NETL UPGRANTS ADDENDUM TO THE CO2U LCA GUIDANCE TOOLKIT

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STRATEGIC SYSTEMS ANALYSIS AND ENGINEERING

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1 INTRODUCTION (ADDITIONAL GUIDANCE)

Section 40302 of the Infrastructure Investment and Jobs Act (Public Law 117-58), also known as the Bipartisan Infrastructure Law (BIL), establishes a program to provide grants to eligible entities to procure and use commercial or industrial products that use or are derived from anthropogenic carbon oxides; and demonstrate significant net reductions in lifecycle greenhouse gas emissions compared to incumbent technologies, processes, and products. To implement this program, the United States Department of Energy is establishing the Carbon Utilization Procurement Grants (UPGrants) Program and supporting tools through Office of Fossil Energy and Carbon Management’s (FECM) Carbon Conversion Program. Under the UPGrants program, LCAs must be prepared and documented in conformance with the NETL CO2U LCA Guidance Document and this addendum. This toolkit, which includes the Carbon Dioxide Utilization Life Cycle Analysis Guidance for the U.S. DOE Office of Fossil Energy and Carbon Management (hereby referred to as the NETL CO2U LCA Guidance Document), was originally written to guide projects in performing LCAs as part of their laboratory-funded project.

The purpose of this addendum is to guide carbon utilization product manufacturers on how to use the NETL CO2U LCA Guidance Document when preparing LCAs for inclusion as a vendor under the UPGrants program. The UPGrants Program is limited to “eligible entities,” which includes States, local governments, and public utilities or agencies. Eligible entities can read a Notice of Intent to publish the UPGrants FOA and access the UPGrants FOA itself (when available) through FedConnect. NETL has established an UPGrants website to provide additional information on the program, and to serve as a portal where carbon conversion product manufacturers can submit their LCA to undergo critical review and potentially be accepted as an approved vendor for the UPGrants Program.

All sections contained in this addendum are meant to serve as either direct replacement for the corresponding section in the toolkit or provide recommendations on how to use the section for the purposes of the UPGrants Program. Each section will be marked as either “direct replacement” or “additional guidance” in the heading for clarity. These sections cannot be implemented in isolation as they stem from the entire approach and methodology within the NETL CO2U LCA Guidance Document.

Similarly, when using the NETL CO2U LCA Guidance Document for the purposes of the UPGrants Program, all references to the “Principal Investigator” or “PI” within the larger CO2U LCA Guidance Toolkit (e.g., the openLCA database) should instead refer to the carbon utilization product manufacturer, called the “vendor”, and all references to the “U.S. DOE Carbon Utilization Program” should instead refer to the “UPGrants Program.”

The NETL CO2U LCA Guidance Document was also intended specifically for the use of carbon dioxide, which is reflected throughout the NETL CO2U LCA Guidance Document text. For the purposes of the UPGrants Program, any discussion of captured or utilized carbon dioxide in the
NETL CO2U LCA Guidance Document or this addendum should be considered synonymous with carbon oxides.

Additionally, the NETL CO2U LCA Guidance Document includes requirements for an “NETL default scenario” and provides support and suggestions for additional scenarios to explore their technology’s potential. While using LCA to better understand a technology’s environmental impact at present and in the future is always best practice, only one scenario will be reviewed per submission. References to the “NETL default scenario” and “alternative” scenarios should be disregarded for the UPGrants LCAs. For these purposes, the “NETL default scenario” is a representation of the actual average environmental life cycle impacts of a single vendor for a year and all modeling decisions should reflect that as well as possible.

Being a current or prior award recipient with FECM’s Carbon Conversion R&D Program, previously named the Carbon Utilization Program, is not a prerequisite for participation as a vendor for this program; any producer of a commercial or industrial carbon conversion product may submit an LCA for critical review. In addition, LCA evaluations received through the Conversion Program, FECM, or NETL for purposes of R&D awards, 45Q evaluations, or other engagements bear no impact on the UPGrants Program. This program is an independent program designed to facilitate the commercial procurement and use of carbon utilization/conversion products by eligible entities. In addition, LCAs can only represent technologies or facilities that have been manufacturing carbon utilization/conversion products within the last 10 years. Technologies or facilities with over a decade of operational experience are no longer of interest to the Carbon Conversion R&D program and its associated UPGrants Program.

