Building Decarbonization Using Fiberglass and Mineral Wool

Insulation Institute™

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Introduction

Buildings account for 40% of global CO_2 emissions[1] and are increasingly the subject of regulation aimed at dramatically lowering their climate impact. The addition of new, robust financial incentives for highly efficient buildings makes it increasingly important for all sectors of the construction industry to understand the tools and policies that will drive low-carbon building construction in the years to come. This guide provides information for residential home builders on decarbonization and how fiberglass and mineral wool insulation can help reduce the carbon footprint of their projects.

Whole Building Decarbonization

Whole building decarbonization means reducing carbon emissions from buildings in two ways: 1) reducing operational carbon by using less energy to heat, cool, light, and otherwise power the building, and 2) reducing embodied carbon by using low carbon building materials. A whole building decarbonization approach involves decisions that balance building design, material selection, construction, and operational energy to minimize energy consumption and maximize the use of renewable energy sources. While adding more insulation to a building's thermal envelope will increase the amount of embodied carbon, that extra insulation will reduce the operational carbon for the entire life of the building. The whole building decarbonization approach calls on the building designer to strike the best balance from a carbon perspective.

[1] IEA, Global Status Report for Buildings and Construction 2019, IEA, https://www.iea.org/reports/global-status-report-for-buildings-and-construction-2019

Operational Carbon + Electrification

Building energy efficiency is driven through compliance with energy codes. Increased stringency of model energy codes over the past 15 years has reduced building energy usage by approximately 50%[2]. Despite these improvements, carbon emissions from building operations still account for 28% of global CO_2 emissions[3]. These carbon emissions are drastically lower than in the past, but there still remains a significant opportunity for emission reductions. This is why the conversation is shifting to building electrification.

Electrification means replacing a building's fossil fuel-based energy sources with carbon free electricity generated from solar, wind, nuclear, or hydropower. Natural gas or delivered fuel space and water heating systems and gas cooking are swapped out for heat pump water heaters, heat pump heating and cooling systems, and electric cooktops and ovens (including those using electric induction technology).

Building envelope energy efficiency plays a vital role in enabling electrification. Well-insulated buildings maintain conditioned space temperature and reduce home heating and cooling requirements. As a result, smaller heating and cooling equipment can be used. Spread over thousands of homes and buildings, insulation can have a profoundly positive effect in helping electric utilities manage load demands during summer and winter peak load events by maintaining indoor temperature.

[2] U.S. Department of Energy, Estimated Improvements in Residential & Commercial Energy Codes, https://public.tableau.com/app/profile/doebecp/viz/HistoricalModelEnergyCodeImprovement/CombinedHistoricalCodeImprovement_1

