

# GREEN TECH CONNECT FORUM

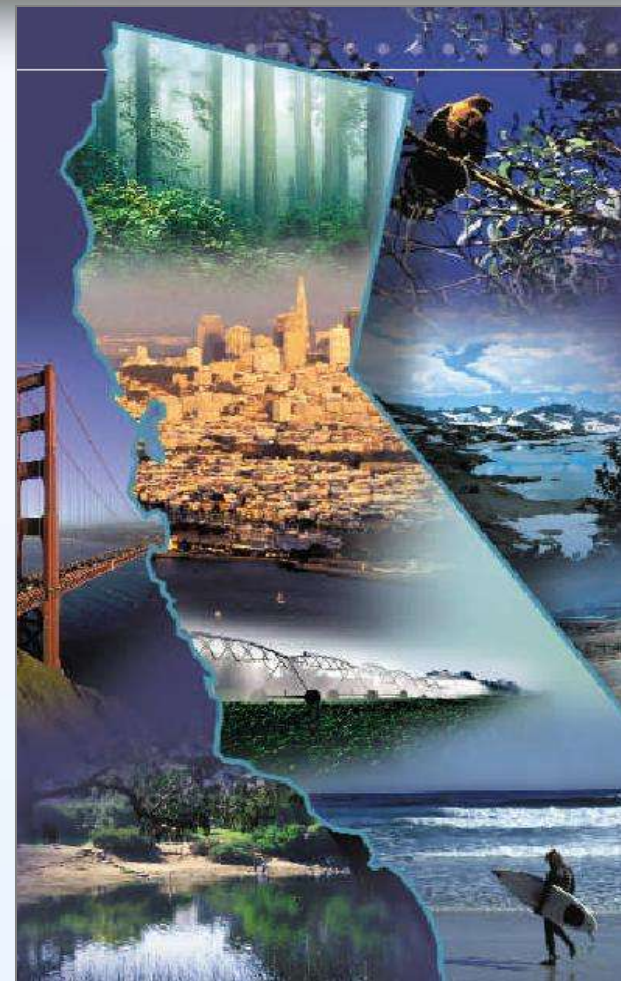
## On-Road Light Duty

Steve Albu

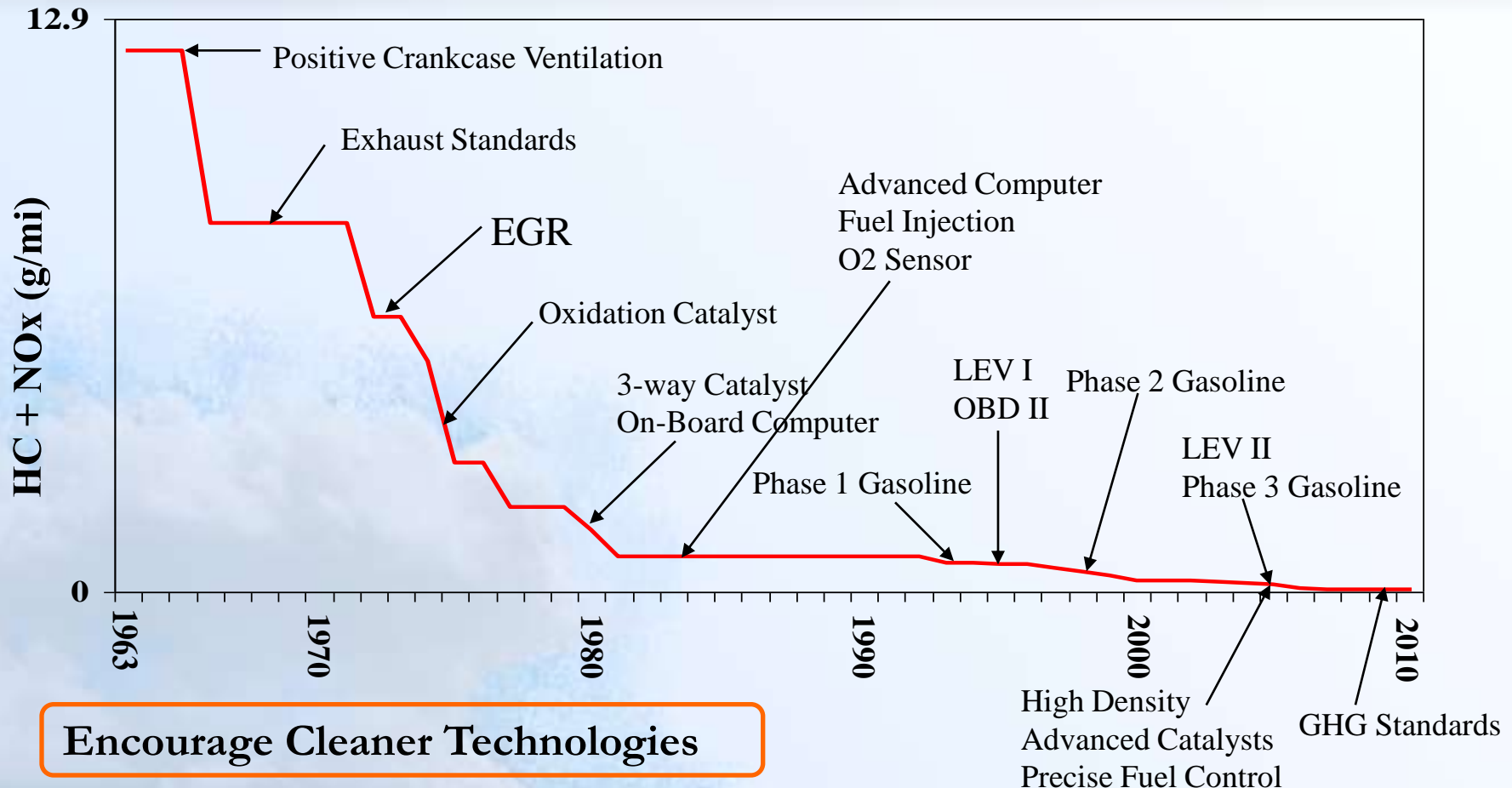
California Air Resources Board

Pasadena, California

August 3<sup>rd</sup>, 2009



# Evolution of Emission Standards (technology based)



# California Leadership

- “It is very important just to look at the history when it comes to the regulation of emissions in California...Consistently, California has hit the bar and then the rest of the country has followed”.

*Obama News Conference Announcing Environment and Energy Team | December 15, 2008*

# California Light Duty Motor Vehicle Future Regulations

- Low Emission Vehicle program - LEV III
  - Criteria emissions
    - Implementation 2014-2022
    - SULEV fleet average (0.030 g/mi NMOG+NOx)
  - GHG emissions
    - Implementation 2017-2025
    - Assumes most vehicles will have high degree of hybridization by end of phase-in
