CLEAN FUELS PROGRAM ADVISORY GROUP AGENDA
SEPTEMBER 12, 2024, 9:00 AM – 3:30 PM
Conference Room GB
21865 Copley Drive
Diamond Bar, CA 91765

TELECONFERENCE LOCATIONS

University of Nevada, Reno 1664 N. Virginia St, Ross Hall 201, Reno, NV 89557	South Valleys Library 15650A Wedge Pkwy Reno, NV 89511

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, September 12, 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 total for all items on the agenda.

Welcome & Overview
9:00 – 10:00 AM

(a)	Welcome, Introductions and Goals for the Day	Vasileios Papapostolou, Sc.D., Technology Demonstration Manager*
(b)	Multiple Air Toxics Exposure Study VI (MATES VI)	Scott Epstein, Ph.D., Planning & Rules Manager**
(c)	Incentives, Grant Updates, and Opportunities	Aaron Katzenstein, Ph.D., Deputy Executive Officer* & Mei Wang, Assistant Deputy Executive Officer*
(d)	Feedback and Discussion	Advisors and Experts
(e)	Public Comment (2 minutes/person)	

1. Grid Readiness & Charging Infrastructure
10:15 AM – 12:00 PM

(a)	Farm-to-Table Hydrogen for EV Charging	JT Steenkamp, Prologis
(b)	Accelerating Electrification of Medium- and Heavy-duty Trucks in Southern California with Data-Driven Planning	Nanpeng Yu, Ph.D., University of California, Riverside & Zuzhao Ye, Ph.D., AmpTrans

	Platforms for Charging Networks, Truck Fleets, and Power Systems	
(c)	Transitioning the MHD Transportation Sector to ZEVs	Arun Raju, Ph.D., University of California, Riverside
(d)	Feedback and Discussion	Advisors and Experts
(e)	Public Comment (2 minutes/person)	

Lunch
12:15 PM – 1:15 PM

2. **Battery & Hydrogen**
1:30 PM – 2:30 PM

(a)	FuelCell Energy: Tri-gen Project at Toyota Logistic Services in the Port of Long Beach	Paul Fukumoto, Fuel Cell Energy
(b)	Battery Workforce Challenge at Cal State LA	Isabel Builes, California State University Los Angeles
(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., Technology Demonstration Manager
(b)	Advisor and Expert Comments	All
(c)	Public Comment (2 minutes/person)	

* South Coast AQMD Technology Advancement Office
**South Coast AQMD Planning, Rule Development & Implementation

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.

Overview of the Multiple Air Toxics Exposure Study VI

Clean Fuels Program Advisory Group
September 12, 2024

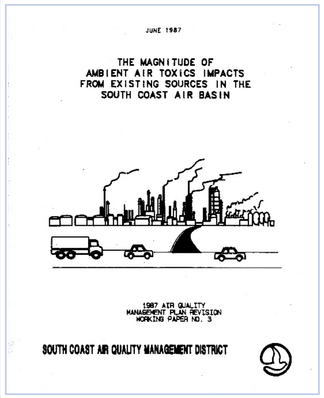
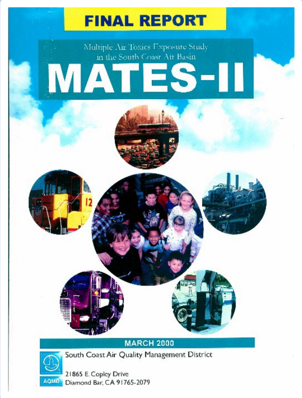
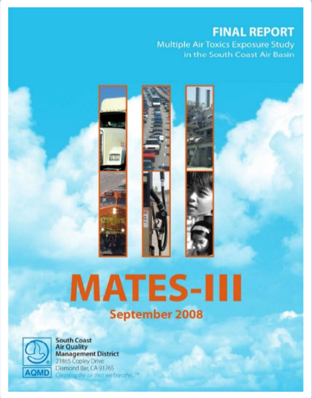
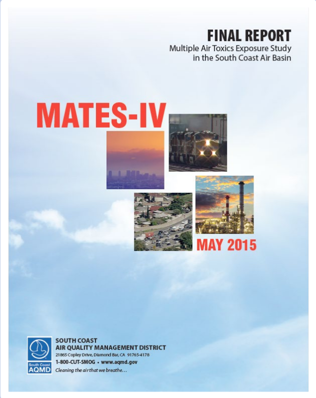
MATES Program Overview

- Board Environmental Justice Initiative
- Focuses on regional air toxics impacts

<u>Goals</u>:

- Provide public information about air toxics and associated health risks throughout the region
- Evaluate progress in reducing air toxics exposure
- Provide direction to future toxics control programs

Previous MATES Campaigns

1986-1987	1998-1999	2004-2006	2012-2013
			

MATES I

Limited Measurements

Impacts of benzene and Cr6

MATES II

Downward trend for certain air toxics

Diesel exhaust accounted for 71% of cancer risk from air toxics

MATES III

Continuing downward trends, other than Diesel PM

Increased Diesel PM risk near ports

Cr6 traced to cement plant emissions

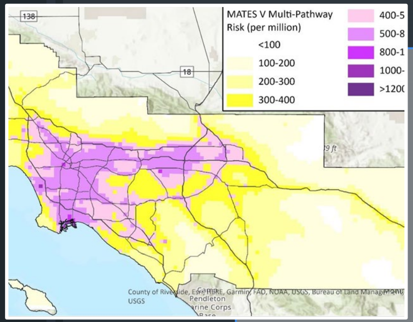
MATES IV

>50% decrease in air toxic cancer risk since MATES III

2/3 of air toxics cancer risk from Diesel PM

Continuous UFP and BC measurements

MATES V: Summary of Results
(2018-2019 Monitoring, 2021 Report)



Air toxics cancer risk decreased by ~50% since 2012, but risks are still high

Highest air toxics cancer risk in and around the ports. Risk also elevated along goods movement corridors and major freeways

Diesel PM is the largest contributor to air toxics cancer risk

EJ communities also had decreased air toxics levels, but still higher compared to Basin averages

Advanced air monitoring methods and techniques were evaluated at and near refineries

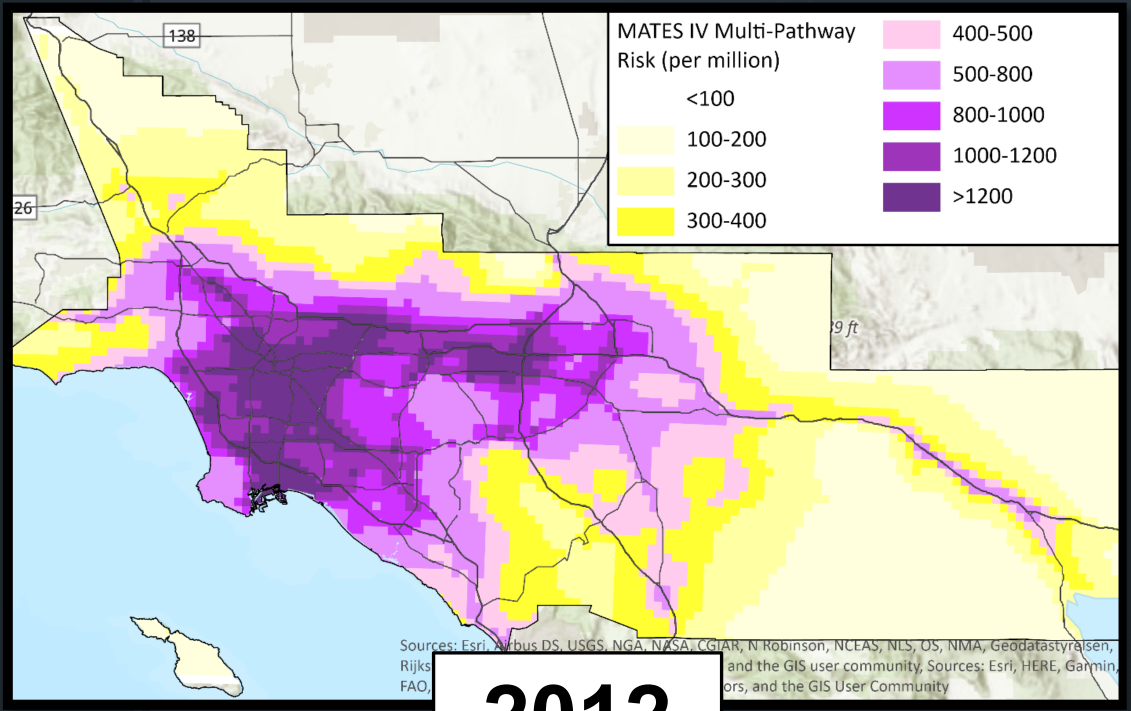
Chronic non-cancer health impacts were estimated for the first time, with a chronic hazard index of 5-9 across the 10 stations

MATES V webpage: http://www.aqmd.gov/MATES5

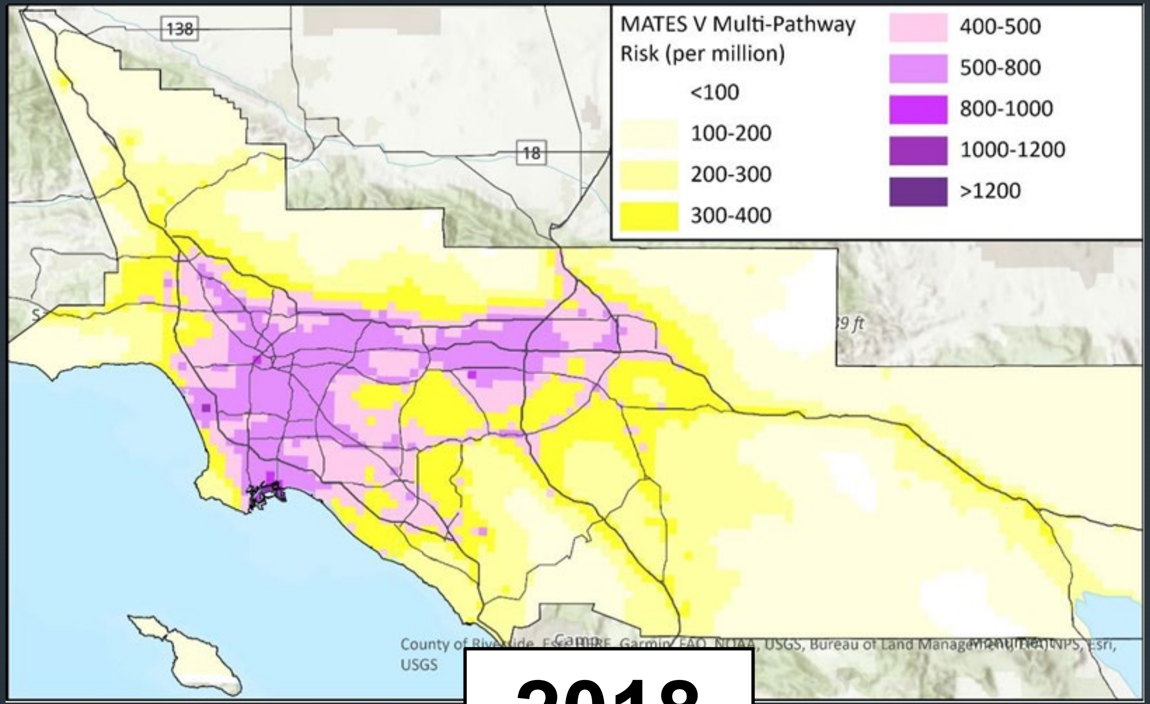
Air Toxics Cancer Risk – Modeling Data

MATES IV (population-weighted):
South Coast Air Basin: **997-in-a-million**
Coachella Valley: **357-in-a-million**

MATES V (population-weighted):
South Coast Air Basin: **455-in-a-million**
Coachella Valley: **250-in-a-million**

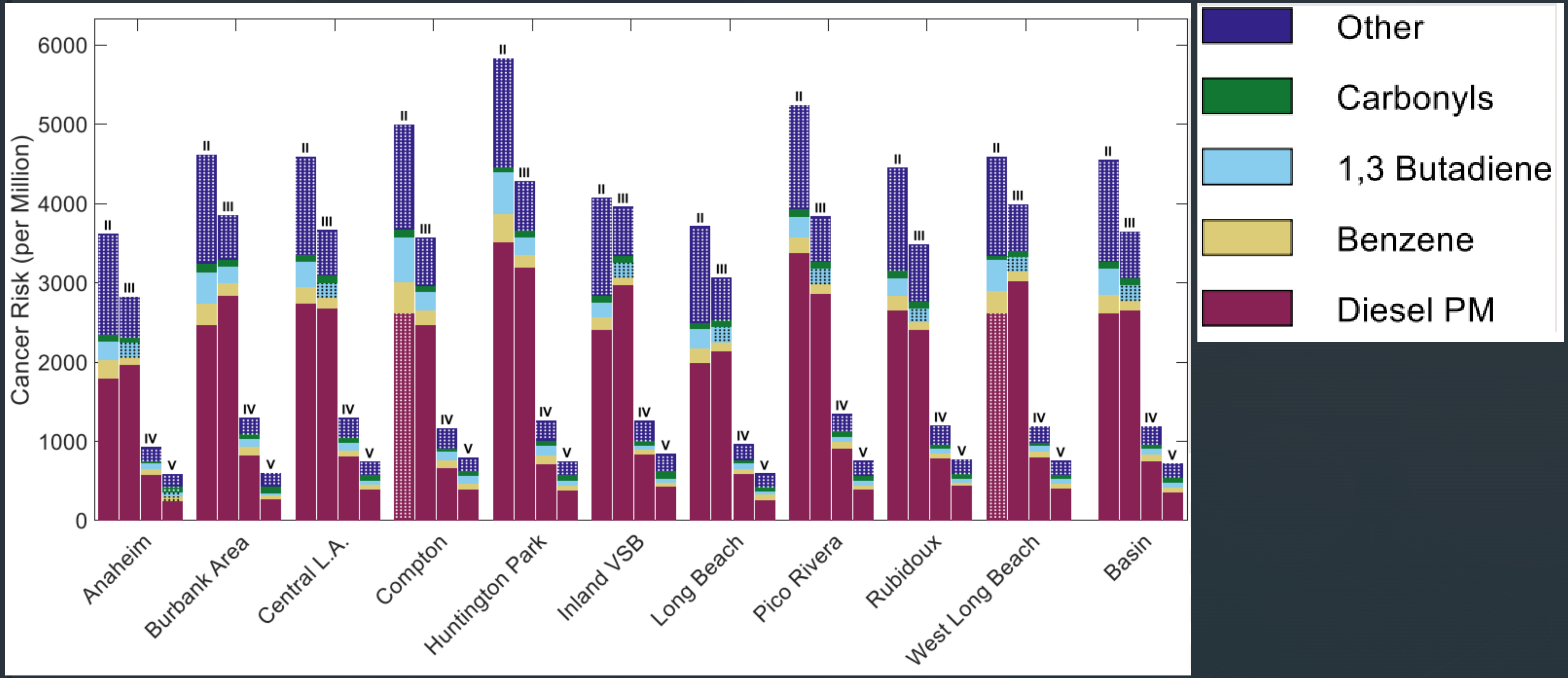


2012



2018

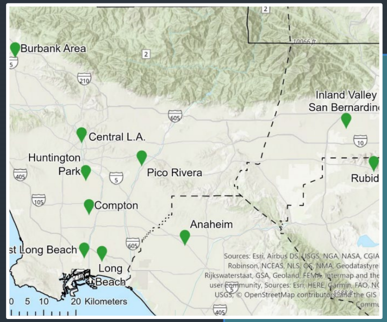
MATES V Cancer Risk Trends
(based on monitoring data)



MATES V webpage and interactive web interface: http://www.aqmd.gov/MATES5

MATES VI Approach

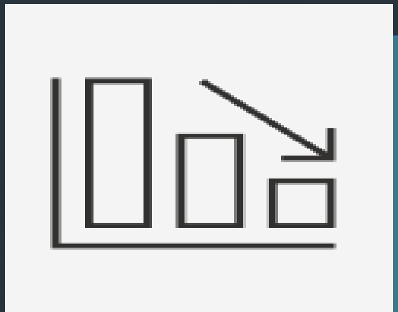
Solicit Feedback from 21 Member Technical Advisory Group



Air Monitoring Campaign at 10 Locations

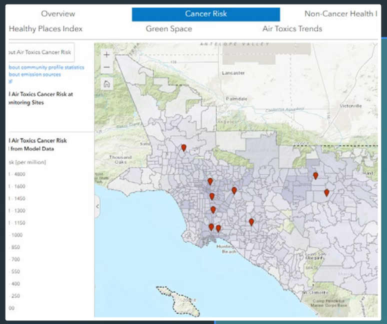
- South Coast Air Basin and Coachella Valley
- Two Near-Road Sites
- One Year

Comprehensive Modeling Analysis of Air Toxics Cancer Risk with Updated Emission Inventory



Analysis of Trends in Concentrations and Health Risk Over Past MATES Studies

Cancer Risk and Chronic Non-Cancer Health Impacts Determined with Measurement Data



Online Interactive Data Display to Visualize Risk and Concentration Data

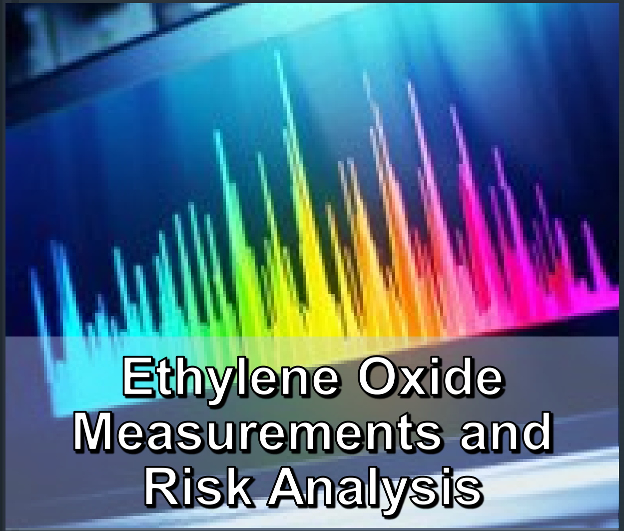
MATES VI webpage: http://www.aqmd.gov/MATES6

What's New for MATES VI?

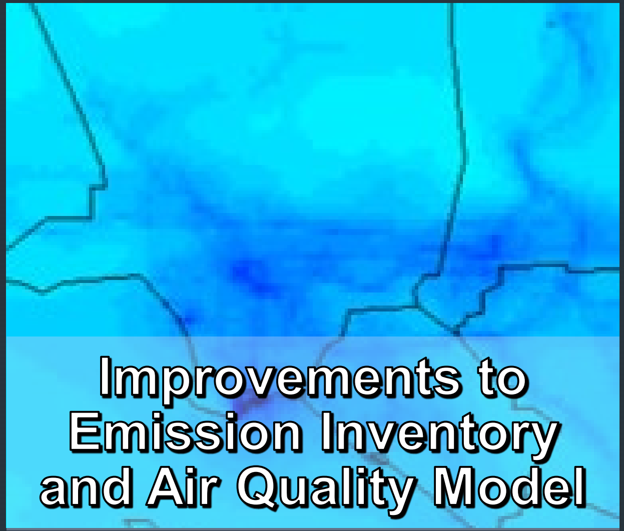
Measurements at Two Near-Road Sites

Expansion of Measurements to the Coachella Valley

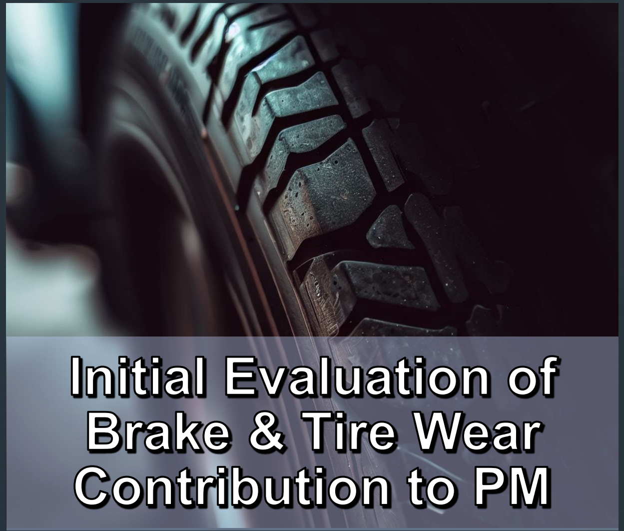
Source Apportionment Study to Capture Air Toxic Sources



Ethylene Oxide Measurements and Risk Analysis

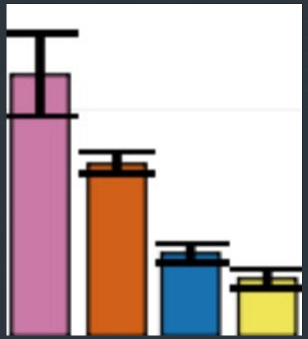


Improvements to Emission Inventory and Air Quality Model



Initial Evaluation of Brake & Tire Wear Contribution to PM

How are MATES Results Used?



- Evaluate progress of air toxic control programs
- Help prioritize policy-making by determining major contributors to toxic risk
- Help interpret data from special air toxics monitoring studies and community air monitoring projects
- Identify unknown air toxics sources
- Help address public inquiries related to air toxics impacts

MATES VI Process

Planning & Preparation Stage (~1.5 years)

Consultation with TAG	Obtaining Equipment & Supplies	Monitoring Site Preparation	Instrument Deployment & Testing

Field Measurements & Air Quality Modeling (~1.5 years)

Instrument Operation & Maintenance	Collection & Lab Analysis of Samples	Emission Inventory Preparation	Meteorology & Air Toxics Modeling

Data Analysis (~1 year)

Data QA/QC	Measured & Modeled Data Comparison	Cancer & Chronic Risk Calculation	Comparison to Past MATES Data	Source Apportionment Study

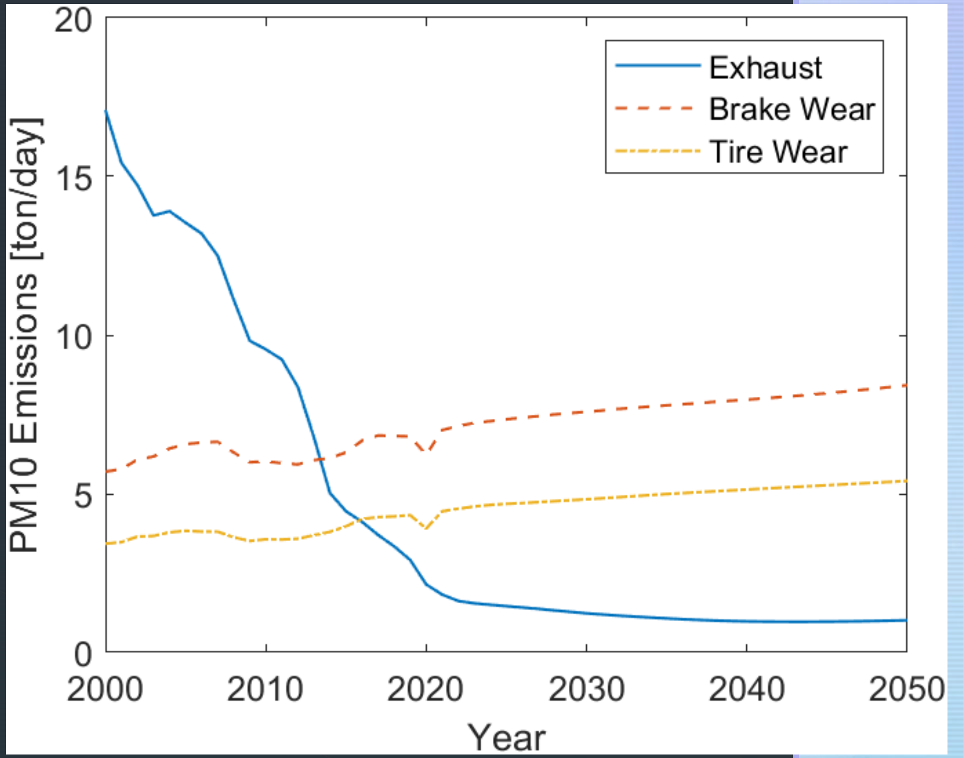
Dissemination (~9 months)

Continued Consultation with TAG	Draft & Final Report	Design and Development of Interactive Tools	Public Outreach

Public Process

Brake and Tire Wear

- The Board approved $850,000 from the Clean Fuels Program Fund to study brake and tire wear as part of MATES VI
- Selected Emissions Analytics LLC as contractor through RFP process, with UCI and USC as subcontractors
- **Objective**: Use measurements and modeling to estimate outdoor concentrations of brake wear particle and tire and road wear particle emissions from on-road vehicles and roadways at a 2 km grid over the South Coast Air Basin and the Coachella Valley during MATES VI



Brake and tire wear emissions are becoming a larger fraction of air toxics emissions

Brake and Tire Wear

- Brake wear particles and tire and road wear particles are generated during friction contact in the brake and with the road surface
- Brake and tire wear particles are also resuspended from the road surface

https://commons.wikimedia.org/wiki/File:Automobile_brake_pad.jpg

https://www.stockvault.net/photo/215160/old-tyres

Evidence for Health Effects

- ischemic heart disease, congestive heart failure, cardiovascular mortality
- respiratory mortality
- adverse birth outcomes, ischemic placental disease
- autism spectrum disorder

Brake and Tire Study Components

Literature Review

- Identify composition of brake, tire, and road dust particles, and VOCs that off-gas from tires and brakes
- Includes academic papers, other scientific research, manufacturer data, government data

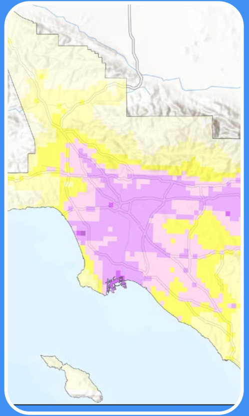
Lab Measurements

- Test brake systems on dynamometer to determine brake emission composition fingerprints
- Analyze organic compound concentrations on collected field samples*

Field Measurements during MATES VI campaign

- South Coast AQMD will provide cuts of 24-hour PM10 samples at the 10 MATES VI measurement stations over a one-year period

Data Analysis and Calculation



- PM10 tire tread concentration
- PM10 brake wear concentration
- PM10 from road dust
- 2 km resolution exposure using regional model data from South Coast AQMD, using hybrid modeling and incorporating measurements

*using gas chromatography and mass spectrometry with pyrolysis sample introduction

Tentative Timeline* & Next Steps

2023
1st TAG Meeting, Governing Board & Administrative Committee Meetings

2024
Instrument Acquisition & Testing

Brake & Tire Wear RFP and Contract

2025-2026
Air Monitoring Campaign

2026-2027
Analysis of Monitoring and Air Quality Modeling Data

2027-2028
Release of MATES VI Report and Online Interactive Data Visualization Tools

- MATES VI homepage: www.aqmd.gov/MATES6.
- Sign up for more info at www.aqmd.gov/sign-up.
- Next MATES VI Technical Advisory Group Meeting 9/27

* Schedule subject to change



Incentives & Grant Update

South Coast AQMD
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

Volkswagen Environmental Mitigation Trust Program

Community Air Protection Program (supports AB 617)

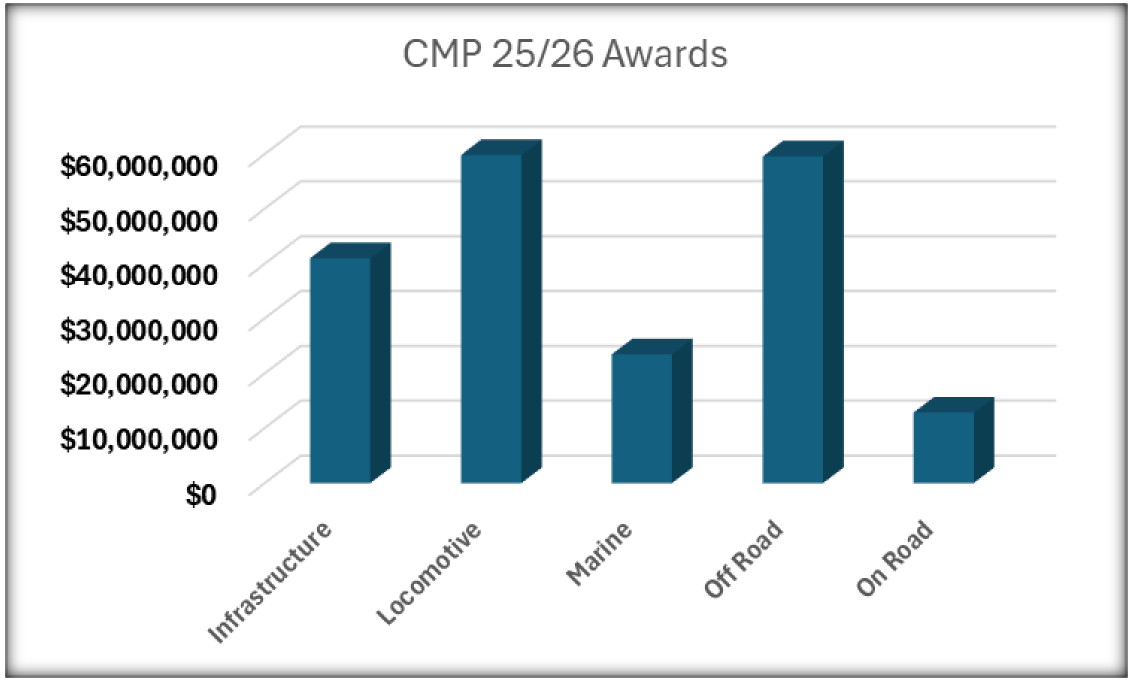
Light-Duty Vehicle Replacement Program

School Buse and CNG Tank Replacement Program and INF

Commercial Electric Lawn and Garden Equipment Program

2024 Carl Moyer Incentive Program Activities

- Carl Moyer Yr 25&26 solicitation closed in May 2023
  - > 900 projects evaluated, requesting $424m
  - >550 eligible projects awarded for $200m
- ZE infrastructure solicitation closed in February 2024
  - $25m fast track projects awarded
  - $330m eligible awards remaining
  - Additional awards anticipated Winter 2024