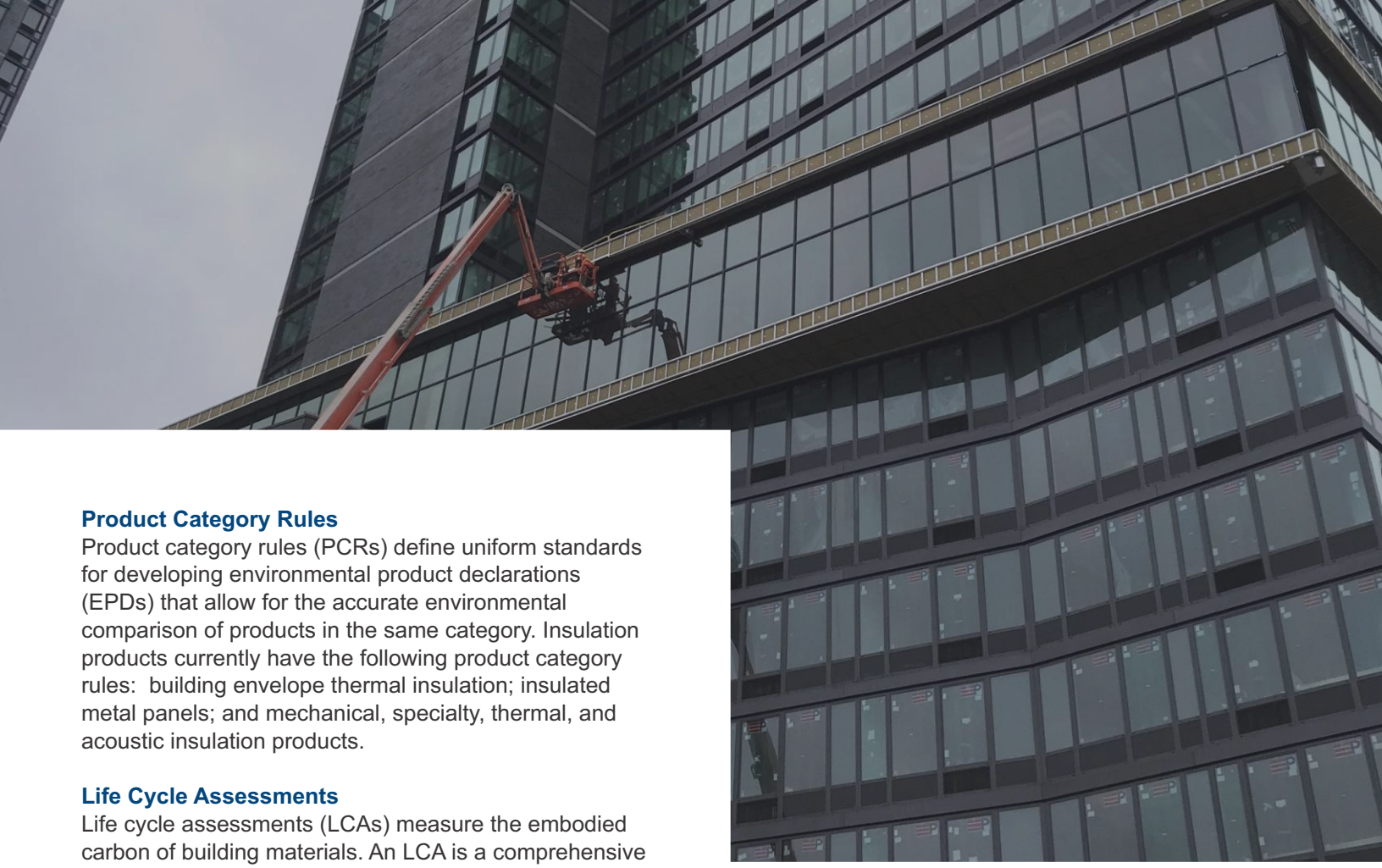
[3] IEA, Global Status Report for Buildings and Construction 2019, https://www.iea.org/reports/global-status-report-for-buildings-and-construction-2019

Material Embodied Carbon

Material embodied carbon includes all the emissions released during the entire lifecycle of a material, from the extraction of raw materials to the disposal of the material at the end of its life. As of 2018, building materials manufacturing accounted for 11 percent of global CO_2 emissions. Building materials like cement, concrete, steel, and glass are carbon intensive and account for up to 50% of a building's embodied carbon. Some building materials, like insulation, are relatively minor contributors to building embodied carbon emissions. Insulation is also unique among building materials in that its specific purpose is to reduce building climate emissions by reducing heating and cooling demand. According to the U.S. Department of Energy, heating and cooling account for about 50% of the energy used in a typical home. Insulating a building can reduce energy consumption for heating and cooling by up to 30%[4].

The following tools are intended to quantify the embodied carbon of specific materials and products. Ideally, these tools allow for an accurate comparison between building material options on global warming potential and other environmental emissions.

