

Using Life Cycle Assessment and Associated Tools to Reduce Embodied and Operational Carbon Impacts

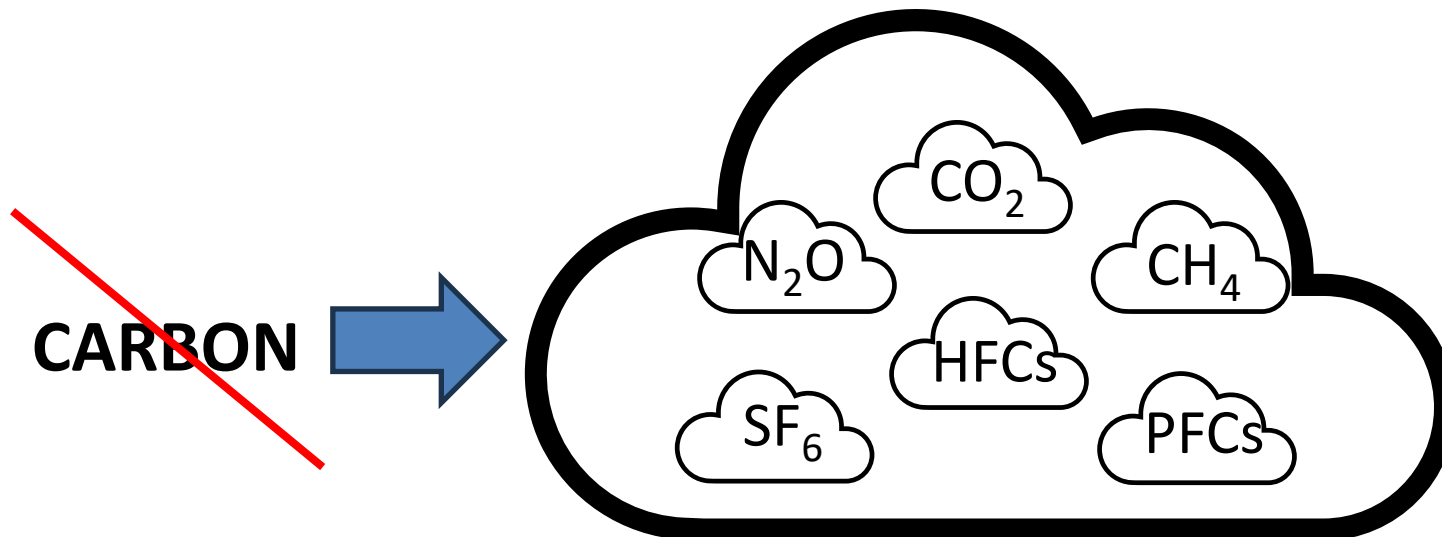


Carbon

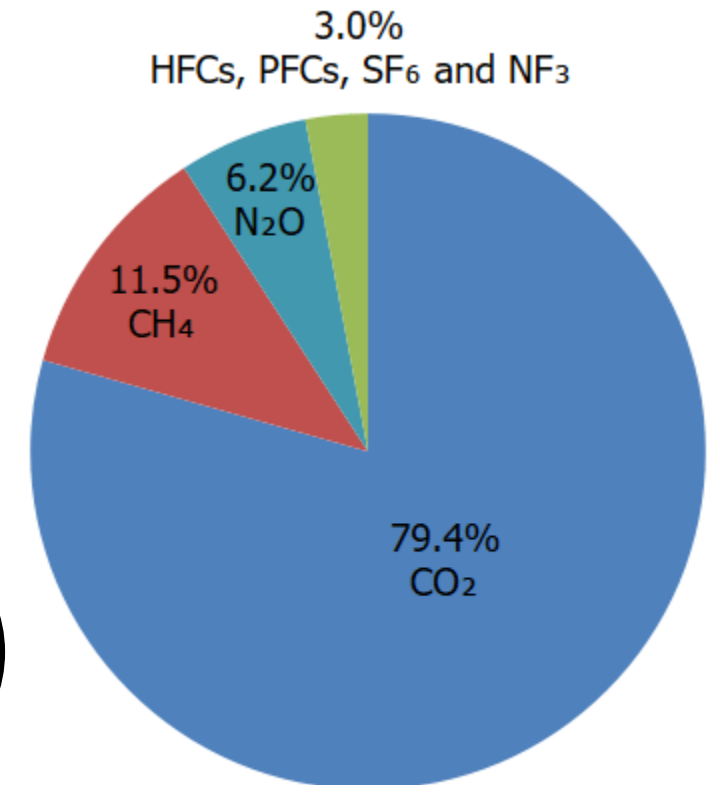


What do we mean when we discuss “Carbon”?

