

**GREENPEACE**



# **FOREVER TOXIC**

**THE SCIENCE ON  
HEALTH THREATS  
FROM PLASTIC  
RECYCLING**



Wastesorting at a recycling plant, Sterlitamak, Russia, 10 January 2019. © Shutterstock

**Without dramatically reducing plastic production, it will be impossible to end plastic pollution and eliminate the health threats from chemicals in plastics.**



Babies chew plastic toys. © pviia / Shutterstock

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**PLASTICS ARE  
INHERENTLY  
INCOMPATIBLE  
WITH A  
CIRCULAR  
ECONOMY**

Pumpjack in Colorado © Les Stone / Greenpeace

# EXECUTIVE SUMMARY

The global Greenpeace<sup>1</sup> network is advocating for an ambitious, legally binding Global Plastics Treaty that accelerates and provides the conditions needed for a just transition away from dependence on plastic. The Treaty should promote safer, toxics-free materials and reuse-based, zero-waste economies, creating new jobs to support these practices, protecting human and planetary health, minimizing resource use, and delivering a just transition for workers and affected communities across the plastics supply and waste chains.

Without dramatically reducing plastic production, it will be impossible to end plastic pollution and eliminate the health threats from chemicals in plastics. The Treaty must cap and reduce plastic production, and establish a pathway to end virgin plastic production.

A key obstacle is the plastics industry, including fossil fuel, petrochemical, and consumer goods companies, which continues to put forward plastic recycling and recycled content as central solutions to the plastic pollution crisis. The reality is that fewer than 10% of

all plastics ever produced have been recycled.<sup>2</sup> This revelation leads many to promote higher recycling targets as the best way to resolve the global plastic crisis. For example, the members of the U.S. Plastics Pact lobby for the recycling and “circular use” of plastics, distracting attention from the need for massive reductions in global plastic production and shifting the burden of dealing with plastic waste away from themselves as the producers and onto the public.

Many consumer goods companies, including Nestlé, Unilever, and Coca-Cola, tout the use of recycled plastic in their packaging as an important part of the solution, while failing to achieve significant reductions of overall plastic use, and in some cases increasing plastic use, or meaningful gains in reuse. But the reality is that most plastics collected for recycling are never recycled - and when plastics are recycled, they contain a toxic cocktail of chemicals that makes them unfit for food-grade and other consumer uses. **In fact, plastics are inherently incompatible with a circular economy.**

Coca-Cola bottles © Paul Hamilton



© Fairfax Media / Getty Images



# DANGEROUS CHEMICALS IN RECYCLED PLASTIC: THE THREE POISONOUS PATHWAYS

Dangerous chemicals make their way into recycled plastic materials from a variety of sources. Since nearly all plastics are made from a combination of carbon (mainly oil/gas) and toxic chemicals, the most obvious pathway is direct contamination, as chemicals from the original plastic products simply transfer into recycled plastic. But chemicals can also enter recycled plastics in other ways, due to contamination in the plastic waste stream and the recycling process itself.

The three uncontrollable poisonous pathways of plastic recycling are:

- 1. Toxic chemicals in new virgin plastic materials:**  
When plastics are made with toxic chemicals and then recycled, the toxic chemicals can transfer into the recycled plastics.
- 2. Leaching of toxic substances into plastic waste:**  
Numerous studies show that plastics can absorb contaminants via direct contact and through the absorption of volatile compounds.<sup>3</sup> When plastics are tainted by toxins in the waste stream and the environment and are then recycled, they produce recycled plastics that contain a stew of toxic chemicals. For example, plastic containers for pesticides, cleaning solvents, and other toxic chemicals that enter the recycling chain can result in contamination of recycled plastic.
- 3. New toxic chemicals created by the recycling process:** When plastics are heated in the recycling process, this can generate new toxic chemicals that make their way into the recycled plastics. For example, brominated dioxins are created when plastics containing brominated flame retardants are recycled,<sup>4</sup> and a stabilizer used in plastic recycling can degrade to a highly toxic substance found in recycled plastics.<sup>5</sup> Sorting challenges and the presence of certain packaging components in sorted materials can also lead to toxicity in recycled plastic. Studies have shown that benzene (a carcinogen) can be created by mechanical recycling of PET#1 plastic, even with very low rates of contamination by PVC#3 plastic, resulting in the cancer-causing chemical being found in recycled plastics.<sup>6</sup>

# PLASTIC RECYCLING'S UNCONTROLABLE POISONOUS PATHWAY

1



TOXIC  
CHEMICALS  
IN NEW  
VIRGIN  
PLASTIC  
MATERIALS



3



NEW TOXIC  
CHEMICALS  
CREATED BY  
THE RECYCLING  
PROCESS

2



LEACHING  
OF TOXIC  
SUBSTANCES  
INTO PLASTIC  
WASTE

# THE HUMAN ENDOCHRINE SYSTEM

The hormones released by the endocrine system control many important functions in the body, including growth and development, metabolism, and reproduction. Because of the endocrine system's critical role in so many important biological and physiological functions, impairments in any part of the endocrine system can lead to disease or even death.





