Meeting Greenhouse Gas Reduction Targets in the Buildings Sector

Research Brief, Issue 5, Volume 2019

PROBLEM

As the threat of climate change grows, lowering the greenhouse gas (GHG) emissions of high emitting sectors of the economy has become critical. The buildings sector is particularly significant, consuming up to 40% of total global energy demand. To lower the associated emissions and meet GHG reduction targets, stakeholders must consider both the energy consumption over a building's operational life, or use phase, and the embodied emissions generated during its construction. Since concrete is a ubiquitous building material and significantly influences both embodied and use phase emissions, its environmental footprint is worthy of investigation.

APPROACH

CSHub researchers sought to estimate the potential for changes in energy efficiency and concrete mixtures for office buildings to help meet GHG reduction targets. To accomplish this, they examined embodied and use phase GHG emissions in newly constructed office buildings through several scenarios, each occurring over 50-year periods. They selected three office building types and, for each type, analyzed designs meeting both 2009 and 2015 IECC commercial energy codes. In addition, they studied the impact of increased use of supplementary cementitious materials (SCMs) as a substitute for a portion of Portland cement, a key element of concrete with a higher GHG footprint. They then analyzed these building types in 14 different U.S. cities, with each city representing a distinct climate zone.

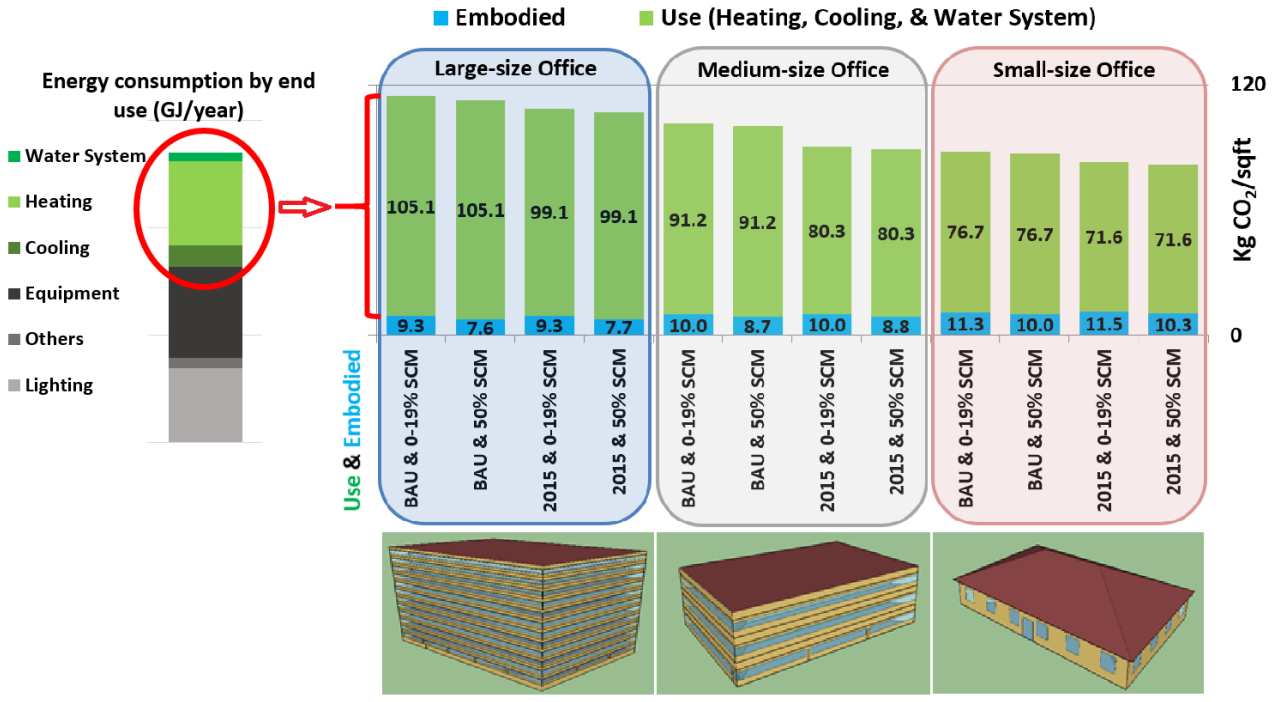

Fig.1: Life cycle GHG emissions from materials and construction (embodied) and heating and cooling energy consumption for large, medium, and small offices normalized by square footage for scenarios considering adoption of different energy codes in the whole US and usage of different SCM contents.

This research was carried out by the CSHub@MIT with sponsorship provided by the Portland Cement Association and the Ready Mixed Concrete Research & Education Foundation. CSHub@MIT is solely responsible for content. Authors: E. Vahidi, R. Kirchain, J. Gregory.

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FINDINGS

Researchers found that in each scenario the GHG emissions due to energy consumption in the use phase outweighed those from materials and construction (embodied) **(See Fig. 1)**. (Use phase emissions focused only on heating and cooling as those are directly affected by material choice.)