CARBON **=** **Carbon Dioxide Equivalent (CO₂e)**
For all anthropogenic greenhouse gases



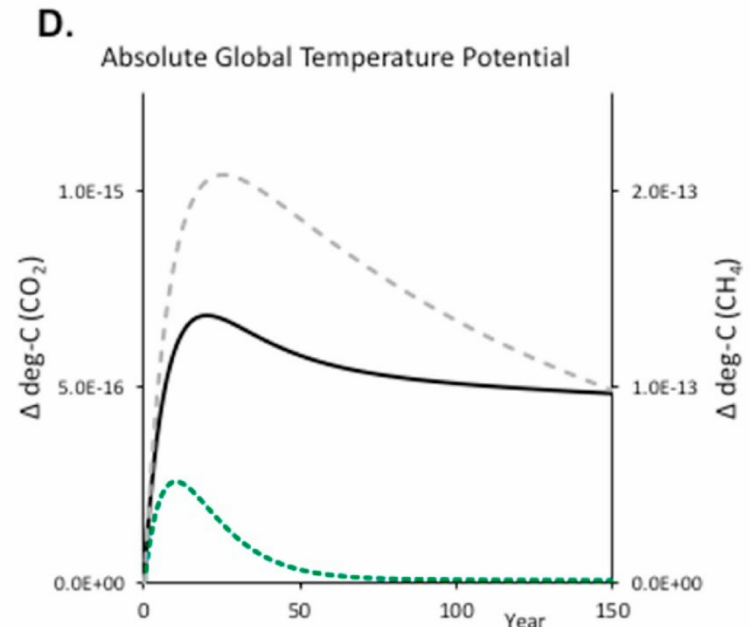
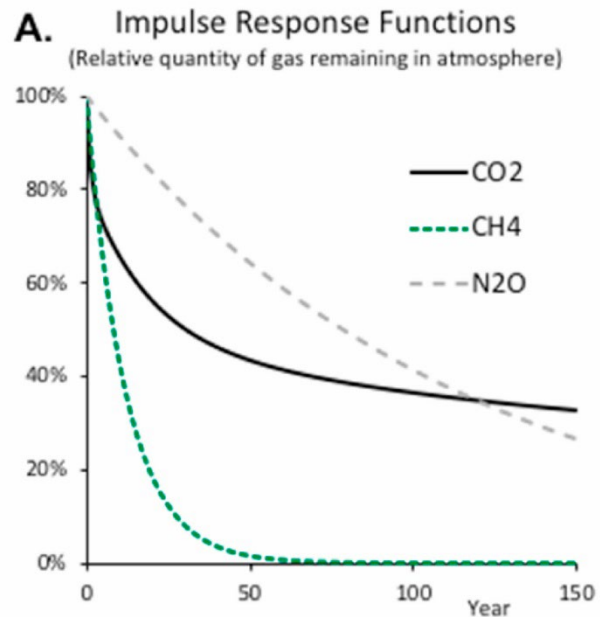
Breakdown of GHG emissions for 2021 in the US



U.S. Environmental Protection Agency (2023). Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2021

Climate response to GHGs

- Earth's atmosphere responds differently to different GHGs
 - Impact constantly increasing
 - Breakdown faster but higher initial impact
 - Last longer in atmosphere impacting a larger area



Global Warming Potential of different GHGs

- 100-year time horizon is standard for GWP
- Cannot combine GWPs of different timescales
- Each GHG is represented by an equivalent emission of carbon dioxide emitted at time $t=0$

Greenhouse Gas	Global Warming Potential ^a		
	20-year	100-year	500-year
Carbon Dioxide (CO ₂)	1	1	1
Methane (CH ₄)	72	25	7.6
Nitrous Oxide (N ₂ O)	289	298	153
Hydrofluorocarbons (HFC-23)	12,000	14,800	12,200

^aGlobal warming potential values taken from Table 2.14
IPCC Fourth Assessment Report: Climate Change 2007

