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Building the Next Generation

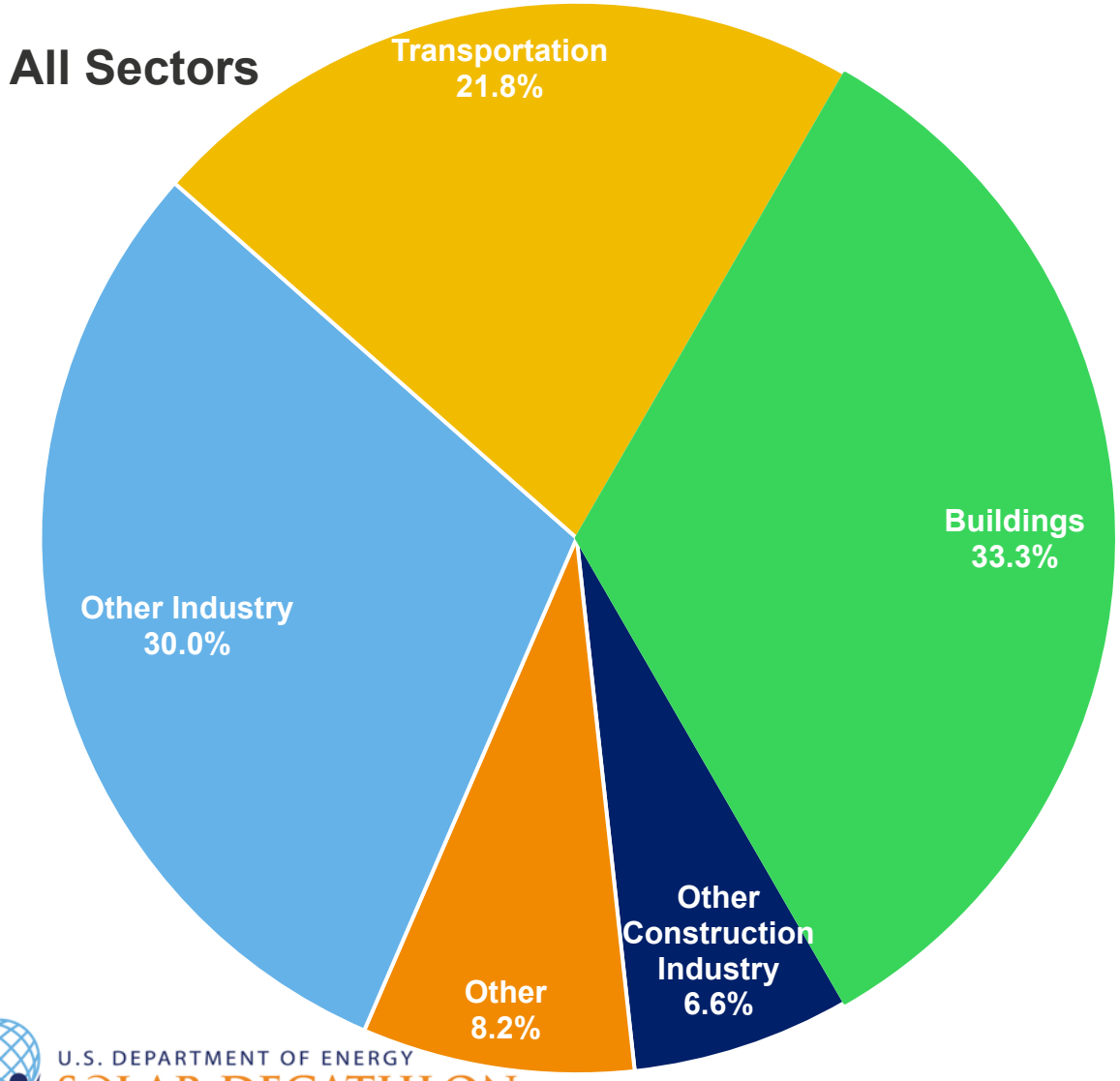
Building Science Education for Solar Decathlon

Emissions and the Built Environment

https://ecology.wa.gov/Air-Climate/Climate-change/Tracking-greenhouse-gases/Greenhouse-gas-reporting

Episode ID: 0701-221017

Global Energy-Related CO_2 Emissions by Sector (2021)



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https://www.ashrae.org/file%20library/about/position%20documents/pd_buildingdecarbonization_2022.pdf

