CARBON ACCOUNTING AND CARBON INTENSITY SCORES: METHODOLOGIES, FRAMEWORKS, AND REDUCTIONS

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Thursday, Sep 4 1:30–2:30 PM

Renewable Energy Markets™ 2025

LCA's & Carbon Intensity Scores

Alycia Tolman, ABC Director of Carbon Markets

September 4, 2025

Understanding the Carbon Market Ecosystem…

1 Commitments → 2 Decarbonization Strategy → 3 Market ← 4 Credit Validation ← 5 Credit Supply

1 Commitments

Corporates

Voluntary commitments by companies to reduce emissions

L'ORÉAL, PEPSICO, Microsoft, AstraZeneca, Nestlé, MAERSK, UPS, Google, LEGO, amazon, Walmart, JPMorganChase

Consumers

Willing to pay more for products or services to counteract emissions

2 Decarbonization Strategy

Consultants

Hired as third-party to support decarbonization strategy

SCS consulting, eco engineers, Carbon Direct, McKinsey & Company

In-house Accounting

Established to measure, monitor, and report emissions.

Carbon Accounting

Tools for lifecycle analysis, carbon accounting & management

GREET LIFE-CYCLE MODEL, P6 TECHNOLOGIES, Carbon Direct, Carbon Chain

3 Market

Platforms & Brokers

Aggregate credits from different sources and offer access to credits

anew climate, M-RETS, Carbon TradeXchange (Access the world's carbon markets), ACT, 3Degrees, STRIVE by STX, TARGRAY, Karbone, VERTIS

4 Credit Validation

Registries & Standards

Set guidelines and rules that govern the measurement and management of emissions and carbon credits.

Gold Standard, GREENHOUSE GAS PROTOCOL, CDP (DRIVING SUSTAINABLE ECONOMIES), SCIENCE BASED TARGETS, CRS, VERRA, American Carbon Registry, ISSB, GLOBAL SUSTAINABILITY STANDARDS, ISO International Organization for Standardization, CLIMATE ACTION RESERVE

5 Credit Supply

Developers

Biogas project developers and credit/commodity generation source

OPAL FUELS, anew climate, US Energy, SJI, Clean Energy, CALGREN, Air Liquide, SKS, WM (WASTE MANAGEMENT), ExxonMobil, ROESLEIN, divert, Shell, BRIGHTMARK, DVO (renewables at work)

Financing

(Up-front) financing and advanced market commitments

GENERATE CAPITAL, AVANA CAPITAL (PRESERVING WEALTH. CREATING GROWTH.), LiveOakBank.

Verifiers & Rating Agencies

Provide ratings and insurance for carbon credits

BeZero, iC THE INTEGRITY COUNCIL FOR THE VOLUNTARY CARBON MARKET, Sylvera

SCSglobal SERVICES, eco engineers

Provide a suite of services including consulting, auditing, and/or verification for various standards/projects

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www.americanbiogascouncil.org

Disclaimer: This slide is not intended to be exhaustive, but rather illustrative of the Voluntary Carbon Market Ecosystem for the Biogas Industry

Carbon Intensity Scores 101

WHAT IT IS

Carbon Intensity (CI) Score:

- A measure of how much greenhouse gas (GHG) emissions are released **across the full life cycle** of producing and using a fuel
- Often expressed as grams of CO_2-equivalent per megajoule of energy (gCO_2e/MJ).

Instead of just looking at the tailpipe (or combustion) emissions, the CI score accounts for all stages:

- **Feedstock** – growing crops, collecting waste, or capturing methane.
- **Production/Processing** – turning that feedstock into fuel (ethanol, biogas, hydrogen, etc.).
- **Transportation & Distribution** – moving the fuel to market.
- **Combustion/Use** – emissions when the fuel is burned.

WHY IT MATTERS

- **Lower CI = cleaner fuel**
  - Example: Renewable Natural Gas (RNG) from dairy manure often has a deeply negative CI score because it avoids methane emissions that would otherwise escape into the atmosphere.
  - By contrast, conventional gasoline has a relatively high CI score (~100 gCO_2e/MJ in California's LCFS).
- **Policy & Credits:**
  - Compliance programs (e.g. CA-LCFS) use CI scores to determine how many credits a fuel generates.
  - The lower the CI compared to the petroleum baseline, the more credits (and value) the fuel earns.

