



Mercedes-Benz



Mid-Blend Ethanol Fuels – Implementation Perspectives

William Woebkenberg - US Fuels Technical and Regulatory Affairs

Mercedes-Benz Research & Development North America

July 25, 2013



Mercedes-Benz

Mid-Blend Ethanol Fuels

CUSTOMER PERSPECTIVE



Mercedes-Benz

Customers are told this....





Mercedes-Benz

But hear this...





Mercedes-Benz

Is E85 making “cents” yet? RIN \$\$\$ changing that...



- E85 has 28% less energy than E0
- E85 delivers 25% fewer miles due to combustion differences
- Compared to E10, E85 delivers 21.5% fewer mpg than E10 but...
- E85 is really E74 (eia.gov basis) so it delivers **18.5%** fewer mpg than E10

But will customers figure it out?





Mercedes-Benz

What Octane Should I Use?



Now I Have to Choose the Right Ethanol?





Mercedes-Benz

Mid-Blend Ethanol Fuels


TECHNICAL PERSPECTIVE



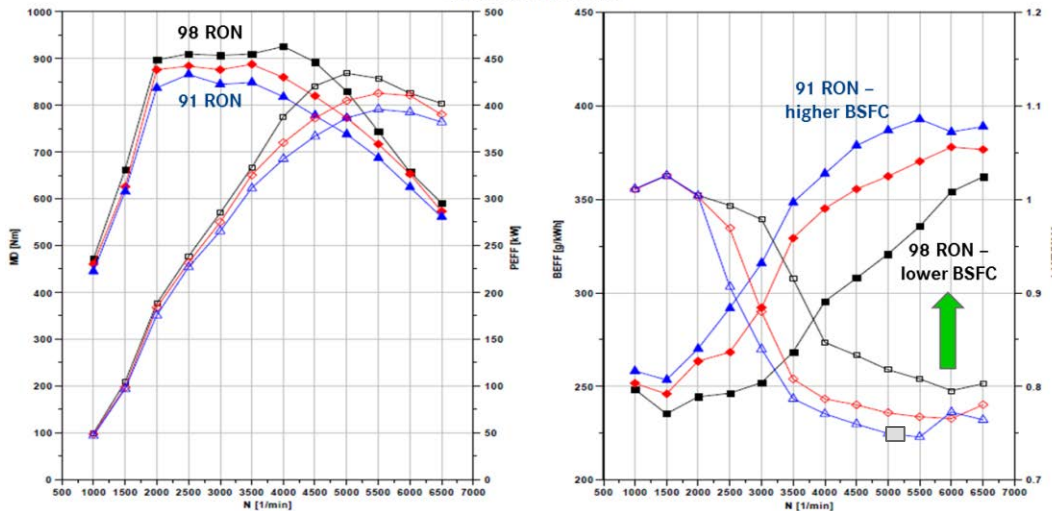
Mercedes-Benz

Octane is the Single Most Important Fuel Property

High Octane is the key enabler for higher torque, power and efficiency.

 Mercedes-AMG GmbH E/TSV - Verbrennung Motor	1: 133_VL / NT140-3058 / VL Kraftstoffvergeich / ROZ 98 /	Motor-Nr.: NT140-3058 Motor-Typ: M273DE55LA Prüfstand: 04 Kraftstoff: ROZ98,95,91
	2: 134_VL / NT140-3058 / VL Kraftstoffvergeich / ROZ 98 /	
	3: 135_VL / NT140-3058 / VL Kraftstoffvergeich / ROZ 91 /	

M278 DELA55: Vollast





Octane + Mid Blend Ethanol (E20+) is a Powerful Fuel

- Ethanol is naturally very high octane 109 RON
- Ethanol has high cooling effect which provides additional benefits for higher “effective” octane – 4x greater than E0.
- E20+ added to various “base” blends of gasoline can provide > than 102 RON



