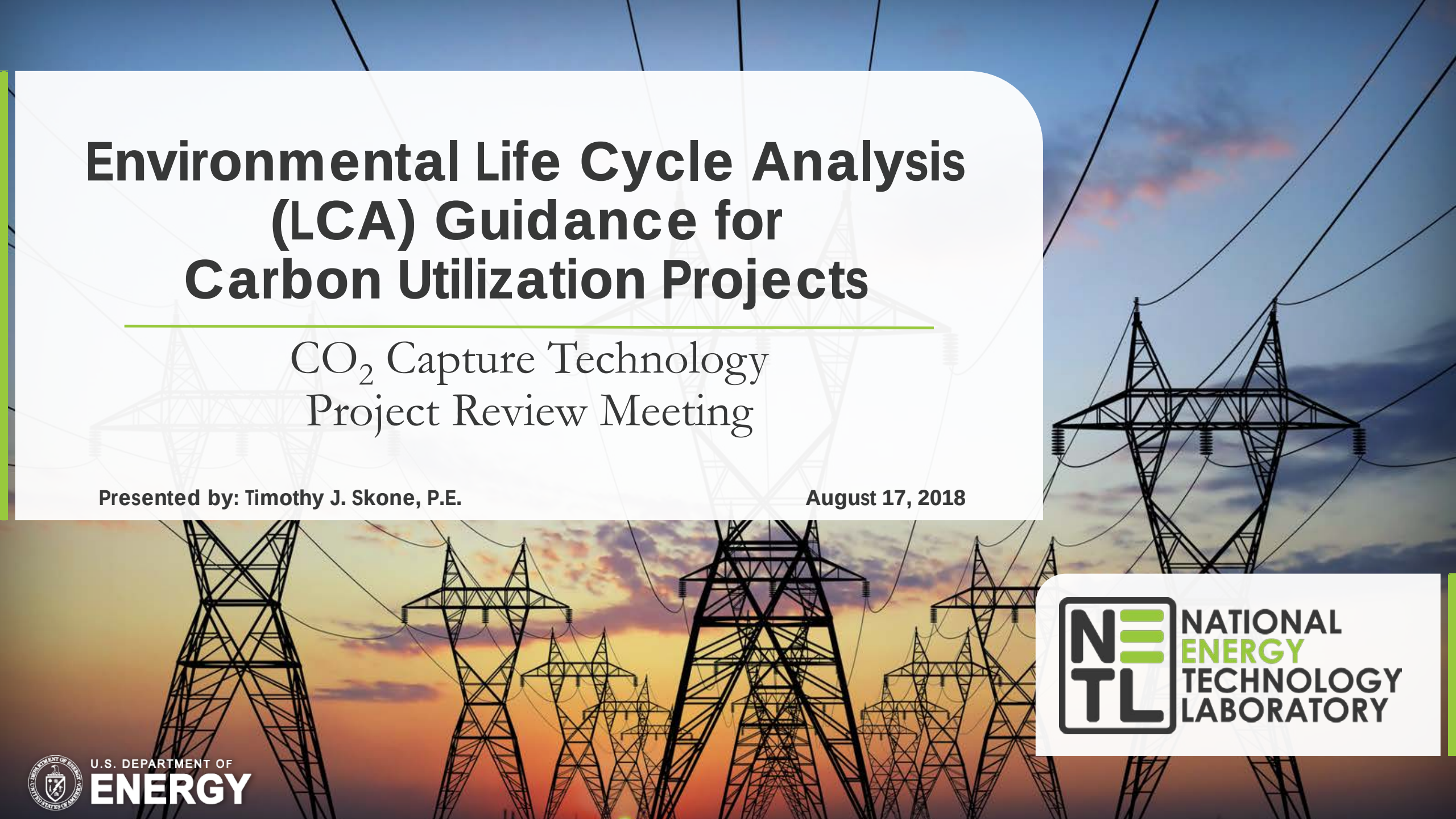
Environmental Life Cycle Analysis (LCA) Guidance for Carbon Utilization Projects

CO_2 Capture Technology Project Review Meeting

Presented by: Timothy J. Skone, P.E.

August 17, 2018



U.S. DEPARTMENT OF ENERGY

NATIONAL ENERGY TECHNOLOGY LABORATORY

The “Who?” “What?” and “Why?” of the U.S. DOE CO2U Guidance

Who?

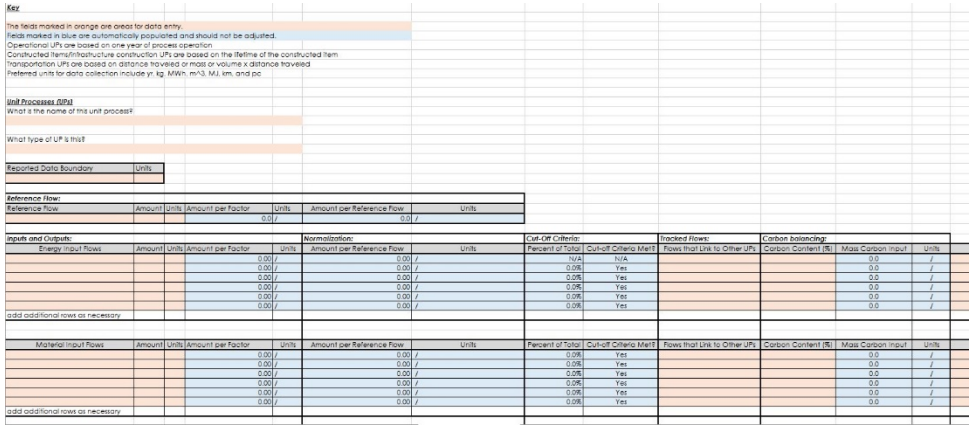
- The LCA team at the National Energy Technology Laboratory at the U.S. DOE
- In collaboration with other researchers and Office of Fossil Energy at the DOE

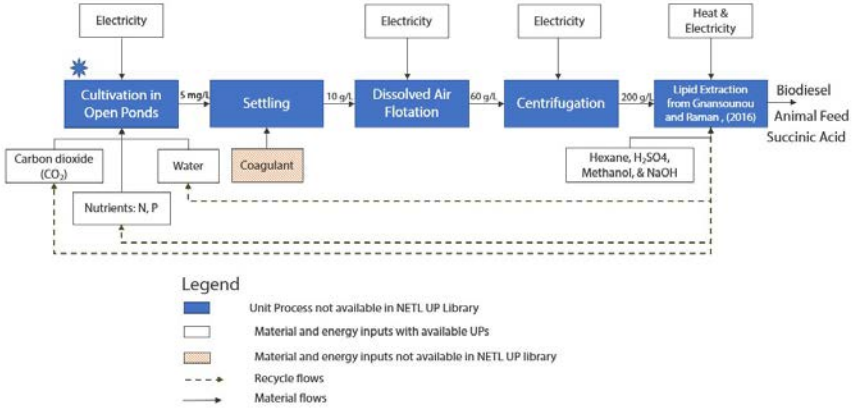
www.netl.doe.gov/lca

The “Who?” “What?” and “Why?” of the U.S. DOE CO2U Guidance

What?

