OCTANE BENEFITS
MOBILE SOURCE TECHNICAL REVIEW SUBCOMMITEE

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Old Town Hilton; Alexandria, Virginia

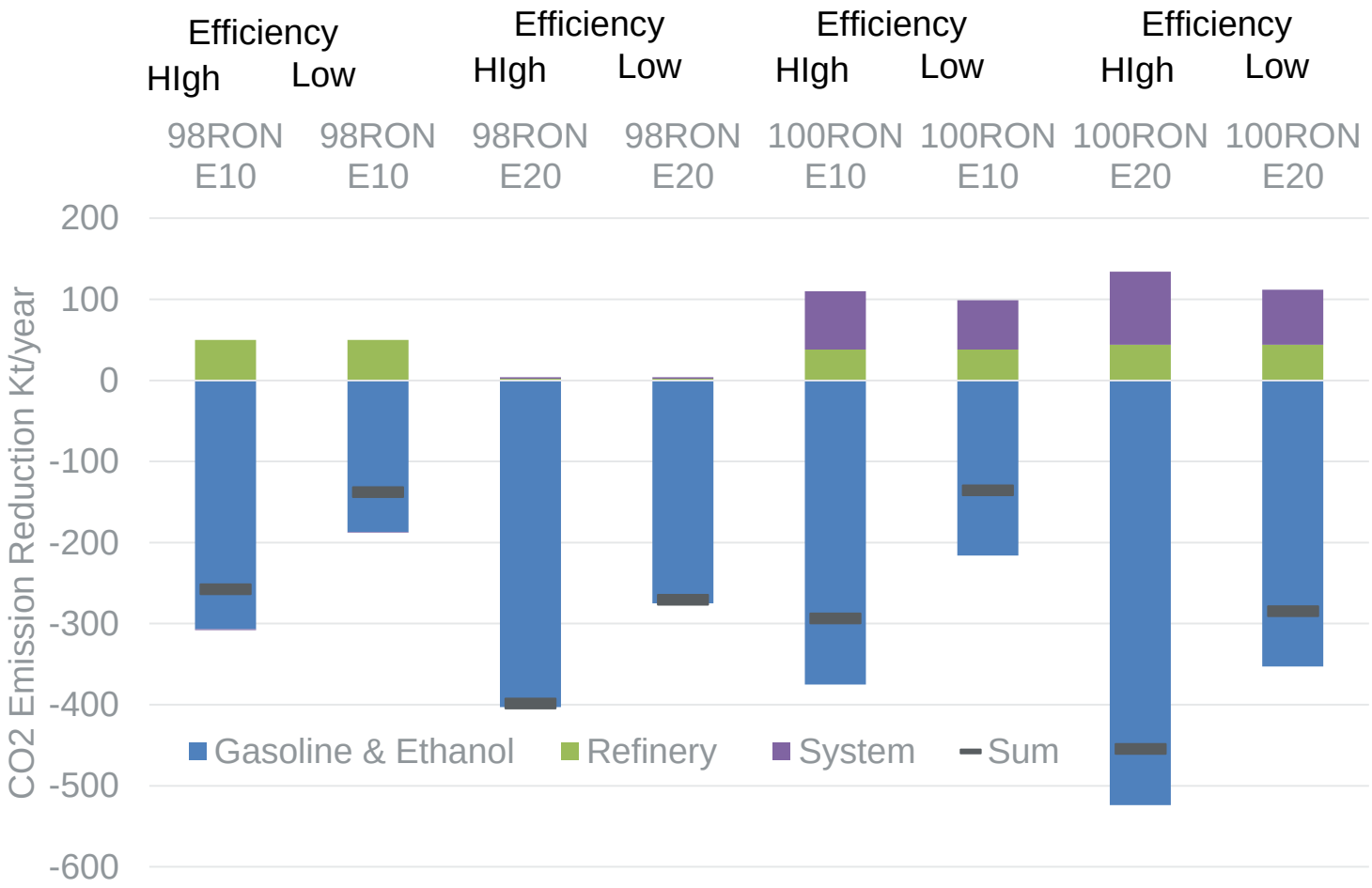
GENERA

GENERAL MOTORS

INCREASING OCTANE

- Increasing octane facilitates increasing compression ratio (CR)
  - Higher CR leads to higher engine efficiencies with higher octane fuel
  - Higher CR leads to lower engine efficiencies and power with lower octane fuel