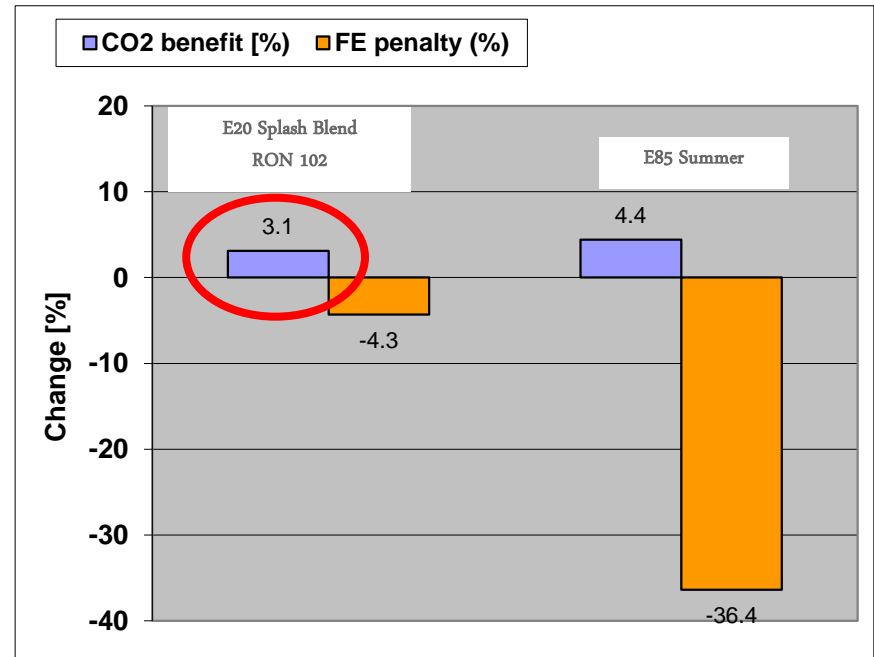


E20 Optimization Can Minimize Customer FE Loss While Improving CO2

FVV Joint Project “Future Fuels for Gasoline DI-Engines”

Vehicle Data:

Ford Focus ST
Curb weight: 1392 kg
Transmission: 6-speed manual



Gasoline/Ethanol blend E20 with RON 102 is a good compromise
between CO₂ benefit and fuel economy



Vehicles “Optimized” for Mid-Blend Ethanol and Octane Can Enjoy Both Power and Efficiency

- Ethanol + Octane benefit is further amplified in smaller, turbocharged engines over octane alone
- Vehicles with small 4 cylinder engines “dedicated” for high octane and ethanol blend levels can perform like are they V8-equipped, yet exhibit fuel economy of smaller engines.



- 2014 Mercedes-Benz AMG CLA 45
- 2.0L 4 cylinder
- 350+ HP
- 98 RON required
- 7 L/100 km Euro cycle
- 33 mpg equivalent



Mercedes-Benz

Mid-Blend Ethanol Fuels

REGULATORY PERSPECTIVE



How the US Regulators See Ethanol:

Biofuels can play several different roles in the very complex market for motor fuels

- Ethanol competes, or could compete, in three distinct market segments, with very different economic characteristics:
 - Octane source
 - Volume extender
 - Energy content provider
- Ethanol is facing significant challenges in moving beyond its current roles as a source of both octane and volume
 - Blend wall
 - Availability of E85 and other high percentage blends
 - Challenging economics of pricing of E85 and other high percentage blends to be competitive on an energy content basis



RFS2 is Driving Higher Ethanol Blend Fuels but....

- E10 is at a retail fuel “Blend Wall”
- E15 is the answer to the question nobody asked
- E85 has no market penetration
- GHG Rulemaking removes incentives for OEMs to produce FFV vehicles





