



Zero-Emission Vehicles

Intro to Technology & How to Choose a
Vehicle

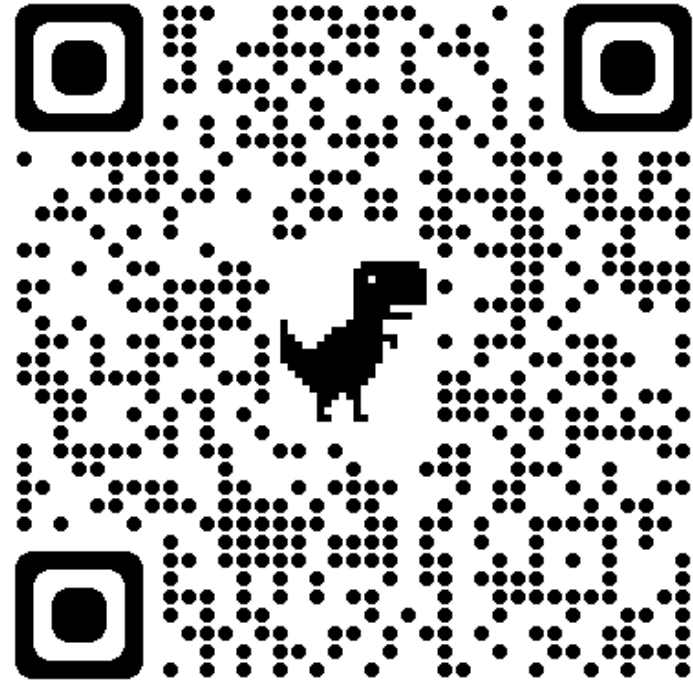


Agenda

- Available Online Resources
 - ZEV TruckStop
- Basic Terminology
- Battery Electric Technology
- Hydrogen Fuel Cell Technology
- How to Choose a Vehicle

ZEV TruckStop

- arb.ca.gov/ZEVTruckStop



ZEV 101: Get Up To Speed webpage

- Basic Terminology
- Battery Electric Technology
- Hydrogen Fuel Cell technology
- Steps to Transition



ZEV 101: Get Up To Speed

Terminology, ZEV fueling, & infrastructure info

Basic Terminology

- Zero-Emission Vehicles (ZEV)
- Battery-Electric Vehicles (BEV)
- Hydrogen Fuel-Cell Electric Vehicles (FCEV)
- Near-Zero Emission Vehicles (NZEV)
- Range
- Regenerative Braking
- Battery Pack
- Electric Drive Train
- Battery Management Systems
- Battery Capacity
- Voltage (Volts)
- Trucking as a Service (TaaS)
- Amperes (Amps)
- Kilowatt (kW)
- Kilowatt-Hour (kWh)
- Level 1 Charger
- Level 2 Charger
- Direct Current (DC) Fast Charger
- Depot Charging
- Opportunity Charging
- Fuel Cell
- Hydrogen Tank
- Charging as a Service (CaaS)
- ICE/ICEV (Internal Combustion Engine) Vehicles

Basic Technology Overview

- Hydrogen Fuel Cell Electric (FCEV)
- Battery Electric (BEV)



FCEV – Refueling

- FCEVs are electric vehicles – they use electricity to power an electric motor
- The hydrogen powers a fuel cell to produce the electricity
- Hydrogen is stored in an on-board tank, and is refueled in a similar fashion to conventional ICE vehicles





FCEV - Benefits

- Zero-emission - only produces water vapor and warm air
- Can be produced domestically
- Faster to refuel compared to charging BEVs
- Can handle tough conditions and environments
- Safe
- Lower operational costs
- Potential for shared fueling



FCEV - Limitations

- High up-front costs
- Currently limited refueling infrastructure availability
- Fuel production process is complex, and hydrogen prices are still higher today than conventional fuels