    - Mis-fueling with low octane (todays “regular unleaded”) will lead to customer dissatisfaction
- On a piece cost basis, increasing CR can be virtually free
  - Development work is needed, particularly to manage mis-fueling with low octane fuels
- Adding increased ethanol capability will have a cost
  - Maximum cost is known, the cost of an FFV

WELL TO TANK TO WHEELS CO2 EMISSIONS



GENERAL MOTORS

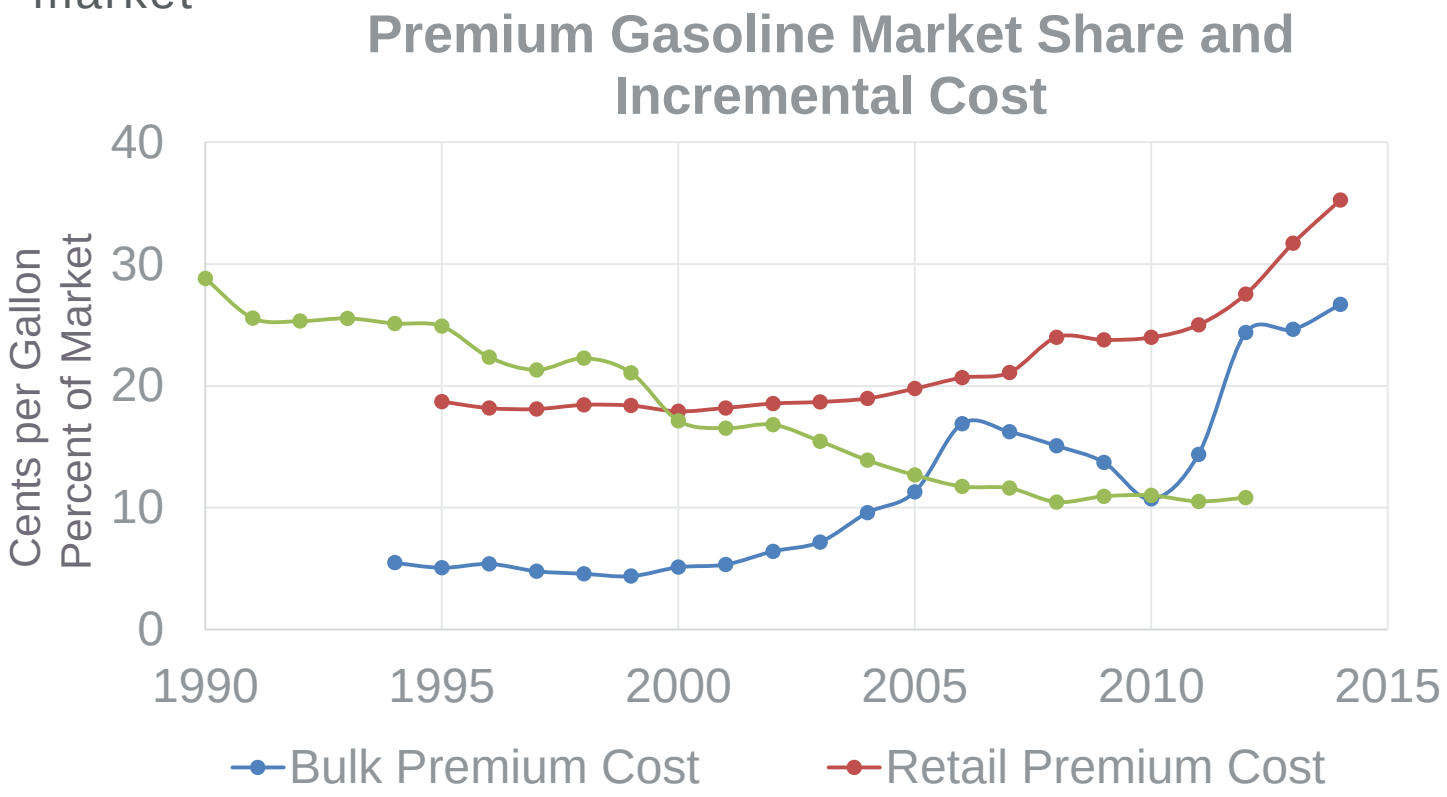
Per 100 kBBL/day refinery
From Speth et al, ES&T 2014, MIT

