

Opportunities to Improve the GHG Performance of Biofuels

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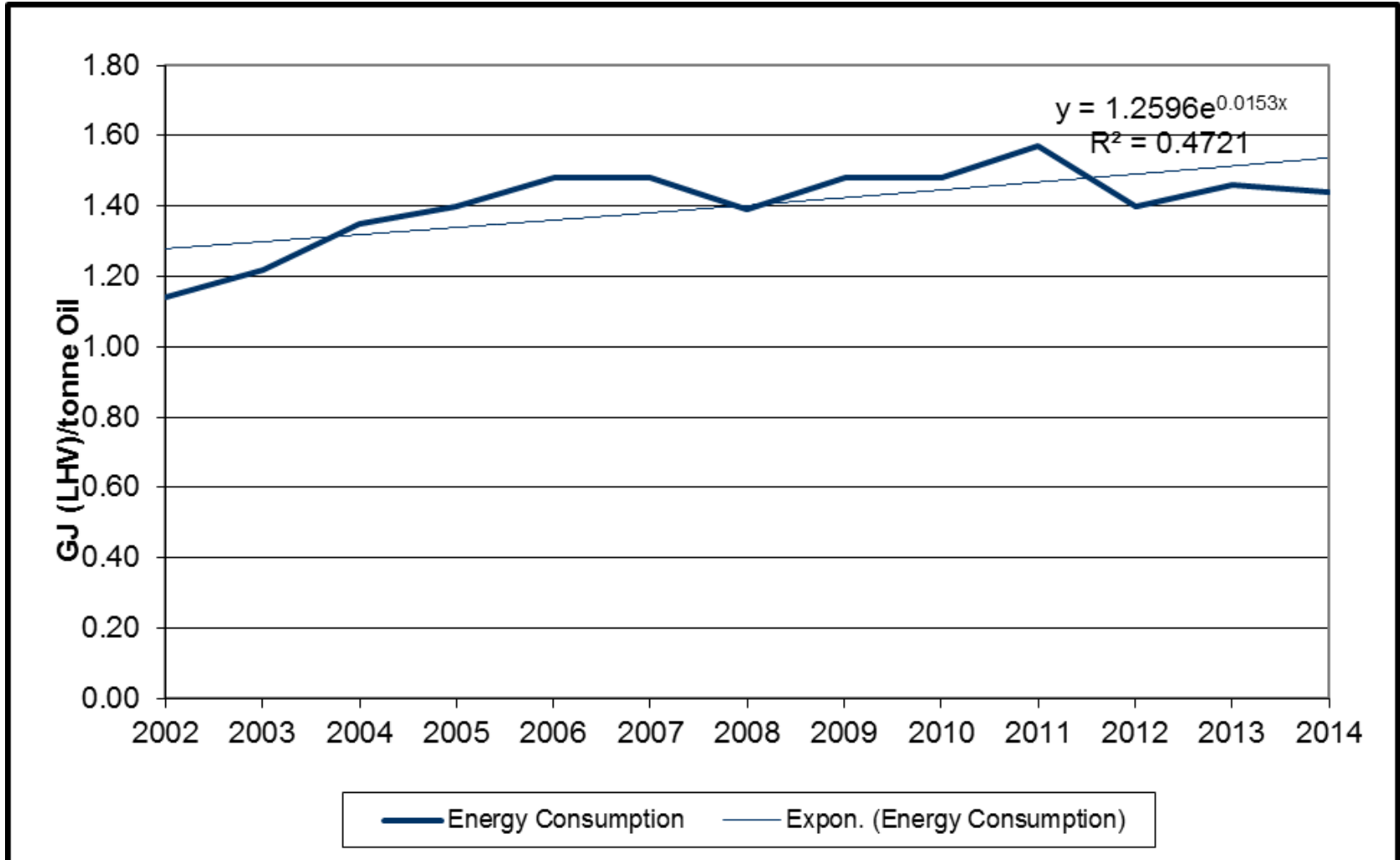
Topics for Discussion

