The Reality Behind the Renewable Fuel Standard: the Economy, and the Environment

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- Founded in 1984 by a bipartisan Congressional caucus as an independent non-profit organization (but receives no Congressional funding)
- Source of non-partisan information on energy and environment policy development for Congress and other policymakers
- Climate change is one of the most serious problems facing civilization today — impacting infrastructure, water supply, agriculture, public health and natural ecosystems

Outline:

- Transportation sector must be greened
- Do we still need biofuels?
- What is an advanced biofuel?
- GHG profile of biofuels vs. oil
- Air quality impacts of ethanol

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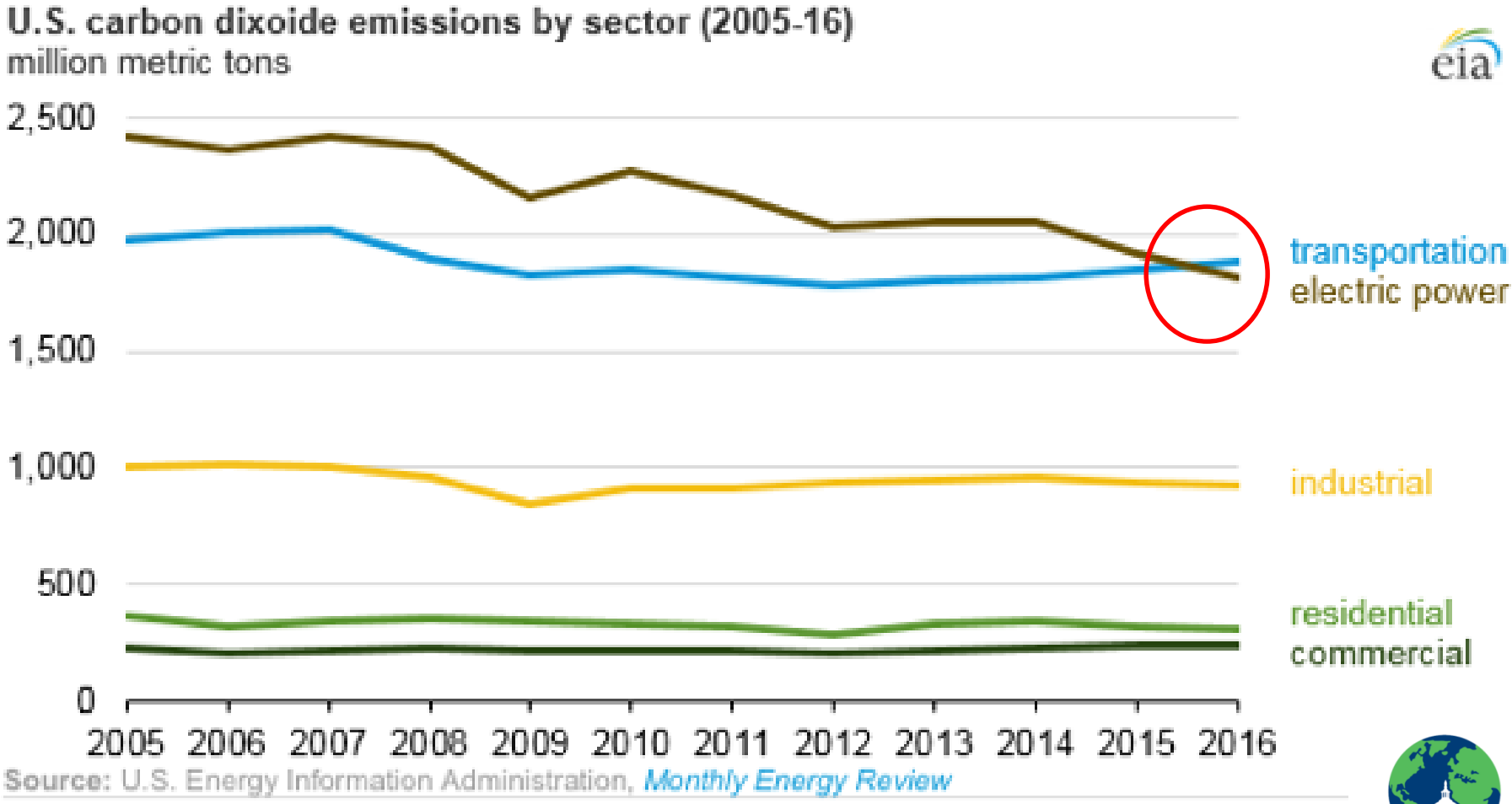
Transportation Emissions Eclipse Power Sector