Types of Carbon

TOTAL

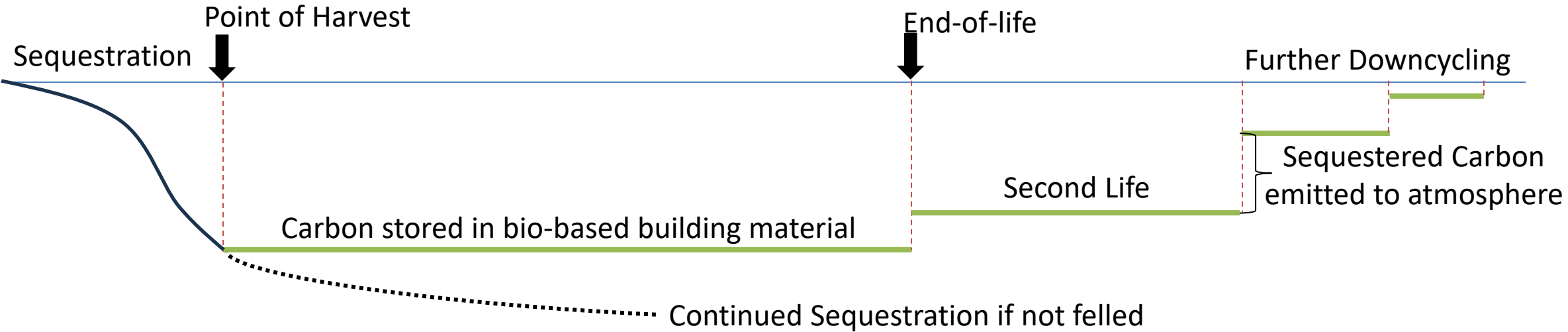
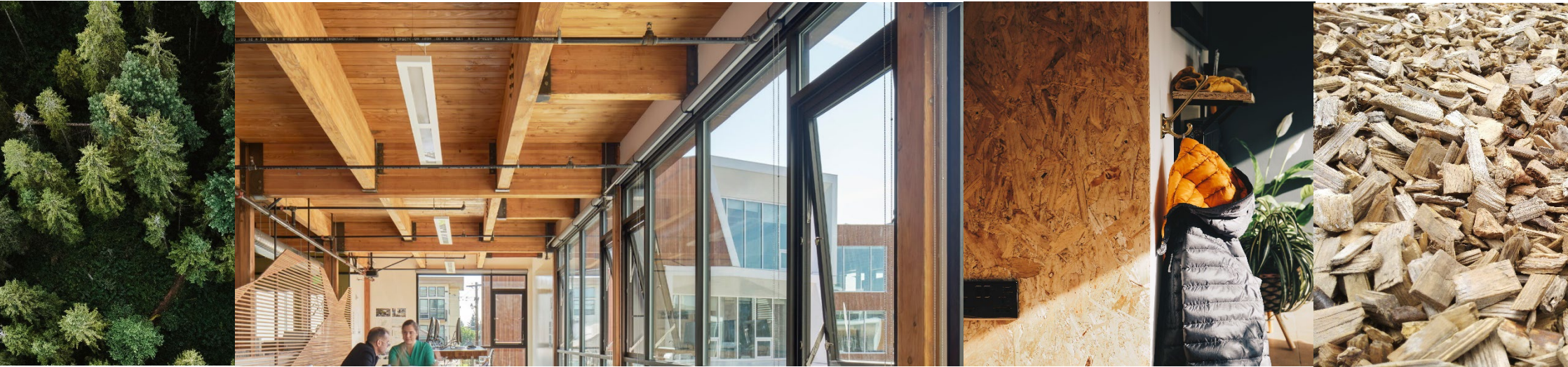
Fossil

Biogenic

**Land Use and Land Use
Change (LULUC)**



Biogenic Carbon and Biobased Materials

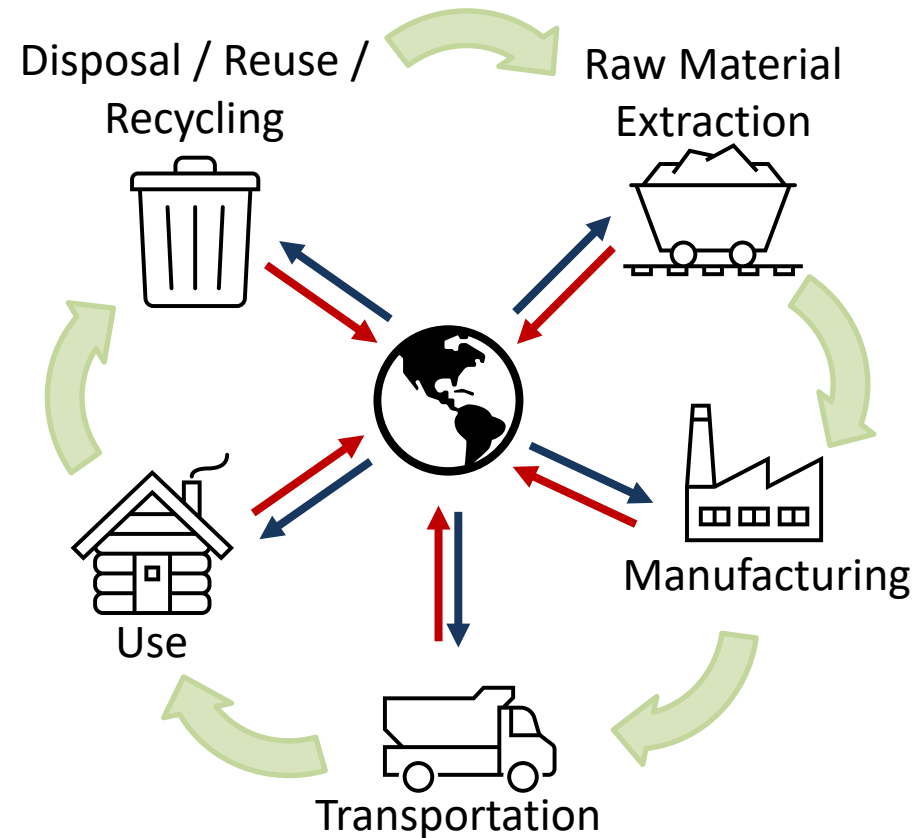


Life Cycle Assessment



Life Cycle Assessment

- Methodology for quantifying the environmental impacts of a product or service throughout all stages of life



