# Ethanol – Gasoline Blend Fuels: An Automotive Perspective

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Environmental and Energy Study Institute Briefing

"Protecting Public Health Through
Cleaner Fuels and Lower Emissions"

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# Background in Automotive Industry

## Defour Group LLC

Dean Drake: 34 yrs @ GM

- Engine design/certification
- CA regulatory policy
- Industry/NGO dialogues

Dr. Tom Walton: 25 yrs @ GM

Dr. Mike Whinihan: 28 yrs @ GM

Dave Aldorfer: 39 yrs@ GM

## Air Improvement Resource

Tom Darlington: 25 yrs @ EPA & GM

- Emissions modeling and analysis
- Fuels and vehicle testing
- Expert for auto, fuels & gov't

## Transportation Fuels Consulting

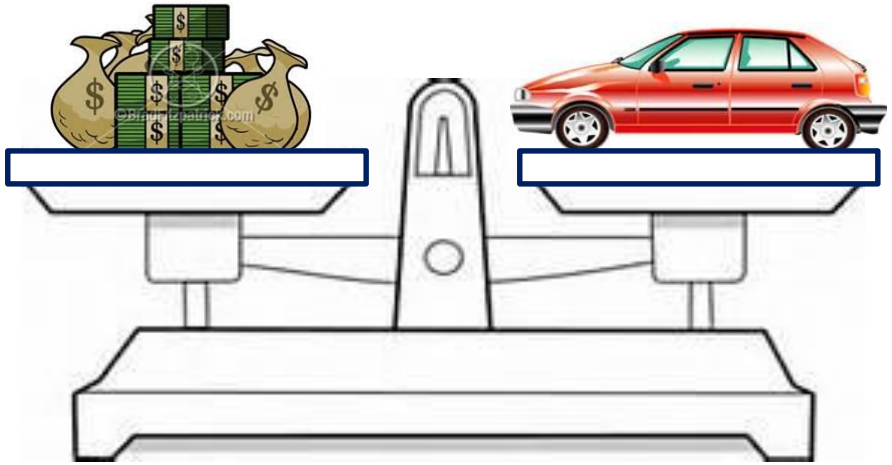
Gary Herwick: 35 yrs @ GM

- Emissions & fuels policy
- Fuel quality and alternative fuels

# What is the Automotive Industry Perspective?

To Ensure that the Benefits of Individual Personal Transportation Outweigh Its Cost

| | |
|---|---|
| Purchase Price | Performance |
| Operating Cost | Utility |
| Social Externalities | Convenience |



# The Impact of Ethanol Gasoline Blends Today

10% Gasoline – Ethanol Blend (E10)