- Guidance
- Tools
  - openLCA template
  - Excel template
- NETL Data
  - Upstream CO_2 data
  - Algae pathway example

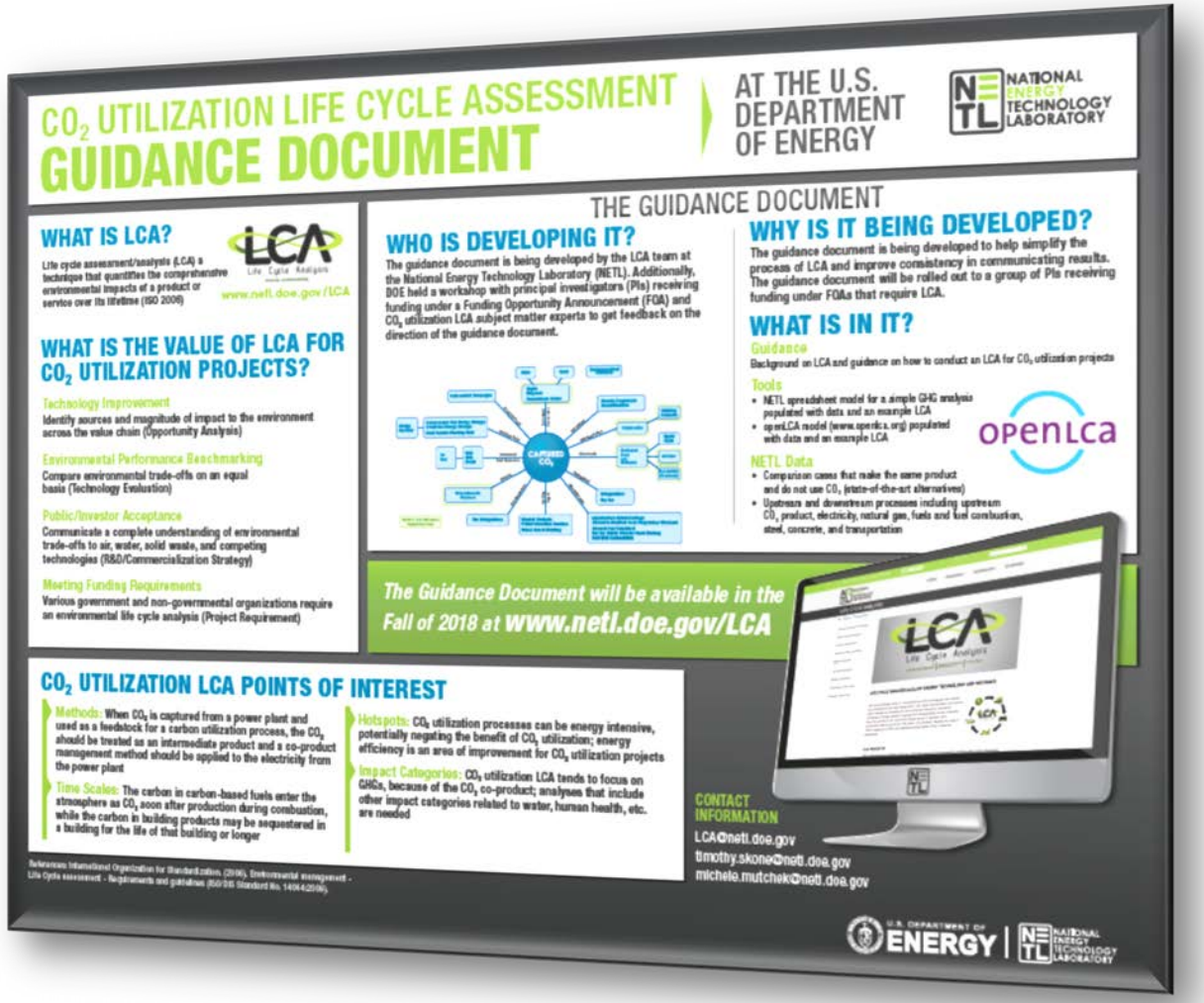




The “Who?” “What?” and “Why?” of the U.S. DOE CO2U Guidance

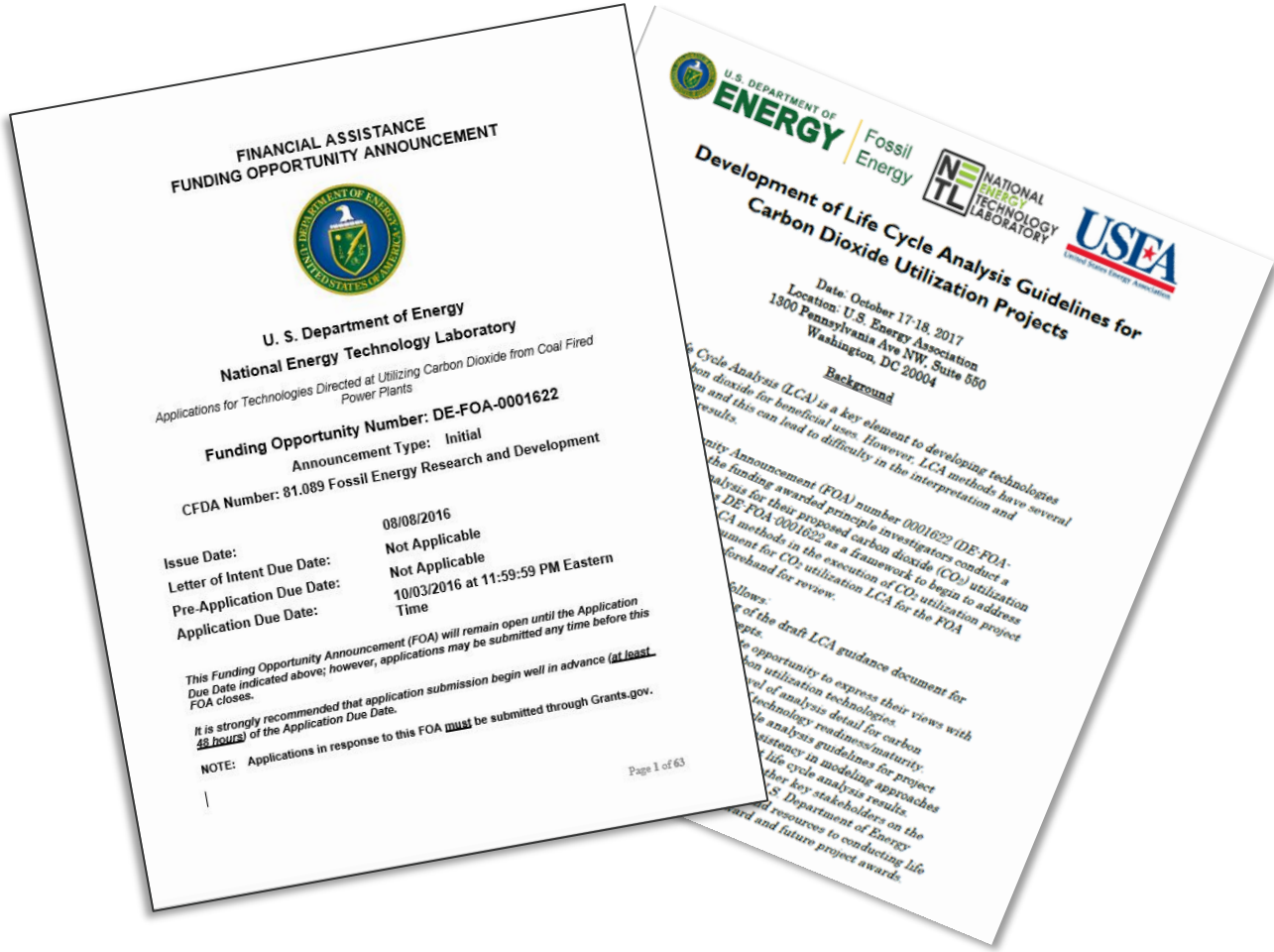
Why?

