# ADVANCED BIOFUELS:

# WHY DO WE WANT THEM?

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EESI
Environmental and
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- Founded in 1984 by a bipartisan Congressional caucus as an independent non-profit organization (but receives no Congressional funding)
- Source of non-partisan information on energy and environment policy development for Congress and other policymakers
- Climate change is one of the most serious problems facing civilization today — impacting infrastructure, water supply, agriculture, public health and natural ecosystems

## Outline:

- Do we still need biofuels?
- What is an advanced biofuel?
- GHG profile of biofuels vs. oil
- Other benefits of biofuels

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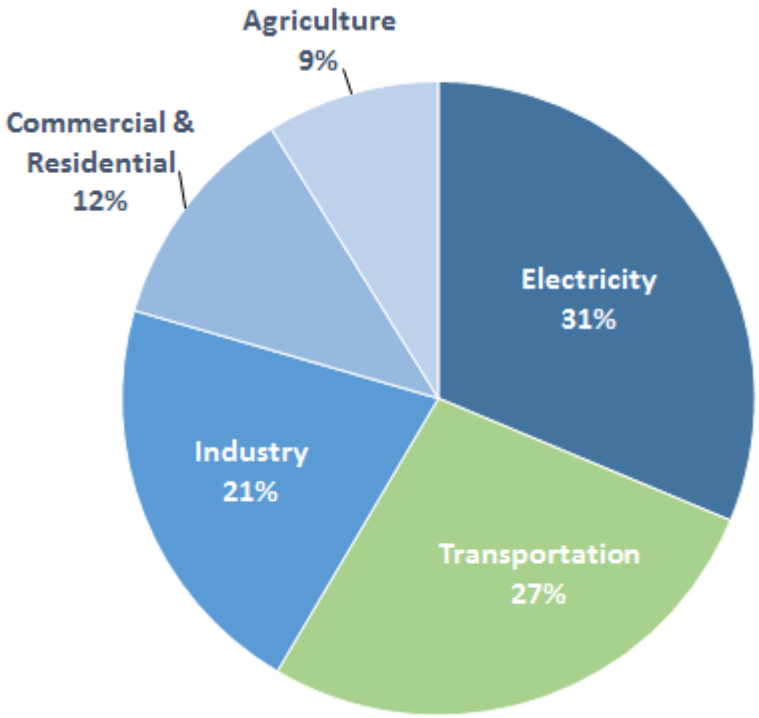
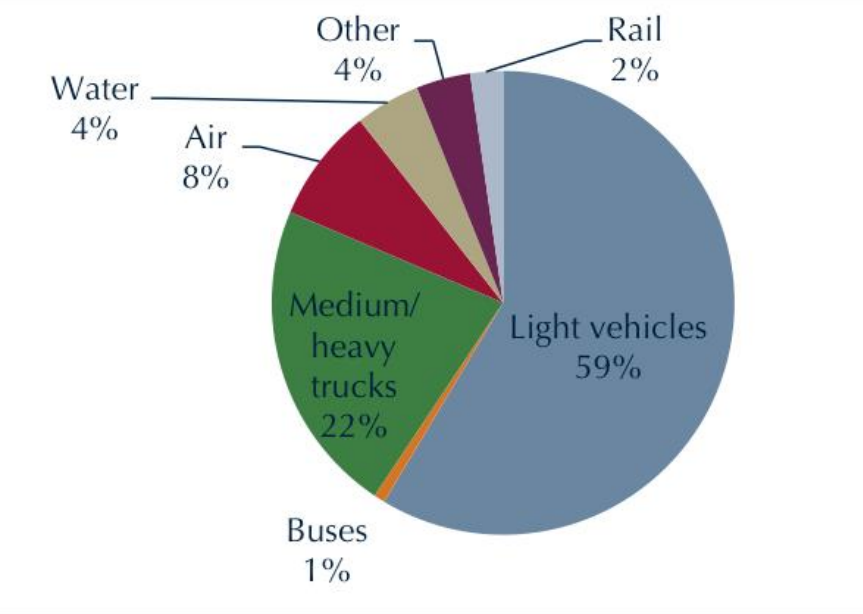
# GHG Emissions from Transportation