OCTANE TODAY

- Premium gasoline has poor customer value
- Additional cost of premium is more than efficiency gain
- An automaker could market their vehicle as “premium required” and capture the efficiency and power gain
  - However their competitors would take advantage of this and tout their regular gasoline capability
  - Some customers may ignore the “Premium Required” admonishment
- Premium in the US is a performance fuel

PRICE OF OCTANE

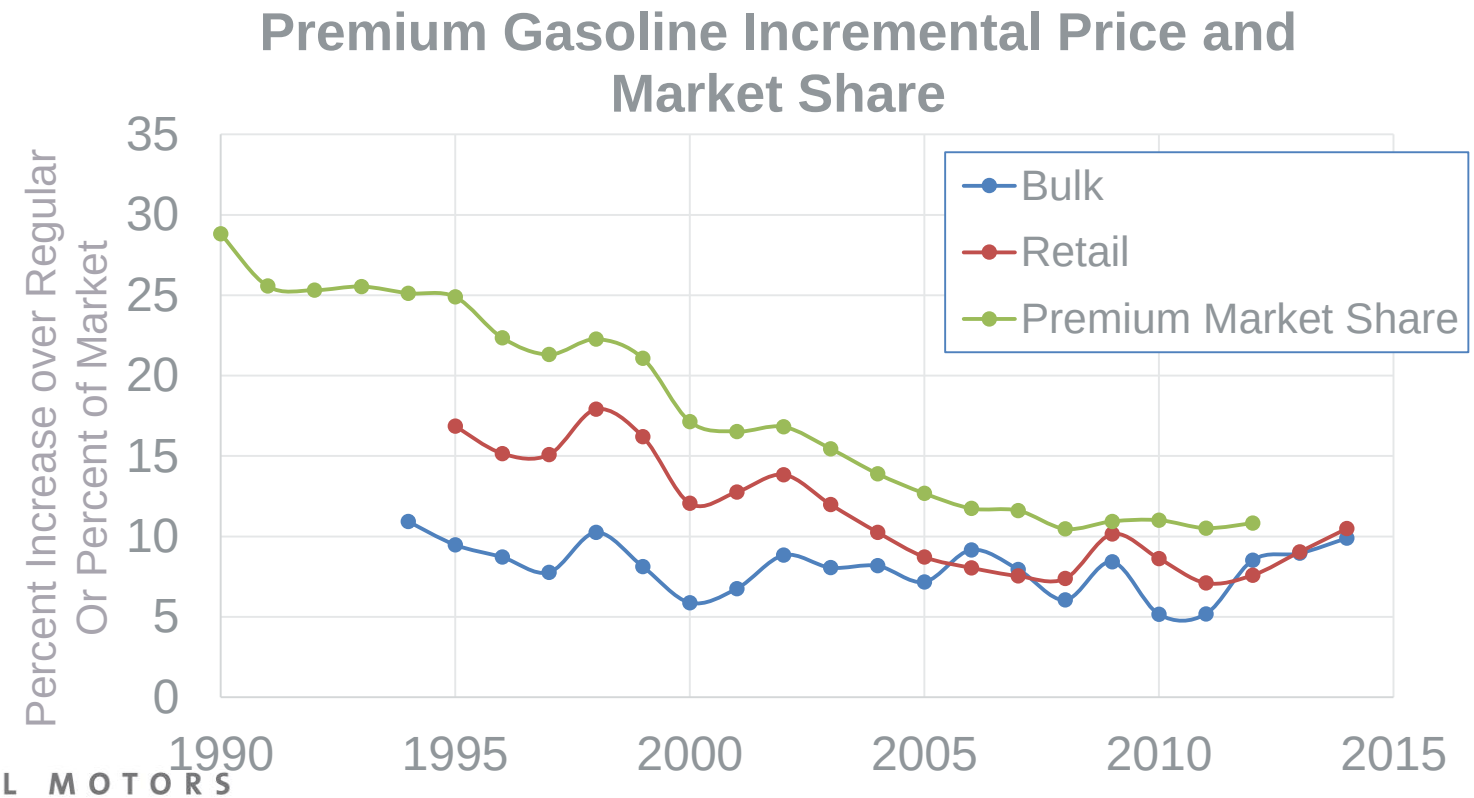
- The difference between retail regular and premium gasoline has risen steadily
- Wholesale prices have fluctuated in line with trends in the fuel market



