CEC Investments in Alternative Transportation Fuels/Technology

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Presentation to
The National Academies of Sciences, Engineering and Medicine
Meeting on Fuel Economy Technologies for the 2025-2035 Timeframe
Davis, California
January 24, 2019
California Transportation Statistics

**VEHICLES**
- 28.9 millions cars
- 1 million trucks

**GHG EMISSIONS**
- 440.4 MMT CO$_2$e (2015)
- ~50% from transportation

**AIR QUALITY**
- Severe Non-Attainment for Ozone
- San Joaquin Valley & South Coast

**PETROLEUM CONSUMPTION**
- 13.9 billion gallons gasoline
- 3.3 billion gallons diesel
Although finished gasoline consumption declined 8.9 percent between 2004 and 2012, strong recovery from the recession and continued population growth have pushed consumption up by 6.9 percent between 2012 and 2016, edging closer to a record high.

Ethanol use has increased from an average concentration of 3.75 percent by volume in 2003 to 10.09 percent by volume during 2016.
On-Road Gasoline Demand

Billions of Gallons


High AFV
High Energy Demand
High Petroleum Demand
Mid Energy Demand
Low Energy Demand
Low Petroleum Demand
Guiding Policies and Regulations

**EXECUTIVE ORDER B-16-12**
**SENATE BILL 1275 (2014)**
**EXECUTE ORDER B-48-18**

1 million ZEVs by 2023
1.5 million ZEVs by 2025
5 million ZEVs by 2030

250,000 EV chargers by 2025
200 hydrogen stations by 2025

**SENATE BILL 32 (2016)**
**EXECUTIVE ORDER S-3-05**

GHG ↓ 40% by 2030
GHG ↓ 80% by 2050
(1990 baseline)

**CLEAN AIR ACT**

NOₓ ↓ 80% by 2023
## Investment Plan Update for the Alternative and Renewable Fuel and Vehicle Technology Program

California Energy Commission
LEAD COMMISSIONER REPORT

### 2018-2019

<table>
<thead>
<tr>
<th>Funded Activity</th>
<th>Cumulative Awards to Date (in Millions)*</th>
<th># of Projects or Units</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Alternative Fuel Production</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Biomethane Production</td>
<td>$62.7</td>
<td>21 Projects</td>
</tr>
<tr>
<td>Gasoline Substitutes Production</td>
<td>$32.1</td>
<td>15 Projects</td>
</tr>
<tr>
<td>Diesel Substitutes Production</td>
<td>$68.3</td>
<td>23 Projects</td>
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<tr>
<td><strong>Alternative Fuel Infrastructure</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electric Vehicle Charging Infrastructure**</td>
<td>$79.9</td>
<td>7,695 Charging Stations</td>
</tr>
<tr>
<td>Hydrogen Refueling Infrastructure</td>
<td>$132.4</td>
<td>64 Fueling Stations</td>
</tr>
<tr>
<td>E85 Fueling Infrastructure</td>
<td>$13.7</td>
<td>158 Fueling Stations</td>
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<tr>
<td>Upstream Biodiesel Infrastructure</td>
<td>$4.0</td>
<td>4 Infrastructure Sites</td>
</tr>
<tr>
<td>Natural Gas Fueling Infrastructure</td>
<td>$21.9</td>
<td>64 Fueling Stations</td>
</tr>
<tr>
<td><strong>Alternative Fuel and Advanced Technology Vehicles</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Natural Gas Vehicle Deployment***</td>
<td>$65.8</td>
<td>3,149 Vehicles</td>
</tr>
<tr>
<td>Propane Vehicle Deployment</td>
<td>$6.0</td>
<td>514 Trucks</td>
</tr>
<tr>
<td>Light-Duty ZEV Deployment (including CVRP Supplemental Funding)</td>
<td>$28.0</td>
<td>10,700 Cars</td>
</tr>
<tr>
<td>Hybrid and Zero-Emission Truck and Bus Voucher Incentive Project Supplemental Funding</td>
<td>$4.0</td>
<td>150 Trucks</td>
</tr>
<tr>
<td><strong>Advanced Technology Freight and Fleet Vehicles</strong>**</td>
<td>$126.8</td>
<td>48 Demonstrations</td>
</tr>
</tbody>
</table>

### Related Needs and Opportunities

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<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>Manufacturing</td>
<td>$46.5</td>
<td>21 Manufacturing Projects</td>
</tr>
<tr>
<td>Emerging Opportunities</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Workforce Training and Development</td>
<td>$31.9</td>
<td>17,440 Trainees</td>
</tr>
<tr>
<td>Fuel Standards and Equipment Certification</td>
<td>$3.9</td>
<td>1 Project</td>
</tr>
<tr>
<td>Sustainability Studies</td>
<td>$2.1</td>
<td>2 Projects</td>
</tr>
<tr>
<td>Regional Alternative Fuel Readiness</td>
<td>$9.6</td>
<td>43 Regional Plans</td>
</tr>
<tr>
<td>Centers for Alternative Fuels</td>
<td>$5.8</td>
<td>5 Centers</td>
</tr>
<tr>
<td>Technical Assistance and Program Evaluation</td>
<td>$5.5</td>
<td>n/a</td>
</tr>
</tbody>
</table>

