

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

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CO<sub>2</sub> Capture Technology  
Project Review Meeting

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August 17, 2018

# 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](http://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<sub>2</sub> data
  - Algae pathway example

**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/Manufacture/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.  
 Referenced units for data collection include: yr, kg, MWh, m<sup>3</sup>, MJ, km, and pc.

**Unit Processes (UP)**  
 What is the name of this unit process?  
 What type of UP is this?

**Reported Data Boundary**

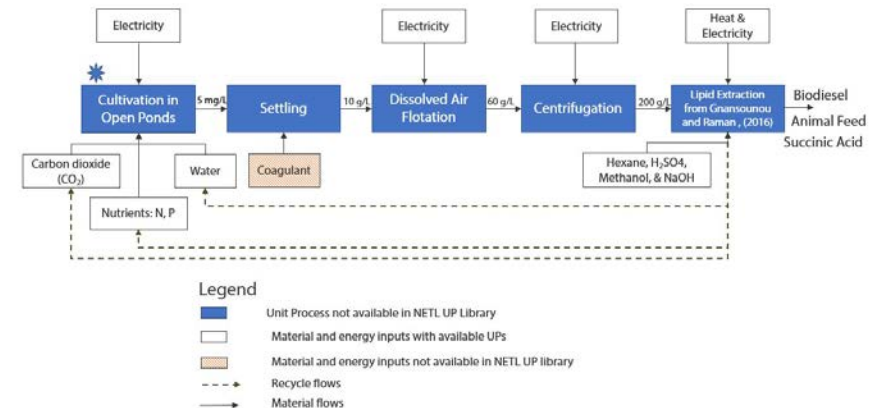
Reference flow:	Amount	Units	Amount per Factor	Units	Amount per Reference Flow	Units
Reference Flow			0.01		0.01	

**Input and Outputs**

Energy Input Flows	Amount	Units	Amount per Factor	Units	Amount per Reference Flow	Units	Cut-Off Criteria		Tracked Flows	Carbon Accounting	
							Percent of Total	Cut-Off Criteria Met?		Carbon Content (t)	Mass Carbon Input
			0.001		0.001		10%	Yes	Flows that Link to Other UPs	0.0	/
			0.001		0.001		0.5%	Yes		0.0	/
			0.001		0.001		0.5%	Yes		0.0	/
			0.001		0.001		0.5%	Yes		0.0	/
			0.001		0.001		0.5%	Yes		0.0	/
add additional rows as necessary											

**Material Input Flows**

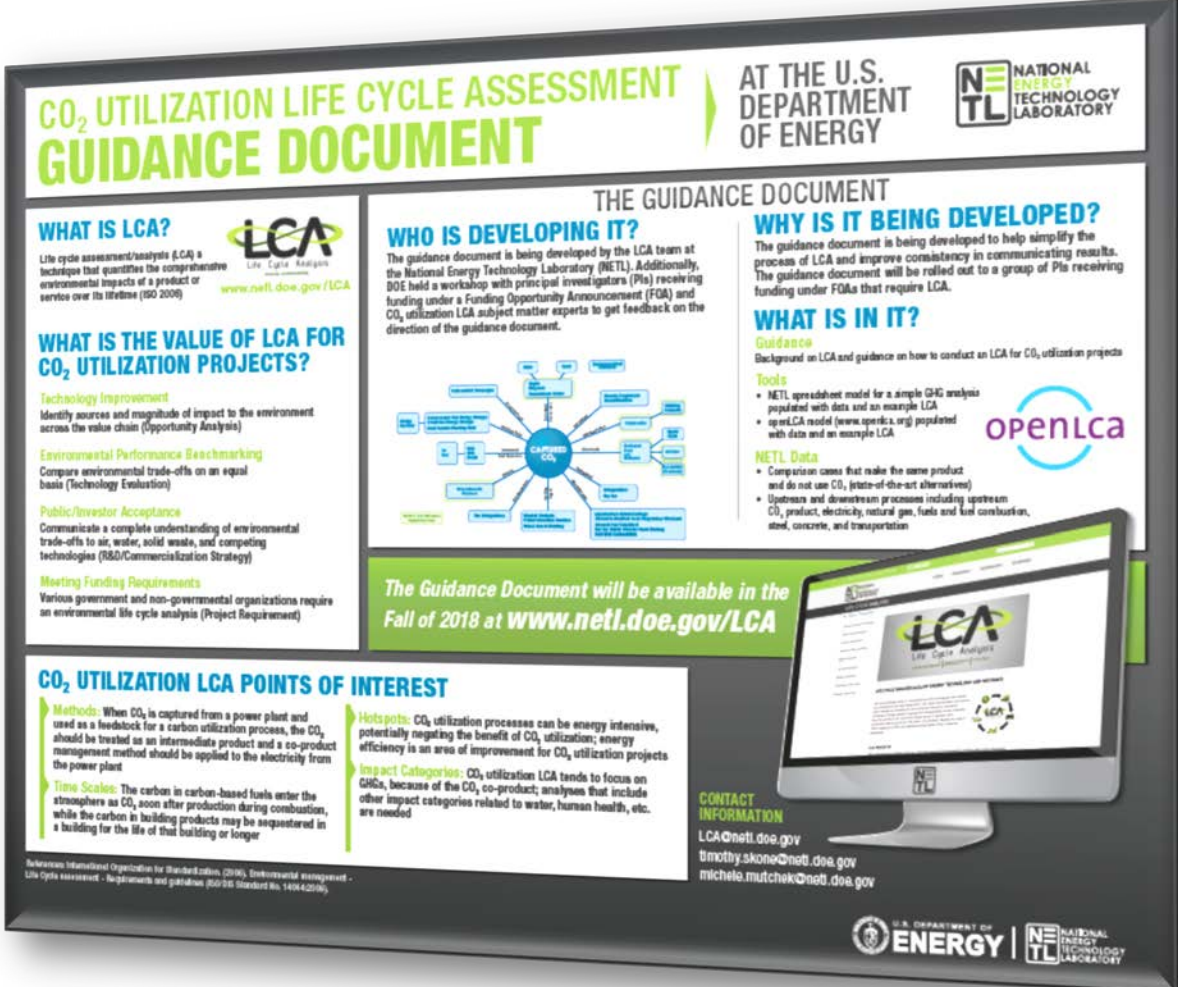
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			0.001		0.001		0.5%	Yes		0.0	/
			0.001		0.001		0.5%	Yes		0.0	/
add additional rows as necessary											



