

# The Changing Economics of Ethanol Blend Fuels

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Scientific Update on Biofuels  
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# Team Behind the Analysis

## MN Corn Research & Promotion Council Study

### Defour Group LLC

### Other Participants

Dean Drake

Dr. Tom Walton

- Ph. D. in Economics from UCLA
- US FTC from 1982 – 84
- Director of Economics at GM

Dave Aldorfer

- Bachelor in Engineering and MS-Environmental Science
- Director, GM Environmental Activities Staff (EAS)

Tom Darlington

- 9 years at US EPA developing MOBILE emission model
- 5 years at GM EAS
- Founded Air Improvement Resources in 1994

Gary Herwick

- BS in Mechanical Engineering
- Director of Alternative Fuels at GM
- Founded Transportation Fuels Consulting

# Ethanol Blend Fundamentals

$$\begin{array}{ccccccc} \text{Benefit of} & & \text{Cost Per} & & \text{Octane} & & \text{Energy} \\ \text{Ethanol in} & = & \text{Gallon} & + & \text{Boosting} & - & \text{Penalty} \\ \text{Gasoline} & & \text{Benefit} & & \text{Benefit} & & \end{array}$$

## Cost Benefit

### Volumetric Price Parity (VPP)

- When ethanol and gasoline cost the same per gallon
- Since 2011, ethanol sells at less than VPP

## Octane Benefit

### Octane: Measure of Fuel's Resistance to Pre-ignition

- Gasoline: low octane
- Ethanol: high octane
- Low octane rating limits ability to design high efficiency engines

## Energy Penalty

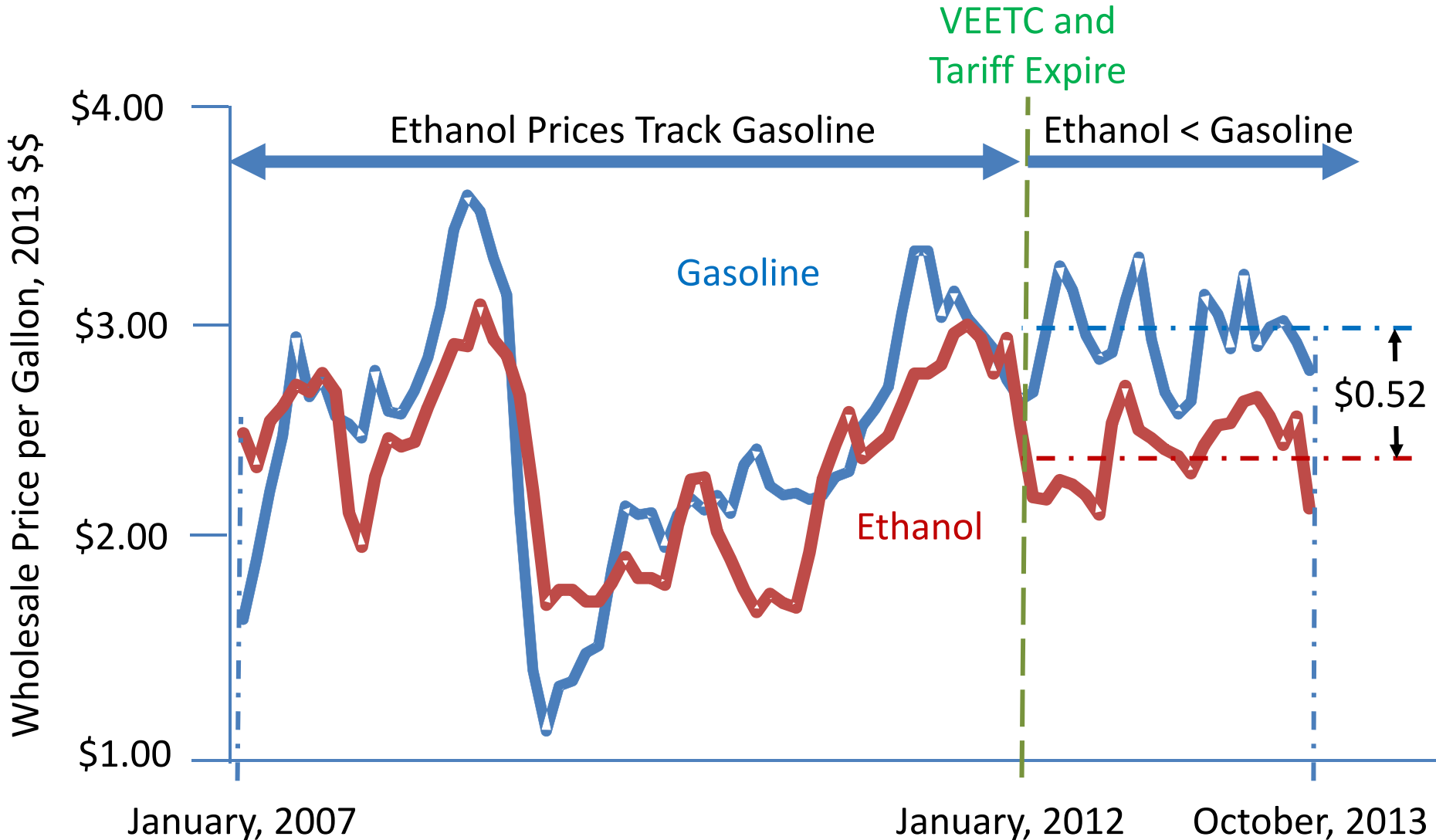
### Energy Price Parity (EPP)

