Advancing Clean Transit Through Innovative Tools and Strategies

08/18/2026

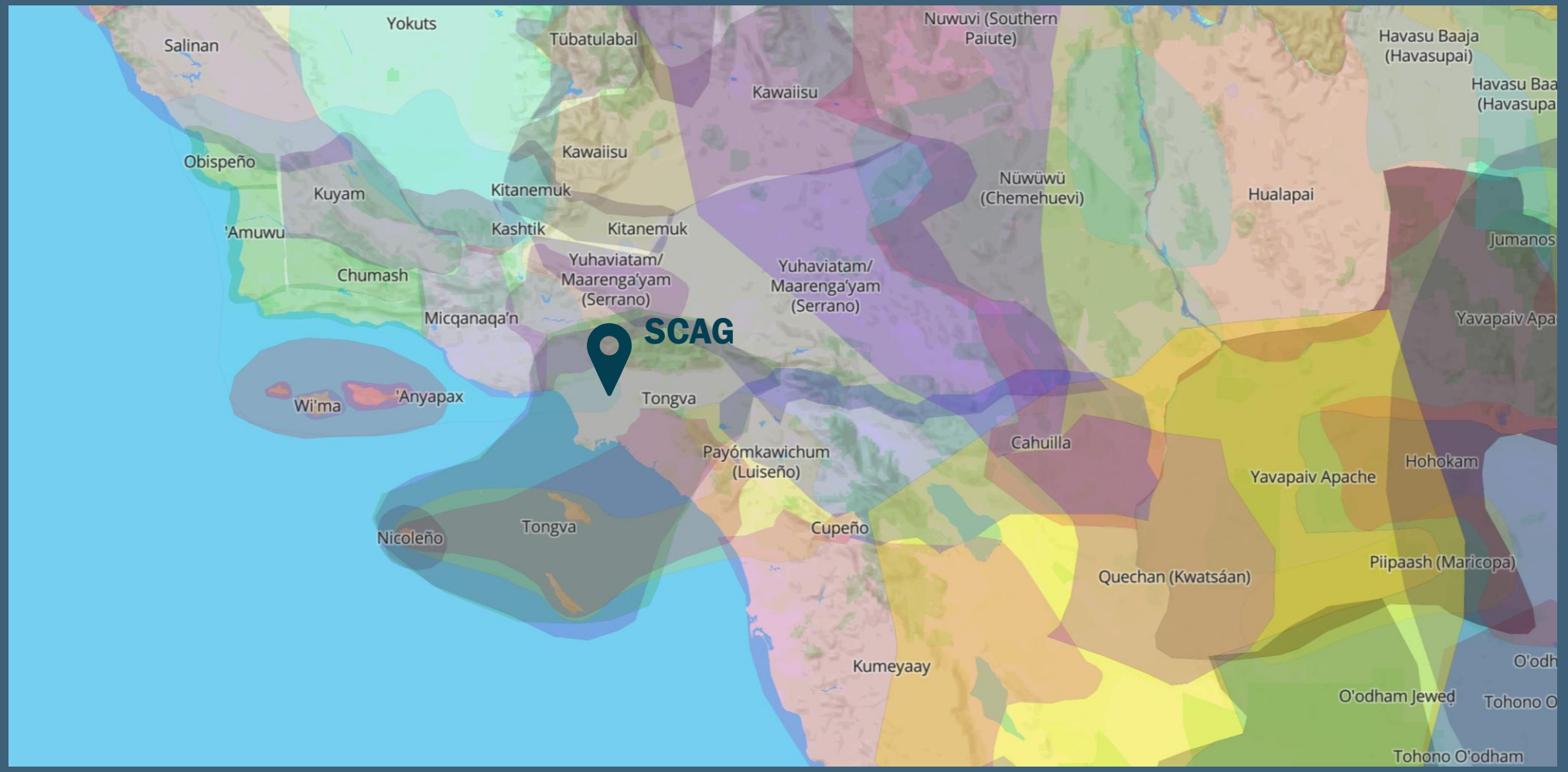
Toolbox Tuesday

WWW.SCAG.CA.GOV

Housekeeping

1. Meeting length: 1.5 hour
2. This meeting is being recorded
3. All participant lines will be muted
4. At the end, there will be a Q&A session
5. If you have a question during the presentation, please type it into the chat box or press the "raise hand" function
6. We will log all questions and then voice a selection at the end of the presentation
7. Closed captioning can be turned on by clicking “Show captions” on the Zoom ribbon
8. A recording of this webinar and the PowerPoint slides will be available on the SCAG website. We will send a link to everyone who has registered after the event
9. Please fill out our survey at the end to help us improve future Toolbox Tuesdays!

Land Acknowledgement



Advancing Clean Transit Through Innovative Tools and Strategies

1. **Innovative Clean Transit (ICT) Regulation Program Update**
2. **California Zero Emission Bus Deployment Toolkit**
3. **SCAG Innovative Clean Transit (ICT) Implementation Toolkit**
3. **SunLine Transit – Journey to Hydrogen Technology**
4. **Antelope Valley Transit Agency – The Nation's 1st and Only 100% Electric Fleet**
5. **Orange County Transportation Authority Zero Emission Bus Program**

Speakers

Shirin Barfjani

Air Pollution Specialist,
Air Resources Board

Ryan Ong

Senior Transportation Planner
Specialist, Caltrans

Priscilla Freduah-Agyemang

Senior Regional Planner, SCAG

Walter Watcher

Chief of Capital Projects,
SunLine Transit Agency

Martin Tompkins

Executive Director & CEO,
Antelope Valley Transit Authority

Cliff Thorne

Director of Maintenance. Orange
County Transportation Authority

CALIFORNIA
AIR RESOURCES BOARD

Innovative Clean Transit Regulation - Program Update

Toolbox Tuesday: Advancing Clean Transit Through Innovative Tools and Strategies

Shirin Barfjani, Air Pollution Specialist

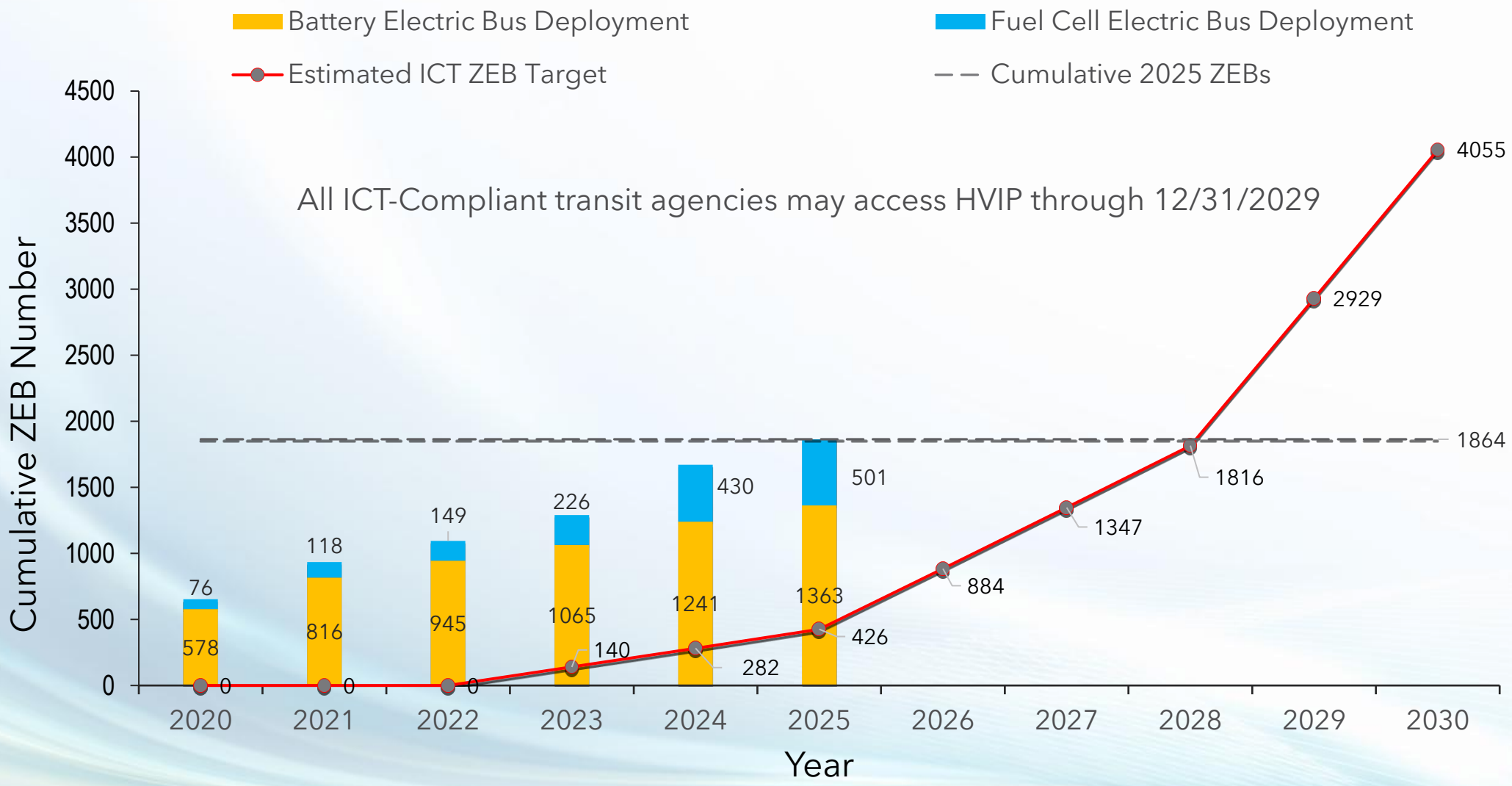
August 18, 2026

Innovative Clean Transit (ICT) Regulation

- Adopted in 2018 as the first heavy-duty zero-emission vehicle regulation in the United States
  - Zero-emission bus (ZEB) Rollout Plan to ensure adequate planning
  - Phase-in schedule to allow preparation time
  - Compliance flexibility and safeguards for a smooth transition
  - Early action for additional benefits
- ZEBs act as beachhead in heavy-duty vehicle sectors

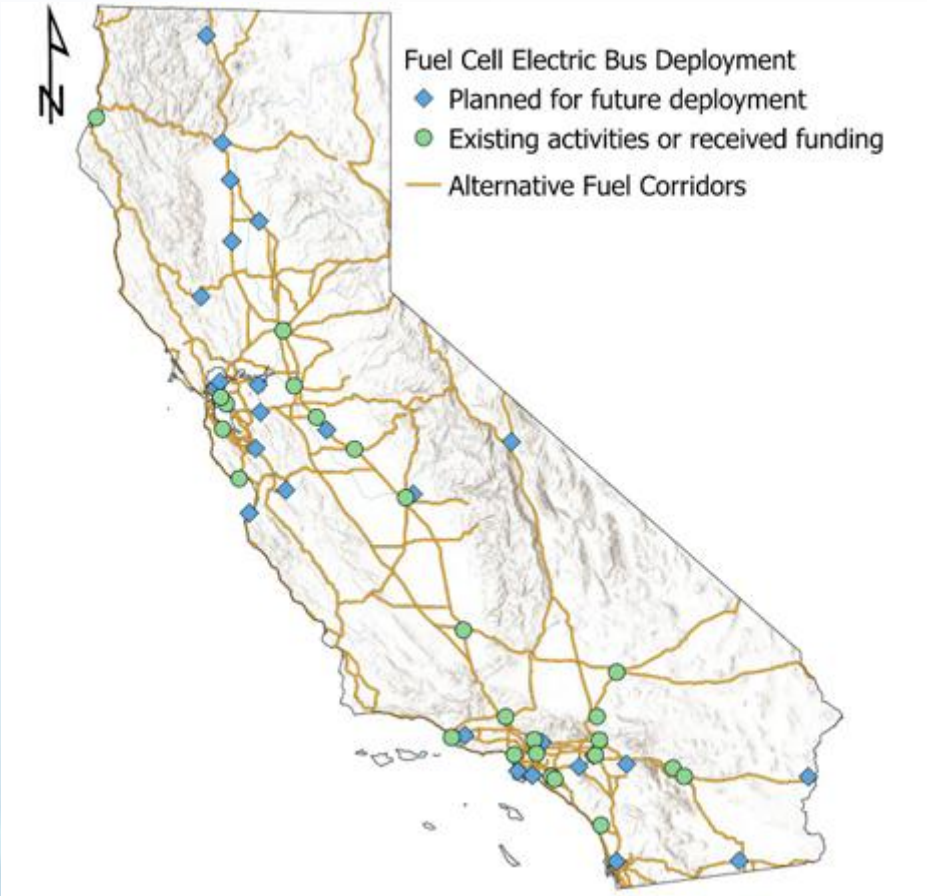
Year	ZEB Percentage of Total New Bus Purchases	
	Large Transit	Small Transit
2023-2025	25%	-
2026-2028	50%	25%
2029 & on	100%	100%

