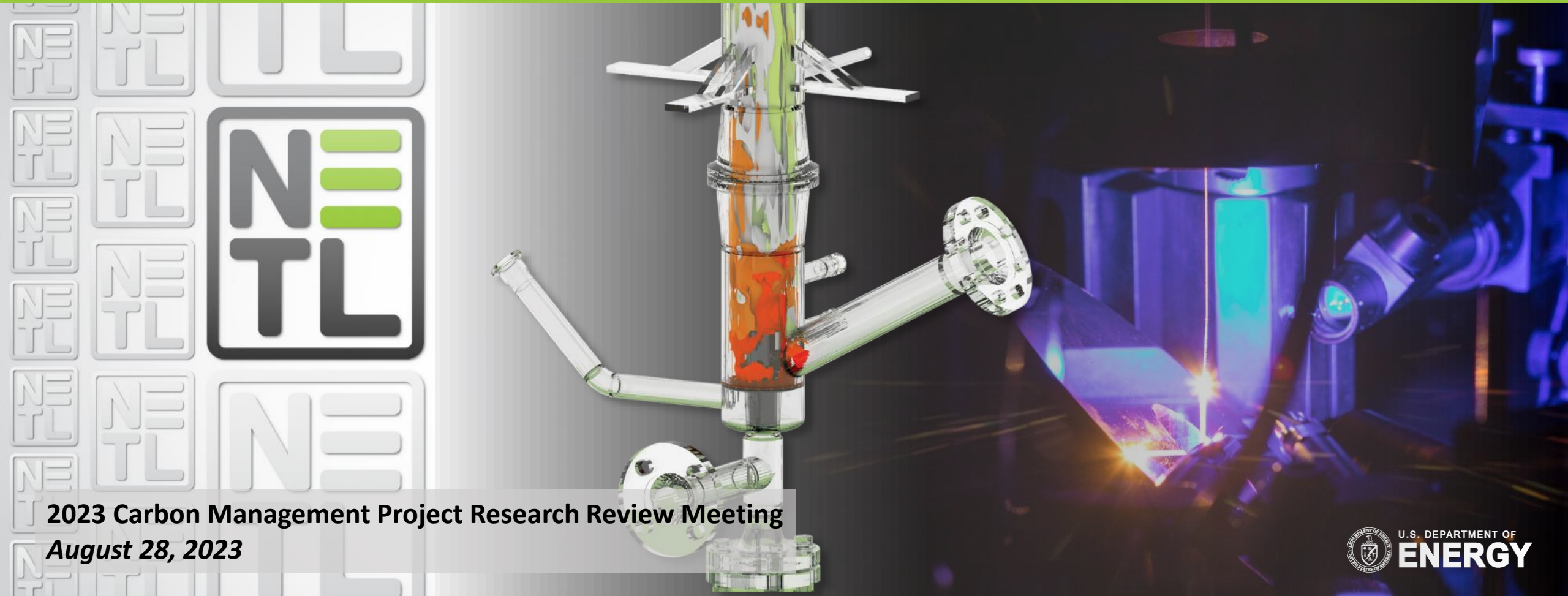


Carbon Conversion Life Cycle Analysis at NETL



Overview

Michelle Krynock
NETL Life Cycle Analyst



2023 Carbon Management Project Research Review Meeting
August 28, 2023



What is Life Cycle Assessment/Analysis (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).