Where is the CI Score Generated?

eco engineers
ICF
Greenlane™ Biogas Upgrading Solutions
ERM

Project Developer

+

Project Analysis

Lifecycle Carbon Accounting (LCA)

×

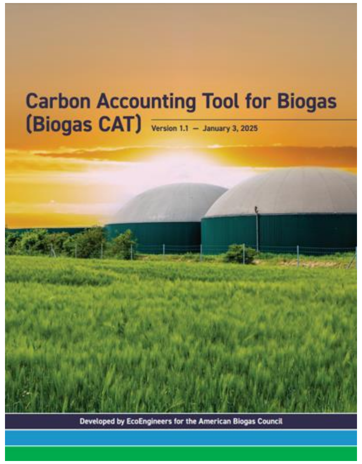
Biogas Production

Emissions Reduction

Third Party Certification

Registry
(Credit Tracking Platform)

Buyers/Sellers
(Transact within Registry)



Argonne GREET LIFE-CYCLE MODEL

CI Score generated here

Verified Carbon Standard
Climate Action Reserve
Gold Standard
CCBA
ACR
ICROA
M-RETS

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Barriers to Carbon Accounting for Bio-based Outputs

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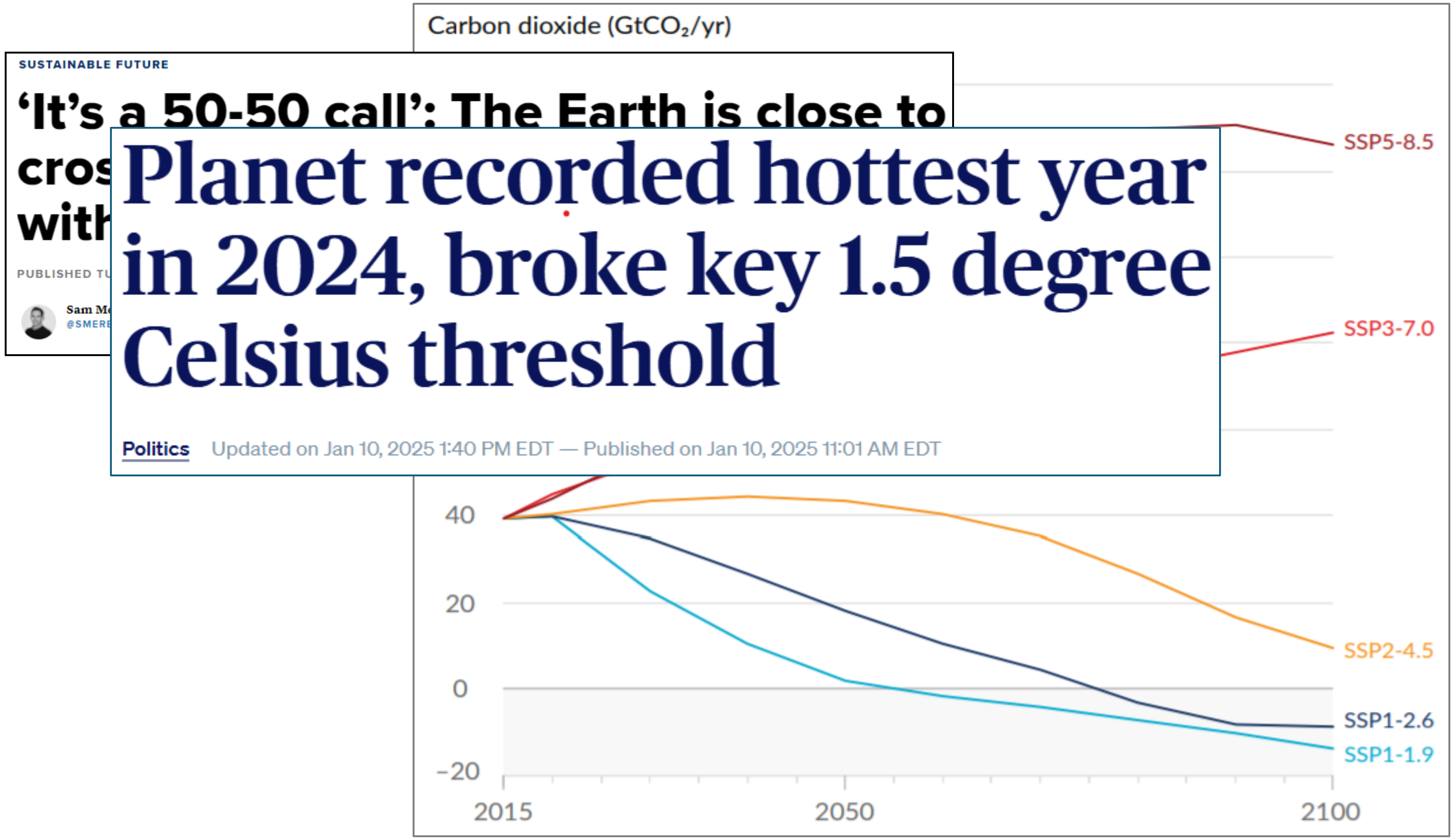
Director of the Bioeconomy Development Institute
SUNY College of Environmental Science & Forestry