Cumulative Zero-emission bus (ZEB) Deployment in California (in service and on order)



CARB

Fuel Cell Electric Bus Deployment in California



CARB https://ww2.arb.ca.gov/sites/default/files/2026-07/FCEB_Deployment_CA_7.22.26.pdf

Phase II Comprehensive Review on 2026-2028 Program Readiness

- Review conducted by National Laboratory of the Rockies
- Highlighted notable ZEB deployments and lessons learned
- Standard and articulated ZEB are more advanced and could meet near-term deployment purposes
- Class 4 cutaway, over-the-road motorcoach, and double decker ZEB technologies need more time to develop long-range models
- Classes 5 and 6 cutaway buses don't have an Altoona tested or commercialized ZEB model
  - Not phased in for 2026-2028

ICT Exemption Website and Templates

- ICT exemptions
  - Bus type specific and good for one calendar year
  - Only one exemption reason for each vehicle
- Streamlined application templates
  - Template 4.1 (unavailability for class 4 cutaway, over-the-road, double decker buses)
  - Template 5 (financial hardship)
- Classes 5 and 6 cutaway buses don't need exemptions
- All exemption applications should be sent electronically to ict@arb.ca.gov

Other Updates

- First Public Hydrogen released competitive solicitation for low-carbon hydrogen fuel for public agencies and other users
  - Due 8/19/26 at 10:00 AM ET
- Clean Truck and Bus Voucher Incentive Project (HVIP)
  - As of 8/4/26, $315K available in Transit Set-Aside and $40M in Standard HVIP
  - When Transit Set-Aside is fully requested, Standard HVIP is available for all Transit Set-Aside eligible users, pending funding availability
- CARB hosted webinar on Low Carbon Fuel Standard (LCFS) on 8/4/26 specific for transit agencies
  - Recording and presentation available on ICT-Meetings & Workshops

Resources and Contacts

- Cal Fleet Advisor https://calfleetadvisor.org/
- LCFS homepage https://ww2.arb.ca.gov/our-work/programs/low-carbon-fuel-standard
- Funding Finder Tool https://fundingfindertool.org/
- ICT website: https://ww2.arb.ca.gov/our-work/programs/innovative-clean-transit
- ICT team ICT@arb.ca.gov

California Zero-Emission Bus Deployment Toolkit

Ryan Ong

Division of Mass Transportation

Caltrans

ryan.ong“at”dot.ca.gov

August 18, 2026

Purpose

- Guide stakeholders through transitioning to zero-emission bus (ZEB) technologies
  - Planning
  - Procurement
  - Deployment
- Aid decisionmakers with choosing the best technological pathway for their organization
  - Toolkit highlights key factors that should be considered in a checklist format

ZEB Toolkit Structure

- Tool 1: ZEB Technology Overview
  - Breaks down zero-emission bus technologies
- Tool 2: Step-by-Step Framework for zero-emission bus (ZEB) Deployment
  - Identifies six steps when adopting zero-emission technologies
    - Appendix checklist
  - Tool 3: Funding Sources
    - Lists vehicle procurement, infrastructure, and planning funding programs
- Tool 4: CA Hydrogen Market Forecast
  - Forecast out to 2040
- Tool 5: Stakeholder Interviews and Recommendations: Hydrogen Market
  - Evaluates barriers with hydrogen deployment and outlines recommendations
- Tool 6: Components of Hydrogen Station Designs
  - Provides visual representation of major hydrogen station fueling components like layouts, equipment configurations, and facility space
- Tool 7: Hydrogen Station Designs
  - Lays out potential hydrogen refueling infrastructure design

Tool 1: ZEB Technology Overview

- Compares battery electric buses (BEBs) and fuel cell electric buses (FCEBs)
  - Topics: vehicle cost, refueling, operational challenges, and scaling up

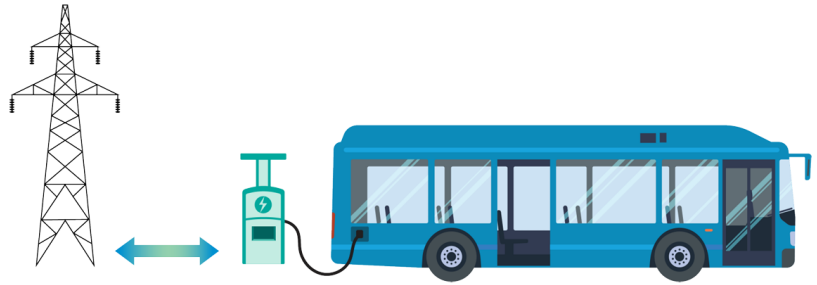


Figure 13 – Bidirectional Charging Graphic Reference

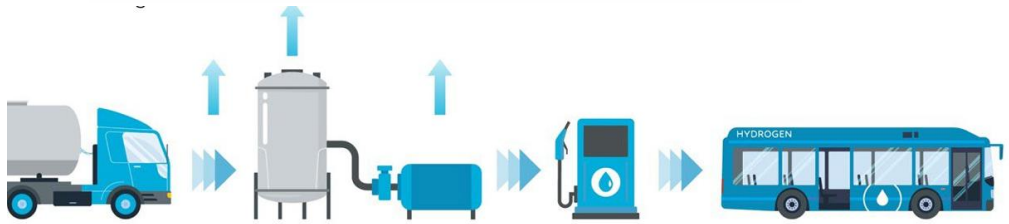
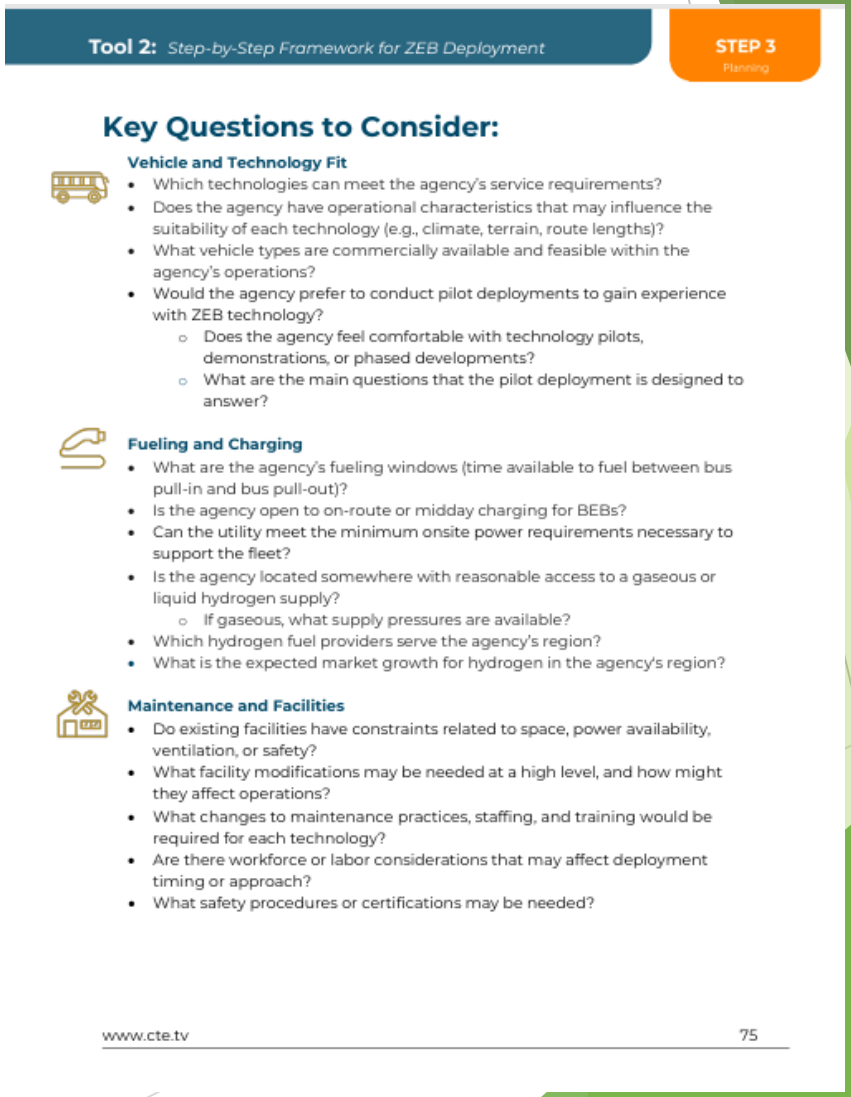


Figure 15 – Boil-Off Gas Graphic Reference

Tool 2 – Deployment Framework

- Step 1: Evaluate agency goals
- Step 2: Education & engagement
- Step 3: Transition planning
- Step 4: Procurement
- Step 5: Service
- Step 6: Deploy key performance indicators



Tool 2: *Step-by-Step Framework for ZEB Deployment*

STEP 3
Planning

Key Questions to Consider:

Vehicle and Technology Fit

- Which technologies can meet the agency's service requirements?
- Does the agency have operational characteristics that may influence the suitability of each technology (e.g., climate, terrain, route lengths)?
- What vehicle types are commercially available and feasible within the agency's operations?
- Would the agency prefer to conduct pilot deployments to gain experience with ZEB technology?
  - Does the agency feel comfortable with technology pilots, demonstrations, or phased developments?
  - What are the main questions that the pilot deployment is designed to answer?

Fueling and Charging

- What are the agency's fueling windows (time available to fuel between bus pull-in and bus pull-out)?
- Is the agency open to on-route or midday charging for BEBs?
- Can the utility meet the minimum onsite power requirements necessary to support the fleet?
- Is the agency located somewhere with reasonable access to a gaseous or liquid hydrogen supply?
  - If gaseous, what supply pressures are available?
- Which hydrogen fuel providers serve the agency's region?
- What is the expected market growth for hydrogen in the agency's region?

Maintenance and Facilities

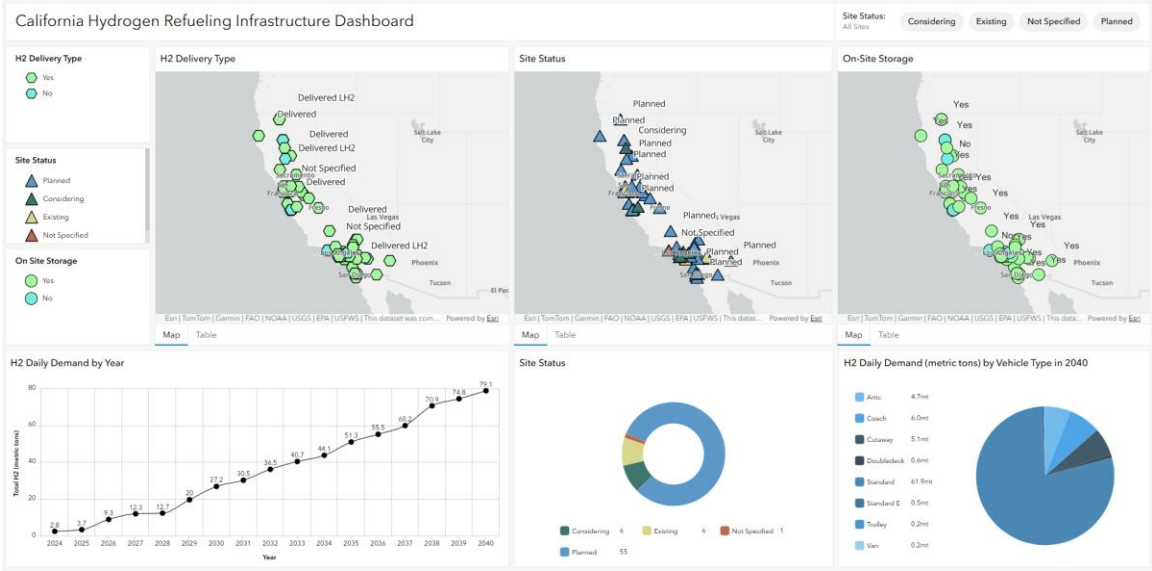
- Do existing facilities have constraints related to space, power availability, ventilation, or safety?
- What facility modifications may be needed at a high level, and how might they affect operations?
- What changes to maintenance practices, staffing, and training would be required for each technology?
- Are there workforce or labor considerations that may affect deployment timing or approach?
- What safety procedures or certifications may be needed?

