CLEAN FUELS PROGRAM ADVISORY GROUP AGENDA
JANUARY 23, 2024, 9:00 AM – 3:15 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 Tuesday, January 23, 2024, 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 – 10:30 AM	
(a)	Welcome & Introductions	Aaron Katzenstein, Ph.D., Deputy Executive Officer *
(b)	Incentives, Grants Updates and Opportunities	Mei Wang, Assistant Deputy Executive Officer *
(c)	Goals for the Day	Vasileios Papapostolou, Sc.D., Technology Demonstration Manager*
(d)	Wind-Assisted Propulsion from Concept to Reality	Jon Halvard Bolstad Olsen, Yara Marine Technologies
(e)	On Board Sensing for Community-Based Emissions Impact Analysis	Kent Johnson, Ph.D., University of California Riverside
(f)	Feedback and Discussion	Advisors and Experts
(g)	Public Comment (2 minutes/person)	

1.	Infrastructure 10:30 AM – 12:00 PM	
(a)	Hydrogen Simultaneous Time-Fill Refueling System for Port Equipment/Drayage Truck Application	Toru Sugiura, Toyota Tsusho America
(b)	Enabling Hydrogen for Maritime with Mobile Refueling Solutions	Ricky Elder, Zero Emission Industries
(c)	Microgrid Infrastructure: Supporting Zero-Emission Transportation	Seungbum Ha, Ph.D.*
(d)	Air Quality Impacts of Microgrid Deployment in the South Coast Air Basin	Michael MacKinnon, Ph.D., University of California Irvine
(e)	Feedback and Discussion	Advisors and Experts
(f)	Public Comment (2 minutes/person)	
	Lunch 12:00 PM – 1:00 PM	

2.	Infrastructure and Trucks 1:00 PM – 2:30 PM	
(a)	Charging Infrastructure Deployment: Challenges and Solutions	Francesca Wahl, TESLA
(b)	Schneider's Commitment to a Sustainable Future	Jeremy Hock, Schneider
(c)	JETSI - Electrify America and NFI's 1st Heavy-Duty Electric Truck Charging Microgrid	Jigar Shah, Electrify America
(d)	Feedback and Discussion	Advisors and Experts
(e)	Public Comment (2 minutes/person)	
3.	**Wrap-up 2:30 PM – 3:15 PM**	
(a)	2024 Clean Fuels Plan Update & Wrap-up	Vasileios Papapostolou, Sc.D., Technology Demonstration Manager*
(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.

South Coast AQMD

Incentives & Grant Updates and Opportunities

Mei Wang

Assistant Deputy Executive Officer

Main Incentive Programs

Carl Moyer Program

Replace HD On-Road, Construction, Ag, Marine, Cargo Handling Equipment, Locomotives and INF

Voucher Incentive Program

(for small fleets with ten or fewer vehicles)

Funding Agricultural Replacement Measures for Emission Reductions (FARMER) Program

Goods Movement Program Replace Program-Trucks, Locomotives, CHE, TRU and Shore Power

California
Mitigation
Trust

Volkswagen Environmental Mitigation Trust Program

Community Air Protection Program (supports AB 617)

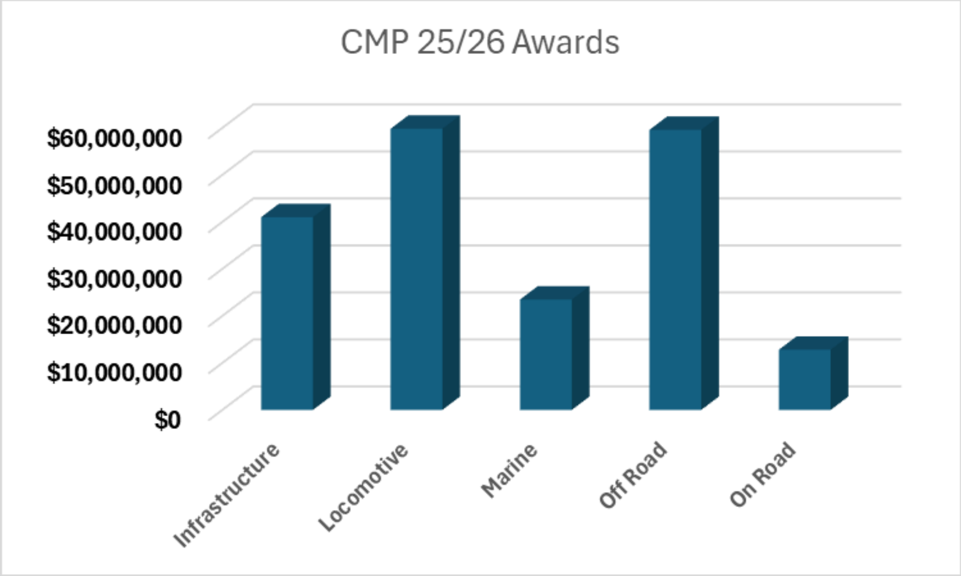
Light-Duty Vehicle Replacement Program

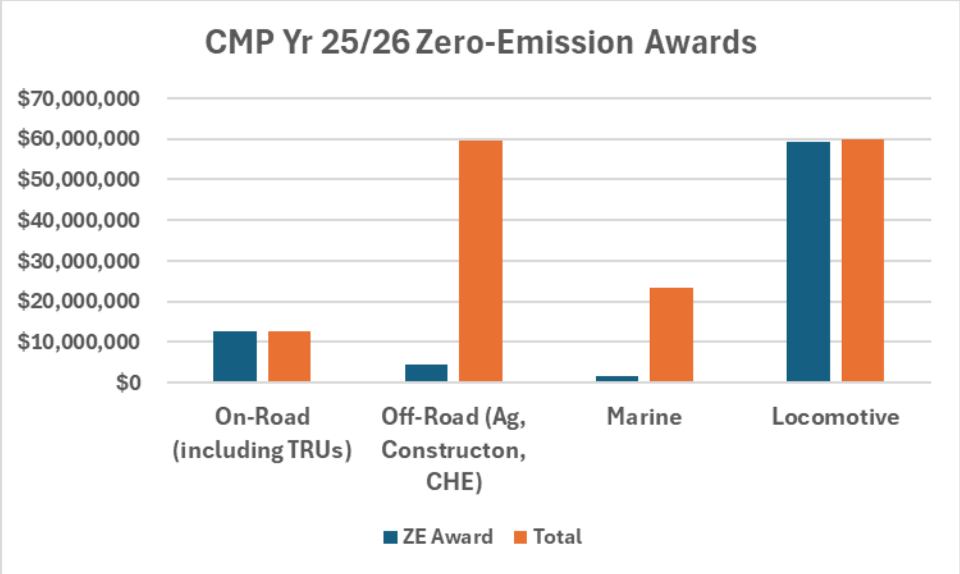
School Buse and CNG Tank Replacement Program and INF

Commercial Electric Lawn and Garden Equipment Program

2023 Incentives Program Activities

- Year 25&26 solicitation released in December 2022 and close in May 2023
- Over 900 projects were evaluated, requesting $424 million
  - Over 550 eligible projects were recommended for awards totaling $200 million
- Released infrastructure project solicitation in December 2023 for ZE infrastructure
  - Total award up to $200 million
  - RFP closes early February
  - Link: https://www.aqmd.gov/docs/default-source/aqmd-forms/moyer/pa2024-02.pdf?sfvrsn=8





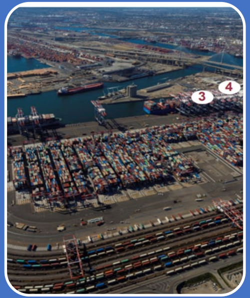
2023 Grant Submittals

January – CalSTA Proposal (DOT)

- Deploy a Liquide Fuel Cell Freight Loco
- Install 400 Chargers and H2 Dispensers at 7 Locations
- Total Project Cost $210 million, Requested $76 Million

June-CFI Proposal (DOT)

- High-Power Chargers for HD
- Partner with Tesla
- Total Project Cost $127 million request $97 million
- 2nd Proposal-West Coast Truck Charging



April – PIDP Proposal (DOT)

- Installation of Electrical Charging Units
- Partner with Long Beach Container Terminal
- Total Project Cost $85 Million, Requested $68 Million

October- Heavy Duty Pilot Projects

- Submitted 5 Proposals (HD ZE Vehicles and Marines)
- Totals Project Cost $ 206 Million, Requested 113 Million

April –EPA CATI

- MD ZE Work Truck System Development
- Partner with Odyne, LADWP and Edison
- Total Project Cost $1.25 Million, Requested $500,000

December –EPA DERA proposal

- Replace 22 Class 8 Trucks with ZE
- Total Project Cost $11 Million, Requested $4.5 Million

2023 Awarded Grants

EPA	EPA	EPA	CalSTA	EPA CATI
Plug-in Hybrid Tugboat	Commercializing HFC HD Trucks	Battery Electric Asphalt Compactors	FC Loco and 400 Chargers/H2 Dispensers	ZE Work Truck System
$10 Million	$7 Million	$1.9 Million	$76 Million	$750,000
April 2023	April 2023	April 2023	July 2023	October 2023

South Coast AQMD

Upcoming Grant Opportunities

Current Notices of Funding Opportunities:

- EPA Climate Pollution Reduction Grants(CPRG)-Implementation Grants
    - Funding Available: up to $4.3B
    - NOFO Closes: 4/1/2024
    - South Coast AQMD likely to lead Goods Movement Proposal requesting $500 million
- MARAD FY 2024 Port Infrastructure Development Program: $450 million (due 4/30/2024)

Upcoming NOFOs Pending Release:

- EPA Reduction of Air Pollution at Ports (late winter 2024):$3B
- EPA Clean Heavy-Duty Vehicles (2024):$1B
- 2023 EPA Target Airshed Grant Program:$66M

Cummins Diesel Emission Settlement (closely monitored): $1.675 B

Questions

BAR Tech WindWings by Yara Marine

From Concept to Reality

Jon Halvard Bolstad Olsen
Strategy and Business Development Director
Head of Shore Power
January 2024

Yara Marine Technologies


Mitsubishi Corporation
Cargill
BAR TECHNOLOGIES
WIND WINGS
YARA
Co-funded by the European Union
PYXIS OCEAN

Current product portfolio


SOx scrubber


Route Pilot AI


FuelOpt


Fleet Analytics


WindWings


Shore Power


Lifecycle Services

We have installations on more than 700 vessels

The three decarbonisation levers currently represent an estimated 23 BEUR market

Total market	3 levers	7 subsegments	Technologies	Technological maturity	Market Size 2023 BEUR
Maritime Greentech market	Energy efficiency	Data-enabled operational efficiency	Cargo and capacity optimization (utilization, stowage, haulage syst etc.)	Emerging	0.2-0.3
			Voyage optimization[1] (routing, port traffic syst. Etc.)	Emerging	0.5-0.7
			Vessel optimization[1] (engine, energy syst., auxiliary syst., autopilot, etc.)	Emerging	1.2-1.4
		Tech efficiency – Propulsion and hybrid energy solutions	Wind propulsion (Sail, kite, Flettner)	Emerging	0.1-0.2
			Wind energy solutions	Emerging	0.1-0.3
			Solar energy solutions	Emerging	0.0-0.2
			Hybrid battery solutions	Emerging	0.1-0.3
		Tech efficiency – Drag reduction	Hull cleaning robots	Emerging	0.1-0.3
			Hull coating (i.e. nano/hard/eco)	Established	4.8-5.0
			Trim optimization system	Established	0.1-0.2
			Hydro/Aero design	Established	0.6-0.8
			Air lubrication systems	Emerging	0.09-0.1
		Tech efficiency – Other technical solutions	Shore power (ship- and port-side)	Emerging	1.5
			Waste Heat Recovery System	Established	1.4-1.6
			Pumps & Cooling Water System	Established	0.0-0.2
	Alternative fuels	Alternative fuel technology	Battery solutions	Emerging	6.6-6.8
			NG fuel & dual fuel systems	Emerging	
			H2, Methanol, Ammonia fuel systems	Emerging	
			Synthetic-& biofuels systems	Emerging	
			New fuel abatement systems	Emerging	
			Nuclear propulsion	Emerging	0.0-0.1
	Environmental measures	Ecosystem measures	Water treatment syst.	Established	3.3-3.5
			Marine mammal detection & warning	Established	0.0-0.1
			Dry waste management	Established	0.5-0.7
			Noise reducing vibration isolators	Established	0.1-0.3
			Water in Fuel	Established	0.0-0.1
		Exhaust treatment	SOx Scrubber (incl. CCS)	Established	1.2-1.4
			Particulate matter/black carbon solutions	Emerging	0.0-0.1
			Exhaust Gas Recirculation	Established	0.5-0.7
			Selective Catalytic Reduction	Emerging	0.3-0.5
Total					**23-28**

Technological maturity: Established, Emerging

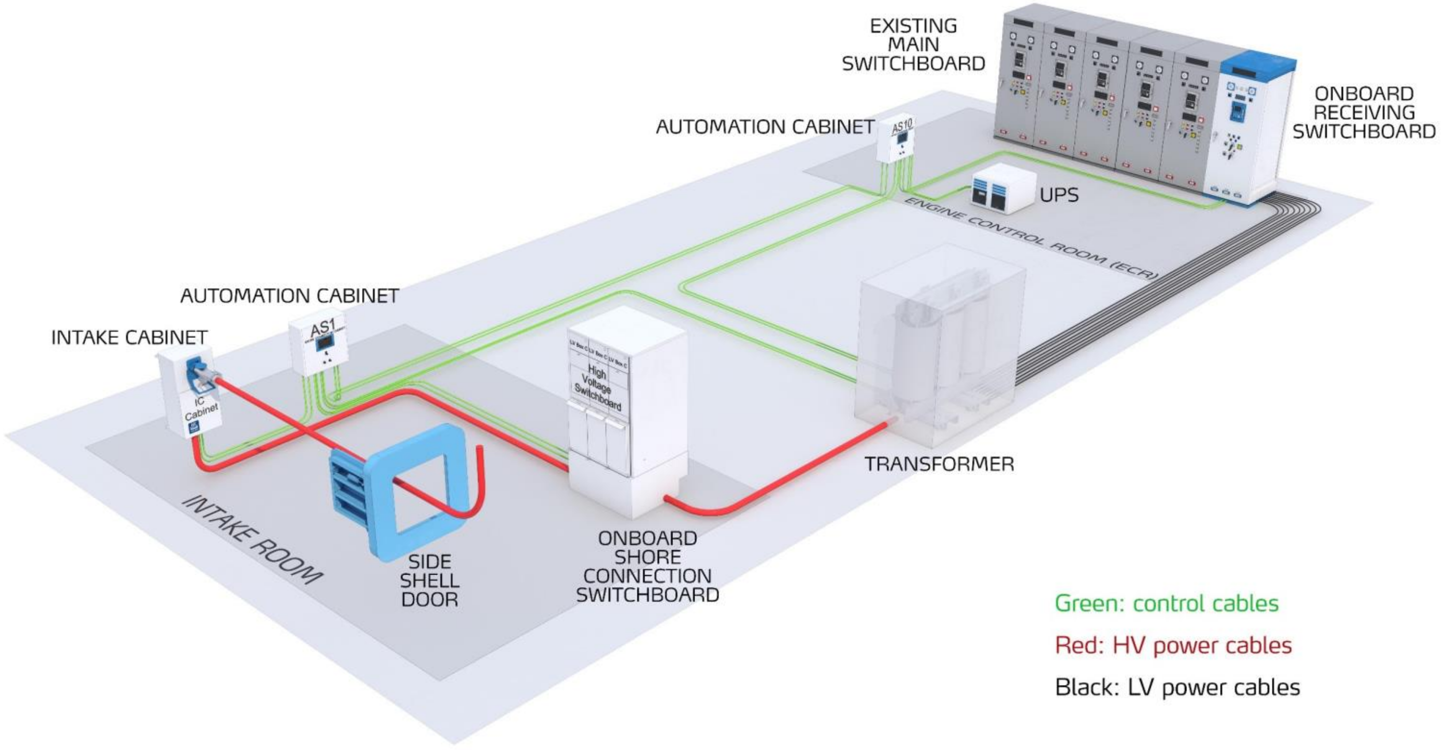
Note: Nuclear established in defense however emerging in merchant fleet applications

Source: Top tier global management consultancy

Yara Marine Technologies offer solutions that are turnkey for all vessel segments, both retrofit and newbuild

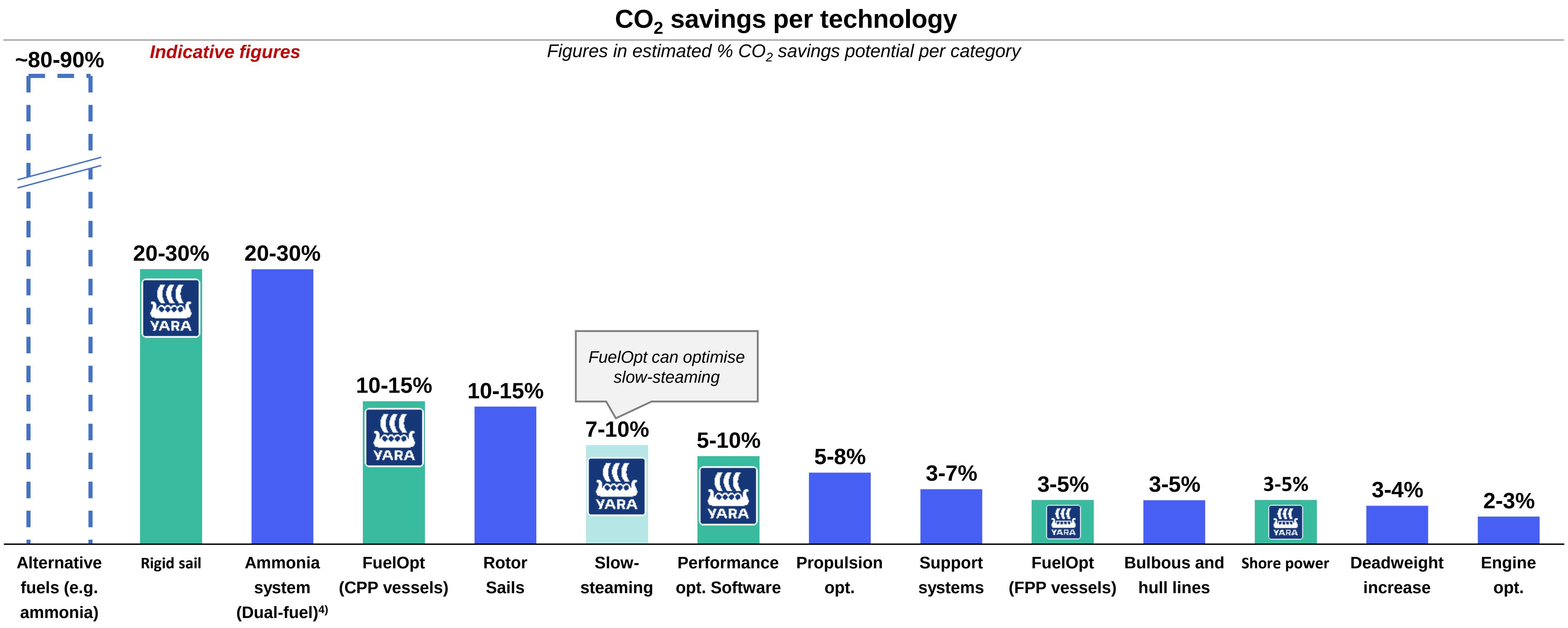
- Entire turnkey solutions normally include:
  - Project management
  - Electrical design
  - Mechanical design
  - Automation system
  - Component selection
  - Utility integration, including HVAC, fire safety and communication
  - Integration and class approval
  - Installation, including hot works
  - Commissioning

Typical integrated shore power solution onboard vessel



Shore Power is the first step towards zero-emission vessels – Limited energy loss in process compared to green fuels

Wind is the biggest lever we have to decarbonize shipping AND save fuel cost at the same time!



Source: Top tier management consulting company, YMT

1) Rough average figures, including installation. Only vessel-side for shore power

2) $600-800 per metric tonne. Includes capex & opex. Source: Washington Post

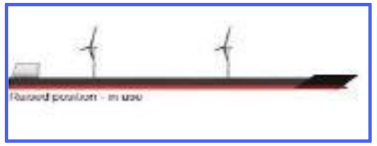
3) Assuming Norwegian grid GHG intensity. Excluding port-side investments

4) Assuming the system is used 1/3 of the time, with CO_2 intensity 80-90% lower than Fuel Oil

Rotor sails currently the most mature wind assisted propulsion technology, with rigid sails closely behind

WAP technology overview

WindWings

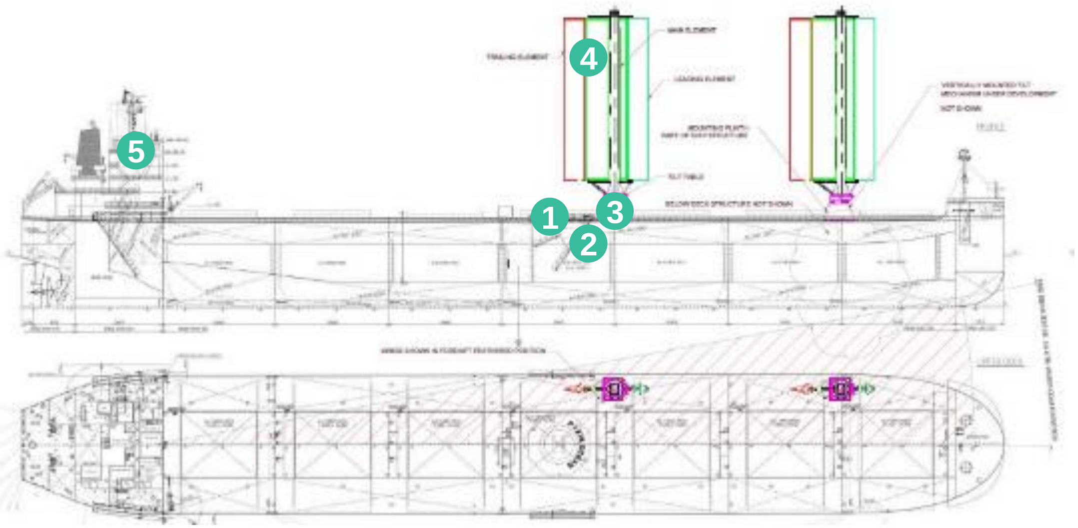
	Rotor sails	Rigid sails	Suction wing	Towing kite	Hull sail	Turbine
Technology						
Description	*Rotating cylinders generating forward thrust through the Magnus effect, utilising low and high pressure*	*Rigid sails are foils that can be adjusted to produce aerodynamic forces*	*Non-rotating wings with vents and internal fans to generate force with boundary layer suction*	*A kite that provides thrust to ships to provide a supplementary power source*	*The hull is built to generate aerodynamic lifts with its symmetrical hull foils*	*Wind turbines that generate electricity and/or thrust by the blades*
Selected players	Norsepower, Magnuss, MariGreen, Anemoi	Yara, Nayam Wings, Oceanfoil, Propelwind, bound4blue, Wallenius Wilhelmsen	Econowind	airseas	Vindskip, Oceanbird	N/A
Selected ship owners	Seatrans, Scandlines, Bore	Bergebulk, Cargill, Mitsubishi Corporation	Van Dam Shipping, Tharsis	Airbus	N/A	N/A
Degree of maturity	Highest					Least

Saves 1,5 mt/day

- An average fuel saving of 1.5 MT/day per sail on average global routes
  - No speed reduction
  - Including interference and bow winds
- Robust technology as guiding principle throughout every part of design process
- Safe and easy to operate and low maintenance costs
- Suitable for both retrofit and new builds
- Configurable for different vessel types and sizes
- Built to last for 25 years (increases vessels asset value)

Several considerations taken into account to optimise the uptime of the wings on the vessel

		Considerations
1	**Port operations**	***Ports are in general positive to the wings considering cargo operations***
2	**Time to lift wing**	***It will take 20 minutes to lift each wing***
3	**Hydraulic equipment**	***Needs maintenance to maintain uptime***
4	**Uptime & wind angle**	***Sails should only be lifted when wind direction in favourable***
5	**Line of sight**	***Solved by using a camera system (not part of YMT/BAR scope***



Port Operations

Details about sails included in Ship Particulars

Thank you!

Yara Marine Technologies

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China office: 21st Floor Unit 2168,
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Yan An Road
Shanghai 200001
China

On Board Sensing For Community Based Emissions Impact Analysis

SC-AQMD Clean Fuels Retreat

January 23, 2024

Dr. Kent Johnson

Co-Authors Drs. Thomas D. Durbin, Georgios Karavalakis, Zisimos Toumasatos, and Grace Johnson (PhD Candidate)

CE-CERT

UNIVERSITY OF CALIFORNIA
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In Use Emissions Vary By The Vehicles Use

Driving condition / Speed range	Urban 0-25 mph	Suburban 25-50 mph	Highway > 50 mph

Driving condition	Urban	Suburban	Highway
Average time spent at this condition	43%	11%	46%
Average share NO_x mass	40%	23%	37%
Brake specific NO_x emissions, g/bhp-hr	1.41*	0.70	0.20
Conformity Factor - CF	7.1*	3.5	1.0
Distance-specific NO_x emissions, g/mile	7.0*	2.4	0.6

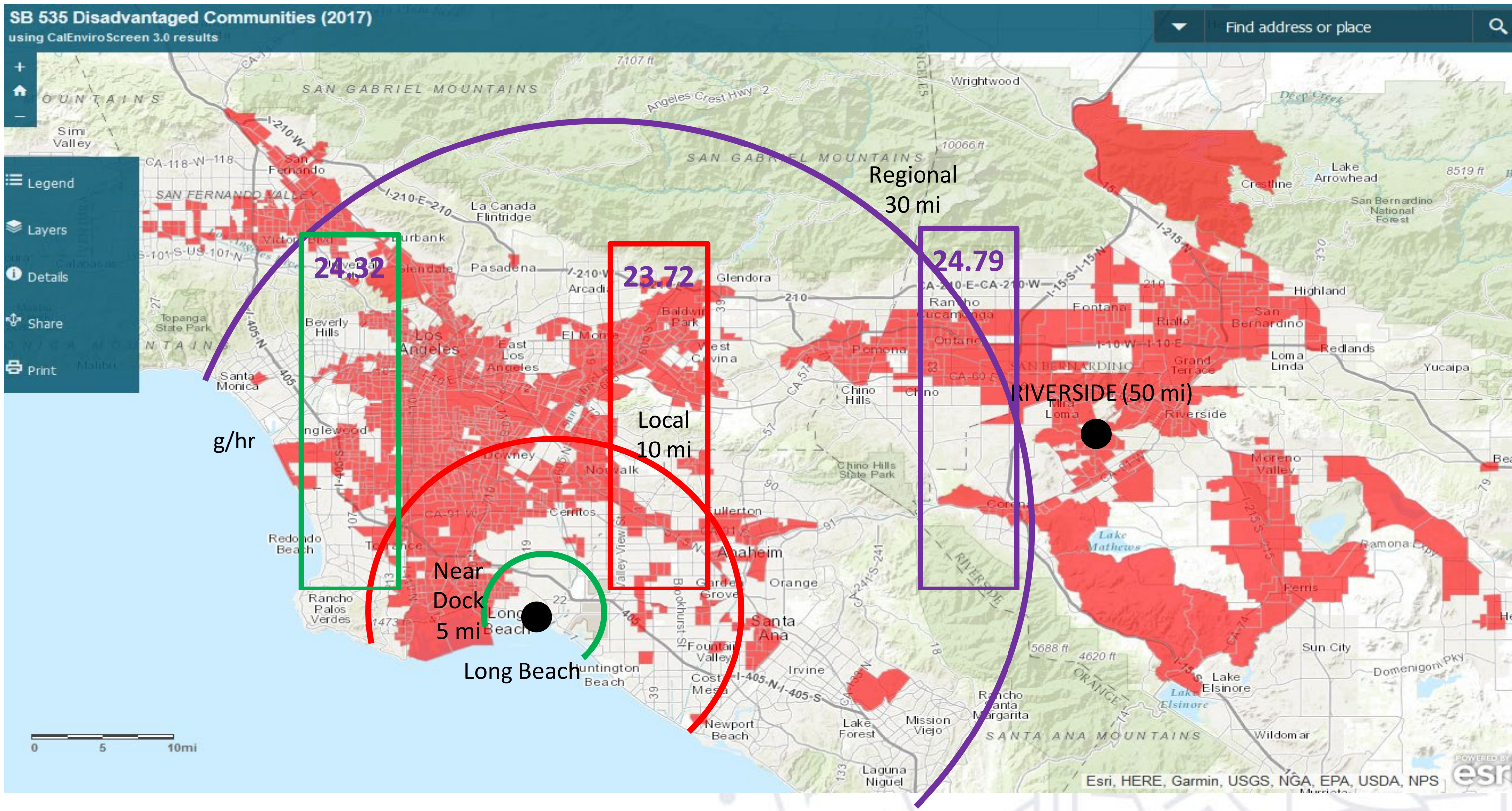
** Brake and distance specific NOx emissions for Urban bin do not include Idle operation, only 1-25 mph operation is included*