EIA data

OCTANE VALUE

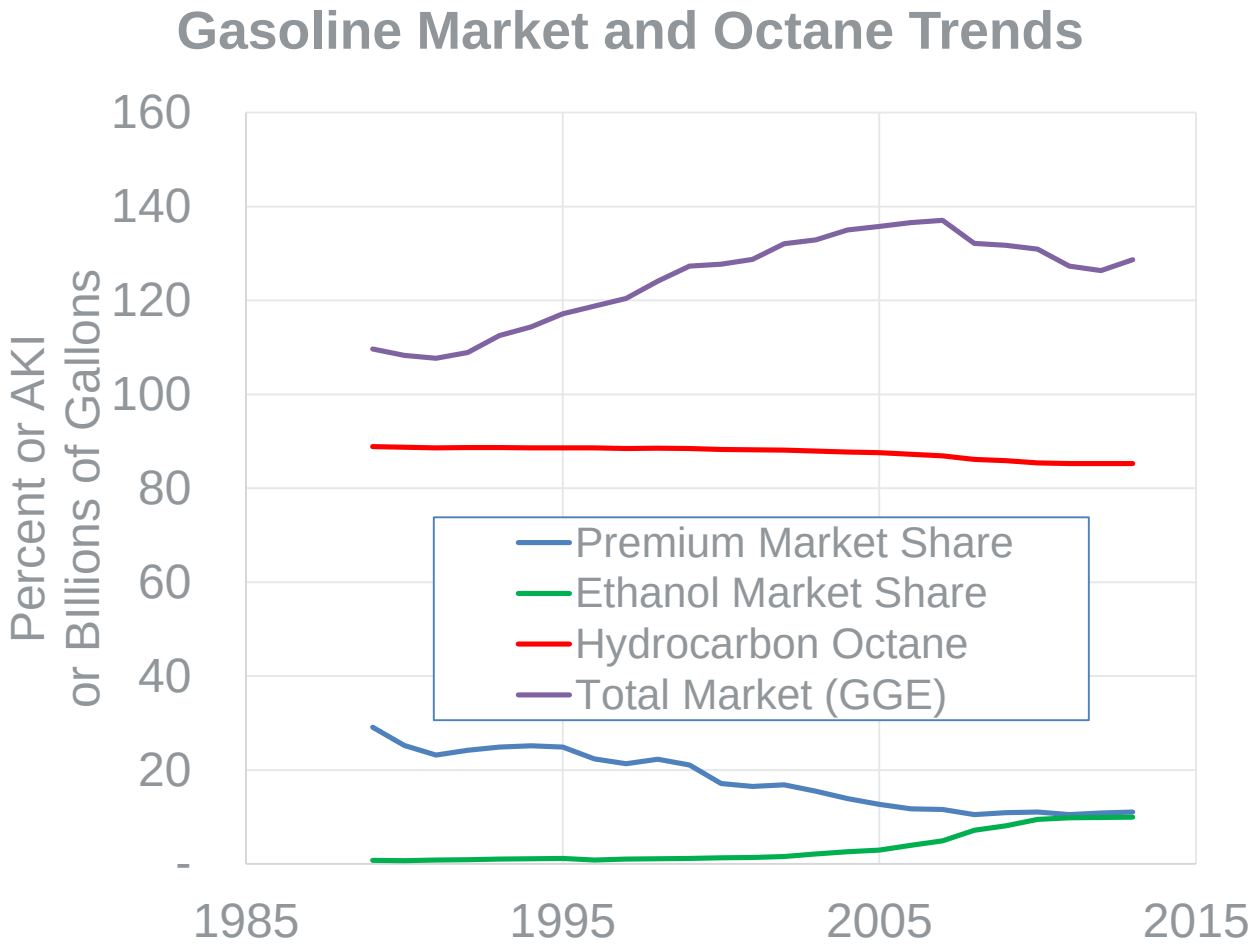
- Fuel needs to be a good value for the average customer
- Percentage price increase for premium typically exceeds the fuel economy benefit
  - Yesterday's and today's premiums are performance fuels
  - As declining usage shows, customers are valuing performance less