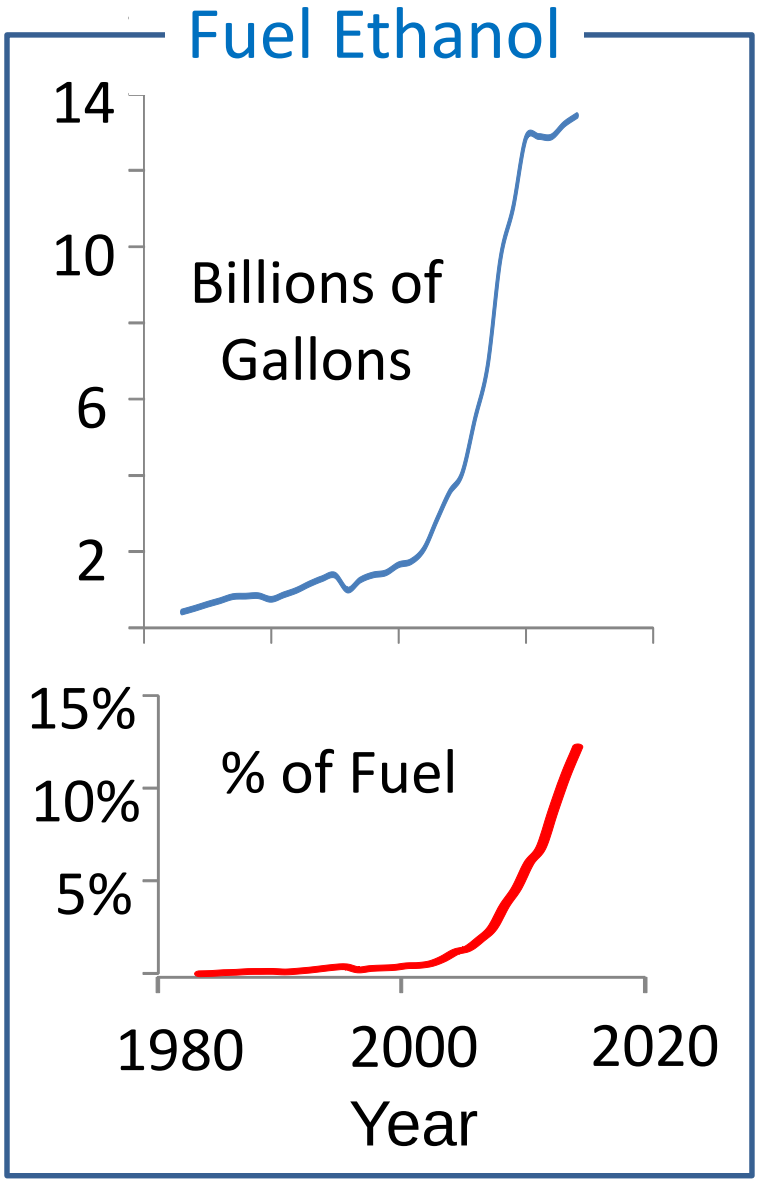
- In the market since 1970's
- Nearly all gasoline today is E10

Refineries: Blend Stock, not Pump Gas

- Blend stock: 84 AKI octane rating
- Ethanol added to boost octane
- Resulting pump gas = 87 AKI octane

Question: What is the Public Impact?

