waters of Marseille and Fos-sur-Mer during September 2019



Good agreement in measurements in magnitude and correlation.

If the average of the two systems is assumed as the "true" emission, then the expanded uncertainty (CI 95 %) for both instruments is 0.20 % S m/m

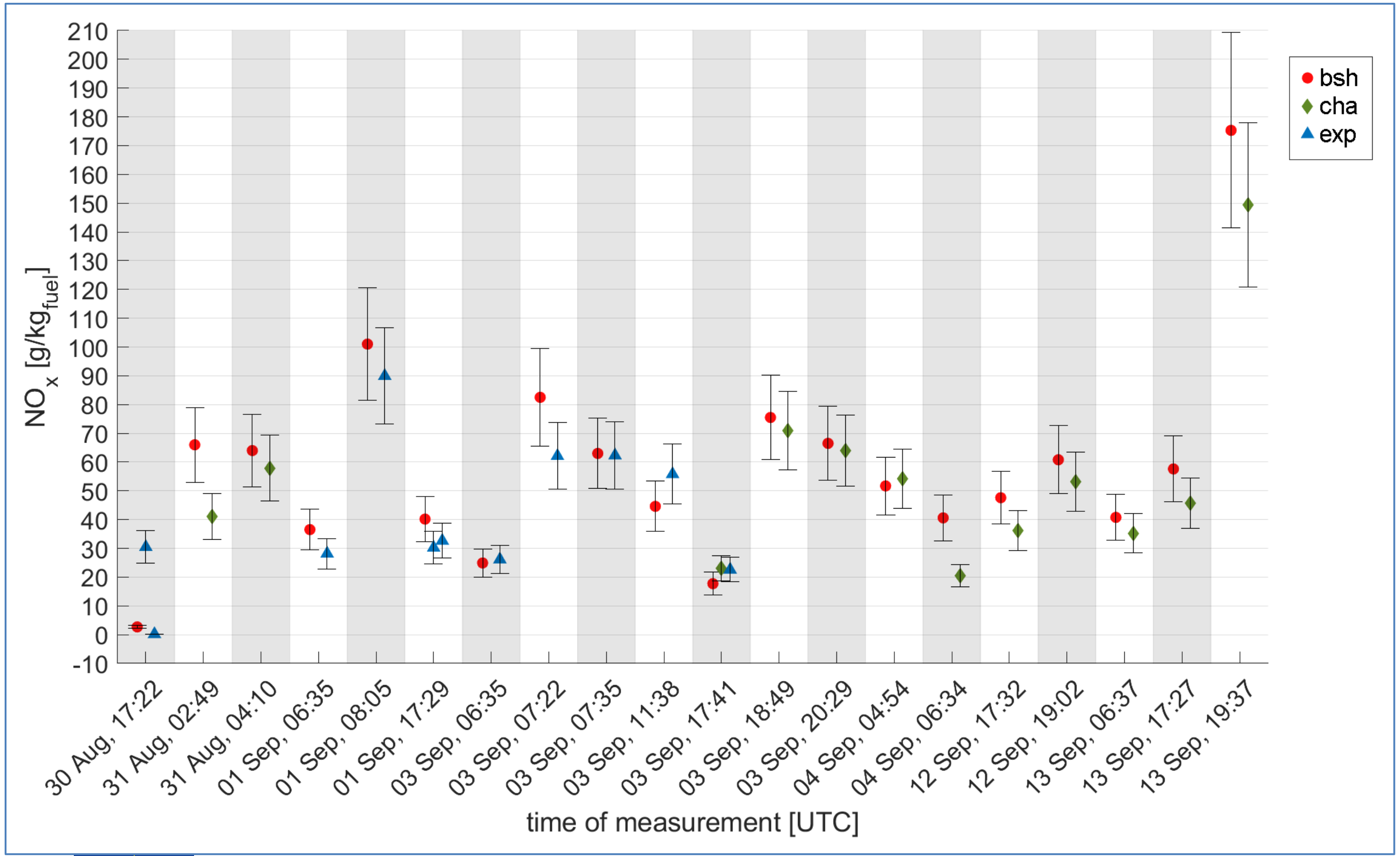


This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement Nr.814893

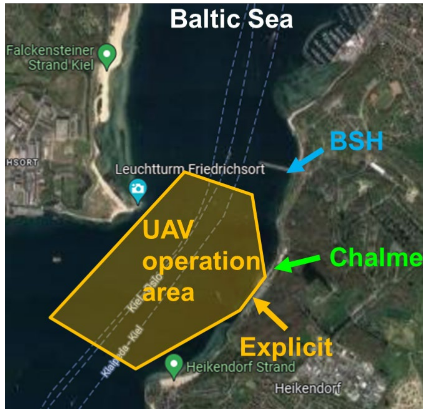
NOx Kiel Sep 2021 C2

Comparison of NOx emission factors (gNOx/kgfuel) from fixed sniffer onshore measurements in Kiel (C2) by Chalmers and BSH, and UAS-borne mini sniffer measurements by Explicit

- Standard sniffer: : bsh , High sensitive sniffer : cha, Minisniffer on UAS: exp



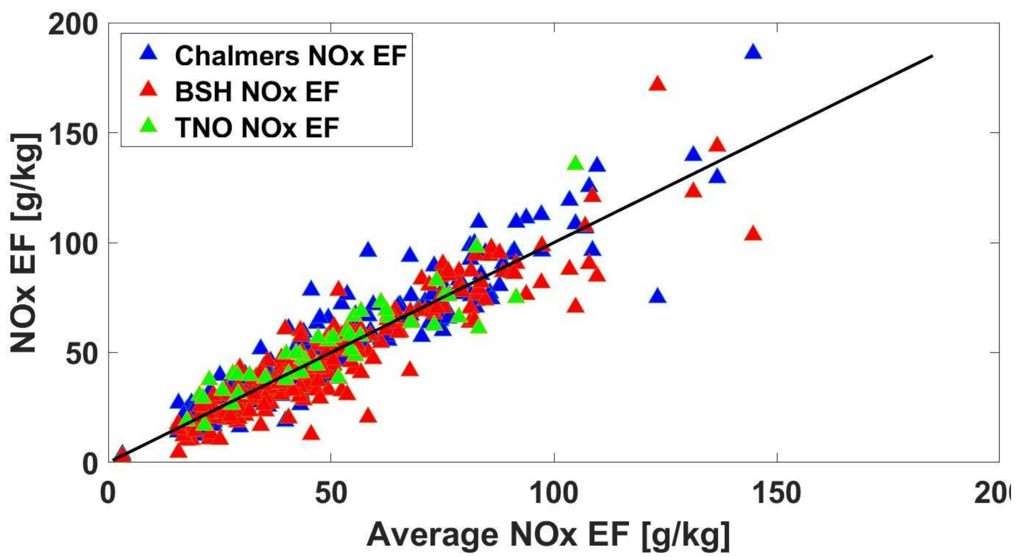
Agreement better than 10 % between the data sets,
The differences are explained by the estimated uncertainty in 85% of the cases.
The calculated estimated uncertainties are around 17-23% for all systems

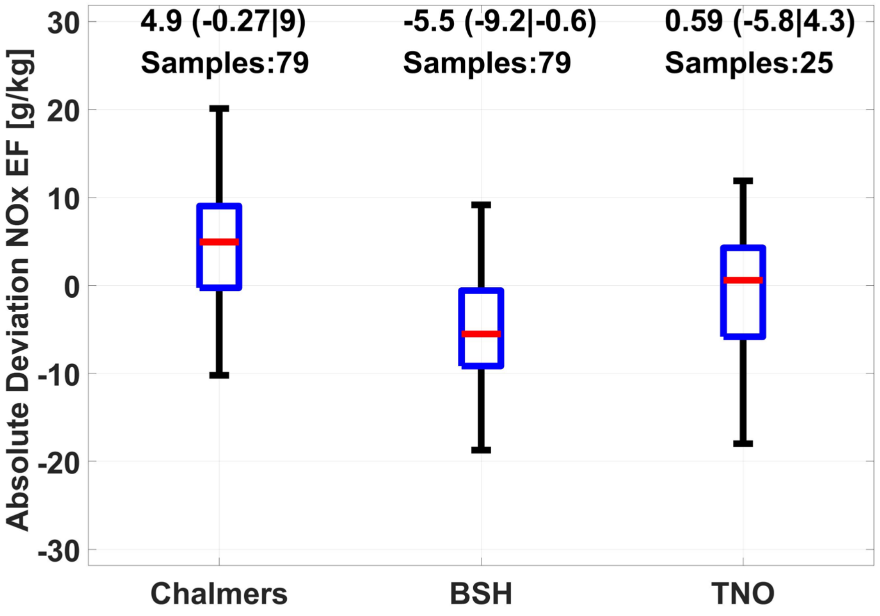


This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement Nr.814893

NOx Wedel Sep 2020 C3

Comparison of NOx emission factors (gNOx/kgfuel) from sniffer measurements by BSH, Chalmers, and TNO for individual ships by comparison to ensemble average (blind exercise)

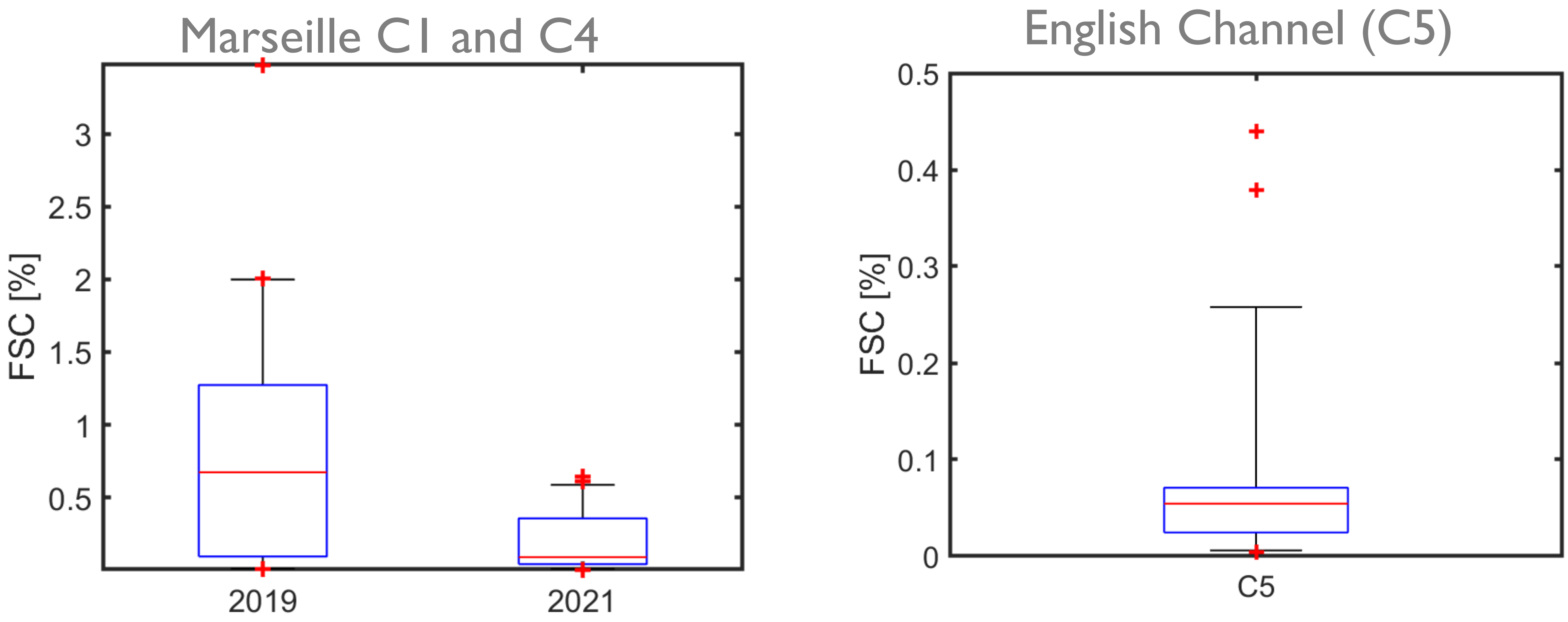




The differences are explained by the estimated uncertainty in 60 - 70 % of the cases, with exception for one system. The measurement error is around 40 % for all systems.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement Nr.814893

Campaigns before and after SECA and close to border



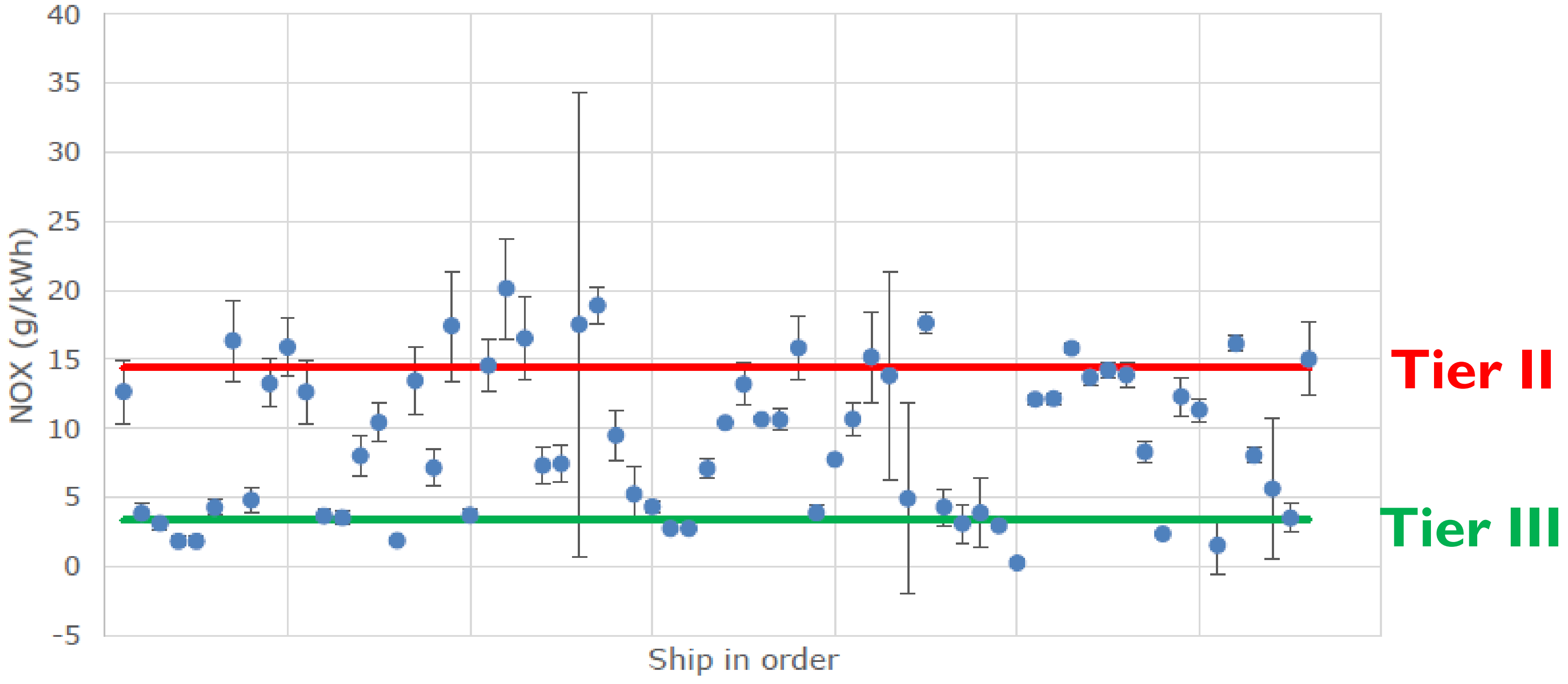
Sniffer measurements in Marseille (C1 and C4) and English Channel C5 (2022) .

During the C5 campaign in the Western English Channel two ships (out of 39) showed non-compliant FSC measurements, above 0.1% FSC, which shows that closer to the SECA border non-compliancy is more likely to occur. **This shows the need for measurements also at sea,**

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement Nr.814893

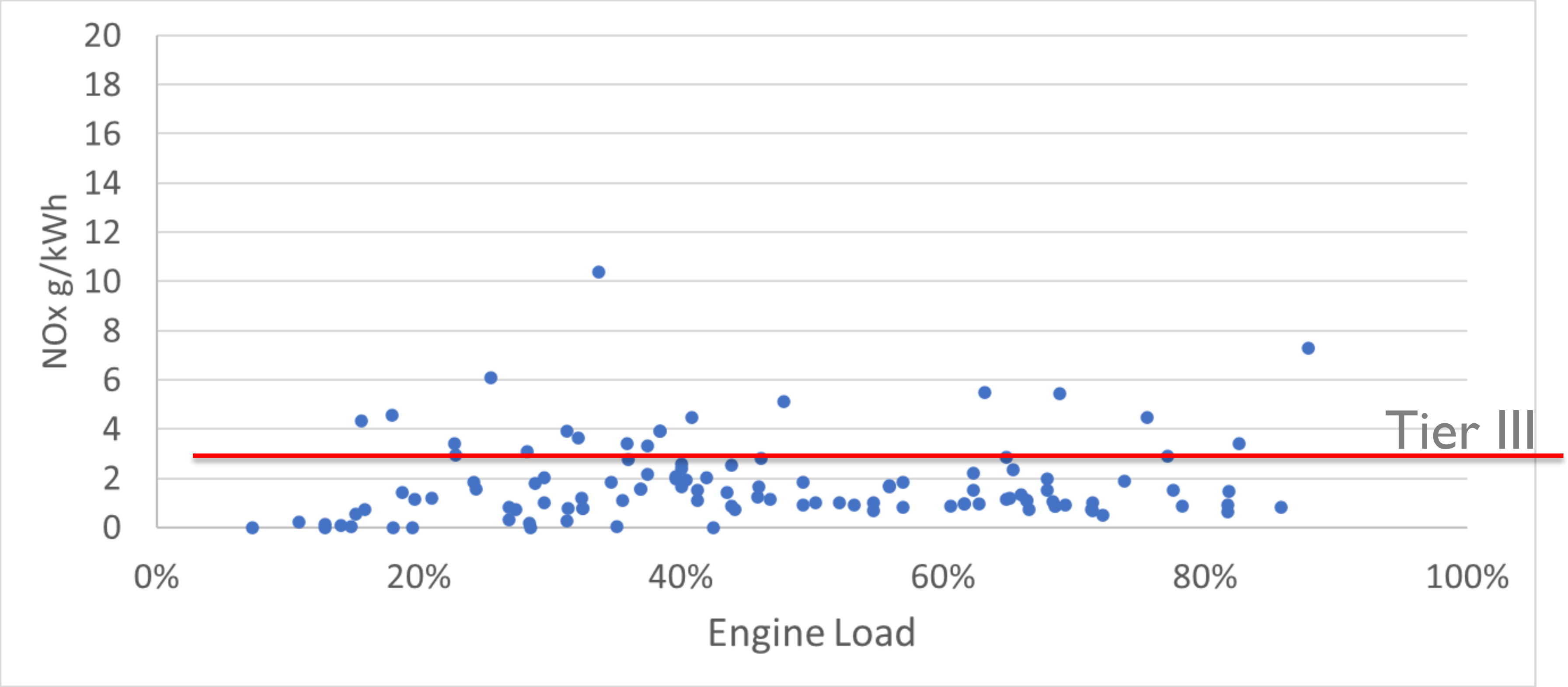
Tier III ships, at different sites (Scipper D 5.5)

Remote fixed measurements Great Belt bridge (Chalmers), Hamburg (BSH) Rotterdam (TNO) and by airborne measurements in Danish and French waters (Explicit). Many of the ships exceed the Tier III limit by more than 50%. Here LNG carriers were not included.