Tool 3: Funding Sources

- Lists 17 funding sources
  - Eligibility
  - Program funding amounts
  - Application timeline
  - Program priorities

Tool 4: CA Hydrogen Market Forecast

- Hydrogen forecast out to 2040
- Identifies current and planned delivery, storage, and refueling locations
- Forecast and visual aid serves as a tool to help identify potential partnerships and hubs



Tool 5: Interviews and Recommendations

- 24 stakeholders were interviewed
  - Common challenges and barriers
    - Funding constraints
    - Technology limitations
    - FCEB and hydrogen availability
    - Workforce development
    - Space constraints
    - Transition timing

Tool 6: Hydrogen Refueling Configurations and Layouts

- Discusses nine different standard design and layouts for liquid and gaseous hydrogen storage

GH_2 Electrolyzer with Gaseous Storage

- Station Footprint: ≈ 200' x 70'
- Gas Compressors
- Electrolyzer (1 MW to Produce 420 kg/day) or Steam Methane Reformer
- GH_2 Buffer Storage (≈ 900 kg)
- With pre-cooling equipment
- Dispensers located adjacent to station platform or at remote location, including existing bus fueling island
- 480V 3-Phase Power
- Electrolyzer will require 12 KV Power supply

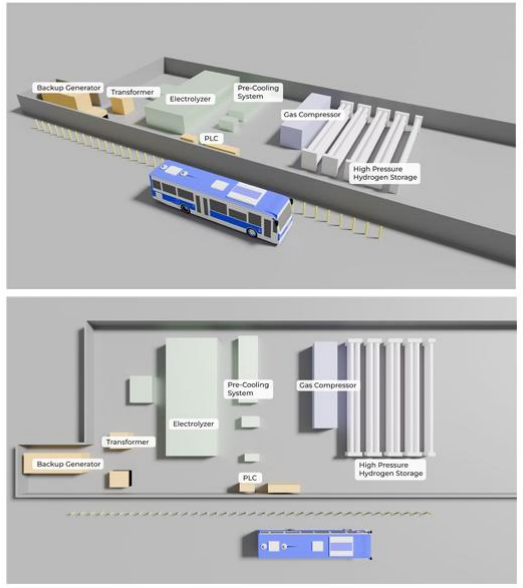


Figure 31 – GH_2 Electrolyzer with Gaseous Storage

Tool 7: Hydrogen Station Schematics

- Four generic designs

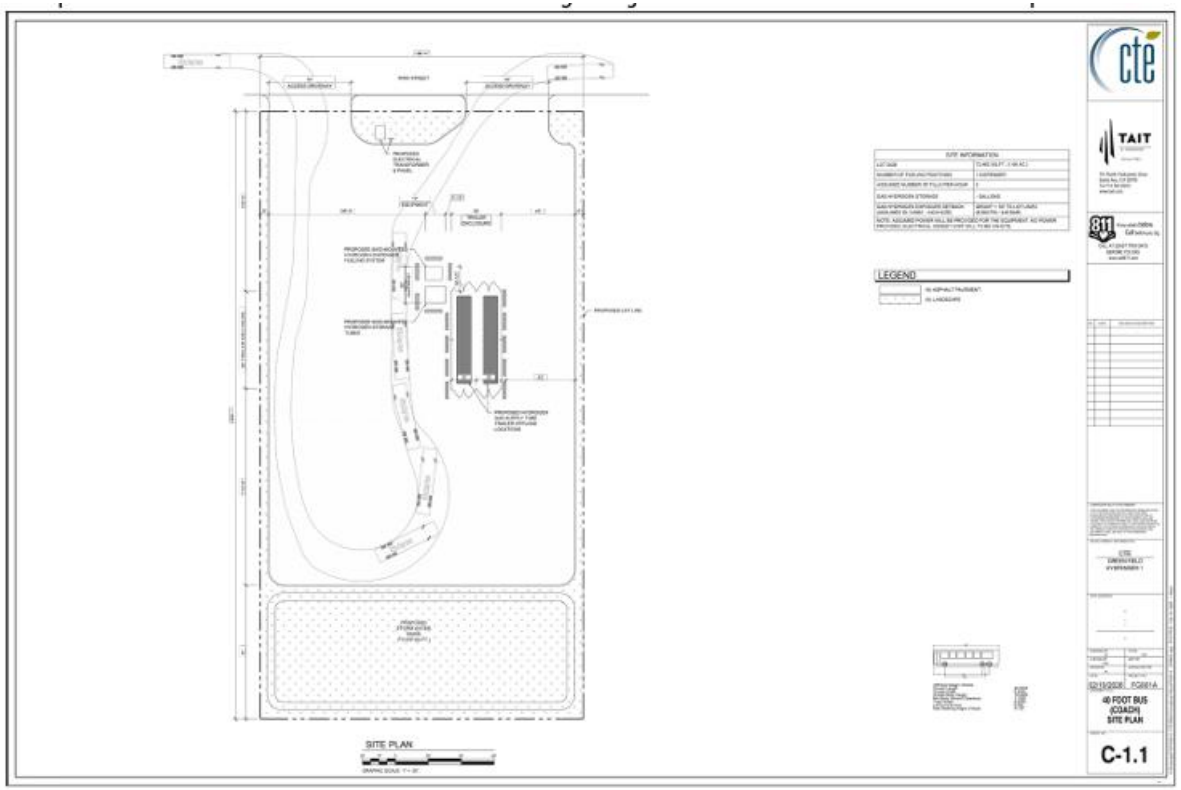


Figure 35 – GH_2 with Dispenser, Compressor, and High-Pressure Gas Storage

Resources

- Caltrans zero-emission transit resources
  - Zero Emission Vehicles (ZEV) Efforts | Caltrans
- California Energy Commission – EnergIIZE
  - Energy Infrastructure Incentives for Zero-Emission Commercial Vehicles (EnergIIZE) — California Climate Investments
- California Governor's Office of Business and Economic Development – Fleet Transition
  - Fleet Transition Services | California Governor's Office of Business and Economic Development
- California Air Resources Board – Innovative Clean Transit
  - Innovative Clean Transit | California Air Resources Board

Innovative Clean Transit Implementation Toolkit

Priscilla Freduah-Agyemang

August 25, 2026

Innovative Clean Transit Implementation Toolkit

SCAG supports transit agencies in meeting California Air Resources Board Innovative Clean Transit (ICT) regulation requirements by leveraging its strengths in regional coordination and collaboration across the transit ecosystem. SCAG provides forums and platforms that bring together transit agencies, utilities, manufacturers, and local jurisdictions to share information, discuss implementation challenges, and exchange lessons learned.

This toolkit, developed as part of SCAG's "ICT Regional Assessment Study," supports this collaborative approach. The toolkit includes a series of focused factsheets designed to translate complex data, technologies, processes, and state policies into accessible, actionable information to support transit agencies across the SCAG region.

Zero-Emission Bus Technology Selection Framework

Charging/ Refueling Station Permitting Checklist

Available Funding Opportunities to Transit Agencies

Smart Charging

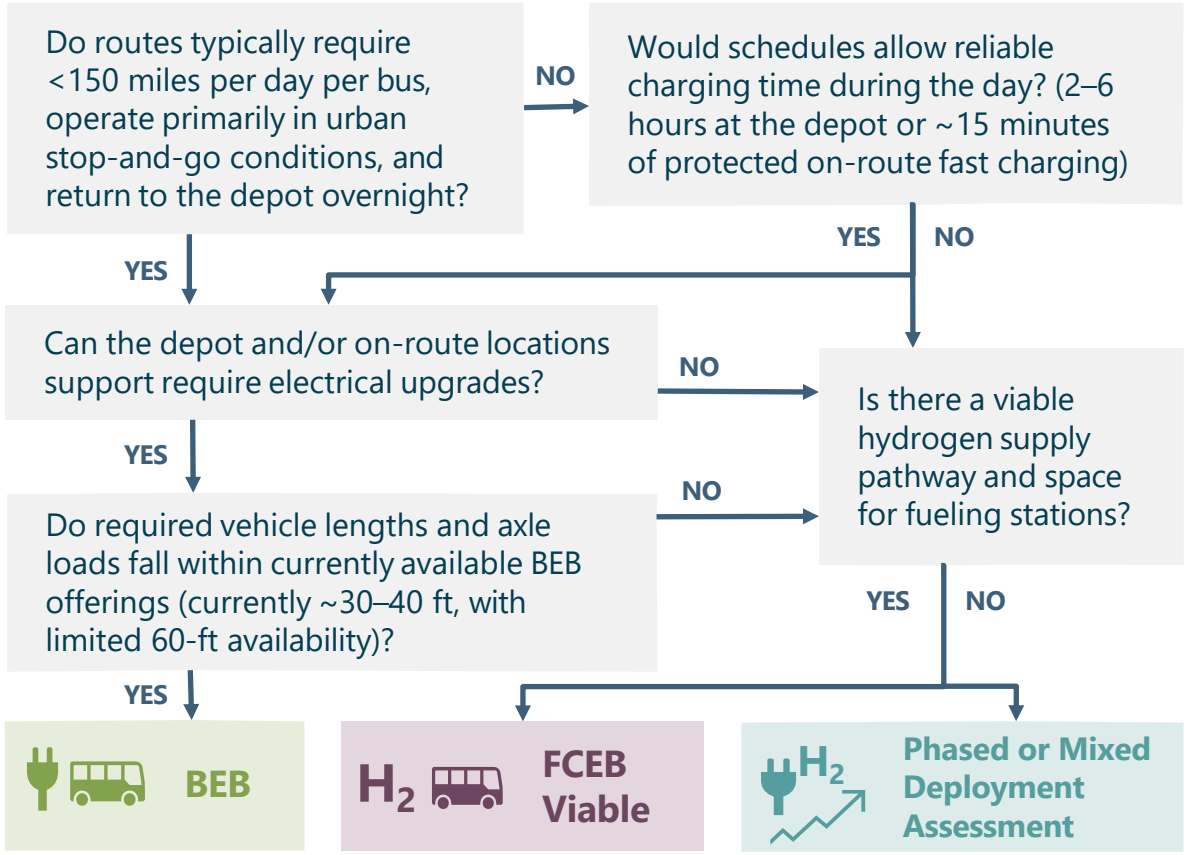
Utility Engagement Starter Kit

Workforce Development for Transit Agencies

Zero-Emission Bus Technology Selection Framework

Transitioning to zero-emission buses requires evaluating how battery electric buses (BEBs) and fuel cell electric buses (FCEBs) compare across operational fit, cost, infrastructure needs, and readiness. This framework offers foundational guidance for technology selection and will evolve as technologies advance.

Step 1: Initial Screen for Operational Feasibility



Mixed BEB and FCEB fleets may be appropriate. Start with a pilot to assess BEB/FCEB suitability.

Step 2: Refine Deployment Approach and Timing

Key Decision Questions	BEB Considerations	FCEB Considerations
Where do most costs occur?	Lower vehicle and charging costs per mile; infrastructure costs grow with charger count and power	Higher vehicle and station costs; fuel cost depends on hydrogen price; improves with scale
What funding is available within the project timeline?	Near-term; utility/ make-ready programs and voucher support	Longer-term; hydrogen hub programs and clean fuel grants
What workforce training is needed?	Builds on existing electric vehicle and electrical skills	Requires hydrogen fueling safety (pressure management, leak detection) and fuel-cell training, plus high-voltage systems
How complex is maintenance?	Fewer moving parts; batteries and thermal systems drive reliability	More complex systems but reliable operation is achievable
How fast does the fleet need to grow?	Expansion depends on depot space and electric grid capacity; growth is gradual	Expansion relies on fueling station throughput; larger fleets can be supported from shared hubs

Zero-Emission Bus Technology Selection Framework

The zero-emission bus market continuous to evolve. To help transit agencies evaluate what technologies best align with their operational needs, this framework outlines key factors to consider and identifies resources on where to seek clarification to support effective decision making.

