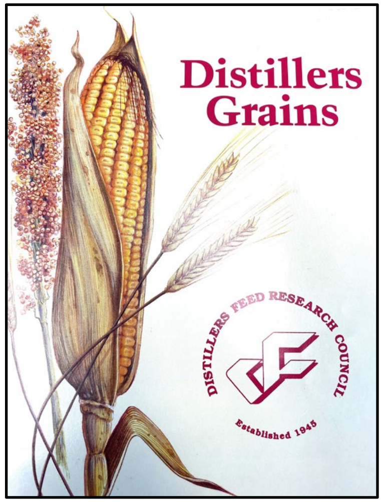
Carbon Intensity, Sustainability, and Co-Products

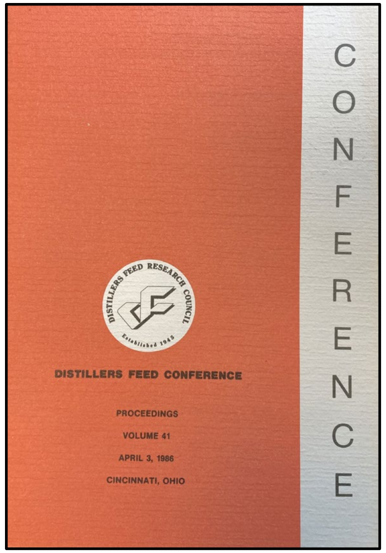


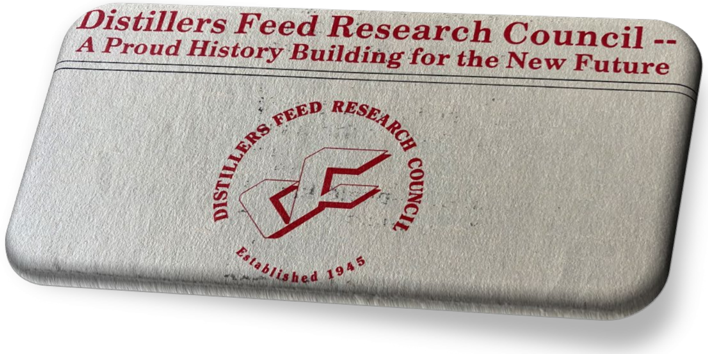
Kelly Davis
Vice President of Regulatory Affairs
Renewable Fuels Association

October 26, 2021

Distillers Grains Technology Council Symposium

"TAKING IT BACK TO WHERE IT BEGAN…"





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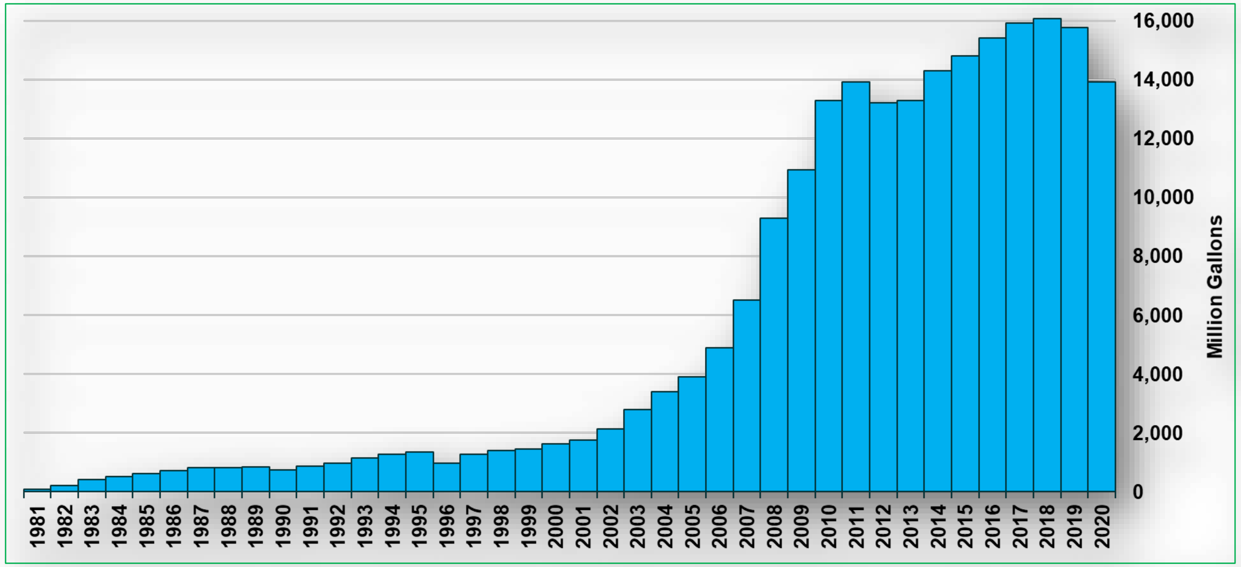
About the Renewable Fuels Association