Scales of Assessment

Material



Assembly



Building

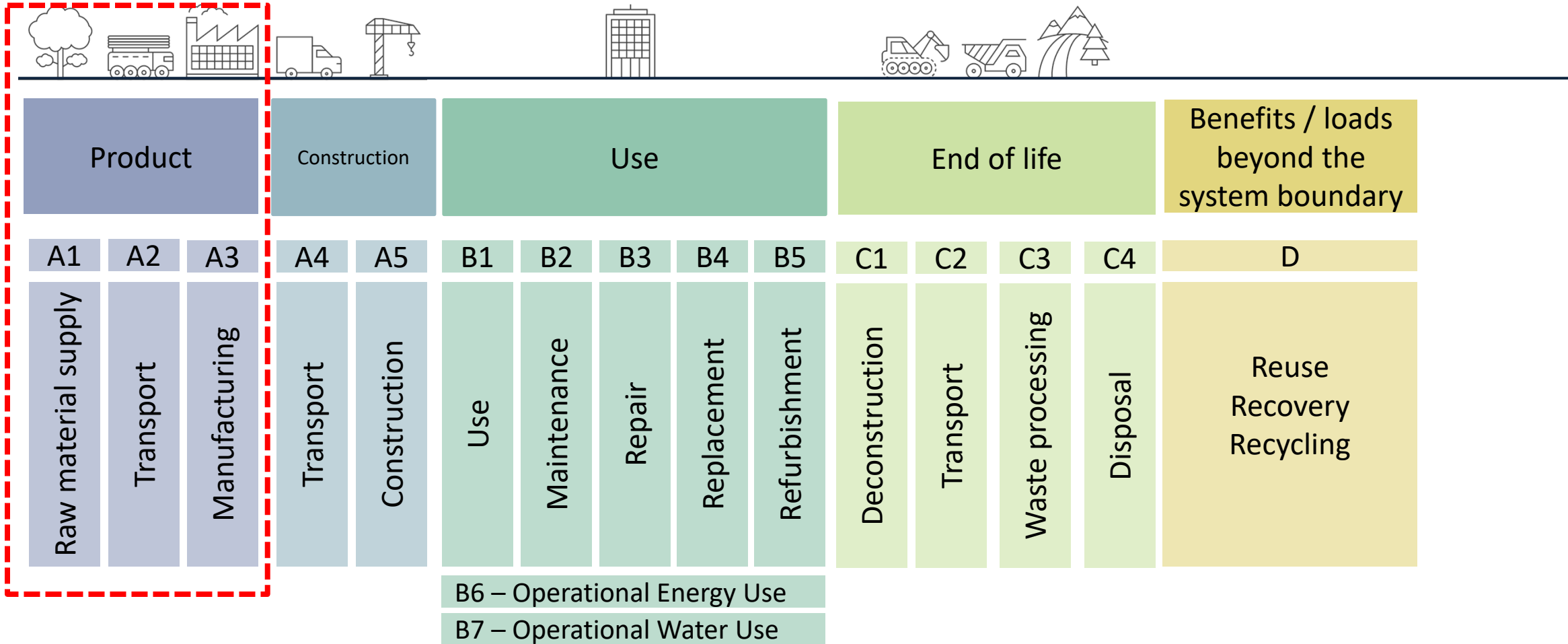


**Masterplan /
Development / City**



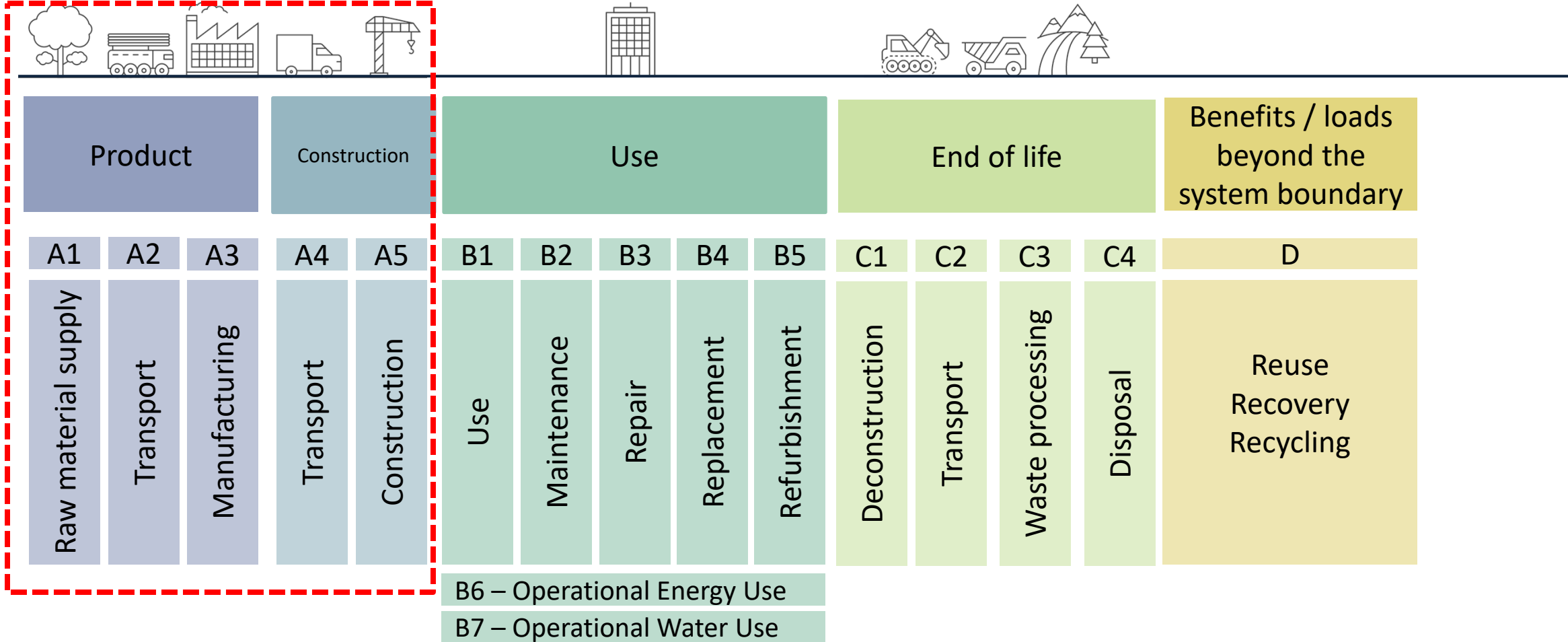
Life cycle stages – EN 15978

Cradle-to-Gate



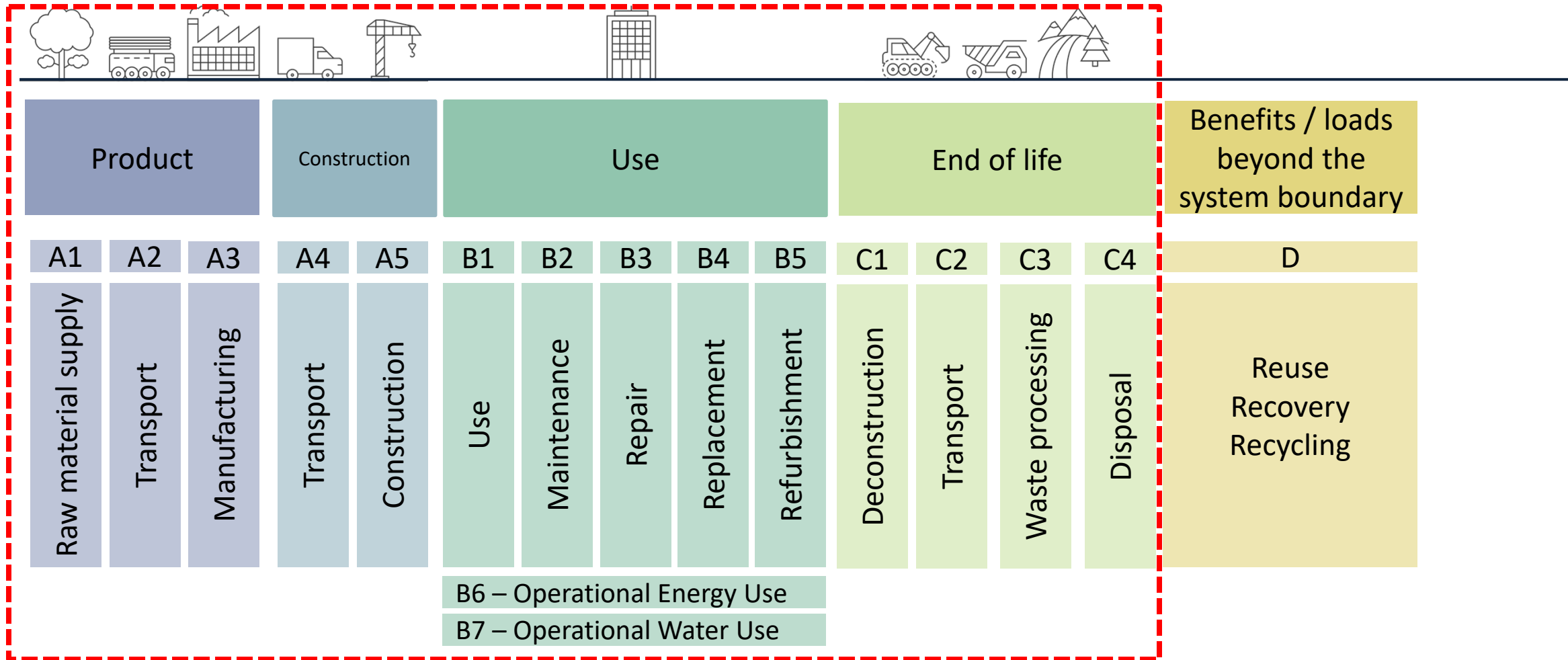
Life cycle stages – EN 15978

Cradle-to-Completion



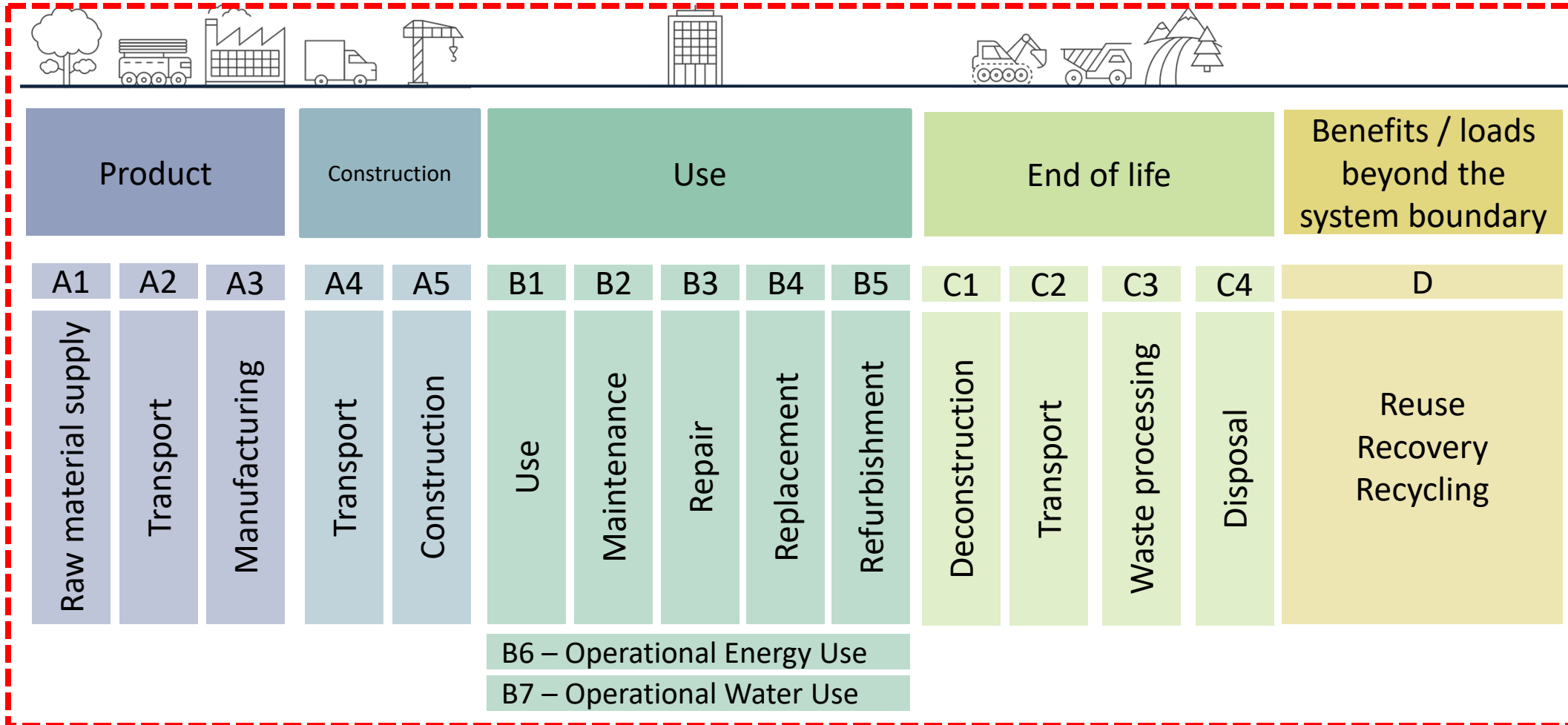
Life cycle stages – EN 15978

Cradle-to-Grave



