Future Regulations – A Catalyst for Technology Development

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Impact of Future Regulations on Engine Technology
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U.S. EPA Office of Transportation and Air Quality: Addressing Transportation Impacts on Air Quality and Climate

Light-Duty

Recreational and Commercial Marine

Heavy-Duty

Clean and Renewable Fuels

Aircraft

Non-Road

Locomotives

Through Standards and Partnerships
OTAQ operates primarily under the statutory authority of the Clean Air Act, the Energy Policy and Conservation Act, and the Energy Independence and Security Act.

States Rely On EPA to address Mobile Source Air Pollution
- With a few notable exceptions, state and local governments are pre-empted from establishing or enforcing clean air standards for new mobile sources and for mobile source fuels
  - Exceptions: California (e.g., passenger car regulations predate federal CAA) and “Section 177” states

Clean Air Act (CAA)
- Set emission standards for new vehicles, equipment, engines and fuels (CAA sections 202, 211, 213)
- Create test procedures and protocols to evaluate performance against the standards (CAA section 206)
- Issue certificates annually (CAA section 206) and register fuels (CAA section 211) prior to their introduction into commerce
- Require manufacturers to recall vehicles and engines that do not comply in-use (CAA section 207)
- Prohibit noncompliance (CAA section 203)
- Take enforcement action when regulated parties violate the law (CAA sections 204-205)
- Renewable Fuel Standards (CAA section 211(o))

Energy Policy and Conservation Act (EPCA)
- Fuel economy labelling
- Responsible for CAFE test procedures, CAFE data collection, and perform CAFE compliance calculations for DOT

Energy Independence and Security Act of 2007 (EISA)
- Significantly expanded Renewable Fuels Standards program
- Approve new fuel pathways
EPA CAA Regulatory Authority
- Setting mobile source emissions standards

• 202(a)(2) “The Administrator shall by regulation prescribe...standards applicable to the emission of any air pollutant from any class or classes of new motor vehicles or new motor vehicle engines...shall take effect after such period as the Administrator finds necessary to permit the development and application of the requisite technology, giving appropriate consideration to the cost of compliance within such period”

• 202(a)(3)(A)(i) “categories of heavy-duty vehicles or engines manufactured during or after model year 1983 shall contain standards which reflect the greatest degree of emission reduction achievable through the application of technology which the Administrator determines will be available...giving appropriate consideration to cost, energy, and safety factors associated with the application of such technology.”
Brief History of CAA Mobile Source Emissions in the U.S.

• The U.S. was a legislative and regulatory pioneer in the 1970’s
  • Under the Clean Air Act, the U.S. Congress gave EPA “technology forcing” authority and preserved a separate ability for California to set its own air pollution standards
  • Major CAA Amendments in 1970, 1977, and 1990

• The results of this authority have been successful and cost-effective mobile source regulations
  • Since 1970, mobile source emissions regulations were responsible for 57% of benefits derived from all major federal rules
  • Examples include:
    • Light-duty vehicle Tier 0, Tier 1, Tier 2, and Tier 3 exhaust and evaporative emissions standards
    • Gasoline and diesel fuel standards
    • 1994, 1998, 2004 and 2007 Heavy-duty engine standards
    • Tier 1, 2, 3 and 4 Nonroad engine standards
    • Tier 1, 2, 3 and 4 Locomotive and Marine standards
    • GHG regulations
Mobile Source National Emission Contributions
2015 for GHG inventory, 2017 for other pollutants

Share of U.S. GHG Emissions by Economic Sector

* Industry, Agriculture, and Commercial sectors include emissions from non-transportation mobile sources that fall under OTAQ's purview. Mobile sources constituted ~31% of total U.S. GHG emissions in 2015.