Presented at the REM 2025
Houston, TX
September 4, 2025

The climate motivation

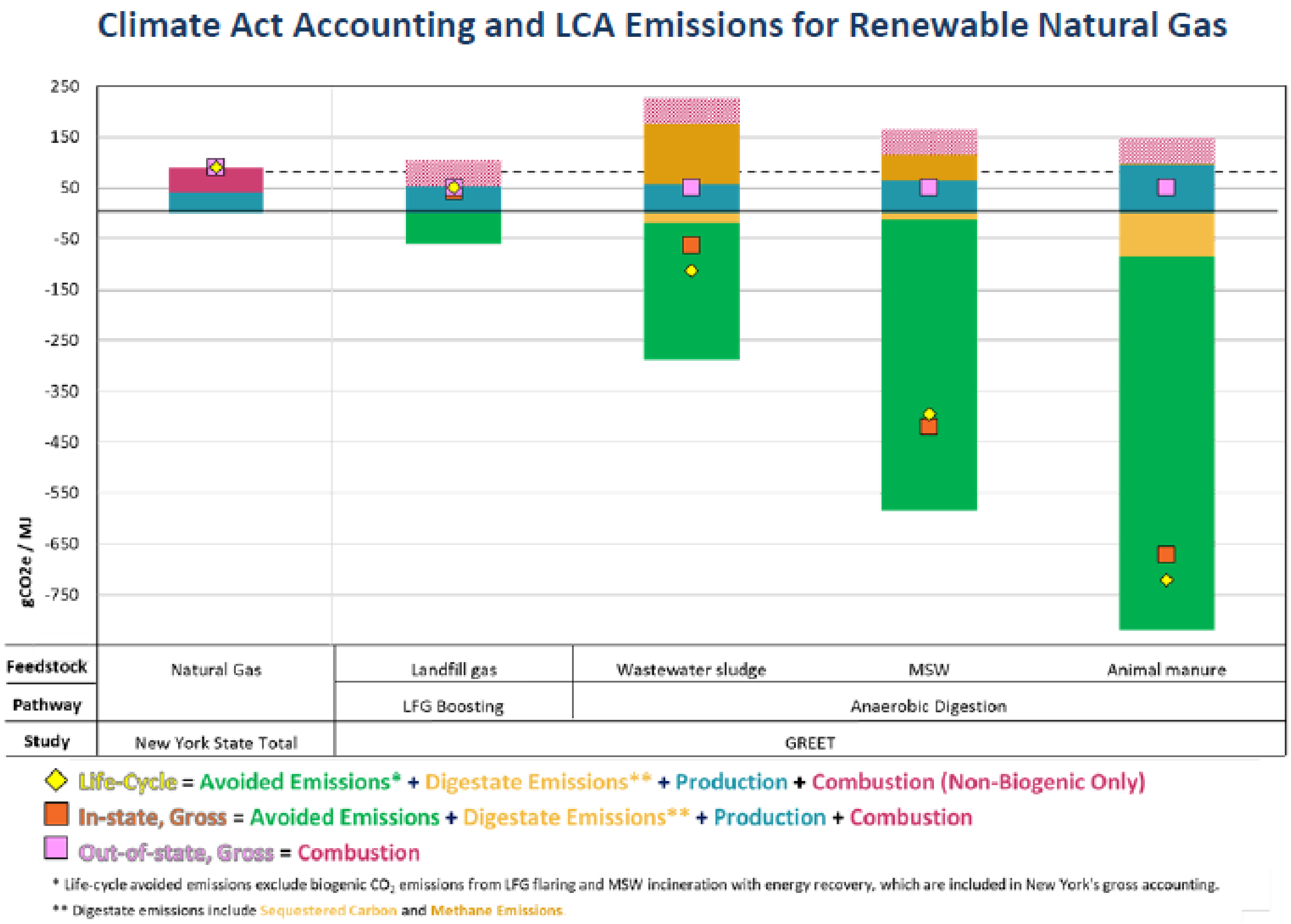
Emissions thresholds and warming targets



UN IPCC AR6: Catastrophic climate change will only be averted via the widespread deployment of Carbon Dioxide Removal (net sequestration) technologies.