Total U.S. Greenhouse Gas Emissions by Economic Sector in 2013, U.S. EPA




U.S. Department of Energy. Transportation Energy Data Book 2014, U.S. DOE

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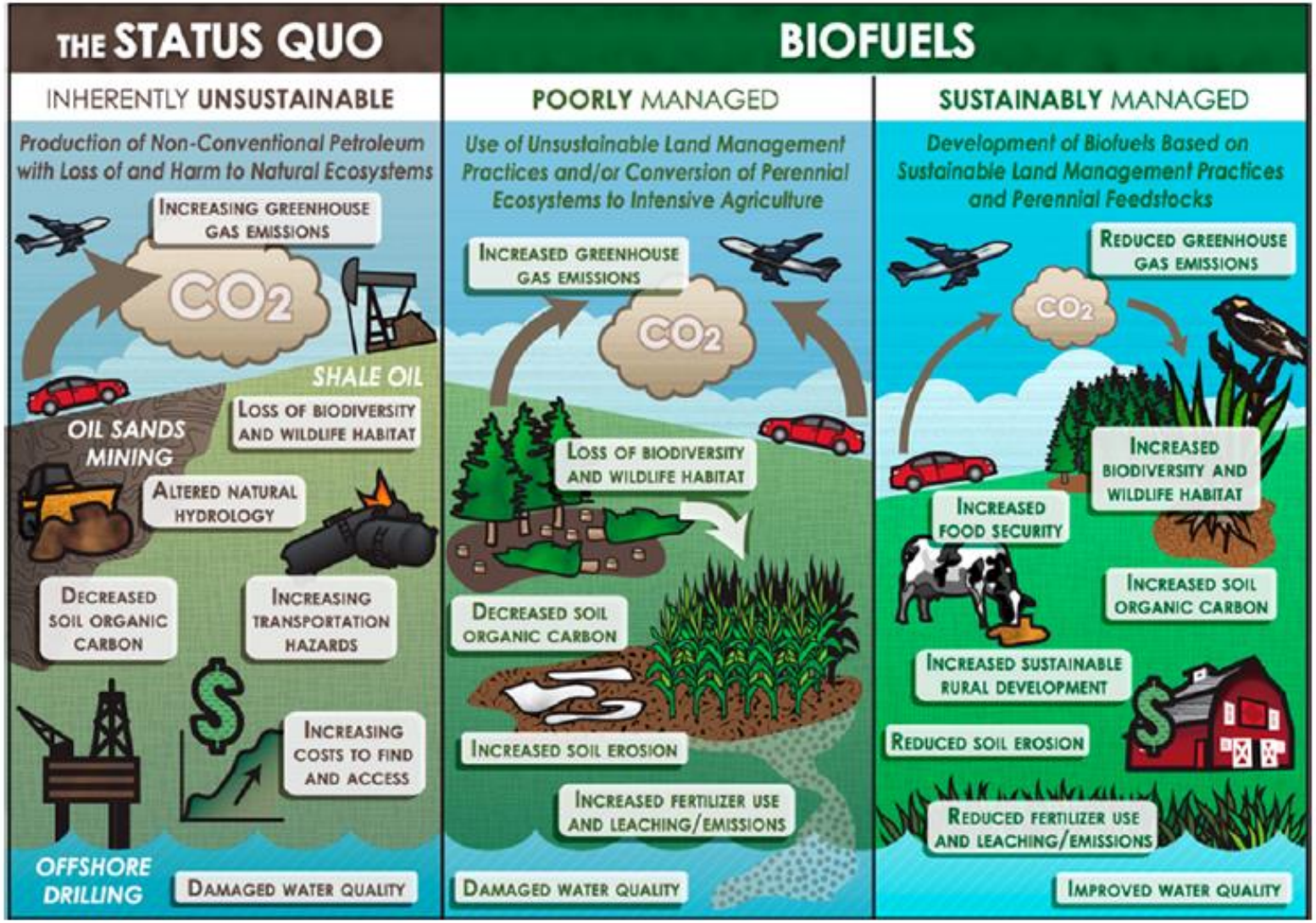
# Biofuels Need to be Done Sustainably




B. Dale et al., Take a Closer Look: Biofuels Can Support Environmental, Economic & Social Goals, Enviro. Sci & Tech., 2014.

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# Renewable Fuel Standard: EPA Fuel Categories

| Fuel | GHG threshold reduction (%) | RFS 2022 Volumes |
|---|---|---|
| **Conventional biofuel** | 20 | 15 bgal |
| **Advanced biofuels** | 50 | 21 bgal |
| **Biomass based-diesel** | 50 | |
| **Cellulosic biofuel** | 60 | |

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# Advanced Biofuels: Ethanol, Biodiesel, Jet & Marine


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Idaho National Lab via a Creative Commons license

Texas A&M via a Creative Commons license

## "Wastes":

- Crop Residue
- Organic wastes
- Forestry waste

## Purpose grown:

- Perennial grasses
- Fast growing woody crops
- Grasses
- Legumes
- Algae, cyanobacteria