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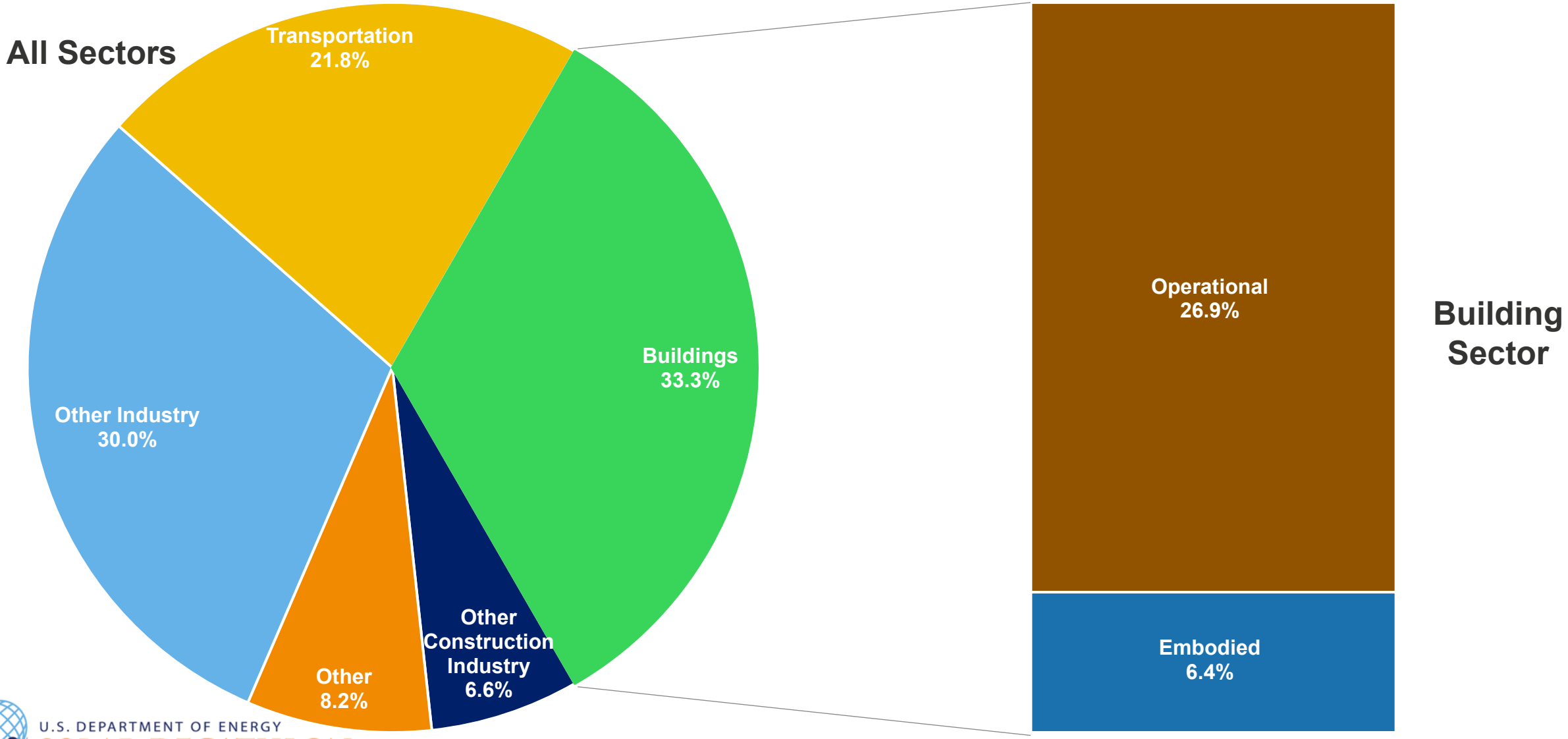

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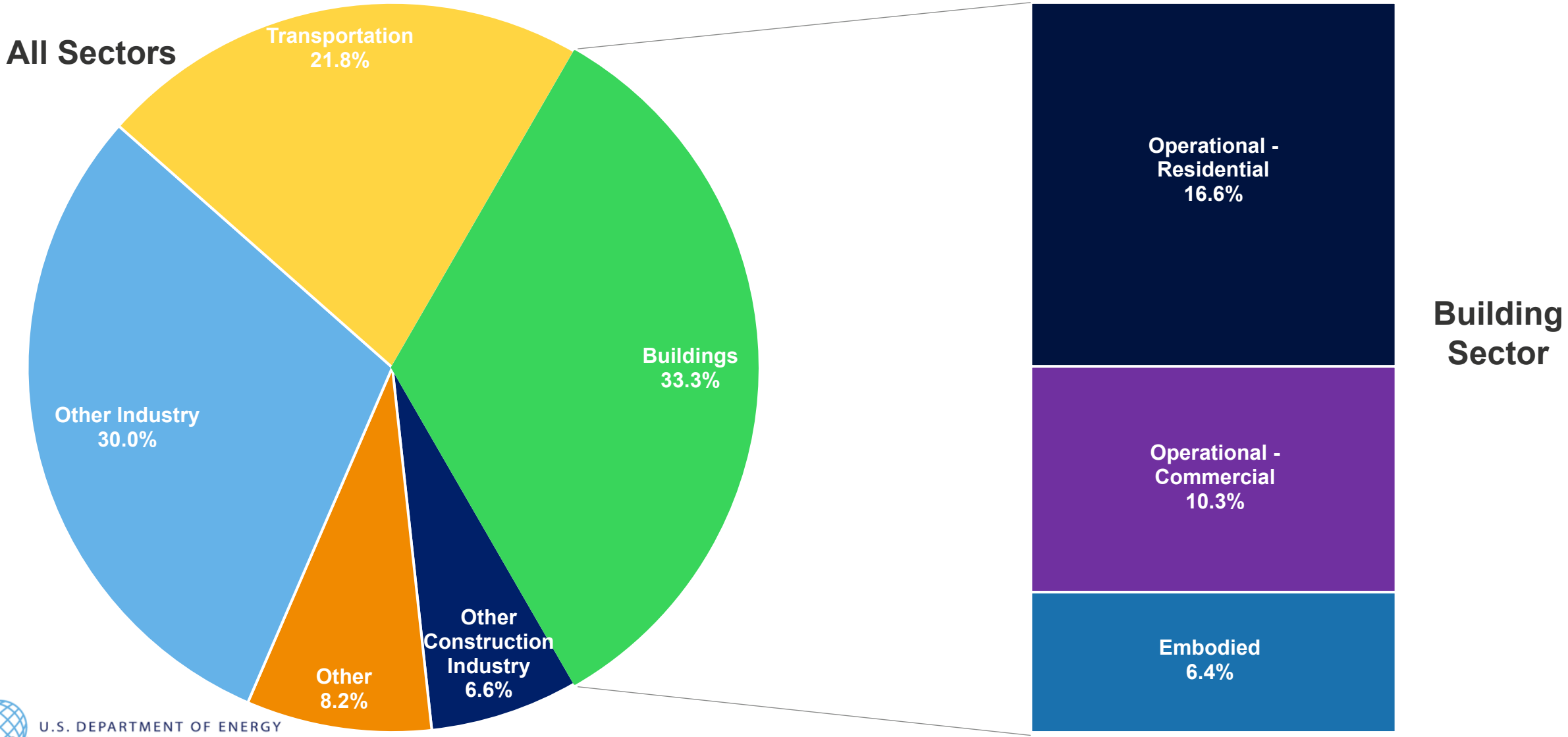