Source: IPCC (2021)

Barrier #1: Carbon accounting systems lack attributional LCA harmonization



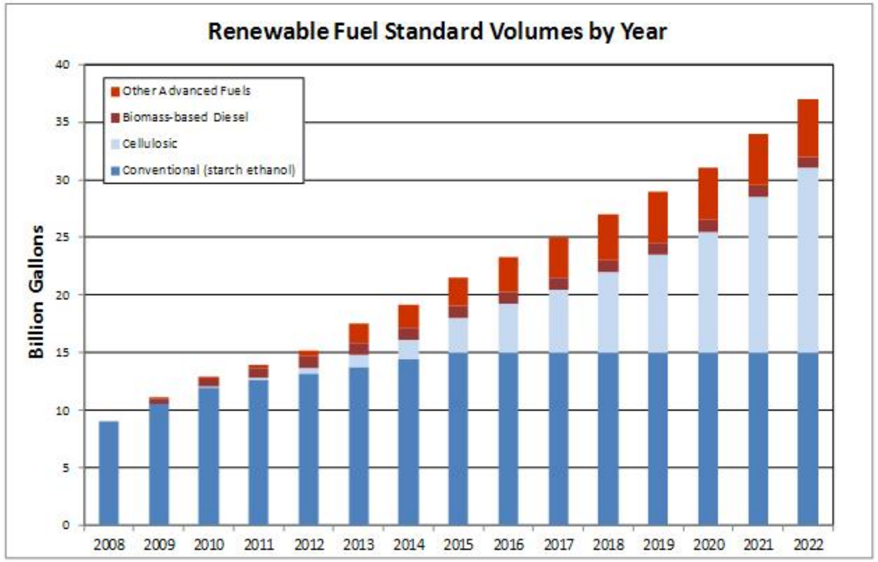
Source: NYS EPB (2025)

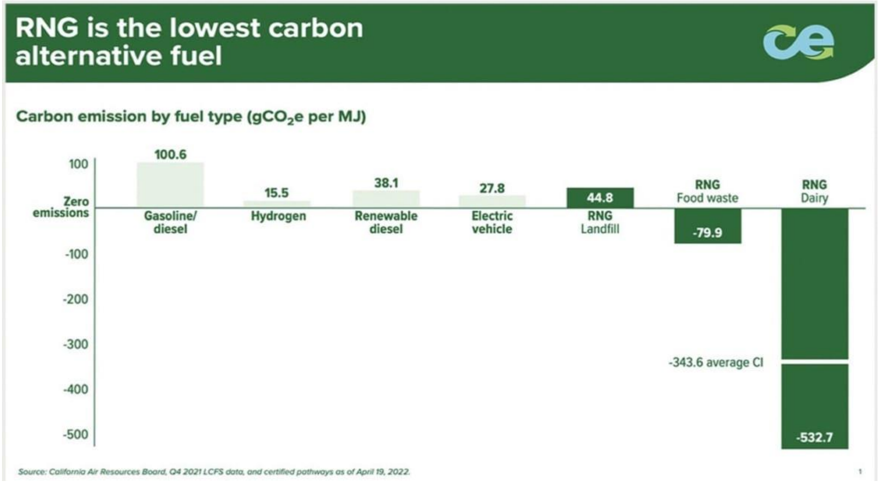
Barrier #2: Carbon accounting systems lack consequential LCA harmonization

- Indirect land-use change (ILUC) calculation continues to confound carbon accounting practitioners nearly 20 years after the original Searchinger et al. analysis
  - GTAP-BIO+CCLUB vs. GTAP-BIO+AEZ-EF vs. GLOBIOM vs. GCAM vs. ???
  - ILUC numbers or ILUC risk assessment categories?
- Accounting for substitution effects, avoided emissions, and other fuel-related LCA impacts
  - When is it appropriate to make use of different assumptions across carbon accounting systems, and when is it being done to achieve a preferred outcome?