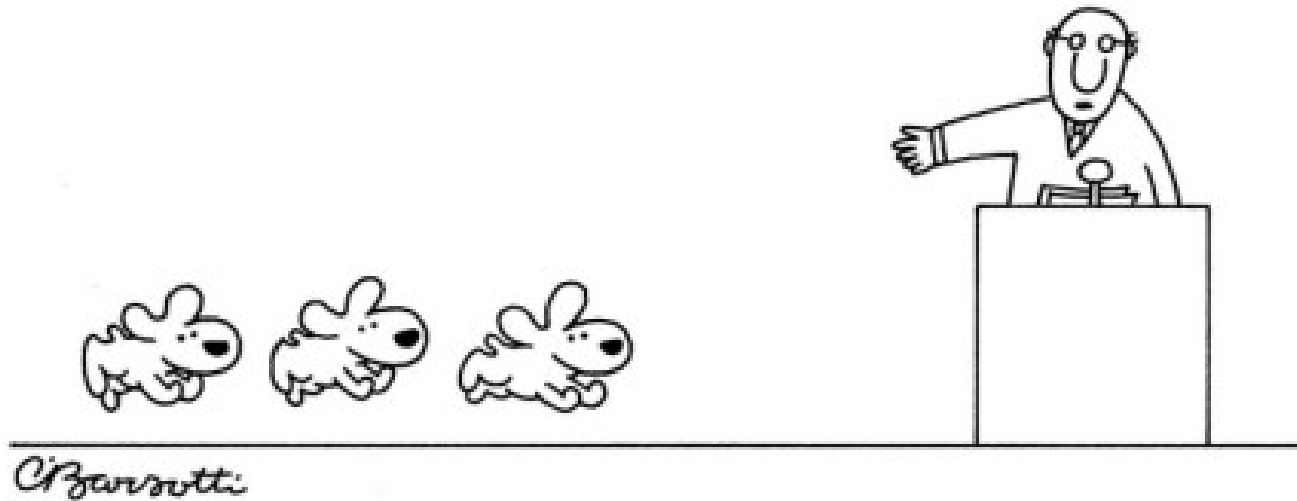
Mid Blend Certification Fuel Addressed in Tier 3 Proposal

Which comes first – certification or market fuel?





Mercedes-Benz



Ci Zanetti

"But first, a distraction."



Ethanol and Fuel Economy: What is the R-Factor?

“R factor is a value that describes change in fuel economy that accompanies a change in the volumetric heating value of the fuel being used.”

“Preliminary Examination of Ethanol Fuel Effects on EPA’s R-factor for Vehicle Fuel Economy”, Oakridge National Laboratory and UT-Battelle, June 2013, <http://info.ornl.gov/sites/publications/files/Pub42819.pdf>

Table 6. Energy Content of Various Fuels *

	Btu per <u>Gallon</u>	Relative Percent <u>Btu (gas 100%)</u>
Gasoline	124,000	100%
Ethanol	83,333	67%

* Energy Information Administration

Note: the above are “gross heating values”

“Net heating values” below are more representative.

Gasoline:	115,000 BTU/gallon (100%)
Ethanol:	76,000 BTU/gallon (66%)

The R factor is the proportion of the energy loss due to ethanol addition or aromatics reduction for which the EPA fuel economy equation compensates.

For example: E30 has ~10% less energy than E0 and 6% is recovered via $R = 0.6$ so OEMs suffer > 4% penalty in certification fuel economy for using E30.



R factor should = 1.0



“The current factor of 0.6 which is called out in CFR is **clearly too low**, and a proper factor for modern vehicles is closer to unity, as might be expected from improved air/fuel ratio control common for more modern vehicles.”

- R factor 0.6 vs 1.0: 4.7% penalty in certification fuel economy for using E30
2.4% penalty in certification fuel economy for using E15
- Removing aromatics from base oxygenate blend and substituting ethanol as octane enhancer doubly penalizes automaker as long as R factor < 1.0

“Preliminary Examination of Ethanol Fuel Effects on EPA’s R-factor for Vehicle Fuel Economy”, Oakridge National Laboratory and UT-Battelle, June 2013, <http://info.ornl.gov/sites/publications/files/Pub42819.pdf>

E20 FE vs energy density: 7.7% drop in fuel economy as compared to E0

“Effects of Intermediate Blends on Legacy and Small Non-Road Engines”, National Renewable Energy Laboratory and Oakridge National Laboratory, February 2009, http://feerc.ornl.gov/pdfs/pub_int_blends_rpt1_updated.pdf

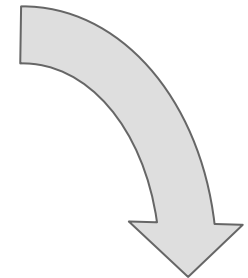
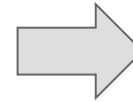


So, How To Get Automakers and Producers Interested in Ethanol?



