



The Importance of Carbon Intensity to Meet Decarbonization Goals and Impact on Capital Projects



Rice Global E&C Forum
**Engineering &
Construction**

Kristine Klavers – Managing Director, Houston

www.ecoengineers.us

January 5, 2023



About Kristine Klavers

**Monetizing Carbon Reduction
Renewable Diesel**



NORWAY



MSc Chemical Engineering



Patent: Methane Coupling Catalyst



**MTBE Product Specialist
ARCO Chemical** ◆

Energy Markets



**International Fuel Quality Center
Fuel Magazine**

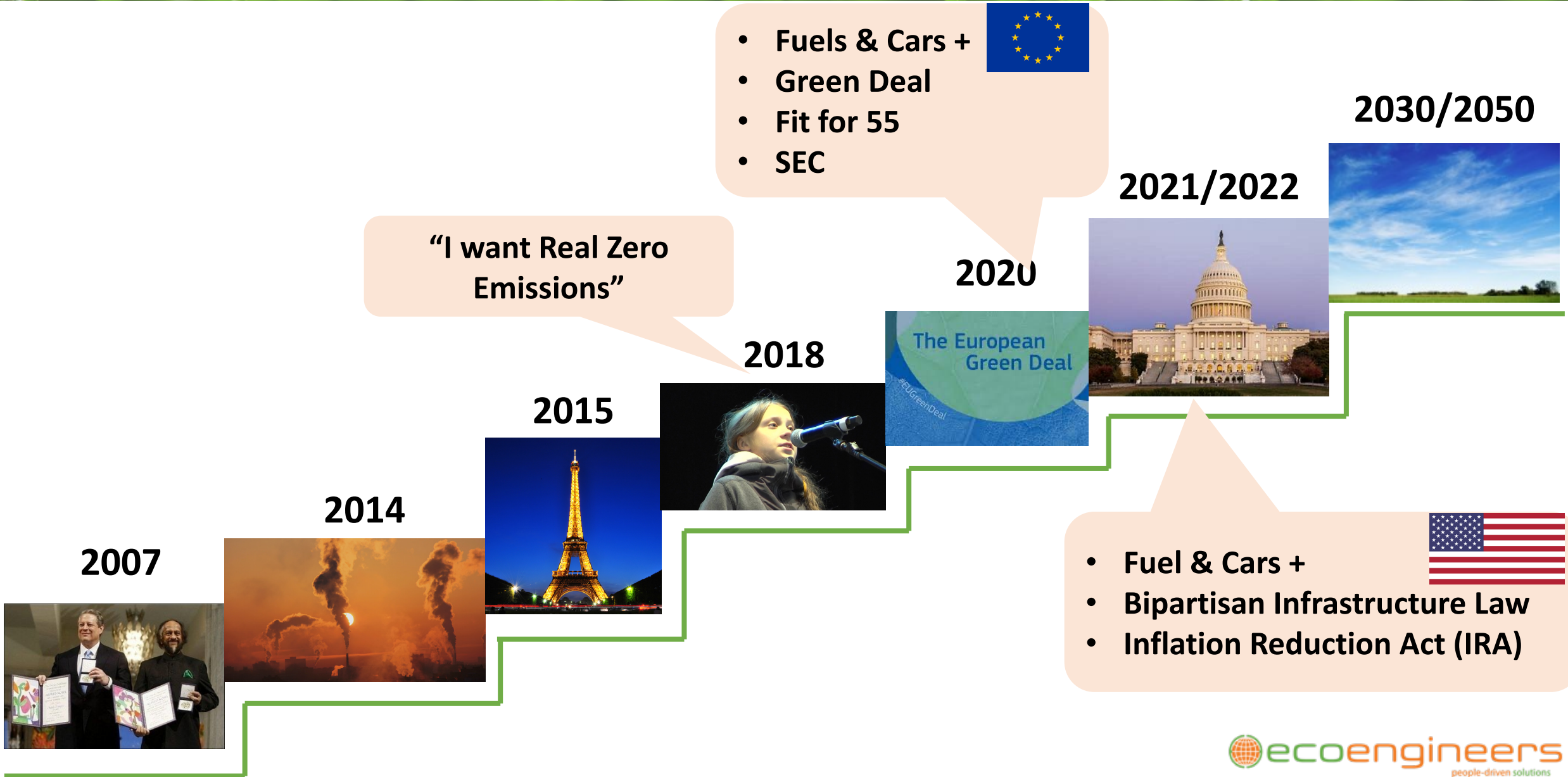


Refinery Design/HAZOP



1. The road to “a zero-emission goal”
2. Carbon markets
3. Carbon Intensity (CI) and Life Cycle Analysis (LCA)
4. Experience from downstream

The road to zero carbon



A close-up photograph of vibrant green grass blades, each topped with a clear, glistening water droplet. The background is softly blurred, creating a sense of depth and freshness. The overall color palette is a rich, natural green.

Carbon Markets

Minimize Risks by Knowing Your Emissions,
Understanding Current & Future Regulations &
related Compliance Requirements

OREGON

Oregon issues \$2.7M fine to electric charging company

by: The Associated Press
Posted: Oct 3, 2022 / 10:01 AM PDT

BioDiesel Scandal: EPA Claims Auditor Genscape Allowed 68Mln Fraudulent RIN Credits – DTN

January 6, 2017
By Todd Neeley DTN Staff Reporter

SEC Charges Goldman Sachs Asset Management for Failing to Follow its Policies and Procedures Involving ESG Investments

FOR IMMEDIATE RELEASE
2022-209

Washington D.C., Nov. 22, 2022 — The Securities and Exchange Commission today charged Goldman Sachs Asset Management, L.P. (GSAM) for policies and procedures failures involving two mutual funds and one separately managed account strategy marketed as Environmental, Social, and Governance (ESG) investments. To settle the charges, GSAM agreed to pay a \$4 million penalty.

CER investigating potential \$1.5 million solar panel fraud

Australia's Clean Energy Regulator has this week executed search warrants on several residential and commercial addresses connected to a Perth-based solar PV retail and installation business as part of an investigation into a potential \$1.5 million solar panel fraud.