- 189 tests between 2010 and 2019
- MY 2010-2016 with SCR Technology

- **43%** of the activity is between 0-25 mph
- This represents **40%** of the NOx mass

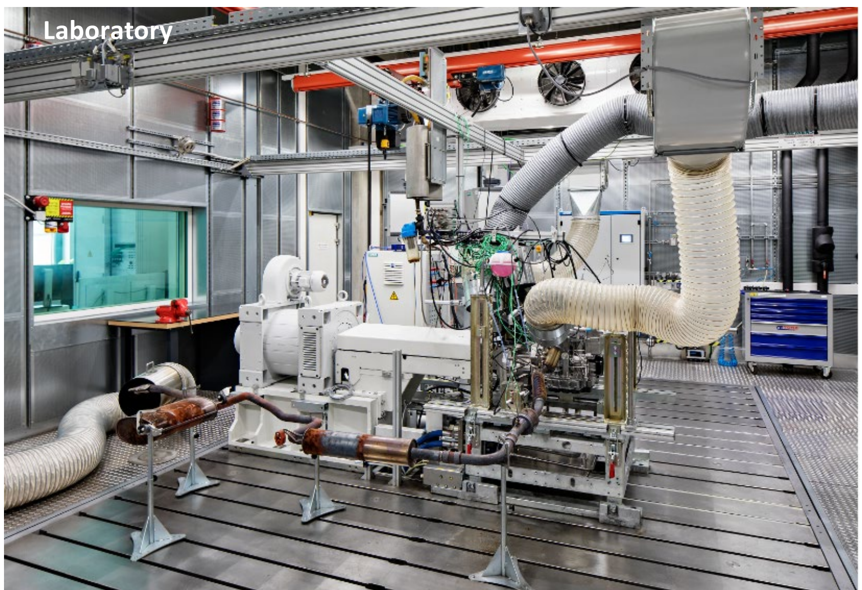
Source: ICCT white paper Nov 2019

Low Duty Cycle Operation Dose Matter

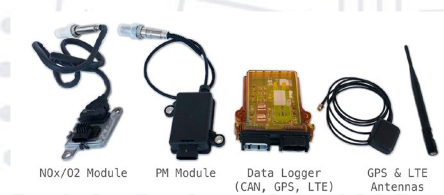


Laboratory, Portable Reference, and On Board Sensing

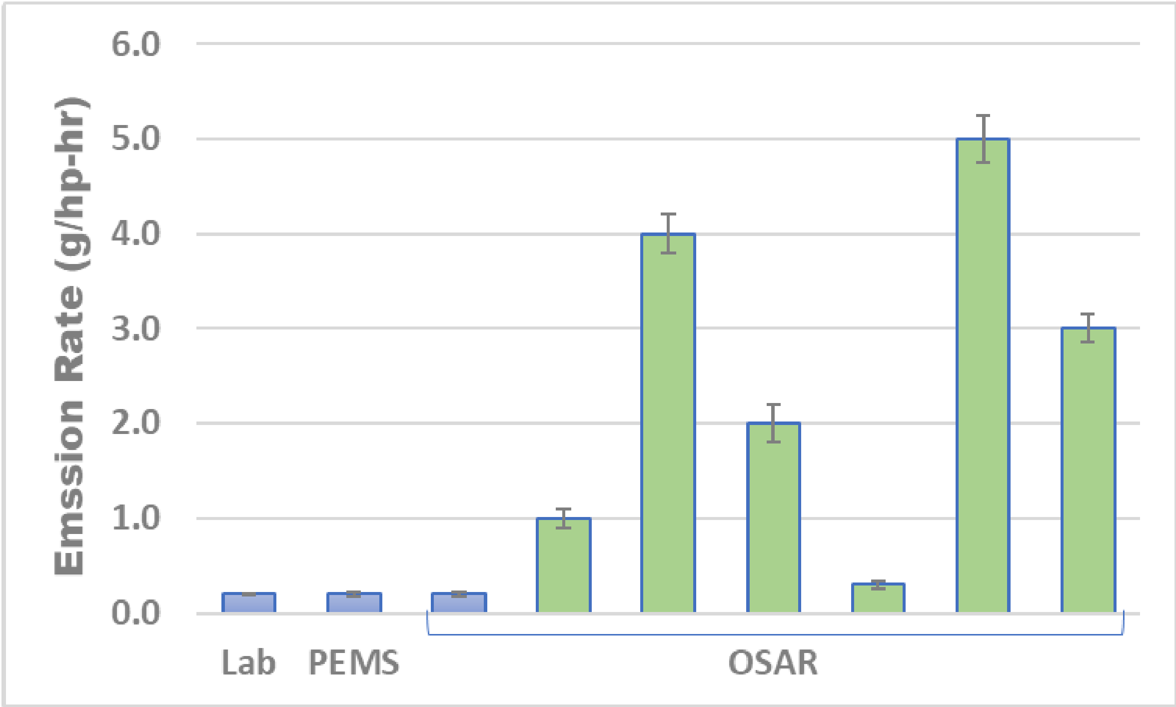
- ➢Laboratory 2% accuracy (1 day data takes weeks/months for in-use setup)
- ➢Portable reference 5% (1 day data takes 4-6 hrs)
- ➢On board sensing 10% (1 year data takes <1 hr)



On Board Sensing



Traditionally Accuracy is Better, but it has Limitations In-use

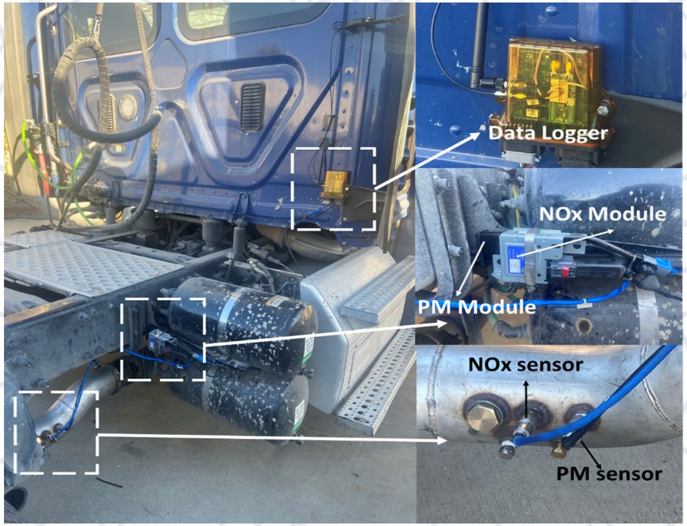


CE-CERT: OSAR system

At CE-CERT we call On Board Sensing OSAR

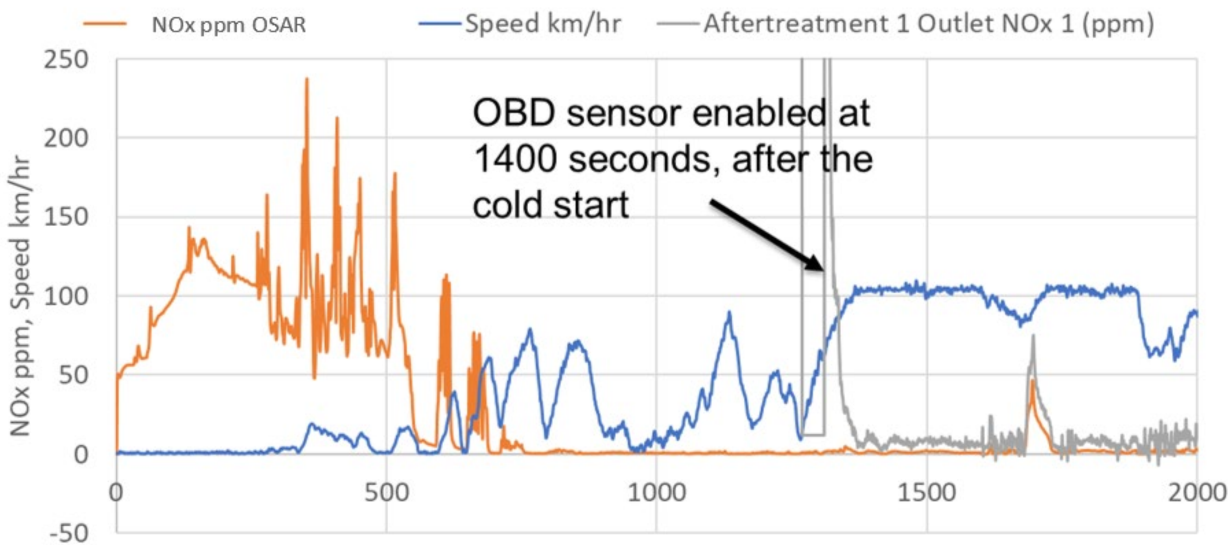
- Onboard Sensing Analysis and Reporting (OSAR) was developed for continuous monitoring of diesel technologies annually
- OSAR started out as a consortium lead research initiative, but has now grown to over nine funded programs
- OSAR includes
  - NOx, PM, GPS, CAN, and other sensors
  - Auto starting and shutdown to capture cold starts and all truck operation

NOx/O2 Module   PM Module   Data Logger (CAN, GPS, LTE)   GPS & LTE Antennas



Data analysis – Methodology & Results

OSAR Sensors Match OEM When Enabled



OBD sensors have demonstrated 10% accuracy over wide range of conditions

- Tan et al., (2018)
- Montes (2018)
- Yang et al. (2018)

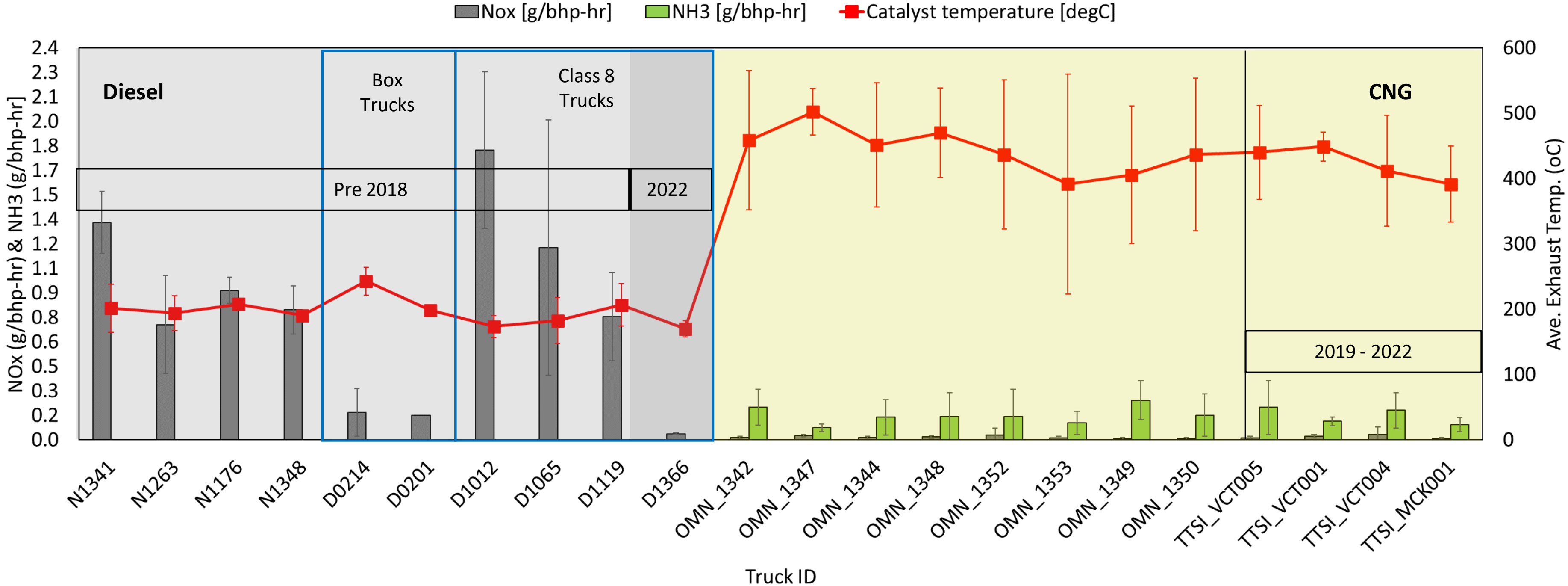
Montes, T., 2018 SAE OBD Symposium Indianapolis, Diesel OBD Programs ECARD Division presentation.

Tan, Y., Collins, J., Yoon, S., Herner, J., Henderick, P., Montes, T., Ham, W., Howard, C., Hu, S., Johnson, K., Scora, G., Sandez, D., Durin, T., 2018. NOx Emission Estimates from the Activity Data of On-Road Heavy-Duty Diesel Vehicles. Presentation at 28th CRC Real World Emissions Workshop, Garden Grove, CA, March.

Yang, J., Durbin, T.D., Jiang, Y., Tange, T., Karavalakis, G., Cocker III, D.R., Johnson, K.C., 2018. A comparison of a mini-PEMS and a 1065 compliant PEMS for on-road gaseous and particulate emissions from a light duty diesel truck, Science of the Total Environment, vol. 640-641, 368-376.

In-Use NOx but is Lowest for NG

Total NOx divided by total power > 80 days



- 2022 DHE vehicle “ID D1366” shows much lower NOx (0.04 g/hp-hr) than MY 2018 and older.
- Large variation of catalyst temperature of CNG vehicle due to different activity performance (frequent start/stops)

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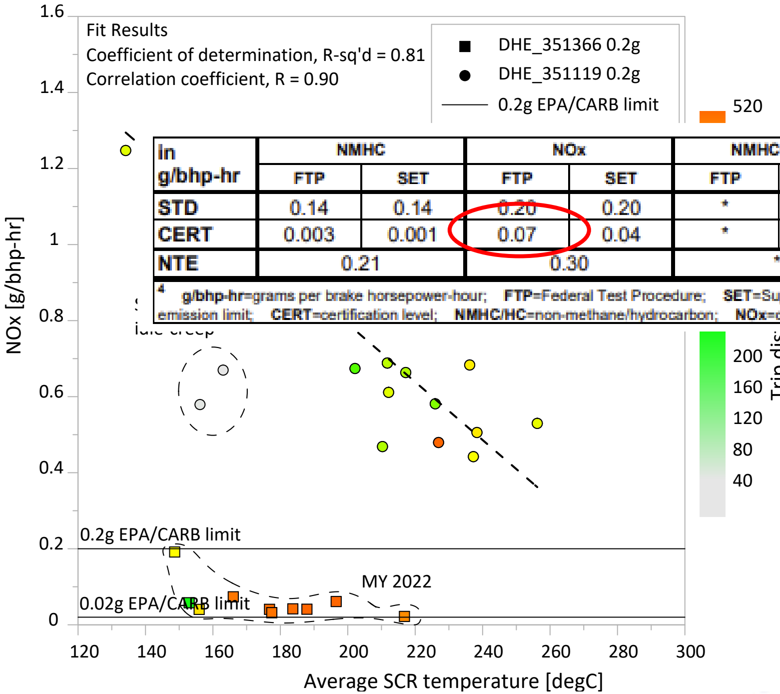
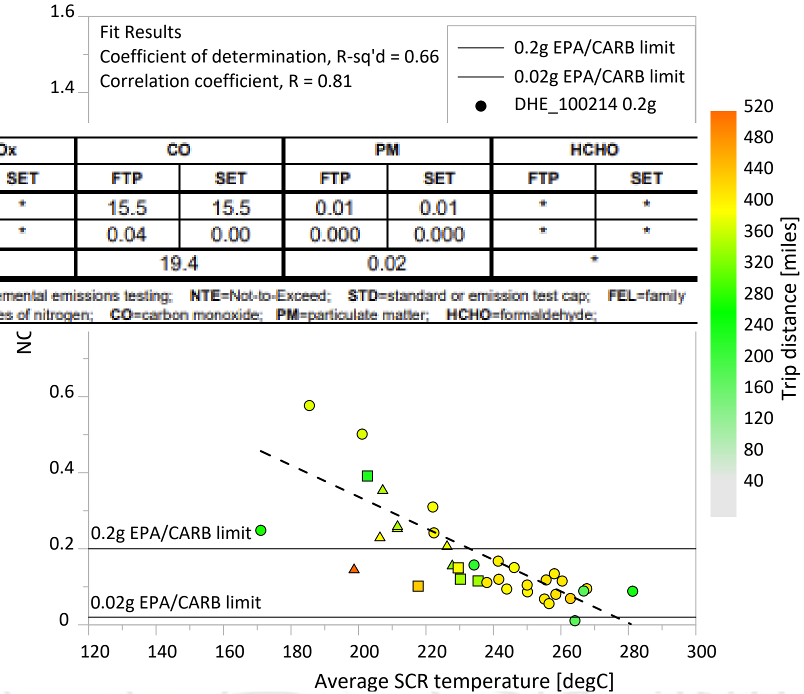
New 2022 Trucks Are Meeting their Design In-Use





in g/bhp-hr	NMHC		NOx		NMHC+NOx		CO		PM		HCHO	
	FTP	SET	FTP	SET	FTP	SET	FTP	SET	FTP	SET	FTP	SET
STD	0.14	0.14	0.20	0.20	*	*	15.5	15.5	0.01	0.01	*	*
CERT	0.003	0.001	0.07	0.04	*	*	0.04	0.00	0.000	0.000	*	*
NTE	0.21		0.30		*		19.4		0.02		*	

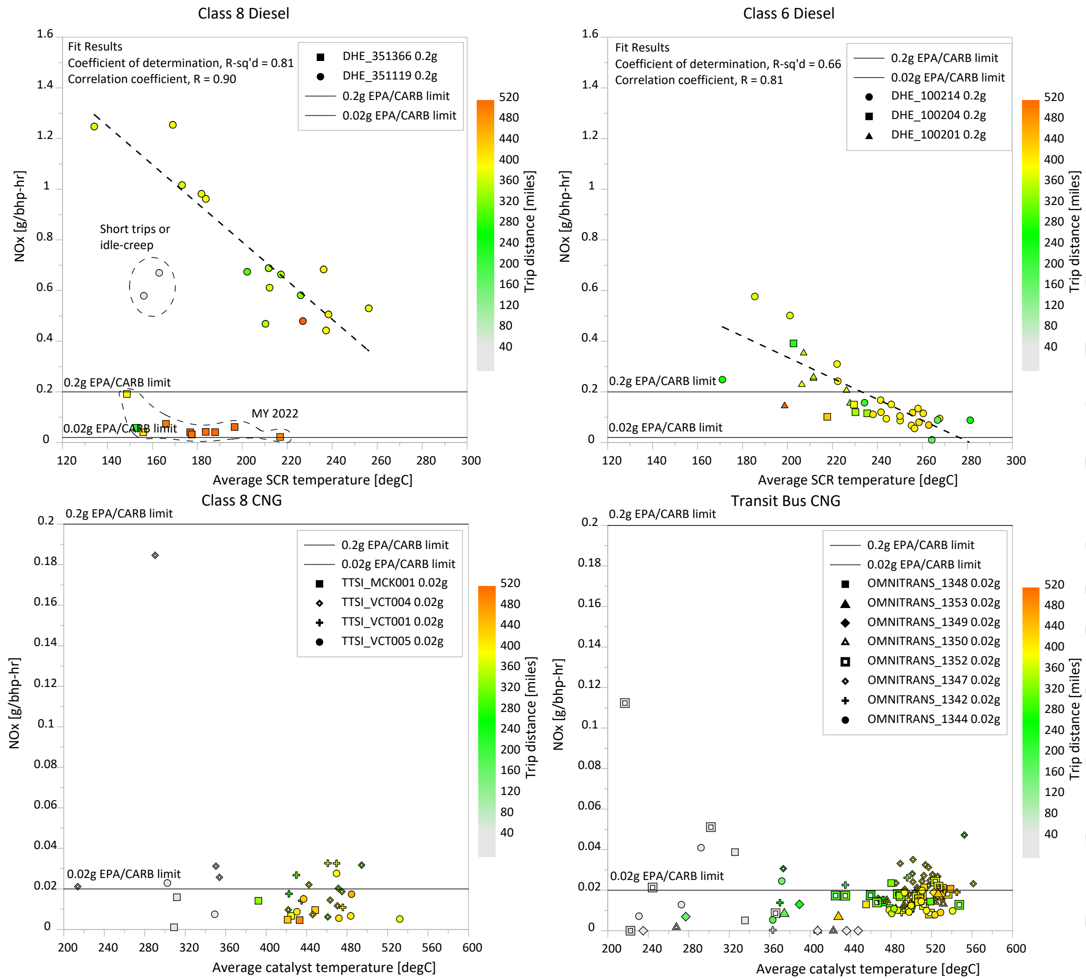
[4] g/bhp-hr=grams per brake horsepower-hour; FTP=Federal Test Procedure; SET=Supplemental emissions testing; NTE=Not-to-Exceed; STD=standard or emission test cap; FEL=family emission limit; CERT=certification level; NMHC/HC=non-methane/hydrocarbon; NOx=oxides of nitrogen; CO=carbon monoxide; PM=particulate matter; HCHO=formaldehyde;

- All Post MY 2020 Class 8 trucks show NOx emission rates [g/bhp-hr] are below 0.2 cert limit
- Some NOx are below the 0.073 BIN2 MAW (2027 – 2030)

0.02 NG Trucks Are Meeting Their Design In-Use

Key findings:

- All newer MY NOx emission rates [g/bhp-hr] are
  - at and below 0.2 limit.
  - One short distance day (140 mi) is at 0.2.
- Most of the NG emission rates
  - are at the 0.02.
  - The NOx sensors were corrected for NH3 using rich/lean corrections.
  - NOx emission performance of CNG vehicles do not change with MY



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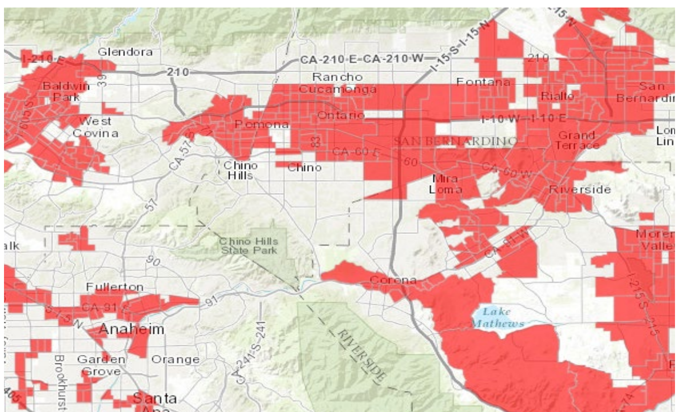
Planned Calculations

- Daily
  - Integrated values
  - EPA 2 BIN MAW
  - UCRs binning method
  - CARB binning
- Hourly CARB REAL binning



UCRs binning method (event based)

UCR performed EPA 3BIN analysis in the following way:

(1) Determine the mean mass percent of CO_2 of a window, $\bar{w}_{CO2win}$, using the following equation:

$$\bar{w}_{CO2win} = \frac{\bar{\dot{m}}_{CO2win}}{\dot{m}_{CO2max}}$$

Where:

$\bar{\dot{m}}_{CO2win}$ = mean mass rate of CO_2 over the valid window (300 seconds average moving window).

$\dot{m}_{CO2max} = e_{CO2FTPFCL} \cdot P_{max}$

$e_{CO2FTPFCL}$ = the engine's FTP FCL CO_2 emission value.

P_{max} = the engine family's maximum power determined according to the torque mapping test procedure defined in 40 CFR 1065.510.

EPA 2 BIN MAW

Vehicle Speed (km/h)

% of Rated Power	0	> 0 ≤ 16	> 16 ≤ 40	> 40 ≤ 64	> 64
≤ 25%	Bin 2	Bin 3	Bin 4	Bin 5	Bin 6
> 25% ≤ 50%	Bin 2	Bin 7	Bin 8	Bin 9	Bin 10
> 50%	Bin 2	Bin 11	Bin 12	Bin 13	Bin 14

Total (Bin 1)

NTE Bin (Bin 15)

Regen Bin (Bin 16)

CARB REAL binning

Next steps and goals

Next Steps

- Continue to deploy hundreds of OSAR systems by the end of 2024.
  - Recruit additional fleets as OSAR deployment expands
- Continue coordinating with sensor suppliers to procure sensors.
- Develop a method to analyze the data to include characterization of vehicle data spatially
- Development of a cloud database for analysis by others.
- Establish a scholarship program

Hydrogen “Simultaneous Time-Fill Refueling System” for transition to large hydrogen demand at Port.

