The Road Towards Decarbonization; Regulation, Implementation and Monetization

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www.ecoengineers.us
Thursday January 12, 2023

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About Kristine Klavers

Monetizing Carbon Reduction
Renewable Diesel

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Energy Markets

argus

NORWAY

MSc Chemical Engineering

University of Twente
The Netherlands

Patent: Methane Coupling Catalyst

東京工業大学
Tokyo Institute of Technology

MTBE Product Specialist

ARCO Chemical

Refinery Design/HAZOP

JGC JGC CORPORATION

International Fuel Quality Center
Fuel Magazine

HARTENERGY

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Presentation Topics

1. The race to “a zero-emission goal”
2. Carbon Intensity (CI) and Life Cycle Analysis (LCA)
3. Carbon markets
4. Monetization of Carbon Reduction in Downstream

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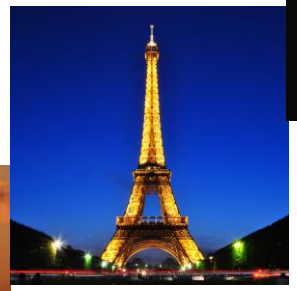
The road to zero carbon

2007

2014

2015



2018

“I want Real Zero Emissions”

2020

- Fuels & Cars +
- Green Deal
- Fit for 55
- SEC

2021/2022

- Fuel & Cars +
- Bipartisan Infrastructure Law
- Inflation Reduction Act (IRA)

2030/2050

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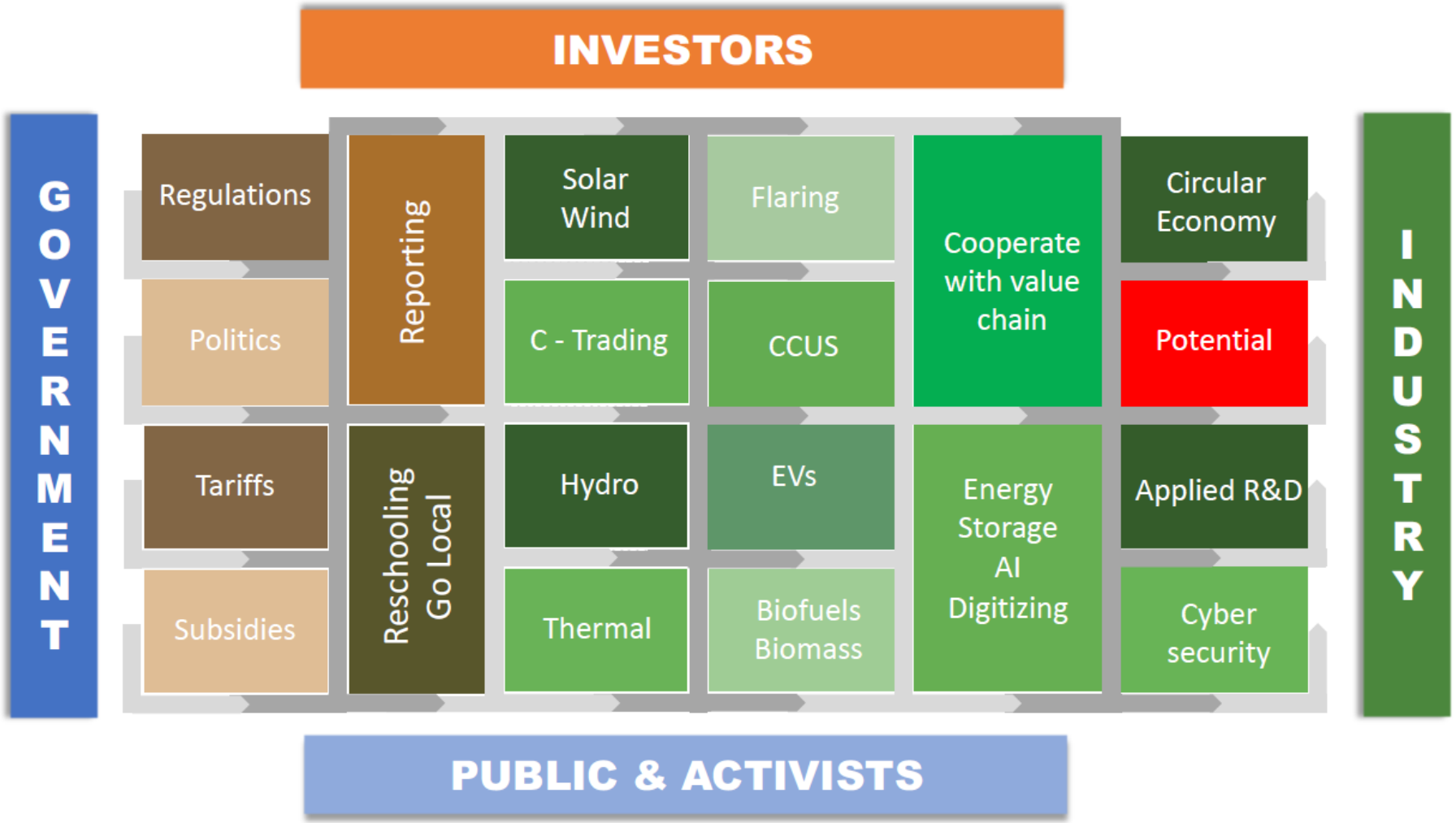
Many entities driving the industry



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Knowing your CI throughout the supply chain is KEY!