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement Nr.814893

Tier III LNG ships (4 stroke) at Great Belt bridge



Example of Tier III LNG ships built in 2023 (LPDF4)

Low pressure
Duel fuel
4 stroke engine
500 RPM

These ships generally fulfil the Tier III limit. Similar measurements of two stroke LNG ships showed higher frequency of high emitters, possibly due to use of other fuel.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement Nr.814893

Some Conclusions Scipper

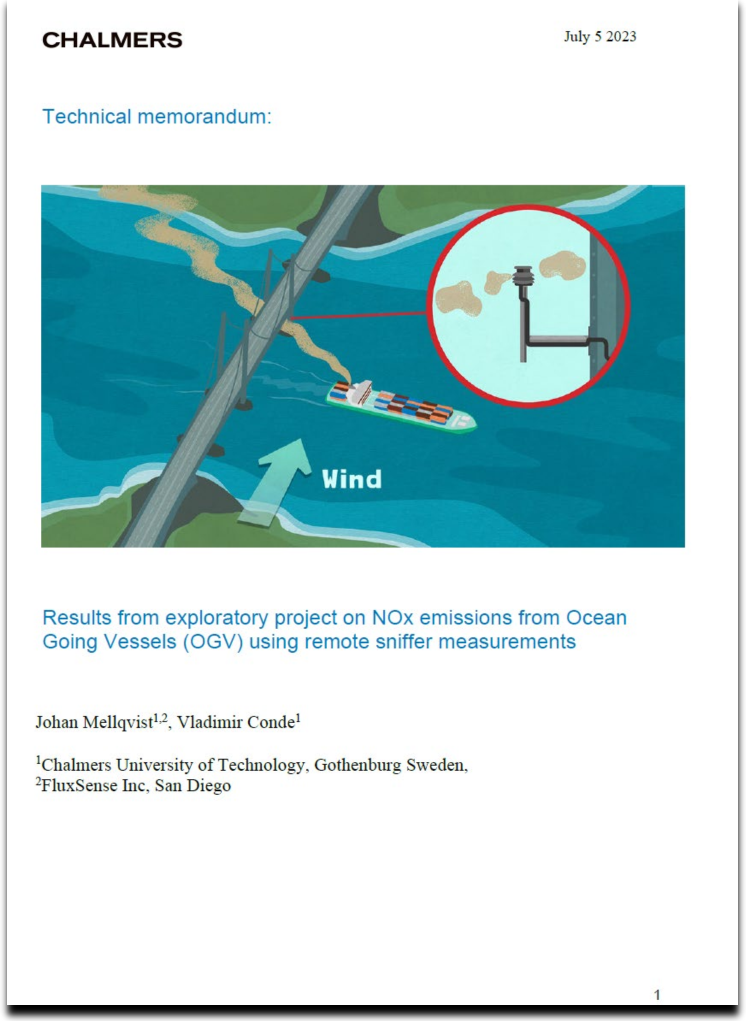
- The uncertainty in remote measurements of Fuel Sulfur Content (FSC) varies from 0.03% to 0.14% S m/m at a level of 0.1% FSC.
- A negative bias ranging from 20-30% in FSC has been noted, which is linked to relative humidity.
- The uncertainty for remote NOx emissions (gNOx/kg fuel) appears to be 15-40%, while for gNOx/kWh, it ranges from 20-45%.
- The uncertainty associated with NO_x allows for the detection of 50% exceedances, compared to NOx technical code for individual vessels, and we suggest amendments to IMO legislation to incorporate a Not-to-exceed limit at any engine load.
- For Tier I & II vessels, NOx emissions remain relatively stable above a 50% engine load.
- In the case of Tier III vessels, notable NOx exceedances have been recorded.
- Reliable Specific Fuel Oil Consumption (SFOC) data is essential for accurate emission evaluations and could be enhanced through AIS-reported data from shipping companies.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement Nr.814893

Project 2: NOx Emissions from Ships at Different Engine Loads (SCAQMD project 2023)

Based on six years of remote sniffer measurements at the Great Belt Bridge, Denmark, mass- and brake-specific NOx emissions were analyzed for 721 container ships, 425 RoRo vessels, 127 reefers, and 892 crude oil tankers. These vessel types are highly relevant to those operating in Southern California waters.

Since ships reduce speed near the Great Belt Bridge, the operational profiles closely resemble those in Southern California, where programs encourage voluntary speed reductions to minimize emission.


CHALMERS

July 5 2023

Technical memorandum:

Results from exploratory project on NOx emissions from Ocean Going Vessels (OGV) using remote sniffer measurements

Johan Mellqvist[1,2], Vladimir Conde[1]

[1]Chalmers University of Technology, Gothenburg Sweden,
[2]FluxSense Inc, San Diego

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Report available on SCAQMD webpage

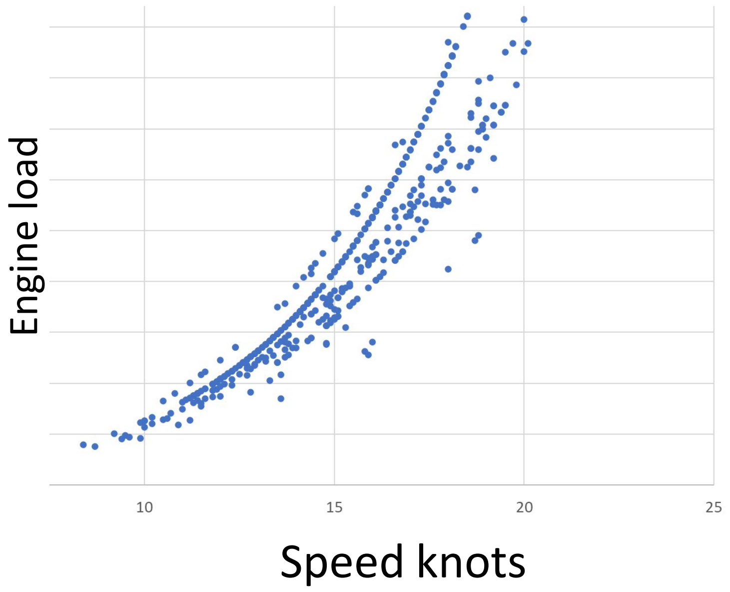
Measurements taken with a sniffer in the eastern pylon of the Great Belt Bridge (red). The data set includes 12,300 ship observations, and this corresponds to 5,300 individual ships.

Calculating Brake specific NOx emission (g/kWh) from Emission factor (g/kg$_{fuel}$)

$$EF_{NOx}\left(\frac{g}{kWh}\right) = SFOC \cdot EF_{NOx}\left(\frac{g}{kgfuel}\right)$$

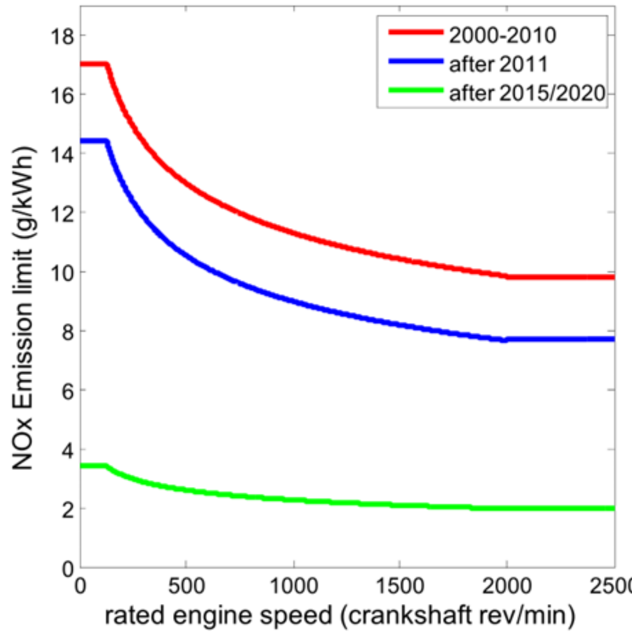
$$SFOC = SFOC_{base} \cdot (0.455 \cdot EL - 0.710 \cdot EL + 1.280)$$

- Engine load (EL in %) calculated from FMI STEAM model (Hollenbach (1998), See graph for Tier II container ships
- SFOC (kg$_{fuel}$/kWh) calculated using formula and SFOC$_{base}$ parameters in IMO 4th greenhouse study.

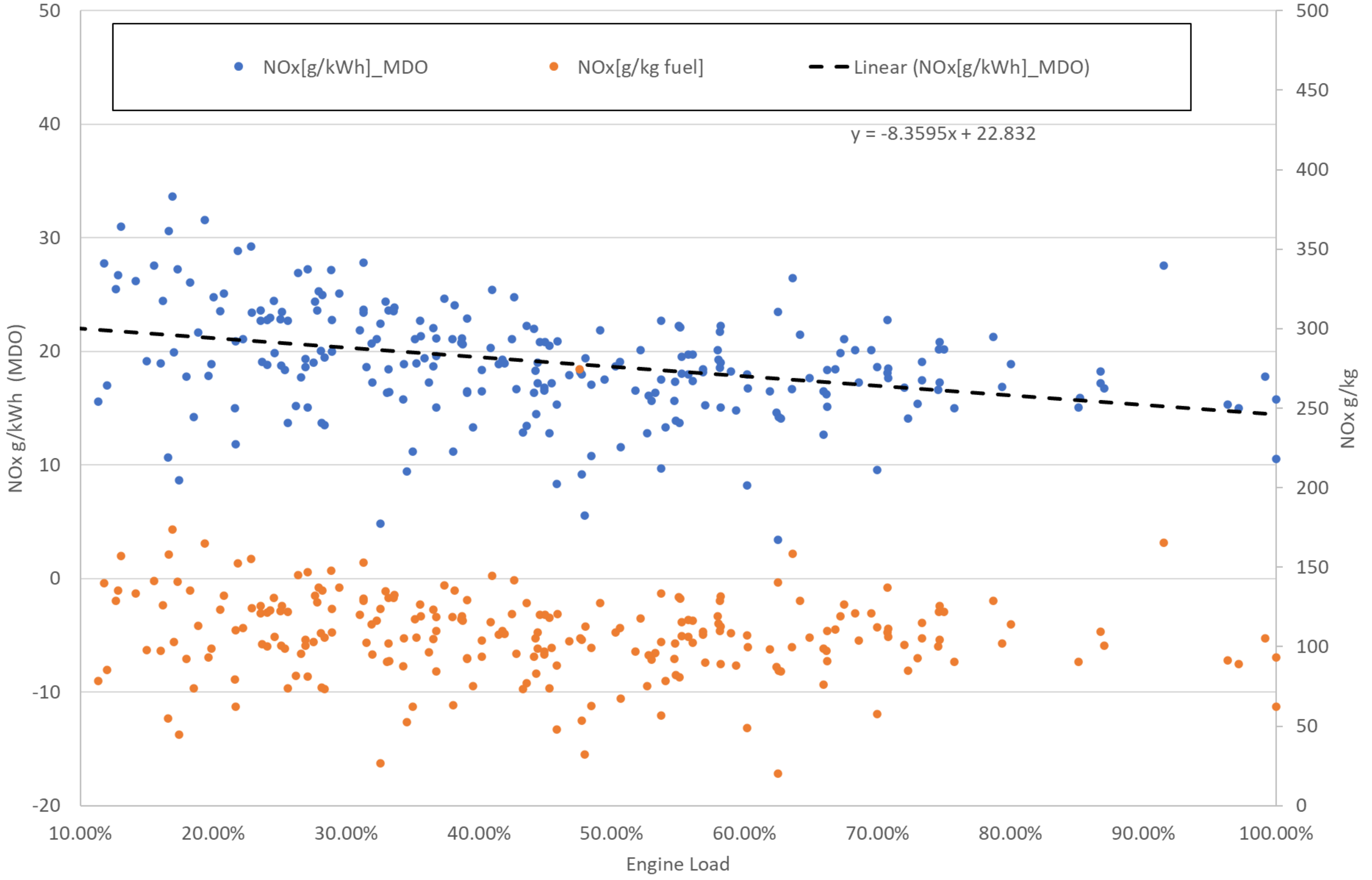


- Note that the IMO regulations corresponds to an average between 4 different engine loads (P=25 %, 50 %, 75 %,100 %) **and it is weighted towards engine loads of (75%) (>50%.)**

$$E_{avg}\left(\frac{g}{kWh}\right) = \frac{\sum_{i=1}^{n} E_i\left(\frac{g}{kWh}\right) \cdot P_{rel,i}(kW) \cdot wf_i}{\sum_{i=1}^{n} P_{rel,i}(kW) \cdot wf_i}$$

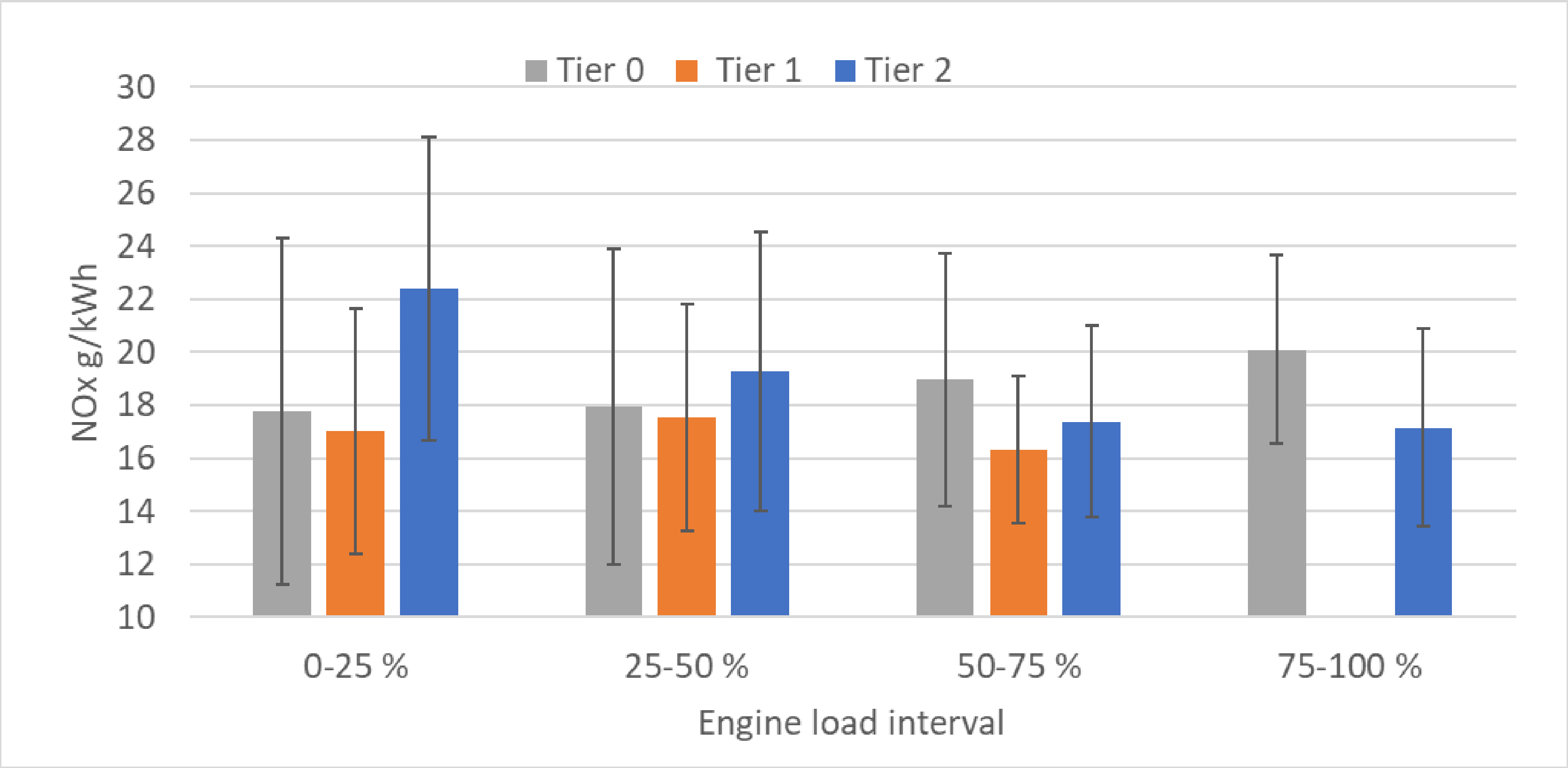


Tier II Container ships, at Great Belt bridge



- Year 2018-2023.
- Tier II container ships
- Engine power> 20,000 kW
- Lengths > 200 m.
- # ships 248 ships.
- Note that Fuel-mass specific emission (g/kg_{fuel}) (orange) has relatively little dependence on engine load, while the brake specific emission g/kWh) (blue) has more dependence. Due to SFOC dependence on load