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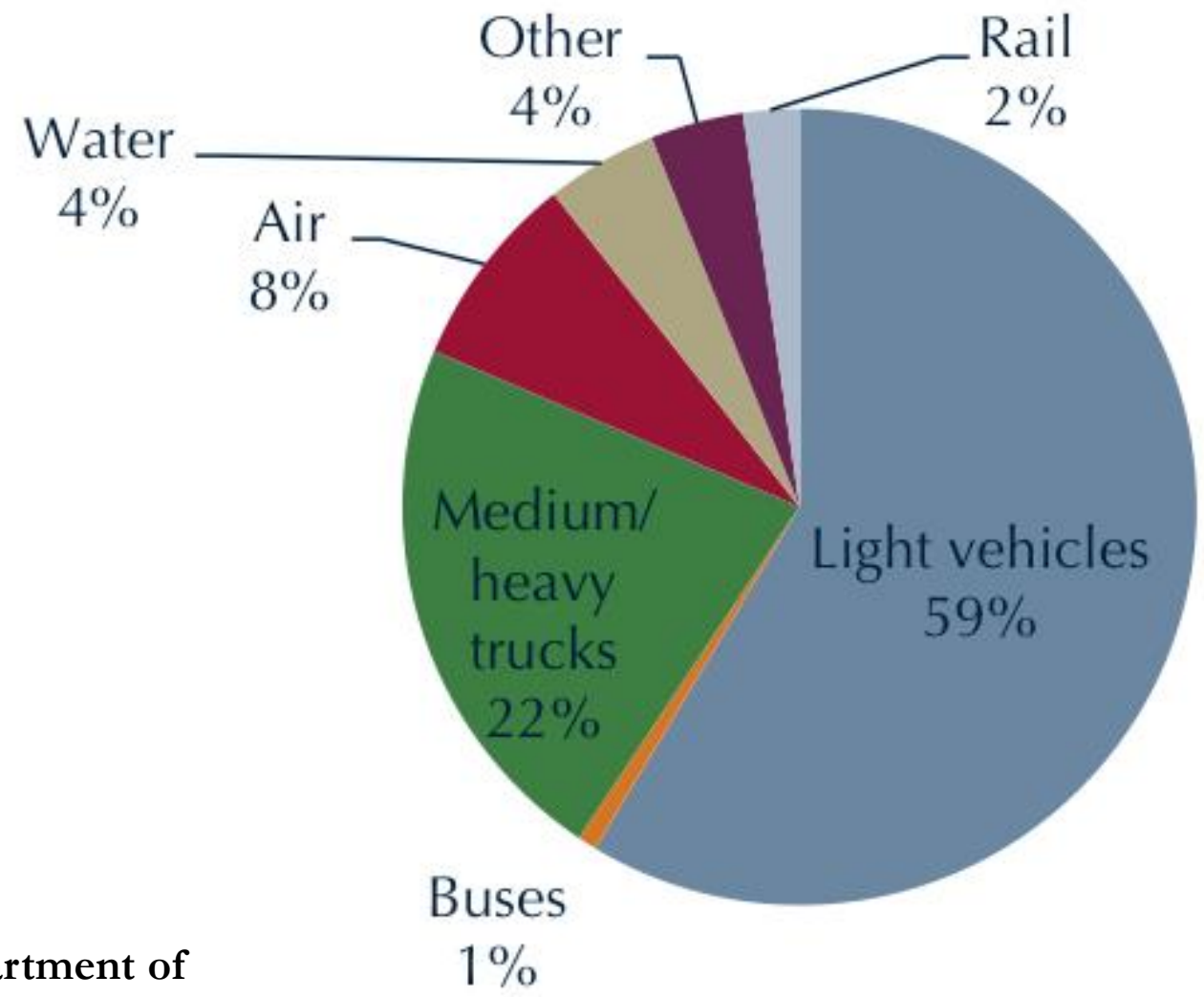
U.S. GHG Emissions from Transportation



