Life Cycle Analysis (LCA) and CCUS

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Tuesday, December 8, 2020

Bush Convention Center

Midland, Texas

Overview

- CCUS is a system with more than one product (e.g., oil & electricity). This creates accounting challenges.
- LCA requires accounting for flows within the system and proper treatment of the coproduct (electricity) to assign greenhouse gas (GHG) emissions to the primary product (oil).
- EOR field performance, system boundaries, and assumptions about coproduct displacement generally affect the LCA results far more than other inputs.
- Consequently, LCA applied to CCUS is wrought with potential for errors and omissions and needs a standard methodology.

CO_2 EOR Performance Drives LCA for CCUS

A Statistical Analysis of a Large Set of Individual CO_2 EOR Projects with an Emphasis on CO_2 Retention and Storage

Nicholas A. Azzolina and David V. Nakles (*The CETER Group, Inc.*)
Charles D. Gorecki, Scott C. Ayash, and Wesley D. Peck (*EERC*)
L. Stephen Melzer (*Melzer Consulting*)
and L. Sumon Chatterjee (*Carnegie Mellon*)

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Midland, Texas

December 2014

March 2015

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CO_2 storage associated with CO_2 enhanced oil recovery: A statistical analysis of historical operations

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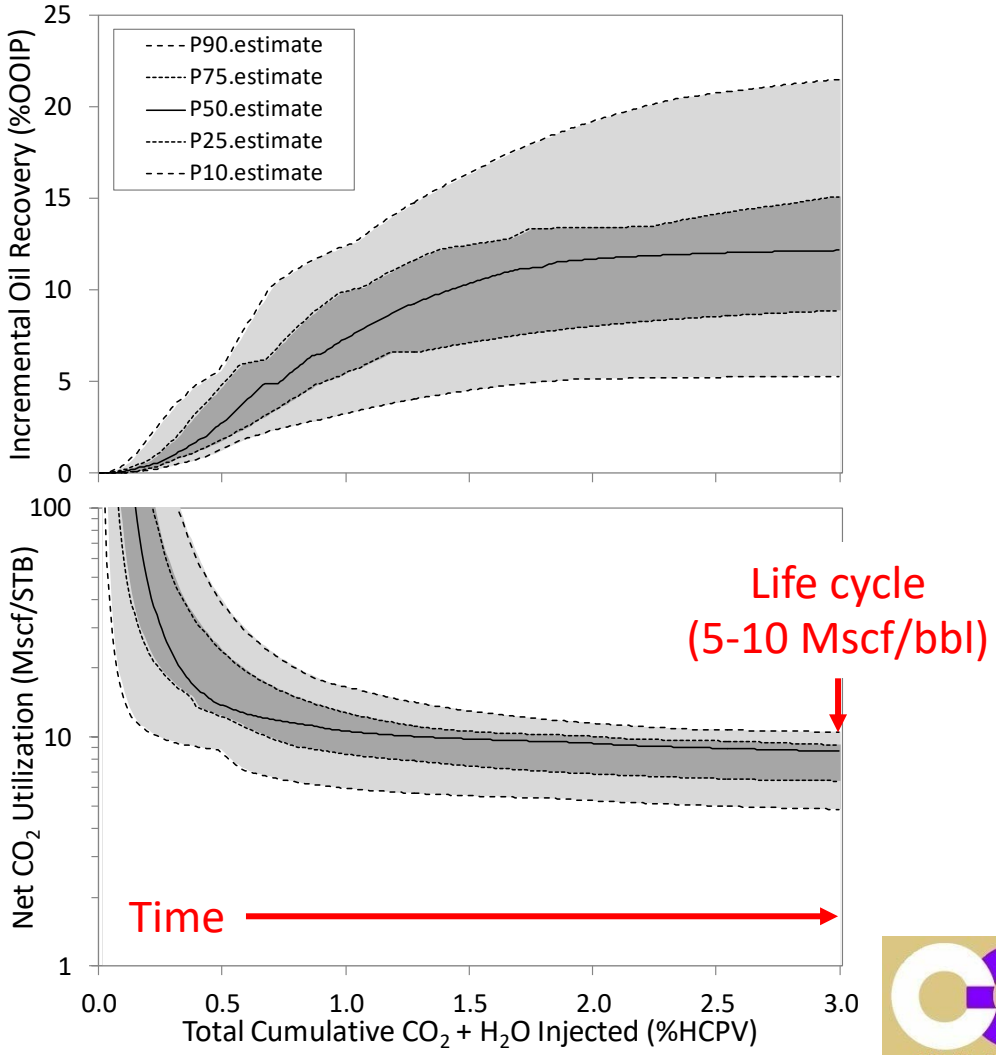
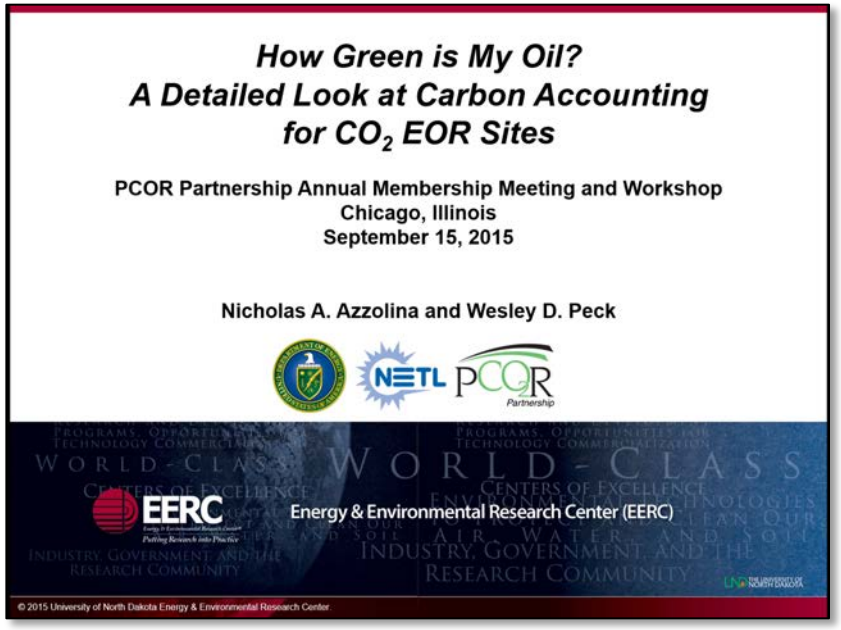