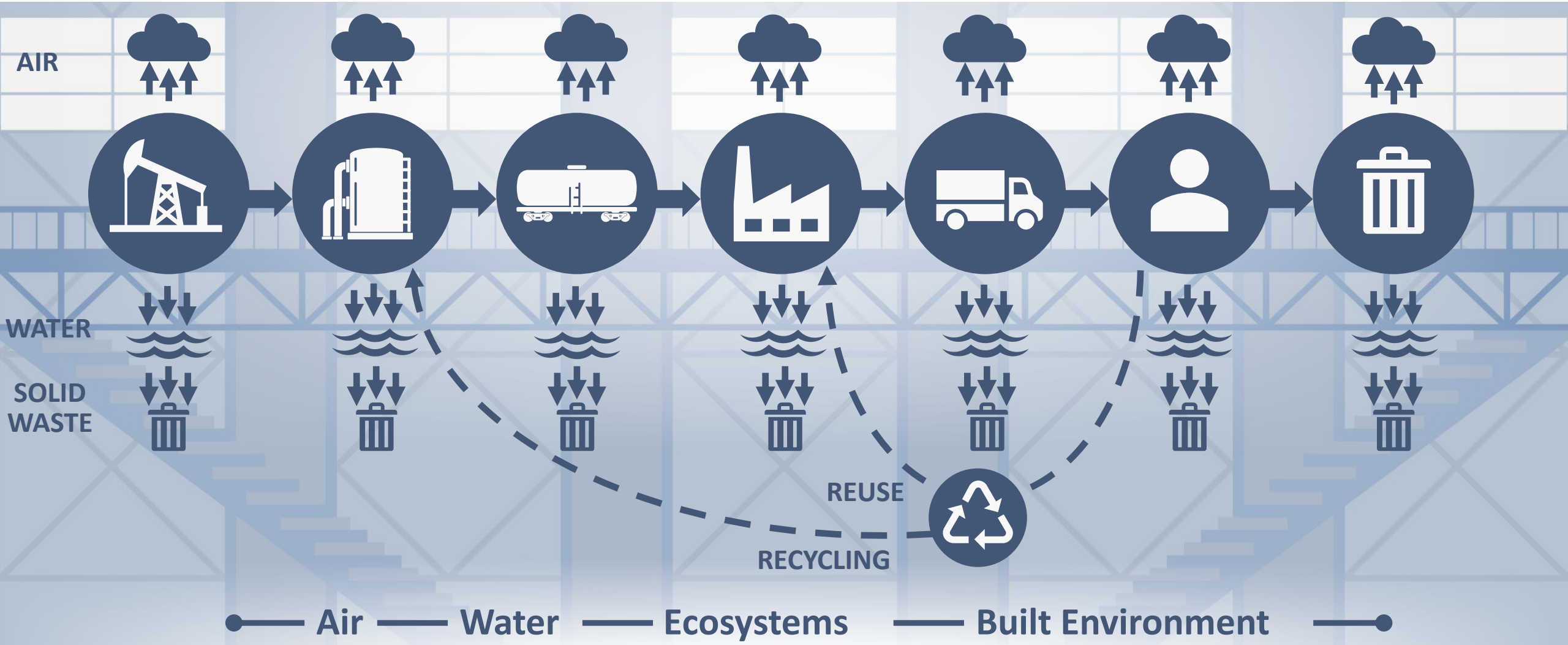
How?

LCA Method



How?

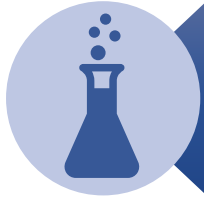
LCA Method



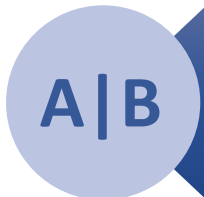
How we use LCA?



