U.S. Department of Energy Solar Decathlon® 2020 Design Challenge

Pilot Contest: *Embodied Environmental Impact*

As part of the U.S. Department of Energy Solar Decathlon 2020 Design Challenge, teams are invited to participate in a pilot Embodied Environmental Impact Contest. This Contest is being piloted for incorporation into future iterations of the Solar Decathlon, with the goal of expanding the competition to better understand the full life cycle of a building. Participation in this contest is ***optional*** and will not be scored as part of the 2020 Design Challenge. Students, faculty advisors, and jurors will be asked to provide feedback to Solar Decathlon Organizers on this new Contest to allow for refinement in preparation for its formal inclusion as one of the 10 Contests in future Solar Decathlon competitions.

Contest Intent

This Contest evaluates the full lifecycle of a building, from cradle to grave[1].

"Circular economy" for a building refers to an economic system in which buildings are designed with a focus on minimizing environmental impact from material extraction and manufacturing to transportation, construction, and use, while also considering "Re-X"[2] of materials throughout the lifecycle. Within the sphere of a circular economy, various measurements and calculations are used to quantify the environmental impacts that are embodied into the building at each life cycle stage. As buildings become more resource efficient during occupancy, the environmental impact during this stage decreases. Consequently, the other life cycle stages—such as material production, manufacturing, construction processes, and end of life—become larger contributors to a building's total environmental impact and, therefore, become more important to address. The building industry must go beyond the occupancy stage to address these impacts in all life cycle stages.

Evaluation Criteria

Teams should consider the following criteria:

- Life cycle assessment of the building's embodied environmental impacts, showing assumptions (e.g., intended service life, functional requirements, etc.) for the assessment of each life cycle stage
- Design decisions with regard to circularity and embodied environmental impacts
- Material selections with regard to circularity and embodied environmental impacts
- Discussion of trade-offs between up-front/embodied environmental impacts (i.e., energy, greenhouse gas emissions) and operational environmental impacts.

[1] Embodied environmental impacts can be measured using various boundary conditions in the building lifecycle. The three most common are cradle to (factory) gate, cradle to site (of use), and cradle to grave. Cradle to grave is the most complete of these three boundary conditions, as it includes the extraction of raw materials, transport, refining, processing, manufacturing, assembly, use, and end of life.

[2] Re-X = Reclamation, refurbishment, repair, reuse, recycle, etc.

Project Report Submission Instructions

Teams that choose to participate in this pilot Contest can include three additional pages in Section 2: Contest narratives of their Project Report. Jurors will not be required to read these additional pages.

Tools and Resources

The building industry uses life cycle assessments (LCA) to evaluate a building's environmental impact over its entire lifetime. LCAs generally consist of a scientific cradle-to-grave quantification of potential environmental impacts of products or services. When an entire building project is being considered—as opposed to individual products or materials within the building—the application of this methodology is called "whole-building LCA." This approach inventories the resources consumed and the environmental emissions created for every stage of the building life cycle. As a result of this analysis, various environmental impact categories—such as eutrophication, global warming potential, and primary energy use—are calculated to quantify a building's environmental impact over its lifetime.

Many tools have been developed to facilitate the whole-building LCA process, all of which utilize user inputs for building materials to calculate environmental impacts such as embodied energy, embodied carbon, and others. One of the programs preferred by the Solar Decathlon, OneClick LCA, is available to students at no charge; however, teams may use other LCA tools as well.

The following resources provide information on the circular economy, embodied carbon, embodied energy, LCA methods and tools, and more.

Tools:

1. OneClick LCA (preferred by Solar Decathlon)

This web-based LCA tool was developed by Bionova Ltd. with the goal of providing the construction industry with a fast and simple way to calculate environmental impacts of buildings. OneClick LCA is preferred by the Solar Decathlon because of its cradle-to-grave approach and overall ease of use.

2. Athena Impact Estimator for Buildings

As an alternative to OneClick LCA, this software tool is available as a free download from the Athena Sustainable Materials Institute. It is designed specifically for individuals without advanced LCA skills, and it is particularly useful in the early conceptual design stage of a project.

3. Embodied Carbon in Construction Calculator (EC3)

Another alternative to OneClick LCA, this web-based tool is available for free from the University of Washington and the Carbon Leadership Forum. Although this tool utilizes industry average data for building materials, it is most useful for projects that have progressed to materials selection with vendor-specific Environmental Product Declaration (EPD) data.

Resources:

1. Bringing Embodied Carbon Upfront (World Green Building Council)

This report from the World Green Building Council was developed to assess the systemic changes needed to achieve full decarbonization across the global buildings sector. It defines embodied carbon, emphasizes the importance of full life cycle assessment, and identifies specific calls to action for stakeholders across the buildings industry.

2. Embodied Carbon Network (Carbon Leadership Forum)

The Embodied Carbon Network's website provides background information and a variety of other resources on life cycle assessments and embodied carbon. One of the resources published by the Embodied Carbon Network is the Embodied Carbon in Construction Calculator (EC3), which is listed above as an alternative LCA tool for use by Solar Decathlon participants.

3. Circular Economy (Ellen MacArthur Foundation)

The Ellen MacArthur Foundation's mission is to accelerate the transition to a circular economy. Their website provides abundant information on the broader concept of the circular economy.

4. Life-Cycle Assessment Guide (OneClick LCA)

Written by OneClick LCA, the Solar Decathlon's preferred LCA tool, this document is a brief but detailed introduction to the importance of building LCAs, how they are calculated, and how LCAs are used in the construction industry.