What the Heck is “Green Oil”?!



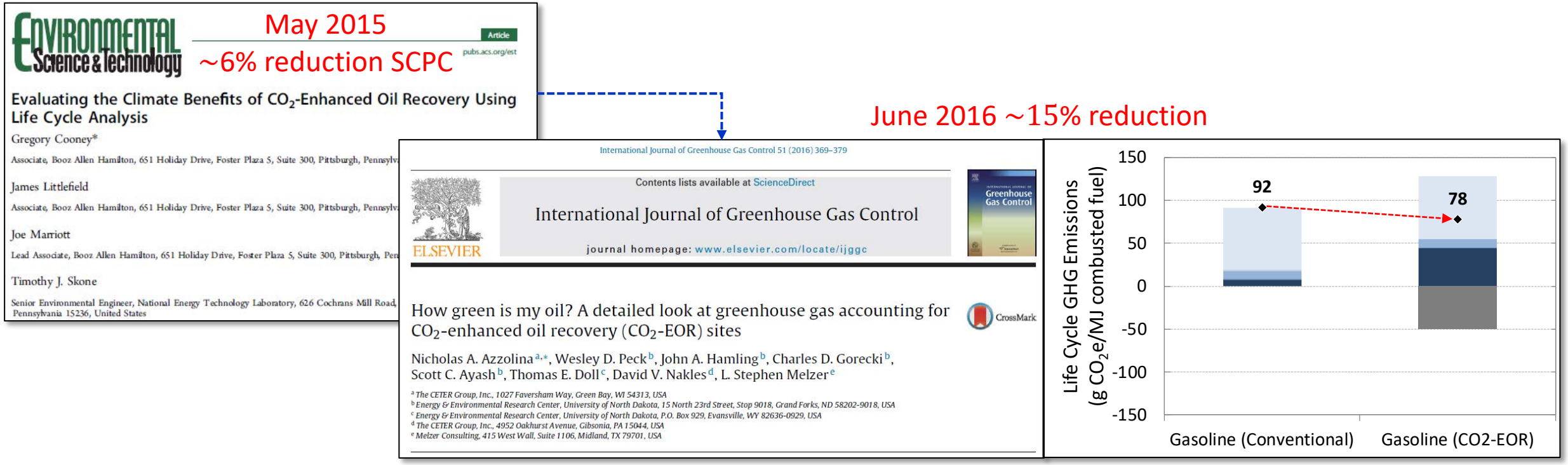
September 2015

Industry audience

Disconnect

Academic audience

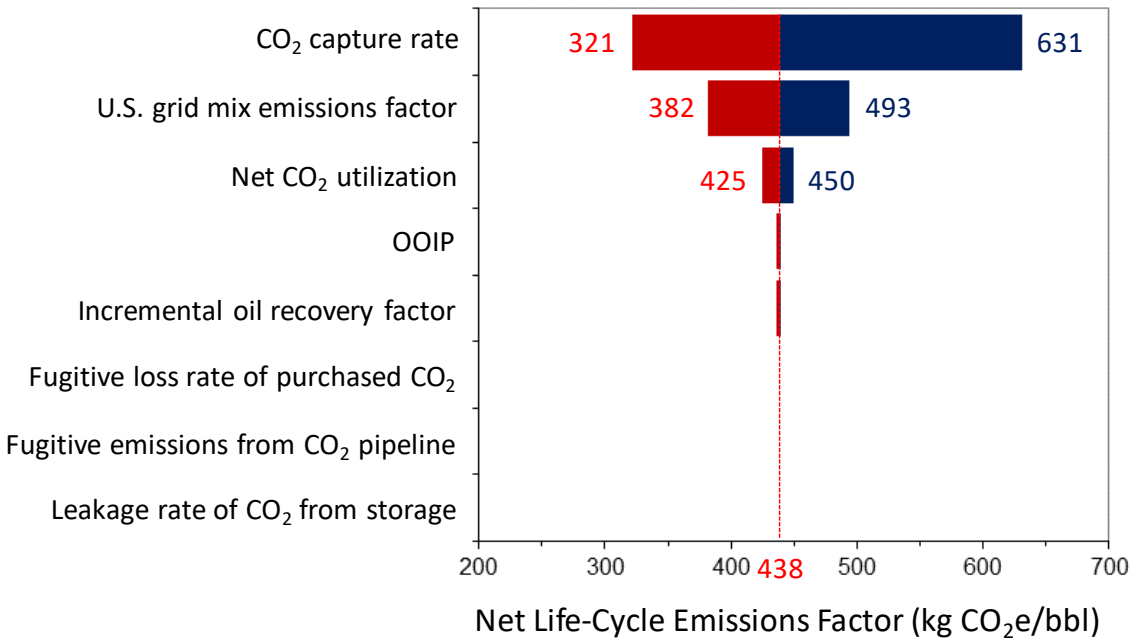
Life Cycle Analysis Results – Case Specific



Approximately 15% reduction in life cycle GHG emissions for incremental oil produced via CO_2 EOR as compared to conventional oil production (artificial lift/waterflood) when the CO_2 is captured from a coal-fired power plant and EOR performance is consistent with historical performance observed in the Permian Basin circa 1980-2007.

Optimization scenarios suggested up to 40% reduction in life cycle GHG emissions was possible.