Life cycle stages – EN 15978

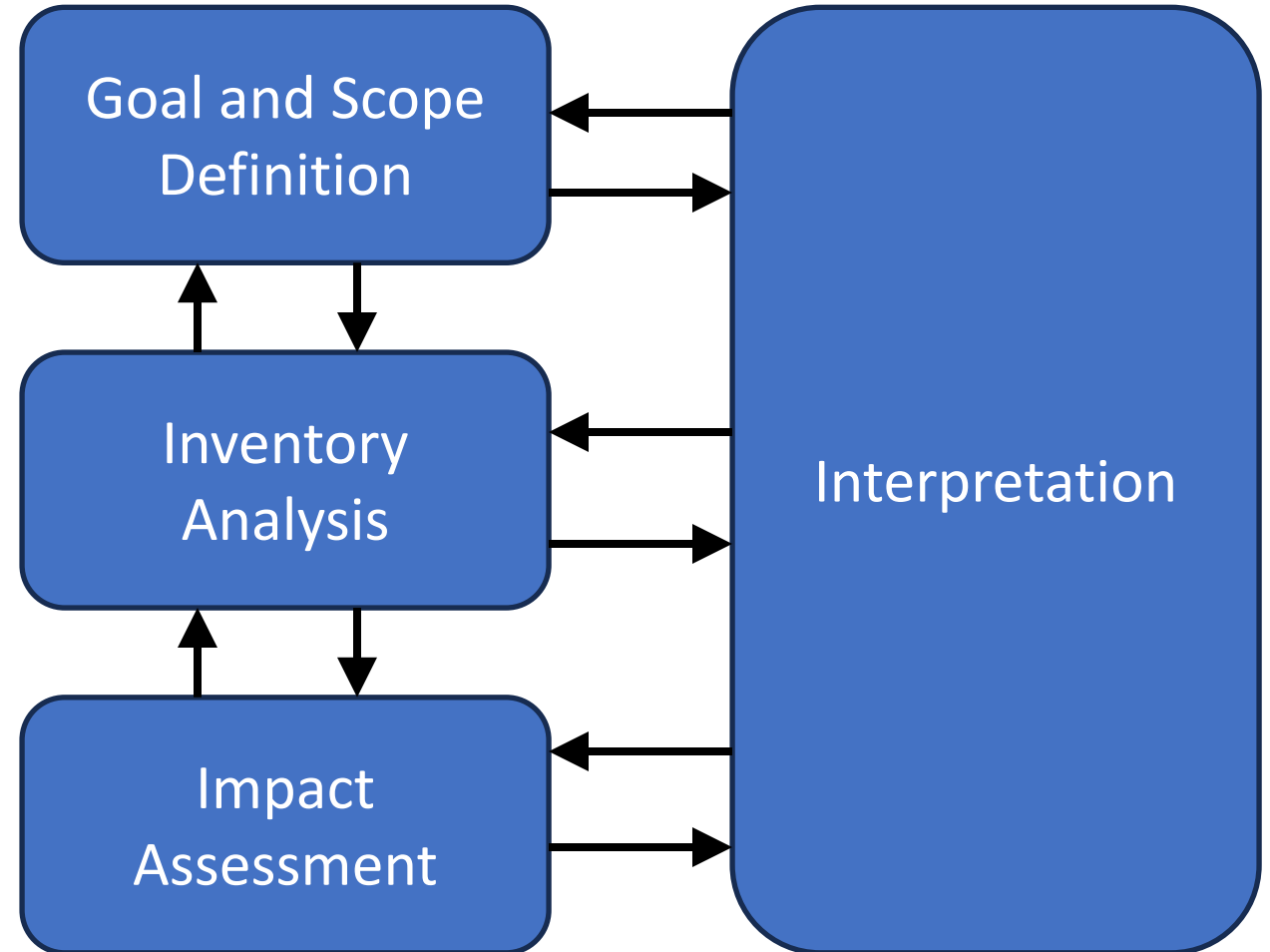
Cradle-to-Cradle



Life Cycle Assessment Framework

Defined by ISO 14040:2006:A1:2020

- LCA is an iterative process



Embodied Carbon in Legislation - CalGreen

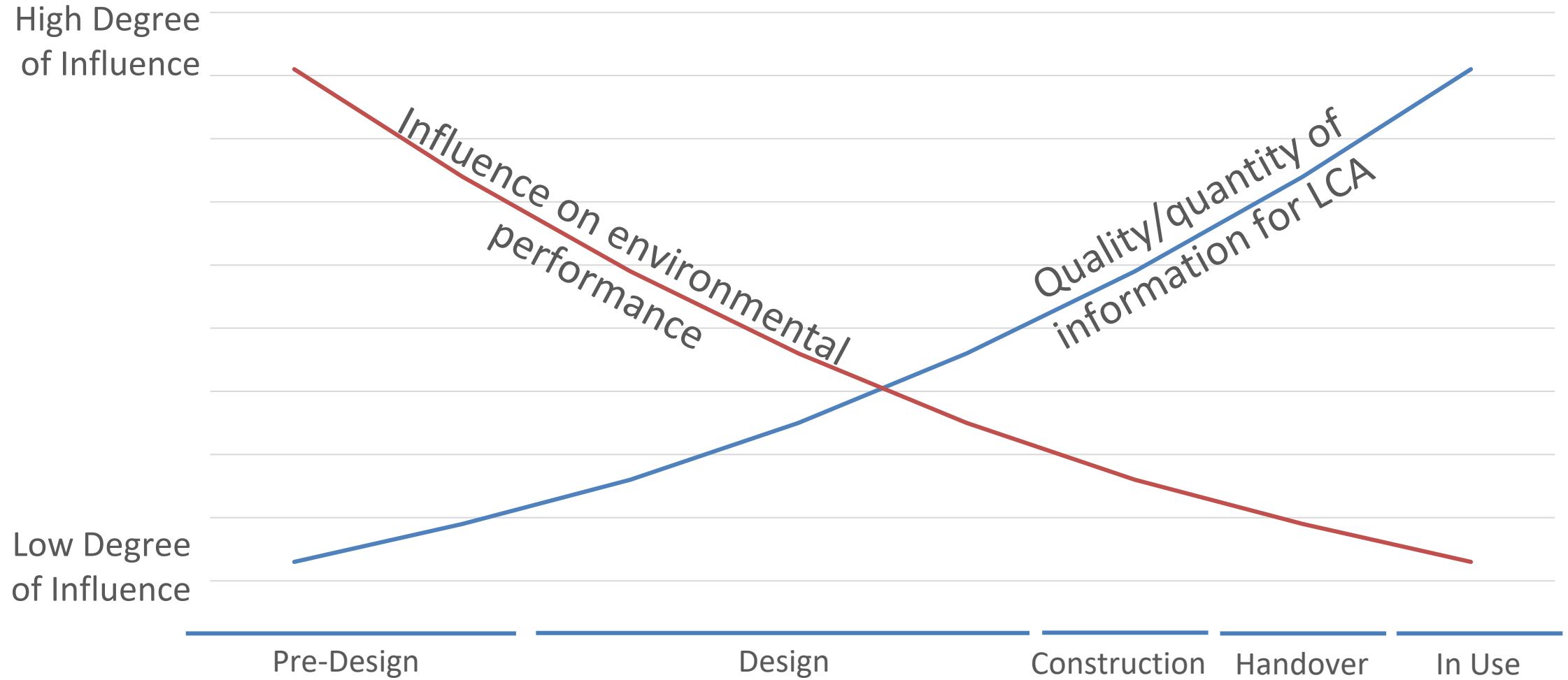
Effective July 2024 for nonresidential buildings >100,000 sf commercial or >50,000sf schools