- To provide technical support to U.S. federal funding recipients
- To influence the development of consistent, robust analyses for policy decisions
- To provide value to the LCA community



Background

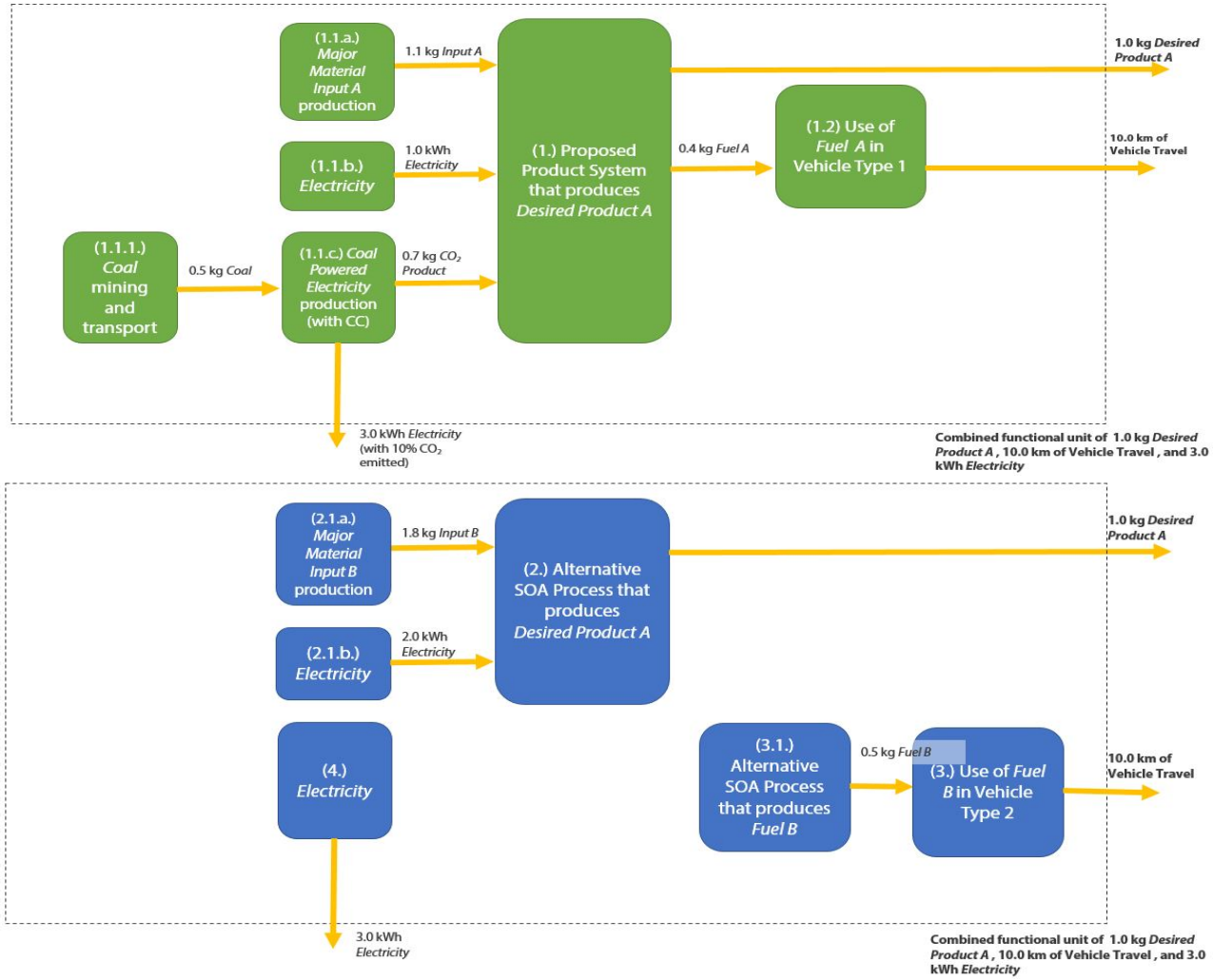
- 2016 – Funding Opportunity Announcement for CO2U projects sets forth requirement for life cycle greenhouse gas (GHG) analysis
- 2017
  - **August** - First exploratory draft of the guidance document is completed
  - **October** - A workshop was held in D.C. with subject matter experts and CO2U project principal investigators
- 2018
  - **January** – Plan for second draft of guidance document is finalized based on stakeholder feedback
  - **Fall (forthcoming)** – Second draft of guidance document will be released to the public



