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EESI Briefing

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Dirksen Senate Office Building

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Viewing the Vehicle and Fuel as a System: The Economic Implications of High Octane Low Carbon Fuel

Not All Vehicles Will Be Battery Powered

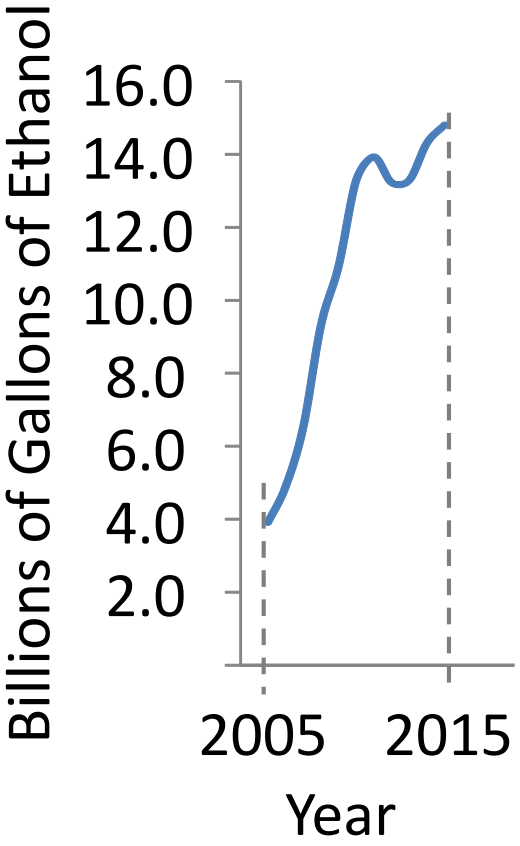
Certain Models Will Require Liquid Fuel

Much More Energy per Pound than Electricity

- Enables longer range
- Provides power to move more weight

Future Liquid Fuels Should be More Renewable and Cleaner than Today's Gasoline

The U.S. Already Runs on Ethanol Blend Fuels



Ethanol: To 10% of Our Fuel in 10 Years

Today, Most Gasoline is 10% Ethanol (E10)

- RFS drove ethanol demand & production
- Refiners chose to make E10
  - Gasoline blend stock octane lowered
  - Ethanol added to blend stock at terminal to replace that lost octane
- Finished fuel shipped to retailers

Our Fuel Infrastructure Designed for Ethanol

87 Octane E10 is Less Expensive than 87 Octane E0 Gasoline

What Ethanol Blend Fuel is Best?

What We Learned from E10

Fully Using Ethanol's High Octane Lowers Consumer Cost

We Can Do Better than E10

- Higher octane can enable high efficiency engines
- With more octane, compliance with standards is less expensive

A New Fuel is Best Implemented When:

- There is widespread support among diverse stakeholders
- The change is transparent to the public

Completing Research to Determine Optimum Blend Ratio

Impact of High Octane Fuel on New Vehicle Cost

Fuel: 98 Research Octane Number (RON) E25

Vehicle: Meets EPA's 2025 Model Year Standards

- Higher compression ratio engines
- Widely available E25 fuel

EPA's OMEGA Model (Run by Air Improvement Resource)

- Simulated 2025 MY fleet
- Estimated overall costs of standards due to technology
  - Fleet average: Savings of $436 per vehicle
  - Buick Enclave SUV: $873 per vehicle

Findings Were Presented in SAE Paper 2017-01-0906

Two Fuels Could Enable High Efficiency Engines

Today's Premium Grade E10

- Could be refined to have desired properties
- Considerably more expensive than today's regular grade E10

Future E25 Performance Grade Fuel

- Begins with regular E10
- More ethanol added to boost octane
- Should cost the same or less than today's regular E10

Is E10 Premium Fuel an Economically Viable Option?

E10 Premium vs E25 Performance Grade Fuel

Fuel Prices for 2025 to 2055

Spot OPIS Prices in 2016 for:

- Ethanol
- Regular Blend Stock
- Premium Blend Stock

Blended and Adjusted to Retail

- Transportation costs
- Wholesale to retail markup

Extrapolated 2016 Prices to 2055 Using EIA Annual % Increases

Annual Gallons Consumed

2025 CAFE Standards

- Fleet average
- LD truck average (e.g., Enclave)
- Adjusted to reflect real world

Adjusted for Each Fuel in High Efficiency Engines Using:

- Fuel energy density & miles traveled per year from EPA
- Thermal efficiency of fuel/engine combination

Tangential Questions

Is Their Enough Ethanol?

Due to declining fuel demand, only modest increases in ethanol production are required.