Establish National Baselines



Assess Emerging and Existing Technologies



Compare Technology and Scenario Tradeoffs

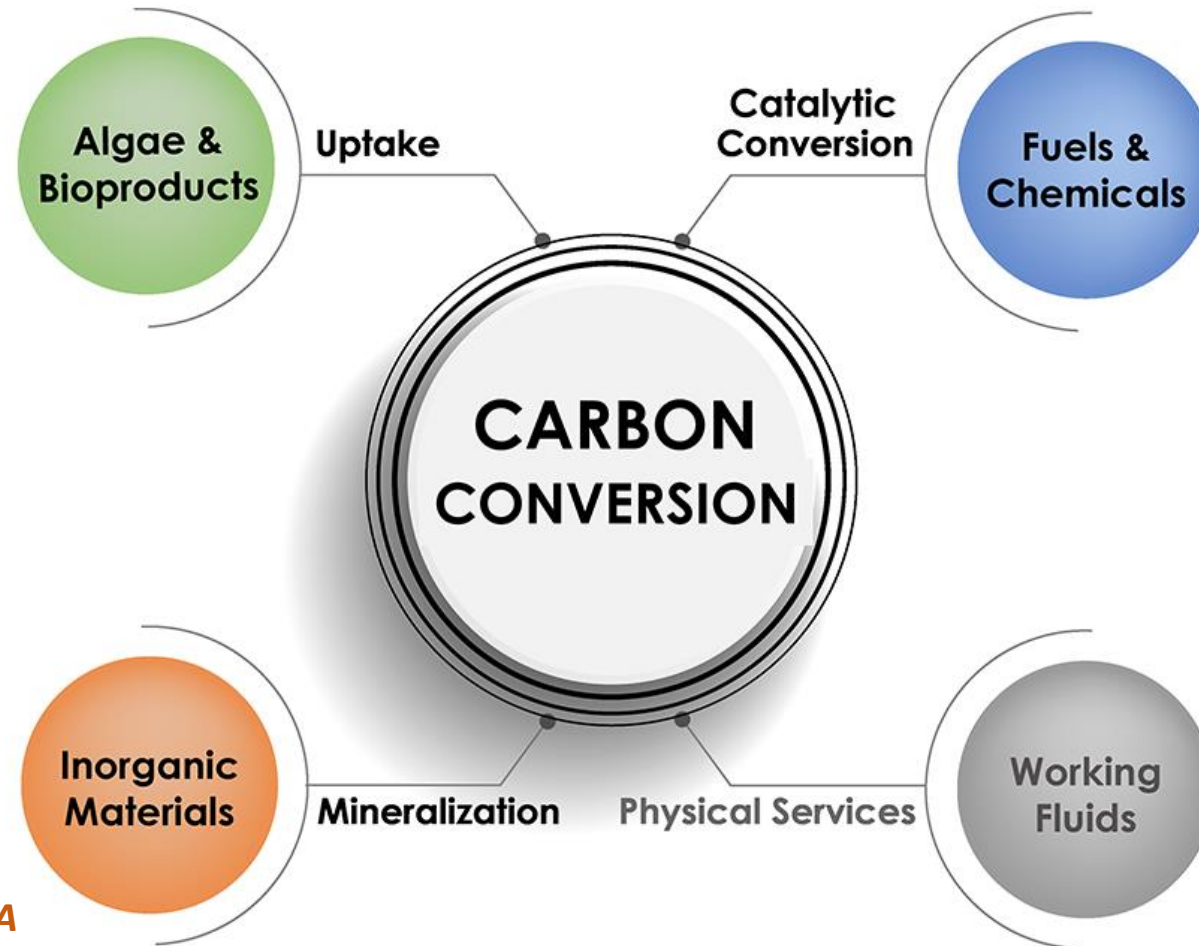


Plan for the Future and Look Ahead

LCA of Carbon Conversion Technologies

Recent/Ongoing Carbon Conversion LCA projects at NETL

- *Algae to Biofuels LCA*



- *Synthetic Natural Gas (SNG) LCA*
- *Microwave-assisted catalytic pathways (Syngas, H₂, Methanol) LCA*
- *Electrochemical conversion of CO₂ into chemicals*