Decisions on Method and Analysis

Items for Discussion

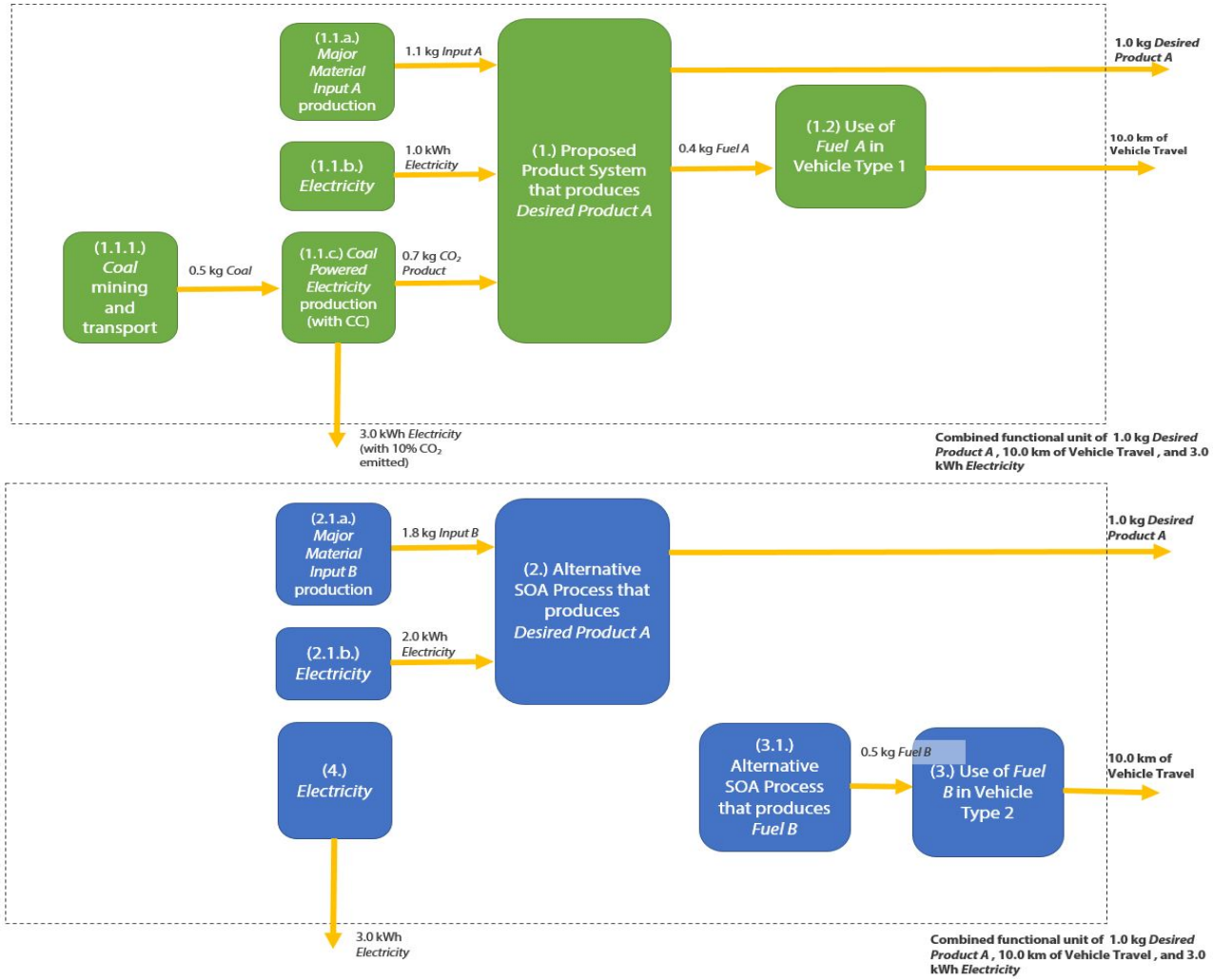
- System Boundary – Do I have to model the entire life cycle?
- Functional Unit – Defining the "system" of Comparison
- Comparison System (SOTA)
- Modeling/Reporting Platform
- Data: Upstream CO2 Profiles
- Data: Product Systems
- Additional Guidance Questions Under Review at NETL



Decisions on Method and Analysis

System Boundary – Do I have to model the entire life cycle?

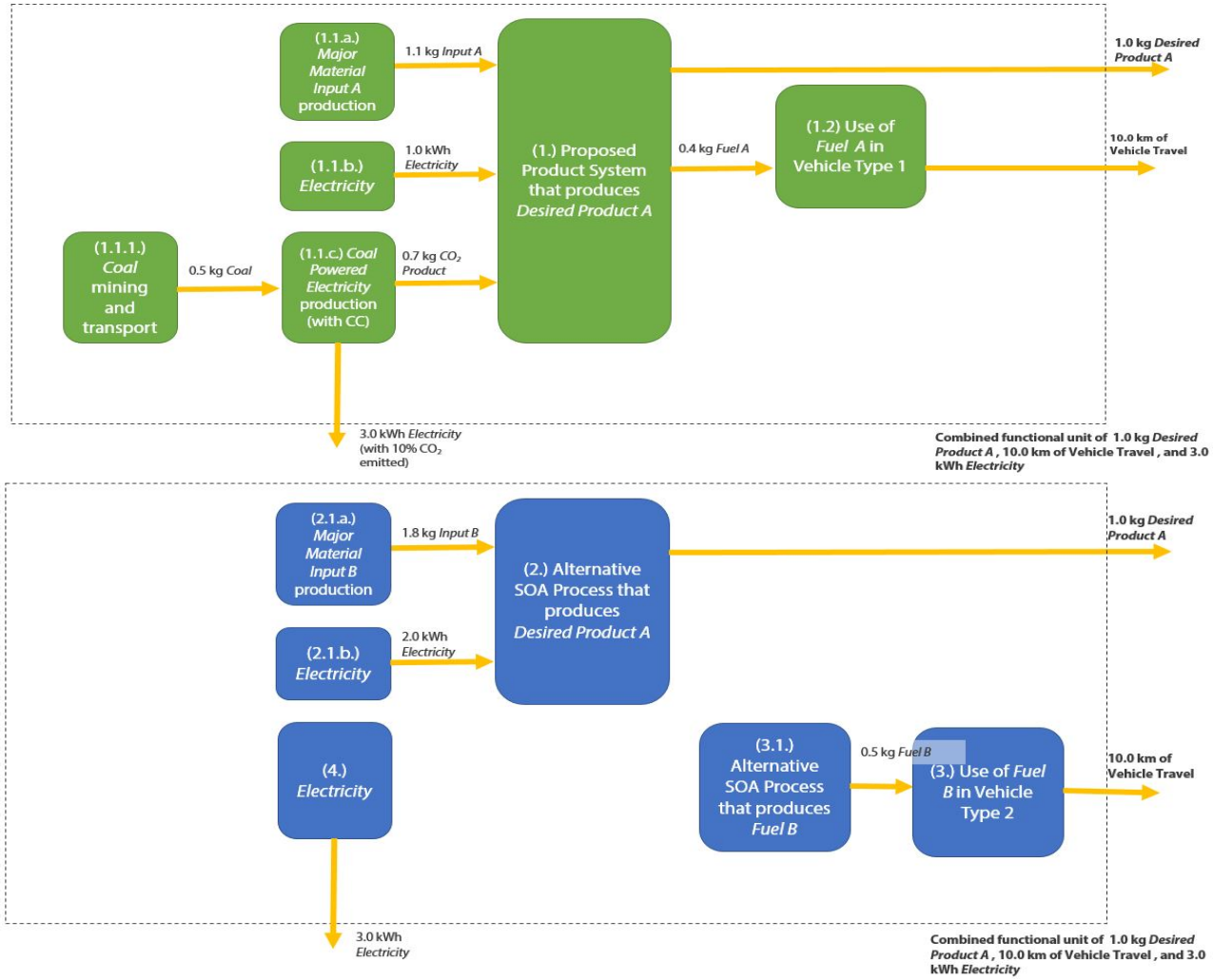
- Preferred: Cradle-to-Grave
- System boundary can be reduced once equivalence of the CO2U product and the SOTA product have been determined to provide (or will provide) the same service or function to society
- LCA must include the "cradle-to-equivalence" for both systems of comparison
- Justification/rationale for reducing the system boundary required (documented)