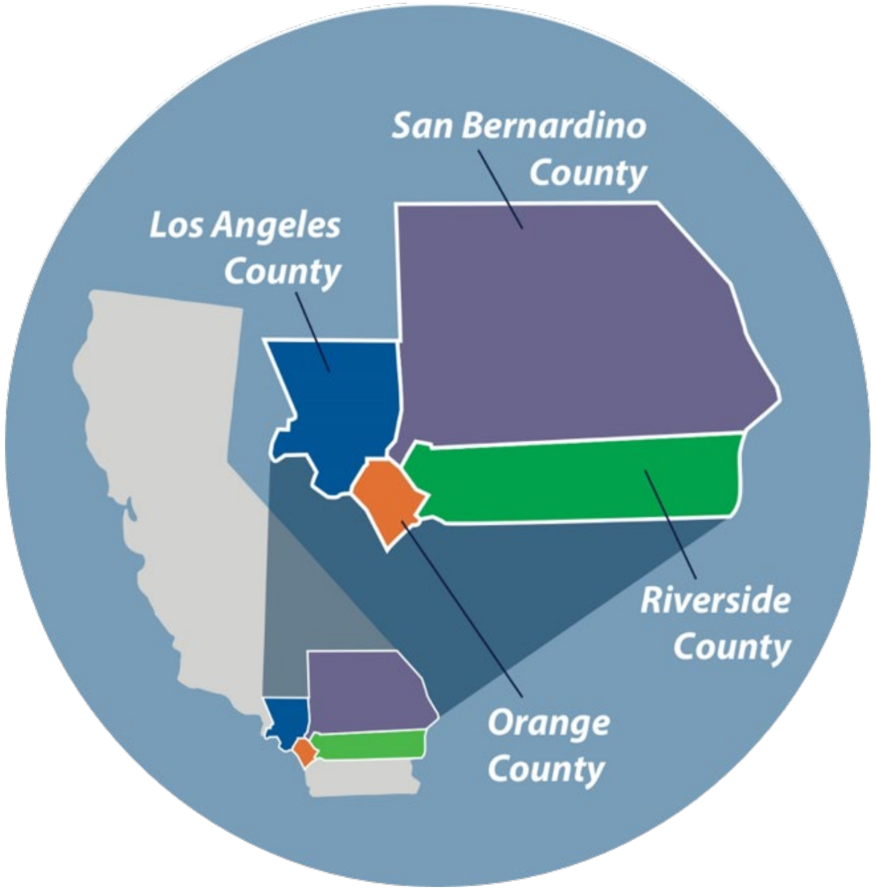


Climate Pollution Reduction Grant
INVEST CLEAN

- INVEST CLEAN - **I**nfrastructure, **V**ehicles, and **E**quipment **S**trategy for **C**limate, **E**quity, **A**ir **Q**uality, and **N**ational **C**ompetitiveness
- Inflation reduction act (IRA) created $4.6 B U.S. EPA Climate Pollution Reduction Grant Program (CPRG)
- The goals to develop climate action plans and implement projects:
  - Reduce air pollution
  - Support jobs
  - Leverage funding, maximize emission reductions and community benefits
  - Address environmental justice

Climate Pollution Reduction Grant
INVEST CLEAN

- South Coast AQMD worked with two Metropolitan Statistical Areas (MSAs) and played an active role
- 81 letters of commitment/support with 131 signatories were included in the proposal
- Nearly 300 applications nationwide requesting almost $33 billion
- 25 proposals awarded
- $500 million award to the South Coast AQMD - the largest in the nation



South Coast AQMD

INVEST CLEAN
Four Incentive Measures

Heavy-duty Charging Infrastructure

(Approx. 1,020 chargers)
$191 million

Class 8 Trucks and Last Mile Freight Class 4/5

(Approx. 70 Class 8 & 750 Class 4/5 trucks)
$84 million

Cargo Handling Equipment

(Approx. 60 CHE)
$26 million

Locomotive Pilot Project

(Approx. 18 locomotives)
$199 million

INVEST CLEAN
Jobs, Workforce Training & Community Benefits

Jobs

- Near-term over 470 jobs created in California and 4,700 nationwide

Workforce Training

- Partnership with International Brotherhood of Electrical Workers – National Electrical Contractors Association, workforce non-governmental organizations, community colleges, and universities/colleges

Community Benefits

- Steering Committee to conduct outreach and education on climate, air quality and zero-emission technologies
- Community priorities incorporated as voluntary measures that infrastructure project can elect to implement
- Emissions reductions and workforce training

INVEST CLEAN
Climate & Air Quality

Benefits Over 25 Years (2025-2050):

12 Million Metric Tons
CO_2e Emissions Reduced

1,600 Tons
NOx Emissions Reduced Per Year

28 Tons
PM2.5 Emissions Reduced Per Year

30 Tons
Diesel PM Emissions Reduced Per Year

1 Billion+
Gallons Diesel Avoided

Excellent cost effectiveness at **$42/metric ton** CO_2e over the **25-year** period.

INVEST CLEAN
Next Steps

SCAQMD Board Approval & Recognizing the Award (Sept. 2024)

→ EPA Grant Agreement (Oct. 2024)

→ Solicitation for 3rd Party Facilitator (Dec. 2024)

→ Subaward Agreement for Training Entity (Q1 2025)

→ Develop Implementation Plan (Q1 2025)

→ Release Program Announcement for Incentive Measures (Q2 2025)

Questions

PROLOGIS® MOBILITY

South Coast AQMD

Farm-to-Table Hydrogen for EV Charging

How Prologis could be turning excess rooftop solar energy into hydrogen fuel

Presented by:

JT Steenkamp

VP Projects & Technology

Prologis Mobility

12 September 2024

One of the World's Largest Microgrid EV Charging Projects

Location: Torrance, CA

- Linear generators, BESS, DCFCs
- Avoided 3 years of grid delay
- Additional reliability when grid joins
- Renewable Natural Gas & H_2 flexible

1.3T/d
H_2-to-EV ready

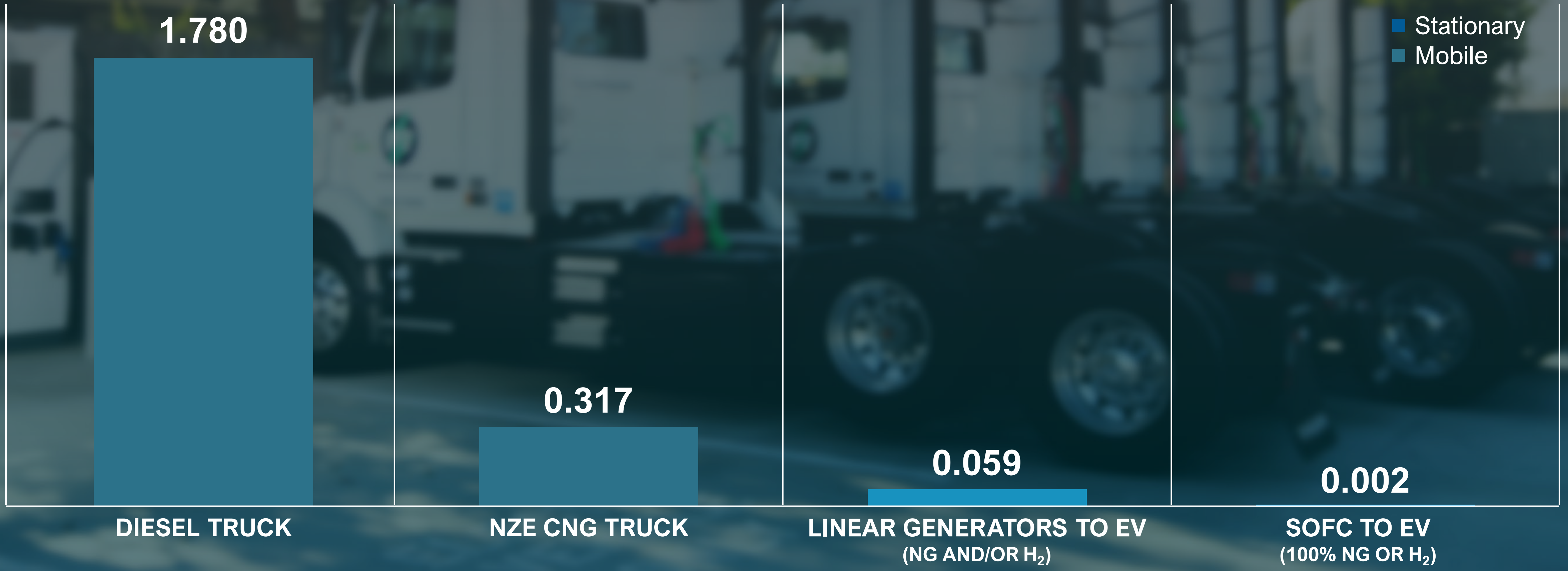
96
Charging stalls

9MW
Charging capacity

18MWh
Energy storage

NOx Emissions Reduction

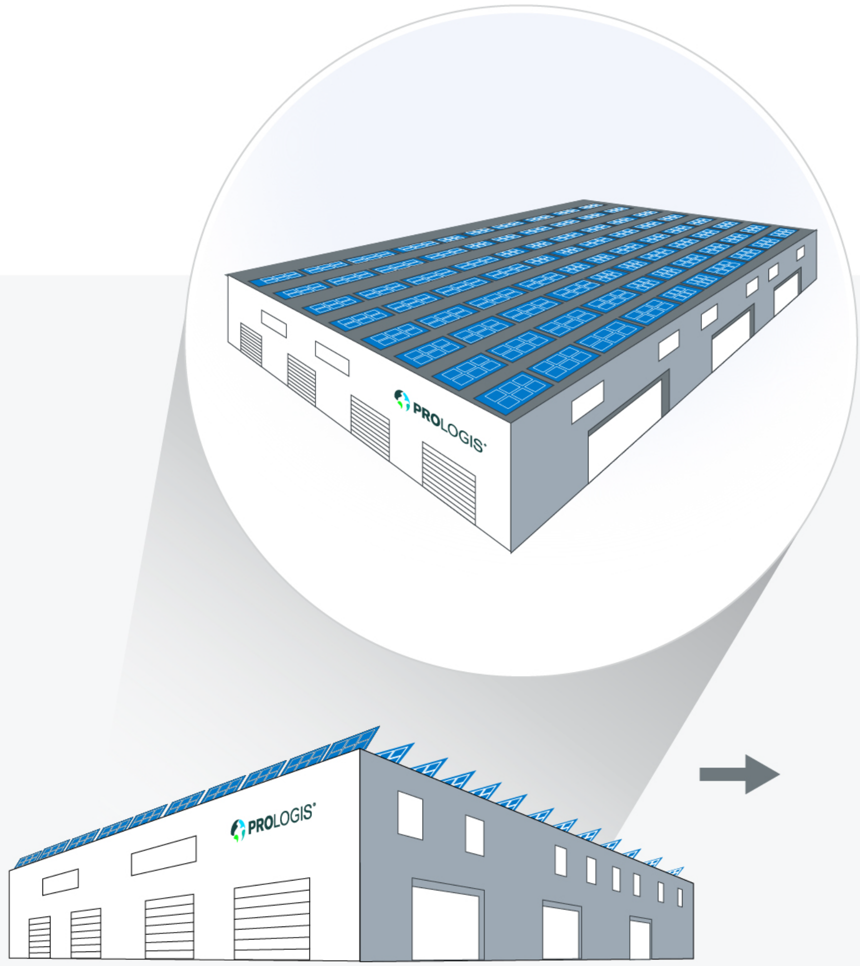
NOx Emissions for Class 8 Trucks (g/mi)



The Benefits of Local Hydrogen Production

- Can make **green hydrogen from our roofs** using solar electrolysis within short distance of mobility hubs
- Green hydrogen made from renewable power **does not emit carbon** or other contaminants
- Hydrogen production, storage, and distribution **moves energy without needing the utility**
- **Storing is cheaper** compared to lithium-ion batteries ($66/kWh trailer vs. $145/kWh Li ion)
- H_2 Infrastructure as **hedge between BEV and FCEV** future
- **Hydrogen is flexible** which means potential customer base more diverse

How it would work



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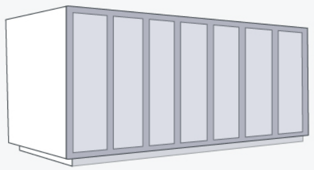
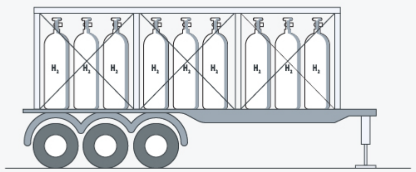


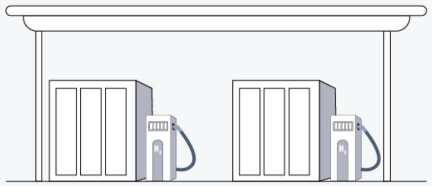
Surplus roof vacancy is committed to hydrogen production. Water is split into O_2 and H_2 using a PEM electrolyzer

2



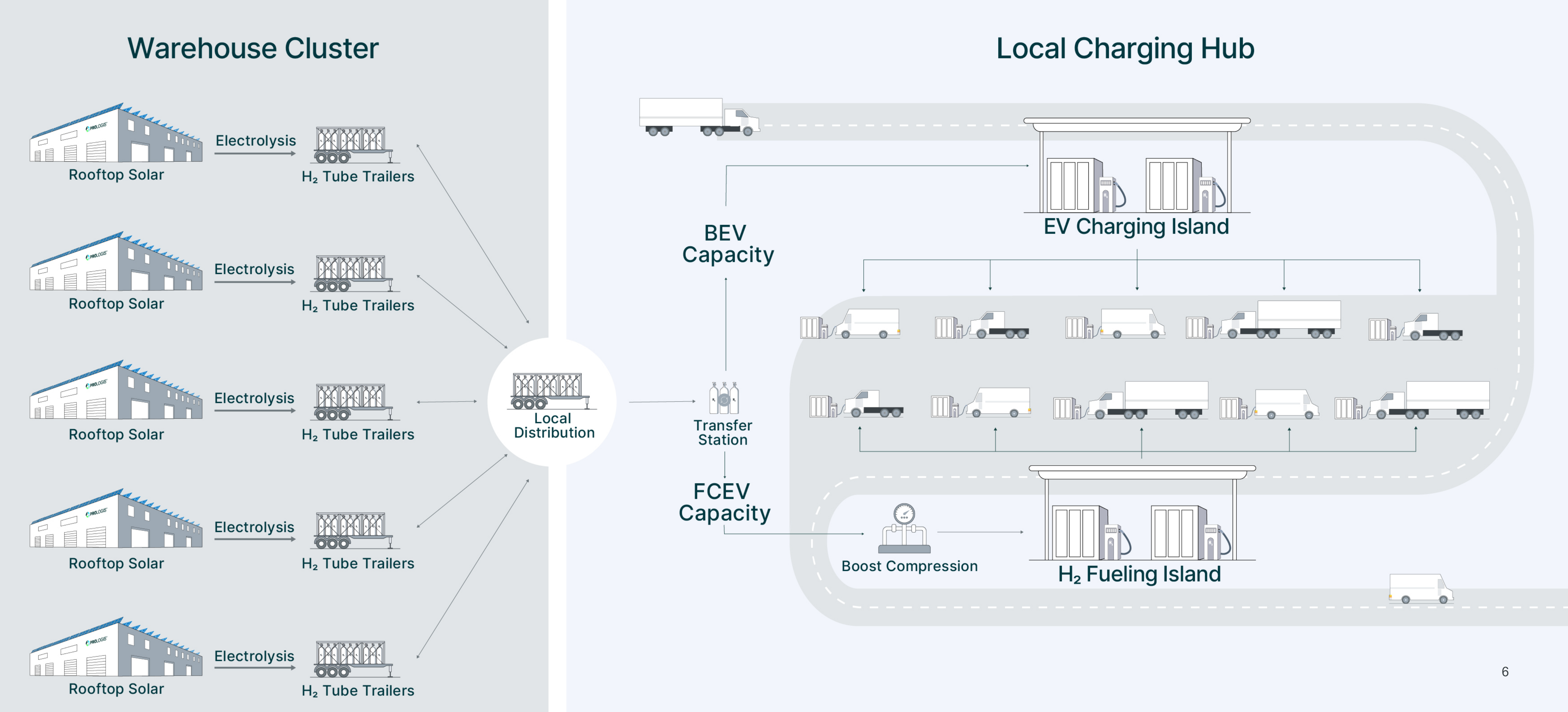
H_2 is compressed into tube trailers creating a network of physically decoupled sources and loads

3

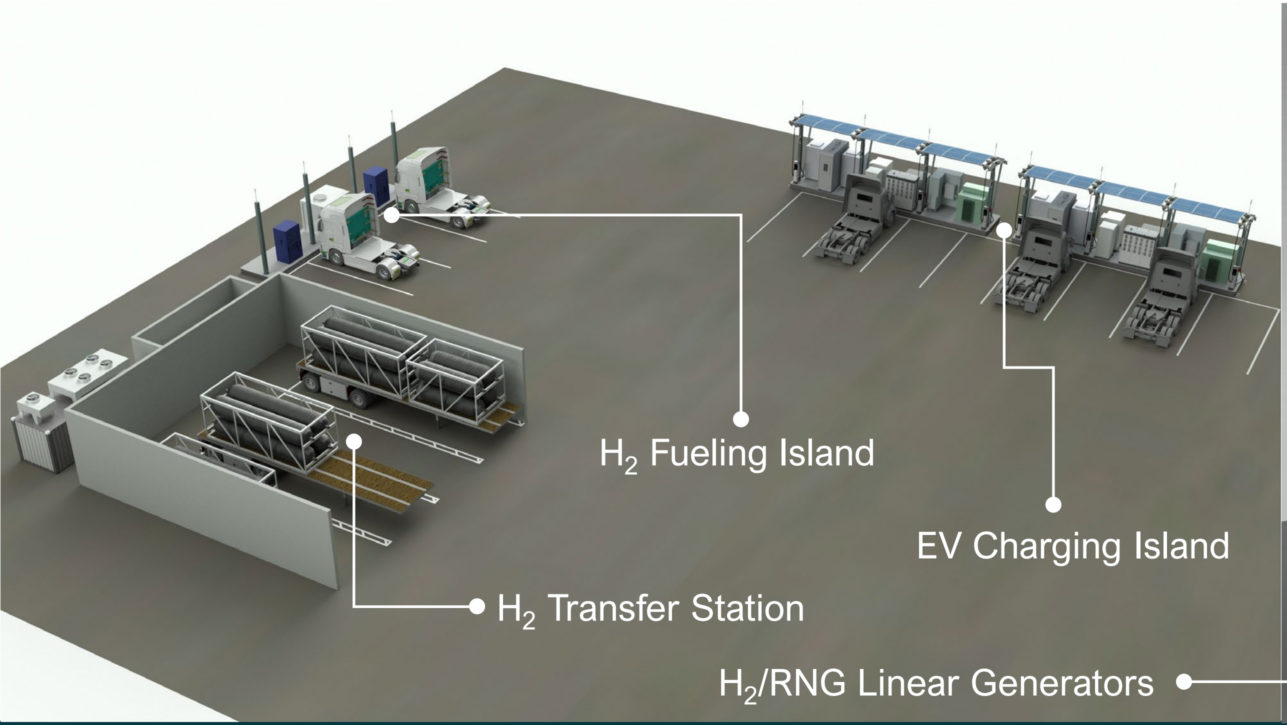


H_2 is delivered to EV charging locations where linear generators consume H_2 to generate electricity for EV charging

Local Hydrogen Production and Distribution Network



The Hydrogen Multi-Fuel Ecosystem



Hydrogen Multi-Fuel Hub

Onsite hydrogen storage -> FCEV & BEV fueling

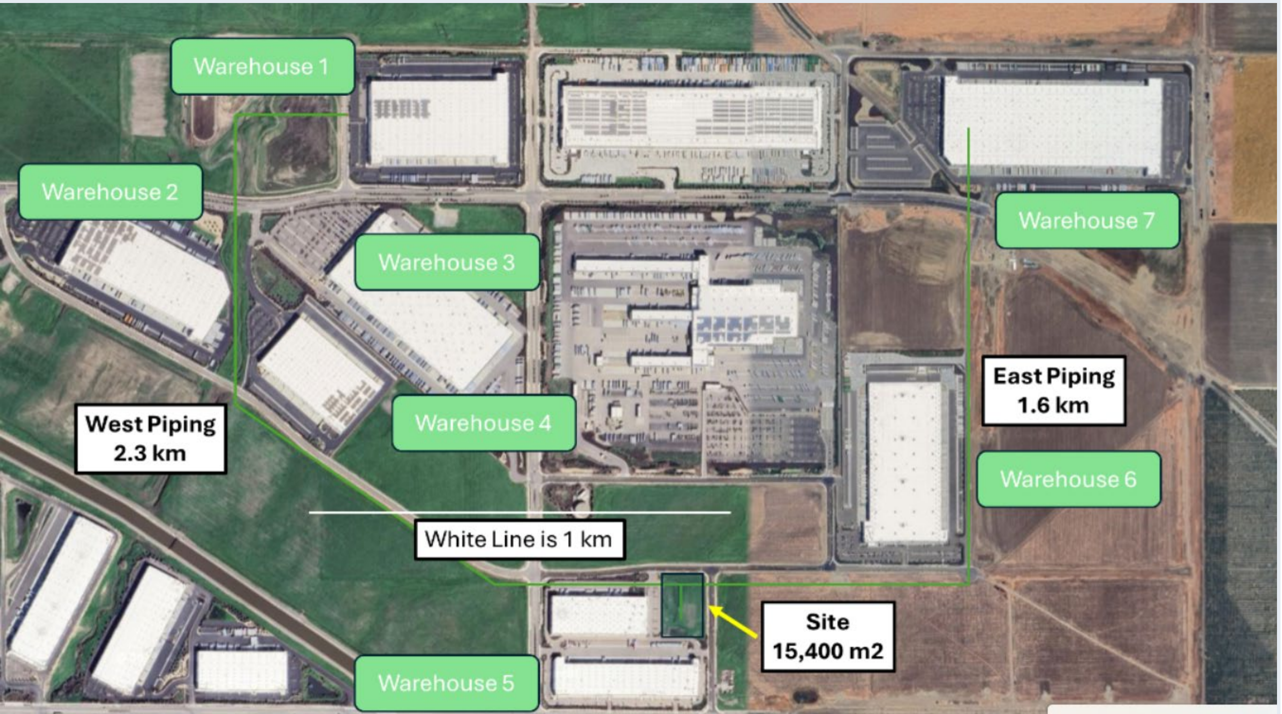
EV Charging Island

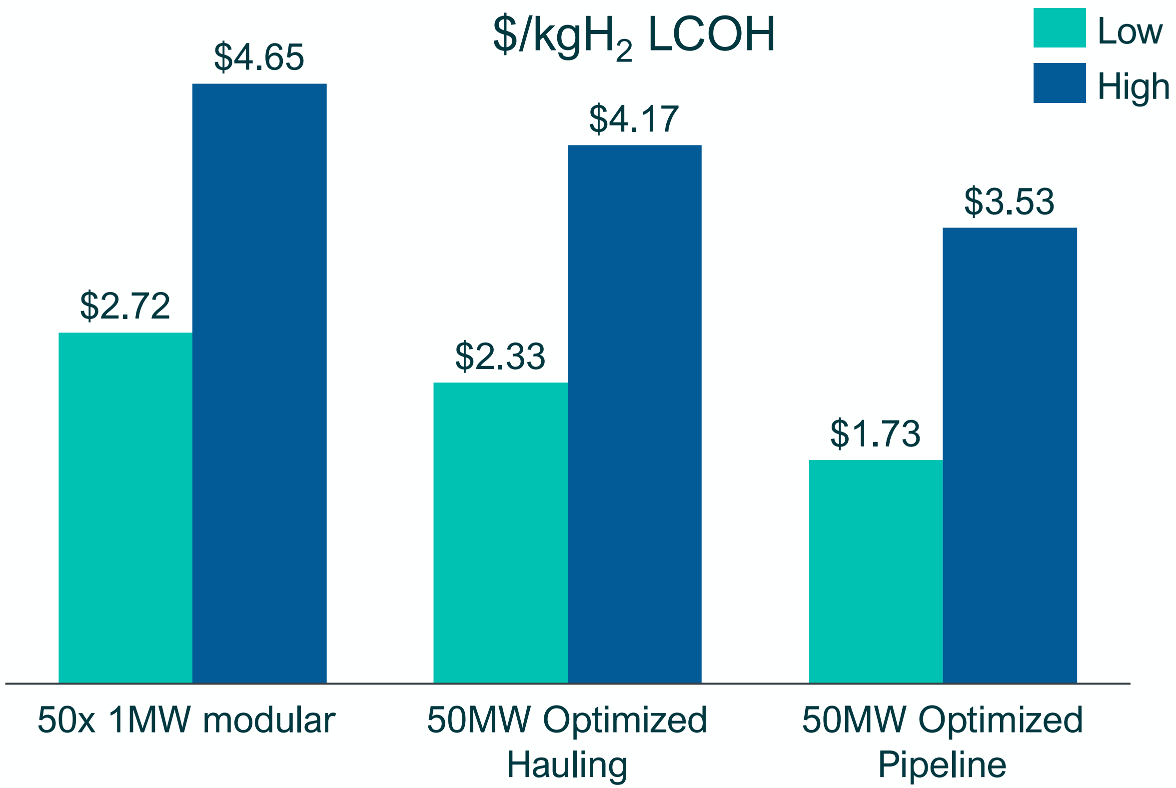
H_2 mixed fuel linear generator + EV charging skid

Feasibility Study Results

Key Findings

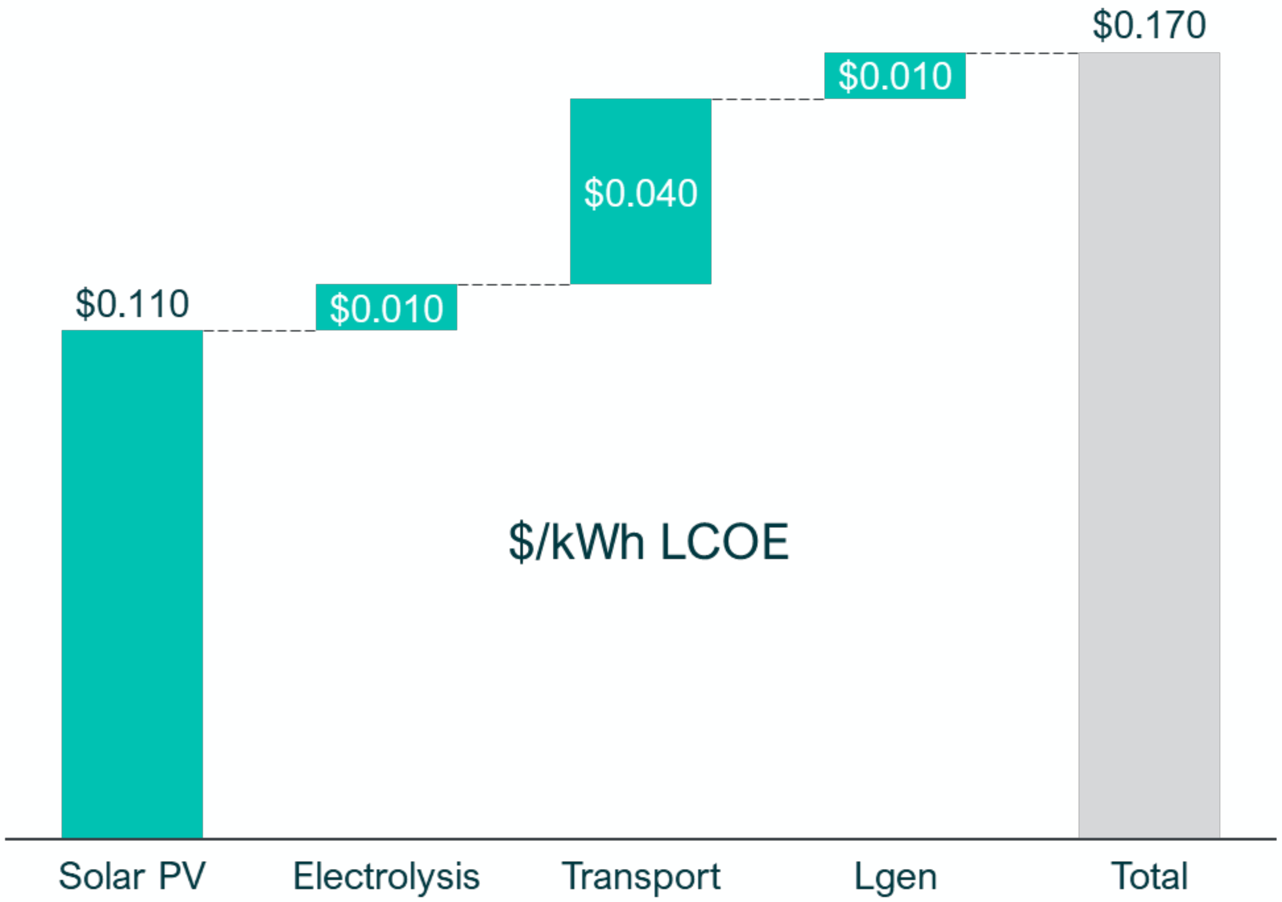
- Technically feasible
- No Regulatory fatal flaws





Feasibility Study Results

Line of Sight on Grid Competitive Electricity Costs in California even with worst cost but most flexible scenario: 1MW modular electrolysis with H_2 hauling in SoCal. Assumes PTC, 50% ITC downstream electrolysis, and 50% grants excl. solar cost.