# 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



### CO<sub>2</sub> UTILIZATION LIFE CYCLE ASSESSMENT GUIDANCE DOCUMENT

AT THE U.S. DEPARTMENT OF ENERGY

**WHAT IS LCA?**  
Life cycle assessment/analysis (LCA) is a technique that quantifies the comprehensive environmental impacts of a product or service over its lifetime (ISO 2006).

**WHAT IS THE VALUE OF LCA FOR CO<sub>2</sub> UTILIZATION PROJECTS?**

- Technology Improvement:** Identify sources and magnitude of impact to the environment across the value chain (Opportunity Analysis)
- Environmental Performance Benchmarking:** Compare environmental trade-offs on an equal basis (Technology Evaluation)
- Public/Investor Acceptance:** Communicate a complete understanding of environmental trade-offs to air, water, solid waste, and competing technologies (R&D/Commercialization Strategy)
- Meeting Funding Requirements:** Various government and non-governmental organizations require an environmental life cycle analysis (Project Requirement)

**WHO IS DEVELOPING IT?**  
The guidance document is being developed by the LCA team at the National Energy Technology Laboratory (NETL). Additionally, DOE held a workshop with principal investigators (PIs) receiving funding under a Funding Opportunity Announcement (FOA) and CO<sub>2</sub> utilization LCA subject matter experts to get feedback on the direction of the guidance document.

**THE GUIDANCE DOCUMENT**

**WHY IS IT BEING DEVELOPED?**  
The guidance document is being developed to help simplify the process of LCA and improve consistency in communicating results. The guidance document will be rolled out to a group of PIs receiving funding under FOAs that require LCA.

**WHAT IS IN IT?**

**Guidance:** Background on LCA and guidance on how to conduct an LCA for CO<sub>2</sub> utilization projects

**Tools:**

- NETL spreadsheet model for a simple GHG analysis populated with data and an example LCA
- openLCA model ([www.openlca.org](http://www.openlca.org)) populated with data and an example LCA

**NETL Data:**

- Comparison cases that make the same product and do not use CO<sub>2</sub> (state-of-the-art alternatives)
- Upstream and downstream processes including upstream CO<sub>2</sub> product, electricity, natural gas, fuels and fuel combustion, steel, concrete, and transportation

**CO<sub>2</sub> UTILIZATION LCA POINTS OF INTEREST**

- Methods:** When CO<sub>2</sub> is captured from a power plant and used as a feedstock for a carbon utilization process, the CO<sub>2</sub> should be treated as an intermediate product and a co-product management method should be applied to the electricity from the power plant
- Time Scales:** The carbon in carbon-based fuels enter the atmosphere as CO<sub>2</sub> soon after production during combustion, while the carbon in building products may be sequestered in a building for the life of that building or longer
- Hotspots:** CO<sub>2</sub> utilization processes can be energy intensive, potentially negating the benefit of CO<sub>2</sub> utilization; energy efficiency is an area of improvement for CO<sub>2</sub> utilization projects
- Impact Categories:** CO<sub>2</sub> utilization LCA tends to focus on GHGs, because of the CO<sub>2</sub> co-product; analyses that include other impact categories related to water, human health, etc. are needed

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The Guidance Document will be available in the Fall of 2018 at [www.netl.doe.gov/LCA](http://www.netl.doe.gov/LCA)

Reference International Organization for Standardization (ISO), Environmental management - Life cycle assessment - Requirements and guidelines (ISO 26264 Standard No. 14064:2006)