Vehicle & Route Requirements

- Bus length, axle limits, passenger capacity requirements
- Route length and daily block miles
- Average speeds and grades

Who to ask

- Original equipment manufacturers (OEMs)
- Fleet manager/operator

Depot & Site Readiness

- Available space for recharging/ refueling equipment
- Yard layout, circulation, and safety constraints
- Ability to stage vehicles and equipment

Who to ask

- Facilities/operations staff
- Electrical engineering staff

Costs & Funding

- Vehicle and infrastructure capital costs; electricity/fuel and maintenance costs
- Available incentives and timing

Who to ask

- Finance and procurement staff
- Vendors
- Funding program administrators
- Electric utility/hydrogen supplier

Schedules & Layovers

- Where buses stop
- Typical dwell or layover times
- Whether dwell time is protected or often disrupted

Who to ask

- Fleet manager/operator

Energy Supply, Utility Constraints & Scalability

- Electric capacity and upgrade timelines
- Electricity tariffs, demand charges
- Hydrogen supply options and reliability
- Utility roadmaps, station throughput

Who to ask

- Facilities/operations staff
- Electric utility/hydrogen supplier

Maintenance & Workforce

- Existing maintenance skills and required training needs
- Parts availability and OEM support

Who to ask

- Fleet manager/operator
- OEMs
- Fleet maintenance technicians

Smart Charging

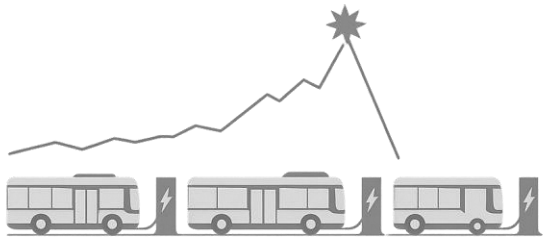
Smart charging uses software to manage power demand across vehicles and chargers, optimizing charging. This framework describes what smart charging is and highlights practical examples of how it can support operational needs, align with utility rate structures, and improve reliability while reducing costs.

What is Smart Charging

Smart charging uses software to control:

- When vehicles charge
- How fast they charge
- Which vehicles get priority

Instead of all buses charging at once, power is intelligently managed to protect the site and reduce costs.



Why it Matters

RELIABILITY

Smart charging prevents electrical overloads that can shut down charging operations.

OPERATIONAL READINESS

Ensures vehicles reach required state of charge before departure.

COST CONTROL

Reduces peak demand charges and shifts charging to lower-cost hours.

Smart Charging in Practice

Examples of transit agencies evaluating and implementing smart charging include:

Antelope Valley Transit Authority

- Evaluated smart charging using real operational data from 30 buses (expanding to 80 buses during the project).
- Simulation analysis estimated up to a 40% reduction in annual utility costs or about $11,460 per bus per year.

Santa Clara Valley Transportation Authority

- Deployed 5 buses and 5 chargers with an integrated smart charging energy management platform.
- Reduced peak demand by 31-65% and nearly eliminated charging during utility peak periods.

References: Smart Charging for Fleets: Smart Charging for Fleets: A Practical Guide, BetterFleet; California E-Bus to Grid Integration Project (CEC-500-2021-014), CEC; VTA Advanced Transit Bus Vehicle-Grid-Integration Project (CEC-500-2022-012), CEC

Smart Charging

Smart charging coordinates site power limits, vehicle priorities, and charging schedules. This framework presents common strategies to help transit agencies balance operational needs, maintain service reliability, and manage utility and infrastructure constraints.

How Smart Charging Works

1. How much power can the site safely use?

Every site has limits:

- Grid connection limits
- Electrical panel and feeder limits
- Other building loads (HVAC, bus wash, offices)

Smart charging ensures total power draw never exceeds what the infrastructure can handle.

2. Which buses should charge first?

The system can then decide which bus receives power and how much power based on:

- Departure time
- State of charge
- Route priority
- Emergency needs

3. When should charging happen?

Smart charging can:

- Shift charging to off-peak hours (time-of-use optimization) and limit peak electricity demand
- Align charging with bus departure times
- Respond to utility demand response events when configured

Common Charging Strategies

Strategy	How It Works	Best When
Even Share (Load Balancing)	Power is distributed evenly across all connected buses.	Depot schedules are predictable and dwell times are long.
First-In/First-Out (FIFO)	Buses charge in the order they plug in.	Departure times are consistent and similar across routes.
Priority-Based Charging	Charging priority is assigned based on operational rules (departure time, battery level, route importance).	Some routes or departures are more critical than others.
Schedule-Driven Charging	Charging aligns with dispatch schedules or duty cycles.	Agencies use structured scheduling systems (e.g., fixed pull-out times).
Peak Demand Management	Charging power is adjusted to avoid demand spikes.	Utility demand charges significantly impact costs.

Examples of Vendors Commonly Used in Transit Smart Charging Deployments

Charging & Energy Management
ChargePoint • BetterFleet • Olivine • Amply

Vehicle-Level Charging Controls
Proterra • BYD

Operations & Scheduling Integration
Clever Devices • Trapeze

References: Smart Charging for Fleets: A Practical Guide, BetterFleet; California E-Bus to Grid Integration Project (CEC-500-2021-014), CEC; VTA Advanced Transit Bus Vehicle-Grid-Integration Project (CEC-500-2022-012), CEC

Charging/Refueling Station Permitting Checklist

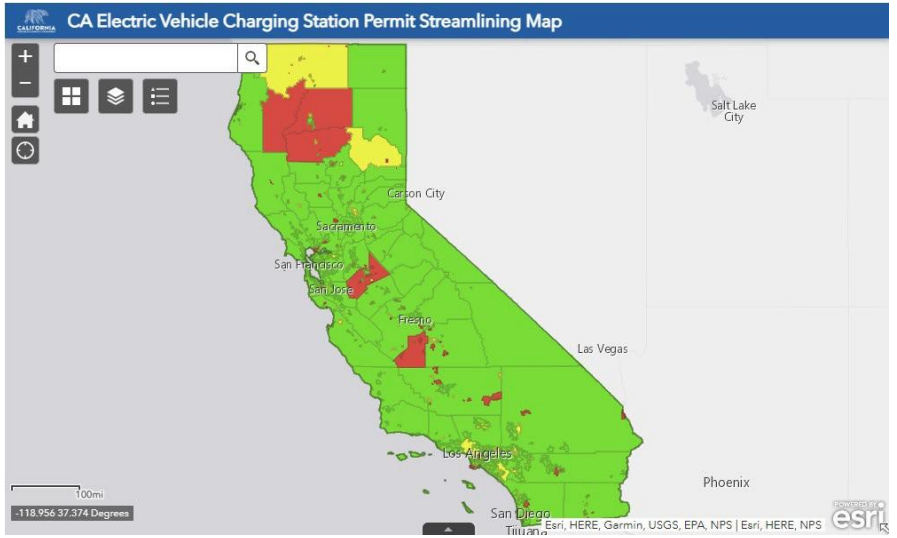
This checklist provides transit agencies with steps to identify the local charging infrastructure permitting process, highlighting critical steps and key information needed to streamline electric vehicle charging station permitting process and support timely project implementation.

California's permit streamlining law, AB 1236, requires every city, county, or city and county to adopt an ordinance that creates an expedited and streamlined permitting process for electric vehicle charging station (EVCS) by September 2016 or 2017, depending on their population size.

Although EVCS permitting practices can still vary among local jurisdictions, AB 1236 mandates that each city or county has an EVCS permitting checklist online, covering both residential and commercial projects.

Where to look? The EVCS permit streamlining status, as well as ordinance and checklist if available, can be found on the EVCS Streamlining Map managed by California GO-Biz team.

Additionally, the Electric Vehicle Charging Station Permitting Guidebook (Second Edition) by GO-Biz team was presented as a statewide resource designed to help local jurisdictions and stakeholders to streamline, standardize, and accelerate the EVCS permitting process, including information on what to include in your permitting application.

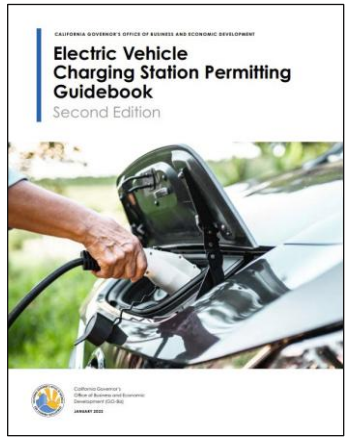


What to include? Each city or county has its own EVCS permitting checklist that can be found through direct contact or EVCS streamlining Map. There are several items commonly required across jurisdictions:

- Project details (e.g., location and number of EVSE)
- Application details (e.g., applicant name, contractor name, owner name)
- Site details (e.g., charging level, voltage, mounting of EVSE)
- Electrical plan (e.g., system voltage, rating of panel supplying EVSE and circuit)

What to avoid?

- Assuming all jurisdictions require the same document
- Waiting too long to involve utilities for information gathering, such as details of project and site, and electrical plan.

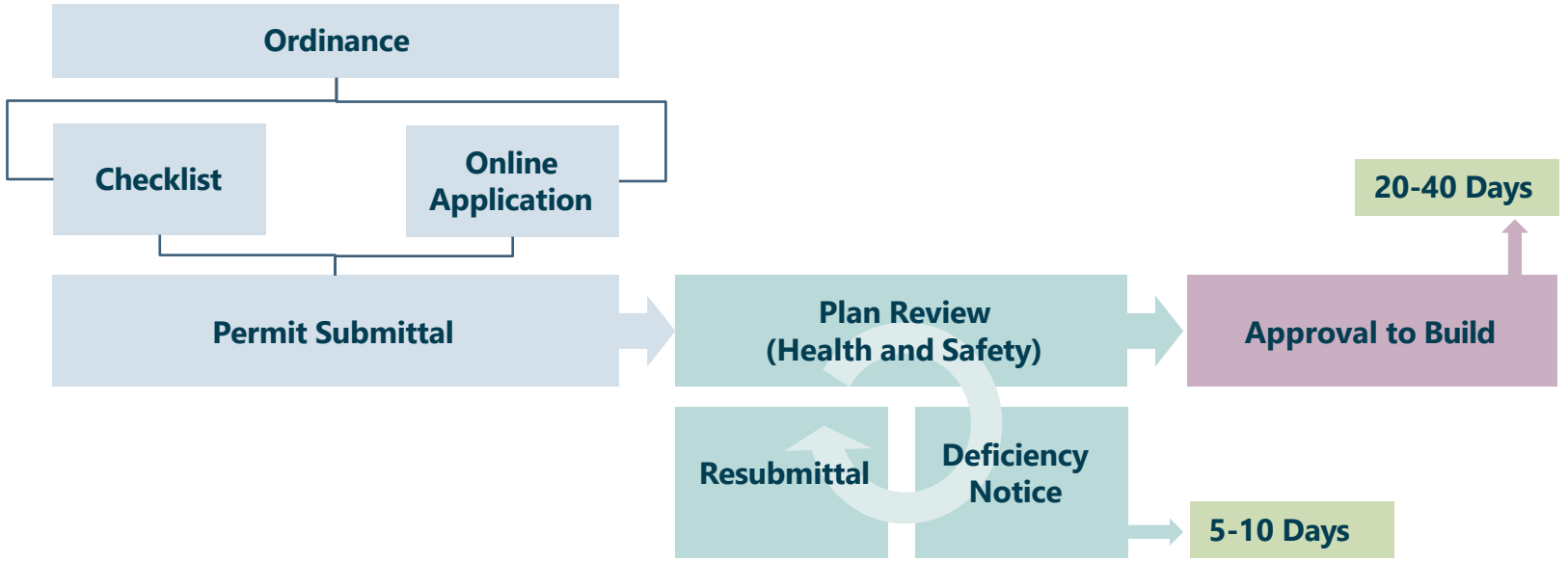


Charging/Refueling Station Permitting Checklist

Under California's AB 970, EVCS permits are subject to binding, expedited review timelines to ensure consistency and timeliness statewide. This timeline provides transit agencies with a clear overview of the permitting process from application submittal through plan review and approval to build.

Charging/Refueling Station Permitting Timeline

In California, AB 970 (effective January 2022 or 2023, depending on the jurisdiction's population size) establishes binding timelines to the expedited, streamlined review of EVCS permit applications. The law sets clear deadlines for application completeness and approval decisions to ensure a consistent and timely permitting process statewide. The EVCS permit application process and review timeline established under AB 970 is depicted below.