# RECYCLING PLASTICS = RECYCLING TOXIC CHEMICALS

Plastics are made with as many as 13,000 chemicals, and researchers say 3,200 of these are chemicals of concern (while many more have never been assessed and may also be toxic).<sup>7</sup> While virgin plastics contain unknown and untested harmful chemicals, studies show that recycled plastics often contain higher levels of chemicals that can poison people and contaminate communities.<sup>8</sup> Chemicals in recycled plastics have been linked to cancer, cardiovascular disease, obesity, and other health issues.<sup>9</sup>

It is important to understand that not only are people exposed to toxic chemicals from the production and use of virgin plastic, they are also exposed to toxic chemicals by plastic recycling throughout the recycling stream:

- When plastics are exported under the guise of recycling, they are often dumped or burned, leading to environmental and food chain contamination.
- Workers and their communities are exposed to toxic chemicals from plastics they collect, sort, and dismantle for recycling. Plastic recycling areas should be regulated as facilities that handle hazardous waste and like contaminated sites that release hazardous chemicals.
- Recycled plastic products expose consumers to toxic chemicals, including chemicals that have been globally banned. Recycling can combine toxic chemicals from different plastics and create new hazardous chemicals, all of which end up in recycled plastic products.

## WHEN PLASTIC WASTE IS HIGHLY TOXIC POPS WASTE

Persistent organic pollutants (POPs) are among the world's most toxic chemicals, regulated globally under the Stockholm Convention, as is waste containing POPs. The Convention sets a concentration limit for each POP, called the Low POP Content Level (LPCL), and any plastic waste that contains one or more POPs above the LPCL threshold is defined as POPs waste. Common plastics with intentionally added POPs include electronics, vehicle and aircraft plastic interiors, and synthetic textiles in furniture, carpets, and other floor coverings, among other products. Under the Convention, Parties must destroy and must not recycle POPs waste (with some exceptions if the POPs can be removed and managed separately). But current LPCLs are not strong enough to prevent recycling of plastic POPs waste, so, as several studies below show, many recycled plastic products have been found with high levels of these highly toxic POPs.

Interior of airplane © Juan Manuel Aparicio Diez. Shutterstock



# THE SCIENCE ON CHEMICAL THREATS FROM PLASTIC RECYCLING: ENVIRONMENT AND FOOD

A broad range of studies demonstrate how people and the environment can be poisoned by plastic recycling.

## RECYCLED PLASTICS CAN CONTAMINATE THE ENVIRONMENT AND FOOD CHAINS:

A 2013 report<sup>10</sup> in *Nature* recommended regulating plastic waste as hazardous waste, including waste presumably intended for recycling, noting threats to the environment, food chains, and health. The article noted that wildlife that consumes plastics can be harmed by toxic chemicals in these products, with previous research showing such threats to all sea turtle species, 45% of marine mammal species, and 21% of seabird species. The authors state, "As plastic (waste) breaks into smaller pieces, it is more likely to infiltrate food webs."

A 2013 study<sup>11</sup> found harmful air-polluting chemicals around and inside plastic recycling facilities in China, with potential health impacts on workers and local residents. Concentrations of harmful chemicals near the facilities were higher than those at a reference site.

Two studies<sup>12</sup> from China found high levels of plastic flame retardant chemicals in soils, sediment, and road dust near plastic recycling facilities compared to low levels in samples from areas where no plastic recycling takes place.

A 2021 study<sup>13</sup> by the International Pollutants Elimination Network (IPEN) and Arnika analyzed 35 pooled free-range chicken egg samples and 1 individual egg sample from 25 locations worldwide for certain persistent organic pollutants. Eggs produced around e-waste and plastic waste recycling yards were among the most contaminated samples in the study.