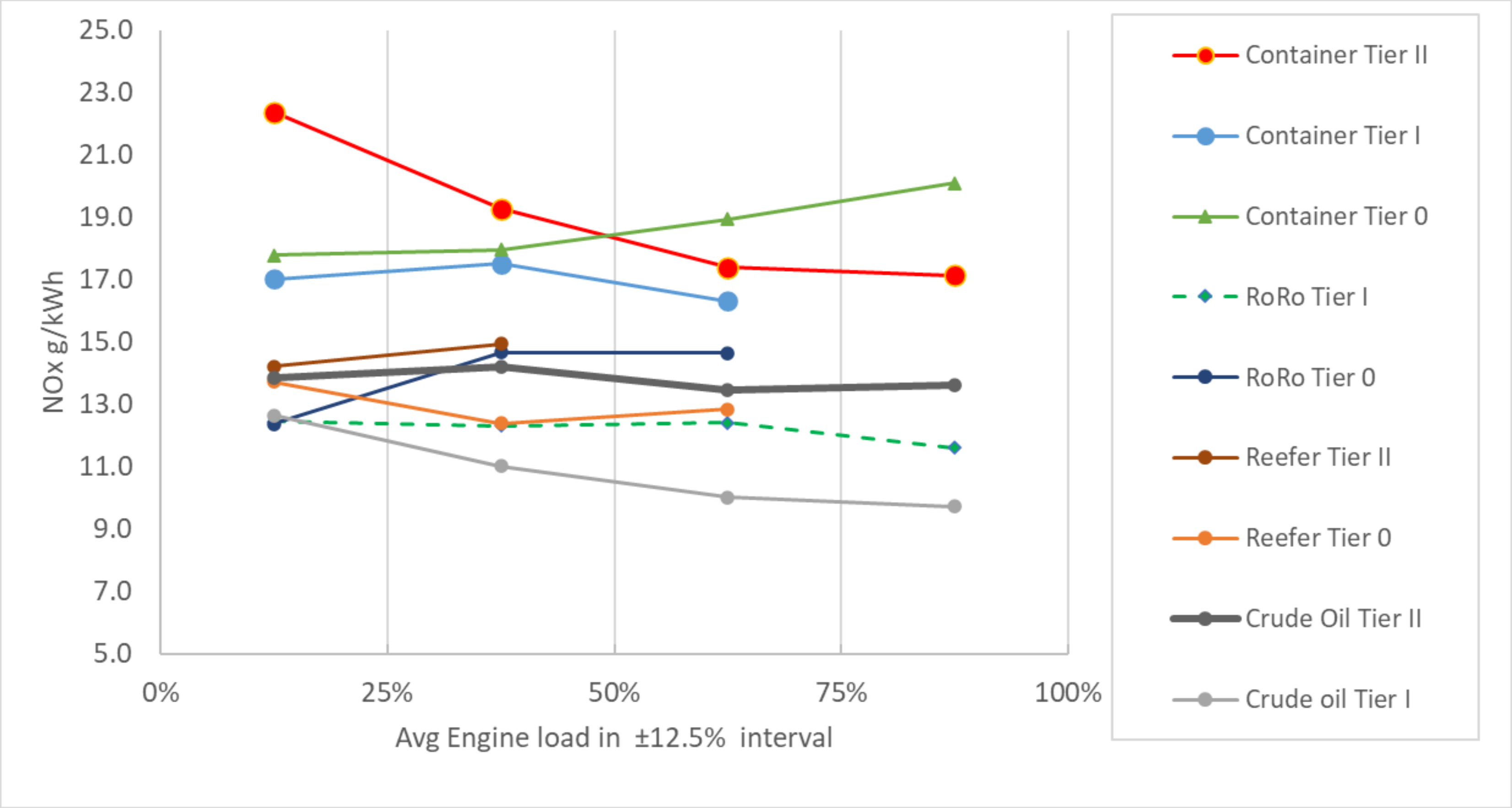
Container ships at Great Belt bridge versus Engine Load , Tier 0,1 and II



Averages of the Brake specific NO_x emissions versus engine load of Tier 0, Tier I and Tier II container ships at Great Belt.

- >200 ships/Tier
- Note that Tier II ships have considerably higher emissions at low loads.
- This is of relevance for slow steaming incentive programs such in California.
- Similar results shown by others (Explicit, Van Roy).

Various vessels types versusu engine load and Tier at the Great Belt bridge



- Averages of the brake specific NO_x emissions versus engine load of different ships at Great Belt.
- 721 container ships, 425 RoRo vessels, 127 Reefers , 892 Crude oil tankers and 370 LNG carriers
- Different dependencies on engine load but above 50% more constant .
- Measurements shows that the Tier II container emissions are above the IMO limit of 14.7 g/kWh (needs more quality assurance)

Conclusion long term measurements of real traffic

Lower Emission Factors in Specific Ship Types:
Reefers, RoRo vessels, and crude oil tankers exhibit considerably lower average emission factors (Eavg) compared to container ships.

Tier II Container Ships & Low-Load Emissions:
While these ships are designed to minimize emissions at high engine loads, NOx emissions tend to rise significantly at lower loads. It is noteworthy that IMO regulations do not address emissions that occur below 25% engine load, a condition that many ships frequently encounter while operating near ports.

Concerns Regarding Vessel Speed Reduction (VSR) Programs: In nearshore lanes, vessels often operate at low engine loads, which can lead to increased NOx emissions. This may be of concern for NOx reductions from VSR initiatives.

Updates to IMO NOx technical code: Suggestion to adjust emission limits to account for low-load emissions in evaluations and broadening certification processes to encompass emissions recorded below 25% engine load. Make possible remote compliance monitoring by including not-.to-exceed limits and requirements to report SFOC via AIS.

Related Papers

Beecken, J., Weigelt, A., Griesel, S., Mellqvist, J., Conde Jacobo, A., van Dinther, D., Duyzer, J., Knudsen, J., Knudsen, B., & Ntziachristos, L. (2023). Performance assessment of state-of-the-art and novel methods for remote compliance monitoring of sulfur emissions from shipping. *Atmospheric Measurement Techniques*, *16*(23), 5883-5895. https://doi.org/10.5194/amt-16-5883-2023

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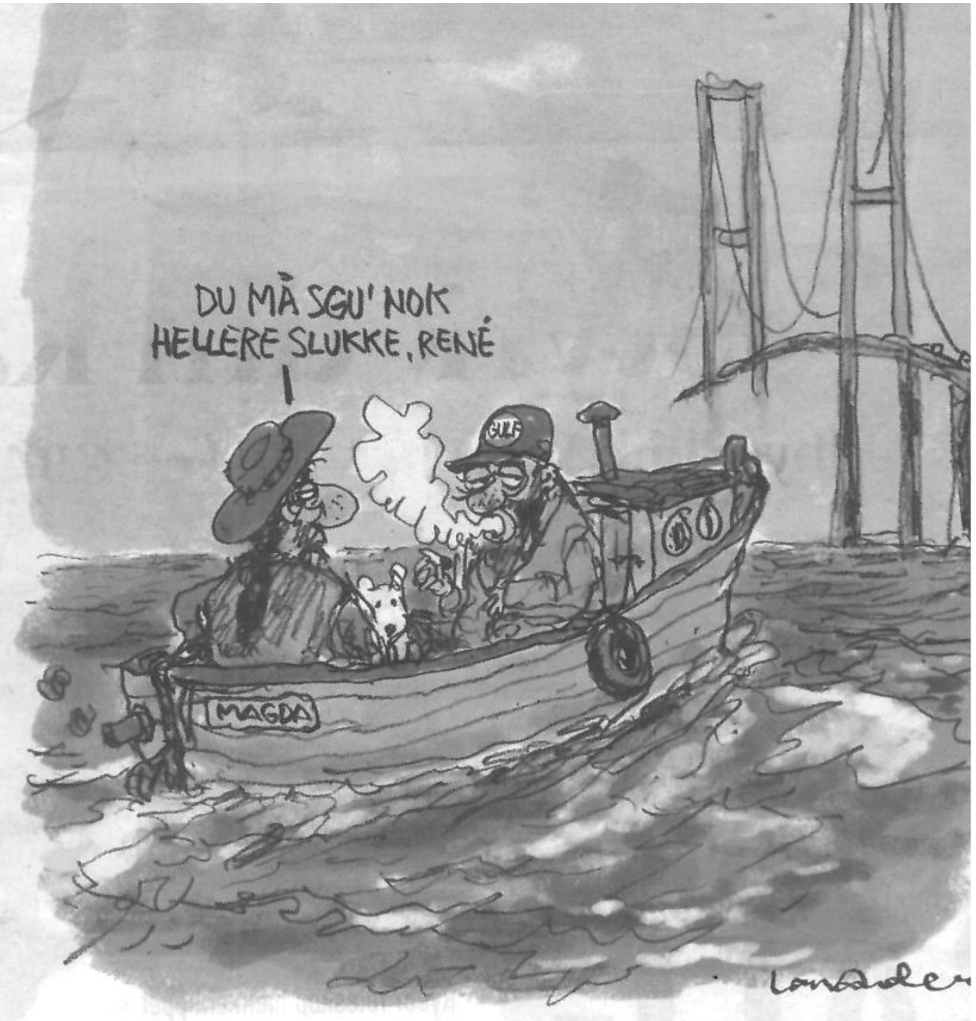
Thanks.

The National Danish newspaper "Berlingske tider" reported in 2016:

The remote sniffer measurements are making quite an impression in 2016 in

We're passing the Chalmers ship emission sensor ("sniffer") , you'd better put away your cigarette!!

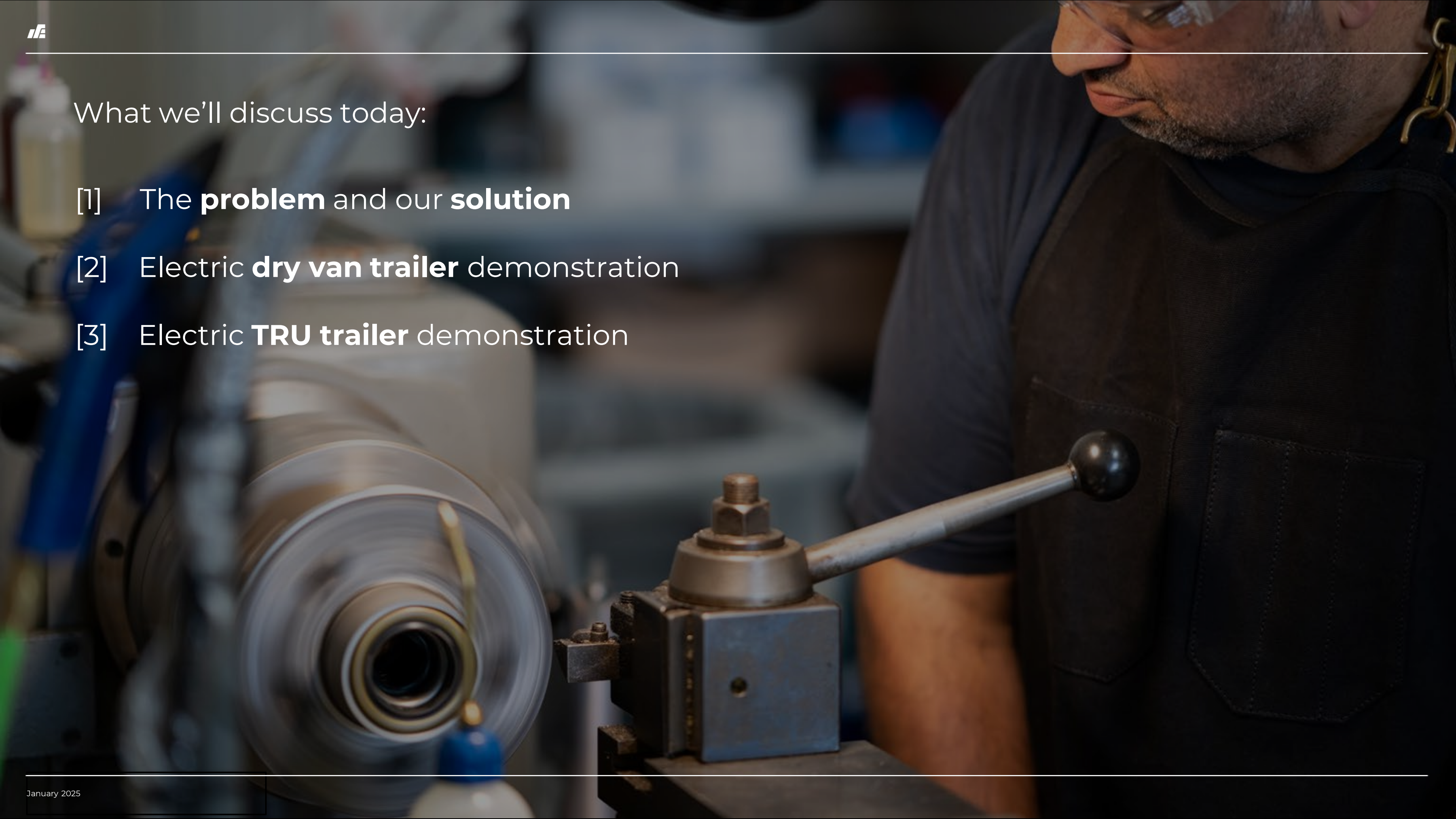


RØGALARM. Storebæltsbroen har fået en "næse", så man kan kontrollere, om skibe bruger ulovligt brænd

range

January 2025

Practical Electrification of Heavy-Duty Fleets with Range Energy Electric-Powered Trailer



What we'll discuss today:

[1] The **problem** and our **solution**

[2] Electric **dry van trailer** demonstration

[3] Electric **TRU trailer** demonstration

The **problem**:

Transportation contributes **over 25%** of greenhouse gas emissions from fossil fuel consumption. And, that number is **rising**.*

*U.S. Environmental Protection Agency, Inventory of U.S. Greenhouse Gas Emissions and Sinks 1990-2022 (https://www.epa.gov/system/files/documents/2024-04/us-ghg-inventory-2024-main-text_04-18-2024.pdf)

Our **solution**:

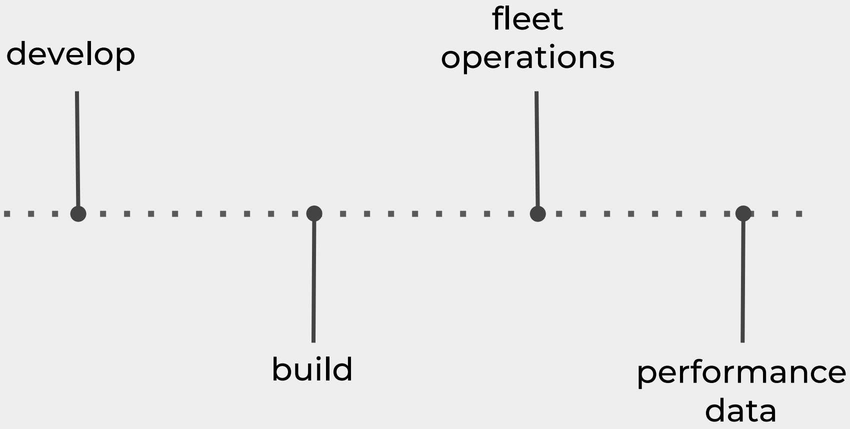
Electric trailer technologies are a practical way to reduce **diesel consumption** and **emissions**, significantly.

They can easily be used now **with in-use tractors** and **no significant charging infrastructure upgrades**.

It’s electric.

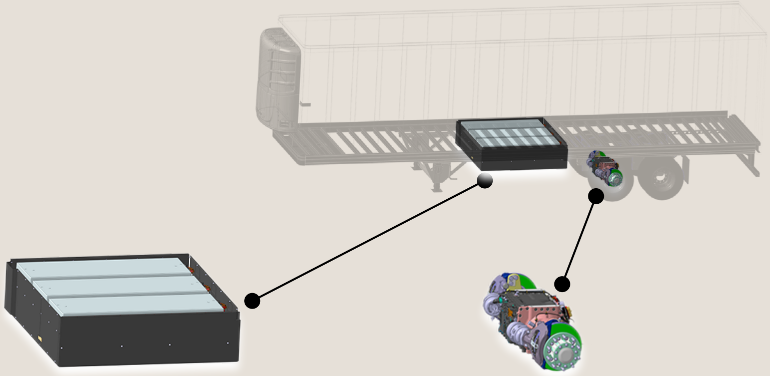
Validating our solution by partnering with the Clean Fuels Program on an **electric dry van trailer** demonstration

South Coast
AQMD



Develop + Build

Electric dry van trailer



Energy Module
192 kWh battery
to power eAxle

Drive Module
250 kW eAxle for
propulsion and
regenerative braking

Fleet operations

Charging

- Partnered with a major beverage distribution fleet in Downey, California to demonstrate our electric dry van trailer in real-world operations.
- Trailer duty cycles allow for charging overnight or while waiting to be loaded.
- Longer charging windows also allow for use of on-site power, avoiding costly infrastructure upgrades. We used an existing 480V 3-phase 30A connection to charge.

