California Environmental Protection Agency
Air Resources Board

First Advanced Clean Local Trucks Workgroup Meeting
Discussion Guide
January 20, 2017 – 1:00-4:00 PM

1. Welcome and introductions

a. Need for Advanced Clean Local Trucks

- Strategy to deploy zero-emission technology in the medium- and heavy-duty markets
  - Last-mile delivery and other local truck uses where best suited
- Battery-electric, plug-in hybrid, and hydrogen technologies
- End-goal of regulation is to accelerate self-sustaining market for medium- and heavy-duty zero emission trucks
- Part of the state's overall strategy to achieve emission reductions as outlined in the State Implementation Plan (SIP), which are
  - 80% reduction in smog-forming emissions in the South Coast
  - 45% reduction in diesel PM emission in the South Coast
  - 45% reduction in greenhouse gas emissions
  - 50% reduction in petroleum usage
- Support the Sustainable Freight Action Plan, SB 350 goals, Mobile Source Strategy, State Implementation Plan, AB32, and SB32

b. Workgroup goals and expectations

- To develop common understanding of costs, fleet operational needs and technology readiness to successfully deploy and expand heavy-duty zero emission vehicle market.
- All workgroups are open to the public.
- Workgroup members expected to attend and contribute at workgroup meetings
- Workgroup meetings will be webcast at https://video.calepa.ca.gov/
- Workgroup meetings will occur every 2-3 months
- Should future workgroups be recorded?

2. Regulatory Strategies

A summary of different strategies we could pursue to achieve the goals of Advanced Clean Trucks.

- Manufacturer Requirement
  - A percentage of manufacturer sales in California would be required to be zero- emission. Open to discussion of role for partial-zero emission technology.
  - Possible credit system modeled after current Advanced Clean Cars regulation

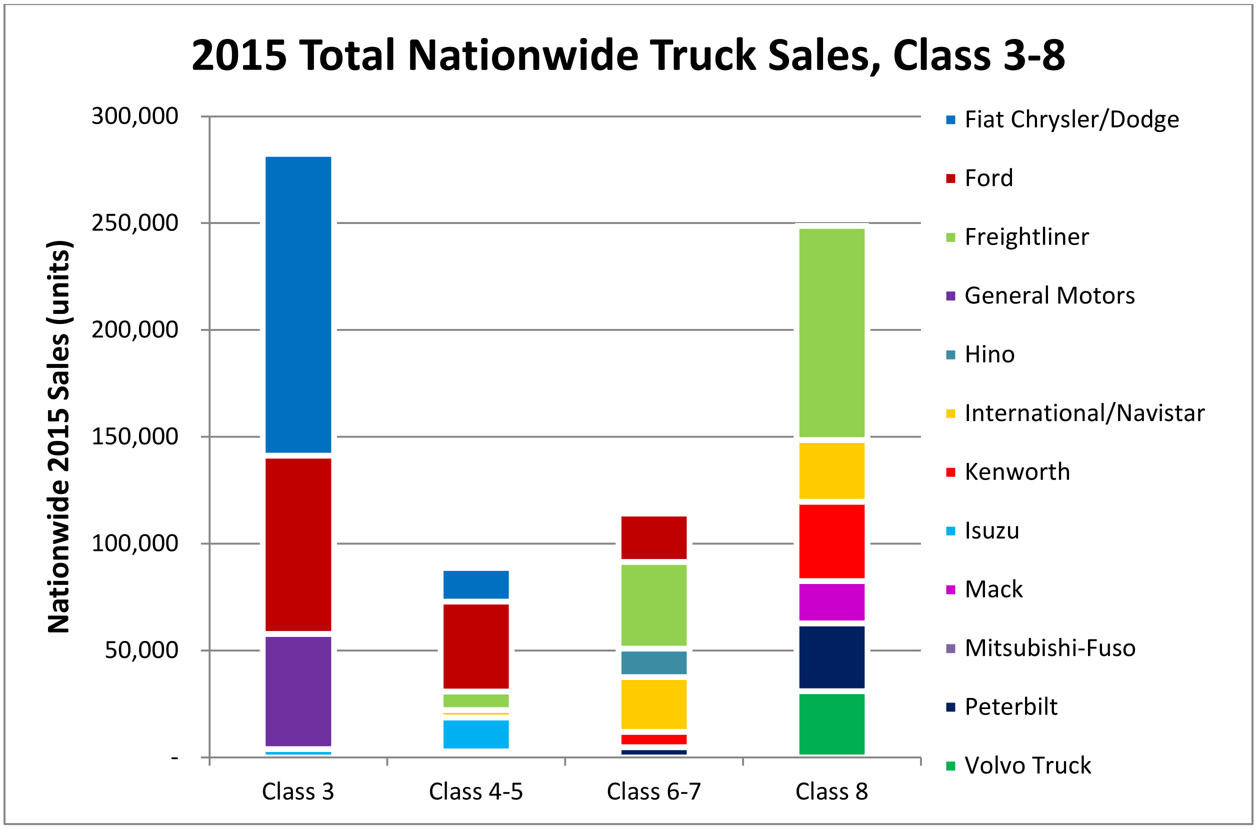
- Fleet/End-User Purchase Requirement
    - o Targeted fleets could be required to phase-in purchases of zero (or partial-zero emission trucks), low NOx engines if available, and use renewable fuels to support the existing LCFS program.
- Both strategies would account for electric and hydrogen technologies
- The key to any regulatory structure requires understanding of costs and feasibility of zero emission vehicles.