Decisions on Method and Analysis

Functional Unit – Defining the "System" of Comparison

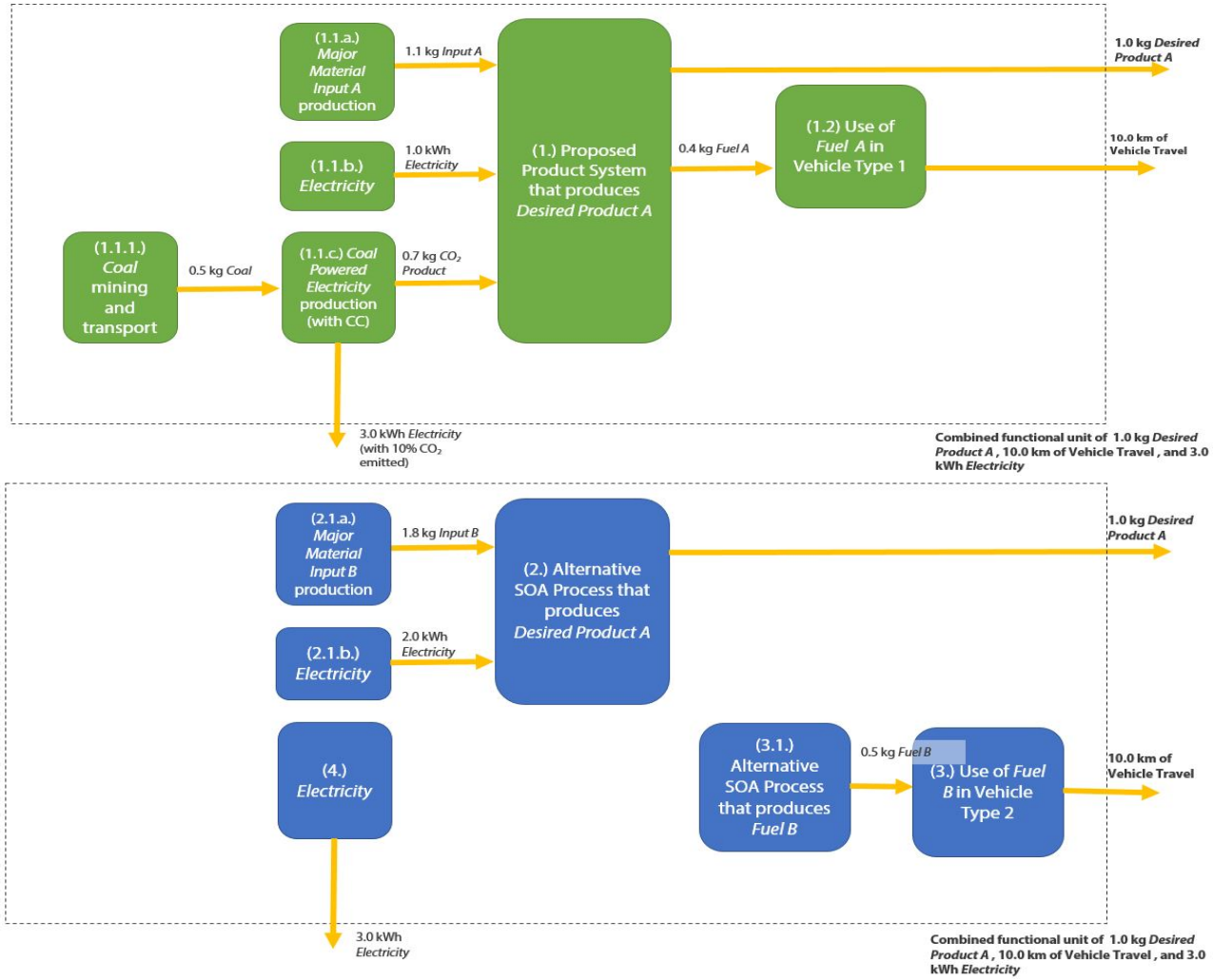
- System expansion
  - Aligns with NETL's goals to compare overall systems rather than single products
  - Multi-product functional unit avoids allocation and displacement
  - Better accuracy of comparability
- Guidance on allocation and expansion with displacement will be included to enable single product/functional unit



Decisions on Method and Analysis

Comparison System

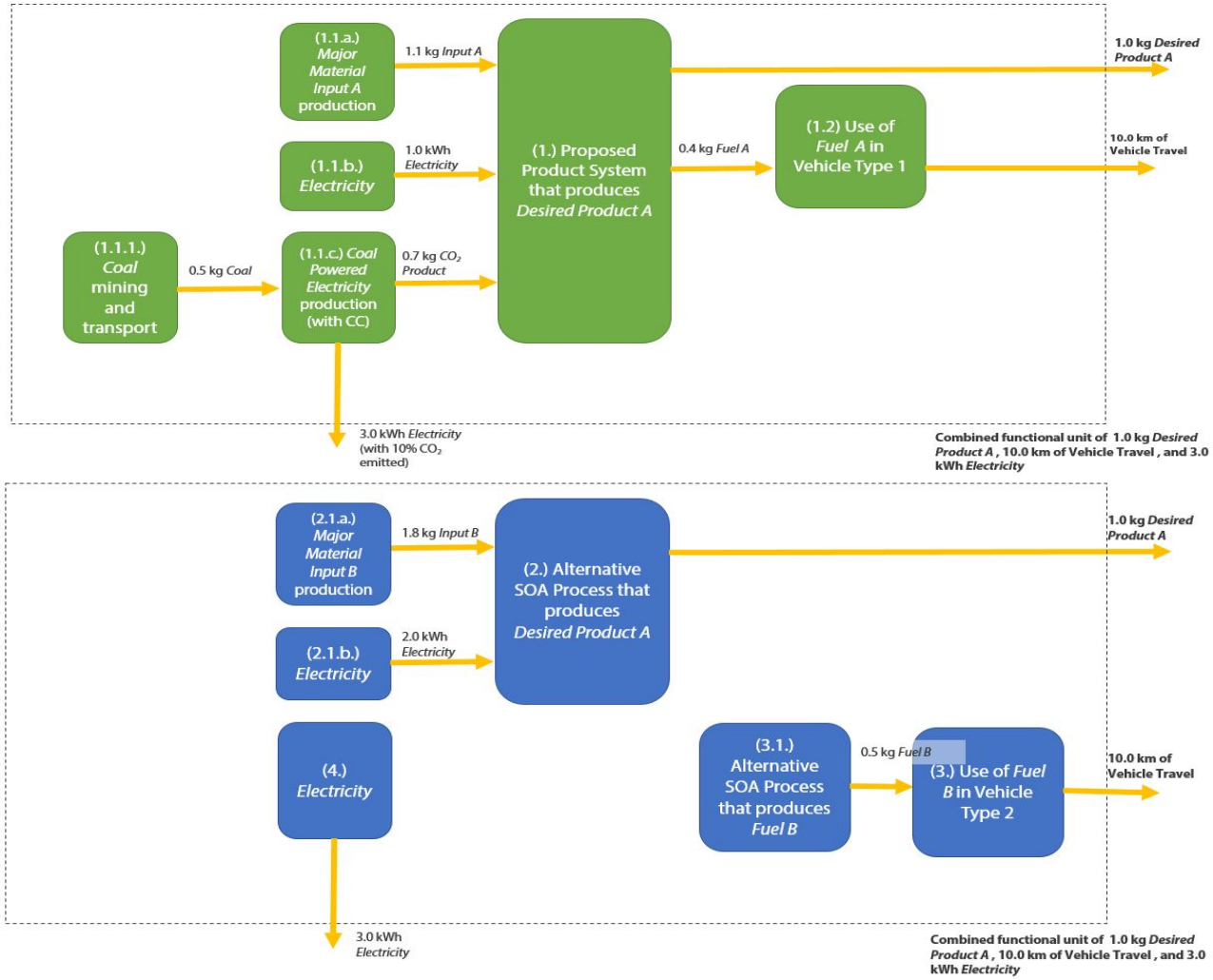
- Current State-of-the-Art (SOTA)
  - The SOTA will depend on what product is ultimately being produced
  - The conventional technology will be compared to the CO2U technology in terms of cost and life cycle impacts
  - SOTA shall be based on the known level of commercial representativeness