SEPTEMBER 16, 2022 DAVID CARROLL

Shell Loses Dutch Appeal Over Misleading Carbon Emission Ads

- Dutch authority queries extent carbon credits offset emissions
- Oil major says no question of deception in advertisements

By [Diederik Baazil](#) and [Cagan Koc](#)

October 21, 2022 at 7:55 AM CDT *Updated on October 21, 2022 at*

• LIVE
Watch

FOR IMMEDIATE RELEASE

Tuesday, October 20, 2020

Pennsylvania Biofuel Company and Owners Sentenced on Environmental and Tax Crime Convictions Arising out of Renewable Fuels Fraud

EPA Discovers More RIN Fraud

The U.S. Environmental Protection Agency said it has invalidated 33.5 million renewable-fuel credits sold by an Indiana company for biofuel it didn't produce, the fourth time the agency has alleged fraud in the program, Bloomberg News reported.

Knowing your CI throughout the supply chain is KEY!

Inflation Reduction Act (IRA)

- H₂ Production Tax Credit
 - \$0.60/kg+ depending on lifecycle GHGs
- Clean Electricity Investment Tax Credit
 - GHG to be 25% lower than 2022
- Clean Fuel Production Credit
 - Fuels with less than 50 kg CO₂e/mmBtu
- Sustainable Aviation Fuel Credit
 - Up to \$0.50/gallon depending on lifecycle GHG

ExxonMobil's GHG reduction plan

- Corporatewide
 - 20-30% reduction in CI
- Upstream
 - GH40-50% reduction in CI
- Methane
 - 70-80% reduction in methane intensity
- Flaring
 - 60-70% reduction in flaring intensity

Regulated by region or state

- Mandated
- Cap-and-Trade regulations
- Credits
 - US Renewable Fuel Standard (RFS)
 - California Low Carbon Fuel Standard (LCFS)