# Background

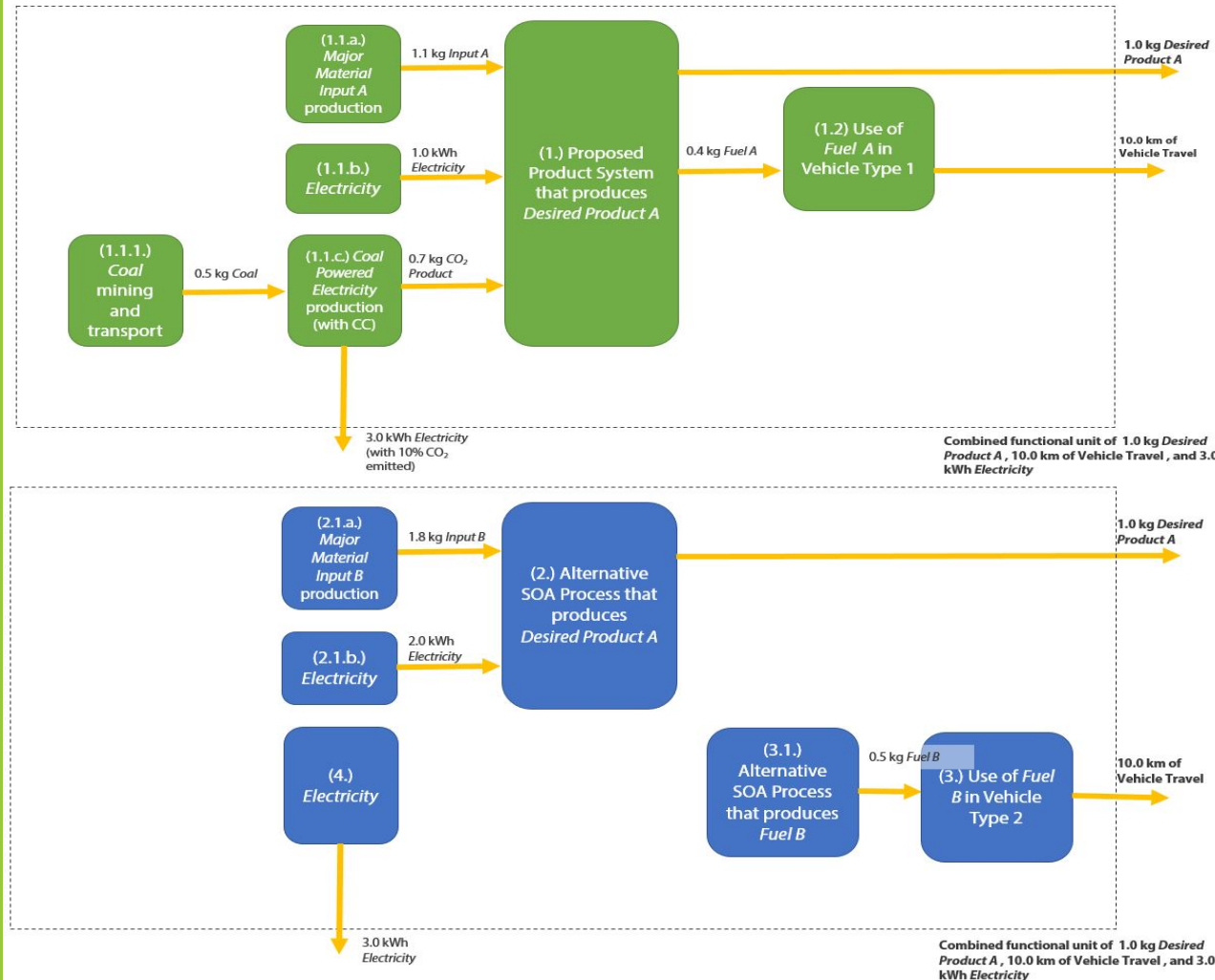
- 2016 – Funding Opportunity Announcement for CO<sub>2</sub>U projects sets forth requirement for life cycle greenhouse gas (GHG) analysis
- 2017
  - August - First exploratory draft of the guidance document is completed
  - October - A workshop was held in D.C. with subject matter experts and CO<sub>2</sub>U 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

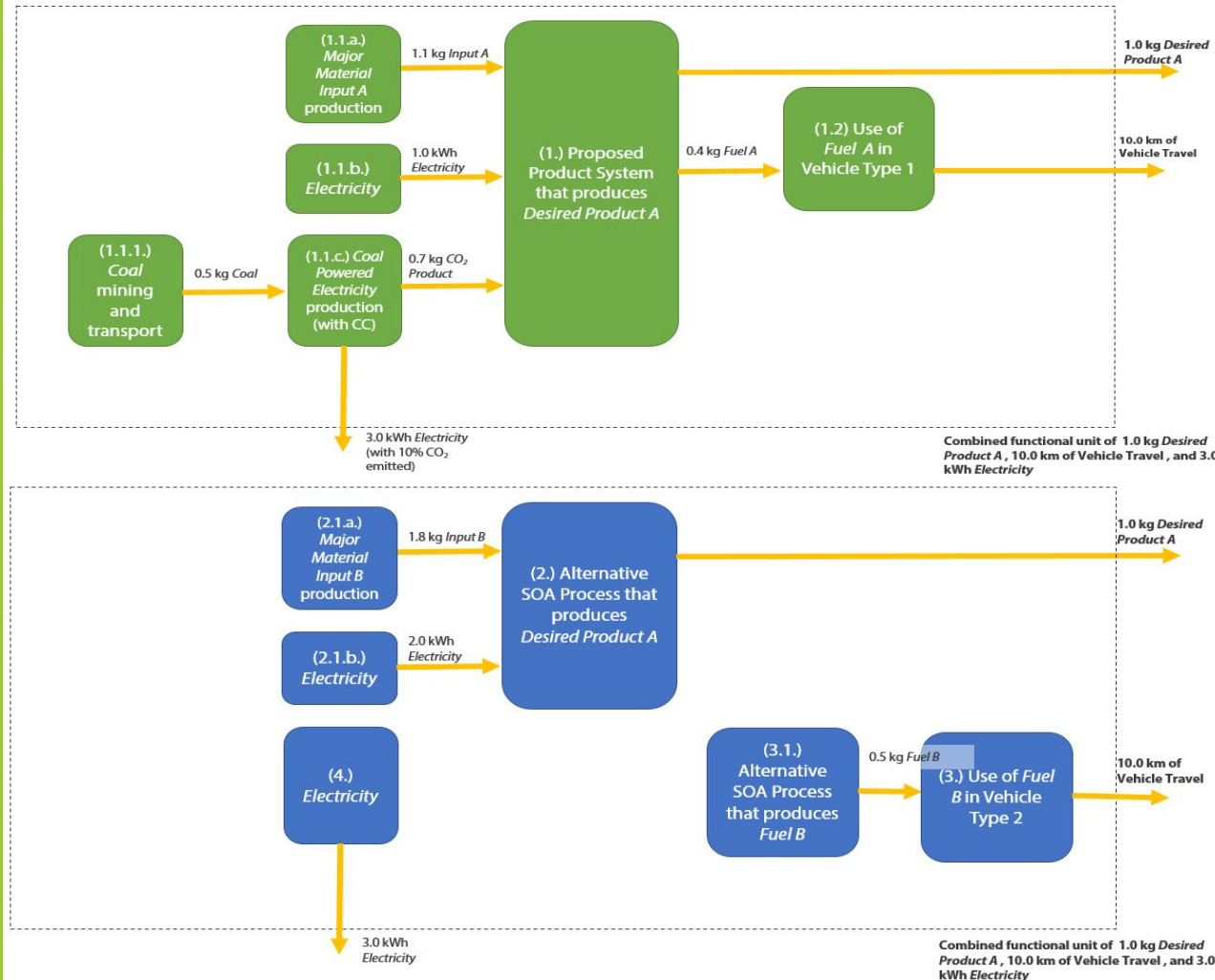
- System Boundary – Do I have to model the entire life cycle?
- Functional Unit – Defining the “system” of Comparison
- Comparison System (SOTA)
- Modeling/Reporting Platform
- Data: Upstream CO<sub>2</sub> Profiles
- Data: Product Systems
- Additional Guidance Questions Under Review at NETL