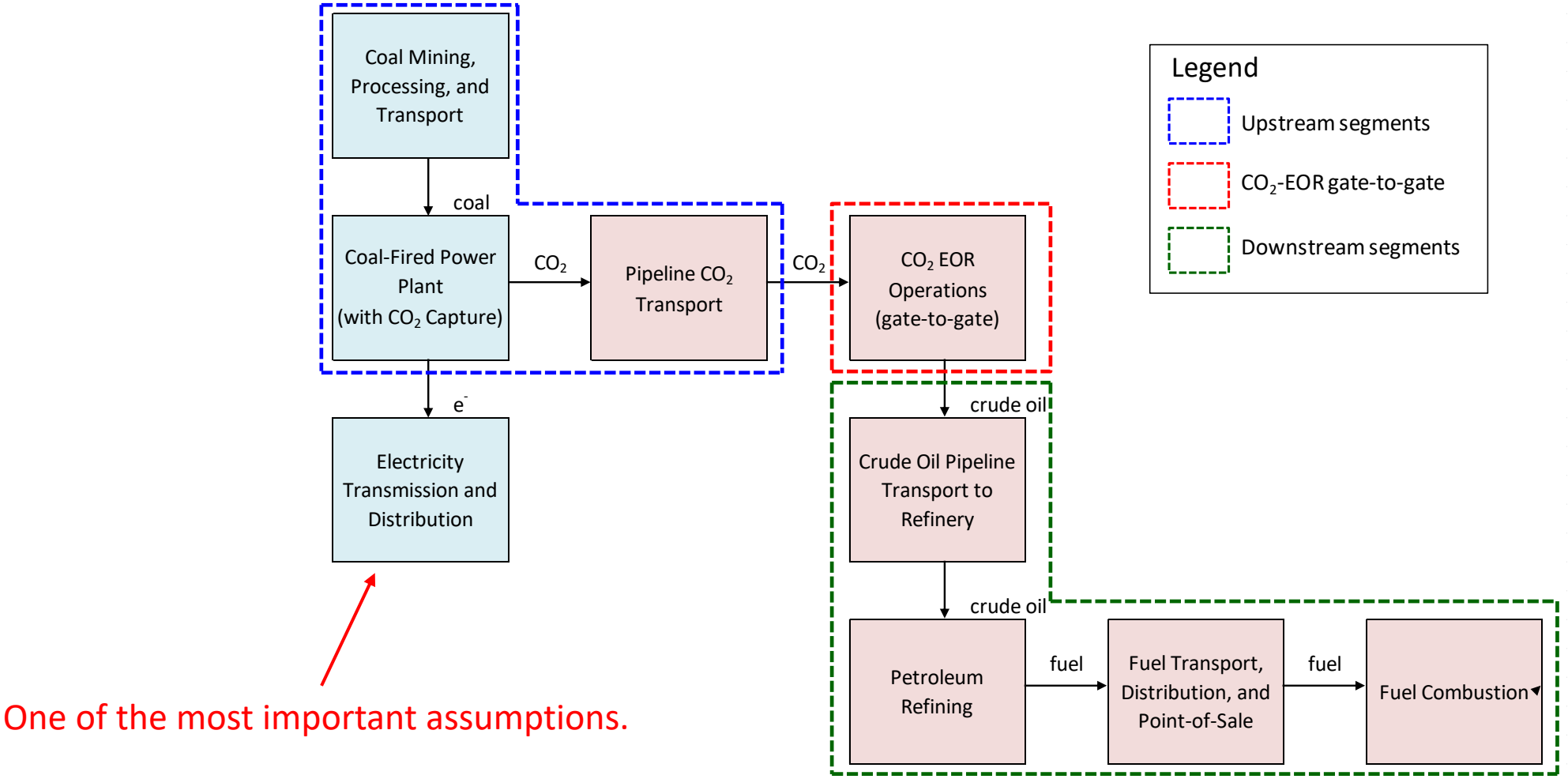
“Optimization” Depends on Perspective



Azzolina et al. (2016) International Journal of Greenhouse Gas Control 51 (2016) 369–379

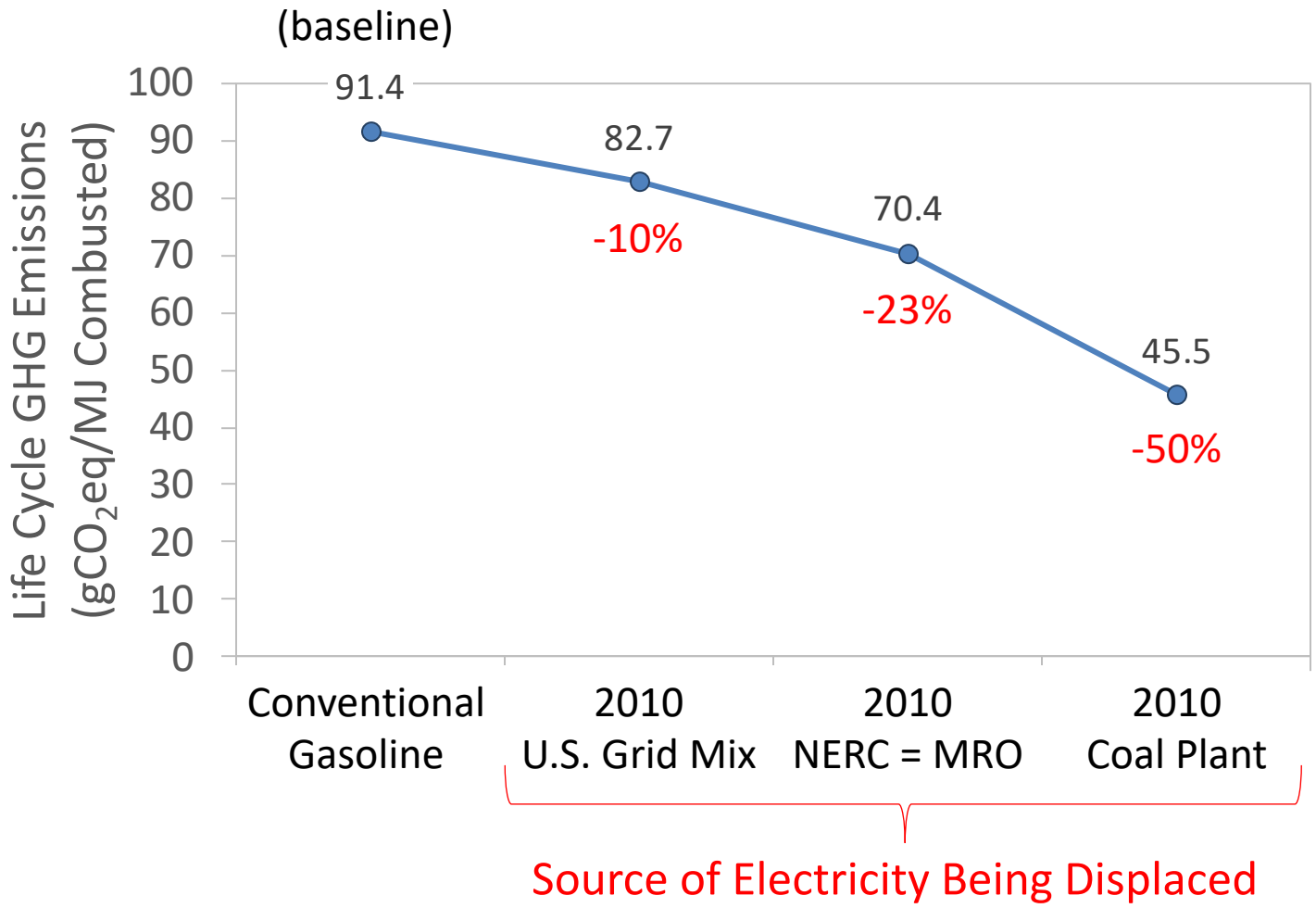
- CO_2 capture rate is by far the most important variable.
- Assumptions about displacement of electricity is very important (see next slides)
- Net CO_2 utilization was less important but still significant.
- “Optimization” depends on the objective function used.