- Cost to consumer
- Environmental



# Ethanol Makes Gasoline Less Expensive

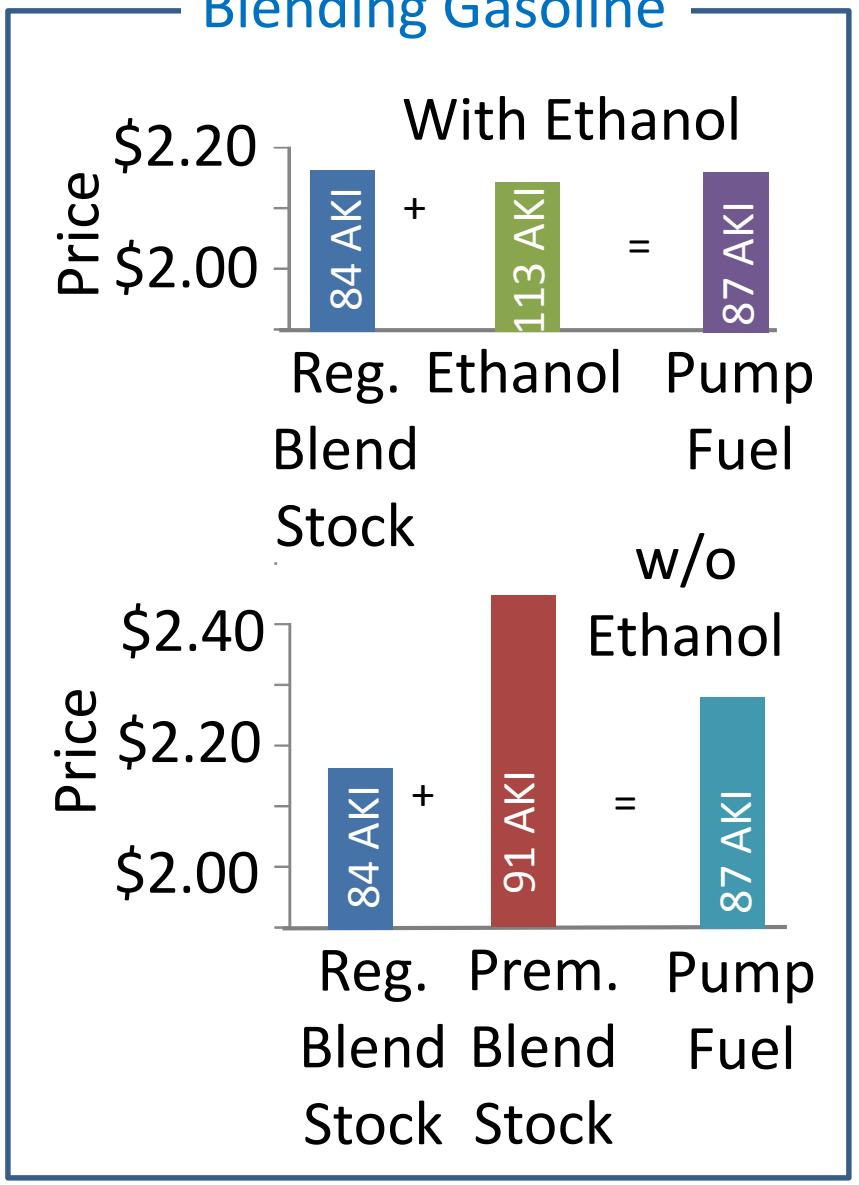
Adding Ethanol to Gasoline

- Price per gallon at source
- Transportation cost to blender
- Octane rating
- Energy density

OPIS prices 05 MAY 14 to 30NOV15

- Ethanol
- Regular blend stock
- Premium blend stock

E10 Saves Consumers **4 cents per Gallon**



# EPAct and the EPA MOVES Model

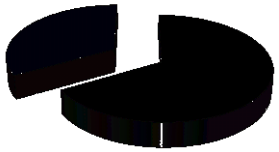
## EPAct Test Program

Used Blends not Sold to Public

EPA: *"different* [results] *if splash blends of ethanol in gasoline were utilized"*

Particulate Matter Increases

No: 5 Vehicles



Yes: 10 Vehicles

EPA: *"fuel properties interact … with vehicle and engine design, controls, and/or calibrations."*

