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<td>2019 IEPR Preliminary Medium- and Heavy-duty Vehicle Forecast</td>
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<tr>
<td>Description</td>
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<td>Raquel Kravitz</td>
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2019 IEPR Preliminary Medium- and Heavy-duty Vehicle Forecast

2019 IEPR Workshop on Transportation Energy Demand Forecast
Rosenfeld Hearing Room

July 22, 2019

Robert McBride
Demand Analysis Office
Energy Assessments Division
Bob,McBride@energy.ca.gov / 916-654-5009
Topics in this presentation

- Description of new data sources and assumptions
- cale for electric freight trucks
- Overviews:
  - Fuel cost per mile,
  - Market share of incentivized trucks in key truck classes
  - Battery electric bus stock
  - Incentivized truck acquisitions and stock
- Plans for revised forecast
MD/HD Vehicle Classes

Class 3 - 10,001 to 14,000 lbs
- Walk-in
- Box Truck
- City Delivery
- Heavy-Duty Pickup

Class 4 - 14,001 to 16,000 lbs
- Large Walk-in
- Box Truck
- City Delivery

Class 5 - 16,001 to 19,500 lbs
- Bucket Truck
- Large Walk-in
- City Delivery

Class 6 - 19,501 to 26,000 lbs
- Beverage Truck
- Single-Axle
- School Bus
- Rack Truck

Class 7 - 26,001 to 33,000 lbs
- Refuse
- Furniture
- City Transit Bus
- Truck Tractor

Class 8 - 33,001 lbs & Over
- Cement Truck
- Truck Tractor
- Dump Truck
- Sleeper
Base Year 2017 MD-HD Vehicle Stock
Diesel and Gasoline

Thousands

diesel gasoline

Class 3 to 6 Truck
Class 7 and 8 Straight Truck
Class 8 Tractor-trailer
Class 8 Refuse & Recycling Truck
Urban Transit Bus
Motor Home
School Bus
Shuttle and Other Bus
California Energy Commission

Base Year 2017 MD-HD Vehicle Stock
Alternative Fuels

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<tr>
<th>Class Type</th>
<th>Diesel-Electric Hybrid</th>
<th>Electric</th>
<th>Hydrogen</th>
<th>Natural Gas</th>
<th>Propane</th>
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<td>Class 7 and 8 Straight Truck</td>
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<tr>
<td>Class 8 Tractor-trailer</td>
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<tr>
<td>Class 8 Refuse &amp; Recycling Truck</td>
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<tr>
<td>Urban Transit Bus</td>
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<tr>
<td>Motor Home</td>
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<tr>
<td>Shuttle and Other Bus</td>
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</tbody>
</table>
Innovative Clean Transit Regulations

- January 1, 2020: new conventional internal combustion engine bus or hybrid bus purchases must purchase buses with Low-NOx engines

- Large transit agencies must purchase a minimum number of zero-emission buses in each calendar year
  - 2023: 25 percent of the total number of new bus purchases
  - 2026: 50 percent of the total number of new bus purchases
  - 2029: 100 percent of the total number of new bus purchases
California Energy Commission

Battery Electric Urban Transit
Bus Stock 2019-2030

HIGH electricity demand
MID
LOW electricity demand
School Bus Funding Programs

- School Bus Replacement (CEC)
- Electric School Bus Incentive Program (SJVAPCD)
- The Carl Moyer Program (Bay Area District)
- Lower-Emission School Bus Program (South Coast District)
- Rural School Bus Pilot Project (North Coast District)
- Hybrid and Zero-Emission Truck and Bus Voucher Incentive Project (HVIP-CARB)
- The Volkswagen Settlement/ Mitigation Funding
- Clean School Bus (US EPA)
  - DERA School Bus Rebate Program (US EPA)
2017 School Bus Population by Vintage

SchoolBus Count

- School of California Energy Commission
School Bus Electrification Forecast

California School Bus Count

Stock Historical  Stock Forecast

Source: CHP historic, IEPR 2019 preliminary
HVIP Incentive Truck Scenarios

- Air Resources Board Heavy Vehicle Incentive Program voucher amounts through 2018 inform truck choice for all classes
- High electricity demand case has full HVIP voucher amount through to 2030
- Mid case lowered to 90% of full voucher amount from 2023 to 2030
- Low electricity demand case has HVIP voucher curtailed to zero from 2023 on
Major Truck Data Changes

- Truck attributes prepared by HD Systems
- Freight Analysis Framework (FAF) v.4.4
  - Scenarios of goods movement prepared by IHS Global Insight for FHWA
  - Implicit modal share, split of freight movement by truck and rail
- California Vehicle Inventory and Use Survey data
  - Miles per truck by class and age, and whether using a home base
  - Percentage of trucks and truck miles in each of 42 group intervals of 5,000 annual miles, groups for zero to over 200,000 annual miles
- Newly revised truck price forecast and fuel economy trend from HD Systems
- Historic fuel economy from EMFAC2017
MD/HD Vehicle Stock Forecast
Trucks, Buses, Motorhomes