1.2 DOCUMENT GOALS (DIRECT REPLACEMENT)

All the guidance included herein complies with the ISO LCA standards (14040/14044) and ensure methodological consistency in applying the ISO standards. The ISO standards provide a broad framework for applying LCA to a wide range of submissions which can lead to inconsistency in modeling choices and results interpretation.

The goals of this addendum are to modify the NETL CO2U Guidance Toolkit to:

1. Provide LCA guidance, data, and tools to vendors to complete the required UPGrants LCA and documentation requirements; and
2. Foster better decision-making as part of the UPGrants LCA critical review process by providing an analysis and reporting structure that enables consistency and transparency for the vendors’ LCAs.
1.3 What Is Included in the NETL CO2U LCA Guidance Toolkit (Direct Replacement)

The NETL CO2U LCA Guidance Toolkit and UPGrants Addendum include the following:

1. NETL CO2U LCA Guidance Document outlines the analysis requirements and how to use the supporting data and tools, including this addendum modifying guidance for UPGrants vendors.

2. NETL CO2U openLCA LCI Database is an openLCA database that includes NETL unit process data and an example CO2U LCA.

3. NETL CO2U openLCA Results Contribution Tool is an Excel template that translates openLCA results into required charts.

4. NETL CO2U LCA Documentation Spreadsheet is an Excel file that can be used to document data when not using openLCA.

5. NETL UPGrants LCA Report Template is a Word report template for summarizing data and results, including a modified version for UPGrants vendors.

NETL CO2U LCA Subject Matter Expert Support and training resources are available as part of the toolkit for vendors preparing LCAs for purposes of UPGrants. All questions related to UPGrants LCAs submitted to DOE shall be directed to upgrants-vendors@netl.doe.gov. Please include your name, contact information, and organization name in the contents of the email when sending questions. Other resources will also be available on the NETL UPGrants website (https://netl.doe.gov/upgrants).

1.5 Modeling and Documentation Options for U.S. DOE Carbon Utilization Program Project PIs (Additional Guidance)

If the submission includes an openLCA database, it shall be submitted using the .zolca file format (right click on the database in openLCA and select “Backup database”). Use of any third-party licensed data shall include permission from the data providers for DOE review access.

To submit an LCA to the UPGrants program, vendors shall complete the form at https://netl.doe.gov/upgrants/form/upgrants-manufacturer-lca-submission and will receive email instructions to upload all relevant files to a secure file transfer protocol (FTP) site. All relevant documents, including the technoeconomic analysis information and voluntary community benefits information shall use the same submission process and uploaded to the FTP site.

2.1.1 LCA Study Goal (Direct Replacement)

The specific goals of the LCA as required by this document are described below:

1. Intended application — to find the net reductions in lifecycle greenhouse gas emissions compared to incumbent technologies, processes, and products. The intention is to find if the proposed product system constitutes a percent reduction from the comparison
product system large enough to qualify for the UPGrants program, i.e., a 10% reduction for the first acceptance or a 25% reduction for a second acceptance for additional funds.

2. Reasons for carrying out the study — to determine the potential of the vendor’s proposed product system to qualify for inclusion as an UPGrants qualified vendor.


4. Public disclosure — the LCAs conducted as a requirement of qualification for the UPGrants will not be published by DOE/NETL. Vendor information such as company name, address, point of contact, and description of the carbon utilization product and its applications will be publicly released if the vendor LCA receives a favorable critical review.

2.1.3.1 Proposed Product System (Additional Guidance)
The NETL CO2U LCA Guidance Document does not provide guidance on choosing which co-product should be considered the primary product. For the UPGrants program, vendors may only receive a grant for a single co-product at a time. The primary product of the LCA shall therefore be co-product which the vendor wishes to be listed on the NETL UPGrants website. If the vendor wishes to change the product available on the UPGrants website, they shall re-submit an LCA with that product as the primary co-product.