- Leading association representing U.S. ethanol producers
  - Lead legislative and regulatory efforts for the industry
  - Promote research & development
- Offices in Washington, D.C. and St. Louis, Missouri
- Members include:
  - Large bioenergy companies;
  - Agribusinesses; and
  - Small, farmer-owned co-ops and LLCs



Mission: Drive expanded demand for American-made renewable fuels and bio-products worldwide

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GHG Reducing Transportation Policies

- **U.S. Renewable Fuel Standard (RFS)**
  - “Renewable fuels” (e.g., corn ethanol) must reduce GHG emissions by at least 20% in order to qualify for RIN credits
- **Canadian Clean Fuel Standard (CFS)**
  - Requires liquid fuel suppliers to gradually reduce the carbon intensity of the fuels
- **European Union Renewable Energy Directive (REDII)**
  - Member States must require fuel suppliers to supply a minimum of 14% of the energy consumed in road and rail transport by 2030 as renewable energy.
- **UNFCCC Paris Agreement**
  - Many countries included GHG reductions from transportation sector in commitments
- **Low Carbon Fuel Standard (LCFS)**
  - British Columbia, California, Oregon, Washington,

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Sustainability

- Sustainability is generally considered to be the ability to meet the needs of the present without compromising the ability of future generations to meet their own needs
- Sustainability analysis of all energy options allows an evaluation of each option with the goal of reducing the current and future impacts and maximizing the options for future generations
- Large-scale use of fossil energy is not sustainable, since it cannot be replaced at the same rate it is being consumed
- Bioenergy is one of the alternatives

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Three Pillars of Sustainability

- ***Environmental*** – considers the impacts on the land, water, and air
- ***Social*** – considers the impacts on people, and on society at large
- ***Economic*** – considers both the micro and macro economic impacts of the production and transportation of the feedstocks and processing and use of the final energy components

Evaluation Tools

- *System Boundaries* for each energy option must be identical
- *Use of Verifiable Data* for the purposes of comparing energy options, the evaluation tool should rely on up-to-date empirical and verifiable data
- *Openness, Transparency and Balance* for development of criteria, metrics and standards tools
- *Consensus Process* is critical to all stakeholders involved in the process of developing criteria, metrics and standards in a clearly defined fully participatory, consensus process

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Estimating the Energy & Environmental Benefits

Lifecycle Assessment (LCA)

- Technique to assess environmental impacts associated with all the stages of a product's life from raw material extraction through materials processing, manufacture, distribution, use, repair and maintenance, and disposal or recycling.
- “Cradle to Grave”, well to wheels…

LCA typically includes:

- Compiling an inventory of relevant energy and material inputs and environmental releases;
- Evaluating the potential impacts associated with identified inputs and releases;
- Interpreting the results to help make a more informed decision

Lifecycle Assessment (LCA)

- LCA is used to estimate the energy use and "~~carbon~~ GHG footprint" of transportation fuels
- LCA examines the energy use and GHG emissions related to every step of the process to manufacture, deliver, and use a fuel
  - Uses a consistent functional unit (e.g., grams CO_2e/MJ)
  - Sum of GHG emissions (CO_2, CH_4, N_2O, and other GHG contributors) often called "carbon intensity score," "well-to-wheels total," or "GHG rating"
  - Allows comparisons amongst various fuel options
- Numerous models/tools developed for the purposes of fuel system LCA
  - GREET (U.S. Department of Energy)
  - GHGenius (Canada) *but they are developing a new model*
  - JEC WTW (Europe)