Meeting Material for SCAQMD

Toyota Tsusho America, Inc.
Sustainability Business Development Group

January 23, 2024

Toyota Tsusho's
Zero Emission Port Equipment
Demonstration Project

Surrounding Environment: POLA/POLB and Zero Emission Goal

Be the Right ONE

THE PORT OF LOS ANGELES

POLA Port Equipment List

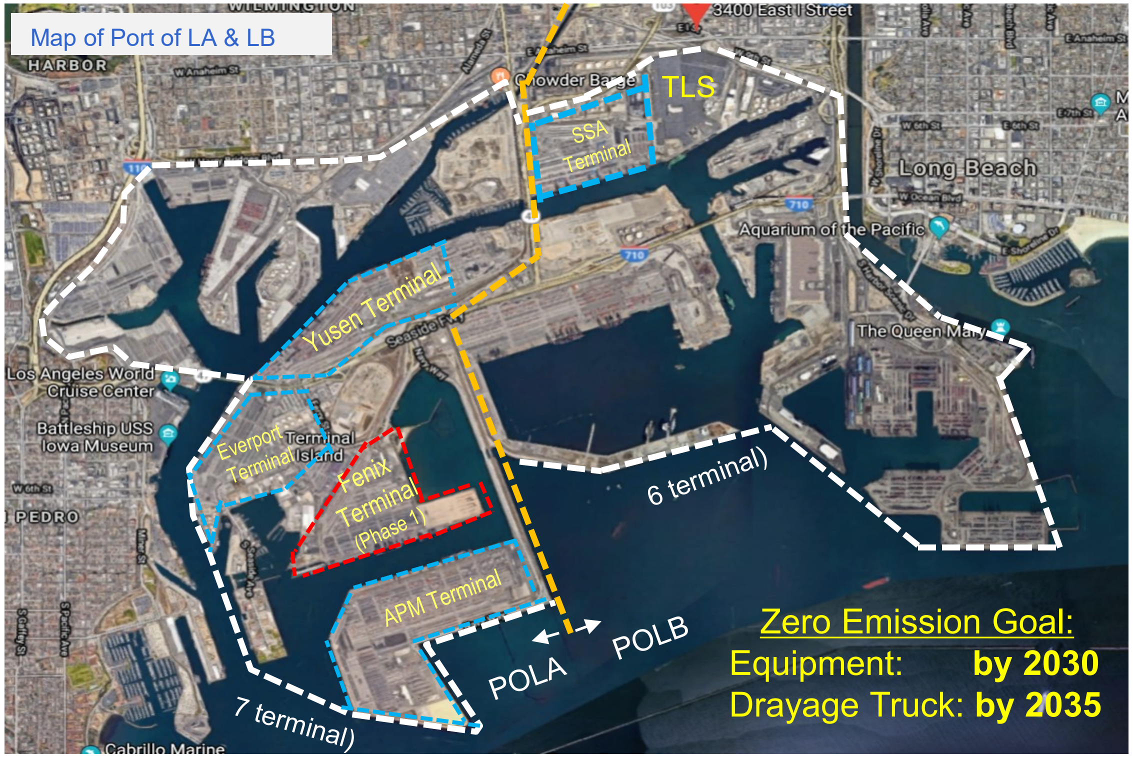
Equipment	Engine Type	Count
Stacking crane	Electric	29
Bulldozer	Diesel	3
Cone Vehicle	Diesel	21
Crane	Diesel	8
Crane	Electric	3
Wharf crane	Electric	86
Excavator	Diesel	1
Forklift	Diesel	110
Forklift	Electric	11
Forklift	Gasoline	7
Forklift	Propane	355
Loader	Diesel	11
Loader	Electric	2
Man lift	Diesel	19
Man lift	Electric	5
Man lift	Gasoline	1
Material handler	Diesel	9
Miscellaneous	Diesel	1
Miscellaneous	Electric	2
Rail pusher	Diesel	1
Reach stacker	Diesel	1
☆ Hybrid RTG	Diesel	13
☆ RTG crane	Diesel	85
Side pick	Diesel	15
Skid steer loader	Diesel	4
Hybrid straddle carrier	Diesel	12
Straddle carrier	Diesel	28
Sweeper	Diesel	8
Sweeper	Gasoline	2
☆ Top handler	Diesel	198
Truck	Diesel	21
Truck	Propane	1
☆ Yard tractor	Diesel	790
☆ Yard tractor	LNG	17
☆ Yard tractor	Propane	158
Total count		2,038

Port of LONG BEACH THE PORT OF CHOICE

POLB Port Equipment List

Equipment	Engine Type	Count
Bulldozer	Diesel	1
Cone vehicle	Diesel	5
Crane	Diesel	2
Excavator	Diesel	2
Forklift	Diesel	98
☆ Hybrid RTG crane	Diesel	15
Loader	Diesel	11
Man Lift	Diesel	12
Material handler	Diesel	2
Miscellaneous	Diesel	2
Rail pusher	Diesel	3
☆ RTG crane	Diesel	39
Side handler	Diesel	7
Skid steer loader	Diesel	2
Sweeper	Diesel	12
☆ Top handler	Diesel	188
Tractor	Diesel	1
Truck	Diesel	12
☆ Yard tractor	Diesel	570
Forklift	Gasoline	24
Man Lift	Gasoline	2
☆ Yard tractor	Gasoline	134
Forklift	Propane	102
Sweeper	Propane	7
Tractor	Propane	5
☆ Yard tractor	Propane	2
Total		1,260

☆ **Hydrogen Fuel Cell favored technologies due to high GHG emission, Long duty cycle (16+hrs/day), high power output, infra feasibility.**



Targeted technology change from "diesel to hydrogen" at port area

Type	Drayage Truck	Top Handler	RTG	Yard Truck
Image				
Units	13,000+	386	152	1,671
Diesel Usage (Average)	30～40 gallon/day	60～80 gallon/day	80～100 gallon/day	30～40 gallon/day
H2 Usage (Estimate)	20～30 kg/day	40～50 kg/day	50～60 kg/day	20～30 kg/day

Over 90% of POLA/LB's GHG Emission from CHE

Toyota Tsusho's Hydrogen Port Equipment Demonstration

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2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029

Phase 1

FENIX MARINE SERVICES — Preparation → Demonstration (1 yr)

Funded by:
- POLA/LB (TAP)
- SCAQMD (Carl Moyer)
- NEDO

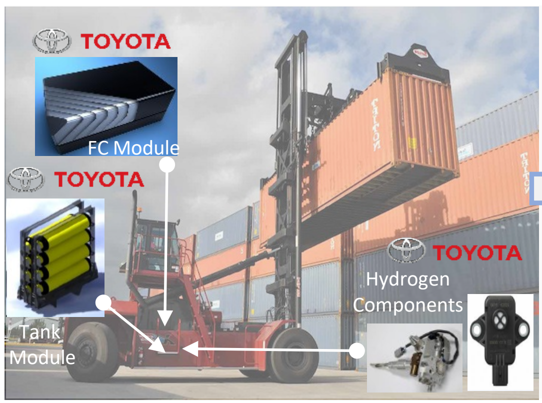
Phase 2

YTI Yusen Terminals LLC — Preparation → Demonstration (4 yrs)

Funded by:
- NEDO

Fuel Cell Powered Top Handler (Repower)

FC Top Handler Design Concept w/ Toyota Components
(For Demonstration)



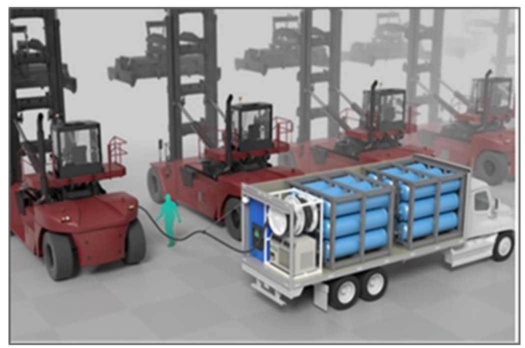
Repower Work in Progress
(For Phase 1)
As of April 29, 2022

FC Module=Phase 1 &2 , Tank and components = Phase 2 (plan)

Hydrogen Mobile Refueler

Phase 1
(Concept Image)

Phase 2
(Concept Image)



Press Release: Our POLA demonstration

TOYOTA TSUSHO CORPORATION | What is Toyota Tsusho? | About Us | Press Room | Sustainability | Investor Relations | Recruit | 日本語 | 中文(簡体) | Search this site

Toyota Tsusho Corporation > Press Room > 2021 > Toyota Tsusho to Start the World's First Long-term Implementation Demonstration Project for the Local Production for Local Consumption of Hydrogen at the Port of Los Angeles in the United States

Toyota Tsusho to Start the World's First Long-term Implementation Demonstration Project for the Local Production for Local Consumption of Hydrogen at the Port of Los Angeles in the United States

https://www.toyota-tsusho.com/english/press/detail/211221_005880.html

2021-12-21

In December 2021, the New Energy and Industrial Technology Development Organization ("NEDO") awarded its grant to Toyota Tsusho Corporation ("Toyota Tsusho") and Toyota Tsusho America Inc. ("TAI") for a technology development project for establishing a hydrogen-based society entitled "Demonstration project for the commercialization of the port hydrogen model at the Port of Los Angeles in North America." To this end, the two companies will commence an implementation demonstration project ("the project") on the use of hydrogen fuel cell ("FC") to power port container handling equipment and drayage trucks*1, and the local production of hydrogen for local consumption specifically at the ports. The project is taking place at the Port of Los Angeles ("POLA"), California, U.S.A. This project is scheduled to be implemented from February 2022 to March 2026 in collaboration with four companies: Mitsui E&S Machinery Co. Ltd., PACECO CORP., Hino Motors, Ltd., and Hino Motor Manufacturing U.S.A., Inc.

Theme

Mail Delivery Service

Our Goal: To develop hydrogen value chain business model.

(Creating Supply and Demand together)

Challenge of Port Electrification = Hydrogen as needed solution.

Study Regions	Terminal Component	Required Power Demand (MW) 2035 On-Shift UTR Charging	2035 Off-Shift UTR Charging	2040 On-Shift UTR Charging	2040 Off-Shift UTR Charging
	Buildings & Area Lighting	51.1	51.1	51.1	51.1
	eCHE	169.4	230.9	203.7	244.0
	Reefer Power	89.0	89.0	98.5	98.5
	Shore Power*	73.9	73.9	78.7	78.7
	Drayage Trucking	125.6	125.6	137.0	137.0
	Totals	**509.1**	**570.6**	**569.0**	**609.4**

Source: Technical Memorandum "Electrification of California Ports"(Moffat & Nichol), June 2021

To put this power requirement into some perspective.

- 1 MW can power between 400 and 900 U.S. households. Using an average of 650 households per MW, the 2040 study region power demand of approximately 600 MW could power about 390,000 households, or a U.S. population of about 1.0 million.
- Total power demand from the port regions in 2035 and 2040 would require 50% and 53%, respectively, of one reactor at the Diablo Canyon Nuclear Power Generating Station, which is scheduled for shut down by 2025,

Grid Power Capability = Not enough for port electrification.

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Hydrogen Demand Potential (Estimate) at Port of LA/LB

Equipment Type	Qty (Units)	Case 1 (H2 100%)	Case 2 (H2 50%)	Case 3 (H2 30%)
Yard Truck	1,614	18,012	9,006	5,404
Top Handler	390	5,686	2,843	1,706
RTG	159	2,576	1,288	773
Total (kg)		**26,274**	**13,137**	**7,883**

Unit=1,000kg The estimated demand is annual volume (360 days)

THE PORT OF LOS ANGELES

Port of LONG BEACH THE PORT OF CHOICE



H2 Usage Assumption ＊ 31kg/day | 45kg/day | 40.5kg/day

＊Source：DOE Hydrogen Fuel Cell Application in Ports

VS

H2 demand in California for Passenger Vehicle (FCV) (CARB Est. by 2030)

＊CARB: California Air Resource Board

Key Points:

- **With assumption, H2 demand in port area is substantially large.**

  1) 100% shift: 26,274 ton/yr. (72 ton/day) **2) 50% shift: 13,137 ton/yr.** (36 ton/day) **3) 30% shift: 7,883 ton/yr.** (21 ton/day)

- **If includes H2 demand for Drayage Trucks, the demand gets even larger.**

  (Note: drayage trucks can refuel hydrogen not only near port area but other areas .)

  100%: 360 ton
  50%: 180 ton
  30%: 120 ton
  Per day

Note: Toyota Tsusho as well as POLA/LB terminals also studies the potential and feasibility for BEV equipment. But for the 3 main equipment, we pursue H2 fuel cell demonstration as favorable option.

Hydrogen Demand => Lower Cost => Accelerate Market Expansion

Be the Right ONE

Repowered Hydrogen Fuel Cell Top Handler (First in the World)

Same Machine

Before Repower（Diesel）

After Repower（FC-Fuel Cell）

We painted the top handler green.

Why Hydrogen Fuel Cell for Top Handler, Why not battery?

- **High Power Output**

  It requires as high as 1.3MWh at rail yard

- **Long Duty Cycle（2 shift = 16 hours)**

  Refueling/charging hour 3am to 7am (4 hours)

- **Refueling/Charging Time**

  If installed 1,000kWh battery = 4 hours (@250kWh)

- **Battery Life**

  Fast charge (high voltage) everyday

  =>degrade the battery, shorten the life of the product.

- **Infrastructure for charging**

  If a terminal (ex Fenix Marine) has 50 top handlers

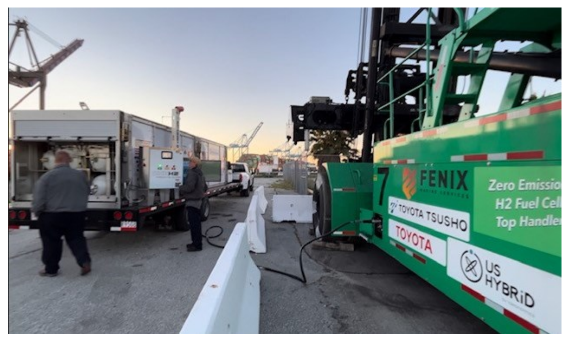
  Ex. 1,000kWh x 50 units = 50,000kWh (50MWh) !

So, How H2 is refueled to the equipment?

Diesel Refueling at LA port terminal (between 3am – 7 am)

We refuel hydrogen the same way as diesel refueling.

(Terminal and ILWU preferred method: No change in refueling labor work, very small footprint, agile and flexible)

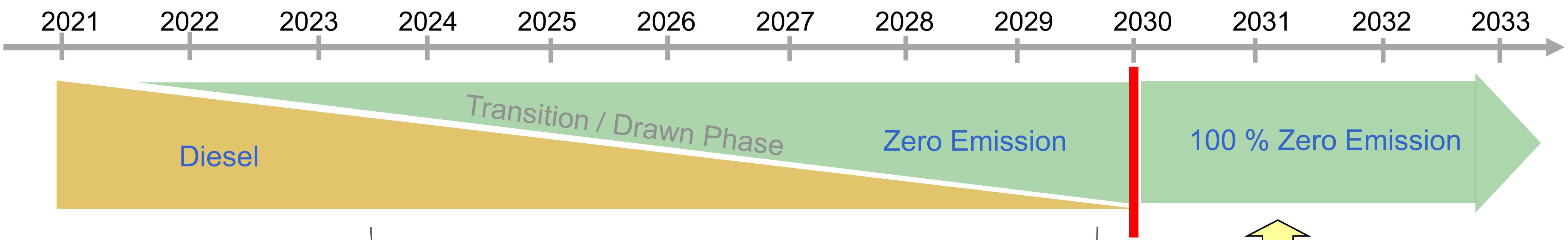


NEXT PAGE: For larger scale refueling, we are developing new refueling system =>

Repowered Equipment Potential

OEMs are not quite ready for commercialized deployment.

For short term, repowering existing equipment inventory is a likely solution before 2030 zero emission goal.



POLA/POLB


386 units


1,671 units


152 units

Repower diesel equipment w/ fuel cell system

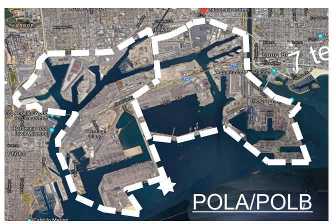
Why "Repower" ?

- Existing equipment are still usable.
- Repower is still cheaper option
- Equipment OEMs, not ready for Zero Emission
- **ILWU (Labor Union)** supports repower & maintenance

100% Zero Emission Ports' Goal

OEM will be ready

HYSTER-YALE, TAYLOR, KALMAR, PACECO CORP., CATERPILLAR, KONE, CAPACITY, ZPMC, MI-JACK PRODUCTS



Enhanced incentives/grant program is needed for:

- Equipment
- Infrastructure

We are under negotiation with funding authorities.

Zero Emission Top Handler Demonstrations at POLA

(Each has different specs for technology validation, ours is also a "MUST DO" demonstration.)

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All of these demonstration will be good technology validation opportunity

Our Demonstration Top Handler "Green Machine"

Taylor @ Everport Terminal

- **Battery-Electric Type**
- (1 MW (1,000kWh) Battery)

Status:

- **Already started**

Challenge:

=> **Battery duration**
(last 16hrs (2 shifts?)
=> **Charging station.**
(Future mass deployment maybe challenging for
- Footprint,
- Large power requirement
- High Investment amount

Hyster-Yale @ Fenix Terminal

- **Battery & Fuel Cell Hybrid**
- (350kWh Battery & 27kg H2 tank)

Status:

- **About to start (Nov.2022)**

Challenge:

=> **Battery/Hydrogen duration**
(last 16hrs (2 shifts?)
=> **Charging/refueling station.**
Future mass deployment maybe challenging for
- Two infrastructure needed, (Battery & Hydrogen)
- Footprint,
- Large power requirement
- High Investment amount

Toyota Tsusho @ Fenix Terminal

- **Fuel Cell Dominant System**
- (FC：80kW, H2: 60kg & 105kWh Battery)
  → Toyota Fuel Cell Module (Gen2)

Status:

- **About to start (Nov.2022)**

. Advantage:

=> **Hydrogen dominant:**
(No battery charging station required.)
=> **Hydrogen supplied by mobile refueler**
- No stational infrastructure needed. (Quick "Refuel and Go" concept.)
- Minimum Footprint,
- No power from terminal needed for power source
- Low Investment amount

*For future mass deployment, we have additional simultaneous mass refueling system that is currently being developed.

What we learned from our demonstration project.

<u>H2 Mobile Refueler</u>
- 467kg Loadable –
930 bar cylinders with duel dispensers for 700 bar and 350 bar refueling.
(Chiller on board)

<u>Hydrogen Usage Result:</u>
- Top Handler -
Container Yard: 60 – 80 kg / 2 shifts (16 hrs)
Rai Yard: 80 – 110 kg/ 2 shifts (16 hrs)

Top Handler requires lots of power = lots of hydrogen

(At rail yard operation, it could use up to 110kg/2 shifts =>GH2 Mobile Refueler (467kg) will serve just a few top handlers)

Mobile Refueler will mainly be used for RTG.

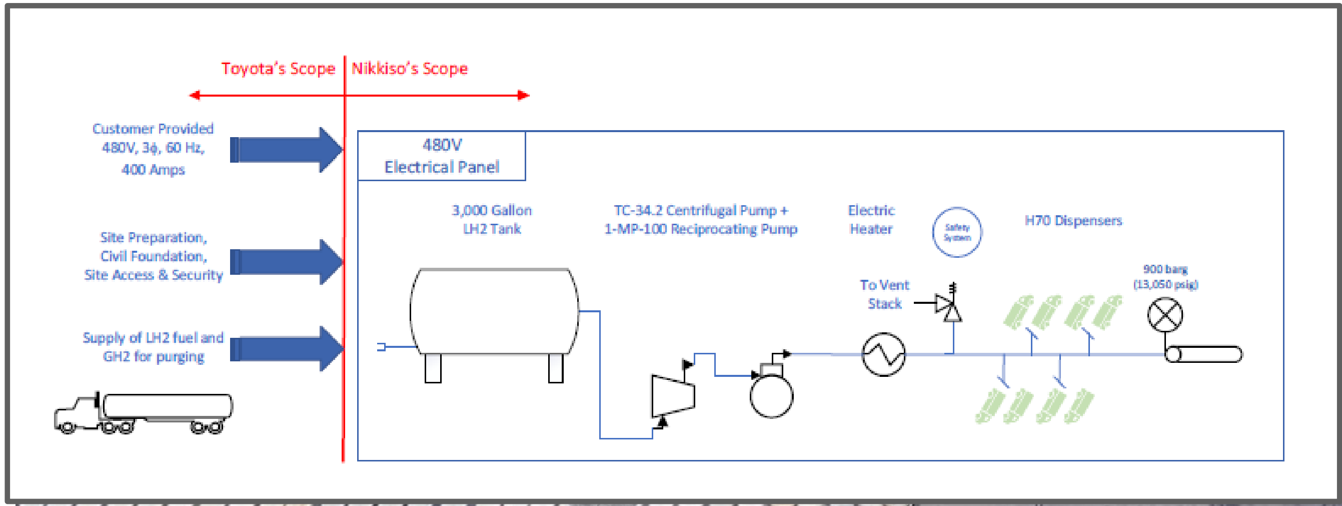
(For Top Handler and Yard Truck, Mobile Refueler will be a useful "Emergency Refueling Tool".)

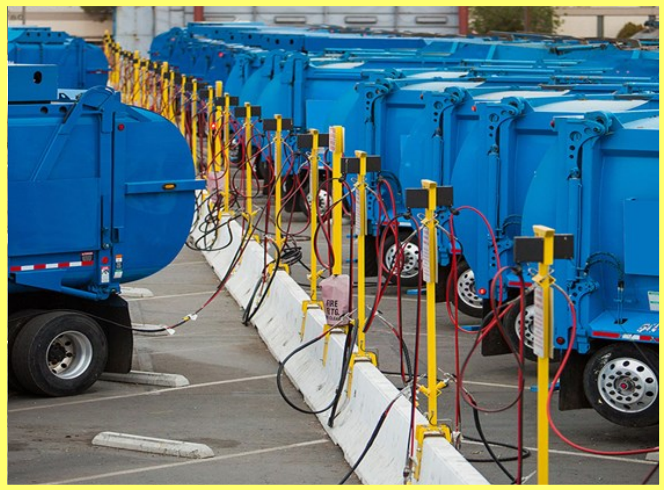
Next Step: We need "Simultaneous Mass Refueling System" for Top Handler & Yard Truck.

Simultaneous Time Fill Refueling System

We are seeking funding opportunity

Simultaneous H2 Time-Fill Refueling, Future Concept

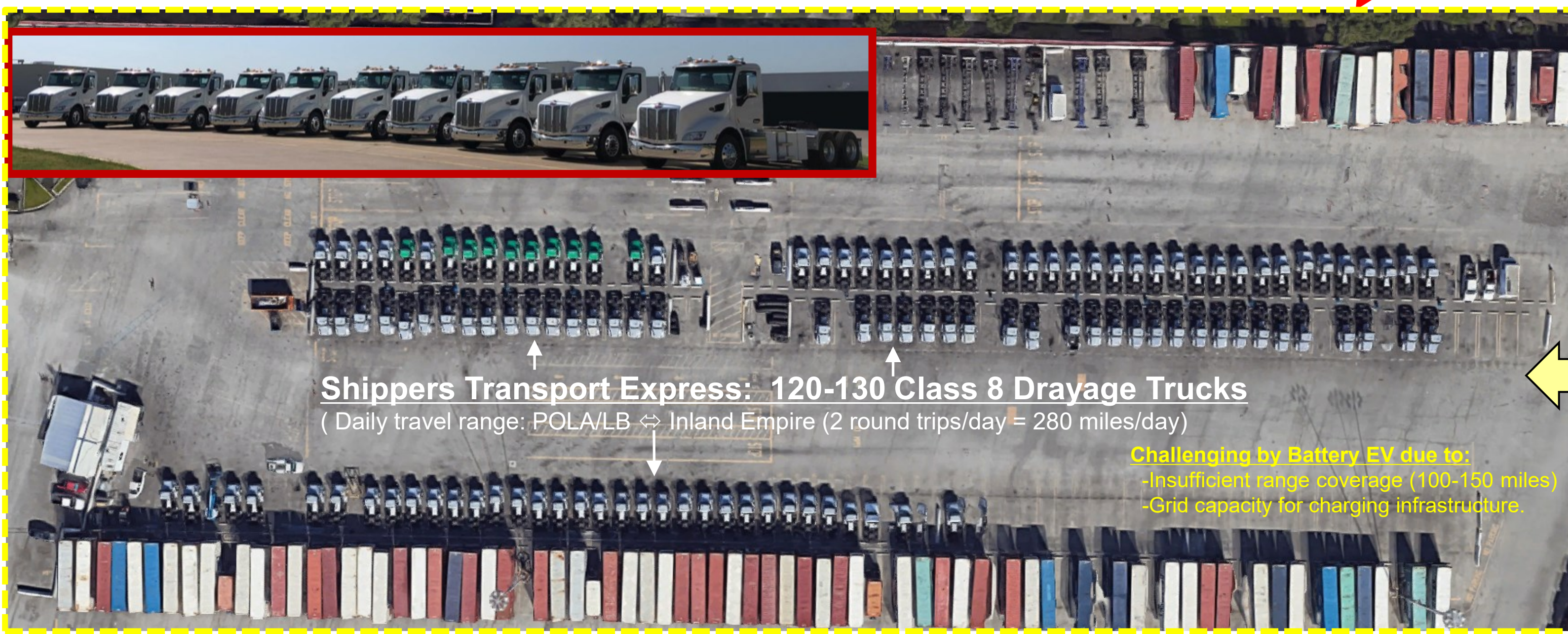




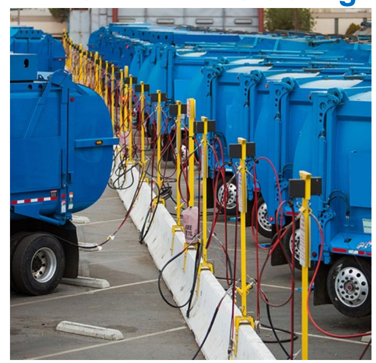
Together with hydrogen mobile refueler, this refueling system will support the hydrogen supply to port terminals

Same Concept for Drayage Trucks application

(Shippers Transport Express – Class 8 Drayage Truck Fleet Operator)

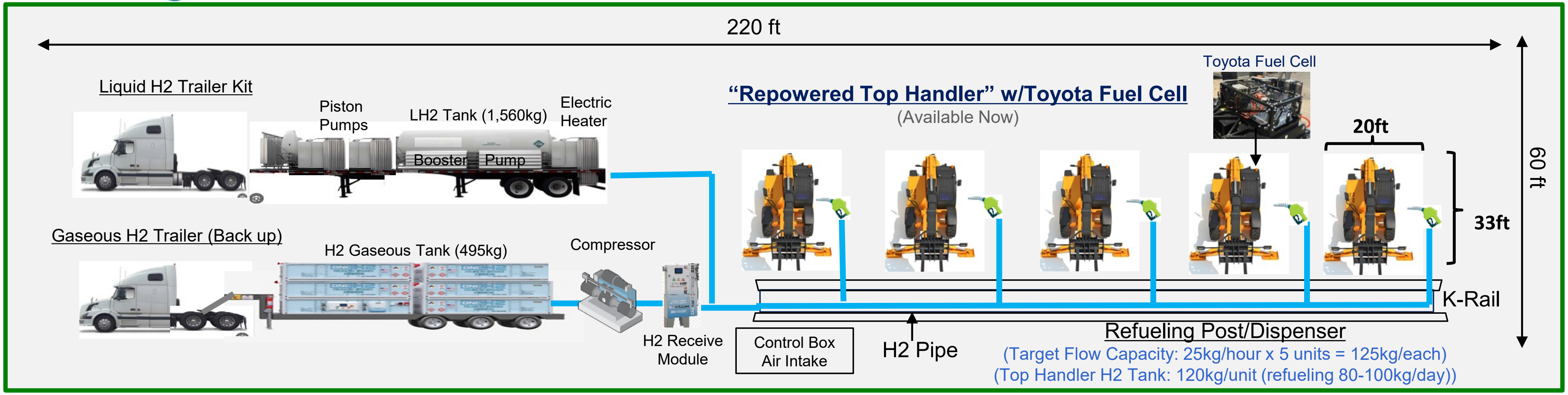


Another Application for Time-Fill H2 Refueling



Shippers Transport Express prefers hydrogen fuel cell class-8 trucks for zero emission solution for range coverage and for concerns of potential requirement for large investment grid upgrade (sub-station).

Simultaneous H2 Time-Fill Refueling, Demonstration Concept



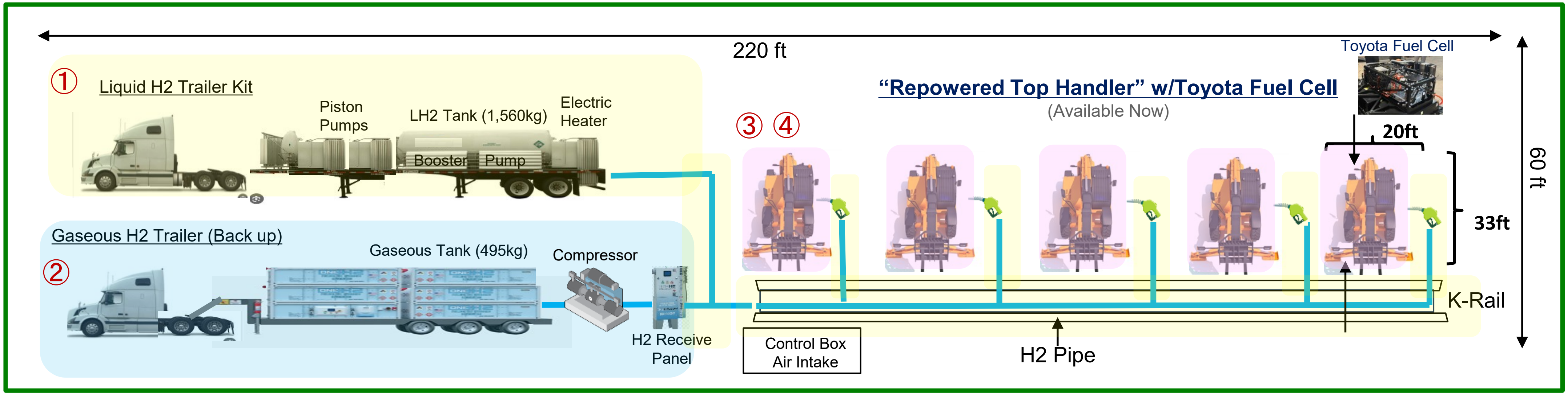
Why Hydrogen "Simultaneous Time-Fill" Refueling System?

- Already **established technology** for CNG fleets => Reliable. (H2 needs temp & pressure control)
- **Cost Effective**: No high flow nozzle, Nearly automated, Low maintenance/repair.
- **Small footprint** with simultaneous refueling capability suitable for "Return-to-Yard" operation.
- **"Mobile Design Concept"** => fast installation/relocation/removal, fast/simple permit process.