Barrier #3: Government GHG accounting incentives focus on individual products

- Government GHG accounting systems utilizing life cycle assessment principles are focused on fuels rather than products
- “Carbon-negative” biofuels such as RNG create confusion when considered alongside biogenic carbon products that are not combusted





Barrier #3: Government GHG accounting incentives focus on individual products

- REDII – IR recognizes CO2 sequestration via soil carbon accumulation for sustainable *biofuels* production (albeit capped)
- In competition between biofuels and bioproducts manufacturers for feedstocks, the former is officially prioritized
  - Competition will worsen as latter's production capacity (e.g., SAF) expands

(a) greenhouse gas emissions from the production and use of biofuels shall be calculated as:

$$E = e_{ec} + e_{l} + e_{p} + e_{td} + e_{u} - e_{sca} - e_{ccs} - e_{ccr},$$

where

$$e_{sca} = (CS_A - CS_R) \times 3{,}664 \times 10^6 \times \frac{1}{n} \times \frac{1}{P} - e_f$$

The maximum possible total value of the annual claim of emission savings from soil carbon accumulation due to improved agricultural management (e_{sca}) shall be capped to 45 g CO_2eq/MJ biofuel or bioliquid for the entire period of application of the Esca practices, if biochar is used as organic soil improver alone or in combination with other eligible e_{sca} practices. In all other cases, the cap referred to above shall be 25 g CO_2eq/MJ biofuel or bioliquid for the entire period of application of the e_{sca} practices.

Source: EU (2022), adapted by Chiaramonti (2025)

Questions?

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Carbon Accounting and Carbon Intensity Scores

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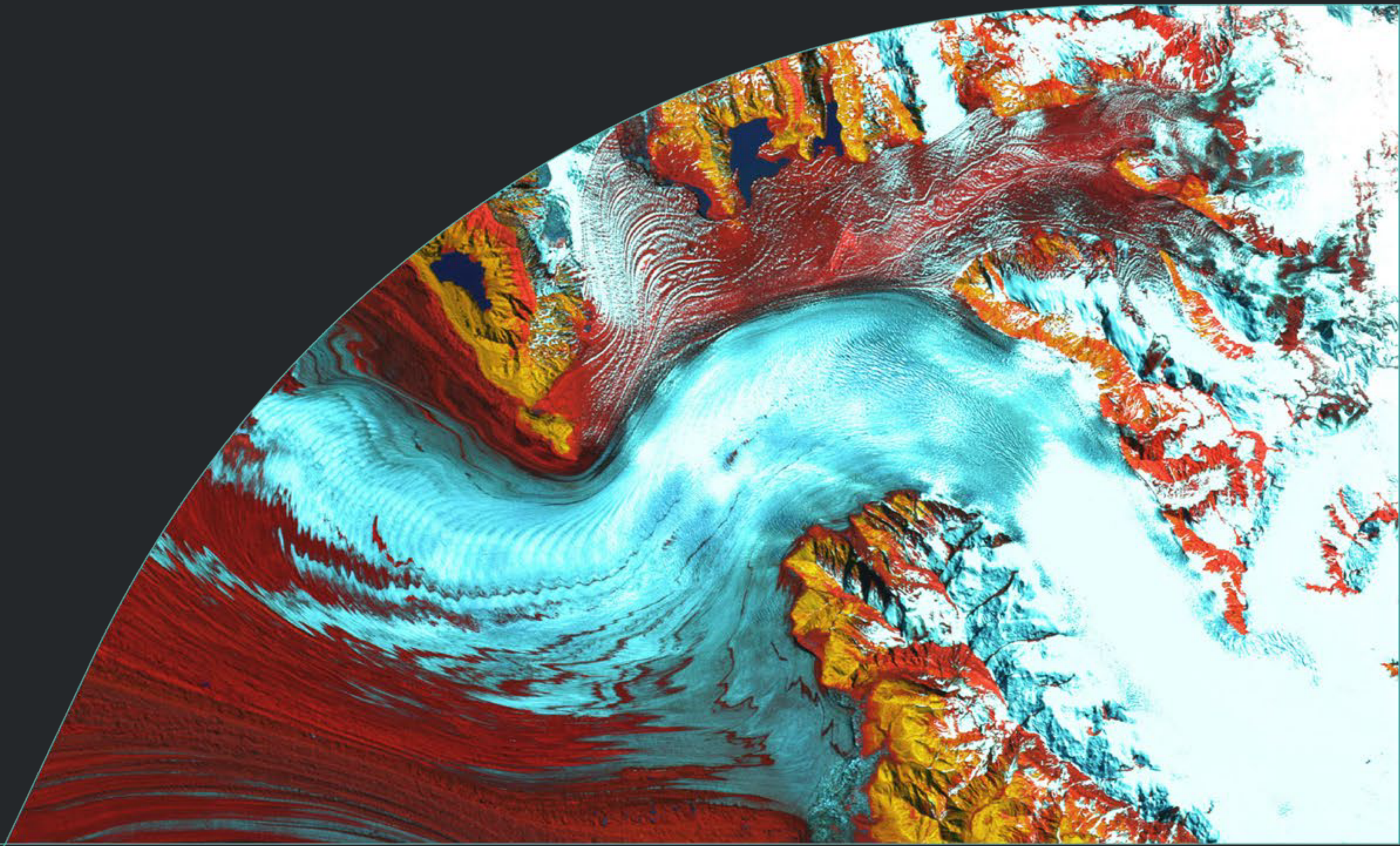