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Type of Lifecycle GHG Analysis

	Attributional	Consequential
Basic Approach:	Attributes energy inputs and outputs and resultant GHG emissions to the various activities directly related to producing, distributing, and using fuels.	Assigns emissions impacts to fuels based on the predicted direct and indirect sector- or economy-wide "consequences" of increased demand for a specific transportation fuel.
System Boundary:	Supply chain + system expansion	Industry sector, related sectors, economy
Primary Tools:	LCA accounting tools (e.g., GREET)	Econometric models + LCA accounting tools
Tools Inputs:	Empirical data	Predictive assumptions + some empirical data
Outputs verifiable?	Yes	Rarely

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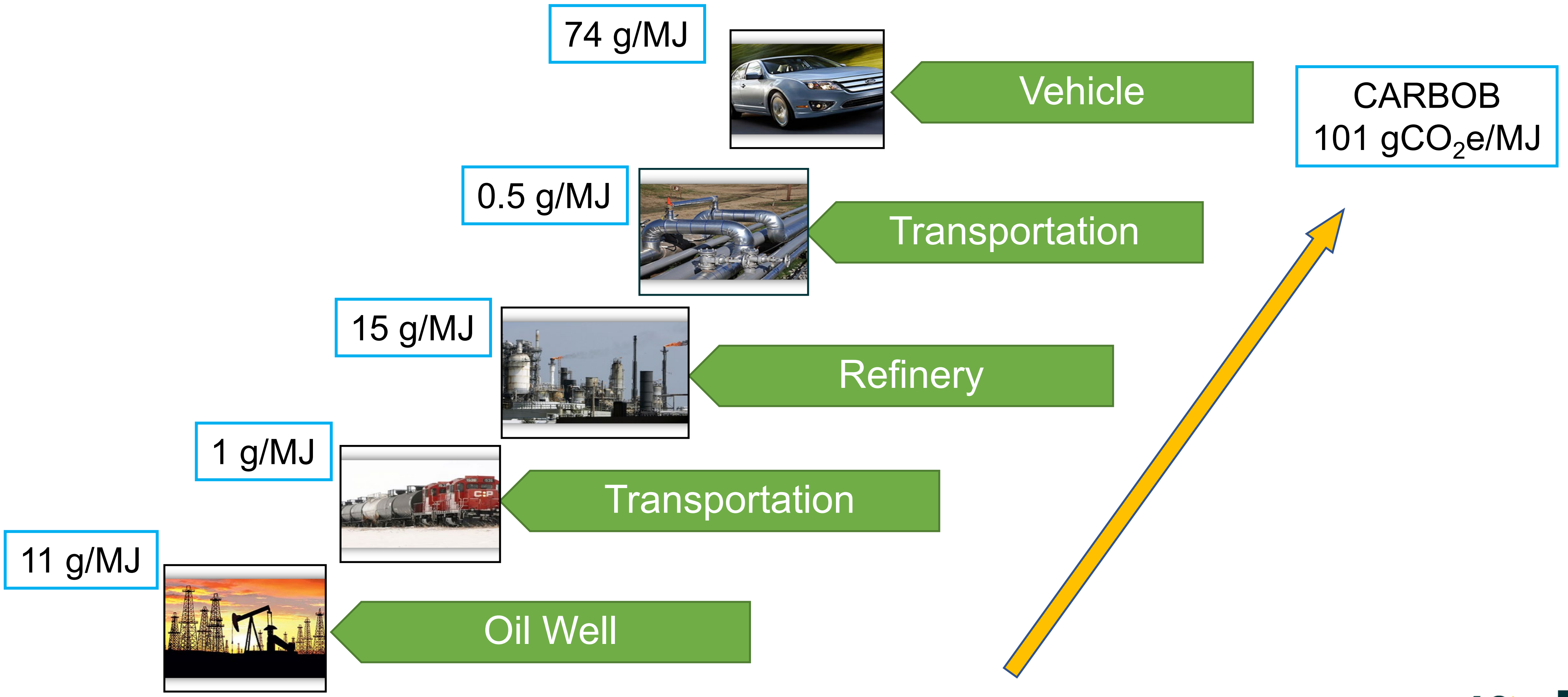
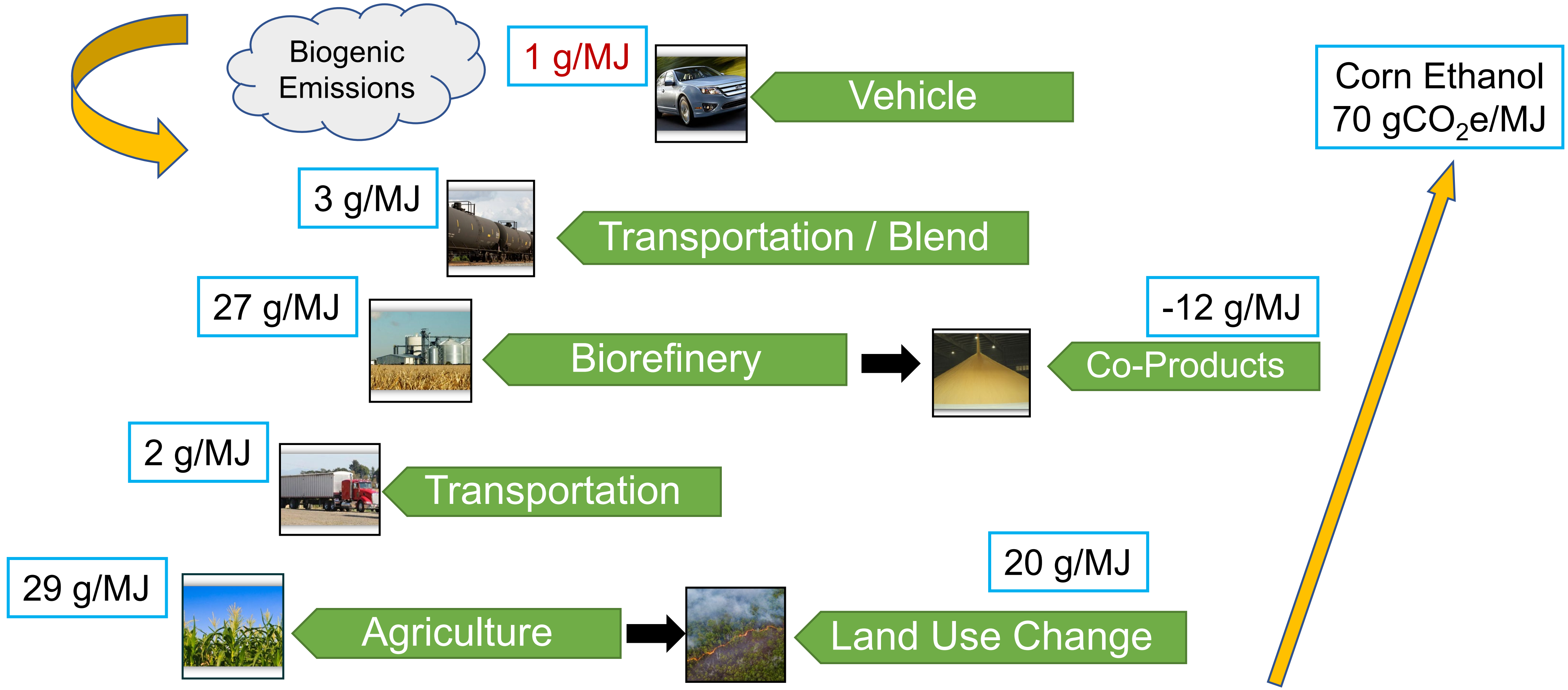
Typical Petroleum Lifecycle GHG Analysis