- *Mineralization of Concrete Products LCA*
- *Building Aggregates LCA*

NETL CO2U LCA Guidance Toolkit

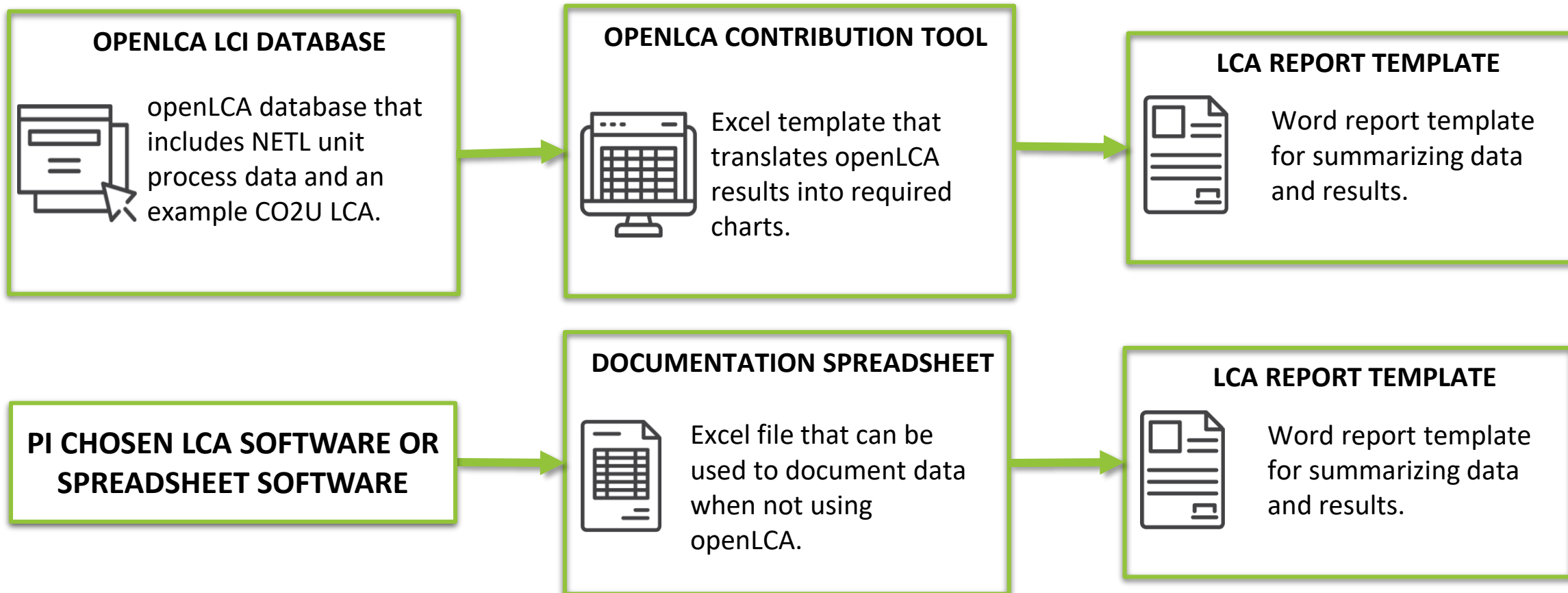


NETL CO2U LCA GUIDANCE TOOLKIT

 <p>CO2U LCA GUIDANCE DOCUMENT FOR THE U.S. DOE OFFICE OF FECD, VERSION 2.0</p> <p>Analysis requirements and instructions for using the supporting data and tools</p>	 <p>NETL CO2U LCA DOCUMENTATION SPREADSHEET</p> <p>Excel file that can be used to document data when not using openLCA</p>	 <p>TRAINING RESOURCES</p> <p>Provided to funding recipients to aid in modeling an LCA</p>
 <p>NETL CO2U OPENLCA LCI DATABASE VERSION 2.1</p> <p>openLCA database that includes NETL unit process data and an example CO2U LCA</p>		<p>45Q ADDENDUM AND TOOLS</p> <p>Information pertaining to the use of this toolkit in performing life cycle analyses in support of the 26 CFR § 1.45Q tax credit, including an addendum to the Guidance Document.</p>
 <p>OPENLCA CONTRIBUTION TOOL</p> <p>Excel template that translates openLCA results into required charts</p>		 <p>NETL CO2U LCA REPORT TEMPLATE</p> <p>Word report template for summarizing data and results</p>

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

The NETL CO2U LCA Guidance Toolkit



netl.doe.gov/LCA/CO2U

The NETL CO2U LCA Guidance Toolkit

GUIDANCE DOCUMENT



Analysis requirements and instructions for using the supporting data and tools.