EIA data

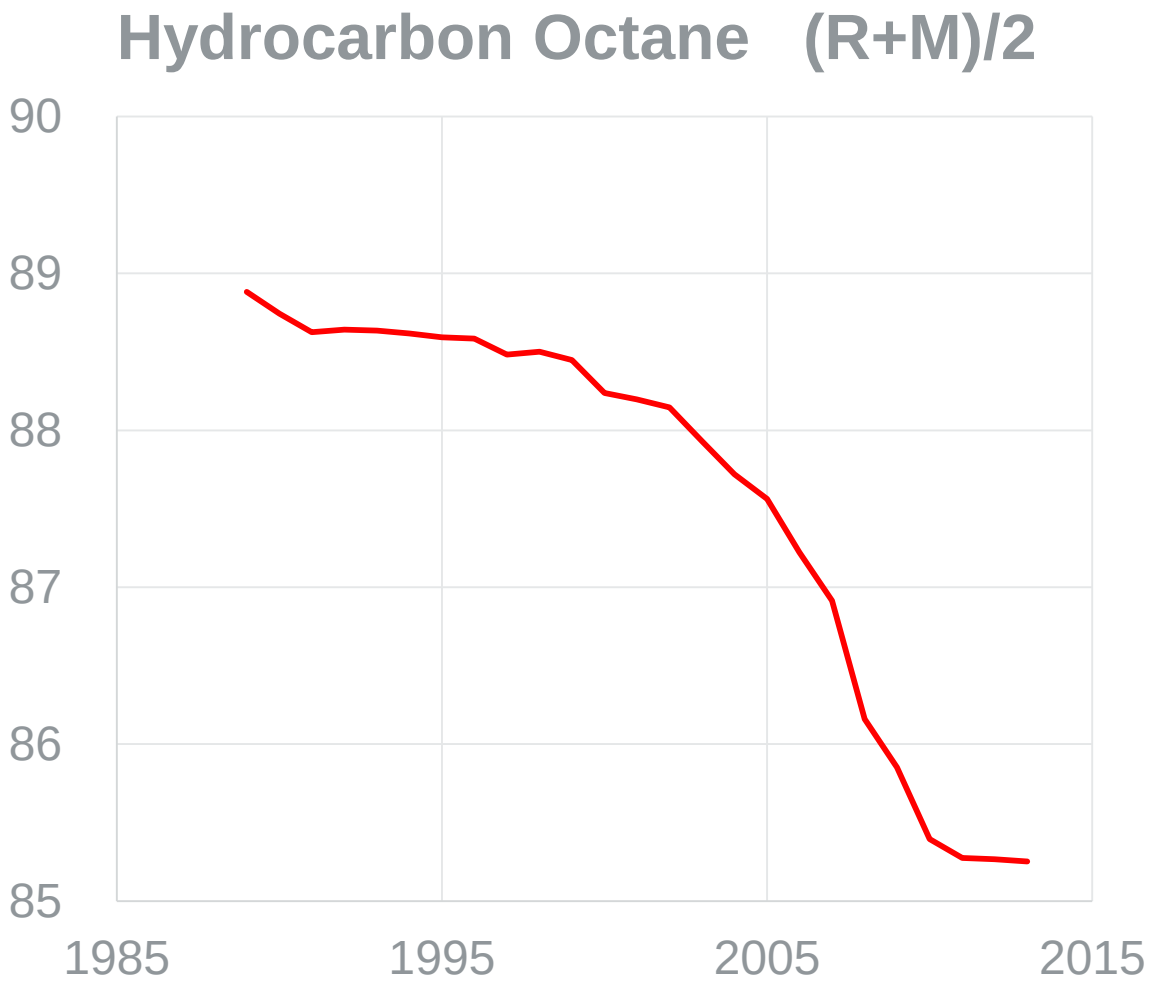
GASOLINE

- Looking back at the gasoline market, several things are evident
  - Recent declines in volume
  - Declining hydrocarbon octane
  - Declining premium market share
  - Increasing ethanol market share



GASOLINE

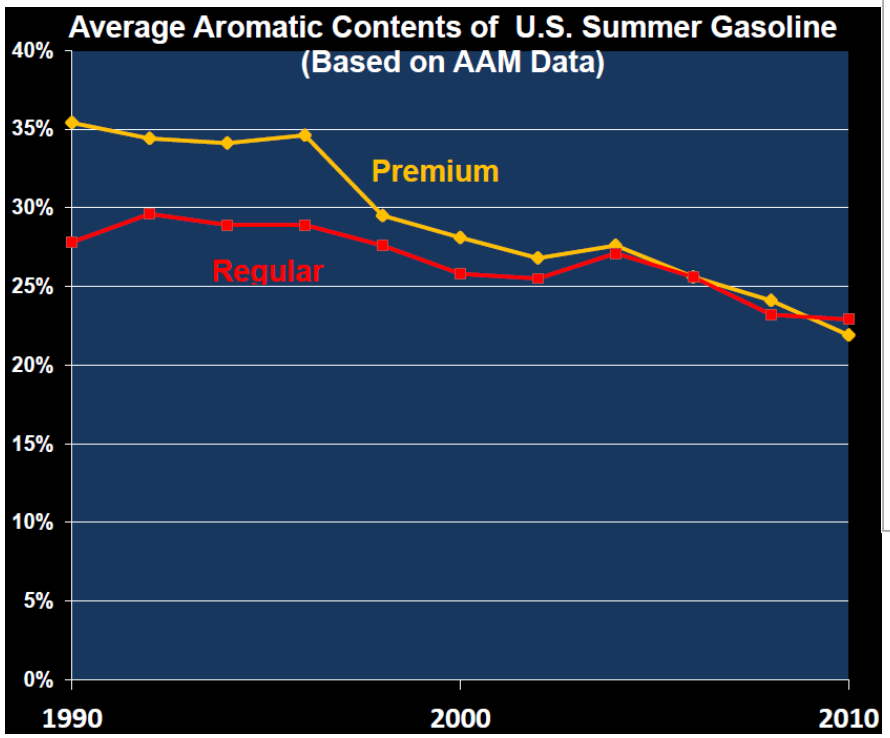
- Declining hydrocarbon octane is primarily related to increased ethanol usage