09/04/2025

eco engineers

We Are EcoEngineers

- An advisory firm with an exclusive focus on the energy transition and decarbonization recently acquired by leading global assurance partner LRQA.
- A team of engineers, scientists, auditors, consultants, and researchers passionate about their work.
- Living and working at the intersection of climate policy, innovative technologies, and the carbon marketplace.
- Helping clients navigate the disruption caused by carbon emissions and climate change.

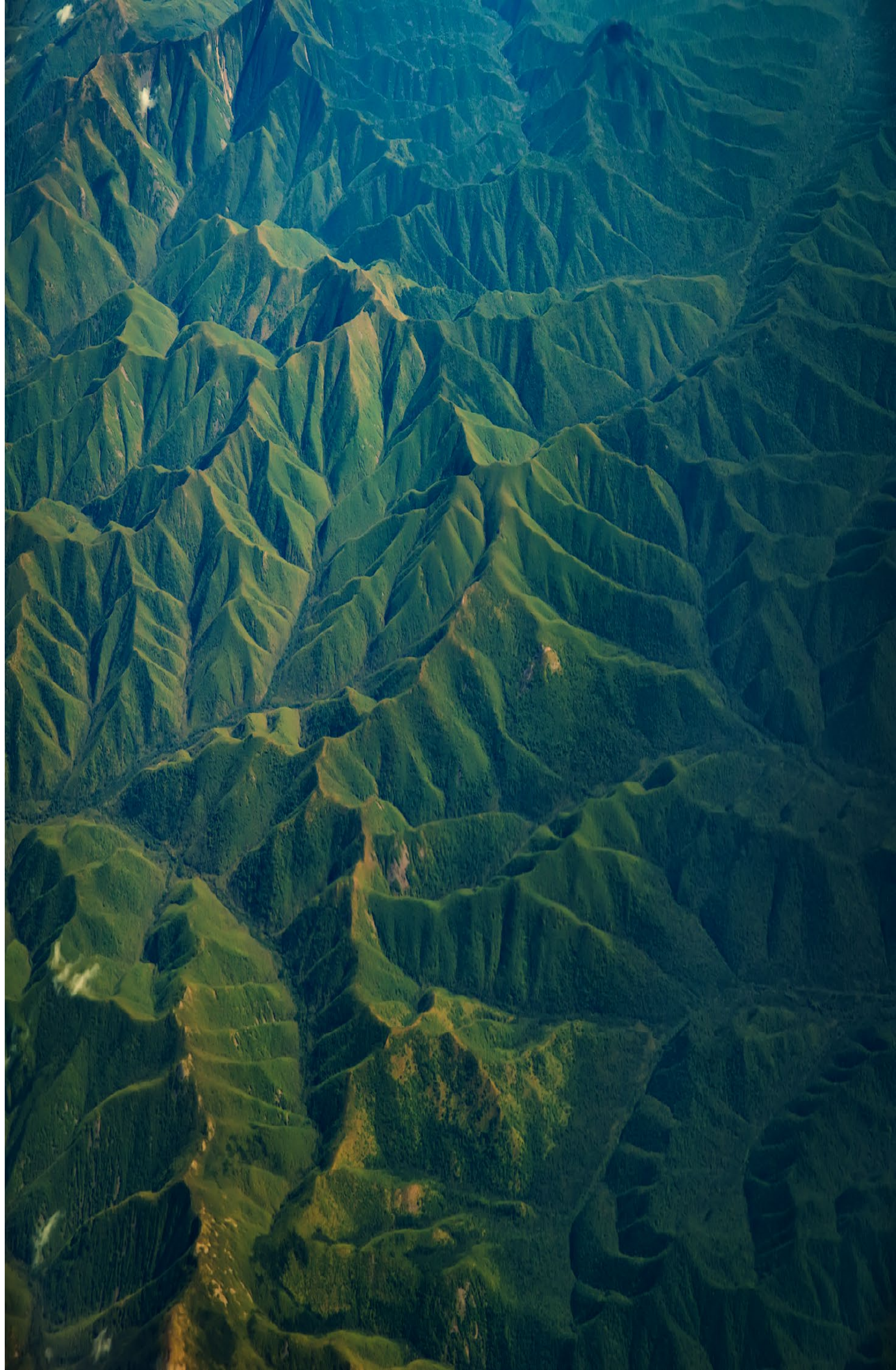