Source: EV Charging Station Permitting Guidebook

Charging/Refueling Station Permitting Checklist

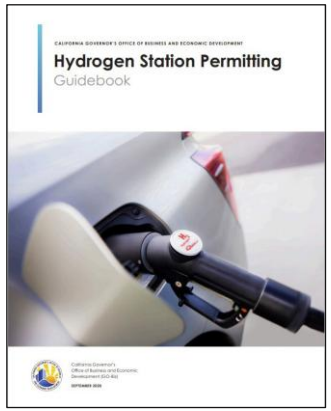
Developed by the GO-Biz team, the *Hydrogen Station Permitting Guidebook* outlines information on station development, permitting checklist, and permit review timeline. The list below also identifies the key information required for the hydrogen fueling station permitting process.

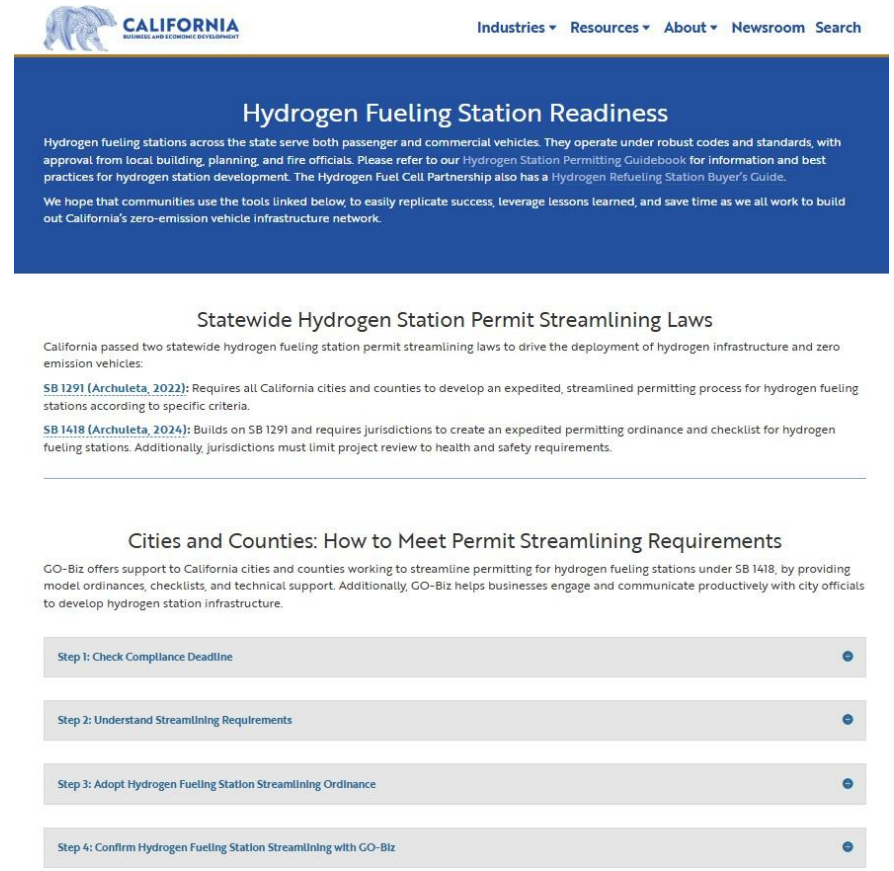
SB 1418 requires all cities and counties in California to adopt nondiscretionary permitting procedures for hydrogen infrastructure, focusing strictly on health and safety requirements, by September 2025 or 2028, depending on their population sizes. SB 1418 was designed to reduce permitting delays, ensure consistency across jurisdictions, and support the growing demand for hydrogen fuel particularly for medium- and heavy-duty vehicles as the state works toward its ZEV goals.

Where to look? In the Hydrogen Station Permitting Guidebook developed by the GO-Biz team, with information on station development, hydrogen and FCEV ecosystem, and how to permit temporary fuelers. The guidebook also includes a Checklist Template.

What to include? Here are items required per the checklist template:

- Project details (e.g., project address, fueling type, location and number of dispensers)
- Contact information (e.g., applicant name, owner name, contract name)
- Site/Station plans and equipment (e.g., existing or proposed site plan, elevation/perspective drawings)
- Permit package plans and drawings (e.g., civil/architectural plan, fire plan, building plan, mechanical plan, electrical plan, Title 24 report/forms)





Charging/Refueling Station Permitting Checklist

California SB 1418 establishes a streamlined hydrogen permitting framework to reduce delays, improve clarity and consistency, and support the accelerated ZEV deployment. The timeline below summarizes the process from planning review through construction and commissioning.

Understanding the Timeline

The hydrogen station development process diagram outlines processes involved and includes a range of estimated timelines. Overall, development timeframes may continue to reduce as local authorities become increasingly familiar with hydrogen station permitting, more entities enter the supply chain, and economies of scale are achieved.

Pre-Application Outreach (ASAP)

Planning Review (1 day – 6 months)	Actual Average ~10.5 months	Conditional use permit or other discretionary approval	
		Planning application submittal	Public Meeting
		Design and architecture review	Public Meeting
		Planning approval	
Building Review (1 day – 6 months)		Detailed package submission	
		Review detailed package	Comment Package Pick-up
		Respond to comments	Re-submittal
		Review	
		Approval to build	
Construction (3 – 9 months)	Actual Average ~9 months	Encroachment permit	
		Construction	
		Milestone inspection (as required by State Building Codes)	
		Notice of completion	
Commissioning (1 – 3 months)	Actual Average ~2.5 months	Station developer commissioning	
		Final inspection/approval	Operational
		Third-party validation	Open

Design Process

Source: Hydrogen Station Permitting Guidebook

Charging/Refueling Station Permitting Checklist

Below is an example of an EVCS permitting checklist from the city of Los Angeles, illustrating the typical level and type of information required. Because requirements can vary by jurisdiction, transit agencies should consult their local EVCS permitting checklist before assembling materials.

Contact your city or county building department or permit counter and ask for "EVCS permitting" or reach out to the Go-Biz team.

An example from the city of Los Angeles

LADBS CITY OF LOS ANGELES DEPARTMENT OF BUILDING & SAFETY

PERMITTING CHECKLIST FOR ELECTRIC VEHICLE CHARGING STATION APPLICATIONS

Electrical installation for electric vehicle charging in single family dwellings and commercial buildings with up to **400 amps of service** (Including any needed charging equipment, service upgrade, receptacle and associated wiring), do not require plan check, and are readily issued as Express Permits in person or e-permits when done on-line.

EVCS shall comply with applicable sections of the California Electric Code (CEC). EVCS shall be listed by UL or another nationally recognized testing laboratory.

For all EVCS, other than those mentioned above, submit the following documents per the checklist below. Please complete the following information related to permitting and installation of electric vehicle chargers/ electric vehicle service equipment (EVCS / EVSE) as a supplement to the application for an electrical and/or building permit. This checklist contains the technical aspects of EVSE installations and is intended to help expedite permitting and use for electric vehicle charging.

Building Plan Check Submittal Documents Required:

Completed **Permit Application for Building Plan Check**, if submitting in person or apply online through ePlanLA (eplanla.lacity.org). **Plan Requirements – See below. Provide the following documents in your in person or electronic plan submittal.**

A.SITE/FLOOR PLAN

A site plan and a floor plan (if located inside a building) must be provided showing the following information:

- Existing building(s) and structure(s)
- Existing parking spaces and proposed location of EVCS parking space(s)
- Dimensioned layout of existing accessible parking spaces, including access aisles
- Location and layout of proposed accessible EV charging station
- Elevation of the charging unit sufficient to demonstrate compliance with the reach ranges for side or front
- approach to the unit by persons with disabilities as required in the Los Angeles Building Code

B.ARCHITECTURAL PLANS

Architectural plans shall show the following information:

- EVCS installed are in compliance with LABC Section 11B-228.3 for the minimum number of required accessible EVCS spaces.
- EVCS installed are in compliance with LABC 11B-812 for dimensions, accessible route, access aisles, reach
- range, identification signage, etc.
- Where rated assemblies are penetrated (through or membrane), an appropriate and listed assembly penetration shall be provided at the time of review and must be made available to the inspector at the time of installation. NOTE: It is not permissible to route conductors or raceways through required stair shafts or exit passageways.

C.STRUCTURAL PLANS

Structural plans and calculations must be signed and stamped by a California registered Civil or Structural Engineer who is responsible for the design and installation of the system. Architectural and Structural plans shall show the following information:

- Location and details for anchorage of EV equipment
- Seismic anchorage calculations for non-structural components per ASCE 7 Chapter 13

LADBS CITY OF LOS ANGELES DEPARTMENT OF BUILDING & SAFETY

PERMITTING CHECKLIST FOR ELECTRIC VEHICLE CHARGING STATION APPLICATIONS

Electrical Plan Check Submittal Documents Required

Completed **Permit Application for Electrical Plan Check**, if submitting in person or apply online through **ePlanLA** (eplanla.lacity.org). **Plan Requirements – See below. Provide the following documents in your in-person or electronic plan submittal.**

A. SITE/FLOOR PLAN

A site plan and a floor plan (if located inside a building) must be provided showing the following information:

- Existing building(s) and structure(s)
- Existing parking spaces and proposed location of EVCS parking space(s)
- Dimensioned layout of existing accessible parking spaces, including access aisles
- Location and layout of proposed accessible EV charging station
- Elevation of the charging unit sufficient to demonstrate compliance with the reach ranges for side or front approach to the unit by persons with disabilities as required in the Los Angeles Building Code
- All disconnects sizes, conduits and conductors routing/sizes, and location of panel/sub-panels connected to the EVCS system and the meter panel.

B. ELECTRICAL PLANS

Electrical plans and calculations must be signed and stamped by a California registered Electrical Engineer who is responsible for the design and installation of the system. The electrical plans shall include the following information:

- Single-line diagram showing the electrical single line drawing showing themain service, sub panels and disconnecting means (as applicable) and theproposed EV charging unit(s). Include/show the size of all overcurrentprotection devices (in amperes) for the main service, sub panels, disconnectsand EV charger circuit supplies. Show conduit sizes and types, and conductorsizes and types.
- Electrical load calculations shall include existing and proposed load(s) thatdemonstrate the that the electrical service and/or distribution equipment isnot overloaded. Note: Unless all electrical equipment and overcurrentprotective devices are listed for use at 100% of rated load, the calculatedload on this equipment shall not exceed 80% of the nameplate rating of theequipment or the over-current protection device (OCPD).
- Electrical panel schedule
- Manufacturers' data sheets for the specified and listed charging equipment.If proposed to be located outdoors, the listing for outdoor use shall beincluded.
- Amperage supplied to charge the electric vehicle
- EVCS has an appropriate NEMA rated enclosure (CEC 110.28) and thewiring method complies with CEC 625.9(A) through (F).
- Based on proposed EVCS location, determine if cord length will reach avehicle's charging inlet without excessive slack and does not exceed 25' inlength (CEC 625.17).
- All enclosures shall have a mounting height between 36" and 48". Connectorheight shall be between 36" and 48" from the ground (CEC 625.29) unlessotherwise indicated by the manufacturer.
- Ensure sufficient space exists around electrical equipment for safe operationand maintenance (CEC 110.26); The minimum required space is 30" wide, 3'deep and 6'6" high and will be higher depending upon system voltage.
- EVCS shall be installed per the requirements of Chapter 3 of the CEC.Conductors shall be sized to support 125% of the rated equipment load(CEC 625.21) unless permitted otherwise.

Charging/Refueling Station Permitting Checklist

Developed by the Go-Biz team, this hydrogen refueling station permitting checklist template offers a useful reference, outlining the typical level and type of information required, helping transit agencies and developers navigate permitting requirements more effectively.

Contact your city or county building department or permit counter and ask for "hydrogen station permitting" or reach out to the Go-Biz team.

(Replace with City or County Logo)

City/County of _____

CHECKLIST FOR PERMITTING HYDROGEN FUELING STATIONS (SB 1418)

Please complete the following information related to permitting and installation of Hydrogen Fueling Station as a supplement to the application for a building permit. This checklist contains the technical aspects of hydrogen fueling station installations and is intended to help expedite permitting and use for hydrogen fueling stations.

Upon completion of this checklist, a permit shall be issued to the applicant. However, if it is determined that the installation might have a specific adverse impact on public health or safety, additional verification will be required before a permit can be issued.

