Emissions Benefits & Sustainability Considerations of Corn-Based Ethanol and Ethanol to Jet Pathways

Presentation to Japan Delegation

Steffen Mueller; PhD
Principal Economist
University of Illinois Chicago
Energy Resources Center

Tokyo, Japan
December 2025

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About the University of Illinois Chicago (UIC)

33,522
students.

4,099
professionals.

16
colleges.

$509 M
in sponsored awards received.

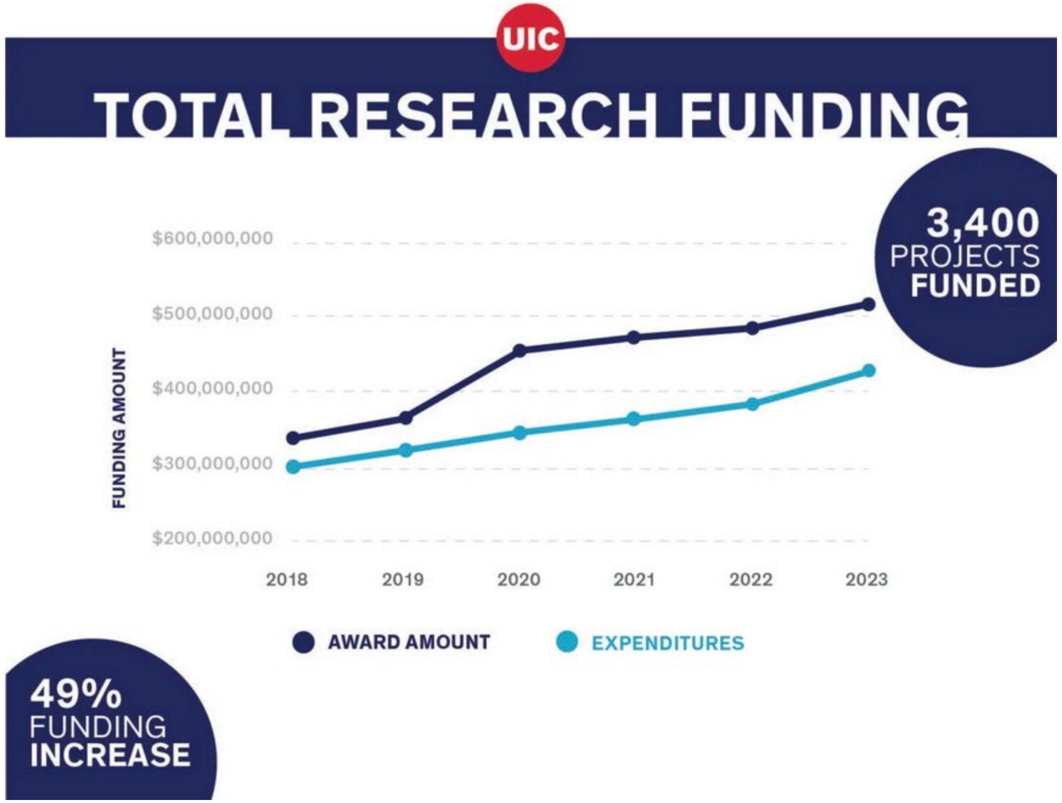
$418 M
in research expenditures.

3,451
research awards received/

11%
funding increase since 2022.

49%
funding increase since 2018.

74%
of total funding came from federal sponsors.



Note: From fiscal year 2023.

"Surpassing the half-billion-dollar milestone in research funding is a clear marker of the exceptional research program at the University of Illinois Chicago and the vitality of our mission to create knowledge that transforms the world. The funding also reflects our commitment to creating positive and enduring impact in science and society."

Marie Lynn Miranda | Chancellor, University of Illinois Chicago

ENERGY RESOURCES CENTER

UIC's Energy Resources Center (ERC) at the College of Engineering

Established in 1973 as an energy advisor to the State of Illinois and City of Chicago

Today, the ERC is an applied research center, based out of the UIC College of Engineering, with a focus on **clean energy and environmental sustainability solutions** providing education and technical assistance services

40 team member staff (50:50 staff-to-student ratio) with advanced degrees in engineering, business, and policy and various professional certifications, including Professional Engineer, CEM, LEED, etc. ERC **regularly utilizes 10+ consultants & contractors** per year.

ERC's **annual operating budget averaged $4.5M** over past 10 years, **~97% soft funded.**

Presentation Overview

- Current Corn/Ethanol Production Review
- Corn Ethanol and Ethanol to Jet LCA 101
  - Main Drivers of Differences in Biofuel Carbon Score
  - Different Policies – Different LCA Results
  - Induced/Indirect Land Use Change
- Ethanol int Road Transportation
- Ethanol into SAF
  - Global Biofuels Policies and their Sustainability and Fuel Certification Requirements
  - SAF United States Updates
  - SAF CORSIA Updates
- Ethanol into Maritime Fuels
- Beyond Greenhous Gas Benefits of Corn Ethanol:
Aromatics Reductions with Ethanol Blended Gasoline

Current Corn / Ethanol Snapshot as of 2025

Current Snapshot: Record 2025 Corn Crop

USDA AGRICULTURE COUNTS

Crop Production

ISSN: 1936-3737

Released November 14, 2025, by the National Agricultural Statistics Service (NASS), Agricultural Statistics Board, United States Department of Agriculture (USDA).

Corn production for grain is forecast at 16.8 billion bushels, down less than 1 percent from the previous forecast but up 12 percent from 2024. If realized, this would be the highest grain production on record for the United States. Based on conditions as of November 1, yields are expected to average a record high 186.0 bushels per acre, down 0.7 bushel from the previous forecast but up 6.7 bushels from last year. Area harvested for grain is forecast at 90.0 million acres, unchanged from the previous forecast but up 8 percent from the previous year.

November 14, 2025

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Main Product Yields from Corn

Mueller provided one of the original ethanol efficiency survey. This data has been continuously updated by other groups.

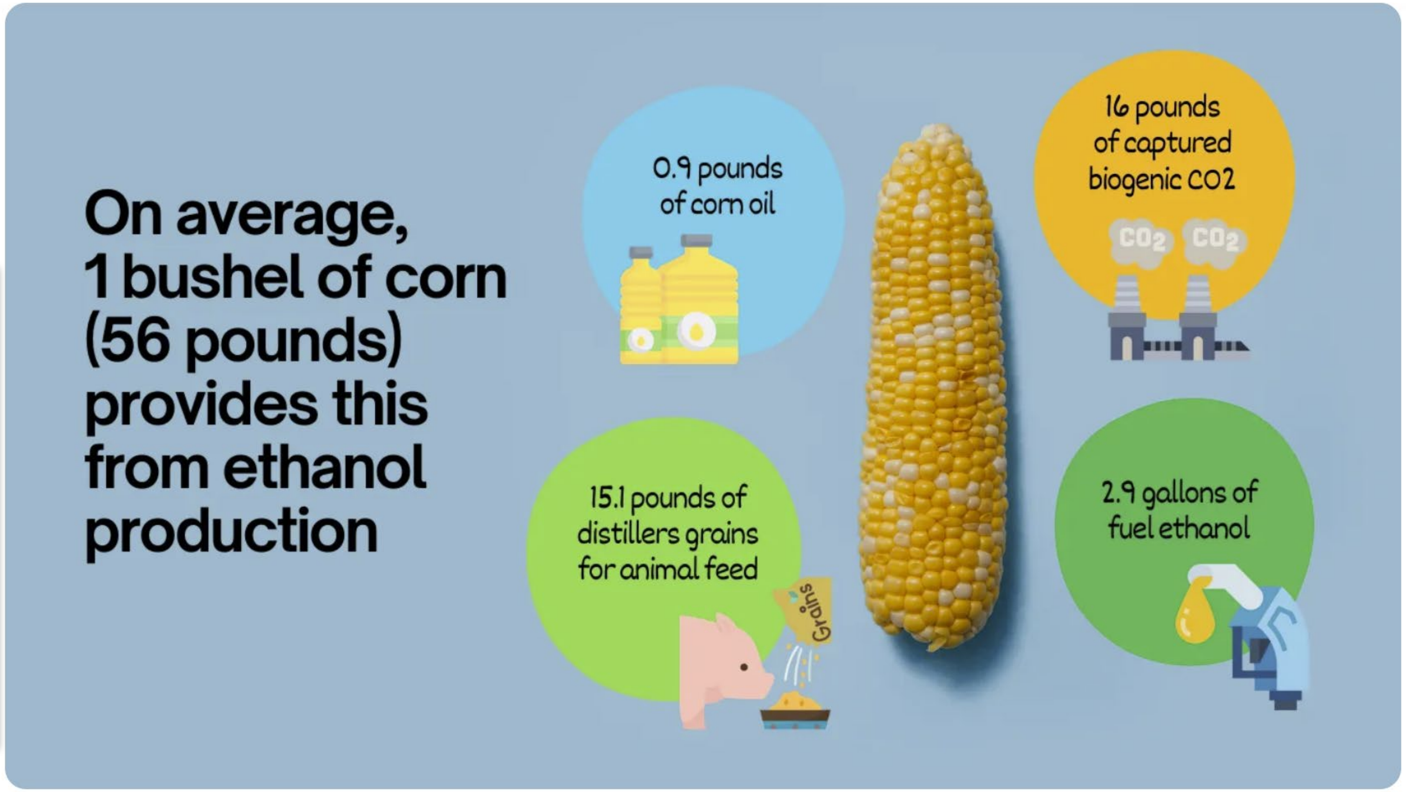
Biotechnol Lett
DOI 10.1007/s10529-010-0296-7

ORIGINAL RESEARCH PAPER

2008 National dry mill corn ethanol survey

Steffen Mueller

Current Data from Nebraska Ethanol Board



Future of Corn: Increased Resiliency to Adverse Weather

"The sustainable intensification of crop production provides more output with similar or fewer inputs, and therefore helps to produce food, feed, fiber, and fuel more efficiently. While short-stature maize (Zea mays L.) hybrids have been shown to be more climate resilient, with reductions in yield-scaled greenhouse gas production due to reduced crop damage during wind events, other aspects of the climate impact of short-stature maize remain to be quantified."

