ZEV Scenarios and Methods, 2019-2030

DAWG Transportation Meeting

November 14, 2019

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Transportation Energy Forecasting Unit
Demand Analysis Office
Energy Assessments Division
Overview

• CEC Transportation Forecasting Methods and Scenarios
• CEC Revised ZEV Forecasts
• Other Studies & Scenarios
• Pathway Scenarios
• 2030 Comparisons
# Demand Forecasting Cases: Electricity Centric

<table>
<thead>
<tr>
<th>Demand Case</th>
<th>Population Growth</th>
<th>Income Growth</th>
<th>Fuel Prices</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Petroleum Fuels</td>
</tr>
<tr>
<td>High Demand</td>
<td>High</td>
<td>High</td>
<td>High</td>
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<tr>
<td>Mid Demand</td>
<td>Mid</td>
<td>Mid</td>
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<tr>
<td>Low demand</td>
<td>Low</td>
<td>Low</td>
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</tbody>
</table>
## 2019 IEPR Light Duty PEV Scenarios

<table>
<thead>
<tr>
<th>INPUTS</th>
<th>Low</th>
<th>Mid</th>
<th>High</th>
<th>Aggressive</th>
<th>Bookend</th>
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</thead>
<tbody>
<tr>
<td><strong>PREFERENCES</strong></td>
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<tr>
<td>Consumers’ PEV</td>
<td>Constant at 2017 Level</td>
<td>Increase with PEV market growth</td>
<td>Increase with PEV market growth</td>
<td>Increase with PEV market growth</td>
<td>Increase with PEV market growth</td>
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<tr>
<td>Preference</td>
<td></td>
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<tr>
<td><strong>INCENTIVES</strong></td>
<td></td>
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<tr>
<td>Federal Tax Credit</td>
<td>Eliminated after 2019</td>
<td>Decreasing starting 2019</td>
<td>Decreasing starting 2019</td>
<td>Decreasing starting 2019</td>
<td>Decreasing starting 2019</td>
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<tr>
<td>State Rebate</td>
<td>To 2025</td>
<td>To 2025</td>
<td>To 2025</td>
<td>To 2030</td>
<td>To 2030</td>
</tr>
<tr>
<td>HOV Lane Access</td>
<td>To 2021</td>
<td>To 2023</td>
<td>To 2025</td>
<td>To 2030</td>
<td>To 2030</td>
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<tr>
<td><strong>FUEL PRICES</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Electricity Rates</td>
<td>Residential &amp; Commercial Rates</td>
<td>Residential &amp; Commercial Rates</td>
<td>Residential &amp; Commercial Rates</td>
<td>Residential &amp; Commercial Rates</td>
<td>Off-Peak rate for Residential</td>
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<tr>
<td><strong>ATTRIBUTES</strong></td>
<td></td>
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<tr>
<td>Number of Models</td>
<td>PEV models available in 14 of 15 CEC LDV classes</td>
<td>PEV models available in 14 of 15 CEC LDV classes</td>
<td>PEV models available in 15 of 15 CEC LDV classes</td>
<td>PEV models available in 15 CEC LDV classes</td>
<td>Models available: BEV in 15, PHEV in 15, FCV in 8, PHFCV in 7 CEC LDV classes</td>
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<tr>
<td>Available in 2030</td>
<td></td>
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<tr>
<td>Vehicle / Battery</td>
<td>PEV prices based on battery price declining to ~$120/kWh</td>
<td>PEV prices based on battery price declining to ~$100/kWh</td>
<td>PEV prices based on battery price declining to ~$80/kWh</td>
<td>PEV prices based on battery price declining to ~$70/kWh</td>
<td>PEV prices based on battery price declining to ~$62/kWh</td>
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<tr>
<td>Price (by 2030)</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Max EV Range (2030)</td>
<td>~333 miles</td>
<td>~341 miles</td>
<td>~341 miles</td>
<td>~341 miles</td>
<td>~341 miles</td>
</tr>
<tr>
<td>Refuel Time (2030)</td>
<td>15 - 21 min</td>
<td>15 - 21 min</td>
<td>10 - 16 min</td>
<td>10 - 16 min</td>
<td>10 - 16 min</td>
</tr>
<tr>
<td>Time to Station</td>
<td>7-8 min</td>
<td>Same as gasoline</td>
<td>Same as gasoline</td>
<td>Same as gasoline by 2025</td>
<td>Same as gasoline by 2025</td>
</tr>
<tr>
<td>(2030)</td>
<td></td>
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<tr>
<td>Forecast</td>
<td></td>
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<tr>
<td>ZEV Stock (2030),</td>
<td>2.8</td>
<td>3.7</td>
<td>4.4</td>
<td>5.2</td>
<td>5.5</td>
</tr>
<tr>
<td>Millions</td>
<td></td>
<td></td>
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</tbody>
</table>
California Energy Commission

Studies & Scenarios of Future

Start from Present, with No Specified Desirable End Point

- **Forecasts** use formal quantitative modelling to predict likely futures based on sound projections of inputs and drivers, or current trends, reflecting uncertainties.
- **Managed Forecast** makes adjustment to the baseline forecasts to reflect the impact of additional elements for resource planning purpose. Example: CEC’s Additional Achievable Energy Efficiency (AAEE) forecast.