Inflation Reduction Act (IRA)

- H_2 Production Tax Credit
  - $0.60/kg + depending on lifecycle GHGs less than 0.4 kg of CO2 per kg of H2
- Clean Electricity Investment Tax Credit
  - GHG to be 25% lower than 2022
- Clean Fuel Production Credit
  - Fuels with less than 50 kg CO_2e/ mmBtu
- Sustainable Aviation Fuel Credit
  - Up to $0.50/gallon depending on life-cycle GHG

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The entire supply chain is looking at decarbonizing opportunities

ExxonMobil's GHG reduction plan

- Net 0 by 2050
- Corporatewide BY 2030
  - 20-30% reduction in CI
- Upstream by 2030
  - 40- 50% reduction in CI
- Methane BY 2030
  - 70-80% reduction in methane intensity
- Flaring
  - 60-70% reduction in flaring intensity

Amazon joins Climate pledge, net 0 carbon by 2040

FedEx $2 billions, Climate pledge, net 0 carbon by 2040

MAERSK

2030 Commitments:

- Ocean: ~50% reduction in GHG **intensity**
- Terminals: ~70% absolute reduction of GHGs

DOW®

By 2030 reduce its **net annual carbon emissions** by 5 MM tons versus its 2020 baseline (15% reduction).

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OREGON

Oregon issues $2.7M fine to electric charging company

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

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

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

January 6, 2017
By Todd Neeley DTN Staff Reporter

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*

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.

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.

Carbon Markets

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

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Carbon Markets

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

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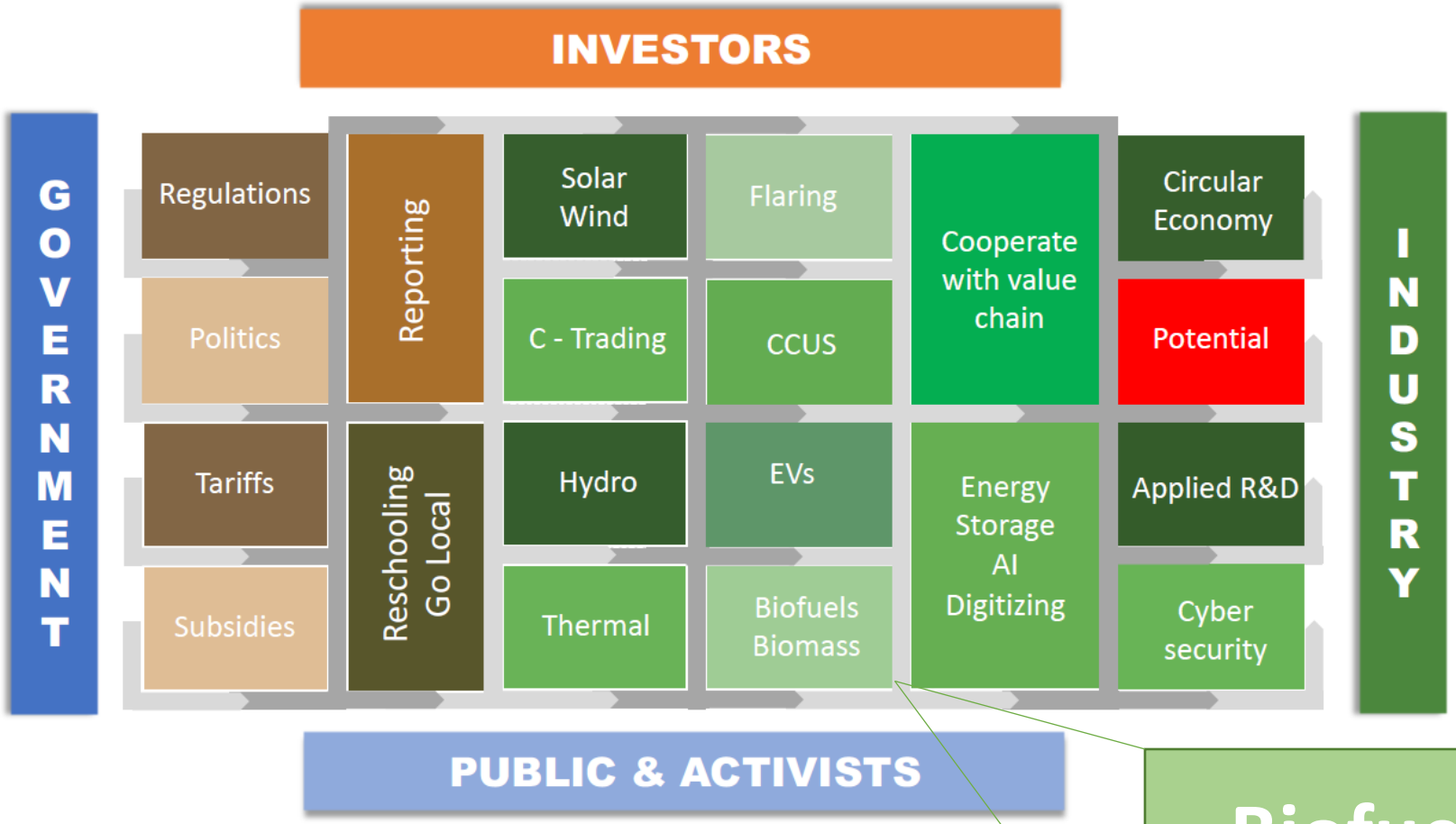
Politics & regulations driving the industry