Starting point for understanding LCA requirements

OPENLCA MODEL TRAINING



Provided to funding recipients to aid in modeling an LCA in openLCA.

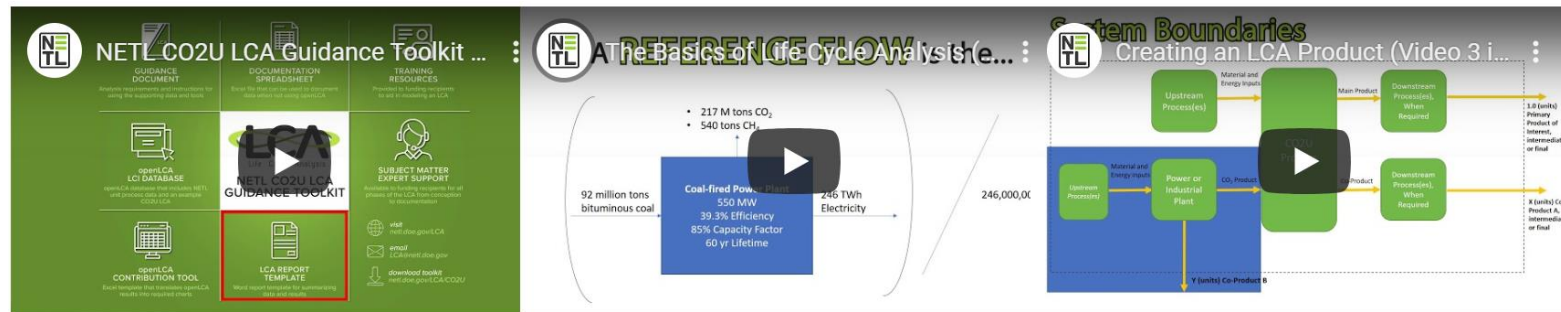
Training videos and live webinars will be available as developed at www.netl.doe.gov/LCA/CO2U

SUBJECT MATTER EXPERT SUPPORT



Available to funding recipients for all phases of the LCA, from conception to documentation.

Contact us with questions at LCA@netl.doe.gov (for NETL Project Recipients)



1. Overview

2. The Basics of Life Cycle Analysis

3. Creating an LCA Product



netl.doe.gov/LCA/CO2U

Comparative LCA

Goal is to compare the CO2U system to the long-run marginal competitor in the market (comparison system).

Multiproduct functional unit with system expansion

Improve comparability and results interpretation.

Default scenarios for CO₂ sources

Applicants permitted to use any upstream source, but default scenarios are provided.

Guidance for comparison processes and system

Data quality and representativeness: Expectations based on TRL.

Three modeling options

1. openLCA with provided data.
2. Excel-based documentation sheet.
3. Other commercial LCA modeling software.

Interpretation requirements

Specific data/figures to provide consistency to study comparisons.

- **LCA guidelines**

- Expand guidelines for reactive capture and CO2 removal
- Expand guidelines for industrial carbon dioxide sources

- **Life cycle inventor (LCI) data tools**

- Expand and improve existing LCI database based on advancements in NETL LCA data and tools
- Better consistency with LCA Commons datasets
- Update TRACI impact method (include new categories and IPCC GWP AR6)
- Transition to the openLCA v2.0 format

- **Additional Updates**

- Modification of openLCA Excel contribution tool for better functionality

Join us for instructional webinars!