The Results of Mobile Source CAA Regulation has been Dramatic Reductions in Air Pollution – While the Economy Grows

EPA Report “Our Nation’s Air: Status and Trends Through 2015”

Based on Midpoint of OMB Estimated Annualized Cost and Benefit Ranges

[Graph showing the benefit to cost ratio for different agencies]

Criteria Air Pollution Impacts
Los Angeles

Then

Now
Some places still face significant challenges with respect to air pollution control

Beijing, February 2014
So how does EPA’S authority actually work?
EPA’s Regulatory Principles

• Identify feasible and cost-effective technology
• Set technology-forcing performance standards to drive innovation and allow flexible compliance
• Allow lead time for normal business investment cycles
• Use a comprehensive approach that considers all subsectors and fuels
• Use an open and transparent process with broad stakeholder involvement
Setting Technology-forcing Standards

• Not just following the market
  • I.e., not just setting standards that capture what the market is already doing

• But pushing it forward – be technology forcing
  • Electronic engine management systems
  • Exhaust catalysts and particulate filters
  • Gasoline and diesel fuel hydrotreating
  • Advanced gasoline engine technologies (GDI, turbocharging/downsizing, Atkinson and Miller cycles)
  • Advanced transmission technologies (CVT, 8+ sp. Transmissions)
  • Hybrids, EVs
  • Light weight materials
  • Renewable fuels
  • Etc.
While Allowing Sufficient Lead-time
-Gates to Market for New Technologies

Research Investment

Breakthrough or Positive Research Outcome

Concept development and testing

Marketing Strategy and Development

Business Analysis

Capital Investment

Product Development

Test Marketing

Production Capacity

Marketing

Consumer Acceptance
Regulations can increase certainty for, and reduce risk from, investment in pollution-reducing technologies

• EPA evaluates mobile source technologies for reducing air pollution, but we do not bring these technologies to market

• EPA relies heavily on leveraging the work of others

• There are now entire companies and associations of companies devoted primarily to developing technologies that can serve as the basis for more stringent air pollution standards
How is Market Risk Reduced?

• Consumers will have to purchase pollution reducing technology

• Most of us as consumers strongly consider the price of a passenger car when making a purchasing decision.
  • Hypothetical question: How many of us would buy a car without any emission control systems if the dealership could offer that as an option for $1000 less?

• Level playing field
  • All vehicles and engines sold in the U.S. must meet emissions standards
    • Fuel and technology neutral
  • Everyone in the market has to invest in some way shape or form
    • If it costs everyone roughly equally, the market disruptions are minimized
Environmental regulations bring otherwise hidden impacts to light in business decisions

• Business decisions typically take into account capital costs, expected sales, and expected return on investment

• Criteria pollutant and GHG emissions have direct health, welfare, and economic impacts which may not be fully factored into business decisions
What Doesn’t CAA Authority Do?

• It does NOT remove risk
  • Your R&D efforts may fail
  • Your solution may not be the most effective
    • While engineers in every company thinks their solution is the best – they can’t all be right all of the time
  • Your costs may be higher than your competitors
  • Consumers may prefer your competitor’s technology solution

• It doesn’t allow us to mandate something that isn’t attainable
  • Regulations must consider cost, benefits, feasibility, leadtime, etc. while maintaining our mission of protecting health and welfare
CAA Example: EPA Mobile Source Climate Change Program

- Light-duty GHG Phases 1 & 2
- Heavy-duty GHG Phases 1 & 2
- Aircraft Endangerment Finding
  - 08/15/2016
- Renewable Fuels Program (RFS2)
On April 1, 2007 U.S. Supreme Court ruled that EPA’s CAA authority covers greenhouse gases including CO₂.

In 2009 EPA issued an endangerment finding for six GHGs along with the finding that motor vehicles cause or contribute to this harm.

