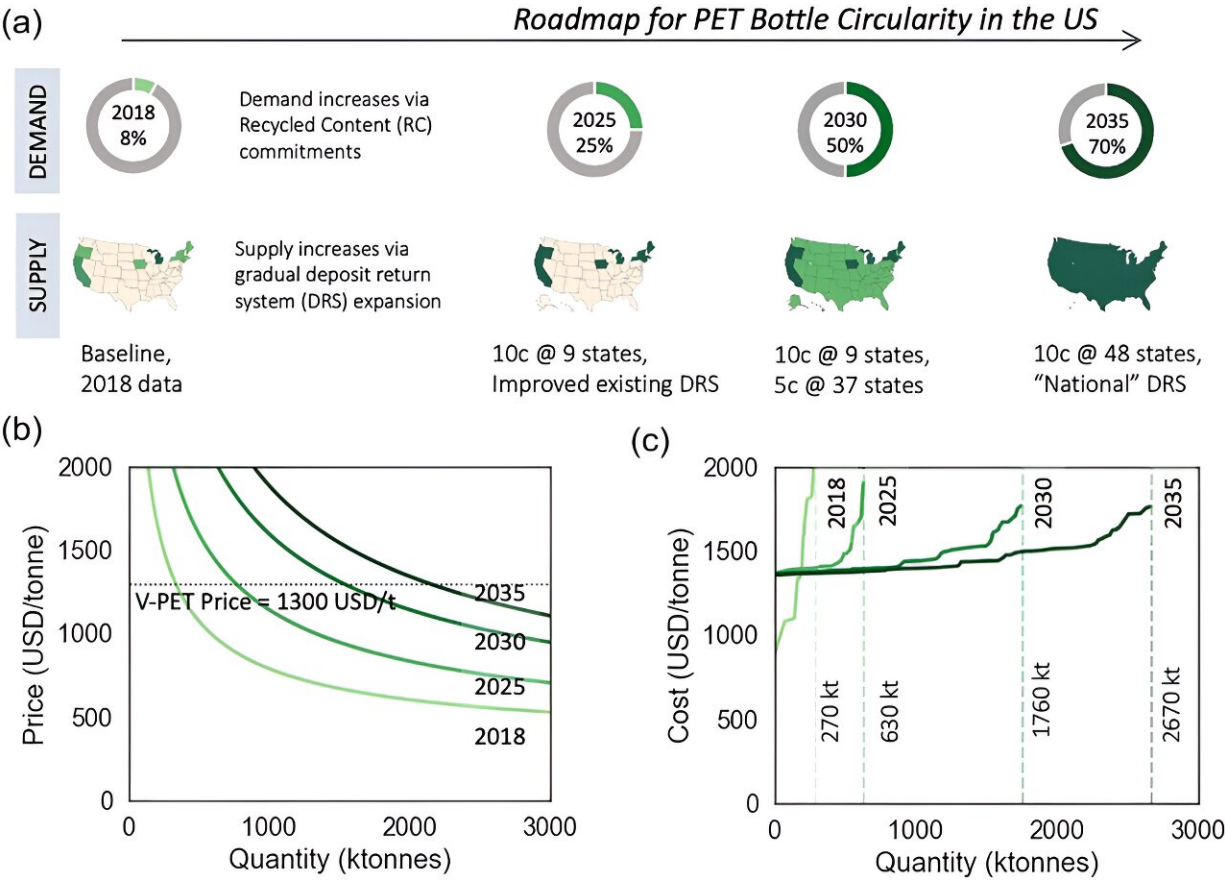


How to increase the rate of plastics recycling

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Roadmap for polyethylene terephthalate (PET) bottle circularity in the United States. (a) Circularity roadmap includes recycled content targets and staged deposit return systems (DRS) expansion to 48 contiguous states in the United States. (b) Demand evolution based on increasing recycled content targets. (c) Deposit supply curves for DRS expansion scenarios. Credit: *Journal of Industrial Ecology* (2024). DOI: 10.1111/jiec.13496

While recycling systems and bottle deposits have become increasingly widespread in the U.S., actual rates of recycling are "abysmal," according to a team of MIT researchers who studied the rates for recycling of PET, the plastic commonly used in beverage bottles. However, their findings suggest some ways to change this.

The present rate of recycling for PET, or polyethylene terephthalate, bottles nationwide is about 24% and has remained stagnant for a decade, the researchers say.

But their study indicates that with a nationwide [bottle](#) deposit program, the rates could increase to 82%, with nearly two-thirds of all PET bottles being recycled into new bottles, at a net cost of just a penny a bottle when demand is robust. At the same time, they say, policies would be needed to ensure a sufficient demand for the recycled material.

