Data-Driven Decarbonization: Supporting Decision-Making for Buildings and Infrastructure

Data Driven Sustainability for Buildings and Infrastructure

Last 5 digits of project number | 82728

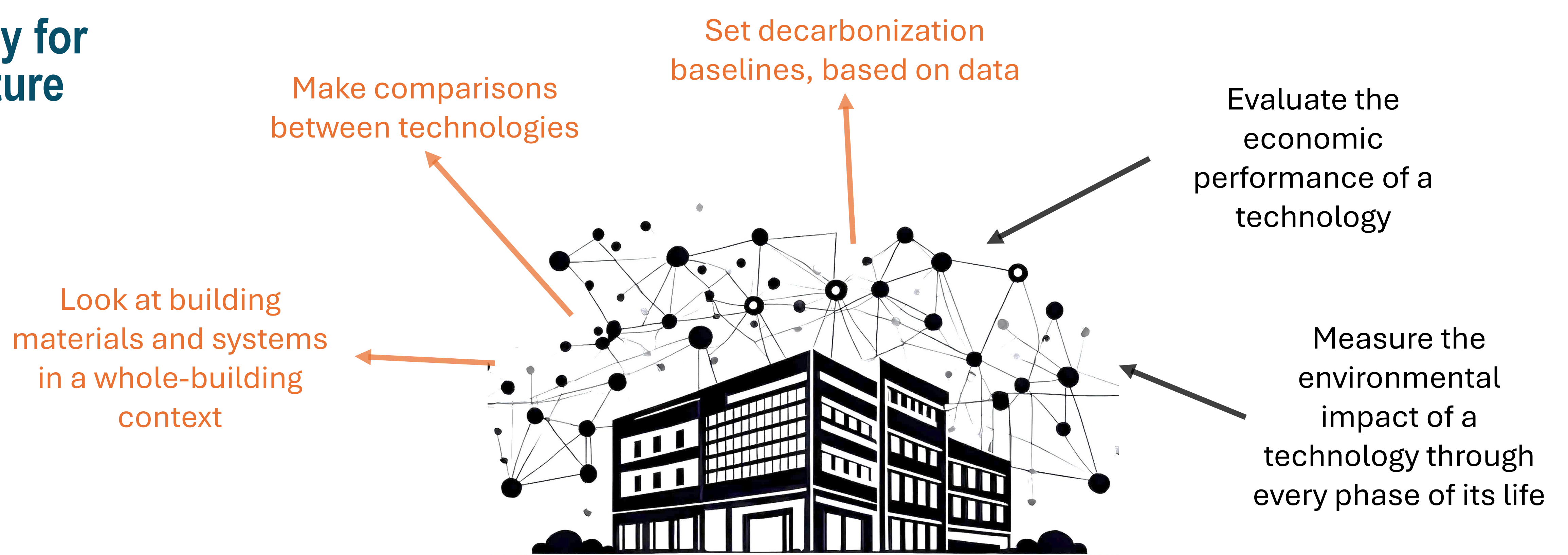**Principal Investigator (PI)** | Kate Hickcox
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Email the PI

Make comparisons between technologies

Set decarbonization baselines, based on data

Evaluate the economic performance of a technology

Look at building materials and systems in a whole-building context

Measure the environmental impact of a technology through every phase of its life

Whole Building Life Cycle Assessment (WBLCA) situates energy efficiency strategies into the DOE Blueprint goals, to enable comprehensive, informed decision-making.

WHY

The DOE Buildings Decarbonization Blueprint urges greater use of whole building life cycle assessments (WBLCA) to minimize carbon emissions in both new and old buildings. Even though there's a lot of interest in making buildings more energy efficient and sustainable, using WBLCA methods in building design is still complicated by lack of data and standardization.

Creating standard methods for collecting data for analyzing the sustainability of energy and buildings equipment, and using this data in WBLCAs, is key for industries to embrace sustainability and create better products.