Do EIA's Rates Change?

Ethanol volumes changes are minor. Reductions in U.S. gasoline demand likely offset by increased exports.

RIN Effects?

Most studies suggest any effect of RINs on 2016 prices are too small to be measured and impact after 2022 are unknown.

Is the Price of Premium Inflated?

Using spot wholesale prices as a starting point eliminates most of the price inflation.

Are Additional Infrastructure Costs Significant?

Match blending = minimal refinery & terminal changes. New dispenser pumps work with E25.

Link Between High Efficiency Engines and E25

Compared to a 2025 MY Vehicle W/O High Efficiency Engine, Average 2025 MY Vehicle Modified to Use High Octane Fuel

Saves $590

E25 @ $2.322 Per Gallon in 2025

Cost Difference	
Vehicle	($436)
Fuel	($154)
Total	($590)

Costs $889

Premium @ $2.767 Per Gallon (Without E25)

Cost Difference	
Vehicle	($436)
Fuel	$1,325
Total	$889

$1,479 More than E25

Saves $32

Premium @ $2.542 Per Gallon (With Competition)

Cost Difference	
Vehicle	($436)
Fuel	$468
Total	$32

$662 More than E25

Potential Savings Even Greater on Trucks

Average 2025 MY Buck Enclave Using High Octane Fuel

Saves $1,072

E25 @ $2.322 Per Gallon in 2025

Cost Difference	
Vehicle	($873)
Fuel	($199)
Total	($1,072)

Costs $780

Premium @ $2.767 Per Gallon (Without E25)

Cost Difference	
Vehicle	($873)
Fuel	$1,653
Total	$780

$1,852 More than E25

Saves $288

Premium @ $2.542 Per Gallon (With Competition)

Cost Difference	
Vehicle	($874)
Fuel	$586
Total	($288)

$785 More than E25

Conclusions

The Nation Already Runs on an Ethanol Blend Fuel – E10

The Ideal Blend May be Higher than 10%

- Ethanol offers plentiful low-cost octane
- Automakers want higher octane to comply with standards

Going From 10% to 25% Ethanol Creates a Fuel That:

- Has the octane of premium grade gasoline
- Costs less than today's regular grade gasoline

High Octane Fuel Enables More Efficient Engines But Today's Premium Makes This Strategy Too Expensive

Backup Slides

The Consumer Benefit of E10

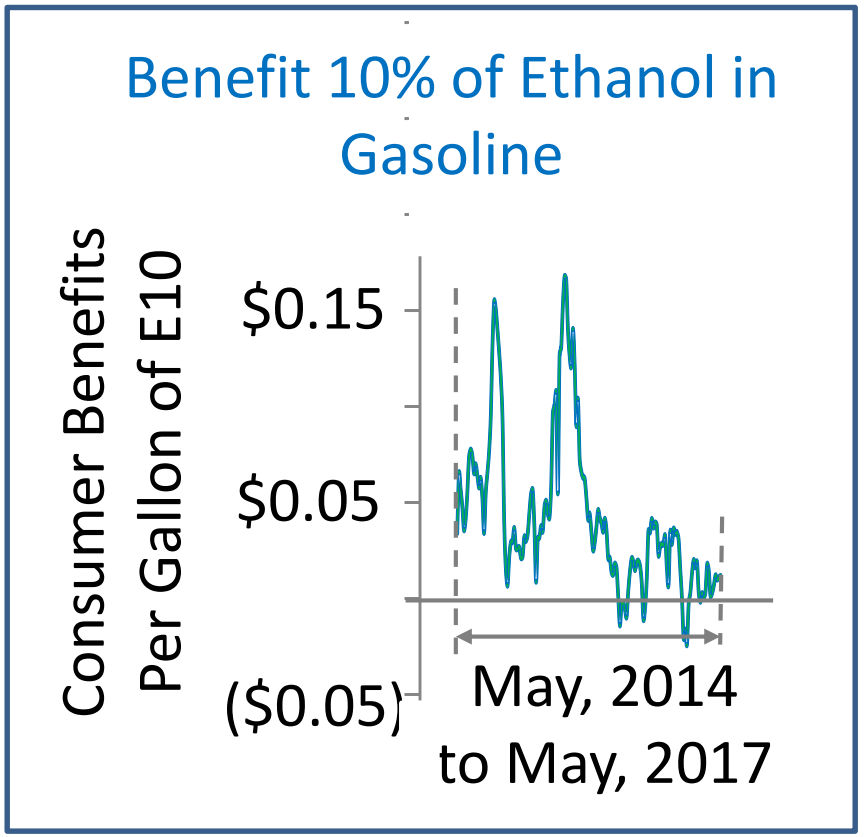
Defour Group Study Began May, 2014

Used Weekly OPIS Prices for:

- Regular gasoline blend stock
- Premium gasoline blend stock
- Fuel Ethanol

Considers:

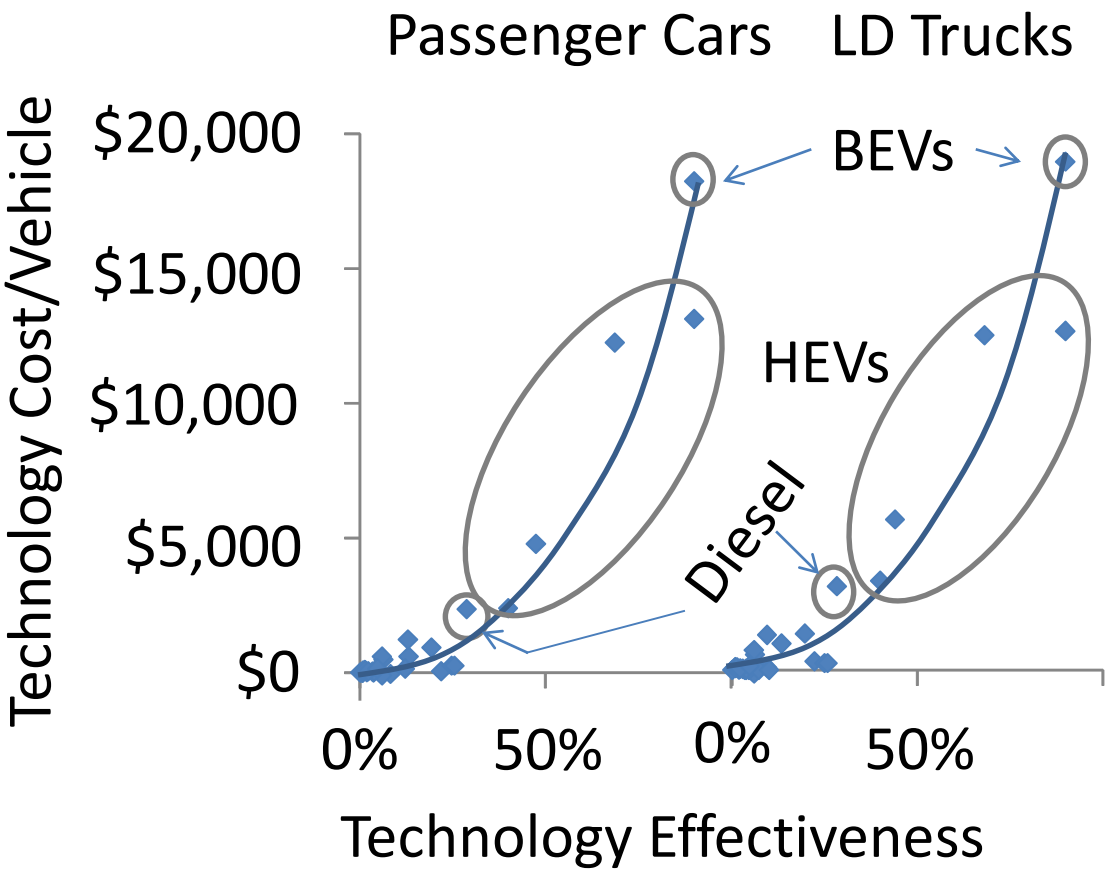
- Octane
- Fuel energy density
- Transportation cost differences
- Charge cooling