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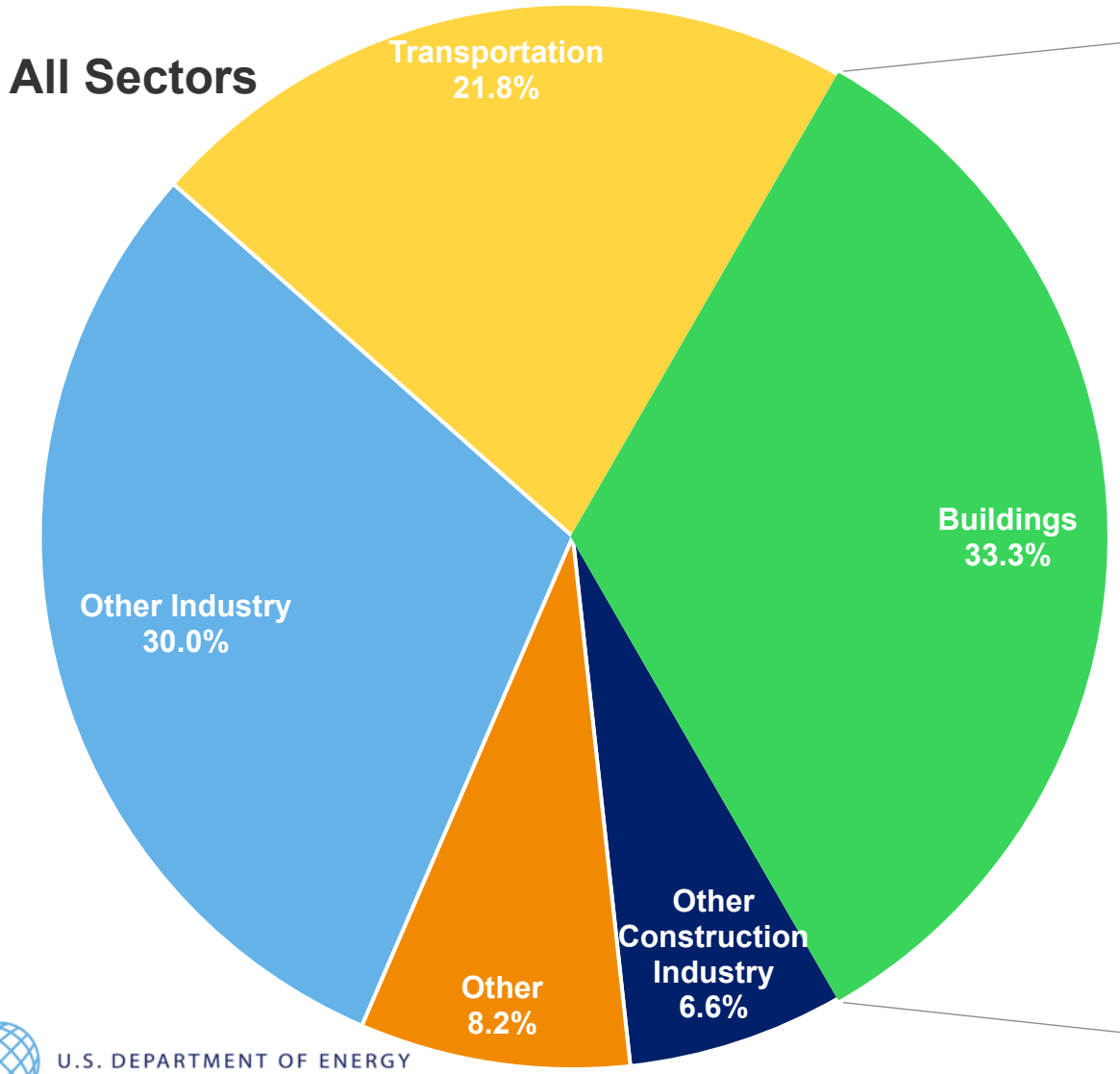