It's difficult to calculate the carbon emissions of a whole building and its systems. This is especially true for mechanical and electrical (M&E) systems. Some main problems are:

- Choosing the right method to calculate the carbon emissions, since there are many options each with different pros and cons.

- Finding the data needed to determine the emissions associated with a building's mechanical or electrical (M&E) components is difficult and time consuming.

- Getting data in a usable format, often requires a more detailed building model than is commonly used.

RESULTS

PNNL developed two life cycle inventory (LCI) workbook/templates for the lighting and rooftop HVAC unit industries. The workbooks standardize and simplify environmental impact reporting and make it easier for industry professionals to provide consistent and accurate data.

PNNL talked to designers, architects, and decision-makers to understand current whole building life cycle assessment (WBLCA) workflows and how products like lighting, small electronics, HVAC, distributed energy resources (DERs), and other M&E components can be integrated into these workflows. By looking at new technologies and systems in the context of the whole building, we can balance the trade-offs between operational and embodied energy/carbon and optimize building systems.
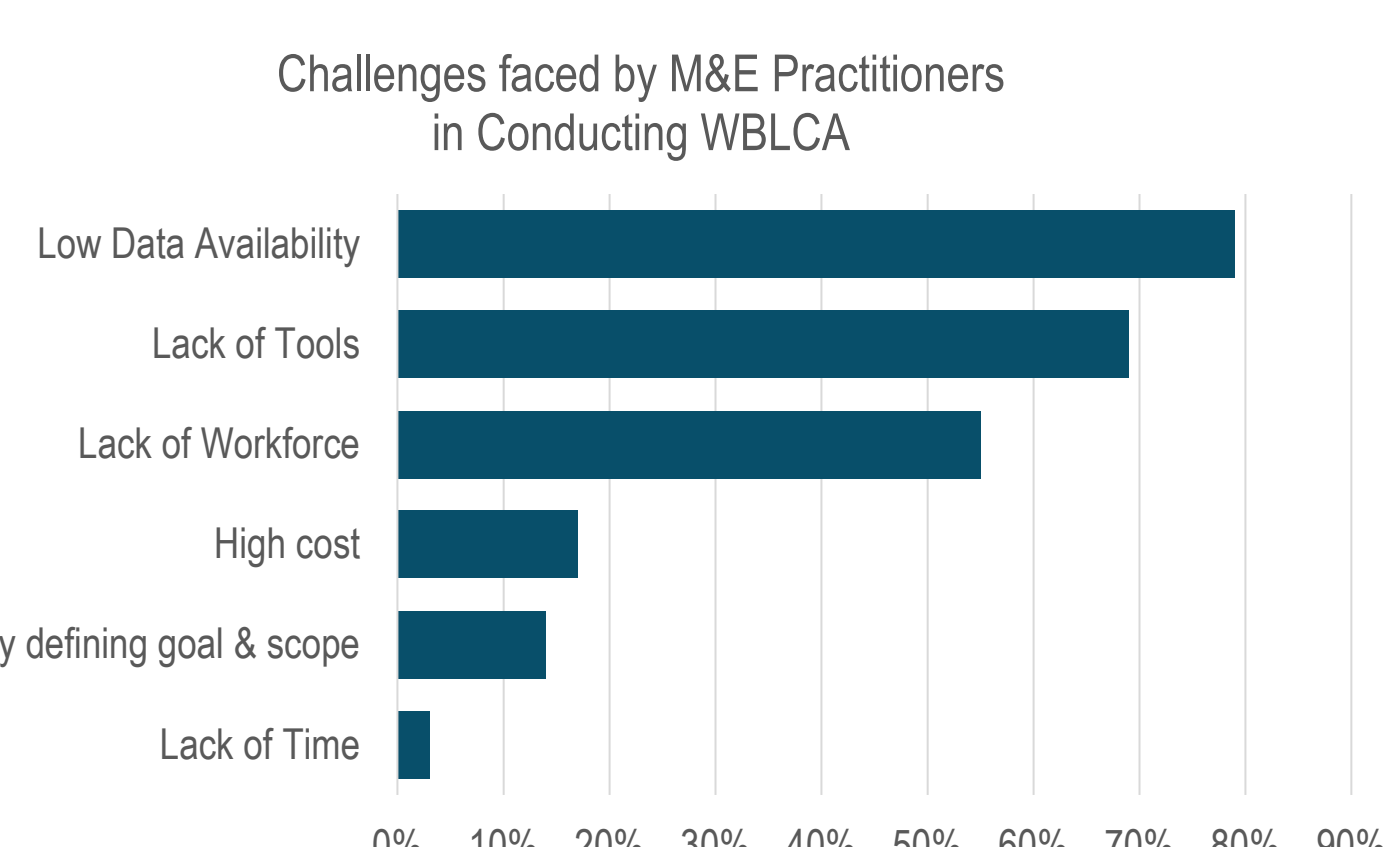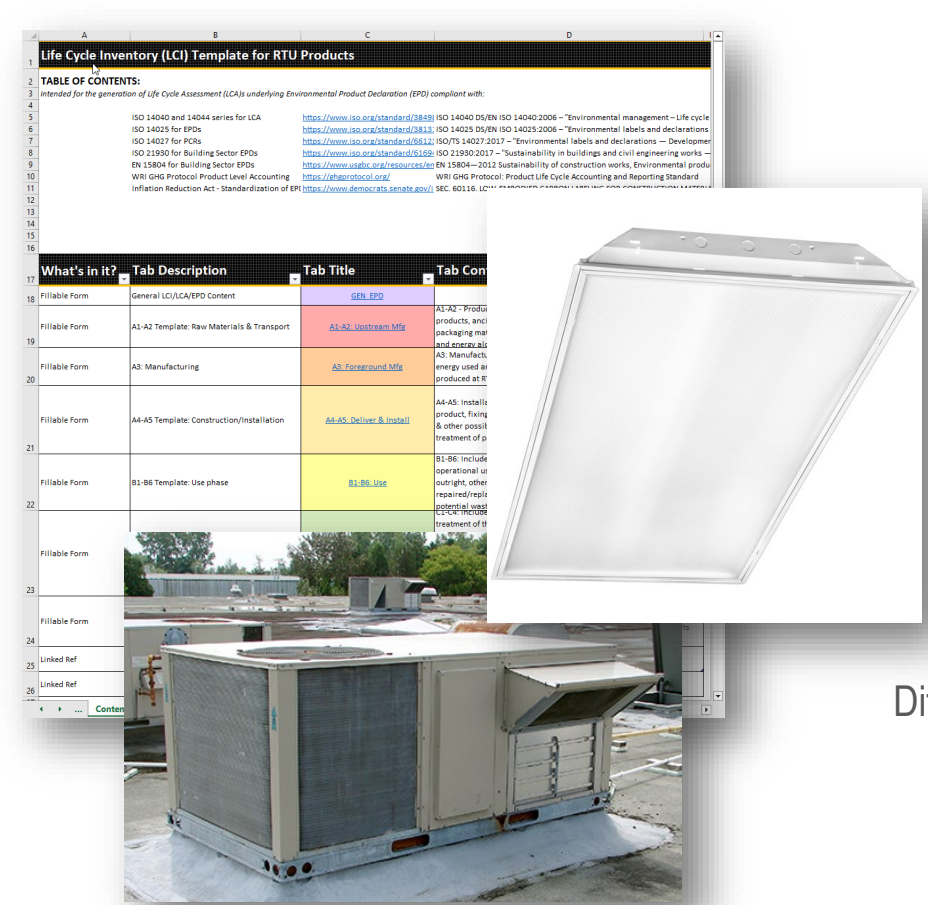
HOW