Webinar 1: CO2U LCA Overview

Tuesday, Oct 10 and Wednesday, Oct 11
1:00 - 2:00 pm EST

Webinar 2: openLCA LCI Database

Tuesday Oct 17 and Wednesday Oct 18
1:00 - 2:30 pm EST

Webinar 3: Results Analysis

Tuesday Nov 14 and Wednesday, Nov 15
1:00 – 2:00 pm EST



UPGrants Addendum to the CO2U Toolkit



UPGrants LCA GUIDANCE TOOLKIT

To be used in conjunction with version 2.1.0 of the NETL CO2U Guidance Toolkit

Released 01/31/23

 <p>UPGRANTS ADDENDUM TO THE CO2U LCA GUIDANCE DOCUMENT</p> <p>Summary of modifications to the CO2U Guidance Document to be used to apply for LCA approval for use in the UPGrants program.</p>	 <p>NETL CO2U LCA DOCUMENTATION SPREADSHEET</p> <p>Excel file that can be used to document data when not using openLCA</p>	 <p>FREQUENTLY ASKED QUESTIONS</p>
 <p>NETL CO2U OPENLCA LCI DATABASE VERSION 2</p> <p>openLCA database that includes NETL unit process data and an example LCA</p>	MORE INFORMATION ON THE UPGRANTS PROGRAM	 <p>ADDITIONAL QUESTIONS?</p> <p>Additional Questions should be directed to LCAUPGrants@hq.doe.gov</p>
 <p>OPENLCA CONTRIBUTION TOOL</p> <p>Excel template that translates openLCA results into required charts</p>	 <p>NETL UPGRANTS LCA REPORT TEMPLATE</p> <p>Word report template for summarizing data and results</p>	NETL ADDITIONAL DOWNLOADS <ul style="list-style-type: none"> <i>Patches, Archives, and Version History</i> <i>Original CO2U Toolkit</i> <i>NETL-Provided Technology Baselines</i>

