California’s Advanced Clean Cars Midterm Review

March 24, 2017
Advanced Clean Cars

Approved as an integrated regulatory package in 2012

- LEV III Criteria and GHG Standards
  - 75% reduction in fleet average NMOG + NOx emissions
  - 90% reduction in PM emission standard
  - 34% reduction in GHG emissions

- ZEV
  - More ZEVs and PHEVs
Meeting long term emissions targets

<table>
<thead>
<tr>
<th>Climate Goals</th>
<th>Air Quality Standards</th>
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<tbody>
<tr>
<td>2015</td>
<td>2020</td>
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<tr>
<td>2020 GHG Emission Target</td>
<td>2025</td>
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<td>2030 GHG Emission Target</td>
<td>2030</td>
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<td>2035</td>
<td>2040</td>
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<tr>
<td>2045</td>
<td>2050</td>
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<tr>
<td>2050 GHG Emission Target</td>
<td>2015</td>
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</tbody>
</table>

- LEV III – Criteria and GHG: Improving Conventional Vehicle Technology
- ZEV Program: Accelerating Advanced Technology Development

2015 - 75 ppb 8-hr Ozone Attainment
2020 - 70 ppb 8-hr Ozone Attainment
2025 - 75 ppb 8-hr Ozone Attainment
2030 - 70 ppb 8-hr Ozone Attainment
2035 - 75 ppb 8-hr Ozone Attainment
2040 - 70 ppb 8-hr Ozone Attainment
2045 - 75 ppb 8-hr Ozone Attainment
2050 - 70 ppb 8-hr Ozone Attainment
Advanced Clean Cars Midterm Review and the Federal Process

- LEV Criteria
  Air Quality Improvements
- ZEV Technology Advancement
- LEV GHG
  Greenhouse Gas Reductions
- Midterm Evaluation of One National Program

NHTSA

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
Inter-agency Coordination on Midterm Evaluation of One National Program

2012

January: ACC 2017-2025 standards

October: Federal 2017-2025 GHG standards

November: CA GHG “deemed to comply” adopted

2013-2016

External Research, Survey and Analysis, In-House Testing

Inter-agency coordination

2016

July: Joint Technical Assessment Report (TAR)

September: ACC Symposium

2017

January: EPA Final Determination

MTR Report

March: Announced Reconsideration of Final Determination
Light-duty GHG Standards

Midterm Review: Focus on the MY2022 - 2025 Federal GHG standards
Manufacturers are over-complying with current GHG standards

Actual Compliance

Standards calculated based on sales from the six large volume manufacturers subject to CA GHG regulations for MY 2012-2015 including credits.
Technology has evolved rapidly to meet the standards

- Advanced engines and transmissions
- Vehicle light-weighting
- Improved aerodynamics
- Low rolling resistance tires
- Stop-start and advanced stop-start (e.g., 48 Volt) technology

~21% of the 2016 fleet already complies with 2020 standards
Future standards can be met with conventional technology at reduced cost.

Gasoline w/ Adv. Stop-Start: 18%

Strong Hybrid: 2%

Plug-in Hybrid Vehicles: 2%

Electric Vehicles: 3%

Advanced Gasoline: 75%

Incremental vehicle costs to meet 2025 stds

<table>
<thead>
<tr>
<th></th>
<th>2012 EPA Rulemaking</th>
<th>2016 Proposed Determination</th>
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<tbody>
<tr>
<td>$1,163</td>
<td>$875</td>
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</table>

Costs in 2015$

Proposed Determination costs represent most recent analysis, using newer data and assumptions than used for the draft TAR.
California on target for fleet GHG reductions

Even with increasing sale of trucks, California is still on track to meet targeted GHG reductions.

CO₂ Emission Target (g/mi)

- **2012 Scenario**
- **2016 Updated Scenario**

**153 to 164 g/mi in 2025**
Issues Raised by Industry

Industry: Analysis overestimates efficiency/underestimates needed technology

- More technology required, including stronger electrification, which means higher costs
- Consumer acceptance/demand, especially of stronger electrification, is inadequate

CARB Response: Data well grounded in actual testing and analysis concluded higher levels of technology are not needed

- Alternative technology evaluations confirmed strong electrification not needed
- Electrified sales in CA already near levels projected for 2025
Staff Recommendation

**Review Question:** Are the model year 2022 - 2025 Federal GHG standards appropriate?

**Recommendation:** Yes, analysis affirmed current federal standards are appropriate, and CARB recommends continued participation in the National Program through 2025, provided no future changes weaken expected benefits in California.
Continue monitoring other activities

• Reconsideration of federal re-opening of Final Determination
• Canada’s midterm review
• Global activities
Analysis of National Fleet

Larger fraction of truck sales projected in 2025 results in a higher fleet CO₂ target.

