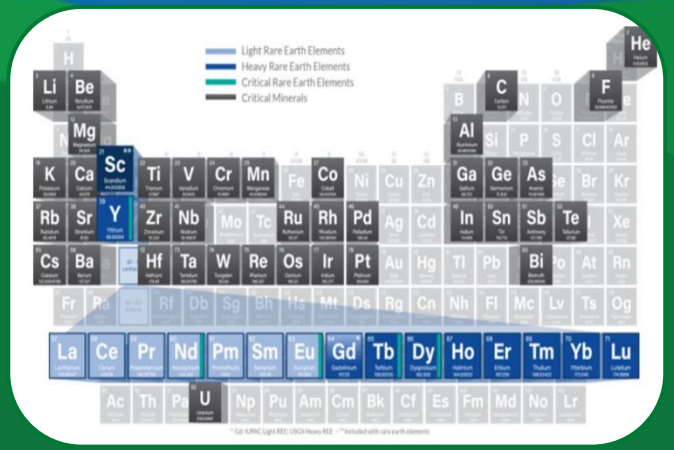
U.S. DEPARTMENT OF ENERGY
Fossil Energy and Carbon Management

Life Cycle Analysis for CO_2 Conversion

Regional Carbon Conversion/Utilization Procurement Grants Workshop



Section 40302 Carbon utilization program

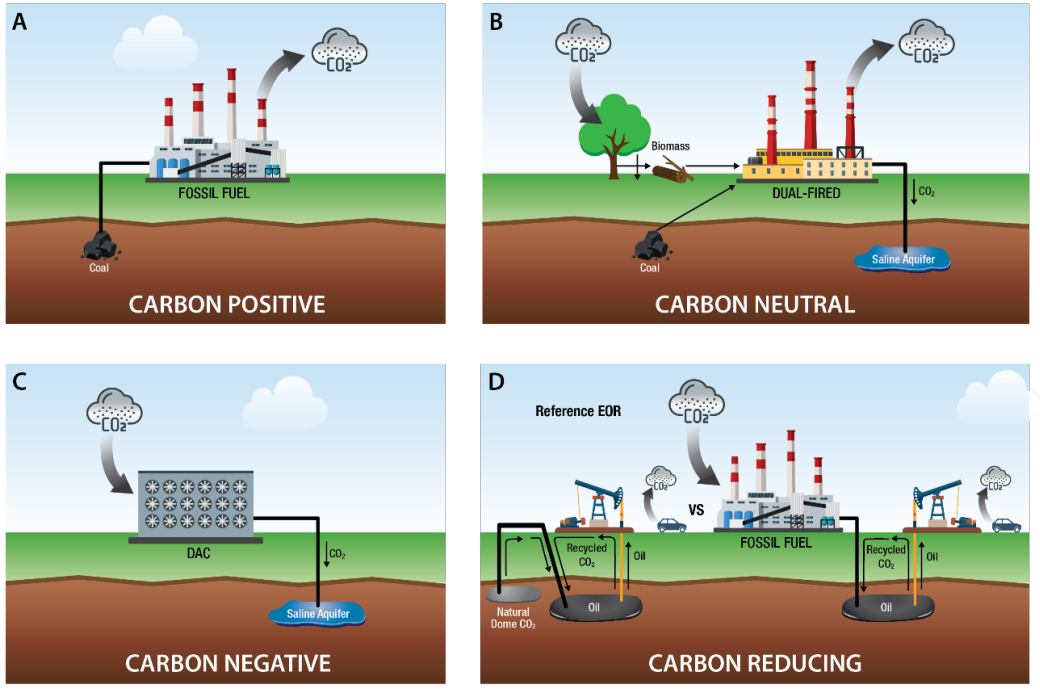
"(D) USE OF FUNDS.—An eligible entity shall use a grant received under this paragraph to procure and use commercial or industrial products that —

"(i) use or are derived from anthropogenic carbon oxides; and

"(ii) **demonstrate significant net reductions in lifecycle greenhouse gas emissions** compared to incumbent technologies, processes, and products."