# Decisions on Method and Analysis

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

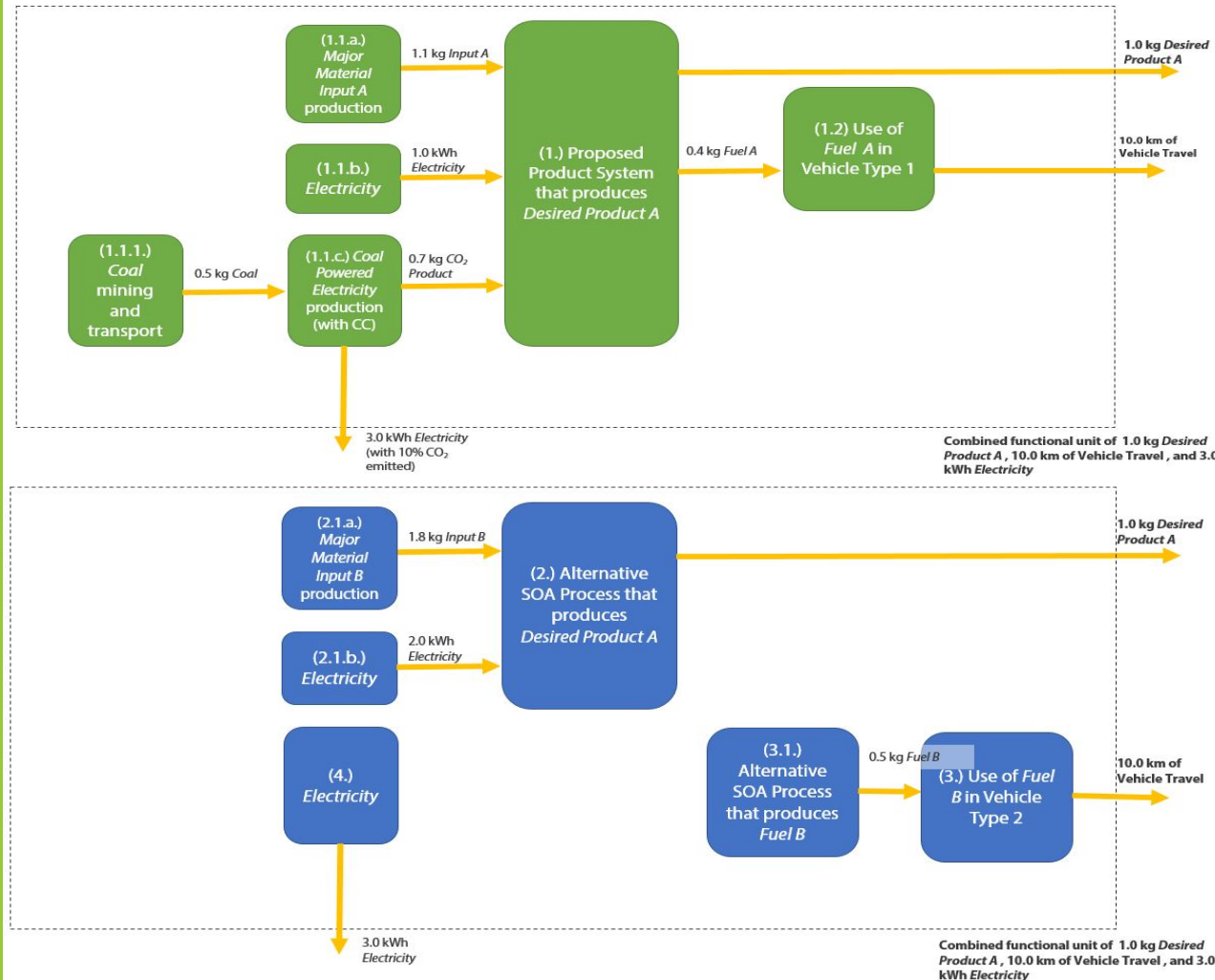
- Preferred: Cradle-to-Grave
- System boundary can be reduced once equivalence of the CO<sub>2</sub>U product and the SOTA product have been determined to provide (or will provide) the same service or function to society
- LCA must include the “cradle-to-equivalence” for both systems of comparison
- 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



