Welcome from the Board

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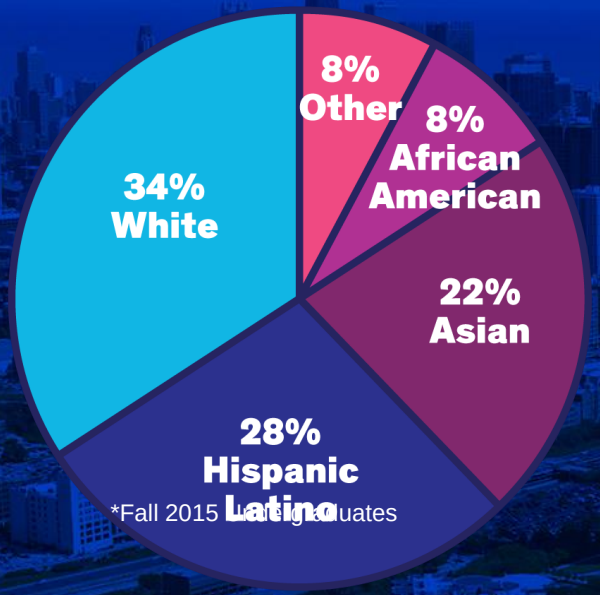
Energy Resources Center

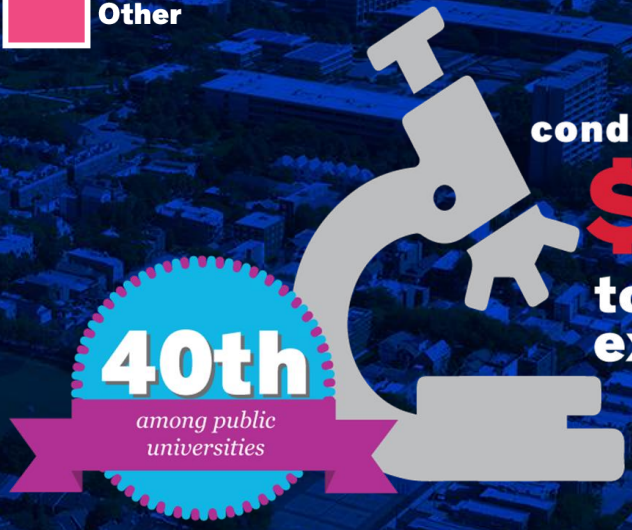
ISCC Stakeholder Meeting North America (ISCC TC NA)
December 5, 2017
Las Vegas

THE UNIVERSITY OF ILLINOIS AT CHICAGO

UIC

University of Illinois at Chicago
Diverse Student Body
29,000 students





conducting
$368M
total research expenditures

UIC

Biofuels Research

- 2 Senior Scientists – 5 Students/Interns – Large Network of Cooperators
- Fuel Ethanol life cycle and combustion emissions modeling
- New biofuels technology evaluation/commercialization
- Land use research using Remote Sensing/Satellite tools
- Pollinator habitat conservation

THE UNIVERSITY OF ILLINOIS AT CHICAGO

UIC

Presentation Overview

2017 Key Biofuels Topics:

- New Renewable Volume Obligations under RFS2
- Sustainability in the US Literature
  - Selected Publications
  - New USDA 2017 Ethanol GHG Data
- EV Vehicles and Biofuels
- New Global Biofuels Emissions Model

RVO Numbers Generally Viewed as Positive for US Biofuels

- On November 30, the Environmental Protection Agency (EPA) released its final rule for 2018 renewable volume obligations (RVOs) under the Renewable Fuel Standard (RFS).

RFS Category (billion RINs)	2018 Statutory	2018 RVO Proposal	2018 Final RVO	2017 Final RVO
Cellulosic biofuel (D3/D7)	7.000	0.238	0.288	0.311
Biomass-based diesel (D4)*	1.500	3.150	3.150	3.000
Undifferentiated advanced biofuel (D5)	2.500	0.852	0.852	0.969
Total advanced biofuel (D3/D4/D5/D7)	**11.000**	**4.240**	**4.290**	**4.280**
Conventional renewable fuel (D6)	15.000	15.000	15.000	15.000
Total renewable fuel (D3/D4/D5/D6/D7)	**26.000**	**19.240**	**19.290**	**19.280**

**Biomass-based diesel (BBD) generates 1.5 RINs per gallon. BBD volumetric requirement for 2018 is 2.1 bg; final BBD volumetric requirement for 2017 was 2.0 bg. EISA requires a min. of 1 bg of BBD (1.5 b. RINs) starting in 2012.*