	Existing Voluntary	Mandatory 50,000sf (project aggregate)	Tier 1 50,000sf (project aggregate)	Tier 2 50,000sf (project aggregate)
Building Reuse	75% of the structure and enclosure to be reused	45% of the structure and enclosure to be reused	75% of the structure and enclosure to be reused	75% of the structure and enclosure to be reused, AND 30% of the interior non-structural elements to be reused
WB LCA	10% reduction from baseline	10% reduction from baseline	15% reduction from baseline	20% reduction from baseline
Prescriptive Approach	n/a	175% of IW-EPD GWP limits; concrete 130% of ready-mixed GWP values	150% of IW-EPD GWP limits; concrete 130% of ready-mixed GWP values	IW-EPD GWP limits; concrete 130% of ready-mixed GWP values

LCA in the Design Process



Influence versus accuracy of assessment

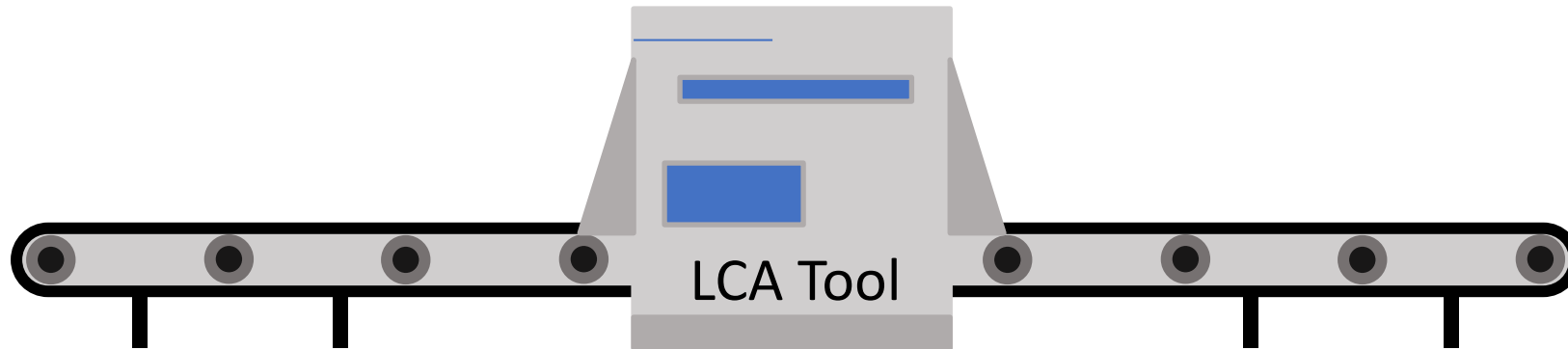


Tools for LCA in the Design Process



Tools for LCA

- **Intended to make it easier to conduct an LCA**
- **Varying levels of complexity**
- **Can be developed in-house, by industry, academia, commercial**



Tools for LCA

Keep in mind:

- The results are only as good as users' ability to interpret them
- Built-in assumptions influences comparability of results between different tools
- Early use requires more simplifications, more built-in assumptions, more uncertainty