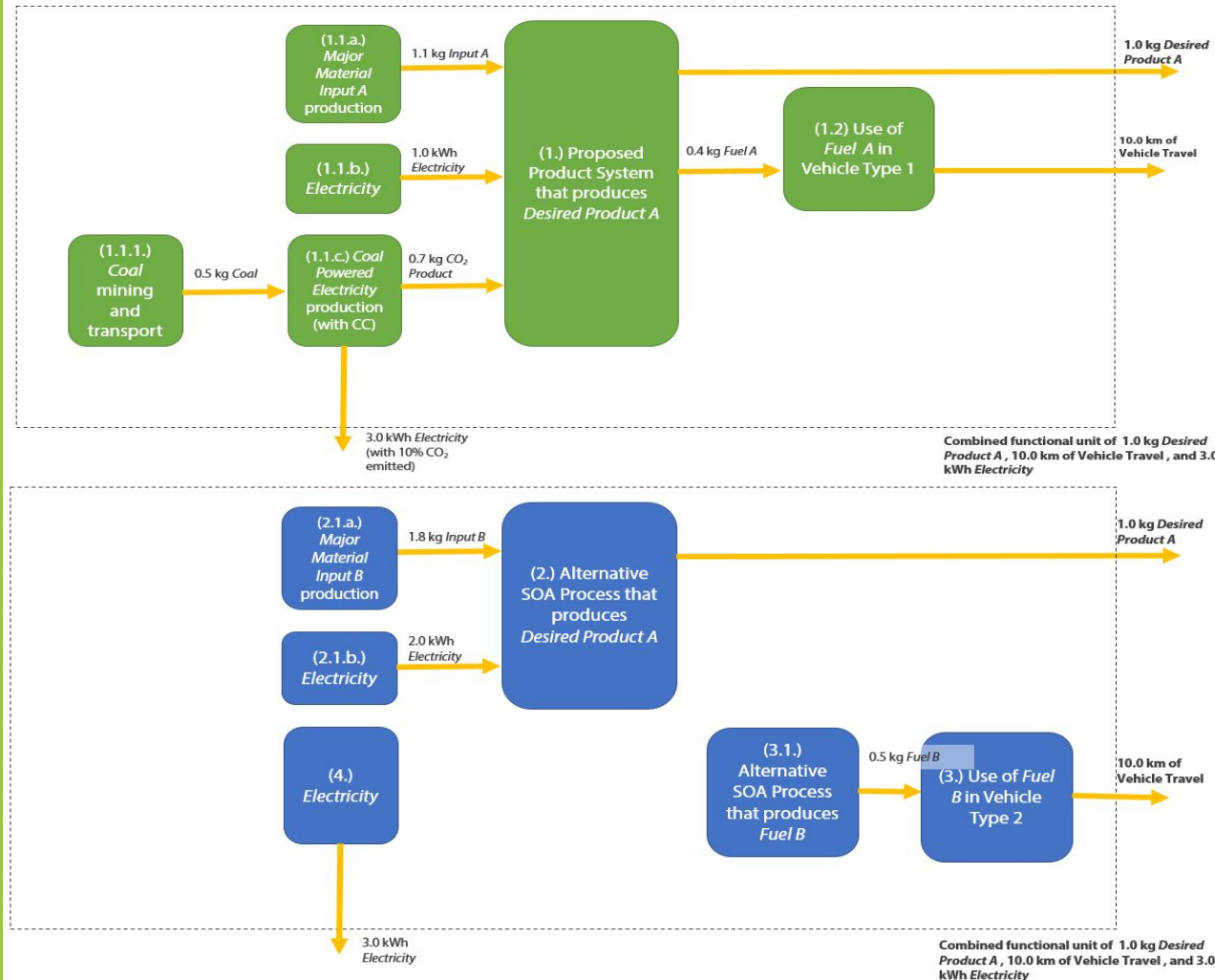


# Decisions on Method and Analysis

## 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 CO<sub>2</sub>U 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