We will validate thru this project for :

- **Technical and Economic feasibility.**
  (H2 temp & pressure control, H2 flow rate thru first to last unit, maintenance/repair cost)

Project Cost

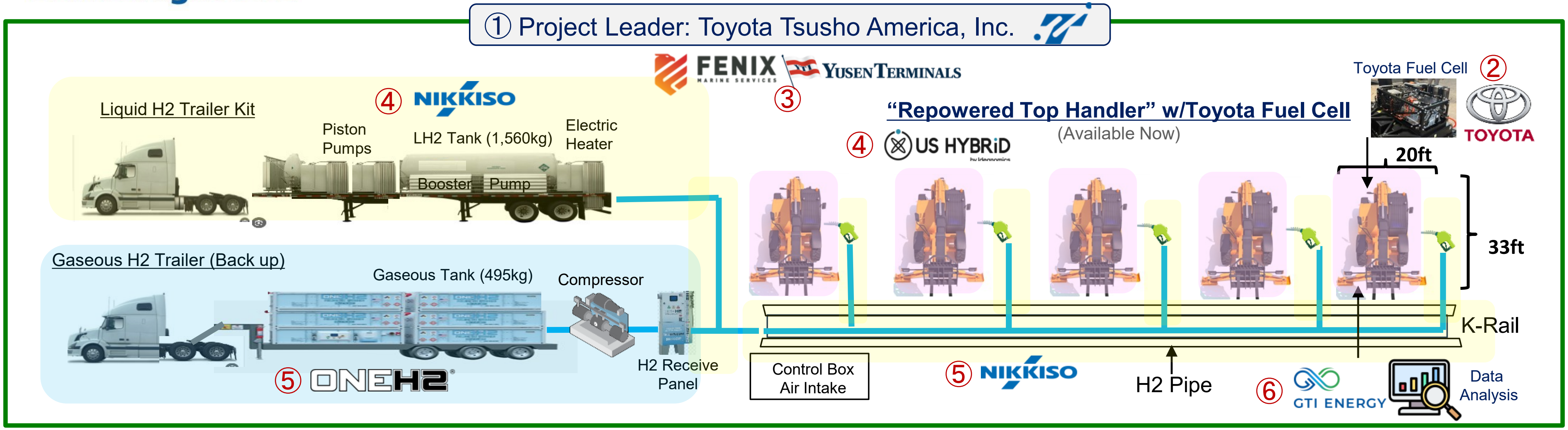


Project Cost Estimate Breakdown (1 year demo)

					Project Team			SCAQMD	
#	Items	Qty	Unit Cost	Total Cost	Cost Share	In-Kind	%	Grant	%
1	Liquid H2 Trailer Kit and Time-Fill System	1	$3,500,000	$3,500,000	$1,750,000		50%	$1,750,000	50%
2	Gaseouse H2 Trailer, Compressor, H2 Panel	1	$1,850,000	$1,850,000	$925,000		50%	$925,000	50%
3	Used Top Handler (diesel) x 5 units	5	$270,000	$1,350,000		$1,350,000	100%		
4	Repower Cost (5 Top Handlers)	5	$1,400,000	$7,000,000	$3,500,000		50%	$3,500,000	50%
5	O&M Cost (Top Handler)	5	$780,000	$3,900,000		$3,900,000	100%		
6	Gear-man refueling cost	1	$102,300	$102,300		$102,300	100%		
7	Fuel (LH2 & GH2) Cost 500kg/day x 210 days x $15/kg	1	$15.00	$1,575,000	$1,575,000		100%		
			Total	**$19,277,300**	**$7,750,000**	**$5,352,300**	**68%**	**$6,175,000**	**32%**

*We plan to produce our own "Port Use Dedicated" hydrogen (Gas and Liquid) near POLA/LB.

Project Partners



	Logo	Company Name	Company Role	Remarks
1	TOYOTA TSUSHO	Toyota Tsusho America, Inc. (TAI)	Project Developer/Leader/H2 provider (LH2)	・TAI is conducting 2 on-going demo projects at Fenix and Yusen Terminal ・Plans to collaborate with large industrial gas company for H2 production. (2027～)
2	TOYOTA	Toyota Motor North America	Fuel Cell Provider	・As known, Toyota's fuell cell is most used and reliable in mobility industry. ・Toyota fuel cells are used all of TAI's port demo at Fenix and Yusen.
3	FENIX or YUSEN TERMINALS	Fenix or Yusen Terminal	Operation Host/Top Handler Provider	・Both Fenix and Yusen are TAI's current 2 on-going port demo host partners. ・Both terminals wants to implement the time-fill system after successful demo.
4	US HYBRiD	US Hybrid	System Integrator (Repower)	・System integrator (repower) for TAI's current demo project at Fenix and Yusen. ・One of the few integrator in the U.S wih fuel cell equipment expertise.
5	NIKKISO	Nikkiso	LH2 Trailer Kit & Time-Fill refuel system	・Over 75 years of experience in design, sales and service of cryogenic machinery, process systems and heat transfer equipment.
6	ONEH2	OneH2	GH2 Tank Trailer/Compressor/H2 Provider	・Current H2 provider/mobile refueler manufacture for TAI demo (Fenix and Yusen) ・They are the only company who manufactures 930 hydrogen mobile refueler.
7	GTI ENERGY	GTI Energy	Project Management/Data Analysis	・Current data-analysis partner for TAI's demo project at Fenix and Yusen Terminal. ・Project developer for FC-Yard Truck (Capacity) demo project at Trapac Terminal.

Hydrogen Production Plan

We are preparing our own hydrogen production for "self-sufficient" and "sustainable supply" to ensure our customers have stable hydrogen supply.

Our Hydrogen Production System (Compact Modular System)

Hydrogen Production Equipment (OneH2=our partner) 400kg/day

"Steam Methane Reformer"(SMR)

53 ft (same size as 53' domestic container trailer)

Advantages vs conventional SMR

- All-in-one and compact design that can easily transport by conventional container tracks.
- Easy and fast installation and removal.
- Function redundancy considered by modularized design.
  (simply replace the module for repair and maintenance)
- Hook up to power and natural gas source for completely independent H2 production, ensuring users have what they need when they need it.
- SMR is currently the cheapest hydrogen production method.
  (Tsusho is considering "Electrolyzer" as well but it is more costly now.)
- Feedstock with biogas (Instead of natural gas)=>Clean Hydrogen
- Carbon capture option is also available.

Conventional SMR

⇩ Load to mobile refueler for delivery.

Collaboration with LACSD-JWPCP (Carson) for H2 Production with Organic Waste Biogas (RNG)

Toyota Tsusho is teaming up with Los Angeles County Sanitation District (LACSD)'s Joint Water Pollution Control Plant (JWPCP) in Cason for H2 production and use (2025~)

Municipal Organic Waste => Biogas (RNG) => Hydrogen => Port Equipment (An ideal eco-system)

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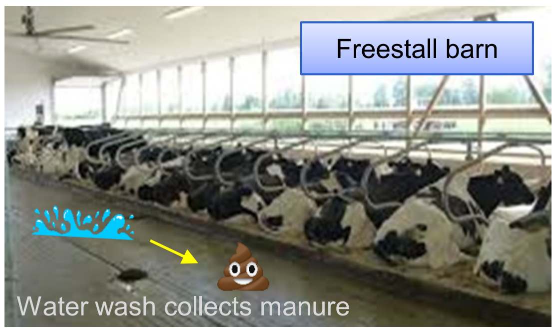
Our Invested RNG (Renewable Natural Gas) Project

① Biogas (RNG) in Hydrogen Value Chain

Our Hydrogen Value Chain Model

RNG plays an important role for our hydrogen production energy source

② Dairy farm digester structure



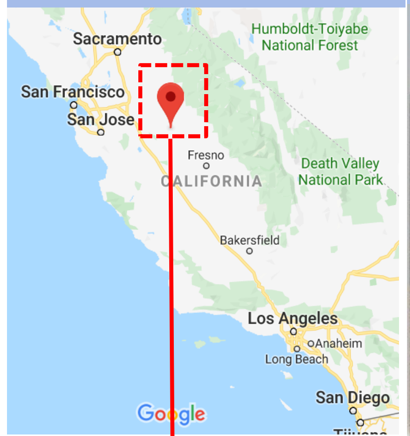
Sago-san's site visit (11/1/2021)

Ribbon Cutting Ceremony (12/6/2021)

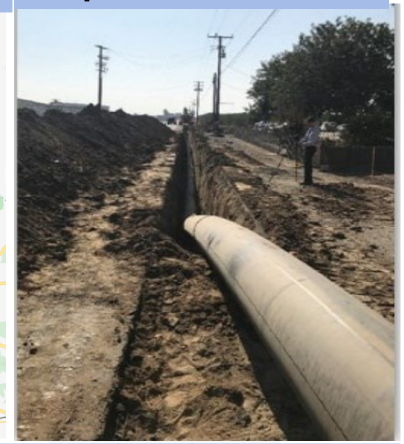
2022 Prod. Volume: 338,990 mmbtu/year (2,179,705 diesel gallon equiv.)

③ Merced Pipeline Project (TAI invested project)

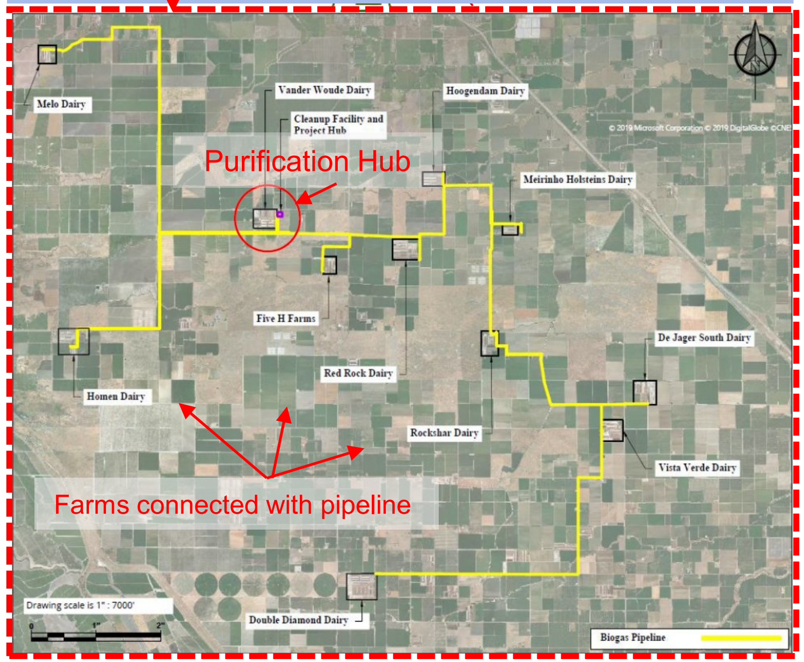
Project Location



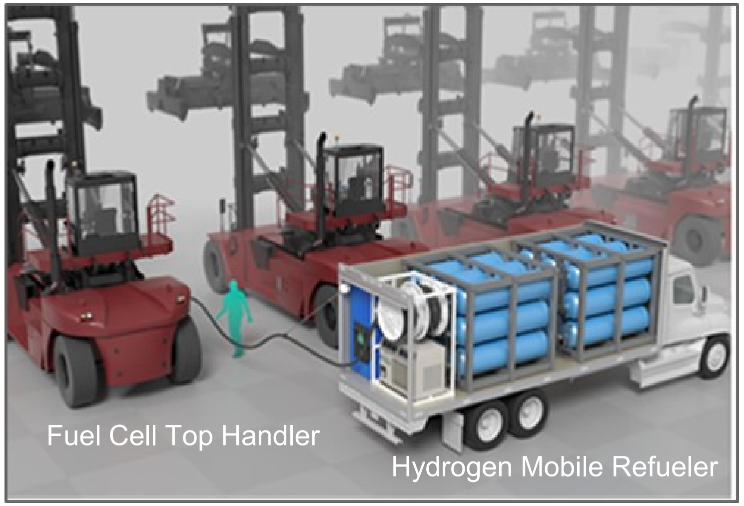
Pipeline to Central



Pipeline and Dairy Map



Advantage and Challenge of Fuel Cell and Hydrogen



Advantage:

- **Zero Emission**
- **Proven Technology** (Fuel Cell) in mobility use. (ex. Toyota Mirai)
- **Safe and sustainable** alternative fuel.
- **Quiet** operation. (vs diesel)
- **Similar** fueling process/**experience** as **diesel**.
- Relatively **fast refueling** time
  【Note: Slower than diesel, but faster than battery charging.】
- **Small footprint** for **refueling infrastructure and relatively easy and fast set-up.**

Challenge:

- **Higher cost** on equipment/hydrogen in initial implementation phase.
- **Lack of equipment** availability by OEM.
- **Lack of experience**:
  a) User confidence
  b) Permit process.
  c) Incentive availability

Overcome this challenge

⇩

Faster market development

Thank you!

For contact:

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E-mail: toru_sugiura@taiamerica.com

ZERO EMISSION INDUSTRIES

Enabling Hydrogen for Maritime Through Mobile Refueling Solutions

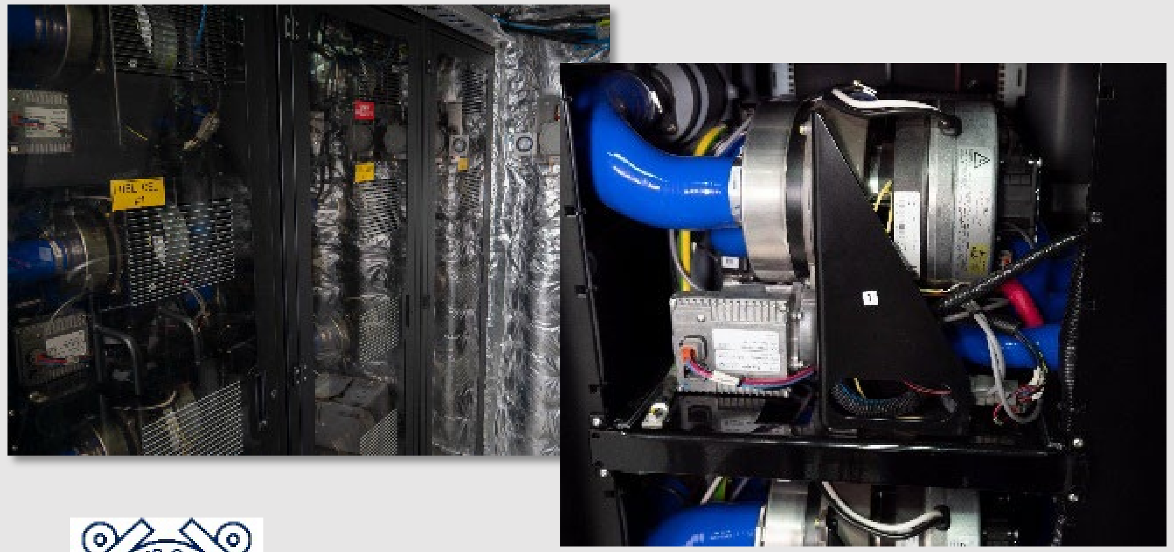
Clean Fuels Program Advisory Group
1//23/24

Previously known as:

GOLDEN GATE ZERO EMISSION MARINE

Video of maritime vessel
(not available online)

2021 Power System



USCG Approved

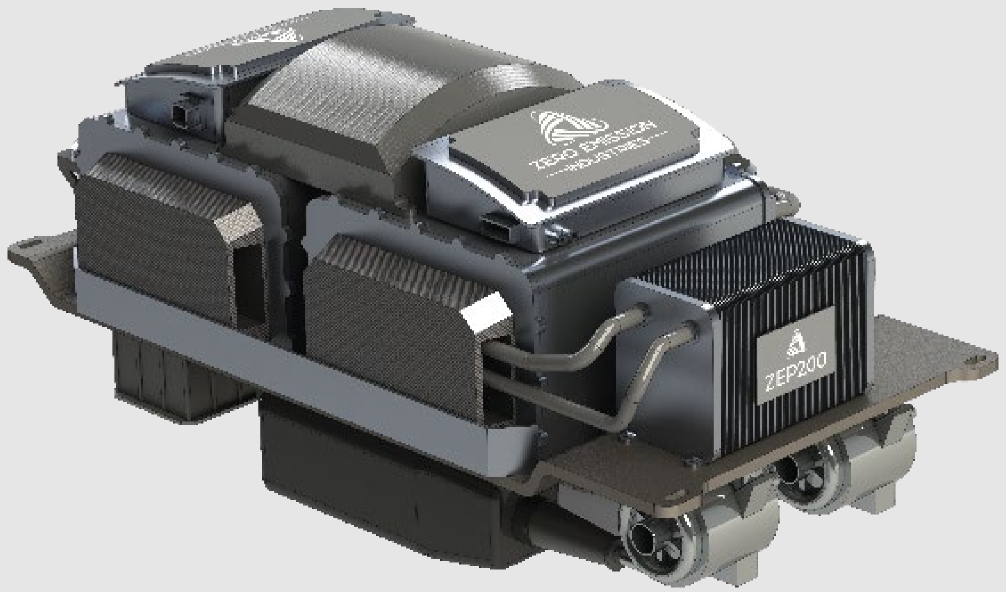
2015 Port Power System

2021 Fueling System

USCG Approved

ZERO EMISSION INDUSTRIES

{Products}



ZEI's

Marine Powertrain

Power Box

Maritime Power System

ZEI FIB

Fuel Interface Box


SF Bay Ferry

ZEI FIB

Fuel Interface Box

<u>US Patent Awarded March 14, 2023</u>

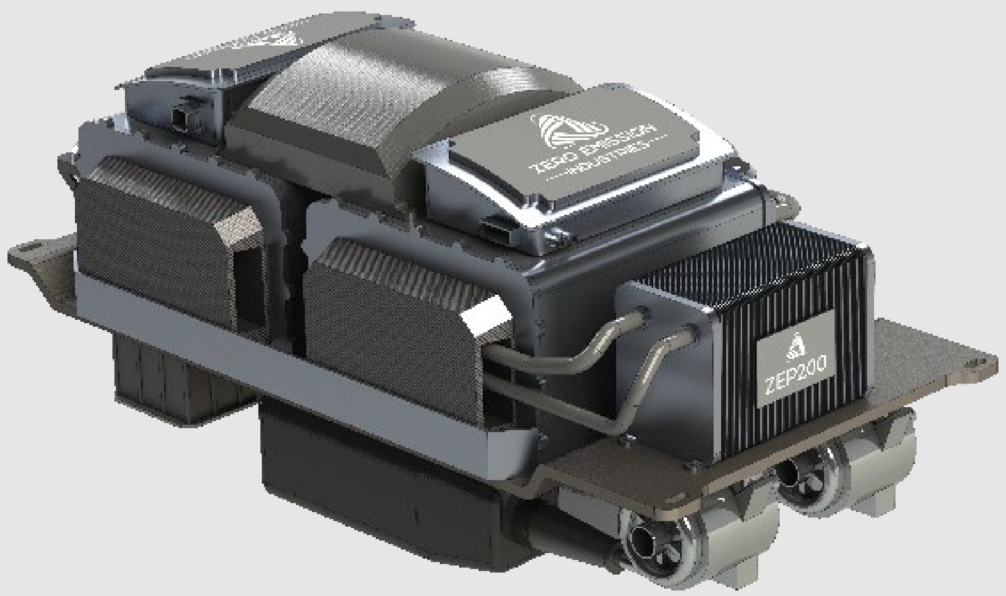
Additional US and International Patents Pending

What it Is:

- Fuels anything, anywhere with gaseous hydrogen
- Zero Infrastructure – immediate deployment
- Man portable
- Software driven, operable by anyone

Any H_2 Source

Any Maritime User



ZEI's

Marine Powertrain

What it Is:

- Turnkey, Drop-in Hydrogen Fuel Cell Power System
- Optimized For Marine
- Stackable and Scalable 200 kW – 10 MW+
- Installation and Operation with Normal Marine Industry Skills
- Cloud Based Real Time Data Capture
- Smaller, Lighter, Less Expensive than Competition

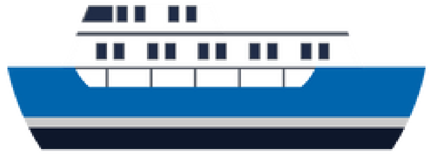
Power Box

Maritime Power System

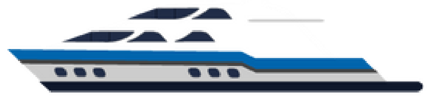
Value Prop:

- **Ports have significant electric grid bottlenecks and cannot physically support increased electrification in a cost-effective or timely way. The power box gives instantly deployable electricity where grid power is unavailable**
- Immediate charging of electric port equipment and trucks
- Allows ships to meet cold-ironing requirements at berth
- Charges e-tugs and harbor craft anywhere they dock
- Moveable to where the power is needed: Shore, Barge, or Deck

Revolutionary Hydrogen power and fueling solutions for the maritime industry



Ferries



Yachts

Recreational

Port Power & Microgrids


HYZON
HYZON
ZERO Emissions
ZERO Compromise


HYZON
HYDROGEN GAS COMPRESS

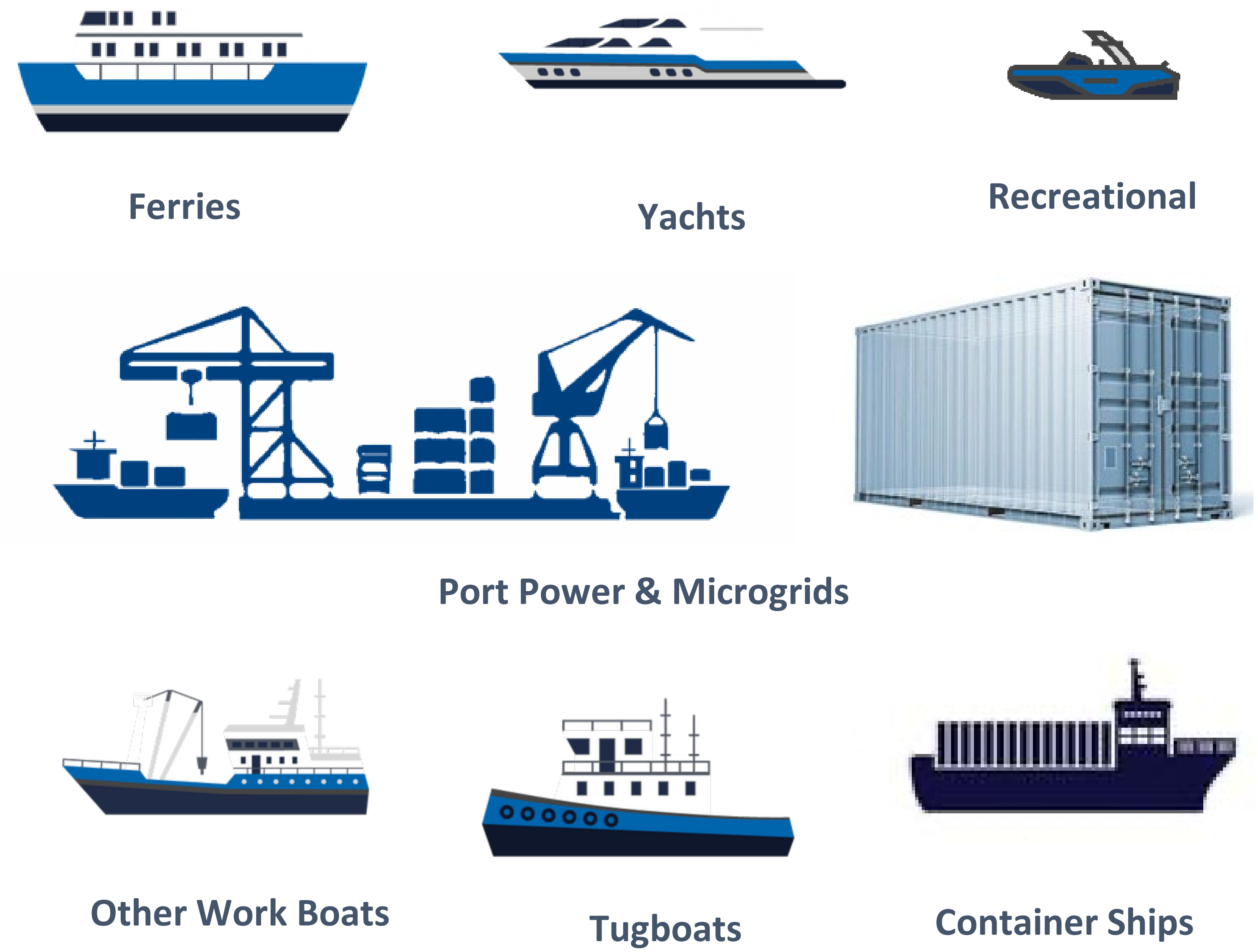

E-STOP
PURGE
INLET VENT
OUTLET VENT
FUEL
ZERO EMISSION
INDUSTRIES
PURGE
IN
OUT

Project Impact

Gaseous H2

Liquid H2

Revolutionary Hydrogen power and fueling solutions for the maritime industry



Thank you!

Please reach out with any questions or inquiries

Contact Info:
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Chief of Staff
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ZERO EMISSION INDUSTRIES

Microgrid Infrastructure: Supporting Zero-Emission Transportation

Technology Advancement Office
Program Supervisor

Seungbum Ha, PhD

Impact on the Grid by Heavy-duty EVs

Charging 100 Electric drayage trucks:

- 400kWh/truck * 100 trucks = 40MWh /day
- 150kW * 100 trucks = 15MW & 3hours continuous charging

Fueling 100 Hydrogen drayage trucks:

- 30kg * 100 trucks = 3ton of hydrogen

Grid or hydrogen station can support cost-effectively?

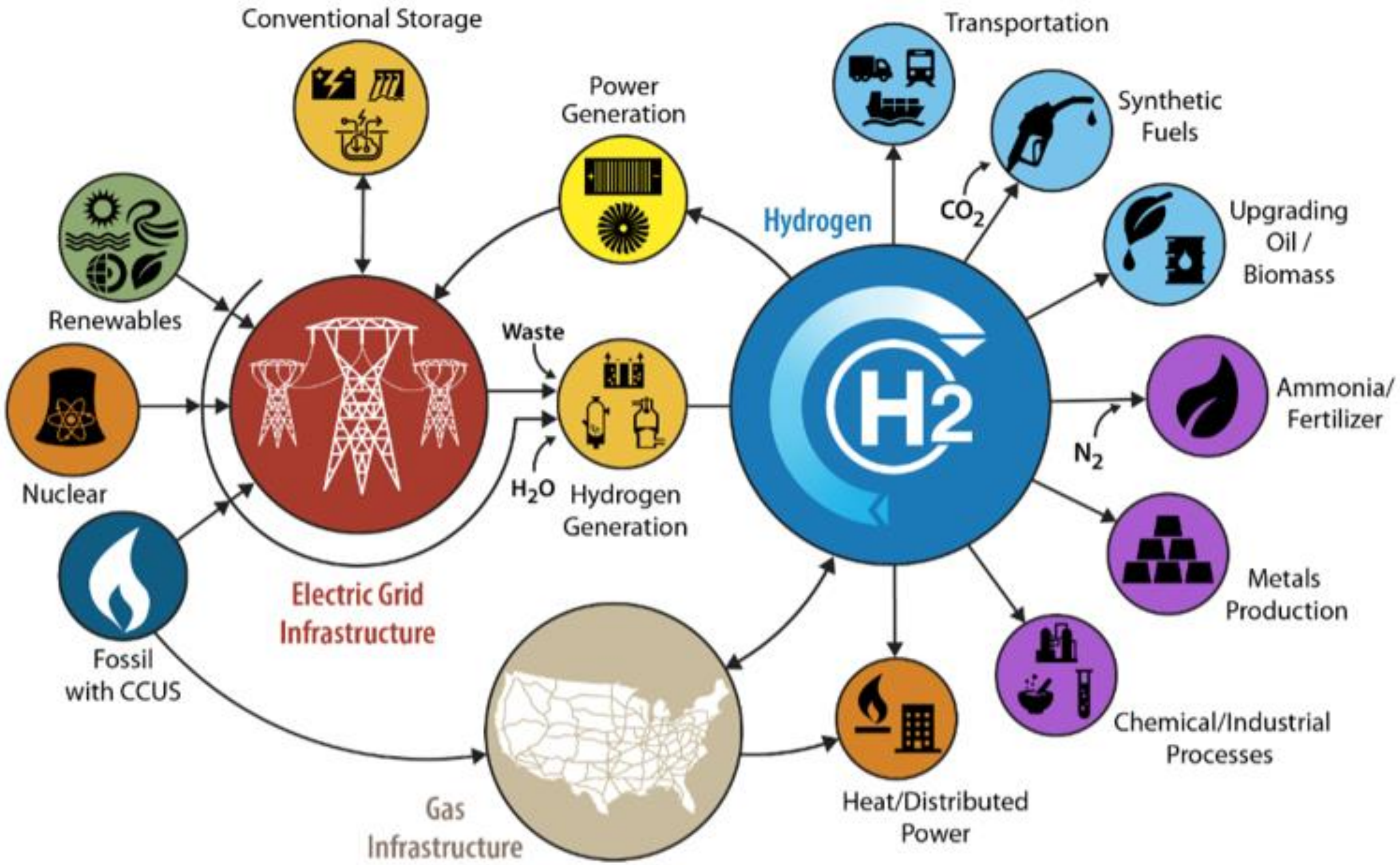
How to add resiliency to avoid grid interruptions?

Renewable energy?

Duck curve?