Source: Renewable Fuels Association

Sustainability in the US Literature

"Critical Zone services as environmental assessment criteria in intensively managed landscapes"

Richardson, M., and P. Kumar (2017),

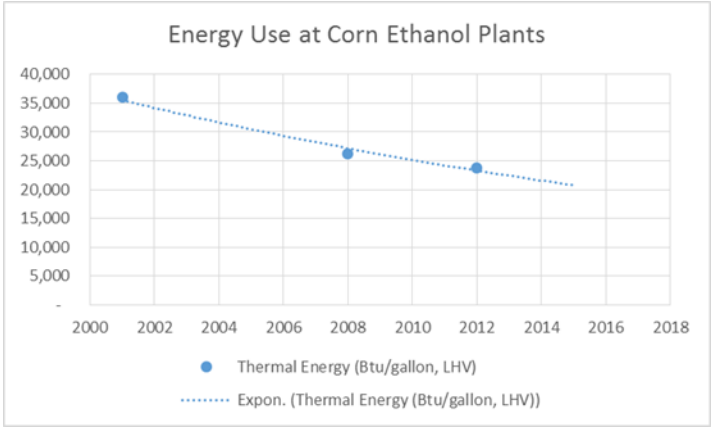
Earth's Future, 4, oi:10.1002/2016EF000517

University of Illinois at Urbana Champaign

Comments on this Publication

From the Publication

- "Although it does not lose energy, the refinery barely yields positive total net energy. At around 3 MJ/m^2,the total net energy for ethanol production demonstrates how this process is merely a transfer of mechanical and chemical energy associated with the refinery inputs, mainly natural gas and coal, to potential chemical energy stored in ethanol"
- "We base the U.S. LCA on *Ethanol Today*, a comprehensive dataset available for corn-based ethanol production, which synthesizes and consolidates six different corn-based ethanol LCA studies into one data set simulating today's production system and GHG emissions."



Our Comment:

- The cited *Ethanol Today* paper by Farrell et al. was written ***in 2006 before the build-up of the modern dry grind ethanol industry***. Since that paper is in itself a synthesis of datasets the underlying references are even older. Below, we have reproduced the energy balances from the Farrell paper.

Our Comments are Posted at:
http://www.erc.uic.edu/assets/pdf/mueller_comments_on_richardson_et_al32..pdf

Sustainability in the US Literature

Subnational mobility and consumption-based environmental accounting of US corn in animal protein and ethanol supply chains.