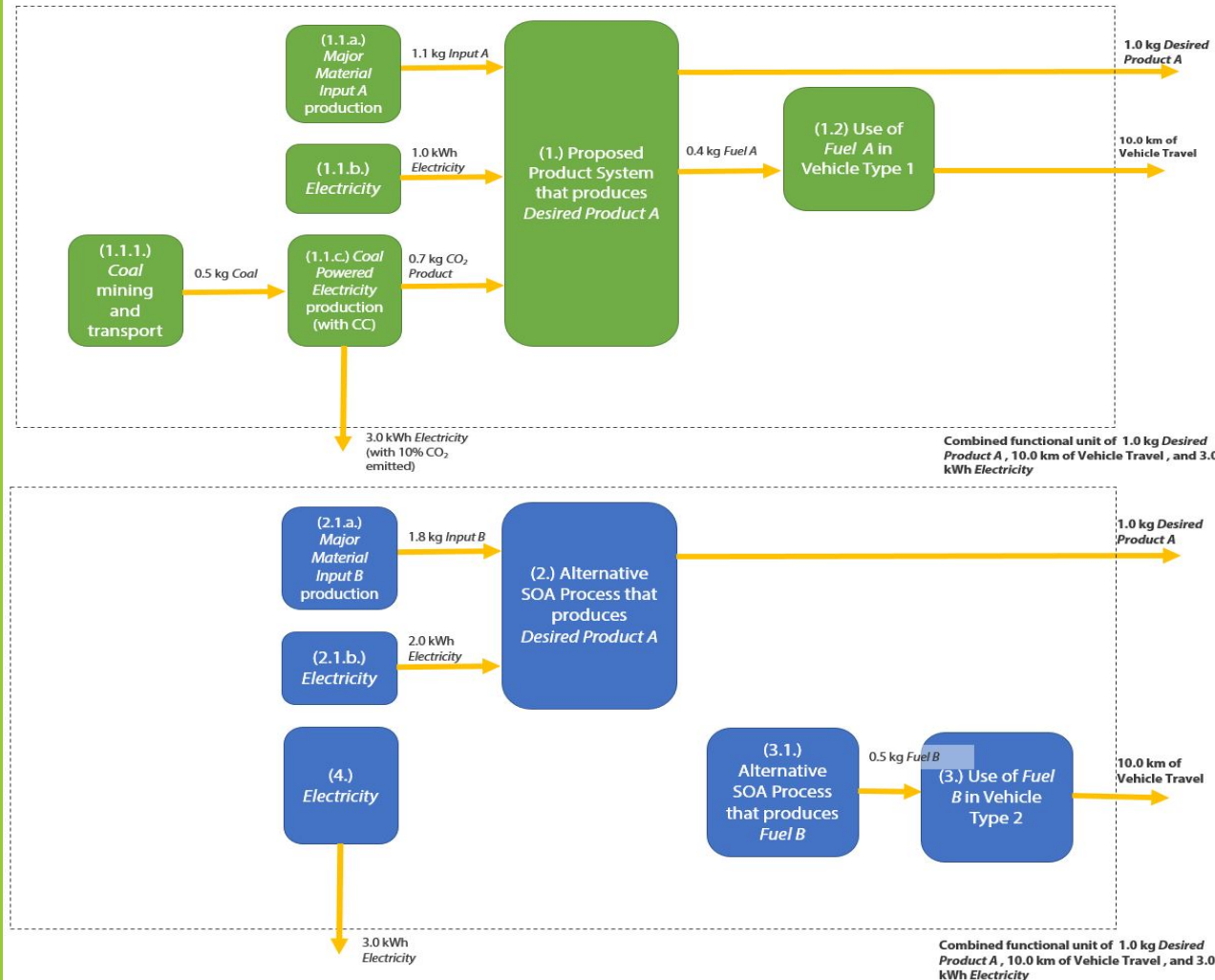
## Comparison System

- 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

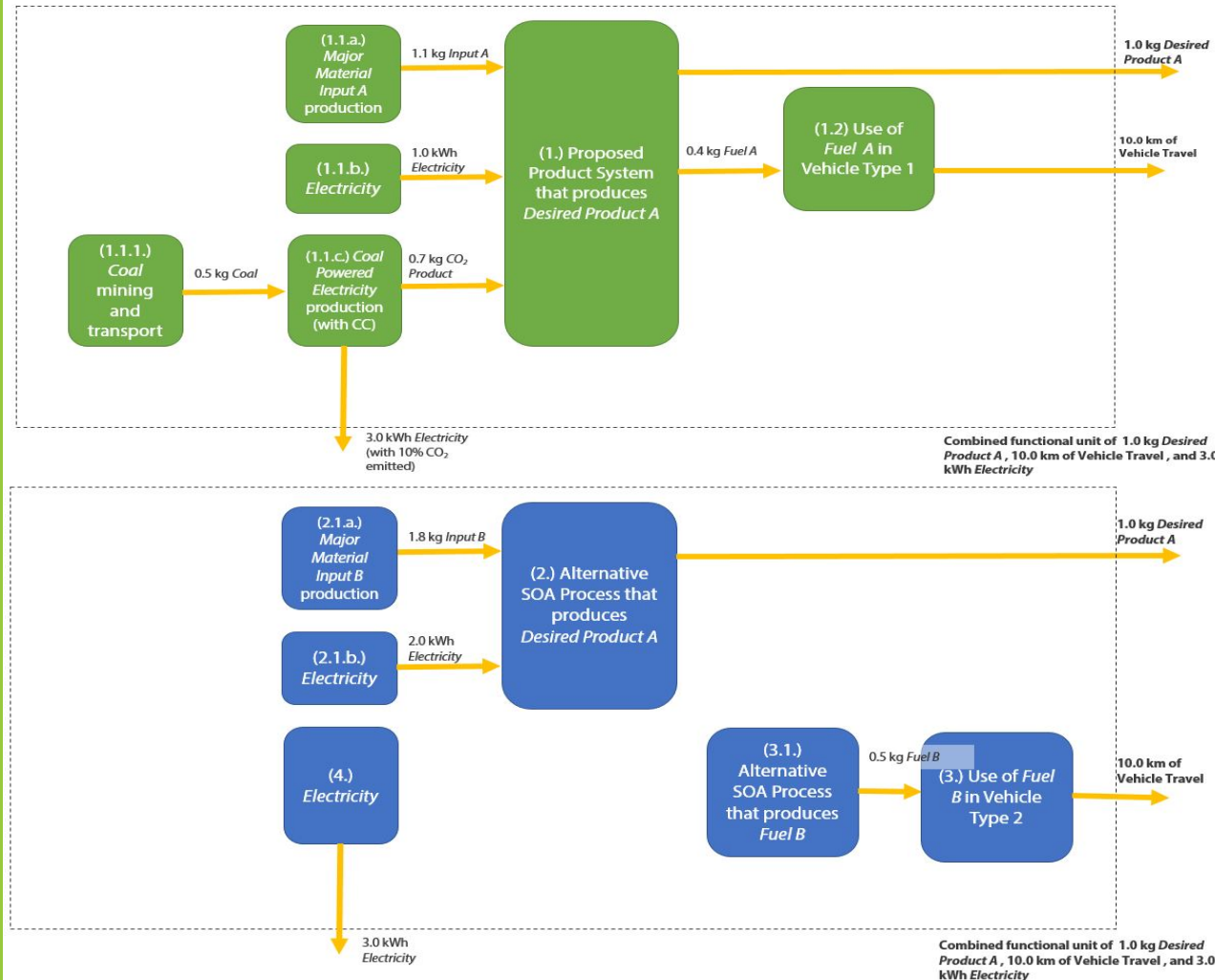


# Decisions on Method and Analysis

## Comparison System

- SOTA choice depends on “how” it will impact the market

- Additive – incremental addition, competitive market, low to medium market penetration. SOTA = 90<sup>th</sup> percentile of market performance\*
- Disruptive – change to how the service is provided to society; high market penetration. SOTA = “average” market performance\*