- Trends
- Substitution
- Synergies

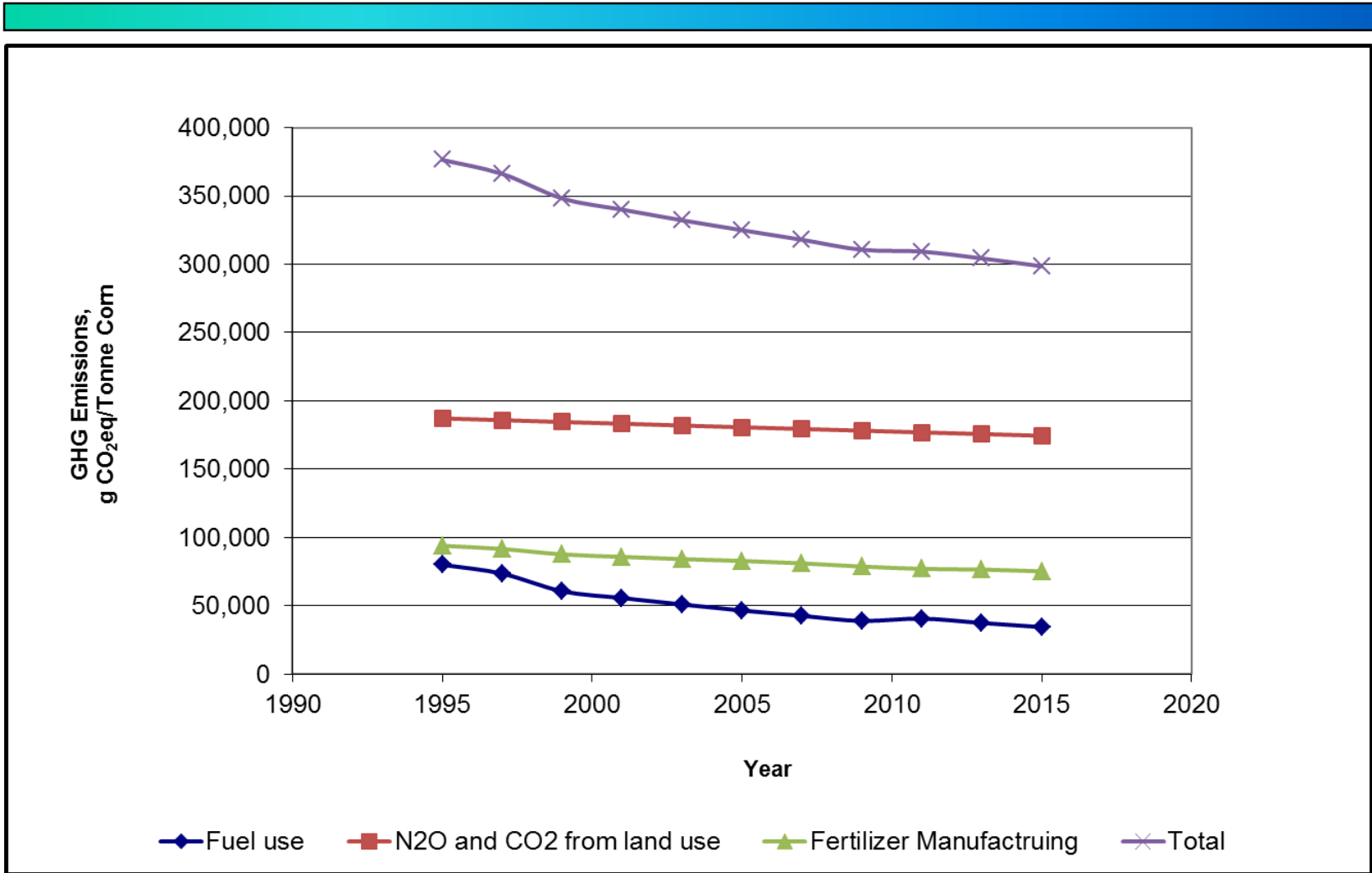
Trends

As investors say, the trend is your friend.