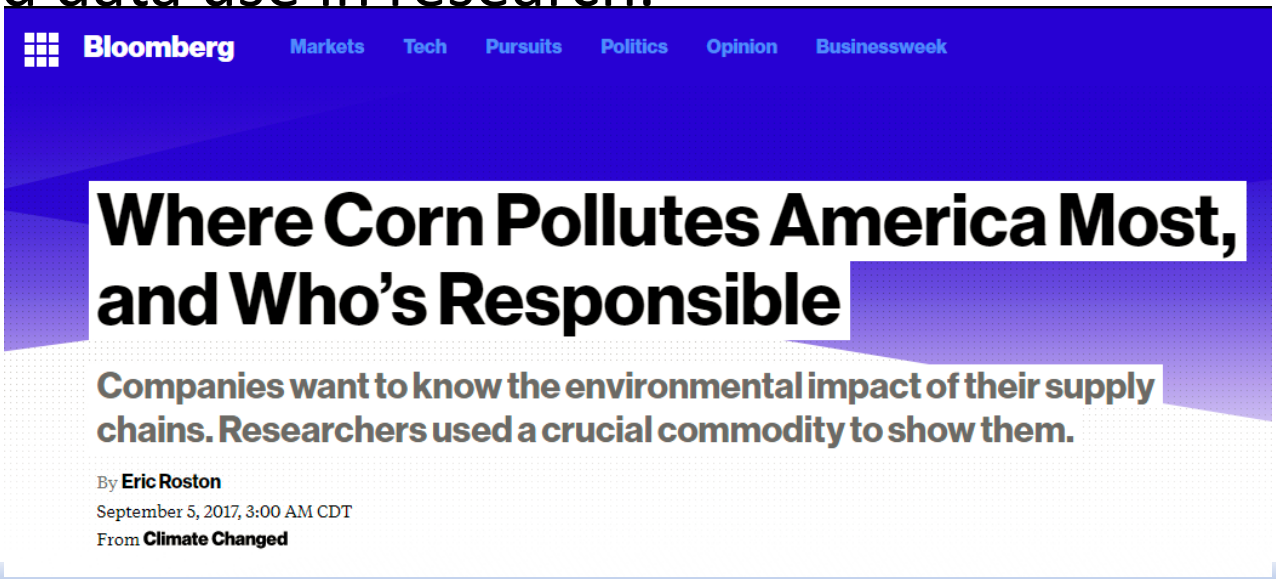
Smith et al, September 2017

University of Minnesota and New Mexico

"Corn production, and its associated inputs, is a relatively **large source of greenhouse gas emissions and uses significant amounts of water and land**, thus contributing to climate change, fossil fuel depletion, local air pollutants, and local water scarcity."

Our Comments on this Publication

- Mueller counter comments quoted in Bloomberg: "[Mueller] criticized the new study for **using 2012 as its base year, a time when devastating drought reduced corn yields to 122 bushels an acre,** which is equivalent to 1995 levels, or roughly 28 percent below 2016."
- "Mueller said that newer data would have been more appropriate, and is concerned with recent examples of outdated data use in research."


Bloomberg Markets Tech Pursuits Politics Opinion Businessweek

Where Corn Pollutes America Most, and Who's Responsible

Companies want to know the environmental impact of their supply chains. Researchers used a crucial commodity to show them.

By Eric Roston
September 5, 2017, 3:00 AM CDT
From Climate Changed

On the Positive Side: New USDA GHG Data

- USDA/ICF report, titled "A Life-Cycle Analysis of the Greenhouse Gas Emissions of Corn-Based Ethanol," finds that greenhouse gas (GHG) emissions associated with producing corn-based ethanol in the United States are about 43 percent lower than gasoline
- "GHG profile of corn ethanol will be almost 50 percent lower than gasoline in 2022 if current trends in corn yields, process fuel switching, and improvements in trucking fuel efficiency continue.
- On-farm conservation practices, such as reduced tillage, cover crops, and nitrogen management, are estimated to improve the GHG balance of corn ethanol by about 14 percent.

Analysis cites repeatedly:
J. Dunn, Z. Qin, S. Mueller, H-Y. Kwon, M. Wander, M. Wang ; Carbon Calculator for Land Use Change from Biofuels Production (CCLUB) Manual; October 07, 2016; https://greet.es.anl.gov/publication-cclub-manual

New Emissions Study for 5 Major Global Cities

The University of Illinois at Chicago International Biofuels and Emissions Analysis Model (iBEAM)

Introduction

- The purpose of this study is to assess the cumulative **future emissions benefits from adopting E10 or E20** for the light duty vehicle market in the light of current and predicted fuel demand
- The study also assesses **refinery profitability** considerations associated with producing these fuels
- The five cities of interest are:

Beijing, Mexico City, New Delhi, Seoul, and Tokyo

Structure of The iBEAM Emissions Model

Vehicle Population Forecast

Accounting for Gasoline Direct Injection Vehicle and Electric Vehicle Share

Project Fuel Economy Over Time

Calculate Annual Total Fuel Combusted

Project Vehicle Distance Travelled per Vehicle per Year

Project Vehicle Retirement and New Cars Added Over time

VEHICLE CHARACTERIZATION

GASOLINE

Collect Fuel Samples from Gasoline Stations

Calculate Emissions Factors for Gasoline Using US EPA Complex Model

Project/ Retrieve Emissions Factors from Standards over time for CO, THC, NOx, PM