2.1.3.2 Comparison Product System (Direct Replacement)
There are likely multiple technologies that can produce a product or function from the Proposed Product System. To simplify the LCA creation and review process, a set of baseline environmental profiles for commonly used technologies (referred to as technology baselines) will be provided by NETL in the NETL CO2U LCA Guidance Toolkit, both in the openLCA database and the data documentation spreadsheet. Vendors shall use the appropriate NETL-provided technology baselines where available. If not, the vendor must provide significant justification for why the provided product system does not meet functional equivalence with the proposed product system. Insufficient functional equivalence is the only acceptable reason to use a different technology baseline when an NETL-provided baseline is available.

Where the specific technology type does not have a corresponding Comparison Product System provided by NETL, the vendors shall use the following hierarchy for determining the type of technology for inclusion in the Comparison Product System to ensure functional equivalence. This hierarchy shall be considered for each of the products/services produced in the Proposed Product System. More detailed guidance on the co-product produced from the carbon oxide source is provided in Section 2.1.5.

1. U.S. average greenhouse gas technology: Identify the profile that represents the average GHG emissions for U.S. production. This should be a production-weighted average of the facilities, such that the GHG emissions from facilities producing the most product have the most influence on the average. In other words, this would be the total GHG emissions across all facilities divided by the total product across all facilities. If sufficient
data is not available to determine the U.S. Average GHG technology for the comparison process, then identify the industry standard practice technology.

2. Industry Standard Practice Technology: Identify the method(s) of production for the CO2U process product or service that represent a technology that contributes to the highest percentage of production relative to the suite of technologies.

3. Repeat this hierarchy until comparison technologies have been identified for all the products/services from the Proposed Product System.

2.1.4 System Boundary (Direct Replacement)

A complete LCA is a cradle-to-grave analysis, with a boundary that begins with the extraction of raw materials and ends with the consumption or disposal of the final product (*end of life*). However, when comparing two systems, portions of the life cycle which are the same in both systems can be exempted without affecting the relative rank of the systems in the comparison. To avoid unnecessary complication from downstream life cycle processes, modeling the downstream fate of carbon oxide utilization products should end when the complete functional equivalency with comparison products has been reached, meaning that all downstream processes will be the same.

An example of cradle-to-gate analysis that meets functional equivalency may be a CO₂ utilization process that makes fuel for vehicles and the Comparison Product System makes a fuel with the exact same performance for the same vehicles because the processes downstream of fuel production will be identical. In these cases, the vendor can exclude the downstream unit processes from the life cycle, because, mathematically, the results would cancel each other out in the comparison. However, this cannot be done if any downstream unit processes would be not identical. For example, if the fuel produced by the CO₂ utilization process has a different chemical composition which would cause different emissions upon combustion, this difference must also be modeled. Similarly, if one fuel produces biogenic carbon emissions upon combustion and another produces fossil carbon emissions, the use-phase combustion should be modeled. Additionally, if the unit process being considered for exclusion is the unit process that creates the functional unit, then the functional unit will need to be changed as well and the new functional unit must be valid.

The Comparison Product Systems provided by NETL will assume a truncated downstream endpoint that most vendors will be expected to match. Only exceptional cases will be considered to change the truncation point based on their product’s function.

Vendors shall illustrate diagrams for the Proposed Product System and the Comparison Product System based on the goals and scope (Section 2.1) of the LCA study while ensuring equivalent functions are provided by both product systems. These diagrams will inform the data development and life cycle boundary development. Quantities of inputs and outputs for parts of the life cycle may or may not be known at this stage. If either the Proposed Product System or the Comparison Product System includes an input that is a waste product, the alternative fate of that waste product needs to be included in the other product system. For example, if mining waste is an input in the Proposed Product System for making mineralized building products, the
Comparison Product System needs to include the alternative fate of the mining waste such as the impacts of disposal of that waste. Diagrams will be made available for any NETL-provided technology baselines through the NETL website.

Vendors shall illustrate the final system boundary of the Proposed Product System and the Comparison Product System based on any changes that have occurred during data development. For example, there may be additional parts of the life cycle to show or additional co-products/functions to include. openLCA can be used to create the product system diagram automatically or alternative software can be used to manually create the product system diagrams.

Note that product system diagrams are schematics of the relevant supply chains inclusive of both operations and construction thereof. For instance, unit process flow diagrams often include construction unit processes that feed into operational unit processes.