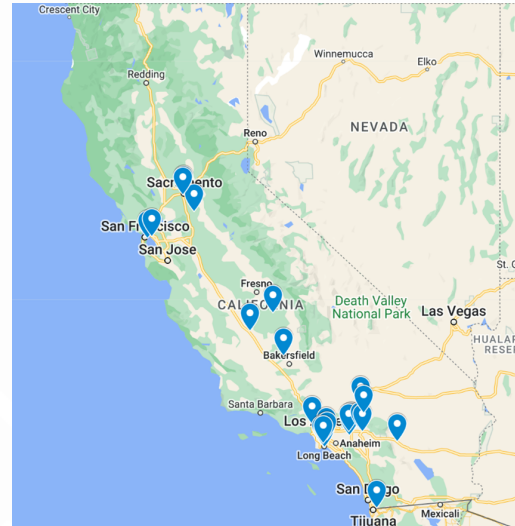
FCEV – Safety Considerations



- Myth – hydrogen is more dangerous than conventional fuel
- Fact – hydrogen is safer than conventional fuels like gasoline and diesel

The Future of Hydrogen

- 200 new hydrogen stations by 2025
- 13 to offer heavy-duty services
- Federal Programs Underway
 - Enbridge Commercial Vehicles
 - Low Carbon Fuel Standard
 - Hydrogen Shot



BEV – Charging

- Need to be plugged into an electric energy source
- Time needed to charge depends mostly on power output of the charging station
- Three categories of chargers:
 - Level 1 (110/120V)
 - Level 2 (208/240V)
 - Level 3 (DCFC) (200+V)



BEV – Charging, cont.

- Charge speed vary based on
 - Ambient temperatures
 - Battery capacity
 - Battery charge level
- Different charging solutions and strategies are available
- Different charger connectors:
 - SAE J1772
 - CCS Type 1
 - SAE 3068



BEV - Benefits



- Lower cost of ownership
- Higher fuel efficiency
- Less maintenance, fewer repairs
- Promotes US energy security
- Zero tailpipe emissions
- Quieter ride, more responsive motor, less vibration

BEV – Limitations

- Limited range
- Higher up-front costs
- Rely on charging infrastructure



BEVs – Overcoming Limitations



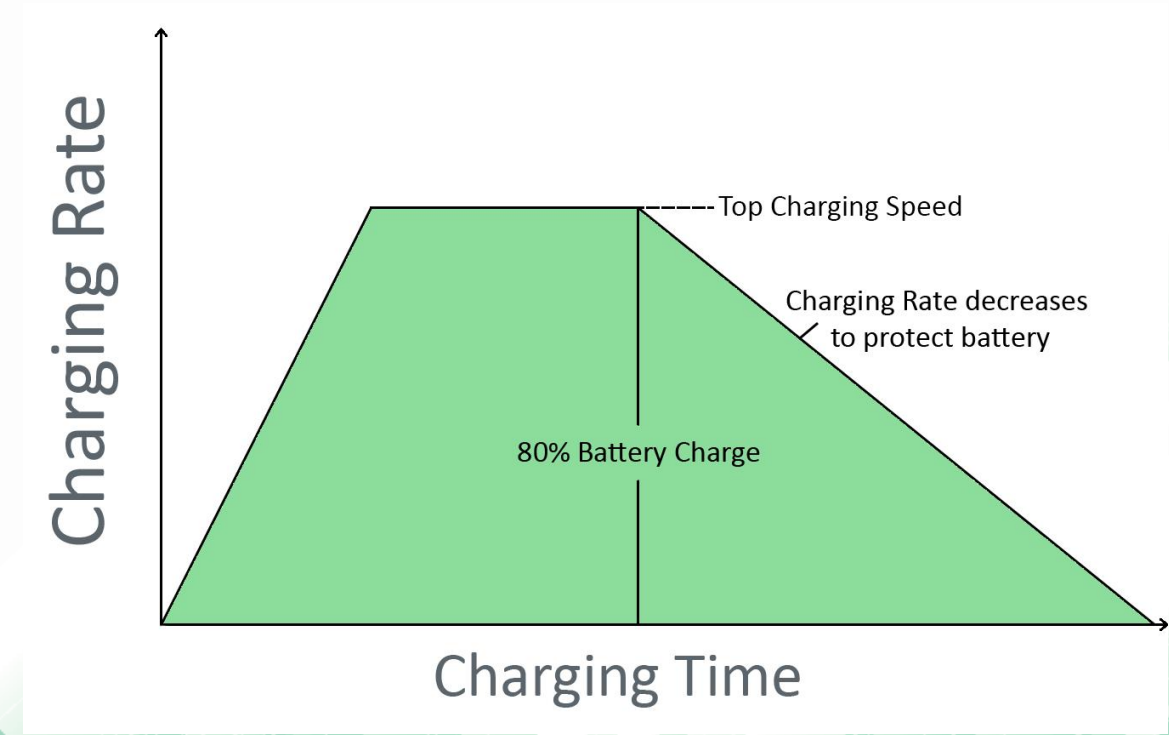
- Charging schedule
- Fleet management strategies
- Route planning
- Opportunity charging

