Title: Opportunities for carbon avoidance in building cycle renovations: A case study of PVC roofing membranes

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Abstract (300 – 400 words):

With the increasing efforts towards a circular economy and reducing carbon emissions globally, there has been an emphasis on end-of-life recovery and value extension practices such as repair, refurbishment, and recycling to replace direct landfilling. One sector where carbon reduction is particularly crucial is the built environment, which globally comprises 15% of carbon emissions from materials and construction. Embodied emission reduction efforts are targeting not only new construction but also building renovations. This includes assessing the impacts associated with routinely replaced building materials. In these renovations, it is essential to understand the embodied emissions of the incoming material (information increasingly available through documentation such as environmental product declaration–EPD) as well as the carbon emissions of the material being removed from the buildings. The carbon impact of the latter depends largely on the chosen end-of-life recovery pathway. Consequently, the building owners and other stakeholders of the renovation process must understand the carbon emissions of different end-of-life pathways to select the most advantageous alternative. This paper presents the quantification of the carbon avoidance potential of alternative end-of-life pathways for routinely replaced materials by comparing them to the carbon emissions of business-as-usual practice. Specifically, we examine the potential for carbon avoidance through recycling PVC single-ply roofing membranes of commercial buildings as a case study. First, we identify possible closed- and open-loop recycling pathways for this material and characterize the process steps involved. Then, we compile the relevant process data from representative EPDs, the U.S. Life Cycle Inventory (USLCI), and PVC recyclers. Using this data, we estimate the carbon avoidance potential of recycling these membranes when compared to the business-as-usual scenario of landfilling. Preliminary results show that closed-loop recycling and open-loop recycling of PVC roofing membranes can result in considerable carbon avoidance. This process characterization and analysis can aid engineers, designers, and built environment practitioners as they perform life cycle assessments (LCAs) for building plans and support end-of-life management decision-making during cycle renovations. More broadly, this work highlights the environmental utility of expanding recycling infrastructure for PVC membrane products and provides a case study for firms seeking to adopt carbon avoidance quantification.