Source: California Air Resources Board; LCFS

Typical Corn Ethanol Lifecycle GHG Analysis



Source: California Air Resources Board; LCFS

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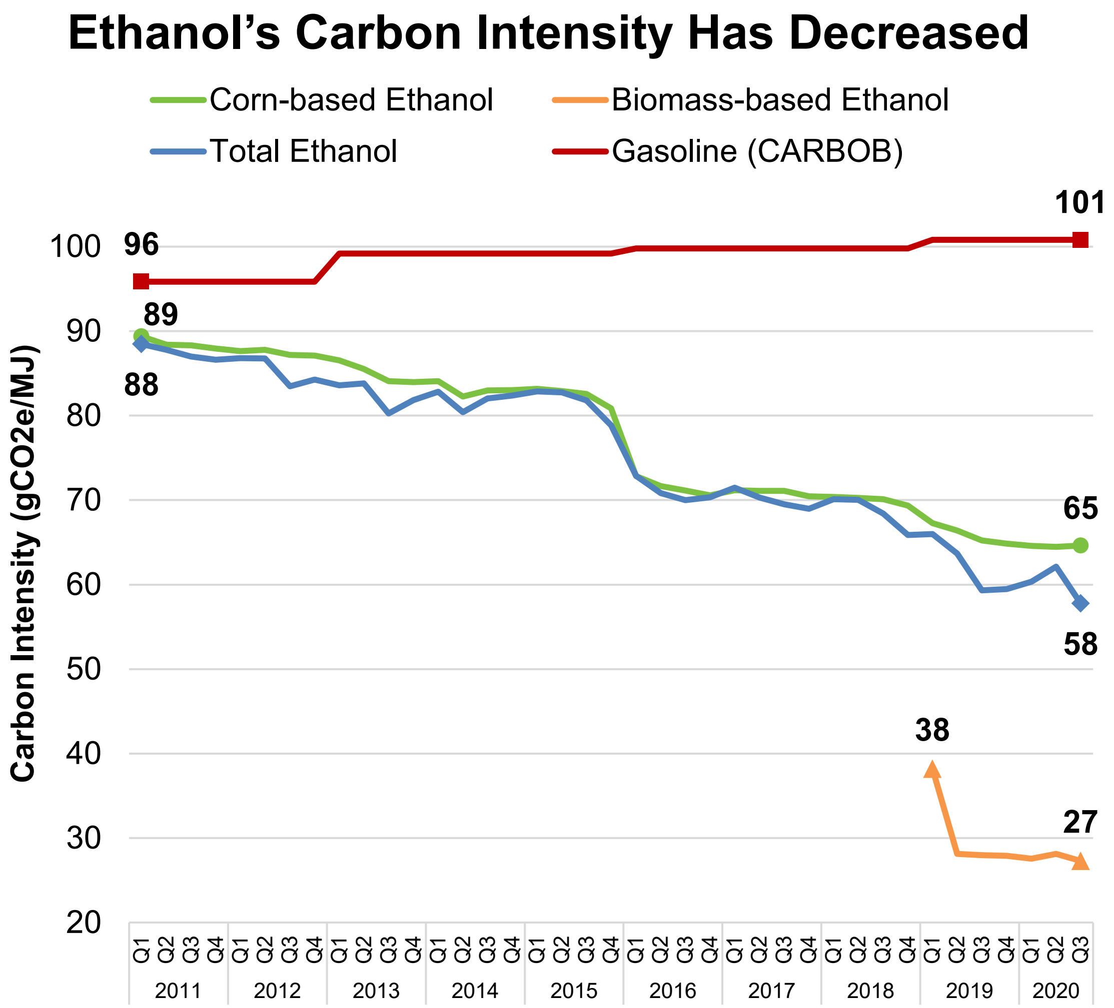
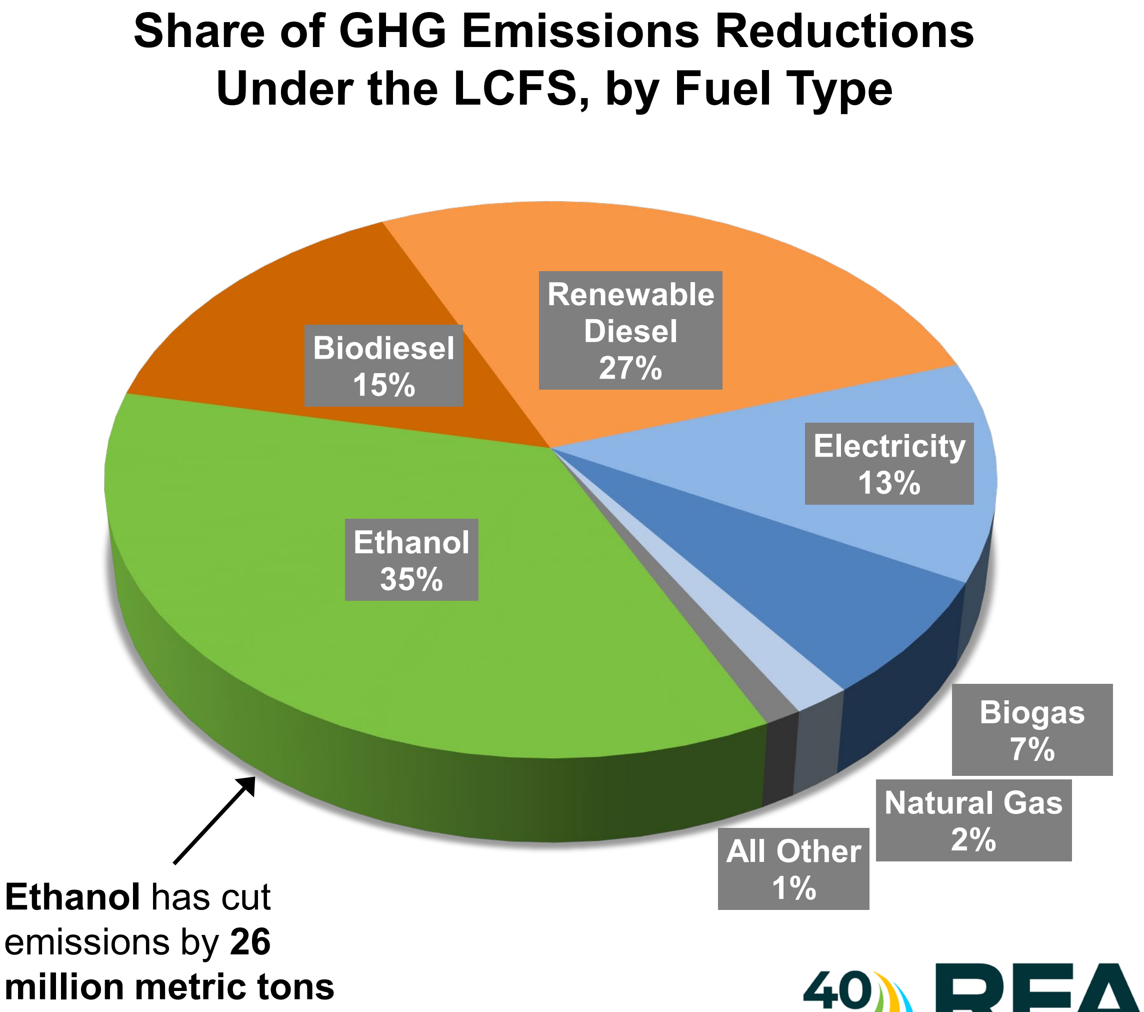
Near-term Decarbonization: Ethanol Has Been the Leading Source of GHG Savings in California