Short-stature maize systems reduce carbon intensity of grain production by an average of 13% compared to commercially relevant tall comparators

Frank G. Dohleman, Ty Barten, Kevin R. Kosola, Mark Reiman, Mike Petersen, Jeff Tichota, Ross Recker, Devin J. Hammer, Adam Gold, Brian Olson, Thomas Orr, Steffen Mueller

First published: 19 November 2025 | https://doi.org/10.1002/jeq2.70097

Published November 19, 2025
Mueller Co-Author

Corn Ethanol and Ethanol to Jet LCA 101

Greenhouse gases, Regulated Emissions, and Energy use in Technologies Model

- Life cycle analysis (LCA) is a framework for assessing the environmental impacts associated with all stages of the supply chain of a technology or product
- For transportation, a main LCA metric is the Carbon Intensity (CI) or "gCO_2e emitted per megajoule" of the produced fuel (e.g. ethanol, ETBE, blended fuels such as E10, E!5, SAF)
- Important LCA model in the United States and increasingly globally: The U.S. Department of Energy's Argonne National Laboratory GREET® (Greenhouse gases, Regulated Emissions, and Energy use in Technologies) life cycle analysis (LCA) model
- Emissions along the fuel's production pathway are added up including:
    - Main product emissions with credits for co-products
    - Emissions from direct and indirect effects
- **Ethanol to ETBE (used in Japan) = emissions from ethanol production + emissions from conversion of ethanol into ETBE**
- Ethanol to jet pathway = emissions from ethanol production + emissions from conversion of ethanol into jet fuel + emissions from induced use change (iLUC)

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Where is the GREET Model Used

Informing Policies and Regulations

- **California-GREET** is an adaptation of Argonne's GREET model
- **Oregon Clean Fuels Program** also uses an adaptation of Argonne's GREET model
- **U.S. EPA** uses GREET with other sources for **Renewable Fuels Standard** pathway evaluations
- **National Highway Traffic Safety Administration** for fuel economy regulation
- **Federal Aviation Administration** and **International Civil Aviation Organization** using GREET to evaluate aviation fuel pathways
- **USDRIVE** Well-to-Wheels Report
- **U.S. Maritime Administration -** renewable marine energy options for IMO GHG intensity and sulfur limits
- **U.S. Dept. of Agriculture bioenergy LCA** and carbon intensity of farming practices
- **Canadian Clean Fuel Standard** for Environment and Climate Change Canada fuel pathways
- LCA results for use in different provisions of the 2021 Bipartisan Infrastructure Bill and the 2022 Inflation Reduction Act

Also, GREET data was used in part for the Japan Biofuels Policy life cycle modeling efforts

Life Cycle Boundaries and Metrics of Biofuels Production

Ag Phase of Life Cycle Emissions: LCA metric is gCO_2e emitted per quantity (e.g. bushel or ton) of ag product
1) Crop Inputs: Farming/tractor fuel/irrigation energy, Emissions from Seed Production, Nitrogen fertilizer, Field emissions from N fertilizer and biomass, P2O5,K2O, CaCO3, Herbicide, Pesticides
2) Direct land use emissions (change in crop rotations, above and below ground carbon effects)
3) Induced (indirect) land use emissions (conversion/reversion of natural lands, above and below ground carbon effects, double/cover crops)

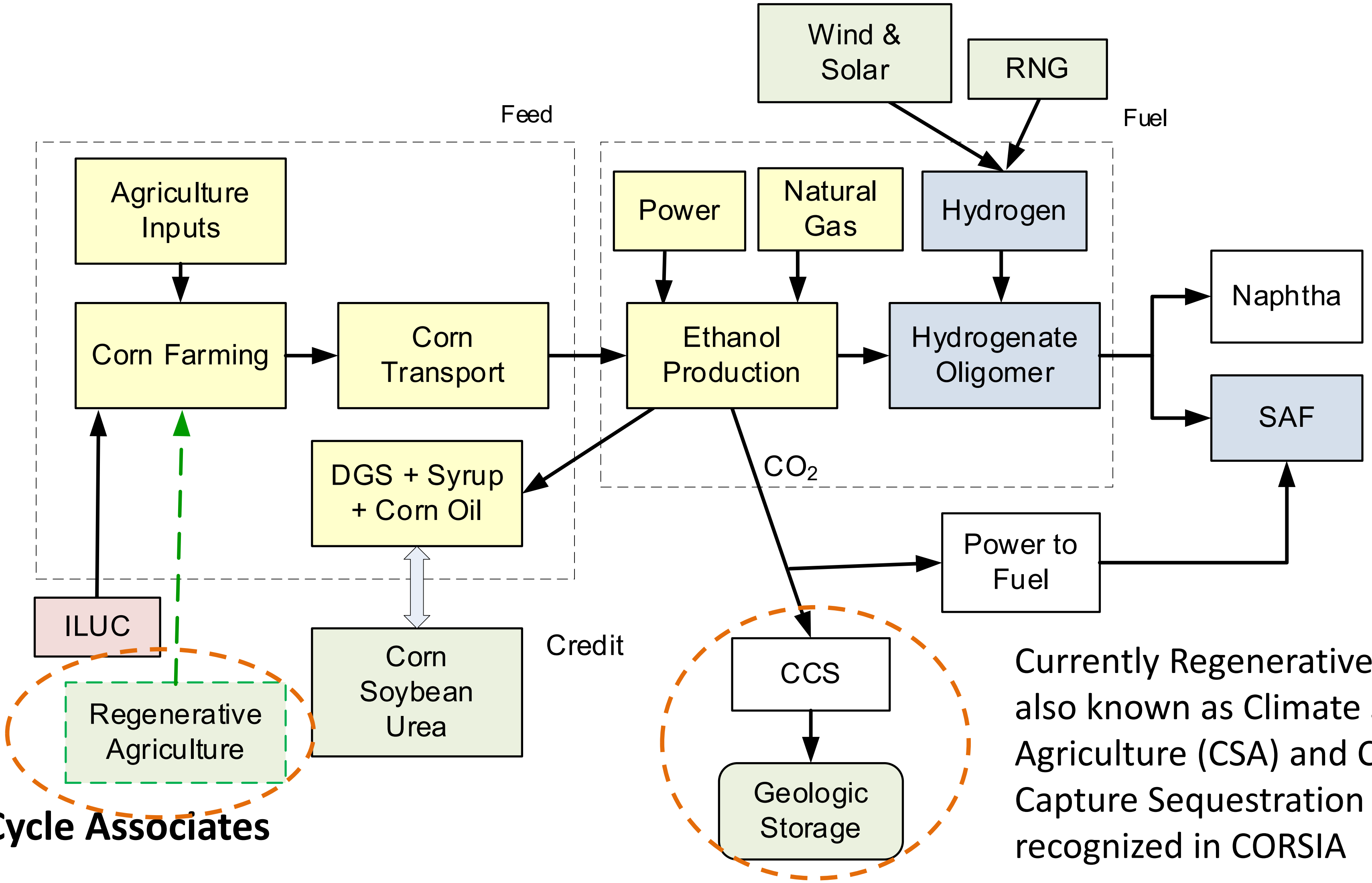
Ag Feedstocks into Bioproducts Value added upgrade of ag product such as biofuels or biopolymers: LCA metric is gCO_2e emitted per MJ or ton of bioplastics.
4) Fuel Production from Ag Feedstocks (e.g Biodiesel, Corn Ethanol Productions, Bioplastics)
If to corn ethanol the LCA metric is gCO2e per mega joule of biofuel produced
Add emissions of the corn ethanol plant (e.g. emissions from thermal energy to cook corn)
5) Additional Conversions e.g. Corn Ethanol to Jet Sustainable Aviation Fuel (SAF). Requires oligomerization, hydrogenation; produces additional co-products
6) Comparative LCAs e.g. corn ethanol blended fuels compared to electric vehicles: Metric is gCO2e per mile or gCO2e per kilometer

LCA Modeling Example:
Corn to Ethanol and Ethanol to SAF

Emissions along the fuel's production pathway are added up including:

- Main product and co-product
- Direct and indirect effects

iLUC or induced land use change is highly debated indirect effect. Accounts for emissions associated with land use responses from a biofuels policy



Currently Regenerative Agriculture also known as Climate Smart Agriculture (CSA) and Carbon Capture Sequestration (CCS) are not recognized in CORSIA