U.S. Department of Energy. Transportation Energy Data Book 2014, U.S. DOE

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Electric Vehicles – Not a Fad

- Volvo: all electric or hybrid cars by 2019
- VW: electric versions of all 300 models by 2030
- Mercedes-Benz: all electric by 2022
- UK, Netherlands, France: bans fossil-fuel burning cars by 2040
- China: plans to ban sale of gas/diesel vehicles

- "Only a matter of time before the transition to electric vehicles takes off" – JP Morgan Chase

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If EVs are the Future …

What Do We Do in the Meantime?

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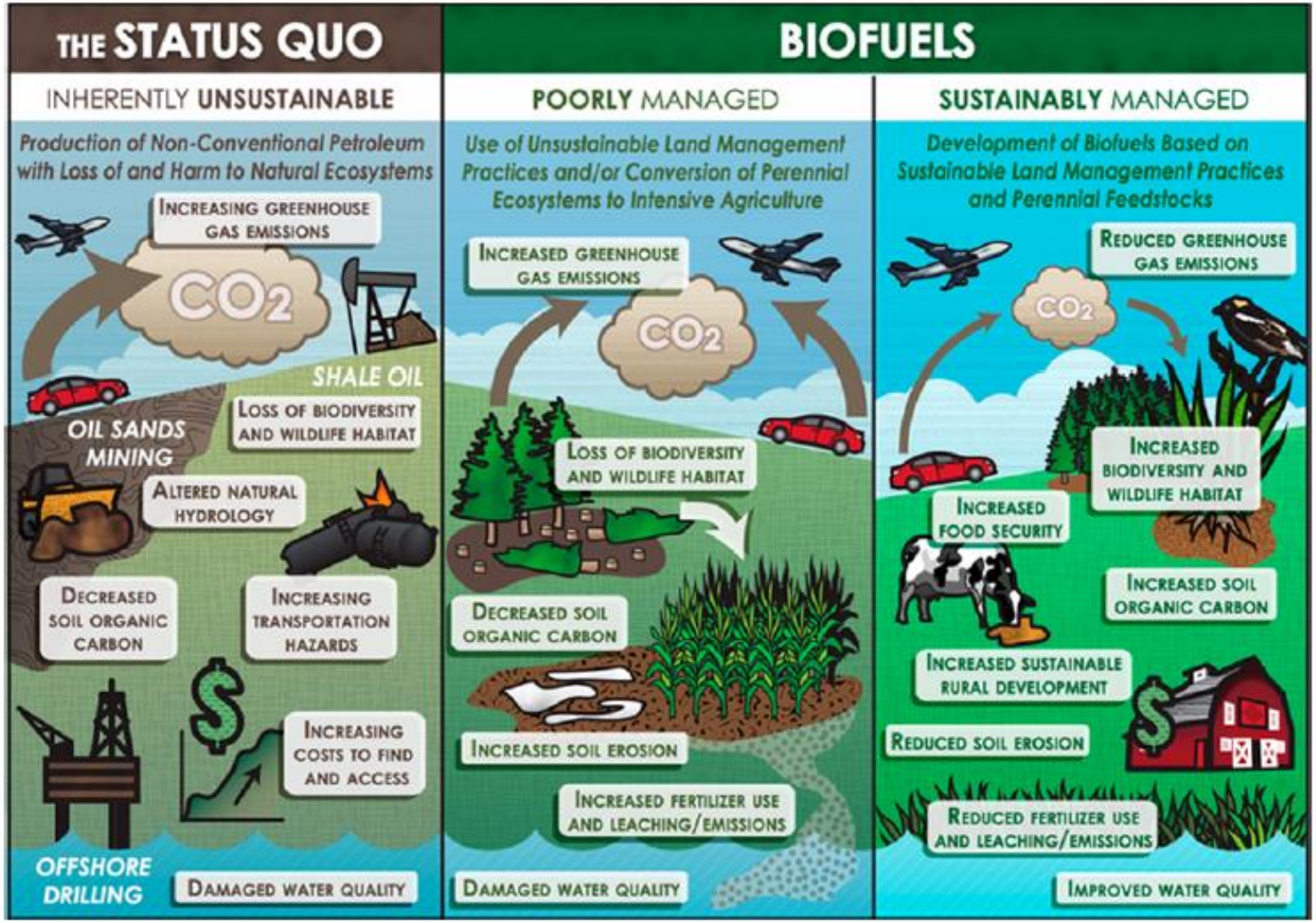
We Will Use Liquid Fuels for Decades