Source: California Air Resources Board

Methods for Co-Product Accounting in LCA

- Displacement / Substitution: Estimates emissions associated with substitute product (e.g., DDGS replacing corn/SBM). Results in “credit” subtracted from total emissions
- Process Energy Allocation: Estimates emissions based on how much energy is used to produce each product
- Energy Content Allocation: Allocates emissions based on energy content of final products
- Mass Allocation: Assigns emissions based on mass of individual product outputs compared to total mass of inputs
- Economic Allocation/Market Value: Allocates emissions based on market values

Treatment of DDGS in Corn Ethanol LCA

- Corn ethanol LCA typically uses displacement method to account for co-products
- Assigns credits to a co-product equivalent
- This method is the most closely related to the environmental impact of the co-product
- Also considers market effects and greater availability
- Requires expansion of the LCA to substitute products
- The substitute products then require an LCA that addresses any co-products

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Treatment of DDGS in Corn Ethanol LCA

- Distillers Grains moisture content and energy use for drying
  - DDG/S vs. Modified vs. WDG
- Distillers Grains yield per corn bushel processed
- How much of each "traditional" feed ingredient is replaced by 1 lb. of DDG's
  - How much corn? How much SBM?
  - How much other (lime, inorganic phos, urea, etc.)
- CARB and EPA originally assumed 1 lb. of DG replaced only 1 lb. (or less) of corn
  - Ingredient replacement varies dramatically by species
  - DDGS replaces more than corn!

Distillers Grains and Indirect Effects

- Co-products also play an important role in estimation of consequential indirect effects
  - **ILUC**: Only **two-thirds** of a “new” acre of corn for ethanol is used for biofuel (by mass). The other **one-third** of the acre produces animal feed. Thus, emissions from the LUC should be allocated accordingly.
    - By displacement, roughly **half** of “new” acre goes to animal feed sector.
  - **Methane**: Research shows inclusion of DG in animal diets reduces methane emissions.
  - **DG Exports**: Reduces pressure for increased crop production (land expansion) in international markets

Improving Co-Product Treatment in LCA

- Refine the GHG emissions from petroleum pathways
- Include indirect effects and co-products in petroleum GHG calculations
- Consider avoidance of marginal petroleum GHG emissions as an indirect effect of biofuels substitution
- Incorporate co-product effects of CRF and soy oil into RFS2 and LCFS ratings for corn ethanol
- Continue to monitor corn ethanol production by production technology
- Consider corn from starch and cellulose as a single feedstock/fuel pathway when assessing the national impact of renewable fuels

RFA

July 27, 2021

The President
The White House
1600 Pennsylvania Avenue, N.W.
Washington, D.C. 20500

Dear Mr. President,

As members of the Renewable Fuels Association (RFA), we share your vision for decarbonizing the transportation fuels sector and we applaud your commitment to addressing climate change. We support your goals of achieving a 50 percent reduction in U.S. greenhouse gas (GHG) emissions by 2030 and reaching net zero emissions economywide by 2050.

Low-carbon renewable fuels like ethanol are already helping our nation confront climate change by significantly reducing GHG emissions from the transportation sector. In fact, since 2008, the use of ethanol and other renewable fuels in the United States has prevented nearly **1 billion metric tons** of GHG from entering the atmosphere.[i]

Today's ethanol already reduces GHG emissions by **52 percent**, on average, when compared directly to gasoline.[ii] Furthermore, many of us are already producing advanced and cellulosic ethanol that is certified by the California Air Resources Board as providing a **65-75 percent** GHG reduction compared to gasoline.[iii]