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MOBILITY

Accelerating Electrification of Medium- and Heavy-duty Trucks in Southern California with Data-Driven Planning Platforms for Charging Networks, Truck Fleets, and Power Systems

Nanpeng Yu, Professor, University of California, Riverside
Zuzhao Ye, Founder and CEO, AmpTrans

Sep 12, 2024

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  - Data Integration
    - Comprehensive stakeholder data incorporation
  - Case Study
    - Application in the Greater Los Angeles Area
  - CHARGE-OPT Platform
    - Overview and capabilities

CHARGE-OPT: Ecosystem Planning for MDHD Electric Trucks

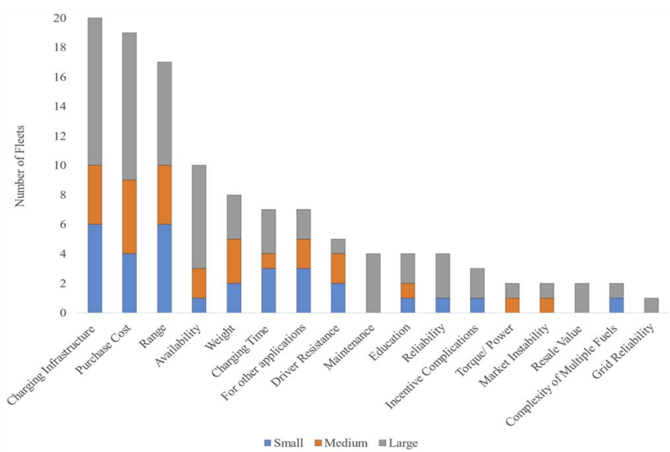
Stakeholder Challenges in MHD Vehicle Electrification

Fleets
- Limited charging infrastructure
- High upfront costs for electric trucks

Charging Station Developers
- Long wait time for energization/interconnection
- Difficulty in securing truck companies' commitment

Utilities
- Uncertain charging demand (timing and location)
- Extended timelines for infrastructure upgrades

Overall Challenges
- Lack of coordinated decision-making platform
- Need for shared data and aligned development



Reported barriers to fleet adoption of electric trucks by fleet size. (total 28, small 8, medium 7, large 13)

Source: C. Sugihara et al. (2023)

Source: IREC (2022)

CHARGE-OPT: Ecosystem Planning for MDHD Electric Trucks

Spotlight: Drayage Truck Sector

Executive Order N-79-20
- 100% zero-emission medium- and heavy-duty vehicles by 2045
- 100% zero-emission **drayage trucks by 2035**

Responsive Actions
- 2022: $10 per TEU going to Clean Truck Fund (POLA/LB)
- 2024: CARB to register only zero-emission trucks

Source: CARB (2023)

Drayage Truck Operational Patterns (Survey by POLA/POLB)

Metric	Average	Maximum
Shift Mileage	209 miles	600 miles
Daily Mileage	252 miles	800 miles

Available Truck Models
- Struggle to meet per-shift mileage requirements without en-route charging

Source: POLA/POLB Clean Truck Program (2021)

Model	Range miles (mi)	Charging Time minutes (mn)	Battery Capacity kilowatt hour (kWh)
Kenworth T680E	150 mi	125mn (80%)	396 kWh
Peterbilt 579EV	150 mi	120mn (90%)	400 kWh
Freightliner eCascadia	150-230 mi	90mn (80%)	291 - 438 kWh
Volvo VNR Electric	275 mi	90mn (80%)	565 kWh
Nikola Tre BEV	330 mi	160mn (80%)	733 kWh
Tesla Semi	500 mi	30mn (70%)	500 - 1,000 kWh

All figures are courtesy of the manufacturers

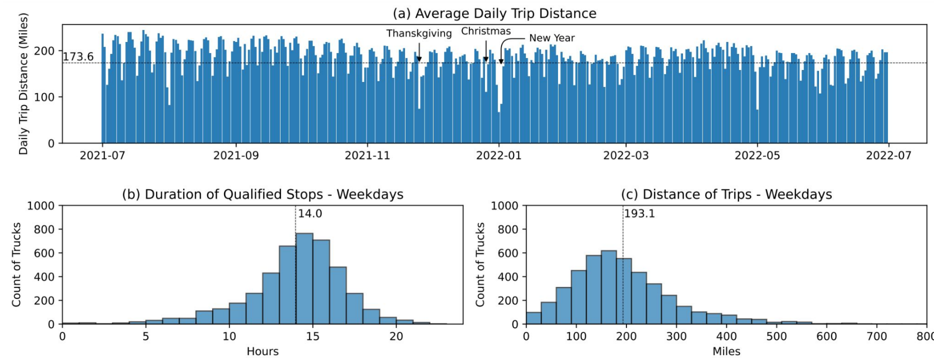
Source: EESI (2023)

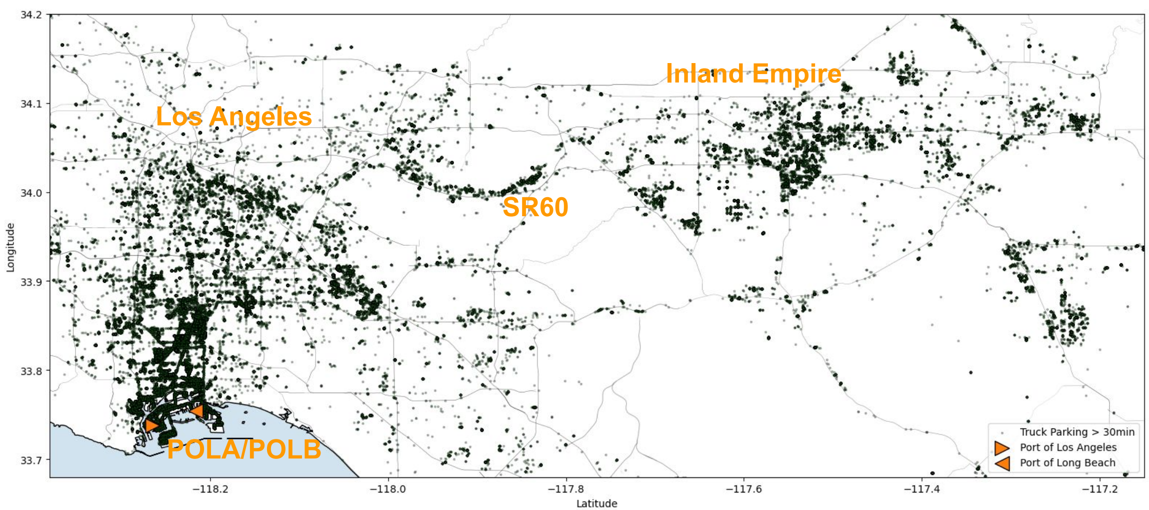
CHARGE-OPT: Ecosystem Planning for MDHD Electric Trucks

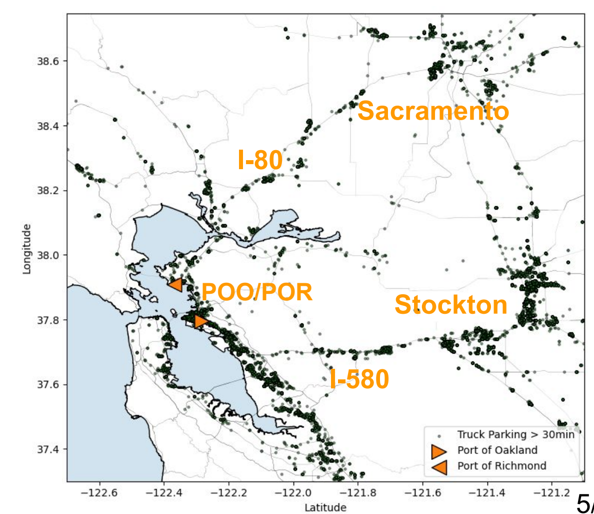
Spotlight: Drayage Truck Sector (cont'd)

Drayage Truck Operational Patterns (in-house data analysis)

- Average daily mileage: 193.1 miles; Average available charging time: 14.0 hours (majority single shift per day, some two shifts)
- Analysis of locations where trucks remained parked for over 30 minutes:
  - Primary concentration: Port areas
  - Secondary patterns: Along major corridors; Near major cities; Around warehouse clusters



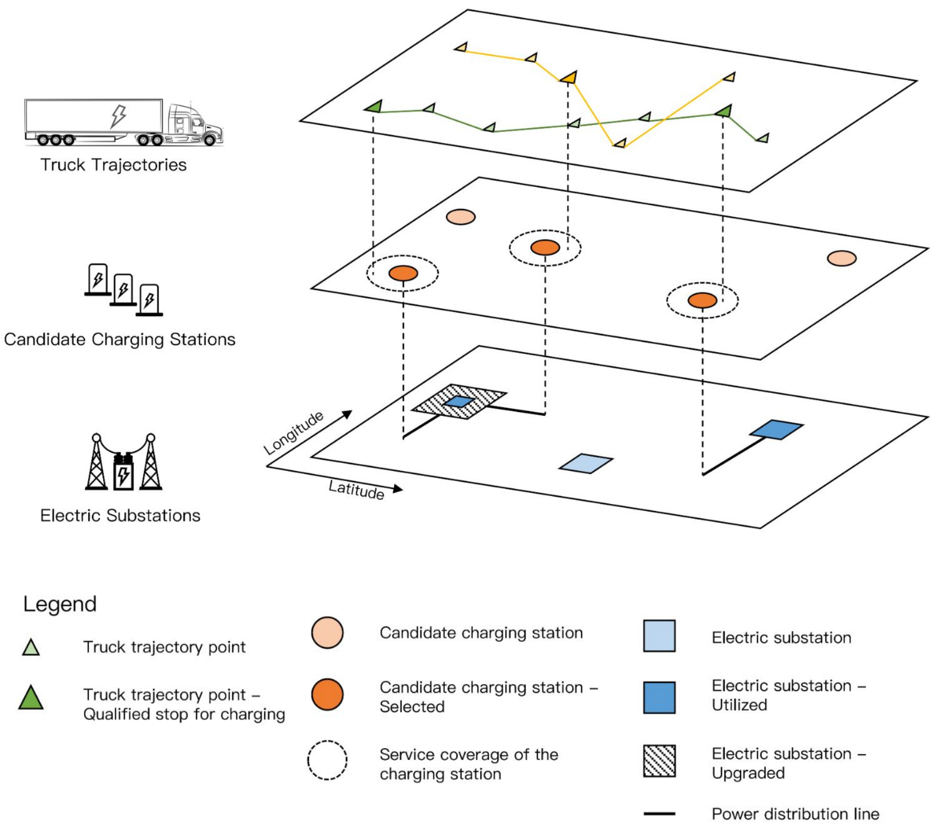




CHARGE-OPT: Ecosystem Planning for MDHD Electric Trucks

Our Approach - Model Development

- **Spatio-Temporal Optimization Model:** Accommodates all stakeholders in an unified framework:
  - Truck Operations
    - Battery SoC
    - Charging power requirements
    - Parking duration
    - Accessibility to charging stations
  - Charging Infrastructure
    - Power capacity
    - Charger specifications
    - Strategic locations
  - Power System
    - Reserve load capacity
    - Interconnection with charging stations
    - Load capacity upgrade planning
  - Cost Factors
    - Vehicle acquisition and battery upgrades
    - Charging station construction and equipment installation
    - Grid interconnection and infra upgrades
    - Time-of-use electricity pricing



CHARGE-OPT: Ecosystem Planning for MDHD Electric Trucks

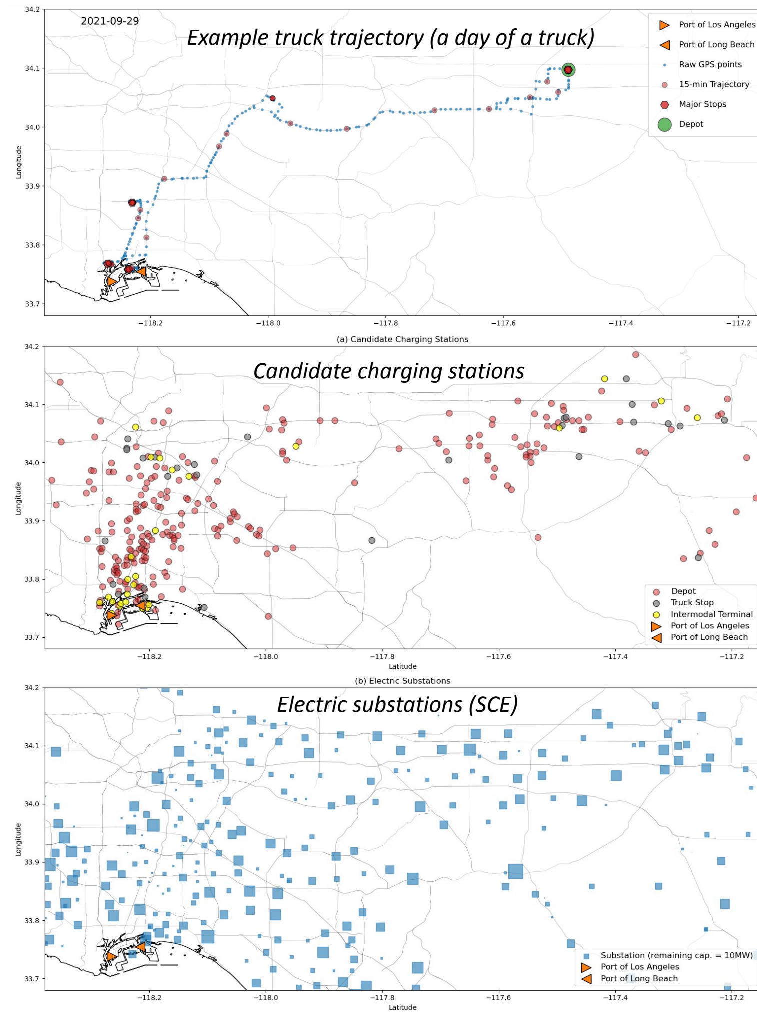
Our Approach - Data Integration

Truck Trajectories
- Raw GPS data converted to 15-minute interval data points. Each interval includes:
  - Location
  - Energy consumption
  - Parking status
  - Other relevant metrics

Candidate Charging Stations
- Existing infrastructure:
  - Truck depots
  - Truck stops (fueling and service areas)
  - Intermodal terminals
- Potential new sites: Suitable land parcels

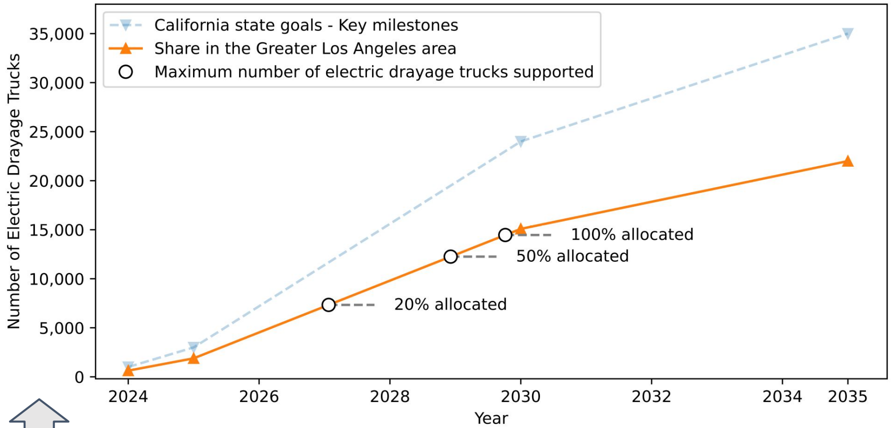
Grid Infrastructure
- Existing reserved load capacity
- Candidate new locations for substations

Case Study in Greater LA
- GPS data of 4,800+ drayage trucks from 06/2021 to 07/2022
- 300+ candidate charging stations
- 200+ electric substations



CHARGE-OPT: Ecosystem Planning for MDHD Electric Trucks

Our Approach - Case Studies in Greater LA



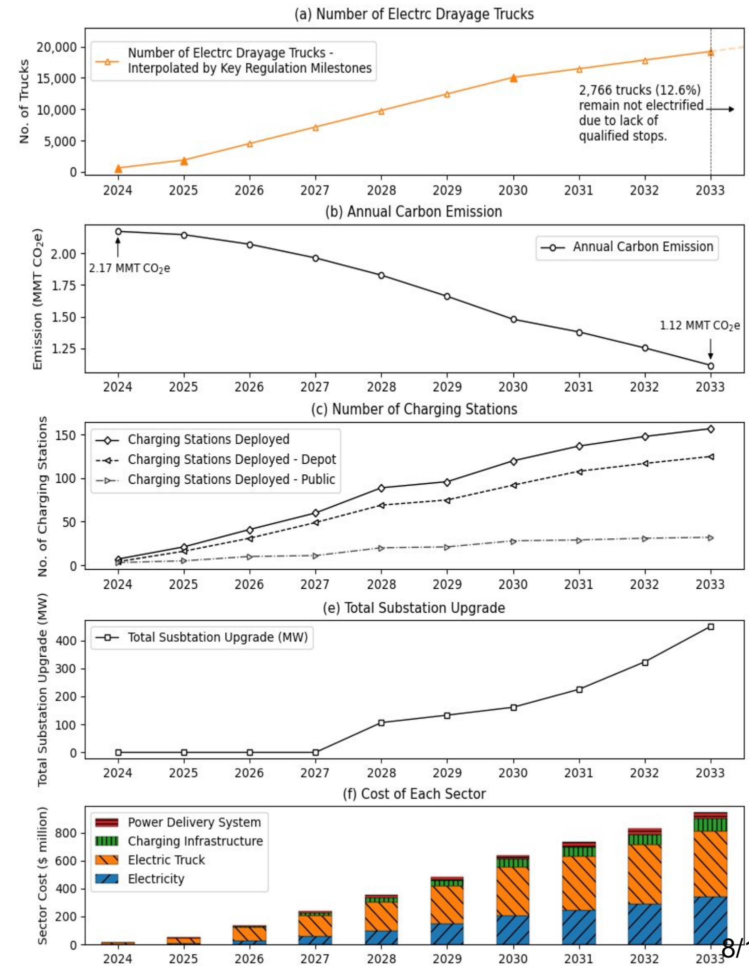
Case 1: Capacity Examination - w/o power grid upgrades:

- Optimistic Scenario (100% capacity allocation):
  - Meets 2029 regulatory goal
- Realistic Scenario (20% capacity allocation):
  - Only meets 2027 goal
  - Considers growth in other sectors (industrial, residential, other EV modes)

* Note: Substation upgrades typically require 5-10 years

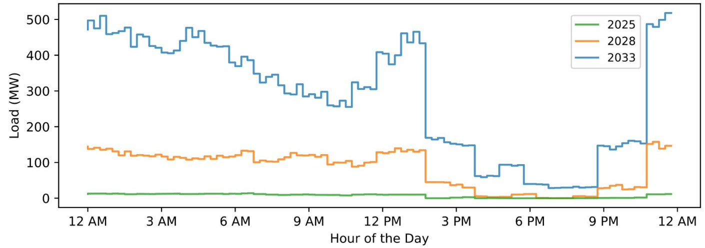
Case 2: Most Cost-Effective Pathway - w/ power grid upgrades:

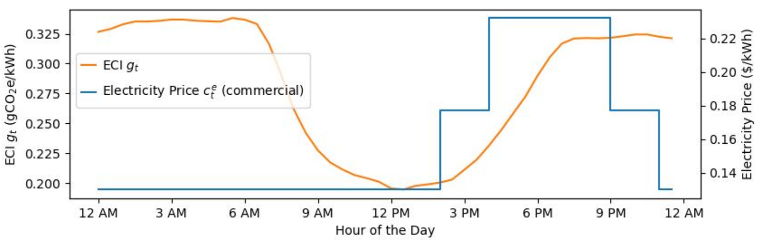
- Assumption: 100% of load capacity allocated to drayage trucks (most optimistic case)
- Key Findings: Grid upgrades needed by 2028 (Planning should commence 5-10 years in advance)
- Environmental Impact:
  - GHG reduction > 1.05 MMT CO_2 per year
  - Context: California's total emissions (2020) = 369.2 MMT CO_2

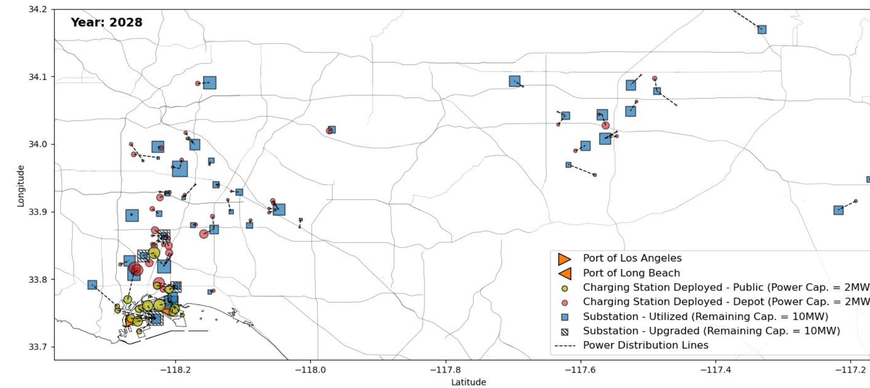


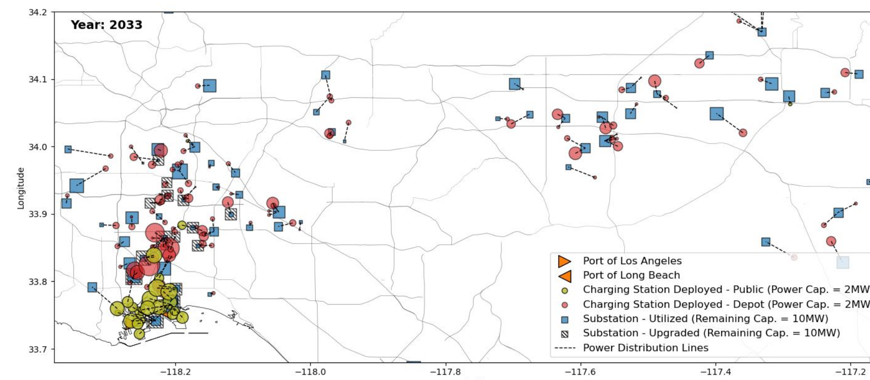
CHARGE-OPT: Ecosystem Planning for MDHD Electric Trucks

Our Approach - Case Studies in Greater LA (cont’d)









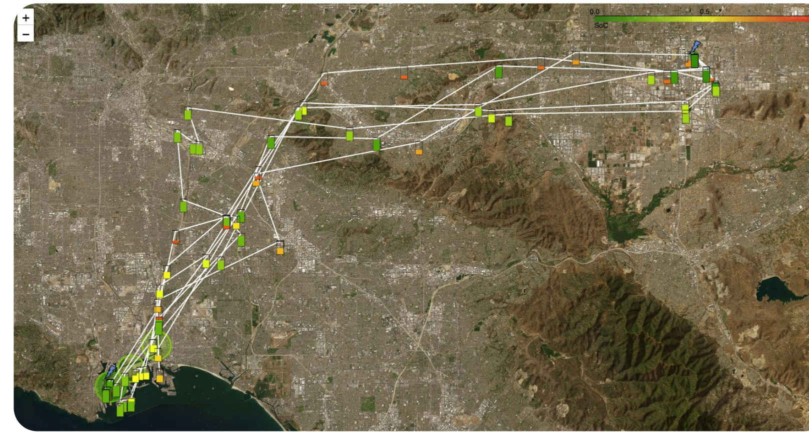
Case 2: Most Cost-Effective Pathway - w/ power grid upgrades (cont’d):

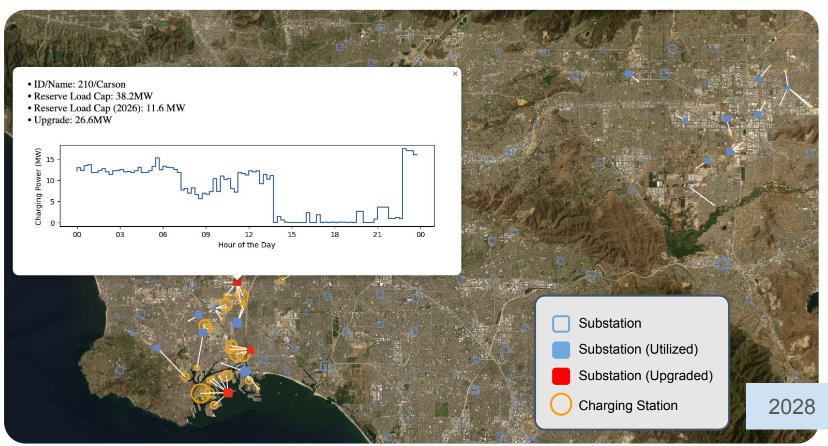
- Load Profiles (Well-Coordinated Scenarios)
  - 2028: Peak load exceeds 150 MW
  - 2033: Peak load exceeds 500 MW
  - Practical Considerations: Less coordination btw. different fleets will result in higher peaks
- Visual Analysis
  - High-granularity mapping of deployment
  - Facilitates detailed, location-specific decision making

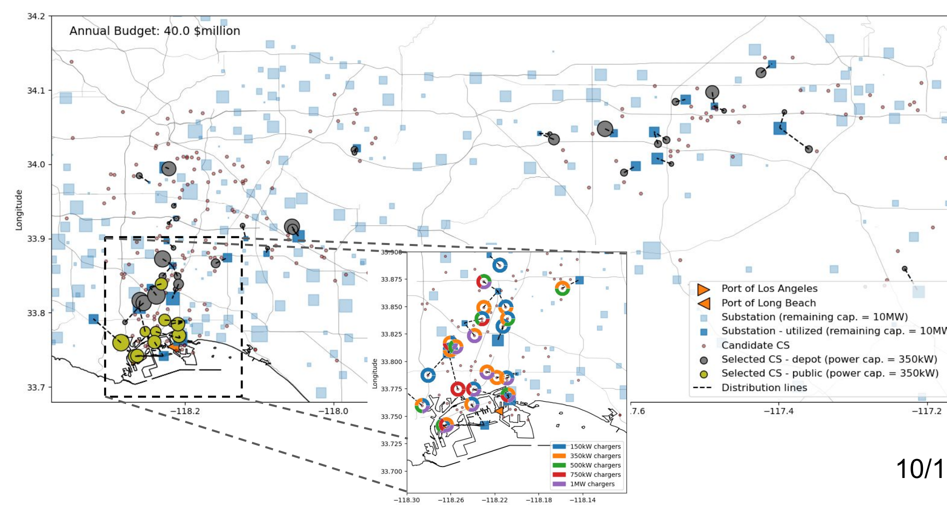
CHARGE-OPT: Ecosystem Planning for MDHD Electric Trucks

Case 2: Most Cost-Effective Pathway - w/ power grid upgrades (cont'd):

- Visual Analysis
  - Electric substation
    - Upgrade requirements
    - Interconnection schemes
    - Load profile forecasts (aggregated from connected charging stations)
  - Charging stations
    - Deployment: location, scale, and timing
    - Charger distribution by power levels
    - Projected utilization rates
  - Fleets
    - Optimized charging strategies (sustain operations & minimize costs)
    - Optimal battery size recommendations

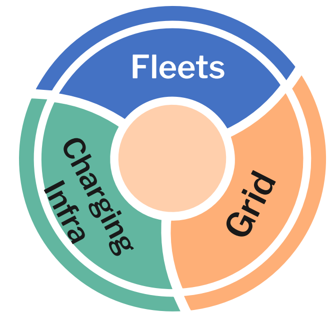






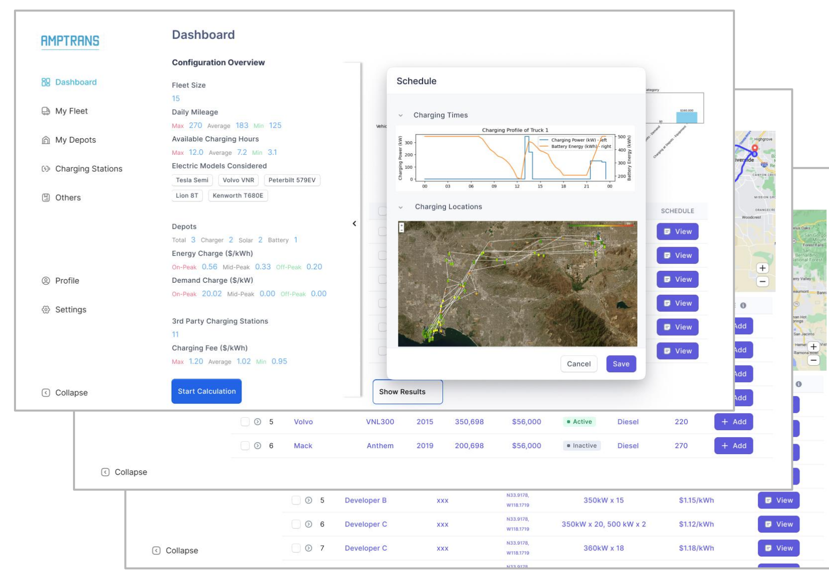
CHARGE-OPT: Ecosystem Planning for MDHD Electric Trucks

CHARGE-OPT Platform - Overview and Capabilities



Charging and Grid Optimization Platform for Transportation
(CHARGE-OPT)

- Foundation
  - Based on a comprehensive spatio-temporal optimization model
  - Integrates shared background data:
    - Truck traffic
    - Existing charging infrastructure
    - Power system capacities
- Stakeholder-Specific Functionalities
  - **Fleet Owners**
    - Route optimization for electrification
    - Charging strategy (time, location, TOU rates)
    - Depot charging analysis
  - **Charging Station Developers**
    - Optimal charging station locations
    - Power capacity assessment
    - Utilization forecasting
    - Renewable integration opportunities
  - **Utilities**
    - Grid upgrade planning
    - Data-driven decision making
    - V2G potential evaluation



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Thank you!