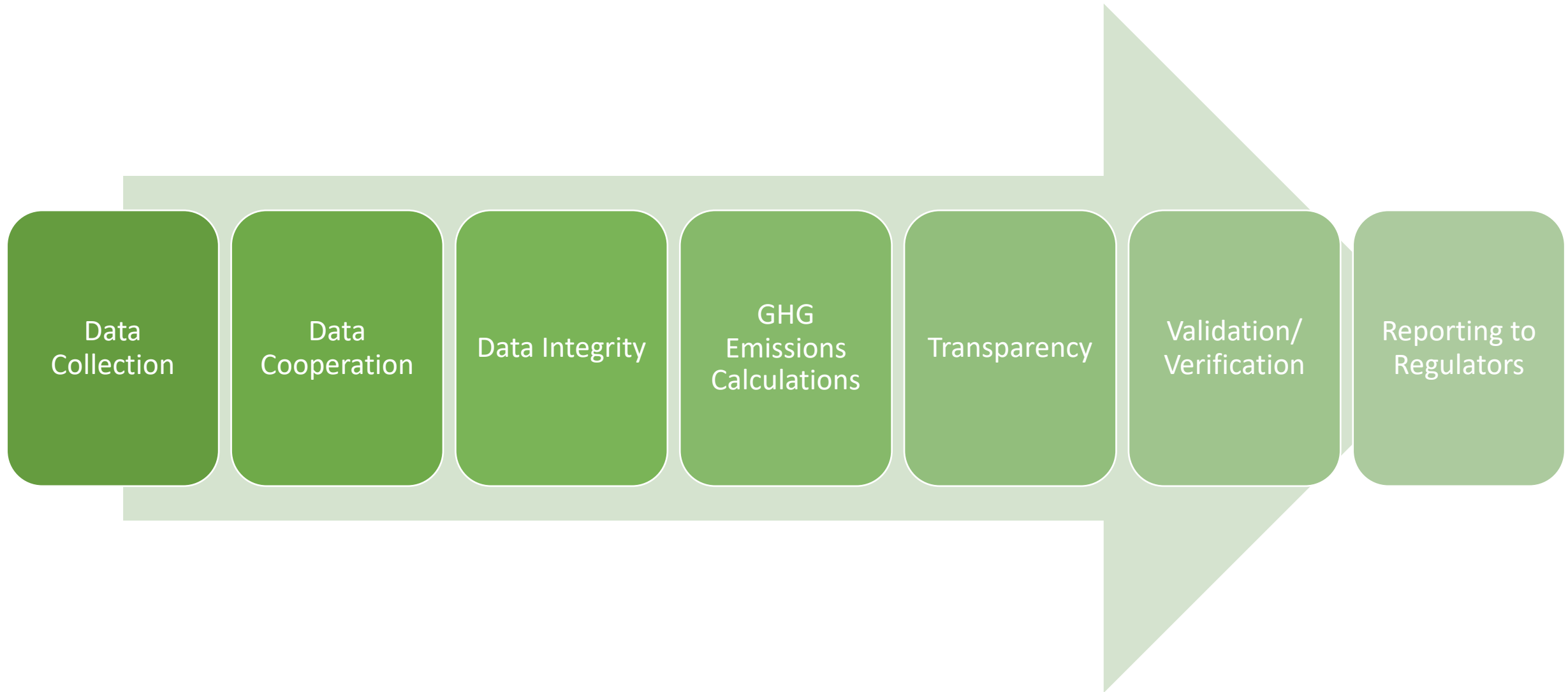
Government managed

Voluntary between businesses

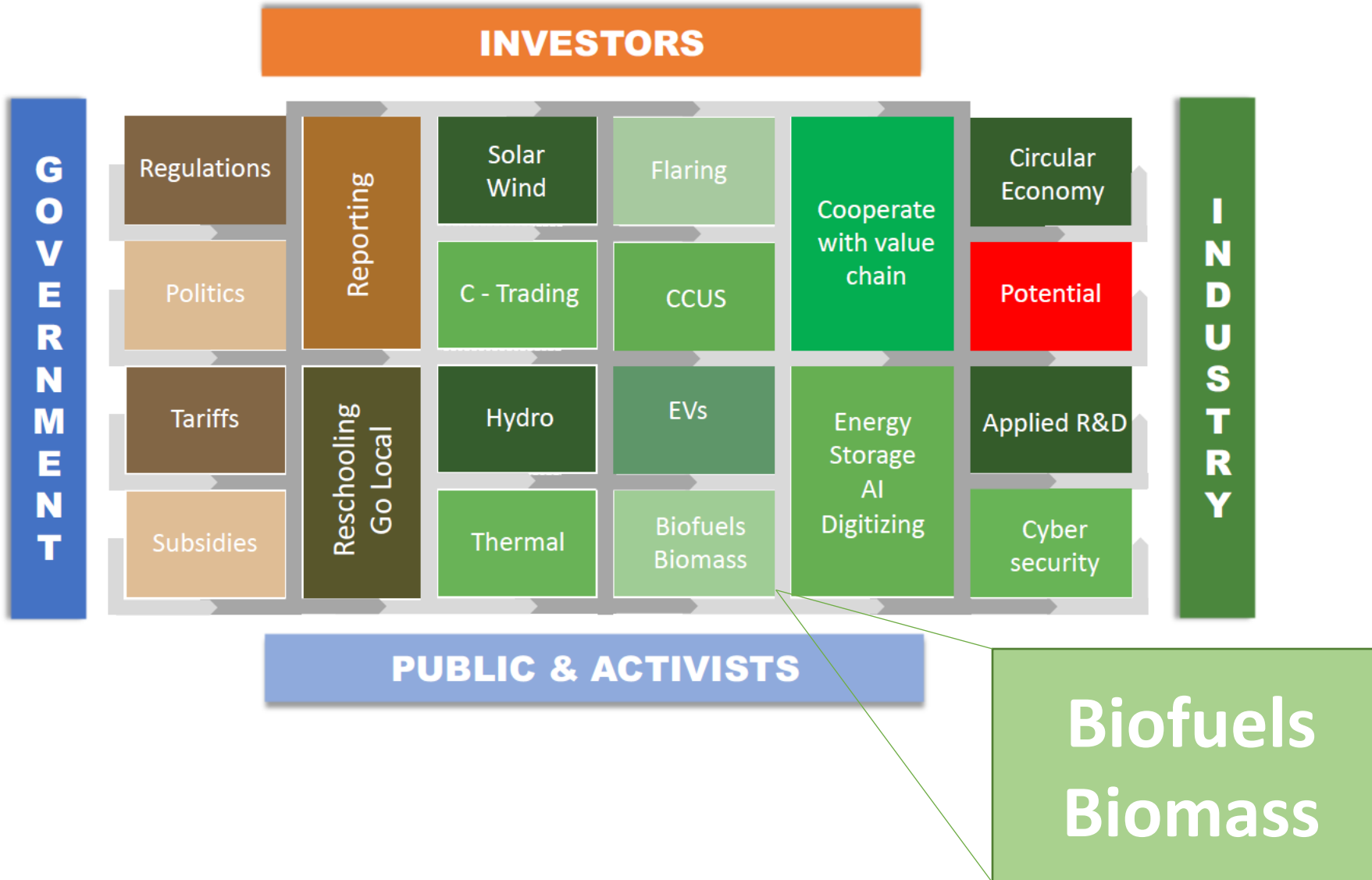
- Optional
- Offsets available for purchase
 - Reforestation
 - Renewable energy
 - Methane capture/combustion

Registry managed

Transparency, disclosures & verification increasingly important



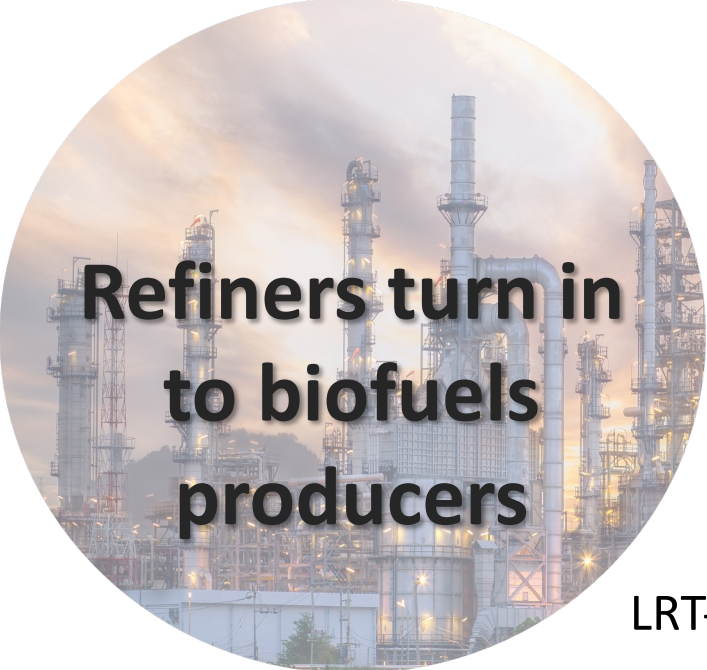
Politics & regulations driving the industry