Decisions on Method and Analysis

Comparison System

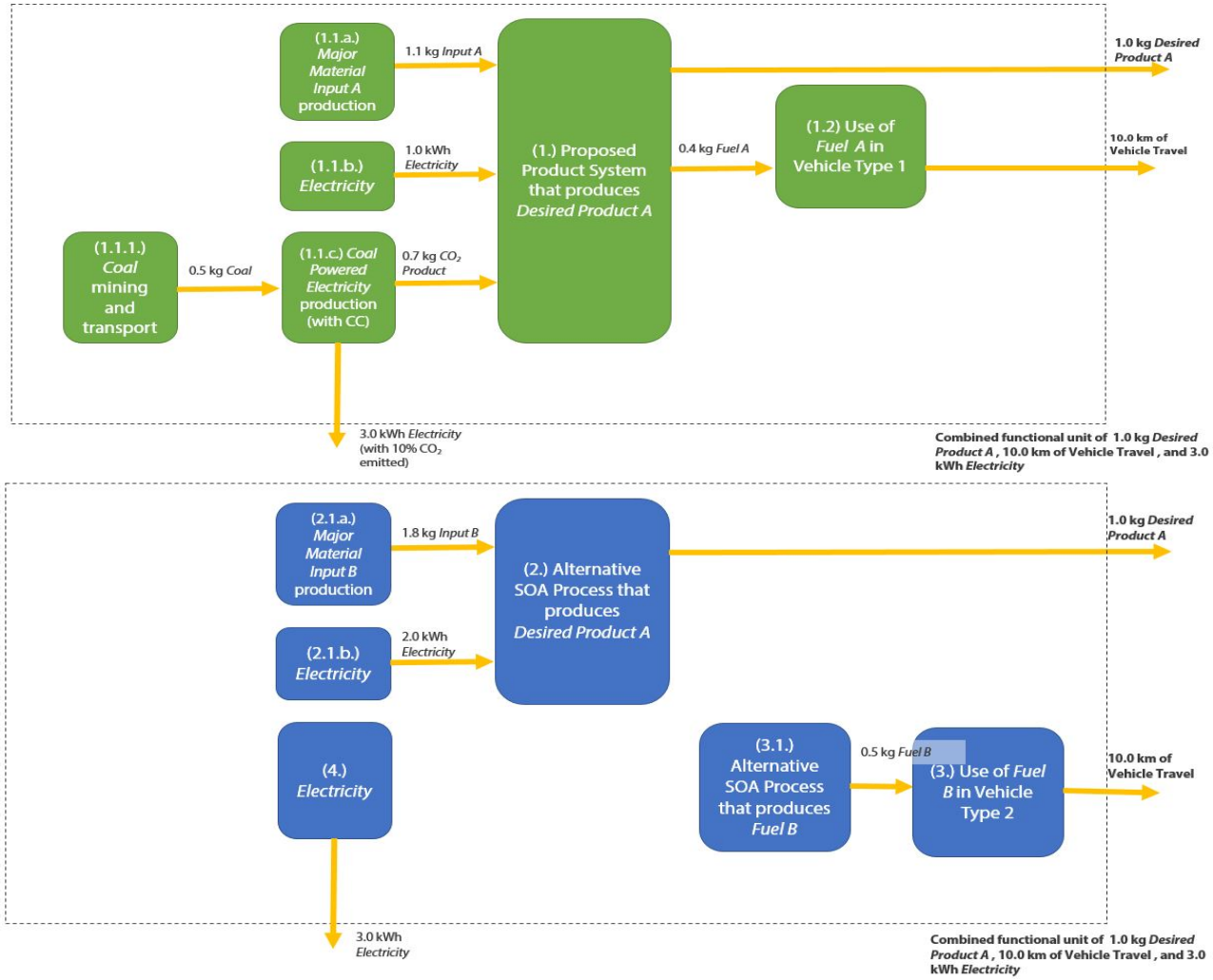
- Current State-of-the-Art (SOTA)
  - CO2U technology developers will be required to define and justify their choice of SOTA
  - SOTA choice is dependent on:
    1. the commercial technology that provides the same service or function to society, *AND*
    2. the current ability to define the competing market



Decisions on Method and Analysis

Comparison System

- SOTA choice depends on "how" it will impact the market
  - Additive – incremental addition, competitive market, low to medium market penetration. SOTA = 90th percentile of market performance*
  - Disruptive – change to how the service is provided to society; high market penetration. SOTA = "average" market performance*

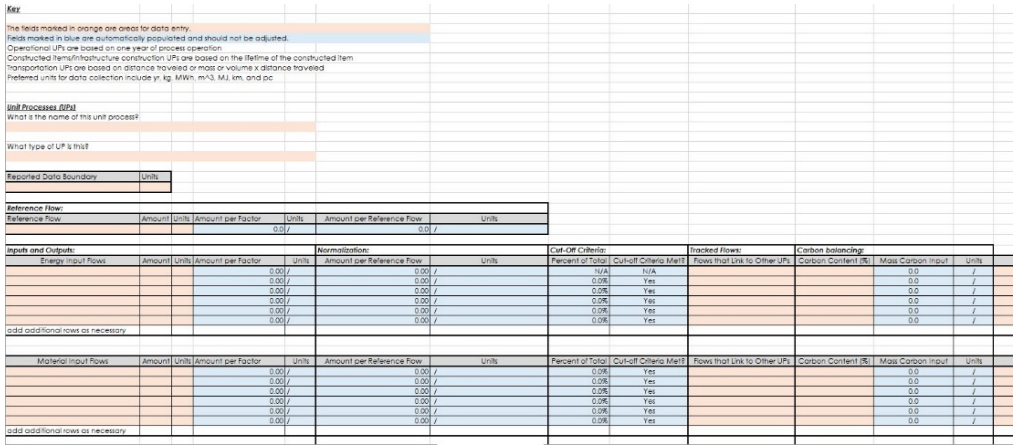


* Market Performance = life cycle GHG performance, GWP, AR5

Decisions on Method and Analysis

Modeling/Reporting Platform

- **Spreadsheet Template**
  - For simple GHG analysis documentation and results
  - Includes data and example LCA
- **openLCA**
  - Free, open source LCA software
  - Allows for expanded inventory and uncertainty analyses
  - NETL to provide template, data, example LCA, and training



Key

The fields marked in orange are areas for data entry.
Fields marked in blue are automatically populated and should not be adjusted.
Operational UPs are based on one year of process operation.
Constructed Items/Infrastructure construction UPs are based on the lifetime of the constructed item
Transportation UPs are based on distance traveled or mass or volume x distance traveled
Preferred units for data collection include yr, kg, MWh, m^3, MJ, km, and pc

Unit Processes (UPs)
What is the name of this unit process?

What type of UP is this?