Source: Life Cycle Associates

DDG is Often More Valuable Thank Corn

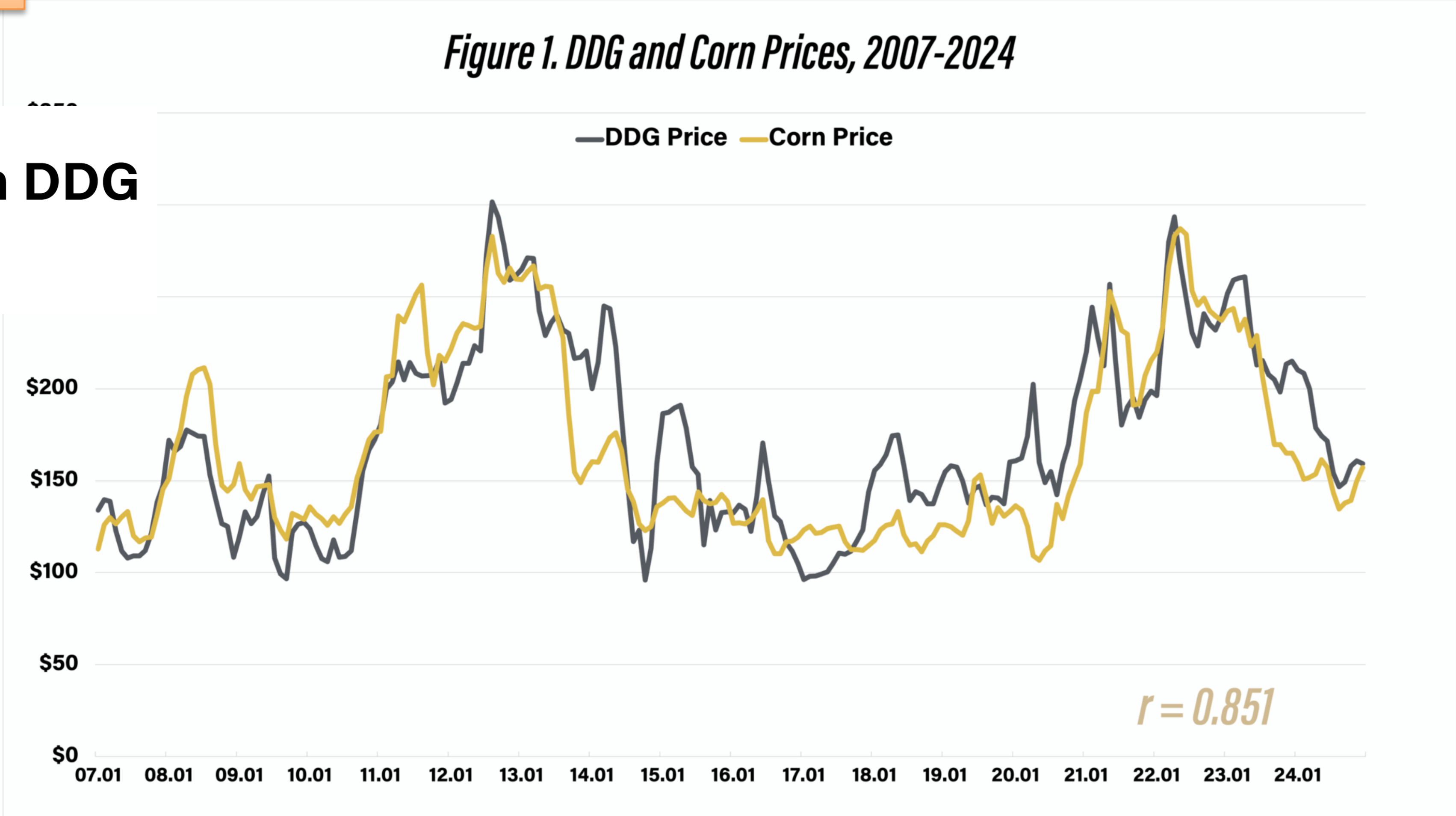
November 5, 2025

November 5, 2025

Explaining Fluctuations in DDG Prices

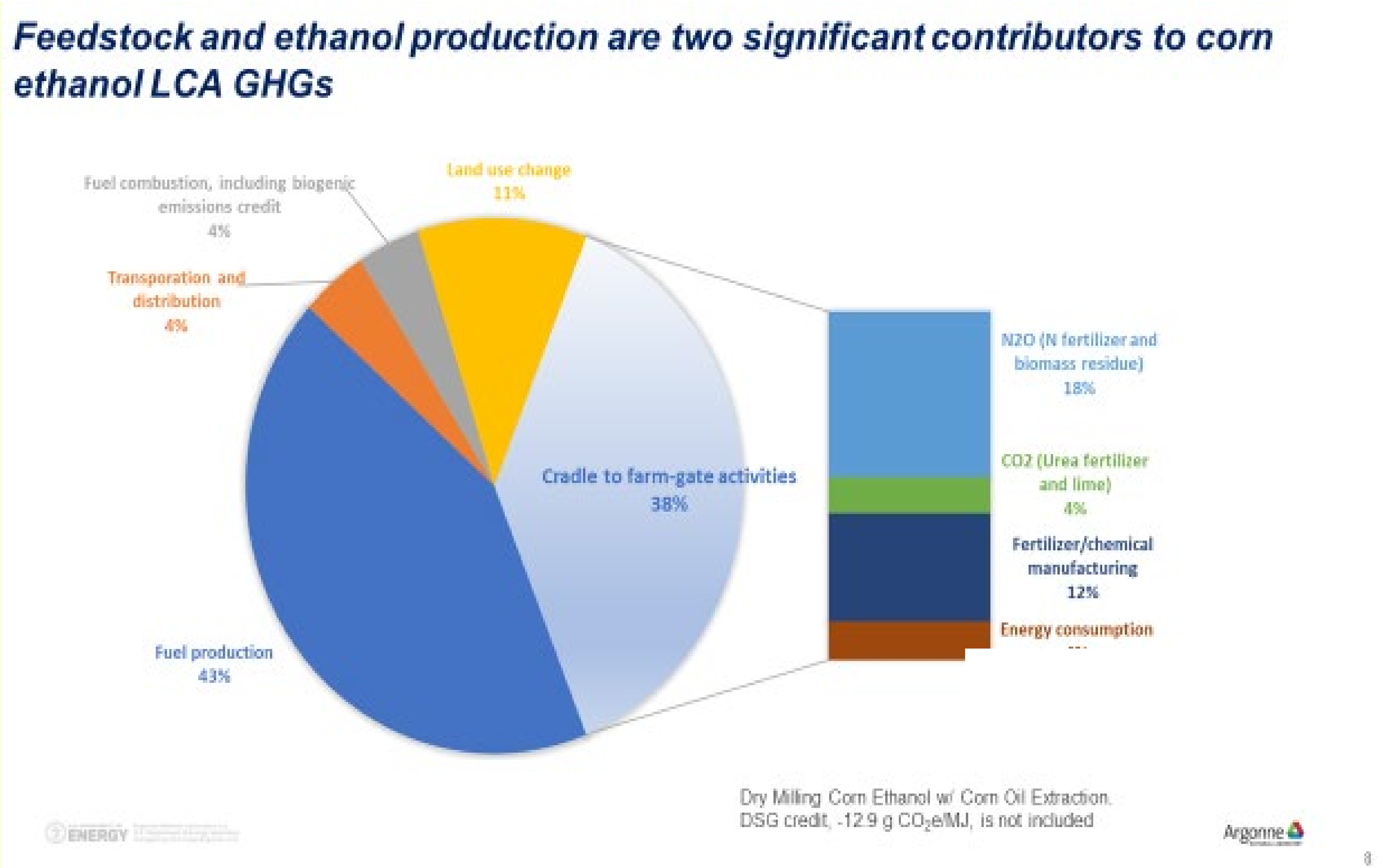
by Michael Langemeier

PURDUE UNIVERSITY | Center for Commercial Agriculture



GREET Corn Ethanol GHG Study

US Average for Corn Production: ~6,300 grams CO_2 per bushel, which converts to 27 grams CO_2 per mega joule of ethanol biofuel.



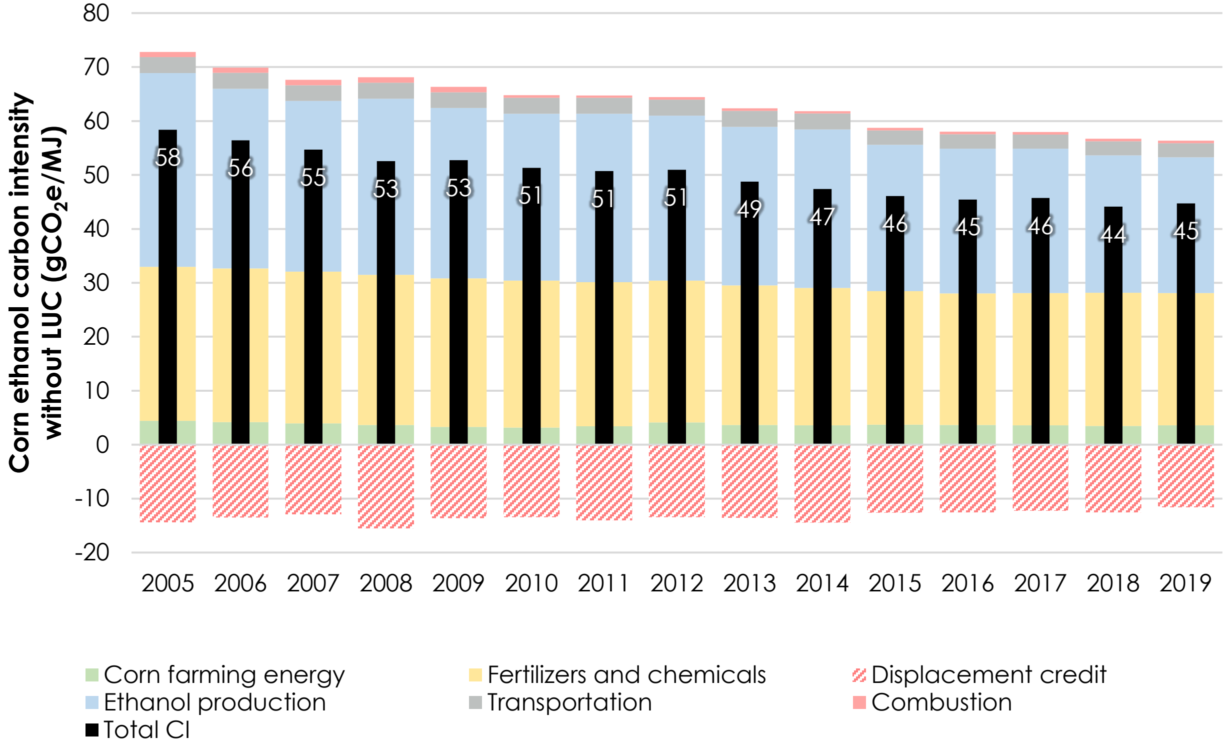
Main Drivers of Differences in Biofuel Carbon Score

Main Drivers of Differences in Biofuel Carbon Score

- Carbon score unit is grams CO_2 emitted per megajoule of fuel (gCO_2/MJ)
    - Petroleum based aviation fuels have carbon score between 84-89 gCO_2/MJ
    - Ethanol-to-Jet can be much lower depending on production method
- Key Drivers of Carbon Score for Biofuels/SAF
    - How the crop feedstock is grown. Opportunities to reduce carbon score via Climate Smart Agriculture (CSA)
        - E.g. Cover crops, optimized nitrogen use, conservation tillage, N-inhibitors
    - How Corn is Converted into Ethanol:
        - Use of Renewable Electricity
        - Use of Renewable Natural gas
        - Carbon Capture Sequestration & Utilization (CCSU) of fermentation CO_2 at the ethanol plant (New Developments)
        - Drying of animal feed co-product (dried distillers grains - DDG) or not drying (wet distiller grains – WDG)
    - Updates to induced land use change (iLUC) modeling
        - Updated GTAP/Purdue University iLUC model

US Ethanol Feedstock Production: Continuously Decreasing CI of Ethanol

- Corn ethanol CIs have decreased over the last 15 years by 23%
- Ethanol production-related emissions have decreased 30%
- Corn farming shows reductions in GHG, 15%



Modeling and Analysis

Biofpr

Retrospective analysis of the U.S. corn ethanol industry for 2005–2019: implications for greenhouse gas emission reductions

Uisung Lee, Hoyoung Kwon, May Wu, Michael Wang, Systems Assessment Center, Energy Systems Division, Argonne National Laboratory, Lemont, IL, USA

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Different Policies – Different LCA Results

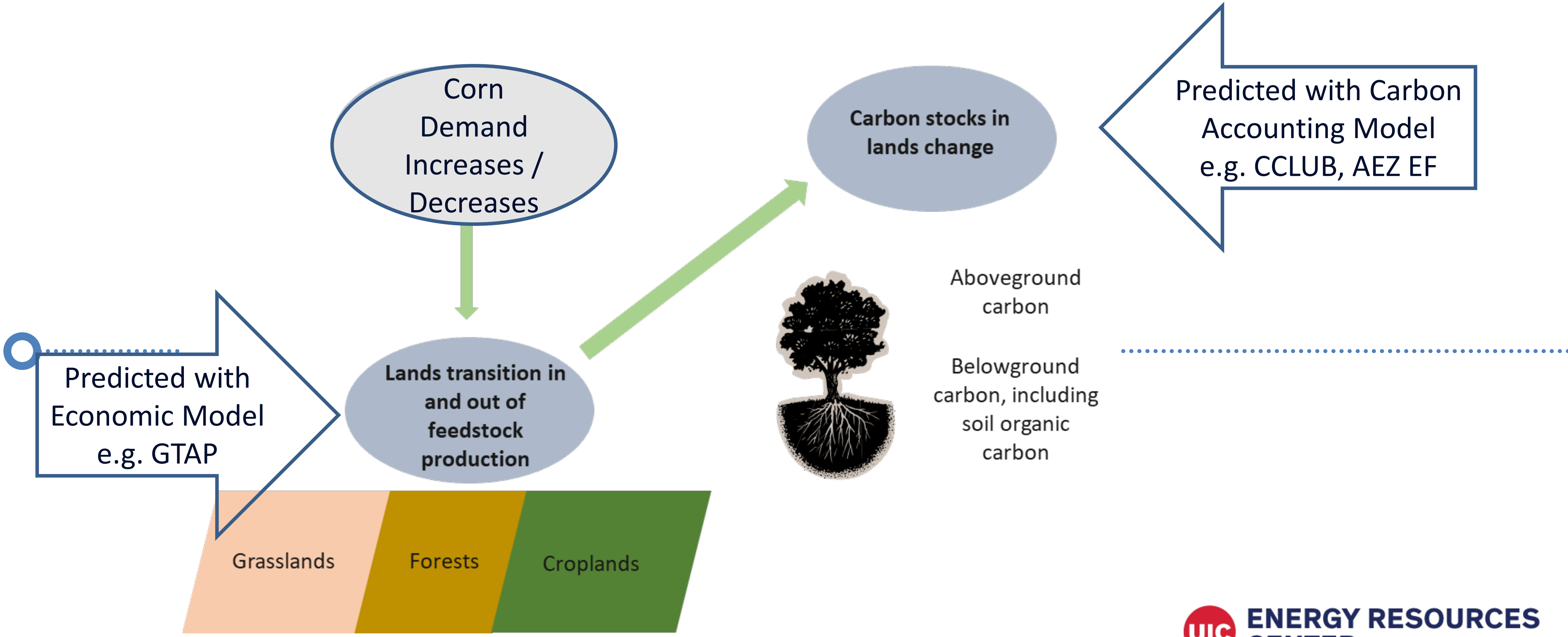
Different Policies – Different LCA Results

	California LCFS	European Union Renewable Energy Directive	USA 45Z Tax Incentive Program	Japan Biofuels Policy	CORSIA Sustainable Aviation Fuel Policy
LCA Model Used	California GREET Version	Various Models, final value approved by Certification Schemes	Version of GREET	Japan own LCA modeling work with information from GREET databases	Mix of European and GREET LCA model
Indirect Land Use Change Included	Yes	No	No	No	Yes
How is Credit for Coproducts Calculated	Based on what coproducts substitute	Based on energy content of coproducts	Based on what coproducts substitute	Based on energy content of coproducts	Based on energy content of coproducts
Does Policy Provide Default Value for Corn Ethanol or Individual Value for each Ethanol Plant	Individual Value calculated for each ethanol plant.	Ethanol LCA value for individual plant must be below minimum reduction threshold set by the policy relative to gasoline. Approval by certification schemes.	Individual Value calculated for each ethanol plant.	Aggregate ethanol supply must meet minimum reduction threshold set by the policy relative to gasoline.	Individual Value and Default Value. Individual Values must be approved by Certification Scheme.