### 2.1.5 Carbon Oxide Source (Direct Replacement)

Vendors’ carbon oxide sources influence the goal and scope of the study that guides the Comparison Product System and other study design choices strongly. CO$_2$ can be sourced from flue gas or captured CO$_2$ from greenfield plants or existing plants. The CO$_2$ source can be power or industrial plants. Carbon monoxide, on the other hand, is likely to only come from industrial sources.

Most UPGrants LCAs will have a minimum of two products exiting the system boundary. This is because the source of the carbon oxide material input into the carbon oxide utilization project (e.g., coal-fired power plant) is included within the system boundary and that source likely co-produces carbon oxide and other products. Vendors shall model the Proposed Product System inclusive of the carbon oxide source capturing the carbon oxide and all non-carbon-oxide co-products produced from the carbon oxide source. Exhibit 2-5 demonstrates the proposed product system for a coal-fired power plant with an electricity co-product.

![Exhibit 2-5. Proposed Product System with CO$_2$ from Coal Power Plant](image-url)
The comparison product system shall account for the same non-carbon-oxide co-product produced at the carbon oxide source. Vendors shall construct the comparison system using the guidance provided in Exhibit 2-8. For example, if CO₂ capture has been applied to an existing coal power plant, then the comparison system shall include electricity produced by the U.S. average grid mix. The comparison product system plant will need to be scaled such that the non-carbon-oxide co-product is the same in both systems.

For the purposes of this addendum, Exhibits 2-6 and 2-7 in the NETL CO2U LCA Guidance Document do not apply. Exhibit 2-8 is modified below to reflect this revised guidance. The revised exhibit is applicable to all carbon oxide source types, such as power plants, industrial plants, and direct air capture sources.

*Exhibit 2-8. Summary of Proposed Guidelines for Considering Carbon Oxide Source Co-Product Based on Type of Carbon Oxide Input to the Utilization Project*

<table>
<thead>
<tr>
<th>CARBON OXIDE STREAM TYPE</th>
<th>PLANT TYPE</th>
<th>PROPOSED PRODUCT SYSTEM</th>
<th>COMPARISON PRODUCT SYSTEM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flue Gas*</td>
<td>Existing or greenfield</td>
<td>Vendor plant with flue gas diversion</td>
<td>Vendor plant with no flue gas diversion</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Greenfield</td>
<td>Vendor carbon oxide plant</td>
<td>Average GHG performance for equivalent products/services, see hierarchy in Section 2.1.3.2.</td>
</tr>
<tr>
<td>Captured carbon oxide</td>
<td>Retrofit with de-rate</td>
<td>Same plant with carbon oxide capture, possibly producing less non-carbon-oxide co-product due to de-rate (e.g., less co-product generation at a plant)</td>
<td>Average GHG performance for equivalent products/services, see hierarchy in Section 2.1.3.2.</td>
</tr>
<tr>
<td></td>
<td>Retrofit with no de-rate</td>
<td>Same plant with carbon oxide capture</td>
<td>Average GHG performance for equivalent products/services, see hierarchy in Section 2.1.3.2.</td>
</tr>
</tbody>
</table>

*Flue gas here is defined as a point-source stream of gas containing carbon oxide which did not undergo separate processing to increase the concentration of the carbon oxide.*

The remainder of Section 2.1.5 (2.1.5.1 and 2.1.5.2) do not apply as the guidance therein is superseded by the above.

**2.1.6.2 Geographical Representativeness (Direct Replacement)**

Geographical boundaries specify the locations of parts of, or all of, the supply chain. This allows calculation of the transport distances between points in the supply chain, the origins of electricity and other energy sources used by unit processes, and specification of other parameters that may change depending on location. It can also serve as the basis for evaluating the extent of interactions among the domestic and global markets of products.
The geographical boundaries of the LCI data are determined by the supply chains required (modeled) to meet the goal and scope of the LCA. It is important to recognize that the geographical boundary specified in the goal and scope of the LCA and reaffirmed in the long description of the functional unit may vary from the geographic boundary of individual product systems (supply chains). This is acceptable and common when noted as a data limitation in study documentation. It is important that the inventory data for the modeled product system represent the product that will be delivered to the geographical boundary of the goal and scope of the LCA study.