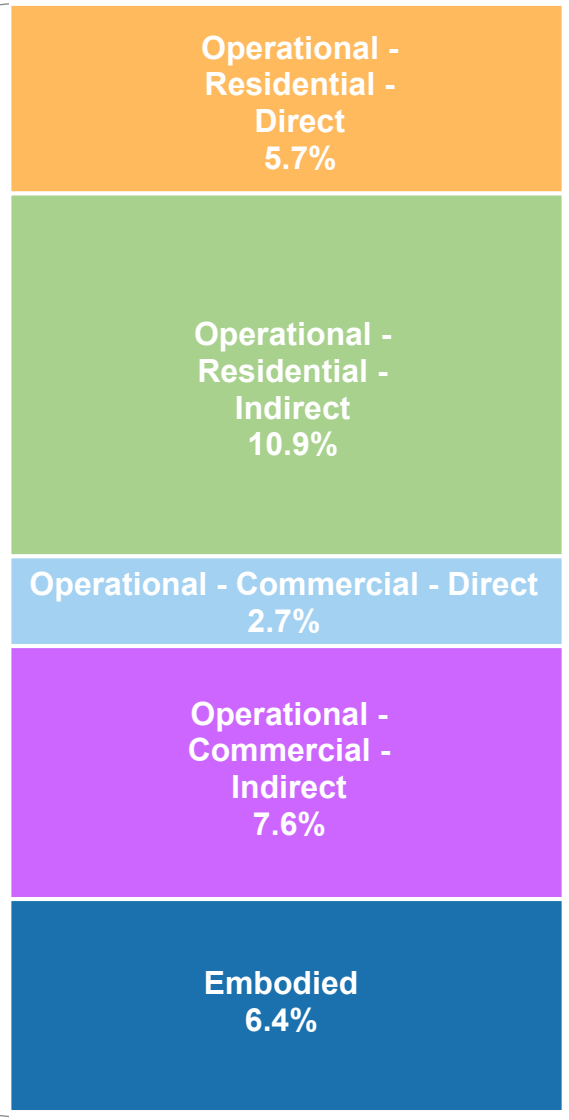

Building Sector

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Scopes of Emissions

Scope 1: Direct Emissions

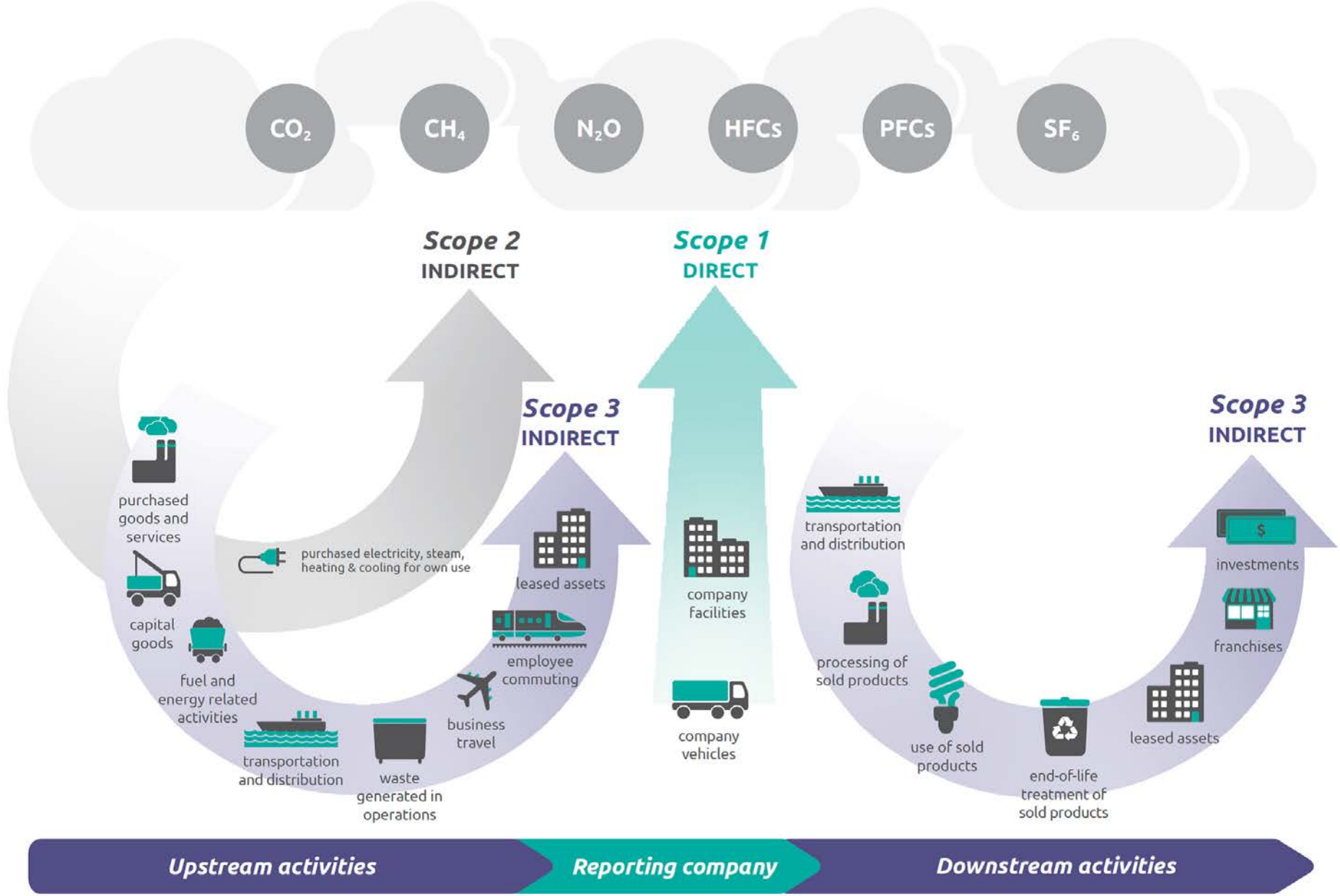
- Direct emissions that occur from sources that are controlled or owned by the reporting company (e.g. fuel combustion in boilers, furnaces, vehicles).

Scope 2: Indirect Emissions from Purchased Energy

- Indirect emissions associated with the purchase of electricity, steam, heat, or cooling as a result of the reporting company's energy use.

Scope 3: Indirect Value Chain Emissions

- All indirect emissions (not included in Scope 2) that occur in the value chain of the reporting company, including both upstream and downstream emissions.