Apply Vehicle Deterioration Factors

Emissions Adjustment Factors by Vehicle Age

Account for THC (Evap, Fueling, Spillage) Emissions

EMISSIONS ETHANOL vs. GASOLINE

Calculate Emissions from Current Gasoline Use

Calculate Emissions for E10 and E20 Blends

ETHANOL

Emissions Adjustment Factors by Vehicle Age

Account for THC (Evap, Fueling, Spillage) Emissions

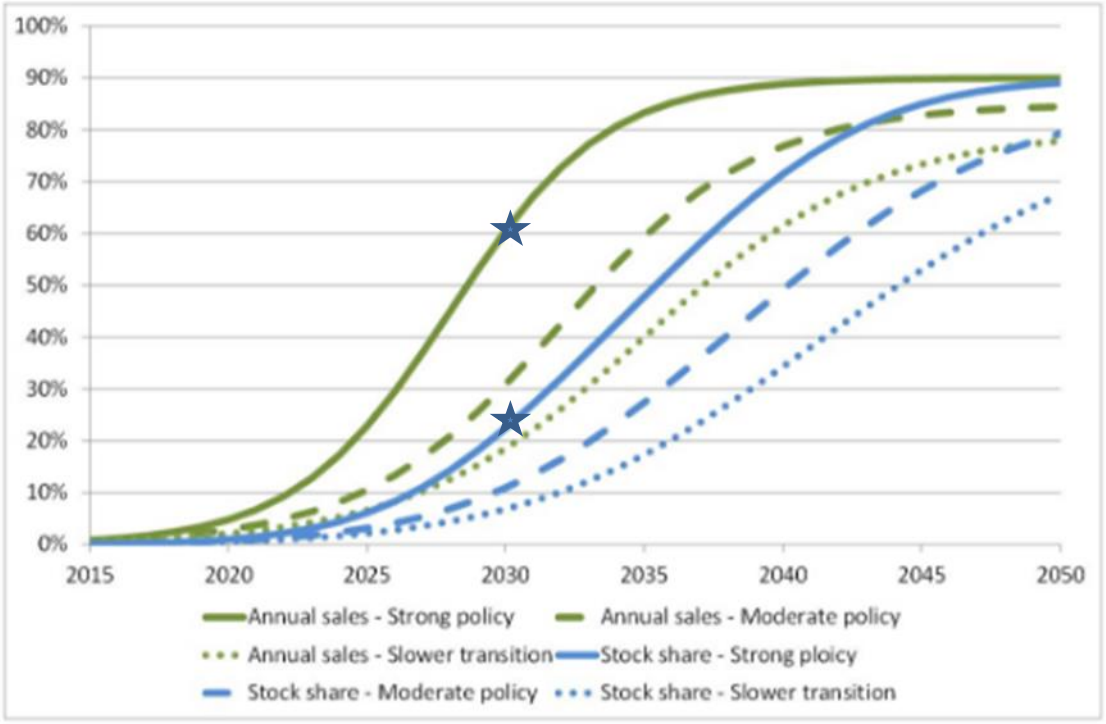
Calculate Refinery Impact

Model Emissions Factors for VOC, Nox, Air Toxins for E10 and E20 by Adjusting Sample Fuel Blendstock Components in Complex Model

Collect Vehicle Emissions Studies Data from Literature for E10 and E20 Blends and Air Toxins

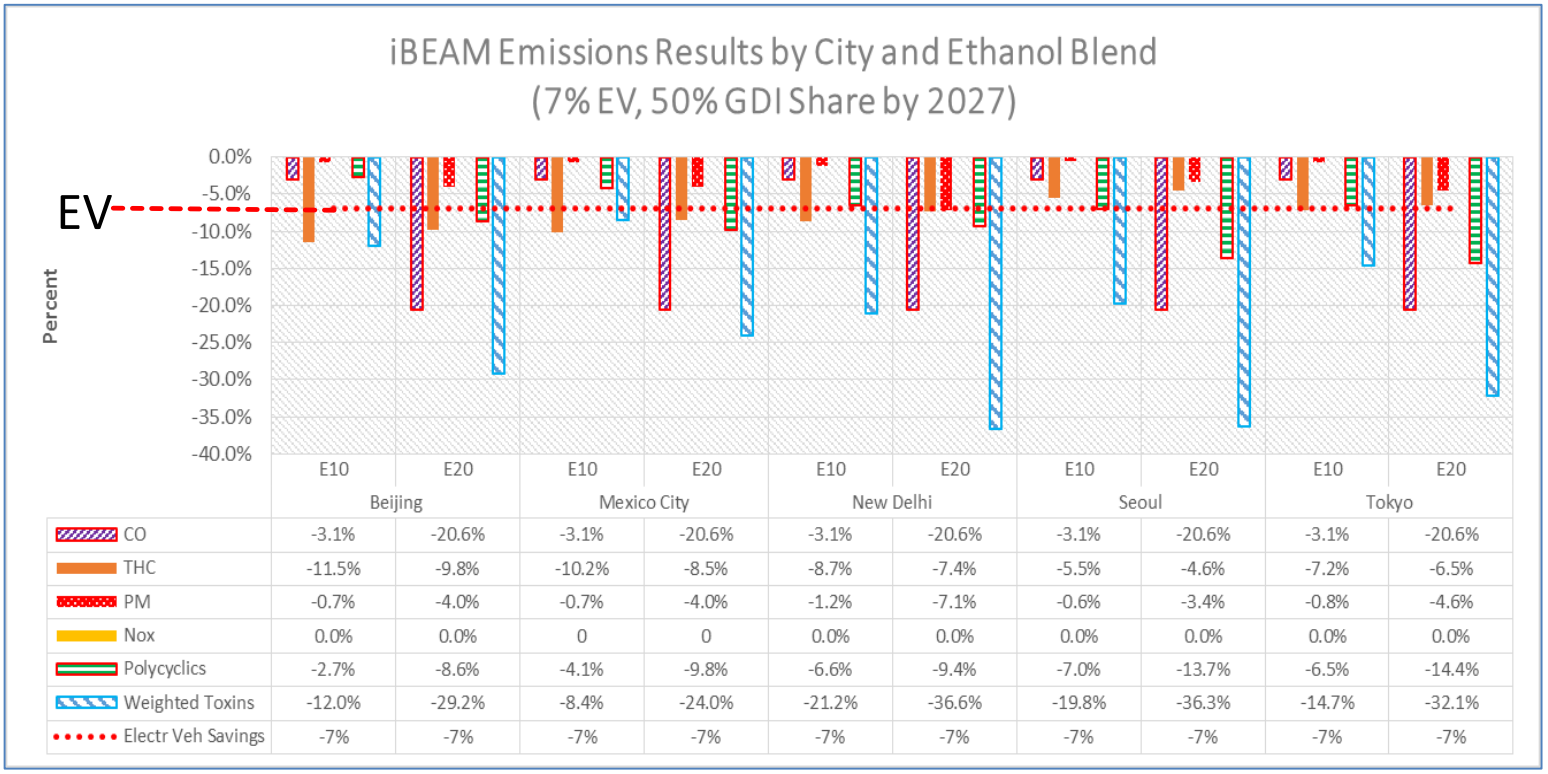
Account for Electric Vehicle Share: Annual Sales vs. Stock Change