Required Charge Rate (kW)
Given a Desired Charge Window / Use Case for Charging

Example EV	Battery Size (kWh)	Fast Charging	Dock Charging		Charging While Staging		Overnight Yard Charging		Multi-Day Idle Charging	
		0.5 hrs	1.00 hrs	2.0 hrs	4.0 hrs	6.0 hrs	8.0 hrs	12.0 hrs	24.0 hrs	36.0 hrs
Passenger Car EV	100	170	85	43	21	14	11	7	4	2
Light Duty Truck EV	150	255	128	64	32	21	16	11	5	4
Orange Terminal Tractor	180	306	153	77	38	26	19	13	6	4
Range Trailer (Standard)	192	326	163	82	41	27	20	14	7	5
Range Trailer (Large)	288	490	245	122	61	41	31	20	10	7
Kenworth T680E	396	673	337	168	84	56	42	28	14	9
BYD 8TT Standard	422	717	359	179	90	60	45	30	15	10
Freightliner eCascadia	475	808	404	202	101	67	50	34	17	11
BYD 8TT Extended	563	957	479	239	120	80	60	40	20	13
Nikola TRE BEV	733	1,246	623	312	156	104	78	52	26	17
Tesla Semi	1,000	1,700	850	425	213	142	106	71	35	24

Charge times shown for 10-95% SOC, with constant-current charge rates

Charging Type & Charge Rates:
AC Slow (7.2kW)
AC Mid (15 kW)
AC Max (19.2 kW)
AC 3-phase (22 kW)
AC 3-phase (44 kW)
DC Slow (50 kW)
DC Mid (100 kW)
DC Fast (150 kW)
DC Fast (360 kW)
DC Fast (400 kW)
MCS (1000 kW)
MCS (+1 MW)

Performance

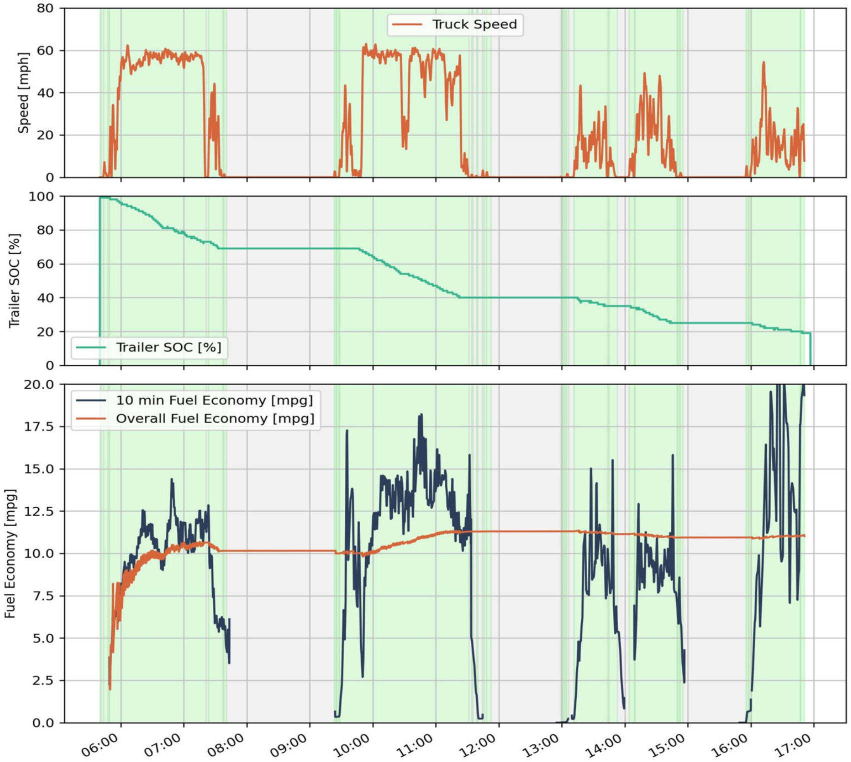
Summary of 4-week fleet demonstration of our electric dry van trailer

Route length	**25 to 246 miles**
Payload	**26,000 to 42,300 lbs**
Tractor fuel efficiency Across all miles traveled	**8.8 to 13.2 mpg**
Overall mpg gains Baseline fleet mpg 7.28	**21 to 81%**

Our electric dry van trailer delivered meaningful fuel savings with minimal to no disruptions to operations and no major infrastructure upgrades, making it a practical solution for heavy-duty fleets to reduce emissions.

Performance

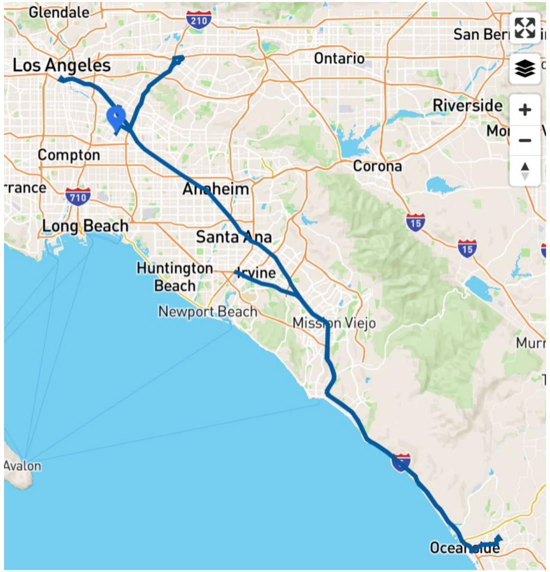
Sample day: Downey > Oceanside > DTLA > Industry



distance: 209.4 mi
duration: 6.6 hrs
diesel fuel used: 19 gal
diesel MPG: 11
battery energy used: 169.6 kWh

payload / leg:
[Leg 1] 38.5k lbs, 20 pallets (cans)
[Leg 2] 15k+ lbs (dunnage + waste)
[Leg 3] 40k+ lbs, 25 pallets (bottles)

93k lbs total payload



Performance

Tractor emissions

- UC Riverside CE-CERT installed OSAR units on fleet tractors to measure PM and NOx.

- Our electric dry van trailer significantly reduced PM and NOx emissions.
  PM: 44% reduction at lower speeds.
  NOx: 53% reduction at lower speeds.

- These are preliminary findings. UCR and Range Energy continue to analyze the emissions data.

Estimated NOx reduction		km/hr			
Engine Load	~0	0-16	16-40	40-64	>64
<25%		-35%	-39%	-10%	-12%
25%-50%	-6%	-53%	-51%	-11%	-13%
>50%		-52%	-33%	-20%	-33%
Estimated PM reduction		**km/hr**			
Engine Load	~0	0-16	16-40	40-64	>64
<25%		-23%	-39%	-42%	-51%
25%-50%	-15%	-37%	-43%	-31%	-44%
>50%		-44%	-41%	-50%	-44%

What's next?

Electric TRU trailer demonstration

- In 2022, CARB highlighted the **emissions reduction potential** of **electric TRU trailers** with range-extending technologies, like regen braking and axle generation, while also noting **challenges** in charging availability and economic and operational feasibility.*

- Since 2022, trailer technologies have **improved**, and our electric TRU trailer can **demonstrate the benefits** and **address the challenges** noted by CARB.

- We plan to team up with **large fleets**, **Thermo King**, **South Coast AQMD**, **Valley Air**, and **AB617 communities** to conduct an end-to-end assessment of operating our electric TRU trailer, validating that it makes sense for fleets and the community.

*2022 California Air Resources Board TRU Technology Assessment (https://ww2.arb.ca.gov/sites/default/files/2022-10/CARB%202022%20TRU%20Technology%20Assessment%2010-14-22.pdf).

Questions

Thank you

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joonsik@range.energy

Commercial Advancement of Mobile Fuel Cell Generators

Jurgen Schulte, Dr. Paul Scott, and Michael Simon
RockeTruck, Inc.

Presentation for AQMD 2025 Retreat
January 30, 2025

RockeTruck gratefully acknowledges the financial support received for its Mobile Fuel Cell Generator project from the California Energy Commission, Unites States Department of Energy, South Coast Air Quality Management District, and Southern California Gas Company. The findings and opinions contained in this presentation are solely those of RockeTruck, Inc.

TOPICS TO BE COVERED

- Mobile generator applications
- “Mobile Fuel Cell Generator” (MFCG) project goals and approach
- Technical Description of Mobile Fuel Cell Generator (“MFCG”)
- Plans for MFCG field demonstrations and commercialization

MOBILE GENERATOR APPLICATIONS

- **Temporary uses where grid power is unavailable**
  - Powering tools at construction sites
  - Powering light stands at outdoor entertainment venues
  - Delivering power for other outdoor activities (e.g., camping)
- **Permanent off-grid applications**
  - Powering remote research facilities
  - Powering off-grid communities
- **Back-up power during grid power outages (focus on wildfires)**
  - Power fixed facilities or portable devices during planned outages
  - Standby backup power during unplanned outages

MOBILE FUEL CELL GENERATOR (MFCG)

- **Initial MFCG funding ($3M) from California Energy Commission's "Mobile Renewable Backup Power System" (MORBUGs) program in February 2022**
    - Sustainable backup power option for larger applications (35 kW)
    - Focus on emergency backup power and delivering power in remote areas
    - Reduce emissions and dependency on fossil fuels
- **Follow-on funding (Total ~$2M to date)**
    - U.S. Department of Energy (DOE) – Small Business Technology Transfer (STTR) grant – Phase I in June 2022, Phase II in August 2023
    - South Coast AQMD – Commercial Advancement of MFCG, August 2023
    - Southern California Gas Co. – Advancement of "Integration and Controls" technologies, August 2024

MFCG PROJECT APPROACH

- **Initial CEC goal: proof-of-concept of using fuel cells in mobile generators**
  - Deliver 110 VAC power to recharge critical devices
  - Large hydrogen supply to deliver higher power (35 kW) for 48 hours
  - Build two prototypes and validate them in field testing

- **Emphasis on <u>commercial viability</u> grew as experience was gained and new funding partners influenced the project:**
  - More power delivery options (e.g., 208/480V three-phase power)
  - Reduced manufacturing cost
  - Smaller, more portable design – practical alternative to diesel generator

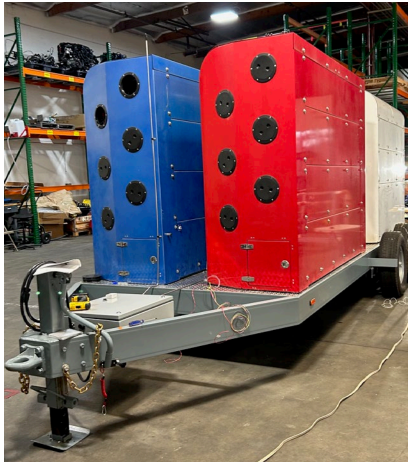
PROJECT HIGHLIGHTS

- **Generator #1**
  - Developed custom trailer to carry generator and 94 kg hydrogen supply
  - Power output upgraded to 208 VAC three-phase (in addition to 110V)
  - Lab testing has validated basic proof-of-concept
- **Generator #2**
  - First such system to use new generation fuel cell (Honda)
  - Design modified to separate generator from hydrogen supply
  - Significantly larger battery pack
  - Design will evolve to accommodate advanced power conversion technologies

A TALE OF TWO PROTOTYPES

Generator #1

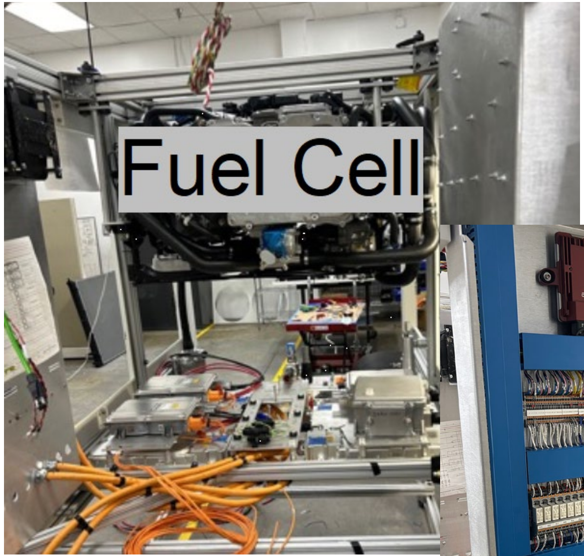
- Fuel cell and hydrogen tanks (94 kg capacity) integrated onto one trailer
- Delivers 35 kW for ~32 hours
- Weight: ~13,000 lb.
- Must be towed by a driver with a Class A commercial driver license

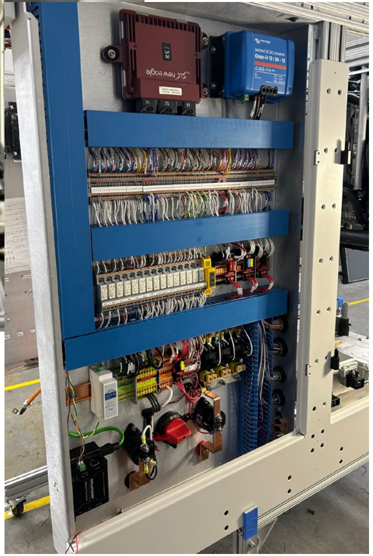


Generator #2

- Fuel cell integrated with one 4.5 kg hydrogen tank
- Delivers 10 kW for ~8 hours
- Weight: ~3,000 lb. – can be transported in the bed of a pickup truck driven by any licensed driver
- Separate 130 kg hydrogen tank trailer can be towed along with generator (by commercially licensed driver) to deliver 35 kW for 48 hours

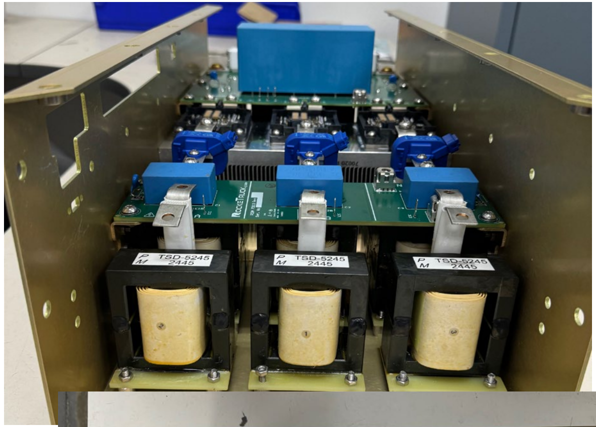
MFCG MINI FEATURES





- Next Generation automotive fuel cell (80 kW)
- One hydrogen storage tank, 4.5 kg capacity @ 5,000 psi
- 70 kWh battery pack (two CATL C-modules, 420V)
- Current inverter: LS Energy Systems solar inverter, 120 kVA @ 480 VDC
- Future inverter: RockeTruck Fuel Cell Integrated Power Electronics Module (“FCIPEM”)
- Aluminum structure

NEW FUEL CELL POWER CONVERTER



Fuel Cell Integrated Power Electronics Module (FCIPEM)

- **Uses new semiconductor technology – gallium nitride (GaN)**
  - More energy efficient
  - Reduces size of filter components and heat sinks
  - Enables reductions in overall size, weight, and cost of fuel cell power conversion
- **Status**
  - Conceptual design funded under DOE Phase I ”STTR” contract (2023-24)
  - First prototype initiated using company funds (mid-2024)
  - Phase II STTR and SoCal Gas funding supporting completion of prototype and eventual demonstration on Generator #2

POTENTIAL IMPACT OF MFCG MINI

- Improved portability, enabled by reducing component size and separating the generator and hydrogen fuel supply
- Lower capital cost, enabled by use of an automotive fuel cell and simplification of system integration
- Lower operational cost, enabled by use of a standard pickup truck for transportation and high efficiency of the fuel cell
- Potential to significantly reduce greenhouse gases by expanding use of hydrogen for portable power generation
- Potential to achieve more equitable energy outcomes by making portable zero-emission power more accessible to remote and lower income communities

FUTURE PLANS

- **Demonstrate Generator #1 in year-round operation in San Diego County mountain and desert regions (2025-2026)**
- **Demonstrate Generator #2 ("MFCG Mini") in three different climate regions in Los Angeles County (2025-2027)**
  - Stand-alone mode, using its integral 4.5 kg hydrogen tank
  - In tandem with large fuel trailer with 131.6 kg capacity to meet CEC 35 kW/48-hour spec
- **Commercialization (2026-)**
  - Upgrade to use advanced power converter technology
  - Pilot manufacturing
  - Marketing and financial initiatives

KEY PROJECT PARTICIPANTS

- **Funding Partners**
  - California Energy Commission
  - South Coast Air Quality Management District
  - U.S. Department of Energy
  - Southern California Gas
- **American Honda Motors**
  - Providing the industry's most advanced fuel cell and valuable technical support
- **California State University, Los Angeles**
  - Support field demonstrations and community outreach
- **San Diego Gas & Electric Company (SDG&E)**
  - Supporting lab testing and field testing in San Diego County
- **Southern California Edison**
  - Supporting lab testing and field testing in Los Angeles region

NOTABLE MFCG PROJECT OUTCOMES

- **Two different mobile generator variants**
  - "All-in-One" system on a custom trailer with 94 kg of hydrogen storage, capable of producing ~5 kW for 32 hours and 50 kW for 28 hours (best current estimates)
  - Flexible system consisting of a small generator that can be used independently for shorter duration applications (4-8 hours) or with auxiliary fuel trailer to meet 35 kW/48-hour spec

- **Numerous subsystem-level advances**
  - Adaptation of advanced automotive fuel cell technology to mobile generator application
  - Incorporation of a high-capacity battery subsystem to increase peak power to 120 kW
  - Advanced fuel cell power converter using GaN semiconductor technology (which will have many additional applications)
  - Sophisticated system control software leveraging major prior investments

- **Significant progress toward commercialization**
  - Extensive market research
  - Detailed production planning
  - Development of a product video and other marketing tools

KEY ISSUES

- **"Green Hydrogen" is a scarce resource**
  - Had to transport Generator #1 to Fresno to refuel
  - Need much more convenient, lower cost accessibility to hydrogen