Q & A

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UCR College of Engineering – Center for Environmental Research and Technology

Transitioning the MHD Transportation Sector to ZEVs

South Coast AQMD Clean Fuels Program Retreat

Arun Raju, Ph.D.
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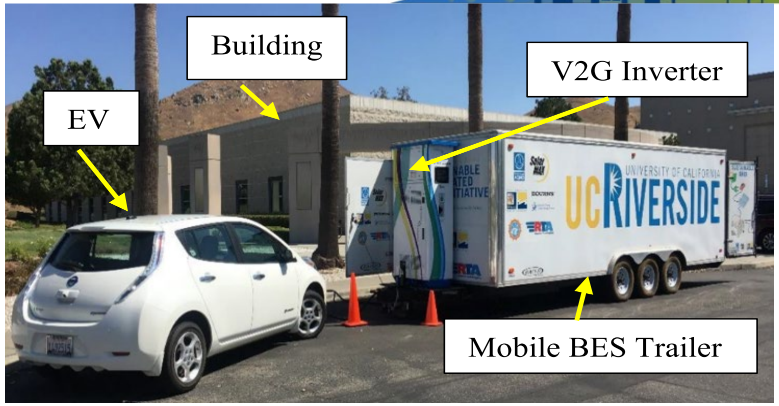
University of California-Riverside
Center for Environmental Research and Technology

September 2024

http://www.cert.ucr.edu

RD&D Activities



BEV – Grid Research Projects

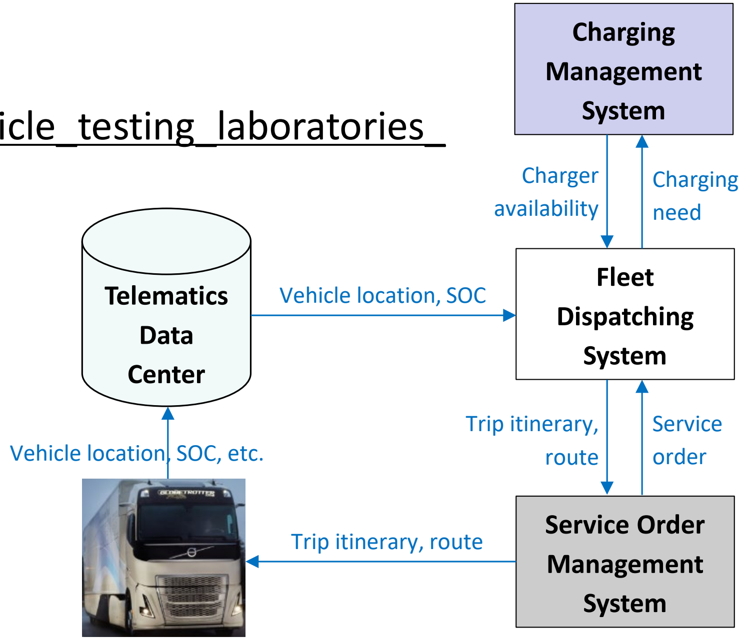
- Carbon-Based EV Charging Strategies: developing pricing strategies to promote EV charging mid-day
- Vehicle-to-Building Energy Connectivity

Medium and Heavy-Duty Electrification

- Participation in several ZANZEFF (Zero- and Near Zero-Emission Freight Facilities) pilot projects; e.g., Volvo LIGHTS
- Vehicle Performance Testing
  https://www.cert.ucr.edu/caltestbed#electric_drive_vehicle_testing_laboratories_

Battery Electric Truck (BET) Fleet Management

- Current limitations of BETs could significantly impact fleet operations, and require BET-specific fleet management solutions
- New methods of scheduling, dispatching, SOC monitoring & forecasting, opportunity charge events



RD&D Activities

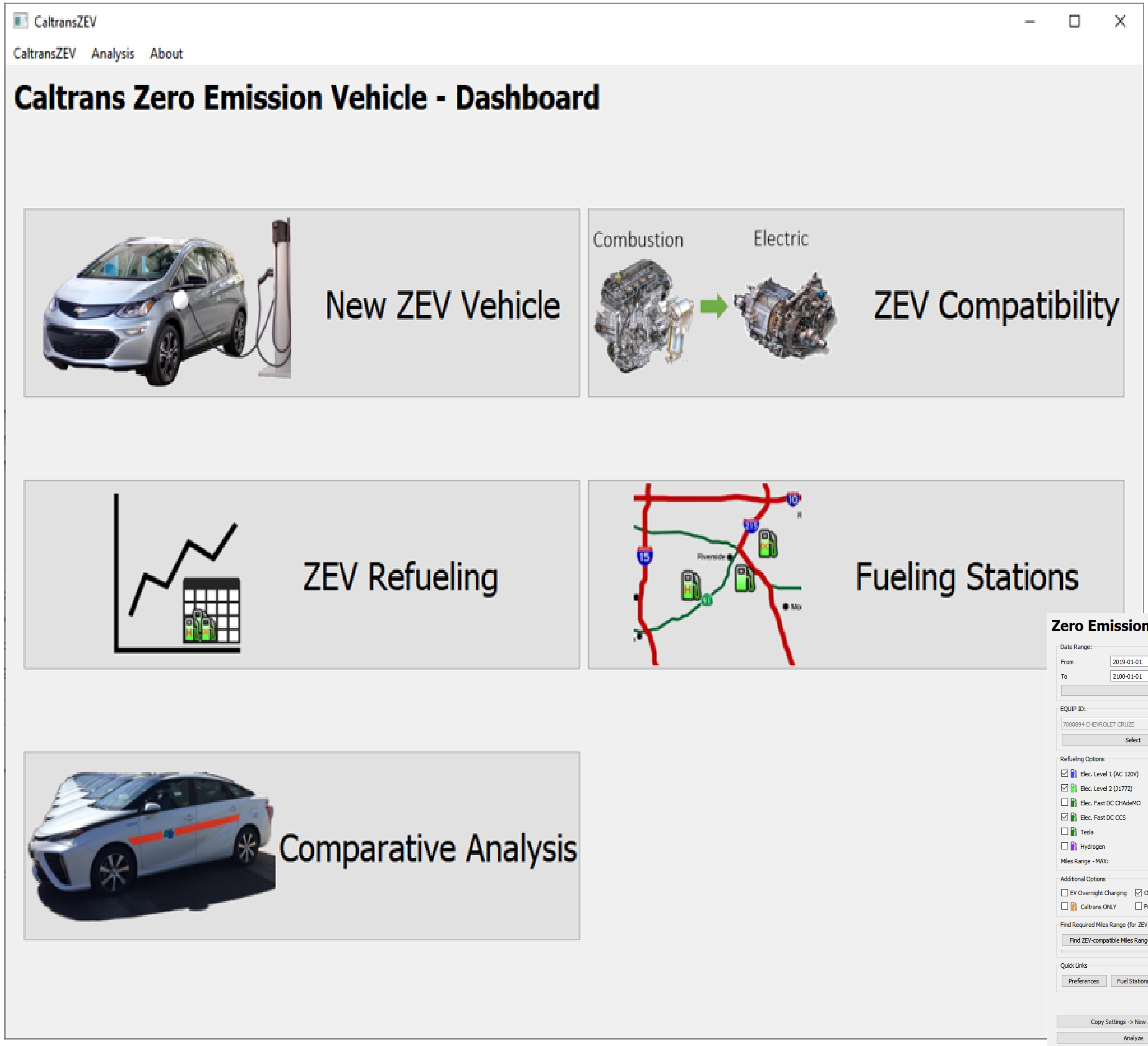
- Developing a Blueprint for MHD ZEV Infrastructure for the South Coast – CEC
- Regional MHD ZEV Infrastructure Analysis – South Coast AQMD
- CA-MX Border ZEV Infrastructure Analysis for Medium-Heavy Duty Vehicles – UC Alianza MX
- Fuel Cell Trucks Performance Evaluation
- Hydrogen Integrated Microgrids - production/storage capabilities for fueling and energy storage
- Evaluation of Hydrogen Fuel Cell Street Sweepers – Caltrans
- Assessment of Electric Vehicle Technologies Associated with Improving Energy Efficiency or Reducing Brake- and Tire-wear Emissions - CARB
- First to Last Mile: Creating an Integrated Goods Movement Charging Network around the I-710 Corridor - DOE
- Energy-Efficient Routing for Electric Trucks - South Coast AQMD
- Electric Truck Fleet Management under Limited and Uncertain Charging Infrastructure Availability – NCST
- Distribution Grid Capacity Analysis for Heavy-Duty Vehicle Chargers and Alternate Solutions

Caltrans ZEV Tool

Spreadsheet tool detailing ZEV vehicle specifications

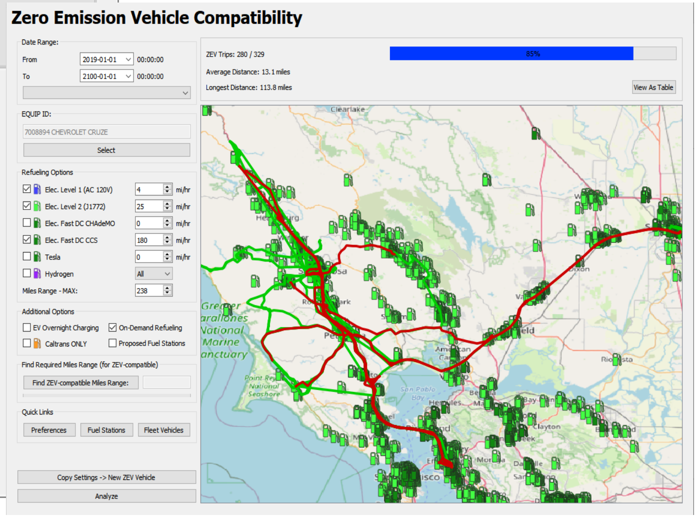
Analysis tool to determine refueling station utilization

Analysis tool providing Comparative statistical results



Analysis tool utilizing vehicle activity data and refueling options

Spreadsheet tool detailing ZEV fueling stations



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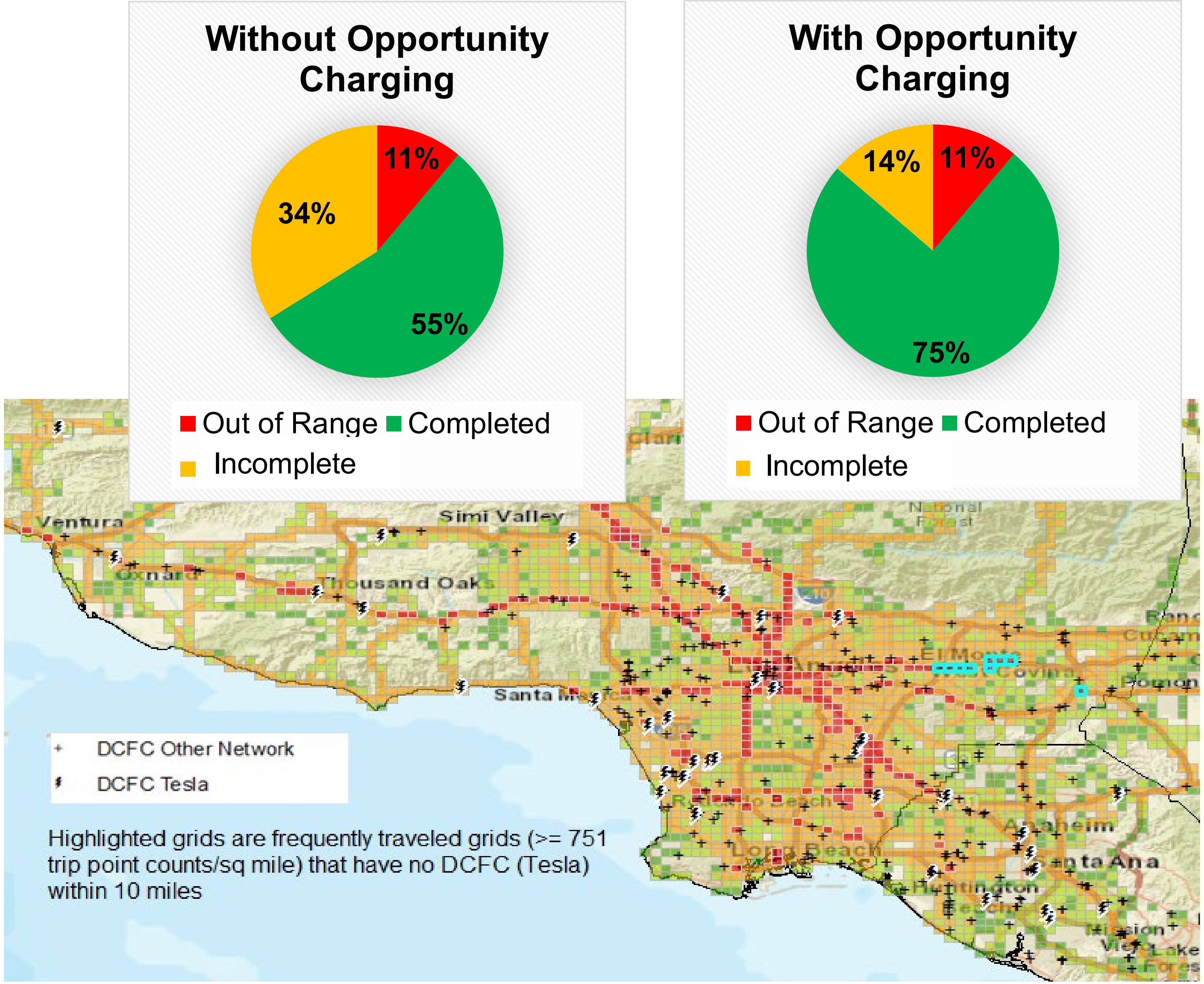
Caltrans ZEV Tool

- ZEV compatibility
- Trip analysis
- Charging activity
- H2 refueling activity
- Vehicle range
- Charger type
- Opportunity charging
- Overnight charging
- LD/MD/HD
- BEV vs. H2
- Vehicle activity based



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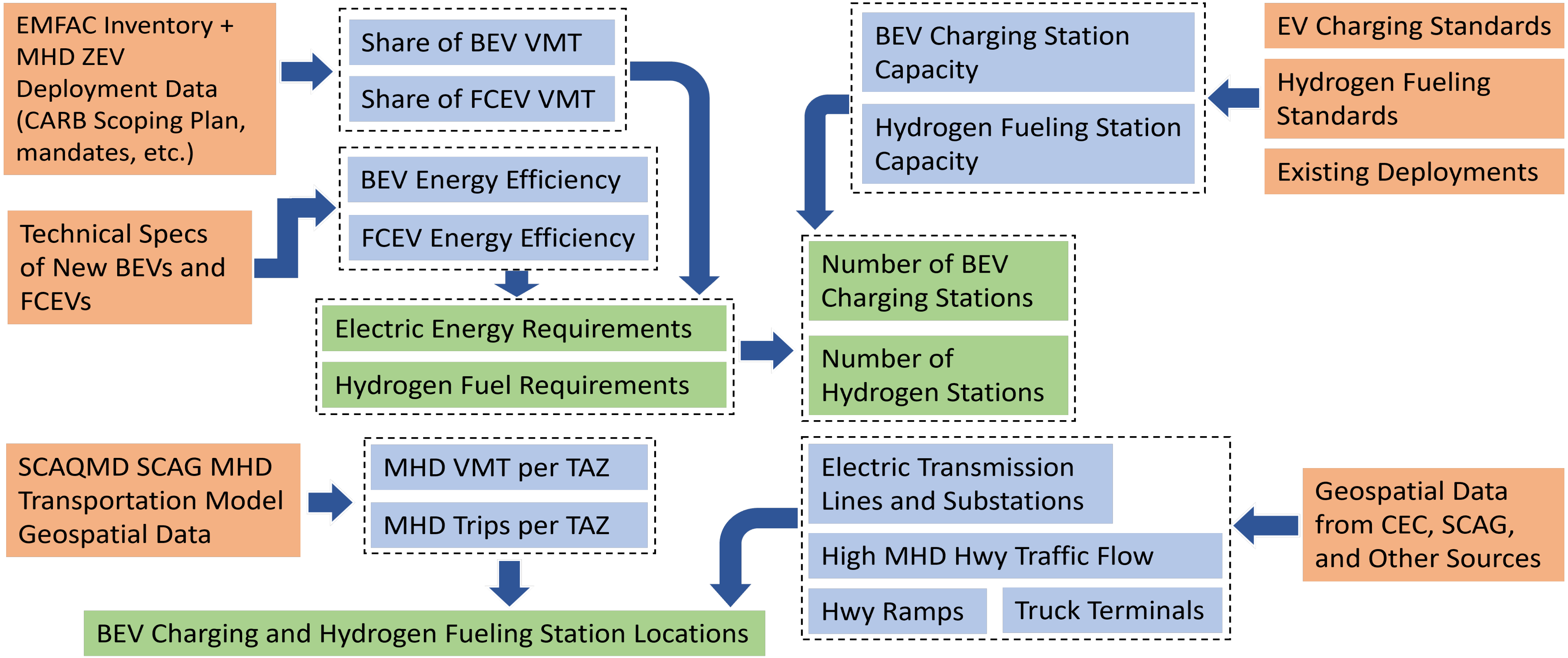
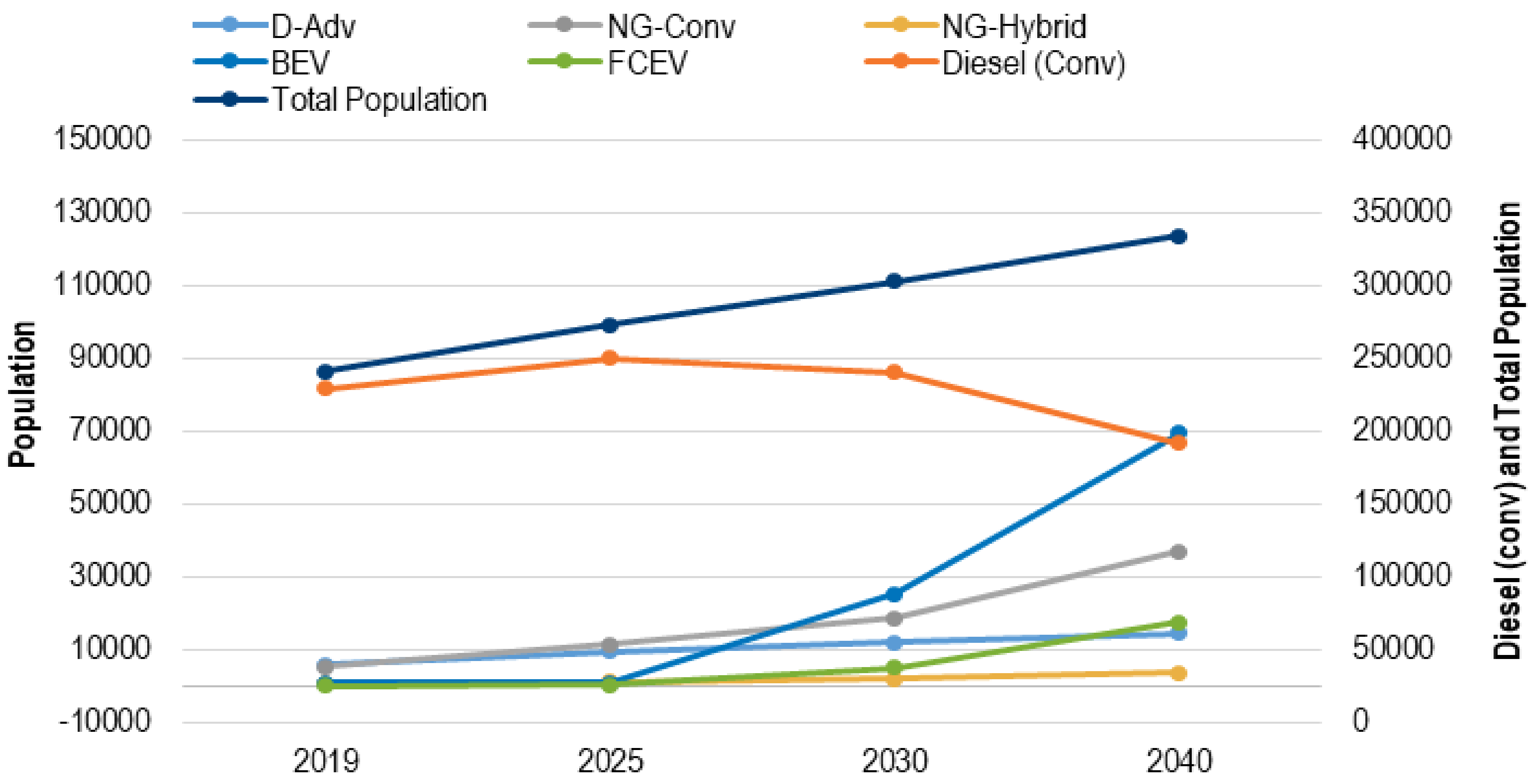
MHD ZEV Infrastructure Deployment Analysis



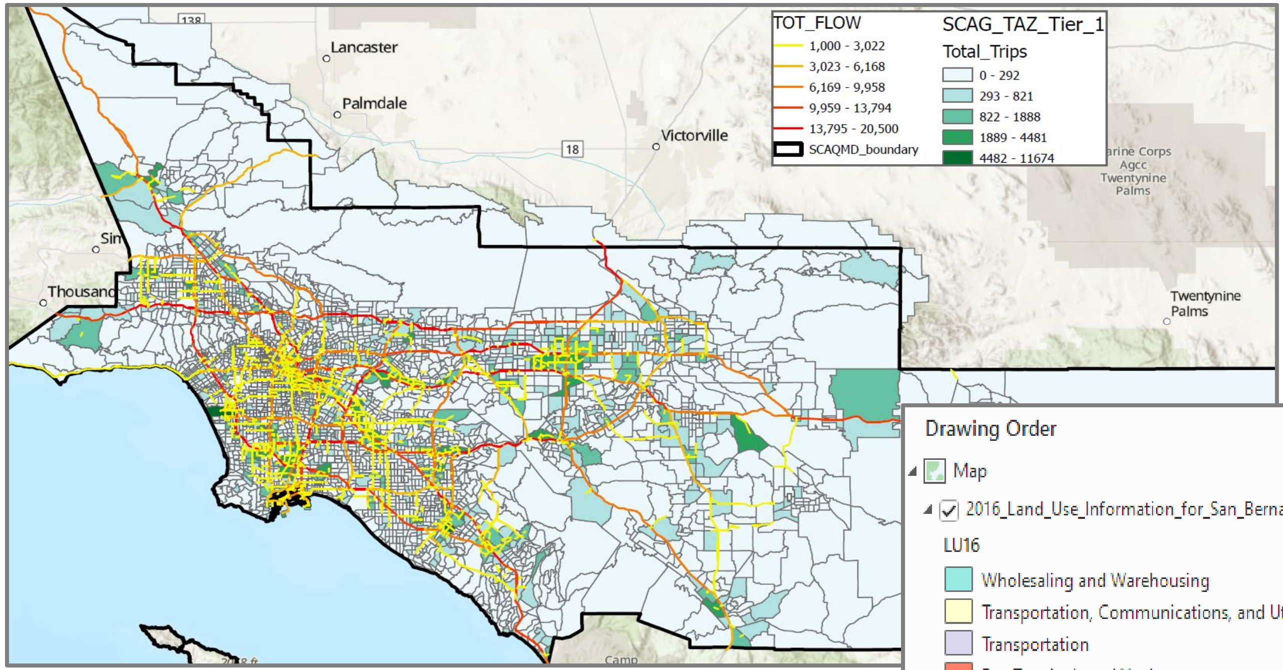
BEV – Battery Electric Vehicle
CARB – California Air Resource Board
CEC – California Energy Commission
EMFAC - EMission FACtor Inventory
FCEV – Fuel Cell Electric Vehicle
MHD – Medium- and Heavy-duty
SCAG – Southern California Associations of Governments
SCAQMD – South Coast Air Quality Management District
TAZ – Transportation Analysis Zone
VMT – Vehicle Miles Traveled