The modeled vendors’ projects, products, and supporting supply chains shall represent the US average GHG emissions wherever possible throughout the supply chain. This simplification of geographical representativeness will allow for better comparability with the NETL-provided technology baselines. Differences in this representativeness due to data limitations shall be noted in the data quality assessment accompanying the results interpretation section of the study findings.

2.1.6.3 Temporal Representativeness (Additional Guidance)

Operational processes for the Proposed and Comparison Product Systems temporal boundaries shall reflect the most recent complete calendar year at the time of submittal to the UPGrants Program. The carbon oxide utilization unit process must use a minimum of six consecutive months of operational data from that calendar year in the calculation of its annual average operations. This clarifies the guidance in which the operational emissions period is not specified.

2.1.8 Life Cycle Impact Assessment Methods for Results Interpretation (Additional Guidance)

LCAs submitted for the UPGrants program are only required to measure impacts based on global warming potential (GWP) and shall use the GWP impact factors provided in the NETL CO2U LCA Guidance Toolkit.

No other impact categories are required for this analysis. Sections 2.1.8.1 and 2.1.8.2 of the NETL CO2U LCA Guidance Document therefore do not apply.

2.1.9.2 Sensitivity and Uncertainty Analysis (Direct Replacement)

Vendors shall complete a sensitivity analysis in which each parameter in the model is varied by one increment to determine degree of influence on the study results. Highly sensitive parameters shall be evaluated using a breakeven analysis to determine what parameter value would result in a change in the percent improvement relative to the comparison system that would result in a change in acceptance to the UPGrants Program, i.e. of a percent reduction of between 10% and 25% for first acceptance, or greater than 25% for second acceptance for additional funds. Vendors shall describe under what modeling conditions the results of the LCA study would change the outcome of the comparison; a break-even analysis is one technique often used to determine the technical boundaries for environmental preferability. In the text of
the LCA report, vendors shall qualitatively describe the likelihood that the breakeven parameter value is realistic given their operations and supply chains.

Uncertainty analysis is not required for the UPGrants program. However, if the vendors choose to use a stochastic modeling method, such as Monte Carlo analysis, they must be consistent in using the mean or the median as the expected value for all product systems. For example, if the vendors choose to use the median value for the Proposed Product System, they must also use the median value for the Comparison Product System.

2.1.9.3 Reporting Units and Methods of Comparison (Direct Replacement)

Product manufacturers shall generate a contribution analysis and display results as a stacked bar chart that includes the Proposed Product System and the Comparison Product System as shown in Exhibit 2-26.

See Section 4.0 for an example of how openLCA displays a contribution analysis as a stacked bar chart. For the purposes of this guidance, vendors shall generate a stacked bar chart that is delineated by unit process and include only unit processes that contribute 10 percent or more to the total life cycle impacts. All other unit processes should be aggregated into an “other” category.

In addition to the chart(s), vendors shall report the quantitative results in a table. Product manufacturers shall also calculate the percent change between the Proposed Product System(s)
and the Comparison Product System(s) and display the results in a table. The difference shall be calculated as follows for the GWP:

\[
\text{Percent Change} = \frac{GWP \text{ of Proposed Product System} - GWP \text{ of Comparison Product System}}{GWP \text{ of Comparison Product System}} \times 100
\]

Negative number results in the percent change calculation indicate a decrease in emissions relative to the Comparison Product System. A positive number indicates an increase in emissions over the Comparison Product System.

Results shall be reported in the report document outlined in Section 6.0.

2.2.2.2 Environmental Inventory Data (Direct Replacement)

Emissions and other output data in unit processes are ultimately linked to an impact assessment method (see Section 2.1.8) to calculate environmental impacts, so it is imperative to report all relevant outputs in each unit process. For the purposes of this guidance, PIs shall at least report the following GHG emissions in their unit processes: CO\(_2\), methane (CH\(_4\)), and nitrous oxide (N\(_2\)O) where applicable. Additionally, significant direct and indirect land use should be reported in land area (e.g., m\(^2\)) to determine the global warming potential derived from it.