<table>
<thead>
<tr>
<th></th>
<th>2025 Fleet Average</th>
<th>Incremental Vehicle Costs</th>
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<tbody>
<tr>
<td>175 g/mi</td>
<td>-875</td>
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<tr>
<td>163 g/mi</td>
<td>~1,375</td>
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</tbody>
</table>
1 mg/mi Particulate Matter (PM) Standard

Midterm Review:
Is it feasible as scheduled for MY2025?

Midterm Review:
Is it measurable?
PM Measurement Evaluation
Staff Recommendation

**Review Question:** Can we accurately measure PM emissions at 1 mg/mi?

**Recommendation:** Yes, as reported to Board in 2015, mass-based measurement method is accurate and most appropriate.
Some vehicles already meeting future PM standards

- Many already meeting 3 mg/mi
- Further refinement needed for many to meet 1 mg/mi
Combustion technology evolving to meet 1 mg/mi standard

Focus on fuel injection system and combustion chamber design
Gasoline particle filters provide additional technology path

- Prototype catalyzed GPFs tested
  - Can control PM levels below 1 mg/mi on FTP
  - Limited use worldwide

### PM Removal Efficiencies

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<thead>
<tr>
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<th>FTP</th>
<th>US06</th>
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<tbody>
<tr>
<td>F-150</td>
<td>88%</td>
<td>72%</td>
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<tr>
<td>Malibu</td>
<td>88%</td>
<td>54%</td>
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</tbody>
</table>

### Average FTP PM Mass (mg/mi)

- **2016 CHEVY MALIBU**
  - Without GPF: 5.5
  - With GPF: 0.6

- **2015 FORD F150**
  - Without GPF: 7
  - With GPF: 0.8
Real-world PM control varies

More aggressive driving can result in higher emissions.

Average PM Mass Results

- Standard Test Cycle
- More Aggressive Driving

<table>
<thead>
<tr>
<th>Model</th>
<th>Average PM Mass (mg/mi)</th>
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<tbody>
<tr>
<td>2013 Prius</td>
<td>0.0</td>
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<tr>
<td>2015 Prius</td>
<td>0.5</td>
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<tr>
<td>2016 VW Jetta TSI</td>
<td>1.0</td>
</tr>
<tr>
<td>2014 Mercedes CLA</td>
<td>1.5</td>
</tr>
<tr>
<td>2013 Chevy Volt</td>
<td>2.0</td>
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<tr>
<td>2016 Toyota Tacoma</td>
<td>2.5</td>
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<tr>
<td>2014 Mini Cooper S</td>
<td>3.0</td>
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<tr>
<td>2016 Honda Accord</td>
<td>3.5</td>
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<tr>
<td>2015 Subaru BRZ</td>
<td>4.0</td>
</tr>
<tr>
<td>2016 Hyundai Sonata</td>
<td>4.5</td>
</tr>
<tr>
<td>2014 Ford Fiesta</td>
<td>5.0</td>
</tr>
<tr>
<td>2015 Mazda 3</td>
<td>5.5</td>
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</tbody>
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PM Staff Recommendations

**Review Question:** Is the 1 mg/mi standard feasible by 2025?

**Recommendation:** Yes, the standard is feasible and the current implementation schedule maintains necessary lead time to refine engine and injection system designs.

**Additional Recommendation:** Develop additional PM standards, to supplement the 1 mg/mi standard, to better ensure robust PM control in real world driving conditions.
Zero Emission Vehicle (ZEV) Regulation

Midterm Review:
Are the ZEV requirements in California appropriate for continuing to help develop the ZEV market?

Midterm Review:
Are the ZEV requirements in Section 177 ZEV states appropriate for continuing to help develop the ZEV market?