CCUS System Boundaries and Material Flows

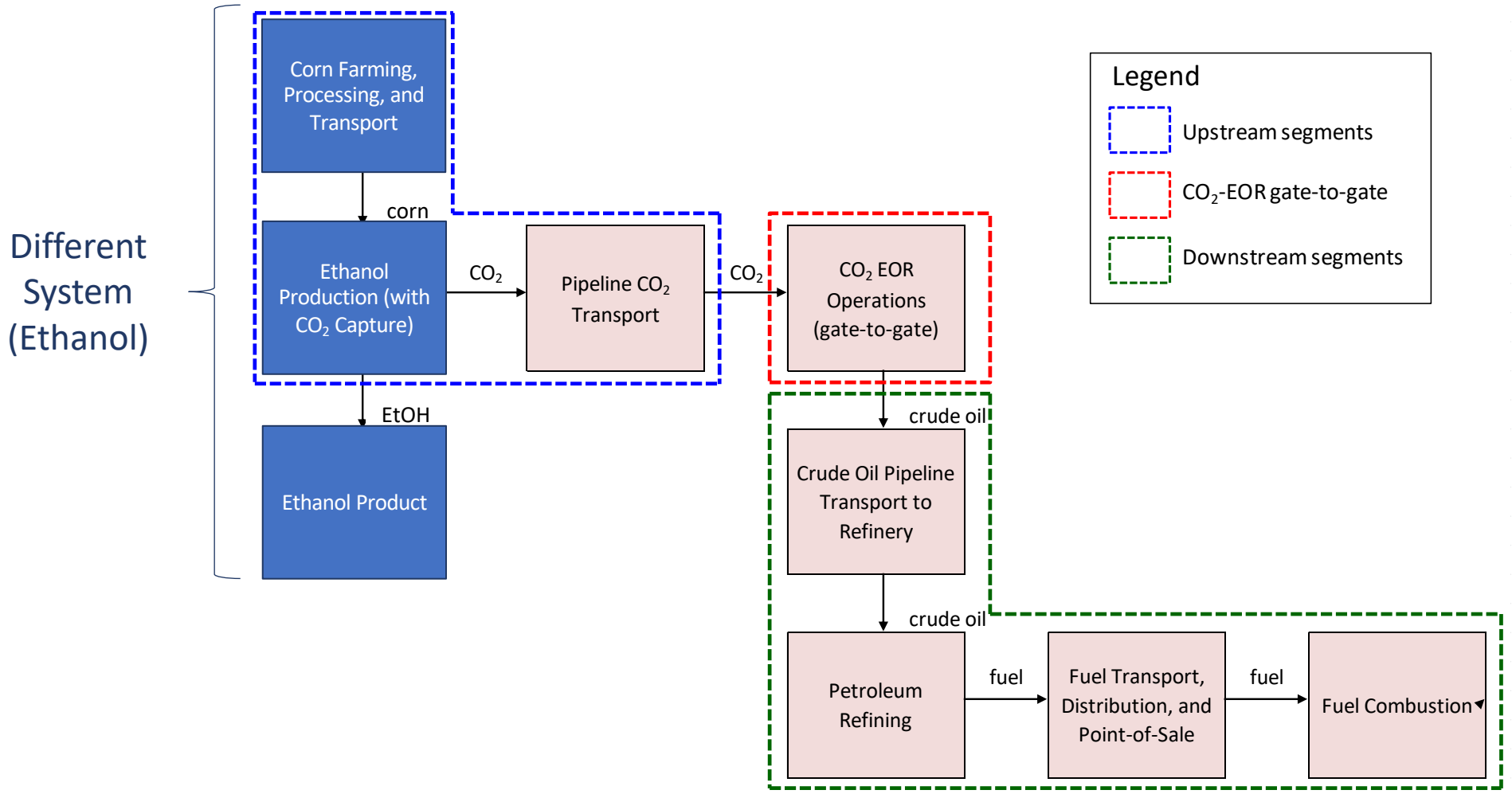


One of the most important assumptions.

