Environmentally Friendly Vehicles: Initiatives in the United States

Overview

- United States Program
  - Evolution of Emissions Standards
  - CAFE Program
  - Other
- California
  - Emission Reduction Strategy
  - Zero Emission Vehicle (ZEV) Regulation
  - Reducing Climate Change Emissions
  - The California Fuel Cell Partnership

Five Government Strategies to Reach Environmentally Friendly Vehicle Goals

- Regulation
- Technology R&D
- Market Incentives
- Infrastructure Investment
- Public Education

New Car Emissions Standards in the US

- Pre-Control
- HC, CO, PM, NOx

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March 1, 2004

US Tier 2 Standards

The US Program To Improve Vehicle Fuel Efficiency

- Corporate Average Fuel Economy (CAFE)
  - Standards For New Cars & Light Trucks
  - Labels on New Vehicles
  - Gas Guzzler Taxes
- Partnership For A New Generation of Vehicles (PNGV); Freedom Car
- Tax Incentives

The Same Standards Apply To Light Duty Diesel & Gasoline Fueled Vehicles
**Fuel Economy Improvements**
in the US

![Graph showing fuel economy improvements in the US from 1970 to 1995 for light duty vehicles and light duty trucks.](image)

**National Clean Cities Program**

- A voluntary, locally based government industry partnership program

  - Currently 77 Active Cities
  - Over 4,400 Stakeholders
  - 96 million gallons of petroleum displaced per year
  - 19,000 metric tons of emissions reduced per year

**Alternative Fuel Vehicles (AFVs) in the U.S.**

- Alternative Fuel Vehicles
  - 110,000 CNG vehicles
  - 10,400 Electric vehicles
  - 269,000 Propane vehicles

- Alternative Fuel Refueling Stations
  - 1,280 Natural gas stations
  - 592 Electric rechargers
  - 3,353 Propane stations
  - 240 E85 stations

- Approximately 43 light-duty models available
- 100 medium/heavy-duty models available

**Los Angeles 1955:**

Unbearable air and no solutions.
Evolution of California Auto Controls
( Implementation: 1963 – 1993)

- Positive Crankcase Ventilation
- Exhaust Standards
- EGR
- Oxidation Catalyst
- Three Way Catalyst
- On-Board Computer
- Advanced Computer
- Fuel Injection
- O₂ Sensor
- Phase 1 Gasoline

Air Quality Trends in Los Angeles

- Days Exceeding Federal Ozone Standard
- Days Exceeding State Ozone Standard
- Days Exceeding State PM10 Standard

Air Pollution Remains Widespread

Based on 2000 Monitoring Data

Evolution of ARB Auto Controls
(Implementation: 1994 - 2010)

- Low Emission Vehicle I
- Cleaner Gasoline
- Low Emission Vehicle II
- Goal: Zero
ZEV Regulation Restructured in 2003 for More Flexibility

- 10% Mandate
- Battery Electric H2 Fuel Cell (Path 3)
- Near-Zero Conventional Vehicles (Path 1)
- Clean Hybrids (Path 2)

Path 1: Near-Zero Emission Conventional Vehicles

- Near zero exhaust emissions
- Zero evaporative emissions
- 15 year/150,000 mile warranty
- On-board diagnostics
- 140,000 sales in 2003
- 200,000 sales in 2004

Path 2: Hybrid Electric Vehicles

- Three models now available
- More models coming
- ~ 20,000 sales expected in 2005

“ZEV enabling” technology:
- electric drive train
- batteries
- power management

- Lexus 400 H Hybrid (coming soon)
- Toyota Prius Hybrid
- Honda Civic Hybrid
Incentives for Near-Zero Emission Hybrid Electric Vehicles

- Extra regulatory incentives (credits) encourage "strong" hybridization
- Incentives based on:
  - system voltage
  - power output of the electric motor
- Short term incentives for 42-volt systems

Path 3: Battery Electric and Fuel Cell Vehicles

- Full size battery electric
- Neighborhood electric
- Fuel cell

Full-Sized Battery Electric Vehicles

- Over 2,500 sold or leased
- Cost and range issues shifts focus:
  - smaller vehicles
  - fuel cells

Neighborhood Electric Vehicles

- 25 mph top speed
- limited range
- 2-4 passengers
- Over 8,000 sold or leased in response to ZEV regulation
**Fuel Cell Vehicles**
- Promising technology
- Significant cost, manufacturing and performance challenges
- Volume production expected 2010 or later

**Vehicle Production Scenario**
(example)

**Hybrid Electric Vehicle Forecast For The US**

**Greenhouse Gas Effect**
- Some of the infrared radiation passes through the atmosphere.
- Some infrared radiation is absorbed and re-emitted in all directions by GHGs.
- The effect is to warm Earth.
- 70% radiation passes through the clear atmosphere.
- Most radiation is absorbed by the Earth and makes it warm.

Source: J.D. Powers & Associates
Climate Change is Also a Major Concern for California

- Agriculture
- Forests
- Water Resources
- Coastal Areas
- Species and Natural Areas

Health
- Air Quality - Respiratory Illness
- Weather-related Mortality
- Infectious and Tropical Diseases

Sea Level Rise
- Temperature Increase
- Precipitation Patterns and Extremes

Hotter Days Lead to Higher Emissions and More Smog

- 10 warmest years of the last century all occurred within the last 15 years.