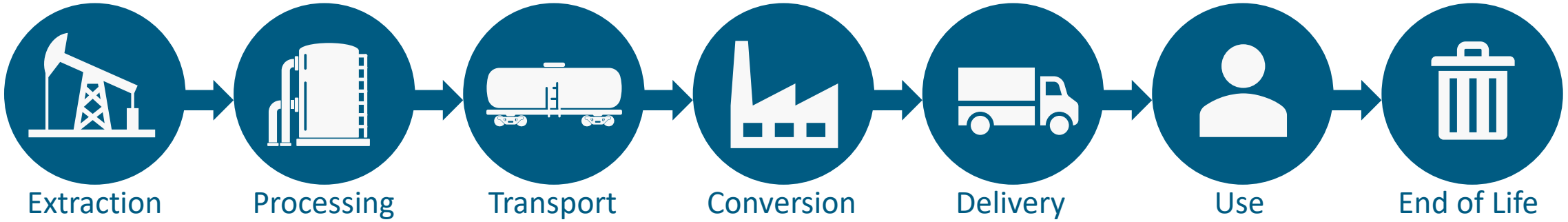
Why Require a Lifecycle Reduction?

- Carbon utilization products are not always environmentally beneficial
- A carbon utilization system is likely to require more energy to produce something than incumbent system
- A lifecycle comparison of both systems is necessary to ensure we're not adding more carbon to the atmosphere



Source: NETL (2022)

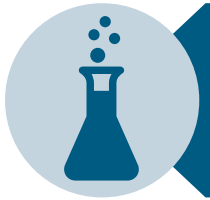
What is Life Cycle Assessment (LCA)?



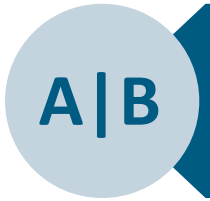
LCA is a technique that helps people make better decisions to improve and protect the environment by accounting for the potential impacts from raw material acquisition through production, use, end-of-life treatment, recycling, and final disposal (i.e., cradle-to-grave).

How Do We Use LCA?

