



WHITE PAPER

The Impact of Plastic Waste Reduction on Process Safety

Author: Arturo Trujillo, Global Director of Process Safety Consulting

The last few years have seen ever-increasing pressure in public opinion to minimize plastic waste—especially, the plastic residue that ends up in the oceans and gives rise to accumulations such as the infamous “Great Pacific Garbage Patch.”

Plastic Production and Process Safety

Plastics are composed of polymers derived mainly from the petrochemical industry. Along their entire production chain there are well-known process safety hazards, as schematized in Figure 1.

The question of how the trend towards a reduction in plastic waste will affect process safety is therefore a very valid one. We might expect to see slower growth in plastic production on one hand, with faster growth in activities related to alternative products or plastic management on the other. In this paper, we analyze the different options at hand for plastic waste reduction and their expected impact on process safety.

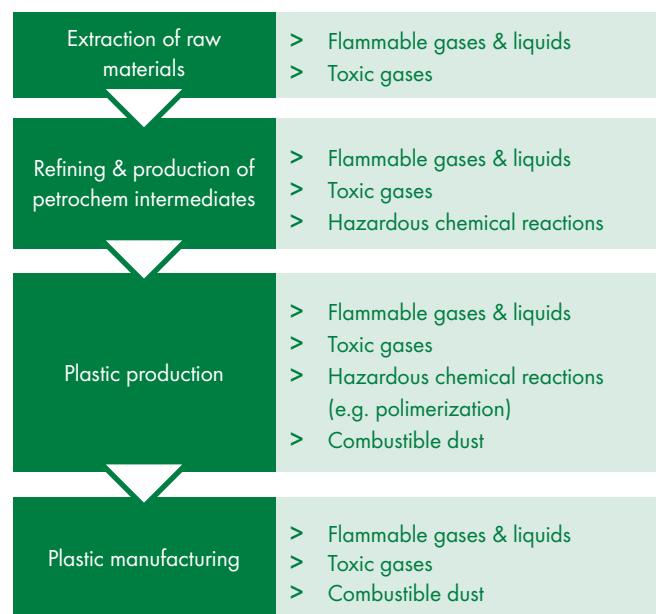


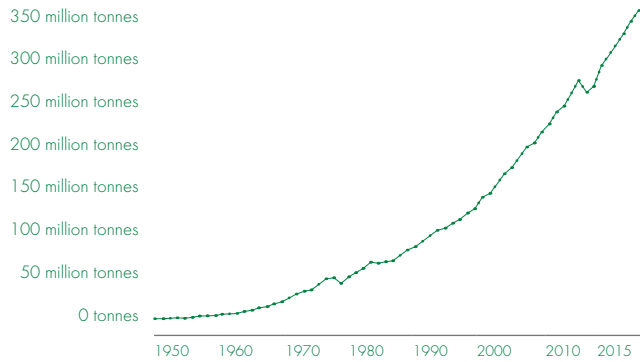
Figure 1. Main process safety hazards in the production of plastics

Where Does Plastic Waste Come From?

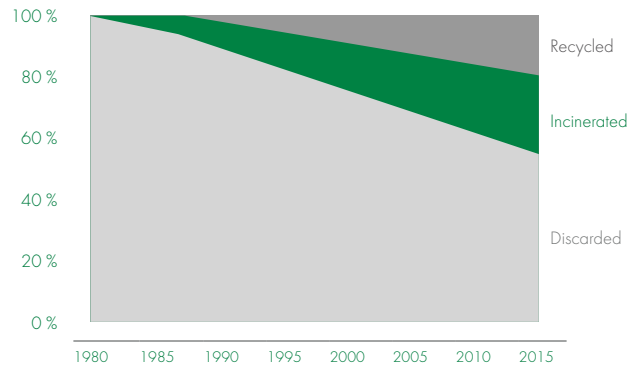
Any discussion on the affects of reducing plastic waste requires a thorough analysis of its origin and distribution. Our World in Data,

a non-for-profit organization based at Oxford University has done just that, publishing an **extensive report**, including many informative charts and maps. Figure 2 is a composite of several charts extracted from the report.

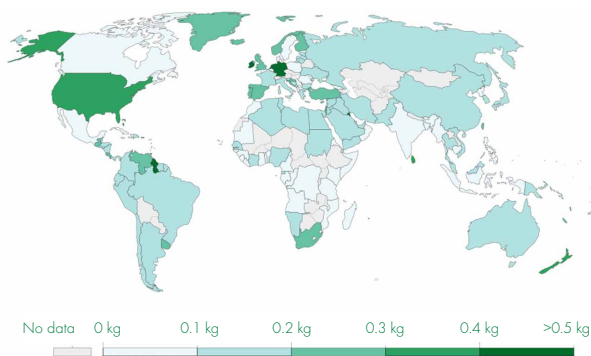
Global production of plastic and resins (1950–2015)