Biofuels Need to be Done Sustainably



B. Dale et al., Take a Closer Look: Biofuels Can Support Environmental, Economic & Social Goals, Enviro. Sci & Tech., 2014.

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Renewable Fuel Standard: EPA Fuel Categories

Fuel	GHG threshold reduction (%)	RFS 2022 Volumes
Conventional biofuel	20	15 bgal
Advanced biofuels	50	21 bgal
Biomass based-diesel	50	
Cellulosic biofuel	60	

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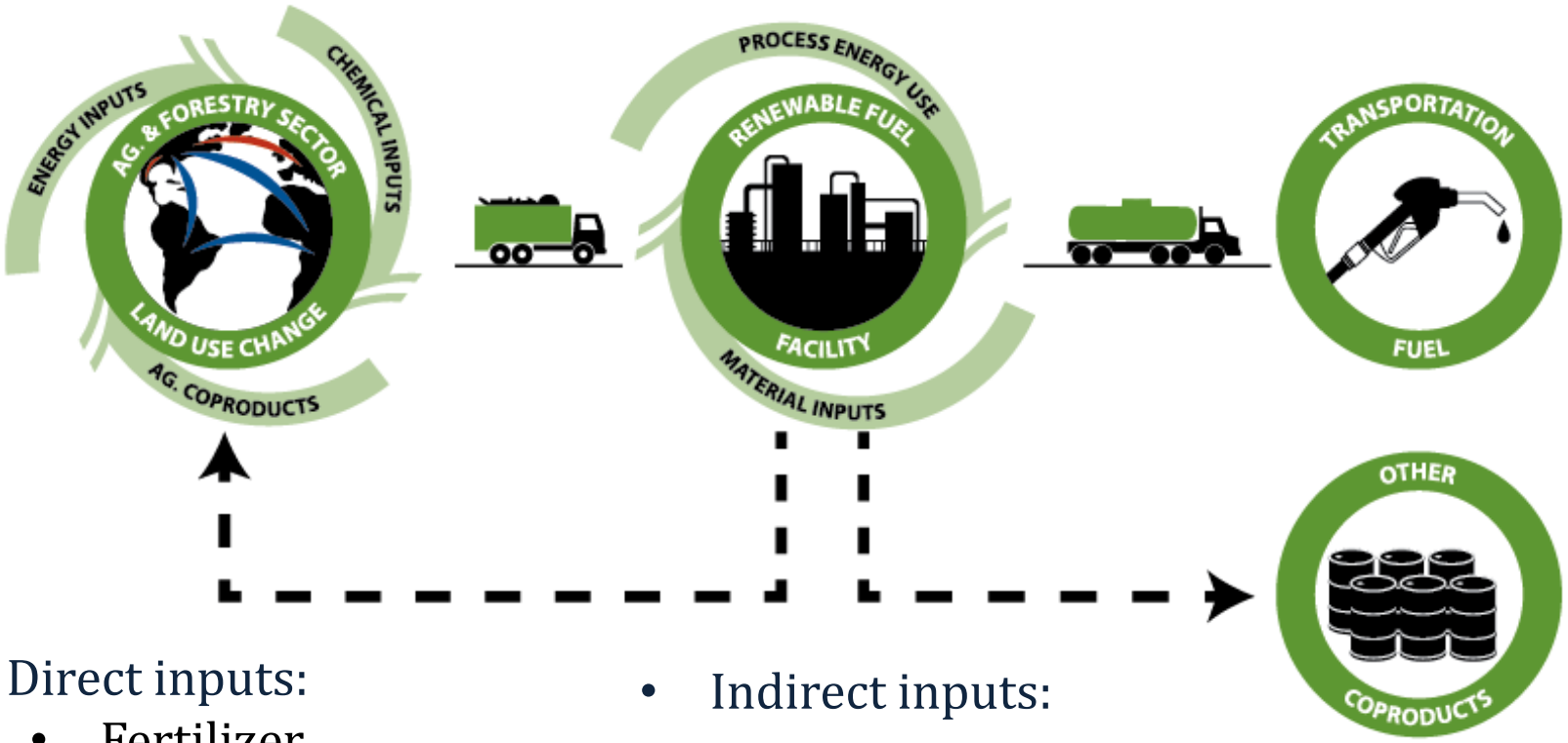
Well to Wheels GHG Accounting