2.2.2.3 Unit Process Data Development Approaches (Additional Guidance)

NETL will provide a set of technology baselines commonly used by carbon oxide utilization technologies. Less commonly produced products may be added to the database in subsequent versions of the Toolkit. A complete list of these technology baselines will be available through https://netl.doe.gov/upgrants website. Product manufacturers shall use any relevant baselines available one month prior to submittal to form their Comparison Product System and cannot use data from another source to form their Comparison Product System without significant justification. Therefore, the NETL CO2U LCA Guidance Document text for this section and Section 2.2.2.4 is only applicable to datasets not already available in the Toolkit.

2.2.2.5 Land Use Change (Additional Guidance)

The NETL unit processes for modeling land use change are not required to be used by vendors, but the choice of land use change modeling shall be justified in the report. Additionally, GWP emissions resulting from land use change should be documented as a separate category of emissions for the graphs and tables specified Section 2.1.9.3.

2.3 Impact Assessment (Additional Guidance)

LCAs submitted for the UPGrants Program are only required to report GWP impacts. While including chemical species required to understand additional impact categories is still encouraged, only the data relevant to GWP will be reviewed as part of the UPGrants Program.

2.3.1 Data Quality Assessment (Direct Replacement)

A critical component of the LCIA is the evaluation of the approach and results. Product manufacturers shall describe any known data limitations or omissions of inventory data that
may affect the GWP result. A completeness check should be performed to determine if sufficient data exists to report on GWP. The completeness is assessed based on environmental relevance; noted deficiencies shall be resolved through additional data collection and/or documented as a key data limitation to inform the results interpretation. The results of the environmental relevance shall be documented as part of the modeling effort and the LCA study report shall contain a statement describing that the completeness was tested and determined not to affect the interpretation of results. If deficiencies do impact the results interpretation, this shall also be noted.
5.0 USING THE NETL CO2U LCA DOCUMENTATION SPREADSHEET FOR DOCUMENTATION (DIRECT REPLACEMENT)

This section provides guidance on using the NETL CO2U LCA Documentation Spreadsheet to provide unit process and life cycle system documentation when the spreadsheet model option is used (not openLCA or other life cycle modeling software). See Section 1.5 for details on modeling options and required methods for study transparency.

5.1 OVERVIEW (ADDITIONAL GUIDANCE)

The original instructions for the Documentation Spreadsheet provide a framework for the submission of multiple product systems. PIs under the NETL CO2U LCA program must complete their own Comparison Product Systems and are encouraged to explore multiple scenarios for both their Proposed Product System and Comparison Product System due to their low technology readiness levels. Product manufacturers for the UPGrants program are likely to only submit their Proposed Product System and use the NETL technology baselines to make up their Comparison Product System. Documentation of the Comparison Product System can then consist solely of the ratio of baseline technologies included in the Comparison Product System. Additional “scenarios” should not be submitted. Therefore, vendors will only submit multiple documentation spreadsheets when NETL-provided technology baselines do not exist for their products.
6.0 Completing the NETL CO2U LCA Report Template (Direct Replacement)

Documenting the LCA study in a clear and consistent manner is important to effectively communicating the results. There are various strategies and approaches to documenting LCA results. To ensure consistency, a standardized report template is provided. The goal is to ensure a minimum level of documentation to effectively communicate the goal of the study, how the study was conducted, and how the results should be interpreted. The NETL UPGrants LCA Report Template is provided to assist in the documentation process. Product manufacturers shall consider the report template a “guide” and add additional documentation or analysis necessary to effectively communicate the study results.

The following sections describe what to include in each section of the NETL UPGrants LCA Report Template. The basis for this report is the International Organization for Standardization (ISO) Environmental Management: Life Cycle Assessment; Requirements and Guidelines, consistent with Section 5.2 of ISO 14044. [1] [2] Where applicable, default text that aligns with UPGrants LCA guidance stated in this addendum is recommended within the report template. The proceeding sections describe the reporting requirements for the Proposed Product System.

