California Environmental Protection Agency

Air Resources Board

LCFS Sustainability Workgroup Meeting

April 4, 2013

Agenda

- Welcome and Introductions
- Presentation: “Sustainability Certification Analysis: CI Signal and Case Study”
- Discussion of Sustainability Provisions
- Next Steps

Presentation – Todd Dooley

CI Signal & Case Study

- CI Signal For Full Sustainability Certification
  - CI Signal Definition: cost-benefit
  - Cost Assumptions of Certification
  - Break-even CIs for Corn Ethanol
  - Cost-benefit of 1.5 gCO_2e/MJ CI Reduction for Corn Ethanol
- Case Study
  - Base Case: CA-GREET Defaults Considered
  - Alternative Case: GREET 2012 Inputs
  - Michigan Ethanol Plant Case Study

CI Signal

- We have been thinking about what potential credit could be given to offset costs for sustainability certification. An actual CI reduction is the first and best option, which will be presented here and shown to be viable.
- Based upon the cost of carbon in $/MT, the type of fuel and the annual production of that fuel.
- As the cost of carbon increases the cost-benefit analysis of certification provides greater economic benefits for a given CI reduction.

Annual Certification Cost Assumptions

Cost Assumptions: **Large supply chain** for **100 mm gal EtOH/y plant**
Approximately **216,000 - 245,000 acres** of harvested corn

Estimation	Auditor Related Costs		Preparation for Audit Costs		
	Audit Costs	Travel	Consultant/ Organizer/ Employee	Capital Costs	Other Operating Costs
High	$35,000	$7,000	$65,000	$15,000	$20,000
Low	$17,000	$4,000	$30,000	$5,000	$5,000

Estimation	Sum of Costs
High	**$142,000/y**
Low	**$82,400/y**

Estimation	Licensing **(Not Included in Sum)**
High	$41,880/y
Low	$21,400/y

What is a Break-even CI?

- The break even CI is the CI reduction calculated based upon certification costs, the cost of carbon, the fuel produced, and the fuel annual production volume. Obtaining that CI reduction yields an equivalent benefit in carbon credits ($) and therefore is a break-even investment.

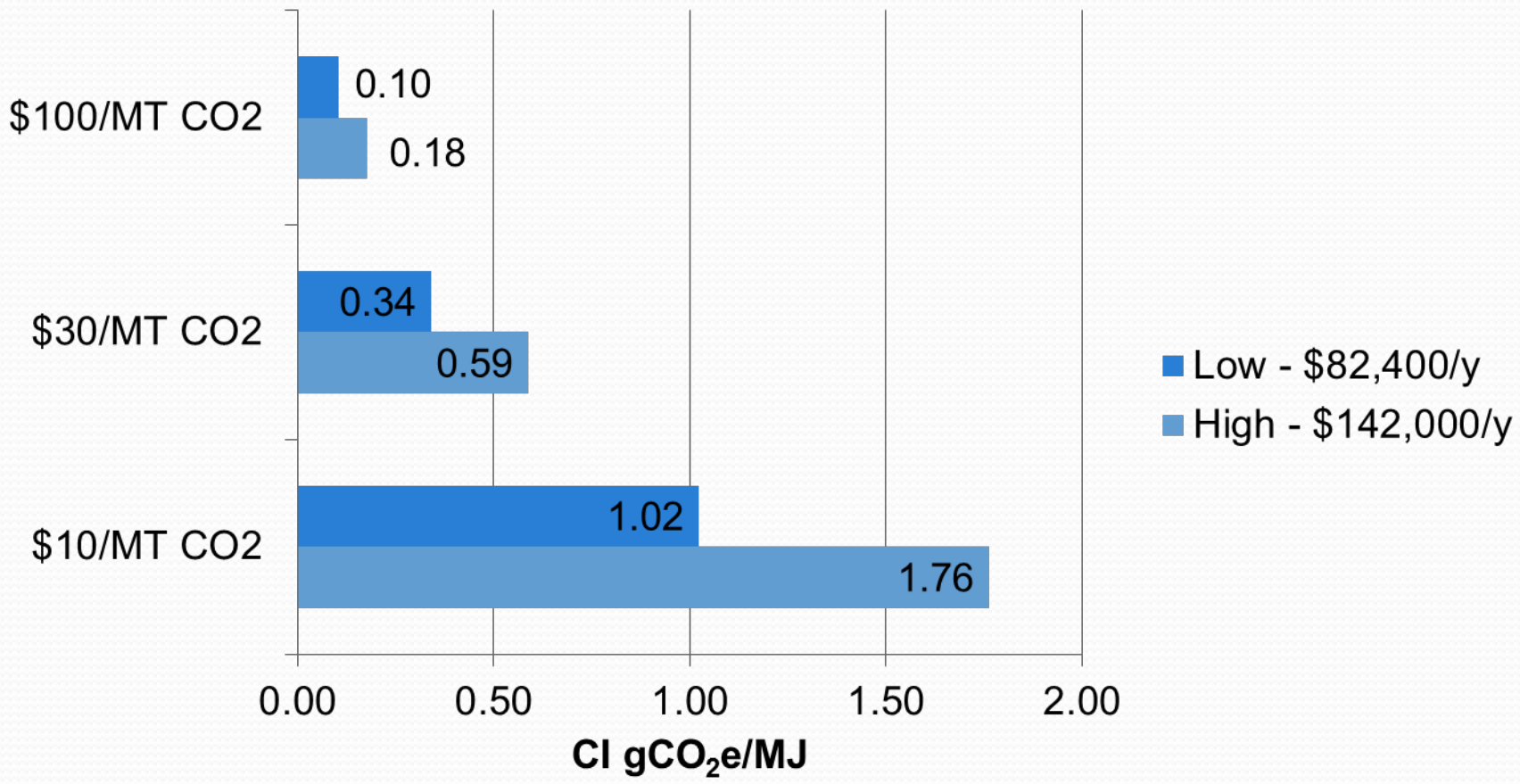
- Example:

Assumptions:

1. The cost of carbon is $10/MT
2. The high cost of certification is $142,000 annually, so this cost is assumed to be recovered annually.
3. A 100 mm gal/y Ethanol plant and its supply chain

$$(\$142{,}000)\left(\frac{MT\ CO_2}{\$10}\right)\left(\frac{1{,}000\ kg}{MT}\right)\left(\frac{1{,}000\ g}{kg}\right)\left(\frac{1}{100X10^6 gal\ EtOH}\right)\left(\frac{gal\ EtOH}{80.53\ MJ}\right)=\frac{1.76\ gCO_2e}{MJ}$$

Annual Break-Even CIs for 100mm gal/y Corn Ethanol Plant and Supply Chain at Various Costs of Carbon



Cost-Benefit Analysis of Sustainability Certification Definition

- The difference between the cost of certification and the value of the carbon credit obtained through certification is <u>the cost-benefit analysis on an annual basis</u>. <u>The cost or benefit occurs on an annual accounting basis.</u>
- Example:

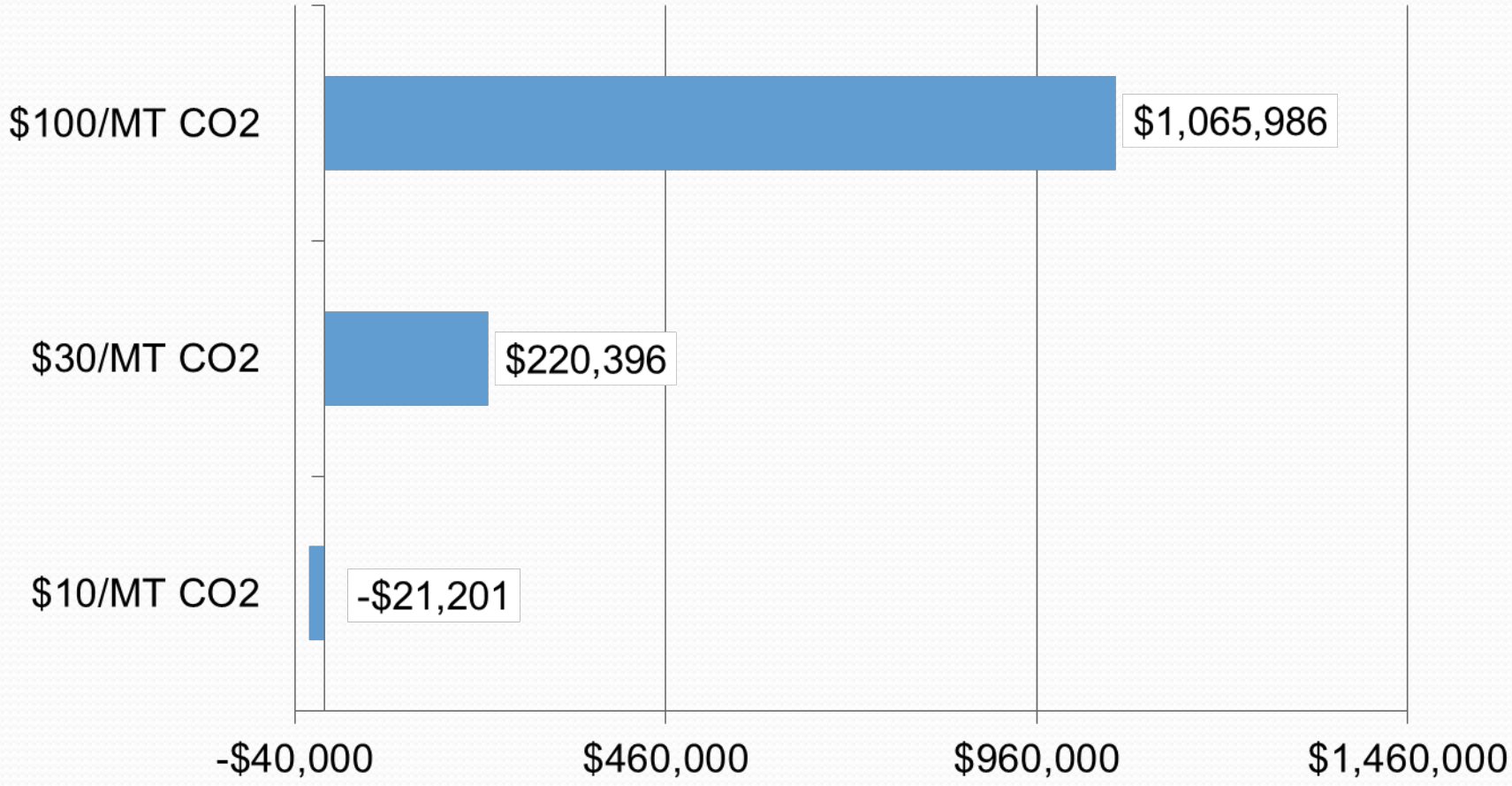
1. The legitimate CI reduction obtained through agricultural practices is: 1.5gCO_2e/MJ
2. The cost of carbon is \$30/MT CO_2
3. The cost of certification is \$142,000/y
4. The entity being certified is a 100 mm gal/y ethanol plant and its feedstock supply chain.

The value of the 1.5 CI reduction is:

$$\left(\frac{1.5\ gCO_2e}{MJ}\right)\left(\frac{80.53241\ MJ}{gal\ EtOH}\right)(100X10^6 gal\ EtOH)\left(\frac{1MT}{1X10^6 g}\right)\left(\frac{\$30}{MT\ CO_2}\right)$$

The cost-benefit analysis of obtaining sustainability certification to obtain that CI is: $\$363,395.84 - \$142,000 = \$\mathbf{220,396}$

Cost-Benefit of 1.5gCO_2e/MJ Reduction at $142,000/Y Certification Cost, 100mm gal/y EtOH Plant and Supply Chain



Agricultural CI Reduction Case Study for Corn Ethanol

- Base Case
  - Specific CA-GREET defaults for base case
  - Base case details

- Change from base case: Some GREET-2012 Inputs

- 100 mm Gal/y Ethanol Plant in Michigan in 2010 to help focus on audit costs and benefits.