Establish National Baselines



Assess Emerging and Existing Technologies



Compare Technology and Scenario Tradeoffs

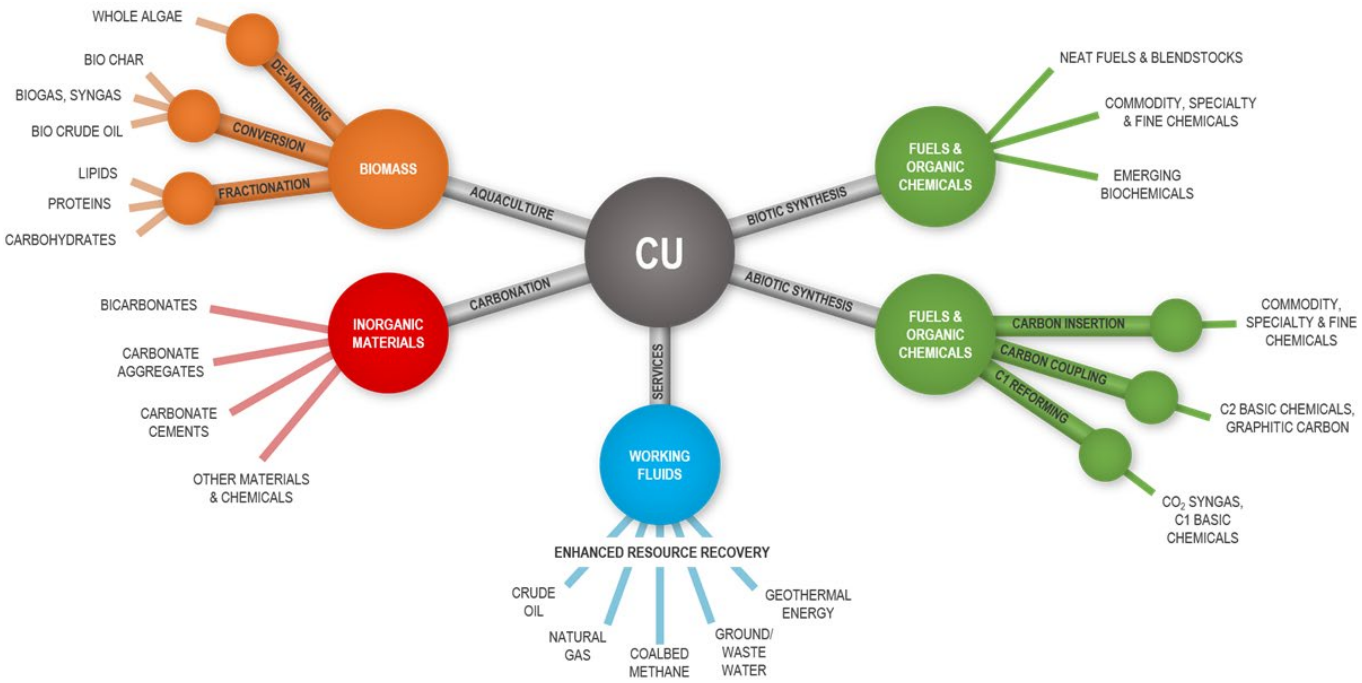
Plan for the Future and Look Ahead

Why LCA?

- **Guide research and development investment.**
  We want to invest in emerging technologies that are better than existing technologies.
- **Evaluate existing systems to identify opportunities for improvement.**
  Where should we invest to obtain the greatest return on investment?
- **Identify data gaps and validation needs to improve decision-making.**
  Inform and guide environmental field monitoring activities (data collection).
- **Assess potential benefits from commercializing technologies.**
  Quantify the environmental value at various levels of commercial adoption (at what scale will our technology make a measurable difference?).

Application of LCA to CCUS Systems

- CO2U systems are unique in that they combine two sectors (CO2 source and CO2U product)
- Variety of sources and uses make assessment complex
- Comparison of integrated system to combination of systems that yield the same function
- Consistent LCA approaches are necessary to ensure comparability for robust decision making



National Energy Technology Laboratory (NETL) CO2U LCA Guidance

Developed specialized CO2U LCA guidance to address the following needs of the carbon conversion community:

- Improving clarity and specificity of existing ISO guidance.
- Ensuring accuracy of LCAs developed by technical personnel who are new to the framework.
- Minimizing PI effort needed to complete LCAs.
- Participation in global community (slide 19).

NETL CO2U LCA Guidance

How do we improve clarity and specificity of existing guidance?

- Guidance included in the NETL CO2U LCA Toolkit is ISO* compliant.
- Additional guidance is provided specific to CO2U systems to:

1. **Understand feedstocks and technology pathways.**

   Knowledge of application enables more specific focus and guidance depending on methodological choices.

2. **Ensure methodological consistency in applying the ISO standards.**

   ISO standards provide a broad framework for applying LCA to a wide range of applications, which can lead to inconsistency.

3. **Define study goal and scope based on project Technology Readiness Level (TRL).**

   This guidance aims to assist principal investigators in completing their comparative LCAs at different stages of technology development.

*International Standards Organization, "ISO 14040:2006: Environmental management -- Life cycle assessment -- Principles and framework," 2006. Available: https://www.iso.org/standard/37456.html.
International Standards Organization, "ISO 14044:2006: Environmental management -- Life cycle assessment -- Requirements and guidelines," 2006.Available: https://www.iso.org/standard/38498.html.

NETL CO2U LCA Guidance

How do we ensure accuracy of LCAs developed by technical personnel who are new to the framework?

- NETL LCA team provides videos, webinars, and one-on-one support throughout the LCA development process
- NETL LCA team completes a technical review of all PI LCAs
- Guidance and data ensure consistency and repeatability:
  1. **Consistent data for common inputs.**
  2. **LCA instruction for novices.**
  3. **Scenario development.**
  4. **Methodological decisions.**

NETL CO2U LCA Guidance

How do we minimize the effort needed for PIs to complete LCAs?