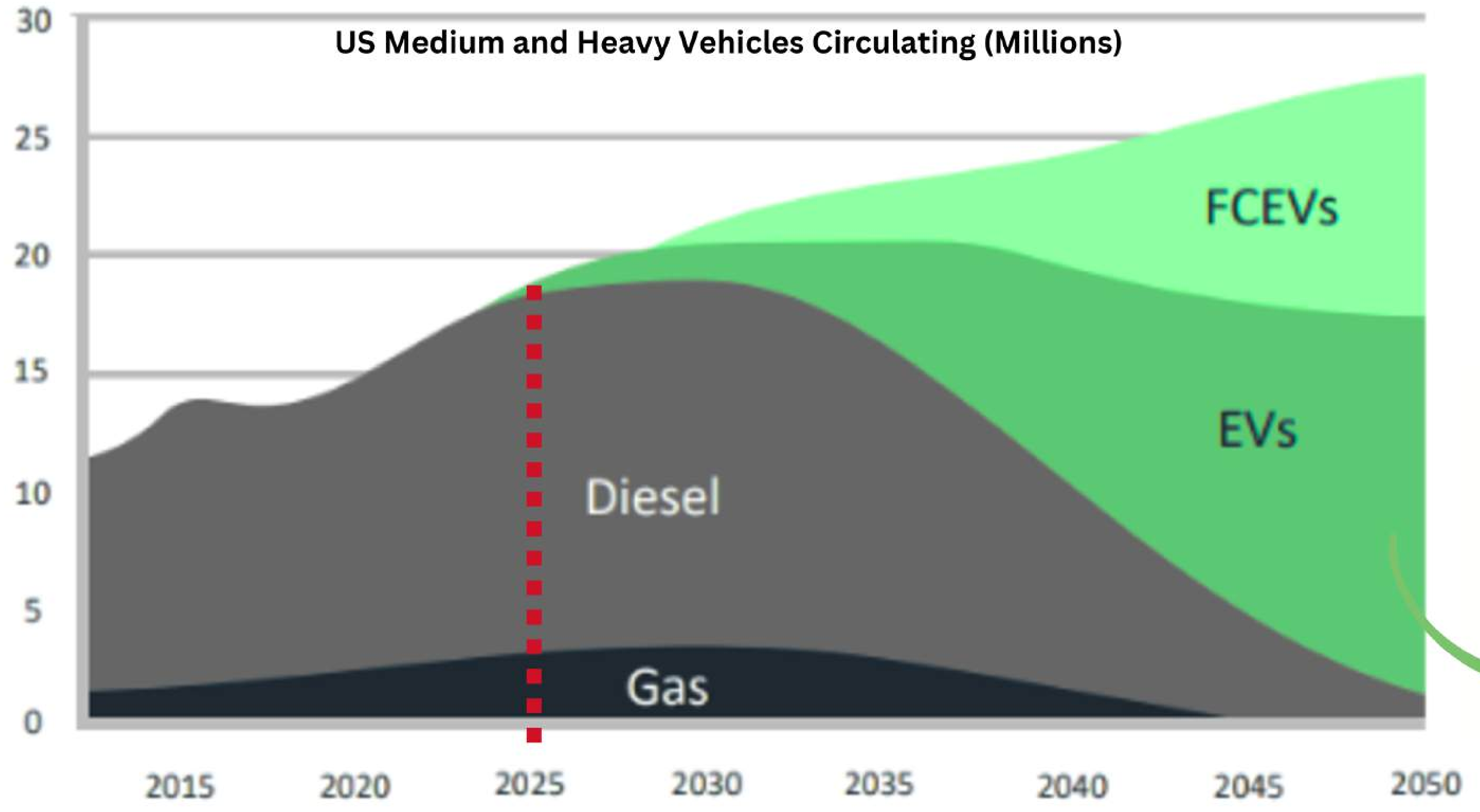
- **Successful commercialization will also require:**
  - *Lower cost fuel cells –* addressed by partnership with Honda
  - *Lower cost hydrogen storage –* partially addressed by decoupling generator from hydrogen tanks
  - *Lower cost generator manufacturing –* addressed with a recent CEC "BRIDGE" proposal and other financing initiatives

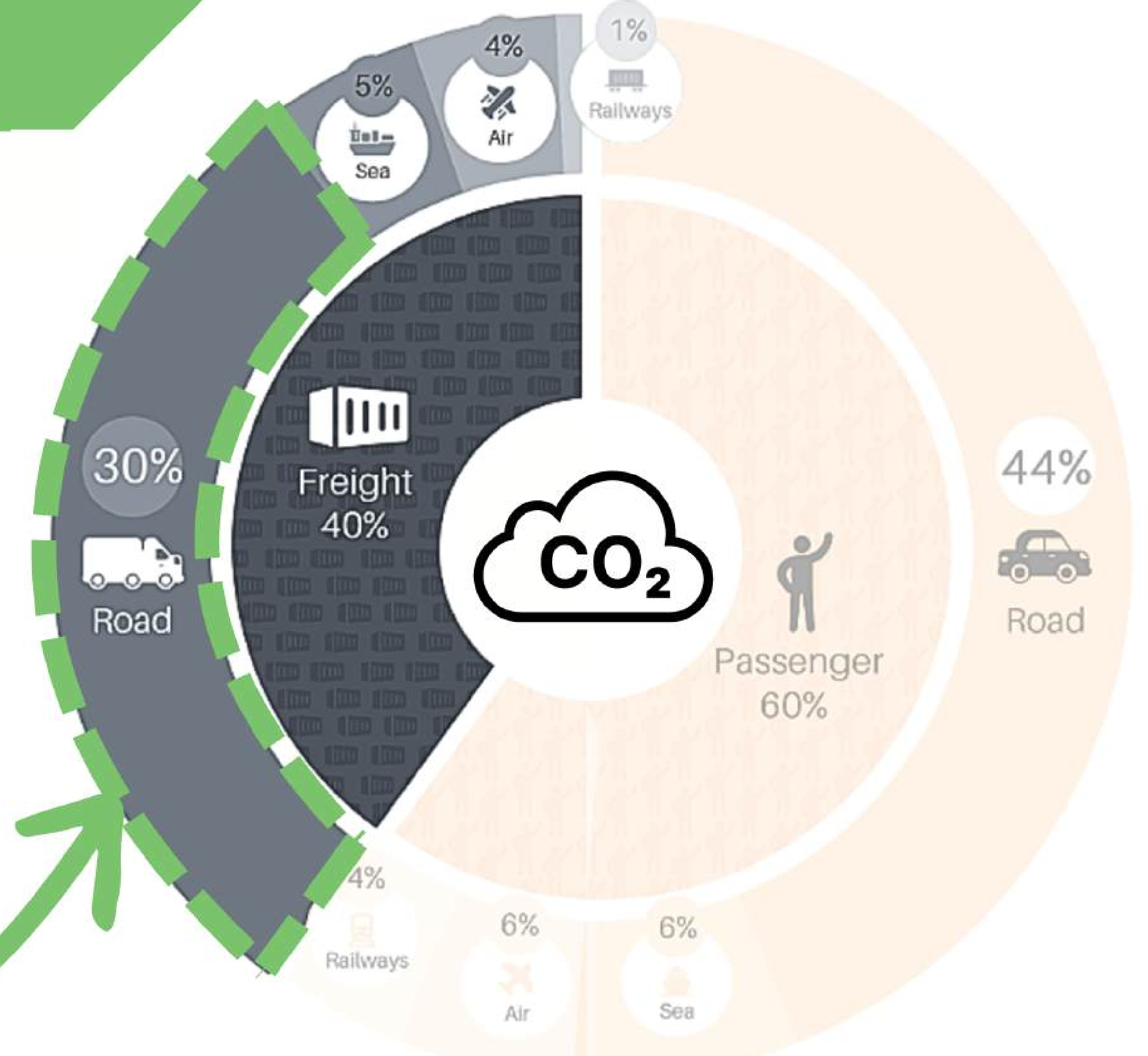
Reducing Commercial Vehicle Emissions Responsibly and Rapidly by Deploying CircularEV™ Solutions

Refreshed and Repowered into 100% Electric & Smart

An Electrifying Growth Moment for Commercial Vehicles

<10% of all vehicles on global roads
>30% of Transportation Emissions





Global Transportation Emissions

Critical and Achievable Target for Global Decarbonization!

Intelligent, Circular Commercial Vehicles

Global Market

335M+ Commercial Vehicles on Today's Roads

Latest Generation Technologies

Compatible with established and popular brands

Network Install Model

Aftermarket partners for Installation & Service

Software-Enabled Ecosystem

Powerful analytics for fleet owners and service partners

CircularEV™ by evolectric

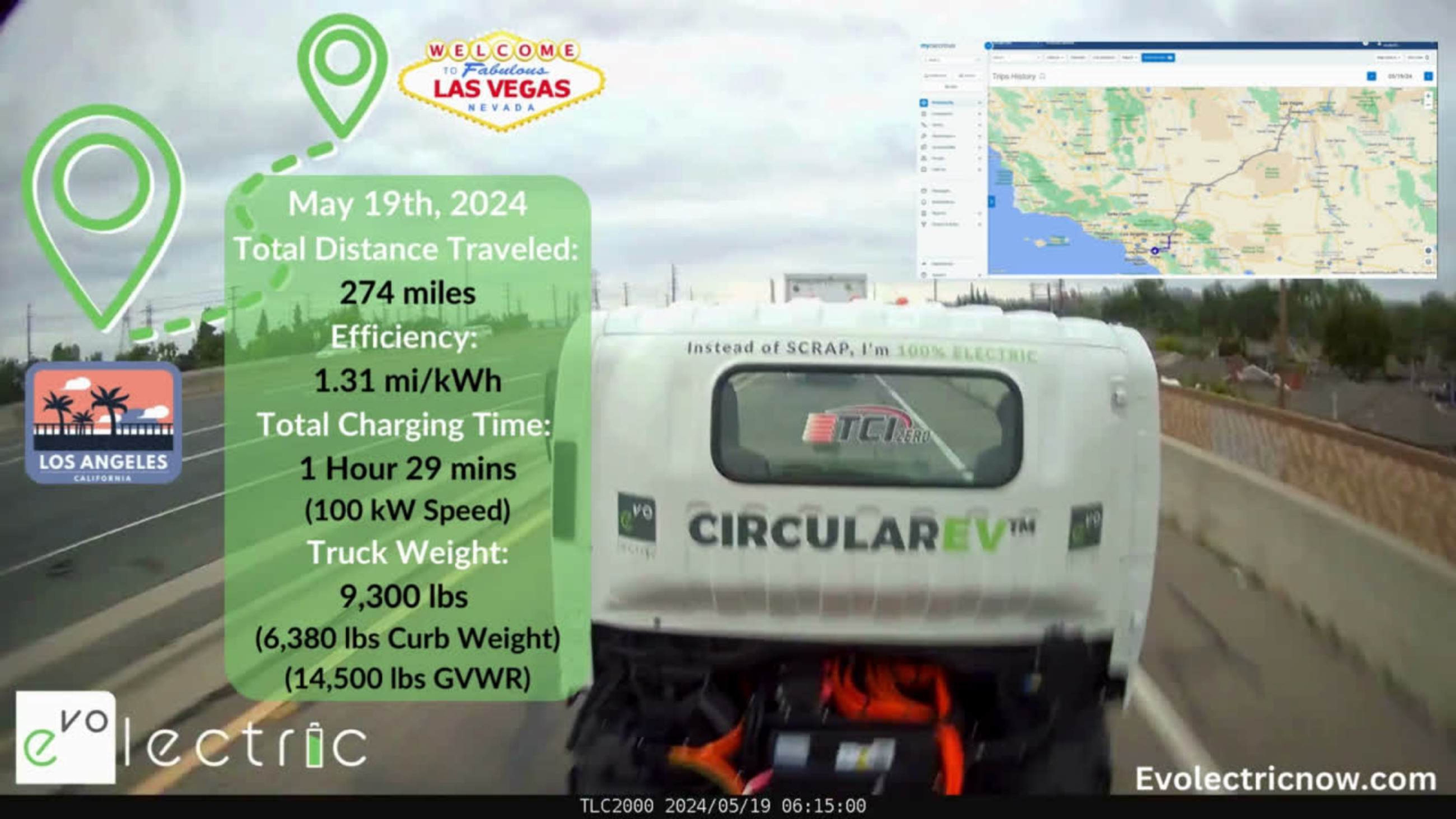
Key Differentiatiors

Up to 45% lower cost
2-Day conversion target

Final/mid-mile focused
Refreshed, Warranty

<u>10+ yrs</u> of extended life
Best in class reliability

Ultra fast-charging
and fleet intelligence


WELCOME
TO Fabulous
LAS VEGAS
NEVADA
May 19th, 2024
Total Distance Traveled:
274 miles
Efficiency:
1.31 mi/kWh
Total Charging Time:
1 Hour 29 mins
(100 kW Speed)
Truck Weight:
9,300 lbs
(6,380 lbs Curb Weight)
(14,500 lbs GVWR)
LOS ANGELES
CALIFORNIA
Trips History
Instead of SCRAP, I'm 100% ELECTRIC
TCI ZERO
CIRCULAREV™
evo electric
Evolectricnow.com
TLC2000 2024/05/19 06:15:00

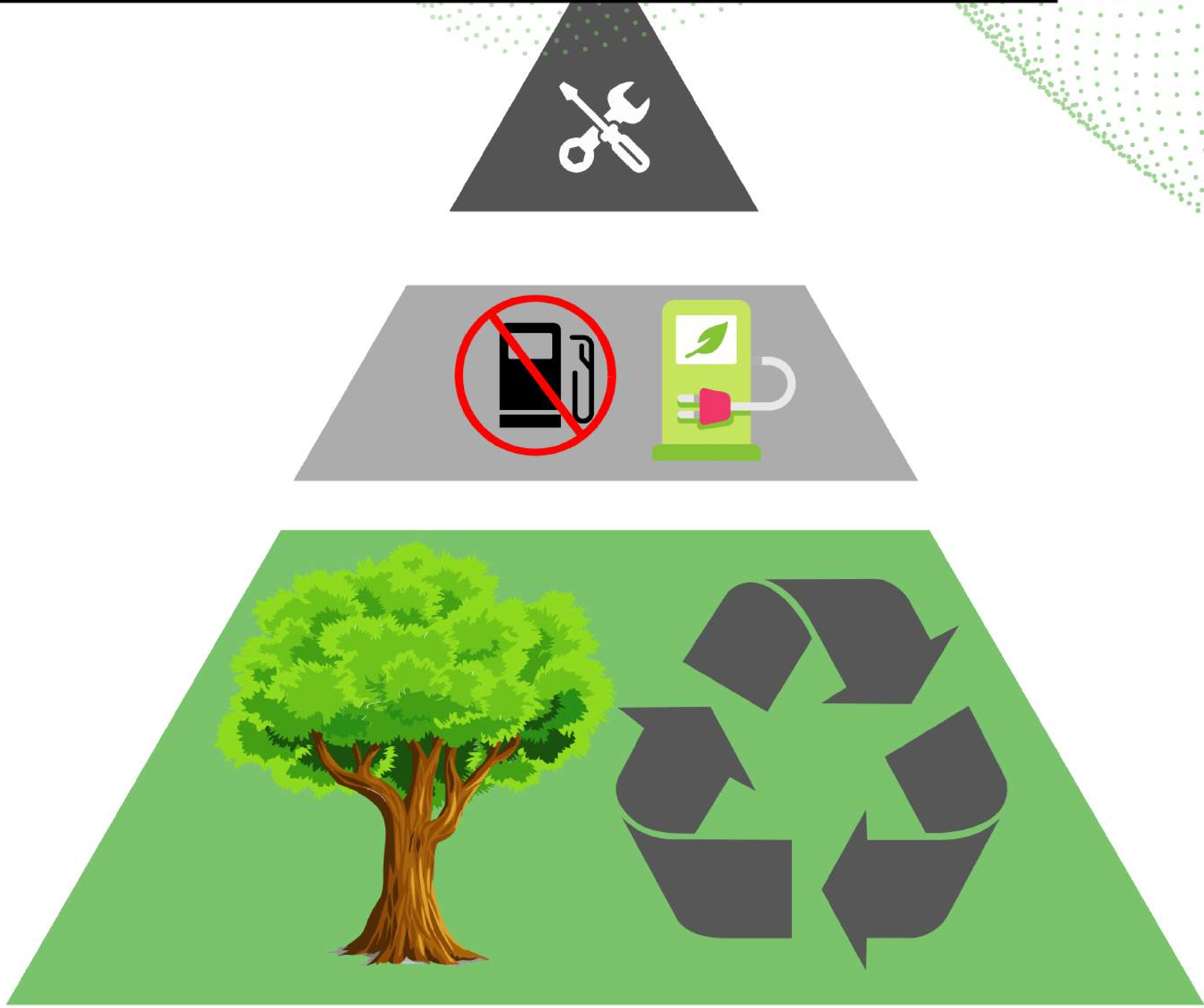
Saving Money AND Reducing Footprint

Maintenance cost
>50% savings

Fuel Costs
>70% savings

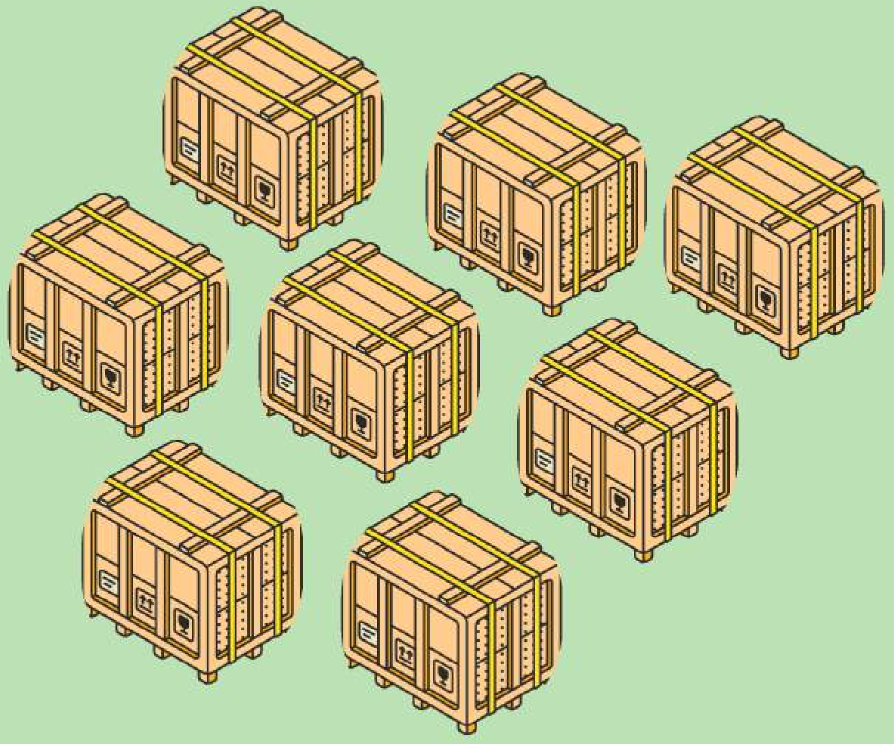
Emissions Avoidance
Up to 50% of the new vehicle's CO2 footprint!

Emmissions Reduction
Equivalent to emissions of 3,793 homes energy usage yearly!