1. Plastic wrapped apples in a Hong Kong supermarket © Patrick Cho / Greenpeace 2. Municipal collection of recycling © Dmitry Kalinovsky / Shutterstock 3. Plastic in a landfill in China © Greenpeace / Yat Yin 4. Fish that ingested microplastic © The 5 Gyres Institute 5. Garbage next to rice fields in China © Rumba a lo desconocido / Shutterstock 6. Microplastics pollution from the river Rhine in Germany © Oliver Tjaden / Greenpeace 7. Cooking with eggs © fizkes / Shutterstock



# THE SCIENCE ON CHEMICAL THREATS FROM PLASTIC RECYCLING: **POISONING WORKERS AND COMMUNITIES**

## **RECYCLED PLASTICS CAN POISON WORKERS AND COMMUNITIES:**

A 2015 study<sup>14</sup> found that workers in plastic recycling workshops face health risks from volatile organic compounds produced by recycling processes, with some workers facing an increased cancer risk.

A 2020 study<sup>15</sup> of plastic recycling workers (waste pickers) in the Gaza Strip found that most had been exposed to hazardous materials in the previous 12 months, and most reported occupational illnesses.

A 2021 study<sup>16</sup> of Vietnamese recycling concluded that “the typical processes for plastic recycling in craft villages come along with health risks for workers and neighbors and a high potential of environmental pollution.”

A 2022 Human Rights Watch report<sup>17</sup> documented the health impacts of plastic recycling facilities in Turkey, finding that recycling workers and nearby residents can be exposed to harmful chemicals when they inhale toxic dust or fumes. This poses risks of life-long health conditions, including cancer and reproductive harm.

A 2023 IPEN study<sup>18</sup> found the plastic flame retardant chemical Dechlorane Plus (DP) in the blood, food, and surroundings of home-based recycling workers. Blood testing of one plastic recycling worker in Thailand found a level of DP nearly 280 times higher than the trace levels found in farm workers who lived 15 km from the recycling operations.





1. Recycled plastic in India © PradeepGaur / Shutterstock 2. A trash collector working in a waste collection facility in Istanbul, Turkey. © Sahan Nuhoglu / Shutterstock 3. Electronic waste recycling plant in Turkey © OVKNHR / Shutterstock 4. Volunteer wearing gloves to handle plastic sorting work at a plastic recycling plant. © Greenpeace

# THE SCIENCE ON CHEMICAL THREATS FROM PLASTIC RECYCLING: PRODUCTS POISONING CONSUMERS

## RECYCLED PLASTIC PRODUCTS CAN POISON CONSUMERS:

A 2015 study<sup>19</sup> by researchers from Czechia and Germany found that recycled plastics used in food packaging and other products contained toxic flame retardants, including banned POPs, with potential health impacts on children and consumers.

A 2017 study<sup>20</sup> found high levels of toxic flame retardants in toys and other recycled plastic products purchased in the EU, with one child's toy containing levels of a regulated chemical nine times higher than EU safety limits.

A 2018 study by IPEN, Arnika, the Health and Environment Alliance, and BUND<sup>21</sup> found high levels of dioxins in recycled plastic products, including toys, from seven countries on four continents. The levels were similar to those found in some hazardous wastes, such as waste incineration ash, and in half of the products exceeded proposed limits for chlorinated dioxin in hazardous waste.

A 2021 IPEN study<sup>22</sup> analyzed recycled plastic pellets purchased from 24 recycling facilities in 23 countries. Testing showed that all of the pellets contained at least one toxic chemical and 21 samples contained all three types of chemicals tested for, including endocrine-disrupting chemicals and chemicals with links to neurotoxicity, cytotoxic effects, and cardiovascular impacts. Noting that recycled pellets are often made into toys and other products for children, the report warned that its results "raise concerns about potential health impacts and exposure of vulnerable populations such as children."

A 2020 study<sup>23</sup> found high levels of highly toxic dioxins in recycled plastic toys, three of which were found to be "as contaminated as hazardous waste" under the Stockholm Convention's limits. It also estimated daily

ingestion of toxic chemicals from children's mouthing habits, finding that the "contribution of the ingestion of contaminated black plastic to children's dioxin body burden is significant and often higher than the recommended TDI [tolerable daily intake]."