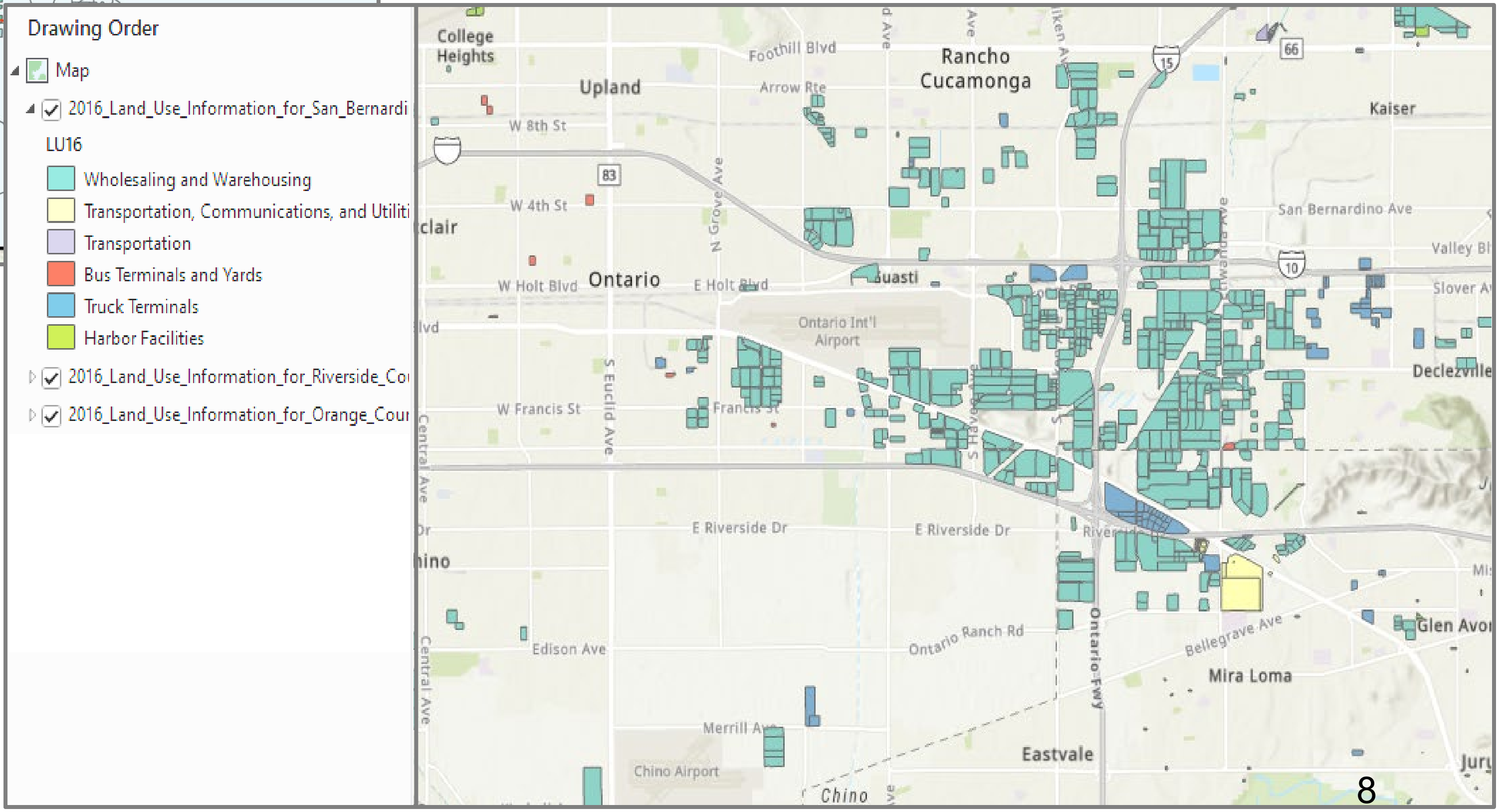
Input Data
Modeling
Results

MHD ZEV Vehicle Population Projections

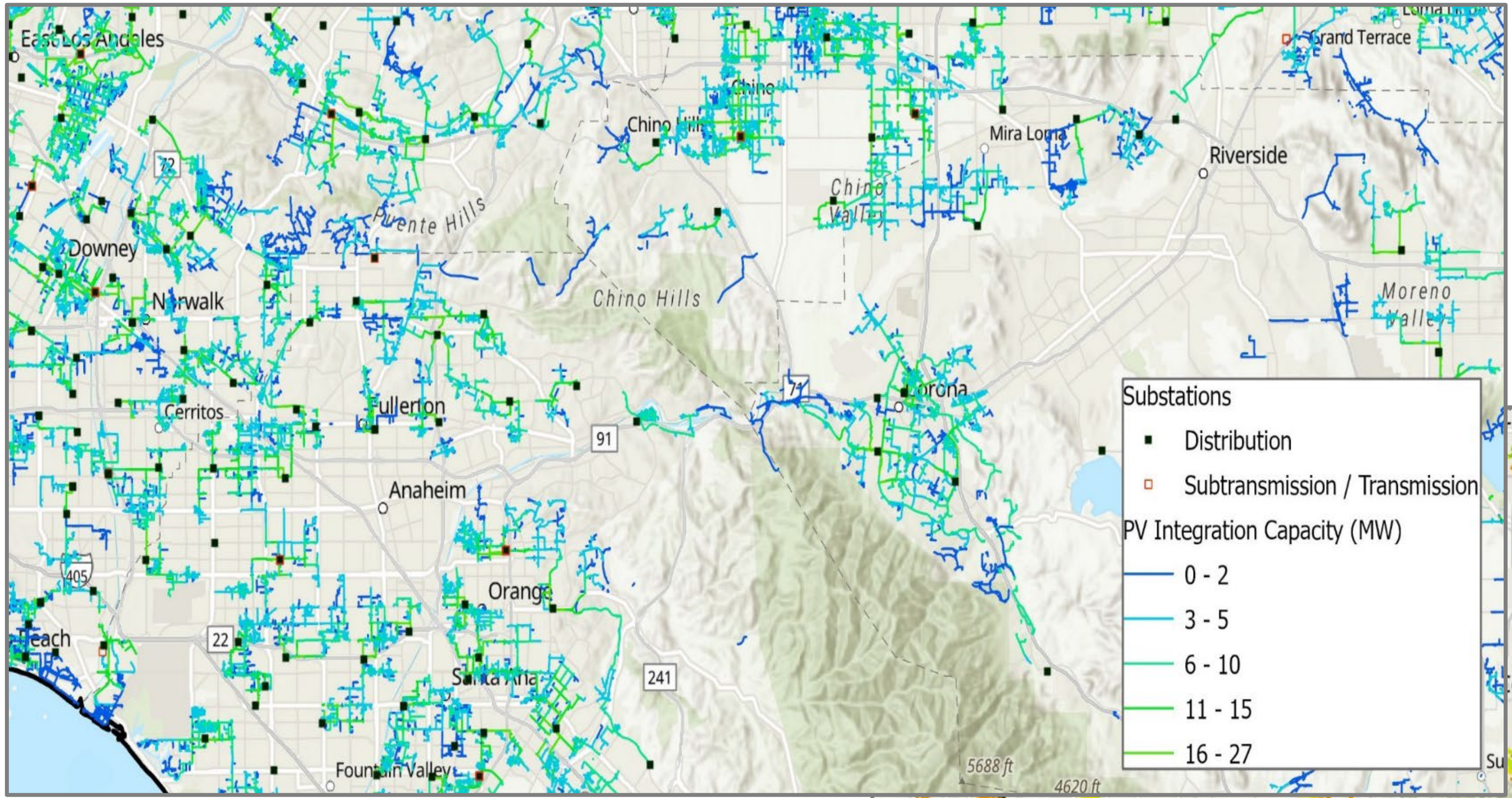


Transportation Model Data - SCAG

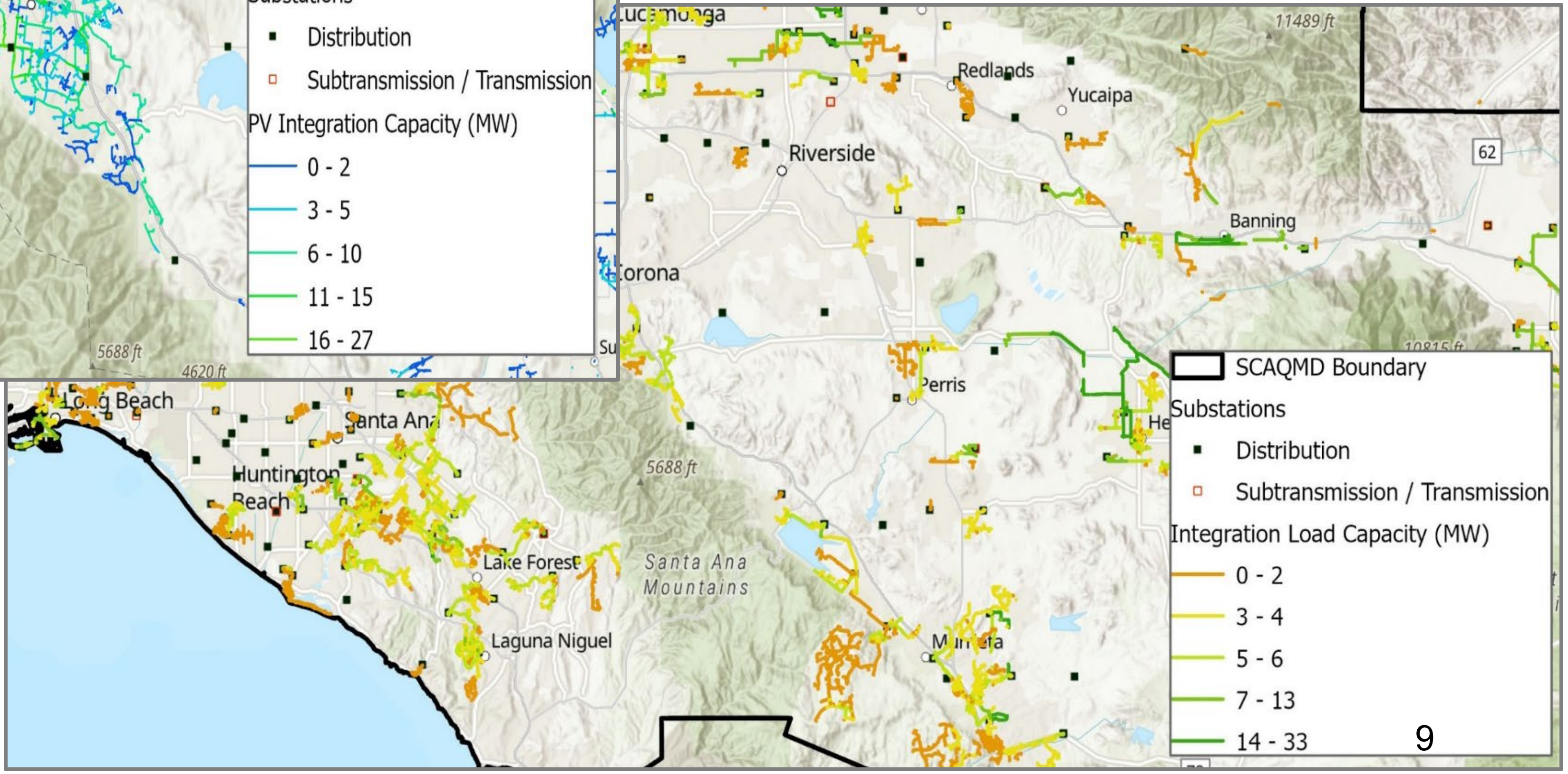




Electric Capacity Considerations



Solar PV generation integration capacity - SCE service territory



Uniform load integration capacity at the distribution level - SCE service territory

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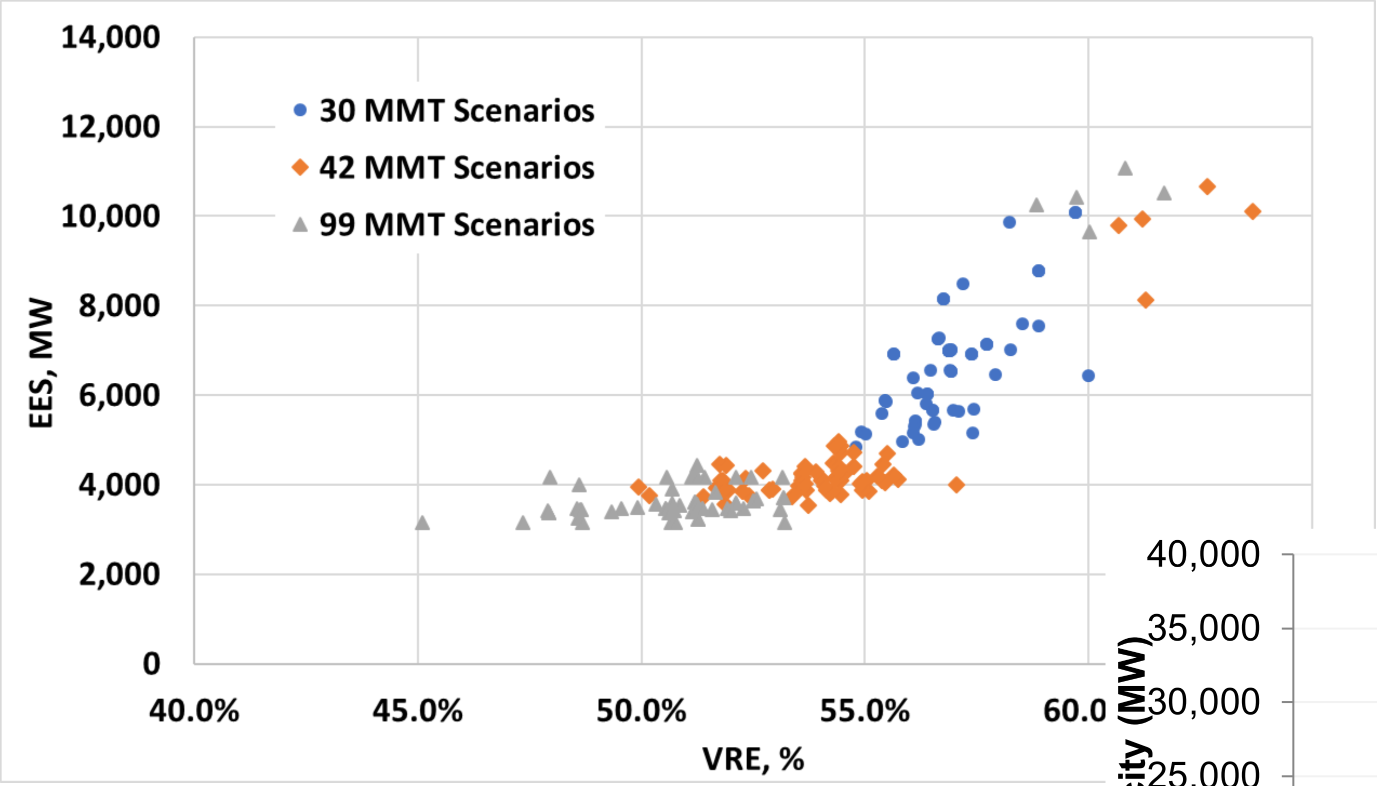
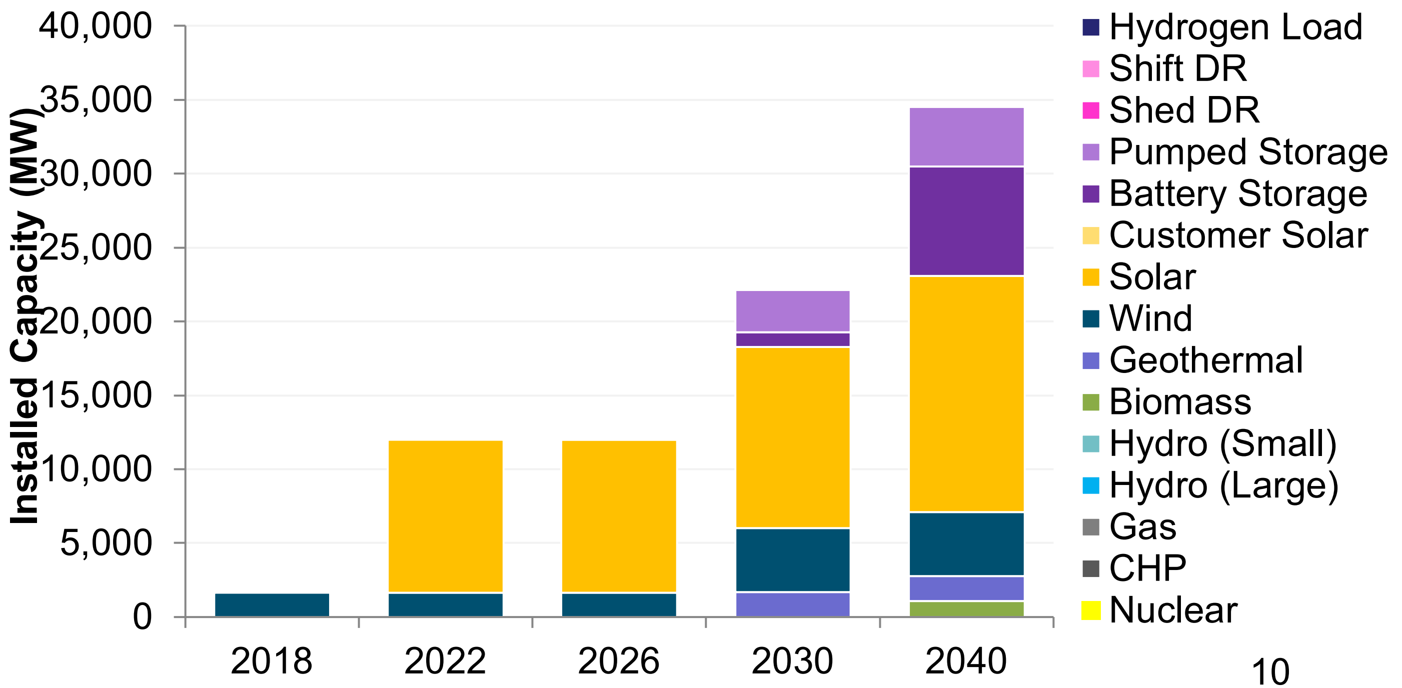
Energy Storage Needs



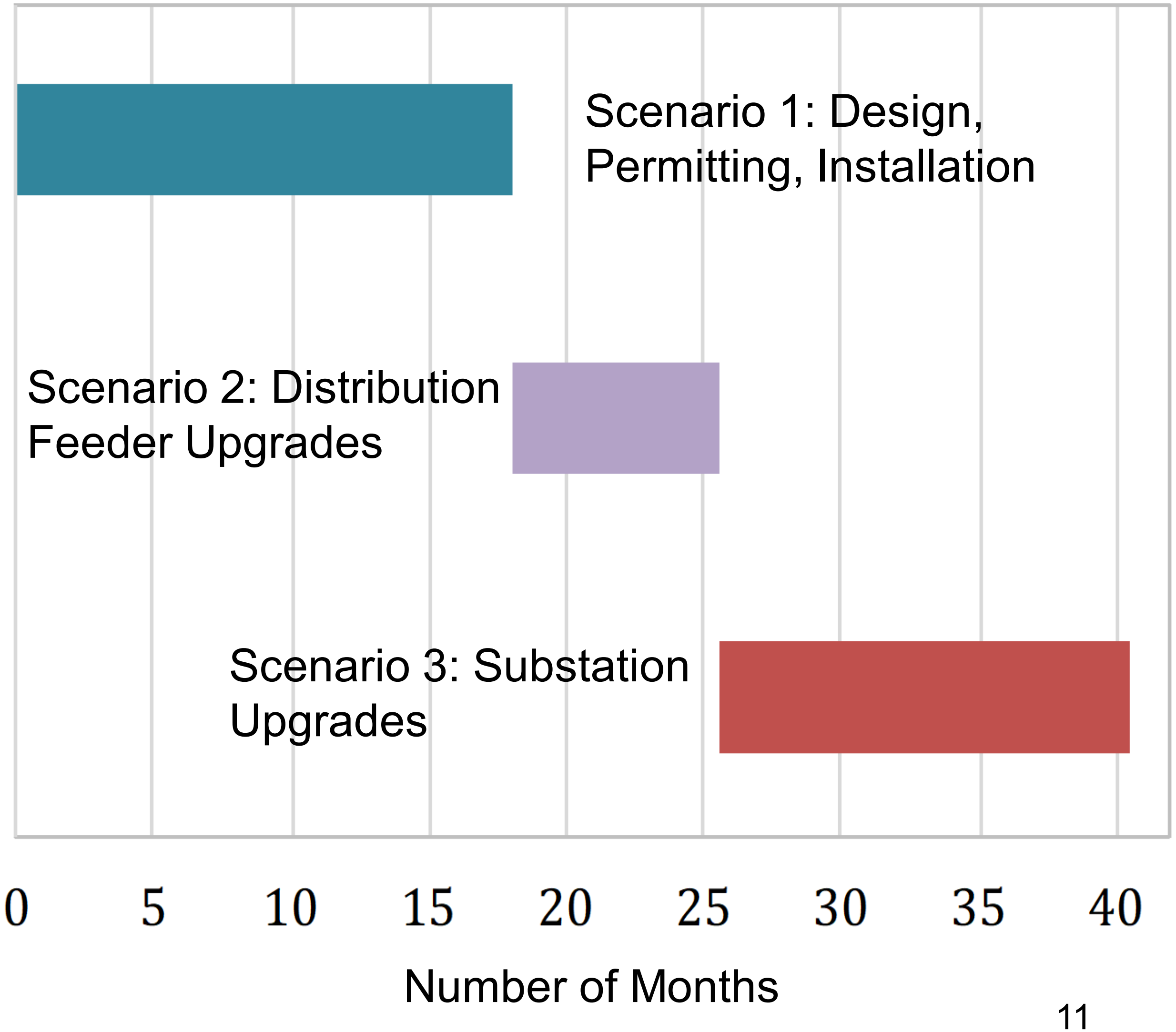
Electric Energy Storage Needs for Variable Renewable Energy (solar & wind) integration into the grid

70% RPS by 2040; 24 MMtCO2e GHG

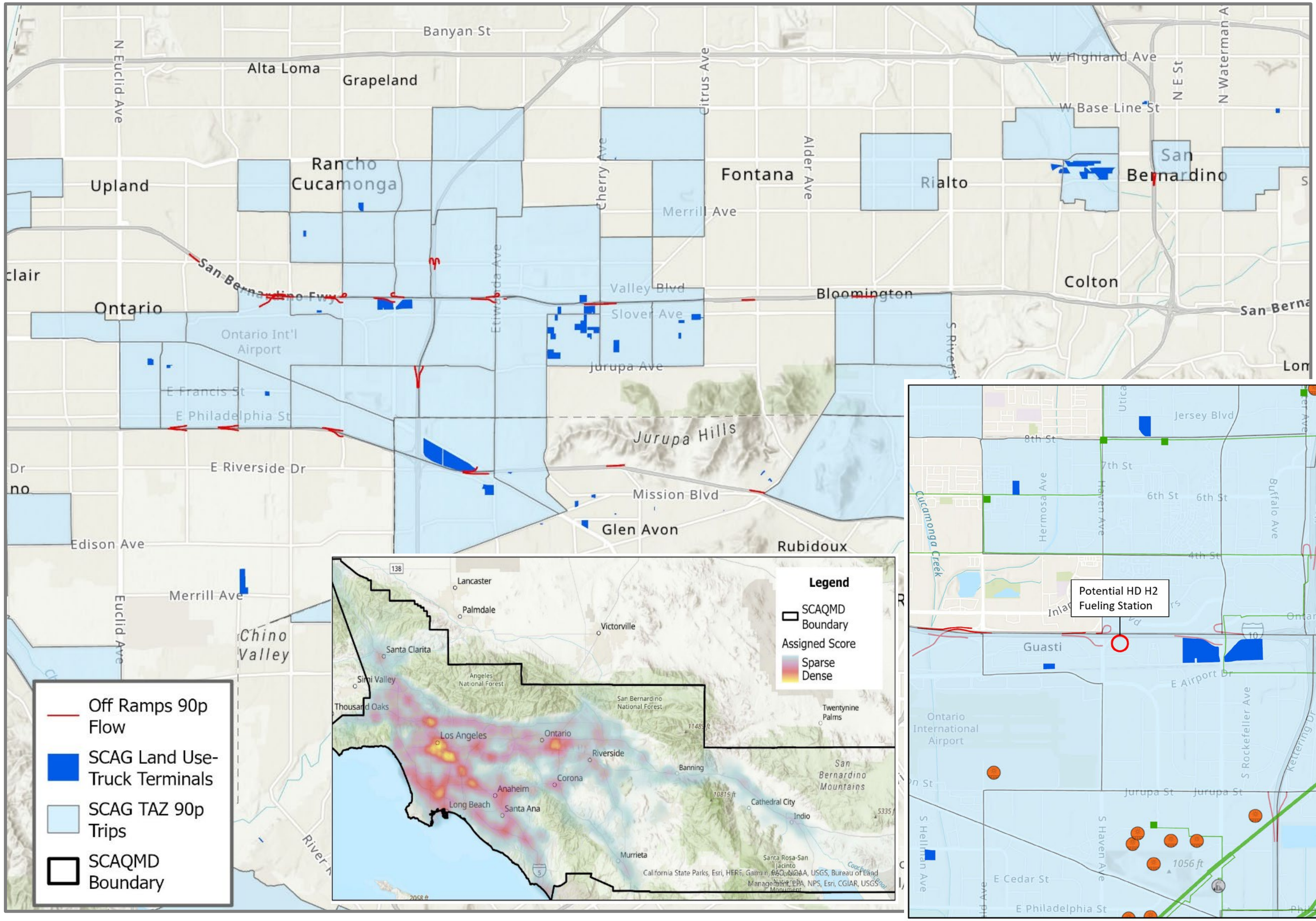


MHD Charging Station Costs and Deployment Timeline

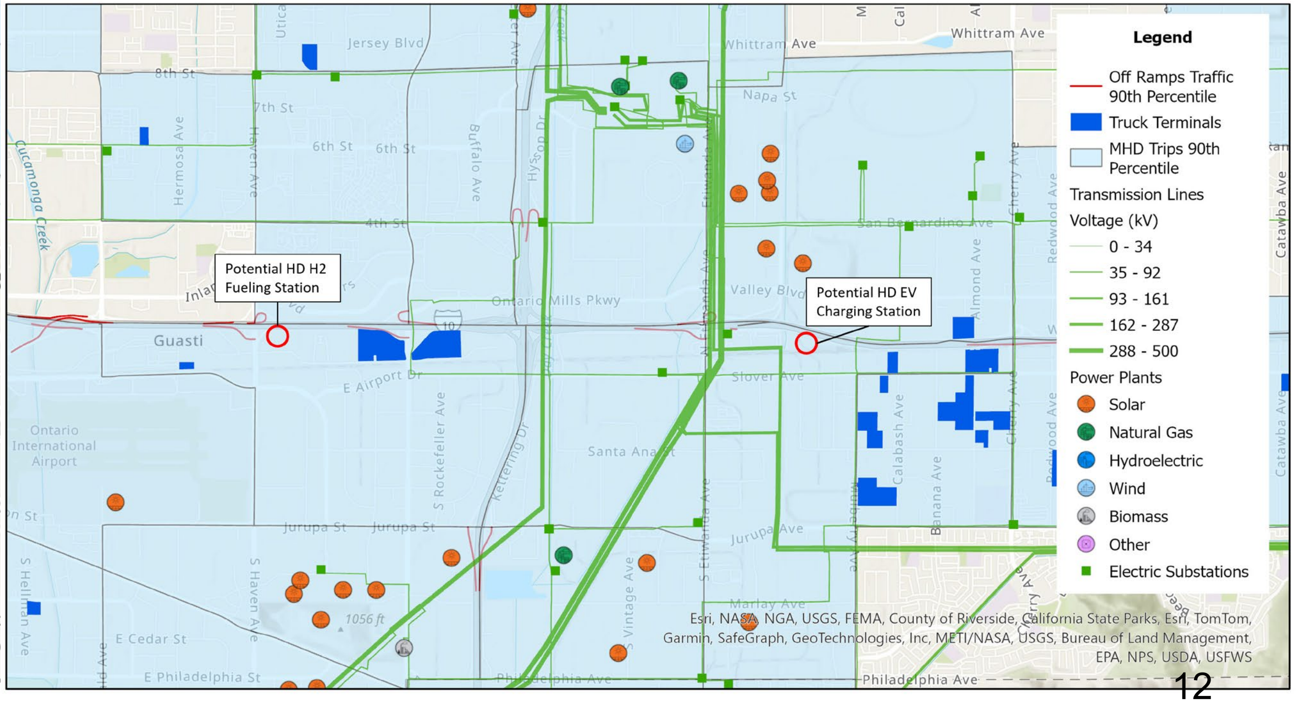
Capital Cost Estimate Scenario 1	
Chargers ($128,000 per charging port)	$1,536,000
Charger Installation ($26,000 per charging port)	$312,000
Site Improvements ($275,000 per acre)	$1,100,000
Power Supply and Interconnection	$340,000
Project Management	$1,000,000
Scenario 1 - Total Capital Cost	$4,288,000
Capital Cost Estimate Scenario 2	
Scenario 1 - Total Capital Cost	$4,288,000
Feeder Upgrades	$2M to $12M
Scenario 2 - Total Capital Cost	$6.3M to $16.3M
Capital Cost Estimate Scenario 3	
Scenario 2 - Total Capital Cost	$6.3M to $16.3M
Substation Upgrades	$3M to $5M
Scenario 3 - Total Capital Cost	$9.3M to $21.3M



Station Location Considerations



- High traffic TAZs and on/off ramps
- Proximity to truck terminals and major route intersections
- Scheduling and other factors



Discussion

- Coordinated deployment, grid and infrastructure planning; policy and permitting
- Workforce development: CE-CERT is developing courses through the Air quality and Climate Training endowment from the South Coast AQMD
  - Introductory level courses on
    - Atmospheric Chemistry and Air Quality
    - Emissions and Performance of Mobile Sources
    - Sustainable Transportation and Associated Community Impacts
    - Electric Grid and Renewable Energy
- Coordinated regional workforce development planning is necessary

FuelCell Energy: Tri-gen Project at Toyota Logistic Services Port of Long Beach

March 2024

FuelCell Energy: a global leader in fuel cell technology

OPERATING SINCE 1969

FuelCell Energy is a global leader in decarbonizing power and producing hydrogen through our proprietary fuel cell technology

FuelCell Energy is working to:

- **Produce** low- to zero-carbon power
- **Capture** carbon and greenhouse gasses while simultaneously generating power
- **Supply** green or blue hydrogen energy
- **Store** energy from intermittent renewables by converting excess power to hydrogen – then converting back into power when it's needed or delivering to other applications

Danbury, CT, USA
Corporate headquarters

Torrington, CT, USA
Carbonate manufacturing

Taufkirchen, Germany
Assembly & service

Calgary, Canada
Solid oxide R&D/manuf.

COMPANY HIGHLIGHTS

HQ Danbury, Connecticut

>500 Employees

95 Platforms in Commercial Operation

3 Continents

FCEL Listing: NASDAQ

>225 MW Capacity in Field

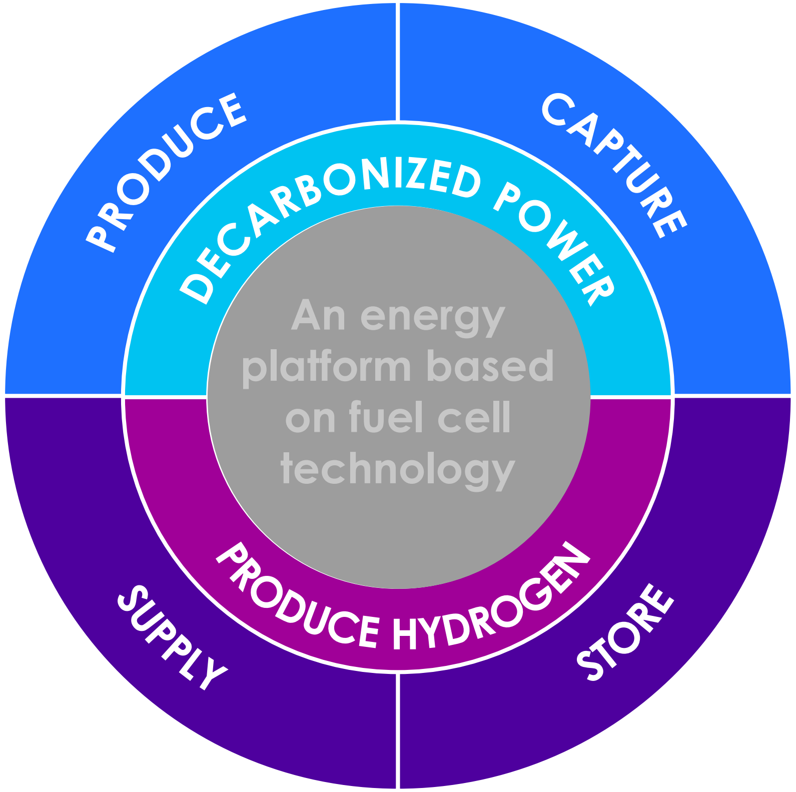
>15 Million MWhs generated with SureSource patented technology

GLOBAL CUSTOMERS

FuelCell Energy

Our Purpose:
Enable a World Empowered by Clean Energy

ENABLING A SAFE, SECURE AND PRACTICAL JOURNEY TO CARBON ZERO



OUR PLATFORM EMPOWERS A SAFE, SECURE AND PRACTICAL JOURNEY TO CARBON ZERO

DECARBONIZING POWER

- Produce decarbonized power
- Capture carbon and greenhouse gases at low cost with the ability to generate power and hydrogen at the same time
- Negligible nitrogen oxide (NOx) and sulfur oxide (SOx) emissions

PRODUCING HYDROGEN

- Supply green hydrogen (using electrolysis of water or reforming of biogas) or blue hydrogen power (using natural gas with carbon separation or carbon capture) with high efficiency
- Working to commercialize a solution that scales renewables by converting excess power to hydrogen – then converting hydrogen back to power when needed
- Ensuring people and industry continue to have access to reliable and affordable energy as the industrialized world continues to move forward by supporting our hardest to decarbonize sectors
- Working to commercialize a gigawatt scalable solution that supports the intermittency of renewables by converting excess power to hydrogen – then using that hydrogen to make zero carbon power

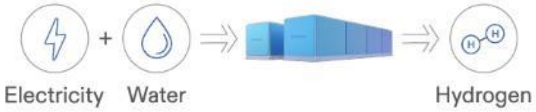
FuelCell Energy

Where do fuel cells make sense?

1 Power Generation

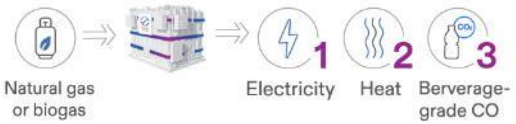
- ✓ Ideal for baseload power applications especially in power constrained regions
  - ✓ Usable waste heat increases site efficiency and lowers OPEX
- ✓ Competitive where energy prices >$0.12/kWh Reduces/eliminates demand charges
- ✓ Provides fuel flexibility: natural gas, biofuels, propane, and hydrogen
- ✓ Fuel cells do not require special air permits.
- ✓ Non-combustion. Eliminate NOx or SOx pollutants

2 Hydrogen Production



- ✓ 600 kg/day H_2 from 1.1 MW (1 MW with thermal input)
- ✓ FCE provides lowest levelized cost of green H2
- ✓ 90% electrical efficiency (100% with thermal input)
- ✓ Use for distributed, on-site H2 fueling or large scale H2 plants

3 Onsite CO2 Recovery



- ✓ Provide competitive, steady supply of CO2 to support local operations
- ✓ Usable heat (3.82 MMBtu/h) to offset boiler fuel and load
- ✓ Decarbonize sites by capturing other on-site flue gas streams

Finance options: Capital Purchase, Power Purchase Agreement (PPA), Lease.
In all options, FCE provides long term service agreement to operate and maintain the systems.