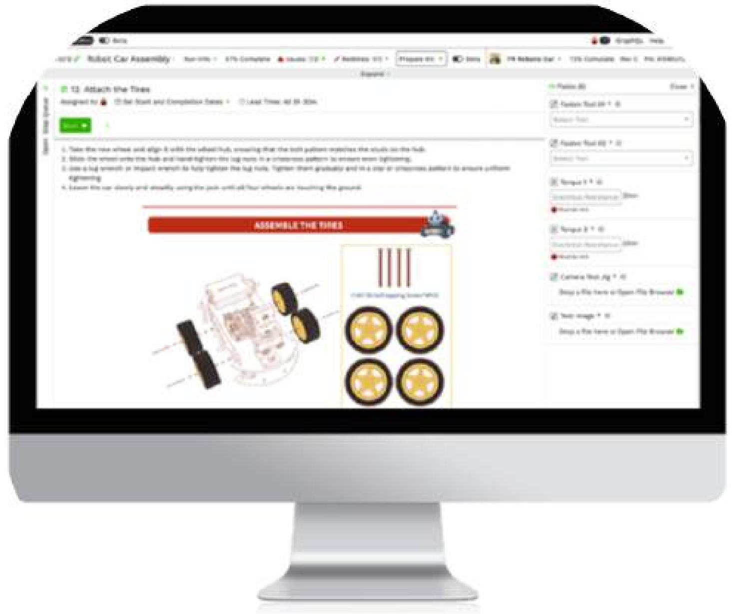


Road to 100,000/Year Vehicles ($8B)

1 Kits-in-a-Crate



2 Cloud Managed Process & Quality



3 Leverage Existing Infrastructure!

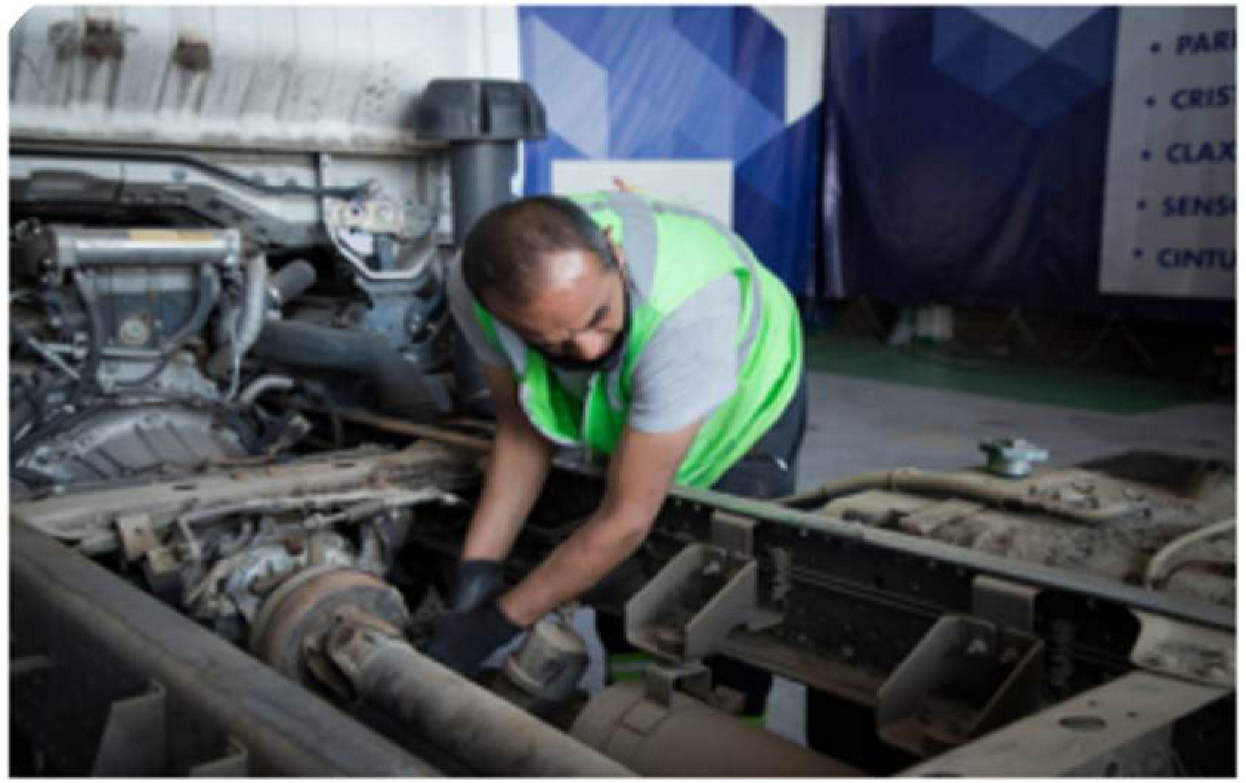
(People, Shops, Equipment)

jiffy lube

BOSCH Service

NAPA TRUCK SERVICE CENTER

PROOF - AbInBev Mexico City - 2023



- **Kit Shipped to Mexico City**
- **Installed inside Customer Service Center**
- **Customer's Service Technicians Involved**
- **Completed in 2 Weeks from Parts Arrival**

Driver/Operator feedback: interviews results

EVOLECTRIC

NPS 78

USERS 9

Scope 🇲🇽

5-Star Rating

Performance in slopes	4,33 ★★★★
Power and Acceleration	4,67 ★★★★★
Absence of engine noise, wind, and road noise	4,56 ★★★★★
Maneuverability in urban traffic	4,78 ★★★★★
Display interaction	4,33 ★★★★
Stability in curves with load	4,56 ★★★★★
Ease of Reading indicators	4,67 ★★★★★
Traction in road conditions	4,67 ★★★★★

Main reason of recommendation:
Comfortable, Good driving

Autonomy
Good

Preferred feature
1. Ease of driving
2. Power
3. Design

Positive aspects vs Diesel:
1. Comfortable
2. Easy to get on an off

Positive aspects vs other EV:
1. Comfortable
2. Size
3. More power
4. Performance

Improvements:
1. Payload
2. Autonomy
3. Power

ABI

Projection to 16,000 km, 50 km traveled daily, 320 days of operation in a year.*

Operator’s insights:

“This is one of the best product that we have experienced, we have around ten different electric brands that they have tried, and this is one of them they have liked the most, so I think that's a lot to say for a vehicle was about to scraped and then became completely new.“
Abdo Bridi – Logistics Innovation Manager.

“Evolectric’s truck is much more stable than an Isuzu diesel truck. ***Its center of gravity is closer to the ground****”* ***Israel Ramirez - Driver***

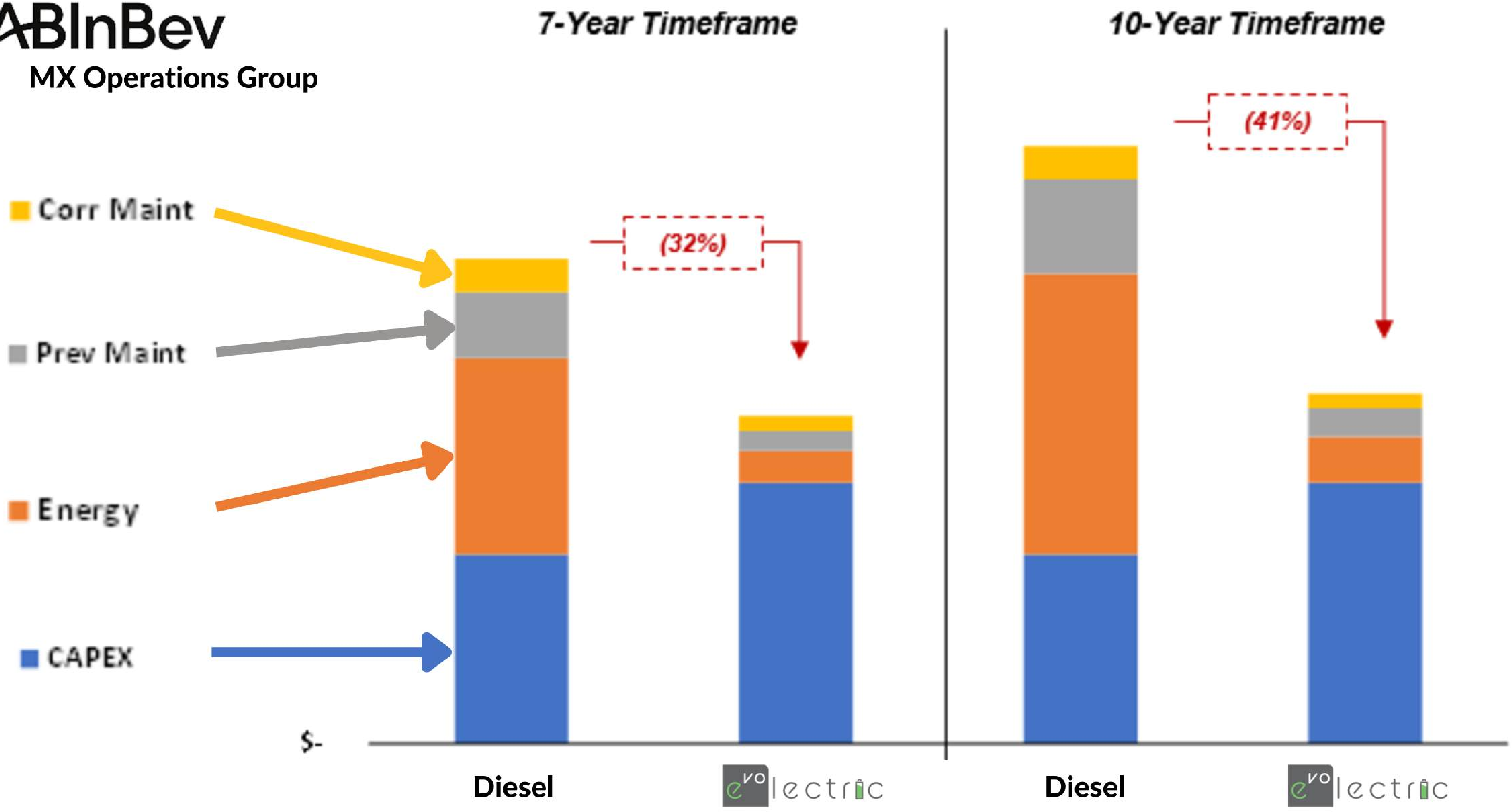
“I was impressed by the ***performance*** *and* ***comfort*** *inside the cabin as well as how the truck* ***looks on the outside*** *after having been in the “junk” for more than two years.”* ***Gustavo Salazar - Operations Manager.***

“It has ***better access for the driver*** *and operators, which is an advantage in terms of* ***ergonomics****.”* ***Héctor Colmenero - Driver***

ABI

Better Total Cost of Ownership (TCO) Vs Diesel

Analysis by
ABInBev
MX Operations Group



US COMMERCIAL VEHICLES
& CIRCULAR EVS POTENTIAL

	Class 3-5	Class 6-7	Class 8
Vehicles on US roads TODAY	11,000,000	5,000,000	2,000,000
New Zero Emissions Vehicle Sales 2023	13,000 (0.12%)	3,000 (0.06%)	1,000 (0.05%)
Annual Vehicle Conversions (Potential)	1,500,000 (8%) Vehicles Per Year		
# of Installers / # of Jobs (Potential)	15,000 Existing Service Centers / 120,000 Green Jobs		
Long-term Average Cost New EV / EV Conversion	$120K / $70K	$250K / $150K	$500K / $250K

Source: Numbers estimated on BloombergNEF and US Department and Bureau of Transportation

Opportunity To Accelerate Class 6/7

Vehicle Lineup - Freightliner M2 (26,000lbs - 33,000lbs GVWR)

Electric Motor, Liquid Cooled	Batteries, Liquid Cooled
Motor Type: Dana TM4	**Total Pack Size:** 210/266 kWh
Max Power: 200-300 kW	**Range:** Up to 160-205 Miles
Max Torque: 3200 Nm	**Cell Type:** Lithium Iron Phosphate (LFP)

Warranty and Useful Life	Charging (CCS1 Combo)
Batteries: 8 years or 200,000 miles	**Level 2 AC Charging:** 19.2 kW (< 10hrs to 90%)
Powertrain: 5 years or 150,000 miles	**Level 3 DC Charging:** 200 kW (< 1.2hr to 90%)
Useful Life Design Target: 500,000 miles	**V2G-Ready for future upgrade/activation**

Performance, Features and Utility

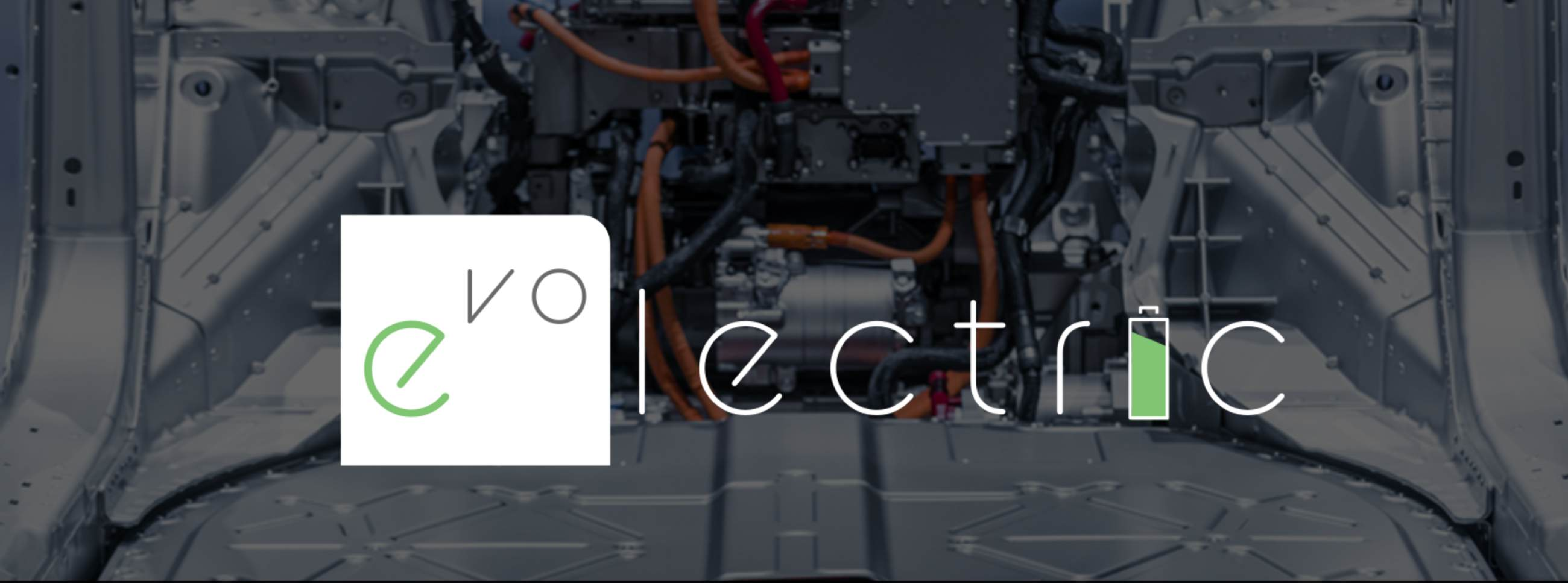
- Gross Vehicle Weight Rating (GVWR) 26,000 to 33,000 LBS (based on vehicle model selection)
- Digital Instrument Panel, CarPlay/Android hands-free infotainment unit and rear-view camera
- Future options include ADAS enhancements and accessory power for Refrigeration/PTO/V2V

Draft specification - targeting 2026

Evolectric solution:

- Expansion of existing deployed Class 4/5 powertrain systems
- V2G-ready (demo with EVSE)
- Solar-integration option
- Re-Purpose existing TRUs
- Established rapid build capability

UCR CE-CERT



evolectric

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voltu
Enabling electrification through innovative technology
voltumotor.com

SIMPLICITY AND INNOVATION

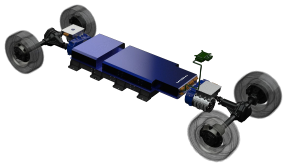
EV Technology Company tackling the adoption barriers

Complete technology framework (**20 World Patents**)

Innovative Efficient Manufacturing

Addressing biggest **MARKET GAP**

Manufacture complete **EV Powertrain**

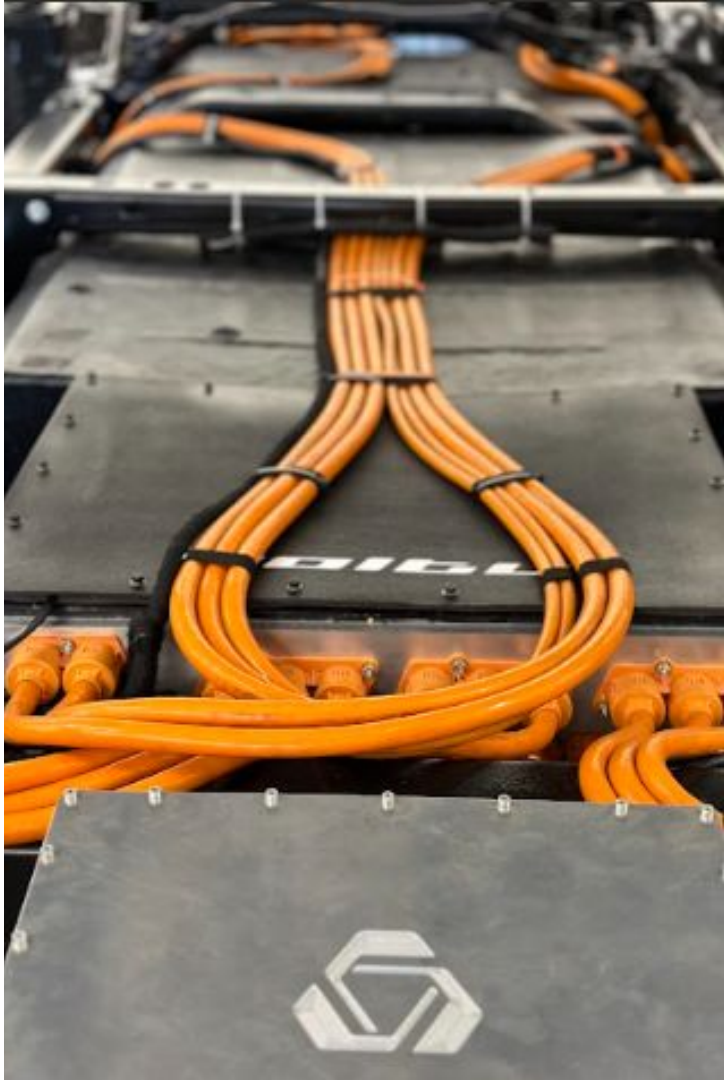


+

Procure **OEM** Chassis/Glider

Brand New Voltu3

Eliminate biggest cost **- Charging Infrastructure**
(US-10252628-B2 & US-10252629-B2)