[4] U.S. Department of Energy, Energy Saver Guide: Tips on Saving Money and Energy at Home, https://www.energy.gov/energysaver/energy-saver-guide-tips-saving-money-and-energy-home



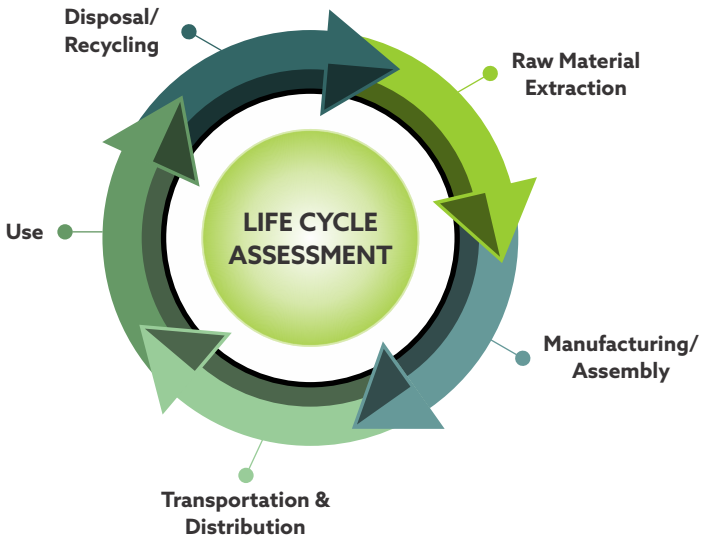
Product Category Rules

Product category rules (PCRs) define uniform standards for developing environmental product declarations (EPDs) that allow for the accurate environmental comparison of products in the same category. Insulation products currently have the following product category rules: building envelope thermal insulation; insulated metal panels; and mechanical, specialty, thermal, and acoustic insulation products.

Life Cycle Assessments

Life cycle assessments (LCAs) measure the embodied carbon of building materials. An LCA is a comprehensive approach that examines all stages of a material's lifecycle, including raw material extraction, manufacturing, packaging, transportation, use, and disposal. LCAs clearly define and quantify the environmental burdens associated with a product's embodied carbon by analyzing the environmental impacts at each stage.

Figure 1. Life Cycle Assessment



Environmental Product Declarations

Environmental product declarations (EPDs) are standardized documents that provide information on a product's environmental impacts and carbon footprint over its lifecycle. EPDs are based on a consistent set of guidelines, allowing a comparison of the environmental impacts of different materials. EPDs provide a transparent way for manufacturers to communicate the environmental performance of their products to the building industry. They are also used as the basic building blocks for a whole building embodied carbon calculation.

In summary, these tools provide a standardized way to compare the environmental performance of different materials and can help inform sustainable material choices in the building industry. Fiberglass and mineral wool manufacturers produce EPDs for many of their products, which can be easily found on their websites.

How Regulation is Addressing Embodied Carbon

Regulation is increasingly addressing embodied carbon in building materials to reduce the built environment's carbon footprint. Commonly referred to as "Buy Clean" regulation, the federal government and many states are mandating the use of low-carbon materials in building construction.

Figure 2. Current status (as of September 2023) of "Buy Clean" laws and regulations in the U.S.

YEAR	JURISDICTION	POLICY TEXT	TYPE OF EPD	STATUS	IMPLEMENTS GWP LIMITS
2022	Federal-GSA	Facilities Standards (P100)	Product-Specific	Passed	Partially
2022	Virginia	SB 272	Not specified	Proposed	No
2022	Illinois	HB 5564	Not specified	Proposed	Yes
2022	Oregon	HB 4139	Product-specific	Passed	No
2021	Federal-Congress	H.R. 5376-Inflation Reduction Act	Not specified	Passed	No
2021	Federal-Congress	H.R. 1512-Clean Future Act	Facility-specific	Proposed	Yes
2021	Washington State	HB 1103	Supply chain-specific	Proposed	No
2021	New Jersey	A5223	Product-specific	Proposed	Yes
2021	Colorado	HB 21-1303	Supply chain-specific	Passed	Yes
2021	California	AB-1365	Supply chain-specific	Proposed	Yes
2021	New York State	SB 542A	Not specified	Passed	No
2020	New Jersey	S3091	Not specified	Passed	Yes
2019	Local - Portland	Concrete Requirements	Product-specific	Passed	Yes
2019	Minnesota	HF 2204	Facility-specific	Proposed	Yes
2019	Minnesota	HF 3702	Product-specific	Proposed	No
2017	California	AB-262	Facility-specific	Passed	Yes