Midterm Review:
How should PHEVs be treated in the ZEV regulation?
A growing ZEV market

CA + Section 177 New Sales

Today's Model Offerings

- 10 PHEV
- 12 BEV
- 1 BEVx
- 3 FCEV
Manufacturers are over-complying

California

Section 177 States

Credits

2012 2013 2014 2015 2016 (proj) 2017 (proj)

Manufacturers are over-complying California

Credits

2012 2013 2014 2015 2016 (proj) 2017 (proj)

Manufacturers are over-complying Section 177 States
Credit banks provide insurance against future requirements.
Updated ZEV Compliance Scenarios

CA + S177 ZEV State Volumes

Cumulative ZEVs + PHEVs

Updates reflect:
- ✓ Increased electric range on BEVs and PHEVs
- ✓ Use of regulatory flexibilities
- ✓ Use of banked ZEV credits
- ✓ Misc. other updates (e.g., total new vehicle sales)
OEMs appear committed to electrification

Daimler to make more than 10 electric cars by 2025

Volvo Cars announces new target of 1 million electrified cars sold by 2025

Honda CEO – Takahiro Hachigo
Press Conference - February 2016

THE ELECTRIFICATION INITIATIVE OF THE VOLKSWAGEN GROUP

- >30 new pure-electric vehicles by 2025
- Annual unit sales of 2 to 3 million e-cars by 2025, equivalent to 20–25 percent of total sales

Hyundai-Kia's grand electrification plan

Korean brands aim to leapfrog past competitors with 26 models by 2020

Toyota Targets 90% Emissions Reduction by 2050 on Fuel Cells
Technology costs falling fast

Fuel cell system costs have fallen 57% from 2006 to 2015

Battery costs have fallen 73% from 2006 to 2015

Neither FCEV nor BEV cost parity anticipated with conventional gasoline technology by 2025
“Range is the most important feature to customers buying EVs, and we know that consideration increases significantly as range goes up.”

– Pam Fletcher, General Motors Executive Chief Engineer

Source: 2016 CVRP Ownership Survey
# Current and Future ZEV/TZEV Models by MY Year

![Chart showing Current and Future ZEV/TZEV Models by MY Year](chart.png)

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<td>Pickup Truck</td>
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<td>Van</td>
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<td>Standard SUV</td>
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<td>Small SUV</td>
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<td>Large Car</td>
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<tr>
<td>Mid-Size Car</td>
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**US Market Share (MY2015)**

- 0%
- 5%
- 10%
- 15%
- 20%
- 25%
- 30%
- 35%
- 40%

**KEY**

- Multiple Makes
- Electric Range (EPA Label)

**Notes:**

- ZEV/TZEV Models by MY Year
- Current and Future ZEV/TZEV Models by MY Year
- MY 2011 to MY 2018-21

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![chart.png](chart.png)
Section 177 State Flexibilities

- CA BEVs allowed to “travel” to S177 states through MY2017, creating credit banks for compliance
- Reduced requirements for PHEVs and BEVs through MY2020
  - Allowed if a few BEVs are delivered prior to 2018
- Pooling amongst states through MY2021 for compliance credits
Intermediate Volume Manufacturers (IVMs) can comply

- 2014: Board adopted flexibilities to ease requirements for IVMs
- 2017: All IVMs (Mazda, Subaru, Jaguar Land Rover, and Volvo) have announced electrified products (BEVs and PHEVs) to be released by MY2020

The overall industry is now shifting its electrification focus toward EVs. We are in the age where we cannot just go on launching EVs only as regulation compliance cars.

-Yasuyuki Yoshinaga, CEO, Fuji Heavy Industries (which owns Subaru)
## Sunsetting policies

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<tbody>
<tr>
<td>BEV travel provision expires</td>
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<td>Optional compliance path and overcompliance provisions expire</td>
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<tr>
<td>ZEV multipliers expire in GHG program</td>
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<td>AB 8 funding expires</td>
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<tr>
<td>ZEV upstream emission exemption expires in GHG program</td>
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### Further costs reductions needed

- **200-mile BEV:**
  - $13,000+ incremental cost
  
- **40-mile PHEV:**
  - $10,000+ incremental cost

Estimated MY2025 costs relative to MY2016 conventional ICE vehicle.
2018-2025 ZEV Requirements
Staff Recommendation

**Review Question:** Is the ZEV regulation appropriate as adopted for model year 2018 through 2025?

**Recommendation:** Yes. Maintain the current ZEV stringency through model year 2025 including the existing regulatory and credit structure in California, the Section 177 States, and for IVMs.
Plug-In vehicles and eVMT

Board direction

• How are plug-in vehicles used?
• Are they credited appropriately?
  • What are the criteria pollutant impacts?
  • What are the greenhouse gas impacts?