Displacement Has a Significant Effect



Other CO_2 Sources are Different Systems



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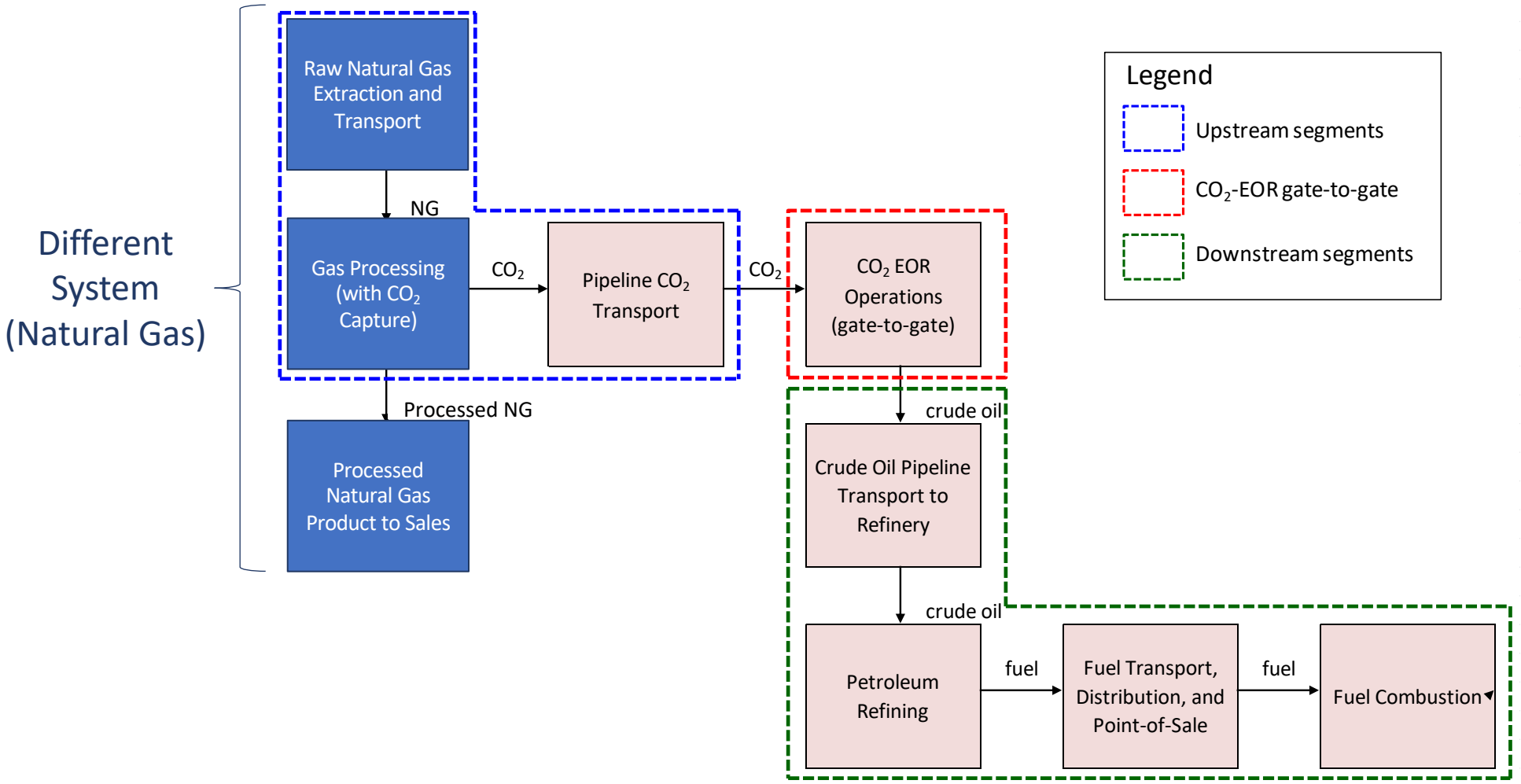


A Call for Harmonization

Energy Technology

Generation, Conversion, Storage, Distribution

Full Paper

The Need for and Path to Harmonized Life Cycle Assessment and Techno-Economic Assessment for Carbon Dioxide Capture and Utilization

Volker Sick, Katy Armstrong, Gregory Cooney, Lorenzo Cremonese, Alexandra Eggleston, Grant Faber, Gregory Hackett, Arne Kätelhön, Greg Keoleian, John Marano, Joseph Marriott, Stephen McCord, Shelie A. Miller, Michele Mutchek, Barbara Olfe-Kräutlein, Dwarakanath Ravikumar, Louise Kjellerup Roper, Joshua Schaidle, Timothy Skone, Lorraine Smith, Till Strunge, Peter Styring, Ling Tao, Simon Völker, Arno Zimmermann ... See fewer authors