Start with a Predetermined Desirable ‘End’ Point

- **Planning Scenarios** describe a specific sequence of actions to meet a specific target at some point in future. Example: SCAQMD Planning Exercise.
- **Pathway Scenarios** investigate possible pathways to the desirable end point. Examples: E3 deep decarbonization study, SCE’s Pathway 2045.
Forecasts & Pathways

Forecasts

- 2020
- 2030 High
- 2030 Mid
- 2030 Low

Pathways

- 2020
- 2030 Target

Time
Pathway Scenarios
Same Model, Same Goals, Multiple Pathways

- Energy & Environmental Economics (E3)’s PATHWAY model has been used in multiple analysis for CARB, CEC, SCE and others.

- PATHWAY is an economy-wide energy supply, demand and GHG emissions accounting tool. It can be used to evaluate long-term decarbonization plans for reaching statewide goals.
Electricity Demand by Sector: Transportation Electricity Grows the Load, with a Third Dedicated to Hydrogen Production by 2050.

Source: E3 Deep Decarbonization in a High Renewables Future - Implications for Renewable Integration and Electric System Flexibility, June 20, 2018
Energy Commission Workshop
Energy Consumption Pathway by Fuel Type: Energy Efficiency, Clean Energy and Fossil Fuel Reductions to Meet 2045 GHG Goals (SCE, Pathway 2045)

Electricity Consumption Pathway by Sector and Source: Transportation Electrification Growing the Load (SCE Pathway 2045)

2030 ZEV Population: Goals & Forecasts

(Millions of Vehicles)

<table>
<thead>
<tr>
<th>Scenario</th>
<th>ZEV (Millions)</th>
<th>FCEV (Millions)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CEC Revised 2019 High Case</td>
<td>4.5</td>
<td>0.19</td>
</tr>
<tr>
<td>CEC Revised 2019 Bookend Case</td>
<td>5.5</td>
<td>0.42</td>
</tr>
<tr>
<td>SCE Pathway**</td>
<td>7.9</td>
<td>0.34</td>
</tr>
<tr>
<td>E3 Pathway* High Electrification</td>
<td>5.9</td>
<td>0.76</td>
</tr>
<tr>
<td>2017 ARB Scoping Plan Update</td>
<td>4.2 ZEV</td>
<td></td>
</tr>
</tbody>
</table>

*Source: E3 Deep Decarbonization in a High Renewables Future - Implications for Renewable Integration and Electric System Flexibility, June 20, 2018 Energy Commission Workshop

How Many Hydrogen Vehicles?

• With a more advantageous range for long distance travel hydrogen can be used for both LDVs as well as MD/HDV travel.
• E3’s 2018 decarbonization pathways included a high electrification scenario, with almost a third of the transportation electricity originating from production of enough hydrogen to supply 0.8 million light duty FCEVs in 2030.
• Light duty FCEVs in the CEC’s current high demand forecast shows about 187,000 in 2030, and about 420,000 in the bookend case.
• SCE’s Pathway 2045 shows 13% of LDV, 5% of MDV and 20% of HDV trucks will be fueled by hydrogen, in 2045.
Green Hydrogen

• Prior legislation requires 1/3 of hydrogen produced by state-funded station to be made from renewables.
• SB 662 (Archuleta) requires the CPUC and the Energy Commission to consider opportunities to increase grid-responsive production of green electrolytic hydrogen for use in transportation sector, and incorporate “green electrolytic hydrogen” into various transportation electrification definitions.
• All this translates into more electricity demand, as E3 Deep Carbonization Pathway shows, whether the electricity is grid supplied or generated behind the meter.
Age Distribution of Light & Heavy Duty Vehicles

Cumulative Distribution of Vehicle Age, 2010-2017

Source: Energy Commission analysis of DMV data
Comments?
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Behavioral Light Duty Vehicle Choice Models

Statewide Light Duty Vehicle Demand Forecast by 7 fuel types, including PHEV and BEVs, and 15 different vehicle classes.
California Energy Commission

Statewide Light Duty VMT & Energy Demand Forecasting Models

- Government Model VMT and Fuel Demand Forecast by Fuel Type
- Rental Model VMT and Fuel Demand Forecast by Fuel Type
- Commercial (CVC) Model VMT & Fuel Demand Forecast by Fuel Type
- Residential (PVC) LDV Forecast by Fuel Type
- Urban Travel Demand Models
- Intercity Travel Demand Model

Statewide Light Duty Vehicle VMT & Fuel Demand Forecast by 7 fuel/technology types, including: gasoline, diesel, E85, electricity & Hydrogen
Forecasting Zone (FZ) Distribution of Statewide PEV Population Forecast, by Sector
Forecasting Zone (FZ) Distribution of Light duty PEV electricity Consumption

EMFAC County Share of Statewide VMT

FZ Share of Statewide VMT

FZ Share of Statewide PEV

FZ Light Duty PEV Electricity Consumption

Statewide Light Duty PEV Electricity Consumption