## EPA's MOVES Model

Vehicle Emissions in Real World

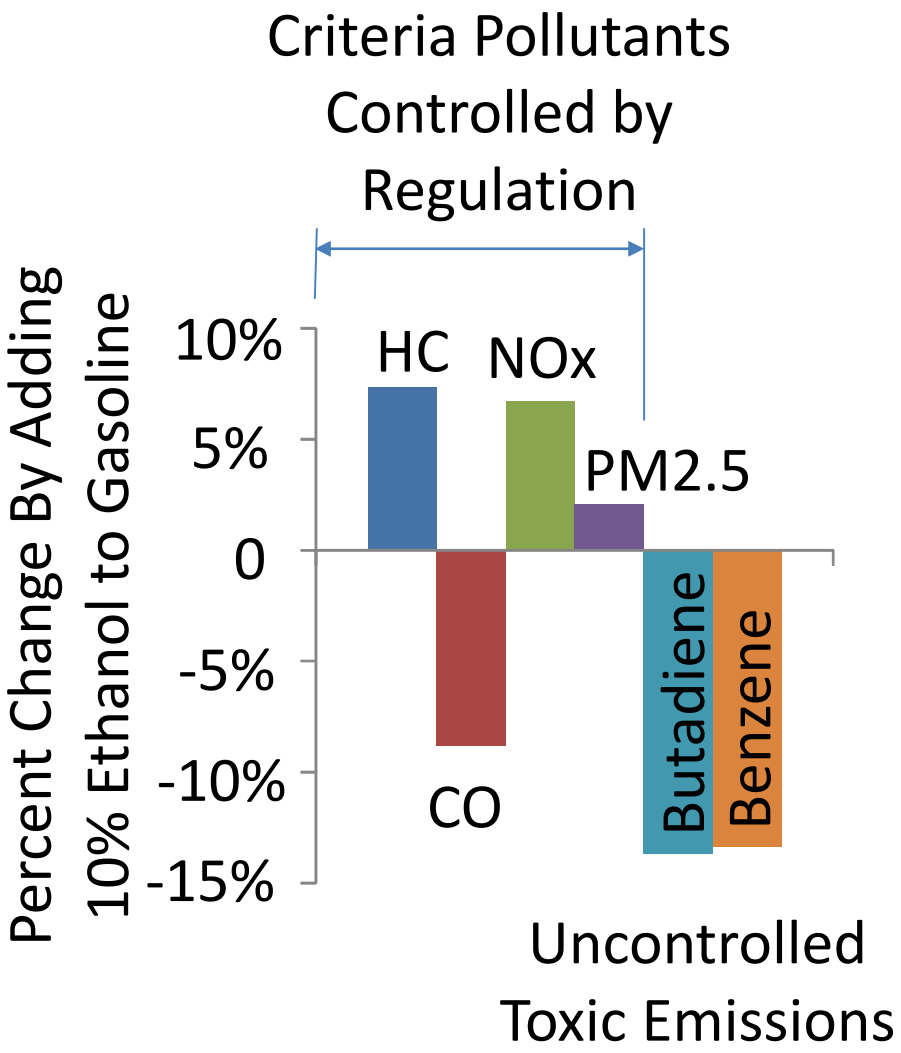
- Problems using MOVES data
- Does not properly represent spash blended fuels like E15

## State Implementation Plans

Required by Clean Air Act

Deprives States Tools like E15

# Ethanol Makes Gasoline Less Toxic




## E10 vs E0

Adapted MOVES to Compare:

- 87 octane E10
- 87 octane pure gasoline

E10 has much lower:

- Toxic emissions
- CO emissions

Higher HC, NOx and PM

- Calibration not fuel?
- Addressed in Tier 3 by adding an E10 test fuel

# Higher Octane Fuel For More Efficient Engines

## High Efficiency Engine Needed

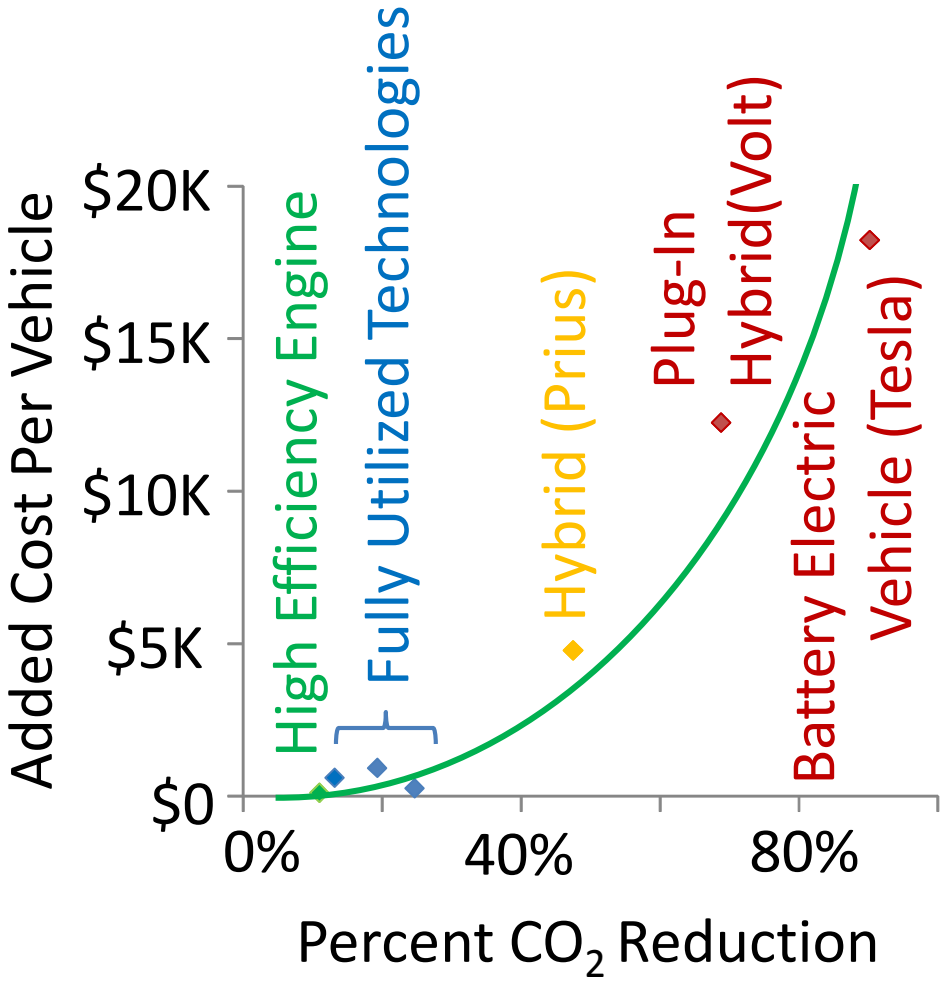
Greater Engine Efficiency = Higher Engine Pressure