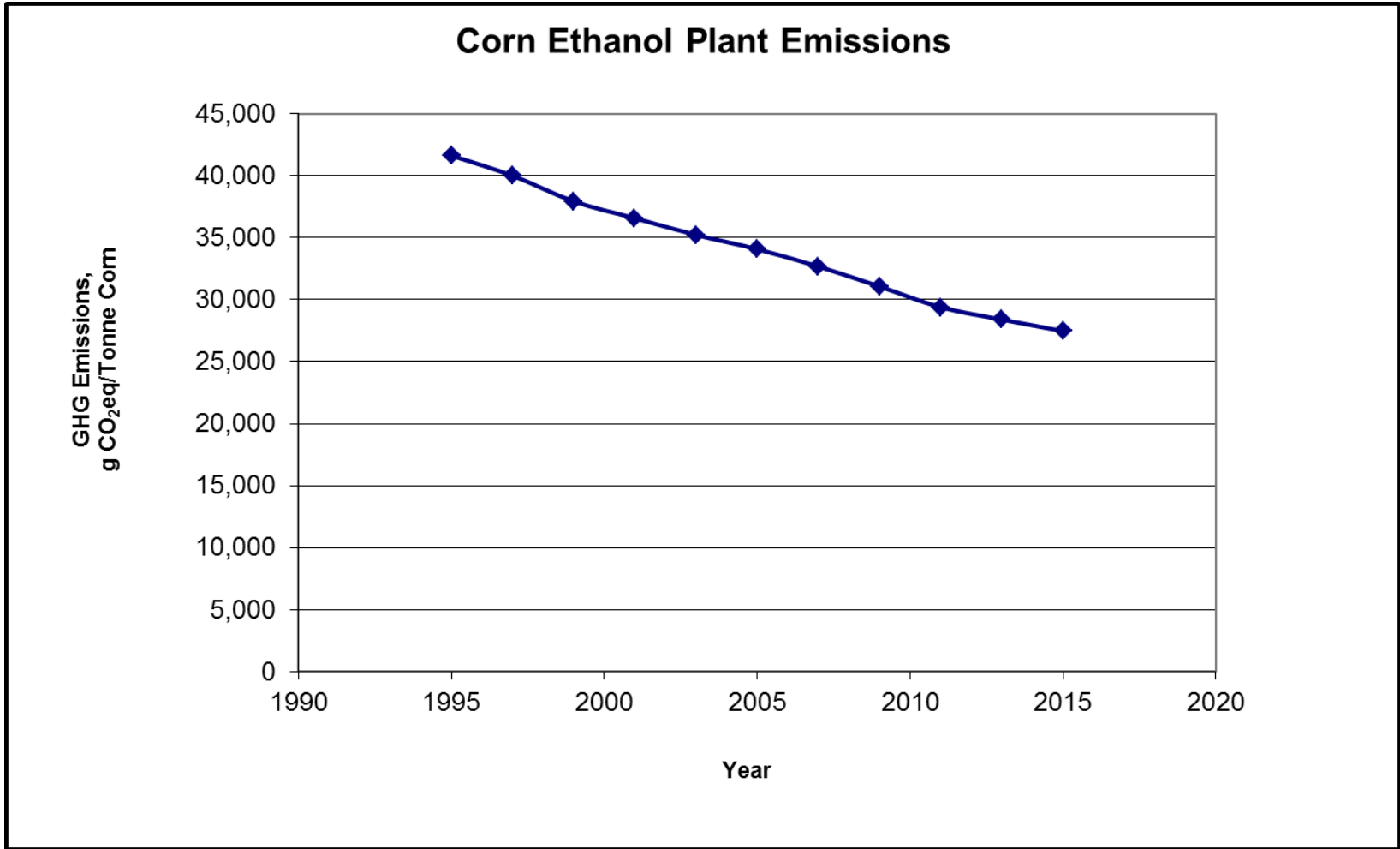
Non Renewable Resources



Renewable Resources



Biorefineries



Substitution

- From a GHG emissions performance the primary difference between first and second generation biofuel is really in the fuel used in the ethanol plant.
 - Substituting biomass (straw or stover) or biogas for natural gas will cut the emissions by about 50%.
 - Substituting biodiesel for diesel fuel in field operations.
 - Sequestering the fermentation CO₂.