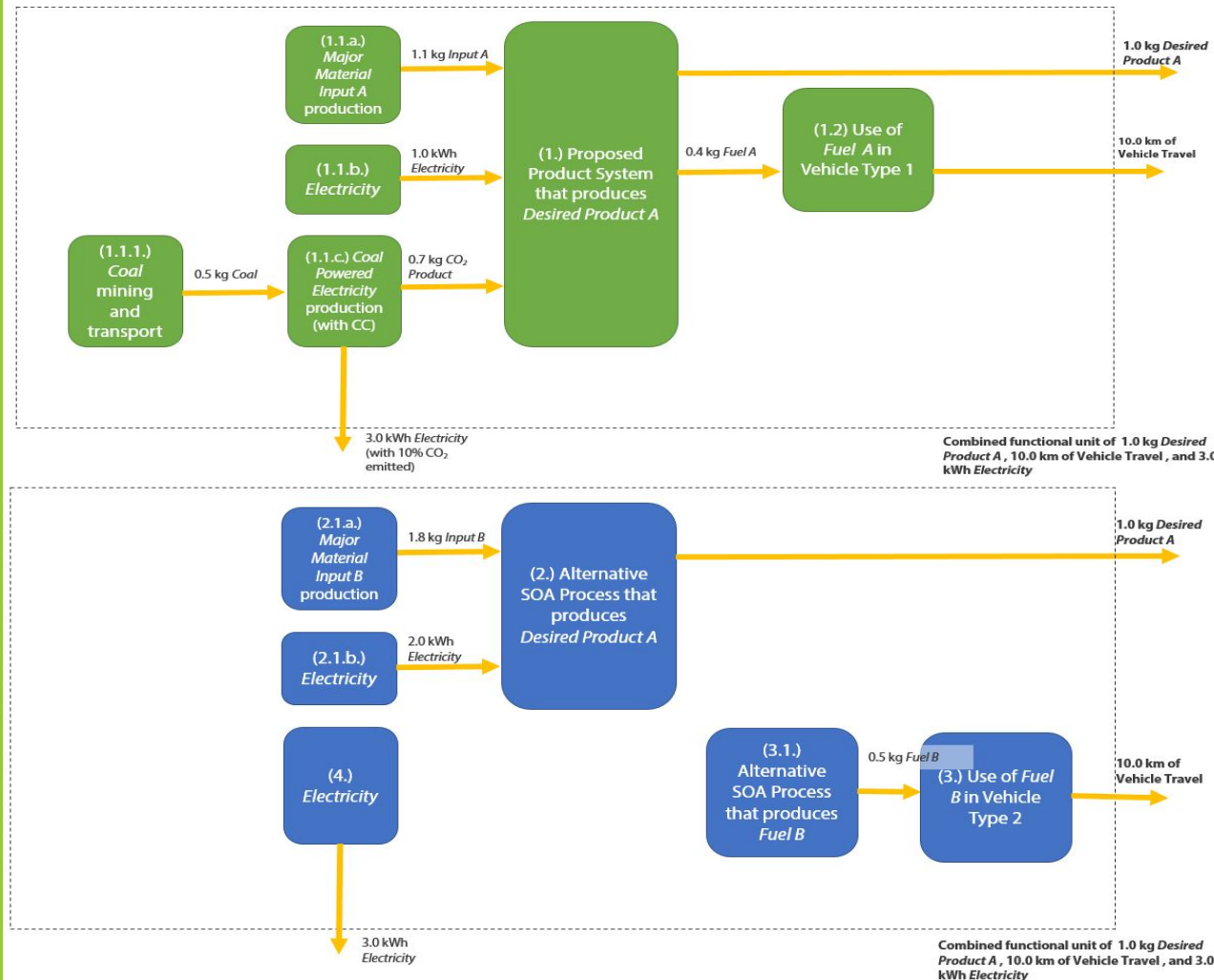
\* Market Performance = life cycle GHG performance, GWP, AR5



# Decisions on Method and Analysis

## Upstream CO<sub>2</sub> Profiles

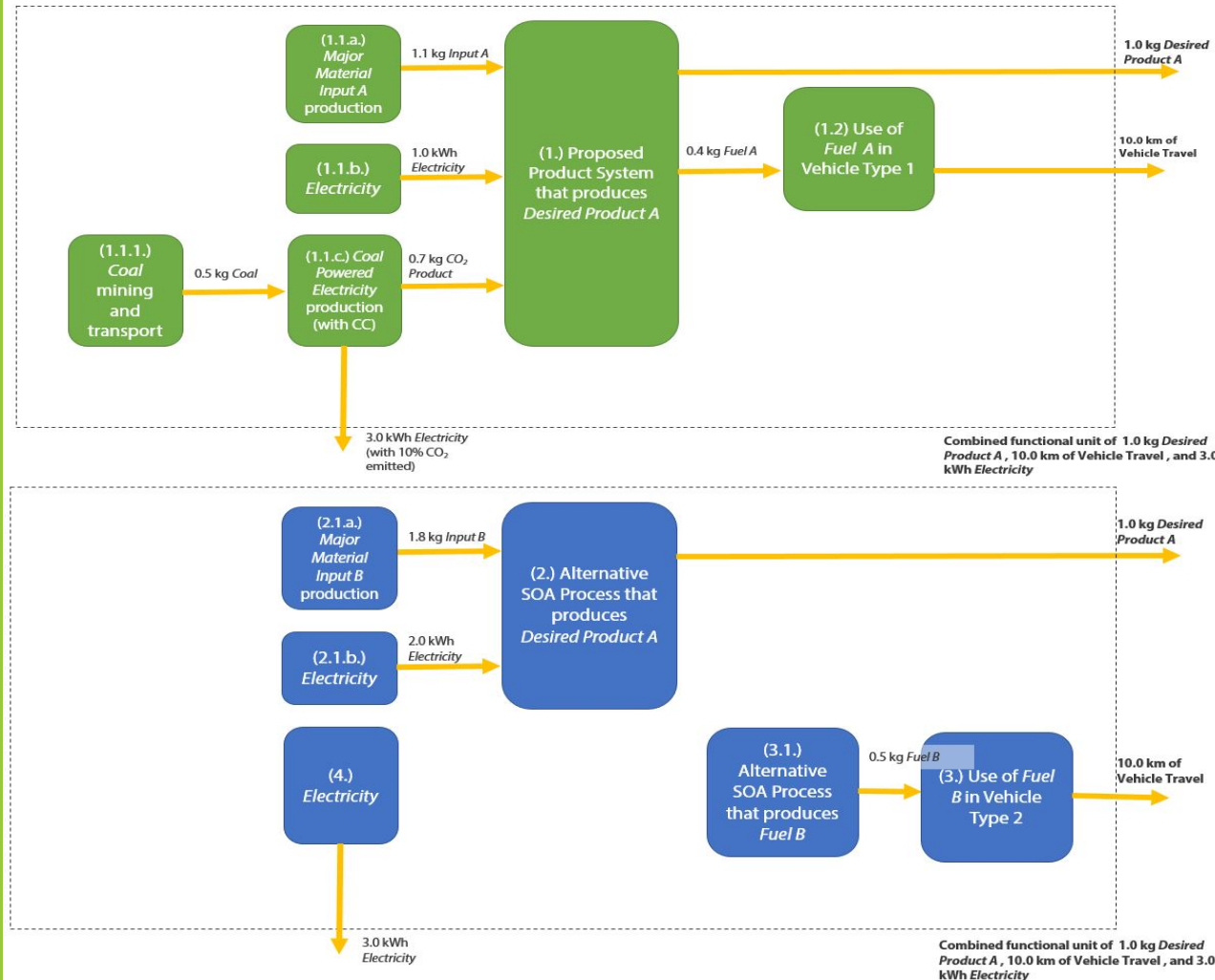
- Upstream CO<sub>2</sub> source profiles (cradle-to-gate) to be provided by NETL (tentative list)
  - Captured and Compressed CO<sub>2</sub>
    - Coal-Fired Power Plant(s)
    - Natural Gas-Fired Power Plant
    - Petroleum Refinery
    - Ammonia Plant
  - Flue Gas from Coal-Fired Power Plant(s)