- Engine knock limits pressure
- Higher octane reduces knock

New Engine and Fuel Last Low Cost Way to Reduce $CO_2$

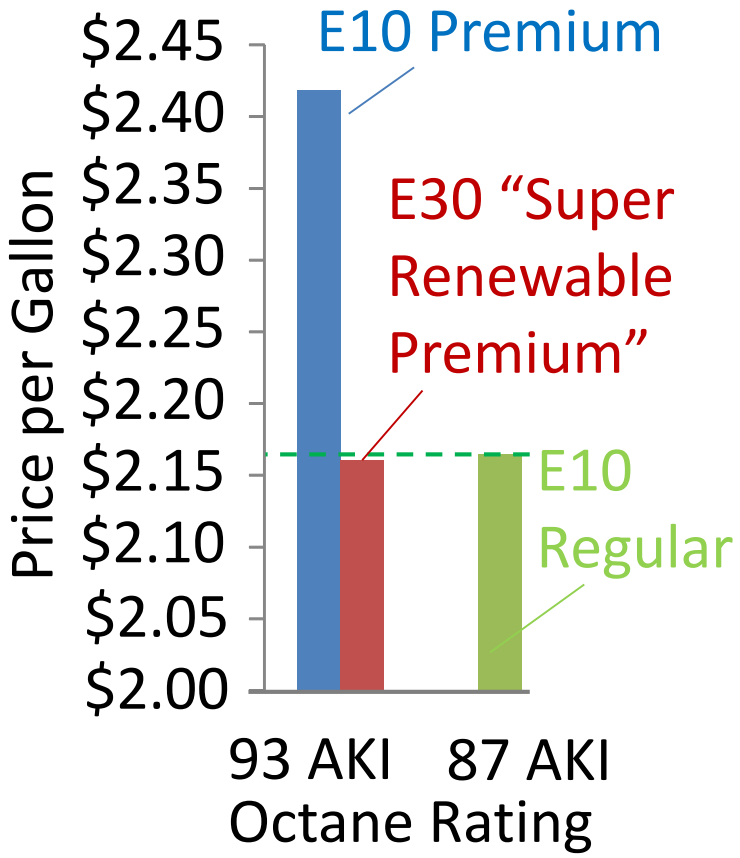
- Higher octane fuel required
- Current “premium” gasoline too expensive

## MY 2025 Propulsion Technologies



# Fuel of the Future: High Octane Mid-Level Blend

## Ethanol: The Low Cost Way to Increase Octane




## Logical Evolution of Ethanol Blends

E10 shows adding ethanol to gasoline:

- Boosts octane for less money
- Reduces toxic emissions
- Reduces greenhouse gas emissions
- Displaces petroleum use

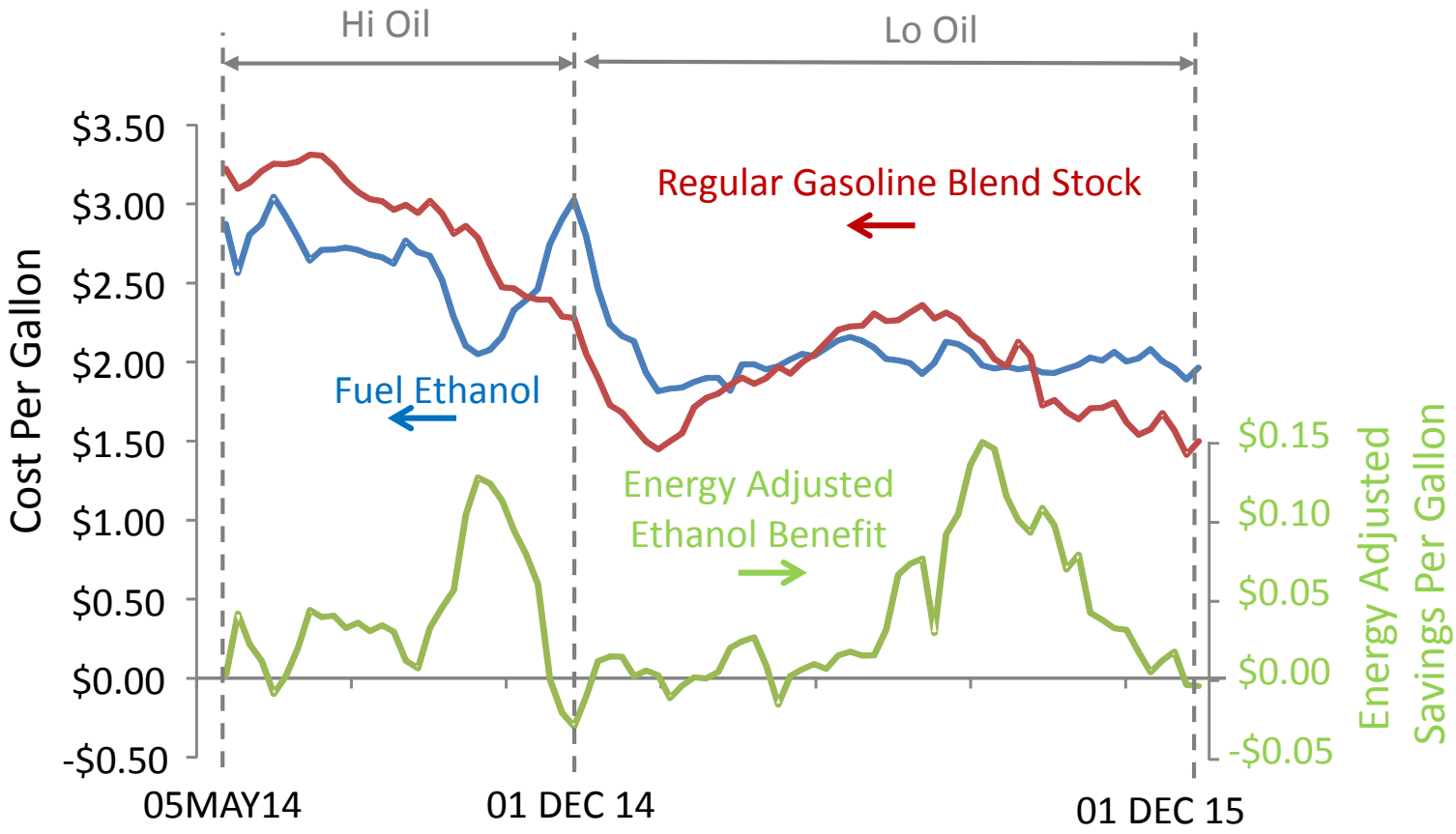
E10 to E30: Pathway to Higher Octane

- All grades of gasoline have 93 octane
- New cars use high efficiency engines
- Legacy vehicles use E10 "premium"