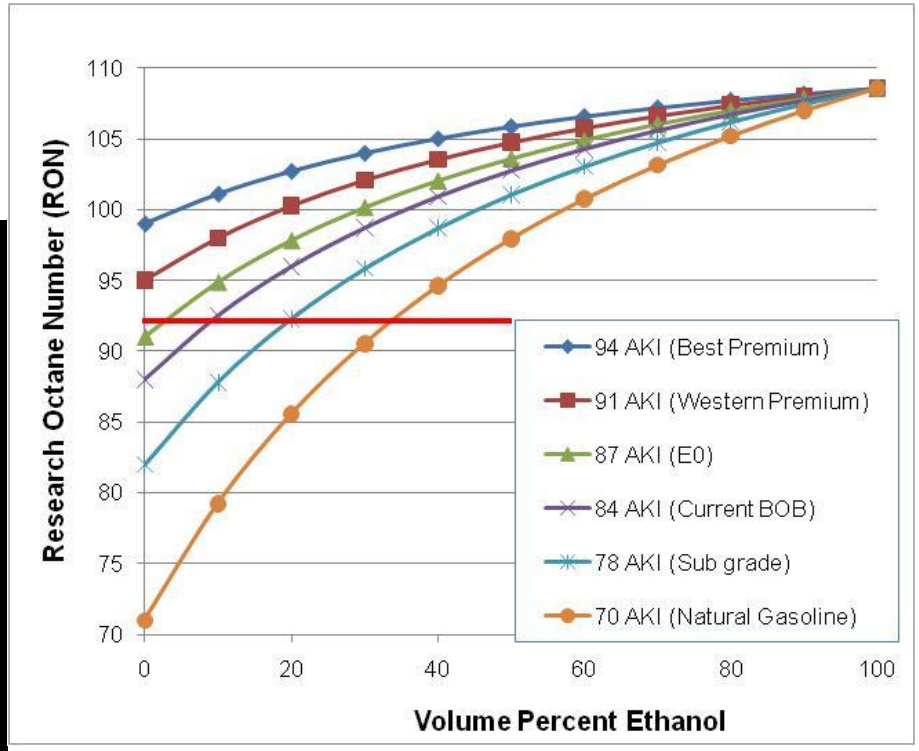


HOW TO INCREASE OCTANE?

- Options
  - Increase production of traditional higher octane components
  - Reduce use of low octane components
  - Increase ethanol usage
  - Introduce new high octane molecules

