Materials recycling in China not enough to reach net-zero emissions – reduced demand must play a role

Recycling bulk materials can realize significant GHG savings but China case study shows that circular economy strategies are needed to reach net zero emission targets.

Based on L. Song et al. China's bulk material loops can be closed but deep decarbonization requires demand reduction. *Nature Climate Change.* https://doi.org/10.1038/s41558-023-01782-6 (2023)

The Policy Problem

Bulk materials, such as cement, steel, aluminum, and glass, are the backbone of modern life, and are essential for building, transportation, technology, and more. However, production of bulk materials accounts for ~70% of global industrial CO_2 emissions. Decarbonizing bulk materials production is a unique challenge – industrial processes require high temperatures and complex chemical reactions, and polluting infrastructure, once installed, lasts decades. Recycling eliminates GHG emissions from materials production but these savings are partially offset by emissions created in the recycling process. Additionally, some materials such as plastics are difficult to recycle. To reach net-zero, materials recycling must be accompanied with a reduction in demand. This study explores strategies for a circular economy including measures that reduce demand for bulk materials.

Key findings and proposed solutions

- Bulk materials recycling alone falls short of net-zero emission targets due to economic challenges and thermodynamic constraints.
- Circular economy strategies such as improved scrap recovery, more intensive material use, and lifetime extension are necessary for deep decarbonization.
- China could source most of its bulk material through recycling by 2060 with the implementation of key strategies that reduce primary material demand.

What We Found

Three circular economy strategies were projected to be effective in reducing GHG emissions from bulk materials production in China from 2019-2060: improve scrap recovery, more intensive material use, and lifetime extension. Improved scrap recovery increases the quantity and quality of recycled materials and was projected to reduce GHG emissions 10% compared to the baseline scenario. More intensive material use strategies aim to reduce the materials needed to provide the same utility, such as lighter cars or more efficient buildings. These strategies contributed to 21% of GHG savings. Extending the lifetime of materials reduced GHG emissions by 3%. Importantly, more intensive use and lifetime extension reduce GHG emissions by reducing overall demand and slowing down the turnover of the materials that exist in cars, buildings, and other infrastructure. In total, these circular economy strategies would reduce cumulative GHG emissions by 66% from 2019 to 2060.

Our results reveal that materials recycling has the greatest GHG savings potential for metals while more intensive use and lifetime extension may be more promising strategies for difficult-to-recycle materials like cement, glass, and plastics. However, the analysis highlights that materials recycling alone is insufficient, and that demand reduction is essential for deep decarbonization. Circular economy strategies that minimize bulk material turnover must be pursued by researchers and policymakers.

What We Did

We developed an integrated modeling framework using the provincial material stocks and flows database for China.[1] This database keeps track of 13 bulk materials and 103 product types, collectively accounting for 80% of all bulk materials produced in China during 1978-2018. With these datasets, we investigated patterns of bulk materials production, use, stocks, and disposal across China's provinces. We explored the viability of creating a closed-loop system for bulk materials and its potential contribution toward achieving net-zero emissions for bulk materials in China from 2019 to 2060.

[1] China was chosen as a case study because of the large volume of bulk materials it produces and the diverse development rates that exist across provinces, serving as a model for countries at different development stages.

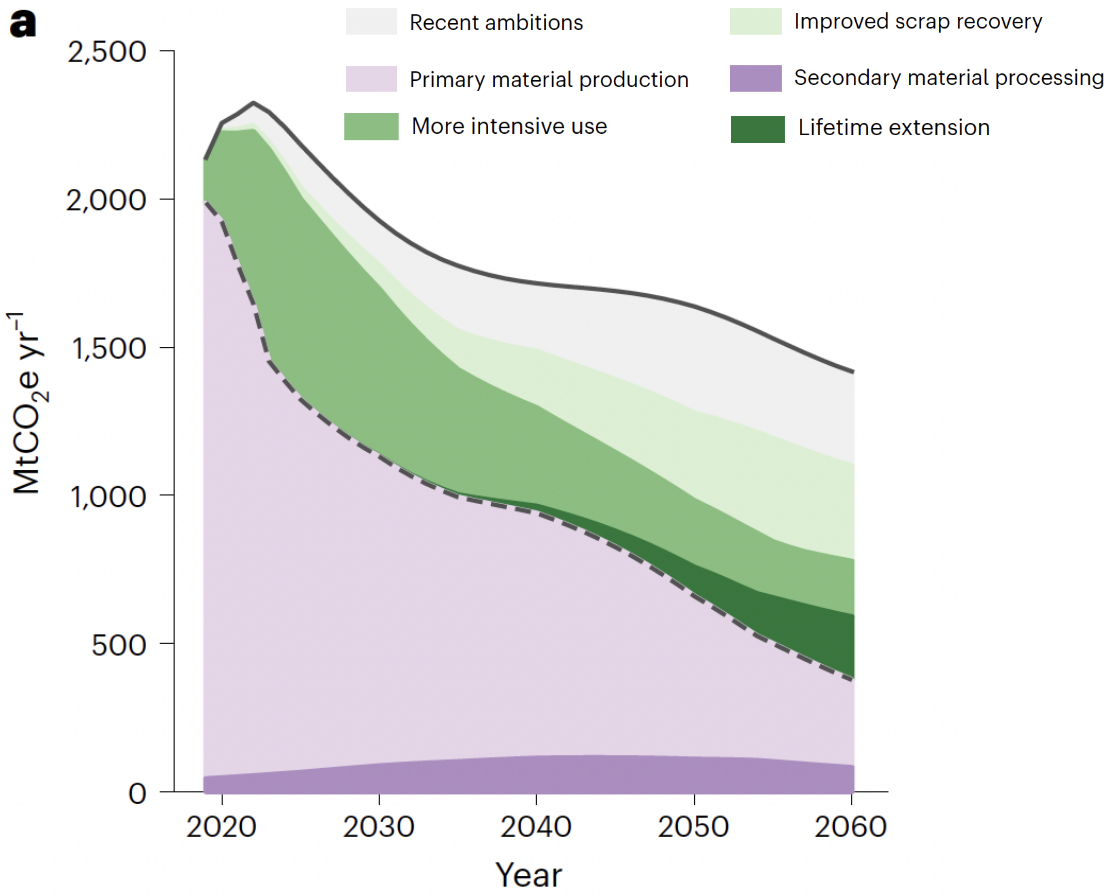

Fig. 1 Materials flows and savings for a circular economy scenario.