



# GREET Life-Cycle Analysis Model Introduction

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Presentation to the CARB Board, September 28, 2023



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## *Trend of Life Cycle Analysis (LCA)*

- ❑ LCA holistically evaluates sustainability of technologies and policies
  - From singular stages to the complete supply chain; shift in environmental burdens from one stage to another is not missed
  - LCA thinking has helped changes in corporation and consumer behaviors
- ❑ Recent trends of transportation LCA applications
  - US domestic regulations and programs
    - ✓ Regulations such as the CA LCFS (and several other states) and EPA RFS
    - ✓ The Inflation Reduction Act incentives for clean hydrogen, sustainable aviation fuels, and clean fuels are based on LCA GHG results
  - International regulations and programs
    - ✓ International Civil Aviation Organization's CORSIA program for SAFs
    - ✓ International Marine Organization's discussion of potential low-GHG fuel standard
    - ✓ EU Renewable Fuel Directive
    - ✓ Canadian Clean Fuel Standard
    - ✓ Brazilian RenovaBio Program



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## ***Life cycle analysis of technologies vs. corporate 3-scope emissions***

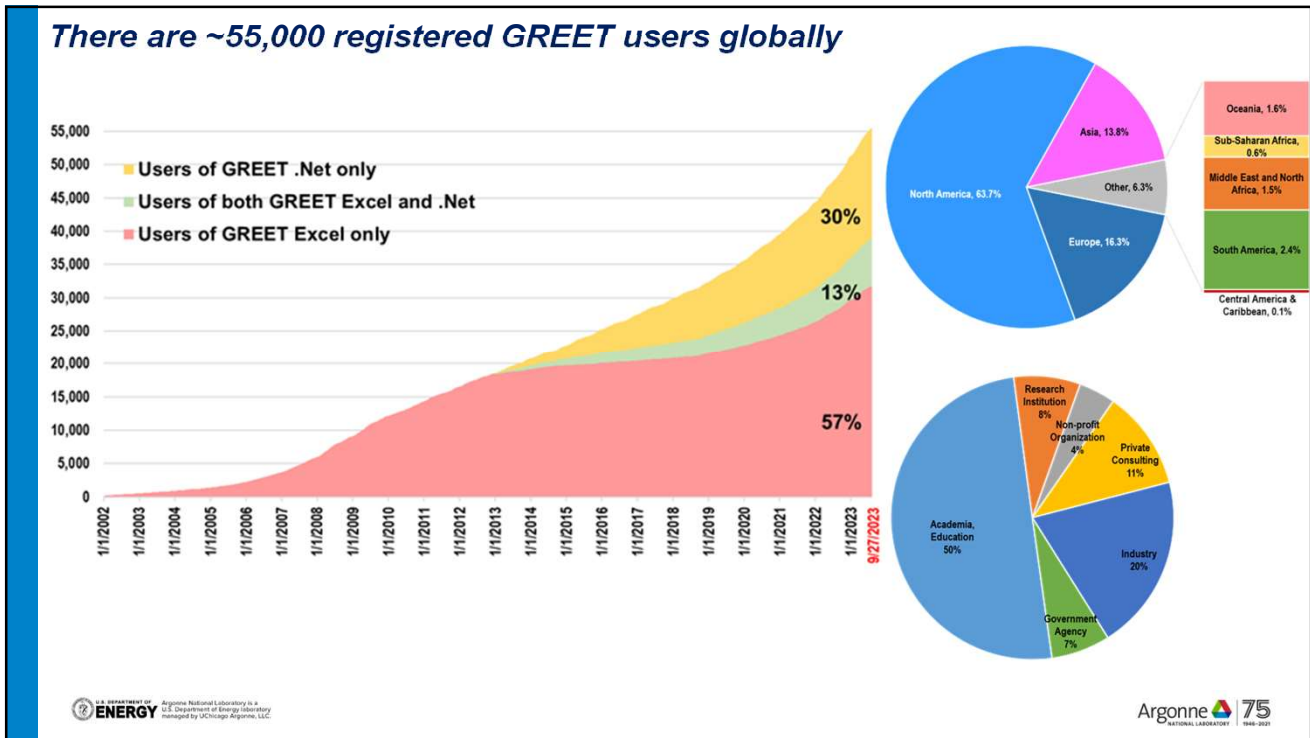
- ❑ Technology LCA: environmental footprints of technologies (e.g., different fuel production technologies)
  - The fuel cycle (the WTW cycle)
  - The vehicle cycle and the facility cycle
  
- ❑ Corporate supply chain environmental footprints (e.g., GHG Protocol by WRI and WBCSD)
  - Scope 1 emissions
  - Scope 2 emissions
  - Scope 3 emissions

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## ***The GREET (Greenhouse gases, Regulated Emissions, and Energy use in Technologies) Life Cycle Analysis Model***

- Argonne has been developing the GREET LCA model since 1995
- Annual updates and expansions: 2023 release is scheduled for Mid-Oct
- GREET is in public domain at [greet.anl.gov](http://greet.anl.gov)
  