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https://www.epa.gov/climateleadership/scope-1-and-scope-2-inventory-guidance

The Global Building Stock is Growing

- **Global building stock predicted to double by 2060** (according to 2017 Global Status Report)
  - The equivalent of adding one New York City each month for 40 years
  - ~2.5 trillion square feet of added floor area

https://www1.nyc.gov/site/sustainability/our-programs/buildings.page

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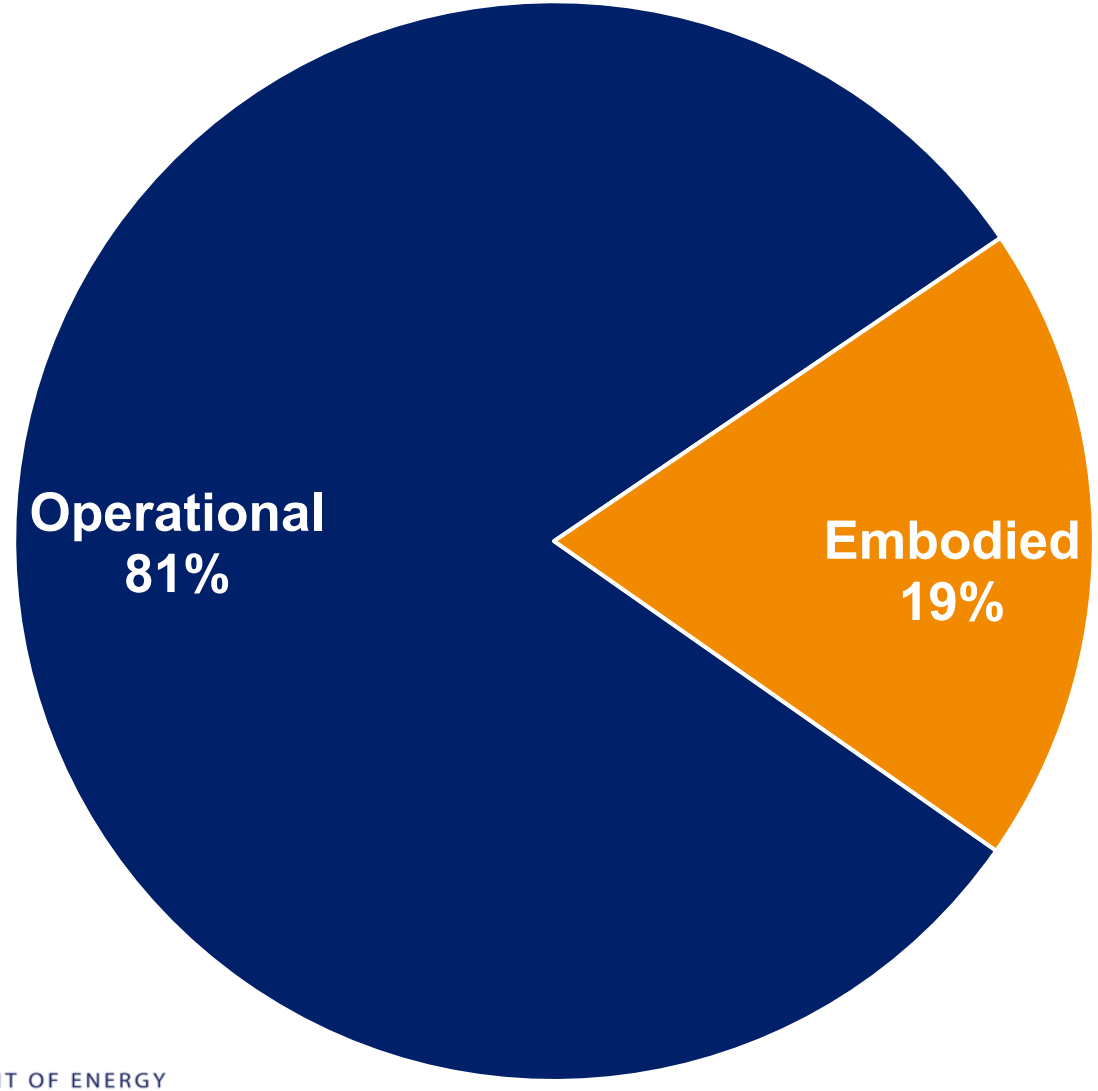
Operational Efficiency Is Improving



Operational efficiency is improving, meaning the embodied piece is becoming more important

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Questions or comments?

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3. Scope 1 and Scope 2 Inventory Guidance: https://www.epa.gov/climateleadership/scope-1-and-scope-2-inventory-guidance
4. What are the Scopes of Carbon Emissions?: https://www.greenworldwide.com/what-are-scope-1-2-and-3-carbon-emissions/

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Building Life Cycle

Photo by Dennis Schroeder, NREL

Episode ID: 0702-231020

Terminology

Embodied Carbon

- **Total emissions from carbon dioxide equivalents** associated with extraction, processing, manufacturing, and transporting of raw materials for the construction of buildings