Section 1: Project Details	
Project Address:	
☐ Commercial/Industrial Zone (No Surrounding Residential Units)	
☐ Existing Retail Fueling Station/Travel Center	
Location and Number of Hydrogen Dispensers/Fueling Positions to be Installed:	
Type of Fueling Available (i.e., Light-Duty Vehicle/Heavy-Duty Vehicle, Retail/Commercial, H35/H70, etc.):	
Storage Type and Volume (i.e gaseous or liquid; storage capacity in kilograms or metric tonnes).	
Description of Work	

Section 2: Contact Information	
Applicant Name:	
Applicant Phone & Email:	
Contractor Name (if applicable):	License Number & Type (if applicable):
Contractor Phone & Email (if applicable):	
Owner Name:	
Owner Phone & Email:	

Section 3: Site/Station Plans & Equipment
Existing Site Plan: Show lot dimension of the property and all existing conditions/buildings/structures.
Proposed Site Plan: Show all proposed conditions/structures/equipment (including setback measurements and equipment dimensions).

Page 1 of 2

(Replace with City or County Logo)

City/County of _____

CHECKLIST FOR PERMITTING HYDROGEN FUELING STATIONS (SB 1418)

Elevation/Perspective Drawings: Show all equipment and structures (drawn to scale, including all proposed refueling canopies).

Section 4: Permit Package Plans & Drawings
Civil/Architectural Plan Set: (Title Page, Notes, Topo/Demo Plans, Proposed Site Plan, Precise Grading and Drainage Plans, Erosion Control Plans and Details, Construction and Framing Details, Elevations, and Landscaping and Irrigation Plans.
Fire Plan Set: (Title page, Notes, Fire Plan Equipment, H2 Storage Equipment and Details, Fire Plan Setback Details, Hazardous Area Class Drawings, NFPA-2 Tables, Safety and Fire Signage Plans, Safety and Fire Equipment Location Plans (ESD, fire extinguisher, alarm light, flame detector, and gas sensor locations).
Building Plan Set: (Title Page, Notes, Structural Specifications and Project Data, Site Plan Layout, Foundation Plan, Foundation Details, Bollard Details, Framing Plans and Details).
Mechanical Plan Set: (Codes and Regulations Piping Plan, Pipe Schedule and Material, Piping Details).
Electrical Plan Set: (Title Page, Notes, IEEE, IEC, and Applicable NFPA Codes, Electrical Specifications, Electrical Single Line Diagram, Electrical Load Schedule, Electrical Telecom Utility Site Plan, Electrical Power Site Plan, Grounding Site Plan and Details, Electrical Installation Details, Electrical Line-Voltage Conduit Schematic, Electrical Low Voltage Site Plan, Electrical Low Voltage Conduit Schematic, Low Voltage Wiring Schedules).
Title 24 Report/Forms: (Title 24 Report/Forms, Calculations)

I hereby acknowledge that the information presented is a true and correct representation of existing conditions at the job site and that any causes for concern as to life-safety verifications may require further substantiation of information.

Signature of Permit Applicant: _____ **Date:** _____

Page 2 of 2

Utility Engagement Starter Kit

Early and ongoing utility engagement helps transit agencies understand grid constraints, upgrade timelines, rate impacts, and available utility programs before key vehicle or infrastructure decisions are finalized. This starter kit outlines when and how to engage utilities and what data to request.

1. Identify your utility contacts

- Who provides electric service to the depot(s)?
- Does the utility have a dedicated transportation electrification or fleet team?

2. Prepare and share a high-level planning concept package

- Scope of work, including planned bus electrification activities, charging infrastructure installation, and any expected utility service upgrades.
- Specific site(s) under consideration.
- Target project timeline, including key milestones for planning, design, procurement, construction, and energization.
- Preliminary load demand estimate, informed by fleet size, anticipated charging needs, power levels, and operating schedules.
- Any anticipated funding sources and timelines.
- Key internal contacts (facilities, fleet, planning, finance).

3. Request an initial utility assessment

- Request preliminary service capacity and upgrade needs using the Utility Data Request Checklist on this page.

4. Align on timelines early and maintain ongoing coordination

- Maintain regular coordination as fleet phasing, upgrade schedules, and funding timelines evolve.

Utility Data Request Checklist

- ☐ Existing electrical service size at the depot
- ☐ Estimated spare capacity currently available
- ☐ Known constraints on the feeder or substation serving the site
- ☐ Preliminary load demand and load capacity to inform the likelihood that service upgrades will be required
- ☐ Typical timelines for utility upgrades
- ☐ Available incentive programs
- ☐ Applicable electric rate options for fleet charging
- ☐ Required steps to initiate formal load studies or interconnection

Funding Opportunities for Transit Agencies

This framework maps out currently available funding opportunities for transit agencies in the SCAG region. Users should refer to each funding program's website for recent information, including application opening dates, deadlines, and program requirements.

Federal Funding Sources

FTA
- Low or No Emission Program
- Buses and Bus Facilities Program
- Public Transportation Innovation–§5312
- Urbanized Area Formula Grants (§5307)

U.S. DOT
- Better Utilizing Investments to Leverage Development Grant Program

FHWA
- Congestion Mitigation & Air Quality
- Surface Transportation Block Grant

Stacking Rules:
For Federal Transit Administration (FTA) funds, they are generally stackable with non-federal funds and certain non-FTA or non-U.S. Department of Transportation (U.S. DOT) federal funds unless otherwise authorized. Note that funds cannot be stacked to exceed the maximum federal share. U.S. DOT funds are stackable with non-federal funds, and Federal Highway Administration (FHWA) funds are stackable with non-federal funds or other federal funds from FHWA, FTA, or discretionary grants.

State Funding Sources

CARB
- Volkswagen Environmental Mitigation Trust – Transit Bus Program
- Low Carbon Fuel Standard
- Hybrid and Zero-Emission Truck and Bus Voucher Incentive Project
- Carl Moyer Air Quality Standards Attainment Program

CEC
- EnergIIZE Commercial Vehicles Project

CalSTA
- SB 125 Transit Program
- Zero-Emission Transit Capital Program
- Transit and Intercity Rail Capital Program

Caltrans
- Low Carbon Transit Operations Program

Regional/Local/Utility Funding Sources

SCAQMD: Carl Moyer Program

LA Metro: Zero-Emission Transit Capital Program

SCE: CHARGE Ready Transport

LADWP: Fleet Electrification Programs

Funding Opportunities for Transit Agencies

Preparing for the applicable package for identified funding opportunities can be challenging. This section outlines some of the common pitfalls to avoid, such as time management, technical concerns, and overall project management.

1. Timing

- Poor project readiness or unrealistic schedule.
- Missing deadlines or submittal requirements.

2. Preparation

- Incomplete or weak local match documentation (for federal and state funding opportunities), such as missing vendor quotes.
- Underestimating project readiness requirements (e.g., California Environmental Quality Act clearance, engineering feasibility, site control, and utility coordination, etc.)
- Incompatible procurement requirements (e.g., Buy America rules for some programs).

3. Technical

- Weak cost estimates and budget structure.
- Incomplete benefit-cost analysis or errors in benefit/impact modeling and quantification.

4. Management

- Weak community engagement (e.g., lack of community co-creation demonstration, letters of support, and documented outreach).
- Misalignment of project timelines and lack of coordination between vehicle and infrastructure planning.
- Missing considerations or dedicated resources for operations and maintenance, administrative and staffing, and compliance activities.
- Lack of proactive measures to ensure consistent and accurate reporting, such as the lack of documentation processes and internal quality assurance and control, especially for programs like ZETCP, STEP, and CMIS that require multi-year reporting obligations.

Funding Opportunities for Transit Agencies

The list below summarizes key **federal-level** funding opportunities available to transit agencies to support investments related to the transition to zero-emission transit buses and associated infrastructure development. Each program includes a link to provide more detailed and updated information.

BUILD Grant Program

- Recurring and competitive
- Funds major capital projects with regional significance, including ZEB maintenance and charging facilities.

Buses and Bus Facilities Program

- Funds remain available for obligation for four fiscal years. This includes the fiscal year in which the amount is made available or appropriated plus three additional years.
- Recurring and competitive funds for bus replacement or procurement, and facility upgrades, including ZEB infrastructure.
- Eligible recipients include fixed-route bus operators, states or local governmental entities that operate fixed route bus service, and Native tribes.

Congestion Mitigation & Air Quality

- Funds projects that reduce emissions and improve air quality, including ZEB purchases, charging stations, and transit improvements.

Low or No Emission Program

- Recurring and competitive funds for zero-emission and low-emission bus purchases, charging and fueling infrastructure, facility construction or leasing.
- Eligible applicants include direct or designated recipients of FTA grants; states; local governmental authorities; and Native Tribes. States and other eligible applicants also may submit consolidated proposals for projects in urbanized areas.
- Funds remain available for obligation for four fiscal years. This includes the fiscal year in which the amount is made available or appropriated plus three additional years.

Public Transportation Innovation (§5312)

- Funds to advance innovative public transportation research and development.
- Eligible recipients include federal labs, state and local governmental entities, providers of public transportation, etc.

Surface Transportation Block Grant

- Funds projects about highways, transit capital, and public transportation assets including ZEB facilities.

Urbanized Area Formula Grants (§5307)

- Funding are available the year appropriated plus five years.
- Funds capital, planning, and operating expenses; eligible for ZEB procurement and early transition planning.
- Funding for urbanized areas with a population of 200,000 or more is made available to designated recipients that are public bodies with the legal authority to receive and dispense federal funds.
- Funding for urbanized areas with a population of between 50,000 and 199,999 is made available to a state's or territory's governor or governor's designee.

Funding Opportunities for Transit Agencies

The list below summarizes key **state-level** funding opportunities available to transit agencies to support investments related to the transition to zero-emission transit buses and associated infrastructure development. Each program includes a link to provide more detailed and updated information.

Carl Moyer Air Quality Standards Attainment Program

- Ongoing, market-based
- Funds cleaner-than-required engines and emissions-reducing projects through local air districts; includes ZEB and infrastructure eligibility.

EnergIIZE Commercial Vehicles Project

- Recurring, first-come first-serve with dedicated set-asides for transit fleets.
- Funded by the California Energy Commission's Clean Transportation Program and implemented by CALSTART, EnergIIZE funds provide up to $5 million for charging or hydrogen fueling infrastructure.

Hybrid and Zero-Emission Truck and Bus Voucher Incentive Project (HVIP)

- Ongoing and first-come first-serve.
- Point-of-sale ZEB bus vouchers, eligible for standard and enhanced (priority population) incentives.

Low Carbon Fuel Standard (LCFS)

- **Fuel-Based LCFS Credits:** Eligible electricity and hydrogen used as transportation fuels can generate LCFS credits when their carbon intensity is below the applicable annual benchmark.
- **ZEV Infrastructure Credits**: LCFS also provides credits for eligible hydrogen refueling and DC fast-charging infrastructure based on unused fueling capacity.

Low Carbon Transit Operations Program

- Recurring, formula-based annual GGRF funded program
- Fund projects including ZEB operations, bus purchases, ZEB charging infrastructure, and service expansions.
- For agencies with service areas that include disadvantaged communities, at least 50 percent of the total money received shall be expended on projects that will benefit disadvantaged communities

SB 125 Transit Program

- Provides $1.1 billion formula allocations to support zero-emission transit and infrastructure projects statewide.

Transit and Intercity Rail Capital Program (TIRCP)

- Recurring and competitive funds for large-scale ZEB procurements, major charging and fueling facilities.
- The 2026 TIRCP grant cycle will program projects starting with the fiscal year 2026-27 and ending with the fiscal year 2030-2031.

Volkswagen Environmental Mitigation Trust – Transit Bus Program

- Provides up to $400,000 per vehicle to replace older gasoline, diesel, CNG, or propane transit buses with new ZEBs.

Zero-Emission Transit Capital Program (ZETCP)

- Authorize regional transportation planning agencies (RTPAs) to use funds for zero-emission transit equipment, including, but not limited to, zero-emission vehicles and refueling infrastructure.
- Funds may also be used to fund transit operating expenditures that prevent service reduction or elimination in order to maintain or increase ridership.
- Transit Agencies should work directly with their RTPA to develop an Allocation Package that will be submitted to the California State Transportation Agency.

Funding Opportunities for Transit Agencies

The list below summarizes key **regional-level** and **local** funding opportunities available to transit agencies to support investments related to the transition to zero-emission transit buses and associated infrastructure development. Each program includes a link to provide more information.

LADWP's Fleet Electrification Programs (Commercial EV Charger Rebate Program)
- Ongoing, non-competitive funds for make-ready work and electric vehicle supply equipment rebates.
- Charger rebates to charge medium- and heavy-duty EVs of up to $125,000 per charger depending on power output.
- Governor or governor's designee.