3. Truck population inventory characteristics

An accurate truck population and sales is necessary to define the scope of the potential market and scope of any regulatory proposal.

- **Conventional trucks**

Figure 1: 2015 nationwide trucks sales by truck and manufacturer



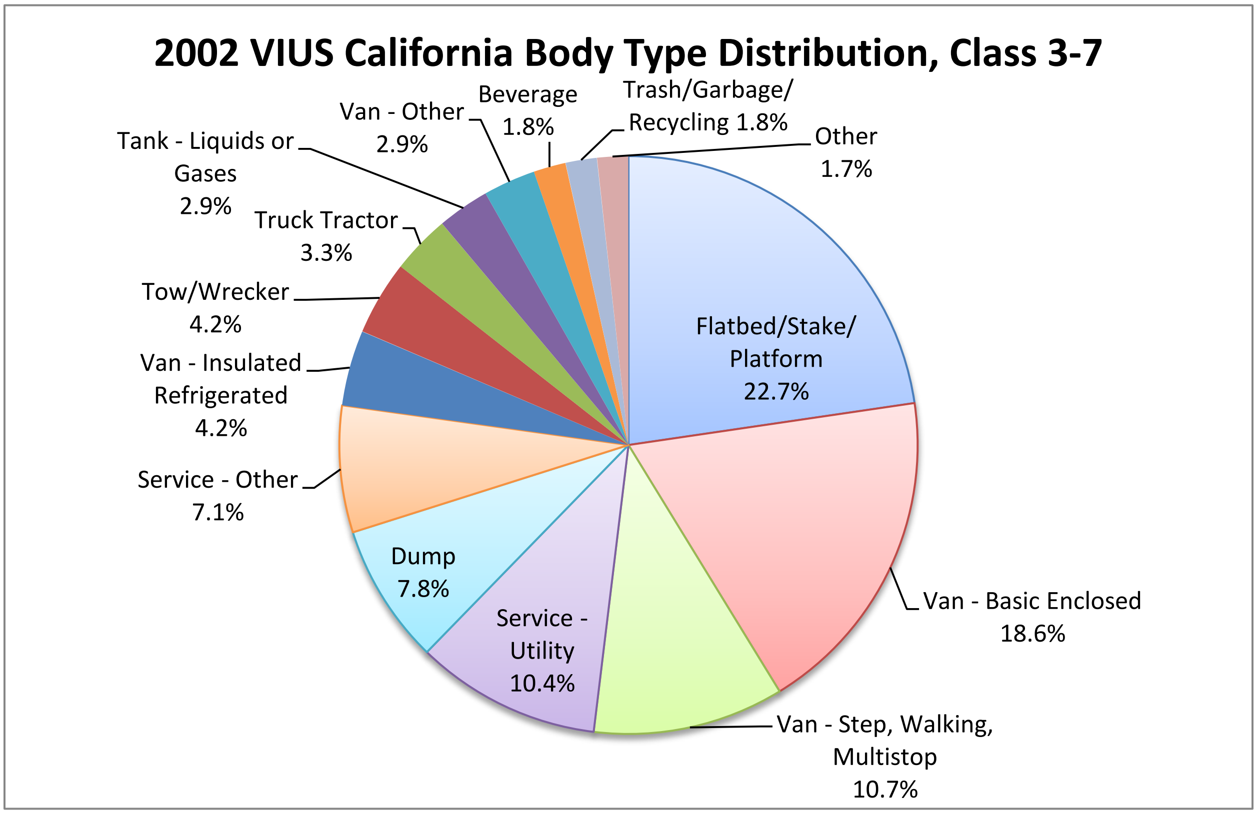
Source: Department of Energy (DoE) (2016), Vehicle Technologies Market Report (http://cta.ornl.gov/vtmarketreport/index.shtml, last accessed January 2017) , Trucks.com (2016), "Ford Grows Work Truck Market Share by Adding Gas Engine Option" (https://www.trucks.com/2016/12/23/ford-work-truck-gas-engine/, last accessed January 2017)