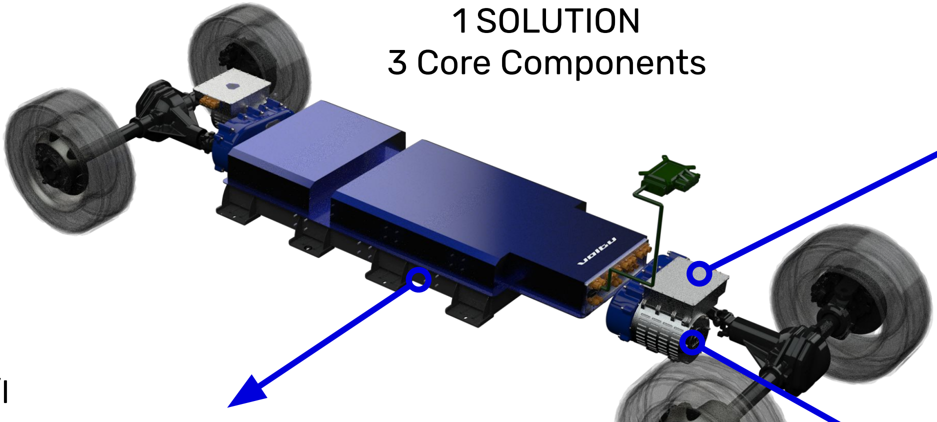


VOLTU3 PICKUP WORK TRUCK

Driveline	Dual Motor 4 wheel drive
Motor	Permanent Magnet Synchronous Motor
Peak Power	620 hp @ 3900 rpm
Peak Torque	827 lb-ft @ 0-3820 rpm
System Voltage	800v
Driving range	350 mi
Curb weight	7000 lb
Towing Capacity	17,000 lb
Payload	4,400 lb
GVWR	11,400 lb
Warranty	Battery Pack - 5 yrs / 100,000 mi Power Unit - 5 yrs / 60,000 mi Limited - 3 yrs / 36,000 mi

UNAVOIDABLE TECHNOLOGY DOMINANCE

1 SOLUTION
3 Core Components



Initio Energy Module
Immersion cooling
(US- 10252628-B2)

Energy Density 450 Wh/l

Initio Energy Pack

800 Volts
(Pack and Vehicle Architecture)

Bidirectional Inverter

200 kW Charging Capability
200 kW V2V

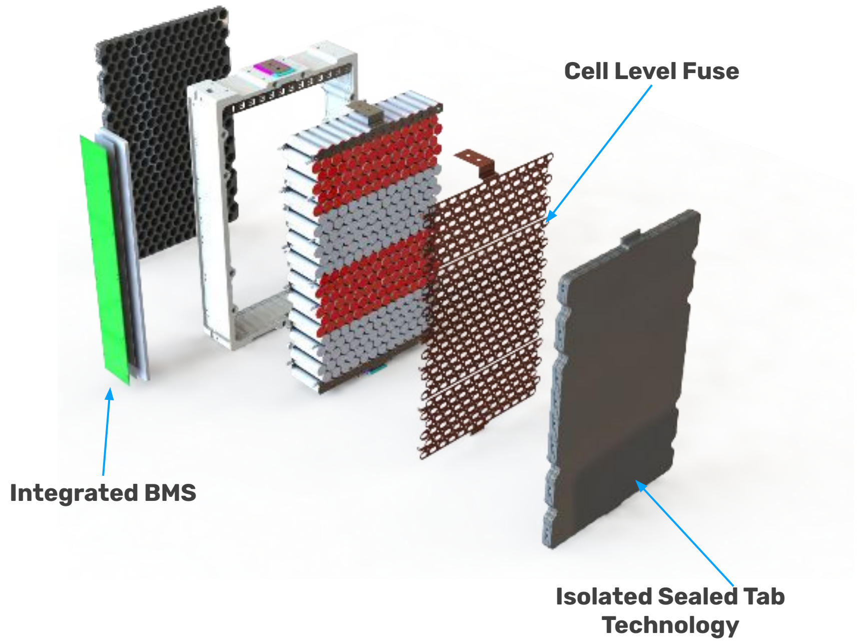
Initio Motor Unit
(US-10252629-B2)

Power 362 hp
Torque 1120 Nm
10,000 rpm

PROPRIETARY IMMERSE COOLING*

*Patent number:
US-10252628-B2

Immersion cooling delivers unmatched energy density, **performance in all weather conditions**, while Enhancing Safety



AC Onboard Fast Charging / Sharing

1. Electric motor coils used as charging coils
2. Motor Inverter power switches used as Fast Charging switches
3. AC single or three phase grid connected directly to motor neutral point though a rectifier
4. Direct Grid Charging: Enables fleets to charge quickly from the grid

Bi-Directional Inverter
Patent number: **US-10252629-B2**

Motoring mode

Charging mode

V2V charging

AC vs DC - Redefining The Paradigm

	AC Onboard Fast Charging[1]	DC Fast Charger
Capability	Up to 300 kW	Up to 350 kW
Chargepoint Price[2]	$10,000	$150,000
California Total Investment (estimated for 1M chargers)	**$10B**	**$150B**
Charging Hardware	On the vehicle	In the street

[1] US PATENT US-10252629-B2

[2] Does not account for grid infrastructure enhancements

South Coast AQMD & Voltu Motor

The project aims to promote a fast deployment of electric vehicles within CA fleets by tackling three adoption barriers: charging infrastructure costs and availability and vehicle performance

1. 10 vehicle with AC onboard fast charger
2. 6 months data gathering
3. TCO and Carbon footprint reduction analysis
4. World´s first Onboard Fast Charging roll out

2025

Thank you

G. Gebhart

jgebhart@voltumotor.com

BET Depoyment Across South Coast Air Basin – JETSI & SWITCH-ON

- Clean Fuels Retreat
- Jan 30, 2025

Deploying BET at Scale

In 2021, South Coast AQMD initiated a $66M pilot project to deploy 100 commercial Class 8 BETs and EVSE

- Two fleets: NFI and Schneider
- Regional, multiagency collaboration
- Located and operate in DACs
  - Drayage & intermodal operations
  - Leverage past & on-going demonstrations
  - ZEV workforce plan & training courses
  - Community and stakeholder outreach
  - Data collection, analysis, fleet tools

	NFI	Schneider
Duty Cycle	Drayage	Drayage & Regional Haul
Number of Trucks	50	50
Number of Chargers	19 (38 ports)	16 (32 ports)
Solar/Battery	1 MW/7.7 MWh	none
Fleet Location	Ontario	South El Monte

Timeline

April 21, JETSI project awarded

Oct 21, SCE CRT Contract Executed

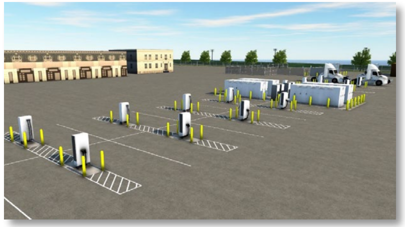
June 22, EVSE Ordered

Jan 23, 1st BET Delivered

June 23, Schneider Ribbon Cutting

April 24, Schneider/JETSI Project wins Clean Air Awards

2020 | 2021 | 2022 | 2023 | 2024 | 2025



2020/2021, Proposal Preparation

Feb 23, Schneider site work begins

Dec 24, 6M miles milestone

*Early 2025, project close out

Schneider Operational Summary

SCHNEIDER

- To date, 92 BET trucks are in operation at Schneider, funded by various programs/grants:
  - 50 (by JETSI)
  - 30 [by CA Hybrid and Zero-Emission Truck and Bus Voucher Incentive Project (HVIP)]
  - 5 (by EPA Targeted Airshed)
  - 7 (by Volkswagen Mitigation Trust)
- Charging - powered by 16 dual corded 350kW dispensers (32 trucks can charge concurrently)

Status (end of Dec '24)	BETs	Baseline
Total Miles Monitored	>3.3M	>200k monitored
Monthly Miles per Vehicle	3.5k – 4k	5k – 5.5k
# of operational days	20 – 25	23 – 25
Average Miles/day	160 – 165	195 – 200

Place Holder for Preliminary Data to be Shown during Presentation

Timeline

South Coast AQMD

April 21, JETSI project awarded

Dec 21, SCE reclassified NFI site, redesign

Mar 23, final quotes in, significantly higher cost/time

Feb 24, NFI Ribbon Cutting** Temp Power Only

*2Q 25, Solar/DER Installation

2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026

2020/2021, Proposal Preparation

Aug 22 SCE Recommends Temporary Power

Aug 23, NFI Construction begins

Jan 24, Temporary Power Installation

Feb 24, All 50 BETs Delivered

*Late 2026, project close out

*1Q25, Permanent Power Installation

NFI Summary

- 50 trucks funded by JETSI:
  - 30 trucks provided by DTNA and 20 trucks provided by Volvo
- 10 additional trucks funded by other programs/grants (e.g., SWITCH-ON)
- Charging - powered by 38 fast chargers
- Pending Infrastructure for the Ontario depot facility:
  - Switch gear to power all 38 chargers
  - 1 MW solar + 7.7 MWh battery storage

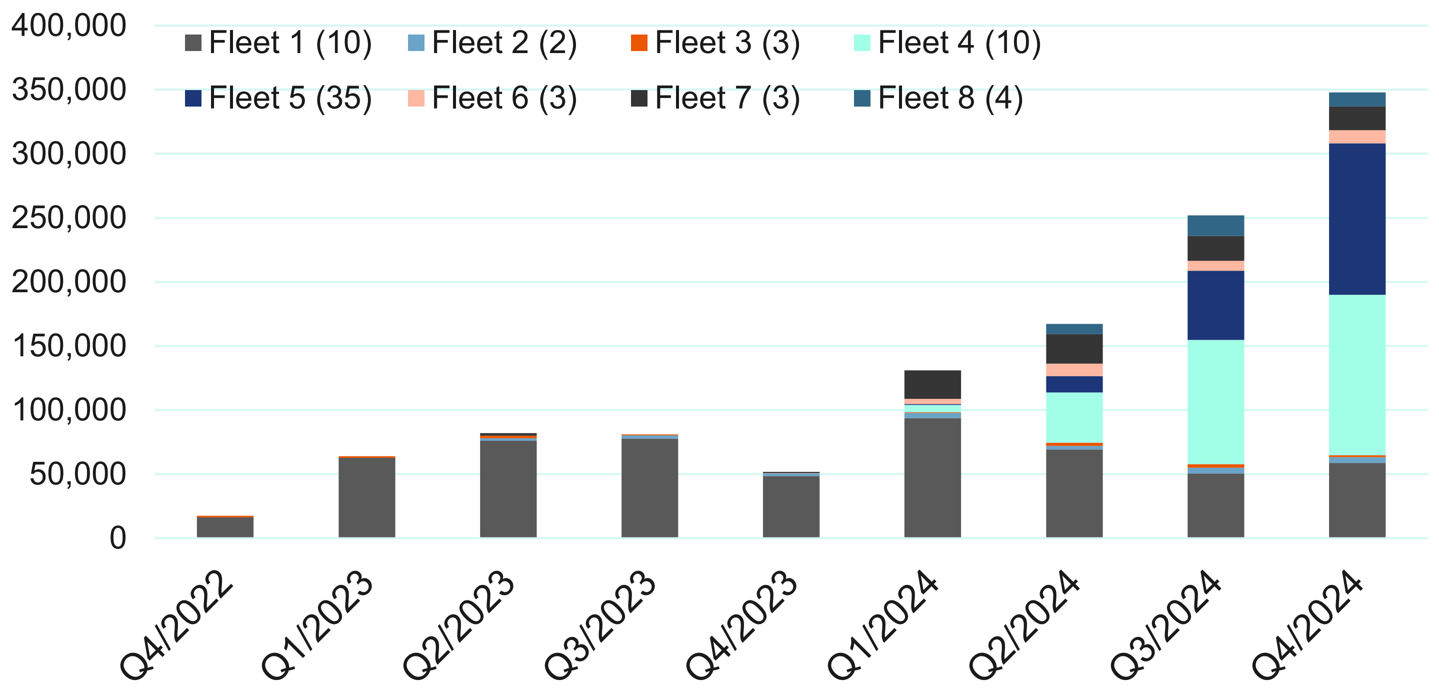
Status (end of Dec '24)	BETs	Baseline
Total Miles Monitored	>1.4M	N/A
Monthly Miles per Vehicle	~3-4k	~4k
Average Utilization	55% – 60%	~65%
Average Miles/day	165 – 170	170 – 175

Place Holder for Preliminary Data to be Shown during Presentation

SWITCH-ON: $32M to Deploy Class 7/8 BETs in SCAB

- U.S. EPA Targeted Air Shed Program funding ($20M) – buy down on 70 trucks and project admin
- Volvo and Fleets contributing towards truck costs ($10M)
- South Coast AQMD Clean Fuels Program funding ($2M) to infrastructure, data collection

SWITCH-ON: Fleet Quarterly Mileages

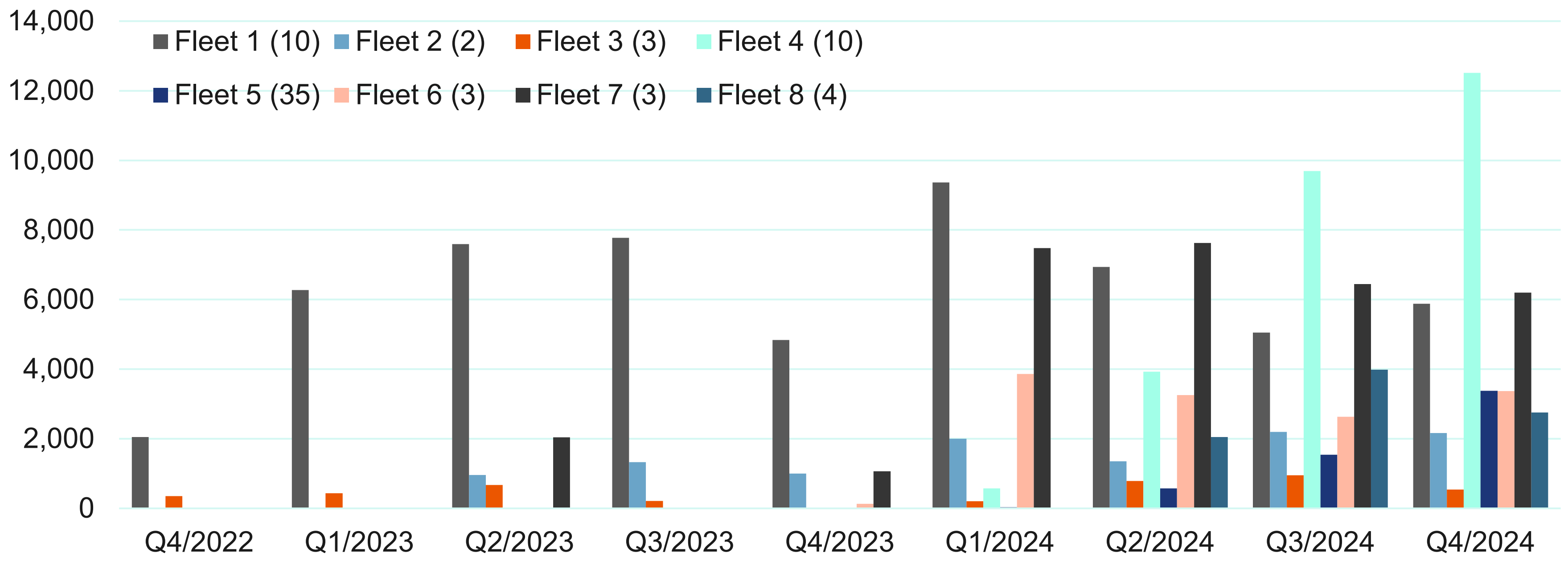


Total by Q4 2024:
- 1.2M miles

Q4 2024 alone:
- 350k miles, or
- 5K miles/truck

# of deployed BETs per fleet in paratheses

SWITCH-ON: Per Truck Mileage traveled quarterly



# of final deployed BETs per fleet in paratheses

Summary and Next Steps

- Class 8 BETs ***CAN*** do the work
- Both ***pilot*** projects operate in full swing overcoming many challenges, > 6 million ZE miles traveled and counting
- Continuous improvement on service/warranty support
- Innovative fleets needed to fit the existing operation around BETs operating characteristics
- Wealth of lessons learned to support upcoming deployment efforts

Empowering Local Environmental Change Through Replacing Internal Combustion with Battery Electric Class 6 or 7 Vehicles (ELECTRIC)

and

Clean Air RidEs for Kids (CARE4Kids)

Background

- In July 2024, South Coast AQMD submitted two (2) proposals in response to the U.S. EPA Notice of Funding Opportunity for the Clean Heavy-Duty Vehicles Grants and were awarded in December:
  - ELECTRIC: $33,898,522 award to replace older internal combustion engine Class 6/7 vehicles with zero emission vehicles
  - CARE4Kids: $24,842,632 award to replace public school buses with zero emission buses

ELECTRIC

- Replace older, high polluting class 6 and 7 freight delivery vehicles with zero-emission battery-electric technology
  - Eligible vehicles include:
    - Box Trucks
    - TRU Trucks
    - Step Vans (class 6 only)
    - Supporting infrastructure with associated vehicle replacement
      - Level 2 and DC Fast Chargers

ELECTRIC (Cont.)

- Workforce Training Program
  - Education and training provided to staff, drivers, mechanics, or other electric vehicle services providers
    - Train at least 100 drivers to operate battery electric vehicles
    - Train at least 25 mechanics for the maintenance and service on battery electric vehicles
    - Provide in person and online courses for the fleets and the public
- Community Engagement
  - Host meetings/events,
  - Work with Environmental Justice Advisory Group, INVEST CLEAN CPRG Community Benefit Steering Committee, AB 617 program and other opportunities

ELECTRIC Emission Reduction Benefits

- Replacing 126 class 6 or 7 internal combustion engine vehicles with equivalent battery electric vehicles
- Installing 45 DC Fast Chargers and 49 level 2 chargers
- Estimated Annual Emission Reductions

	NOx (lbs/yr)	PM2.5 (lbs/yr)	DPM (lbs/yr)	GHG (MT CO_2e/yr)
Total	29,434	558	775	599,236

School Bus Incentive Program

- Lower Emission School Bus Program
  - Awarded nearly $372 million
    - Replaced over 1,900 diesel school buses with alternative fuel and zero-emission buses
    - Retrofitted 3,400 diesel school buses with particulate traps
  - Anticipate Program Reopen: February 7th, 2025

CARE4Kids

- Replace older, high polluting class 6 and 7 school buses with zero-emission buses
  - Eligible Projects:
    - Class 6 and 7 School Buses
    - Owned by Public School Districts
    - Supporting infrastructure for new school buses

CARE4Kids (Cont.)