Refiners turning into carbon reducers

Federal RFS Renewable Fuels Standard Volume Driven

State LCFS Low Carbon Fuels Standard Carbon Driven



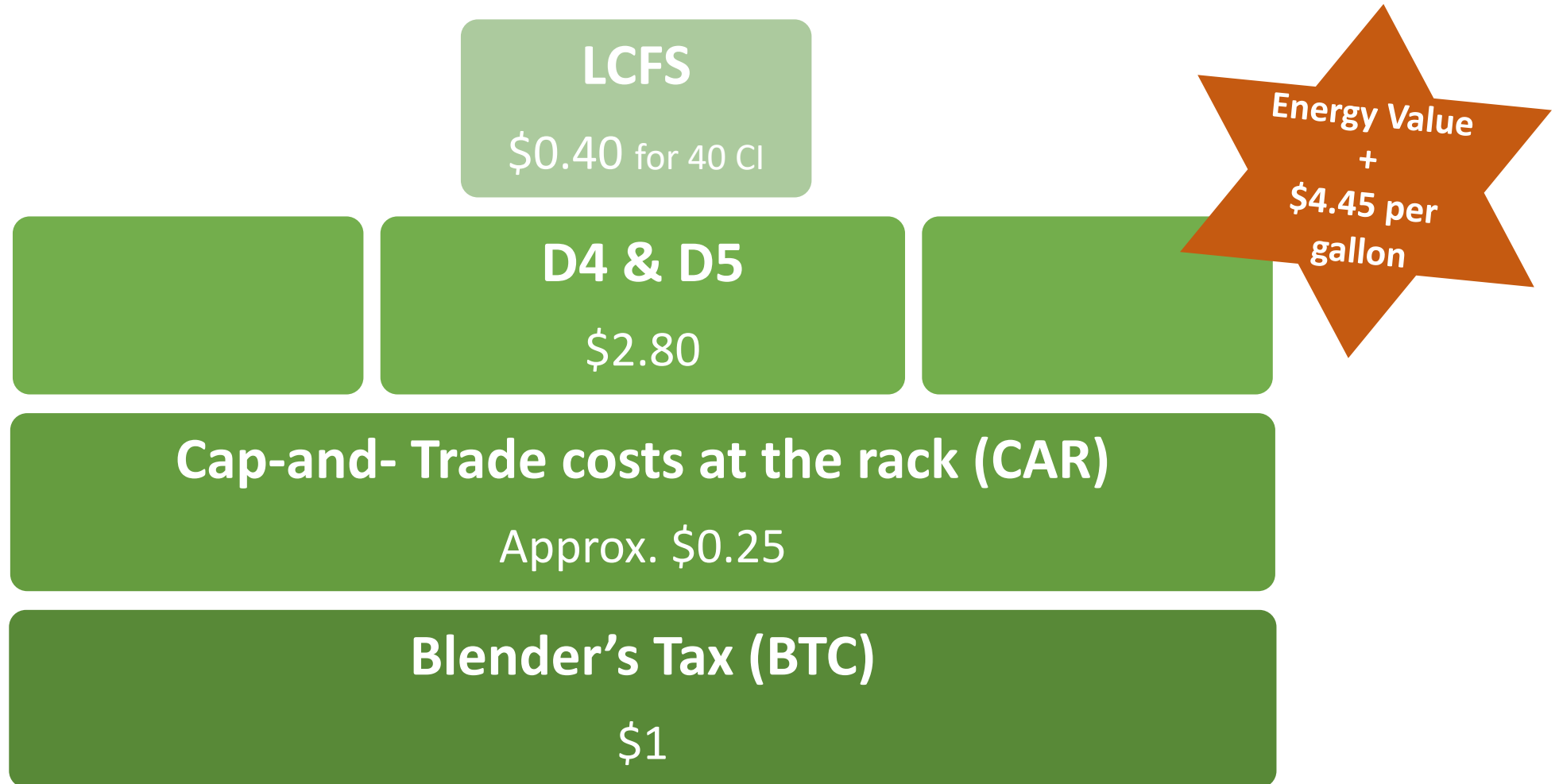
Quarterly Reporting
 Biointermediate UCO
 SREs RIN Generation Protocol
 Retirement Q-RIN CDX
 COI Cellulosic
 EMTS QAP 79 Registration
 Third Party Engineering Review
 USEPA 40CFR Part 80
 Import/Export documentation
 D3, D4, D5, D6, D7