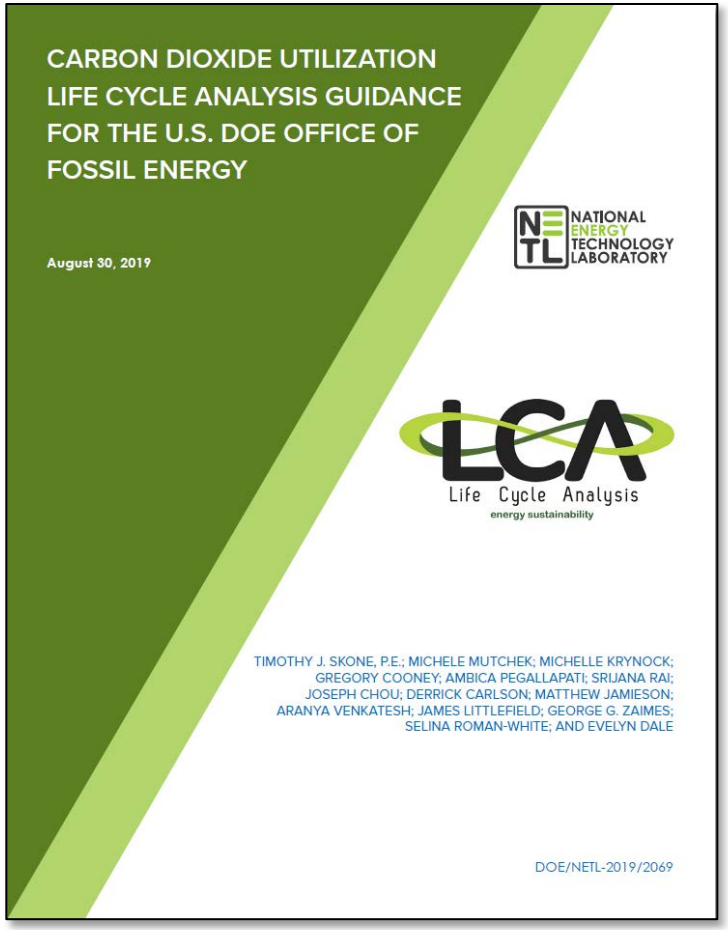
First published: 22 October 2019 | https://doi.org/10.1002/ente.201901034 | Citations: 5

- The need for a standardized methodology was recognized several years ago and there have been recent articles on this topic.
- Sick et al. (2019) made the case for a “harmonized” approach to LCAs and techno-economic assessments (TEAs) for CCUS.
- Two key related documents.