California Ozone Levels

Transportation is California's Largest Source of CO2

- Transportation 58%
- Commercial 4%
- Industrial 13%
- Residential 9%
- Electricity Generation 16%

Carbon Dioxide Emissions Intensities California and Selected Countries - 1995

- Source: Draft Greenhouse Gas Inventory Update, California Energy Commission, 2001
## AB 1493 General Requirements

- By January 1, 2005 Board to adopt regulations that achieve maximum feasible and cost-effective reduction of greenhouse gas emissions from motor vehicles
- Report to Legislature and Governor by January 1, 2005
- Regulations may not take effect prior to January 1, 2006
- Regulations apply only to 2009 and later model years

## In Developing Regulations …

- Consider technical feasibility
- Consider impact on economy of state
- Provide flexibility as to means of compliance
- Conduct public workshops
  - Communities with significant exposure to air contaminants, including communities with minority or low-income populations
- Grant credit for early reductions

## Regulations Shall Not Require …

- Fees or taxes on vehicle, fuel or VMT
- Ban on sale of any vehicle category
- Reduction in vehicle weight
- Limitation on or reduction of speed limit
- Limitation on or reduction of VMT

## Climate Change Regulation

- Regulations will provide flexibility, not mandate specific technology
- Hybrid vehicles will compete with other emerging technologies
- Hybrid’s role will depend on developments in conventional and fuel cell technology - but increased sales seems certain
Hybrid Electric Drive

- Honda Civic: 25% CO₂ reduction compared to non-hybrid model
- Toyota Prius: 29% CO₂ reduction compared to comparable conventional vehicle

Diesel Engines

- Diesel engines can provide substantial CO₂ reductions compared to their gasoline counterparts.
- Diesels face a significant challenge in meeting California’s NOx emission requirements

Long-Term Vision

- The ultimate goal remains - zero-emission technology
- Must be energy-efficient; reduced climate impact
- California is taking the necessary steps now

Advanced Low Emissions Technologies Will Play A Critical Role

- Substantially Reduce Conventional Urban Pollutants
- Reduce Oil Consumption Through High Efficiency
- Major Challenges:
  - Cost
  - Vehicle Availability
Issues Require a Public Policy Response—1

- Large, heavily populated urban areas with a developed or developing motor vehicle population suffer or will suffer from smog, particulate matter and toxic air pollution with serious public health impacts.

- Global warming is real, and action to reduce warming gases to or below current levels will need to be taken. Motor vehicles are a major source of warming gases.

Issues Requiring a Public Policy Response—2

- Petroleum production will peak and begin to decline, and alternative motor vehicle power sources will need to be developed.

- Advanced motor vehicle technologies can and should play an important role in addressing these issues.

Current Technology: Good But Not Enough—1

- Gasoline cars: 95+% reduction of smog emissions, but so many vehicles in developed countries this is not enough.
- Diesel cars: PM/NOx controls lag gasoline, but efforts to catch up underway.
- Diesel trucks/equipment: 60-80% reduction of NOx/PM.

Current Technology: Good But Not Enough—2

- Motorcycles/three wheelers: 0-50% HC reductions, still many 2-strokes with very high emissions.
- Other gasoline engines (e.g. small engines) 50+% HC reductions = 1970s level of car pollution control technology.
- Big diesels (ships, trains, + jet aircraft) 0 to 50% NOx/PM reductions.
Current Technology: Good But Not Enough

- Limited alternative fuel use (some NG buses/medium trucks, a few electric vehicles)
  - Petroleum supply problems viewed as a distant problem.
- Improvements to reduce warming gases modest at best.
  - Improvements mainly go to improve performance, overcome increased weight, or
  - More diesel at the expense of urban smog.

Solutions: Urban Smog

- Cars need to achieve zero and near-zero life cycle emissions. Existing and emerging technologies can achieve this goal.
- All diesels should use NOx/PM after-treatment and cleaner fuel (essential) for 95+% emission reduction. Zero-emission alternatives should be used wherever possible, especially in densely populated areas.

Solutions: Greenhouse Gases

- Ensure that technology improvements increase efficiency not power (e.g. more stringent fuel economy standards).
- Rapidly expand of use of hybrid electric drive-trains (~50% CO₂ reduction).
- Develop small car BEV market and integrate with mass transit (where electricity production is clean, and transit under-developed).
- Accelerate commercialization of fuel cell engines for a variety of vehicle types.

Solutions: Fuel Diversity

- Increase natural gas use in urban fleets.
- Use gas-to-liquids.
- Develop hydrogen infrastructure to support fuel cell commercialization.
Solutions addressing all three goals (smog, warming, fuel diversity) complement each other and should be implemented in a coordinated manner.

California Fuel Cell Partnership
- Promotes fuel cell vehicle commercialization
- Infrastructure
- Safety
- Public Education

Fuel Infrastructure
- Liquid H₂ storage
- Delivers gaseous hydrogen at two pressures: <6000 psi & 5000 psi
- Fill time < 4 minutes

2400+ fueling events
Fuel Cell Vehicles - Today

41 cars

Over 122,000 miles

5,000+ riders/drivers