6.1 Executive Summary (Direct Replacement)

This section in the NETL UPGrants LCA Report Template is to provide a high level one- to three-page overview of the study goal and scope, key modeling assumptions, results interpretation, and any data limitations that effect the results interpretation. A simplified system boundary with reference flows between key processes or life cycle stages shall be included to quickly communicate the Proposed and Comparison Product Systems modeled, demonstrate that both systems provide the same service or function to society (both systems have the same functional unit exiting the system boundary), and to assist in the interpretation of results. When using the NETL-provided baseline technologies, the systems can be represented with a single “block” each. A brief description of the Proposed and Comparison Product Systems shall be provided. If any proprietary information is obscured or withheld from the report, it shall be noted. This section shall state that this LCA is being commissioned for the UPGrants Program, identify the vendors and the practitioner of the LCA, and that this LCA report has been prepared in accordance with ISO 14040/14044 requirements for release of comparative assessments for third parties.

6.2 Goal of the Study (Direct Replacement)

The purpose of this section is to describe why the study was conducted, how the information/results will be used, by who, and if the study is intended to be made public. These goals are generally the same for all UPGrants LCAs. Suggested text for vendors’ consideration and modification is provided in the report template.
6.3 Scope of the Study (Direct Replacement)

The purpose of this section of the report is to define what was modeled, what the data quality/representative goals are, what the basis of comparison is in terms of the functional unit (inclusive of all co-products), and how the results are to be compared. This section also defines the level of completeness required to make a comparison between the Proposed and Comparison Product Systems. Expectations for sensitivity analysis shall also be described in this section. At a minimum, the following items shall be defined with respect to the PI’s specific project in this section of the report:

1. Functional unit of the study
   a. The product outputs of the proposed product system define the functional unit; more than one product may be produced within the system boundary, in these cases the functional unit is considered a “multiproduct functional unit”
   b. The primary product of interest is set to one unit and the other co-products are expressed as the appropriate ratio to the primary product of interest
   c. The Comparison Product System must meet the same function or service provided to society by all of the co-products produced within the Proposed Product System

2. System boundary
   a. Describe the life cycle stages included, and if applicable excluded, from the study
   b. Provide an illustrative depiction of the process flow diagram for both the Proposed and Comparison Product Systems; key material and energy inputs, reference flows, and the functional unit shall be included on the diagram describing the system boundary

3. Carbon oxide source
   a. Clearly define the source and quality properties as received by the utilization technology and/or facilities

4. Technology representativeness
   a. Describe the state of the Proposed Product System based on current operations of the vendor’s facility
   b. Describe the state of the Proposed Product System based on current operations of the vendor’s facility. If the vendor has multiple facilities, descriptions of each shall be included so that the average can be obtained. Relevant information may include:
      i. A narrative description of the facility layout and configuration, accompanied by a process flow diagram (PFD) that identifies all major equipment.
      ii. A detailed description of the critical process equipment, including novel technologies
iii. Material and energy balance (MEB) diagrams and tables for the facility
iv. Feedstock volumes (e.g., carbon oxide), utility demand (e.g., imported electric power and heat energy requirements) and assumed costs
v. Identification of products and byproducts (if applicable), anticipated and maximum production volumes for each, as well as the production cost and assumed sales prices

5. Geographical representativeness
   a. All UPGrants final products shall be produced and consumed in the United States of America
   b. The geographical representativeness of each primary life cycle stage/supply chain shall be assumed to be the “US Average” where possible to allow for better comparability against the provided technology baselines

6. Temporal representativeness
   a. Define the production year the operational unit processes of the Proposed Product System represent, i.e., the most recent complete calendar year at the time of submittal to the UPGrants Program.
   b. Provide the time frame of the data used to calculate representative operations for the utilization process (must be minimum of 6 consecutive months)
   c. Define if the carbon embedded in the CO2U products, if applicable, will remain in a sequestered (not released to the atmosphere) state or not. If not, what is the service life of each product and how will the carbon be released to the atmosphere; carbon expected to be retained in the product for greater than 100 years is considered permanently sequestered for the purposes of LCA modeling within this Guidance document
   d. Generally, the study period is defined by the service life of the primary product of interest from the Proposed Product System

7. Life cycle impact assessment methods for results interpretation
   a. Required: global warming potential (kg CO$_2$e) provided in the NETL CO2U LCA Guidance Toolkit

8. Completeness requirements
   a. 99% of the carbon balance and at least 99% of the known energy inputs to the system boundary
   b. Environmental relevance - all life cycle emission that would contribute to each life cycle impact assessment category that would change the lifecycle results for the Proposed Product System at the third significant digit.