Compares Cost of a Gallon of 87 Octane E10 vs E0

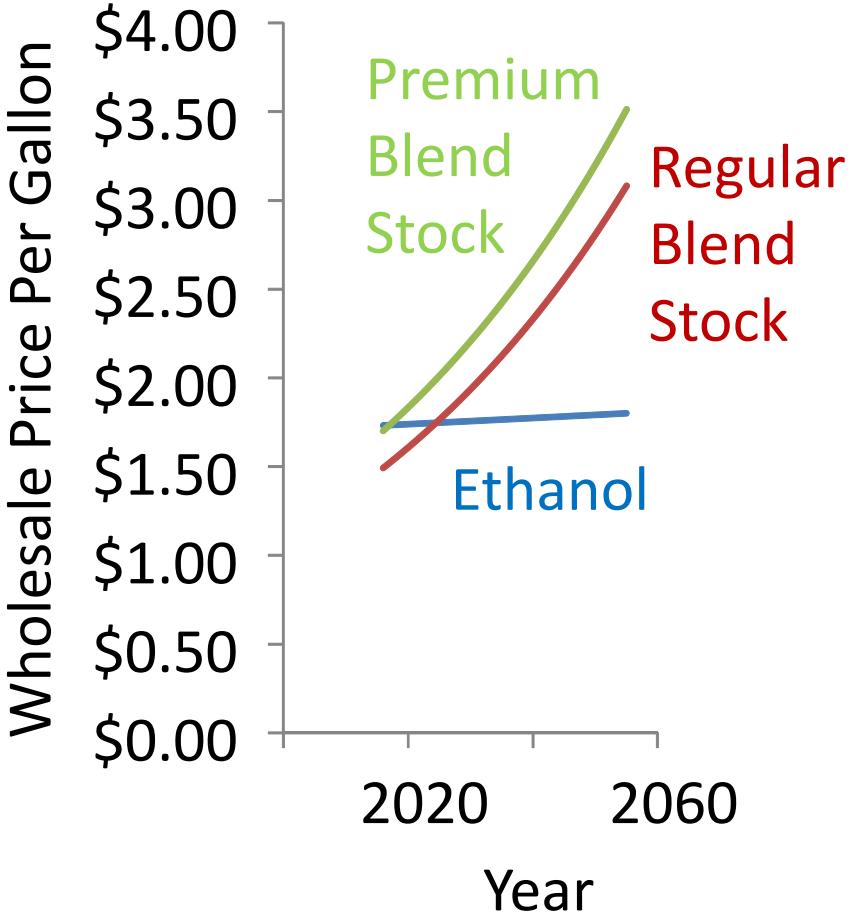
How OMEGA Calculates Compliance Costs

Technology Cost Curves

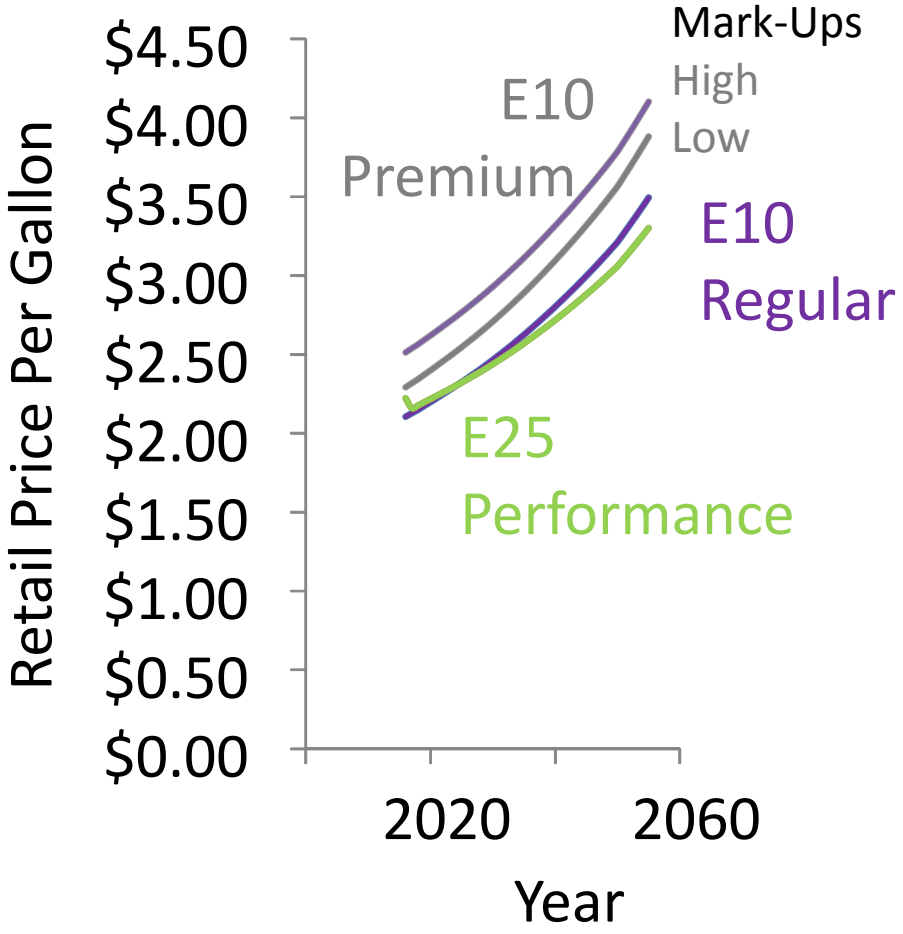


Estimating Fuel Prices

Fuel Components



Retail Fuel



Is Their Enough Ethanol?