# Backup Slides

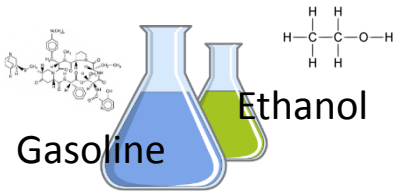
# E10 Input Prices vs Ethanol Benefits

May, 2014 – Dec., 2015



# Complications with EPAct Study

## Used Blends not Sold to Public




### Gasoline is Not Oil

Blend of compounds extracted from oil

Formula affects properties of final product

Many different ways to get the same end

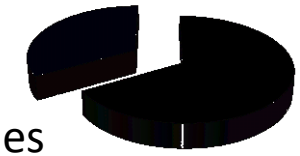
EPAct blends not the same as pump gasoline

From SAE Paper 2015-01-9071

*"the results … would have certainly been different had ethanol … replace*[d the] *aromatics … instead of the … aliphatics, or if splash blends of ethanol in gasoline were utilized"*

## Some Vehicle Emissions Unaffected

No PM Increase in 5 Vehicles



Some PM Increase in 10 Vehicles

### Vehicle / Fuel Interactions

Ethanol did not increase PM emissions in 1/3 of vehicles tested

Suggests that vehicle design may confound impact of fuel differences

From SAE Paper 2015-01-1072

*"Five of the 15 test vehicles showed little or no sensitivity of PM emissions to ethanol"*

*"fuel properties interact in important ways with vehicle and engine design, controls, and/or calibrations."*

# Today's Arguments Aren't Tomorrow's Reality

## Competition Altered Ethanol's Economics

## Studies Before 2012 Not Always Reliable

- API's NERA study
- Recent CBO report


## Others Are Recognizing Transformation

*"There has been considerable innovation at existing biorefineries that produce corn ethanol…*

- [N]*ew … processes … now integrated into about 80 percent of U.S. corn ethanol plants…*
- [S]*witching … plant fuel to lower-carbon sources …*
- [L]*owering the energy use of their plant …*
- [I]*mproving the starch-to-ethanol yield through the use of corn … genetically optimized for ethanol production."*

from "Three Routes Forward for Biofuels,"
UC Davis, July 24, 2014

# Neither Oil Nor Ethanol is Perfect

## Octane Rating

- Measure of fuel's resistance to pre-ignition
- Low octane rating limits ability to design high efficiency engines

## Gasoline

- High energy density (BTU per gallon)
- Low octane rating

## Ethanol

- Lower energy density
- Much higher octane rating

## Ethanol in Gasoline Blends

| **Boost the Octane Rating of Gasoline** | **Replace Gasoline – e.g., E85 in Flex-Fueled Vehicles** |
|---|---|
| E10 Saved Drivers $0.06 per Gallon in 2013 | Drivers Paid $0.32 per Gallon More for E85 than E10 in 2013 |
| Ethanol's Octane Fully Utilized | Ethanol's Octane Benefit Wasted |
| Provides Energy Security Benefit = $0.46 per Gallon of Ethanol Used | |

# Automakers Want Higher Octane

## For Automakers: High Octane =

- More efficient high compression engines
- Common worldwide powertrains
- Lower $CO_2$ tailpipe emissions

**Concern: Current High-Octane Premium Gasoline is 30 cents per gallon more expensive than E10**

## Automotive News Article April 14th

*"Detroit 3: High octane has pluses"*

Ford

*"It's a common-sense thing ... We can put in higher compression ratios, and we won't be knock limited"*

CHRYSLER

*"A* [high octane] *fuel shared with Europe would allow automakers to design common engines … which would cut costs."*

GM

*"you can't deny the physics."*

**Mercedes Now Testing Vehicles in Germany on High Octane E20/25**