The adoption of the latest building codes proved an effective way to reduce GHG emissions. By building according to 2015 code standards in all states and by utilizing 50% SCM in concrete mixes, GHG emissions from office buildings would decrease by 12%. Nationwide, this would save up to 1.04 million metric tons of CO_2-eq over a 50-year period where the latest code adoption contributes to 82% of the total CO_2-eq savings **(See Fig. 2 d)**. Certain states like Ohio and North Carolina that currently use older energy codes saw considerable savings by adopting 2015 codes and utilizing SCM in concrete mixes. North Carolina, for instance, could see 96 thousand tons CO_2-eq in savings. In the future, researchers will expand the number of building types analyzed to include schools, stores, hotels, hospitals, and so on.

WHY DOES THIS RESEARCH MATTER?

- This research shows that there is greater potential to reduce GHG emissions in the buildings sector through improvements in energy efficiency than in concrete impacts.
- Utilizing more SCMs as well as implementing stricter building standards will lead to significant reductions in CO_2-eq emissions in newly constructed office buildings in the U.S.
- Stakeholders can use the results of this study to make informed choices regarding the environmental impacts of new commercial buildings. This, in turn, can help them meet emission reduction targets.

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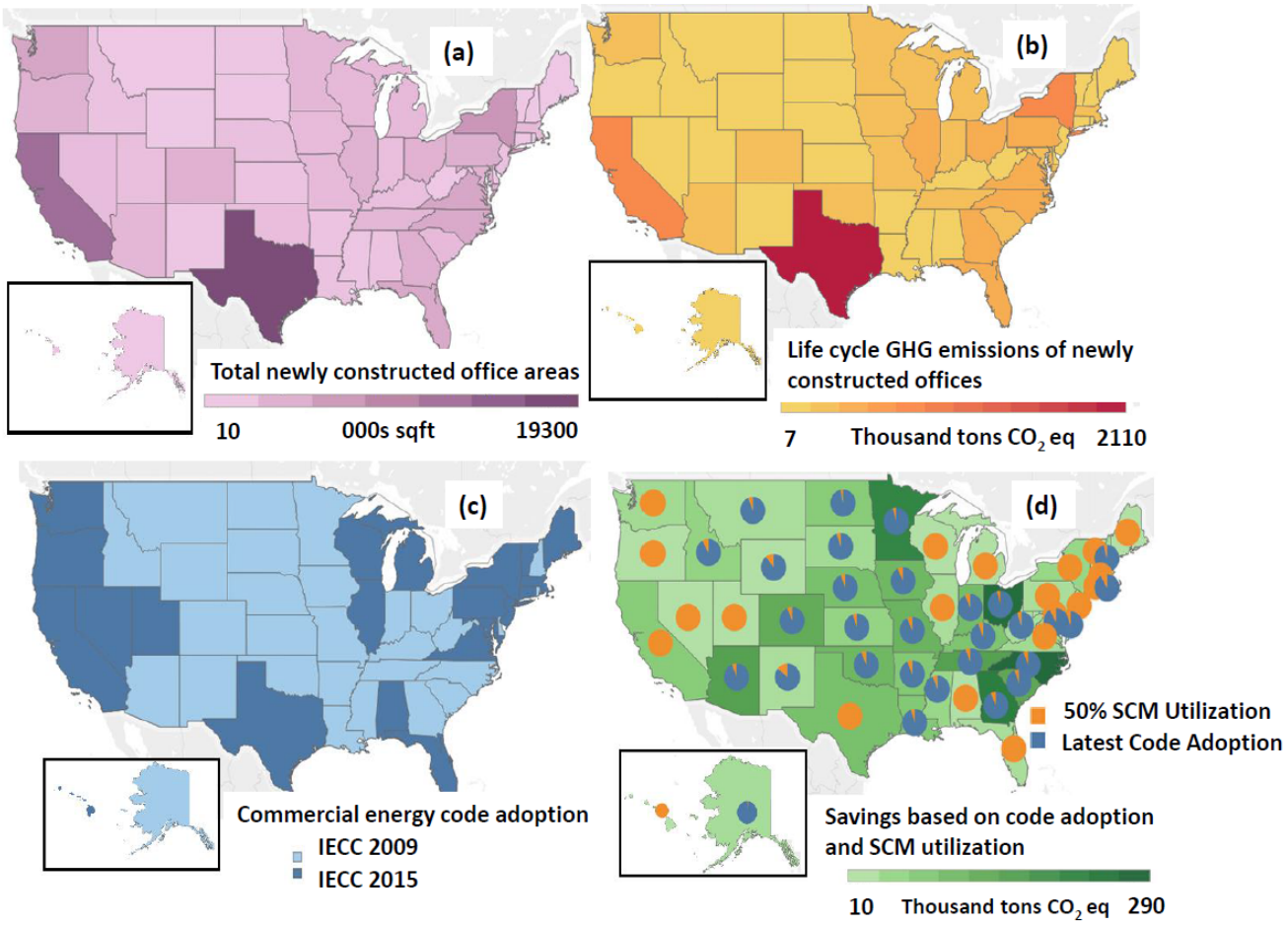

Fig.2: (a) Total area of newly constructed office buildings in each state; (b) life cycle GHG emissions of newly constructed office buildings in each state over a 50-year period; (c) commercial energy code adoption status of each state in the US; and (d) CO_2-eq savings in each state by applying 2015 standard and utilizing 50% SCM in concrete over a 50-year period.

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