Electricity storage: Hydrogen

Conceptual H2@scale (hydrogen at scale) energy system



Source: U.S DOE, Hydrogen program plan

How to produce Hydrogen

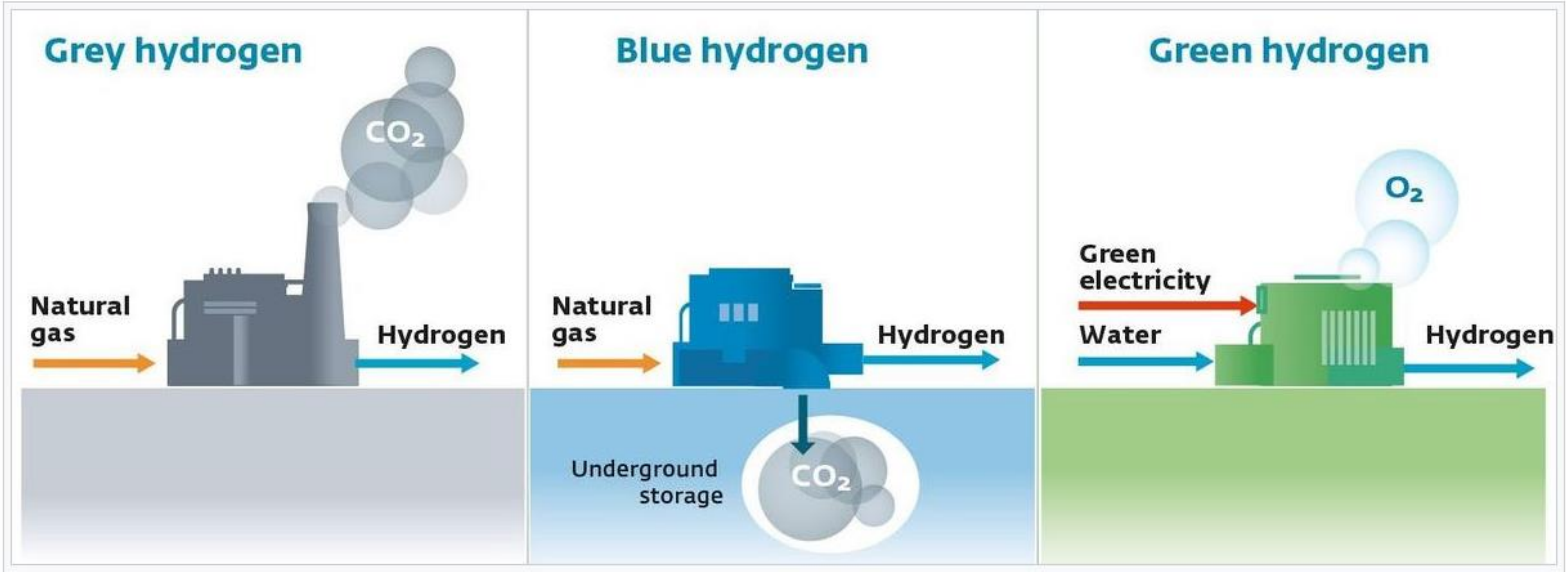
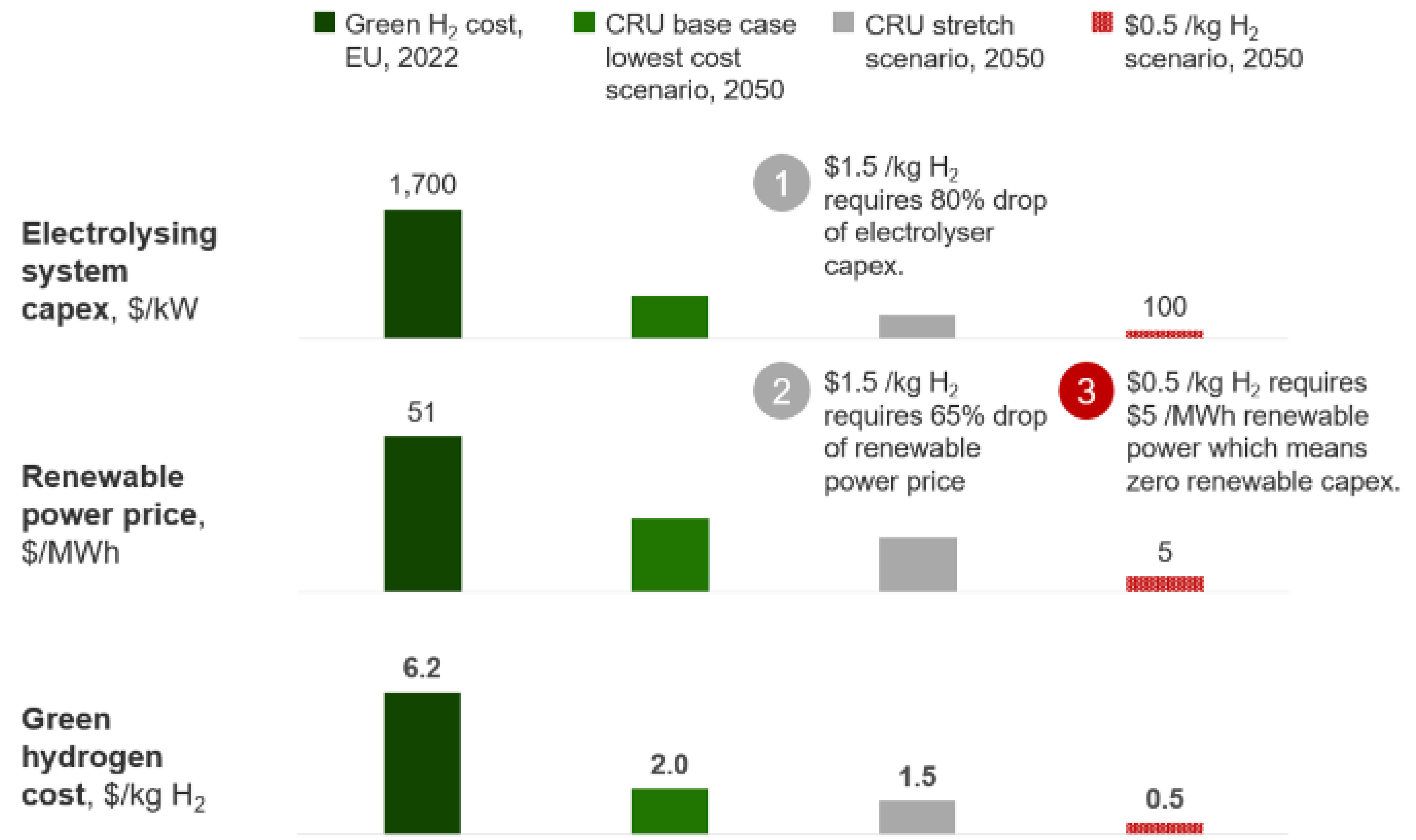
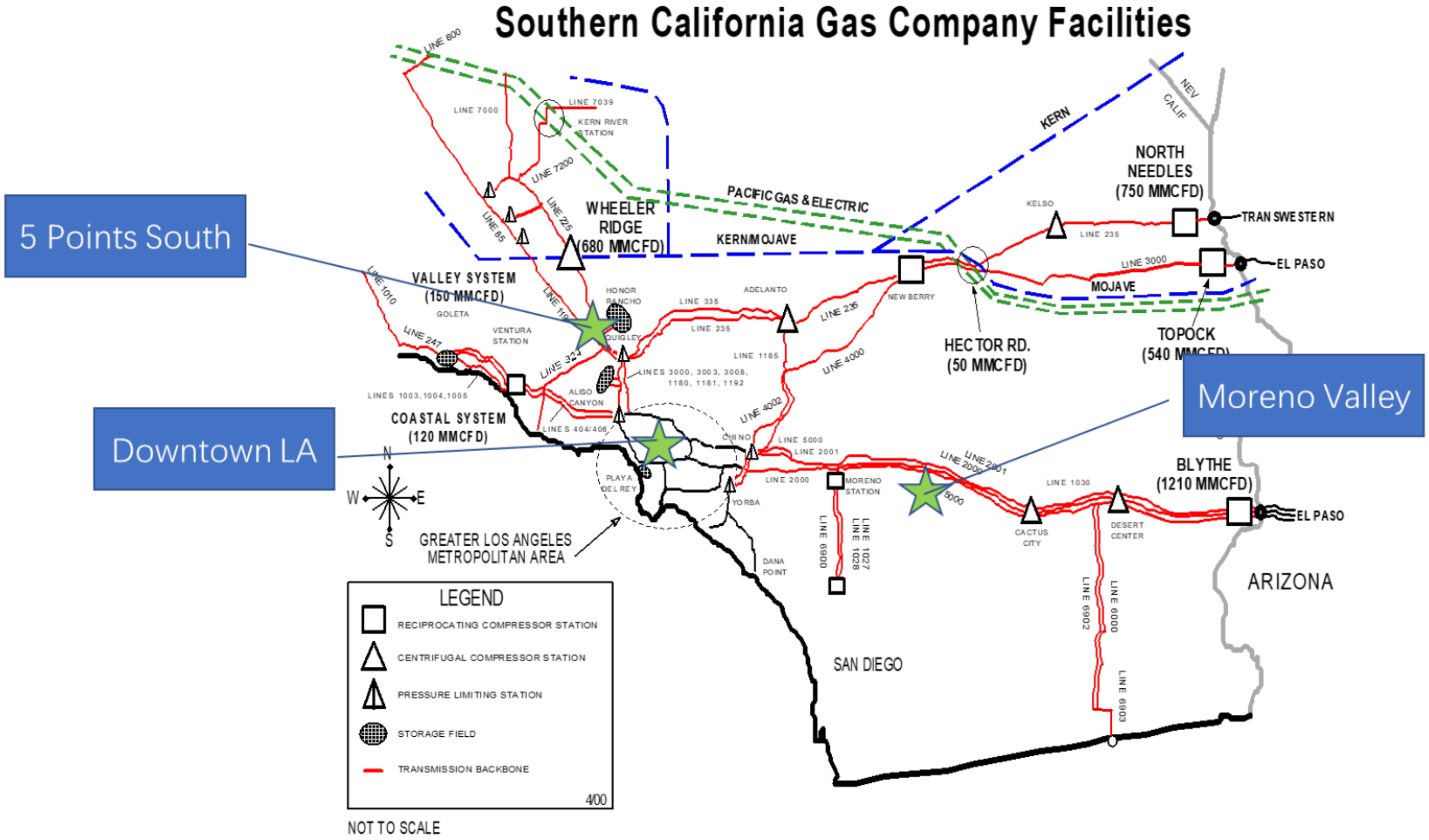


Figure 4: Green hydrogen at $0.5 /kg effectively requires zero renewables capex.



DATA: CRU Hydrogen Cost Model, CRU Long-term Renewable Energy Cost Model; NOTE: hydrogen costs do not include renewables connection costs or H_2 storage, compression, or distribution

Electrolyzer Operational Optimization



Review the potential to produce hydrogen in the target cost range of $2/kg injected onto the gas grid using combinations of self-generated and grid delivered energy

Electrolyzer Operational Optimization

- Device sizing and cost parameters

Category	Property	Moreno Valley		Downtown LA (LA1)	Five Points (5PT)
		MV-1	MV-2		
Hydrogen	Electrolyzer size (MW)	15	50	2	30
	Electrolyzer capital cost ($/kW)	400-800	400-800	400-800	400-800
	Electrolyzer fixed operation and maintenance cost ($/kW-yr)	53	53	53	53
	Hydrogen storage cost ($/kg)	822 [3]	822 [3]	822 [3]	822 [3]
	Hydrogen compressor cost ($/kg)	See footnote [3]	See footnote [3]	See footnote [3]	See footnote [3]
Renewable	Renewable size (MW)	5	50	0	30
	2020 Annual Technology Baseline Price info	2030 - Solar - moderate	2030 - Solar - moderate	NA	2030 - Solar - moderate
	Renewable capital cost ($/kW)	687.8	687.8	NA	687.8
	Renewable fixed operation and maintenance cost ($/kW-yr)	8.055	8.055	NA	8.055

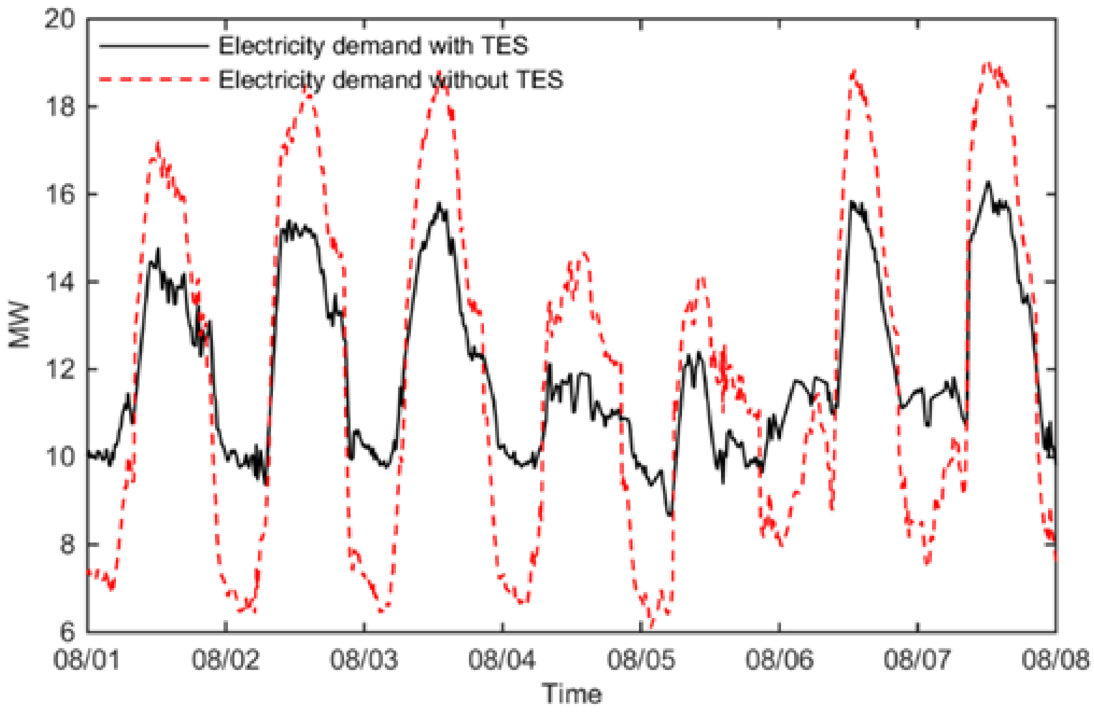
Electrolyzer Operational Optimization
- Key Lessons-Learned

- **Higher electrolyzer capacity →lower hydrogen production cost.**
- **Amount of renewable sources available (Co-location with solar PV facilities helps to reduce hydrogen breakeven cost by increasing the utilization of the electrolyzer.)**
- **Location Moreno Valley (2) (the largest electrolyzer used in this study, e.g., 50 MW) , highest availability of renewable …has the lowest hydrogen breakeven cost ($0.62/kg).**
- **Market mechanism such as LCFS significantly reduces hydrogen B.E. cost (Decrease of ~$1.3 per kg for an increase of $40 per LCFS credit for MV2).**

Connected Network of Microgrids

Connected Network of Microgrids

- Energy mix for total load of various facilities



Hospitals

- 60% Fuel Cell with CHP system
- 25% Solar
- 15% battery energy storage system (BESS)
- up to 30,000 Ton-Hour thermal energy storage (TES), vary based on total load

Shopping Centers

- 40% Fuel Cell
- 35% Solar
- 25% BESS

Universities

- 50% Fuel Cell with CHP system
- 30% Solar
- 20% BESS
- up to 20,000 Ton-Hour TES, vary based on total load

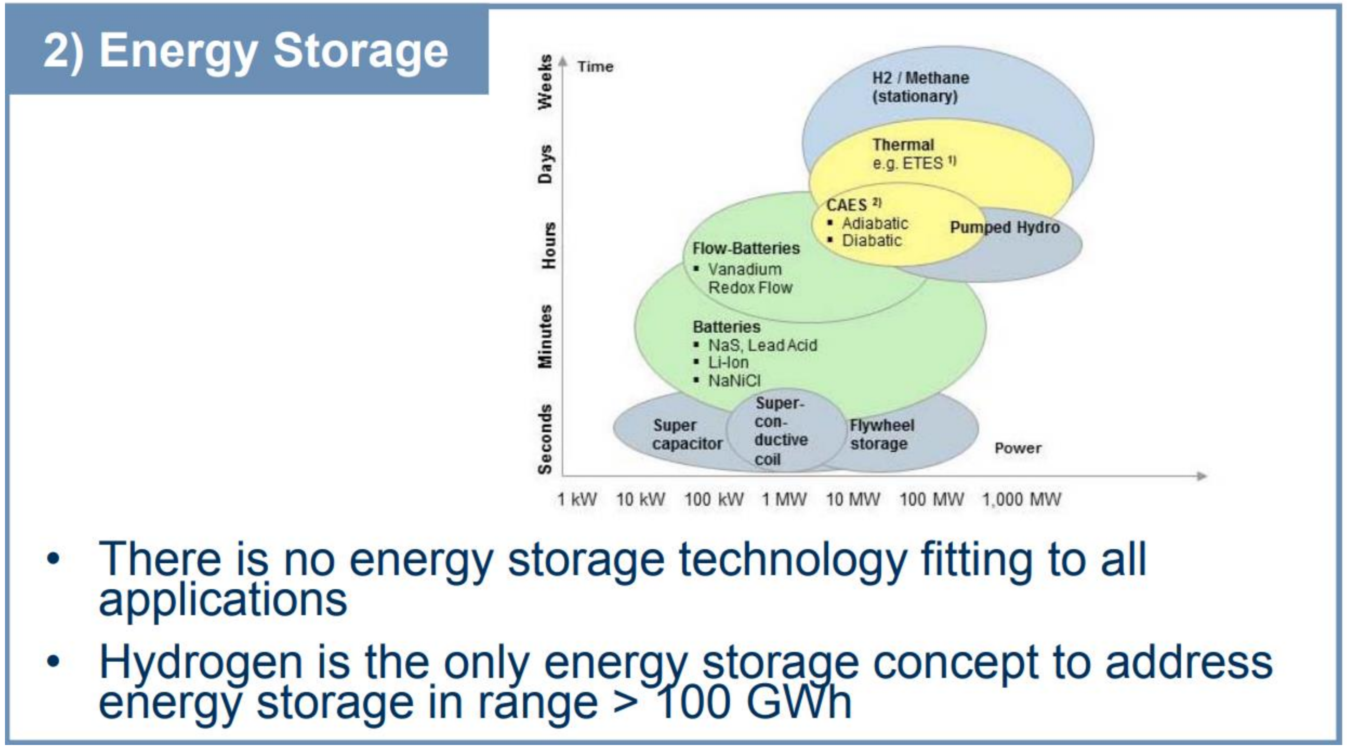
Connected Network of Microgrids

- **Improve the hypothetical analysis using real data**

University of California Irvine Medical Center	University of California Irvine (UCI)	Stonewood Center
o 6 MW SOFC Generator o 2.5 MW Solar o 1.5 MW/1.5 MWh BESS o 30,000 Ton-Hour TES	o 10 MW SOFC Generator o 6 MW Solar PV o 4 MW/4MWh BESS o 60,000 Ton-Hour TES	o 1.3 MW SOFC Generator o 900 kW- 1MW Solar o 500 kWh BESS

- **Develop the model connecting the zero-emission heavy-duty vehicles' data from CF demo project to microgrid systems**
- **Complete the connected microgrid model to understand synergy impact of mass deployment of microgrid systems**

Challenges of Hydrogen storage



https://iea.blob.core.windows.net/assets/imports/events/192/Session4.2WaidhasSiemens.pdf

- **Scale-up of cells, stacks and systems into the 100-MW-range**
- **Acceptance of H2 as a safe technology for storage of renewable energy**
- **Sustainable market development**

Q & A

Thank you

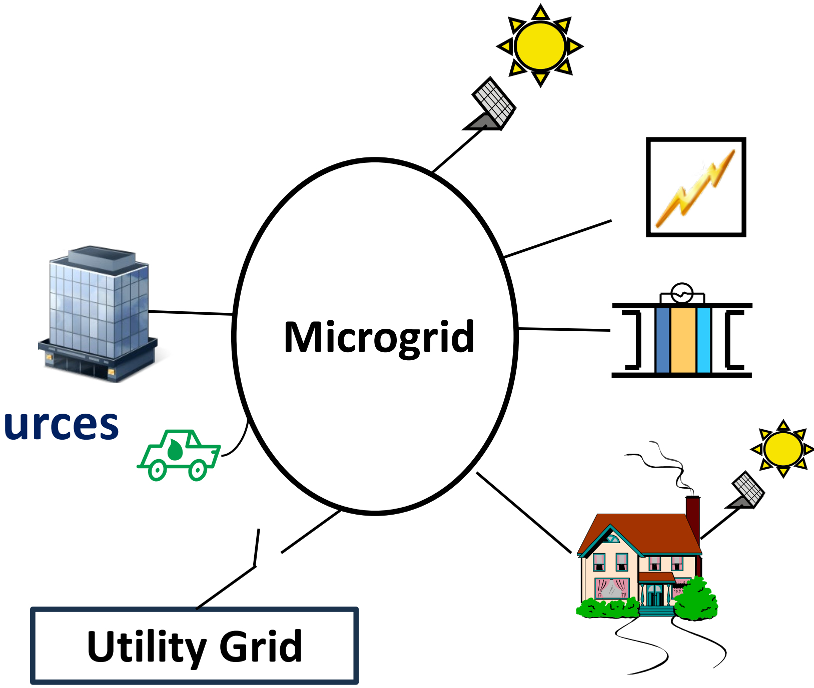
Air Quality Impacts of Microgrid Deployment in the South Coast Air Basin

ADVANCED POWER
& ENERGY PROGRAM
UNIVERSITY of CALIFORNIA · IRVINE

Dr. Michael Mac Kinnon
Dr. Ghazal Razeghi
Professor Scott Samuelsen
January 23, 2024

Background

- **Microgrid:**
  - A microgrid is a group of interconnected loads, generation and/or a battery resource, and potentially other distributed energy resources within clearly defined electrical boundaries that (1) acts as a single controllable entity with respect to the grid, and (2) connects and disconnects from the grid to enable operation in both grid-connected or island mode.

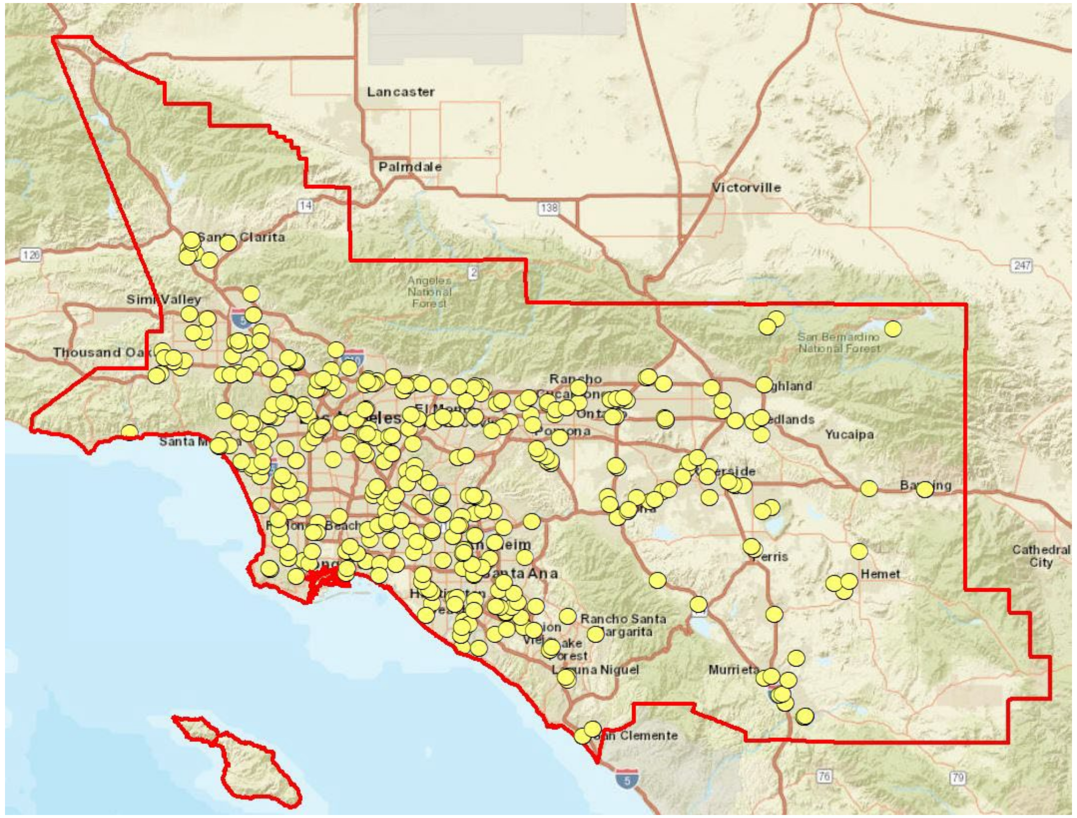


- **Microgrid benefits:**
  - Increase reliability of serving loads and community resiliency
  - Increase public safety
  - Increase efficiency of operations through better management of resources
  - Enable higher levels of local renewable generation
  - Reduce emissions
  - Defer/ reduce the need for transmission expansion
  - Provide voltage support and regulation at point of interconnection
  - Enhance demand response
  - Reduce operation costs

Microgrid Candidates

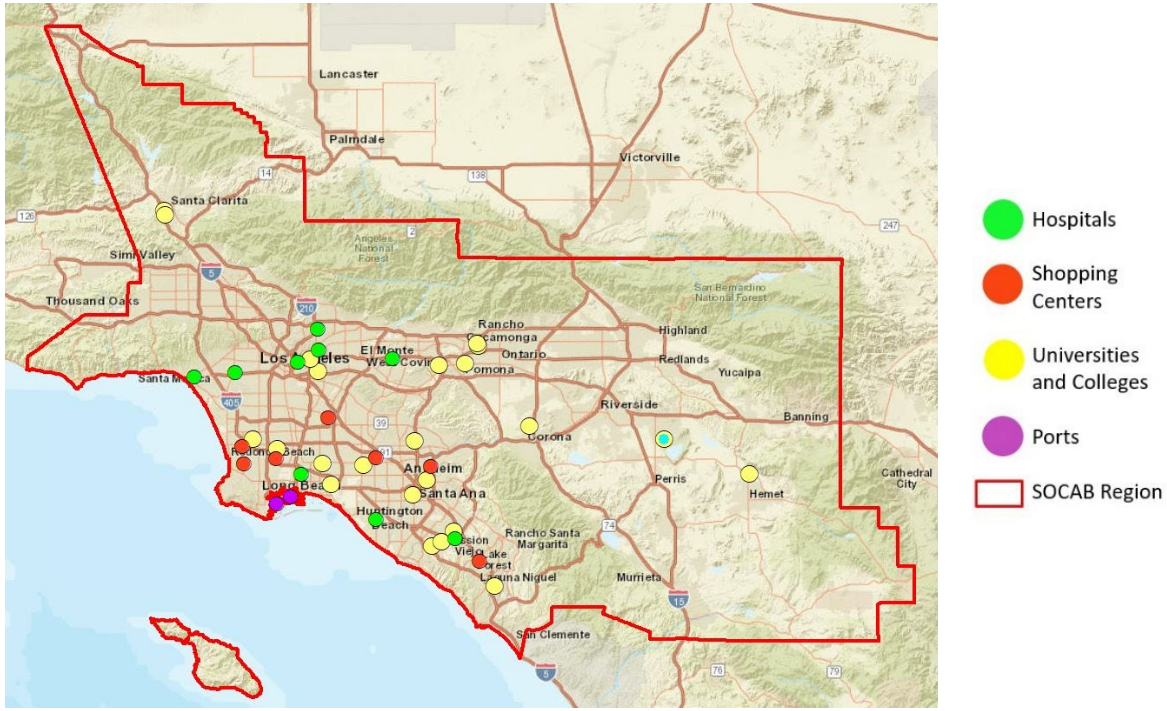
- **Four categories were identified:**
  - University/college campuses
  - Shopping centers
  - Hospitals
  - Ports

- **Candidates in SoCAB were identified:**
  - Already have a clear electrical boundary
  - One point of interconnection with utility
  - Total of 610 candidates
  - Due to the high number of candidates, this is a <u>long-term</u> deployment target



Microgrid Candidates

- **Near-term deployment:**
  - The candidate list was further filtered based on:
    - Existing access to the transmission system
    - Existing distribution infrastructure to accommodate DERs
    - Existing DER on microgrid candidates, and
    - Size of the microgrid
  - 58 candidates were identified for near-term
- **Microgrid Resources**
  - Business as usual (BAU):
    - Natural gas combustion turbine
  - Zero-emission (ZE):
    - Mix of fuel cell, solar PV, and BESS
    - Mix determined based on end use and load profile
    - Fuel cell as a 24/7 firm resource
    - CHP in cases with high heating demand (such as hospitals)