Compliance Recordkeeping/Monitoring Plan

Annual Reporting

CI RCO Validation
 Life Cycle Analysis
 AFP CA-GREET 3.0 Model
 Verification
 Temporary Pathway Deadlines
 LRT-CBTS Fuel Pathway Code
 Tier 1 and Tier 2 Pathways

Monetize Your Renewable Diesel



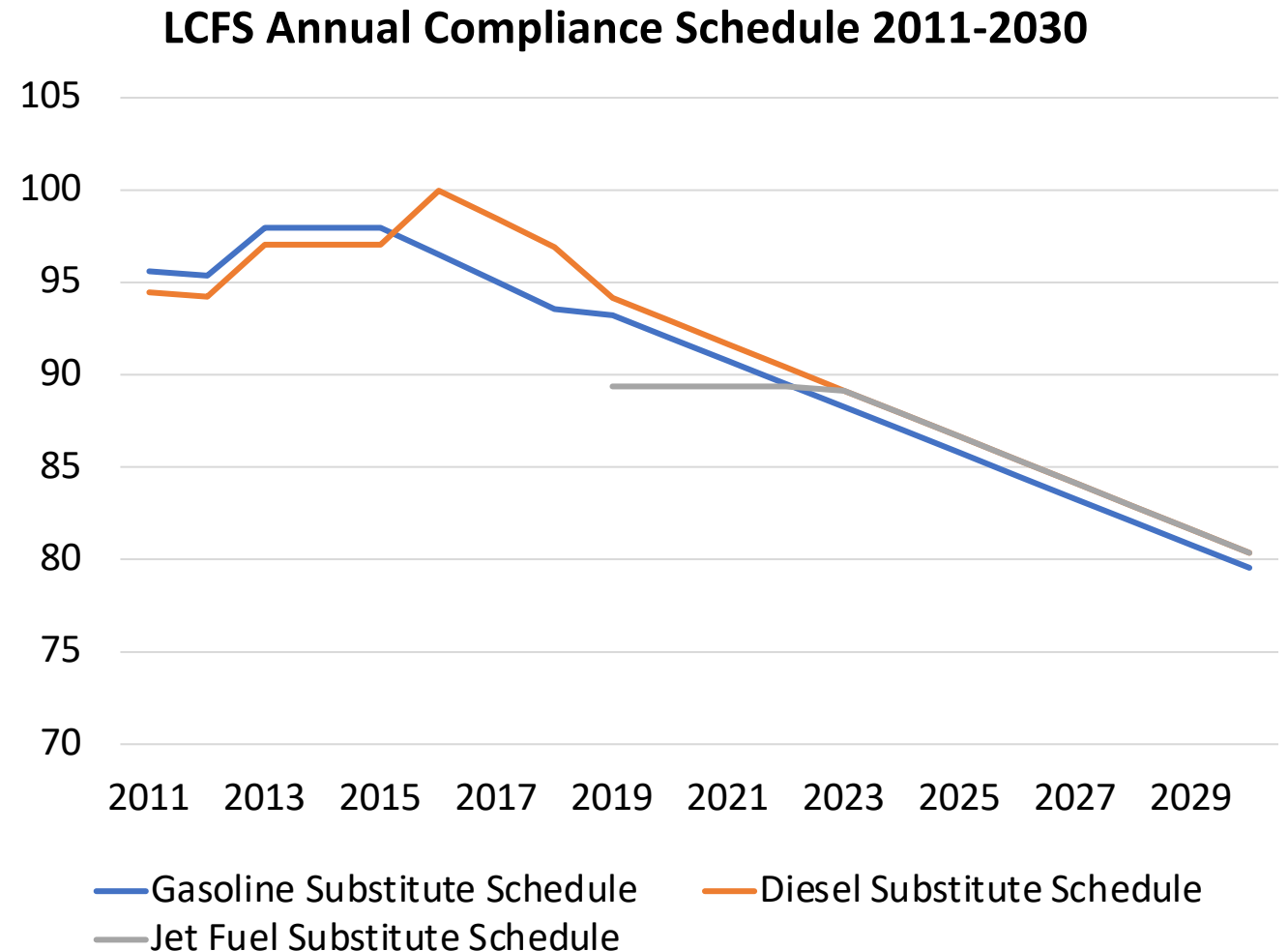
* Prices are per gallon

US Renewable Fuel Standard

Title 40, Chapter I, Subchapter C, Part 80

D-RINs	Fuel	GHG reductions *compared to 2005 baseline	RVO target billion gallons *2022	Pathways examples Product-Feedstock-Process	RIN price per RIN
D6	<ul style="list-style-type: none"> ▪ Corn ethanol ▪ Grandfathered 	20%	15	Ethanol-corn starch-dry mill	\$0.80-1.80
D4	<ul style="list-style-type: none"> ▪ Sugarcane ethanol 	50%	5	Renewable diesel-soybean-hydrotreating	\$1.20-2.00
D5	<ul style="list-style-type: none"> ▪ Renewable diesel ▪ Biodiesel 			Naphtha-camelina-transesterification	
D3	<ul style="list-style-type: none"> ▪ Cellulosic fuels ▪ RNG/LNG 	60%	0.63 No target is set yet	RNG-dairy-aerobic digestion	\$2.50-3.50
D7					