CAA Example:
EPA Mobile Source Climate Change Program

- Transportation: 27%
- Electricity: 33%
- Industry: 20%
- Agriculture: 8%
- Residential: 5%
- Commercial: 6%
- US Territories: 1%

Passenger Cars: 43%
Light-Duty Trucks: 18%
Medium & Heavy-Duty Trucks: 22%
Aviation: 8%
Rail: 2%
Other: 4%
Marine: 3%

Transportation: 2011 Data
Footprint-based CO₂ Target Curves for Trucks – “The Standards” [separate footprint curve for Cars]

With a shift from cars to SUVs & trucks, the OEM’s standard becomes less stringent.

As Sales Shift, OEMs Standards automatically adjust.
Footprint-based CO₂ Target Curves for Cars – “The Standards” (separate footprint curves for Cars & Trucks)
LD Gasoline consumption and GHG will be below 2011 levels by 2022 despite increasing VMT

Source: EIA AEO 2017
Early Years of LD GHG Program Producing Positive Results

**Industry Outperforming Standards**

- 2012: 11 g/mi lower than target
- 2013: 12 g/mi lower than target
- 2014: 13 g/mi lower than target
- 2015: 13 g/mi

**7 Years of Sales Increases Thru 2016**

- First Time in 100 Years
EPA Most Recent Assessment –
2022-2025 Standards can be Met Mostly with Advanced Gasoline Technologies

Cost estimate of $875/vehicle
✓ Advanced engines and transmissions
✓ Vehicle light-weighting
✓ Improved aerodynamics
✓ More efficient accessories
✓ Low rolling resistance tires
✓ Stop-start technology
✓ Mild hybrid (e.g., 48 volt systems)
✓ Small levels of strong HEV, EV, PHEV

Fuel Savings Offsets Cost increase
✓ Net lifetime savings of $1,650

One possible powertrain pathway modeled by EPA

- Advanced Gasoline 75%
- Mild HEV 18%
- PHEV/EREV 2%
- Electric Vehicles 3%

Strong HEV 2%
There is already significant growth in the sales of advanced powertrain technologies to meet new GHG and CAFE standards.
HDGHG Phase 2 Standards

**Ambitious and Significant:** The Phase 2 standards are expected to lower CO2 emissions by approximately 1.1 billion metric tons, save vehicle owners fuel costs of about $170 billion, and reduce oil consumption by up to 2 billion barrels over the lifetime of the vehicles sold under the program. The technology-advancing Phase 2 program goes beyond the successful Phase 1 program, with standards based not only on currently available technologies but emerging technologies that are not yet in widespread use.

**Achievable and Flexible:** The performance-based standards provide multiple technological pathways to compliance and were informed by a comprehensive assessment of advanced technologies and extensive stakeholder outreach. The standards phase in beginning in model year 2021 and culminate in standards for model year 2027. First-time GHG and fuel efficiency standards for trailers start in 2018 for EPA and in 2021 for NHTSA. The long phase in and incremental increases in stringency give industry time to ensure products are reliable and durable, and provide long-term regulatory certainty.
In the face of sustained growth, Phase 2 achieves a 13-year period of net decreasing GHGs and fuel consumption.
EPA’s Medium & Heavy Duty GHG Standards

By 2027, fuel consumption and CO2 emissions lowered by up to:

- 25%
- 24%
- 16%

TOTAL FUEL SAVINGS:

$170 BILLION

Over lifetime of vehicles
Climate Indicators: CO2 Concentration & Average U.S. Temperatures

Concentrations of Carbon Dioxide in the Atmosphere from 800,000 Years Ago to Present Day

Rate of Temperature Change in the United States, 1901–2015

Data source: Compilation of 10 underlying datasets.

Data source: NOAA, 2016
Climate Indicators: CO2 Concentration (58 years) & Global Temperatures (166 years)

Atmospheric CO₂ concentration (1958–2016)

Global temperature change (1850–2016)

Transformational Change is Needed

We are headed here

But we need to go here

$\text{CO}_2$ - 80% Emissions reduction by 2050
Clean Air Act Regulations are Not the Only Tools in the Tool Box

Voluntary Measures

Transport Sector Transformation

Local, State, & Regional Partnerships
Thank you

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