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Representative models and energy and material efficiency strategies for residential buildings in urban India

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40% of global energy demand can be attributed to buildings, and 75% of this share is contributed by residential buildings. Developing countries are expected to be the hotspot for future growth in residential energy demand, as many of them expect significant growth in population and urbanization. For instance, 75% of the residential floorspace expected to exist in India in 2030 remained to be constructed in 2015. Thus, a lot of the new energy demand from residential buildings can still be controlled and mitigated. As the country expected to have the largest population in the world by 2025, India has a responsibility to grow sustainably, in a way that aids global climate change mitigation goals. Studying the residential building sector in India thus is a necessary step towards achieving these goals.

Indian residential buildings are diverse, and include informal slums, low-quality formal buildings, mid-rise formal buildings, and high-rise skyscrapers. Global models for energy efficiency in the residential sector usually consider only one type of building from developing countries, the formal (cement-concrete) type. They create a generalized model, based on the assumption that appliances and thermal comfort standards are the same in most countries. These generalizations do not consider the diverse types of buildings, appliances and thermal comfort standards in India, or any developing country.

This project presents a life-cycle assessment representing all residential building types in India - formal, semi-formal and informal. The semi-formal typology is hitherto missing from building energy modeling literature. We include and model embodied phase and use-phases separately. The embodied phase study helps understand the energy demand and material demand from the building materials and construction. In the use-phase study, we create detailed models of all residential building typologies, and simulate cooling energy demand results for the city of Mumbai. We study building clusters, to account for the heat transfer and shading effects from the crowded urban environment in India. We also model realistic cooling appliances commonly used in Indian households, like fans and water-based coolers, in addition to air conditioners, and more representative cooling behaviour.

For the first time in this Indian residential life-cycle assessment study, we define three

representative typologies for Indian residential buildings. We study clusters and model real appliances used in these homes. We explore some simple material efficiency and energy efficiency strategies through different envelopes, appliances and usage. The goal of this study is to create a preliminary model of what buildings in India are like, and understand how their life-cycle energy demands differ, and some simple options to reduce this demand.