- Note: Above graph is nationwide, not California specific.

Table 1: ARB's 2017 EMFAC Inventory – Our agency's current vehicle population estimates.

Vehicle Class	2017 Vehicle Population
2B (GVWR 8,501 lb.-10,000 lb.)	713,206
3 (GVWR 10,001 lb.-14,000 lb.)	157,777
4-7(GVWR 14,001 lb.-33,000 lb.)	320,892
8 (GVWR 33,001 lb. and greater)	259,655

Figure 2: Class 3-7 Body Types based on 2002 VIUS Data



Source: United States Department of Commerce (2002), Vehicle Inventory and In-Use Survey – Discontinued, 2002 Data Releases (https://www.census.gov/svsd/www/vius/2002.html, last accessed November 2016)

- **Zero-Emission**

Table 2: Estimated populations of zero-emission trucks in the United States

Vehicle Type	In Service	On Order
Battery-Electric Delivery Van/Step Van	500-1000	~40
Battery-Electric Drayage Truck	~10	~25
Battery-Electric Yard Tractor	~10	~60
ePTO Systems	3000+ (1000+ in CA)	?
Fuel-Cell Electric Truck	~2	37
Plug-in Hybrid Delivery Van	~60	~340

- Ongoing data collection efforts
  - California Vehicle and In-Use Survey (CalTrans)
  - Freight Hub Data Collection (ARB)

4. Fleet operational characteristics

Initially exploring opportunities for electrification of vehicles that operate shorter distances in stop and go operation.

Table 3: Vehicle operational data from NREL's Fleet DNA project

	Average Distance (miles)	% Trips <100 miles/day	Total Avg Speed (mph)	Stops Per Mile	# Trucks Studied	# Days Studied
Refuse	72.8	81%	9.5	5.6	39	387
Service Van	32.8	100%	14.7	1.8	4	29
Delivery Van	57.0	93%	11.7	2.8	94	974
Delivery Truck	43.3	96%	18.4	1.1	36	553
Class 8 Tractor	96.1	63%	20.1	1.1	70	1150
Bucket Truck	26.9	100%	11.0	1.5	20	283

Source: National Renewable Energy Laboratory (NREL) (2016), Fleet DNA: Commercial Fleet Vehicle Operating Data (http://www.nrel.gov/transportation/fleettest_fleet_dna.html, last accessed January 2017)

- Operational characteristics – average daily range, distance per trip, payload weight and volume considerations, and other
- Additional information needed to understand fleet specific issues and concerns.

5. Cost methodology – Total cost of ownership

Understanding costs on a total cost of ownership basis are key to understanding financial impacts of any proposal. Our goal is to develop a common understanding of the best available information about current and projected costs on a vehicle lifecycle basis for different vehicle types and applications.