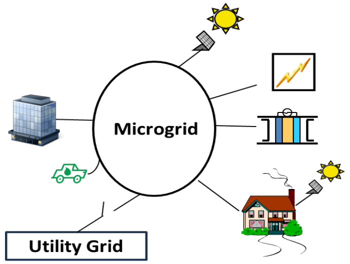


Air Quality Analysis

- **Objective: Analyze the air quality and health impacts of microgrids powered by NG combustion gas turbines (CTGs) and, as an alternative, fuel cells (FCs)**

Air Quality Scenarios

- Near-term vs. long-term
- CGT vs FC



Baseline Scenario: California Air Resources Board 2022 Scoping Plan scenario

Scenario 1 (S1): Near-term deployment with CTG

Scenario 2 (S2): Near-term deployment with FC

Scenario 3 (S3): Long-term deployment with CTG

Scenario 4 (S4): Long-term deployment with FC

Air Quality Analysis

- **Objective: Analyze the air quality and health benefits of microgrids and using ZE resources in microgrids in lieu of natural gas combustion turbines**

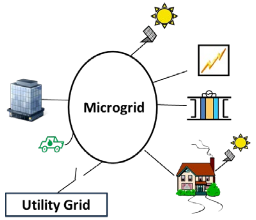
Air Quality Scenarios
- Near-term vs. long-term
- CGT vs FC

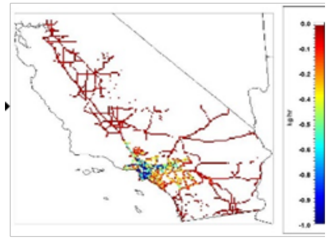
Pollutant Emissions
- Resolve direct emission changes

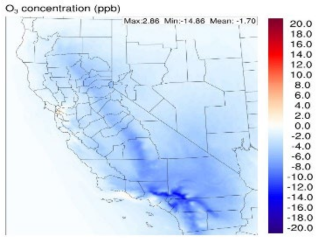
Air Quality Impacts
- Episodic differences in atmospheric pollution levels

Health Impacts
- Quantify and value the short-term health benefits

Disadvantaged Communities
- Insight into implications for environmental equity

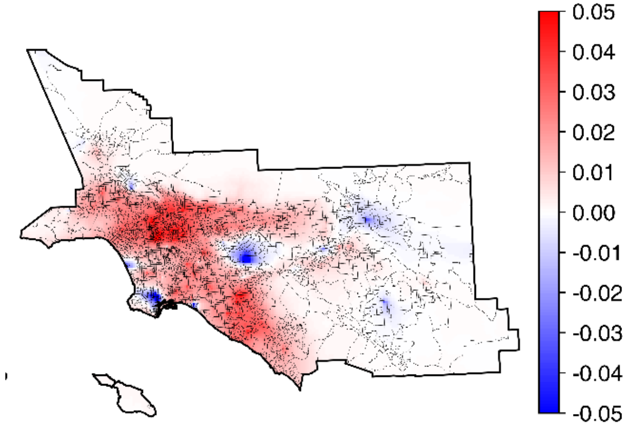




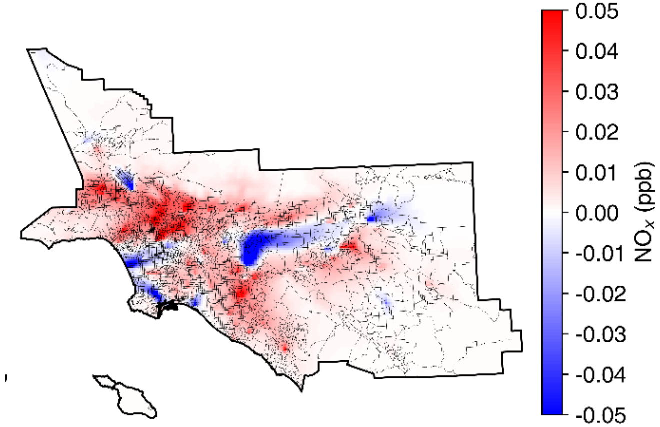


NO_x Emissions Results

- **The difference between S3 and Baseline**

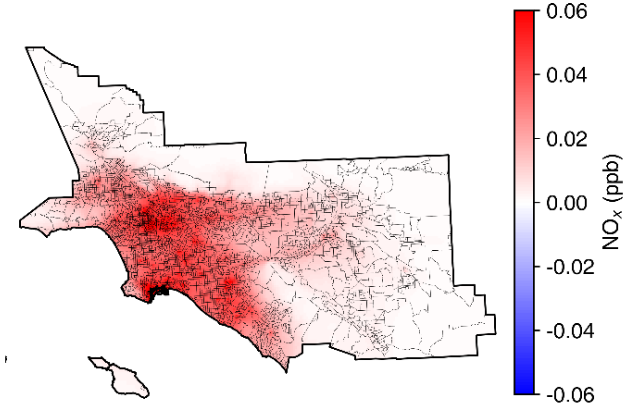


January

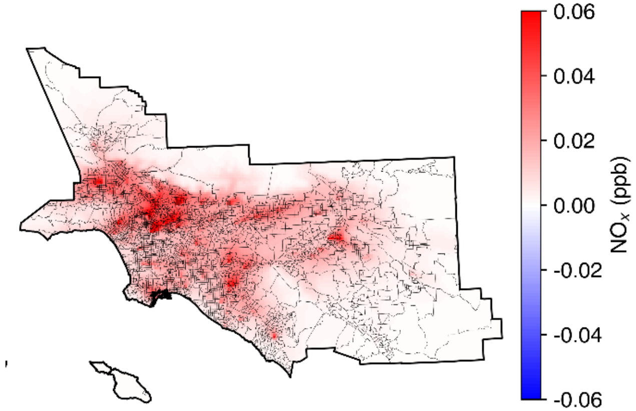


July

- **The difference between S3 and S4**



January



July

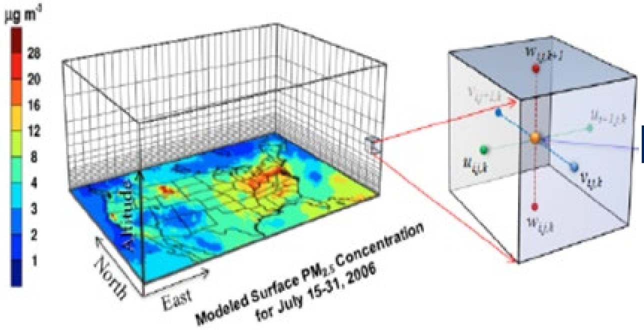
Air Quality Modeling

- **Community Multi-scale Air Quality Model (CMAQ) used to develop a comprehensive understanding of how atmospheric pollution changes with 1 km x 1 km resolution**
    - **The two pollutants considered for assessment are ozone and $PM_{2.5}$**
    - **CMAQ accounts for both primary (emitted) and secondary (formed) pollutants including ozone and $PM_{2.5}$**

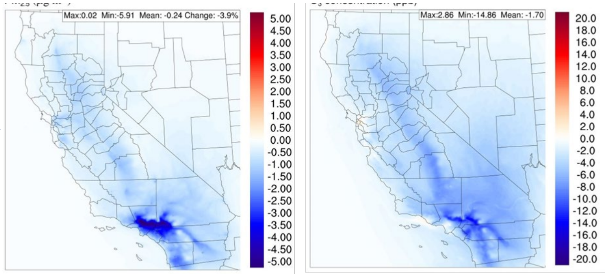
- **January and July are modeled as they have the highest ozone and $PM_{2.5}$ due to meteorology and other factors**
    - **Provides an estimation of the maximum impact on air pollution from the emission reductions associated with each scenario**

CMAQ

- **Anthropogenic Emissions**
- **Biogenic Emissions**
- **Meteorology**
- **Topography**
- **Boundary Conditions**

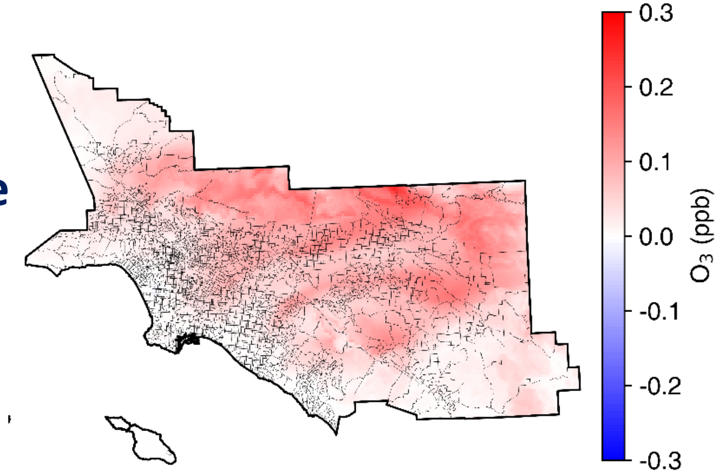


Differences in $PM_{2.5}$ and Ozone

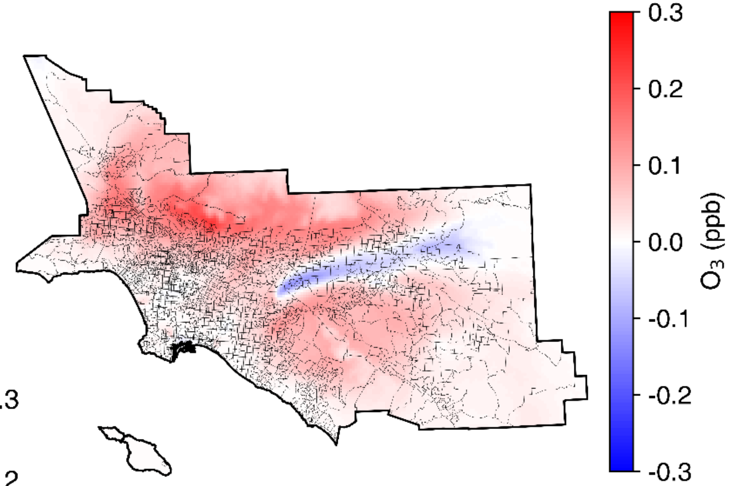


Air Quality Results

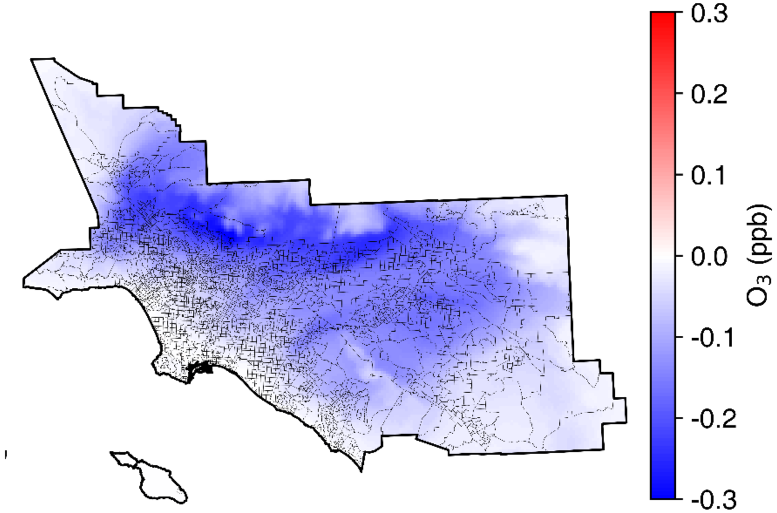
- **Ground-level ozone (July)**
  - **The difference between S1 and Baseline**



  - **The difference between S3 and Baseline**

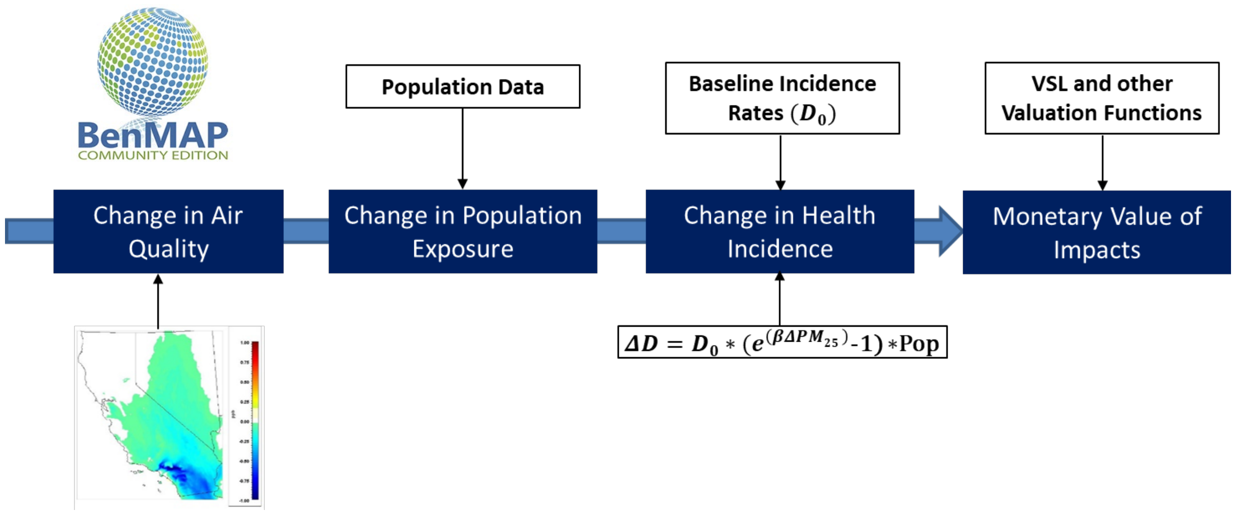


  - **The difference between S3 and S4**



Health Impact Assessment

- EPA's BenMAP v1.5.8 used to translate pollutant changes into health impacts
  - Total benefits that accrue during July and January
  - Health impacts estimated for short-term exposure only as appropriate for the episodic modeling
  - Selection of health impact functions generally represent the core functions in BenMAP v1.5.8
- Health impacts estimated for $PM_{2.5}$ and ozone in July and $PM_{2.5}$ in January
  - Ozone concentrations are below health-based standards in winter and have an inverse relationship with precursor emissions



$PM_{2.5}$ Health Endpoints	Ozone Health Endpoints
• Avoided Mortality	• Avoided Mortality
• Hospital Admissions, Alzheimer's Disease	• Emergency Room Visits, Respiratory
• Hospital Admissions, Parkinson's Disease	• Hospital Admissions, Respiratory
• Incidence, Lung Cancer	• Asthma Symptoms
• Incidence, Asthma Onset	• Incidence, Asthma Onset
• Acute Myocardial Infarction, Nonfatal	
• Asthma Symptoms	
• Hospital Admissions, Cardiovascular	
• Emergency Room Visits, Cardiovascular	
• Hospital Admissions, Respiratory	
• Emergency Room Visits, Respiratory	
• Work Loss Days	

Health Impact Assessment

- **Results**
  - S3 and S4 difference
    - ~3 incidences of mortality
    - $45 million in health savings for the month of January and $36 million for the month of July

January

Scenario	S1	S3	S4	S1	S3	S4
Endpoint	Incidence (#)			Valuation ($)		
Mortality, All Cause	-4.56	-0.56	2.36	-52,985,600	-6,477,042	27,569,338
HA, Alzheimers Disease	-30.86	-25.94	101.67	-434,219	-364,973	1,430,720
HA, Parkinsons Disease	-2.38	-1.77	7.46	-1,569,026	-1,165,978	4,914,755
Incidence, Lung Cancer	-3.44	-2.52	11.11	-613,957	-449,720	1,982,192
Myocardial Infarction	-1.83	-0.22	0.96	-820,870	-96,968	431,787
Incidence, Asthma	-5,634.92	-511.87	3,100.34	-2,236	-190	1,153
HA, All Cardiovascular	-3.44	-0.45	1.81	-173,650	-22,680	91,629
HA, All Respiratory	-0.56	-0.08	0.30	-23,739	-3,194	12,548
ER visits, All Cardiac	-5.33	-0.63	2.78	-7185	-855	3,746
ER visits, respiratory	-7.22	-0.70	3.80	-7,329.47	-711	3,862
Total				-56,637,816	-8,582,315	36,441,735

- Disadvantaged community analysis
  - Population ratio of disadvantaged tracts within the SoCAB is 41%
  - In S3 January, 50% of increased health consequences occurs in disadvantaged communities
  - In S4 January, 48% of health benefits occurs in disadvantaged communities
  - Both positive and negative health impacts are weighted towards disadvantaged communities

Season	Scenario	Health ($)		DAC (%)
		Disadvantaged	Non-Disadvantaged	
July	S1	-16,351,501	-17,412,731	-48.4%
	S3	-9,465,631	-14,733,392	-39.1%
	S4	17,480,057	18,520,467	48.6%
January	S1	-24,490,902	-32,146,913	-43.2%
	S3	-4,292,536	-4,289,778	-50.0%
	S4	17,483,632	18,958,102	47.9%

Conclusions

- Deploying microgrids has a relatively small impact on air quality.
- While having minor air quality impacts, deploying natural gas combustion turbine microgrids result in notable health effects.
- Deployment of zero-emission microgrids mitigate health impacts giving importance to pursuing zero emission microgrids
- Deployment of zero emission microgrids maximize the benefits and avoid further degrading air quality in disadvantaged communities

Air Quality Impacts of Microgrid Deployment in the South Coast Air Basin

ADVANCED POWER & ENERGY PROGRAM
UNIVERSITY of CALIFORNIA • IRVINE

Dr. Michael Mac Kinnon
Dr. Ghazal Razeghi
Professor Scott Samuelsen
January 23, 2024

TESLA

Tesla’s Mission

Accelerate the world's transition to sustainable energy

WHY SEMI?

COMBINATION TRUCKS ACCOUNT FOR:

of US Vehicles

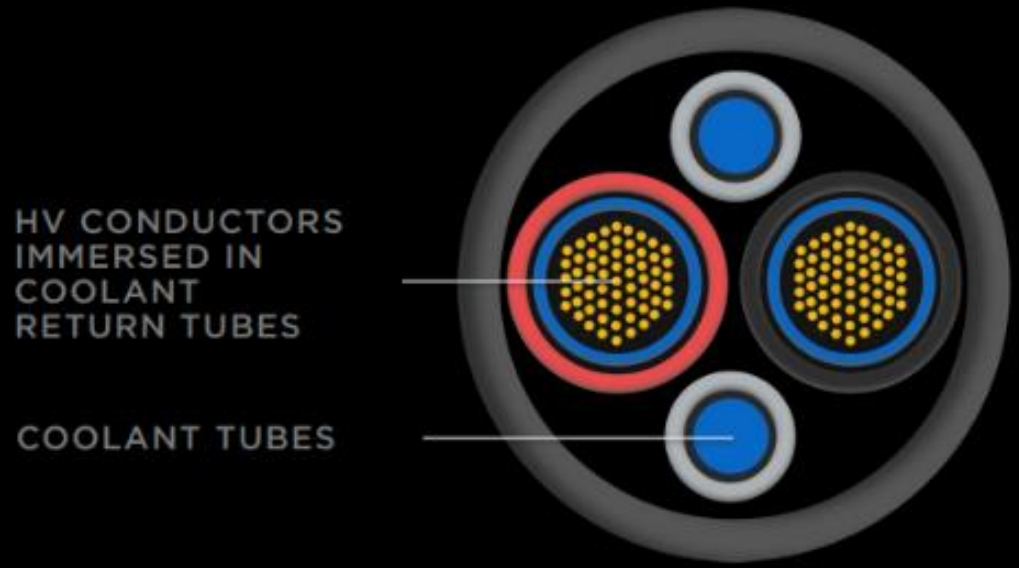
of US Vehicle Emissions

of US Vehicle Particulate Emissions

Max Power Meets Hyper Efficiency

1 MW+ DC Charging

Immersion cooling technology



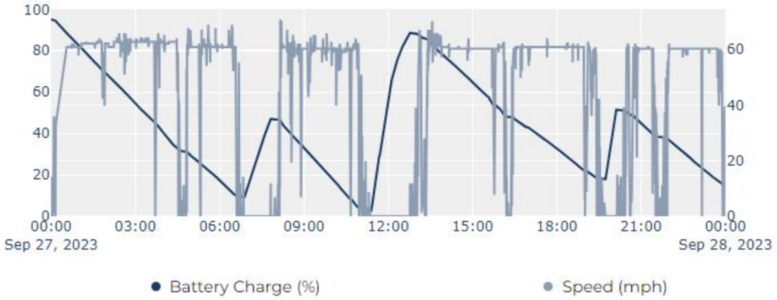
Customer Use Case – Long-Range Semi

Run on Less – Electric Depot

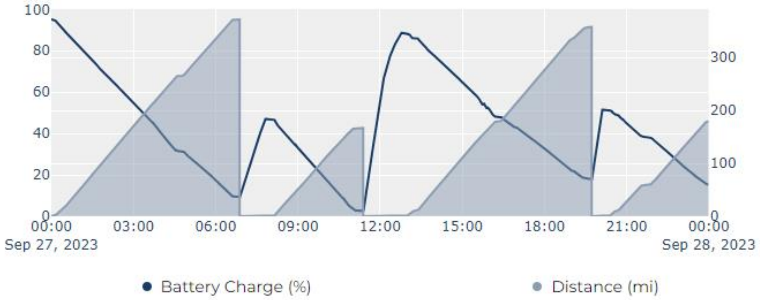
DATA FOR TESLA 3

Total Miles	1076
Average Miles/Day	1076
Estimated Deliveries	1
Average Deliveries/Day	1

Battery Charge (%) & Speed (mph)



Battery Charge (%) & Distance (mi)



RUN ON LESS BY NACFE

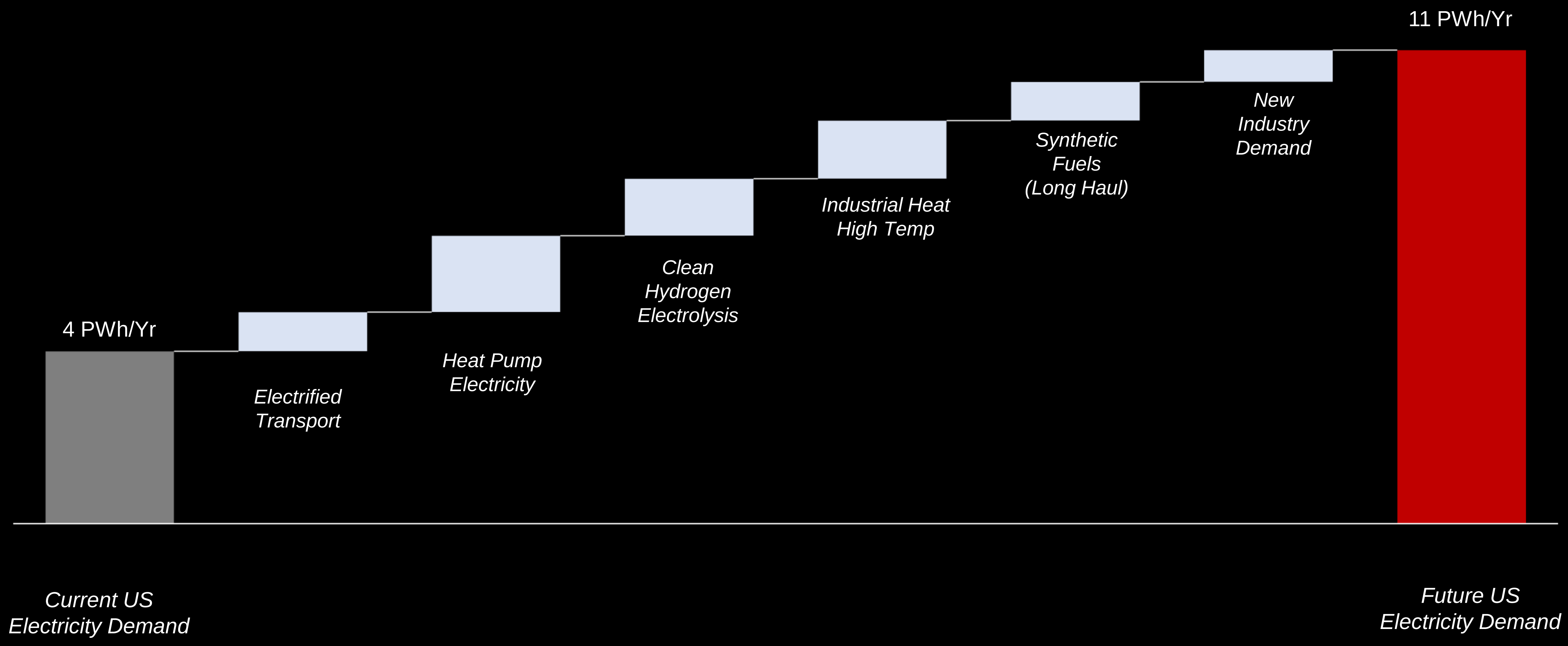
Giga Nevada Expansion to Scale Semi Production

Unlike passenger cars, MDHD production can not outpace charging installations

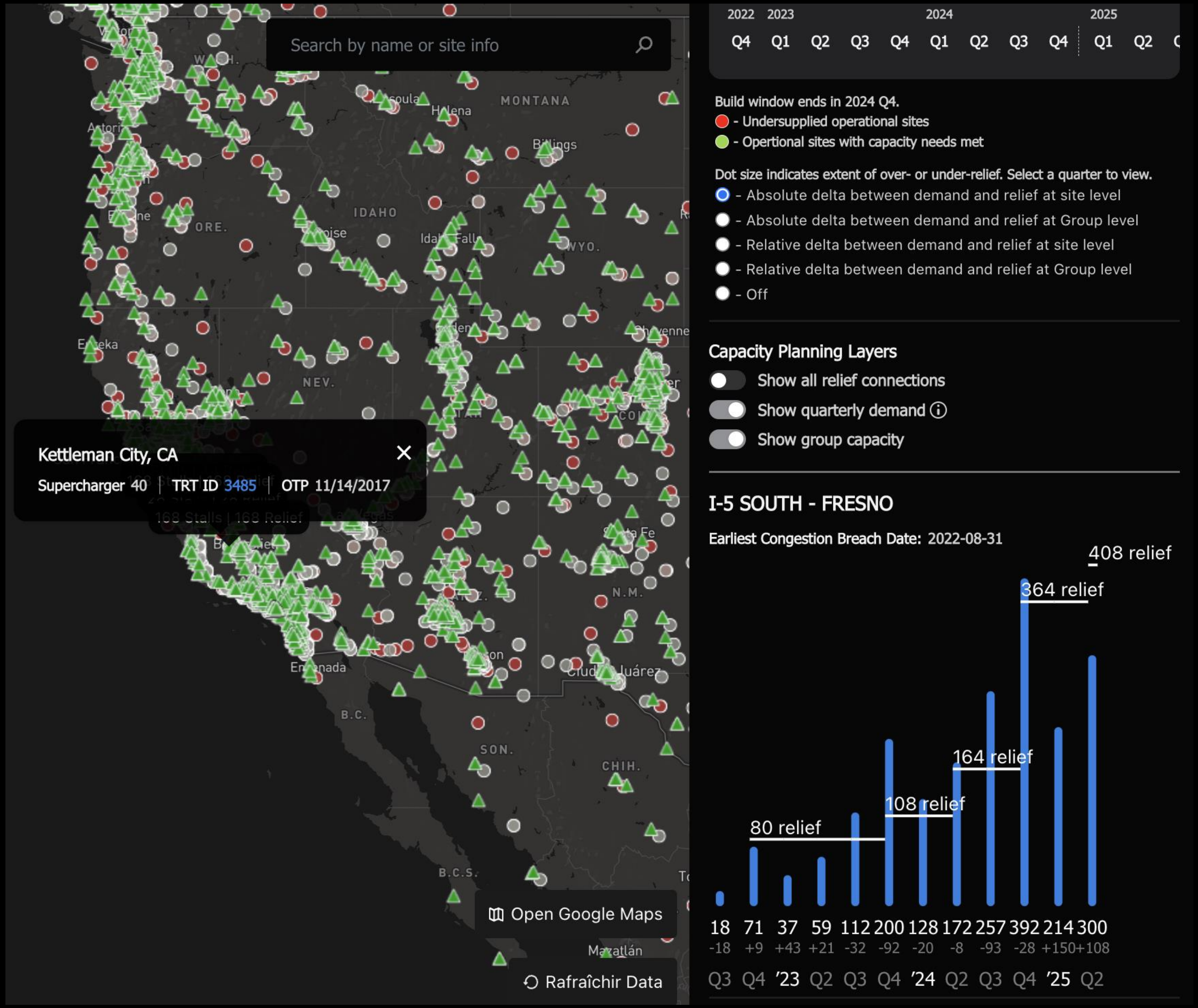
Tesla Charging Goals

Supply necessary Semi charging quickly, conveniently, and cost-effectively

~3X US Electricity Consumption Increase is an Opportunity



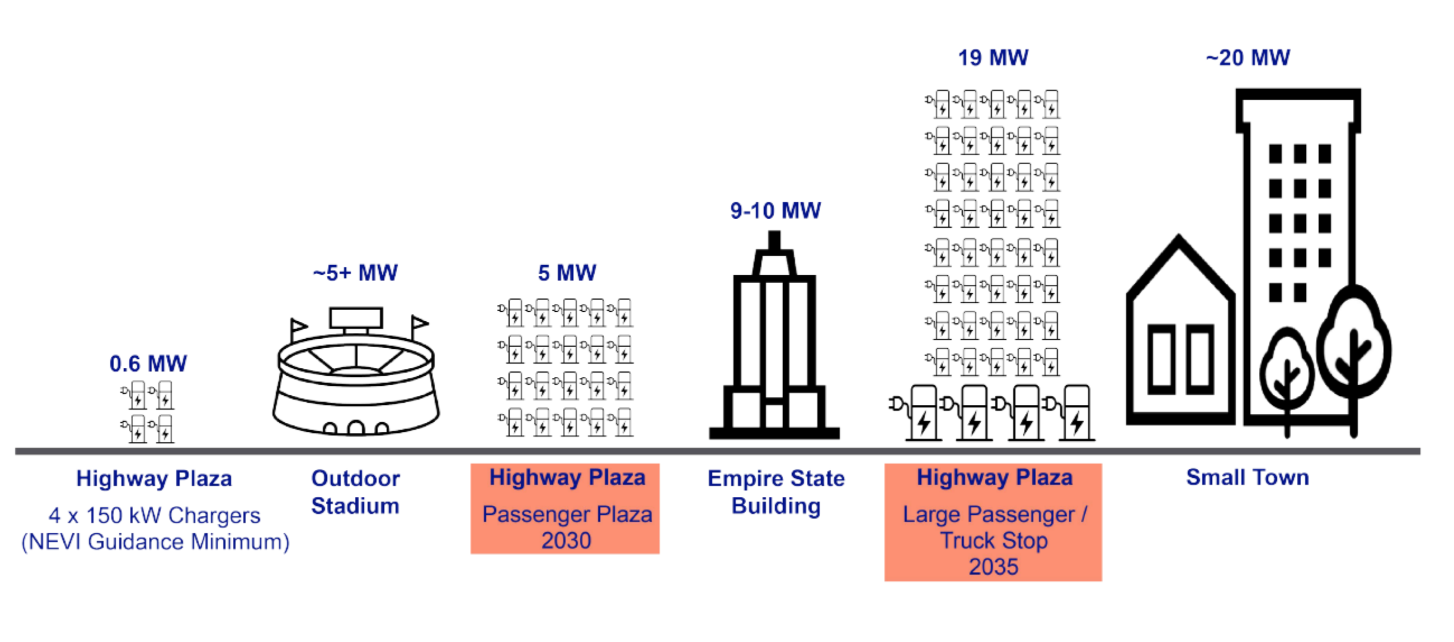
Ensure Utilities Make Investments for Increased Load