eco consulting

eco auditing

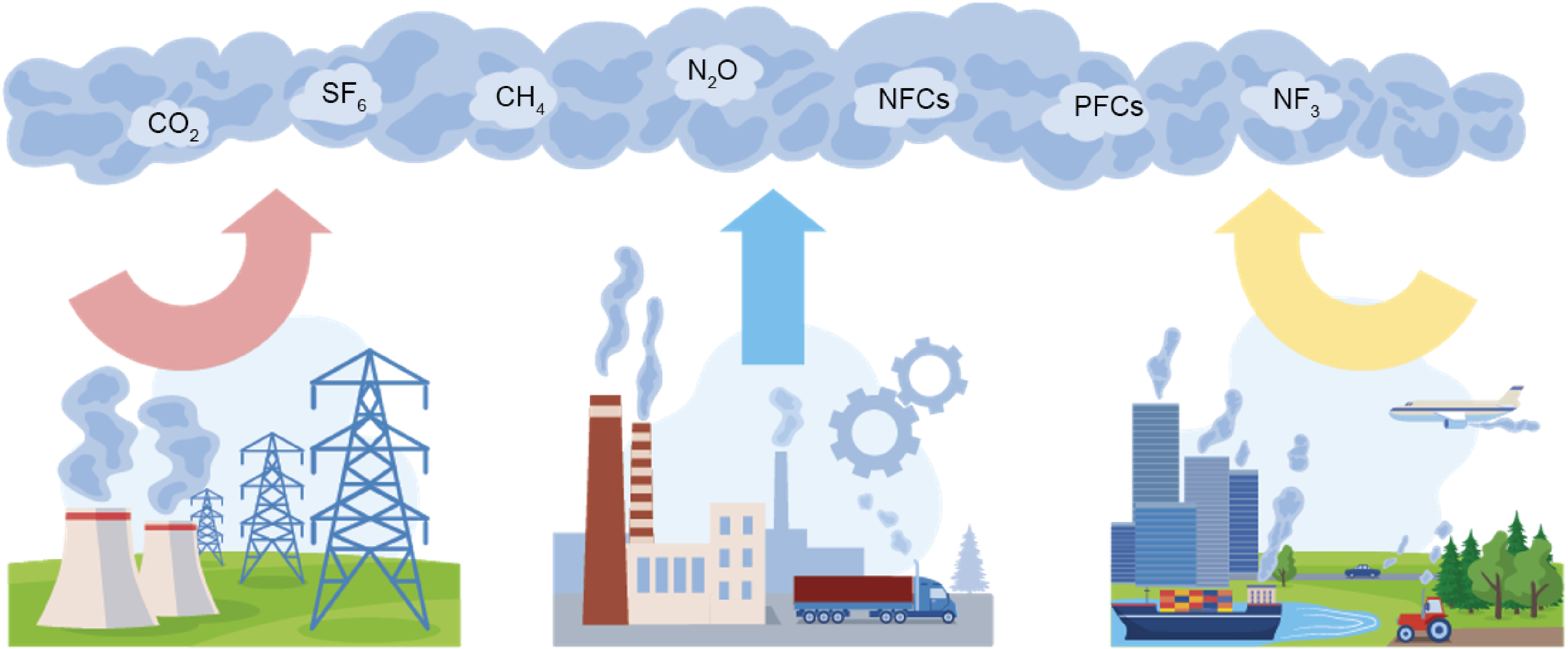
eco university

Voluntary Market Basics

- Not legally mandated, driven by ESG commitment, sustainability goals, PR, consumer/investor pressure
- Projects must follow approved methodologies
- Projects can include:
  - Reforestation
  - Renewable energy
  - Methane/Carbon capture
- 1 credit = 1 t CO_2e. Credits are tradeable, then retired to meet emissions goals
- Carbon accounting is the right approach. LCA has a supporting role



GHG Accounting (Scope Emissions)