- Want to avoid burdensome requirements while providing useful and actionable results for decision-makers
- Diverse set of technologies, but there are many commonalities such as feedstock
- Structure the toolkit to provide guidance for all stages of the LCA

1. **Goal and scope identification.**
2. **LCI data.**
3. **Modeling.**
4. **Results interpretation.**
5. **Reporting.**

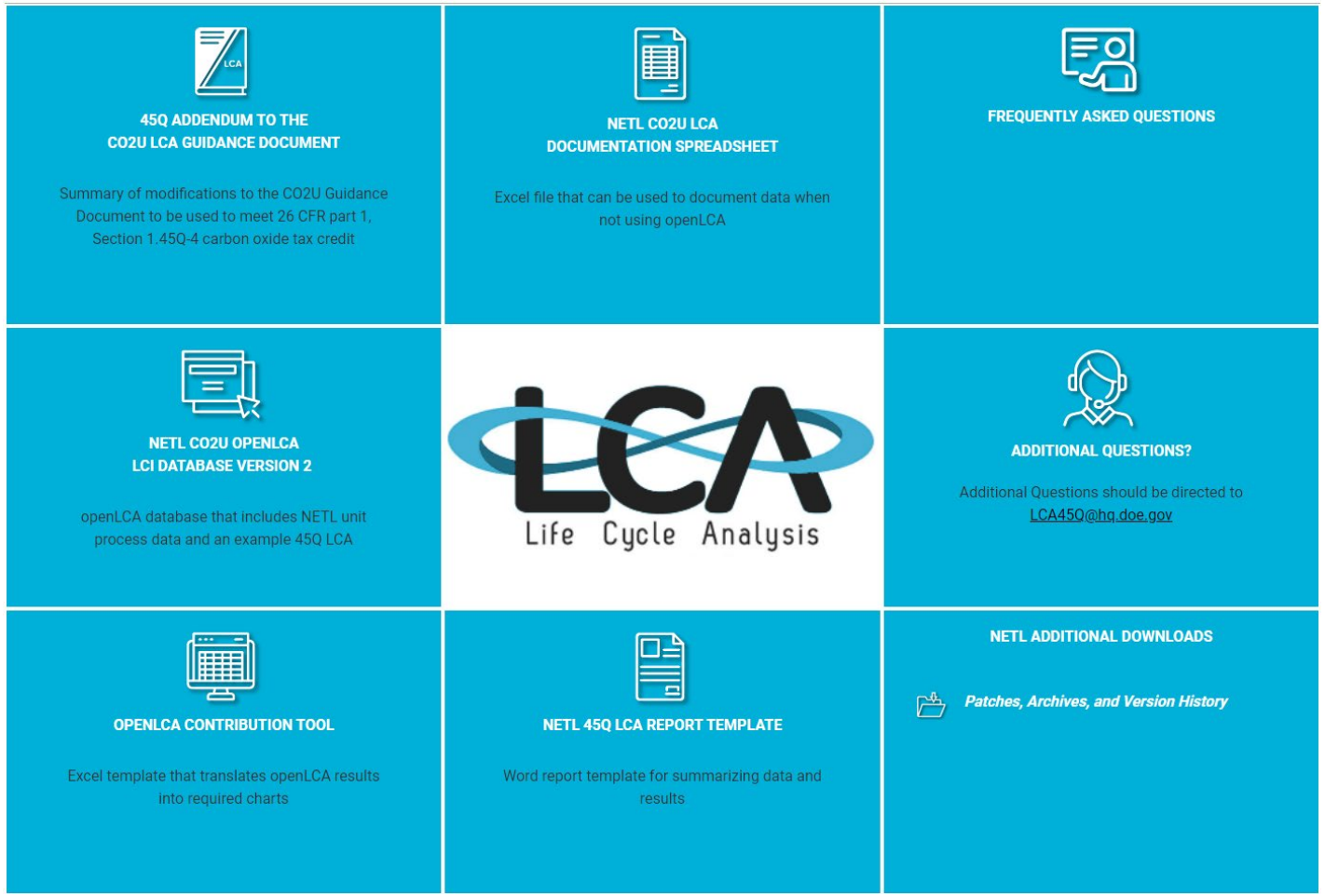
DOE/NETL CO2U LCA Guidance Toolkit

- CO2 utilization LCA guidance and tool package for Carbon Utilization Program primary research projects
- LCA guidance, open source LCA software (openLCA), NETL data, and results reporting tools
- An openLCA database has been populated with data and an example to help conduct LCA within the openLCA software
- An Excel tool has been created to take openLCA results and translate them into stacked bar charts for results communication