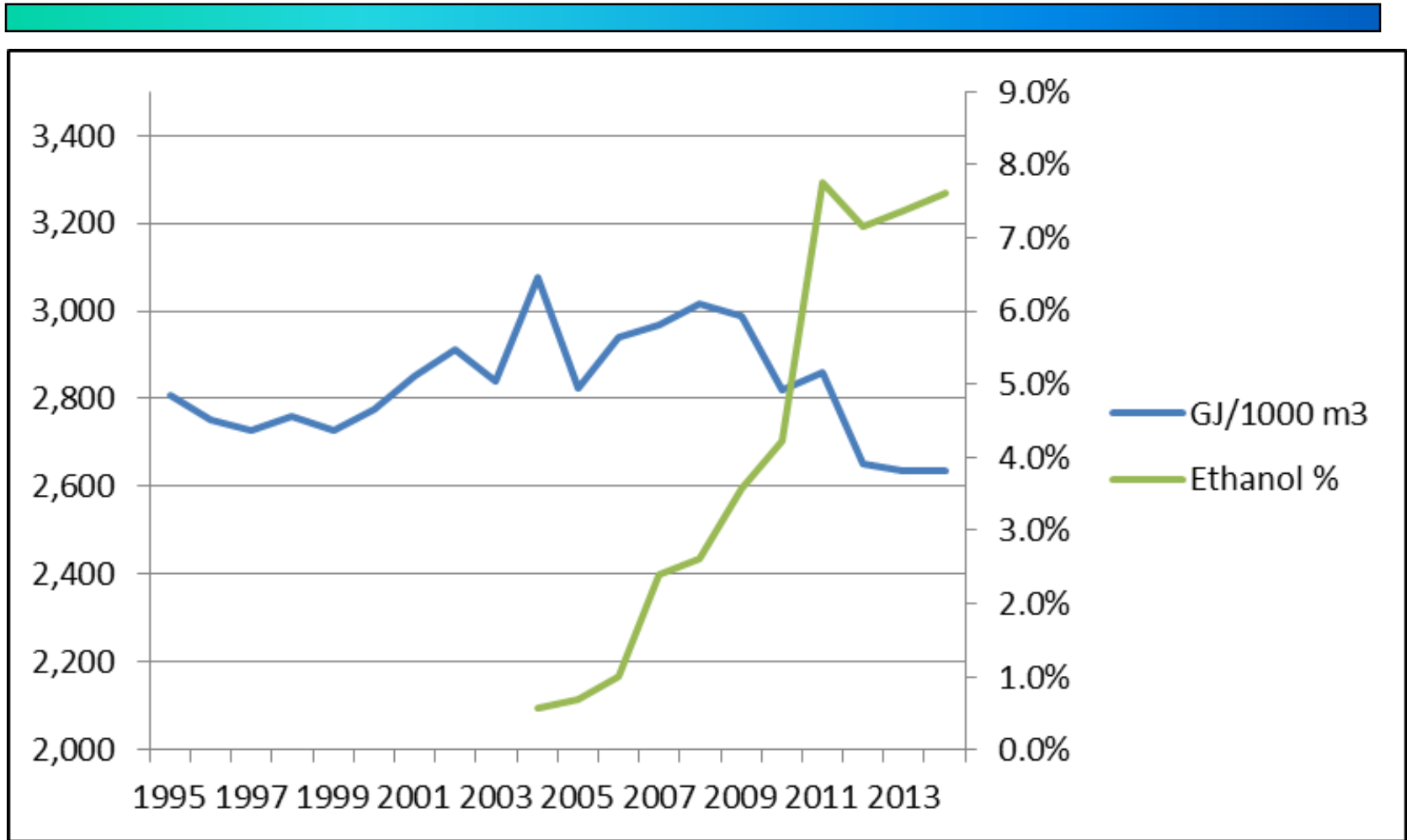
Impact

	NG	Stover	+ BD	+BCS
	g CO₂eq/ GJ Corn Ethanol (HHV)			
Fuel dispensing	187	187	187	187
Fuel distribution and storage	1,382	1,382	1,382	1,382
Fuel production	21,764	3,194	3,194	-23,633
Feedstock transmission	2,555	3,035	3,035	3,035
Feedstock recovery	3,201	3,201	1,703	1,703
Land-use changes, cultivation	28,269	28,269	28,269	28,269
Fertilizer manufacture	4,995	4,995	4,995	4,995
Emissions displaced - co-products	-17,397	-17,421	-17,085	-17,085
Total	44,956	26,843	25,680	-1,147

Synergy

- Ethanol has different properties than gasoline.
- Taking advantage of those properties
 - In the refinery
 - In the engine
- 10% ethanol increases the octane of gasoline by about 3 octane numbers.
- Refiners can lower the octane of the gasoline used for blending which saves energy and emissions in the refinery.

