REMADE INSTITUTE

SYSTEMS ANALYSIS OF TECH & MARKETS FOR PAPER RECYCLING

A model captures how changes in the supply of different fibers can affect the prospects for recycling more paper in the United States.

In paper recycling, certain types of fibers have far higher recycling rates than others. While the overall U.S. rate for paper and paperboard is 68%, certain types far exceed this rate. More than 91% of cardboard boxes, for example, were recycled in 2021.[1] But other types of recyclable material can fall through the cracks.

Improvements in the range of available waste pulp and paper will raise the general domestic paper recycling rate even higher. Which advances in technology and systems will enable a more energy-efficient and more circular economy to emerge for fibers in the next decade? Researchers at the Massachusetts Institute of Technology (MIT), working with the American Forest & Paper Association (AFPA) and WestRock, a packaging solutions company, have built a systems analysis tool to provide answers to this question.

The team's model quantifies the implications of trends in three areas: new fiber recovery technologies; changes in the materials market, such as shifts in recovery strategy; and interactions among materials from multiple product systems.

PROJECT DESCRIPTION

This project provides a tool that can quantitatively assess proposed strategies to achieve meaningful boosts in the recovery and reuse of waste pulp and paper. It accounts for the system-wide shifts in recovered fiber that result from changes in quality requirements and specifications of materials recovered. This kind of analysis can help identify how to prioritize actions that can make fiber recovery systems more efficient.

To start, the team assembled and adapted life-cycle inventory data and other material flow information for all fiber market products to calculate the material efficiency, embodied energy, and emissions for fiber production that incorporates recovered materials.

Next, the researchers developed representative scenarios for the model to capture. These included: 1) incremental increases in material yield based on single stream recovery coupled with increasing average recovered fiber content of a product, including printing and writing, containerboard, paperboard, and tissue products; 2) a decrease in yield (and increase in quantity) of mixed paper percentage (for example, using lower-quality material that was previously shipped abroad); and 3) the increase in demand for containerboard from the boom in e-commerce sales, which causes a shift in containerboard destination toward residential areas and affects the amount of containerboard that can be collected.

Next, basic process models were developed for recovery technologies, including information on yield, capacity, and economics, that prove promising for the pulp and paper industry. The modules for the scenarios and recovery technologies were integrated into the model, compared with other external models, and reconciled with differing results.

[1] American Forest & Paper Association. "Unpacking Continuously High Paper Recycling Rates." May 23, 2022. https://www.afandpa.org/news/2022/unpacking-continuously-high-paper-recycling-rates. Accessed July 17, 2023.

PROJECT NUMBER: 18-02-SA-05

PROJECT IMPACT

The pulp and paper industry require sufficient raw material from both primary and secondary sources to meet production requirements. But innovations in paper recovery and reuse require quantitative analysis and assessment to reach scale. Modeling every individual factory in the domestic pulp and paperboard sector is not feasible. Instead, this project creates representation of the market that incorporates market segment (i.e., end-use or type of product), use of secondary materials (in percentage and grade), and, if needed, other characteristics such as composition.

NEXT STEPS

The project team is ensuring that the practical outcomes of this project are available to industry and other researchers. The model is being integrated with the U.S. Environmental Protection Agency's Forest and Agricultural Sector Optimization Model Greenhouse Gas Version and the agency's Waste Reduction Model WARM model, as well as the National Renewable Energy Laboratory's "Materials Flows through Industry" tool.

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PUBLICATIONS

Olivetti, E. and Baidoo, J. *Identifying strategies to maximize the benefit of fiber recovery through systems quantification: Final Report for REMADE Project: 18-01-SA-05*. April 2022.

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Office of ENERGY EFFICIENCY & RENEWABLE ENERGY

Acknowledgment: "This material is based upon work supported by the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy (EERE) under the Advanced Manufacturing Office Award Number DE-EE0007897."