Two Critical References for LCA and CCUS

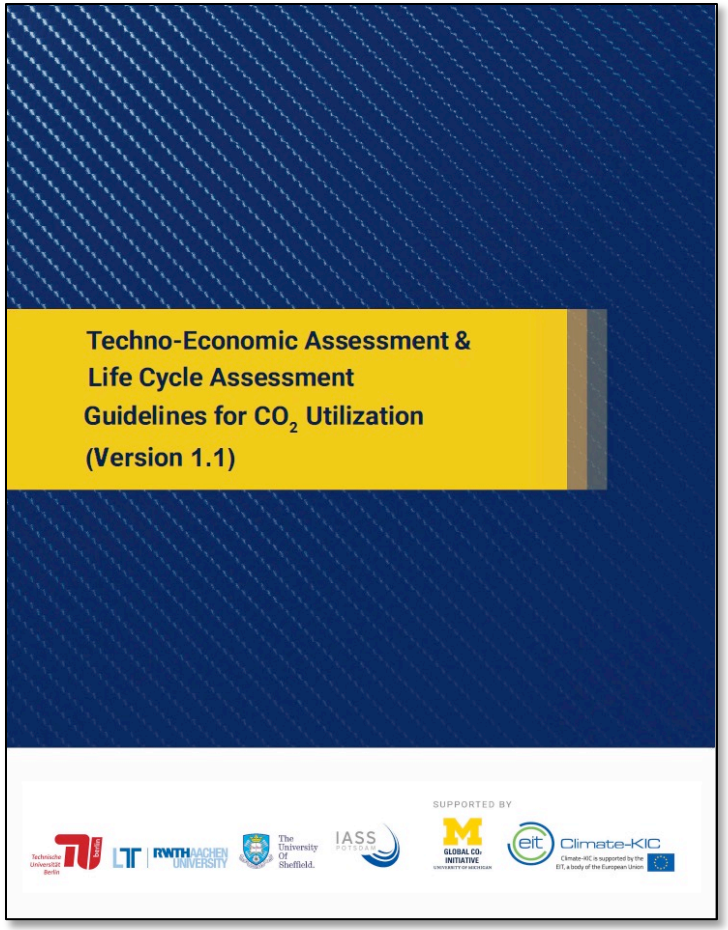
August 2019

https://www.netl.doe.gov/projects/files/NETLCO2ULCAGuidanceDocument_092019.pdf



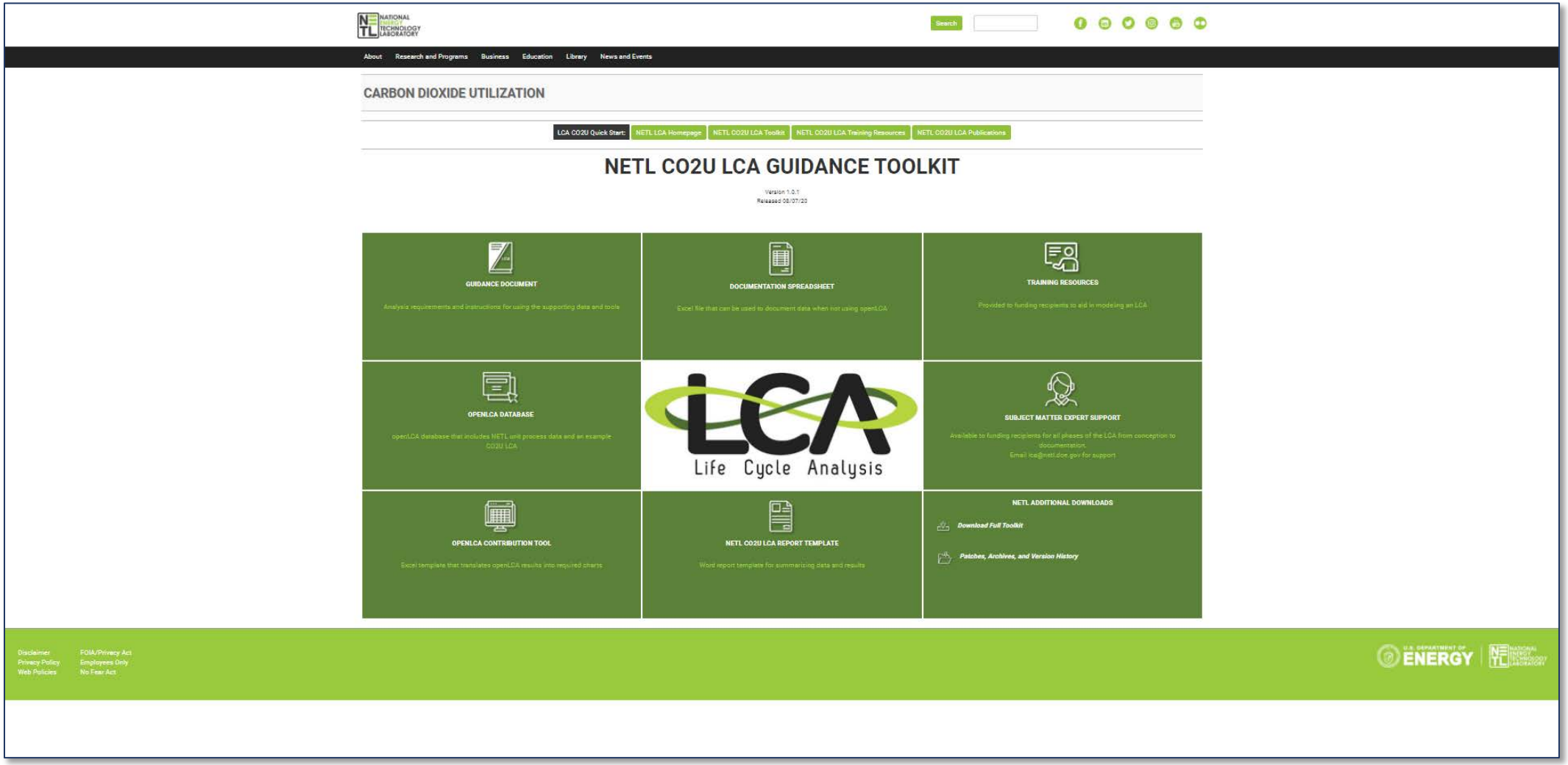
September 2020

https://deepblue.lib.umich.edu/handle/2027.42/162573



Open-Source Tools from NETL

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



Summary

- CCUS is a system with more than one product (e.g., oil & electricity). This creates accounting challenges.
- LCA requires accounting for flows within the system and proper treatment of the coproduct (electricity) to assign GHG emissions to the primary product (oil).
- A standard methodology is needed to ensure consistency with system boundaries and assumptions about coproduct displacement.
- Recent guidance from NETL (2019) and associated tools like the “NETL CO2U LCA Guidance Toolkit” provide a standard methodology.