Scope 2 - Indirect
Emissions from energy and utilities

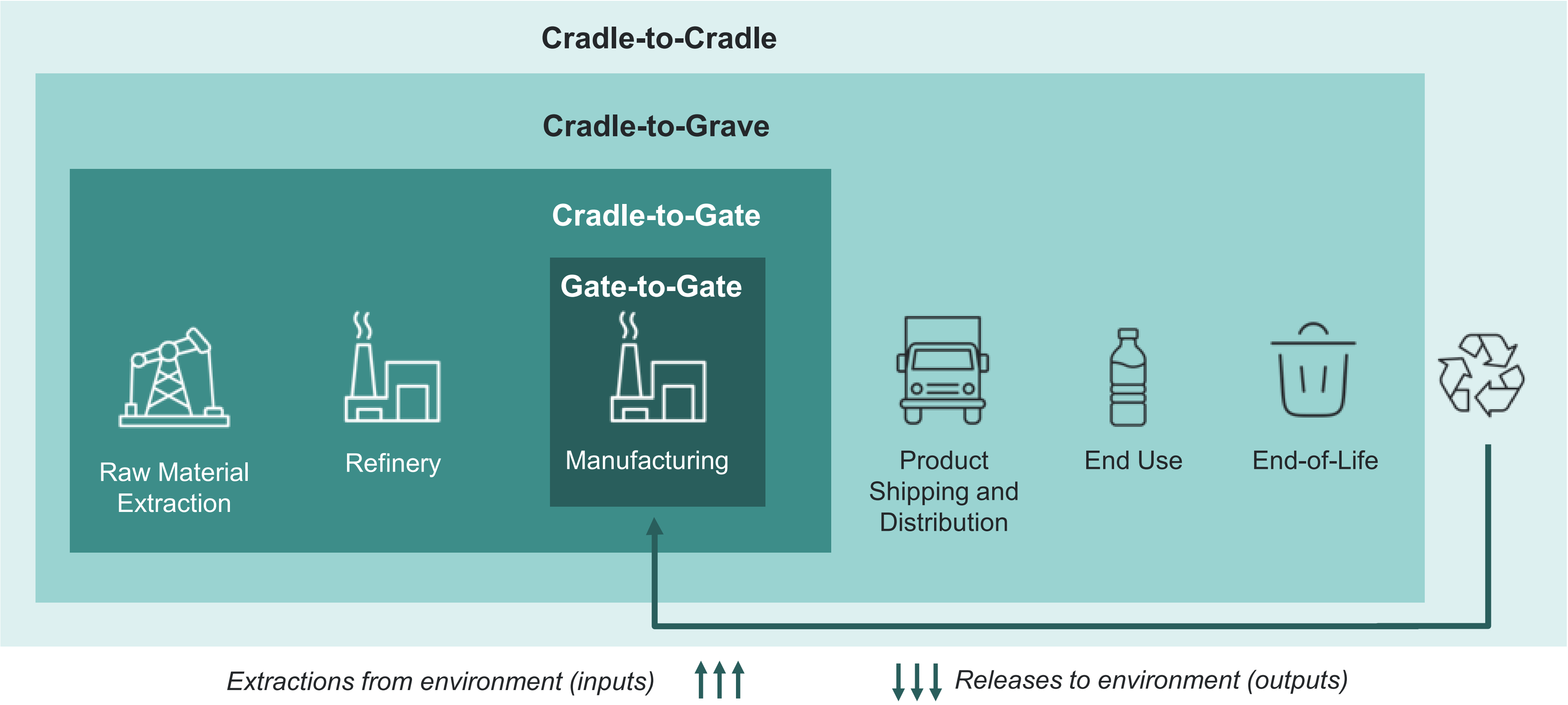
Scope 1 - Direct
Emissions from on-site sources

Scope 3 - Indirect
Emissions of the supply chain or service

Compliance Market Basics

- Government-mandated systems where companies must measure and reduce GHG emissions to meet regulatory targets.
- Can use carbon accounting and LCAs.
  - LCAs are the right tool in sectors where CI scores for specific products matter more, e.g., fuels
- The required LCA Tool will follow the specific program's protocol
- LCA will directly determine eligibility and deficits/credits to be generated

Example: LCA of a Plastic Bottle



A Variety of LCA Tools are Available

openLCA

thinkstep GaBi

GREET LIFE-CYCLE MODEL

ecoinvent

GREENHOUSE GAS PROTOCOL

SimaPro

Thank You

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