Summary: Advances Toward a Net-Zero Global Building Sector

Abstract

The building sector is responsible for 39% of process related greenhouse gas emissions globally, making net or nearly zero energy buildings pivotal for reaching climate neutrality. The paper reviews recent advances in key options and strategies for converting the building sector to be climate neutral.

The evidence from the literature shows it is possible to achieve net or nearly zero energy building outcomes across the world in most building types and climates with systems, technologies, and skills that already exist, and at costs that are in the range of conventional buildings.

Maximizing energy efficiency for all building energy uses is found as central to net zero targets. Jurisdictions all over the world, including Brussels, New York, Vancouver and Tyrol, have innovated visionary policies to catalyze the market success of such buildings, with over 7 million square meters of nearly zero energy buildings erected in China alone in the past few years.

Since embodied carbon in building materials can consume up to a half of the remaining 1.5ºC carbon budget, the paper reviews recent advances to minimize embodied energy and store carbon in building materials.

Summary points

1. The transformation of the building sector towards net zero energy and low embodied carbon buildings is a key component of meeting climate neutrality targets, because the building sector contributes approximately 36% to final energy demand and 39% to process related greenhouse gas emissions.
2. Recent advances in building design, know-how, construction, operation and retrofit, as well as low-carbon or even carbon storing building materials suggest that the building sector could become climate neutral in itself.
3. There is a wide range of net and nearly zero building terms, standards and definitions. The paper provides a summary figure that navigates the reader to understand the differences among these.
4. The evidence from the reviewed literature indicates that it is possible to reliably and affordably achieve net or nearly zero energy building outcomes all over the world in most building types and climates with systems, technologies and skills that already exist, and at costs that are in the range of conventional buildings.
5. The evidence shows that the key to net zero targets is the maximization of energy efficiency for all building energy uses, with the remaining energy loads to be covered from locally produced renewable energy sources. The greatest technological challenges to net zero energy buildings are in high-rise commercial buildings in hot and humid climates as well as for retrofitted historic heritage buildings, but solutions and best practices exist for these, too.

6. While net and nearly zero energy buildings increasingly achieve market success, there are many significant barriers worldwide to their wider adoption. However, recognizing their environmental, climate, social, health, productivity, economic and other advantages, many jurisdictions have successfully introduced policies and incentives to overcome these barriers and thus increase their market penetrations. China alone has built over 7 million square meter Passive Houses with significantly more under construction; New York City, Vancouver, Brussels, Tyrol, and other jurisdictions have introduced innovative policies and incentives to catalyze market transformation towards Passive House standard buildings.
7. Strategies to minimize embodied energy and carbon in building materials are gaining significant attention, and include material efficiency, recycled and reused materials, durable components, design and new materials; replacing carbon-intensive materials by bio-based ones, as well as carbon capture and utilization
8. The review of literature for this paper reinforced the existence of the significant gap and time lag between the advanced professional knowledge and scientific documentation, and thus recommends strengthened research and publication in co-production among these communities in order to enhance the broader uptake of these advanced solutions as well as their wider inclusion in climate and energy policy portfolios and modelling.

Future Issues

1. A significant gap and time lag exist between the work of professionals, the industry and policy leaders and its scientific documentation. Strengthened research and publication in co-production among these communities (science, building professionals, policy-makers) will enhance knowledge co-generation and dissemination of advances.
2. While the knowledge and technology currently exist to deliver net zero buildings, their performance can be improved and cost reduced through innovation in design, project delivery and building components. Targeted research can support rapid advances.
3. Due to the major gap between acceptable social and private payback times, deep retrofits delivering the major climate benefits discussed in the paper require innovative financing mechanisms that bridge long-term climate interests and finance with individual building-level private retrofit decisions.
4. Further and more granular understanding is needed related to the possibilities and challenges to carbon storage in building materials, especially through bio-based materials, given the complex interactions of land, water and biological productivity availability for food, feed and fiber production considering the high demands on fertile land, ecological considerations for the share of biomass removal from the production sites, as well as competition for different biomass products for other purposes.

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