Indirect Land Use Change

Induced Land Use Change (iLUC) Modeling & Carbon Accounting

Combine economic models with carbon accounting models



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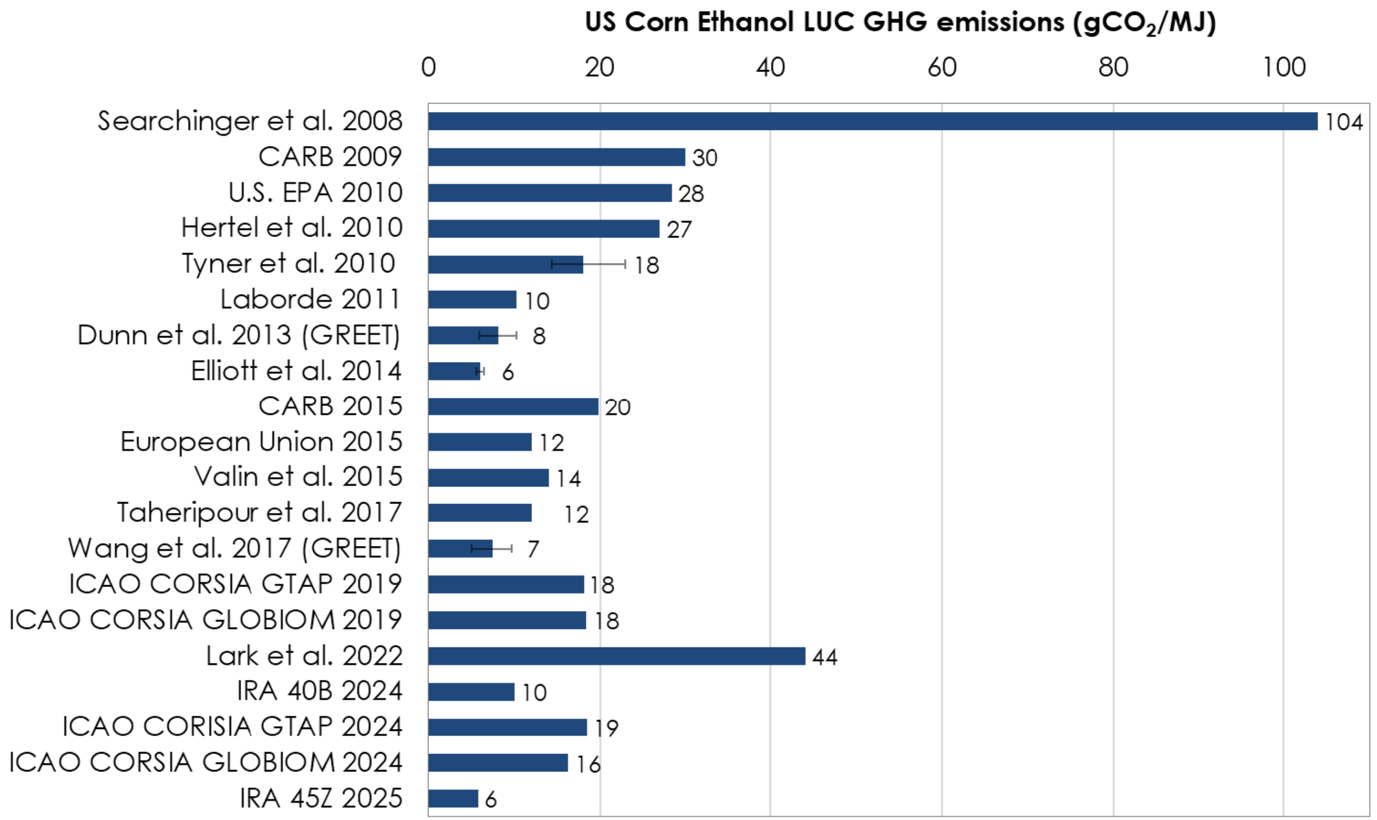
The LUC GHG emissions from large-scale ethanol production have been simulated since 2008

- Induced LUC is defined as the shift in land use and land cover (e.g., forest and grassland) that could accompany large-scale feedstock production in cropland to produce biofuels
  - Economic models simulate the scenarios of biofuel production volume shocks to estimate LUC
  - The estimated LUC area is multiplied by “emission factors” (EF, CO2e emitted per unit area)
  - EFs can be modeled using simple and/or sophisticated modeling frameworks
- The down trends in estimated LUC emissions are a result of better developed, calibrated economic models to incorporate up-to-date data



Ethanol in Road Transportation Fuels

Comparison of GHG Emissions from Different Fuel / Vehicle Combinations

Life Cycle Emissions of Electric Vehicles

- LCA of Electric Vehicles depends largely on resources used for electricity generation.
  - EVs charged largely on coal generated electricity do not have significant savings over gasoline
  - Large EV deployment may require increased dispatch of marginal electric generating resources. In the US the marginal resources are often still oil, nautral gas, or coal fired peaking plants.
- Note: Significant coal fired generation capacity in Japan

Table 1. Japan's energy overview, 2021

	Coal	Natural gas	Petroleum and other liquids	Nuclear	Renewables
Primary energy production (quads)	<0.1	0.1	<0.1	0.6	1.8
Primary energy production (percentage)	<1%	4%	<1%	24%	71%
Primary energy consumption (quads)	4.6	4.2	6.9	0.6	1.8
Primary energy consumption (percentage)	25%	23%	38%	3%	10%
Generation (billion kWh)	286.5	373.0	30.7	~~61.2~~27.3	167.8
Generation (percentage)	32%	42%	3%	3%	19%

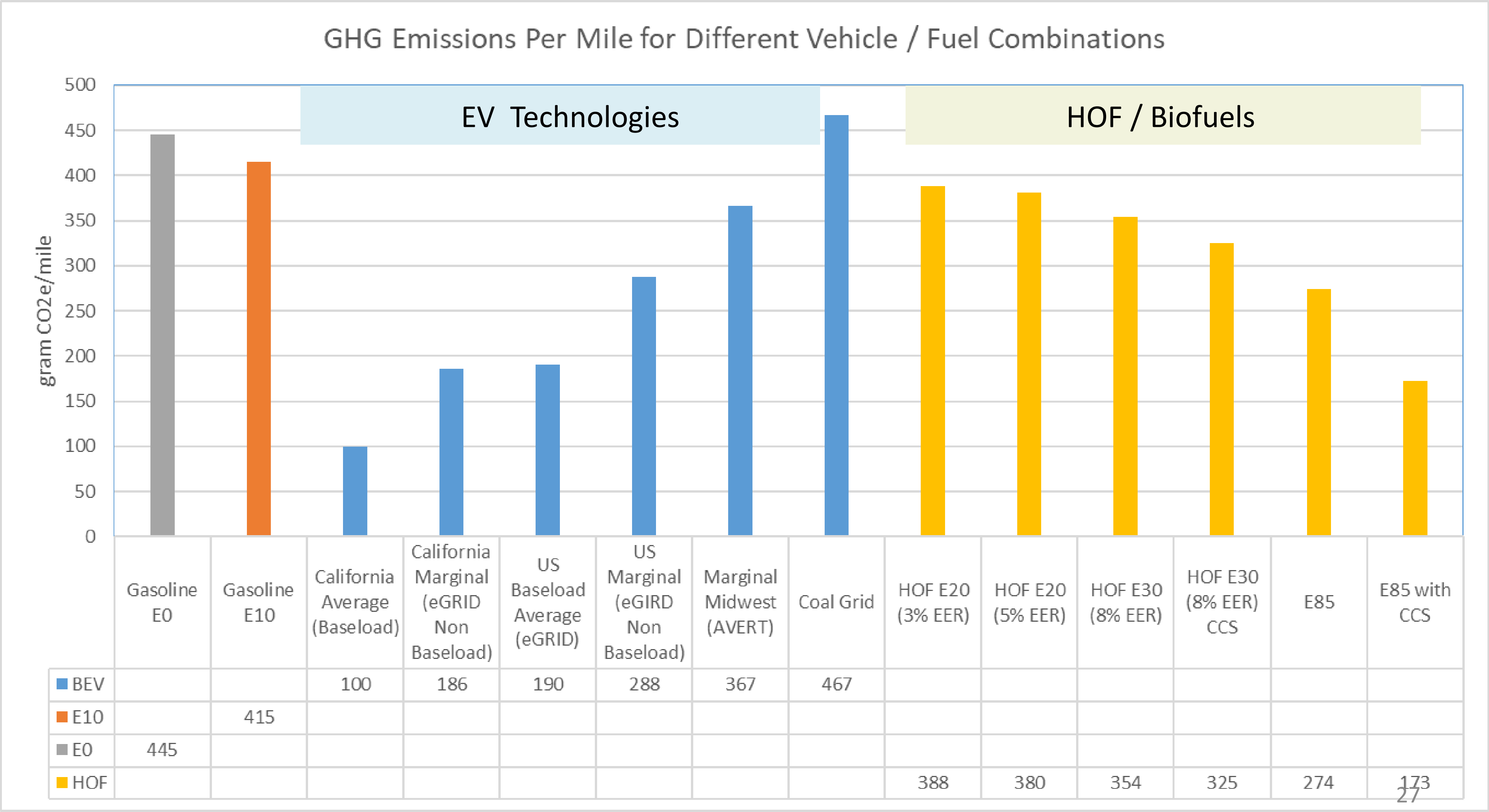
Data source: U.S. Energy Information Adminstration, International Energy Statistics and estimates