Biofuels
Biomass

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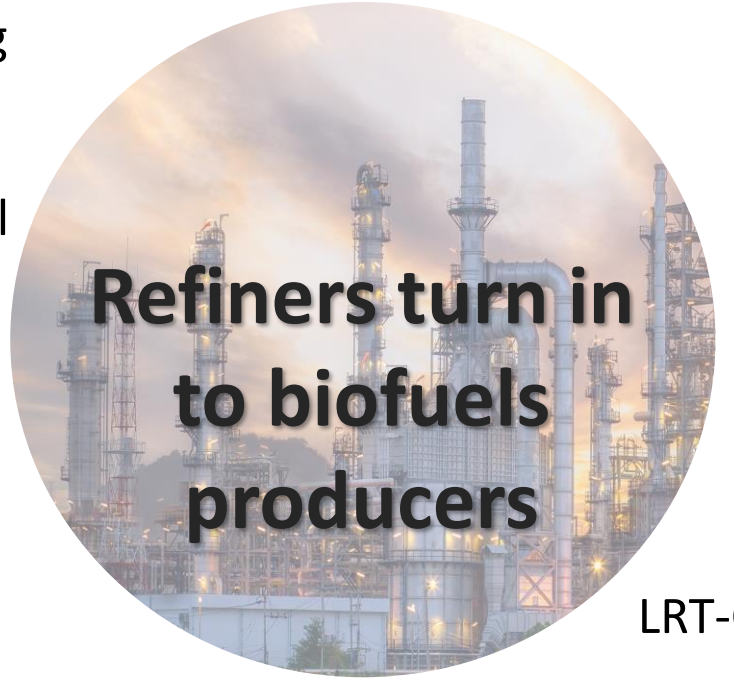
Refiners turning into carbon reducers

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

CI

RCO

Validation

Life Cycle Analysis

AFP

CA-GREET 3.0 Model

Verification

Deadlines

Temporary Pathway

LRT-CBTS

Fuel Pathway Code

Compliance Recordkeeping/Monitoring Plan

Tier 1 and Tier 2 Pathways

Annual Reporting

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Monetize Your Renewable Diesel

LCFS

$0.40 for 40 CI

D4 & D5

$2.80

Cap-and- Trade costs at the rack (CAR)

Approx. $0.25

Blender's Tax (BTC)

$1

Energy Value + $4.45 per gallon

** Prices are per gallon*

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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	▪ Corn ethanol ▪ Grandfathered	**20%**	15	Ethanol-corn starch-dry mill	$0.80-1.80
D4 D5	▪ Sugarcane ethanol ▪ Renewable diesel ▪ Biodiesel	**50%**	5	Renewable diesel-soybean-hydrotreating Naphtha-camelina-transesterification	$1.20-2.00
D3 D7	▪ Cellulosic fuels ▪ RNG/LNG	**60%**	0.63 No target is set yet	RNG-dairy-aerobic digestion	$2.50-3.50

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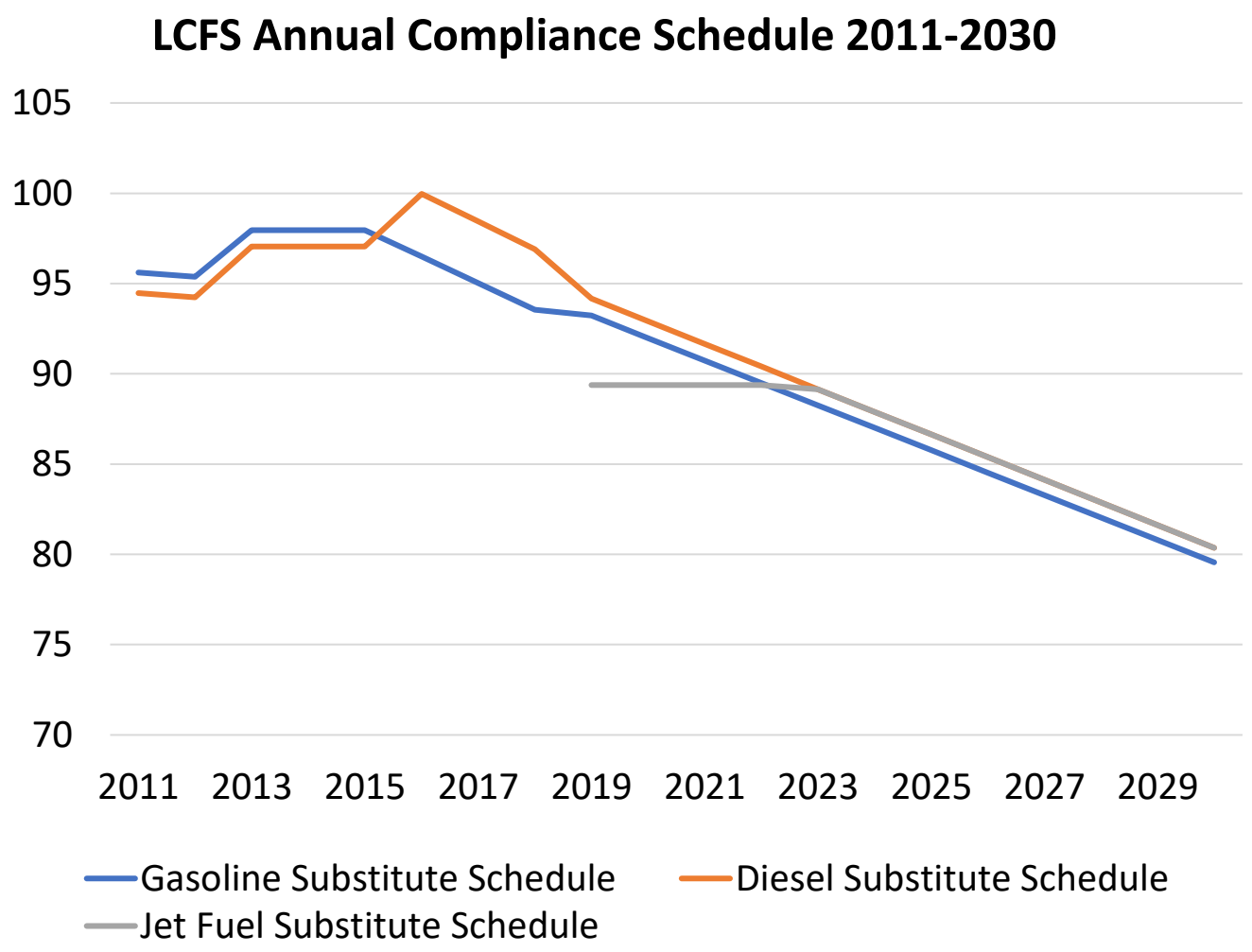
CARB LCFS
Title 17, CCR, sections 95480-95503