- Reduce GHG Emissions by 20% by 2030
- Reduce petroleum dependency
- Incentivize the development of low carbon fuels based on CI score
 - Performance-based: Credit or Deficit
 - Fuel neutral: No fuel type-specific goals



What is the Life-Cycle-Analysis (LCA)?

- Assess the environmental aspects and potential impacts associated with a product, process, or services.
- Consistent LCA methodologies help:
 - Compare technologies
 - Identify drivers for environmental improvements
- Minimum requirements for reliability:
 - The entire supply chain
 - Objectivity
 - Mass and energy balances
 - Co-product methods
 - Functional units



Source: Wiki Commons

REET covers many groups of energy systems

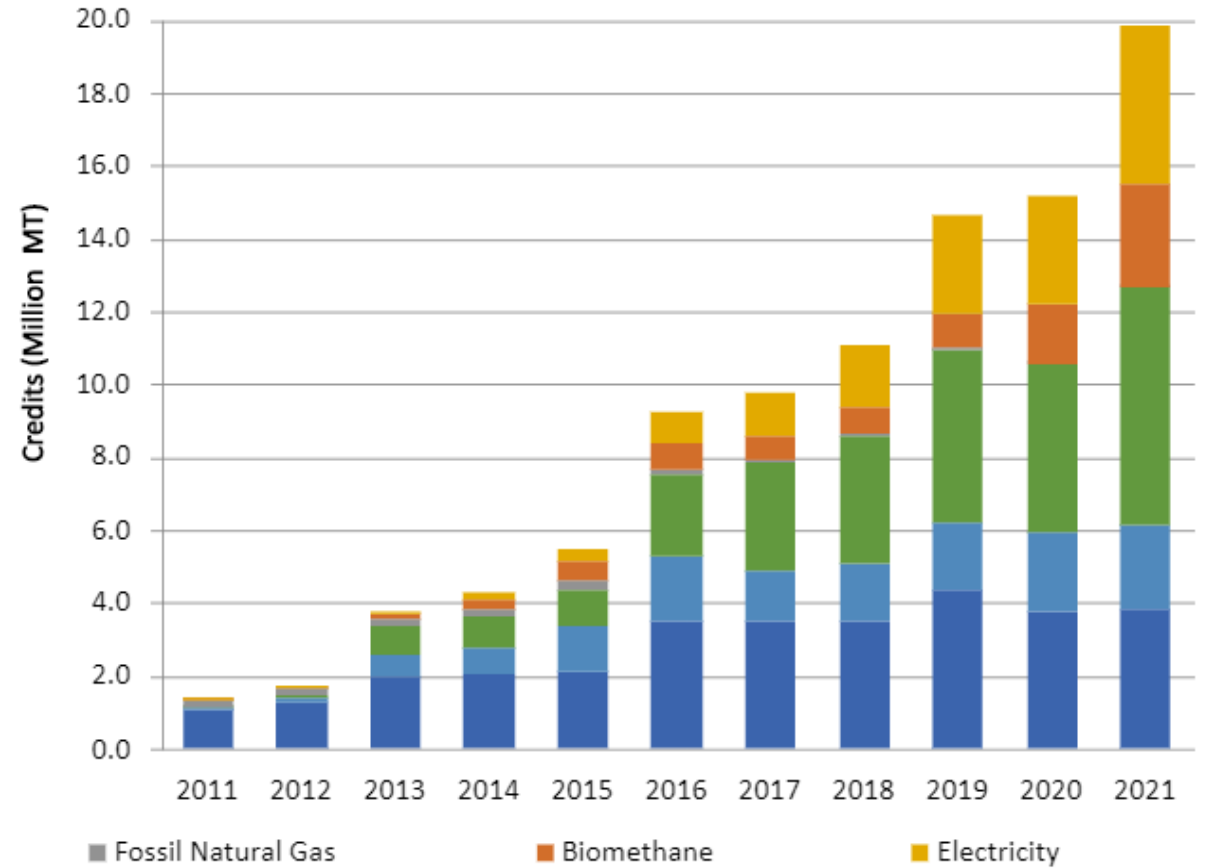
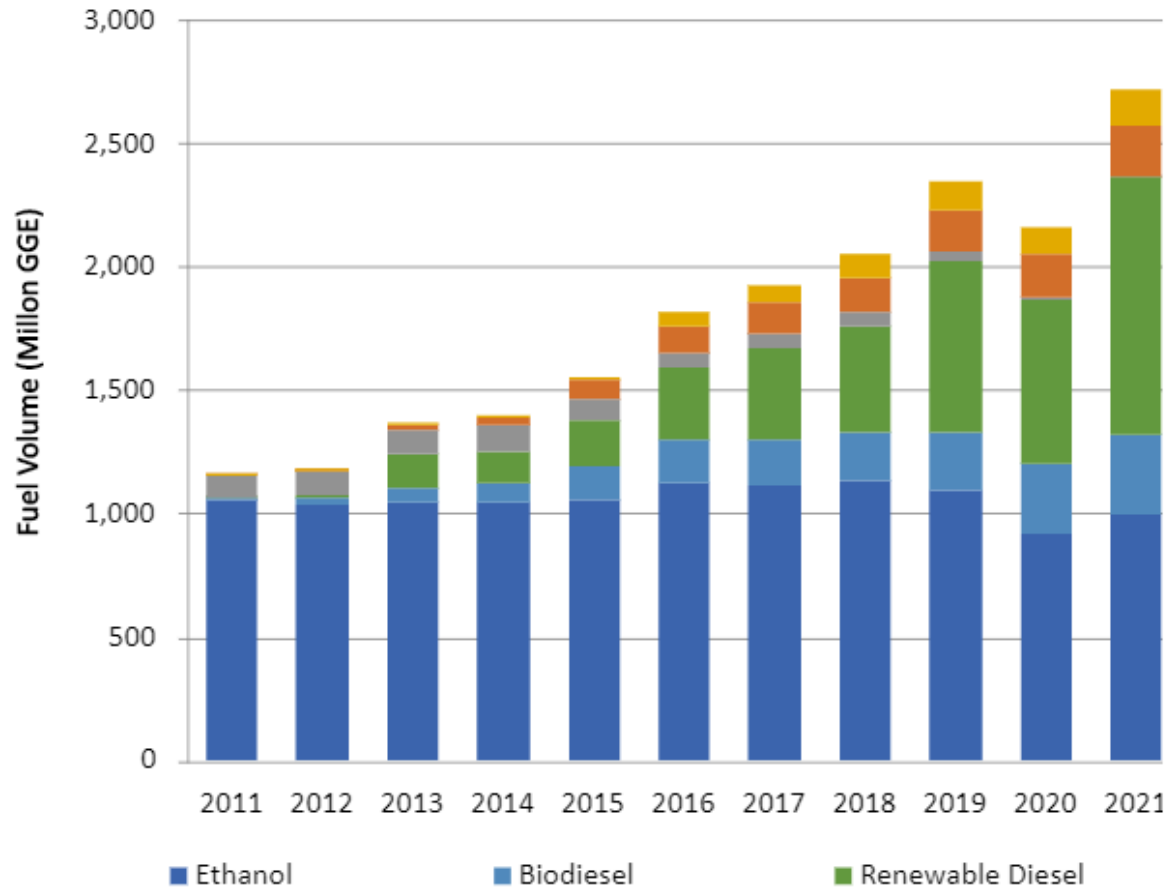
<p>Petroleum Sector</p> <ul style="list-style-type: none"> Conventional oil Shale oil Oil sands 	<ul style="list-style-type: none"> Gasoline Diesel Jet fuel LPG Naphtha Residual Oil 	<p>Electric System</p> <ul style="list-style-type: none"> Electricity generation at US plant level Aggregate to national, NERC and state level With CCS 	<ul style="list-style-type: none"> Natural gas Coal Residual Oil Biomass Nuclear Hydro Wind Solar
<p>NG Sector</p> <ul style="list-style-type: none"> Conversational NG Shale gas 	<ul style="list-style-type: none"> NG end use in electric, industrial and residential sectors Transportation: CNG, LNG Alt fuels: LPG, MeOH, DME, FT diesel, FT jet 	<p>Renewable Energy/Fuels</p> <ul style="list-style-type: none"> Ethanol Biodiesel Renewable Diesel Renewable Gasoline Renewable jet fuel Renewable NG 	<p>1st generation feedstock</p> <ul style="list-style-type: none"> Corn, Sorghum, Soybeans Rapeseed, Sugarcane <p>2nd Generation feedstocks</p> <ul style="list-style-type: none"> Crop and Forest residues MSW, Animal Wastes <p>Algae</p>
<p>Hydrogen Economy</p> <ul style="list-style-type: none"> Gaseous H2 Liquid H2 With CCS 	<ul style="list-style-type: none"> Natural gas Biomass Coal Petroleum coke Coke Oven gas Electrolysis with electricity Nuclear energy 	<p>Renewable H2 via electrolysis</p> <ul style="list-style-type: none"> Wind Solar Nuclear 	<p>Electro Fuels</p> <ul style="list-style-type: none"> Gasoline Diesel Jet fuel Methanol