Carbonate Power Generation Solutions

FuelCell Energy

Carbonate power generation platforms

400-cell fuel cell
stack package

Four-stack
module
1.4MW

1.4 MW net power
47% electrical efficiency
up to 90% total efficiency

2.8 MW net power
47% electrical efficiency
up to 90% total efficiency

Tri-generation
2.35 MW net power
1,270 kg/day hydrogen
1,400 gal/day water

Carbon Recovery
1.3-1.8 MW power
20+ Mt/day CO2

14 MW (Derby, CT)

15 MW (Bridgeport, CT)

59 MW (Korea)

Large-scale fuel cell parks

FuelCell Energy

Global track record of reliable power generation

Grid Support with CHP

- 20 MW site built in 2018
- Power sold to grid
- Heat sold to district heating
- 6 month construction time
- Easily scalable

Grid Support / Urban Redevelopment

- 15 MW on 1.5 acres
- Power sold to grid
- Enhanced resiliency
- Brownfield revitalization
- 12 mo. Installation

Resiliency for Pharma

- 5.6 MW w/steam for company campus
- Reliable power solving local grid instability
- Immediate cost savings
- Complements ESG goals

Fuel Cell / Solar Integration

- 2.8 MW fuel cell on ¼ acre
- 2.2 MW solar on ~9 acres
- Utility-owned, rate-based
- Enhanced resiliency

MORE THAN 15 MILLION MWH GENERATED BY CARBONATE POWER PLATFORMS

FuelCell Energy

Extensive on-site biogas experience

City of Riverside (1.4 MW)

The SureSource 1500™ fuel cell plant cleans and consumes renewable biogas from the wastewater treatment process to generate carbon-neutral power and heat for the facility.

- 24/7 power profile
- Limited capital costs
- Heat supports anaerobic digesters

San Bernardino (1.4 MW)

The SureSource 1500™ fuel cell plant supports the City of San Bernardino Municipal Water Department using anaerobic digester gas (ADG) and supplemental natural gas as needed.

- Carbon-neutral power
- Heat support anaerobic digesters
- Biogas cleaned with FCE conditioning system

Tulare (2.8 MW)

The SureSource 3000™ fuel cell system is fueled by the City's biogas which is treated using the SureSource Treatment™ fuel cleaning system.

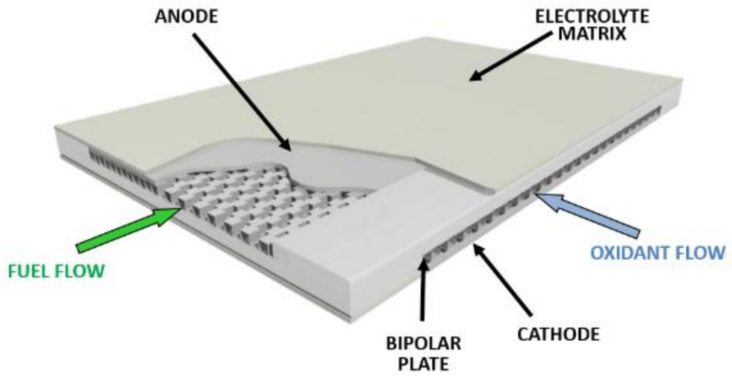
- Carbon-neutral power
- Now uses biogas instead of flaring it
- Benefits from the state's BioMAT program

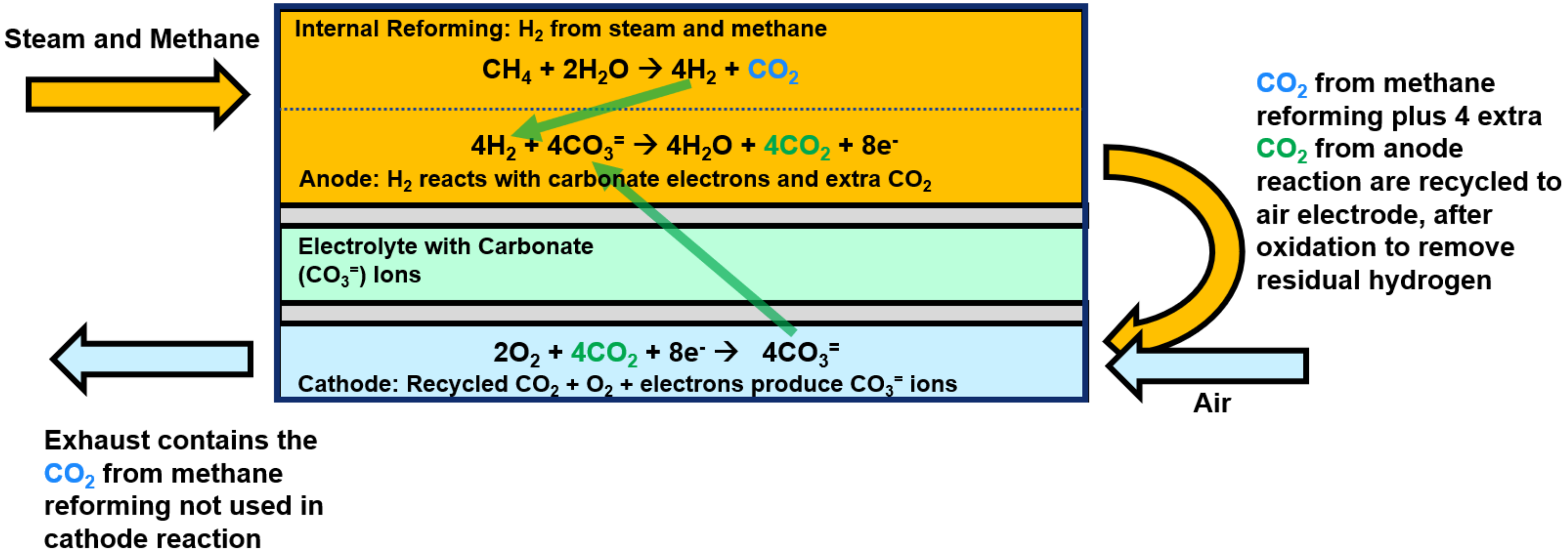
We have more than 500,000 operating hours of experience from decades of biogas-fueled projects

FuelCell Energy

Carbonate Tri-gen for Hydrogen Production

Carbonate fuel cell operating principle





- Efficient conversion of methane fuel to hydrogen in the stack drives high efficiency and provides the opportunity for hydrogen export
- SureSource carbonate fuel cell electrochemistry involves transfer of CO_2 from cathode (air electrode) to anode (fuel electrode)
- This aspect can be exploited to use carbonate stack for CO_2 separation, with concentration in anode gas allowing for easy capture and use or sequestration

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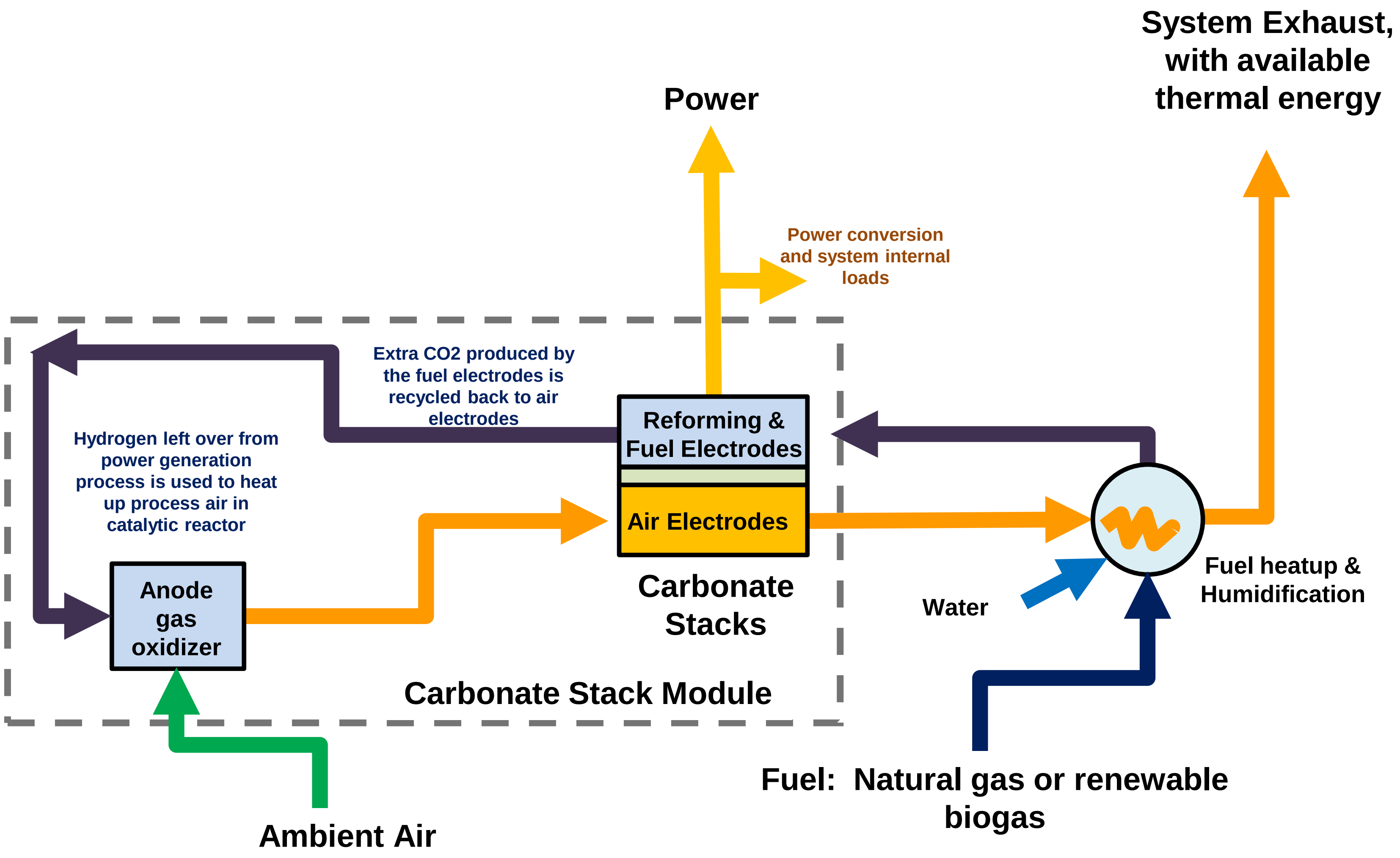
Carbonate fuel cell process overview

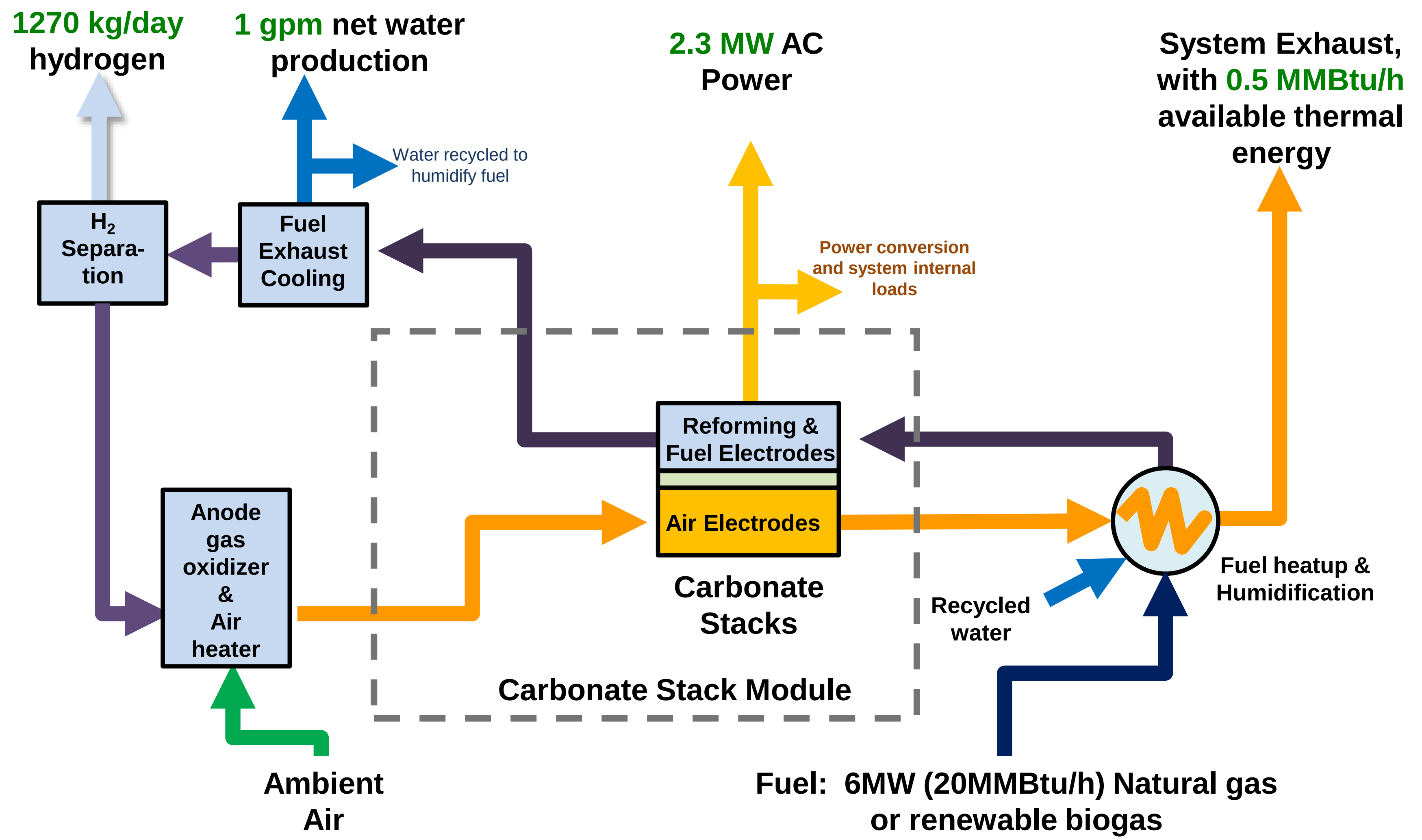
The carbonate stack module includes four stacks, ducting, and the anode gas oxidizer



Hydrogen is produced from internal reformation of methane-based fuel, and used to make power and heat process air for fuel cell reaction

FuelCell Energy

Carbonate Tri-gen process overview



The entire anode exhaust stream is extracted from each 1.4MW module, which no longer has an internal anode gas oxidizer. The gas is processed to remove hydrogen, and then returned to the modules

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Tri-gen process components overview

1. **Inlet:** Directed biogas from adjacent pipeline

2. **Gas saturation:** Wetting gas to ideal water/methane ratio for reforming

3. **Pre-heating:** Via fuel cell stack exhaust waste heat

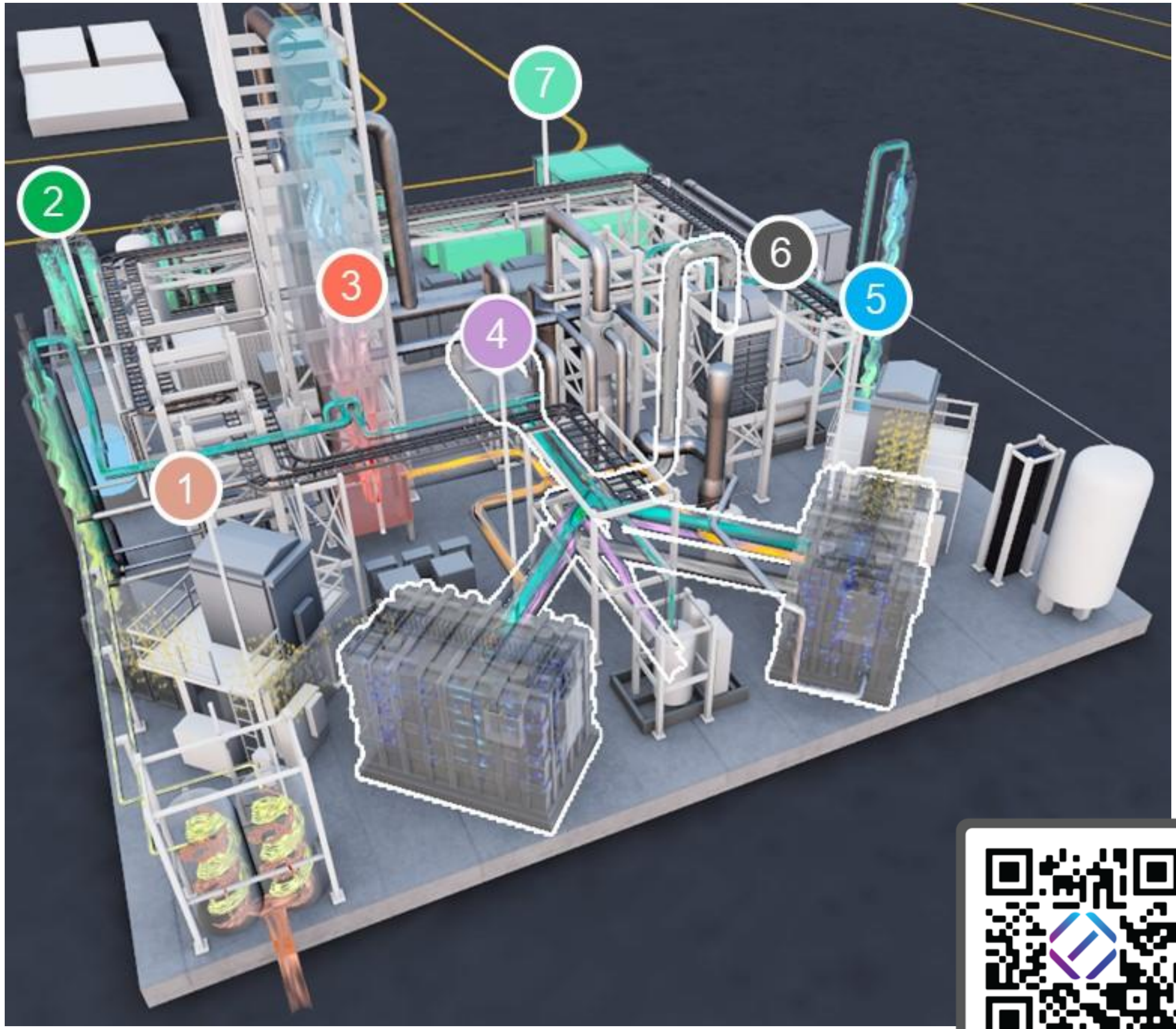
4. **Fuel cell reforming:** Heat and water from fuel cell power generation used to reform gas to produce H2

5. **Power generation:** From fuel cell, inverted from DC to AC

6. **Water recovery:** Cooling of gas leaving fuel cell for water vapor recovery and re-use

7. **Hydrogen purification:** H_2 purified to SAE specification for fuel cell vehicle use

8. **Offtake:** Hydrogen dispensing at vehicle refueling station.



3D Tour

Virtual Tour →

FuelCell Energy

Tri-gen added balance of plant equipment

Added equipment beyond standard carbonate BOP:

Air to air heat exchanger for air pre-heat

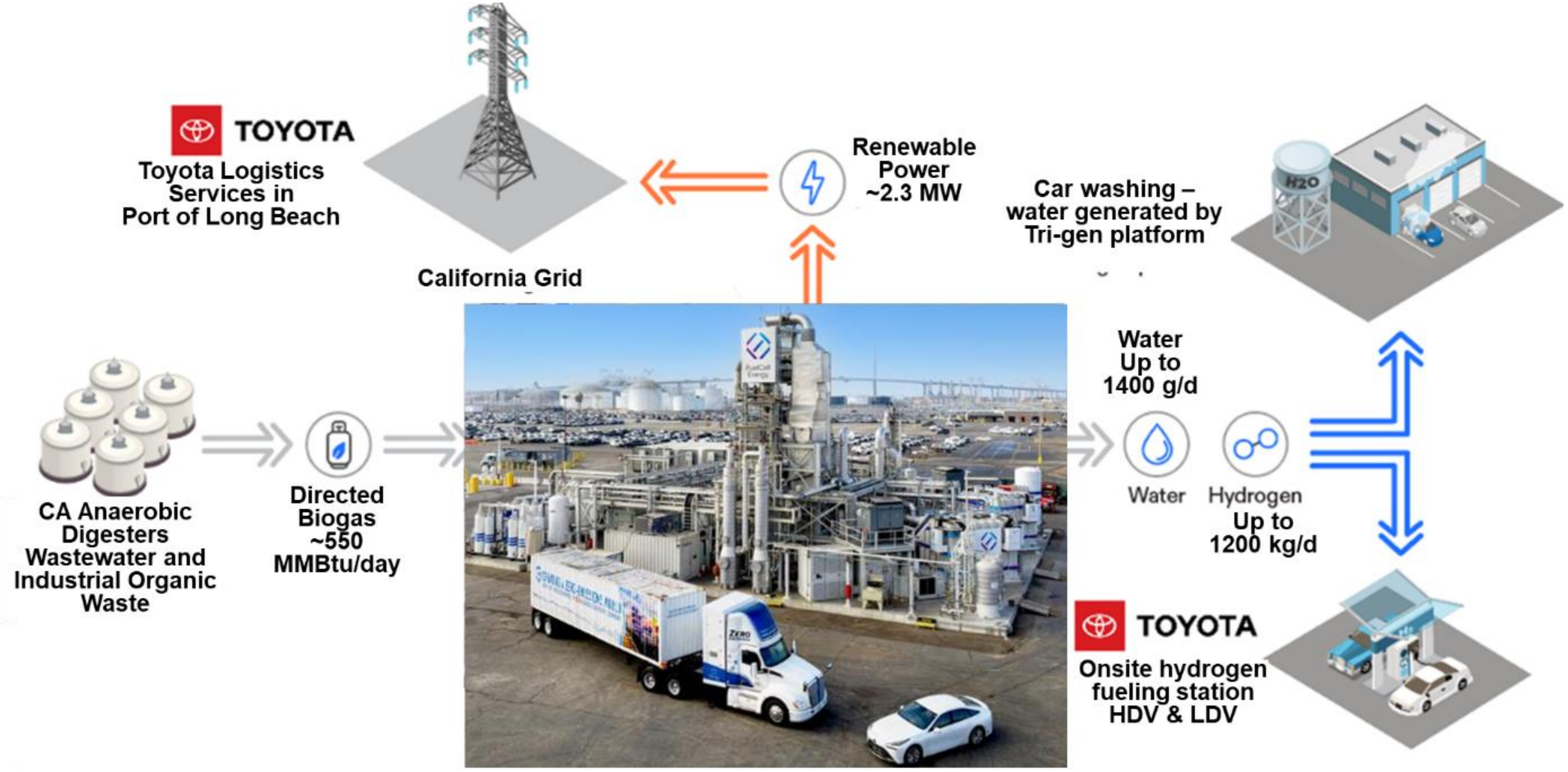
Equipment to cool and dry anode exhaust

Equipment to extract and purify H_2 from anode exhaust

Tri-gen: power, hydrogen and recovered water

3D Tour

- Hydrogen production from methane reforming using fuel cell heat and water during power co-production
- Compared to conventional steam methane reforming (SMR):
  - No fuel combustion for process heat
  - No water consumption
- Avoided combustion emissions, lower CO_2
- The system produces up to:
  - 2.3MW of electricity
  - 1200 kg of hydrogen/day
  - 1400 gallons of water/day



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Carbonate Tri-gen sustainability benefits

Biogas

Natural gas

2.35 MW Clean and renewable power – 18 GWh/year

- 1200 tons per year avoided grid CO_2 emissions with natural gas fuel
- 10,000 tons per year avoided grid CO_2 emissions with biogas fuel
- 5 tons per year avoided NOX

0.5 MMBtu/h thermal energy

- 290 tons per year avoided boiler CO_2 emissions
- 200 lbs per year avoided NOX

1270 kg/day hydrogen

- 1700 tons per year CO_2 reduction vs SMR
- 4200 tons per year CO_2 reduction vs SMR with biogas fuel
- 700 lbs per year NOX reduction vs SMR
- 2 million gallons less water used per year vs SMR

1400 gallons / day water

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Tri-gen on-site biogas application

- Operation with on-site biogas may be best value proposition
  - Low-cost renewable fuel
  - Minimal fuel upgrading required since carbonate can operate on dilute biogas
  - Co-production of power, heat, and water supports water treatment facility operation
  - FCE has extensive experience in biogas processing and on-site biogas power projects at wastewater treatment plants and breweries
  - The first demonstration of Tri-gen was at the wastewater treatment plant of Orange County Sanitation District in Fountain Valley, CA using on-site biogas with on-site hydrogen filling station

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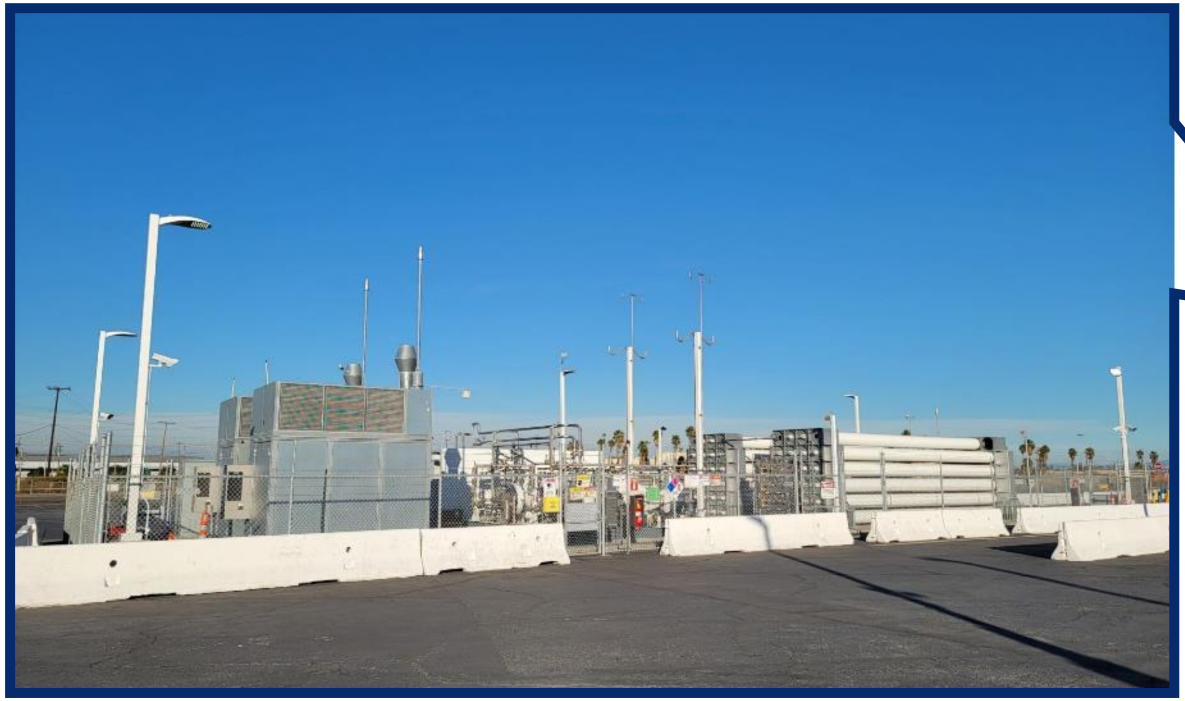
Tri-gen Photos

FuelCell Energy

Tri-gen at Toyota Logistic Services (TLS)

Generating renewable electricity with renewable natural gas
Delivering hydrogen to Shell station for light duty Mirai’s and heavy duty trucks



Tri-gen at Toyota Logistic Services (TLS)

Generating renewable electricity with renewable natural gas
Delivering hydrogen to Shell station for light duty Mirai's and heavy duty trucks


FuelCell
Energy


SNOWDEN
ELECTRIC
COMPANY
INC.