GHG Emissions Comparison: Gasoline and EV and Biofuels

EV Vehicles provide small benefit in coal-dominated electricity grid

HOF = High Octane Low Carbon Fuel

CCS = Carbon Capture& Sequestration

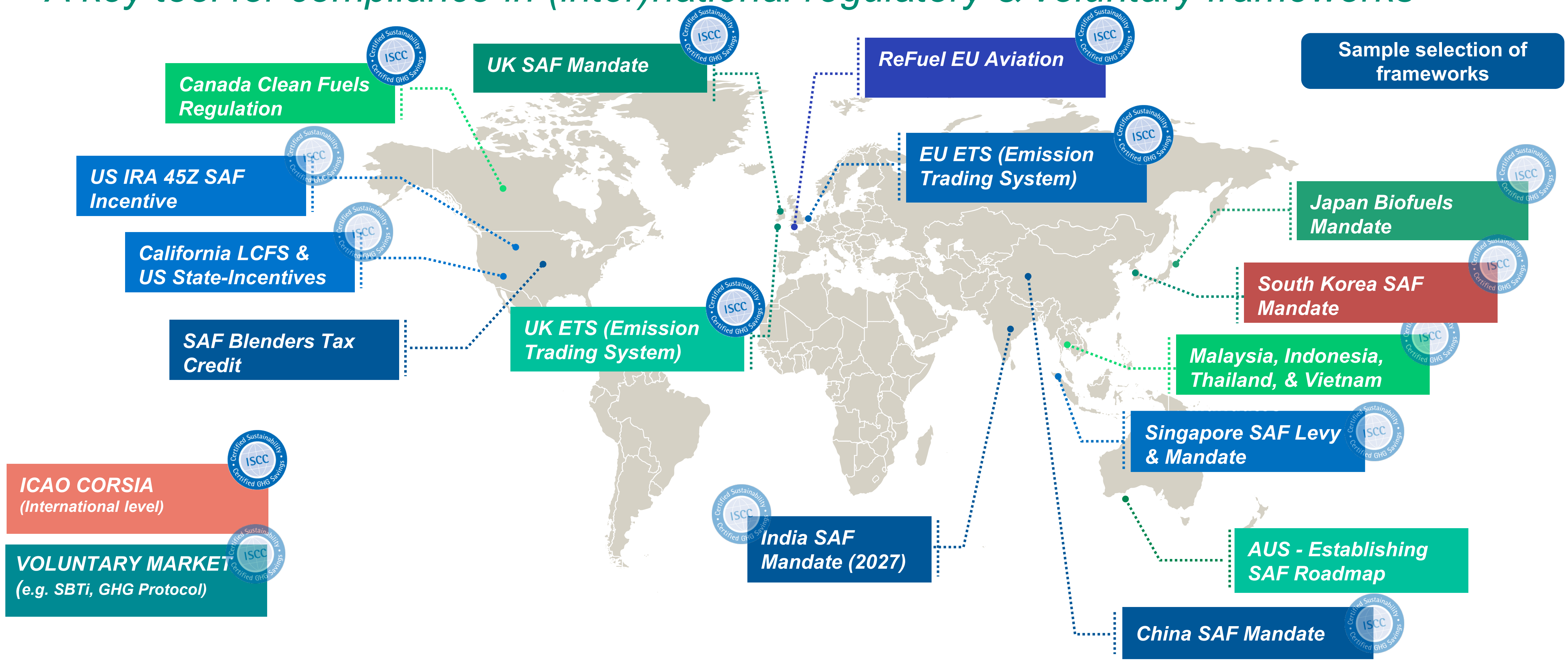


Ethanol to Jet Sustainable Aviation Fuels

Review of Biofuels Policies and their Sustainability and Fuel Certification Requirements

Powering SAF Sustainability Through Certification

A key tool for compliance in (inter)national regulatory & voluntary frameworks



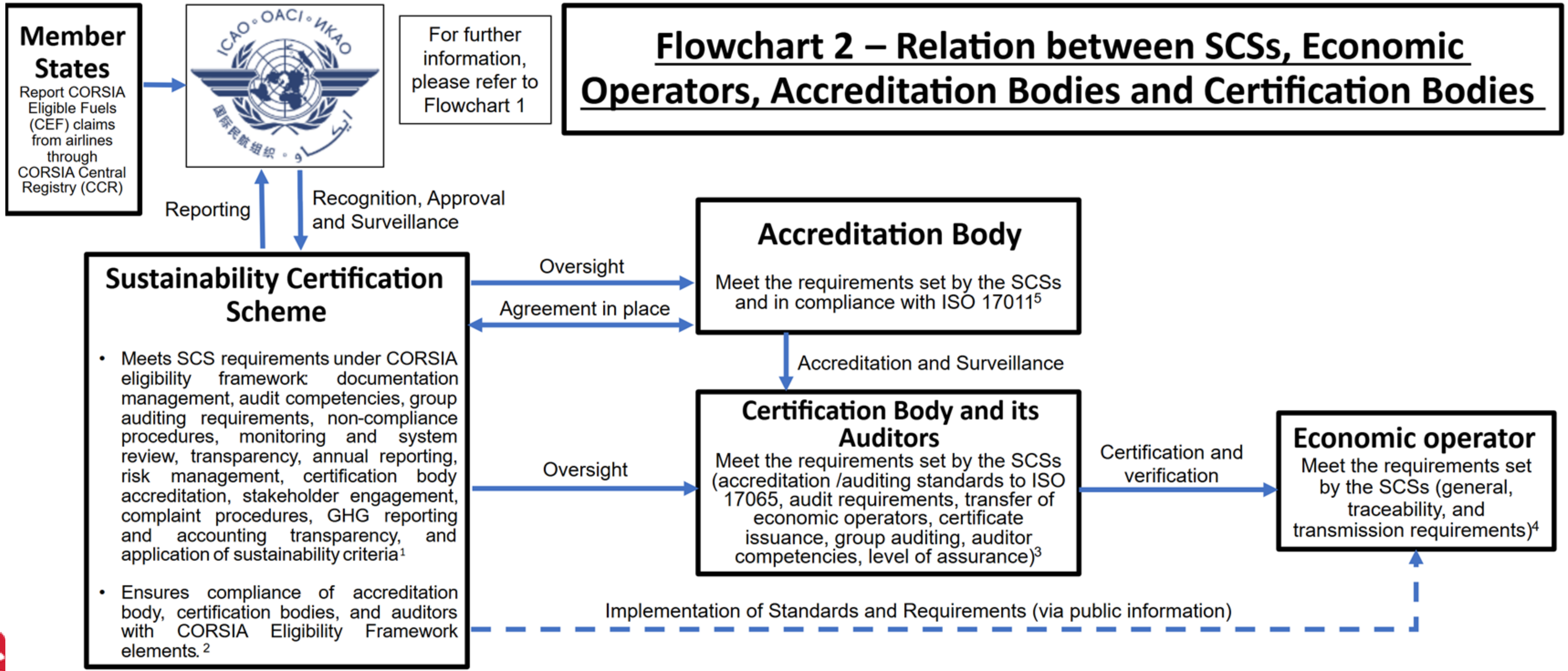
= recognition in place

= certification supporting

Example CORSIA: Interaction Between Parties

- In the context of the ICAO Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA), an aeroplane operator can reduce its CORSIA offsetting requirements in a given year by claiming emissions reductions from the use of CORSIA Eligible Fuels **(CEF).**
- In order to become eligible, such fuels shall come from fuel producers that are certified by a Sustainability Certification Scheme (SCS) approved by the ICAO Council to perform this certification.

Example CORSIA: Interaction Between Parties



Certification Schemes Approve Actual GHG Values

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Eligible to certify CORSIA eligible fuel economic operators for compliance with the ICAO document "CORSIA Sustainability Criteria for CORSIA eligible fuels", and to ensure that the methodology defined in the ICAO document "CORSIA Methodology for Calculating Actual Life Cycle Emissions Values" has been applied correctly.

ICAO document

CORSIA Approved Sustainability Certification Schemes

Name of the Sustainability Certification Scheme	Date of approval	Website	Scope of approval
International Sustainability and Carbon Certification (ISCC)	16 Jun. 2023	https://www.iscc-system.org/about/sustainable-aviation-fuels/corsia/	Certification of CORSIA Sustainable Aviation Fuels economic operators covered by Chapters 1 and 2 of the ICAO document "CORSIA Sustainability Criteria for CORSIA eligible fuels"
Roundtable on Sustainable Biomaterials (RSB)	16 Jun. 2023	https://rsb.org/rsb-corsia-certification/	Certification of CORSIA Sustainable Aviation Fuels economic operators covered by Chapters 1 and 2 of the ICAO document "CORSIA Sustainability Criteria for CORSIA eligible fuels"
ClassNK SCS	28 Oct. 2024	https://www.classnk.or.jp/hp/en/authentication/scs/index.html	Certification of CORSIA Sustainable Aviation Fuels economic operators covered by Chapter 2 of the ICAO document "CORSIA Sustainability Criteria for CORSIA eligible fuels"

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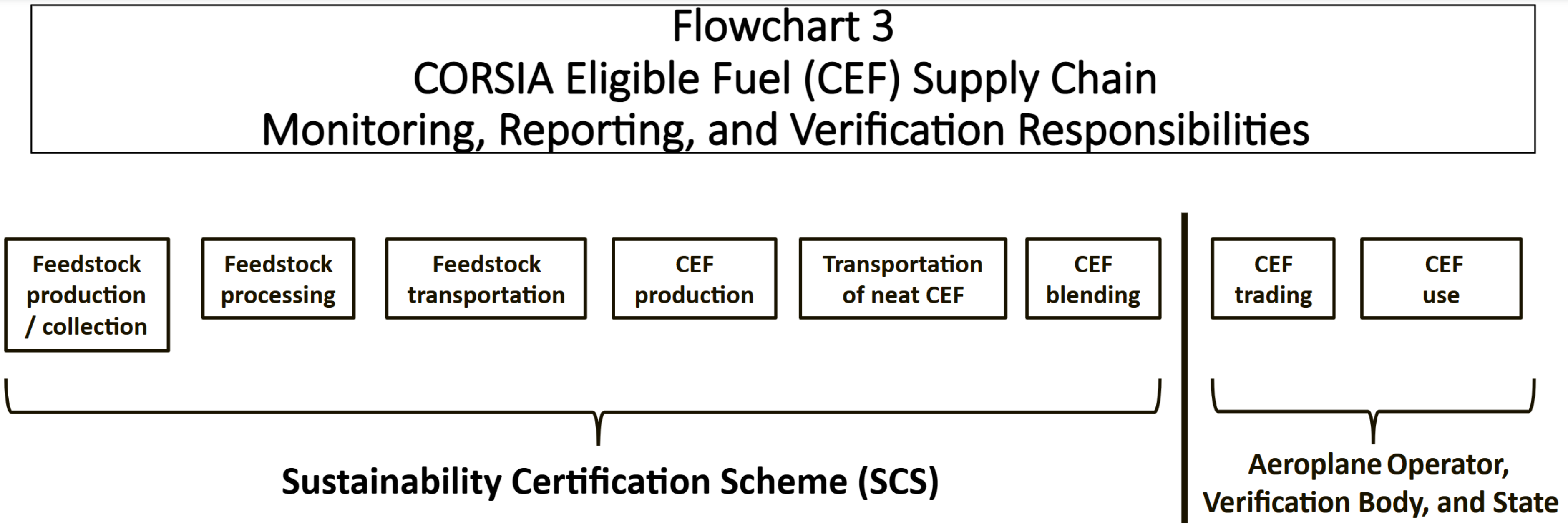
CORSIA Sustainability: Audits