Base Case Assumptions

Parameter	Value in Basis Case	Changed Variable in Alternatives (Yes/No)
Ethanol Yield (gal/bu)	2.72	No
DGS Yield (lb dry DGS/gal EtOH Produced)	5.34	No
DGS Co-product Displacement Credit (gCO_2e/MJ)	-11.48	Yes
Farming Direct Energy Use (Btu/bu)	12,635	Yes
Chemical Application Upstream Production	Detailed in Slide	Yes
N_2O and CO_2 Soil Emissions	Detailed in Slide	Yes
Corn Transportation	Detailed in Slide	No

Base Case Farming Energy Use

	Shares	Direct	Upstream	Total	CIs Total
Fuel Shares	%	Btu/bu	Btu/bu	Btu/bu	gCO_2e/MJ
Residual Oil	**0.0%**	-	-	-	**0.00**
Diesel	**45.2%**	5,715	932	6,646	**2.47**
Gasoline	**18.2%**	2,298	465	2,763	**1.01**
Natural Gas	**14.5%**	1,835	128	1,963	**0.63**
Coal	**0.0%**	-	-	-	**0.00**
LPG	**16.8%**	2,119	248	2,367	**0.79**
Biomass	**0.0%**	-	-	-	**0.00**
Electricity	**5.3%**	667	1,767	1,767	**0.70**
Total	**100.0%**	**12,635**	**3,539**	**15,506**	**5.59**

On Farm Chemical Use: Production of Chemicals CI

	Application	Upstream Energy	Upstream Energy Per EtOH Energy	CI
Chemical	g/bu	Btu/bu	Btu/MMBtu	gCO_2e/MJ
Nitrogen	**420**	19,252	92,728	**5.67**
P2O5	**149**	1,983	9,552	**0.70**
K2O	**174**	1,464	7,054	**0.55**
CaCO3	**1,202**	9,268	44,641	**3.44**
Herbicide	**8.1**	2,142	10,318	**0.79**
Insecticide	**0.7**	212	1,023	**0.08**
Total	**-**	**34,322**	**165,316**	**11.21**

Corn Transport

Corn Transport						
Travel	Miles	Means	%	Btu/ton	Btu/bu	gCO_2e/MJ
From Field to Stack	10	MDT	100%	51,161	1,433	0.53
From Stack to Biorefinery Plant	40	HHDT	100%	159,349	4,462	1.66
Total				**210,510**	**5,894**	**2.19**

Soil N_2O and CO_2 Emissions

Soil N_2O and CO_2 Emissions		
	CA-GREET	**GREET 2012**
Type	gCO_2e/MJ	gCO_2e/MJ
Soil N_2O Emissions	15.91	**18.31**
CO_2 Emissions	3.05	3.05
Sum	**18.96**	**21.36**

CA-GREET 2009: 1.325% N Fertilizer to N_2O

GREET 2012: 1.525%

$$\left(\frac{420\ gN_2}{bu} + \frac{141.6\ gN_2}{bu}\right)(1.525\%)\left(\frac{44\ \frac{g}{mol}N_2O}{28\ \frac{g}{mol}N_2}\right) = 13.458\ \frac{g}{bu}N_2O$$

$$\left(13.458\ \frac{g}{bu}N_2O\right)\left(\frac{bu}{2.72\ gal}\right)\left(\frac{gal\ EtOH}{76{,}330\ Btu}\right)\left(\frac{10^6\ Btu}{mmBtu}\right)\left(\frac{1\ mmBtu}{1055.05\ MJ}\right)\left(\frac{298\ gCO_2e}{gN_2O}\right)$$