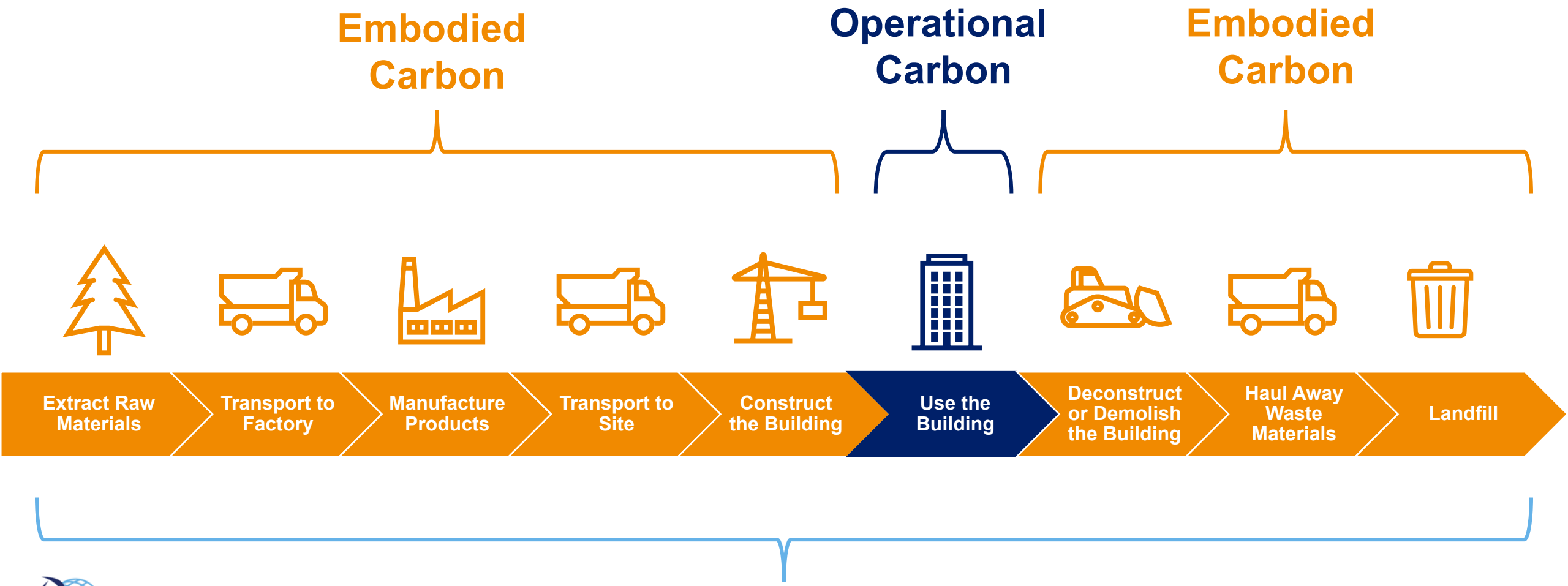
Embodied Energy

- **Total energy** associated with extraction, processing, manufacturing, and transporting of raw materials for the construction of buildings

Embodied Water

- **Total volume of freshwater** associated with extraction, processing, manufacturing, and transporting of raw materials for the construction of buildings

Building Life-Cycle



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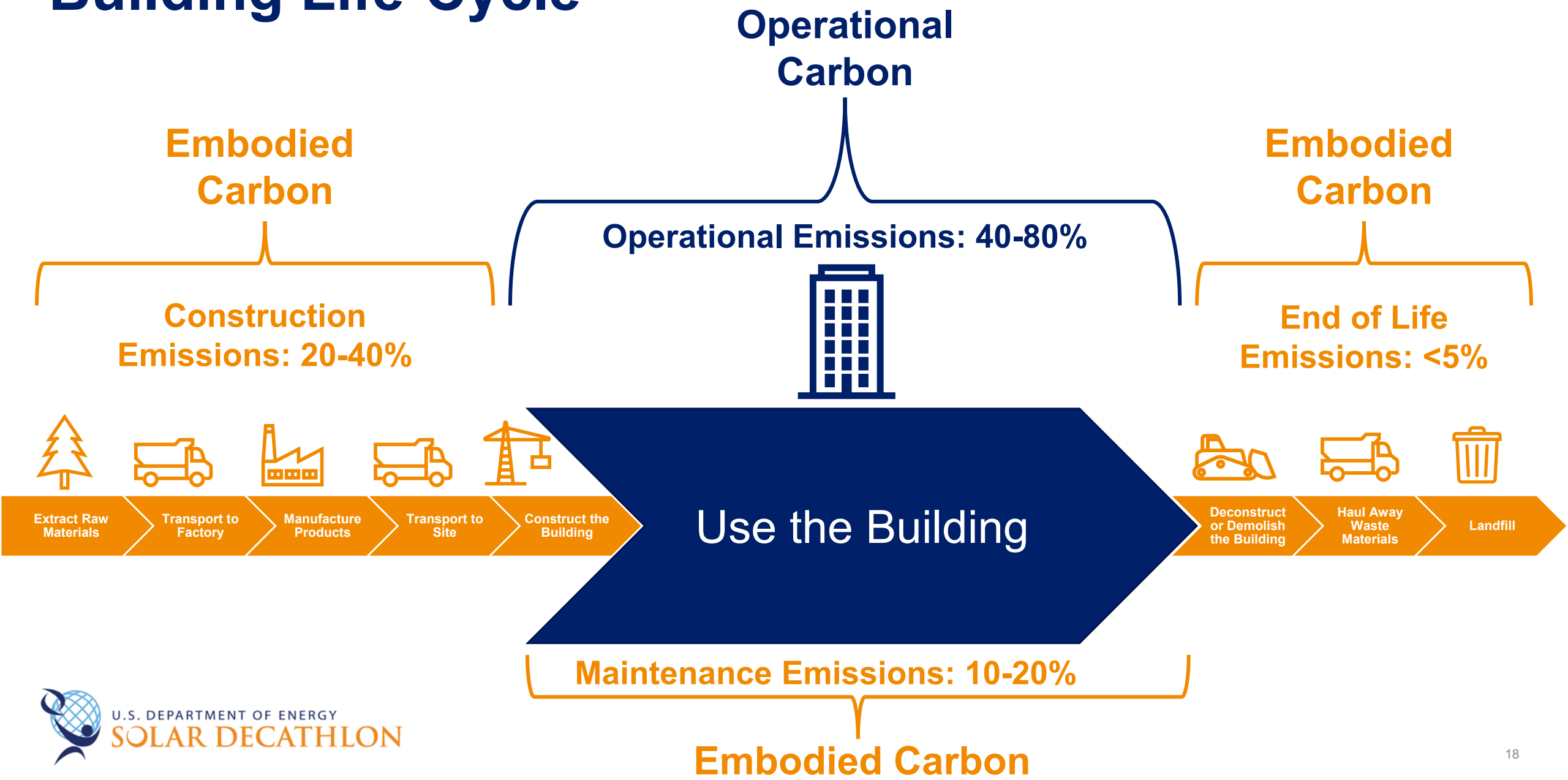
Building Life-Cycle



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More Terminology

Cradle to Grave

- A product or material's full life cycle from extraction to disposal; **acknowledges that a certain amount of waste is produced**