- Workforce Development and Training
  - Education and training for school district staff
    - Collaborate with school bus manufacturers and local community colleges
    - Offer training for operation and maintenance of electric school bus
    - Provide education to keep the workforce updated and allow for training of new workers

- Community Engagement
  - Host meetings and events
  - Work with Environmental Justice Advisory Group and engage with other opportunities

CARE4Kids Emission Reduction Benefits

- Replacing 74 high-emission class 6 or 7 internal combustion engine school buses with zero-emission buses
- Installation of chargers to support new school buses
- Estimated Annual Emission Reductions

	NOx (lbs/yr)	PM2.5 (lbs/yr)	GHG (MT CO_2e/yr)
Total	10,000	200	605

ELECTRIC & CARE4Kids Implementation Timeline

1. SCAQMD Board Approved & Recognized Award (January 2025)
2. Develop Implementation Plan (Q1 2025)
3. Solicitation for 3rd Party Facilitator (Q2 2025)
4. Contract with Training Entity (Q2 & 3 2025)
5. Select and Contract with Awardees (Q2 & 3 2025)
6. Equipment Deployment (2026)

Questions?

South Coast Air Quality Management District

Clean Fuels Program

Clean Fuels Program Advisory Group Meeting

January 30, 2025

Vasileios Papapostolou, Sc.D.
Technology Demonstration Manager

Background

State law requirements:

- Annual Report on Clean Fuels Program and Technology Advancement Plan Update (HSC 40448.5.1)
- 2025 Plan Update (draft) submitted to Technology Committee October 18, 2024
- Submit to Legislature by March 31 every year

Reports: https://www.aqmd.gov/home/technology/reports

Public Outreach and Input

- Clean Fuels Advisory Groups meetings
- Meetings: Agencies, Technology Providers, National Labs and other Stakeholders

- Symposiums and Conferences:
  - Sponsored 21 technology conferences, including:
    - Real World Emissions Workshop (3/2024)
    - Electric & Hybrid Marine Technology Conference (3/2024)
    - Tire Emissions & Sustainability Conference (4/2024)
    - Irvine Clean Energy Conference (9/2024)
    - CoMotion LA (11/2024)
- Clean technology Partnerships:
  - California Hydrogen Business Council
  - CALSTART
  - Hydrogen Fuel Cell Partnership

Clean Fuels Program – Overview

Technology Readiness Level

0 — 3 — 8 — 9

Research
- Basic Research
- Lab Bench
- Proof-of-Concept

Development
- 1st Gen Demos
- System/Component Integration
- Proof-of-Technology

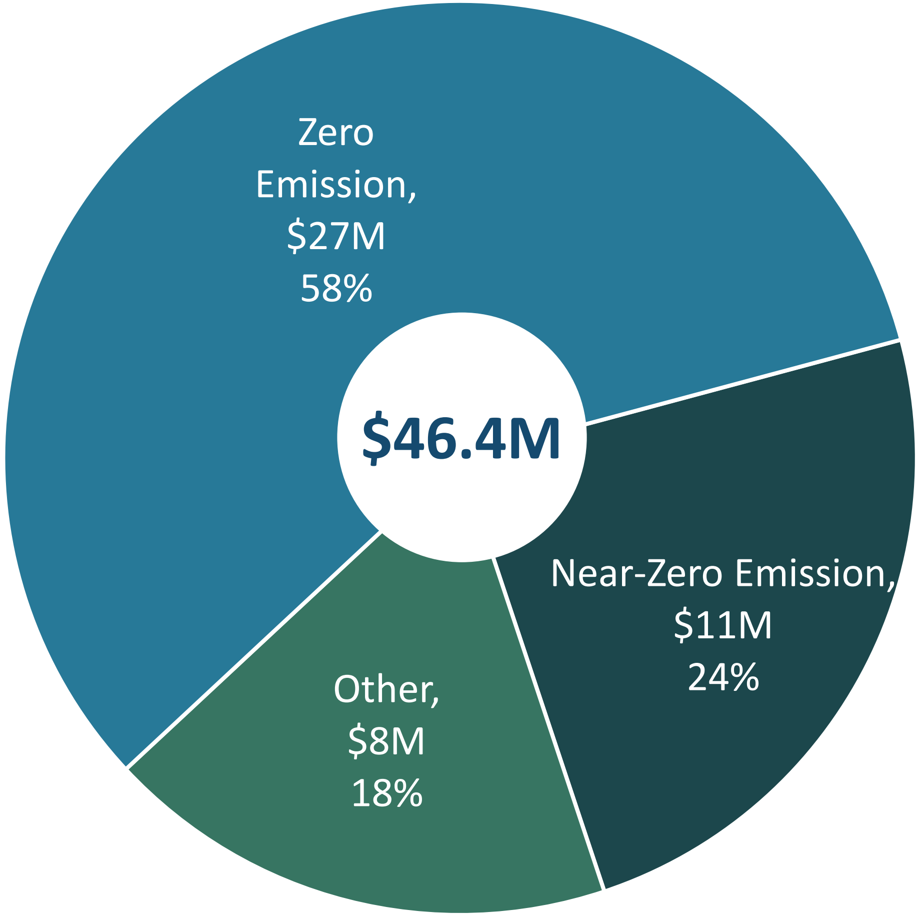
Demonstration
- 2nd/3rd Gen Demos
- Durability Acceptance
- Proof-of-Product

Deployment
- Pre-Commercial Demos
- Market Readiness
- Proof-of-Commercialization

Commercialization
Incentives

Regulations

Clean Fuels Funding Allocation Between 2019 – 2024*



Clean Fuels Fund Cost Share

*Includes projected numbers from 2024 approved projects

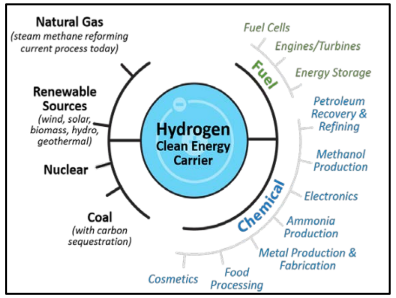
Major Funding Partners for R&DDD Projects in 2024

$30.1M

Funding Government Agencies	Major Manufacturers/ Technology Providers	Fleet Partners	Project Partners
CALIFORNIA AIR RESOURCES BOARD	range energy	CROWLEY	SoCalGas
STATE OF CALIFORNIA ENERGY COMMISSION	ZERO EMISSION INDUSTRIES		UC RIVERSIDE UNIVERSITY OF CALIFORNIA CE-CERT
			UNIVERSITY OF CALIFORNIA ALIANZA MX

Key Clean Fuels Contracts Completed in 2024

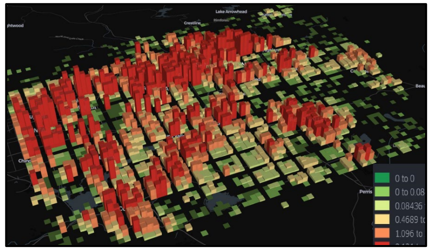
Assessment of emission impact of hydrogen-natural gas blend in near-zero emission engines (UC Riverside CE-CERT)



H2@Scale program by NREL for advancing California heavy-duty hydrogen infrastructure research

Development and Demonstration of Near-Zero Emission Opposed Piston Engine (CALSTART)

Key On-going Clean Fuels Contracts in 2024



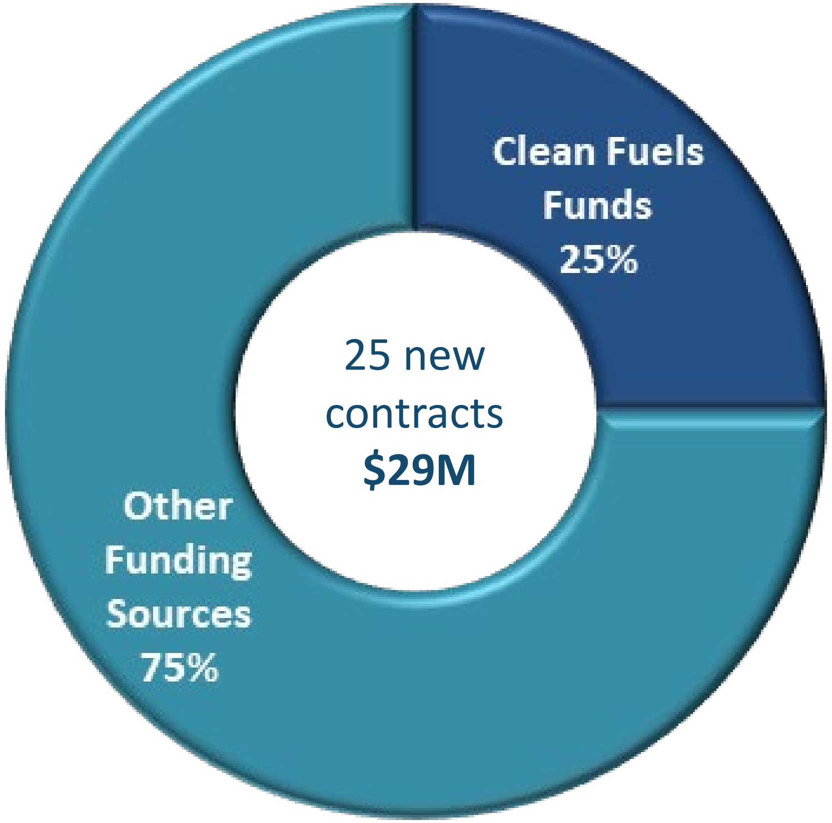
Study of Emissions and Air Quality Impacts from Goods Movement Operations on Inland Southern California Communities

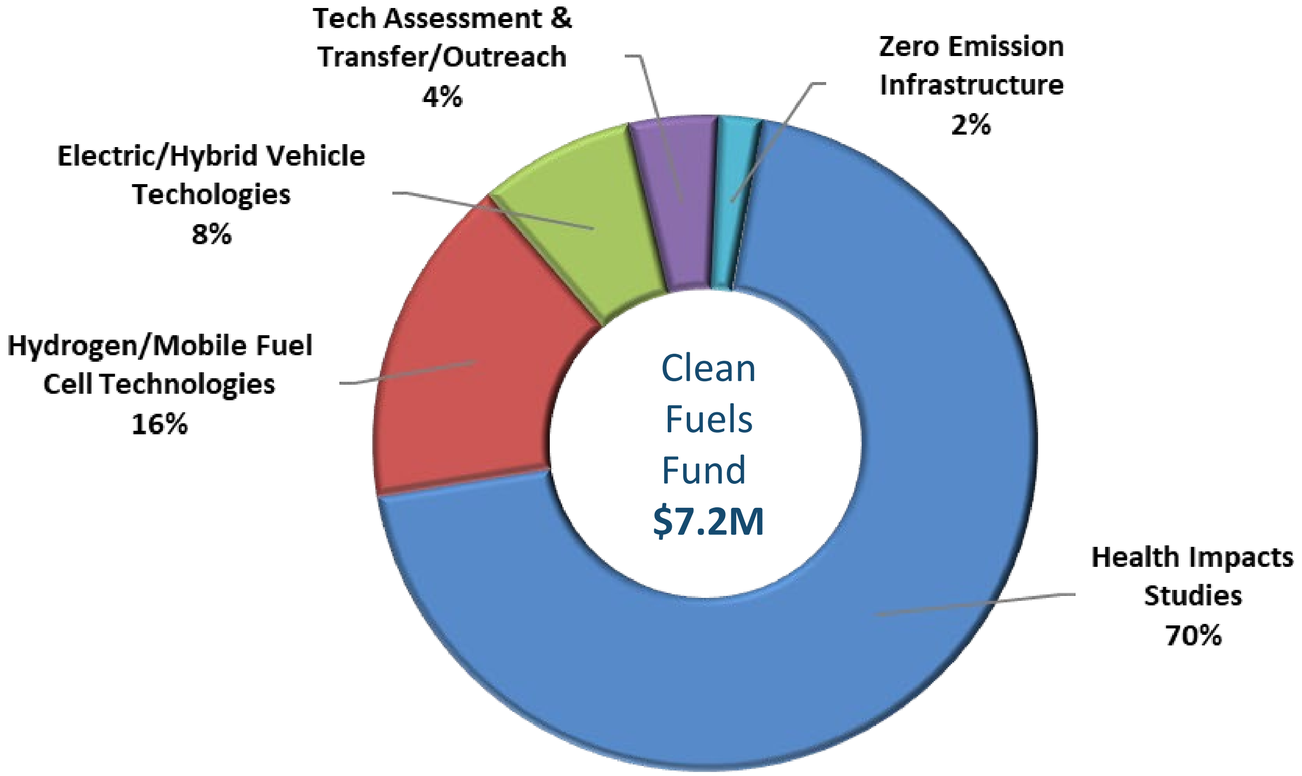
Joint Electric Truck Scaling Innovative (JETSI) Drayage Pilot Project

Deployment of 70 battery electric heavy-duty trucks and data collection and installation of charging infrastructure under the Volvo Switch-On project

Development of two battery electric heavy-duty refuse trucks by Meritor (an Accelera by Cummins company) and demonstration with the City of Los Angeles

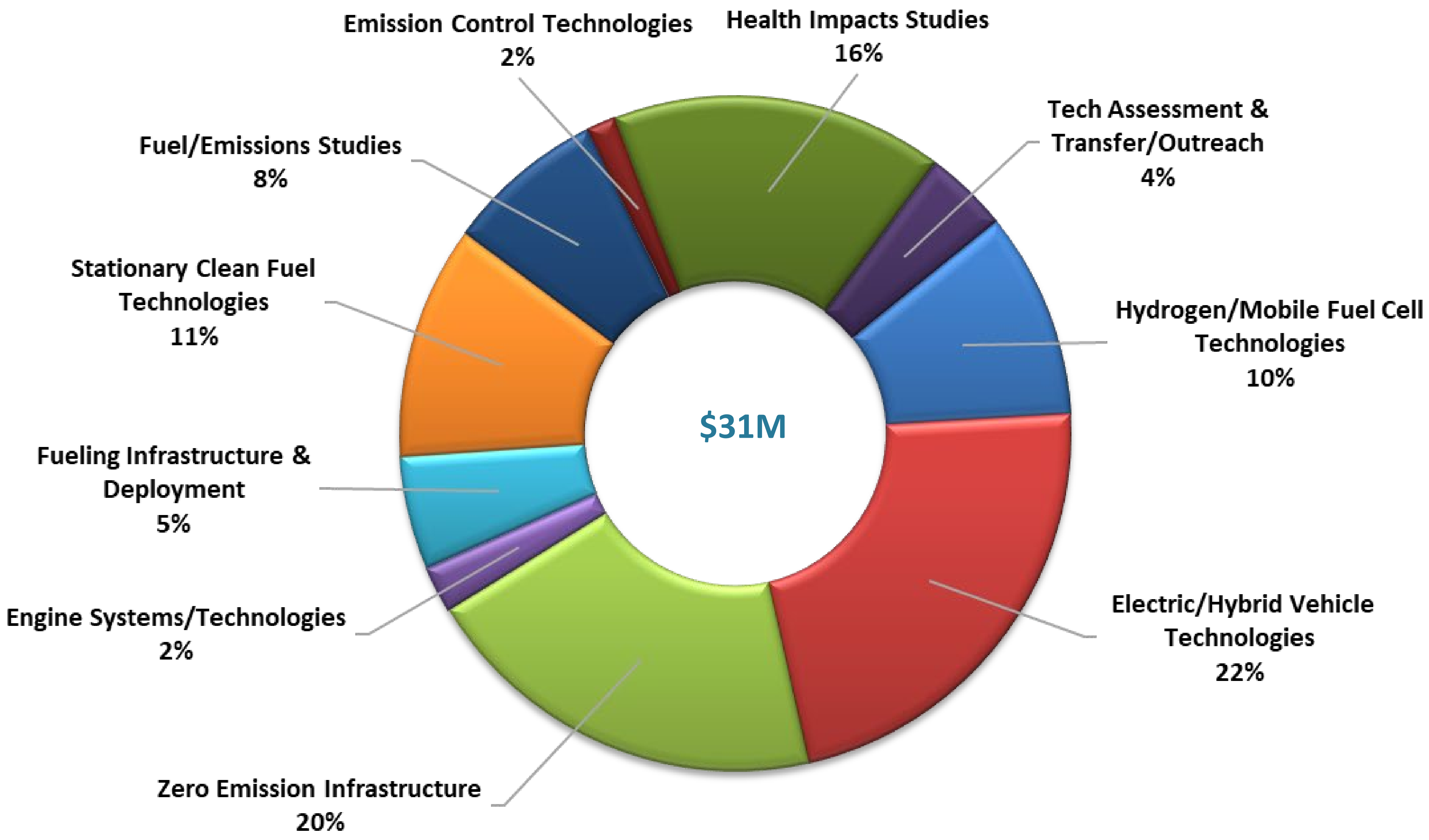
Clean Fuels Contracts in 2024





Clean Fuels funds were leveraged with a 1:4 ratio

2025 Potential Funding Distribution



Proposed Advisory Group Members

Technology Advancement Advisory Group (13 Members):

Dr. Leela Rao, Port of Long Beach

Clean Fuels Advisory Group (13 Members):

Dr. Gordon Abas Goodarzi, Magmotor Technologies, Inc.

Yassi Kavezade, Sierra Club

2024 Annual Report & 2025 Plan Update – Development Schedule

Technology Committee	October 18, 2024 (Draft version)
Advisory Group Review	November 2024 (Draft version)
Advisory Group Review	January 30, 2025 (Final version)
Technology Committee	February 21, 2025 (Final version)
Governing Board Approval	March 7, 2025
Due to State Legislature	March 31, 2025

Thank you!