$$= \frac{18.31\ gCO_2e}{MJ}$$

GREET 2012 Farming Energy and Chemical Use in CA-GREET

GREET 2012: **9,608 Btu/bu** Farming Energy
GREET 2009: 12,635 Btu/bu

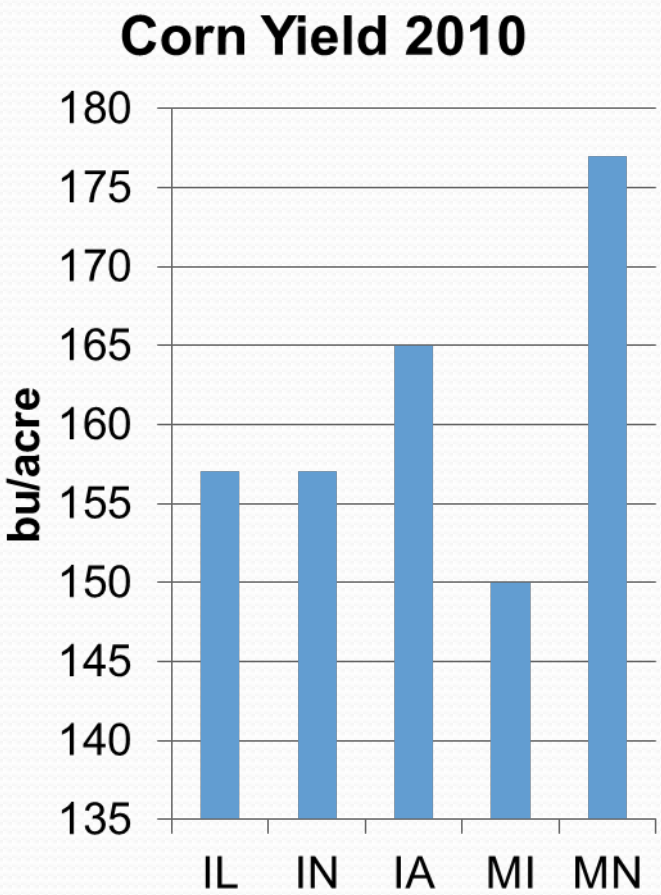
	Base	**GREET 2012**
	Shares	Shares
Fuel Shares	%	%
Residual Oil	0.0%	**0.0%**
Diesel	45.2%	**49.2%**
Gasoline	18.2%	**14.7%**
Natural Gas	14.5%	**13.6%**
Coal	0.0%	**0.0%**
LPG	16.8%	**17.9%**
Biomass	0.0%	**0.0%**
Electricity	5.3%	**4.6%**
Sum	**100.0%**	**100.0%**

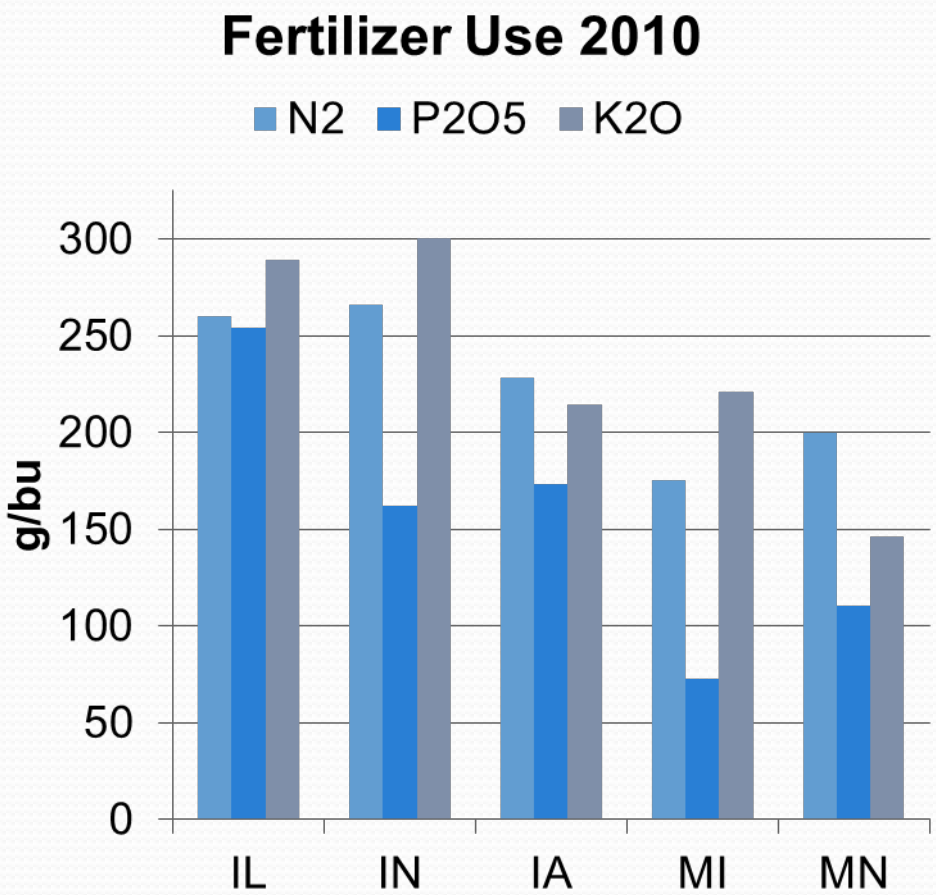
	Base Case	**GREET 2012**
Chemical	g/bu	g/bu
Nitrogen (g/bu)	420	**415.3**
P2O5	149	**147.8**
K2O	174	**172.1**
CaCO3	1,202	**1,149.9**
Herbicide	8.1	**4.8**
Insecticide	0.68	**0.4**