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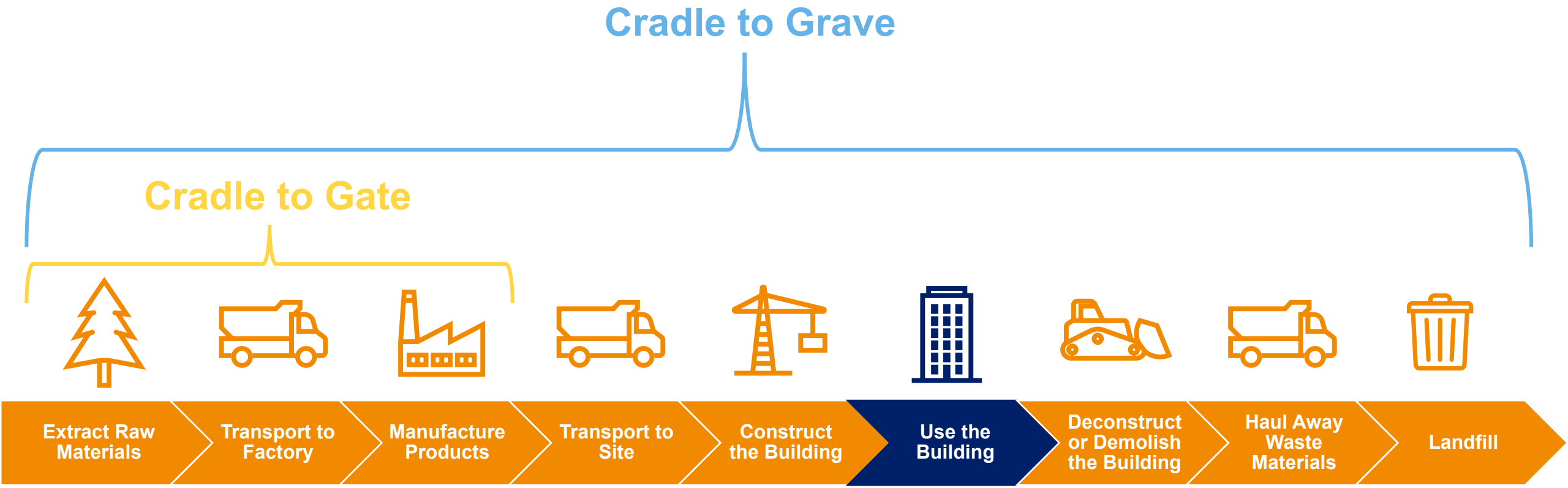
Cradle to Gate

- A product or material's partial life cycle from extraction to factory gate; **evaluates environmental impact before it reaches the consumer**

Cradle-to-Grave vs. Cradle-to-Gate



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- A product or material's full life cycle from extraction to disposal; **acknowledges that a certain amount of waste is produced**

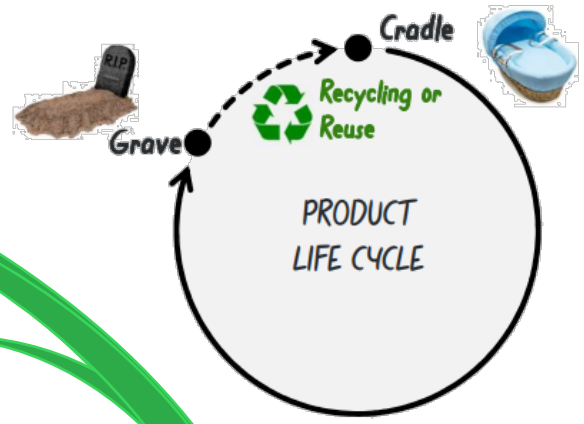
Cradle to Gate

- A product or material's partial life cycle from extraction to factory gate; **evaluates environmental impact before it reaches the consumer**

Cradle to Cradle

- Creating products or materials that can be truly recycled at the end of their life; **everything is a resource for something else**

Circular Economy: Cradle to Cradle Approach



Extract Raw Materials → Transport to Factory → Manufacture Products → Transport to Site → Construct the Building → Use the Building → Deconstruct or Demolish the Building → Haul Away Waste Materials → Landfill

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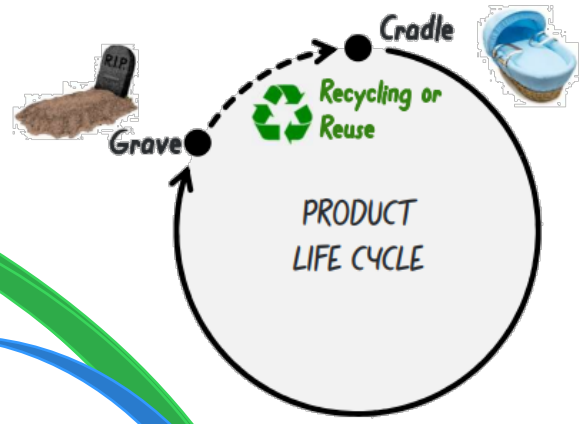
Circular Economy: Cradle to Cradle Approach



Reuse

Extract Raw Materials → Transport to Factory → Manufacture Products → Transport to Site → Construct the Building → Use the Building → Deconstruct or Demolish the Building → Haul Away Waste Materials → Landfill

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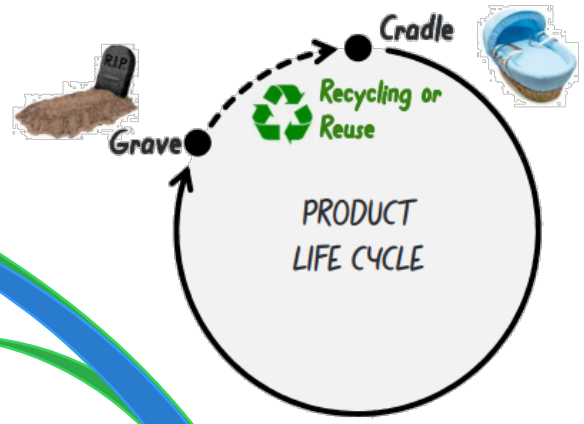
Circular Economy: Cradle to Cradle Approach