- **GREET sponsors: DOE**
  - ✓ EERE: Vehicle Technology Office; Hydrogen and Fuel Cell Technology Office; Bioenergy Technology Office
  - ✓ ARPA-E
  - ✓ Office of Technology Transitions (OTT)
  - ✓ Fossil Energy and Carbon Management Office
  - ✓ Nuclear Energy Office
- **GREET sponsors: other federal agencies**
  - ✓ Federal Aviation Administration of DOT
  - ✓ Federal Maritime Administration of DOT
  - ✓ Federal Rail Administration of DOT
  - ✓ USDA
  - ✓ The National Institute of Standards and Materials of Department of Commerce

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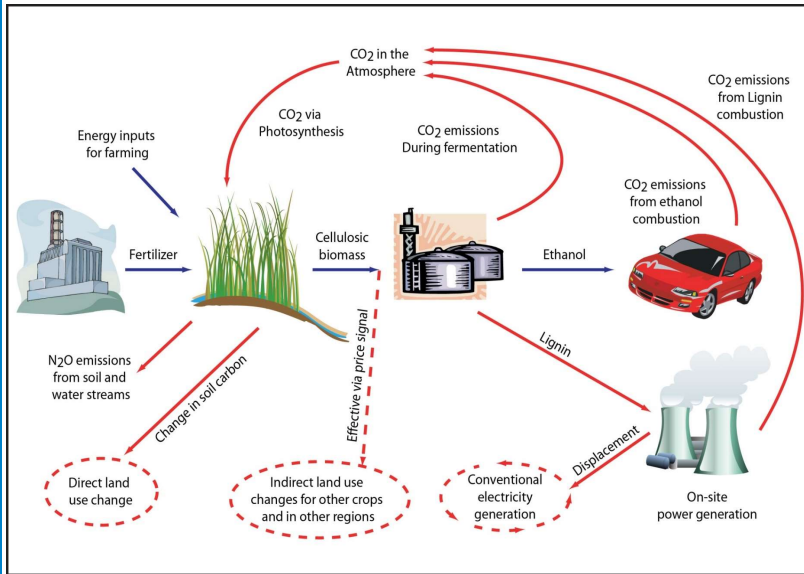
**LCA in general, GREET in particular, is data intensive**

- ❑ Background vs. foreground data: in relation to specific technology under LCA
  - Background data:
    - ✓ Improvements of the rest of economy on specific technology under LCA
    - ✓ Consistency is key
  - Foreground data
    - ✓ Representation of specific technology under LCA
    - ✓ Geographic and temporal differences
    - ✓ **Verification is key**
- ❑ Primary vs. secondary data: related mainly to foreground data
  - **Primary data: data from facility operations (reporting, surveys, etc.)**
  - Secondary/proxy:
    - ✓ Simulations with process engineering modeling (techno-economic analysis)
    - ✓ Literature data
    - ✓ Approximation
    - ✓ Mass and energy balance can help verification

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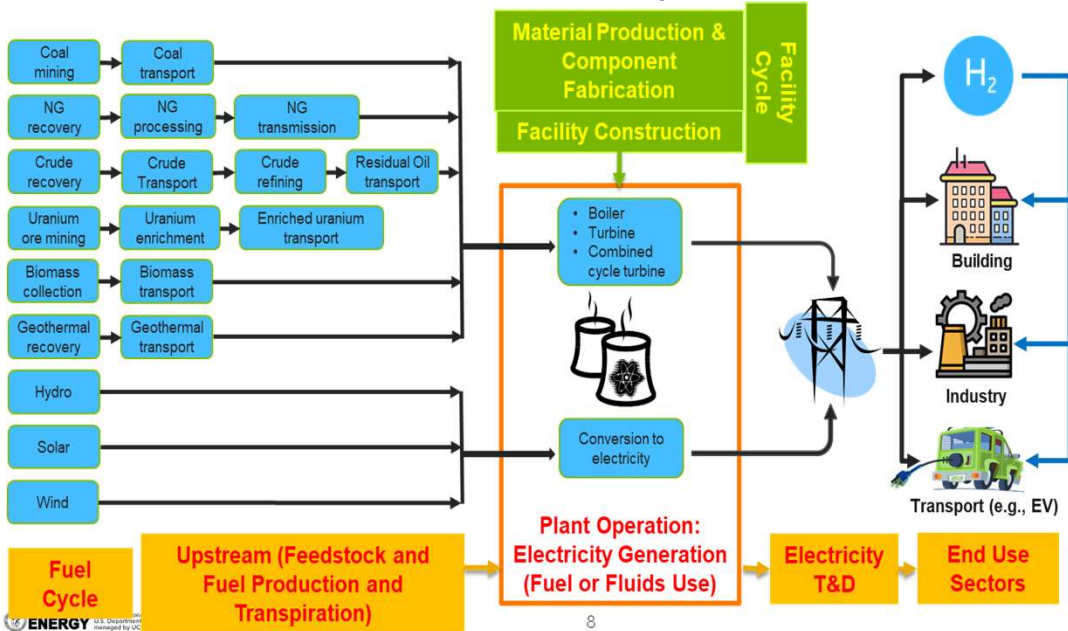
**Example of biofuel LCA: direct activities and indirect effects are included**



**Key stages of biofuel LCA**

- Fertilizer production
- Farming activities
- Biofuel conversion
- Direct and indirect land use changes

**Example of electricity LCA: facility cycle for energy production (sometimes called embodied emissions) is included**



Questions?

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Visit <https://greet.anl.gov/>