Toolkit available at netl.doe.gov/LCA/CO2U

45Q Addendum to the Toolkit

- **Modifies existing language from CO2U Guidance Document**
- **Shares existing tools from the CO2U toolkit**
- **Changes scope to fit new purpose**
  - No longer focused on early development technologies
  - Focus on verifiability
- **Addendum site: netl.doe.gov/LCA/CO2U/45Q**



Preliminary LCA Process for UP Grant Program

1.

Product producer completes LCA for eligible product(s) in accordance with DOE/NETL guidelines and submits for review

2.

DOE reviews producer LCA:

- Conformance with guidelines
- Minimum of 10% improvement over business-as-usual

3.

Once approved, producer and product are added to an approved list of vendors

4.

Eligible entities identify suppliers of products that qualify for grant funding and establish a purchase agreement

Contributions to Global Discussion

- The FECM/NETL LCA Team has been participating in numerous global workgroups to ensure CO2U LCA is consistent:
  - International CCU Assessment Harmonization Group
  - American Center for Life Cycle Assessment (ACLCA) and Society of Environmental Toxicology and Chemistry (SETAC) LCA of Emerging Technologies Workgroup

- The collaboration with the International CCU Assessment Harmonization Group has resulted in several peer-reviewed articles in Frontiers in Climate:
  - Life-Cycle and Techno-Economic Assessment of Early-Stage Carbon Capture and Utilization Technologies – A Discussion of Current Challenges and Best Practices
  - Adapting Technology Learning Curves for Prospective Techno-Economic and Life Cycle Assessment of Emerging Carbon Capture and Utilization Pathways
  - Why Terminology Matters for Successful Rollout of Carbon Dioxide Utilization Technologies

International CCU Assessment Harmonization Group Participants

UP Grant Program and Environmental Product Declarations (EPDs)

- Why not accept EPDs?
  - EPDs don’t require a comparison
  - Want to ensure carbon oxide sources are adequately and consistently characterized

- Buy clean or similar programs
  - This process won’t create EPDs but the LCA can potentially be used to create one

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Thank You

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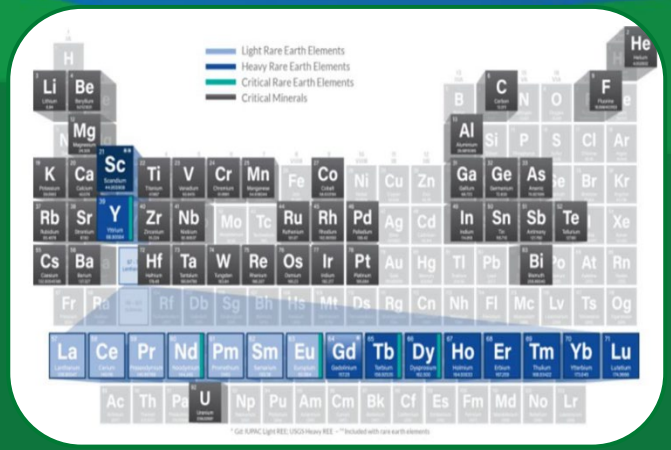
https://netl.doe.gov/LCA/CO2U



Roundtable discussion topics

- Which CO2U products are most likely to be procured using this program?
- Do you already participate in sustainable procurement? What sorts of processes do you follow?
- Have you conducted TEA previously and what did you find useful about it?
  - If so, what did you find to be the most critical consideration for your process?
- Are you supportive of LCA and environmental certification programs (e.g., EPDs) for evaluating utilization/conversion opportunities? Is there a benefit that your product delivers that is not captured by these approaches?