- Key Features:-The Sustainability Certification Schemes (SCS) certification scope under CORSIA goes up to the CEF blender, although lifecycle emissions values go through to the CEF combustion using estimated or default lifecycle emissions values for downstream transportation.
- Once the CEF is produced and blended, the Aeroplane Operator takes the responsibility of tracking the CEF through the CORSIA Monitoring, Reporting and Verification process. The State to which the Aeroplane Operator is attributed has the prerogative of overseeing the data submitted by the Aeroplane Operator for compliance with CORSIA provisions



ISCC
International Sustainability & Carbon Certification

Meet the ISCC Board

Rob Vierhout
Vice President Public Affairs and Communication
Alcogroup
Brussels, Belgium

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Director Sustainability and Market Development
UPM Biofuels
Helsinki, Finland

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Principal Economist
Energy Resources Centre
University of Illinois
Chicago, United States

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London, United Kingdom

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Muenzer Bioindustrie GmbH
Vienna, Austria

Peter Schild
Managing Director Sustainability
Proman AG
Wollerau, Switzerland

Erika Sanchez Garrido
Sustainability Commercial Director
Dow Europe
Horgen, Switzerland

SAF United States Updates

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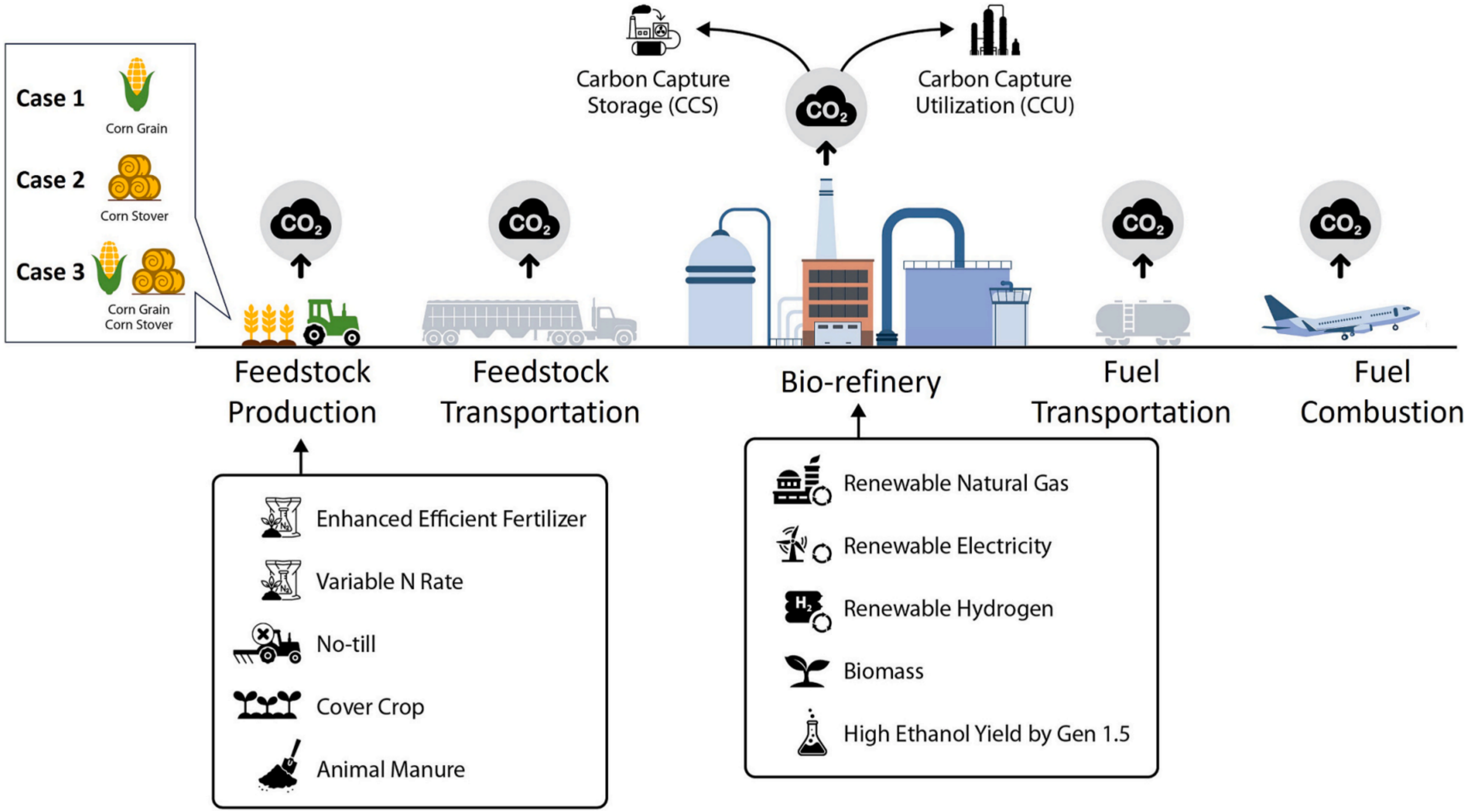
United States Updates

Applied Energy
Volume 398, 15 November 2025, 126373



In November 2025 Issue of Applied Energy
https://www.sciencedirect.com/science/article/pii/S0306261925011031?via%3Dihub

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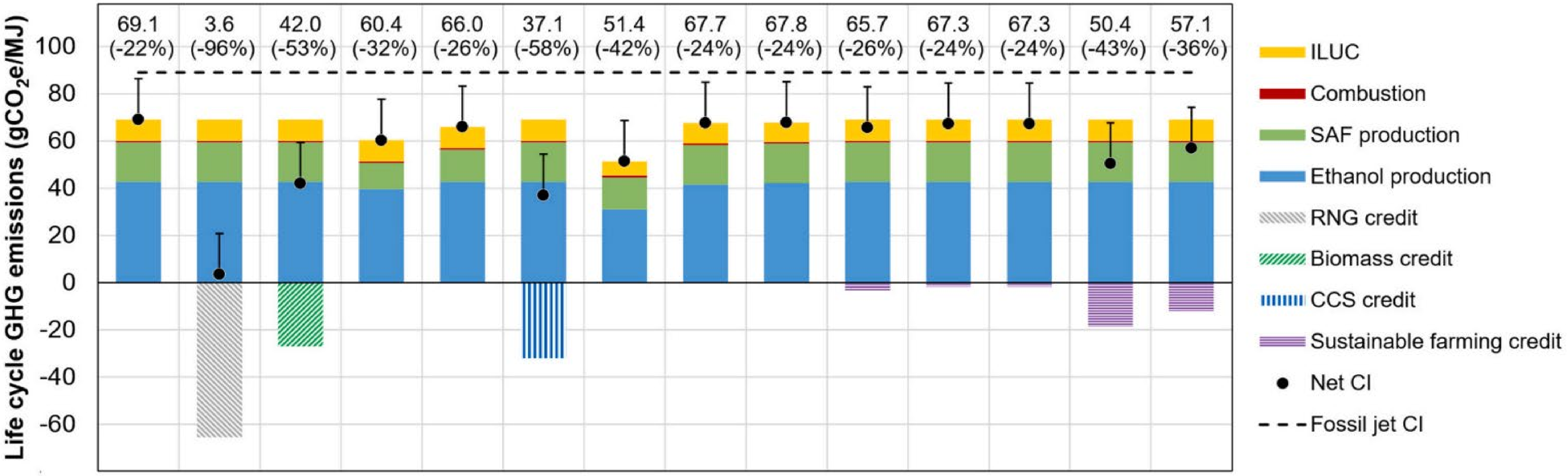
New Publication (July 2025)

United States Updates
New Technologies GHG Reduction Opportunities

ELSEVIER
journal homepage: www.elsevier.com/locate/apenergy

Sustainable aviation fuel from ethanol: Techno-economic analysis and life cycle analysis☆



1.0 Base Line

1.1.1 Switch Process fuel to Dairy Manure

1.1.2 Switch Process fuel form Natural Gas to Biomass

1.4 Carbon Capture Sequestration

1.7.4 Cover Crops

1.7.5 Manure Application

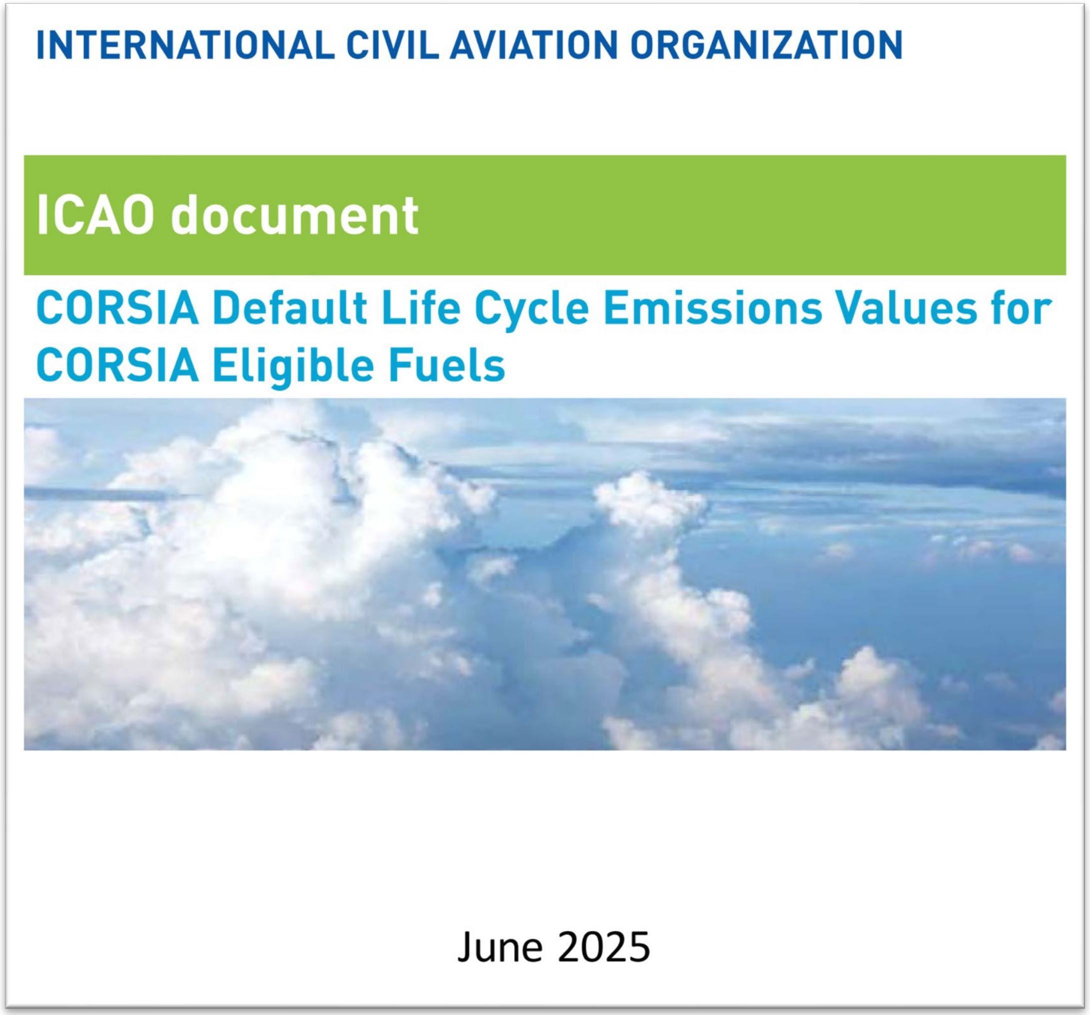
SAF CORSIA Updates

Updated CORSIA Default Values

	Corn Ethanol	Soy Bean SAF	Corn Oil from Ethanol Plant
Core LCA	54.1	40.4	17.2
iLUC	18.3	22.5	-
Total	72.4	62.9	17.2