PNNL is working on ways to compare the carbon emissions and other environmental impacts of building materials and technologies, as well as mechanical and electrical (M&E) equipment and distributed energy resources (DERs) like electric cars, solar panels, and battery storage. We're tackling sustainability issues by:
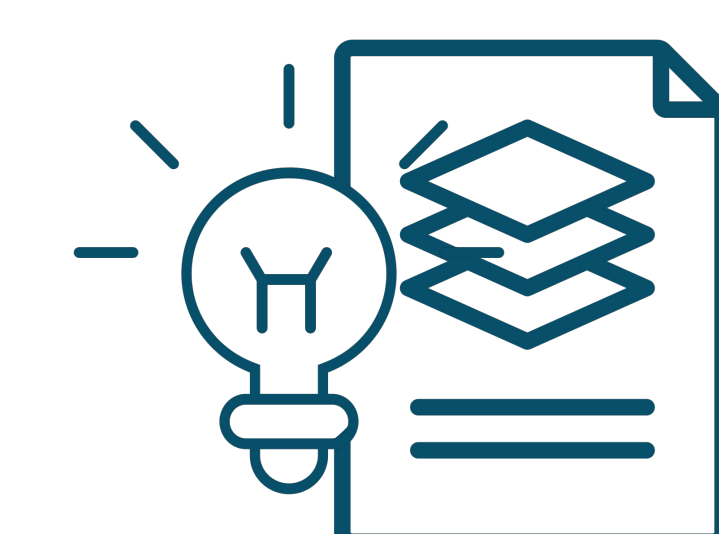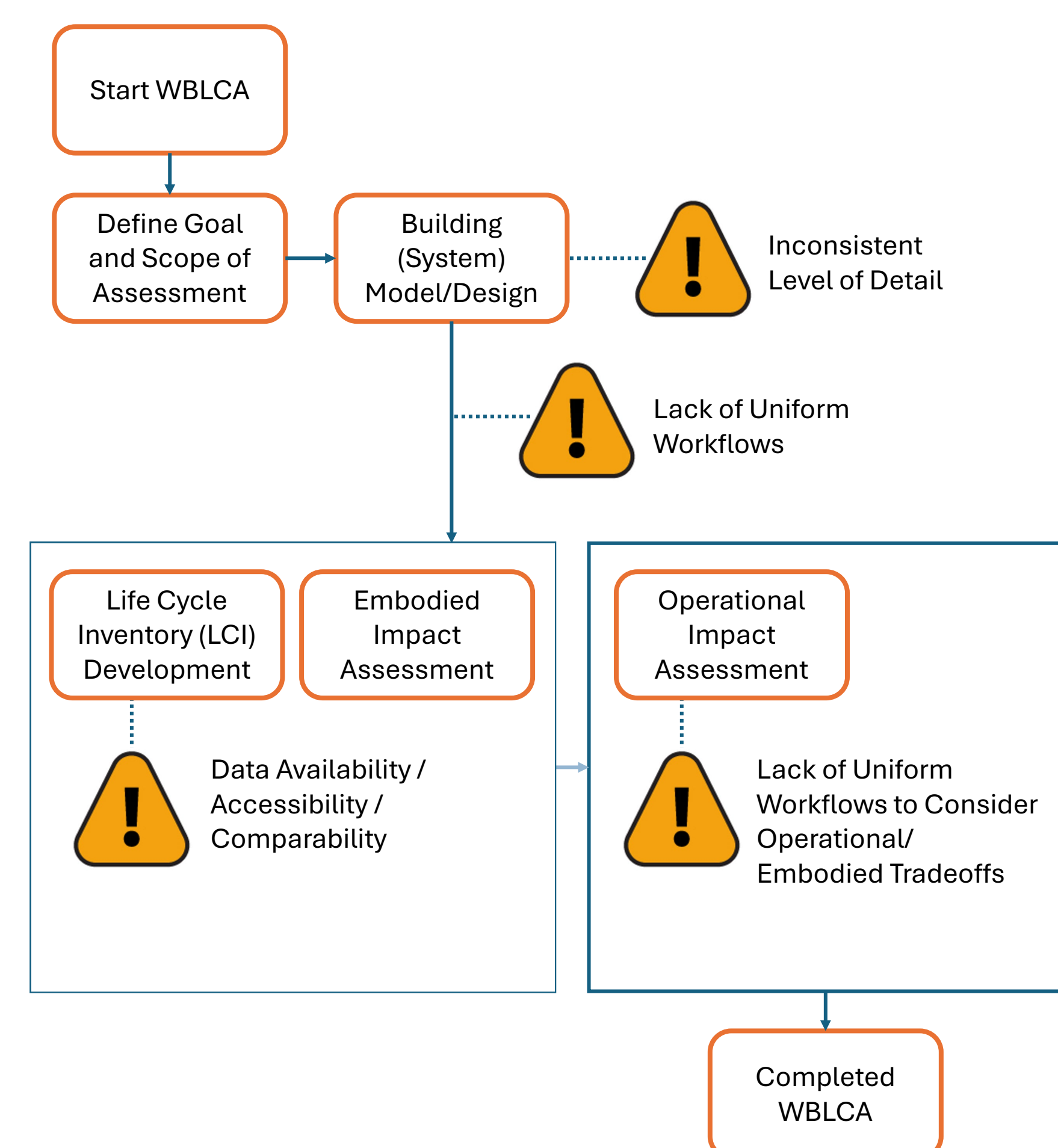
- Creating WBLCA workflows that align with the DOE Buildings Blueprint's strategic goals.