- Direct inputs:
  - Fertilizer
  - Energy
- Indirect inputs:
  - Land use change
- Outputs:
  - Main: fuel
  - Co-products: electricity, high protein animal feed, oils.

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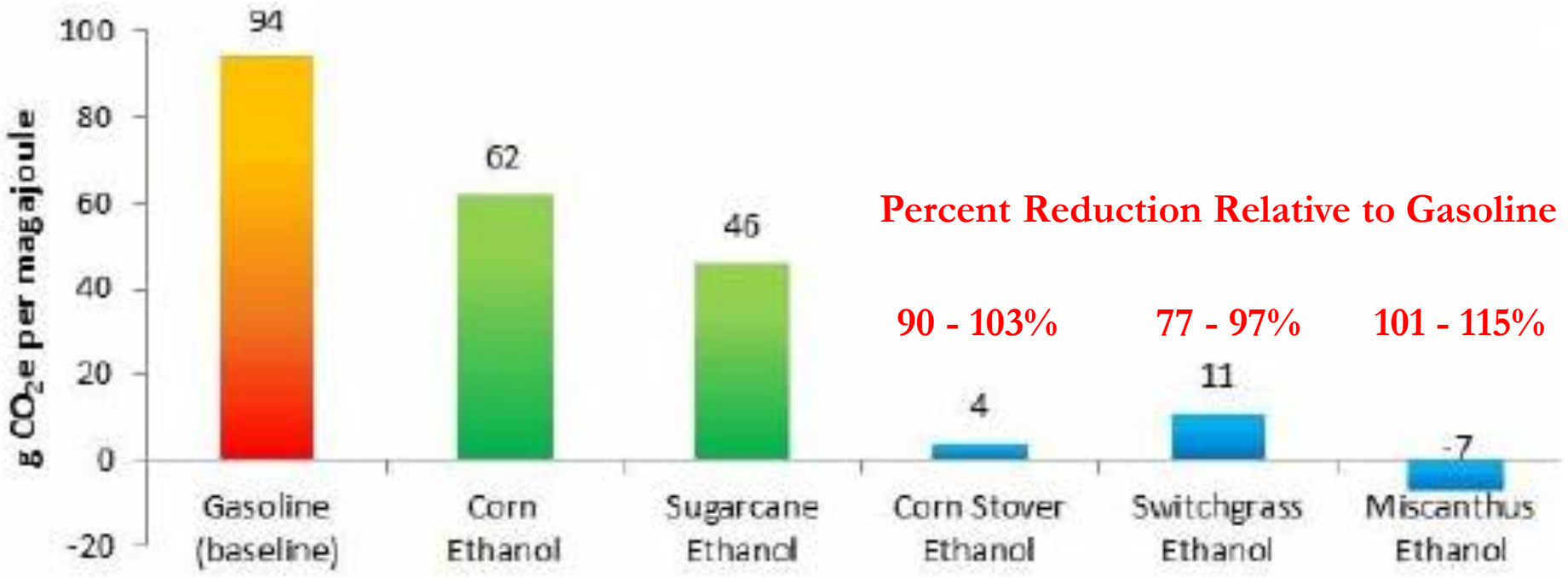
Well to Wheels GHG Accounting for Fuel Feedstocks – g CO2/mj