- Charging needs utilities to accurately plan to accelerate EV adoption
- Tesla's detailed 5y+ models are available to all utilities
- Includes Tesla and non-Tesla vehicle demand and will include Tesla Semi expectations soon

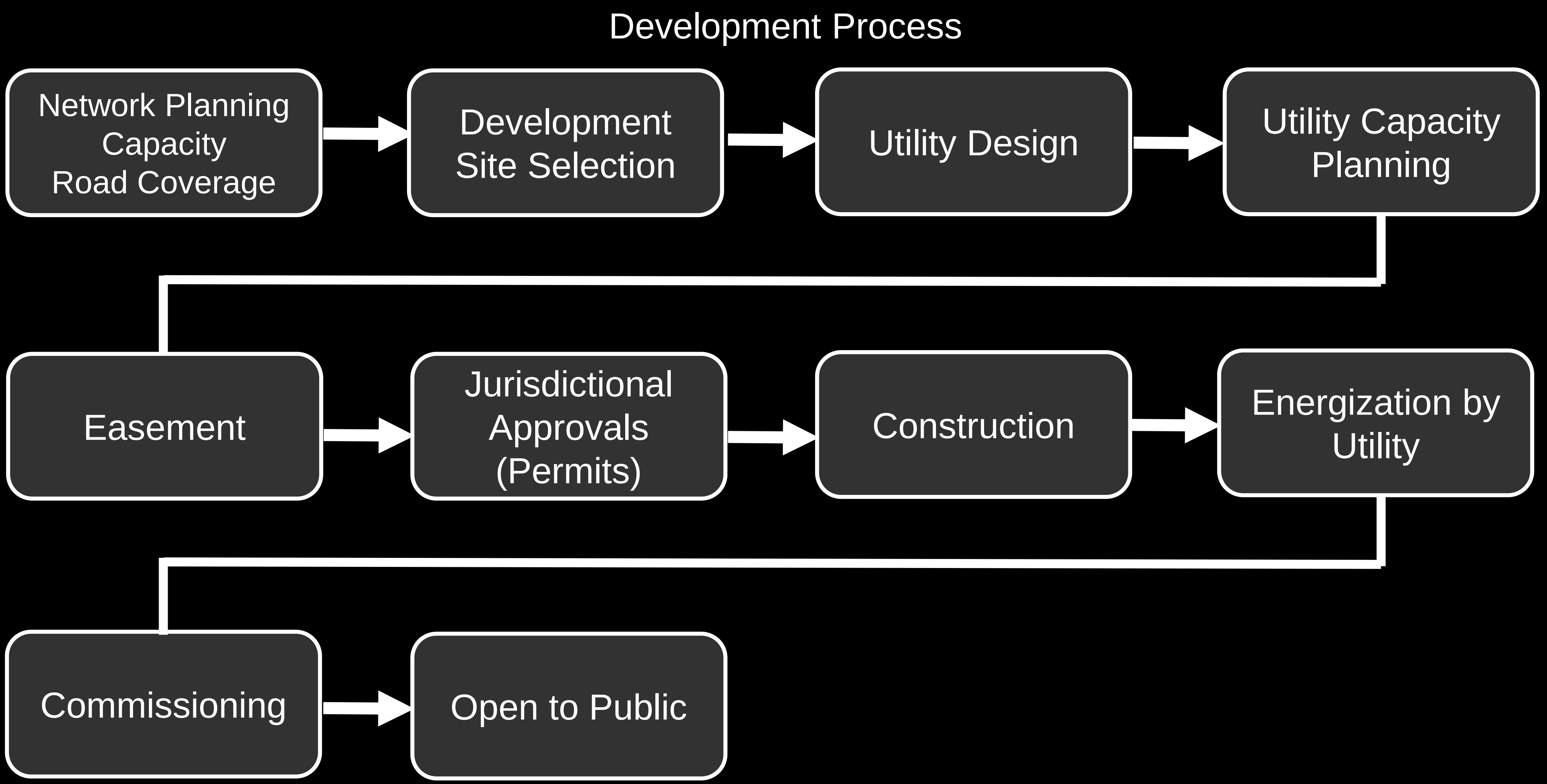
Policy Problem

Insufficient T&D Capacity for Fast-Charging Sites Along Truck Corridors

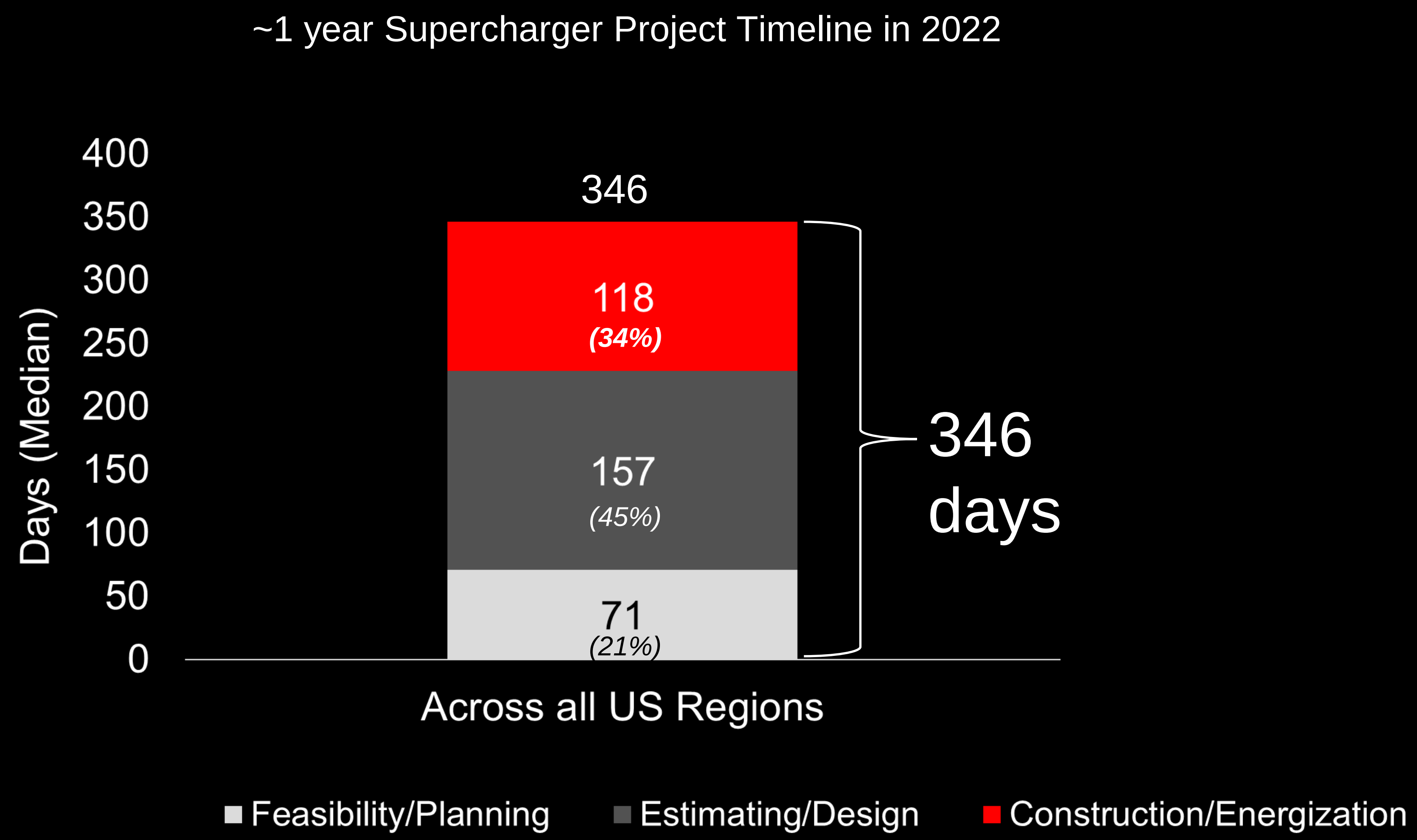


- Semi charging is starting at fleet domiciles to enable regional operations
- Long-haul operations will require substantial public charging network along major corridors
- Fast-charging sites can have electric demand of a factory or sub-division, but are built in a fraction of the time
- These sites are needed in rural areas and truck corridors, which often lack high-capacity T&D equipment
- As a result, the necessary T&D upgrades can delay interconnection by 2 years or more

Scaling EV Charging Infrastructure



US Supercharger Project Timelines are Too Long
Semi Charger Projects will be Bigger



Scaling EV Charging Infrastructure

Timeline Challenges

Cause of Delay	Possible Delay	Possible Solutions
Transformer shortage	18-24 Months	• More frequent updates to EV forecasts would inform growing need for transformers
Disruptions to construction scheduling (weather events, etc.)	6+ Months	• Dedicated EV/Interconnection crews
Right-of-way permitting with AHJs and CalTrans	3-6 Months	• Streamline ROW permitting for EV projects at state and local levels
Capacity upgrades	2+ Years	• Proactive planning & upgrades • More frequent updates to EV forecasts • Regulatory certainty outside GRCs

SCHNEIDER'S COMMITMENT TO A SUSTAINABLE FUTURE

1/24/24

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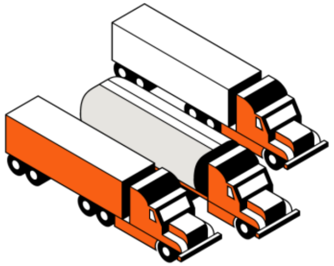
Agenda

- Schneider's Goals
- Project Timeline
- South El Monte, CA
  Intermodal Operations Center
- Site Capability
- Challenges

The Options you need with the Transportation and Logistics expertise to Perform as Promised

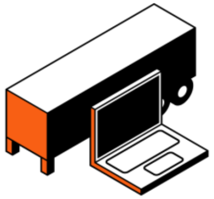
Intermodal

- Bulk
- Express Services
- North America Cross-Border
- Regional
- Transcontinental
- Rail Dray



Truckload

- Bulk
- Dedicated
- Long-Haul
- North America Cross-Border
- Regional
- Expedited
- Power Only



Logistics

- Cross-Dock Logistics
- Port Dray
- Supply Chain Management
- Transloading and Distribution
- Brokerage
- Warehousing

Approximately	Approximately	Approximately	Over	Approximately		
10,200	**72,500**	**2,150**	**64,000**	**17,000**	**1935**	**1992**
company tractors	company trailers and containers	owner-operator business relationships	qualified carrier relationships	associates worldwide	operations in United States	operations in Mexico

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Schneider's sustainability goals

We are integrating a sustainability mindset across our entire enterprise. Moving goods as efficiently as possible means less carbon dioxide emitted, and we are strategically investing in areas that allow us to continue to push efficiency in the near- and long-term, such as electrification and optimization of diesel trucks.

We set four ambitious goals:

2025: Reduce CO_2 emissions by 7.5% per mile.

2030: Double our intermodal business, thus reducing CO_2 emissions by an additional 700 million pounds per year.

2035: Achieve a 60% reduction in CO_2 emissions per mile.

2035: Achieve net-zero status in all company-owned facilities.

We have:

Reduced CO_2 emissions per mile by 5%.

Deployed 92 electric trucks for our intermodal operations in Southern California.

Increased our year over year intermodal capacity and owned assets.

Reduced energy consumption at our facilities by 12.5% by switching to LED light bulbs.

Decreased energy consumption at our HQ by 25% through facility updates.

Collaborations

As part of our commitment to improving the sustainability of the industry, we participate in multiple industry councils. Environmental progress requires collaboration, and we strive to share and learn from others to better the industry.

Our achievements are proof of our ongoing commitments

Smartway High Performer Award
Presented by: EPA

Dedicated Traditional Operation Carrier of the Year Award
Presented by: Dollar General

Inbound Logistics Top 100 Trucker
Presented by: Inbound Logistics

2022 External Business Partner Excellence Award
Presented by: P&G

Bronze Sustainability Rating
Presented by: EcoVadis

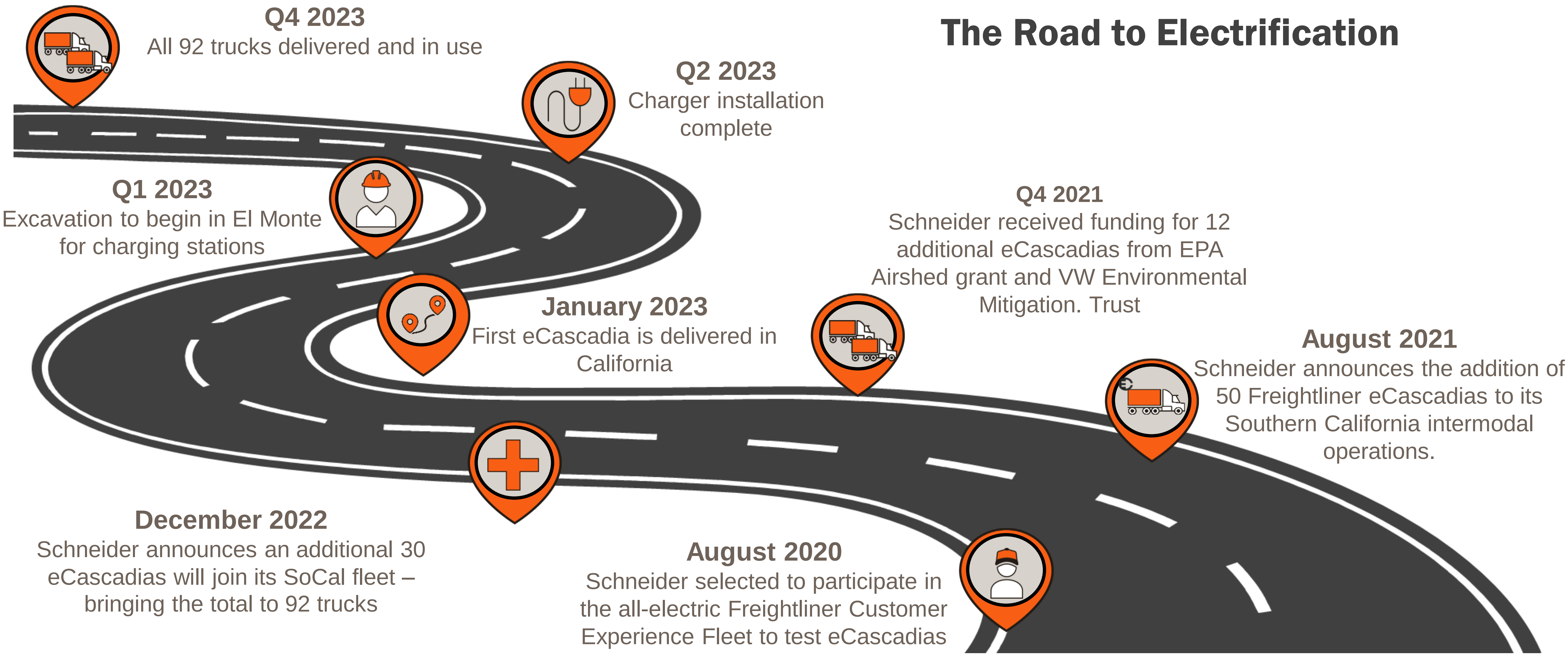
Top 10 of 100 For-hire Carriers
Presented by: Transport Topics

Top 50 Carrier, Excellence in Service Award
Presented by: Isometric Technologies

FREIGHTTECH 100
Presented by: FreightWaves

Asset Sustainability Carrier of the Year
Presented by: PEPSICO

The Road to Electrification



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Schneider's network in and out of California

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South El Monte Operation

- South El Monte local intermodal drayage operations
- Operational model is a 24/7/365 next up slip seat model
- Each driver shift consists of 175-275 miles
- 30+% of the trucks run two shifts daily
- 92 Freightliner eCascadias

Charging Stations

- Project planning began September 2021
- 4 – 1.5mW power stations each feeding 4 charger
- 16-unit charging depot with 350 kW chargers.
- Parallel charging, allowing 32 trucks can be charged simultaneously.
- OTA Rate-of-charge management
- Required heavy engineering hours to coordinate and optimize charging times.
- Construction completed in May 2023.

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The Battery Electric Driver Experience

Lupe Aguilar Hernandez (pictured to right)

"My experience from these two months driving the BEV is that I love the suspension. I love the ride. I know the BEVs are just going to improve with time."

Oscar Lopez

"Ride is smooth, steering wheel is buttery smooth. I feel like I'm driving in a luxury SUV and not a semi-truck."

Anthony Merritt

"I have been driving at SNI since 1998 and can't remember being as excited about new technology as I'm now driving the EV. After driving the EV, I managed to convince my wife to buy a Tesla since we both have long commutes to work."

EV Deployment Challenges

- Infrastructure
  - Grid upgrades
  - Permitting
  - Charging hardware changes over long build timeline

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1.5 Million zero emission miles in 2023 – 2 Million to date

SCHNEIDER

January 23, 2024

JETSI - Electrify America and NFI's 1st Heavy-Duty Electric Truck Charging Microgrid

Jigar J. Shah
Director, Energy Services
Jigar.Shah@electrifyamerica.com

electrify america

Public

Electrify America operates the largest open ultra-fast only* network in North America

4000+	900+	180+	47
Individual Chargers	Charging Stations	Site Hosts	States and the District of Columbia

- Public Ultra-Fast Charging Stations as of YE 2022
- Forthcoming Public Ultra-Fast Charging Stations

*Electrify America's network does not include DC fast chargers below 150kW

A Focus on Continuous Innovation

Electrify America chargers provide Combined Charging System ("CCS") charging capable of 900 volts at 500 amps to deliver 350+ kW of high-power charging
Leverages deep industry knowledge and unparalleled insight into the customer experience to deliver the ultimate charger

- Charge power up to 350+ kW
- Liquid-cooled cables
- Dual connect CCS or CHAdeMO / Future NACS
- 15 inch touch display
- Commercial grade Level 2 AC solution for longer dwell times

Renewable energy generation operations began at Electrify America Solar Glow™ 1 in August 2023

The Electrify America Solar Glow™ 1 project is located in San Bernardino County, CA.
It has over 200,000 solar panels and encompasses an area over one square mile.

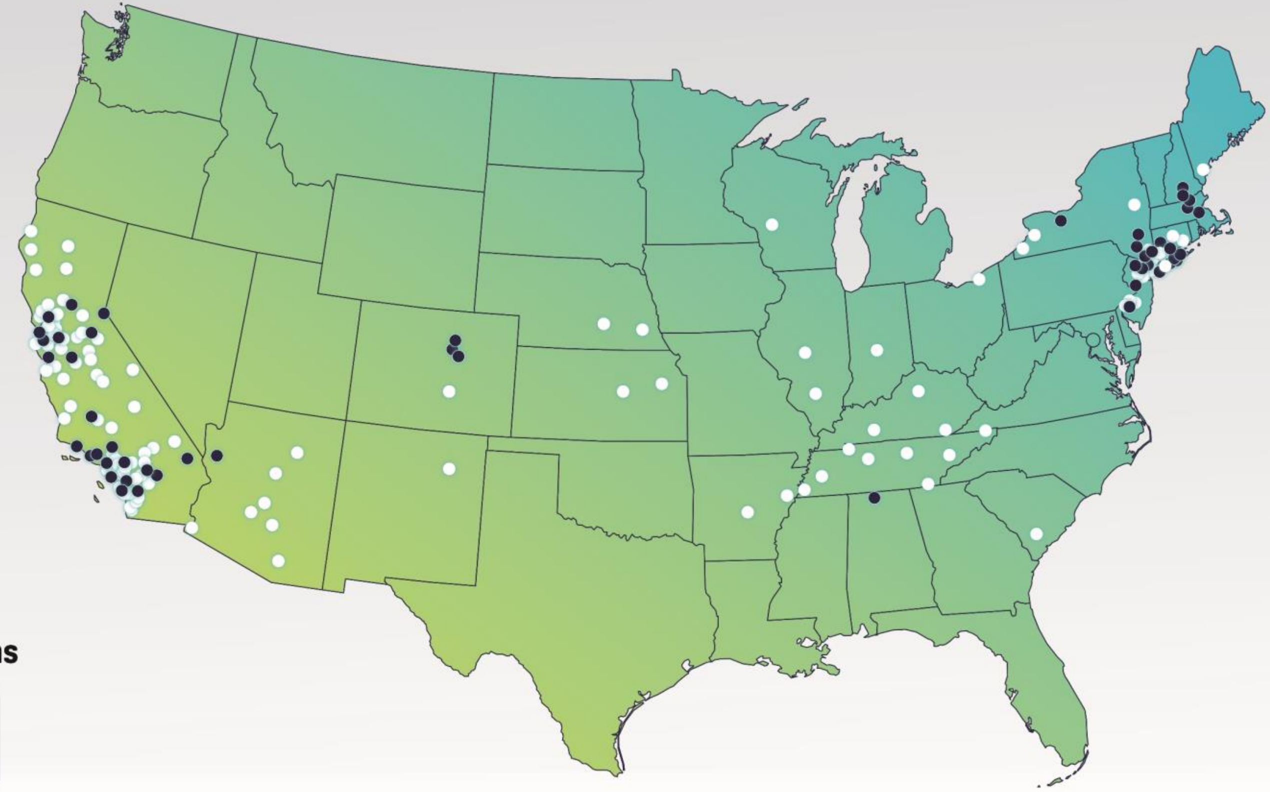
Backed by 100% Renewable Energy

Net-zero energy carbon footprint for all energy delivered to drivers across its coast-to-coast public ultra-fast DC charging network

Estimated Annual Production
225,000
Megawatt hours

Maximum Capacity
75
Megawatts

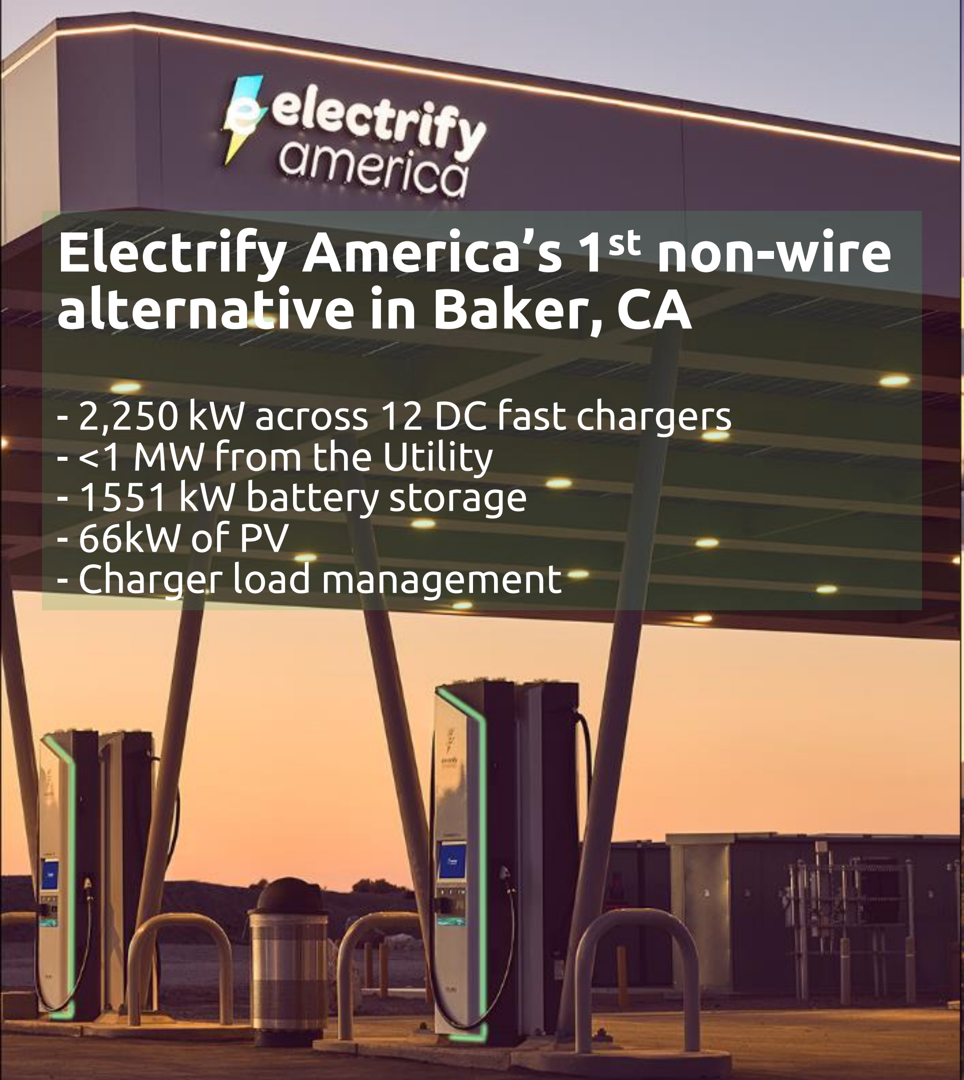
The largest roll-out of onsite behind-the-meter battery energy storage coupled with ultra-fast DC chargers in North America



Storage Locations

- Existing
- Future

electrify america



Electrify America’s 1st non-wire alternative in Baker, CA

- 2,250 kW across 12 DC fast chargers
- <1 MW from the Utility
- 1551 kW battery storage
- 66kW of PV
- Charger load management

Electrify America 2023

Selected to deploy turnkey depot charging for 50 Class 8 tractors.