Remanufacturing
Refurbishing

Reuse

Extract Raw Materials → Transport to Factory → Manufacture Products → Transport to Site → Construct the Building → Use the Building → Deconstruct or Demolish the Building → Haul Away Waste Materials → Landfill

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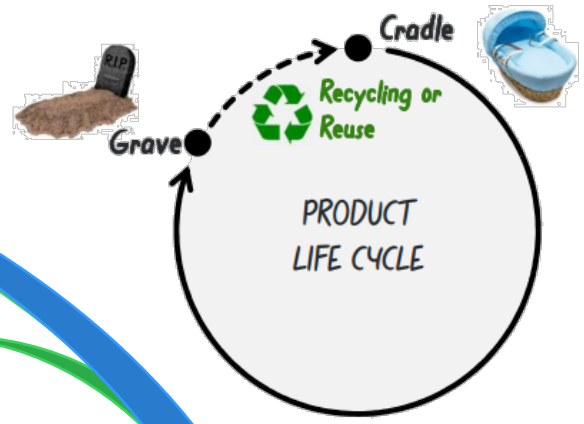

Recycling

Remanufacturing
Refurbishing

Reuse

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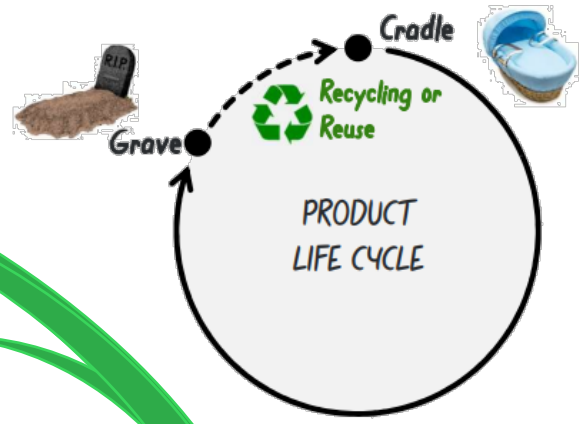

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Extract Raw Materials → Transport to Factory → Manufacture Products → Transport to Site → Construct the Building → Use the Building → Deconstruct or Demolish the Building → Haul Away Waste Materials → Landfill

Prolonging Use
Intensifying Use
Dematerialization

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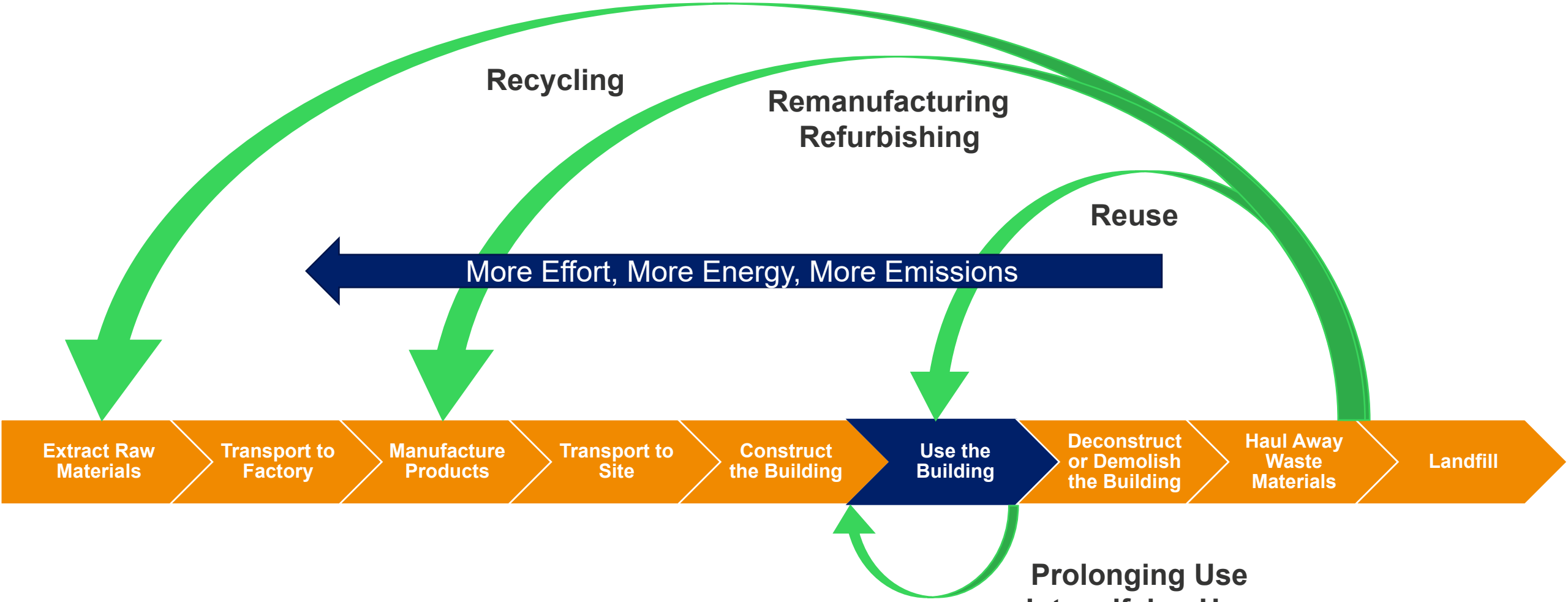
The Green Arrows Do Not Come Without a Carbon Penalty



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