Source: DOE

Determine your CI score through LCA

Feedstock	CI g/CO2e/MJ	
Gasoline	100.82	
Diesel	100.45	
Fossil NG	79.21	
Used Cooking Oil Biodiesel	8.63	30.15
Oil (soy, corn) Biodiesel	29.42	61.94
Ethanol	7.18	80.85
CNG (dairy manure, landfill gas...)	-408.6	52.64
Hydrogen	-35	-170
Electricity	-762.09	108.43

Advanced Renewables Increase Volume, Decrease CI

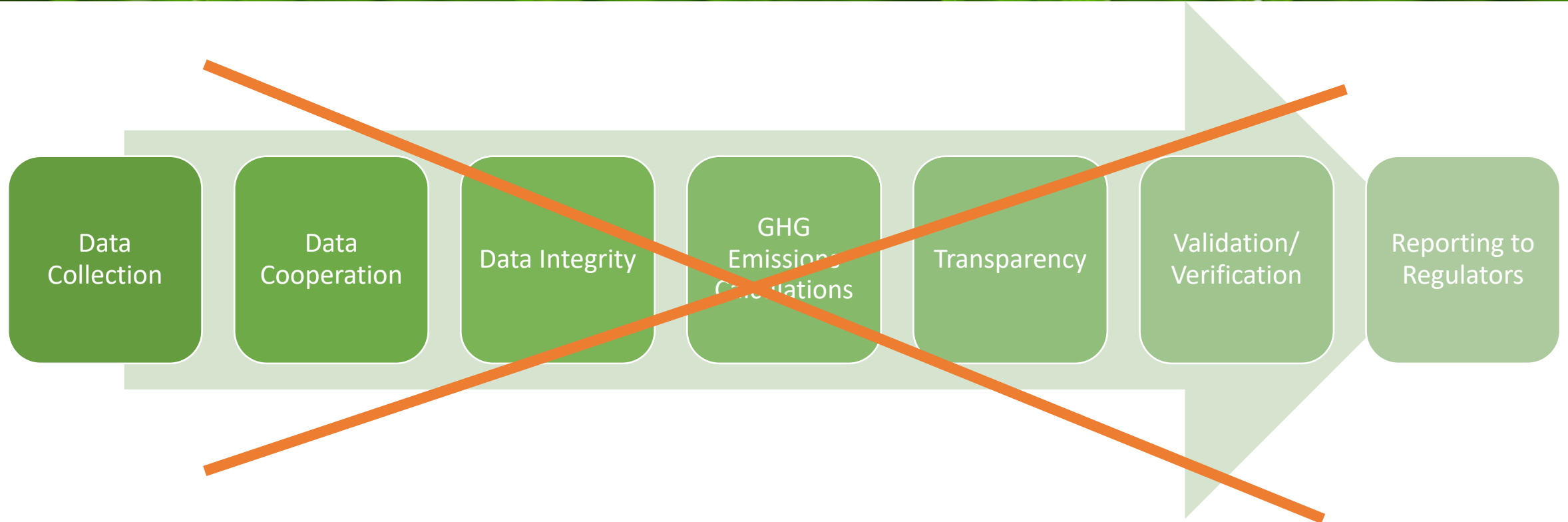


Source: CARB

Know the Compliance Requirements

YEAR	MONTH	UCO CARRY-OVER (KG)												12 MO UCO PURCHASES (KG)												UCO INPUT - REPORTED (KG)												12 MO UCO INPUT - CALCULATED (KG)												UCO LOSSES (KG)												UCO SALE + OTHER USE (KG)												SICO CARRY-OVER (KG)												SICO INCOMING (KG)												SICO INPUT (KG)												SICO LOSS (KG)												SICO MONTH-END STOCK (kg)												UCO + SICO INCOMING (KG)												POOL CARRY-OVER (KG)												POOL INCOMING (KG)												POOL INPUT (KG)												POOL MONTH-END STOCK (kg)												TOTAL FEEDSTOCK CARRY-OVER (KG)												TOTAL FEEDSTOCK INCOMING (kg)												12 MO FEEDSTOCK INCOMING (KG)												CUMULATIVE FEEDSTOCK INCOMING (KG)												TOTAL FEEDSTOCK INPUT (kg)												12 MO FEEDSTOCK INPUT (kg)												CUMULATIVE FEEDSTOCK INPUT (KG)												TOTAL FEEDSTOCK LOSSES (KG)												TOTAL FEEDSTOCK MONTH-END STOCK (kg)												MOON CARRY-OVER (KG)												MOON INCOMING (KG)												12 MO											
		UCO CARRY-OVER (KG)	UCO INCOMING (KG)	12 MO UCO PURCHASES (KG)	CUMULATIVE UCO PURCHASES (KG)	UCO INPUT - REPORTED (KG)	UCO INPUT - CALCULATED (KG)	12 MO UCO INPUT (KG)	CUMULATIVE UCO INPUT (KG)	UCO LOSSES (KG)	UCO SALE + OTHER USE (KG)	SICO CARRY-OVER (KG)	SICO INCOMING (KG)	SICO INPUT (KG)	SICO LOSS (KG)	SICO MONTH-END STOCK (kg)	UCO + SICO INCOMING (KG)	POOL CARRY-OVER (KG)	POOL INCOMING (KG)	POOL INPUT (KG)	POOL MONTH-END STOCK (kg)	TOTAL FEEDSTOCK CARRY-OVER (KG)	TOTAL FEEDSTOCK INCOMING (kg)	12 MO FEEDSTOCK INCOMING (KG)	CUMULATIVE FEEDSTOCK INCOMING (KG)	TOTAL FEEDSTOCK INPUT (kg)	12 MO FEEDSTOCK INPUT (kg)	CUMULATIVE FEEDSTOCK INPUT (KG)	TOTAL FEEDSTOCK LOSSES (KG)	TOTAL FEEDSTOCK MONTH-END STOCK (kg)	MOON CARRY-OVER (KG)	MOON INCOMING (KG)	12 MO																																																																																																																																																																																																																																																																																																																
2020	JAN	358,450	598,310	598,310	598,310	956,760	956,760	956,760	956,760	0	0	0	0	0	5,453,610	4,741,950	0	711,660	6,051,920	0	58,010	58,010	0	358,450	6,109,930	6,109,930	6,109,930	5,756,720	5,756,720	5,756,720	5,756,720	0	711,660	44,880	577,690	577,690																																																																																																																																																																																																																																																																																																													
2020	FEB	0	445,570	445,570	1,043,880	445,570	445,570	445,570	1,402,330	0	0	0	0	0	1,646,370	0	3,973,020	3,471,650	501,370	711,660	5,619,390	5,619,390	11,729,320	5,829,680	5,829,680	11,586,400	0	501,370	46,500	609,670	609,670																																																																																																																																																																																																																																																																																																																		
2020	MAR	0	56,810	56,810	1,100,690	56,810	56,810	56,810	1,459,140	0	0	0	0	0	56,810	501,370	5,806,090	5,890,160	417,300	501,370	5,862,900	5,862,900	17,592,220	5,946,970	5,946,970	17,533,370	0	417,300	37,480	628,610	628,610																																																																																																																																																																																																																																																																																																																		
2020	APR	0	0	0	1,100,690	0	0	0	1,459,140	0	0	0	0	0	0	417,300	6,751,480	6,519,160	649,620	417,300	6,751,480	6,751,480	24,343,700	6,519,160	6,519,160	24,052,530	0	649,620	20,690	727,050	727,050																																																																																																																																																																																																																																																																																																																		
2020	MAY	0	0	0	1,100,690	0	0	0	1,459,140	0	0	0	0	0	0	649,620	5,637,440	6,006,710	280,350	280,350	6,438,050	6,438,050	36,419,190	6,006,710	6,006,710	30,059,240	0	280,350	33,700	650,620	650,620																																																																																																																																																																																																																																																																																																																		
2020	JUN	0	0	0	1,100,690	0	0	0	1,459,140	0	0	0	0	0	0	0	280,350	6,438,050	6,203,430	514,970	514,970	5,789,040	5,789,040	42,208,230	5,779,310	5,779,310	36,261,670	0	514,970	40,130	700,860	700,860																																																																																																																																																																																																																																																																																																																	
2020	JUL	0	0	0	1,100,690	0	0	0	1,459,140	0	0	0	0	0	0	3,558,700	2,834,000	0	724,700	3,558,700	514,970	2,230,340	2,745,310	0	724,700	5,222,920	5,222,920	0	724,700	55,480	599,510	599,510																																																																																																																																																																																																																																																																																																																	
2020	AUG	0	0	0	1,100,690	0	0	0	1,459,140	0	0	0	0	0	0	724,700	5,222,920	5,776,380	0	171,240	5,222,920	0	0	0	724,700	5,222,920	5,222,920	0	724,700	43,260	574,740	574,740																																																																																																																																																																																																																																																																																																																	
2020	SEP	0	1,782,390	1,782,390	2,883,080	1,157,950	1,157,950	1,157,950	2,617,090	0	624,440	171,240	1,244,800	1,399,740	16,300	0	3,027,190	0	2,852,770	2,852,770	0	171,240	5,879,960	5,879,960	53,311,110	5,410,460	5,410,460	53,028,820	16,300	624,440	18,850	626,000	626,000																																																																																																																																																																																																																																																																																																																
2020	OCT	624,440	5,133,890	5,133,890	8,016,970	5,197,170	5,197,170	5,197,170	7,814,260	0	561,160	0	963,810	963,810	0	0	6,097,700	0	0	0	6,097,700	6,097,700	62,440	6,097,700	6,097,700	62,440	6,097,700	0	561,160	50,690	680,420	680,420																																																																																																																																																																																																																																																																																																																	