- 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



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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

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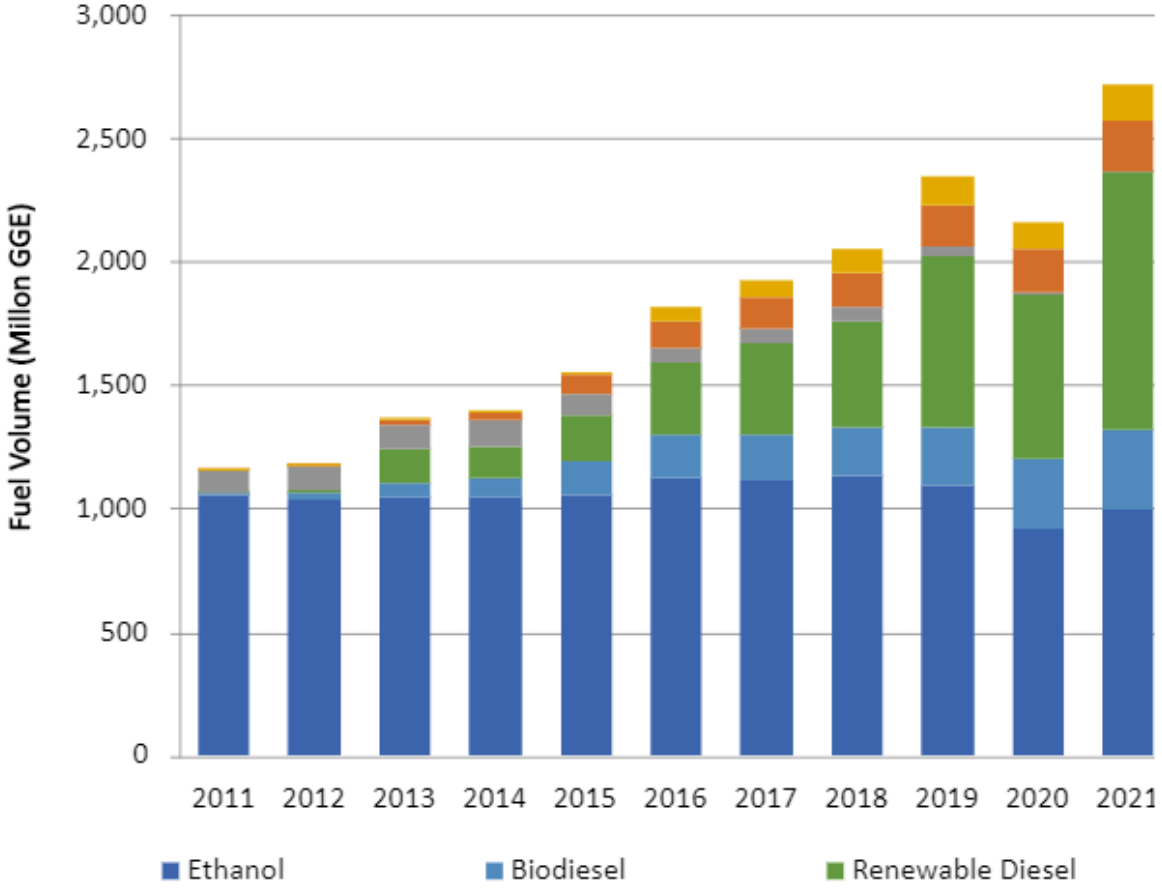
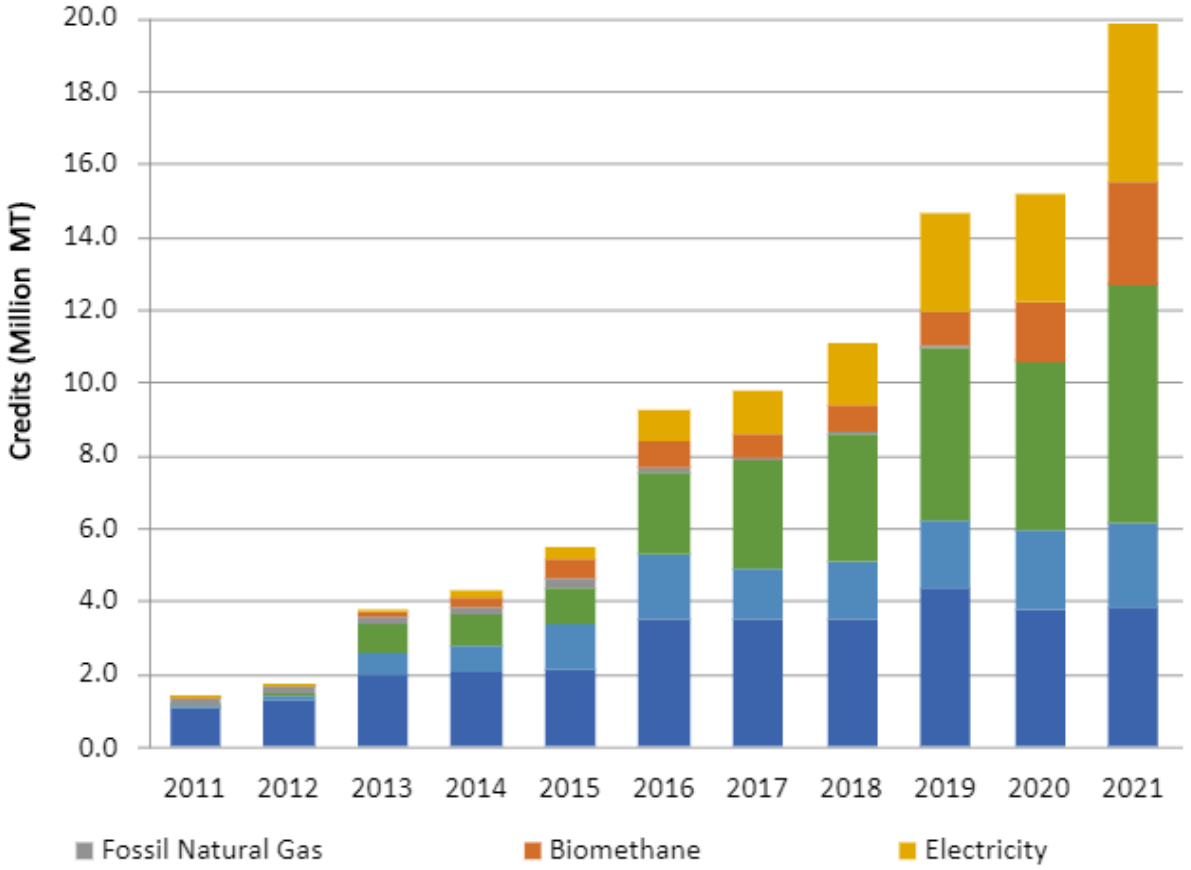
Advanced Renewables Increase Volume, Decrease CI