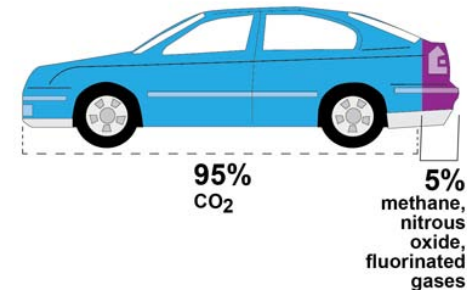


EPA Needs to Develop a Strategy to Encourage Automakers and Oil Producers to Produce of Mid-Blend Ethanol Fuels and Dedicated Vehicles.



- GHG/CO₂ Burden Reduction incentive for automakers based on ethanol blend level at which vehicle is optimized

- Federal Fuel Tax rebate, RIN multiplier or other incentive to oil producers based on ethanol blend level





No Manufacturer Would Voluntarily Certify on Any Ethanol Fuels with $R < 1.0$





Mercedes-Benz

Mid-Blend Ethanol Fuels

MERCEDES-BENZ PERSPECTIVE



Proposal – Reallocation of Current Ethanol Pool into Tier III-Dedicated High Octane Fuel

Tier III Ethanol Pool Scenarios

Regular	Mid-Grade	Premium	Tier III	Tier III Octane*
E7	X	E10	E30	101 RON
E8	X	E10	E25	100 RON
E8.5	X	E10	E20	99 RON
E9	X	E10	E15	98 RON

*based on 92 RON Premium BOB

Assumptions:

- Based on 2 tank retail system
- Mid-Grade eliminated
- Premium is blended from Tier III and Regular
- Tier III volume initially is equal to Mid-Grade volume eliminated





Current Gasoline Blends and Consumption

Current Fuel Pool*

Regular	Mid Grade	Premium
87 AKI – E10	89 AKI – E10	91 AKI – E10

*excluding 85-86 AKI, 93-94 AKI, E15 and Flex-Fuels

Current Blend Consumption Mix*

86%	6%	8%
-----	----	----

*based on www.eia.gov 2011 annualized sales volumes and blend consumptions





Proposal – Reallocation of Current Ethanol Pool into Tier III-Dedicated High Octane Fuel

Regular	Mid-Grade	Premium	Tier III	Tier III Octane*
E7	X	E10	E30	101 RON
E8	X	E10	E25	100 RON
E8.5	X	E10	E20	99 RON
E9	X	E10	E15	98 RON

*based on 92 RON Premium BOB

Additional gasoline in each gallon of E8 regular + Tier III gasoline volume for E25 blend recovers 6% gasoline volume previously occupied by Mid-Grade fuel.



Daimler Supports Mid-Blend Ethanol Fuels with Increased Octane

Gasoline fuels

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Main Grade	E10 (from 2010 applicable for all new models)							E20-E25 with octane increase			
Protection Grade (Legacy Fleet)	E10 in US/E5 in EU (EU needed until at least 2016)							E10			





It's almost 2014...what if Mid-Blend Ethanol Fuels Need More Time to Market?





Proposal: Super-Premium E10 as Interim Step to “Tier 3” Fuel

- Fuel can be used by all vehicles immediately
- Replaces current premium grade with 96AKI E10 fuel
- Provides future “protection grade” for vehicles dedicated to high octane, mid-blend ethanol “Tier 3” fuel as fuel penetration ramps up
- Can be implemented more quickly and as interim step to mid-blend ethanol Tier 3 fuels.
- Gets customers used to the reality of a new fuel introduction with the concept with which they already are familiar – OCTANE.





What We Get:

- EPA Provides early GHG Burden Reduction or CAFE Credits based on CO₂ Reduction as compared to 91 AKI Certification Fuel
- Higher Octane market fuel to assess field performance of Tier 3 hardware prior to mid-blend ethanol introduction

What Petroleum Producers Get:

- “Improved” fuel for which there is a current market at potentially higher margin
- Experience with base fuel to which higher ethanol amounts may be blended in the future

What EPA Gets:

- Early implementation of Tier 3 vehicles for quicker GHG and criteria emission reduction.