Investing $25M in medium-heavy duty public and depot charging stations in Southern California:

- Drayage Depots
- Public Access Class-8 Tractor Stations
- Testing with all MD/HD OEMs

Electrify Commercial has been selected by NFI Industries to build one of the **largest ultra-fast charging depots** (38 x 350kW dispensers) to serve fifty class-8 drayage trucks.

Green Car Congress

Energy, technologies, issues and policies for sustainable mobility

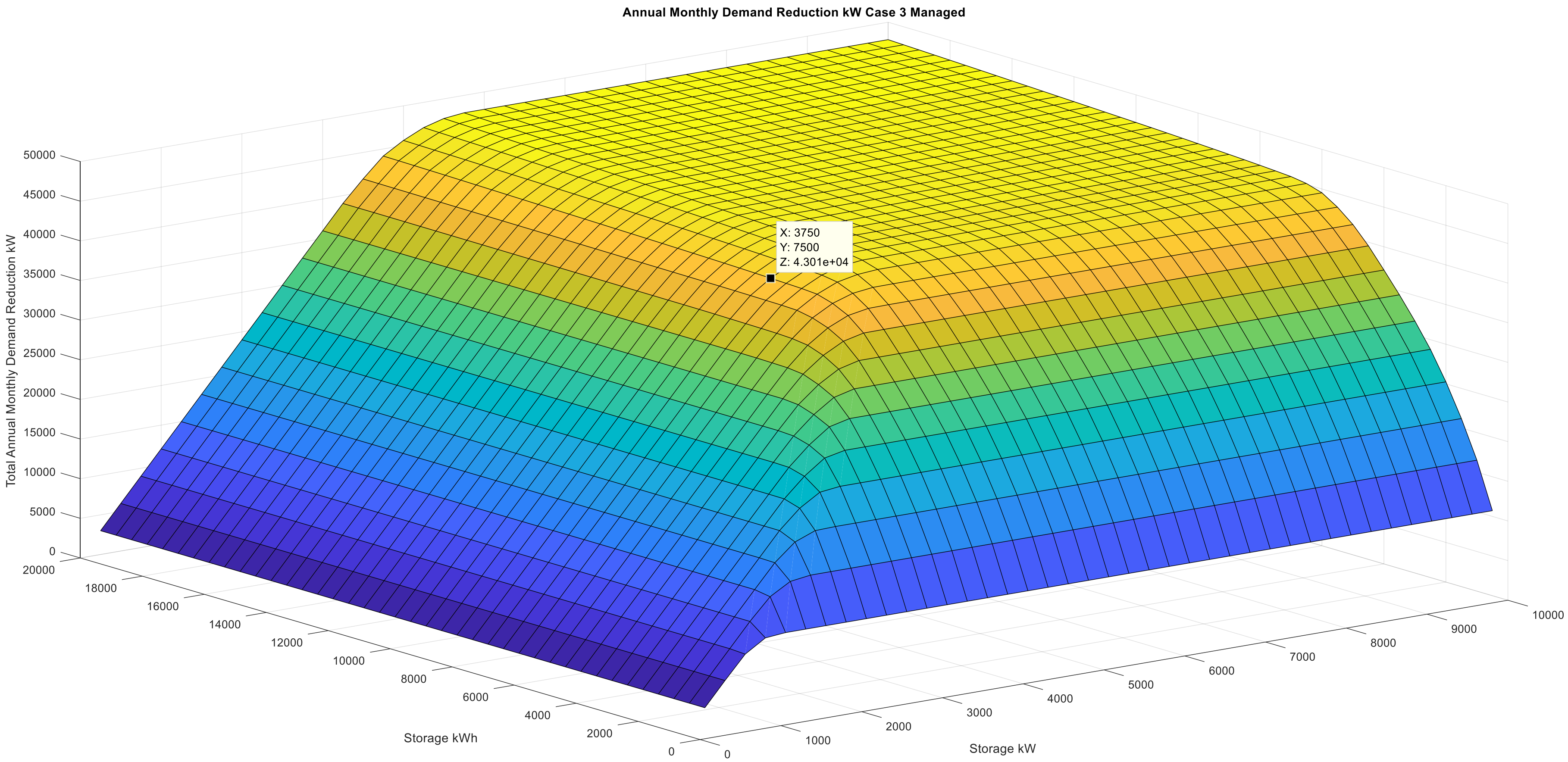
Electrify America and NFI Industries collaborate on US' largest heavy-duty electric truck charging infrastructure project

01 September 2021

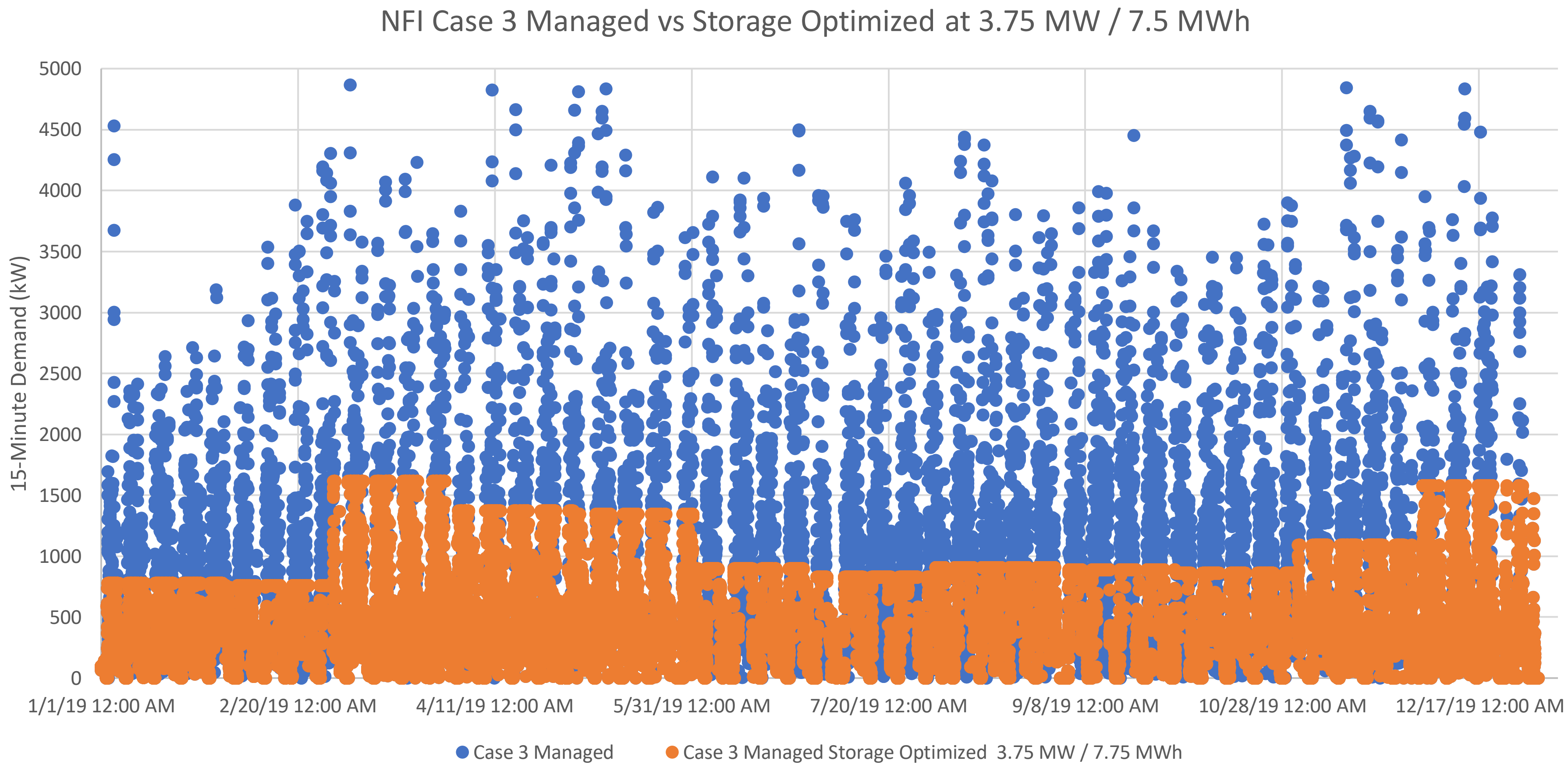
3.85 MW / 7.7 MWh of Energy Storage + 1 MW CEC-AC of Solar + Microgrid Capable / Grid Resiliency

Total Assets Greater Than 11.5 MW – Compare to Empire State Building Peak Draw at 9 MW!

Electrify America’s Energy Modeling – Sizing of Energy Storage for NFI



Energy Storage modeling shows significantly reduced grid impacts when combined with managed charging to facilitate heavy duty fleet electrification



Fast, reliable charging is everything

Jigar J. Shah
Director, Energy Services
Jigar.Shah@electrifyamerica.com

South Coast
Air Quality
Management District

Clean Fuels Program Advisory Group Meeting

January 23, 2024

Vasileios Papapostolou, Sc.D.
Technology Demonstration Manager

The 2024 Plan Update

Background

State law requirements:

- Annual Report on Clean Fuels Program and Technology Advancement Plan Update (HSC 40448.5.1)
- 2024 Plan Update (draft) submitted to Technology Committee October 20, 2023
- Submit to Legislature by March 31 every year

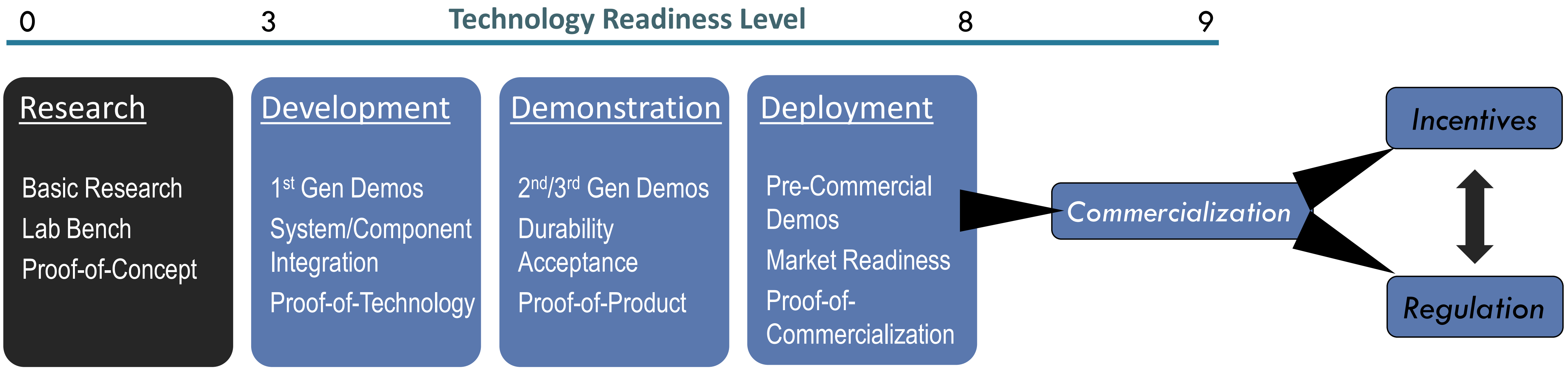
Reports: https://www.aqmd.gov/home/technology/reports

Public Outreach and Input

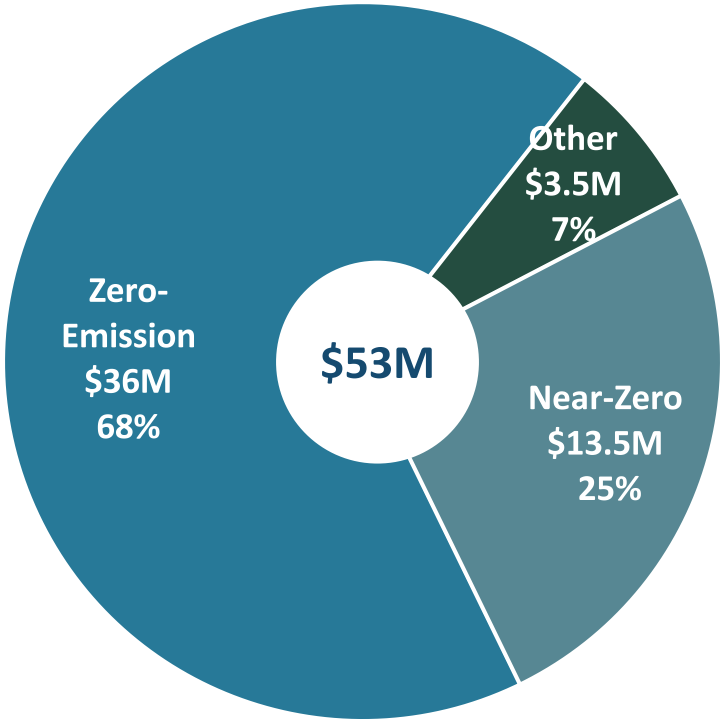
- Advisory group meetings
  - September 2023 and January 2024
  - Technology Advancement/Clean Fuels
  - Invited Technical Experts
- Meetings - agencies, industry groups, technology providers and other stakeholders

- Symposiums and conferences
  - Sponsored 16 technology conferences, including
    - 17th Annual Energy Independence Summit (02/2023)
    - PEMS Conference (03/2023)
    - Real World Emissions Workshop (03/2023)
    - ACT Conference and Expo (05/2023)
    - California Hydrogen Leadership Summit (06/2023)
    - SoCal Electrified Drive Event (10/2023)
    - Clean Mobility Forum (10/2023)
- Clean tech partnerships
  - California Hydrogen Business Council
  - California Natural Gas Vehicle Partnership
  - CALSTART
  - Hydrogen Fuel Cell Partnership

Clean Fuels Program - Overview

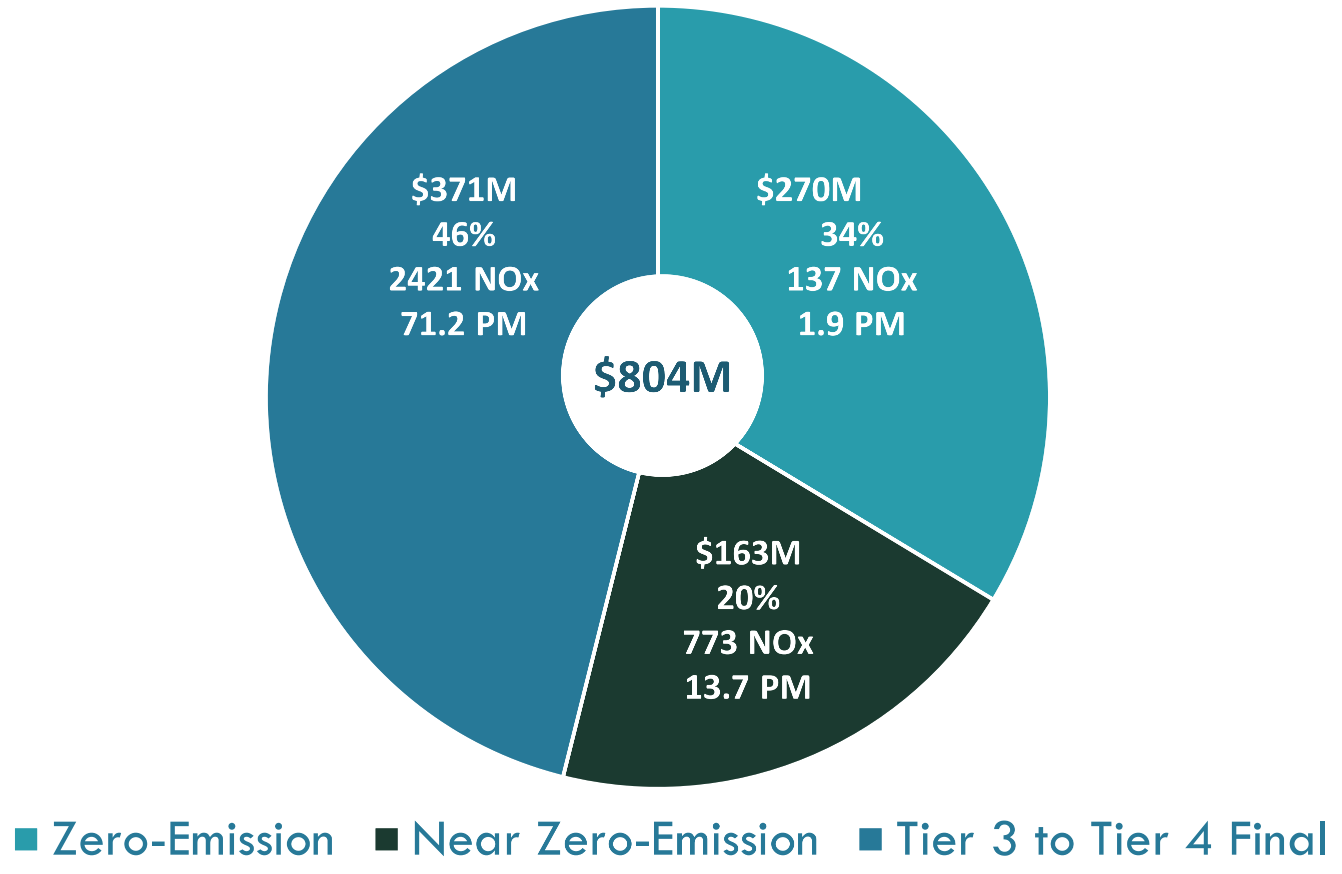


Clean Fuels Funding Allocation Between 2018 - 2023



Clean Fuels Fund Cost Share

Emission Benefits from Incentive Programs Between 2018 - 2023



Major Funding Partners in 2023

$94M

Research Funding Organizations	Major Manufacturers/ Technology Providers	Local Entities	Fleet Providers

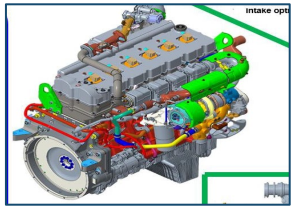
2023 Key Contracts Executed and Completed

Develop and Demonstrate Hydrogen Fuel Cell Mobile Power Generation System (ROCKETRUCK)

JETSI/Schneider Battery Electric Heavy Duty Truck and Charging Infrastructure Deployed

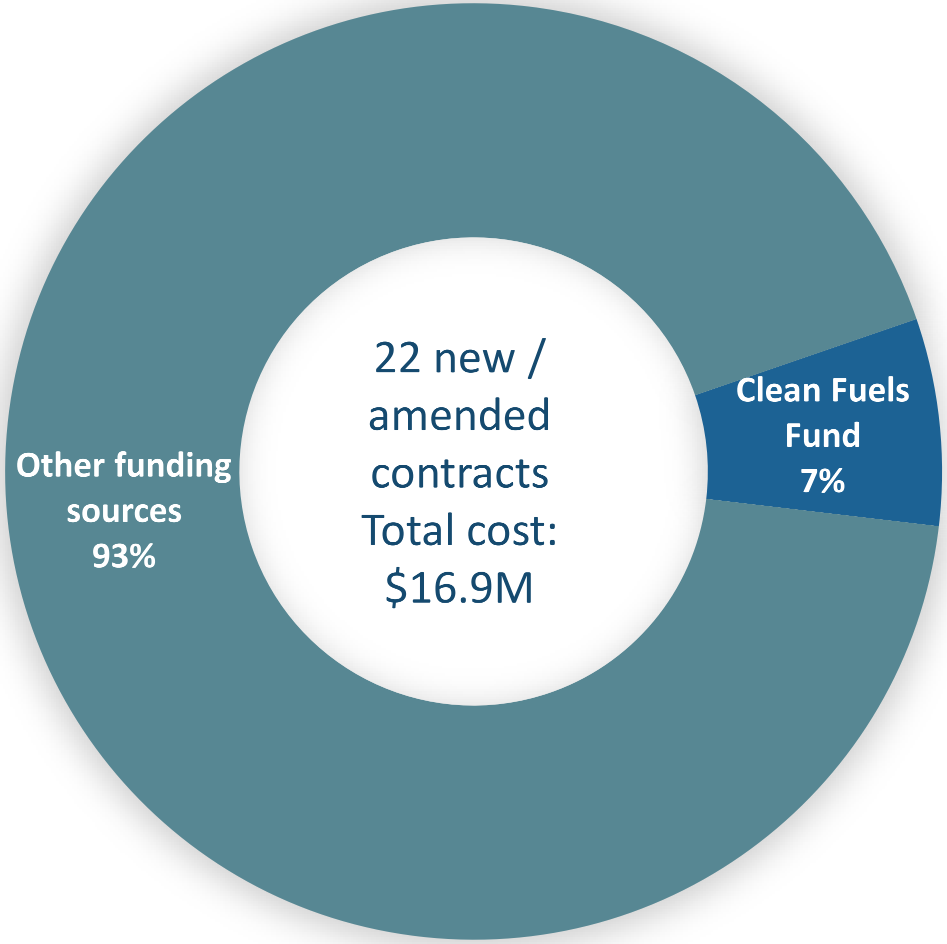
Daimler Trucks Customer Experience of Zero Emission and Mobile EV Infrastructure

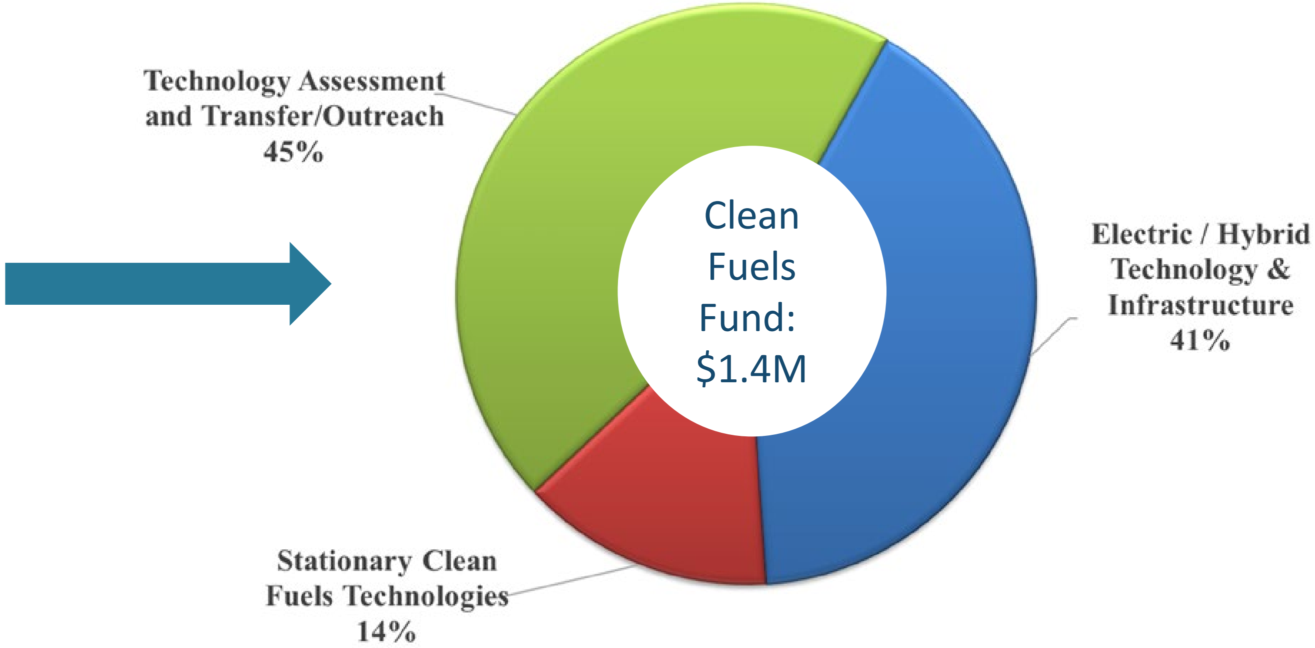
CTE Fuel Cell Extended Range Drayage Truck Demonstration/Cummins Fuel Cell Range-Extended Drayage Trucks



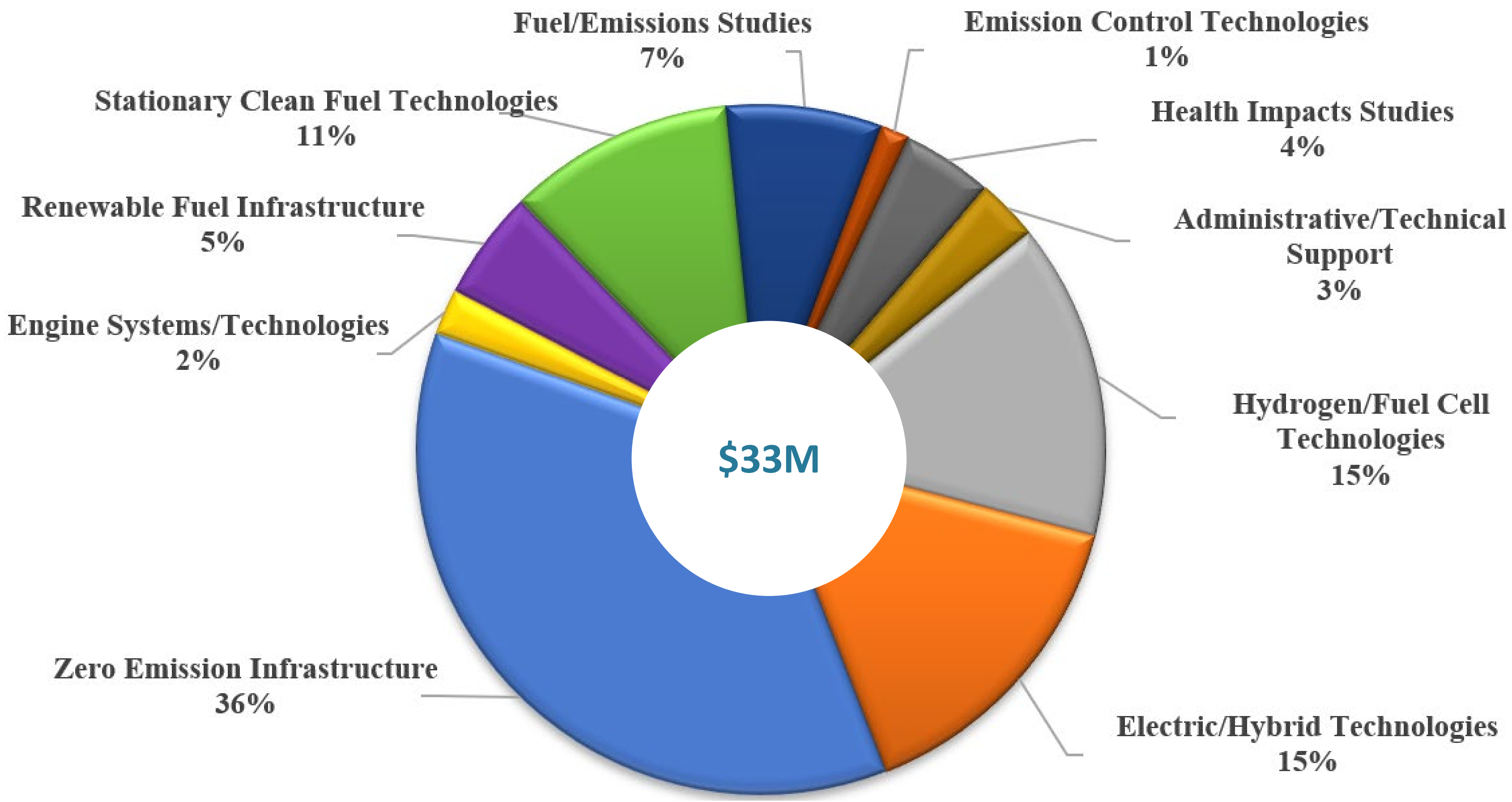
High Efficiency, Ultra Low Emissions Heavy-Duty Natural Gas Engine Research and Development

2023 Executed Clean Fuels Projects





2024 Potential Funding Distribution



RNG: renewable natural gas
CF: clean fuel

Proposed Advisory Group Members

Technology Advancement Advisory Group (14 Members):

Morgan Caswell, Port of Long Beach

Jacob Goldberg, Port of Los Angeles

Dr. Matt Miyasato, FirstElement Fuel

Dr. Laura Verduzco, Chevron

Sam Wilson, Union of Concerned Scientists

Clean Fuels Advisory Group (12 Members):

Bret Stevens, DTNA

Tom Swenson, Cummins

2023 Annual Report & 2024 Plan Update – Development Schedule

Advisory Group Review	September 14, 2023 (Draft version)
Technology Committee	October 20, 2023 (Draft version)
Advisory Group Review	January 23, 2024 (Final version)
Technology Committee	February 16, 2024 (Final version)
Governing Board Approval	March 1, 2024
Due to State Legislature	March 31, 2024

Thank you!