Metro's Zero Emission Transit Capital Program (ZETCP)
- Metro received and administered CalSTA's ZETCP funds for L.A. County, including $320.6 million over four years in state ZETCP funds.

SCE's CHARGE Ready Transport
- Ongoing, non-competitive funds for utility-side make-ready, including design, trenching, transformers.
- Charge Ready Transport applications will be accepted through June 30, 2026, and program participation agreements must be signed by both parties by December 31, 2026, 11:59 PM.

SCAQMD's Carl Moyer Program (CMP)
- Recurring competitive funds for zero-emission bus purchases and infrastructure.
- To be eligible for CMP funds, project must meet the criteria and must meet the cost-effective limits per guidelines.
- Once awarded, projects must be fully in operation within 18 months of contract execution and are required to submit annual reports as specified in the contract.

Workforce Development for Transit Agencies

Zero-emission transit fleet deployment requires role-specific training across operations, maintenance, infrastructure, and safety functions. This framework summarizes the core training focus areas and key competencies needed for each workforce role, helping agencies build workforce capacity.

Role	Training Focus	Required Training
Bus Operators 	Maximizing vehicle range and ensuring safe everyday operations.	▫ Regenerative braking proficiency ▫ State of charge (SOC) and range management ▫ Indicator awareness (high-voltage isolation faults, thermal management alerts) ▫ Safe fueling or charging ▫ Climate control management
Maintenance Technicians 	Shifting from mechanical repair to high-voltage (HV) system diagnostics.	▫ HV isolation, Lockout/Tagout, Arc flash personal protective equipment, zero energy verification ▫ Technical systems (traction motors, battery management systems, fuel-cell stacks) ▫ Digital diagnostics using manufacturer software and telematics
Facility & Charging/Fueling Technicians 	Keeping the power flowing and the fueling stations safe.	▫ Electric vehicle supply equipment maintenance, troubleshoot DC fast chargers ▫ Energy systems (breaker coordination, load management platforms, microgrid) ▫ Hydrogen infrastructure (compressor maintenance, leak detection, NFPA 2 safety)
Dispatch & Operations Control 	Managing an energy-constrained fleet instead of just a schedule.	▫ Energy-constrained dispatching based on real-time SOC and weather conditions ▫ Charger queuing logic ▫ Crisis management for low-energy events mid-route or power outage incidents
Emergency Response Personnel 	Containing incidents involving high-voltage or chemical hazards.	▫ Thermal runaway and safe evacuation ▫ Hydrogen hazards (invisible flames and rapid gas dispersion) ▫ Safe stabilization (high voltage cut points to de-energize a vehicle during an accident)

Workforce Development for Transit Agencies

Transit agencies can use this *Training Partner Request Checklist* when interviewing community colleges, original equipment manufacturers (OEMs), or training centers to evaluate training quality, ensure consistency in delivery, and support the development of a skilled and well-prepared workforce.

Training Partner Request Checklist

- ☐ **Industry Track Record:** How many transit agencies have you successfully trained in ZEBs? Can you provide references from agencies of a similar size to ours?
- ☐ **Standard Alignment:** Does your curriculum align with APTA's ZEB Maintenance Training Recommended Practices (Levels 100, 200, and 300)?
- ☐ **Hands-On Training:** Does the curriculum include hands-on practice (e.g., using a training charger or mock HV isolation points)?
- ☐ **Fueling/Defueling Protocols:** Does the training include SAE J2601 fueling protocols and steps for safely defueling a vehicle for indoor storage or major repair?
- ☐ **Load Management Software:** Will facility staff learn how to use the charge management software to avoid peak demand charges?
- ☐ **Safety Certifications:** Does the program offer NFPA 70E, equivalent high-voltage safety certification, or hydrogen safety certifications in compliance with NFPA 2? How do you assess qualified person status for our technicians?
- ☐ **OEM Alignment:** Is the training specific to the vehicle models in our fleet?
- ☐ **Data Literacy:** Does the course cover how to interpret fault codes and readings related to fuel cell stack and battery management system?
- ☐ **Post Training Support:** Do you provide a help desk or follow-up site visit to troubleshooting issues that arise once the buses are in service?

Workforce Development for Transit Agencies

Transit agencies that invest in their people before their fleet see lower maintenance costs, higher vehicle uptime, and a more empowered workforce. This section highlights multiple best practices and workforce training resources to support effective workforce development.

Best Practices: Roadmap to Success

- **Start Training Early (6-12 Months Lead Time):** Don't wait for the buses to arrive. Begin training well before the first vehicle or charger is on-site to build staff confidence and safety culture.
- **Conduct a Skills Gap Analysis First:** Before procurement, benchmark your team's current capabilities to target training budget where they are needed most.
- **Create Role-Specific Pathways:** Avoid one-size-fits-all training. Tailor curricula to the specific demands of each job to ensure deep competency.
- **Implement a Tiered Training Framework:** Structure learning as a progression, moving from Level 100 (Safety and Orientation) to Level 300 (Advanced Diagnostics) to avoid information overload. Consider certifying your senior staff to lead future onboarding trainees.
- **Prioritize High-Voltage & Hydrogen Safety Certifications:** Treat safety as a core operational requirement, not an elective. Require industry-standard certifications to mitigate risk.
- **Use Multi-Mode & Hands-On Learning:** Theory is not enough; technicians and operators need to touch the technology. Combine classroom learning with physical training labs with mock charging cabinets and simulated high-voltage isolation points.
- **Leverage National & Regional Resources:** Do not reinvent the wheel! Utilize established frameworks and federally supported programs to access standardized curricula, saving your agency both time and budget.

Examples of Workforce Training Resources and Partners

National Training Centers: Transit Workforce Center | Industry Standards: APTA's ZEB Maintenance Training Recommended Practices, SAE J3105/J2954/J2601 | OEM Training: New Flyer, Gillig, BYD | Educational Institutions: Community Colleges (e.g., Rio Hondo, AV College) | Utilities: SCE, LADWP | Emergency Response: Local Fire/HazMat, NFPA 70E, NFPA 2

THANK YOU!

For more information, please visit:

https://scag.ca.gov/transit-program

POLL

Journey to Hydrogen

ICT SCAG – Toolbox Tuesday

Walter Watcher, Chief of Capital Projects

History in Hydrogen


1st GENERATION


2nd GENERATION


3rd GENERATION


4th GENERATION


5th GENERATION


6th GENERATION

7th GENERATION


8th GENERATION


9th GENERATION


10th GENERATION


11th GENERATION

At the Forefront of Hydrogen Electric Fuel Cell Bus Technology

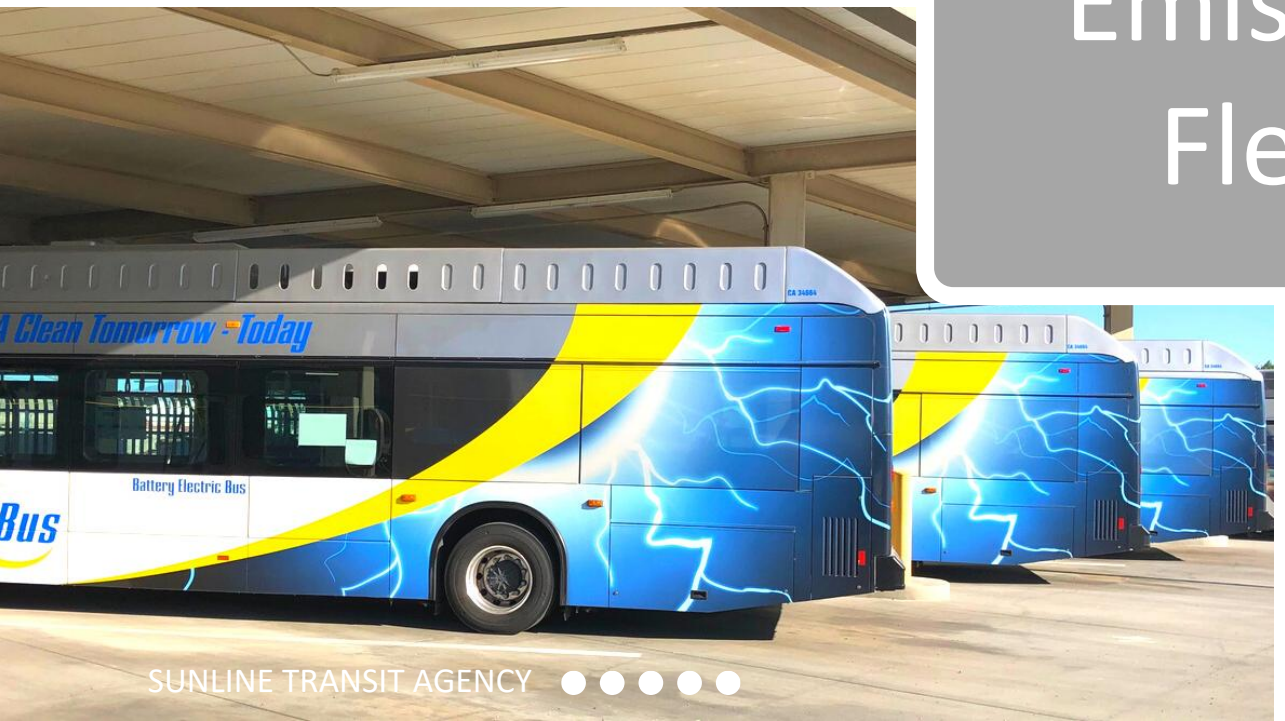
Zero Emission Program Goals

- Continue legacy of implementing leading edge, clean air technology
- Transition full fleet to zero emission by 2035 (5 years before CARB's 2040 target)
- Minimize carbon footprint by generating renewable energy and producing green hydrogen
- Invest in technology that best supports operating requirements

Zero Emission Fleet

32

Fuel Cell Buses



04

Battery Electric Buses

Zero Emission Fleet =
36 ZEBs or 41% of total fleet

32	Fuel Cell Buses (23 New Flyers & 9 El Dorados)
04	Battery Electric Buses (BYD)

Preferred Fuel Path - Hydrogen

- Summer temperatures can exceed 120° F
- Approximately 200 miles operated by each bus daily
- Combination of rural, highway and city routes
- FCEB is closest to 1 for 1 replacement of a CNG bus

HYDROGEN FUELING STATIONS

HYRODGEN ELECTROLYZER STATION

900 kg per day

IN SERVICE SINCE NOVEMBER 2019

CONTRACTOR: NEL HYDROGEN

LIQUID HYDROGEN STATION

15,000 gallon liquid capacity

BEGAN FUELING: JULY 2024

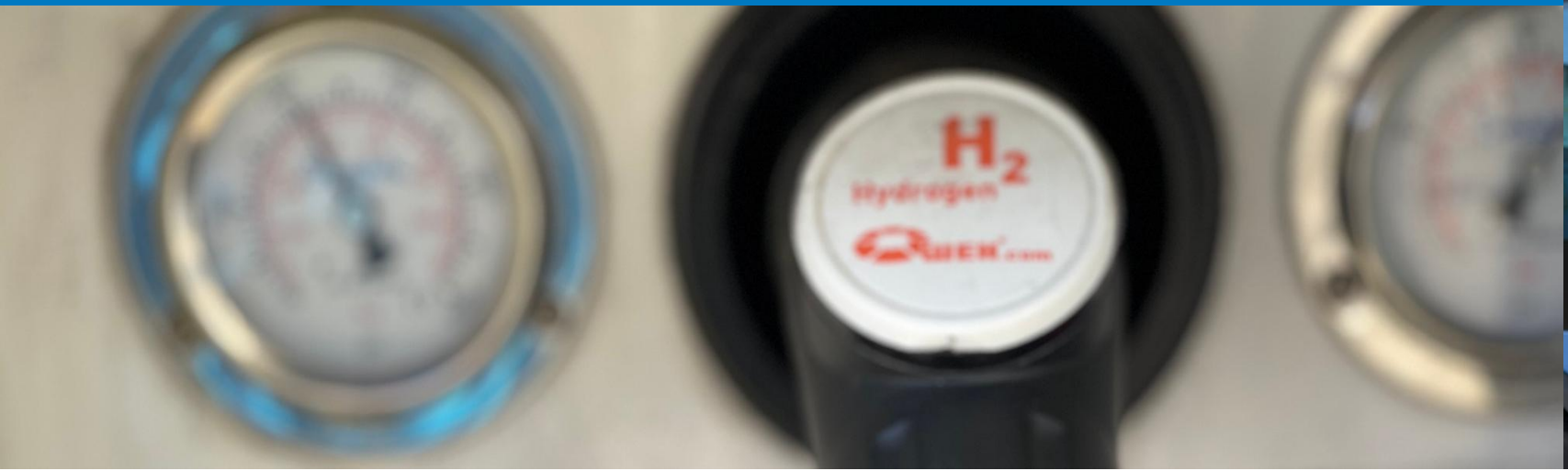
CONTRACTOR: NIKKISO/INTEGRATED CRYOGENIC SOLUTIONS