The findings are [published](#) in the *Journal of Industrial Ecology*, in a paper by MIT professor of materials science and engineering Elsa Olivetti, graduate students Basuhi Ravi and Karan Bhuwalka, and research scientist Richard Roth.

The team looked at PET bottle collection and recycling rates in different states as well as other nations with and without bottle deposit policies, and with or without curbside recycling programs, as well as the inputs and outputs of various recycling companies and methods.

The researchers say this study is the first to look in detail at the interplay between public policies and the end-to-end realities of the packaging production and recycling market.

They found that bottle deposit programs are highly effective in the areas where they are in place, but at present there is not nearly enough collection of used bottles to meet the targets set by the packaging

industry. Their analysis suggests that a uniform nationwide bottle deposit policy could achieve the levels of recycling that have been mandated by proposed legislation and corporate commitments.

The recycling of PET is highly successful in terms of quality, with new products made from all-[recycled material](#) virtually matching the qualities of virgin material. And brands have shown that new bottles can be safely made with 100% postconsumer waste.

But the team found that collection of the material is a crucial bottleneck that leaves processing plants unable to meet their needs. However, with the right policies in place, "one can be optimistic," says Olivetti, who is the Jerry McAfee Professor in Engineering and the associate dean of the School of Engineering.

"A message that we have found in a number of cases in the recycling space is that if you do the right work to support policies that think about both the demand but also the supply," then significant improvements are possible, she says.

"You have to think about the response and the behavior of multiple actors in the system holistically to be viable," she says. "We are optimistic, but there are many ways to be pessimistic if we're not thinking about that in a holistic way."

For example, the study found that it is important to consider the needs of existing municipal waste-recovery facilities.

While expanded bottle deposit programs are essential to increase recycling rates and provide the feedstock to companies recycling PET into new products, the current facilities that process material from curbside recycling programs will lose revenue from PET bottles, which are a relatively high-value product compared to the other materials in the

recycled waste stream.

These companies would lose a source of their income if the bottles are collected through deposit programs, leaving them with only the lower-value mixed plastics.

The researchers developed [economic models](#) based on rates of collection found in the states with deposit programs, recycled-content requirements, and other policies, and used these models to extrapolate to the nation as a whole.

Overall, they found that the supply needs of packaging producers could be met through a nationwide bottle deposit system with a 10-cent deposit per bottle—at a net cost of about 1 cent per bottle produced when demand is strong. This need not be a federal program, but rather one where the implementation would be left up to the individual states, Olivetti says.

Other countries have been much more successful in implementing deposit systems that result in very high participation rates. Several European countries manage to collect more than 90% of PET bottles for recycling, for example. But in the U.S., less than 29% are collected, and after losses in the recycling chain about 24% actually get recycled, the researchers found. Whereas 73% of Americans have access to curbside recycling, presently only 10 states have bottle deposit systems in place.

Yet the demand is there so far. "There is a market for this material," says Olivetti. While bottles collected through mixed-waste collection can still be recycled to some extent, those collected through deposit systems tend to be much cleaner and require less processing, and so are more economical to recycle into new bottles, or into textiles.

To be effective, policies need to not just focus on increasing rates of

recycling, but on the whole cycle of supply and demand and the different players involved, Olivetti says.

Safeguards would need to be in place to protect existing [recycling](#) facilities from the lost revenues they would suffer as a result of bottle deposits, perhaps in the form of subsidies funded by fees on the bottle producers, to avoid putting these essential parts of the processing chain out of business.

And other policies may be needed to ensure the continued market for the material that gets collected, including recycled content requirements and extended producer responsibility regulations, the team found.

At this stage, it's important to focus on the specific waste streams that can most effectively be recycled, and PET, along with many metals, clearly fit that category. "When we start to think about mixed plastic streams, that's much more challenging from an environmental perspective," she says.

"Recycling systems need to be pursuing extended producers' responsibility, or specifically thinking about materials designed more effectively toward recycled content," she says.

It's also important to address "what the right metrics are to design for sustainably managed materials streams," she says. "It could be energy use, could be circularity [for example, making old bottles into new bottles], could be around waste reduction, and making sure those are all aligned. That's another kind of policy coordination that's needed."

More information: R. Basuhi et al, Evaluating strategies to increase PET bottle recycling in the United States, *Journal of Industrial Ecology* (2024). [DOI: 10.1111/jiec.13496](https://doi.org/10.1111/jiec.13496)

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