2020	NOV	561,160	4,864,310	4,864,310	9,998,280	4,920,670	4,920,670	4,920,670	10,111,340	12,754,350	0	0	0	0	0	0	4,864,310	0	0	0	4,864,310	4,864,310	64,210	4,864,310	4,864,310	64,210	4,864,310	0	504,800	52,130	503,740	503,740																																																																																																																																																																																																																																																																																																																	
2020	DEC	504,800	6,154,520	6,154,520	19,035,800	6,111,710	6,111,710	6,111,710	18,846,640	0	0	0	0	0	0	6,154,520	0	0	0	0	6,154,520	6,154,520	70,222,180	6,111,710	6,111,710	70,222,180	0	547,610	35,220	630,020	630,020																																																																																																																																																																																																																																																																																																																		
2021	JAN	547,610	6,028,460	6,028,460	25,064,260	6,287,080	6,287,080	6,287,080	25,133,720	0	0	0	0	0	0	6,028,460	0	0	0	0	6,028,460	6,028,460	76,556,160	6,287,080	6,287,080	76,509,260	0	288,990	31,630	656,500	656,500																																																																																																																																																																																																																																																																																																																		
2021	FEB	288,990	4,559,410	4,559,410	29,623,670	4,610,130	4,610,130	4,610,130	29,743,850	0	0	0	0	0	0	4,559,410	0	0	0	0	4,559,410	4,559,410	81,119,390	4,610,130	4,610,130	81,119,390	0	238,270	33,490	477,930	477,930																																																																																																																																																																																																																																																																																																																		
2021	MAR	238,270	6,653,070	6,653,070	36,276,740	4,608,730	4,608,730	4,608,730	36,152,580	0	0	0	0	0	0	6,653,070	0	0	0	0	6,653,070	6,653,070	87,528,120	4,608,730	4,608,730	87,528,120	0	482,610	40,640	655,440	655,440																																																																																																																																																																																																																																																																																																																		
2021	APR	482,610	6,169,390	6,169,390	42,446,130	4,241,900	4,241,900	4,241,900	42,394,480	0	0	0	0	0	0	6,169,390	0	0	0	0	6,169,390	6,169,390	93,377,020	4,241,900	4,241,900	93,377,020	0	410,100	34,110	653,310	653,310																																																																																																																																																																																																																																																																																																																		
2021	MAY	410,100	5,805,630	5,805,630	48,251,760	5,895,510	5,895,510	5,895,510	48,289,990	0	0	0	0	0	0	5,805,630	0	0	0	0	5,805,630	5,805,630	99,665,630	5,895,510	5,895,510	99,665,630	0	320,220	34,650	626,720	626,720																																																																																																																																																																																																																																																																																																																		
2021	JUN	320,220	5,044,710	5,044,710	53,296,470	4,916,950	4,916,950	4,916,950	53,206,940	0	0	0	0	0	0	5,044,710	0	0	0	0	5,044,710	5,044,710	104,582,480	4,916,950	4,916,950	104,582,480	0	447,980	47,260	635,160	635,160																																																																																																																																																																																																																																																																																																																		
2021	JUL	447,980	7,339,960	7,339,960	60,636,430	7,551,620	7,551,620	7,551,620	60,756,560	0	0	0	0	0	0	7,339,960	0	0	0	0	7,339,960	7,339,960	112,028,270	7,551,620	7,551,620	112,134,100	0	236,320	36,800	801,800	801,800																																																																																																																																																																																																																																																																																																																		
2021	AUG	236,320	6,792,140	6,792,140	67,428,570	6,248,340	6,248,340	6,248,340	67,006,960	0	0	0	0	0	0	6,792,140	0	0	0	0	6,792,140	6,792,140	118,820,440	6,248,340	6,248,340	118,820,440	0	780,120	51,180	674,830	674,830																																																																																																																																																																																																																																																																																																																		
2021	SEP	780,120	5,984,670	5,984,670	73,413,240	6,128,050	6,128,050	6,128,050	73,134,950	0	0	0	0	0	0	5,984,670	0	0	0	0	5,984,670	5,984,670	124,805,080	6,128,050	6,128,050	124,510,490	0	636,740	54,200	610,490	610,490																																																																																																																																																																																																																																																																																																																		
2021	OCT	636,740	5,924,710	5,924,710	79,337,950	6,145,680	6,145,680	6,145,680	79,280,630	0	0	0	0	0	0	5,924,710	0	0	0	0	5,924,710	5,924,710	130,656,170	6,145,680	6,145,680	130,656,170	0	415,770	35,510	628,780	628,780																																																																																																																																																																																																																																																																																																																		
2021	NOV	415,770	5,792,160	5,792,160	85,130,110	5,999,240	5,999,240	5,999,240	85,279,870	0	0	0	0	0	0	5,792,160	0	0	0	0	5,792,160	5,792,160	137,685,820	6,502,530	6,502,530	137,158,700	0	869,270	31,880	683,950	683,950																																																																																																																																																																																																																																																																																																																		
2021	DEC	208,690	6,694,310	6,694,310	91,830,110	6,643,230	6,643,230	6,643,230	91,870,870	208,690	0	660,580	6,511,320	6,612,680	-208,690	6,511,320	767,910	767,910	6,511,320	0	6,511,320	6,511,320	144,197,140	6,612,680	6,612,680	143,711,380	0	767,910	47,270	659,650	659,650																																																																																																																																																																																																																																																																																																																		

Non-Compliance leads to project and financial risks



Regulated Market	Voluntary Market
Invalid RINs or Credits	Reduced price
Financial penalties	

We Can ONLY Improve What We Measure!



Know your CI score!

Thank you!

Kristine Klavers

Managing Director, Houston

1 713 444 9700

kklavers@ecoengineers.us

www.ecoengineers.us

EcoEngineers is here to help!

Our experienced engineers, scientists, auditors, researchers, and analysts help you navigate the carbon market and monetize your carbon reduction, by knowing:

- the low-carbon fuel policies
- the innovative technologies

We deliver expertise through the entire clean energy continuum, including education, regulatory engagement, life-cycle analysis, asset development, compliance management, audit, and verification.