Reported Data Boundary	Units

Reference Flow:

Reference Flow	Amount	Units	Amount per Factor	Units	Amount per Reference Flow	Units
			0.00	/	0.00	/

Inputs and Outputs:					Normalization:		Cut-Off Criteria:		Tracked Flows:	Carbon balancing:		
Energy Input Flows	Amount	Units	Amount per Factor	Units	Amount per Reference Flow	Units	Percent of Total	Cut-off Criteria Met?	Flows that Link to Other UPs	Carbon Content (%)	Mass Carbon Input	Units
			0.00	/	0.00	/	N/A	N/A			0.0	/
			0.00	/	0.00	/	0.0%	Yes			0.0	/
			0.00	/	0.00	/	0.0%	Yes			0.0	/
			0.00	/	0.00	/	0.0%	Yes			0.0	/
			0.00	/	0.00	/	0.0%	Yes			0.0	/
			0.00	/	0.00	/	0.0%	Yes			0.0	/
add additional rows as necessary												

Material Input Flows	Amount	Units	Amount per Factor	Units	Amount per Reference Flow	Units	Percent of Total	Cut-off Criteria Met?	Flows that Link to Other UPs	Carbon Content (%)	Mass Carbon Input	Units
			0.00	/	0.00	/	0.0%	Yes			0.0	/
			0.00	/	0.00	/	0.0%	Yes			0.0	/
			0.00	/	0.00	/	0.0%	Yes			0.0	/
			0.00	/	0.00	/	0.0%	Yes			0.0	/
			0.00	/	0.00	/	0.0%	Yes			0.0	/
			0.00	/	0.00	/	0.0%	Yes			0.0	/
add additional rows as necessary												

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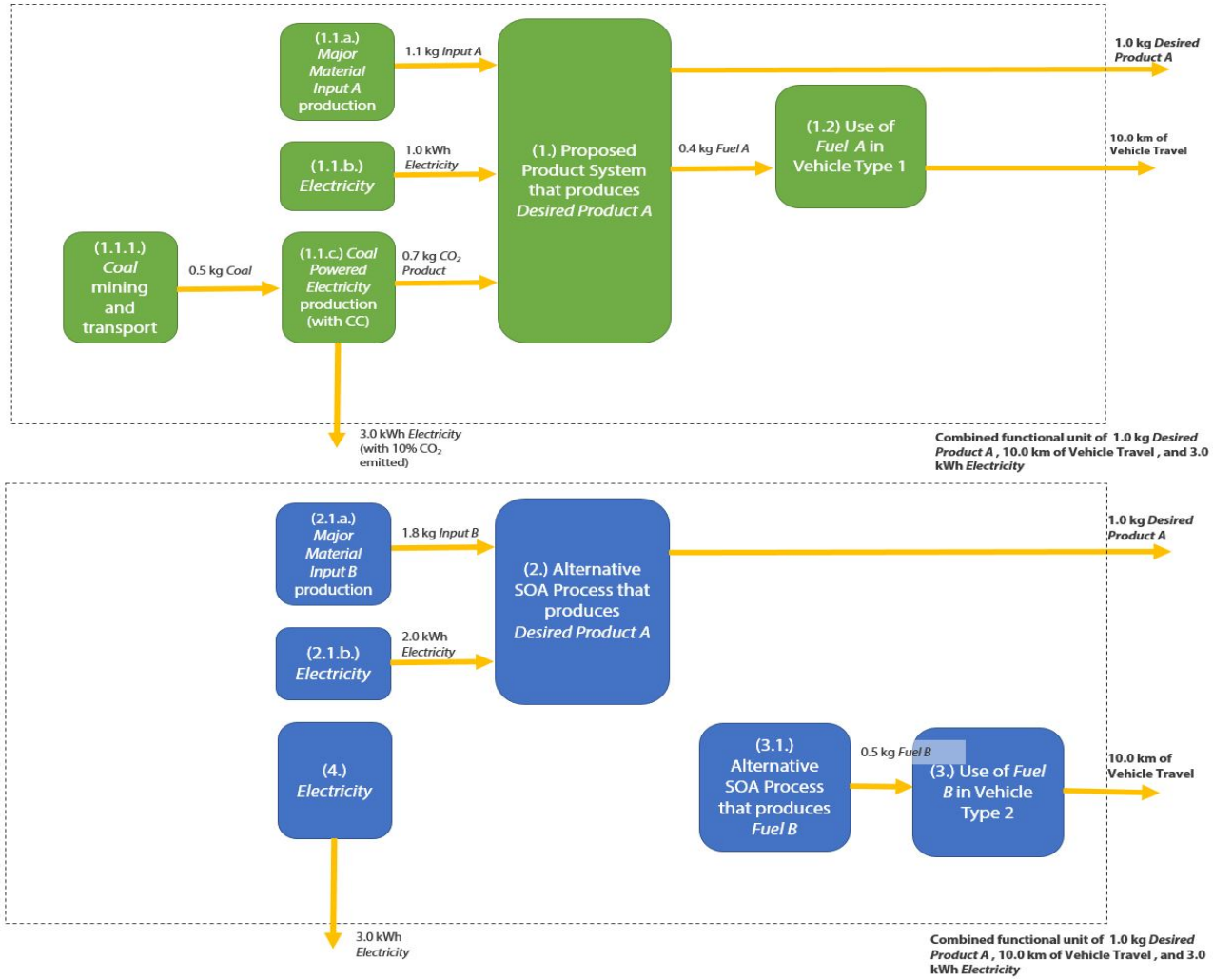
Decisions on Method and Analysis