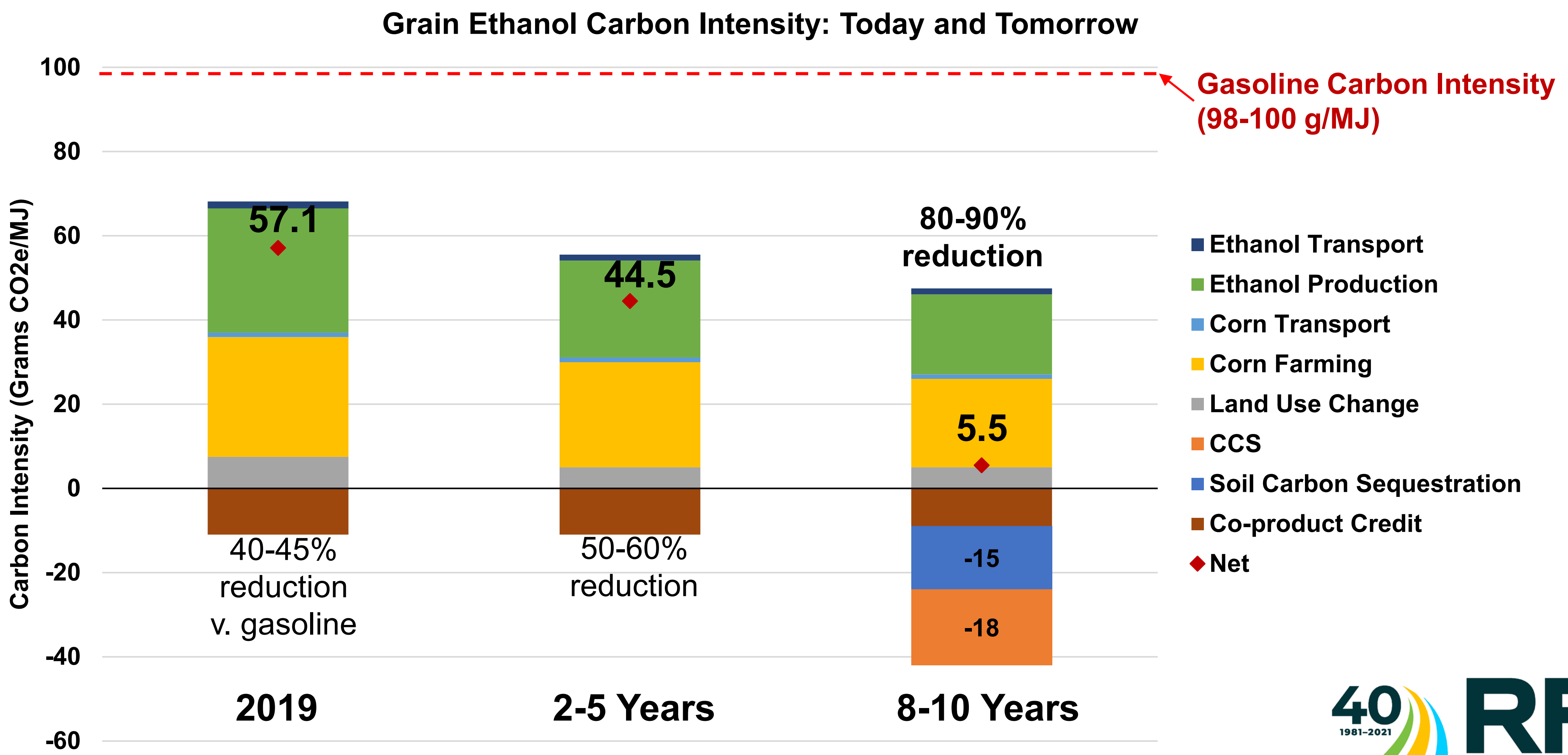
But given the urgency of the climate crisis and the need to reasonably decarbonize, we can—and must—do more. **Therefore, the producer members of the Renewable Fuels Association are committing today to the pursuit of the following carbon performance goals:**

- **By 2030, ensure that ethanol reduces GHG emissions by at least 70 percent, on average, when compared directly to gasoline.** This equates to a 33 percent reduction in ethanol's average carbon footprint from 45 grams CO_2-equivalent per megajoule (g/MJ) today[iv] to about 30 g/MJ by 2030.

- **By 2050, ensure that ethanol achieves net zero lifecycle GHG emissions, on average.** As ethanol producers continue to adopt carbon capture, utilization, and sequestration (CCUS) and other low- and no-carbon technologies between 2030 and 2050, U.S. ethanol can achieve **net carbon neutrality,** on average, by mid-century or even sooner.

Ethanol's carbon footprint continues to shrink rapidly, as new technology and innovation have improved the efficiency of the entire production process. In fact, a recent study by Department of Energy (DOE) scientists found that ethanol's carbon footprint shrunk by 23 percent between

Low-Carbon Corn Ethanol Is Coming, and Ethanol Has the Potential to Be Carbon Negative



Source: RFA analysis using GREET1_2019 and user-defined assumptions/projections www.**ethanolrfa**.org

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