<https://netl.doe.gov/LCA/UPgrants>

Source: NETL

Disclaimer



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Questions/ Comments

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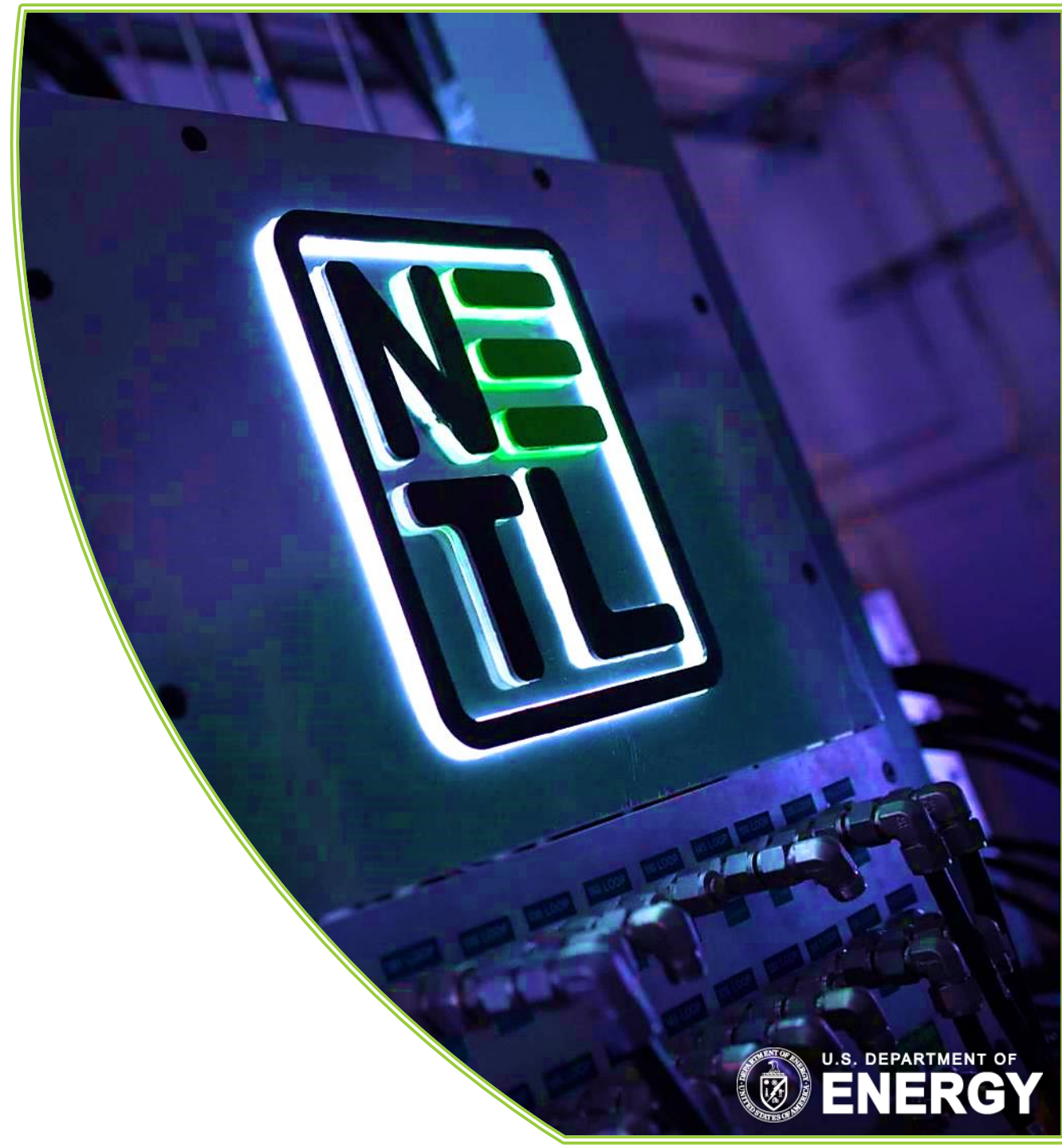


@NationalEnergyTechnologyLaboratory

CONTACT:

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U.S. DEPARTMENT OF
ENERGY

<https://netl.doe.gov/LCA/CO2U/45Q>

- **§ 1.45Q-4 Utilization of Qualified Carbon Oxide:**
- 26 CFR § 1.45Q-4 (hereby referred to as 45Q) requires a life cycle analysis (LCA) to be performed to document the amount of qualified carbon oxide for the utilization tax credit.
- Under the Internal Revenue Service's (IRS) regulations, LCAs must be prepared and documented in conformance with certain ISO standards.
- The Treasury Department and the IRS noted in its final rule that the Department of Energy (DOE) National Energy Technology Laboratory (NETL) CO₂ Utilization Guidance Toolkit is consistent with the ISO standards and directed taxpayers in the final rule to use such guidance when submitting LCAs under 45Q.

- **§ 1.45Q-4 Utilization of Qualified Carbon Oxide.**
- **(a) In general.** For purposes of this section, *utilization of qualified carbon oxide* means -
 - **(1)** The fixation of such qualified carbon oxide through photosynthesis or chemosynthesis, such as through the growing of algae or bacteria,
 - **(2)** The chemical conversion of such qualified carbon oxide to a material or chemical compound in which such qualified carbon oxide is securely stored, or
 - **(3)** The use of such qualified carbon oxide for any other purpose for which a commercial market exists (with the exception of use as a tertiary injectant in a qualified enhanced oil or natural gas recovery project), as described in paragraph (d) of this section.