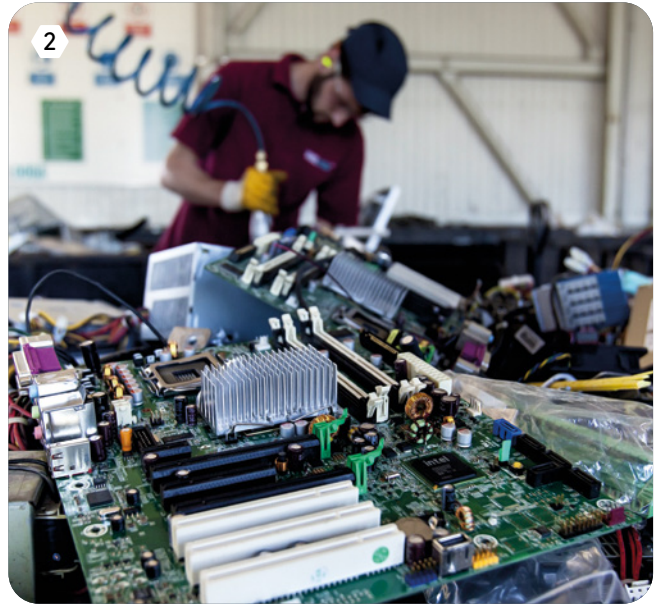
A 2022 IPEN report<sup>24</sup> summarized data on recycled plastic products from China, Indonesia, and Russia, finding that all of the products contained toxic chemicals, including substances banned under international conventions. All 73 products analyzed contained one or more globally banned flame retardant chemicals.

A 2022 study<sup>25</sup> found that recycled plastic bottles had higher concentrations of toxic chemicals than bottles made with new plastics, indicating that the recycling process can intensify chemical threats.

A 2022 study<sup>26</sup> by IPEN, Arnika, and partners in 11 African and Arabic countries found toxic chemicals in recycled plastic toys, kitchen utensils, and other products. Out of 83 products analyzed, 61 had levels of POPs that would define the products as POPs waste under limits proposed by African countries.

A 2023 study<sup>27</sup> from the Fraunhofer Institute and IES Landau tested post-consumer plastic recyclates from different European countries, finding 51 chemicals with intermediate to high toxicity risks and 30 that could not be identified (under EU law, only authorized substances can be used in food grade plastics<sup>28</sup>).

A 2023 IPEN study of recycled plastic products purchased in Kenya<sup>29</sup> found that 14 of the 18 products contained high levels of toxic flame retardants, exceeding a definition of hazardous POPs waste proposed by African countries. One sample, a toy car, was tested for brominated dioxins and contained the toxic chemicals at higher concentrations than levels found in ash from waste incineration.



1. Plastic fragments © Meaw\_stocker / Shutterstock 2. Electronic waste recycling plant in Turkey © OVKNHR / Shutterstock 3. Fruit in single use plastic packaging © monticello / Shutterstock 4. Product images of plastic bottles made by Coca-Cola, Pepsi and Nestle, three of the biggest plastic polluters. © Tim Aubry / Greenpeace 5. Child chewing on plastic toy © DeymosHR / Shutterstock



# HEALTH THREATS FROM PLASTIC RECYCLING INDUSTRY ACCIDENTS

As plastic stockpiles increase, the risk of large fires at recycling facilities is increasing, especially when facilities hold e-waste plastics with used batteries. A survey in the U.S. and Canada in 2022 found a record 390 fires in plastic recycling and waste facilities<sup>30</sup> Another project has mapped fires at plastic recycling facilities globally since 2018.<sup>31</sup> A report from Turkey noted that the number of fires at plastic recycling facilities in that country increased from 33 in 2019 to 121 in 2021, one every three days.<sup>32</sup> Similarly, in Malaysia a 2020 report noted a





doubling in fires at plastic recycling facilities over the previous year, stating that environmental health experts had warned residents that the fumes from the fires could cause respiratory problems, trigger and aggravate asthma, and cause rashes and eyesores.<sup>33</sup> Two 2017 studies<sup>34</sup> found that a 2015 fire at a plastic recycling facility in Greece released persistent carcinogenic compounds (dioxins and furans) and concluded that even short-duration releases could increase lifelong cancer risks for nearby residents. After another Greek

plastic recycling facility fire in 2020, health experts warned residents to avoid or thoroughly wash local produce due to the toxicity of chemicals released by burning plastics.<sup>35</sup> In the 12 months up to April 2023, large fires have been reported at plastic recycling facilities in Australia,<sup>36</sup> Canada,<sup>37</sup> Ghana,<sup>38</sup> Russia,<sup>39</sup> Southern Taiwan,<sup>40</sup> Thailand,<sup>41</sup> and the United Kingdom,<sup>42</sup> and in the U.S. states of Florida,<sup>43</sup> Indiana,<sup>44</sup> North Carolina,<sup>45</sup> and Nebraska<sup>46</sup> (at a plant that was producing plastic lumber from recycled plastics).]