BEVs - Charging Efficiency

- Many factors affect charging efficiency
 - Battery capacity
 - Charger level
 - Charger output power rate
 - Vehicle charging max power rate
 - Access to chargers
 - Down time available to spend at charger
 - Ambient temperature
 - Battery temperature
 - Battery charge level



BEVs – General Charging Curve



BEVs – Factors Affecting Range



- Route conditions/topography
- Vehicle speeds
- Weather – AC/Heater use
- Driving habits
- Load weight
- Wind
- Tire condition/pressure

BEVs – Best Practices to Extend Range



- Driver habits
- Opportunity charging
- Route planning

BEVs – Determining Charger Needs

- The fastest/most powerful chargers are not always the right chargers
- Factors to consider:
 - Daily range
 - Availability of depot charging
 - Availability of opportunity charging
 - Vehicle down time
- Resources/services available to help



BEVs – Charging options

- Public charging
 - Opportunity charging
 - Loading/unloading
 - Downtime
 - Can sometimes be combined with route planning to maximize efficiency
- Private charging
 - Owning/installing infrastructure
 - CaaS options - Lease vs own
 - Working with utilities early
 - Developing accurate timeline

BEVs - Common Myths

Myth

- BEVs can't yet meet the range demands for most commercial vehicle uses
- There aren't enough commercial BEVs on the market

Fact

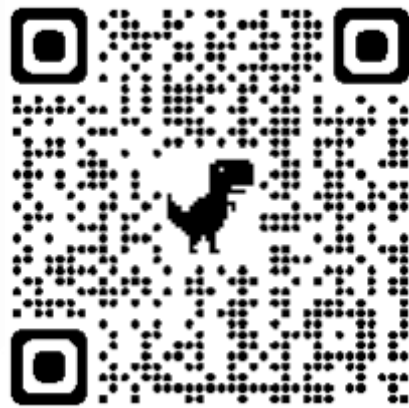
- Most trucks and vans operate less than 100 miles per day
- Over 135 different models of vans, trucks, and buses are currently available

Applying Charging Strategies

- Determine optimal vehicle battery size
 - Range
 - Weight
 - Cost
- Determine optimal charger speed
 - Route distance
 - Distance to opportunity chargers
 - Battery capacity
 - Planned downtime
 - Cost

ZEV TruckStop - Partners

- California Energy Commission (CEC)
- Local Utilities
- GO-BIZ
- CALSTART
- California Air Districts
- NESCAUM



Choosing the Right Vehicle

- Determine range needed, utilizing charging strategies
- Return to yard nightly?
- Making frequent stops?
- Drive long distances?
- Within reasonable distance to hydrogen refueling?
- Possible to install charging infrastructure?
- Is CaaS an option? TaaS?
- Tools and services available to assess needs and assist this decision

CAL Fleet Advisor

- Planning
- Permitting
- Vehicle locator
- Advisors available
- Custom plans
- Route Planning
Coming Soon



Choosing a Vehicle - Online Tools

- ZEV TruckStop – ZEV 101 Steps to Transition
 - Process broken into 9 steps
 - Relevant tools and resources
 - Helpful videos



ZEV TruckStop – Zero-Emission Market



- Over 135 different models of ZEVs already commercially available
- Online resources to help find them
- Page updated regularly



Choosing a Vehicle - ZETI

- CALSTART Zero-Emission Technology Inventory Tool
- Interactive online resource
- Displays ZEVs available in specific regions


ZERO-EMISSION TECHNOLOGY INVENTORY

US & Canada | Europe | China | India | Mexico | South America | Oceania











SELECT FUEL TYPE ?