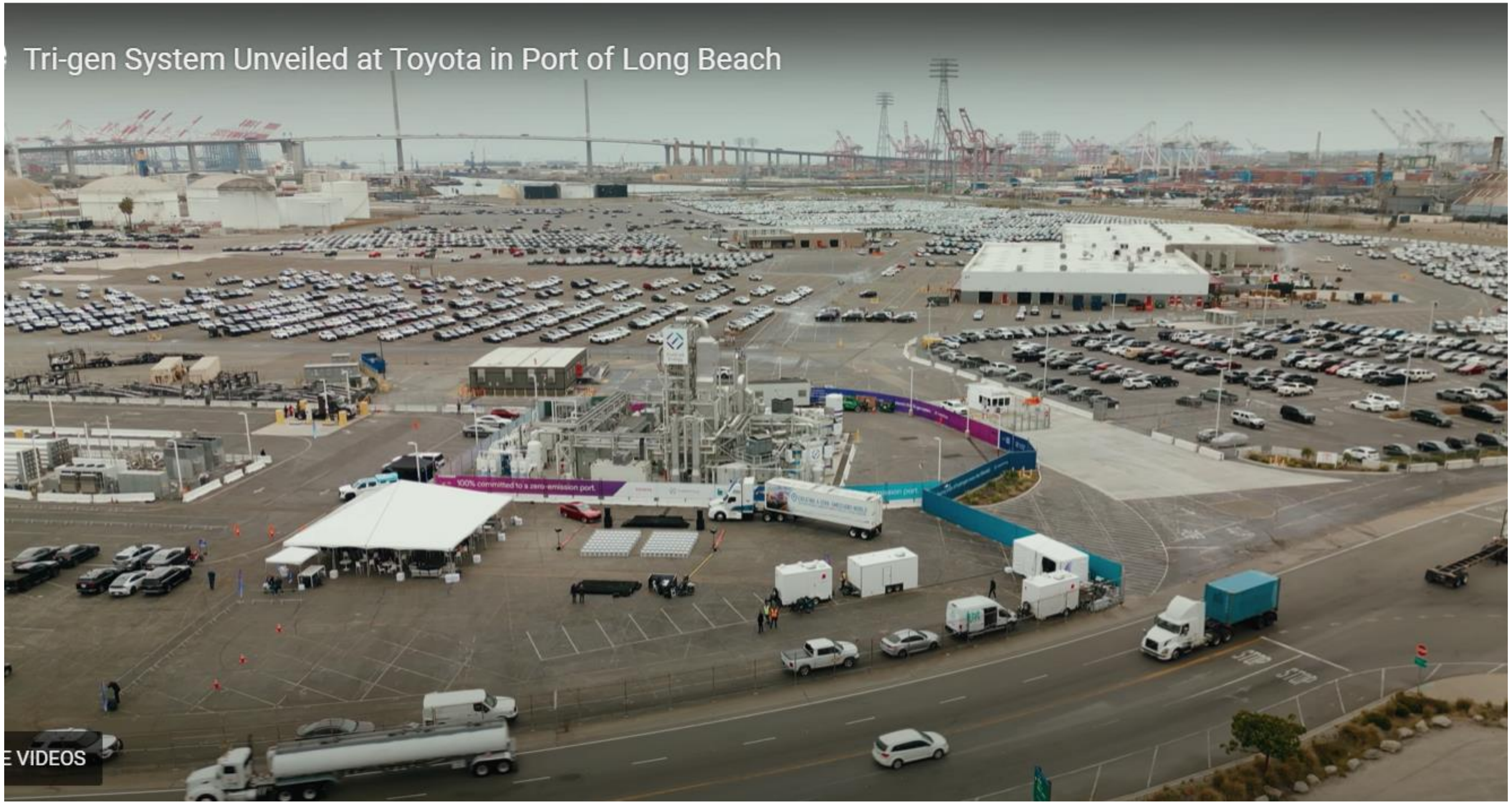

FuelCell
Energy


FuelCell
Energy
PASHA HAWAII
STECH


FuelCell Energy
SOUTHWEST MOBILE STORAGE INC.
FASTECH


FASHA HAWAII

https://polb.com/port-info/news-and-press/renewable-energy-project-powers-port-with-hydrogen-05-02-2024



Thank You

FuelCell Energy contact: Paul Fukumoto pfukumoto@fce.com 949.636.9746

FuelCell Energy

Charging Eagles

BATTERY WORKFORCE CHALLENGE

Presenter

Isabel Builes

Project Manager

Second-year graduate student

M.S. Mechanical Engineering

California State University, Los Angeles

Cal State LA Team

What is the Battery Workforce Challenge?

CAL STATE LA

Video not available for web version

What is the purpose of the Battery Workforce Challenge?

The Battery Workforce Challenge is an immersive, hands-on learning experience for all students to gain valuable engineering skills and become the next generation of vehicle electrification engineers. Students will:

- Develop partnerships
- Follow real-world industry milestones
- Follow industry design and development processes
- Design a custom battery pack

CAL STATE LA

Competition and Club Sponsors

DANA

VECTOR

Admiral Instruments
Test the potential™

AQMD

STELLANTIS

MathWorks®

ABTC
AMERICAN BATTERY TECHNOLOGY COMPANY

Argonne NATIONAL LABORATORY

ANALOG DEVICES

SIEMENS

DEPARTMENT OF ENERGY • UNITED STATES OF AMERICA

GAMMA TECHNOLOGIES

EATON

AVL

Clean Air Awards

2018 Cal State LA EcoCAR 3

The Cal State LA EcoCAR 3 team received the 2018 Clean Air Award from the South Coast Air Quality Management District for educating the public about energy-efficient vehicles. EcoCAR2 2011-2014 and EcoCAR3 2014-2018.

THE COMPETITION

CAL STATE LA

Competition Status

POSITION 6

After Year 1

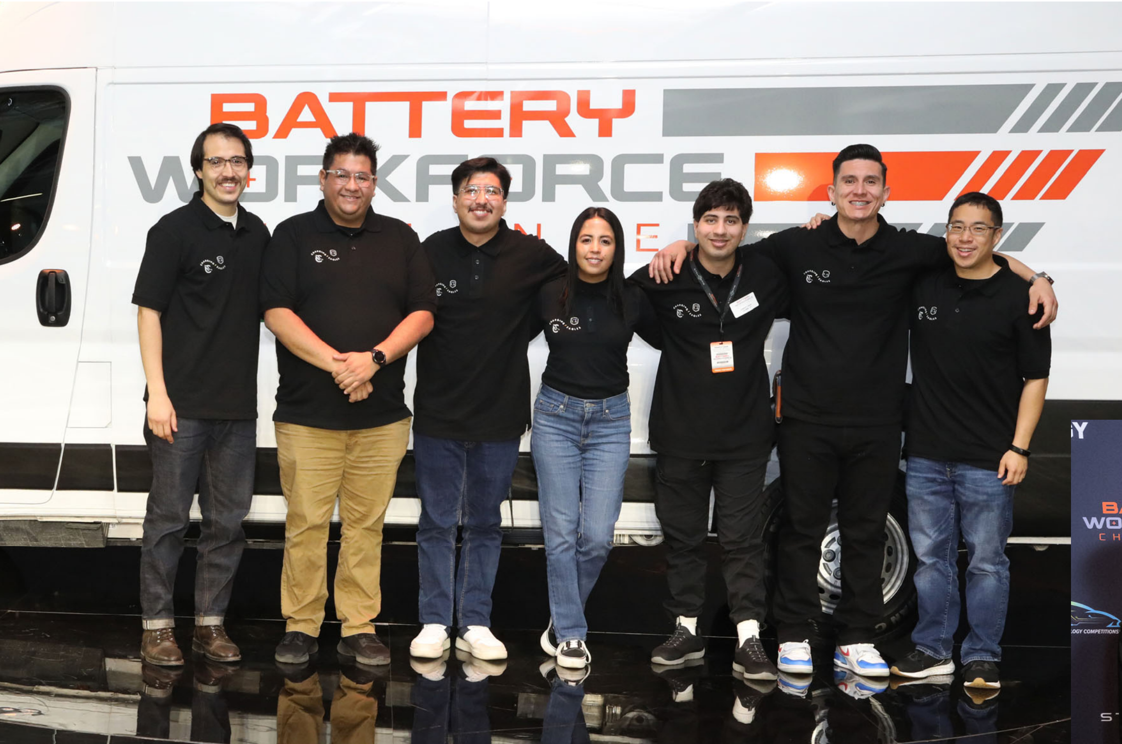
RAM ProMaster


BATTERY
WORKFORCE
WATERLOO
ENGINEERING

Competition and Awards

- First place – Facilities Binder

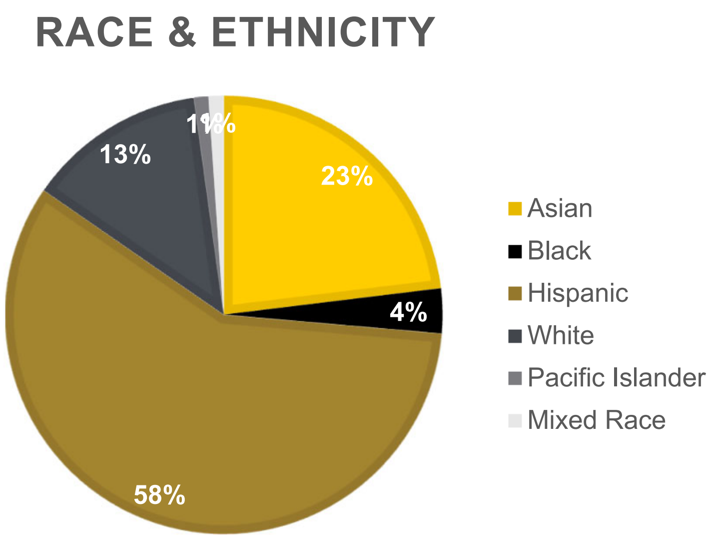
OUR TEAM

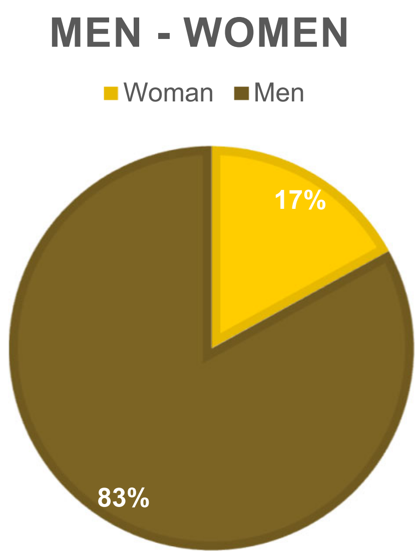


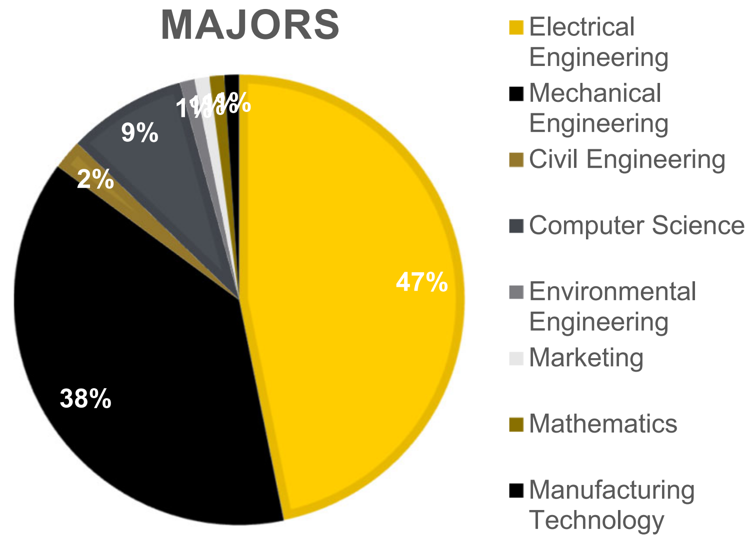
RAM ProMaster reveal at Detroit. March 2024

Competition Year 1 at Chicago. May 2024

Team’s Demographics







- Total members **43**
- Retention Rate **72%**

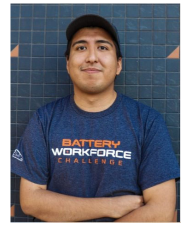
Team Structure

Dr. David Blekhman
Co-Advisor Cal State LA

Isabel Builes

Engineering Management

Project Management



Brian Castillo

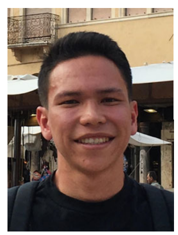
Battery Electric Hardware

Instrumentation/ Software

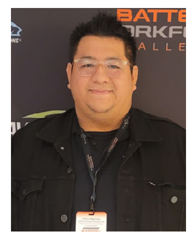
Thermal Management

Mechanical & Vehicle Integration

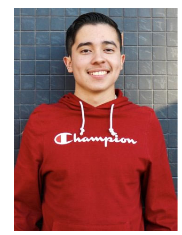
Raymond Tran



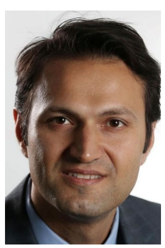
Nate Tan



Arthur Espinosa

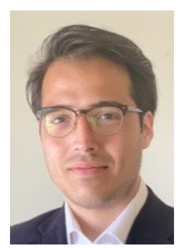


Luis Arias



Dr. Masood Shahverdi
Engineering Advisor

Dr. Curtis Wang

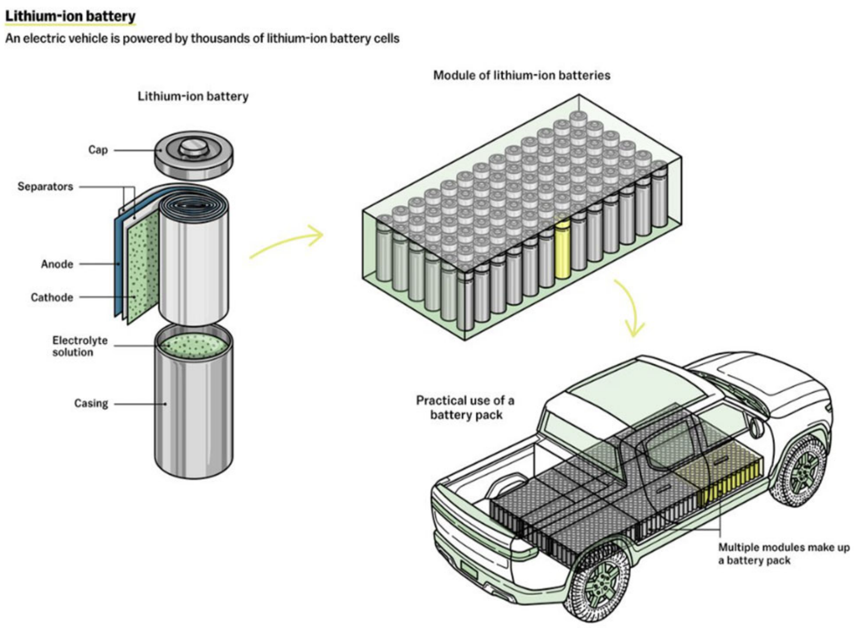


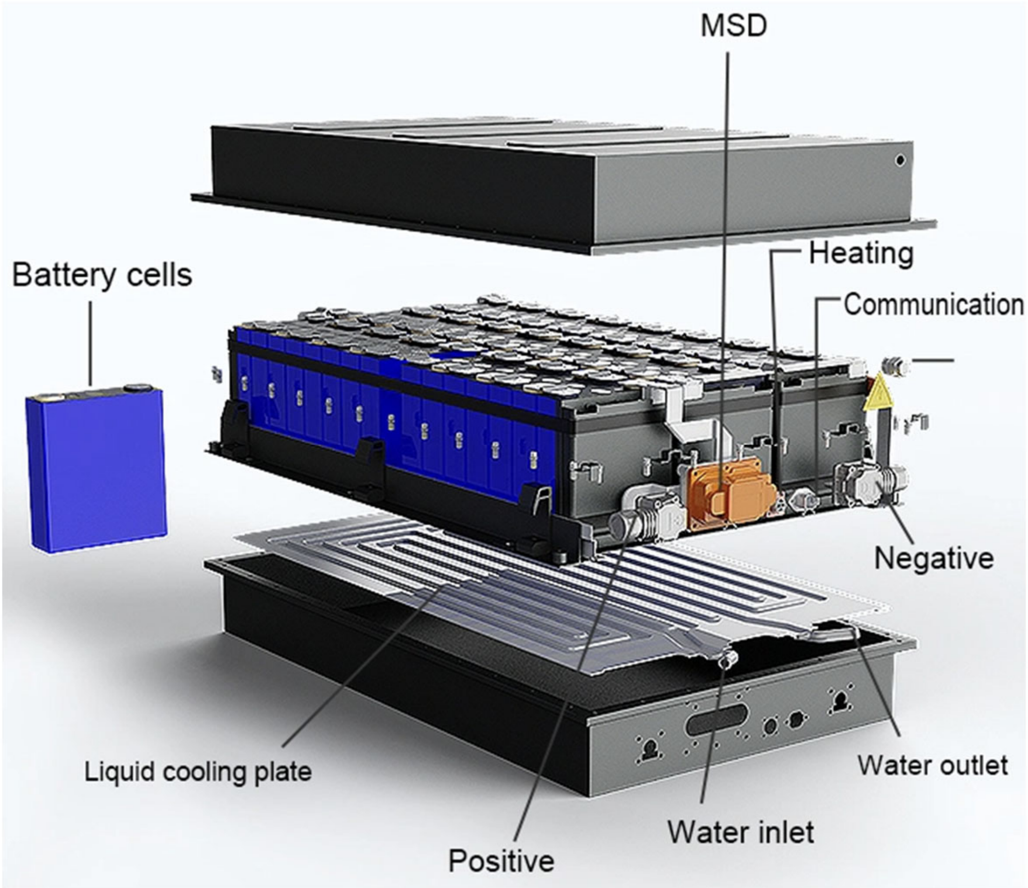
Dr. Mario Medina
Project Advisor

Dr. Chris Bachman

Battery Pack Overview

Battery Module





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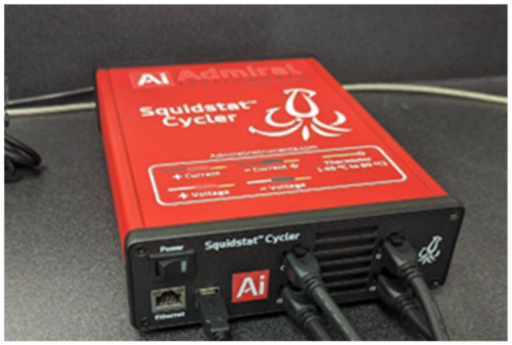
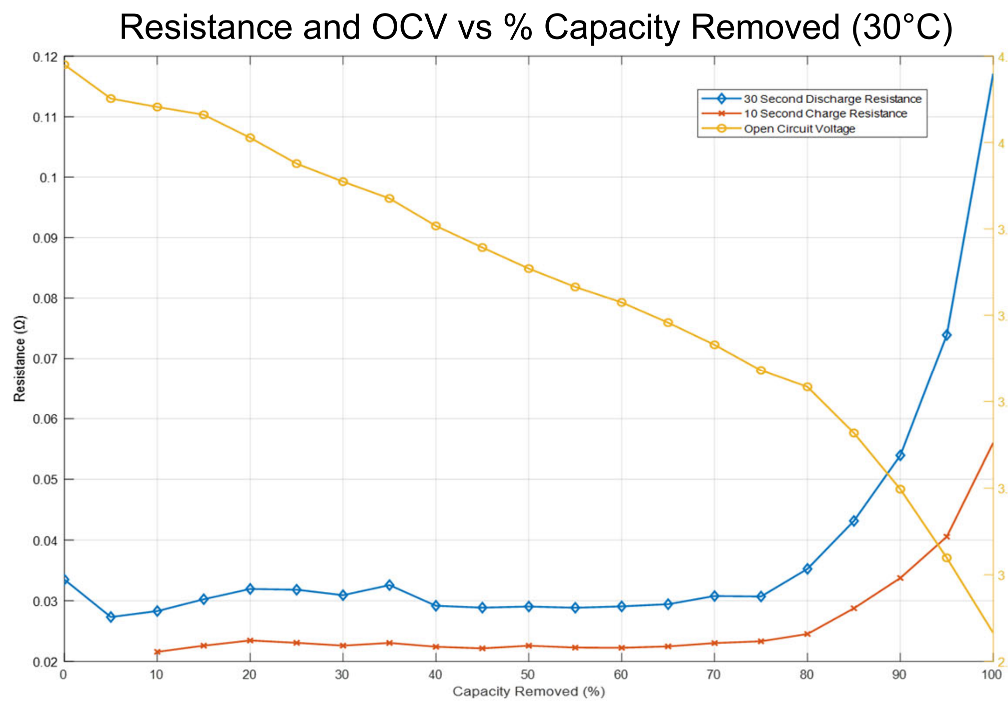
Hardware / Battery Test Setup and Results

Temperature Chamber



Battery Cycler



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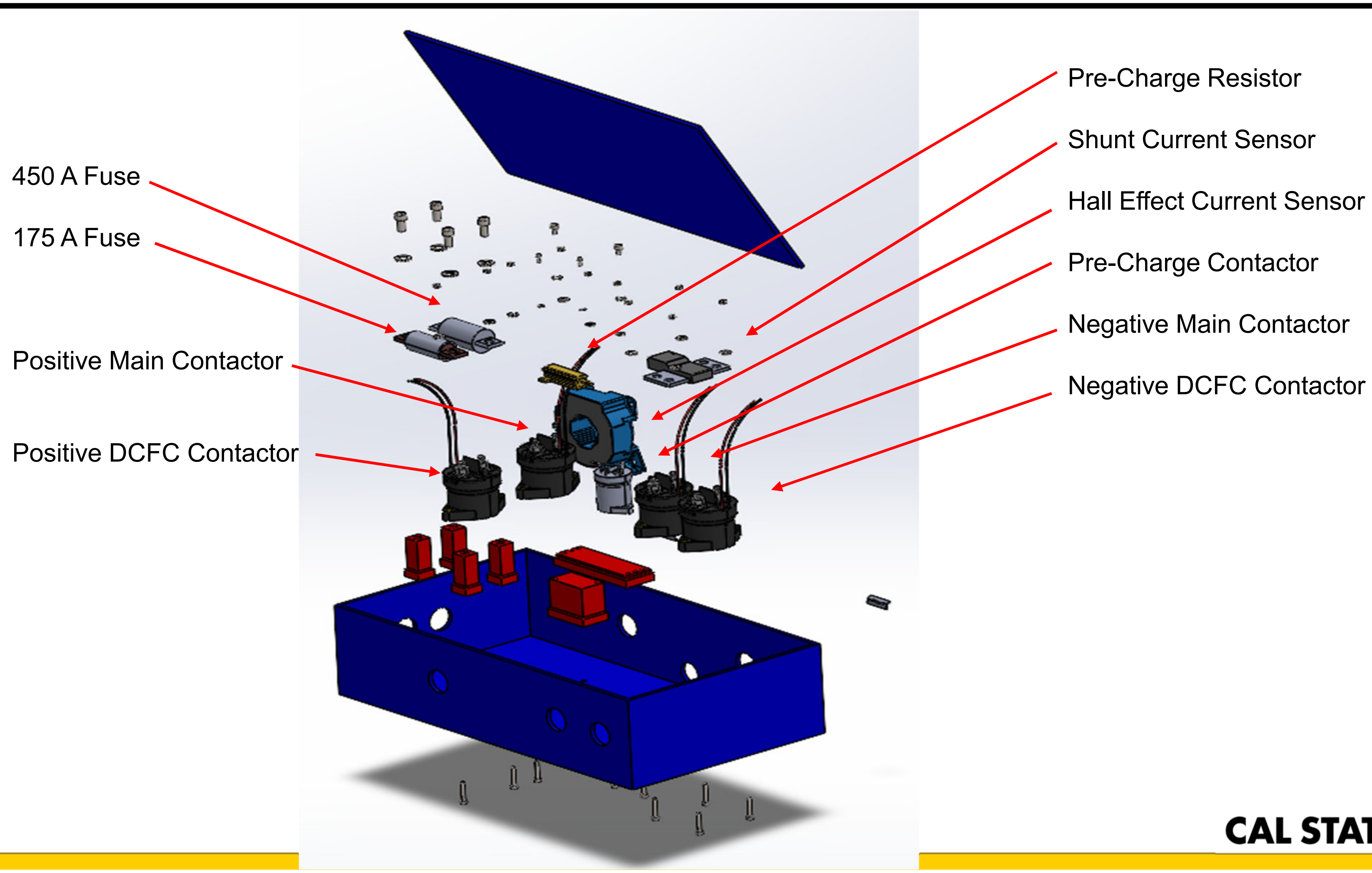
Hardware / BDU Exploded View

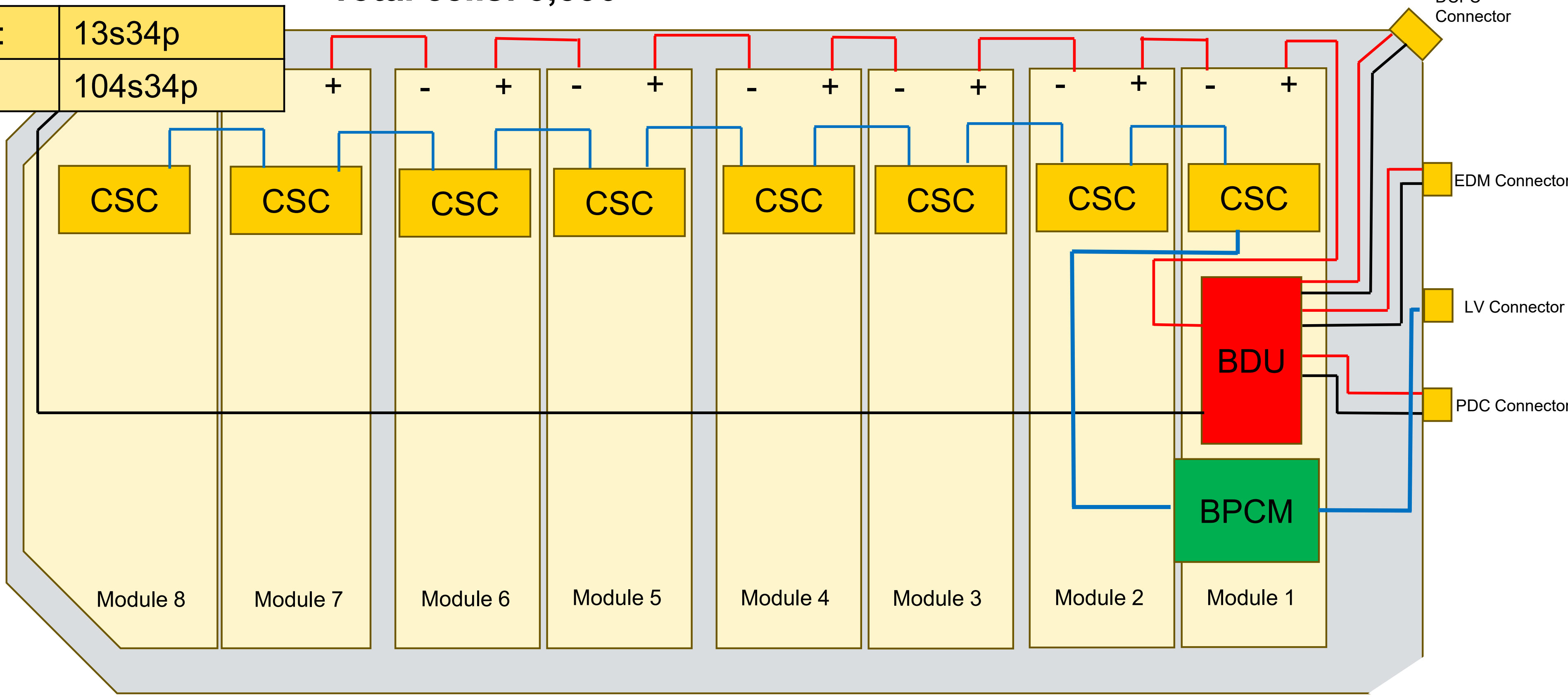


Software / BMS Connection Strategy

Final Configuration:

Module:	13s34p
Pack:	104s34p

Total cells: 3,536



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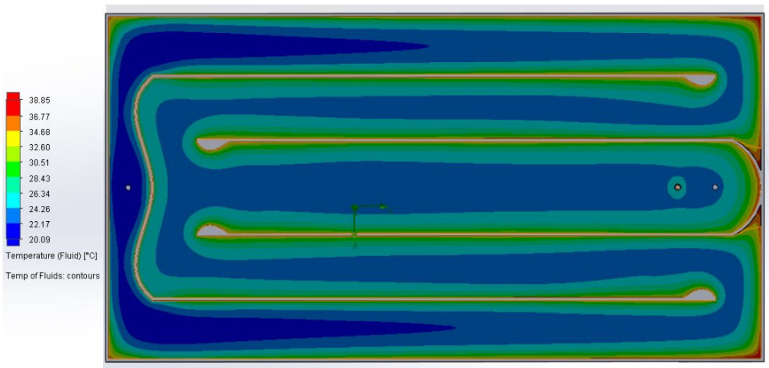
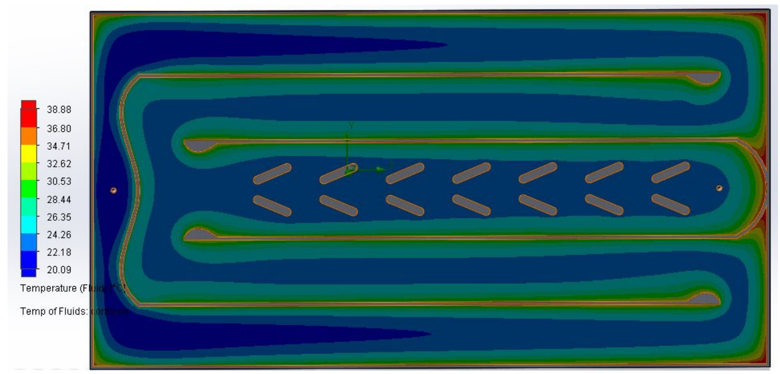
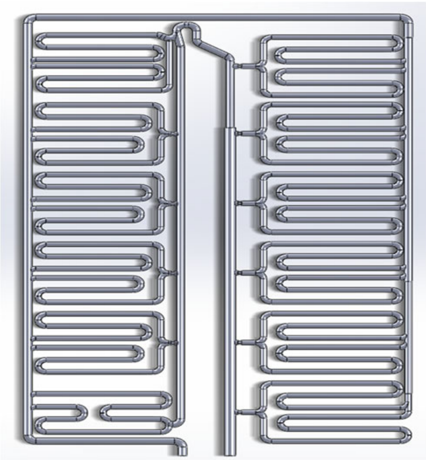
Thermal / Cooling Plate Design and Simulation