Refinery Energy Use

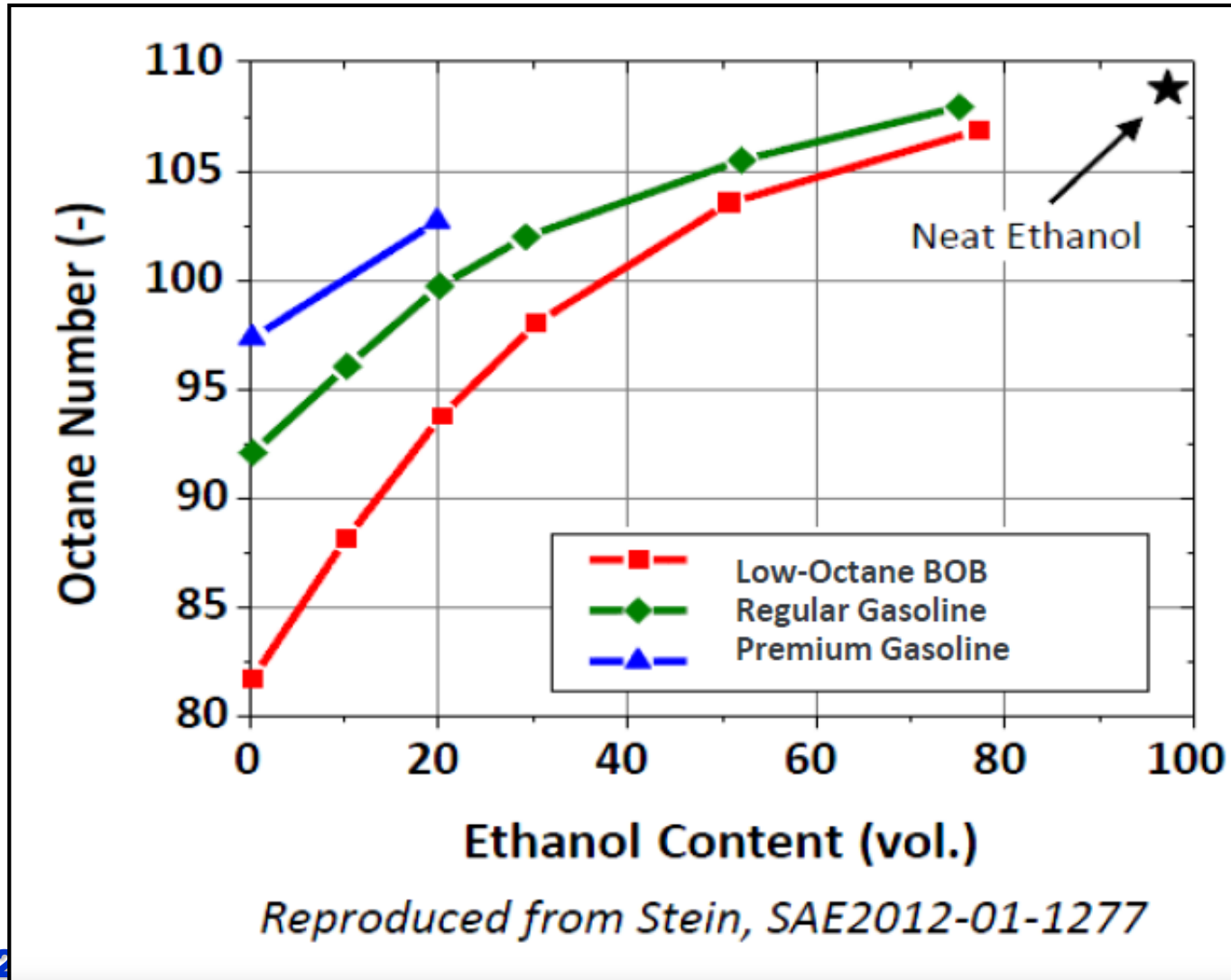


Source: Statistics Canada

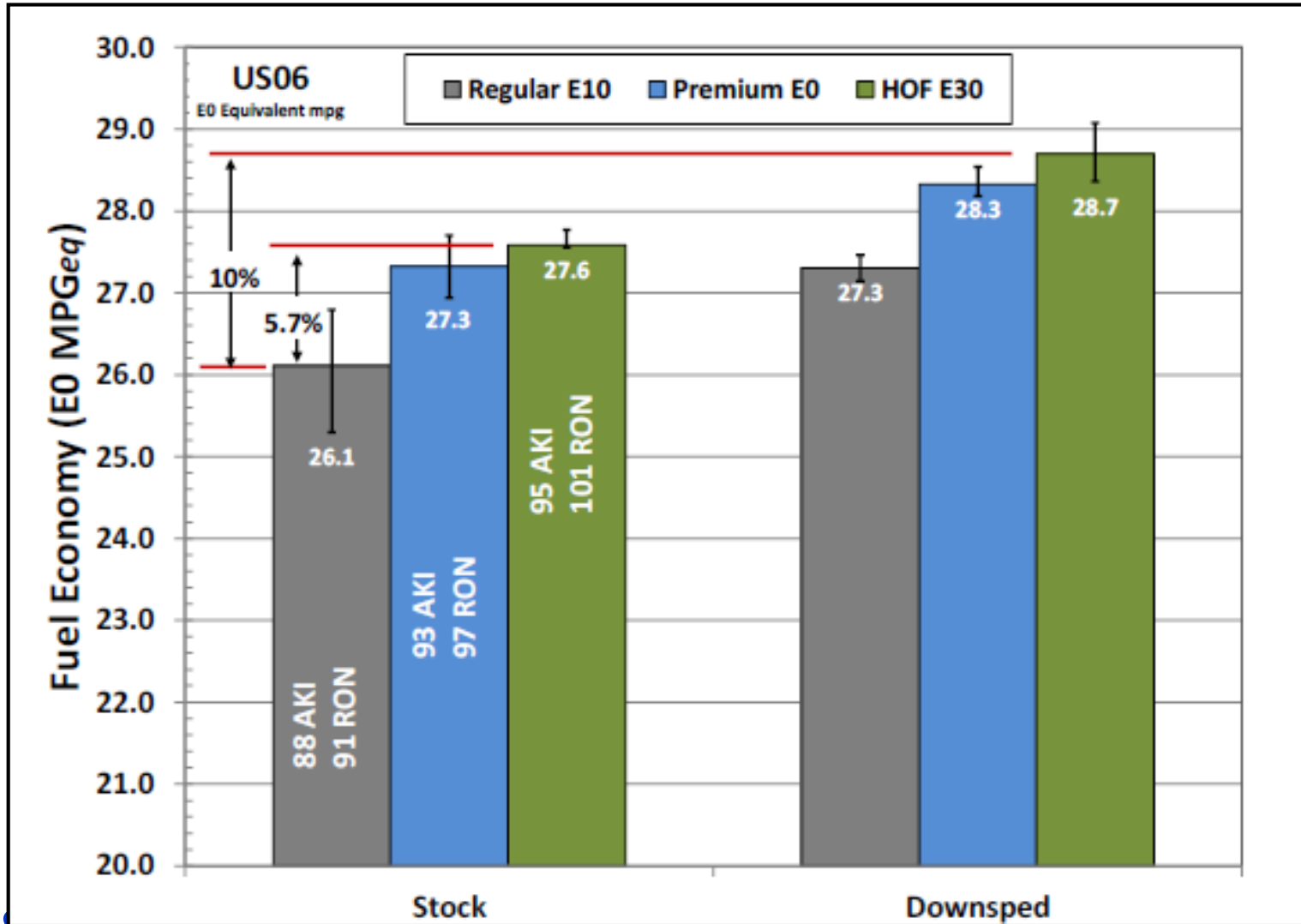
Engine Synergy

- High octane E30 (101 RON, 97 AKI) has been demonstrated to increase the engine efficiency by 10% compared to E10 and completely offset the lower energy content of the ethanol.
 - This effectively improves the GHG emissions benefit by a further 35%.

Blending High Octane Gasoline



High Octane Gasoline



Summary

- The GHG emissions of biofuel are improving compared to fossil fuels.
- Commercial technologies can produce zero emission 1st generation ethanol.
- There are GHG emissions benefits in the current system that aren't being captured due to a lack of data.
- There are significant opportunities to improve vehicle performance with high octane gasoline.
- It may be possible to get a 10% reduction in gasoline emissions with E10.