- Teaming up with key players in the M&E industries to remove obstacles that prevent manufacturers from making high-quality, publicly accessible life cycle assessments (LCAs).

- Releasing an Excel-based open-source life cycle inventory (LCI) workbook/template on GitHub to automate, standardize, and expand LCA and sustainability labeling (e.g., EPDs) use in the lighting industry.

- Planning to release an LCI workbook for Rooftop Units by the end of 2024.

WHAT'S NEXT

Help the building industry, especially distributed energy resources (DER) and mechanical & electrical (M&E) equipment manufacturers, to achieve sustainability goals. Future efforts might include:

- Expanding impact categories to include embodied carbon, water usage, air quality, biodiversity, human health, and social equity.

- Filling in data gaps for products lighting, small electronics, HVAC, DER, and other M&E components.

- Improving data accuracy and transparency with open-source data platforms, allowing for the generation and use of valid, transparent, and reproducible data.

- Creating user-friendly web versions of life cycle inventory (LCI) workbooks.

- Educating decision-makers on sustainability best practices and the impacts of their product choices on society and the environment.

- Defining standard workflows for whole building life cycle assessment (WBLCA) for DOE prototype buildings, enabling benchmarking and analysis of the U.S. building stock.

There's a significant opportunity for designers, architects, and decision-makers to reduce environmental impact and enhance sustainability in the building industry. This work creates practical pathways to realize this opportunity.

Start WBLCA → Define Goal and Scope of Assessment → Building (System) Model/Design

⚠ Inconsistent Level of Detail
⚠ Lack of Uniform Workflows

Life Cycle Inventory (LCI) Development | Embodied Impact Assessment
⚠ Data Availability / Accessibility / Comparability

Operational Impact Assessment
⚠ Lack of Uniform Workflows to Consider Operational/ Embodied Tradeoffs

→ Completed WBLCA

Access the Luminaire LCI Workbook

Read more on the PNNL Data-Driven Sustainability Website

Challenges faced by M&E Practitioners in Conducting WBLCA

Challenge	
Low Data Availability	
Lack of Tools	
Lack of Workforce	
High cost	
Difficulty defining goal & scope	
Lack of Time	

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