  - Board hearing summer 2010
- Zero Emission Vehicle program (ZEV)
  - Simplify program beginning in 2017
  - Include plug hybrid electric vehicles, pure electric vehicles, fuel cell vehicles only
  - Board hearing late 2010
- Future light duty technology primarily driven by need to reduce GHG emissions

# Future Powertrain Technology 2010-2016 (Mainstream)

- Downsized turbo engines w/gasoline direct injection (GDI)
  - GDI lowers combustion temperature → allows higher compression ratio
  - Smaller engines have reduced pumping losses, friction
  - Turbos boost performance
  - Very cost-effective



VW Turbocharged GDI Engine

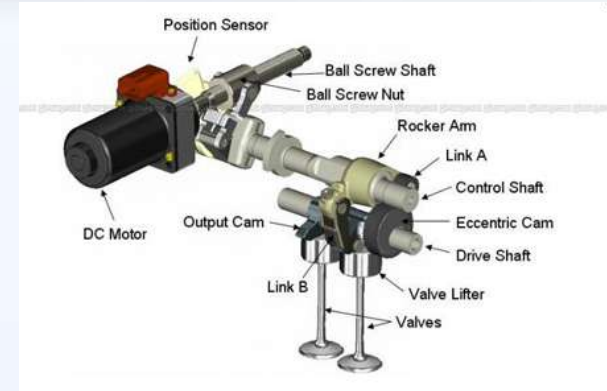


# Future Powertrain Technology (cont.)

## 2010-2016

### (Mainstream)

- Variable valve timing & lift
  - BMW Valvetronic, Nissan VVEL, Chrysler/Fiat Multi Air
  - Cylinder deactivation
    - Chrysler 300, Hemi V8
    - GM Chevrolet Malibu V6
    - Honda Odyssey V6