- Total cost of ownership including operation and maintenance cost (O&M) and capital costs for conventional trucks and advanced technology in same application.
  - Capital costs to include vehicle purchase, fueling/charging infrastructure, and upgrades to maintenance infrastructure.
  - O&M costs include fuel costs, and maintenance and repair costs for vehicles, fueling infrastructure, and maintenance bays.
  - Also may include training, effects of payload limits, etc.
  - Interested in understanding costs for individual fleets

a. Capital Costs – Vehicles and infrastructure

Our current understanding of the costs associated with purchasing zero or partial-zero emission technology

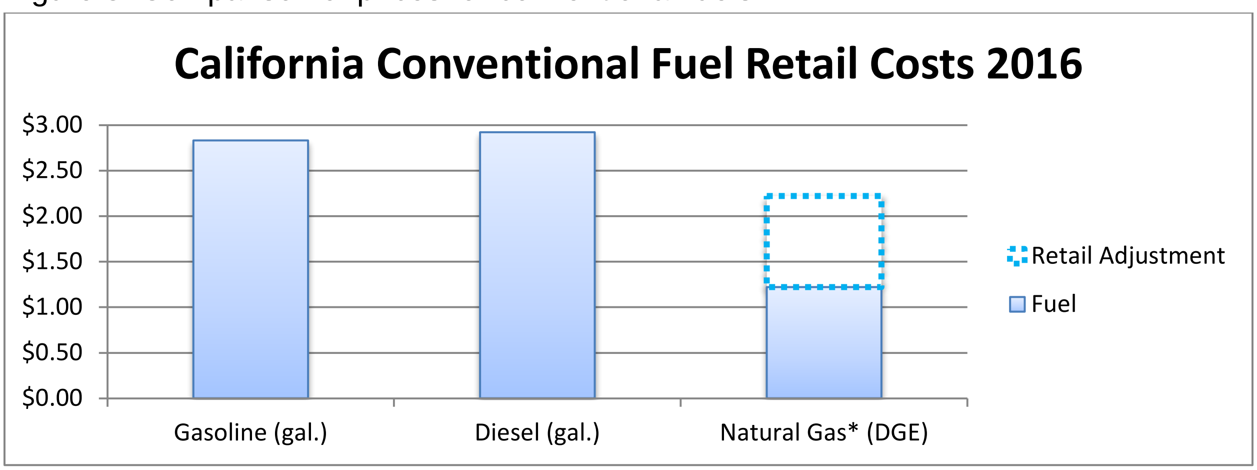
Table 4: Cost assumptions for conventional and advanced technology trucks

Class	Body Type	Technology	Conventional Cost	Incremental
3-6	Delivery Van	Battery Electric	~$50,000	~$100,000
3-6	Delivery Van	Plugin Hybrid	~$50,000	$20,000-$50,000
3-6	Delivery Van	Hydrogen	~$50,000	$150,000+
5	Bucket Truck	Plugin Hybrid	~$100,000	~$28,000
8	Bucket Truck	Plugin Hybrid	~$250,000	~$70,000
8	Refuse Truck	Range-Extended	~$225,000	~$150,000
8	Yard Tractor	Battery Electric	~$100,000	~$150,000

- Electrical infrastructure
  - Purchase and installation of a Level 2 charger is roughly $2,500 (adequate below Class 6 or below). Once the amount of power needed exceeds the facility's current limit, the upstream infrastructure will need to be upgraded; this is expected to cost roughly $20,000. For larger vehicles chargers may cost $50,000 each with additional infrastructure upgrades depending on a number of site specific factors.