Electric  Fuel Cell 


SELECT AVAILABILITY ?

Available 

SELECT A VEHICLE PLATFORM ?

Coach Bus  School Bus  Shuttle Bus  Transit Bus  Cargo Van  MD Step Van  MD Truck  HD Truck  Yard Tractor  Other 

SELECT A VEHICLE MANUFACTURER ?



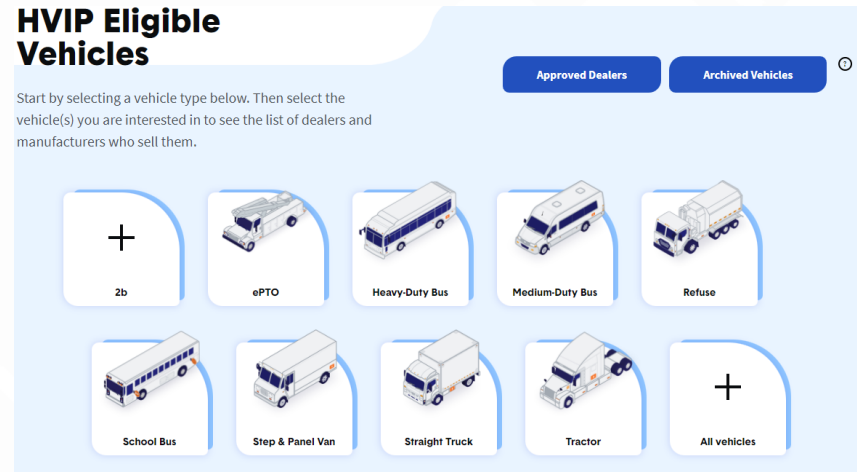
SELECT VEHICLE MODEL ? **VEHICLE MODEL COMPARISON**

CLICK ON MODEL NAMES SELECT UP TO THREE MODELS FOR COMPARISON



Choosing a Vehicle – HVIP Catalog

- Interactive online tool
- 152 vehicles
- All eligible for HVIP funding

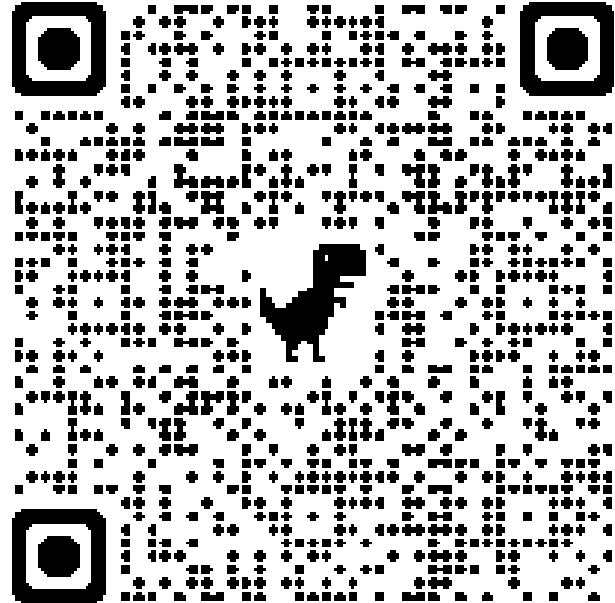


CARB

<https://californiahvip.org/vehiclecatalog/>

Steps to Transition

1. Learn about ZEVs
2. Identify your fleet needs
3. Define your team and contact your utility
4. Choose a vehicle
5. Plan timeline and permitting
6. Plan for financing and apply for funds
7. Build out infrastructure
8. Ensure driver/maintenance staff training
9. Get recognized for your efforts





ZEV TruckStop Homepage - arb.ca.gov/zevtruckstop

HVIP – californiahvip.org

Cal Fleet Advisor – calfleetadvisor.org

Questions? Email ZEVTruckStop@arb.ca.gov