Nissan Variable Valve Event and Lift



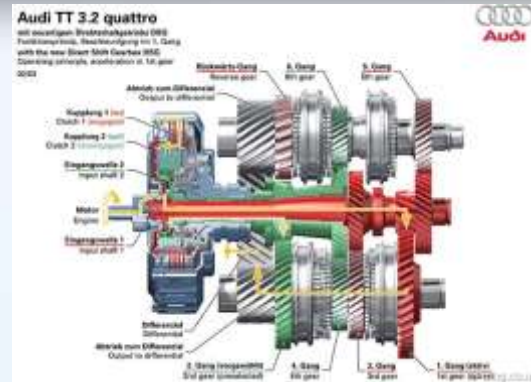
Chrysler Multi Displacement System

# Future Powertrain Technology (cont.)

## 2010-2016

### (Mainstream)

- Transmissions
  - Automated Manual
    - VW/Audi
  - CVT
    - Nissan, Chrysler
  - 6-8 Speed Automatics
    - Ford, GM, Mercedes, Lexus
  - Integrated Starter/Generator
    - Honda Accord/ Civic



VW Automated Manual



Nissan CVT



Honda ISG

# Future Powertrain Technology (cont.)

## 2010-2016

### (Mainstream)

- Miscellaneous technologies
  - Reduced vehicle weight
  - Electric power steering
  - Electric water pumps - BMW
  - Electric oil pumps - BMW
  - E85 Flex fuel vehicles
  - Lower tire rolling resistance
  - Improved aerodynamic drag
  - Low drag brakes

# Future Powertrain Technology (cont.)

## 2010-2016

### (Reduced Volumes)

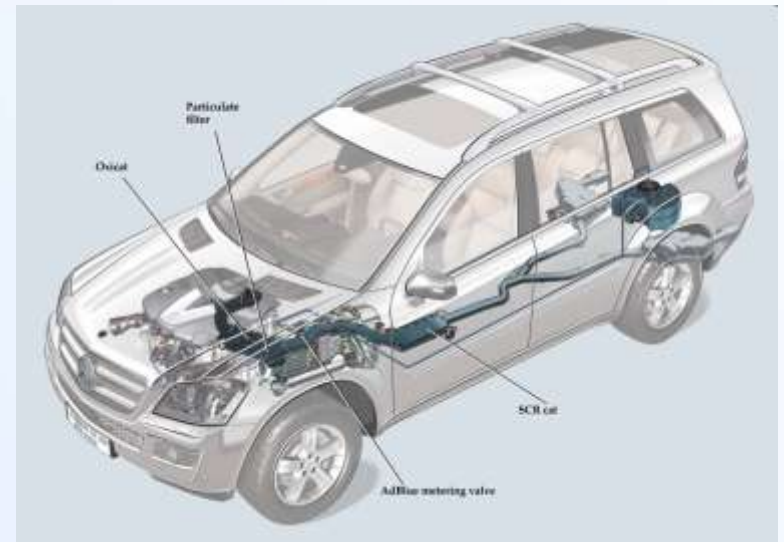
- Full gasoline hybrid electric vehicles
- Diesels
- Fuel cell vehicles
- Plug hybrid electric vehicles
- Battery electric vehicles



Honda Fuel Cell Clarity

# Future Powertrain Technology 2017-2025

- Gasoline hybrid electric vehicles
- Plug hybrid electric vehicles
- Battery electric vehicles
- Diesels
- Fuel cell vehicles



Mercedes Benz Bluetec

# Future Powertrain Technology (cont.)

## 2017-2025

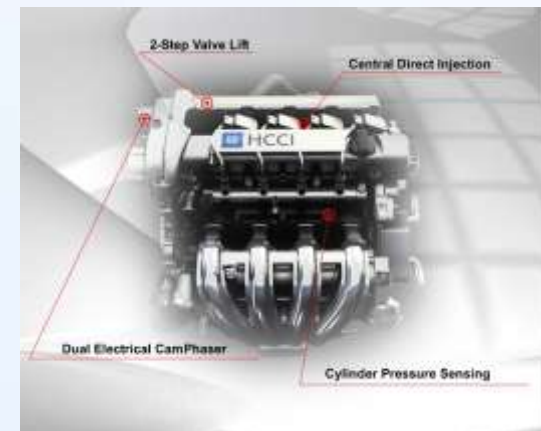
- Gasoline hybrid electric powerplants
  - Downsized, turbo GDI engines
  - Conventional engines with flexible valve control
  - Homogeneous charge compression ignition
  - Lean burn conventional engines
  - Diesel



Fiat Multi Air



Homogeneous Charge Compression Ignition



GM HCCI Engine

# Contacts/Information

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<http://www.arb.ca.gov/msprog/levprog/levprog.htm>

<http://www.arb.ca.gov/regact/grnhsgas/grnhsgas.htm>

<http://www.epa.gov/otaq/climate/regulations/420f09028.htm>

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