Source: CARB

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Know the Compliance Requirements

YEAR	MONTH	UCO CARRY-OVER (KG)	UCO INCOMING (KG)	12 MO. UCO PURCHASES (KG)	CUMULATIVE UCO PURCHASES	UCO INPUT - REPORTED (KG)	UCO INPUT - CALCULATED (KG)	12 MO. UCO INPUT (KG)	CUMULATIVE UCO INPUT	UCO LOSS (KG)	UCO SALE + OTHER USE (KG)	UCO MONTH-END STOCK (kg)	SJCO CARRY-OVER (KG)	SJCO INCOMING (KG)	SJCO INPUT (KG)	SJCO LOSS (KG)	SJCO MONTH-END STOCK (kg)	UCO + SJCO INCOMING (KG)	POIL CARRY-OVER (KG)	POIL INCOMING (KG)	POIL INPUT (KG)	POIL 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 LOSS, SALE (KG)	TOTAL FEEDSTOCK MONTH-END STOCK (KG)	MeOH CARRY-OVER (KG)	MeOH INCOMING (KG)	12 M
2020	JAN	358,450	598,310	598,310	598,310	956,760	956,760	956,760	956,760	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	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	711,660	1,200,800	1,912,460	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	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	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	0	0	0	649,620	5,637,440	6,006,710	280,350	649,620	5,637,440	5,637,440	29,981,140	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	0	0	280,350	6,438,050	6,203,430	514,970	280,350	6,438,050	6,438,050	36,419,190	6,203,430	6,203,430	36,262,670	0	514,970	40,120	700,860	700,860
2020	JUL	0	0	0	1,100,690	0	0	0	1,459,140	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	514,970	5,789,040	5,789,040	42,208,230	5,579,310	5,579,310	41,841,980	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	724,700	5,222,920	5,776,380	0	171,240	5,222,920	0	0	0	0	724,700	5,222,920	#########	47,431,150	5,776,380	#########	47,618,360	0	171,240	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	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	#########	53,311,110	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	0	561,160	0	963,810	963,810	0	0	6,097,700	0	0	0	0	624,440	6,097,700	6,097,700	59,408,810	6,160,980	6,160,980	59,189,800	0	561,160	50,690	680,420	680,420
2020	NOV	561,160	4,864,310	9,998,200	12,881,280	4,920,670	4,920,670	10,117,840	12,734,930	0	0	504,800	0	0	0	0	0	4,864,310	0	0	0	0	561,160	4,864,310	#########	64,273,120	4,920,670	#########	64,110,470	0	504,800	52,150	503,740	1,184,160
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	547,610	0	0	0	0	0	6,154,520	0	0	0	0	504,800	6,154,520	6,154,520	70,427,640	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	288,990	0	0	0	0	0	6,028,460	0	0	0	0	547,610	6,028,460	6,028,460	76,456,100	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	10,587,870	29,623,670	4,610,130	4,610,130	10,897,210	29,743,850	0	0	238,270	0	0	0	0	0	4,559,410	0	0	0	0	288,990	4,559,410	#########	81,015,510	4,610,130	#########	81,119,390	0	238,270	38,410	477,930	1,134,430
2021	MAR	238,270	6,653,070	17,240,940	36,276,740	6,408,730	6,408,730	17,305,940	36,152,580	0	0	482,610	0	0	0	0	0	6,653,070	0	0	0	0	238,270	6,653,070	#########	87,668,580	6,408,730	#########	87,528,120	0	482,610	40,640	655,440	1,789,870
2021	APR	482,610	6,169,390	23,410,330	42,446,130	6,241,900	6,241,900	23,547,840	42,394,480	0	0	410,100	0	0	0	0	0	6,169,390	0	0	0	0	482,610	6,169,390	#########	93,837,970	6,241,900	#########	93,770,020	0	410,100	34,110	653,310	2,443,180
2021	MAY	410,100	5,805,630	29,215,960	48,251,760	5,895,510	5,895,510	29,443,350	48,289,990	0	0	320,220	0	0	0	0	0	5,805,630	0	0	0	0	410,100	5,805,630	#########	99,643,600	5,895,510	#########	99,665,530	0	320,220	34,650	626,720	3,069,900
2021	JUN	320,220	5,044,710	34,260,670	53,296,470	4,916,950	4,916,950	34,360,300	53,206,940	0	0	447,980	0	0	0	0	0	5,044,710	0	0	0	0	320,220	5,044,710	#########	104,688,310	4,916,950	#########	104,582,480	0	447,980	59,540	475,260	3,545,160
2021	JUL	447,980	7,339,960	41,600,630	60,636,430	7,551,620	7,551,620	41,911,920	60,758,560	0	0	236,320	0	0	0	0	0	7,339,960	0	0	0	0	447,980	7,339,960	#########	112,028,270	7,551,620	#########	112,134,100	0	236,320	36,800	801,800	4,346,960
2021	AUG	236,320	6,792,140	48,392,770	67,428,570	6,248,340	6,248,340	48,160,260	67,006,900	0	0	780,120	0	0	0	0	0	6,792,140	0	0	0	0	236,320	6,792,140	#########	118,820,410	6,248,340	#########	118,382,440	0	780,120	51,180	674,830	5,021,790
2021	SEP	780,120	5,984,670	54,377,440	73,413,240	6,128,050	6,128,050	54,288,310	73,134,950	0	0	636,740	0	0	0	0	0	5,984,670	0	0	0	0	780,120	5,984,670	#########	124,805,080	6,128,050	#########	124,510,490	0	636,740	54,200	610,490	5,632,280
2021	OCT	636,740	5,924,710	60,302,150	79,337,950	6,145,680	6,145,680	60,433,990	79,280,630	0	0	415,770	0	0	0	0	0	5,924,710	0	0	0	0	636,740	5,924,710	#########	130,729,790	6,145,680	#########	130,656,170	0	415,770	35,510	628,780	6,261,060
2021	NOV	415,770	5,792,160	66,094,310	85,130,110	5,999,240	5,999,240	66,433,230	85,279,870	0	0	208,690	0	1,163,870	503,290	0	660,580	6,956,030	0	0	0	0	415,770	6,956,030	#########	137,685,820	6,502,530	#########	137,158,700	0	869,270	31,880	683,950	6,945,010
2021	DEC	208,690	0	66,094,310	85,130,110	0	0	66,433,230	85,279,870	208,690	0	0	660,580	6,511,320	6,612,680	-208,690	767,910	6,511,320	0	0	0	0	869,270	6,511,320	#########	144,197,140	6,612,680	#########	143,771,380	0	767,910	47,270	659,650	7,604,660