**Total** $750.9
Projects To-Date

As of March 1, 2017
## Projections for Statewide PEV Charger Demand

### Demand for Level 2 Destination (Workplace and Public) Chargers (The Default Scenario)

<table>
<thead>
<tr>
<th></th>
<th>Total PEVs</th>
<th>Lower Estimate (Chargers)</th>
<th>Higher Estimate (Chargers)</th>
</tr>
</thead>
<tbody>
<tr>
<td>As-of-2017</td>
<td>239,207</td>
<td>20,000</td>
<td>28,000</td>
</tr>
<tr>
<td>By-2020</td>
<td>650,000</td>
<td>50,000</td>
<td>70,000</td>
</tr>
<tr>
<td>By-2025</td>
<td>1,250,000</td>
<td>100,000</td>
<td>125,000</td>
</tr>
</tbody>
</table>

### Demand for DC Fast Chargers (The Default Scenario)

<table>
<thead>
<tr>
<th></th>
<th>Total BEVs</th>
<th>Lower Estimate (Chargers)</th>
<th>Higher Estimate (Chargers)</th>
</tr>
</thead>
<tbody>
<tr>
<td>As-of-2017</td>
<td>133,386</td>
<td>2,000</td>
<td>6,000</td>
</tr>
<tr>
<td>By-2020</td>
<td>350,000</td>
<td>5,000</td>
<td>13,000</td>
</tr>
<tr>
<td>By-2025</td>
<td>700,000</td>
<td>9,000</td>
<td>25,000</td>
</tr>
</tbody>
</table>
Electric Vehicle Infrastructure Deployment

Program Funding:
$64.6 M for infrastructure

<table>
<thead>
<tr>
<th>Charging Outlets</th>
<th>Private</th>
<th>Public</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Installed</td>
<td>4,346</td>
<td>3,257</td>
<td>7,603</td>
</tr>
<tr>
<td>Planned</td>
<td>57</td>
<td>1,026</td>
<td>1,083</td>
</tr>
<tr>
<td>Total</td>
<td>4,403</td>
<td>4,283</td>
<td>8,686</td>
</tr>
</tbody>
</table>

California Electric Vehicle Infrastructure Project:
$38.8 M for incentive projects

Map Excludes Residential Chargers

http://energy.ca.gov/transportation/arfvtp/project_map.html

http://www.CALeVIP.org
All Public EV Charging in California

Current Operational Statewide
(As of August 14, 2018)

4,540 public charging sites
16,640 public charging outlets

- Chargers in California
- Publicly Accessible
- Outlets by type:
  - 465 Level 1 outlets
  - 14,333 Level 2 outlets
  - 1,842 DC Fast outlets

Map from US DOE Alternative Fuels Data Center
https://www.afdc.energy.gov/fuels/electricity_locations.htm
Smart EVSE costs overlap with basic EVSE. Additional functions ensure cost-effective operations.

Incremental cost recovered in ~3 months of CA average EV driving with -$0.10/kWh time-of-use arbitrage.
Improving technology readiness of vehicle-to-grid charging equipment

Cost of Bidirectional (V2G) DC EVSE

- A, Gen. 2013
- A, Gen. 2018
- B, AC charge & DC discharge
- C, v1
- D, Only Unidirectional

Original Equipment Manufacturer

Capacity Cost $2018/kW

- ↓50%
- +37%
Innovative charging systems are here (and more are coming)!

Clockwise from top left:
4. https://www.youtube.com/watch?v=V8xL4gZohuA
Current Hydrogen Infrastructure Status

- 35 open hydrogen refueling stations
- 64 stations funded
- 3 renewable hydrogen production facilities funded
Electric Vehicle Charging Infrastructure

$94.2 million
Proposed Allocation

76,000 – 128,000 chargers installed by 2025
(Expected to be installed under a business-as-usual scenario; from all sources)

Shortfall of 122,000 – 174,000 chargers expected by 2025

Estimated cost: $963 million to $2.89 billion
(In addition to currently planned and expected public and private investments)
Hydrogen Refueling Infrastructure

$20 million
Proposed Allocation

Funding support for additional refueling stations
- Complete initial network of up to 100 stations
- Provide sufficient fueling capacity into 2022
- Enable further FCEV sales throughout the state

Continued funding for Operations & Maintenance support
Manufacturing & Workforce Development for Zero-Emission Vehicle Infrastructure

$8.5 million
Proposed Allocation

Support for ZEV infrastructure industry & workforce needs

Encourage new or expanded in-state manufacturing facilities

Goals Supported:
- Indirect support for other ARFVTP project types
- Equitable economic development
Low-Carbon Fuel Production and Supply

$25 million
Proposed Allocation

Liquid and gaseous fuels (non-petroleum)

Focus on waste-based & renewable feedstocks

Pilot, demonstration, and commercial scale

Renewable hydrogen production
Biomass and renewable electricity feedstocks

Proposed funding source:
Greenhouse Gas Reduction Fund
Low Rolling Resistance Tire Efficiency (AB 844)

Requires CEC to develop regulations:

• Rolling resistance reporting system for LDV tire manufacturers (Replacement tires) – rating system to compare fuel economy characteristics

• Adopt minimum fuel economy standards for tires (if feasible)
  – Technical feasibility/cost
  – Tire safety
  – Tire life
  – Tire recycling

• Estimated benefits
  – Gasoline fuel savings up to 300 million gallons per year
  – Up to 4% fuel economy improvement
Energy Technology Market Entry

Market Challenges:
- Level playing field
- Transparent decision-making process
- Institutional/regulatory certainty
- Competetive pricing
- Experienced management team
- Technology
- Customer awareness

Commercialization:
- Export Program
- Renewables incentives
- BACT
- Wind performance reporting
- Capturing externality benefits
- Business plan
- Investor confidence
- Market strategy
- Project financing at competitive terms

Application research:
- PIER
- USDOE
- NREL
- LBL

Basic Research:
- USDOE
- NSF
- Labs

Market Penetration

Time

Exponential growth
Slow/moderate growth
Valley of Death