NCSL – AGRICULTURE TASK FORCE
SESSION: FUTURE OF FUEL
August 8, 2016

Presented By: Dominic DiCicco, Manager
Sustainability and Vehicle Environmental Matters
Agenda

• Changing Global Societal Trends
• 2016 World’s Most Ethical Company
• 17th Annual Ford Sustainability Report
• Balancing Competing Requirements
• Technology Considerations
• Portfolio Considerations
• Infrastructure Reality
• Regulation Impact On Consumers
• Higher Octane Rated Gasoline
• Well-to-Wheel
• Shared Responsibilities
Changing Global Societal Trends Will Shape The Future Of Our Industry, And Will Transform The Way We View Innovation And Mobility
A 2016 World’s Most Ethical Company

Only automaker to earn the recognition

Ford
Go Further

The Right Way

2010 WORLD’S MOST ETHICAL COMPANIES
WWW.ETHISPHERE.COM

2011 WORLD’S MOST ETHICAL COMPANIES
WWW.ETHISPHERE.COM

2012 WORLD’S MOST ETHICAL COMPANIES
WWW.ETHISPHERE.COM

2013 WORLD’S MOST ETHICAL COMPANIES
WWW.ETHISPHERE.COM

2014 WORLD’S MOST ETHICAL COMPANIES
WWW.ETHISPHERE.COM

2015 WORLD’S MOST ETHICAL COMPANIES
WWW.ETHISPHERE.COM

2016 WORLD’S MOST ETHICAL COMPANIES
WWW.ETHISPHERE.COM
“Contributing to a better world always has been a core value at Ford, and our commitment to sustainability is a key part of our company DNA. Ultimately, our vision is to make people’s lives better by changing the way the world moves, just as Henry Ford did more than a century ago.”

“With sustainability deeply embedded in our overall strategy, we remain committed to running a strong and responsible business that treats our customers, our employees, our communities and our planet with respect.”

While Our Industry – And The World Around Us – Continues To Evolve Faster Than Ever, Our Entire Team Remains Fully Committed To Keeping Sustainability At The Heart Of Our Strategy
Balancing Competing Requirements And Increasing Customer Expectations Constrains The Feasible Solutions Zone
Technology Considerations

Advanced Engines

Weight Reduction

Electrification
- Hybrid
- Plug-in Hybrid
- Battery Electric

Product Portfolio Scenarios

Future Transportation Fuels ???

Iterating Technology Levels To Achieve Affordable Compliance Pathways; Improvements To Future Transportation Fuels Are Unclear
In the U.S., alternative fuel stations are advancing, gasoline remains dominant ~127,000 total stations providing conventional motor fuels

* Electric count includes each plug rather than by geographical location which is reflected in the other fuels regardless of how many dispensers and nozzles are on site


Opportunity To Improve Efficiency Across The Fleet (Today) Remains With The Most Dominant Fuel → Gasoline (…Increase Octane Rating)
Tighter CO₂ Requirements Drive Higher Vehicle Technology Costs
Buyers See Diminishing Fuel Cost Savings As Fuel Economy Improves
Knock Risk Increases As Engine Technologies Shift Operation To Higher Load / Lower Speed To Improve Efficiency - Improved Fuel Properties Can Help

- Downsizing
- Downspeeding (Longer Gearing)
- Cylinder Deactivation
- 7+ speed transmissions
- HEV powertrains
Higher Octane Rating – Efficiency Improvement - Compression Ratio and Spark Timing

- Higher compression ratio (CR) can improve fuel efficiency with higher octane rated fuel.
- At a fixed compression ratio, higher octane rated fuel enables more optimum spark timing.

\[ \frac{\text{Relative Brake Eff. Change [\%]}}{\text{Compression Ratio}} \]

\[ \frac{\text{Normalized Efficiency}}{\text{Spark Retard}} \]

SAE 2014-01-2599

SAE 2006-01-0229

Higher Octane Rated Fuel Reduces Knock, Enabling Both Higher Compression Ratio And More Optimum Spark Timing
Individually Higher-octane Rated Fuel And Higher Compression Ratio Improve Efficiency, Optimal Results Are Achieved By A Combination Of The Two

- **1.1% M/H benefit**
- **2.5% US06 benefit**
- **4.8% M/H benefit**
- **4.9% US06 benefit**
- **2.6% M/H benefit**
- **4.9% US06 penalty**

Turbocharged engine (SAE 2013-01-1321)
Higher octane fuel enables higher engine efficiency.

- **Key question**: Engine benefit vs. Fuel cost

Well-to-wheels (WTW) analyses are needed to identify “optimum” octane ratings.
- **Metrics**: CO$_2$, oil, cost, ...

Vehicle Efficiency Gains For Higher-octane Fuel Can Outweigh Fuel Production Impacts, Yielding Net WTW Reductions In CO$_2$ Emissions
Approach:

- Transition to high-RON gasoline
- Vehicle fleet model
- Aspen refinery model scenarios

Conclusions:

- CO₂: Widespread adoption of 98 RON in the US would reduce WTW CO₂ emissions by 2.5–4.7%
- Economic: Per-gallon cost more than offset by fuel efficiency improvement → CO₂ benefits are achieved with net cost savings

Each stakeholder has an opportunity to contribute positively to the societal goals of improving fuel economy/reducing carbon emissions from the on-road light-duty transportation sector.
Great Products – Strong Business – Better World