Soy-based Jet can have a lower CI but Corn has many more levers to lower its LCA value below Soy:

- Process Improvements
- Ag Practices

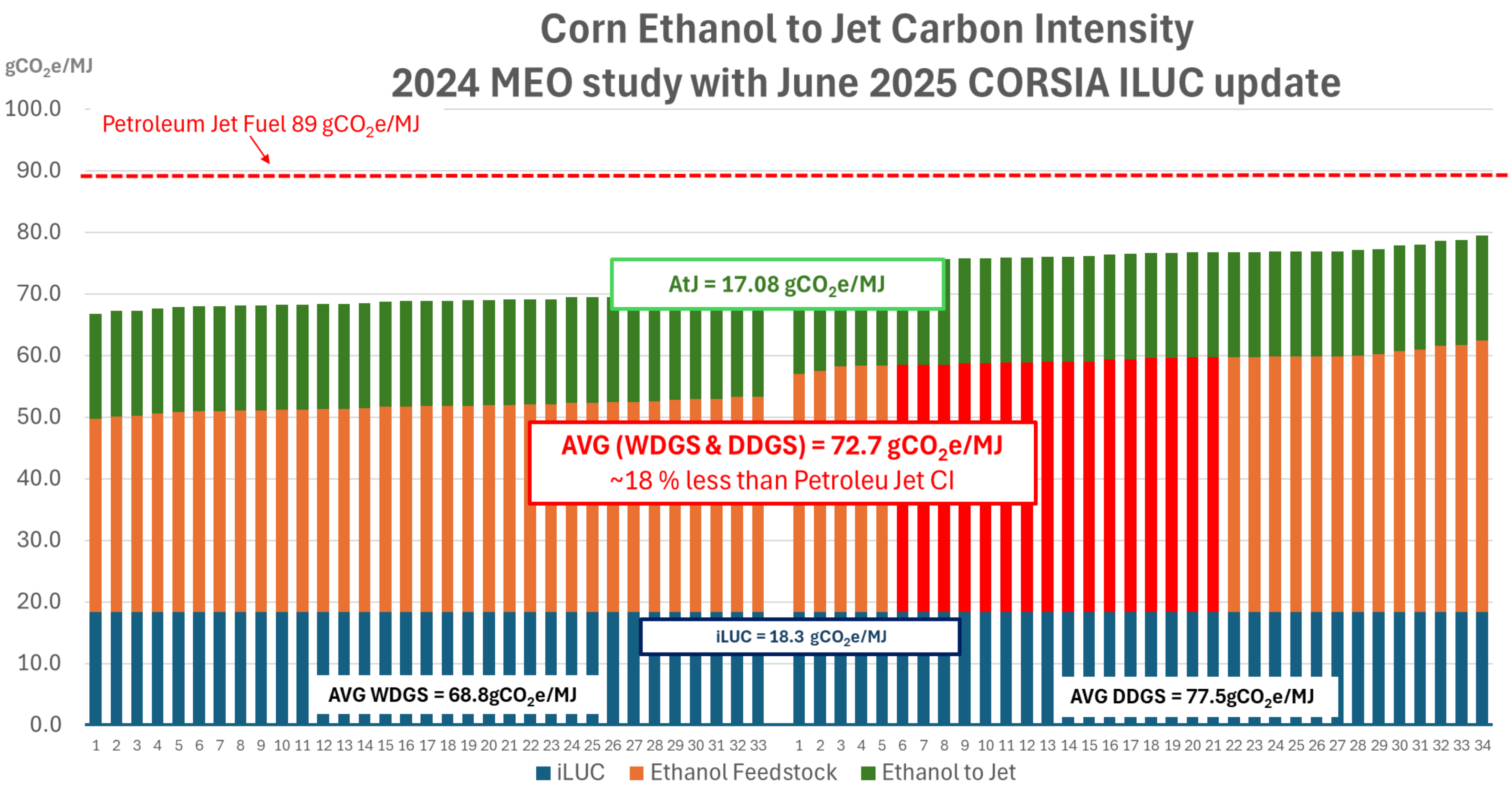

INTERNATIONAL CIVIL AVIATION ORGANIZATION

ICAO document

CORSIA Default Life Cycle Emissions Values for CORSIA Eligible Fuels

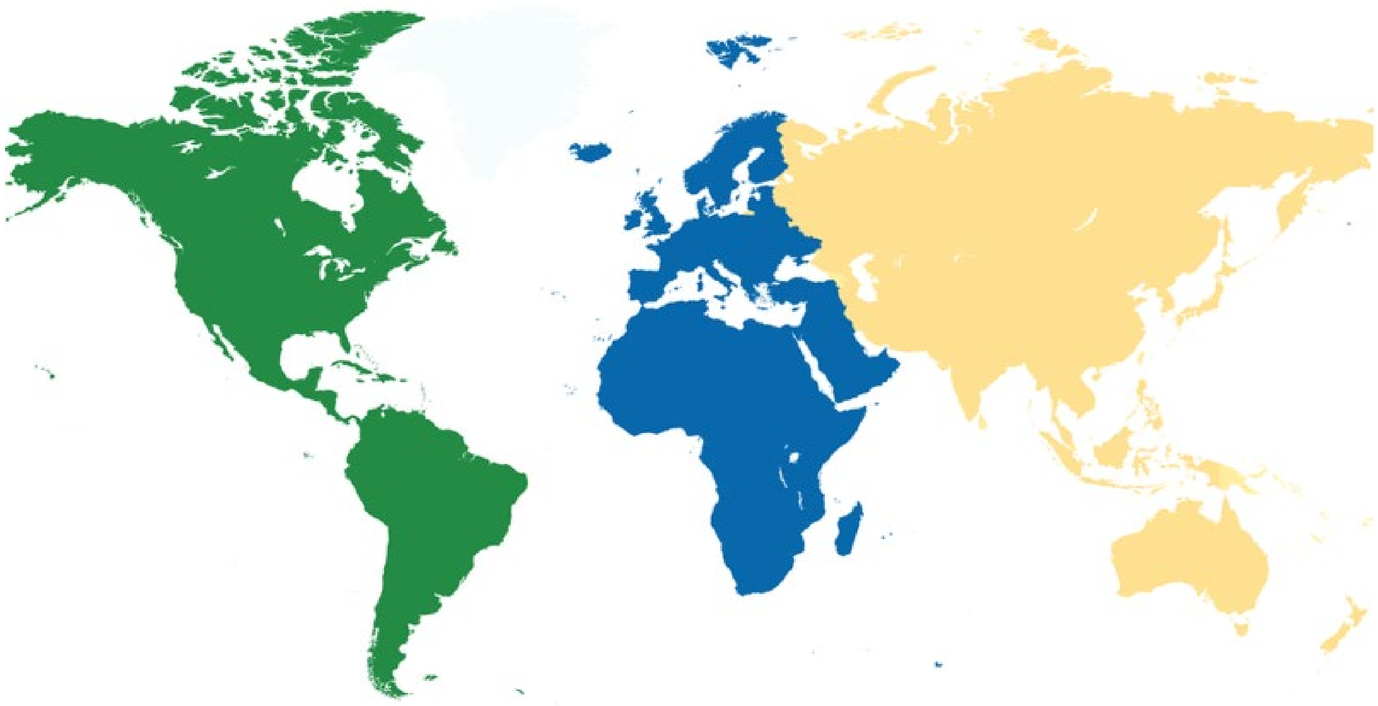
June 2025

Projected Individual SAF Values from Different US Ethanol Plant



604 Organizations Certified Under ISCC CORSIA standard

Growth of 104% from 2024 to 2025: CORSIA demand is rapidly expanding



17% AMERICAS
100 Certificates

18% EMEA
106 Certificates

66% APAC
398 Certificates

294 Trader with storage

197 Collecting Point

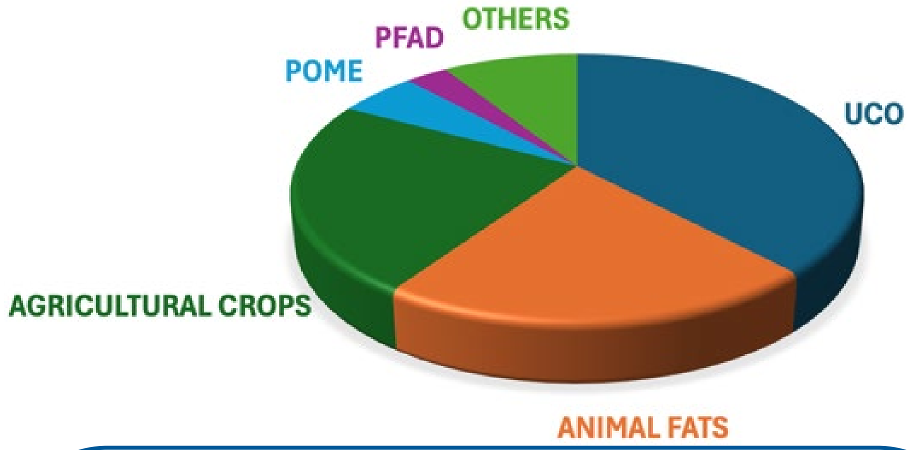
125 Trader

23 HEFA

Data as of 1st November 2025

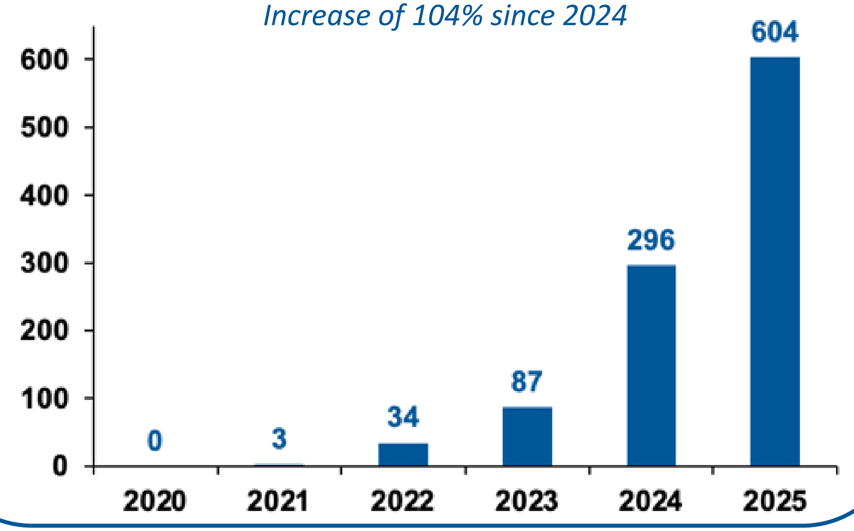
FEEDSTOCK DISTRIBUTION

(based on valid certificates)



CORSIA Certification Count Growth

Increase of 104% since 2024



As the Japanese SAF market develops, a growing number of companies and partnerships select ISCC for certification

Examples from 2025 press releases

DHL Express and Cosmo Oil Marketing Signed a Deal to Drive Further Usage of Sustainable Aviation Fuel in Japan

Press Release: Tokyo, Japan, January 28, 2025

Source: DHL, Jan 28th 2025

Cosmo to launch Japan's first sustainable aviation fuel production in April

By Yuka Obayashi

March 7, 2025 7:03 PM GMT+1 · Updated March 7, 2025

Aa

Source: Reuters, March 7th 2025

Article • Supply Chain Sustainability

DHL: Asia's First Sustainable Aviation Fuel Cargo Service

By Jasmin Jessen

January 31, 2025 • 4 mins

The logistics giant has secured a significant yearly supply of 7,200 kilolitres of SAF from Cosmo Energy Holdings, a dynamic player in the Japanese oil market.