Electrolyzer Station Characteristics

- 2.5 megawatt station producing gaseous hydrogen
- Power Consumption per kg of H2 produced = 60.3 kWh/kg
- Feed Water Consumption per kg of H2 produced = 14.3 L/kg
- Maximum hydrogen production per day = 900 kg
- Low Pressure storage: 200 bar; High Pressure Storage: 450 bar
- 2 Dispensers; Max fill per FCEB: 30 kg; Dispensing @ 350 bar, -40°C; Fill time: 10-15 minutes
- Nel was system integrator & primary OEM
- Proton Exchange Membrane (PEM) Electrolyzer
- Chilling systems, A/C Units, Heat Exchanger System

OVERVIEW OF COSTS & FUEL USAGE

- Total cost of electrolyzer station in 2017: Approximately $9 million
- Average cost per dispensed kg is $21.45 - Excludes O&M cost
- Electrolyzer was designed to produce 900 kg per day.
- Total cost of the Liquid Station in 2024: $9.1 million
- Monthly O&M cost is approximately $11,000
- Average cost per dispensed kg is $15.24 – Including O&M and electricity
- Station can fuel buses back-to-back – similar fueling times to CNG – 8 min



Liquid Hydrogen Station – In Use

Construction Completed:
July 2024

Liquid station is SunLine's primary hydrogen fueling source. The Electrolyzer is a secondary solution.

Thank You

WEBSITE
www.sunline.org

For more information:

Shawn Craycraft
Alternative Fuels Program Manager
scraycraft@sunline.org

Walter Watcher
Chief of Capital Projects
wwatcher@sunline.org

Antelope Valley Transit Authority

The NATION's 1st and ONLY
100% Battery-Electric Powered Fleet

August 18, 2026

Martin Tompkins
CEO/ED

Antelope Valley Transit Authority

The NATION's 1st and ONLY
100% Battery-Electric Powered Fleet

August 18, 2026

AVTA FLEET

TOTAL FLEET: 123

LOCAL TRANSIT

18 BYD 60-ft articulated bus

45 BYD 40-ft bus

7 BYD 35-ft bus

8 BYD 30-ft bus

COMMUTER

24 45-ft MCI

PARATRANSIT PLUS

19 20-ft Ford Lightning E-vans

2 Toyota Sienna

- Dial – A – Ride
- Microtransit Ride Service
- NEMT

Antelope Valley Transit Authority

AVTA EV RANGE / CHARGING

LOCAL TRANSIT

60-ft Bus Range 130-160 miles
40-ft Bus Range 110-130 miles

INDUCTIVE CHARGING

- 14 250 kWh WAVE charging pads across 4 transit centers + AV College
- 1 250 kWh WAVE charging pad at AVTA maintenance yard
- 10 minutes of WAVE charge = 12 miles

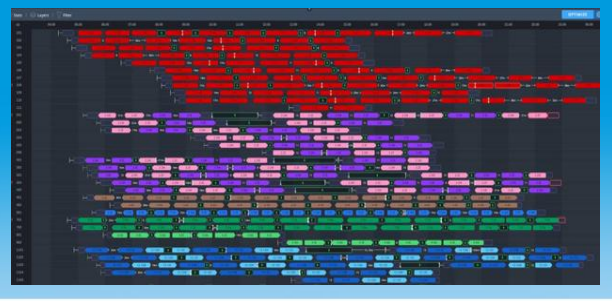
COMMUTER

4 Routes - longest one-way = 76 miles

- Downtown L.A.
- Newhall
- Century City/UCLA
- West San Fernando

SOFTWARE

- Proprietary software - monitors the state of charge (SOC)/bus
- Scheduled in-route opportunity charging, thru OPTIBUS



Antelope Valley Transit Authority

AVTA FACILITY

- Built in 2004
- Over 15 acres
- 100+ charger-ready stalls; charging rate from 50kW – 200kW
- 1.5 MW generator (activated during disasters)
- Photovoltaic System generates energy for facility consumption = approx. 800,000 kWh
- 12 ABB plug-in chargers throughout service area
- Bus energy consumption 8.4 MWh

Antelope Valley Transit Authority

CHALLENGES ENCOUNTERED

- 1st in the nation – 1st to discover ALL the problems.

- Battery overheating challenges resulted in the downing of our entire commuter fleet for several months.
  - NTD/FTA denied our hold harmless waiver request; the reason stated was our experience was not a *"typical" reason*. These were the 1st, 45-ft, battery-electric, commuter coaches in the NATION. See #1 above.
  - Loss of NTD data = loss of federal funds.

- Initial commuter bus did not pass Altoona – we were forced to switch manufacturer or risk the loss of millions in grant funds. This change cost the agency an additional $15 million (manufacturer change to MCI + increased bus cost + loss of HVIP).

- Aggressive internal timelines – bus delivery schedules delayed.

- WAVE acquired in 2025. Continued parts supply challenges.
- Greenpower (vans) challenges; did not last their useful life.
- Lightning E-Motors (vans) out of business; parts have been a challenge & costly.
- EV's for rural paratransit: our service area is too vast for ease of recharging without significant capital investment. Increased mileage needed travel for recharging, accelerated the useful life by miles and replacement schedule = increased capital costs.

Antelope Valley Transit Authority

LESSONS LEARNED

- Square mileage, weather and terrain of your service area needs to be considered.

- Range anxiety is real; plan accordingly.
  - Properly trained BEB operators can increase efficiency dramatically.

- Plan for different seasons - batteries perform differently.
  - Operations and Maintenance plans
  - Winter & Summer plans

- Equipment / Infrastructure – buyer beware.
  - Manufactures/companies can go out of business and you are left without support through the asset's lifecycle. Vendor support is crucial.

- Telematics - find the right for your team; ability to see the SOC remotely and proactively respond is crucial to efficiency as you acquire more BEBs. Procure it before you need it - preferably w/the bus.
  - Have a human system to monitor the charging and SOC in the yard. You can't always rely 100% on technology; it is crucial (and cost effective) to have buses recharge overnight.

- AVTA's 30-ft, 35-ft & 40-ft battery electric BYD's have proven the most efficient for our local service.

LESSONS LEARNED

- Plan for operation with long term loss of power.
  - AVTA installed a 1.5 megawatt backup generator and recently purchased 43 acres of land for a solar farm and battery storage backup; we will be able to operate off-grid if necessary.
- Plan your infrastructure BEFORE you procure buses. It will determine your success/failure.
  - Be mindful this technology changes rapidly. Ex: AVTA infrastructure was designed to move from AC to DC charging without a full demo and rebuild.
- The BEB parts sector is volatile. Plan for adequate parts on hand, lead time can be months.
  - Procure critical parts for spares along with the bus, research parts most likely to fail, and keep on hand.
- Have a backup plan in the event units have charging issues while in service.
  - AVTA prepares to bring units back at 30% SOC if unable to charge in route with WAVE.
- Ensure charges pedestals are protected from weather.
  - AVTA covers the chargers to block direct sun/damage to the screens, allowing better visual of the digital screen.

Antelope Valley Transit Authority

CHALLENGES ANTICIPATED

- 90% of fleet transitioned with span of 3 years – replacement will need a large influx of $$.
- Cost of replacement vehicles have become unsustainable; we are faced with tough decisions
- Replacement fleet will be D/C powered; current local transit fleet of 78 buses is A/C powered, as are a majority of onsite chargers.
  - Will require a change of infrastructure A/C > D/C = increased significant capital costs; the third time.
- Financially - accumulating enough funds for replacement will be an obstacle.
  - A significant amount of discretionary funds made this goal possible, but will lightning strike twice when we need to replace the fleet?

Every obstacle we encountered was necessary for us to reach our current position.
Each challenge was a learning opportunity that contributed to our progress.

Faced with multiple challenges, we never faltered. This is the team proven to handle whatever may come our way. We are small ~ we are mighty ~ we have overcome & learned a LOT along our journey~ WE ARE AVTA!

What's Next for AVTA (off the grid charging solutions)

- Solar Field - AVTA Board of Directors approved securing and purchasing 43 acres (9 Parcels) of land adjacent to the AVTA facility. Break ground fall of 2026.
  - ✓ Solar field coupled with battery storage will allow enough energy production to cover current consumption and create resiliency.
  - ✓ Reduce energy cost through a 25-year PPA.
- Alternative service vehicles to operate in Rual areas

Antelope Valley Transit Authority

Orange County Transportation Authority Zero Emission Bus Program

Cliff Thorne
Director of Maintenance

Background

Prior to the Innovative Clean Transit Regulation – OCTA developed a strategy to test both technologies

- February 2020, OCTA initiated the Fuel Cell Electric Bus (FCEB) Pilot
  - Ten 40-foot FCEBs, hydrogen fueling station, maintenance shop upgrades
- July 2022, OCTA initiated the Battery Electric Bus (BEB) Pilot
  - Ten 40-foot BEBs and ten charging stations
- June 2024, Battery Electric Paratransit Van Pilot
  - Ten 20-foot battery-electric vans and charging infrastructure
- November 2024
  - Purchased 40 additional FCEBs and 10 additional BEBs
- May 2026
  - Awarded 2nd hydrogen fueling station, shop upgrades

ZEB Pilot Buses – *Direct Experience*

Vehicle Information	CNG Bus	FCEB	BEB
Number of Buses	10	10	10
Manufacturer/Model	New Flyer Xcelsior	New Flyer Xcelsior	New Flyer Xcelsior
Model Year	2016 / 2026	2018 / 2026	2020 / 2026
Bus Purchase Price	$580k / $980k	$1.3M / $1.5M	$1.1M / $1.3M
Length	40 foot	40 foot	40 foot
Curb Weight	30,000 pounds	33,560 pounds	33,500 pounds
Propulsion System	CNG Engine 280 hp (209 kW)	Electric Motor 210 kW	Electric Motor 210 kW
	Transmission	Fuel Cell 85 kW	
Energy Storage	Six Composite Fuel Cylinders	Five Composite Fuel Cylinders	
		Lithium-ion Batteries 100 kW	Lithium-ion Batteries 440kW
Total Operating Range	400 miles	300 miles	200 miles
Usable Operating Range	350 miles	250 miles	150 miles

Key Takeaways

- Higher Upfront Costs:
  - BEB cost 25% more than CNG buses (2026)
  - FCEB cost 35% more than CNG buses (2026)
- Reduced Operating Range:
  - BEB operating range up to 150 miles (200-mile now available)
  - FCEB operating range up to 250 miles (300-mile now available)
- Performance:
  - Reliability (*MBRC) – BEB avg 5,801; FCEB avg 7,061; CNG 19,259
  - Availability - Both ZEBs about the same at 55-60%, CNG 80%+
- Maintenance:
  - BEB midlife battery replacement $435,000
  - FCEB midlife battery replacement and fuel cell overhaul $180,000
- Infrastructure
  - Hydrogen fuel remains expensive, but fueling infrastructure is lower in cost for larger fleet
  - Electrical capacity limited, charging infrastructure is complex, and higher cost for larger fleet

*MBRC – Miles between Road Calls

OCTA ZEB Transition Timeline

2027– 70 ZEBs

2020 - **10 Fuel Cell Electric Buses (FCEBs)**

2022 - **10 Battery Electric Buses (BEBs)**

2027 **- 40 40ft FCEBs, 10 40ft BEBs**

2029

20 60ft Buses

Start bus procurement 2027 - CNGs

2034

189 Buses: 163 40ft, 16 60ft, 10 40ft FCEBs

Start bus procurement 2031 - FCEBs

Infrastructure upgrades required

2040

211 Buses: 201 40ft, 10 BEB

Start bus procurement 2037 - FCEBs

Infrastructure upgrades required

DISCUSSION

Q&A

Tell us how we did!

Take a quick 2-minute survey to help us improve future Toolbox Tuesdays!