YEAR	MONTH	INCOMING (KG)	12 MO. MeOH INCOMING (KG)	CUMULATIVE MeOH INCOMING	MeOH INPUT (KG)	12 MO. MeOH INPUT (KG)	CUMULATIVE MeOH INPUT	MeOH MONTH-END STOCK (kg)	UCOME CARRY-OVER (KG)	UCOME OUTPUT REPORTED(KG)	UCOME OUTPUT CALCULATED(KG)	12 MO. UCOME OUTPUT (KG)	CUMULATIVE UCOME OUTPUT	UCOME INCOMING - TRANSFER FROM SJCOME (KG)	UCOME INCOMING - TRANSFER FROM OTHER DANSUK FACILITY (KG)	UCOME WORK IN PROCESS (KG)	UCOME OUTGOING (KG)	12 MO. UCOME OUTGOING (KG)	CUMULATIVE UCOME OUTGOING	UCOME LOSS (KG)	UCOME MONTH-END STOCK(kg)	SJCOME CARRY-OVER (KG)	SJCOME OUTPUT (KG)	SJCOME OUTGOING- SALES OR TRANSFER OUT (KG)	SJCOME OUTGOING- TRANSFER TO UCOME/BD100(KG)	SJCOME LOSS (KG)	SJCOME MONTH-END STOCK(kg)	TOTAL UCOME + SJC OUTPU
2020	JAN	577,690	577,690	576,070	576,070	576,070	46,500	294,030	918,080	918,080	918,080	918,080	0	0	0	1,212,110	1,212,110	1,212,110	0	0	0	4,520,680	4,352,210	0	0	168,470	5,438,760	
2020	FEB	609,670	1,187,360	618,690	618,690	1,194,760	37,480	0	463,690	463,690	463,690	1,381,770	0	0	0	463,690	463,690	1,675,800	0	0	168,470	1,850,420	2,018,890	0	0	0	2,314,110	
2020	MAR	628,610	1,815,970	645,400	645,400	1,840,160	20,690	0	55,399	55,399	55,399	1,437,169	0	0	0	55,399	55,399	1,731,199	0	0	0	0	0	0	0	0	55,399	
2020	APR	727,050	2,543,020	714,040	714,040	2,554,200	33,700	0	0	0	0	1,437,169	0	0	0	0	0	1,731,199	0	0	0	0	0	0	0	0	0	
2020	MAY	650,620	3,193,640	644,200	644,200	3,198,400	40,120	0	0	0	0	1,437,169	0	0	0	0	0	1,731,199	0	0	0	0	0	0	0	0	0	
2020	JUN	700,860	3,894,500	685,500	685,500	3,883,900	55,480	0	0	0	0	1,437,169	0	0	0	0	0	1,731,199	0	0	0	0	0	0	0	0	0	
2020	JUL	599,510	4,494,010	611,730	611,730	4,495,630	43,260	0	0	0	0	1,437,169	0	0	0	0	0	1,731,199	0	0	0	0	2,677,644	2,414,450	24,354	0	238,840	2,677,644	
2020	AUG	574,740	5,068,750	599,150	599,150	5,094,780	18,850	0	0	0	0	1,437,169	0	0	0	0	0	1,731,199	0	0	238,840	5,443,060	5,368,300	0	0	313,600	5,443,060	
2020	SEP	626,000	5,694,750	594,160	594,160	5,688,940	50,690	0	1,091,234	1,091,234	1,091,234	2,528,403	0	0	0	897,244	897,244	2,628,443	0	193,990	313,600	1,354,250	1,667,850	0	0	0	2,445,484	
2020	OCT	680,420	6,375,170	678,960	678,960	6,367,900	52,150	193,990	4,952,540	4,952,540	4,952,540	7,480,943	0	0	0	4,970,110	4,970,110	7,598,553	0	176,420	0	884,360	884,360	0	0	0	5,836,900	
2020	NOV	1,184,160	6,878,910	520,670	1,199,630	6,888,570	35,220	176,420	4,609,630	4,609,630	9,562,170	12,090,573	0	0	0	4,493,690	9,463,800	12,092,243	0	292,360	0	0	0	0	0	0	4,609,630	