b. Operation and Maintenance

Figure 3: Comparison of prices for conventional fuels

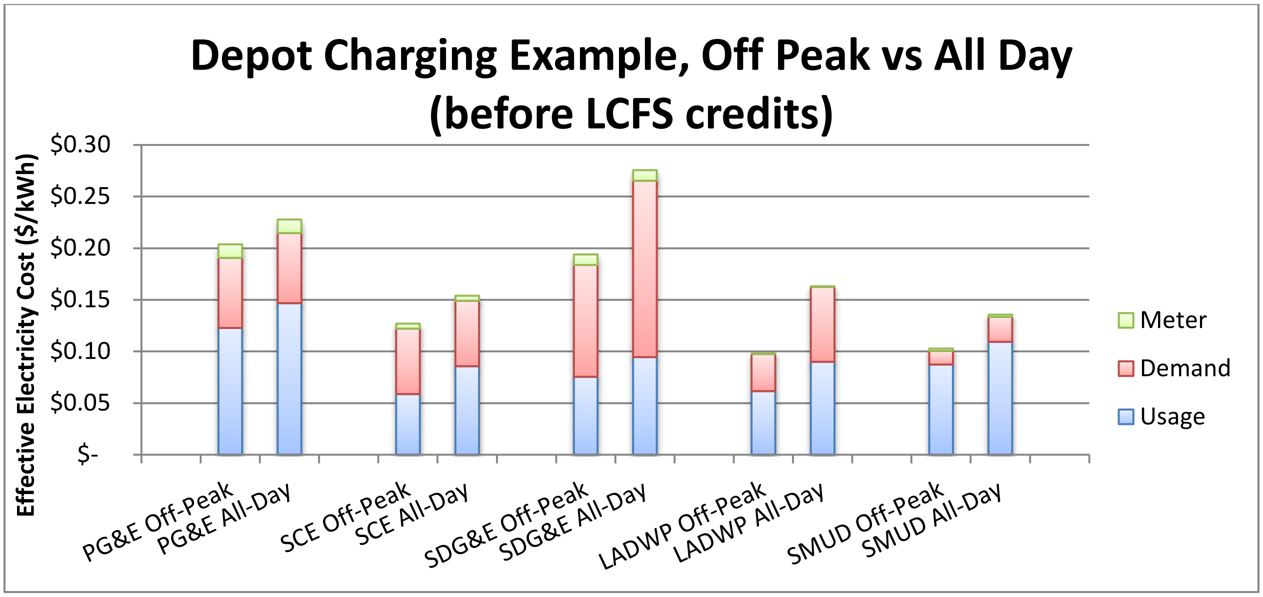


Source: Energy Information Administration (EIA) (2017) Weekly Gasoline and Diesel Prices (http://cta.ornl.gov/vtmarketreport/index.shtml, last accessed January 2017); CNG Prices (2017), Station Map (http://www.cngprices.com/, last accessed January 2017)

*EIA for natural gas only lists the commercial price, which is uncompressed. The retail price is roughly $2.25 in early 2017.

- Electricity rate overview – electricity bills are composed of three main components
  - The usage fee is a flat charge for every kilowatt-hour (kWh) used
  - The demand fee depends on the maximum power drawn at your facility. Separate demand fees are leveed for total power drawn and power drawn during peak rate periods
  - The meter fee is a monthly fee charged for your meter
- Assumptions: Fleet of 20 vehicles (initial rollout), 1.1 kWh/mile efficiency, 25,000 miles annually per vehicle, 11 kW charger
  - Off-peak means all charging is done overnight during the off-peak period, all-day means charging is split three-ways between on-peak, mid-peak, and off-peak.
  - The rate schedules used were for commercial usage less than 500 kW. PG&E – A-10, SCE – EV-4, SDG&E – AL-TOU, LADWP – A-2(B) TOU, SMUD – GS-TOU3

Figure 4: Electricity Costs Vary by Utility, Rate, and Charging Strategy



- An overview of how commercial electricity rates affect electricity costs for charging buses (applicable to larger trucks) is described at https://www.arb.ca.gov/msprog/bus/ratesanddemand.pdf
- Hydrogen costs in California vary substantially depending on the source. Retail hydrogen costs can range from about $8/kg if produced in larger quantities on site to about $14/kg if purchased at retail.
- Maintenance costs. There is limited data for maintenance costs for zero emission trucks compared to conventional trucks. Information about zero emission buses supports that there should be substantial savings due to lower

brake repair frequency and fewer planned and unplanned maintenance components. An analysis of available data for bus maintenance costs is at https://www.arb.ca.gov/msprog/bus/maintenance_cost.pdf. There is some data from NREL reports about maintenance costs for a typical delivery van. We are seeking additional data and information to identify a reasonable estimate for different truck types.

c. Low Carbon Fuel Standard (LCFS) program

- The LCFS program requires a 10 percent reduction in carbon intensity for transportation fuels sold in California.
- The program allows fleet owners that use low carbon fuel such as electricity and conventional CNG to generate credits that can be sold on the open market to refiners and other fuel producers that need them to comply.
  - A heavy duty vehicle fleet owner must register online to report fuel use and to track earned credits
- Credits for fossil CNG and electricity are generated by the end-user, while credits for other low carbon renewable fuels are generated by the producer
  - Hydrogen credit recipient criteria currently being reviewed
- Currently, the LCFS program uses an engine efficiency rating (EER) factor of 2.7 for a battery-electric truck compared to a conventional diesel fuel truck. This will earn about $0.06/kWh for a typical battery-electric truck if the credits are worth $100/credit.
- Recent available data for Class 8 trucks suggests that fuel efficiency improvements are higher for battery electric trucks in lower speed operation.
- We are seeking additional data about different truck classes to determine if changes to the LCFS EER for battery electric are appropriate.
- We are also interested in additional data associated with fuel cell trucks, and range extender concepts.
- For more information about the LCFS program and how to register is at https://www.arb.ca.gov/fuels/lcfs/lcfs.htm

d. Other

6. Related heavy-duty electrification efforts

There are a number of other programs that can complement or relate to the heavy duty advanced technology vehicle market.