9. Sensitivity and uncertainty analysis
a. Describe the expectations for how sensitivity and uncertainty will be modeled within the study

b. NETL minimum expectation for sensitivity analysis is to vary each parameter in the model by one increment to determine degree of influence on the study results; highly sensitive parameters shall be evaluated to determine at what level a change in the parameter would result in a change in study conclusions (interpretation of LCA results)

c. NETL minimum expectation is to bracket the data uncertainty and technical variability of the key modeling parameters to define “low” and “high” scenarios that bracket the “expected” result from the recommended parameters/technical performance; this approach results in three discrete LCA results for each proposed and Comparison Product Systems modeled

d. Describe under what modeling conditions the results of the LCA study would change the outcome of the comparison; a break-even analysis is one technique often used to determine the technical boundaries for environmental preferability

10. Reporting units and method of comparison

a. NETL standard is International System of Units (SI) reported in scientific notation (e.g., 2.34+01 kg CO\textsubscript{2}e)

b. NETL default comparison requirement is three forms/metrics:
   i. Stacked bar chart with uncertainty bars
   ii. Ratio of Proposed/Comparison Product System
   iii. Percent change calculation of the Proposed Product System from the Comparison Product System

Item 4 of the above list matches much of the information requested for a techno-economic analysis (TEA), as described by Basis for Techno-Economic Analysis: Bi-Partisan Infrastructure Law Utilization Procurement Grants. If the carbon conversion manufacturer chooses to complete a TEA, the information provided to the UPGrants program under item 4 can be reproduced in the LCA report or referenced and summarized in the LCA report.

6.4 Life Cycle Inventory Analysis (Additional Guidance)

Unit process descriptions and quality assessments are not required for any NETL-provided data. The NETL-provided data used in the LCA must be listed by its full name and version. Additionally, a discussion of NETL-provided data’s fitness for purpose (e.g., how it matches the intended technology, temporal, geographical, etc. representativeness) must be included. All non-NETL data must include complete descriptions and quality assessments.
APPENDIX A ACCESSING THE NETL CO2U LCA TOOLKIT AND RESOURCES FOR ASSISTANCE (DIRECT REPLACEMENT)

The NETL CO2U LCA Guidance Toolkit and 45Q Addendum includes the following:

1. NETL CO2U LCA Guidance Document outlines the analysis requirements and how to use the supporting data and tool, including this addendum modifying guidance for UPGrants Program vendors.

2. NETL CO2U openLCA LCI Database is an openLCA database that includes NETL unit process data and an example CO2U LCA.

3. NETL CO2U openLCA Results Contribution Tool is an Excel template that translates openLCA results into required charts.

4. NETL CO2U LCA Documentation Spreadsheet is an Excel file that can be used to document data when not using openLCA.

5. NETL CO2U UPGrants LCA Report Template is a Word report template for summarizing data and results, including a modified version for UPGrants Program vendors.

NETL CO2U LCA Subject Matter Expert Support and training resources are available as part of the toolkit for vendors preparing LCAs. All questions related to UPGrants LCAs submitted to DOE shall be directed to [email address]. Frequently Asked Questions and other training resources will be available on the NETL website.

The entire contents of the NETL CO2U LCA Toolkit can be accessed at the following URL:

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

The UPGrants addendum and additional resources can be accessed at the following URL:

https://netl.doe.gov/upgrants/resources

The openLCA software can be downloaded at the following URL:

https://www.openlca.org/download/

APPENDIX B (ADDITIONAL GUIDANCE)

Appendix B does not apply for the purposes of the UPGrants program.
APPENDIX C (ADDITIONAL GUIDANCE)

This appendix is provided for information only. For the purposes of the UPGrants program, the expectation is that system expansion is used whenever possible and not overly burdensome. Any use of the allocation methods covered in this appendix will need to be justified in the body of the report.

APPENDIX D (ADDITIONAL GUIDANCE)

Appendix D does not apply for the purposes of the UPGrants program.
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