2020	DEC	630,020	7,508,930	633,610	633,610	7,522,180	31,630	292,360	5,707,070	5,707,070	5,707,070	17,797,643	0	0	0	5,775,370	5,775,370	17,867,613	0	224,060	0	0	0	0	0	0	5,707,070	
2021	JAN	656,500	8,165,430	649,720	649,720	8,171,900	38,410	224,060	5,829,460	5,829,460	5,829,460	23,627,103	0	0	0	5,664,480	5,664,480	23,532,093	0	389,040	0	0	0	0	0	0	5,829,460	
2021	FEB	1,134,430	8,643,360	475,700	1,125,420	8,647,600	40,640	389,040	4,276,210	4,276,210	10,105,670	27,903,313	0	0	0	4,357,370	10,021,850	27,889,463	0	307,880	0	0	0	0	0	0	4,276,210	
2021	MAR	1,789,870	9,298,800	661,970	1,787,390	9,309,570	34,110	307,880	5,927,060	5,927,060	16,032,730	33,830,373	0	0	0	5,911,730	15,933,580	33,801,193	0	323,210	0	0	0	0	0	0	5,927,060	
2021	APR	2,443,180	9,952,110	652,770	2,440,160	9,962,340	34,650	323,210	5,776,100	5,776,100	21,808,830	39,606,473	0	0	0	5,913,380	21,846,960	39,714,573	0	185,930	0	0	0	0	0	0	5,776,100	
2021	MAY	3,069,900	10,578,830	601,830	3,041,990	10,564,170	59,540	185,930	5,569,830	5,569,830	27,378,660	45,176,303	0	0	0	5,593,930	27,440,890	45,308,503	0	161,830	0	0	0	0	0	0	5,569,830	
2021	JUN	3,545,160	11,054,090	498,000	3,539,990	11,062,170	36,800	161,830	4,593,510	4,593,510	31,972,170	49,769,813	0	0	0	4,585,280	32,026,170	49,893,783	0	170,060	0	0	0	0	0	0	4,593,510	
2021	JUL	4,346,960	11,855,890	787,420	4,327,410	11,849,590	51,180	170,060	7,047,270	7,047,270	39,019,440	56,817,083	0	0	0	7,030,580	39,056,750	56,924,363	0	186,750	0	0	0	0	0	0	7,047,270	
2021	AUG	5,021,790	12,530,720	671,810	4,999,220	12,521,400	54,200	186,750	5,840,260	5,840,260	44,859,700	62,657,343	0	0	0	5,957,480	45,014,230	62,881,843	0	69,530	0	0	0	0	0	0	5,840,260	
2021	SEP	5,632,280	13,141,210	629,180	5,628,400	13,150,580	35,510	69,530	5,572,250	5,572,250	50,431,950	68,229,593	0	0	0	5,390,580	50,404,810	68,272,423	0	251,200	0	0	0	0	0	0	5,572,250	
2021	OCT	6,261,060	13,769,990	632,410	6,260,810	13,782,990	31,880	251,200	5,735,990	5,735,990	56,167,940	73,965,583	0	0	0	5,562,740	55,967,550	73,835,163	0	424,450	0	0	0	0	0	0	5,735,990	
2021	NOV	6,945,010	14,453,940	668,560	6,929,370	14,451,550	47,270	424,450	5,672,860	5,672,860	61,840,800	79,638,443	0	0	0	6,097,310	62,064,860	79,932,473	0	0	0	413,800	345,670	0	0	68,130	6,086,660	
2021	DEC	7,604,660	15,113,590	666,680	7,596,050	15,118,230	40,240	0	0	0	61,840,800	79,638,443	0	0	0	0	62,064,860	79,932,473	0	0	68,130	6,283,040	6,171,510	0	0	179,660	6,283,040	