- When \$1 of ethanol has the same energy as a \$1 of gasoline
- Ethanol vs gasoline:
  - 32% less energy per gallon
  - Costs 19% less

# Why Ethanol Now Costs Less Than Gasoline

# The Decoupling of Gasoline and Ethanol Prices

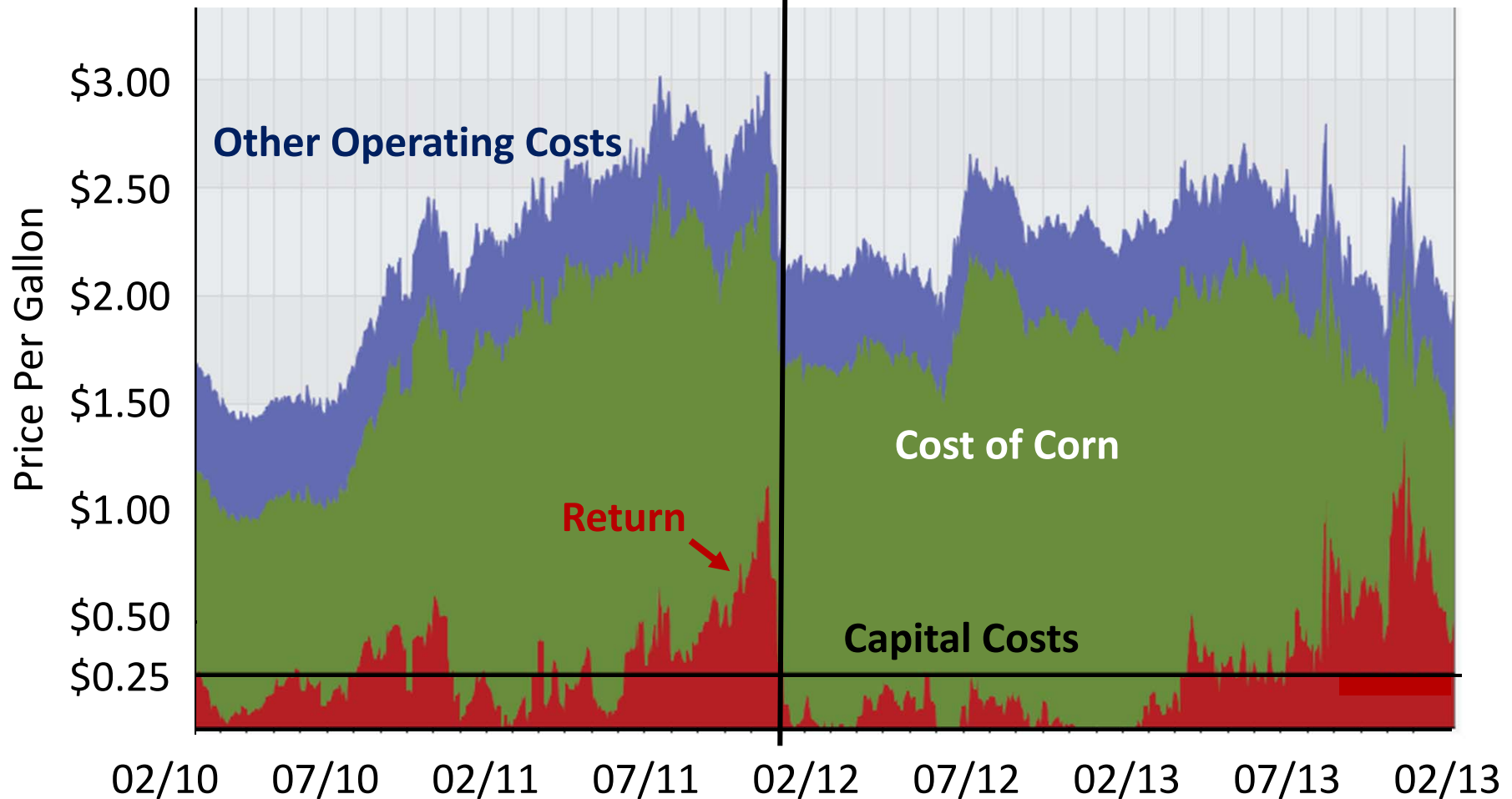
Monthly Averages Source: Nebraska Energy Board