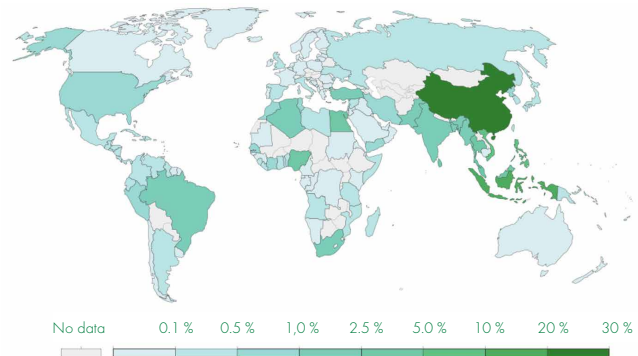
Fate of waste plastic (1980-2015)



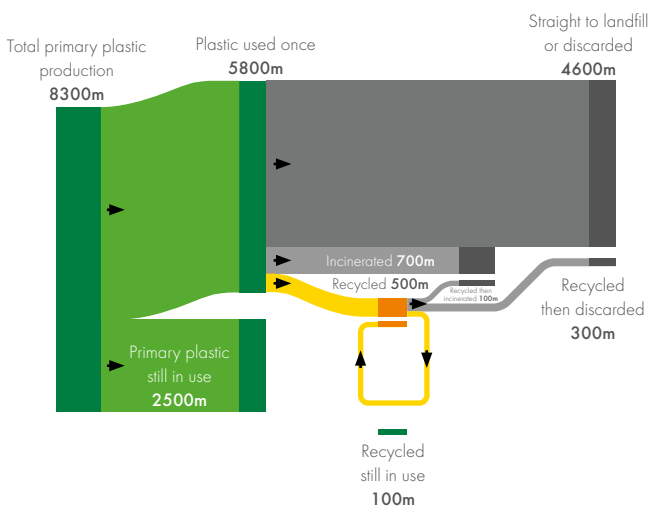
Daily plastic waste generation (kg per person per day)



Percentage of mismanaged waste (2010)



Global plastic production and its fate (1950–2015)



Plastic waste generation by industrial sector (2015)

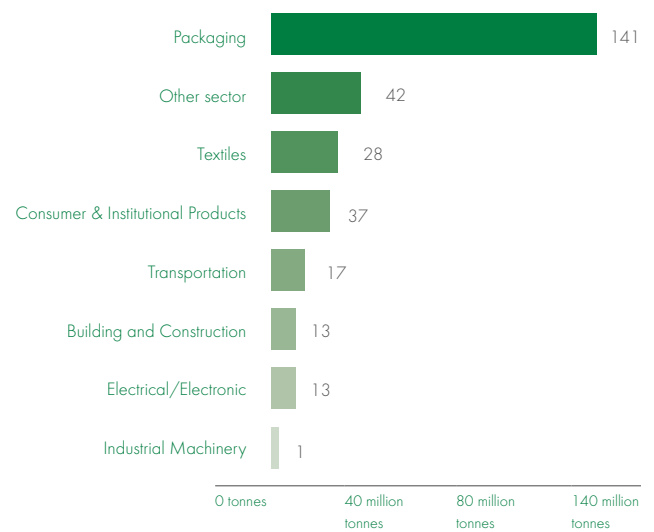


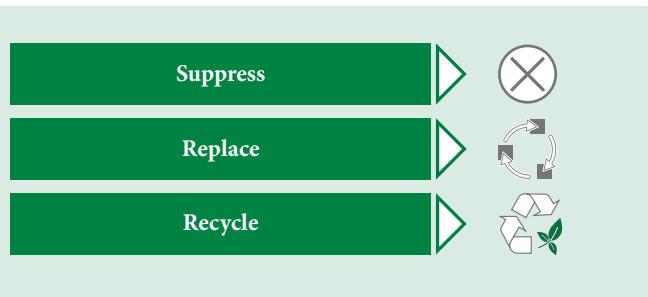
Figure 2. Summary of results of the report on plastic waste by Our World in Data

The main ideas that these charts convey are the following:

- > The production of plastics has been growing steadily since 1950, with no signs of slowing except during deep economic downturns (e.g. 2008-10).
- > The percentage of recycled or incinerated plastic waste has also been increasing steadily.
- > Regionally, the production of plastic waste seems to be loosely correlated with per capita GDP (i.e. richer countries generate more plastic waste per person). Mismanagement of waste, on the other hand, is inversely correlated with per capita GDP (i.e. richer countries manage plastic waste better).
- > Out of the estimated 8.3 billion metric tons of plastics produced globally since 1950:
 - 4.6 billion tons (55 percent) went straight to landfill or were discarded;
 - 2.5 billion tons (30 percent) were still in use in 2015;
 - 0.7 billion tons (8 percent) were incinerated;
 - 0.5 billion tons (6 percent) were recycled (0.1 billion tons of recycled plastic was still in use; 0.1 billion tons was later incinerated; and 0.3 billion tons was later discarded or sent to landfill).
- > Packaging accounts for a whopping 47% of all plastic waste.