GREET 2012 Farming Energy and Chemical Use in CA-GREET CI Change

CI Parameter	Base Case	Greet 2012 in 2009
	gCO_2e/MJ	gCO_2e/MJ
Ag Phase CI Sum	37.96	**35.75**
DGS Credit	-11.48	-10.81
Ag Phase CI Sum w/ Credit	26.48	24.94
Difference From Basis (w/ DGS Credit)	0.00	**-1.54**
Farming Energy	5.59	4.21
Upstream Ag Chemicals	11.21	10.64
Soil N2O Emissions	15.91	**15.77**
Soil CO2 Emissions	3.05	2.94
Total Soil Emissions (N2O + CO2)	18.96	18.71
Transportation and Distribution	2.19	2.19

Why Michigan (MI), 2010?





100 mm gal/y Ethanol Plant in MI

EtOH Yield	**2.72**	gal/bu
EtOH Produced	**100**	mm gal/y
Bushels Required	**36,764,706**	bu/y
MI Corn Yield (2010)	**150**	bu/acre
Acres reqd.	**245,098**	acre
Cash Receipts MI (2010)	$1,082,488,000	$ 2010 Total Receipts
Acres Harvested in MI (2010)	2,100,000	acres
Percent of MI Acres Harvested	**12%**	
Total Bu Harvested MI (2010)	315,000,000	bu
Cost Per Bu MI 2010	**$3.44**	$/bu
Cost Per Bu 2013 (ref)	$6.89	$/bu
Cost Per Bu 2010 (ref)	$3.41	$/bu

MI 2010 Chemical Use Change in CA-GREET

	Base Case	**MI 2010**
Chemical	g/bu	g/bu
Nitrogen (g/bu)	420	**175.39**
P2O5	149	**72.57**
K2O	174	**220.75**
CaCO3	1,202	1,202
Herbicide	8.1	8.1
Insecticide	0.68	0.68

MI 2010 Chemical Use Change in CA-GREET CI

CI Parameter	Base Case	MI 2010 Fertilizer (N, P, K)
	gCO_2e/MJ	gCO_2e/MJ
Ag Phase CI Sum	37.96	**27.15**
DGS Credit	-11.48	-8.21
Ag Phase CI Sum w/ Credit	26.48	18.94
Difference From Basis (w/ DGS Credit)	0.00	**-7.54**
Farming Energy	5.59	5.59
Upstream Ag Chemicals	11.21	7.7
Soil N2O Emissions	15.91	8.98
Soil CO2 Emissions	3.05	2.68
Total Soil Emissions (N2O + CO2)	18.96	11.66
Transportation and Distribution	2.19	2.19

Key Findings and Future Work

- Presented costs for certification in terms of CI reduction credits and have shown there is an economically viable path to being sustainably certified through actual CI reduction.
- Presented examples of agricultural input changes that would need to audited due to changes in parameters over time and how those reductions fall within the certification audit cost-benefit analysis
- Presented a case study to help guide stake-holders when considering the relevance of the assumed costs for sustainable certification and related audits.
- **To-do:**
- Look more closely at other scenarios for CI reduction in the agricultural phase not presented here: different fuels for on farm use (renewable diesel, biodiesel, etc.), different chemicals as alternatives with lower production CI.
- Look into non-CA-GREET input parameters that could be considered within the full fuel cycle and ability to improve on those through sustainability cert.
- Refine costs of sustainability certification audits and assumptions of costs for meeting certification requirements
- Look at other feedstocks and fuels

Thank you for your time and participation!

- You can reach me with questions or for discussion at:

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Discussion Topics

- Is there enough valid data for the auditor to prove a claim?
  - Case-by-case basis
  - Work from ARB direction
- GHG reduction requirements in standards
  - Reporting methodology
  - Inherent in LCFS

Discussion Topics

- Annual review/audit?
  - How frequently do input values change?
  - Natural disasters
- Benchmarking certification standards
  - Baseline set of principles/criteria needed?
  - Sliding scale applied?

Next Steps

Next LCFS Sustainability Workgroup Meeting

- Next SWG Meeting – May 1, 16, 21
- Agenda under Development

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