# Ethanol Producer Struggle to Return to Profitability

Ethanol Operating Margins based on futures and Iowa Corn Prices  
Center for Agricultural and Rural Development, Iowa State University

Tax Credits and Tariff Protection Expire



# Ethanol Gasoline Blends Today

## Subsidy Loss Transforms Fuel Ethanol

### Ethanol Industry Boosts Productivity

- *“new ... processes ... integrated into about 80 percent of U.S. corn ethanol plants...”*
- *“switching ... plant fuel to lower-carbon sources ...[and] lowering the energy use of their plant”*
- *“improving the starch-to-ethanol yield through the use of corn [developed] for ethanol production.”*

From “Three Routes Forward for Biofuels,”  
UC Davis, July, 2014

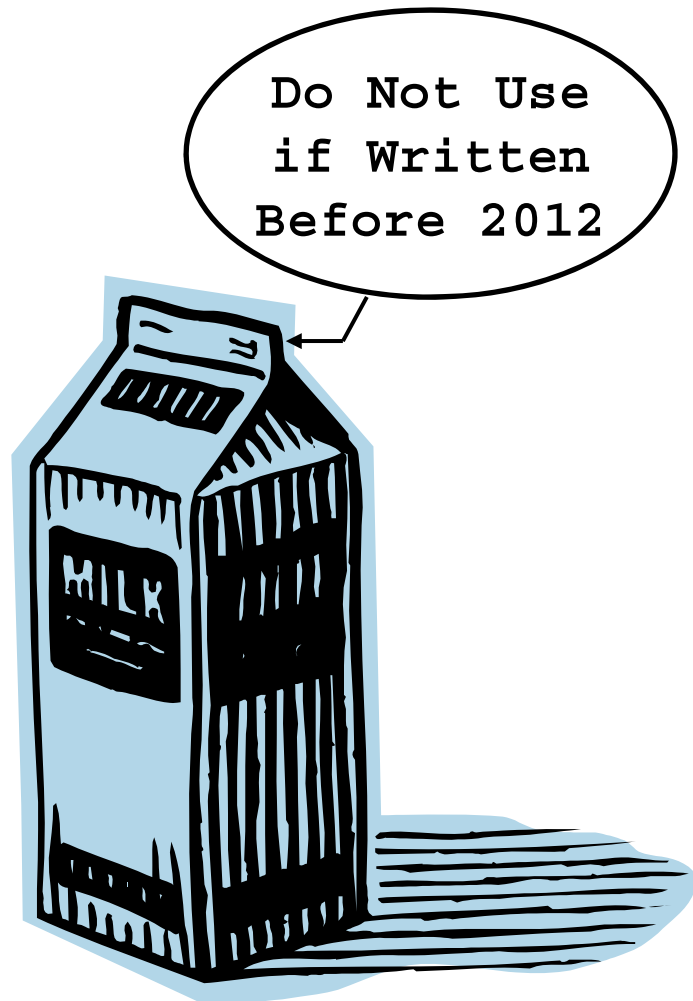
### Oil Industry Modifies Processes

- Oil refineries now produce lower octane blendstock
- Blenders add 10% ethanol to boost octane to legal minimum

### 10% Blend (E10) is New Regular

- Lowest cost per BTU
- Infrastructure now tailored it
- Nearly universal consumer acceptance

# Some Recent Studies Based on Pre-2012 Information



## API's NERA Study

*"Economic Impacts Resulting from Implementation of RFS2 Program"*

- Published October, 2012
- Phase 1 of the Report, *"Impact of the Blend Wall Constraint in Complying with the Renewable Fuel Standard"* was published November 2, 2011.