Retrofitting Existing Buildings

Insulation can significantly reduce existing building energy use. A report by consulting firm ICF estimates that energy savings ranging from 10 to 45 percent can be achieved in existing homes that are air sealed and have insulation added in the ceiling and floors (and walls in limited circumstances) to levels prescribed by the 2021 International Energy Conservation Code.[5]

Insulation Benefits When Switching to Heat Pumps

A recent study by the American Council for an Energy-Efficient Economy (ACEEE) found that the average residential customer who weatherizes an electrified home can expect to save an additional $150–$1,200 in operational costs per year, with most households saving $500–$800 per year. Envelope improvements allow a building to maintain a comfortable indoor temperature with a less powerful heat pump, which costs less to purchase and operate. The report also found that if the cost of heat pump ownership is factored in, moderate home envelope improvements can lower lifetime customer costs by $3,000–$11,000, while deeper envelope improvements that add window upgrades and more insulation lower the lifetime costs by $8,000–$22,000.[6]

Resilience During Power Outages

Increasing the ability to shelter safely in place for longer periods benefits Americans nationwide. A recent report from the Department of Energy (DOE) shows that increased insulation extends the amount of time building occupants will remain comfortable indoors during extreme heat or cold that knocks out power. An analysis from the report “Enhancing Resilience in Buildings Through Energy Efficiency”, finds that homes built to meet or exceed the 2021 International Energy Conservation Code (IECC) extend the habitability of buildings by 120% during extreme cold and up to 140% during extreme heat.[7]

[5] ICF, Insulation Industry Opportunity Study, https://www.insulationadvocacy.org/_files/ugd/bb658f_fa77af9cf52e4329bbcfd28cc1c20a35.pdf

[6] ACEEE, Empowering Electrification through Building Envelope Improvements, https://www.aceee.org/sites/default/files/pdfs/empowering_electrification_through_building_envelope_improvements_-_encrypt.pdf

[7] U.S. Department of Energy, Enhancing Resilience in Buildings Through Energy Efficiency, https://www.energycodes.gov/sites/default/files/2023-07/Efficiency_for_Building_Resilience_PNNL-32727_Rev1.pdf

Building Decarbonization Strategies

A well-sealed and insulated building envelope is the first and most important step for low-carbon construction. This lowers heating and cooling-related emissions for the life of the building.

Builders should also incorporate energy-efficient features into their designs, such as passive solar heating and energy-efficient windows. Using efficient appliances and lighting can also help to reduce energy consumption. When designing a home, builders should consider the orientation of the building, the placement of windows and doors, and the use of natural ventilation to maximize energy efficiency.

The materials used in construction also impact a home's carbon footprint. Along with other performance priorities, builders should also compare the global warming potential of potential building products and materials by referring to manufacturer environmental product declarations (EDPs). Manufacturers provide EPDs for most fiberglass and mineral wool insulation products.

Conclusion

Decarbonization, electrification, and operational/embodied carbon are complicated but essential concepts for the future of construction. As consumers demand sustainable homes and federal and local incentives continue to grow, familiarity with the topic will give you an advantage over your competition.

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NAIMA is the association for North American manufacturers of fiberglass, rock wool, and slag wool insulation products. Its role is to promote energy efficiency and environmental preservation through the use of fiberglass, rock wool, and slag wool insulation, and to encourage the safe production and use of these materials. Through the Insulation Institute™, we leverage the collective insulation expertise of our organization and our members to empower homeowners and professionals to make informed insulation choices. Our mission is to enable a more comfortable, energy-efficient and sustainable future through insulation — and we are constantly working with building professionals, homeowners, government agencies, and public interest, energy and environmental groups to realize that vision.

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