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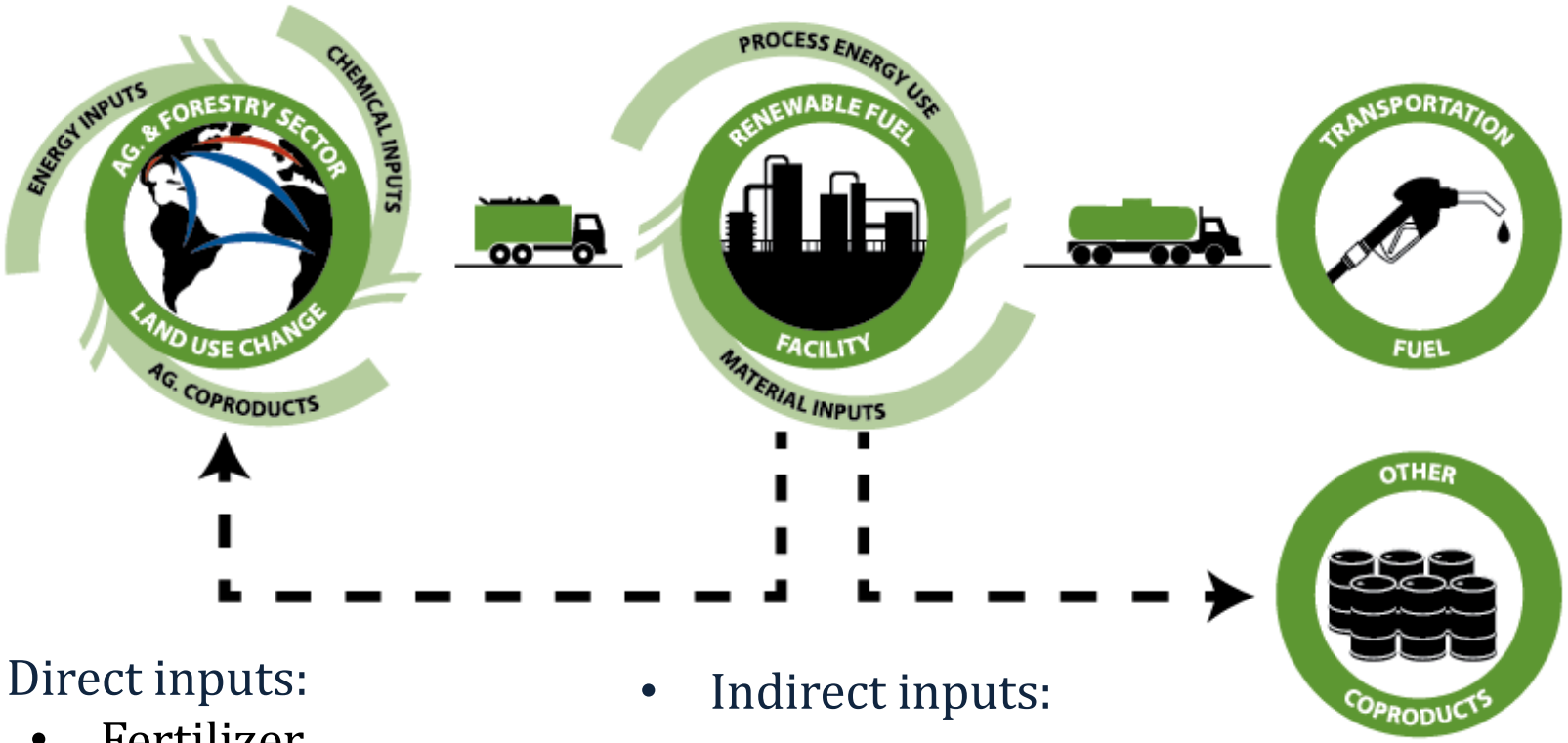
# Well to Wheels GHG Accounting




- Direct inputs:
  - Fertilizer
  - Energy
- Indirect inputs:
  - Land use change
- Outputs:
  - Main: fuel
  - Co-products: electricity, high protein animal feed, oils.