## CBO Report on RFS

*"The Renewable Fuel Standard: Issues for 2014 and Beyond"*

- Published June, 2014
- Uses 21 sources published before 2012



# Ethanol is the Low Cost Way to Boost the Octane Rating of Gasoline

# Ethanol Reduces the Cost of Gasoline

## Cost of Octane at the Refinery

- Regular gasoline must have an 87 AKI (anti-knock index) octane rating
- Blendstock has an 84 AKI rating
- Cost to refine blendstock
  - Defour Group: 11 cents/gallon
  - APF Economics: 11 – 17 cents/gallon
  - Hart Energy: 14 cents/gallon

## Using Ethanol to Boost Octane

- Fuel ethanol is rated over 110 AKI
- Adding 10% ethanol:
  - Boosts blendstock octane 3 AKI
  - Lowers blendstock price by 5 cents per gallon

## Impact on Pump Price to Add 3 AKI to Blendstock

- At refinery: + 11 cents per gallon
- Using ethanol: - 5 cents per gallon

Bottom Line: Even After Adjusting for Ethanol's Lower Energy, Consumers Save About 6 Cents Per Gallon Because of Ethanol

# Octane Benefit Greater Than Energy Loss

## E85 is Affordable with Low Octane Blendstock

### Natural Gasoline

- A gasoline-like natural gas liquid
- Used to denature fuel ethanol
- Has 90% of the energy in E10
- Costs about 73 cents/gallon less than blendstock
- Rated octane is only 30 – 50 AKI

### Ethanol Producers

- Produce their own E85 by mixing in additional natural gasoline
- Sell directly to retailers

### E85 Sold Below EPP

- In 2013, E85 needed to sell for \$0.72 less than E10 to be at EPP
- Some E85 now \$1 a gallon less than E10
- Low octane gasoline could be substituted for natural gasoline

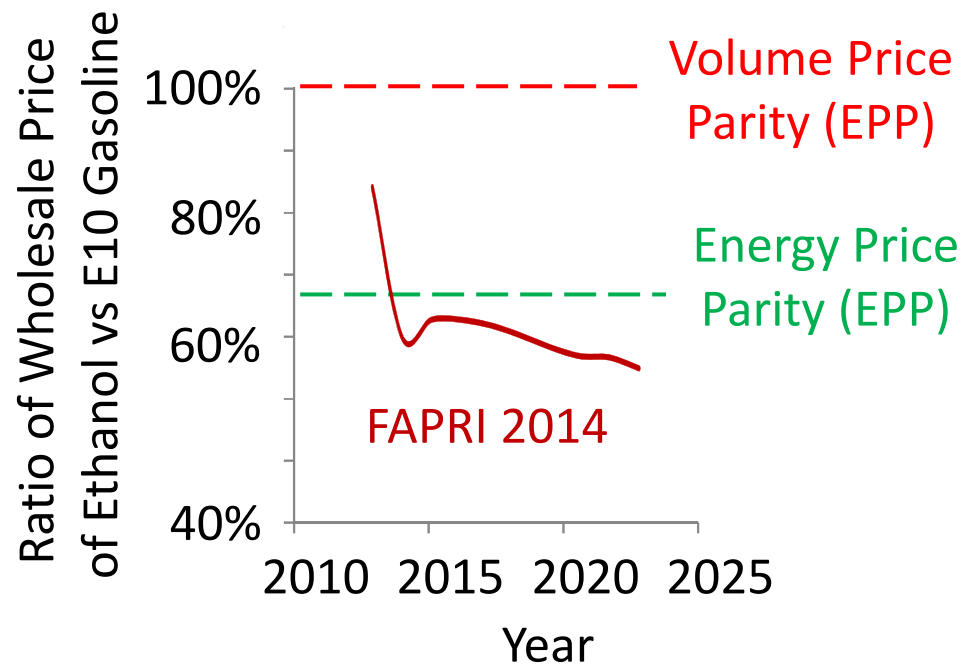


# Ethanol May be a Better Value in the Future

## Ethanol Reaching Energy Price Parity

U of MO FAPRI Now Estimates  
Ethanol Will Approach Energy Price  
Parity with E10 in 2014