- Whitmore global EV adoption model: Annual EV vehicle **sales will account for between 20% to 60% by the year 2030 converting to 7% and 22% of total vehicle stock** depending on the policy scenario.
- Roland Berger report cites annual new vehicle sales of EVs by 2030 of 19% (3% Battery Hybrid plus 3% Plug-in Electric Vehicle plus 1% Full Hybrid and 11% Mild Hybrid) which would correspond more closely with the slower adoption scenario by Whitmore
- China recently introduced a new vehicle energy score with aggressive targets of 10 percent of low or zero emissions vehicle sales per auto manufacturer starting in 2019, rising to 12 percent in 2020.



Source: Whitmore, Adam: How fast could the market for electric vehicles grow?

7% EV Vehicle Adoption through Year 2027 vs Immediate E10/E20 Adoption



	E10 Beijing	E20 Beijing	E10 Mexico City	E20 Mexico City	E10 New Delhi	E20 New Delhi	E10 Seoul	E20 Seoul	E10 Tokyo	E20 Tokyo
CO	-3.1%	-20.6%	-3.1%	-20.6%	-3.1%	-20.6%	-3.1%	-20.6%	-3.1%	-20.6%
THC	-11.5%	-9.8%	-10.2%	-8.5%	-8.7%	-7.4%	-5.5%	-4.6%	-7.2%	-6.5%
PM	-0.7%	-4.0%	-0.7%	-4.0%	-1.2%	-7.1%	-0.6%	-3.4%	-0.8%	-4.6%
Nox	0.0%	0.0%	0	0	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Polycyclics	-2.7%	-8.6%	-4.1%	-9.8%	-6.6%	-9.4%	-7.0%	-13.7%	-6.5%	-14.4%
Weighted Toxins	-12.0%	-29.2%	-8.4%	-24.0%	-21.2%	-36.6%	-19.8%	-36.3%	-14.7%	-32.1%
Electr Veh Savings	-7%	-7%	-7%	-7%	-7%	-7%	-7%	-7%	-7%	-7%

- Across Major Global Cities the Emissions Savings from EV Vehicles for Weighted Air Toxins, Carbon Monoxide, Total Hydrocarbons will be less than the Savings from Immediate E10/E20 Adoption
- We need **both technologies** to clean up the urban air emissions

Summary

- The US RFS2 Holds Strong
- Sustainability of Biofuels Remains a Topic of Continued Analysis
- New USDA GHG Data is Positive for the US Biofuels Community
- Electric Vehicle Adoption **cannot be** viewed as the **only global solution** for emissions (and decarbonization of the transport sector)