M. Wang et. al., "Well-to-Wheels Energy Use and Greenhouse Gas Emissions of Ethanol from Corn, Sugarcane, and Cellulosic Biomass for US Use." Enviro. Research Letters, 2012.

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GHG Well to Wheels: Mandated vs. Actual

Fuel	Feedstock	RFS GHG Reduction Mandate (%)	CARB/EPA Pathway actual (%)
Cellulosic Ethanol	Corn stover	20	93%
Biodiesel	Waste fats & oils	50	78%
Biogas	Landfill gas	60	77%

U.S. EPA, Approved Pathways, California Air Resources Board

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Increasing Efficiency, Co-Products

	2001	2008	2012	Trend
Yield (undenatured, gallon/bushel)	2.64	2.78	2.82	
Thermal Energy (Btu/gallon, LHV)	36,000	26,206	23,862	
Electricity Use (kWh/gallon)	1.09	0.73	0.75	
DDG Yield (dry) incl. corn oil (lbs/bu)		15.81	15.73	
Corn Oil Separated (lbs/bushel)	0	0.11	0.53	
Corn Oil Separated (% of Plants)	0%	33%	74%	
Water Use (gallon/gallon)	5	2.72	2.7	

Table 2: Efficiency Gains in Corn to Ethanol Processing

Steffen Muller, PhD, Lifecycle Analysis of Ethanol and Gasoline Under the Renewable Fuel Standard, UIC Engineering

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Advanced Biofuels: Ethanol, Biodiesel, Jet & Marine

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Idaho National Lab via a Creative Commons license

Texas A&M via a Creative Commons license

"Wastes":

- Crop Residue
- Organic wastes
- Forestry waste

Purpose grown:

- Perennial grasses
- Fast growing woody crops
- Grasses
- Legumes
- Algae, cyanobacteria

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GHG Well to Wheels: Oil

- Conventional crude:
  - Easy to extract & refine
  - Naturally occurring in liquid form

- Unconventional crude:
  - Energy intensive to extract & refine
  - Examples: fracking, tar sands, offshore drilling
  - Canadian tar sands: 18 – 21% higher emissions than conventional crude oil.

- **Understanding Unconventional Oil, Carnegie Endowment for Peace, 2012**
- **C. Hai et. al, Well-to-Wheels Greenhouse Gas Emissions of Canadian Oil Sands Products: Implications for U.S. Petroleum Fuels, Enviro Sci. & Tech., 2015**

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Air Quality & E15

45 million Americans live, go to school or work within 300 feet of a major roadway, airport or railway. -- U.S. EPA

- Modest increases (E10 – E15) in ethanol content:
  - Reduces ozone precursors
  - Reduces GHGs
  - Reduces Volatile Organic Compounds (VOCs)

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Ethanol is Clean Octane

- Gasoline contains ~25% by volume gasoline aromatics (as octane boosters)
- Ethanol is the cleanest, cheapest source of octane
- Auto manufacturers want additional octane