HOW TO INCREASE OCTANE?





Application of Anderson & Kramer's method, et al, Energy & Fuels, 2010, 24, 6576-6585

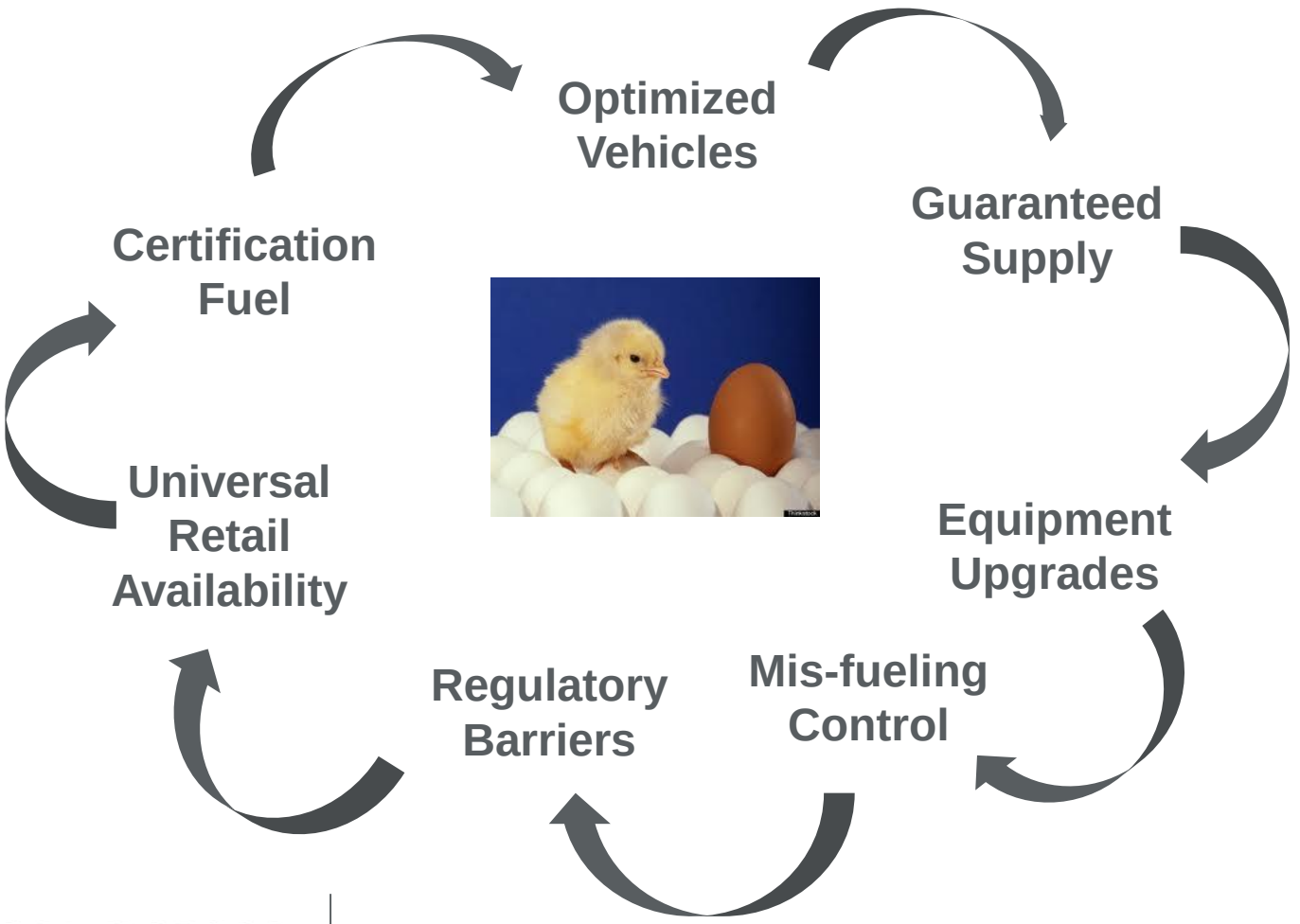
"WHERE WILL THE OCTANE COME FROM?"
Joseph M. Colucci,
SAE 2013 INTERNATIONAL HIGH OCTANE FUELS SYMPOSIUM