Others See EPP in  
the Near Future



Based on a study of futures prices, CBO predicts *“in 2017... [t]he price of ethanol is about the same as that of gasoline per British thermal unit (Btu) of energy content”*

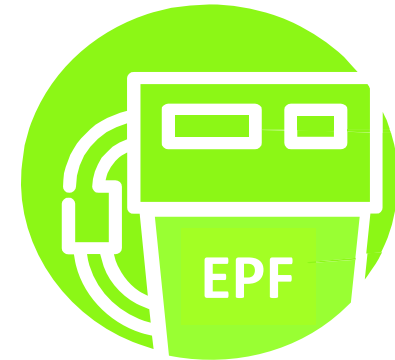
Pg. 13, “The Renewable Fuel Standard: Issues for 2014 and Beyond”, Congressional Budget Office, June, 2014

# Most Cost-Beneficial Use of Ethanol Maximizes Octane Benefit

# Ethanol the Key to an Affordable High Octane Fuel

## Eco-Performance Fuel (EPF)

- 98 Research Octane Number, or RON (approx. 93 AKI)
- Made from proven components
  - Base is E10 (Also marketed for legacy vehicles)
  - Ethanol added to get to 98 RON
- Improves engine performance by:
  - Allowing higher compression ratios
  - Enhancing combustion



## Advanced Vehicles + EPF Would:

- Have equal or better fuel economy
- Produce 2X the engine torque

Than Today's Vehicles Running on E10

# Why Eco-Performance Fuel?

## Cleaner

### Low CO<sub>2</sub> Emissions

- Less carbon in fuel =
- Lower CO<sub>2</sub> tailpipe

### Less Toxic

- Aromatics linked to cancer use to boost octane in gasoline
- Ethanol boosts octane w/o adding toxic chemicals

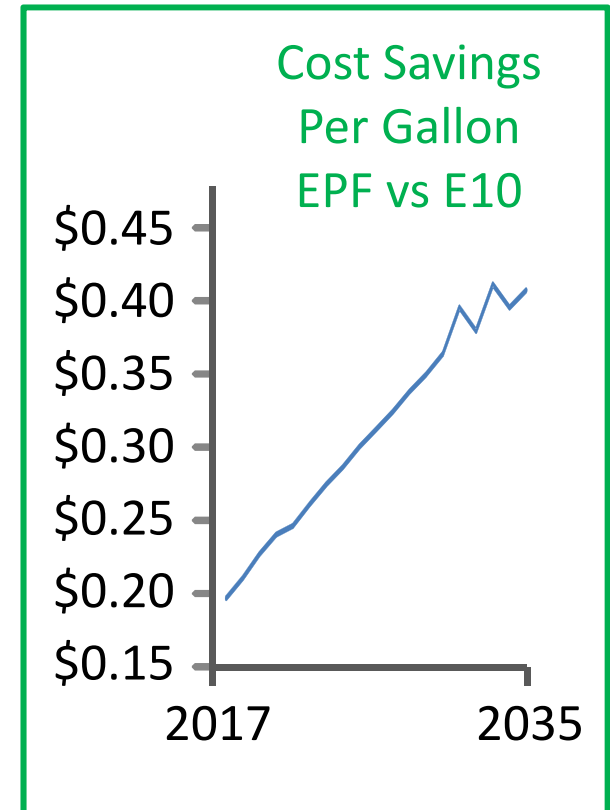
## Cheaper

### Ethanol Boosts Octane

- Highest value use
- Proven with E10
- Higher concentrations = more savings if vehicle can utilize the octane