How Can We Reduce Plastic Waste and How Will It Impact Process Safety?

Typically, there are three strategies to reduce waste:



By “suppress” we mean generate less plastic waste by using less plastic. Since packaging accounts for 47% of the total plastic waste generated, maybe it’s time to reflect: do we really need biscuits or tomatoes to be individually plastic wrapped? Do we need so many single-use plastic items? Completely suppressing the use of plastics is a complex, far-reaching undertaking, but if and when it is achieved, the production of plastics will consequently decrease and, most likely, grow at a slower rate. From a process safety standpoint, reducing plastic production will mean that some hazards can be avoided. Analyzing the statistics of major accidents and plastic production, and making some reasonable assumptions, we estimate

that every reduction of one thousand tons of plastic production will save 1.2 lives in major accidents alone. This estimation includes the entire production line, as schematized in Figure 1.

In most cases, however, plastic will not be suppressed, but rather replaced with other products, such as cardboard or paper as packaging materials or biodegradable single-use items. Obviously, manufacturing replacement materials entails industrial processes with their own hazards and risks. For example, the paper industry also has a track record of process safety incidents. At this point, we cannot estimate whether the replacement of plastics with new, more environmentally friendly, materials will have a net positive or negative impact on process safety, as there are too many uncertainties:

- > What materials will be used?
- > What raw materials will be needed?
- > What will the production processes look like?

The only thing we can be certain of is that the new materials and production processes will pose new challenges to the process safety community.

Finally, the third strategy to reduce plastic waste is to recycle it. So far, the proportion of plastic that has been recycled successfully (i.e., still in use) is small—only about 1% of all plastic produced. This means that we will need to develop new, more efficient, technologies to recycle plastics. Undoubtedly, these technologies will also generate new process safety challenges. Here again, it is too early to make a call regarding the net effect of recycling on process safety.



Moving Toward Plastic Waste Reduction

To summarize, public opinion is pushing regulators and industry towards plastic waste reduction. To achieve this purpose, the methods available are:



Suppress plastic completely in some applications.



Replace plastic with more environmentally friendly material.



Recycle plastic.

Suppression will have a positive impact on process safety, with an estimated 1.2 lives saved per thousand tons of plastic not produced. On the other hand, as there are many uncertainties about replacement materials and recycling processes, it is too early to figure out whether the impact of these measures will be positive or negative. What we can be sure of is that both new materials and new processes, will generate new challenges for the process safety community. The result of implementing plastic waste reduction strategies in terms of process safety will depend heavily on our ability to respond appropriately to those challenges.

As a presence on the market for many years, gathering and building on experience along the way, DEKRA is in a unique position to support plastic replacement manufacturers and recyclers in the implementation of pragmatic **process safety management** programs that minimize the risk of loss of life, environment or property.

DR. ARTURO TRUJILLO

Dr. Arturo Trujillo is Global Director of Process Safety Consulting. His main areas of expertise are diverse types of process hazard analysis (HAZOP, What-if, HAZID), consequence analysis and quantitative risk analysis. He has facilitated more than 200 HAZOPs over the last 25 years, especially in the oil & gas, energy, chemicals and pharmaceutical industries.



DEKRA Process Safety

The breadth and depth of expertise in process safety makes us globally recognised specialists and trusted advisors. We help our clients to understand and evaluate their risks, and work together to develop pragmatic solutions. Our value-adding and practical approach integrates specialist process safety management, engineering and testing. We seek to educate and grow client competence to provide sustainable performance improvement. Partnering with our clients we combine technical expertise with a passion for life preservation, harm reduction and asset protection. As a part of the world's leading expert organisation DEKRA, we are the global partner for a safe world.

Process Safety Management (PSM) Programmes

- > Design and creation of relevant PSM Programmes
- > Support the implementation, monitoring, and sustainability of PSM Programmes
- > Audit existing PSM Programmes, comparing with best practices around the world
- > Correct and improve deficient Programmes

Process Safety Information/Data (Laboratory Testing)

- > Flammability/combustibility properties of dusts, gases, vapours, mists, and hybrid atmospheres
- > Chemical reaction hazards and chemical process optimisation (reaction and adiabatic calorimetry RC1, ARC, VSP, Dewar)
- > Thermal instability (DSC, DTA, and powder specific tests)
- > Energetic materials, explosives, propellants, pyrotechnics to DOT, UN, etc. protocols
- > Regulatory testing: REACH, UN, CLP, ADR, OSHA, DOT
- > Electrostatic testing for powders, liquids, process equipment, liners, shoes, FIBCs

Specialist Consulting (Technical/Engineering)

- > Dust, gas, and vapour flash fire and explosion hazards
- > Electrostatic hazards, problems, and applications
- > Reactive chemical, self-heating, and thermal instability hazards
- > Hazardous area classification
- > Mechanical equipment ignition risk assessment
- > Transport & classification of dangerous goods

We have offices throughout North America, Europe, and Asia.

For more information, visit www.dekra.com/process-safety

To contact us: process-safety@dekra.com

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