HOW TO INCREASE OCTANE?

- The market is large
- Regional solutions are likely
  - Raw material cost
  - Conversion availability
  - Transportation costs
- All states and provinces need a solution

GENERAL MOTORS

HOW TO IMPLEMENT A NEW FUEL?



CHALLENGES

1. Regulating market fuel changes
2. Providing good value to the customer
3. Managing the transition to a new market
4. Matching certification and field fuel so that the “actual use” of certification fuel is high

MISFUELING

- If ethanol blends above 10% ethanol appear in the market, mis-fueling become a significant concern
  - Legacy E10 vehicles need to be protected
- If the ethanol level is above 15%, newer vehicles also need protection
- “Premium Required” vehicles can also be mis-fueled with low octane fuel
  - Full optimization to high octane fuel makes this a more serious concern

- The Lead experience in the 70s shows that many consumers ignore requirements
  - A significant portion of vehicles were mis-fueled despite the nozzle mis-match
- API commissioned a study of mis-fueling prevention pathways
  - There was no painless, highly effective pathway

CONCLUSIONS

- Higher octane gasoline offers fuel economy and GHG benefits on both a tank to wheels and well to wheels basis
- Higher octane gasoline is not and has not been a good value for consumers except for those seeking improved performance
- The pathway to higher octane market fuels is unclear
- Mis-fueling control remains an important issue that limits optimization to higher octane

- All stakeholders will have to work together to capitalize on the advantages and address the challenges of moving to higher octane fuels

DOE High-Octane Fuels Study:

How much fuel economy can be gained by increasing octane ratings, and how does this answer change for different high-octane blends?

Approach: Generate engine-based data for a range of fuel octane ratings, comparing blend streams at approximately equivalent RON. Downselect fuels for complete engine maps and vehicle modelling to estimate fuel economy impacts.

Include in study

- Multiple paths to higher octane.
  - Ethanol, isobutanol, high-octane hydrocarbons
- Multiple octane levels.
  - ~100 RON, ~ 98 RON, ~ 95 RON
- Fundamental fuels, such as isooctane.
- Identify technical challenges that limit improvements.