Upstream CO2 Profiles

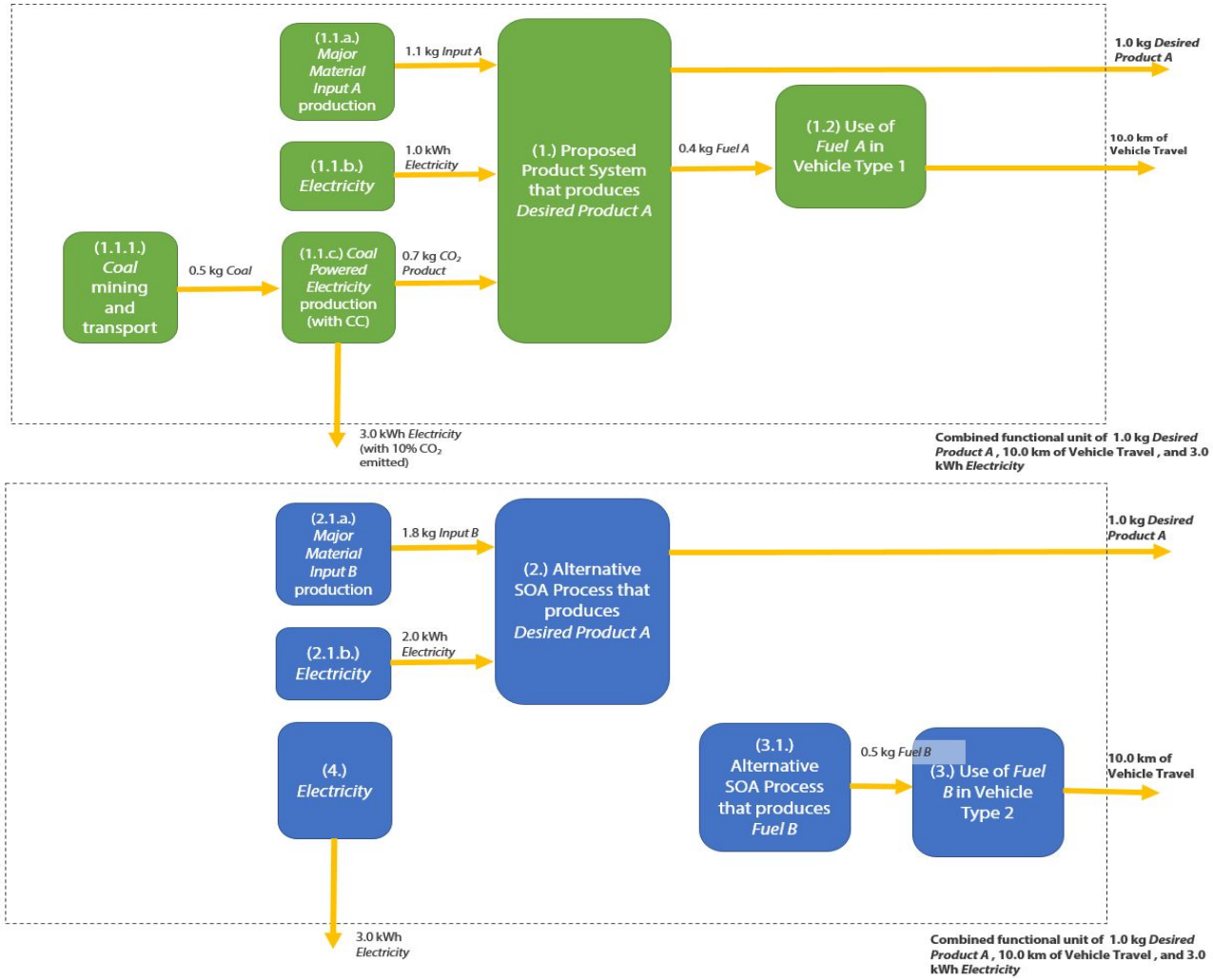
- Upstream CO_2 source profiles (cradle-to-gate) to be provided by NETL (tentative list)
  - Captured and Compressed CO_2
    - Coal-Fired Power Plant(s)
    - Natural Gas-Fired Power Plant
    - Petroleum Refinery
    - Ammonia Plant
  - Flue Gas from Coal-Fired Power Plant(s)



Decisions on Method and Analysis

Product System Models (aka " Cradle-to-Gate Rollups")

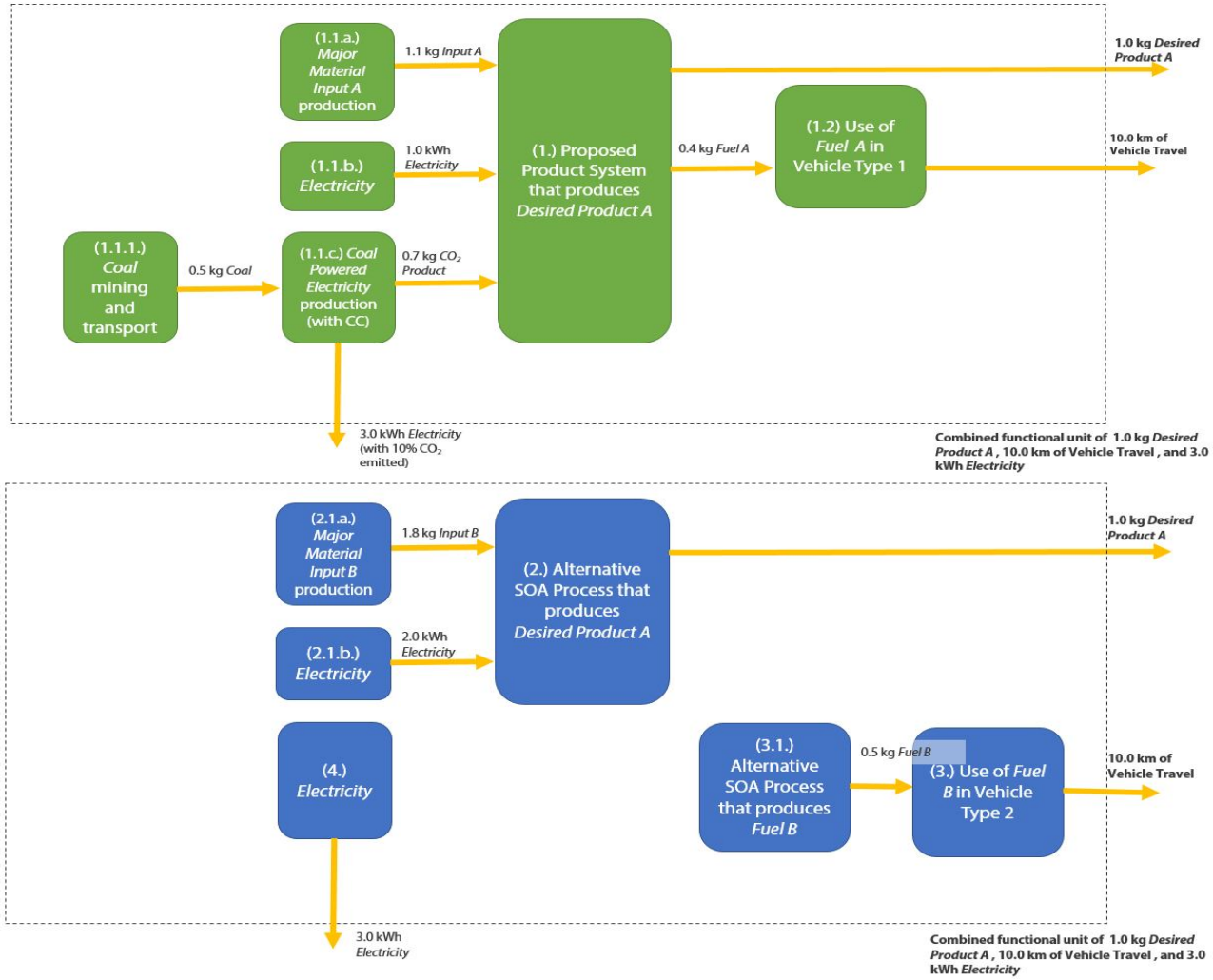
- Coal Mining
- Coal-Fired Power Plant
- Natural Gas Production
- Natural Gas-Fired Power Plant
- US and North America Electricity Grid Profile
- Regional Electricity Grid Profiles
- Biomass Cultivation
- Algae to Biodiesel Pathway



Decisions on Method and Analysis

Additional guidance questions under review….

- Uncertainty bounding versus scenario bounding
- Vertical System Boundary – cut-off rules and documentation requirements
- Time Scales – service life versus study period versus level of commercial deployment (1st of a kind versus nth of a kind performance)
- Technology Learning in the SOTA
- Uncertainty/flexibility in CO2U Process Design (system could be operated in multiple ways)



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