1. A fire at a plastics recycling plant in Richmond, Indiana, forced the evacuation of 2,000 nearby residents. Credit: Kevin Shook/Global Media Enterprise. 2. Fire at plastics factory, Hull, UK 3. Black smoke rises over an explosion at a plastic factory in Thailand. © Varit Sophonpis / Shutterstock





# PLASTIC PRODUCTION FORECAST TO TRIPLE BY 2060



Drinking water in plastic jugs  
© Sergey Ryzhov / Shutterstock

# ENDING THE LOVE AFFAIR WITH PLASTIC “RECYCLED CONTENT” AND FOCUSING ON REDUCING PLASTIC PRODUCTION AND USE

Without dramatically reducing plastic production, it will be impossible to end plastic pollution. The existing discrepancy between the amount of plastic produced and the amount recycled is vast, with the Organisation for Economic Co-operation and Development (OECD) estimating that only 9% of plastic waste is recycled globally. The situation is only set to get worse as plastic production is forecast to triple by 2060, with only a minimal increase in recycling predicted.<sup>47</sup> The downstream impacts of overproduction of plastic are well documented, including harming the health of communities living near dumpsites and incinerators, evidence of prevalence of plastic in the human body, and devastation to marine life.

According to UN statistics, in 2018 approximately 6 million tonnes of plastic waste were traded internationally, largely in the form of exports of unsorted mixed plastics from high-income to low-income countries, predominantly in South and South East Asia.<sup>48</sup> A 2023 report found that this number is likely a significant underestimation, and warned that “without global policies to reduce plastic production, there will continue to be an unequal exchange of plastic wastes from high-income countries to low- and middle-income countries”<sup>49</sup> - many of them with a lower GDP than the revenue of major plastic producing companies.

Despite the devastating impacts of the overproduction of plastic and the need to accelerate refill- and reuse-based systems, the plastics industry continues to argue that the global plastic crisis can be addressed by raising national recycling targets and increasing the amount of recycled content in single-use plastic packaging. But in addition to the health concerns associated with the use of recycled plastics, increased plastic recycling means expanding toxic health and environmental threats throughout the recycling stream. These threats unequally impact the most vulnerable communities.

Instead of encouraging more toxic plastic recycling, the Global Plastics Treaty must:

- 1 **Achieve immediate, significant reductions in plastic production, establishing a pathway to end virgin plastic production.**
- 2 **Promote a shift to refill- and reuse-based economies, creating jobs and standards in new reuse industries and supporting established zero-waste practices.**
- 3 **Support a just transition for workers across the plastics supply chain, prioritizing waste pickers who collect approximately 60% of all plastic that is collected for recycling globally.**
- 4 **Promote non-combustion technologies for plastic stockpiles and waste disposal.**
- 5 **Institute the “polluter pays” principle for plastic waste management and for addressing the health and environmental costs throughout the plastics life cycle.**
- 6 **Significantly improve regulation, oversight, safety and worker protections for existing recycling facilities.**
- 7 **Require transparency about chemicals in plastics and eliminate all toxic additives and chemicals used in the plastics life cycle.**

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Activists from Greenpeace Africa hold banners in support of a Global Plastics Treaty. Ngong Hills, Nairobi, Kenya, 02/24/2022 © Paul Basweti / Greenpeace

## ENDNOTES

- 1 References to Greenpeace in this document refer to the programmatic work of the Plastic Free Future Campaign, a global campaign involving several offices across the global Greenpeace network of 26 independent organizations, including Greenpeace USA and Greenpeace International
- 2 UN Environment Programme (2021)
- 3 See e.g. Cook et al. (2023).
- 4 Petrlik et al. (2022)
- 5 Rung et al. (2023)
- 6 Alvarado Chacon et al. (2020), van Velzen et al. (2020)
- 7 UN Environment Programme & Secretariat of the Basel, Rotterdam and Stockholm Conventions (2023)
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- 9 See e.g. Ahern et al. (2022), Callaghan et al. (2020), and Heindel et al. (2022).
- 10 Rochman et al. (2013)
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- 13 Petrlik et al. (2021)
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- 45 Martin (2022)
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- 47 OECD (2022). The OECD estimates that the share of plastic waste that is recycled will increase to approximately 17% by 2060.
- 48 Cook et al. (2023)
- 49 Karlsson et al. (2023)



Greenpeace projects messages and plastic waste imagery in Uruguay as global leaders come together to discuss a Global Plastics Treaty in Punta del Este, Uruguay. © Greenpeace / Manuela Lourenço

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**GREENPEACE, INC.**

1300 Eye Street NW

Suite 1100 East

Washington, DC 20005

[www.greenpeace.org/usa](http://www.greenpeace.org/usa)

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**DESIGN**

Paul Hamilton, [weareoneanother.net](http://weareoneanother.net)