### Savings Over Time

- Ethanol prices stable (EIA) or falling (U of MO)
- Gasoline prices rise



# Low-Cost Way to Meet National Energy Goals

## Goals

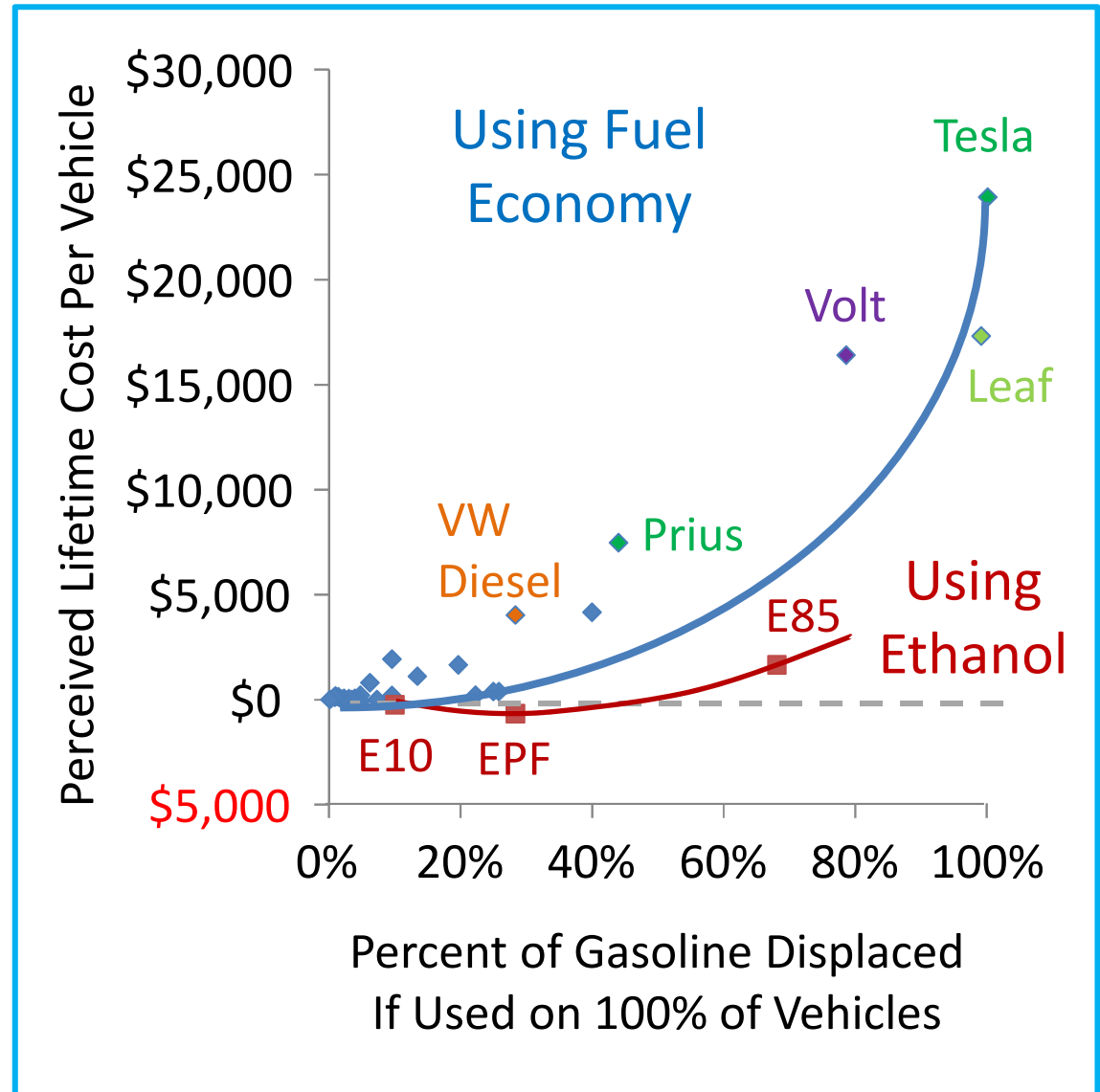
- Reduced oil dependence
- Lower greenhouse gas (GHG) emissions

## Programs

- Corporate Average Fuel Economy (CAFE): 1975
- Renewable Fuel Standard: 2005, 2007
- Clean Air Act for GHG emissions: 2007