Millions

- High
- Low
- Mid

Years:
- 2019
- 2020
- 2021
- 2022
- 2023
- 2024
- 2025
- 2026
- 2027
- 2028
- 2029
- 2030

Graph showing the forecasted stock of MD/HD vehicles from 2019 to 2030, with three different scenarios: High, Low, and Mid.
Two Battery Electric Vehicles, Different Weight

- Chevy Bolt curb weight is 3,563 pounds plus an average adult person’s weight of 170 pounds
- Gross weight of the Xos ET-One is 80,000 pounds
Weight Ratio 21.4:1

A Xos ET-One fully loaded is 21.4 times the weight of the Bolt & driver. **Takeaway:** A loaded truck needs over 20 times the battery an auto needs to cover the same range in the same drive cycle.
### Attributes Used in Truck Choice

<table>
<thead>
<tr>
<th>INPUTS</th>
<th>Low</th>
<th>Mid</th>
<th>High</th>
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</thead>
<tbody>
<tr>
<td>CARB Heavy Vehicle Incentive Program</td>
<td>constant % of incremental cost to 2022, zero thereafter</td>
<td>constant % of incremental cost to 2022, 90% thereafter</td>
<td>constant % of incremental cost to 2030</td>
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</table>

#### FUEL EFFICIENCY INCREASE FROM 2017 TO 2030 (DIESEL)

| GVWR3 | 23% | 23.5% | 23.5% |
| GVWR4and5 | 23% | 28.2% | 28.2% |
| GVWR6 | 25% | 25.8% | 25.8% |
| GVWR7 | 22.5% | 22.90% | 22.90% |
| GVWR8 Single unit (straight) | 24.40% | 24.90% | 24.90% |
| GVWR8 In-state Tractor-trailer | 26.7% | 27.30% | 27.30% |
| GVWR8 Interstate tractor-trailer | 30.70% | 31.40% | 31.40% |
| GVWR8 Refuse / Recycling | 9% | 9.20% | 9.20% |

#### FORECAST (ZEV STOCK, 2030)

| GVWR3 | 166 | 3,159 | 7,107 |
| GVWR4and5 | 842 | 704 | 8,021 |
| GVWR6 | 269 | 3,830 | 5,173 |
| GVWR8 In-state Tractor-trailer (battery) | 5 | 2,105 | 4,901 |
| GVWR8 In-state Tractor-trailer (catenary) | 76 | 1,852 | 2,108 |

#### INCREMENTAL ZEV VEHICLE PRICE

| GVWR3 | $40,235 | $35,225 | $30,710 |
| GVWR4and5 | $59,749 | $52,461 | $45,893 |
| GVWR6 | $88,751 | $79,474 | $71,115 |
| GVWR8 In-state Tractor-trailer | $253,728 | $233,838 | $204,210 |
Annual Miles per Truck by Class and Age
Estimated from 2017 California Vehicle Inventory and Use Survey
# Fuel Types Applied to Truck Classes

<table>
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<th>O – OEM</th>
<th>A – Aftermarket</th>
<th>P – Pilot production</th>
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<th>Truck Classes</th>
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<th>Diesel</th>
<th>Diesel Electric Hybrid</th>
<th>Battery Electric Vehicles</th>
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<th>Liquefied Natural gas (LNG)</th>
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GVWR: Gross Vehicle Weight Rating
California Energy Commission

Fuel Cost per Mile, Mid case
Class 4 and 5 trucks and vans

2019 2020 2021 2022 2023 2024 2025 2026 2027 2028 2029 2030

$0.40
$0.35
$0.30
$0.25
$0.20
$0.15
$0.10
$0.05
$0.00

diesel GVWR4and5
Diesel-Electric Hybrid GVWR4and5
electric GVWR4and5
natural gas GVWR4and5
propane GVWR4and5

gasoline GVWR4and5
California Energy Commission

Fuel Cost per Mile, Mid Case
In-state Class 8 Tractor-trailer
Incentivized Fuels, Market Share of New Truck Sales
In-state Class 8 Tractor-trailer
Incentivized Battery Electric Truck Stock

Thousands

LOW Total  MID Total  HIGH Total

2018 2019 2020 2021 2022 2023 2024 2025 2026 2027 2028 2029 2030
Incentivized Diesel-Electric Hybrid Truck Stock
Incentivized Natural Gas Truck Stock

![Graph showing the trend of incentivized natural gas truck stock from 2019 to 2030. The graph indicates a steady increase over the years, with different color bars representing low, mid, and high total stock.]
Hydrogen Truck Stock Forecast

2019 2020 2021 2022 2023 2024 2025 2026 2027 2028 2029 2030

Low
Mid
High

California Energy Commission
Hydrogen Bus & Truck Stock Forecast: Mid Case

- Bus
- Truck

Comparison of hydrogen bus and truck stock forecast from 2019 to 2030, showing projected growth over time.
Truck Diesel Consumption

Diesel consumption declines in all Cases
Under Consideration for the Revised Forecast

- Incentive levels and duration will be updated
- Update to GSP economic data for activity and service trucks
- Possible inclusion of announced truck prices as an Aggressive or Bookend case
- Revisit battery prices for battery-electric trucks
- More?
Questions?

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