

# A wholly sustainable plastics economy is feasible, shows study

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Plastic is everywhere. Our society cannot do without it: plastics have numerous advantages, are extremely versatile, and are also cost effective. Today, plastics are mainly produced from crude oil. When the products reach the end of their life, they often end up in a waste incineration plant. The energy-intensive production of plastics and their incineration release large amounts of CO<sub>2</sub> into the atmosphere, making plastic products a major contributor to climate change.

One way out would be to rely on sustainable production methods, such as the [circular economy](#), in which as much plastic as possible is recycled. Then the main raw material for plastic products would no longer be crude oil but shredded plastic waste. But is it even possible to tweak the [plastics](#) economy to absolute sustainability?

Yes, it is, according to a new study led by André Bardow, Professor of Energy and Process Systems Engineering at ETH Zurich. Gonzalo Guillén Gosálbez, Professor of Chemical Systems Engineering at ETH Zurich, and researchers from RWTH Aachen University and the University of California, Santa Barbara collaborated on the study. The research is published in the journal *Nature Sustainability*.

## **Massively increased recycling rate needed**

The scientists looked at the complete value chains of the 14 most common types of plastics, including polyethylene, polypropylene and polyvinyl chloride. These 14 bulk plastics account for 90% of the plastic products manufactured worldwide.

In their study, the researchers investigated for the first time whether it is possible for the plastics industry to respect planetary boundaries. These are a measure of comprehensive sustainability. They go beyond energy and climate issues to include, for example, impacts on land and water resources, ecosystems and biodiversity. In short: processes that adhere to

planetary boundaries can be sustained over the long term without depleting the Earth's resources.

The study finds that circular plastics are feasible within planetary boundaries. This would require at least 74% of the plastic to be recycled. By way of comparison, only around 15% is recycled in Europe today, and the rate is likely to be much lower in other regions of the world. In addition, the study finds that [recycling](#) processes would have to be improved. Specifically, plastics recycling would have to become as efficient as other chemical processes already are today. As things currently stand, not all plastics can be recycled. In the case of polyurethanes used as foams, for example, recycling has yet to be established—a question Professor Bardow is also addressing.

For the remaining maximum 26% of plastics, the carbon needed for production could be sourced using two other technologies, according to the study: on the one hand, CO<sub>2</sub> captured from combustion processes or from the atmosphere (known as [carbon capture](#) and utilization or CCU), and on the other hand, from biomass. "Recycling alone won't do it; we need all three pillars," Bardow says.

"Increasing the recycling rate to 74% worldwide is a very ambitious goal," Bardow admits. As such, it is unlikely to be achieved by 2030, but 2050 is more realistic. Another challenge, however, is that more plastic products are currently being manufactured year after year. If the current trend continues until 2050, it won't be enough to simply improve recycling processes, as planetary boundaries would still be exceeded in 2050.

That is why the study's authors suggest also addressing demand as well as assigning a different value to plastic. "Plastic is considered cheap, which for a long time was a blessing but has now become a curse," Bardow says. "Given its outstanding properties, we should view plastic as the

high-quality material it truly is. That way, it would be okay for it to cost a little more, and its recycling, too."

## A fuller understanding of product stewardship

In the study, the scientists point out that [plastic products](#) must be better aligned with the circular economy in future. To this end, manufacturers should work more closely with recyclers. According to the study's authors, it would be desirable if plastics manufacturers had a wider understanding of the responsibility they hold: Today, responsibility often ends where the product leaves the factory gates. The scientists therefore call for product stewardship to encompass the entire life cycle—including disposal and recycling—as the basis for optimizing the design of sustainable processes.

In any case, pushing recycling is the right way to go: given that it has no serious disadvantages, it should be treated as a special case in the transformation of the economy toward sustainability. In many other areas, conflicting goals arise. Take, for example, the production of synthetic fuels, which is extremely energy-intensive, or the use of biomass, which competes with food production. Recycling plastic, on the other hand, does not lead to such a conflict of goals. "Recycling efforts should be intensified wherever possible," Bardow says. "As a good rule of thumb: More recycling of plastic always leads to more sustainability."

**More information:** André Bardow, Towards circular plastics within planetary boundaries, *Nature Sustainability* (2023). [DOI: 10.1038/s41893-022-01054-9](https://doi.org/10.1038/s41893-022-01054-9).  
[www.nature.com/articles/s41893-022-01054-9](https://www.nature.com/articles/s41893-022-01054-9)

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