- Data collected from 8 OEMs
- Over 90,000 vehicles
- 11 different models
- Over 20 million miles of trip-level data
Credits are consistent with usage
Criteria Pollutant Considerations for PHEVs

- Testing found some real world engine starts can have significant emissions
  - 2-5x higher
- Vehicle technology improvements are needed to minimize emissions
PHEV eVMT usage depends on consumer behavior

“My main purpose for purchasing it was the HOV sticker. I'm very happy with the car, but I don't charge it very often. If it got more mileage off a charge, I would charge it more.”

-2013 Ford C-MAX Driver

“Love the car, more Level 2 destination chargers and ability to charge at home without pushing into the highest rate tiers are my biggest issues. Currently the price of gas is less than comparable charging cost (break even around $3-4/gal) so I don't charge much right now.”

-2013 Toyota Prius Plug-in Driver

Source: 2016 CVRP Ownership Survey, open-ended final comments
PHEV GHG emissions can be highly variable

- High PHEV Sales + Low eVMT
- High PHEV Sales + High eVMT
- Low eVMT
- High eVMT

±8% in GHG emissions based on driver habits

+15 to 60% GHG increase if much larger PHEV sales
PHEVs Role and Usage
Staff Recommendation

**Review Question:** Are PHEVs credited and treated appropriately in the ZEV regulation?

**Recommendation:** Yes. Maintain existing credit structure and credit caps for PHEVs through MY 2025
ZEV: Stakeholder Concerns

• Section 177 Dealers: concerned OEMs will require them to take delivery of more ZEVs than they can readily sell

• Auto Industry: concerned about PHEV credits, S177 state markets, support for complementary policies
Alternatives for increased ZEV stringency

MY 2022 through 2025:

• Increase stringency with focus on pure ZEVs (BEVs, FCEVs)
• Require PHEVs with greater all-electric functionality
• Add credit usage restrictions
New complementary policy actions needed to accelerate ZEV Market

<table>
<thead>
<tr>
<th>Challenge</th>
<th>Complementary Policy</th>
</tr>
</thead>
</table>
| Low consumer awareness                   | • New consumer education campaigns  
                                            • VW Appendix C: ZEV awareness campaign |
| Shortage of fueling infrastructure      | • SB 350: Electric utility investments  
                                            • VW Appendix C: Electric infrastructure investments  
                                            • Hydrogen grants for traditional energy firms |
2026 and beyond

Evolution of the light-duty vehicle emission program
Need large emission reductions beyond current programs

NOx, South Coast, All Sources

GHGs, Statewide LDV & HDV

Current Programs

2023 South Coast Target

2031 South Coast Target

SB 32 40% Reduction

Exec Order 80% Reduction
Mobile Source Strategy & Scoping Plan
Re-affirm Need for ZEVs & Clean Cars

By 2050, 100% sales of ZEVs and PHEVs

By 2030, 4M to 4.5M ZEVs and PHEVs on the road
Tracking published literature for 2026 and Beyond

American Lung Association (Oct 2016)
  • Large public health and climate benefits from ZEV fleet expansion

Environmental Defense Fund (Feb 2017)
  • Feasibility of 10-90 gCO2/mi reductions between 2025 and 2030

International Council on Clean Transportation (Mar 2017)
  • Feasibility of 4%-6% annual reductions in GHG emissions by 2030

Indiana University (Mar 2017)
  • Combined GHG and ZEV regulations can have long-run positive economic impacts
2026 and beyond: Thinking “Outside the Box”

Early considerations:
• Should fuels be addressed in the regulations?

Broader considerations:
• What is best structure of GHG and criteria emission stds to accelerate necessary technologies like ZEVs?
• Should vehicle regulations include elements for new transportation systems?
• Should the ZEV regulation be expanded to include heavier vehicles?
2026 and beyond: Guiding Principals and Approach

- Maximize emission reductions long-term cost effectively
- Maintain tech forcing requirements as long as barriers exist
- Learn from other jurisdictions, including Europe & Asia
- Consider transition from current rule to new rule
- Leverage partnerships
- Board proposal within 3-4 years for model year 2026 start
Midterm Review
Recommendations Summary

• Adopted MY 2022-2025 GHG standards remain appropriate
• PM standard is feasible but further action needed to ensure robust control
• Continue with existing technology-forcing ZEV requirements to develop the market
• Direct staff to immediately begin rule development for MY 2026 and beyond