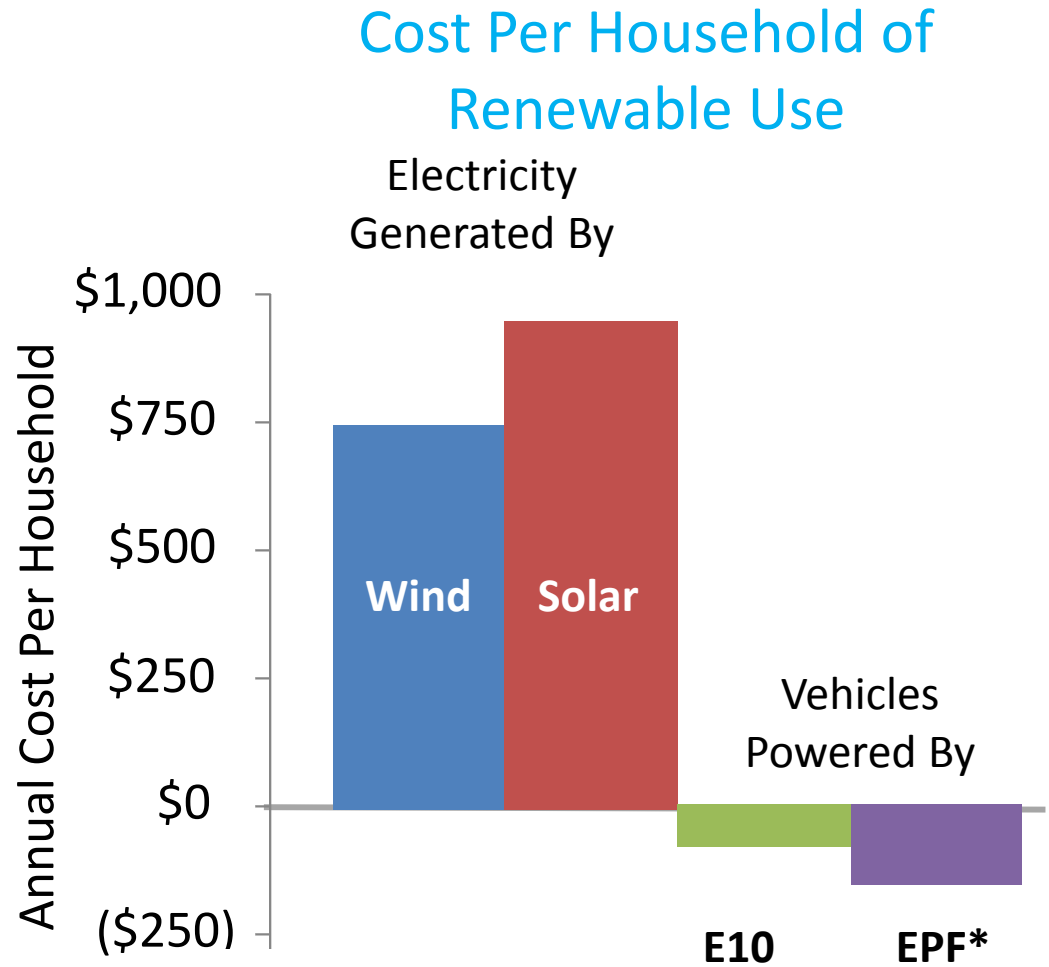
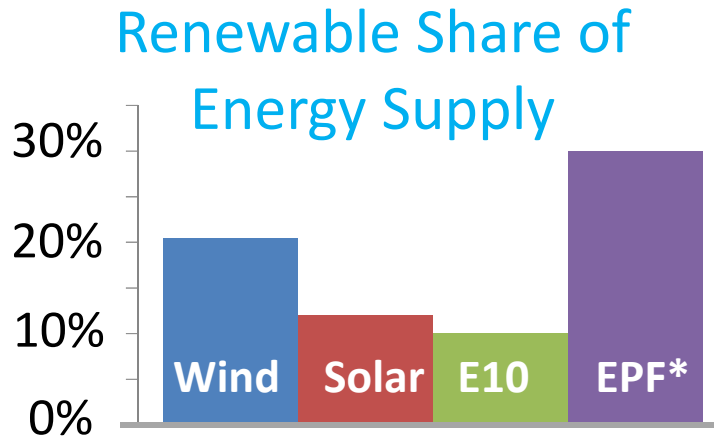
## Cost Effectiveness

- EPF: (\$3) to (\$9) per ton CO<sub>2</sub>
- Tesla: \$497 per ton CO<sub>2</sub>





# Ethanol: The Renewable That Saves Consumers Money



Renewables Can't Completely Replace Fossil Fuels

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Only Ethanol Both Displaces Fossil Fuel and Saves Consumers Money!

\* Eco-Performance Fuel, or EPF, has about 30% ethanol

Sources: Brookings Institute Defour Group EIA