# Decisions on Method and Analysis

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

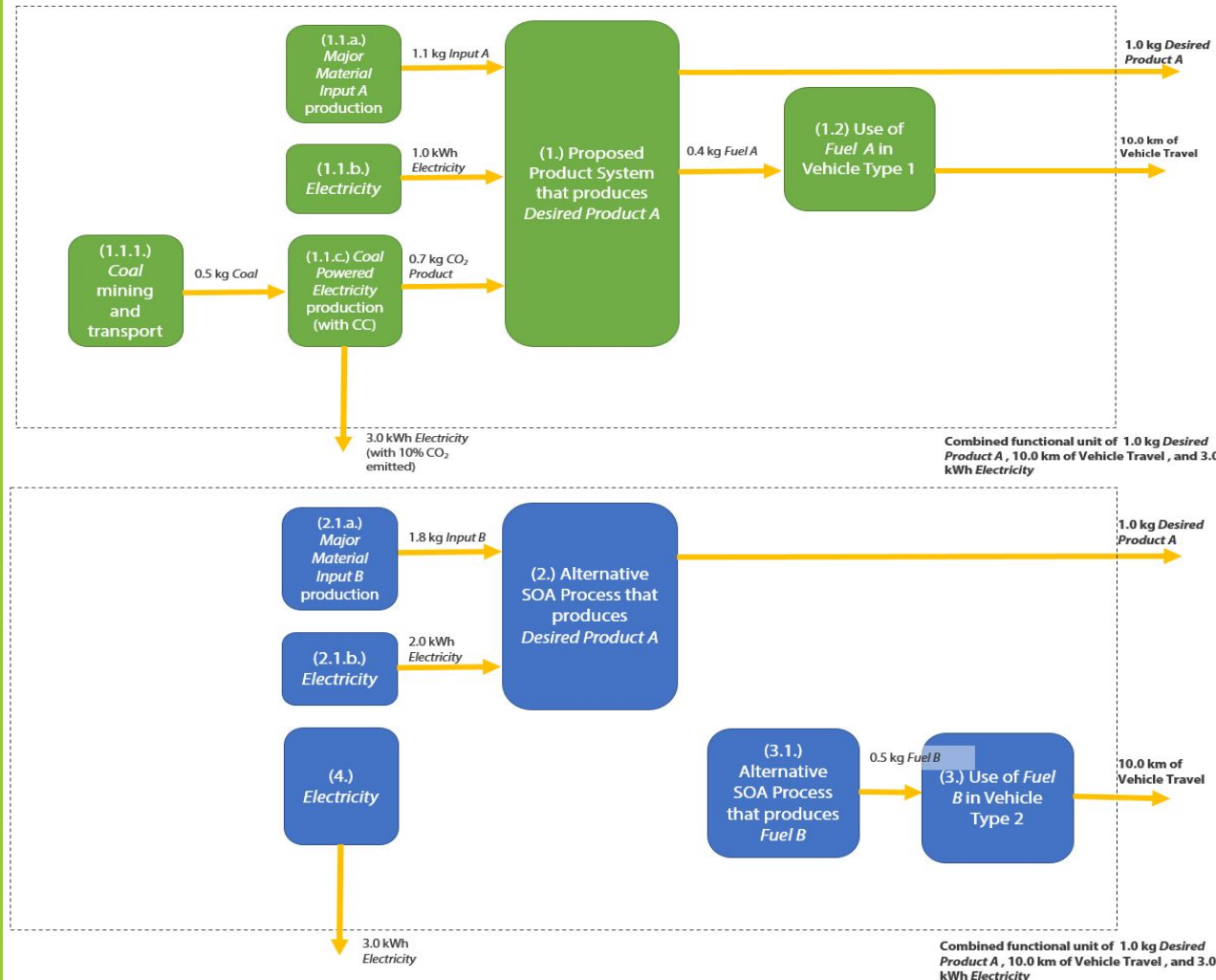
- Coal Mining
- Coal-Fired Power Plant
- Natural Gas Production
- Natural Gas-Fired Power Plant
- US and North America Electricity Grid Profile
- Regional Electricity Grid Profiles
- Biomass Cultivation
- Algae to Biodiesel Pathway



# 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 (1<sup>st</sup> of a kind versus n<sup>th</sup> of a kind performance)
- Technology Learning in the SOTA
- Uncertainty/flexibility in CO<sub>2</sub>U Process Design (system could be operated in multiple ways)



# Contact Information

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