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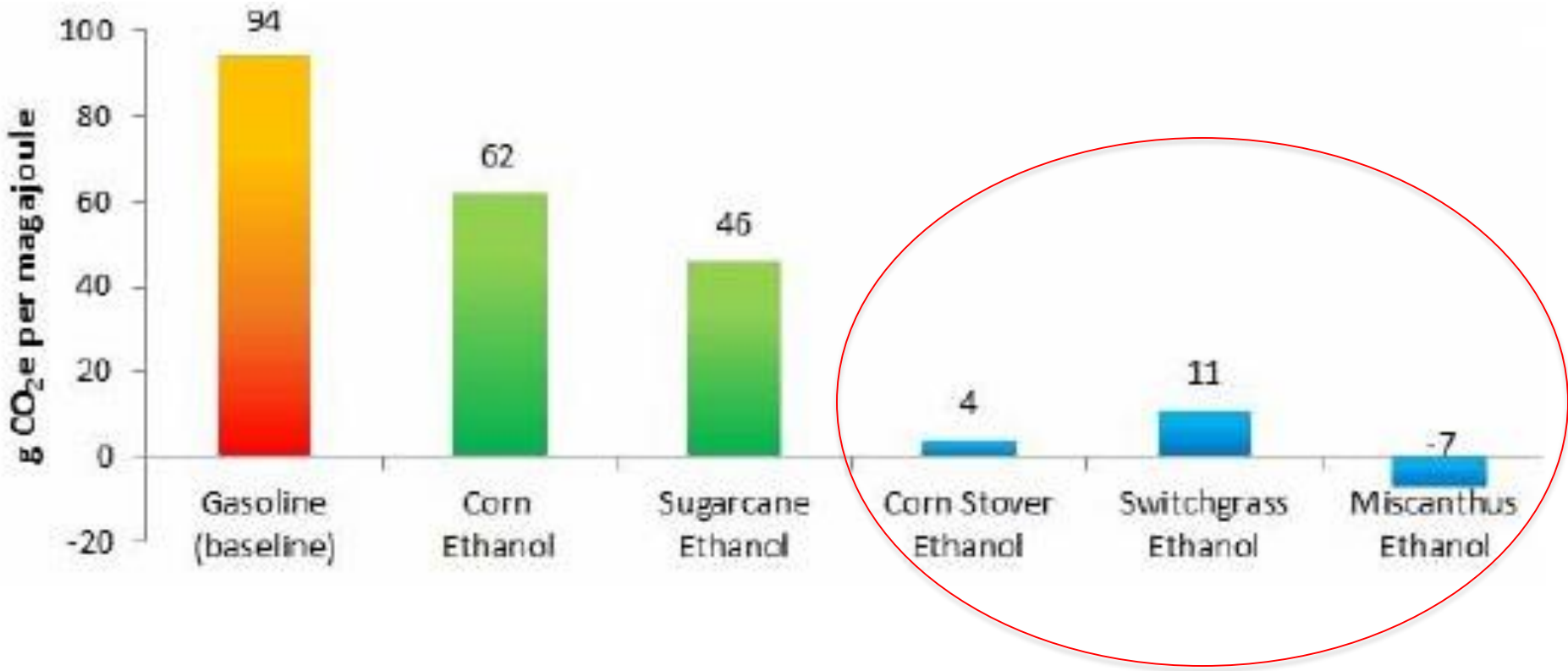
# Well to Wheels GHG Accounting for Fuel Feedstocks – g CO2/mj




**M. Wang et. al., "Well-to-Wheels Energy Use and Greenhouse Gas Emissions of Ethanol from Corn, Sugarcane, and Cellulosic Biomass for US Use." Enviro. Research Letters, 2012.**

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# GHG Well to Wheels: Mandated vs. Actual

| Company/Fuel | Feedstock | RFS GHG Reduction Mandate (%) | EPA Pathway actual (%) |
|---|---|---|---|
| **Poet Laddonia: Ethanol** | Corn starch | 20 | 28.2% |
| **High Plains Bioenergy: Biodiesel** | Waste fats & oils | 50 | 78% |
| **ENVIA: Biogas** | Landfill gas | 60 | 77% |
| **Algenol: Ethanol** | Algae | 60 | 69% |

U.S. EPA, Approved Pathways

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# GHG Well to Wheels: BioJet Fuel

| BioJet feedstock | GHG reduction potential relative to jet fuel (%) |
|---|---|
| **Cellulosic (algae, crop wastes etc.)** | 41 – 63% |
| **Oil seed crops** | 68 -76% |
| **corn stover (100%)** | 89% |

J. Han et. al., "Life-cycle analysis of bio-based aviation fuels." Bioresource Tech., 2013.

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# GHG Well to Wheels: Oil

- Conventional crude:
  - Easy to extract & refine
  - Naturally occurring in liquid form

- Unconventional crude:
  - Energy intensive to extract & refine
  - Examples: fracking, tar sands, offshore drilling
  - Canadian tar sands: 18 – 21% higher emissions than conventional crude oil.


- **Understanding Unconventional Oil, Carnegie Endowment for Peace, 2012**
- **C. Hai et. al, Well-to-Wheels Greenhouse Gas Emissions of Canadian Oil Sands Products: Implications for U.S. Petroleum Fuels, Enviro Sci. & Tech., 2015**


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# Fuel Choice Effects Beyond GHGs

45 million Americans live, go to school or work within 300 feet of a major roadway, airport or railway. -- U.S. EPA

- Gasoline contains ~25% by volume gasoline aromatics
- Gasoline aromatics → benzene, toluene, ethylbenzene & xylene
- Increasing the volume of ethanol in gasoline lowers toxic gasoline additives

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# Takeaways:

- Biofuels are a necessary piece in de-carbonizing the transportation sector
- Sustainability is KEY – and goes beyond GHGs
- Progress on sustainability is being made, and needs to continue
- Renewable fuels are more than just corn ethanol

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# THANK YOU

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