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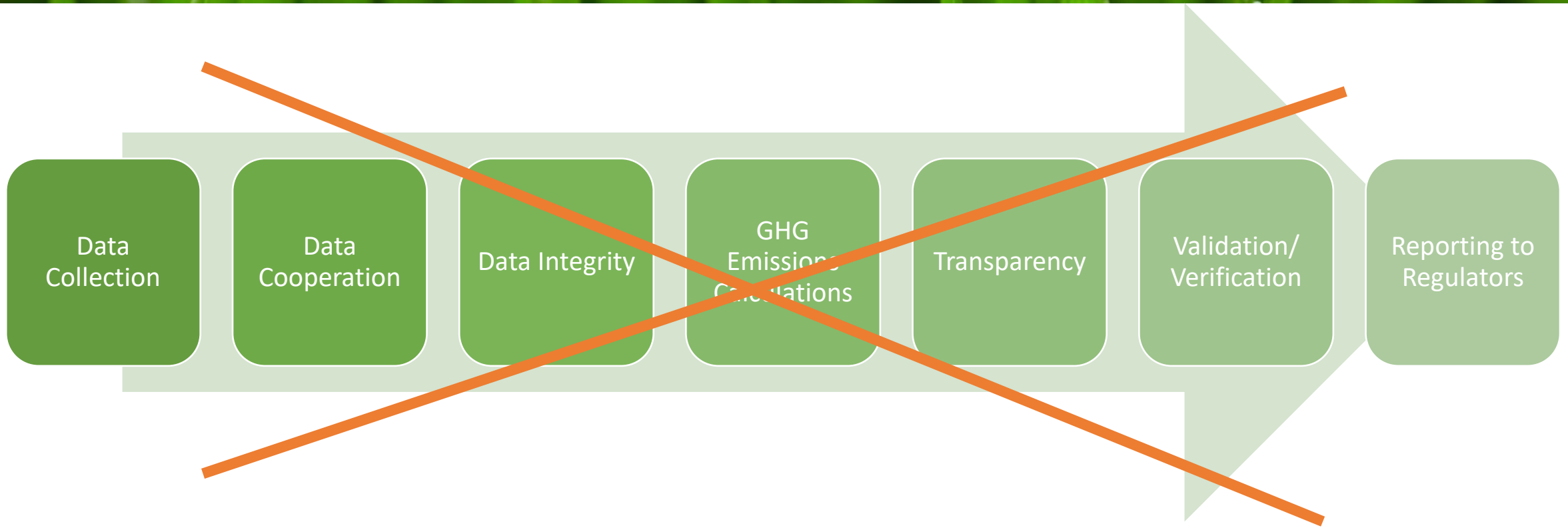
Non-Compliance leads to project and financial risks



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

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We Can ONLY Improve What We Measure!

Know your CI score!

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Thank you!

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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.

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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

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GREET covers many groups of energy systems

Petroleum Sector ▪ Conventional oil ▪ Shale oil ▪ Oil sands	▪ Gasoline ▪ Diesel ▪ Jet fuel ▪ LPG ▪ Naphtha ▪ Residual Oil	**Electric System** ▪ Electricity generation at US plant level ▪ Aggregate to national, NERC and state level ▪ With CCS	▪ Natural gas ▪ Coal ▪ Residual Oil ▪ Biomass ▪ Nuclear ▪ Hydro ▪ Wind ▪ Solar
NG Sector ▪ Conversational NG ▪ Shale gas	▪ NG end use in electric, industrial and residential sectors ▪ Transportation: CNG, LNG ▪ Alt fuels: LPG, MeOH, DME, FT diesel, FT jet	**Renewable Energy/Fuels** ▪ Ethanol ▪ Biodiesel ▪ Renewable Diesel ▪ Renewable Gasoline ▪ Renewable jet fuel ▪ Renewable NG	**1st generation feedstock** ▪ Corn, Sorghum, Soybeans ▪ Rapeseed, Sugarcane **2nd Generation feedstocks** ▪ Crop and Forest residues ▪ MSW, Animal Wastes **Algae**
Hydrogen Economy ▪ Gaseous H2 ▪ Liquid H2 ▪ With CCS	▪ Natural gas ▪ Biomass ▪ Coal ▪ Petroleum coke ▪ Coke Oven gas ▪ Electrolysis with electricity ▪ Nuclear energy	**Renewable H2 via electrolysis** ▪ Wind ▪ Solar ▪ Nuclear	**Electro Fuels** ▪ Gasoline ▪ Diesel ▪ Jet fuel ▪ Methanol

Source: DOE

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