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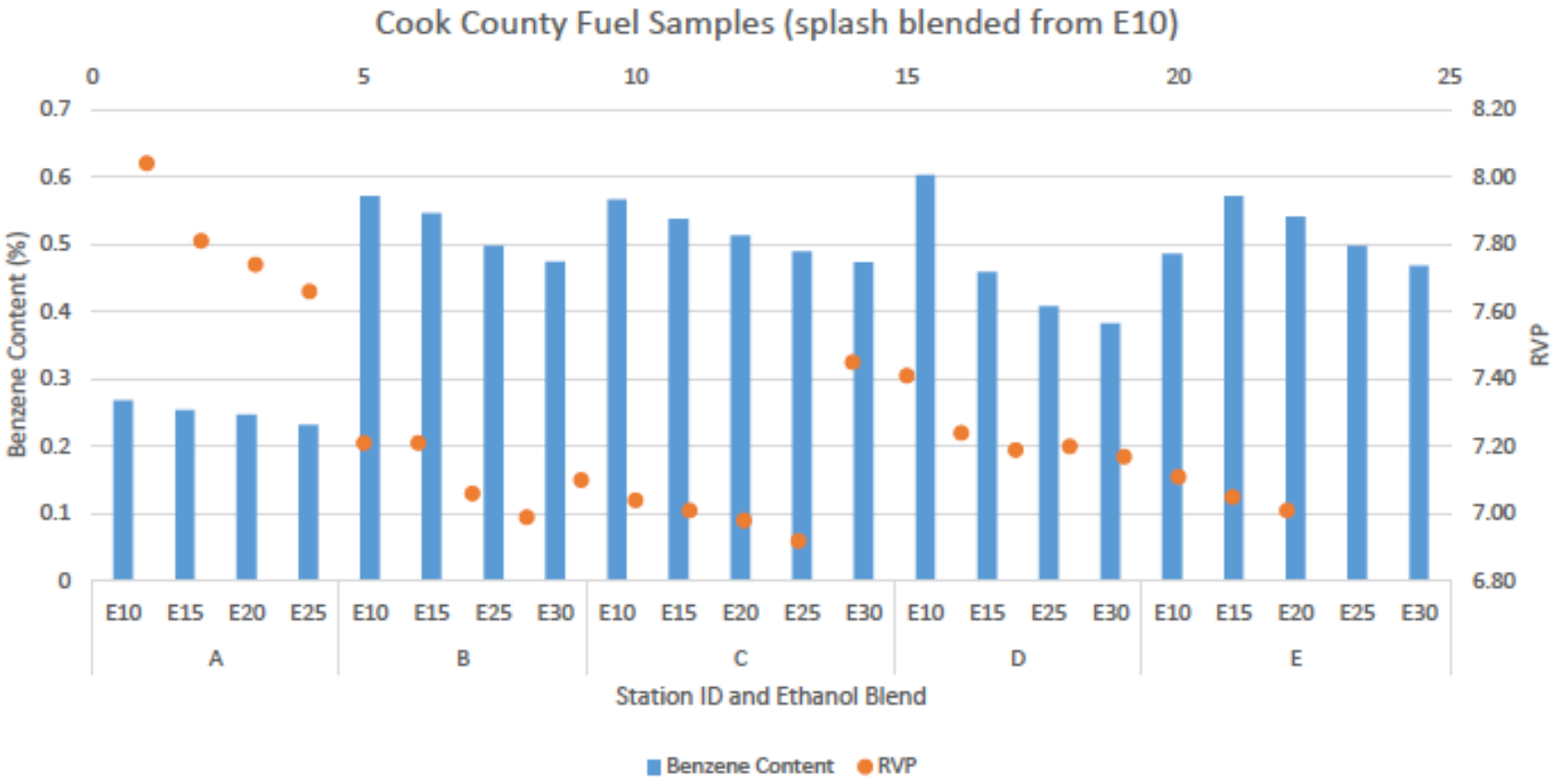

Increasing ethanol content decreases toxics in gasoline, such as benzene

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Steffen Muller, PhD, PM and Benzene in Splash Blended Fuels with Ethanol, UIC Engineering

Takeaways:

- Biofuels are STILL a necessary piece in greening the transportation sector and will continue to be
- Greenhouse gas footprint of ethanol continues to shrink while gasoline continues to rise
- Use of ethanol represents immediate reduction in tailpipe emissions, GHGs
- Renewable fuels are more than just corn ethanol – but market certainty is needed to build cellulosic space

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THANK YOU

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