Source: Sustainability Magazine, Jan 31th 2025

JAPAN'S KEY ROLE IN THE SAF INDUSTRY

OPINION BY FAYAZ HUSSAIN JULY 11, 2025 0 PRINT THIS PAGE

The Japanese government, through its 'Green Growth Strategy', is providing subsidies and tax incentives to accelerate SAF development. In recent years, the Ministry of Economy, Trade and Industry (METI) has increased funding for SAF projects, reinforcing the policy support, including through various of Japan's 'GX' (Green Transition) policies, critical to de-risking early investments.

Source: SAF Investor, July 11th 2025

Alaska Airlines, Cosmo Oil Marketing sign sustainable aviation fuel sales agreement for Hawaiian Airlines Osaka-Honolulu flights

"Japan is an important international market for Hawaiian Airlines, and we appreciate Cosmo's investment in locally sourced SAF – the most effective technology to lower our carbon emissions – that we are now using on our flights between Osaka and Honolulu."

Alanna James – Sustainability innovation director Hawaiian Airlines

Source: Alaska Air News Hub, August 29th 2025

ISCC CORSIA System Documents Soon to be Update Reflecting Recent CORSIA Details

Submitted to ICAO and waiting for approval

CARBON CAPTURE AND STORAGE

- Specific **provisions for CCS eligible projects**, including compliance though existing CCS frameworks
- **Sustainability criteria**, LCA **emission savings**, and traceability requirements

ELECTRICITY SOURCING

- Rules to **source compliance electricity** (including for hydrogen producers)
- Additionality, temporal matching, deliverability are included
- **Sustainability criteria**, **LCA emissions**, and traceability requirements

SOIL CARBON ACCUMULATION

- Methodology for **accounting LCA emission savings** from soil carbon accumulation practices
- Specific rules for **soil sampling and usage of models** for estimate accumulation of carbon

Maritime IMO

ISCC is moving forward by developing an IMO NZF Certification Scheme

Insights on current developments

Active contribution: ISCC is working with the Mærsk Mc-Kinney Møller Center for Zero Carbon Shipping and industry stakeholders

Development of ISCC IMO NZF Certification Scheme: ISCC is committed to be recognized as IMO SFCS to provide certification solutions to show compliance with IMO criteria

Outlook

IMO NZF postponement by 1 year was decided in October 2025

Likely limited impact on certification implementation timelines (development of the guidelines) as stakeholders continue their work despite the announced delay.

A Large Variety of already Certifiable Feedstock under ISCC can be used for the Production of Alternative Marine Fuels (AMF) for the Maritime Sector

Agricultural feedstocks

Corn

Sugarcane

Rapeseed

Waste and residues

Tall Oil

UCO

PFAD

Non-bio feedstocks

Mixed Plastic Waste

End-of-life tires

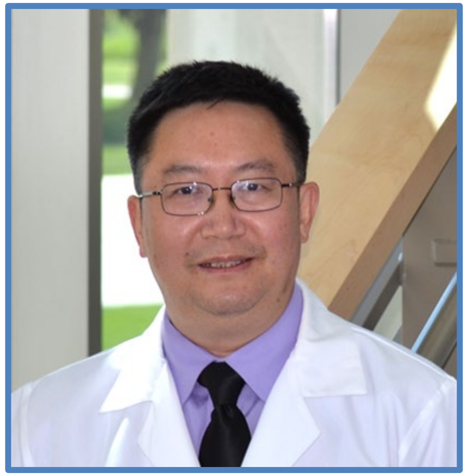
Renewable electricity

Beyond Greenhous Gas Benefits of Corn Ethanol: Aromatics Reductions with Ethanol Blended Gasoline

Research Across 3 Different US Universities

Dr. Shujun Liu

Professor
Department of Medicine
Co-Director, Metrohealth Center for Cancer Research
Case Western Reserve University School of Medicine



Dr. Steffen Mueller

Principal Economist
Energy Resources Center,
University of Illinois at Chicago

Dr. Leena Hilakivi-Clarke

Professor of Food Science and Nutrition, University of Minnesota
Assistant Director for Faculty Affairs, the Hormel Institute

Gail Dennison, M.A., CFRE

Development & External Relations Director

Aromatics in Aviation Fuels

Powering aircraft with 100 % sustainable aviation fuel reduces ice crystals in contrails

Raphael Satoru Märkl[1,2], Christiane Voigt[1,2], Daniel Sauer[1], Rebecca Katharina Dischl[1,2], Stefan Kaufmann[1], Theresa Harlaß[1], Valerian Hahn[1,2], Anke Roiger[1], Cornelius Weiß-Rehm[1], Ulrike Burkhardt[1], Ulrich Schumann[1], Andreas Marsing[1], Monika Scheibe[1], Andreas Dörnbrack[1], Charles Renard[3], Maxime Gauthier[3], Peter Swann[4], Paul Madden[4], Darren Luff[4], Reetu Sallinen[5], Tobias Schripp[6], and Patrick Le Clercq[6]

[1]Institut für Physik der Atmosphäre, Deutsches Zentrum für Luft- und Raumfahrt, Oberpfaffenhofen, Germany
[2]Institute of Atmospheric Physics, Johannes Gutenberg-Universität, Mainz, Germany
[3]Airbus Operations SAS, Toulouse, France
[4]Rolls-Royce plc., Derby, UK
[5]Neste Corporation, Innovation, Porvoo, Finland
[6]Institute of Combustion Technology, Deutsches Zentrum für Luft- und Raumfahrt, Stuttgart, Germany

Correspondence: Raphael Satoru Märkl (raphael.maerkl@dlr.de)

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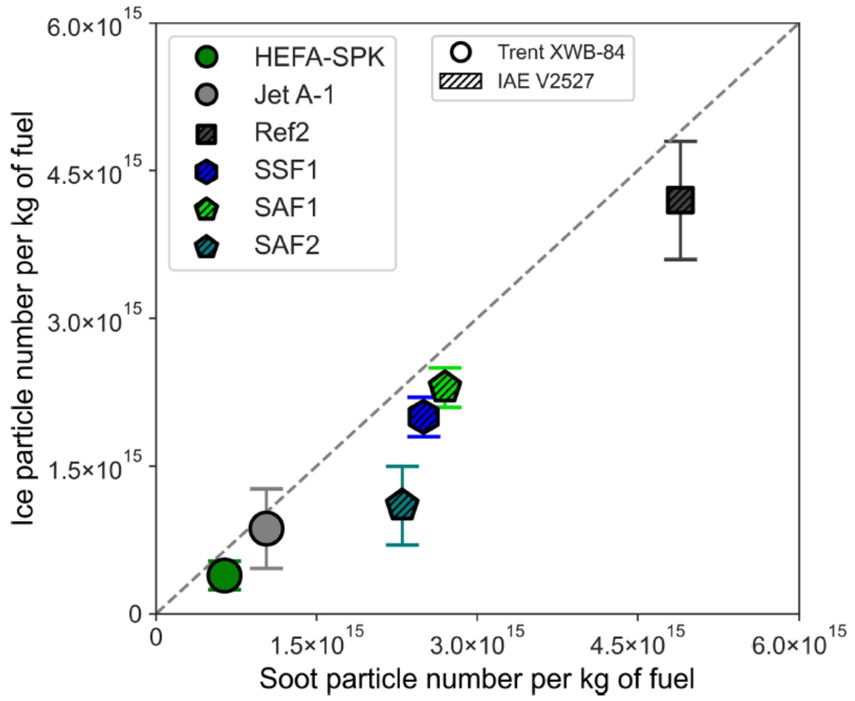
Powering aircraft with 100% sustainable aviation fuel reduces ice crystals in contrails

"Naphthalene as a polycyclic aromatic compound is especially conducive to soot formation, and a reduction in naphthalene has been experimentally demonstrated to reduce apparent contrail ice emission indice (Voigt et al., 2021; Bräuer et al., 2021b). **<u>As shown in Fig. 2b and c, the naphthalene and aromatic contents are reduced to below their ASTM D1840 and ASTM D637! detection limits for HEFA-SPK compared to Jet A-1. Hence, the soot reduction of 35% can be explained by this reduction in aromatics and naphthalene in the SAF.</u>**



SPK = Synthetic Paraffinic Kerosene

First Publication: Toxicity of Aromatics

International Journal of
Environmental Research and Public Health

MDPI

Review

An Assessment on Ethanol-Blended Gasoline/Diesel Fuels on Cancer Risk and Mortality

Steffen Mueller [1], Gail Dennison [2] and Shujun Liu [2,*]

genotoxicity of chemical agents has been thoroughly studied. However, less effort has been put into studying the epigenotoxicity. Moreover, as the blending of ethanol into gasoline substitutes for carcinogens, like benzene, toluene, xylene, butadiene, and polycyclic aromatic hydrocarbons, etc., a reduction of secondary aromatics has been achieved in the atmosphere. This may lead to diminished cancer initiation and progression through altered cellular epigenetic landscape. The present review summarizes the most important findings in the literature on the association between exposures to carcinogens from gasoline combustion, cancer epigenetics and the potential epigenetic impacts of biofuels.

Second Publication: Aromatics and Breast Cancer

iScience

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Review

Aromatics from fossil fuels and breast cancer

Leena Hilakivi-Clarke,[1,2,*] Theresa Krista Jolejole,[2] Joas Lucas da Silva,[1] Fabia de Oliveira Andrade,[1] Gail Dennison,[1] and Steffen Mueller[3]
[1]The Hormel Institute, University of Minnesota, 801 16th Avenue NE, Austin, MN 55912, USA
[2]Department of Food Science and Nutrition, University of Minnesota, 1334 Eckles Avenue, St Paul, MN 55108, USA
[3]Energy Resources Center, University of Illinois Chicago, 1309 South Halsted, MC 156, Chicago, IL 60607, USA
*Correspondence: hilak001@umn.edu
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Contact Information

Steffen Mueller, PhD
Principal Economist, Energy Resources Center
University of Illinois Chicago
P: (312) 316-3498
E: muellers@uic.edu | **W:** erc.uic.edu
1309 South Halsted | MC 156 | Chicago, IL 60607

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Energy Resources Center

Questions ???

Steffen Mueller; PhD
Principal Economist
University of Illinois Chicago
Energy Resources Center
muellers@uic.edu