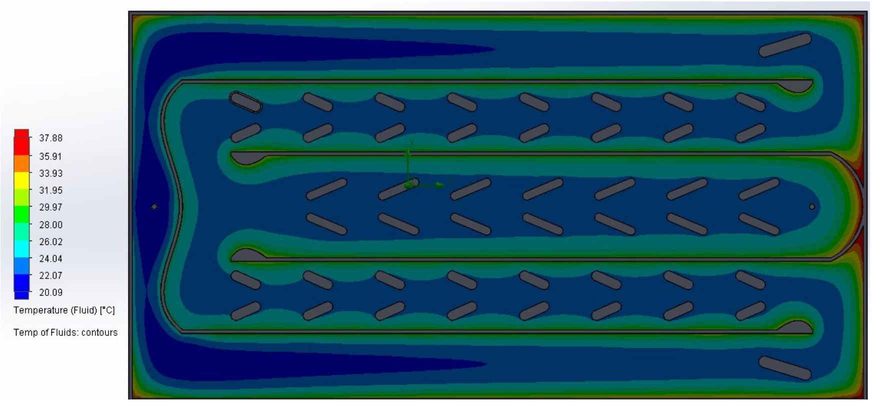
Initial design no slot extrusions



Secondary design with slot extrusions at the center

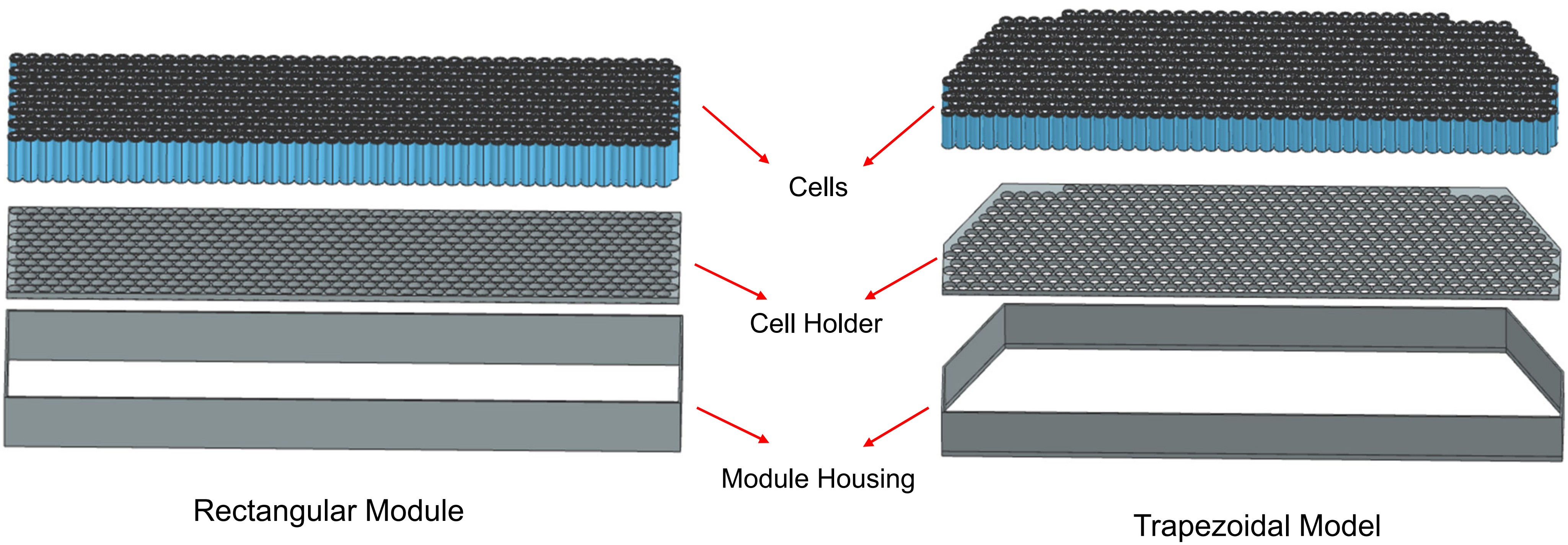


Initial Cooling Plate Design



Final Design

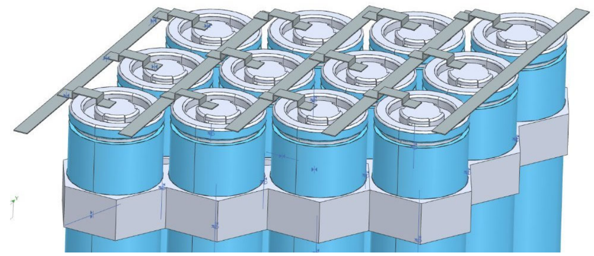
Vehicle Integration / Battery Module Exploded View



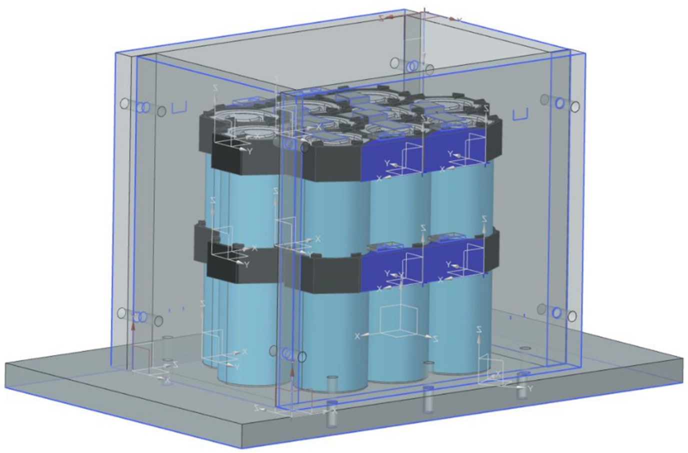
Vehicle Integration

- Goals for Year 2:
  - Fully design the battery pack modules
  - Build our concept models
  - Have a working module at the end of Year 2

- In-Progress Work:
  - Developing concept designs for modules
  - Develop a strategy for interconnecting our cells
  - Determining ways on how to mount modules to the battery pack structure
  - Practicing spot welding our nickel foil busbars to our battery cells



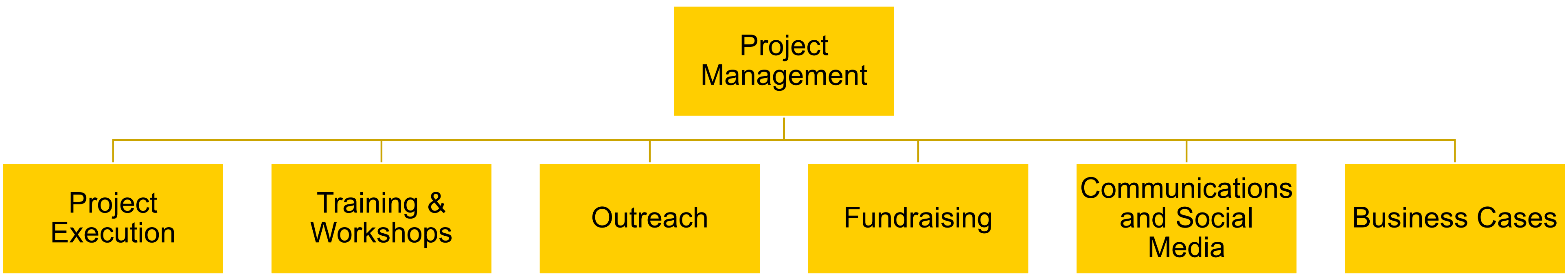
Battery Cell Interconnection Concept Design



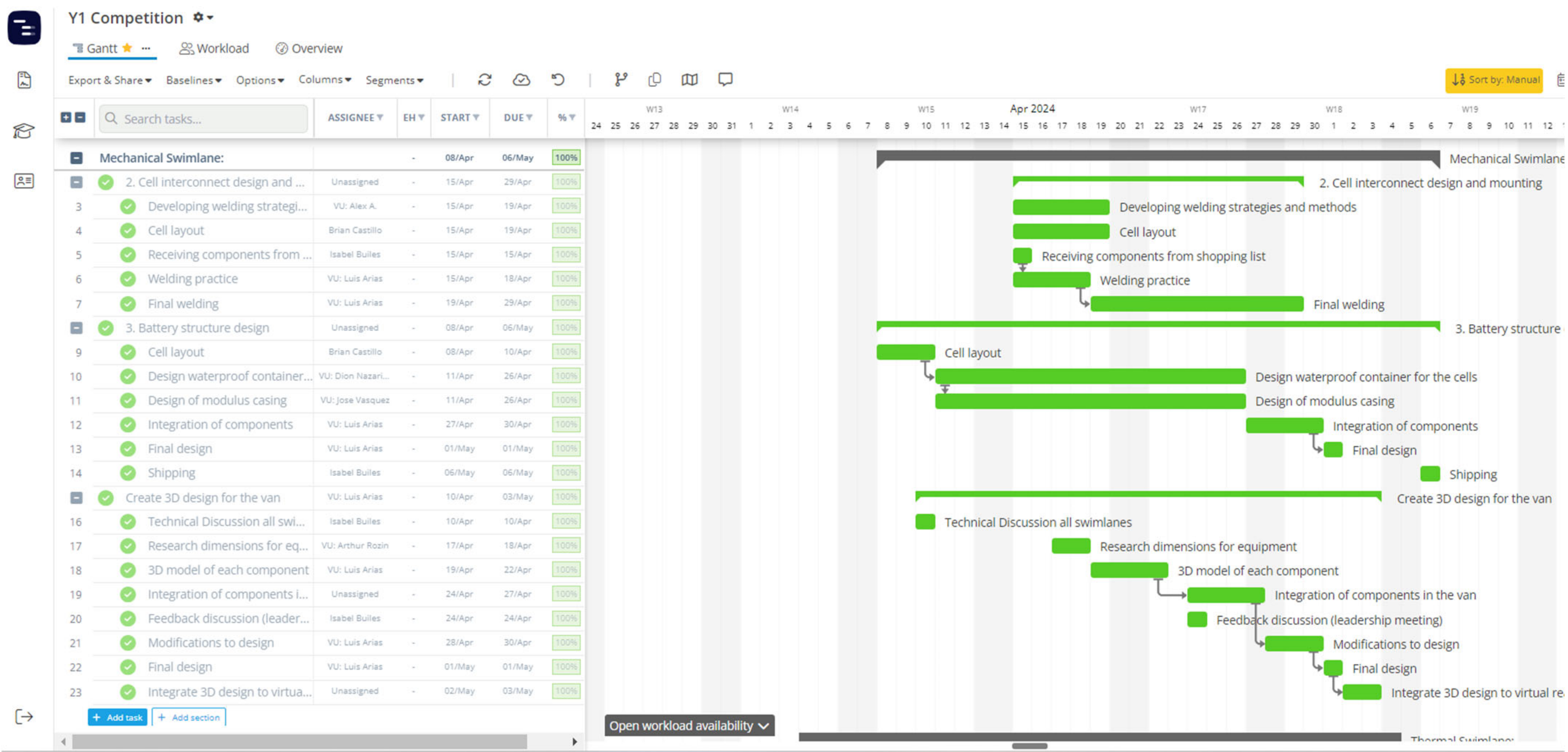
Battery Module Casing Concept Design

Note: Concept Designs aren't fully scaled in size

PM Structure

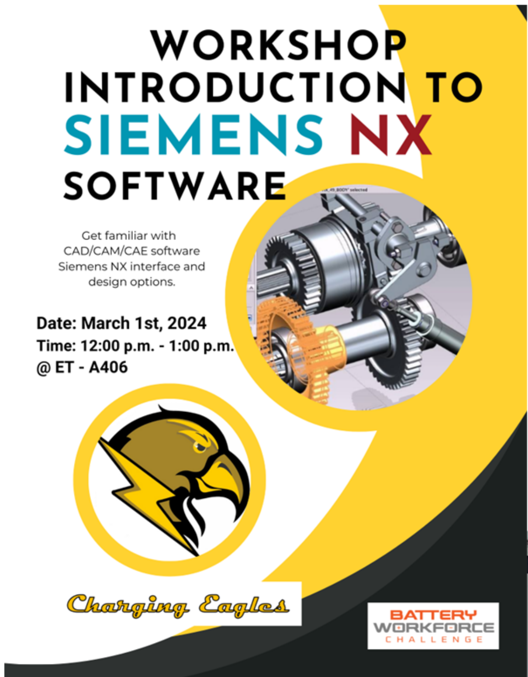


PM / Project Execution

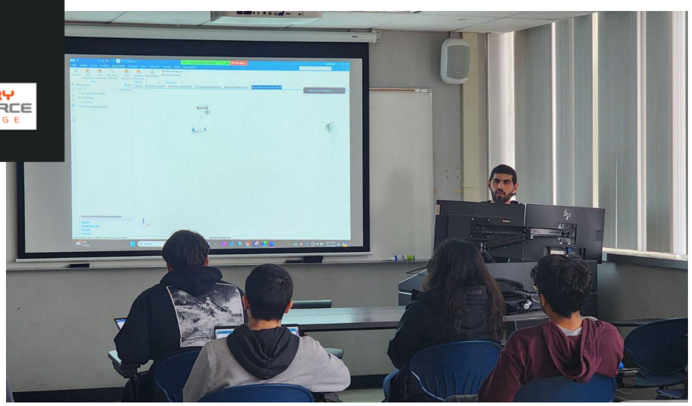


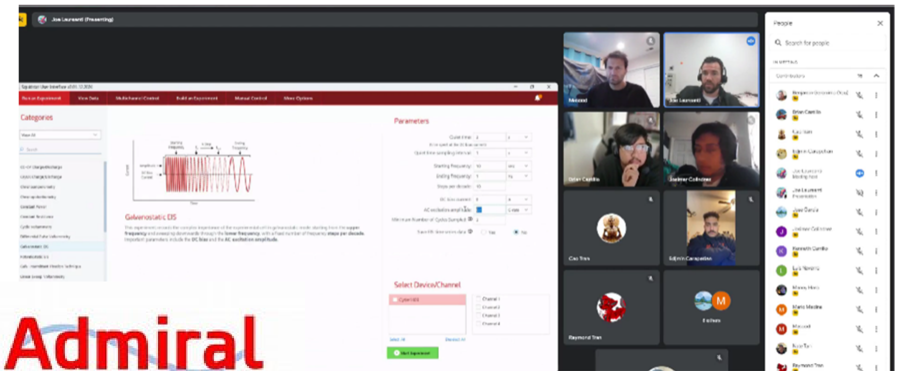
Year 1 Competition – Gantt Diagram

PM / Training and Workshops

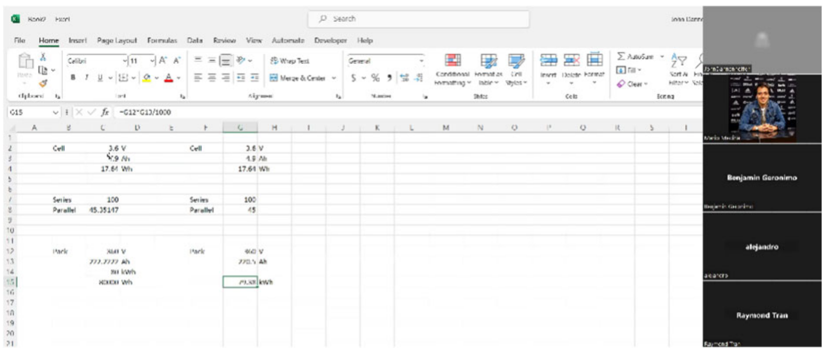


Internal in-person workshop





Online workshop with Admiral Instruments



Hybrid workshop with Danhoff Engineering

PM / Outreach

- Cal State LA
- Vocational School
- High Schools

PM / Fundraising

Events

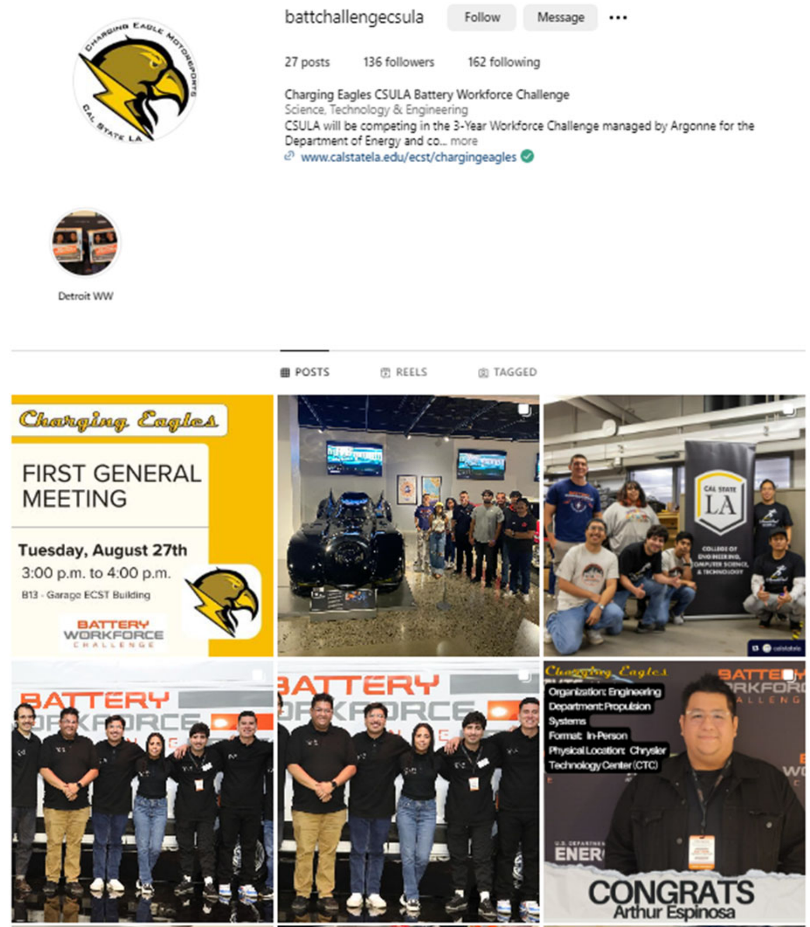
- Internal events

Companies / Industry

CAL STATE LA

PM / Communications and Social Media

- Instagram:
  @battchallengecsula
- LinkedIn
  Batt Challenge CSULA
- Facebook:
  Battchallenge csula



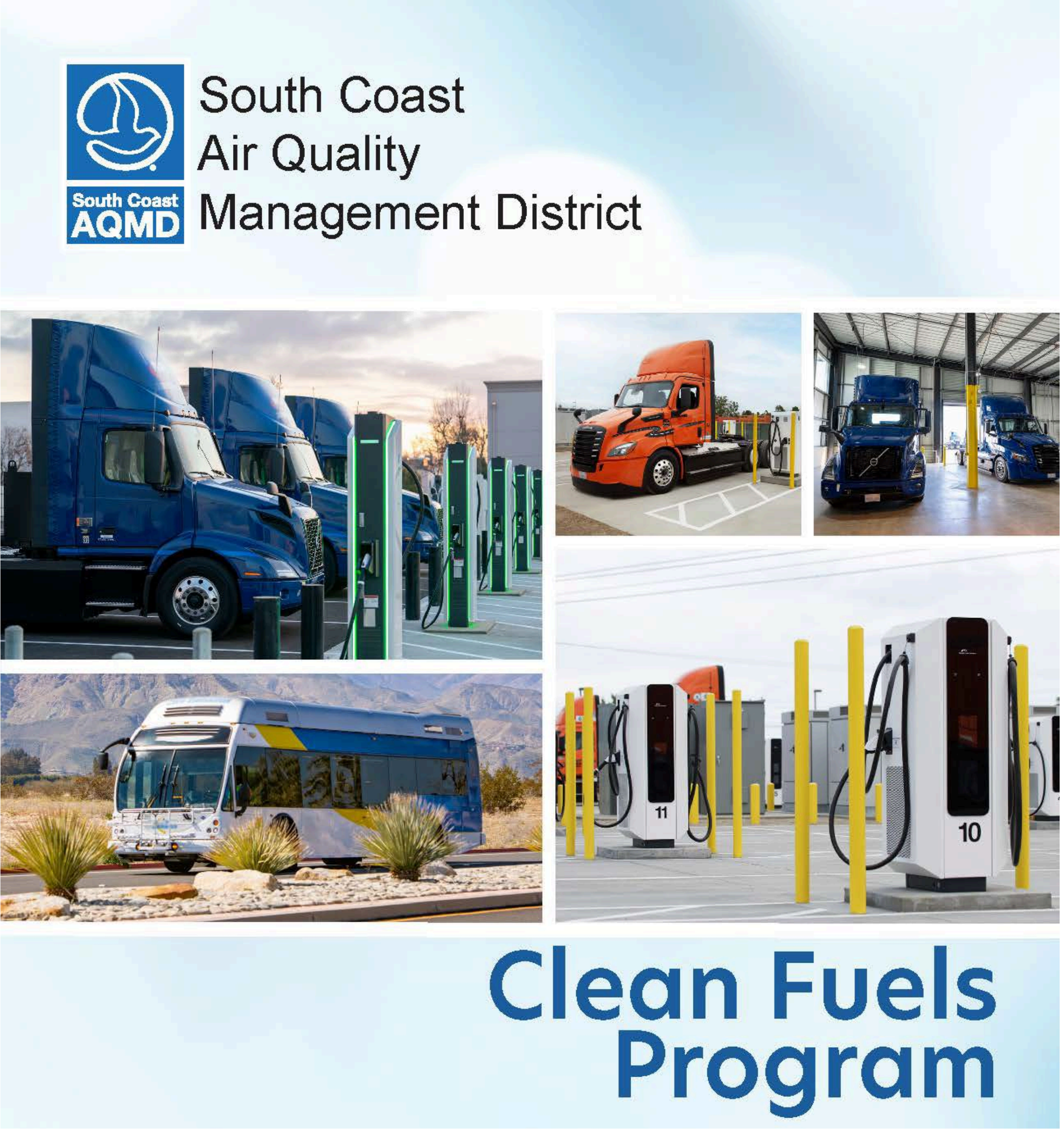
PM / Business Case

GreenRoute
FARM TO TABLE


RAM
2500
Promaster

Thank You!

CAL STATE LA



The 2025 Plan Update

Clean Fuels Program Advisory Group Meeting

September 12, 2024

Vasileios Papapostolou, Sc.D.
Technology Demonstration Manager

Clean Fuels Program - Overview

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

Regulation

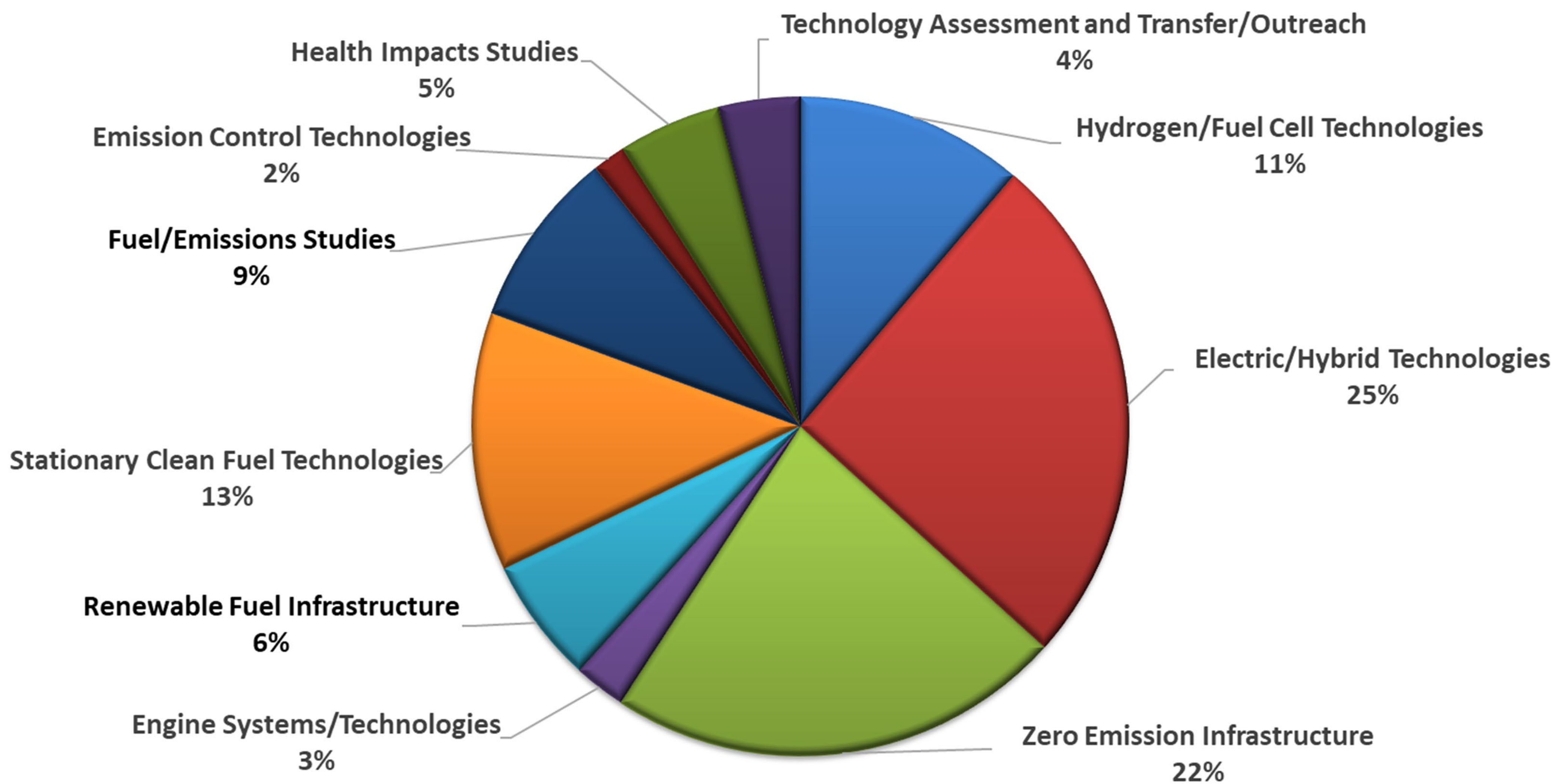
Draft 2025 Clean Fuels Plan Update (Key Technical Areas)

- Zero emission MHD trucks and equipment, including innovative electrified trailer, battery-swap technologies and vocational applications
- Alternative charging solutions to deploy ZE infrastructure
- Microgrid technologies including vehicle-to-grid and vehicle-to-home
- Grid capacity, fleet electrification assessment studies
- Fuel and emission studies from hydrogen fueled internal combustion engines, linear generators, and brake and tire wear
- Workforce training & development
- Maintain other areas of emphasis

Draft 2025 Clean Fuels Plan Update Proposed Projects

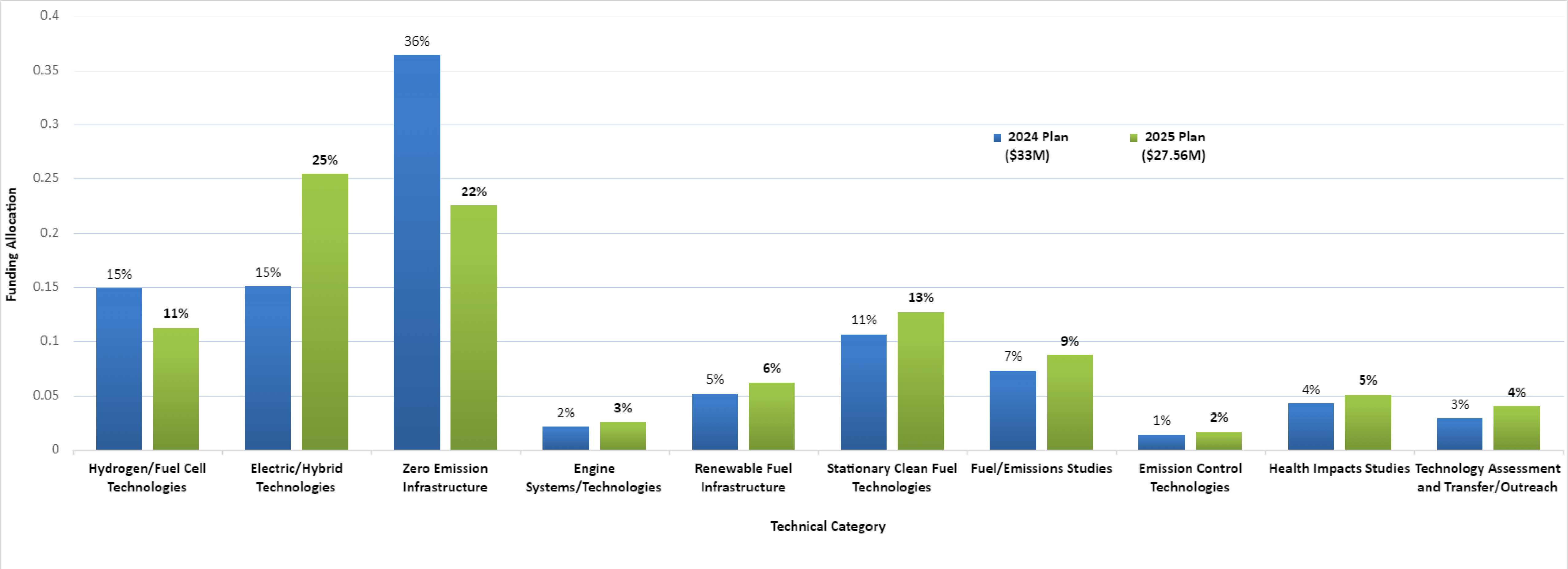
- Deployment of zero emission (ZE) MHD trucks and infrastructure
- Development of data-based energy & planning management tools for ZE MHD truck charging infrastructure
- Super/Fast charging infrastructure installations to increase BE MHD truck utilization
- Innovative solutions to support ZE MHD truck charging and hydrogen fueling
- Power grid readiness, energy and planning management studies
- Development and demonstration of ZE vocational trucks and equipment
- Deployments of localized hydrogen production, storage and distribution pathways

Proposed 2025 Clean Fuels Plan Distribution



$27.56M

Plan Update Comparison



Proposed Distribution

	2024 Plan ($33M)	2025 Plan ($27.56M)
Hydrogen/Fuel Cell Technologies	15%	11%
Electric/Hybrid Technologies	15%	25%
Zero Emission Infrastructure	36%	22%
Engine Systems/Technologies	2%	3%
Renewable Fuel Infrastructure	5%	6%
Stationary Clean Fuel Technologies	11%	13%
Fuel/Emissions Studies	7%	9%
Emission Control Technologies	1%	2%
Health Impacts Studies	4%	5%
Technology Assessment and Transfer/Outreach	3%	4%
	100%	**100%**

Feedback

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