a. Innovative technology vehicle/engine certification

- Manufacturer must demonstrate vehicle or engine compliance with applicable emission standards – includes emissions testing, on-board diagnostics (OBD), warranty, and other requirements
  - Based on vehicle class and propulsion system
- Innovative Technology Regulation
  - Provide certification flexibility to facilitate market launch of advanced truck and bus technologies
    - May offer OBD flexibility and eased in-use durability testing
  - Approved by the Board in October 2016, currently being finalized
  - Two certification flexibility pathways
    - Certification Flexibility for Innovative New HD engines
      - Certification for Heavy-Duty Hybrids – allows certification flexibility for hybrid systems, with an extended flexibility period for vehicles with greater than 35 miles all-electric range
      - Certification flexibility for light-duty engines in a heavy-duty plug-in truck - small quantities and minimum of 35 mile all-electric range
    - Certification procedures for Truck or Bus hybrid conversion systems

b. HVIP Funding and Eligibility

- The Hybrid and Zero-Emission Truck and Bus Voucher Incentive Program (HVIP) grants a voucher at the point of sale for vehicles with advanced technology.
- Voucher amount depends on the class of the vehicle and the incremental cost and whether located in disadvantaged community.
- Eligibility criteria for HVIP:
  - Be a new vehicle for commercial usage
  - Must be certified for California sale by ARB
  - A hybrid must have 30% improved fuel economy as compared to a baseline model
  - A plug-in hybrid must demonstrate 40% increased fuel economy and an all-electric range of 35 miles
  - Warranty must be a minimum of 3 yrs./50,000 miles and cover battery, drivetrain, parts, and labor
- Technologies that may be funded include conventional hybrids, plug-in hybrids, zero-emission, ePTO, exportable power, and low NOx engines
- Link to HVIP website: http://californiahvip.org/

c. Transportation Electrification Overview

- SB 350 mandates that utility providers eliminate barriers to transportation electrification in the light-, medium-, and heavy-duty sectors.
- ARB is closely coordinating with the California Public Utilities Commission (CPUC) and California Energy Commission on several issues associated with SB350.
- Applications from the major Investor Owned Utilities (IOU's) – PG&E, SCE, and SDG&E are due to the CPUC today (1/20/2017), and applications from several smaller utilities due mid-year.
- Several utilities have described preliminary plans that could reduce or eliminate infrastructure upgrade costs for deploying battery electric vehicles, some indicated rate changes may be part of their plan.
- All utility proposals are subject to CPUC approval. Addressing barriers for the use of hydrogen fuel are not expected to be address in these initial plans.

d. Fueling/charging standardization

- Currently, chargers for lighter vehicles are either using existing J1772/CCS 1 standards or their own proprietary charger.
- The Society of Automotive Engineers (SAE) is developing standards for a variety of heavy-duty high power chargers
  - J3105 – Overhead charging
  - J3068 – 480VAC 3-phase
  - J2954/2 – Wireless charging
- Standardization process is ongoing and may be on track to complete one or more draft standard this year (http://www.cte.tv/wp-content/uploads/2016/12/DavidWarren1.pdf)
- J2601 standard exists for light-duty hydrogen fueling infrastructure, suitable up to 10 kg of hydrogen dispensed
  - Applies to light duty hydrogen fueling stations, and may be suitable for smaller fuel cell trucks or range extender concepts.
  - No common standard in place for refueling larger hydrogen capacities

7. Next Steps

Topics to cover for our next workgroup meeting, and action items for members and staff to follow up on.

- Expected timeline
  - The State Implementation Plan proposed schedule for Board consideration in 2018, and beginning implementation in 2020
- Topics for next workgroup meeting