From: <https://www.ecfr.gov/current/title-26/chapter-I/subchapter-A/part-1/subject-group-ECFR321685e6a0496a0/section-1.45Q-4>

<https://netl.doe.gov/LCA/UPgrants>

- Section 969A(b)(2) of EPA Act 2005, as amended by BIL Section 40302 (42 U.S.C. 16298a(b)(2)), states the following:
- “(2) Grant program.—
 - (A) In general.—Not later than 1 year after November 15, 2021...the Secretary shall establish a program to provide grants to eligible entities to use in accordance with subparagraph (D).
 - (B) Eligible entities.—To be eligible to receive a grant under this paragraph, an entity shall be— (i) a State; (ii) a unit of local government; or (iii) a public utility or agency.
 - (C) Applications.—Eligible entities desiring a grant under this paragraph shall submit to the Secretary an application at such time, in such manner, and containing such information as the Secretary determines to be appropriate.
 - (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.”

From: <https://www.grants.gov/web/grants/view-opportunity.html?oppld=344870>

LCA Methods Comparison



	CO2U	45Q	UPGrants
Program Origination	U.S. DOE Carbon Conversion Program FOAs	26 CFR § 1.45Q-4	Section 40302 of the Bipartisan Infrastructure Law
Terminology for LCA Submitter	Principal Investigator (PI)	Applicant	Vendor
LCA Submitter	DOE FOA recipient working on carbon conversion project	Owner of carbon capture equipment selling carbon oxide for utilization applying for 45Q tax credit	Carbon conversion product manufacturer intending to be available to Grant Applicants
Species Utilized	Carbon Dioxide	Carbon Oxide	Carbon Oxide
Expected TRL*	1-9	8-9	7-9
Review Scope	NETL provides critical and conformance review	NETL provides conformance review, third-party permitted to perform critical review (NETL provides if not)	NETL provides critical and conformance review
Approval	NETL works with PIs to bring LCA to sufficient quality	NETL provides conformance/critical review to IRS. IRS makes final decisions	NETL provides conformance/critical review to Carbon Conversion Program. Program makes final decisions

LCA Methods Comparison



	CO2U	45Q	UPGrants
Technological Scope	CO2U process based on data from FOA project	Carbon conversion Process based on applicant's sales to qualified utilization	Carbon conversion process based on product manufacturer's operations
Temporal Scope	Projected Start Year	Tax Year Relevant to Application	Most Recent Calendar Year to Submission
Geographical Scope	Default to US Average, PI to fill in information as they learn it	Applicant's real supply chain	US Average
NETL data usage	Required for CO ₂ upstream defaults and electricity inputs	Required, but third-party data acceptable with justification	Required where available
Downstream System Boundary	Cradle-to-grave encouraged	Truncation at the point of functional equivalence preferred	Truncation at the point of functional equivalence preferred
Carbon Oxide Source	Default required for comparability; alternates permitted	As is	As is
Sensitivity Analysis	Required	Required	Required (breakeven to 10% or 25% change instead of 0)
Uncertainty Analysis	Required	Not Required	Encouraged

LCA Comparison



	CO2U	45Q	UPGrants
LCA Website	https://netl.doe.gov/LCA/CO2U	https://netl.doe.gov/LCA/CO2U/45Q	https://netl.doe.gov/LCA/UPgrants
Email address for support	<p>LCA@netl.doe.gov</p> <p>Or your NETL project manager</p>	<p>General, including eligibility questions: LBI.EEF.45QLCA@irs.gov</p> <p>LCA-specific: lca45q@hq.doe.gov</p>	<p>General: LCAUPGrants@hq.doe.gov</p> <p>Vendor Questions: UPGrants-Vendors@netl.doe.gov</p>
Helpful links	<ul style="list-style-type: none"> https://netl.doe.gov/LCA 	<ul style="list-style-type: none"> Regulatory Text (eCFR) IRS Final Rule (including preamble) ISO 14040:2006 ISO 14044:2006 	<ul style="list-style-type: none"> UPGrants Program General Information Information for Eligible Entities Notice of Intent to issue Funding Opportunity Announcement DE-FOA-0002829 ISO 14040:2006 ISO 14044:2006